Oceans 11

Guide

NOVA SCOTIA
NOUVELLE-ÉCOSSE

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Oceans 11

Prepared by the Department of Education and Early Childhood Development

This is the most recent version of the current curriculum materials as used by teachers in Nova Scotia.

Oceans 11

Foreword

Oceans 11 curriculum was developed by the Nova Scotia Department of Education as part of a joint project with the federal Department of Fisheries and Oceans. This curriculum reflects the framework described in *Foundation for the Atlantic Canada Science Curriculum* and the pan-Canadian *Common Framework of Science Learning Outcomes K to 12*.

Oceans 11 satisfies the second science credit requirement for high school graduation.

Oceans 11 includes the following modules: Structure and Motion, Marine Biome, Coastal Zones, Aquaculture, and Fisheries.

This guide provides the outcomes framework for the course and includes some suggestions to help teachers design learning experiences and assessment tasks. Additional information regarding resources, the research process, and portfolios is provided in the appendices.

Contents

Appendices

Introduction

Background

The Department of Education has made a commitment to providing a broad-based, quality education for students in the public education system and to expanding the range of programming to better meet the needs of all students. The department is working to develop several new courses in collaboration with school boards and other partners in education, business, the community, and government.

These new courses provide increased opportunities for senior high school students to earn the credits they require to attain high school graduation, to diversify their programs, and to prepare for varied post-secondary destinations. These courses are designed to appeal to a wide variety of high school students; to assist students in making connections among school, the community, and the workplace; and to allow them to explore a range of career options.

These courses are characterized by the following features:

- a strong focus on hands-on, minds-on learning experiences, including experiences with a range of technologies
- a strong applied focus with an emphasis on integrating, applying, and reinforcing the knowledge, skills, and attitudes developed in other courses
- a strong connection to the essential graduation learnings: aesthetic expression, citizenship, communication, personal development, problem solving, and technological competence
- a strong focus on refining career-planning skills with a “futures” orientation that invites students to explore a range of pathways from school
- a strong connection to labour market opportunities with a focus on enhancing students’ employability skills: academic skills, social and teamwork skills, technological skills, and personal management skills such as responsibility, adaptability, and positive attitudes
- a strong connection to the community and workplace with a focus on using real-world community and workplace problems and situations as practical contexts for the application of knowledge and skills and for further learning

Aim

The aim of science education in the Atlantic provinces is to develop scientific literacy.

Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their future.

Rationale

The ocean has a positive impact on every community in Canada. The country's ocean-related activities include fishing and aquaculture, shipping and shipbuilding, recreational boating and water sports, tourism, and offshore oil and gas industries. "Canada's cultural and economic identity are inextricably linked to the oceans. About 23 percent of Canadians live in coastal communities and about $24 billion a year—4 percent of our gross domestic product—is generated by ocean industries. However, these waters are a finite resource and every Canadian has a stake in protecting them." (Honourable David Anderson, Minister of Fisheries and Oceans, January 14, 1998). Nowhere is this statement more applicable than in Nova Scotia, which has a long history of ocean harvesting, exporting, and research.

The oceans are a part of the heritage of Nova Scotians, so in the broadest sense oceans should be of great interest to a wide range of students. As citizens living in a province dominated by coastline, students rely on the ocean and its related industries for the transportation of goods, recreational sailing, climate, weather, ecotourism, whale watching, disposal of our waste products and sewage, beauty, food, livelihoods, and employment. However, most students and other citizens experience the oceans as a peripheral part of their existence rather than central to many of the things they enjoy and need. It is important that students have an opportunity to develop a broad, holistic understanding of the ocean, their personal connection to it, and ultimately their reliance on it.

Oceans 11 is intended to enable students to develop a sound scientific oceans background, an awareness of future opportunities in the oceans field, an understanding of the importance of a healthy oceans environment, and a recognition of the important role of every Canadian in oceans management.

The themes that are interwoven throughout Oceans 11 are relevant to the needs of today's students. They include

- commitment
- science
- innovation/entrepreneurship/industry
- cooperation in problem solving
- sustainability
- connections
- awareness

Considerable resources are available within our province to support the implementation of an oceans-related science course. The ability to provide science curriculum that is current and responsive to the developing needs of students, teachers, and communities is a tremendous asset of the course. As a result, Oceans 11 is a resource-based course, relying on information collected from diverse sources.

Oceans 11 reflects current priorities, issues, and realities in the oceans field while increasing students' knowledge of emerging technologies and career opportunities in areas such as aquaculture and oceans management. It offers opportunities for students to develop an understanding of the complexity of issues surrounding the management of Nova Scotia's coastal zone and an enhanced appreciation of the methods and role of science as one foundation of sound environmental management.

The Nature of Oceans 11

Oceans 11 is designed to allow students to explore aspects of global and local oceanography and current ocean-related issues. Grounded in a strong oceans-science base, the course examines the oceans from a systems perspective focusing on the connections within the ocean and between the ocean and the terrestrial world, with an emphasis on ocean-human interactions. The notion of sustainability and the role of the ocean in the earth's sustainability are central to the course.

Oceans 11 uses local examples as a means of connecting the big picture issues, such as sustainability, to the lives and communities of Atlantic Canadians.

Significant time is spent examining local economic and community interests and investigating emerging new economies and opportunities in areas such as aquaculture, ecotourism, and integrated coastal management.

Course Design

Oceans 11 may be offered as a full credit, requiring a minimum of 110 hours of instructional time. The course is also available as half-credit options: Oceans 11A and Oceans 11B, each comprising two modules.

Oceans 11 is an academic credit. It is important to note that the course has been designed to engage and meet the needs of a wide range of learners.

Oceans 11 has five learning modules:

Module 1: Structure and Motion

Module 2: Marine Biome

Module 3: Coastal Zones

Module 4: Aquaculture

Module 5: Fisheries

Each module takes 25–30 hours of instruction time. Successful completion of four modules is required for one credit. Successful completion of two modules is required for one half-credit. (See page 9 for details.)

Program Design and Components

Learning and Teaching Science

What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include

- creating a classroom environment to support the learning and teaching of science
- designing effective learning experiences that help students achieve designated outcomes
- stimulating and managing classroom discourse in support of student learning
- learning about and then using students' motivations, interests, abilities, and learning styles to improve learning and teaching
- assessing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions
- selecting teaching strategies from a wide repertoire

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment that reflects a constructive, active view of the learning process. Learning occurs through actively constructing one's own meaning and assimilating new information to develop a new understanding.

The development of scientific literacy in students is a function of the kinds of tasks they engage in, the discourse in which they participate, and the settings in which these tasks occur. Students' disposition toward science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to all facets of curriculum.

Learning experiences in science education should vary and should include opportunities for group and individual work, discussion among students as well as between teacher and students, and hands-on/minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations and the evaluation of the accumulated evidence provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

Oceans 11 Course Design

For Oceans 11, three modules are compulsory: Structure and Motion, Marine Biome, and Coastal Zones. When Coastal Zones is done throughout the course, the impact and knowledge that result enhance the learning. The fourth module may be selected, based on student, school, and community interest, from Aquaculture, or Fisheries.

Students will be required to complete the following sequence of modules to receive a full credit for Oceans 11.

[insert graphic: CourseDesign-Part 1.eps)

Teachers may wish to organize the class into two groups, each selecting one of the two remaining modules. Alternatively, the class may be divided into two groups to accommodate selection of one of Modules 4, or 5. A third option is the selection of one of Modules 4 or 5 for whole-class study.

[insert graphic: CourseDesign-Part 2.eps)

Oceans 11A and Oceans 11B

Schools may choose to offer Oceans 11A as a half-credit. For Oceans 11A, Module 1: Structure and Motion and Module 2: Marine Biome are compulsory. The second half-credit may be offered as Oceans 11B. For Oceans 11B, Module 3: Coastal Zones is compulsory; the remaining module may be any of Module 4: Aquaculture, or Module 5: Fisheries.

Course Codes

Oceans 11: 011214

Oceans 11A: 011158 (1/2 credit)

Oceans 11B: 011200 (1/2 credit)

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he or she is familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analyzing data, and interpreting data are fundamental to engaging in science. These activities provide students with opportunities to understand the nature of science and to practise the process of theory development.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important in their own right, and they also provide a relevant context for engaging in scientific inquiry and problem solving.

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equitable opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of, and make adaptations to accommodate, the diverse range of learners in their classes. To adapt instructional strategies, assessment practices, and learning resources to the needs of all learners, teachers must create opportunities that will permit students to address their various learning styles.

As well, teachers must not only remain aware of and avoid gender and cultural biases in their teaching, they must also actively address cultural and gender stereotyping (e.g., about who is interested in and who can succeed in science and mathematics). Research supports the position that when science curriculum is made personally meaningful and socially and culturally relevant, it is more engaging for groups traditionally under-represented in science and indeed, for all students.

While this curriculum guide presents specific outcomes for each module, it must be acknowledged that students will progress at different rates. Teachers should provide materials and strategies that accommodate student diversity, and they should validate students when they achieve the outcomes to the best of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have opportunities to experience success as they work toward achieving designated outcomes. Teachers should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provides access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

The Role of Technology

Vision for the Integration of Information Technology

The Nova Scotia Department of Education has articulated five components of the learning outcomes framework for the integration of information technology (IT) within curriculum programs:

BASIC OPERATIONS AND CONCEPTS

- Concepts and skills associated with the safe, efficient operation of a range of information and communication technology.

SOCIAL, ETHICAL, AND HUMAN ISSUES

- The understanding associated with the use of ICT, which encourages in students a commitment to pursue personal and social good, particularly to build and improve their learning environments and to foster stronger relationships with their peers and others who support their learning.

PRODUCTIVITY

- The efficient selection and use of ICT to perform tasks such as
  - the exploration of ideas
  - data collection
  - data manipulation, including the discovery of patterns and relationships
  - problem solving
  - the representation of learning

COMMUNICATION

- Specific, interactive technology use supports student collaboration and sharing through communication.

Research, Problem Solving, and Decision Making

- Students' organization, reasoning, and evaluation of their learning rationalize their use of information and communication technology.

Integrating Information and Communication Technology within Oceans 11

As information and communication technology shifts the way in which society accesses, communicates, and transfers information and ideas, it inevitably changes the ways in which students learn.

Students must be prepared to deal with an information and communications environment characterized by continuous, rapid change, an exponential growth of information, and expanding opportunities to interact and interconnect with others in a global context.

Because technology is constantly and rapidly evolving, it is important that teachers make careful decisions about applications, always in relation to the extent to which technology applications help students to achieve the curriculum outcomes.

Technology can support learning for the following specific purposes: inquiry, communication, construction, and expression.

Inquiry

Theory Building: Using software and hardware for modelling, simulation, representation, integration, and planning, students can develop ideas, plan projects, and track the results of growth in their understanding; develop dynamic, detailed outlines; and develop models to test their understanding.

Data Access: Students can search for and access documents, multimedia events, simulations, and conversations through hypertext/hypermedia software; digital, CD-ROM, and Internet libraries; and databases.

Data Collection: Students can create, obtain, and organize information in a range of forms, using sensing, scanning, image and sound recording and editing technology, databases, spreadsheets, survey software, and Internet search software.

Data Analysis: Students can organize, transform, analyze, and synthesize information and ideas using spreadsheets, simulation, statistical analysis or graphing software, and image-processing technology.

Communication

Media Communication: Using word processing, publishing, presentation, web page development, and hypertext software, students can create and edit documents, presentations, multimedia events, web pages, simulations, models, and interactive learning programs, which they can then publish, present, or post.

Interaction/collaboration: Students can share information, ideas, interests, concerns, and questions with others through e-mail; Internet audio, video, and print conferences; information servers; Internet news groups and listservs; and student-created hypertext environments.

Teaching and Learning: Students can acquire, refine, and communicate ideas, information, and skills using tutoring systems and software, instructional simulations, drill and practice software, and telementoring systems.

Construction

Students can explore ideas and create simulations, models, and products using sensor and control systems, robotics, computer-aided design, artificial intelligence, mathematical and scientific modelling, and graphing and charting software.

Expression

Students can shape the creative expression of their ideas, feelings, insights, and understandings using graphic software, music making, composing, editing and synthesizing technology; interactive video and hypermedia; animation software; multimedia composing technology; sound and light control systems and software; and video and audio recording and editing technology.

Writing in Science

Learning experiences should provide opportunities for students to use writing and other forms of representation as ways to consolidate and communicate their understanding. Students should be encouraged to use writing to speculate, theorize, summarize, discover connections, describe processes, express understandings, raise questions, and make sense of new information using their own language as a step to the language of science. Science logs are useful for such expressive and reflective writing. Purposeful note making is an intrinsic part of learning in science, helping students better record, organize, and understand information from a variety of sources. The process of creating webs, maps, charts, tables, graphs, drawings, and diagrams to represent results and data helps students learn and provides them with useful study tools.

Learning experiences in science should also provide abundant opportunities for students to communicate their findings and understandings to others, both formally and informally, using a variety of forms for a range of purposes and audiences. Such experiences should encourage students to use effective ways of recording and conveying information and ideas and to use the vocabulary of science in expressing their understandings. It is through opportunities to talk and write about the concepts they need to learn that students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in, and demonstration of, the strategies they will have to develop and apply in reading, viewing, interpreting, and using a range of science texts for various purposes. It will be equally important for students to have demonstrations of the strategies they need to develop and apply in selecting, constructing, and using various forms for communicating in science.

Assessment and Evaluation

The terms **assessment** and **evaluation** are often used interchangeably, but they refer to quite different processes. Science curriculum documents developed in the Atlantic region use these terms as follows.

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analyzing, reflecting upon, and summarizing assessment information, and making judgments or decisions based upon the information gathered.

The assessment process provides the data, and the evaluation process brings meaning to the data. Together, these processes improve teaching and learning. If we are to encourage enjoyment in learning for students now and throughout their lives, we must develop strategies to involve students in assessment and evaluation at all levels. When students are aware of the outcomes for which they are responsible and of the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate their learning.

The Atlantic Canada science curriculum reflects the three major processes of science learning: inquiry, problem solving, and decision making. When a teacher assesses student progress, it is helpful to know some activities, skills, and actions associated with each process of science learning. Student learning may be described in terms of ability to perform the following.

INQUIRY

- define questions related to a topic
- refine descriptors/factors to provide focus for practical and theoretical research
- select an appropriate way to find information
- make direct observations
- perform experiments, record and interpret data, and draw conclusions
- design an experiment that tests relationships and variables
- write lab reports that meet a variety of needs and place emphasis on recorded data
- recognize that quality of both the process and the product is important

PROBLEM SOLVING

- clearly define a problem
- produce a range of potential solutions for the problem
- appreciate that several solutions should be considered
- plan and design a process or product or device intended to solve a problem
- construct a variety of acceptable prototypes; pilot test, evaluate, and refine them to meet a need
- present the refined process/product/device and support why it is the preferred solution

- recognize that quality of the process and the product is important

Decision Making

- gather information from a variety of sources
- evaluate the validity of the information source
- evaluate which information is relevant
- identify the different perspectives that influence a decision
- present information to reflect different perspectives
- use information to support a given perspective
- recommend a decision and provide supporting evidence
- communicate a decision and provide a "best" solution

Effective Assessment and Evaluation Practices

Effective assessment improves the quality of learning and teaching. It can help students become more reflective and have control of their own learning, and it can help teachers monitor and focus their instructional programs.

Assessment and evaluation of student learning should accommodate the complexity of learning and reflect the complexity of the curriculum. Evaluation should be based on the full range of learning outcomes toward which students have been working during the reporting period, be proportionate to the learning experiences related to each outcome, and focus on patterns of achievement as well as specific achievement.

In reflecting on the effectiveness of their assessment program, teachers should consider the extent to which their practices

- are fair in terms of students' backgrounds or circumstances
- are integrated with learning
- provide opportunities for authentic learning
- focus on what students can do rather than on what they cannot do
- provide students with relevant, supportive feedback that helps them shape their learning
- describe students' progress toward learning outcomes
- help them to make decisions about revising, supporting, or extending learning experiences
- support students' learning about risk-taking
- provide specific information about the processes and strategies students are using
- provide students with diverse and multiple opportunities to demonstrate their achievement
- accommodate multiple responses and a range of tasks and resources
- provide evidence of achievement in which students can take pride
- acknowledge attitudes and values as significant learning outcomes
- encourage students to reflect on their learning and to articulate personal learning plans
- help them to make decisions about teaching strategies, learning experiences and environments, student grouping, and resources
- include students in developing, interpreting, and reporting on assessment

Involving Students in the Assessment Process

When students are aware of the outcomes they are responsible for and the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate what they know, are able to do, and value.

It is important that students participate actively in the assessment and evaluation of their learning, developing their own criteria and learning to judge a range of qualities in their work. Students should have access to models in the form of scoring criteria, rubrics, and work samples.

As lifelong learners, students assess their own progress rather than relying on external measures (marks, for example) to tell them how well they are doing. Students who are empowered to assess their own progress are more likely to perceive their learning as its own reward. Rather than asking What does the teacher want? Students need to ask questions such as What have I learned? What can I do now that I couldn’t do before? What do I need to learn next?

Effective assessment practices provide opportunities for students to

- reflect on their progress toward achievement of learning outcomes
- assess and evaluate their learning
- set goals for future learning

Diverse Learning Styles and Needs

Teachers should develop assessment practices that affirm and accommodate students’ cultural and linguistic diversity. Teachers should consider patterns of social interaction, diverse learning styles, and the multiple ways oral, written, and visual language are used in different cultures for a range of purposes. Student performance takes place not only in a learning context, but in social and cultural contexts as well.

Assessment practices must be fair, equitable, and without bias, providing a range of opportunities for students to demonstrate their learning. Teachers should be flexible in evaluating the learning success of students and seek diverse ways for students to demonstrate their personal best. In inclusive classrooms, students with special needs have opportunities to demonstrate their learning in their own ways, using media that accommodate their needs, and at their own pace.

Curriculum Outcomes Framework

Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the essential graduation learnings will prepare students to continue to learn throughout their lives. These learnings describe expectations not in terms of individual school subjects but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries and to be ready to meet the shifting and ongoing opportunities, responsibilities, and demands of life after graduation. The essential graduation learnings are as follows:

Aesthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in local and global contexts.

Communication

Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s) and mathematical and scientific concepts and symbols to think, learn, and communicate effectively.

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving

Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, and mathematical, and scientific concepts.

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

Teachers should consult *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the vision for scientific literacy, the essential graduation learnings, general curriculum outcomes, and key-stage curriculum outcomes.

General Curriculum Outcomes

The general curriculum outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

Science, Technology, Society, and the Environment

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

Attitudes

Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Specific Curriculum Outcomes

Specific curriculum outcomes for Oceans 11 are statements identifying what students are expected to know and be able to do as a result of their learning experiences in this course. They provide the framework for instructional design and assessment of student learning and are intended to help teachers design learning experiences and assessment tasks. Specific curriculum outcomes represent a framework for helping students achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately the essential graduation learnings.

Specific curriculum outcomes are organized in five modules. Each module is organized by topic. Oceans 11 modules and topics follow.

Module 1: Structure and Motion

- Oceans, Seas, Gulfs, and Straits
- The Ocean Bottom: Origins and Bathymetry
- The Properties of Seawater
- Ocean Currents
- Ocean Currents (extension)
- Tides

Module 2: Marine Biome

- Life in the Oceans
- Habitats
- Open Ocean versus Coastal Areas
- The Field Trip
- Organisms and Habitats

Module 3: Coastal Zones

- Identifying Coastal Zones
- Variations in Coastal Zone Structure and Properties
- The Importance of Coastal Zones to Humans
- Keeping Our Coastal Zones

Module 4: Aquaculture

- Farming, Fishing, and Food
- What Species? Where?
- Water Quality
- Site Acceptance by the Community
- Marketing the Product

- Aquaculture-related Issues

Module 5: Fisheries

- Fisheries Are a Unique Resource
- Life Cycle
- Models of Fish Stocks
- Fish Population and Management
- Technology in the Fisheries
- What Does Management Mean?

The following pages outline Oceans 11 specific curriculum outcomes grouped by modules and topics.

MODULE 1: STRUCTURE AND MOTION

Students will be expected to

Oceans, Seas, Gulfs, and Straits

- identify oceans and related water areas in the world and describe related science- and technology-based careers (OSM-1)

The Ocean Bottom: Origins and Bathymetry

- analyze the basic structure of Earth's waters using evidence and information to support your findings (OSM-2)

The Properties of Seawater

- identify, collect data, and describe the unique properties of water (OSM-3)

Ocean Currents

- identify, explain, and show how ocean currents' Coriolis effect, and thermohaline currents are related (OSM-4)

Ocean Currents (extension)

- identify and describe wave motion found in the marine environment and in everyday situations (OSM-5)

Tides

- identify and describe tide theory and types of tides (OSM-6)

Module 2: Marine Biome

Students will be expected to

Life in the Oceans

- explain the marine biome and describe the biodiversity of ocean life and determine interconnections that exist within the marine biome (MBIO-1)

Habitats

- compare representative marine organisms and communities (MBIO-2)

Open Ocean versus Coastal Areas

- compare characteristics of the open ocean and coastal zones referencing terms and impact on local ecosystems (MBIO-3)

The Field Trip

- develop and report appropriate sampling procedures to obtain quantitative data on the abundance of marine organisms at a local coastal area and describe and apply classification systems and nomenclatures to organisms found in the marine biome (MBIO-4)

Organisms and Habitats

- explain how a particular organism functions in its habitat (MBIO-5)

Module 3: Coastal Zones

Students will be expected to

Identifying Coastal Zones

- discuss the concept of coastal zones and how these vary around the world (CZON-1)

Variations in Coastal Zone Structure and Properties

- describe and explain the causes and characteristics of major types of coastal zones (CZON-2)

The Importance of Coastal Zones to Humans

- identify and explain sustainability and human use of an environment, including populations and resources, locally and globally (CZON-3)

Keeping Our Coastal Zones

- list and discuss human interactions with the processes involved in the coastal zone environment, and describe competing views (CZON-4)
- discuss the purpose and process of integrated coastal zone management and analyze a coastal zone management structure and the interrelationships found in a local area (CZON-5)

MODULE 4: AQUACULTURE

Students will be expected to

Farming, Fishing, and Food

- identify, and compare aquaculture—locations and species—grown in Nova Scotia, in the rest of Canada, and globally (AQUA-1)

What Species? Where? Why?

- describe and identify groups of organisms raised through aquaculture and their geographic locations, referring to anatomy and physiology of a major species and ecology of cultured species (AQUA-2)

Water Quality

- describe, measure, and analyze conditions for aquaculture operations (AQUA-3)

Site Acceptance by the Community

- analyze site planning from various perspectives and report on both the risks and benefits to society and the environment (AQUA-4)

Marketing the Product

- identify, analyze, and evaluate various aquaculture business opportunities (AQUA-5)

Aquaculture-Related Issues

- explain aquaculture-related issues (AQUA-6)

MODULE 5: FISHERIES

Students will be expected to

Fisheries Are a Unique Resource

- explain the importance of a sustainable fishery as a resource to global and local food supply and employment with reference to terminology (FISH-1)

Life Cycle

- describe, identify, and analyze the external and internal anatomy of a major finfish or shellfish species that is part of the commercial fishery (FISH-2)

Models of Fish Stocks

- construct, interpret, and evaluate various ecological factors (FISH-3)

Fish Population and Management

- compile and organize fish population data and explain the dynamic interrelationships among the physical environment, the biological environment, and the health and distribution of a fish stock (FISH-4)

Technology in the Fisheries

- compare the risks and benefits to society and the environment of applying scientific knowledge or introducing a technology to the fisheries (FISH-5)

What Does Management Mean?

- identify, describe, and analyze multiple perspectives of the main organizations in research and decision making in fisheries management in Canada (FISH-6)

Attitude Outcomes

It is expected that the Atlantic Canada science program will foster certain attitudes in students throughout their school years. The STSE, skills, and knowledge outcomes contribute to the development of attitudes, and opportunities for fostering these attitudes are highlighted in the Elaborations—Strategies for Learning and Teaching sections of each unit.

Attitudes refer to generalized aspects of behaviour that teachers model for students by example and by selective approval. Attitudes are not acquired in the same way as skills and knowledge. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating a readiness for responsible application of what they learn.

Since attitudes are not acquired in the same way as skills and knowledge, outcome statements for attitudes are written as key-stage curriculum outcomes for the end of grades 3, 6, 9, and 12. These outcome statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the pan-Canadian *Common Framework of Science Learning Outcomes K to 12* for the end of grade 12.

Key-Stage Curriculum Outcomes: Attitudes

By the end of grade 12, students will be expected to

Appreciation of Science	**Interest in Science**	**Scientific Inquiry**
436 value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not **437** appreciate that the applications of science and technology can raise ethical dilemmas **438** value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds *Evident when students, for example,* ▪ consider the social and cultural contexts in which a theory developed ▪ use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on STSE issues ▪ recognize the usefulness of being skilled in mathematics and problem solving ▪ recognize how scientific problem solving and the development of new technologies are related ▪ recognize the contribution of science and technology to the progress of civilizations ▪ carefully research and openly discuss ethical dilemmas associated with the applications of science and technology ▪ show support for the development of information technologies and science as they relate to human needs ▪ recognize that western approaches to science are not the only ways of viewing the universe ▪ consider the research of both men and women	**439** show a continuing and more informed curiosity and interest in science and science-related issues **440** acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research **441** consider further studies and careers in science- and technology-related fields *Evident when students, for example,* ▪ conduct research to answer their own questions ▪ recognize that part-time jobs require science- and technology-related knowledge and skills ▪ maintain interest in or pursue further studies in science ▪ recognize the importance of making connections among various science disciplines ▪ explore and use a variety of methods and resources to increase their own knowledge and skills ▪ are interested in science and technology topics not directly related to their formal studies ▪ explore where further science- and technology-related studies can be pursued ▪ are critical and constructive when considering new theories and techniques ▪ use scientific vocabulary and principles in everyday discussions ▪ readily investigate STSE issues	**442** confidently evaluate evidence and consider alternative perspectives, ideas, and explanations **443** use factual information and rational explanations when analyzing and evaluating **444** value the processes for drawing conclusions *Evident when students, for example,* ▪ insist on evidence before accepting a new idea or explanation ▪ ask questions and conduct research to confirm and extend their understanding ▪ criticize arguments based on the faulty, incomplete, or misleading use of numbers ▪ recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen ▪ expend the effort and time needed to make valid inferences ▪ critically evaluate inferences and conclusions, cognizant of the many variables involved in experimentation ▪ critically assess their opinions of the value of science and its applications ▪ criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist ▪ insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position taken can be judged ▪ seek new models, explanations, and theories when confronted with discrepant events or evidence

Collaboration	Stewardship	Safety in Science
445 work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas *Evident when students, for example,* ▪ willingly work with any classmate or group of individuals regardless of their age, gender, or physical and cultural characteristics ▪ assume a variety of roles within a group, as required ▪ accept responsibility for any task that helps the group complete an activity ▪ give the same attention and energy to the group's product as they would to a personal assignment ▪ are attentive when others speak ▪ are capable of suspending personal views when evaluating suggestions made by a group ▪ seek the points of view of others and consider diverse perspectives ▪ accept constructive criticism when sharing their ideas or points of view ▪ criticize the ideas of their peers without criticizing the persons ▪ evaluate the ideas of others objectively ▪ encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision making ▪ contribute to peaceful conflict resolution ▪ encourage the use of a variety of communication strategies during group work ▪ share the responsibility for errors made or difficulties encountered by the group	**446** have a sense of personal and shared responsibility for maintaining a sustainable environment **447** project the personal, social, and environmental consequences of proposed action **448** want to take action for maintaining a sustainable environment *Evident when students, for example,* ▪ willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation ▪ assume part of the collective responsibility for the impact of humans on the environment ▪ participate in civic activities related to the preservation and judicious use of the environment and its resources ▪ encourage their peers or members of their community to participate in a project related to sustainability ▪ consider all perspectives when addressing issues, weighing scientific, technological, and ecological factors ▪ participate in social and political systems that influence environmental policy in their community ▪ examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans ▪ willingly promote actions that are not injurious to the environment ▪ make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations ▪ are critical-minded regarding the short- and long-term consequences of sustainability	**449** show concern for safety and accept the need for rules and regulations **450** be aware of the direct and indirect consequences of their actions *Evident when students, for example,* ▪ read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood ▪ criticize a procedure, a design, or materials that are not safe or that could have a negative impact on the environment ▪ consider safety a positive limiting factor in scientific and technological endeavours ▪ carefully manipulate materials, cognizant of the risks and potential consequences of their actions ▪ write into a laboratory procedure safety and waste-disposal concerns ▪ evaluate the long-term impact of safety and waste disposal on the environment and the quality of life of living organisms ▪ use safety and waste disposal as criteria for evaluating an experiment ▪ assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place ▪ seek assistance immediately for any first aid concerns such as cuts, burns, or unusual reactions ▪ keep the work station uncluttered, with only appropriate lab materials present

Curriculum Guide Organization

Specific curriculum outcomes are organized by unit and topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement of the outcomes.

The order in which the units appear in the guide reflects the recommended sequence.

Unit Organization

Each unit begins with a two-page synopsis. On the first page, introductory paragraphs provide an overview. The second page lists the specific curriculum outcomes for the unit under the headings STSE, Skills, and Knowledge.

The numbering system used is as follows:

- OSMs—Structure and Motion outcomes
- MBIOs—Marine Biome outcomes
- CZONs—Coastal Zones outcomes
- AQUAs—Aquaculture outcomes
- FISHs—Fisheries outcomes
- 400s—Attitude outcomes (see pages 22–23)

These code numbers appear in parentheses after each specific curriculum outcome (SCO).

The curriculum has been organized into four sections: Outcomes, Tasks for Instruction and/or Assessment, Elaborations—Strategies for Learning and Teaching, and Resources/Notes.

These four sections relate learning experiences to the outcomes by

- providing a detailed explanation of the outcome, an understanding of what students should know at the end of the study, and ideas around inquiry that relate to the outcome
- providing a range of strategies for teaching, learning, and assessment associated with a specific outcome
- providing teachers with suggestions in terms of supplementary resources

OUTCOMES

This section provides specific curriculum outcomes students are expected to know, be able to do, and value by the end of the year. The outcomes combine STSE, Skills, and Knowledge, in a context. The grouping of outcomes provides a suggested teaching sequence. Teachers may prefer to plan their own teaching sequence to meet the learning needs of their students. Attitude outcomes statements are meant to guide teachers in creating a learning environment that teachers model for students by example.

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

This section provides suggestions for ways that students' achievement of the outcomes could be assessed. These suggestions reflect a variety of assessment techniques and materials that include, but are not limited to, informal/formal observation, performance, journal, interview, paper and pencil, presentation, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in parentheses after the item.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

This section provides teachers with a detailed explanation of the outcomes through the elaboration. It identifies what teachers are expected to focus on in this outcome or group of outcomes. It gives direction to that focus. It may include elaborations of the outcomes and describe learning environments and experiences that support students' hands-on, minds-on learning. Critical thinking and science and literacy skills are embedded in the outcomes and learning experiences.

These suggestions offer a range of strategies for learning and assessment. Suggested learning experiences can be used in various combinations to help students achieve an outcome. It is not necessary to use all of these suggestions, nor is it necessary for all students to engage in the same learning or assessment activity.

RESOURCES/NOTES

The Resources/Notes section provides links to other curriculum areas and suggested supplementary resources. It also provides an opportunity for teachers to make their own notes.

Specific Curriculum Outcomes

Module 1: Structure and Motion

Examination of the ocean environment must address the topic of the structure and motion of the oceans from a global perspective. This global view is integrated with frequent, relevant local examples for this unit.

Oceans, Seas, Gulfs, and Straits covers the basic geography of the oceans. The Ocean Bottom: Origins and Bathymetry addresses the structural features of the sea bottom and examines their formation. The Properties of Seawater examines the relevant physical and chemical properties of water and seawater. Ocean Currents looks at the major surface currents of the worlds oceans and examines the driving forces behind them. Ocean Waves examines the causes and properties of waves. This is an extension/enrichment section. Tides looks at the causes and effects of tides.

The activities in this unit provide students with key background information while allowing them to construct explanations or understandings of many of the concepts involved. While the scientific principles may be fairly straightforward, there are frequent opportunities for students to appreciate that the ocean is a complex system and that our understanding of it is still developing. The concept of time and the constancy and change that the ocean displays over time are themes that permeate the unit.

Curriculum Outcomes

Students will be expected to

STSE	Skills	Knowledge
▪ **OSM-3** identify, collect data, and describe the unique properties of water ▪ **OSM-5** identify and describe wave motion found in the marine environment and in everyday situations	▪ **OSM-1** identify oceans and related water areas in the world and describe related science- and technology-based careers ▪ **OSM-2** analyze the basic structure of Earth's waters using evidence and information to support your findings	▪ **OSM-4** identify, explain, and show how ocean currents' Coriolis effect, and thermohaline currents are related ▪ **OSM-6** identify and describe tide theory and types of tides

Oceans, Seas, Gulfs, and Straits

OUTCOME

Students will be expected to

- identify oceans and related water areas in the world and describe related science- and technology-based careers (OSM-1)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance/Presentation

- Describe, using varied formats, the ocean-related career you chose.

Paper and Pencil

- Evaluate a world map or a map of the North Atlantic and a list of bodies of water that students have produced.
- Evaluate students' calculations of proportion of the Earth's surface covered by water.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students can brainstorm to generate questions for discussion such as How many oceans are there on Earth? What are some factors that should be taken into account when defining an ocean? What are the differences between an ocean and a sea?

Using a globe or atlas, students can find the parts of the ocean that make up the whole. A blank world map can be distributed to the students so that they can label the oceans, seas, continents, and major gulfs and straits.

Students can calculate the ratio of land to sea surface area using a world map divided into grids. Student estimates can be compared to published values. Approximations and compromises involved in such a calculation can be discussed.

Teachers can introduce a project in which students, working in groups, research local ocean-related high-tech industries and careers. The project will show other ways in which the ocean influences our economy and to give students a chance to investigate ocean-related employment opportunities. Students may begin their research at the beginning of the module and present orally at the end.

RESOURCES/NOTES

Classroom Materials/Supplies

- Blank maps of the Earth and the North Atlantic

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 1
  - The Ocean Industry in Nova Scotia
  - Bodies of Water

Video

- *A Day in the Life of the People on the Hudson* (Bedford Institute of Oceanography)

The Ocean Bottom: Origins and Bathymetry

OUTCOME

Students will be expected to

- analyze the basic structure of Earth's waters using evidence and information to support your findings (OSM-2)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Construct a two-dimensional representation of the ocean basin surrounding Nova Scotia. Use a computer to graph data.
- Perform a lab activity pertaining to density and the theory of isostasy.

Paper and Pencil

- Using a provided diagram, identify the features of the ocean basin.
- Write a response to the videos *Plate Dynamics* and *Ocean Mapping*.
- Summarize "Very Remote Sensing" reading.

Presentation

- Discuss plate tectonics. Include Wilson's contributions to world views and its impact.
- Discuss and illustrate the theory of plate tectonics using diagrams and three-dimensional models. Include Wilson's contribution and discuss its impact.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

To understand ocean structure, students should identify the features of ocean basins and theories explaining their formation. Students should have a basic knowledge of plate tectonics. The common physical features of the open ocean and coastal zones can include the continental margin (shelf, slope, and rise), mid-ocean ridges, deep-sea trenches, and island chains. Students can construct a two-dimensional representation of the ocean basin surrounding Nova Scotia using profile mapping techniques.

Teachers may discuss the development of plate tectonics theory. J. Tuzo Wilson was an important Canadian scientist, who formulated this theory and helped to change scientific and world views. Representations of the ocean bottom should be varied: bathymetric charts, physiographic drawings, and three-dimensional models.

Students can be introduced to Earth's cross-sectional composition and its various densities. A hard-boiled egg may be used as a model to illustrate the internal layers of the earth such as core, mantle, and crust. Differences between the characteristics of ocean crust, basalt, continental crust, and granite, can be discussed and linked to their formation. Depending on past experiences of students, the theory of plate tectonics may be largely reviewed. Students can address questions such as, What makes ocean basins lower than land? and If you emptied all of the water out of the ocean, what would happen to the sea floor? The concepts of isostatic equilibrium and the notion of post–Ice Age continental rebound can be used to help students understand this topic.

Students can explain echo sounding (SONAR) and its relationship to the ocean floor. Observational data used to establish the plate tectonic theory may be used.

Students may express interest in how such detailed information has been obtained about the nature of the internal structure of Earth. It is useful to examine the use and interpretation of seismic information in the development of models of Earth's interior. Students may identify other modern enhancements to the collection of bathymetric data, such as side-scan sonar and satellite radar imagery.

The video *Plate Dynamics* can be shown to better enable students to visualize the processes involved. The types of plate boundaries, such as divergent, transform, and convergent, can be identified on a world map. As an extension, calculations of plate movements can be made to help students grasp the time scales involved. Students can solve problems such as, If North America and Europe are 5000 km apart now and moving at a constant rate of 5 cm/y, when did they separate? How far apart will they be in 50 million years?

The video *Ocean Mapping* illustrates improvements in echo-sounding technology. Connections should be made between the processes of the past, what is occurring today, and the processes of the future. Students may do a lab relating to density and the theory of isostasy.

Working in pairs, students can draw to scale a profile of the sea floor off the Nova Scotia coast and label prominent features. A bathymetric chart can be used to obtain depth contour information. Students may create a data table of information by using the scale given on the map to determine the distance from a known starting position to a particular depth indicated by the contour line. If time permits, or as an alternative activity, a three-dimensional scale model of the sea floor may be created by shaping cardboard pieces to match the contour areas of equal depth and then layering them. The structure can be covered with papier mâché, painted, and labelled.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 1
  - Bathymetric Profile Sketching

Videos

- Learning Resources and Technology Services: Media Library
  - *Plate Dynamics* (23457)
  - *Ocean Mapping* (V1680)
  - *Ocean Pollution* (V0431)

Software

- *The Sable Gully: A Virtual Tour,* CD-ROM. Department of Fisheries and Oceans

The Properties of Seawater

OUTCOME

Students will be expected to

- identify, collect data, and describe the unique properties of water (OSM-3)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Complete the water facts activity sheet.
- Do a water property lab.

Paper and Pencil

- Interpret data and construct graphs looking for similarity between salinity, density, temperature, and depth.
- Write lab reports or activity summaries for water property labs.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Using a KWL chart, students can write what they know about water. Sample questions include, Under what conditions does it evaporate? Does it evaporate quickly or slowly compared to other liquids? How does it evaporate? What does “evaporate” mean anyway? Students can list the properties of water and make connections between these properties and events in their everyday lives and in the marine environment.

In small groups, students can address questions such as How come water freezes from the top down whereas every other liquid freezes from the bottom up? What would happen to fish survival if water froze at the bottom of a lake rather than at the top? Does seawater contain nearly every element on Earth? Explain. Does the temperature of inland areas fluctuate greatly from day to night while coastal areas experience much smaller fluctuations? Explain. How can the Gulf Stream retain sufficient heat to appreciably warm the climate of Europe after having travelled so long and far? Discussion results can be organized using a concept map.

Once students have explored the properties of water, they will be able to explain the forces that drive currents. Currents influence climate and control nutrient availability in the water column.

Students will explore properties of water such as solvency, heat and light absorbency, vaporization, and density. Water density may be affected by temperature, salinity, and pressure. Students can use hydrometers to measure the densities of water and seawater. The specific gravity and salinity can be calculated from the students' measurements. The relationship between density and salinity can be identified. Students can find the salinity of seawater samples. Students can compare the solubility of certain solutes in a variety of liquids. Students can provide equal amounts of heat to equal volumes of different liquids and note differences in the temperature changes observed. Sea surface temperature data can be found on the Internet.

Note: *Much of this material is necessary for the Water Quality section in Aquaculture and will not need repeating in detail in both sections.*

RESOURCES/NOTES

Curriculum Support Materials

- Garrison, Tom. *Essentials of Oceanography* (Chapter 6)
- *Oceans 11: A Teaching Resource,* Volume 1
  - Water Facts
  - Comparing Densities of Water and Seawater

Ocean Currents

OUTCOME

Students will be expected to

- identify, explain, and show how ocean currents' Coriolis effect, and thermohaline currents are related (OSM-4)

Tasks for Instruction and/or Assessment

Performance

- Do a lab on currents. Report your findings.
- Construct a model of the North Atlantic Ocean basin. Fill it with water and with a straw blow across the model to observe and record the effects of wind on the surface currents.
- Plot coordinates of several drifting buoys and observe the course each buoy takes. Discuss reasons for various courses and submit a final report to the teacher.
- Complete "surface currents" activities.

Paper and Pencil

- Label the surface circulation currents on a map of the world and a map of the North Atlantic.

- Demonstrate and explain the Coriolis effect.
- Draw and explain thermohaline currents.

Elaborations—Strategies for Learning and Teaching

Using a world map or globe, students can identify the major global ocean currents. Students should be aware that patterns may be distorted by the shape and location of the continents. Spiral patterns and currents of the Southern Hemisphere may be compared to those of the Northern Hemisphere.

Students can examine the effects of some of the major ocean surface currents on the climate of nearby landmasses. Groups of students can be assigned specific currents to examine. Presentations may emphasize the three broad categories of currents: western boundary currents, eastern boundary currents, and transverse currents.

Students may answer questions such as What makes all these currents in the ocean? How come ocean water does not stay still? Newton's laws tell us that objects remain still unless one or more forces act on them. What forces are at work? Have students discuss these questions in groups and note their ideas. Follow up with a general class discussion. Usually at least one group will have listed the wind as a driving force for surface currents. Introduce thermal expansion and contraction as the other principal force putting surface currents into motion.

Students can discuss the prevalence of spiral patterns among the world's currents. A connection to atmospheric phenomena may be made. Have you seen the weather reports on TV lately? What makes weather systems have a spiral pattern to them? How does water spiral down the drain?

The Coriolis effect can be demonstrated to students by using a turntable and a piece of chalk. A line may be traced on the turntable while it is stationary and then while it is spinning and the two results compared. Examples from sports may be discussed and demonstrated outside or in the gym.

Discussion of this effect may be extended to the impact that the rotation of Earth has on the movement of seawater in the world's oceans. Global wind patterns and ocean circulation patterns may be made.

Videos may be used to help students understand the patterns.

Drift-buoy data on the Gulf Stream available from the Internet can be used to construct large wall maps depicting the direction and speed of the current. Each student may collect data on the position of a particular drift buoy over time to generate a more complete picture of the pattern of the current. This project may be started early in the module and revisited throughout.

Students should gain some appreciation of thermohaline currents—water movement below the surface. Students can investigate the effect of temperature and salinity on water movement. Small groups of students can fill two large pop bottles with water of very different salinities and/or temperatures. Food colouring can be used to colour the water in one of the bottles to make observations easier. The bottles are connected at their mouths, but an index card is used to keep the different waters separated. Students can predict and observe the relative movement of the different waters once the index card is removed.

The relationships between salinity, temperature, and density explored using this activity can be related to ocean current movements. Students may predict the movement of water based on knowledge of its temperature and salinity. Thermohaline circulation can be demonstrated by introducing very salty, cold, coloured water gently into one end of an aquarium and observing how it sinks to the bottom and spreads throughout the aquarium.

RESOURCES/NOTES

Classroom Materials/Supplies

- Blank maps of the world and the North Atlantic

Curriculum Support Materials

- Garrison, Tom, *Essentials of Oceanography*.
- *Oceans 11: A Teaching Resource,* Volume 1
  - Identification and Location of Major Global Surface Currents
  - Surface Currents of the North Atlantic
  - The Effects of Depth on Temperature, Salinity, and Density

Ocean Currents (extension)

OUTCOME

Students will be expected to

- identify and describe wave motion found in the marine environment and in everyday situations (OSM-5)

Tasks for Instruction and/or Assessment

Informal Observation

- Observe students modelling wave types by having them in a long line joined together by their arms. Discuss the difference and similarities for these waves and processes that can affect wave size.
- Observe student work during ripple tank labs.

Performance

- In groups, set up situations where waves encounters barriers, deepwater, or other waves and sketch the resulting waves. Record your observations.
- Perform a lab on waves, using a ripple tank.

Paper and Pencil

- In small groups, look at different properties of a wave and how the wave size and length can be affected by changing the intensities of the properties. Submit a report.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students, in groups, may use a ripple tank or Slinky to explore wave characteristics. These characteristics should include crest, trough, wave length, and height. Wave behaviour may also be observed using a ripple tank (wave tank) such as wave generation, reflection, refraction, diffraction, and wave interference.

Students can use a fan, hair dryer, or straw directed toward the surface of water to demonstrate the effect of wind on wave size. Strength, duration, and fetch of the wind are all factors of wave size. A discussion of what makes waves break as they move on shore should be done with emphasis on bottom features as they affect wave breaking properties.

Students should connect their observations with real-life situations of coastal erosion and deposition of sediments, both natural and as the result of human interventions. This may be accompanied with a stream table and sound to simulate a coastline.

Students may be taken on a field trip to a sandy beach where they can observe and make measurements of wave height, wave length, and breaking properties.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource*, Volume 1
  - When Humans and the Oceans Meet
  - Adrift on the Gulf Stream
  - Wave Properties
  - Waves, Beaches, and Coasts

Videos

- Learning Resources and Technology Services: Media Library
  - *Adrift on the Gulf Stream* (22801)
  - *Waves, Beaches, and Coasts* (23449)

Tides

OUTCOME

Students will be expected to

- identify and describe tide theory and types of tides (OSM-6)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Informal Observation

- Given a month in the current year, plot the tide heights and times for the primary port closest to you.

Journal

- Reflect on the tides and write a poem, song, or journal entry about them.

Pencil and Paper

- Construct, using Internet puzzle-makers, crosswords, word searches, or cryptograms pertaining to tidal terminology. Complete another student's puzzle.
- Plot tidal information for a month. Identify spring and neap tides and correlate tides to lunar phases.
- Write a response to the video *Touched by the Tide*.

Portfolio

- Review the work you have done for this module and choose two or three pieces to include in your portfolio.

Elaborations—Strategies for Learning and Teaching

Tide data are available from many sources. Each student can be assigned a local port (hopefully near the school) for which one month of data are compiled, displayed, and graphed in a tidal curve for that month. The months can be connected for an annual tidal curve for that port. The teacher can discuss tidal terminology with reference to this graph. Terminology such as spring and neap tides, perihelion and aphelion tides, and full or new moon can be introduced. Students can explain the causes and effects of tides. Students can identify and describe the tides in the Northwest Atlantic area; for example, the tides of the Bay of Fundy.

Students can use interpretation and prediction techniques to determine tide heights. Use of a tide table book can be part of this activity. Students can also view the video *Touched by the Tide* paying particular attention to the tidal information included rather than the salt-marsh life shown.

Resources/Notes

Curriculum Support Materials

- Garrison, Tom. *Essentials of Oceanography*.
- *Oceans 11: A Teaching Resource,* Volume 1
  - All about Tides
  - Touched by the Tide
  - Reading Tide Tables

Video

- Learning Resources and Technology Services: Media Library
  - *Touched by the Tide* (V1048/23161)

Module 2: Marine Biome

This topic is an exploration of the marine biome from a broad, holistic ecosystem perspective. Connections between and within the natural environment, including human interactions, are emphasized through various activities.

Initially, ocean life is approached from a global perspective emphasizing the vastness and dynamic nature of the marine biome and its connection to freshwater systems. The focus is then narrowed to a local perspective, emphasizing that interactions occurring at the global scale also occur at the local level. Students will analyze how a coastal area functions in time (daily, seasonal) and space, considering biotic factors (trophic levels, etc.) and abiotic factors (temperature, salinity, currents, etc.). The majority of time in this topic is spent on close examination of a local ecosystem. A field trip to a local coastal area (rocky beach, sandy beach, mudflat, or salt marsh) provides students with the opportunity for primary data collection and analysis as well as for reflection of their own connections to the ocean. The life history and structural and behavioural adaptations of a few representative organisms from different trophic levels are studied.

Marine Biome concludes with further reflection on the role we all have to play in the long-term health and sustainability of the oceans.

Curriculum Outcomes

Students will be expected to

STSE	Skills	Knowledge
▪ **MBIO-3** compare characteristics of the open ocean and coastal zones referencing terms and impact on local ecosystems	▪ **MBIO-2** compare representative marine organisms and communities ▪ **MBIO-4** develop and report appropriate sampling procedures to obtain quantitative data on the abundance of marine organisms at a local coastal area and describe and apply classification systems and nomenclatures to organisms found in the marine biome	▪ **MBIO-1** explain the marine biome and describe the biodiversity of ocean life and determine interconnections that exist within the marine biome ▪ **MBIO-5** explain how a particular organism functions in its habitat

Life in the Oceans

OUTCOME

Students will be expected to

- explain the marine biome and describe the biodiversity of ocean life and determine interconnections that exist within the marine biome (MBIO-1)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Journal

- Comment on what is needed to support life in the ocean.
- What is your definition of a marine biome?
- Make journal entries developing a definition of the term biome and thoughts on questions posed in class discussion.

Paper and Pencil

- Using a chart, write down what you know about the diversity of life in the oceans. After you watch the video, *Shores of Life*, add and modify the information in your chart.

Presentation

- Post- and present future-wheel results on various questions about life in the oceans.
- Design a questionnaire that asks what someone might want to learn or what interests them about the ocean. Have students complete the questionnaire and report on the results.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

The marine biome can be introduced by showing students a video illustrating the tremendous diversity of life in the oceans. While viewing the video, students can record the different types of life that they see. The interactions of humans with the ocean should be a part of this visual introduction.

Students should have an opportunity to express their thoughts on the ocean. Students can be asked to write down and illustrate what they know about the oceans on a large piece of mural paper. All student work can be taped to one wall to create a brainstorming wall where students can easily begin to assess similarities and differences in ideas held by different members of the class. Students can briefly discuss their contributions in front of the class. The focus should be on human involvement, connections, and linkages. Students should discuss positive and negative aspects of these human connections.

To encourage students to think holistically, a model of the ocean can be used to explore the question What is needed to support life? An aquarium or fish bowl can be used to model the factors needed for survival. Students can predict the consequences of removal of one or more of the identified factors. The model aquatic ecosystem can be compared to another model ecosystem, such as the Apollo 13 space craft, the space shuttle, or Biosphere 1.

Students can discuss their dependence on the oceans through a future-wheel activity that poses the questions, What if the oceans dried up and disappeared? and What if a meteor crashed into Earth and killed everything in the oceans? Pairs of students can brainstorm the primary, secondary, and tertiary consequences (both positive and negative) of the scenario. Using a presentation tool to prepare their answers, students can present them to the class. It may be beneficial to revisit this activity at the end of the module to see if there has been any change in the outlook of students toward the oceans.

A project to allow students to further explore their personal or human connection to the ocean may be done. Students can communicate their most favourite ocean place—what it means to them and why—in writing or some other form. For example, the issue of whale watching as a tourist attraction can be researched and the positive and negative aspects of the issue addressed.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 1
  - Marine Communities Project
  - Relationships in the Ocean
  - Marine Biome Size and Productivity

Video

- Learning Resources and Technology Services: Media Library
  - *Shores of Life* (V1047/23160)

Software

- *The Sable Gully: A Virtual Tour,* CD-ROM. Department of Fisheries and Oceans

Habitats

OUTCOME

Students will be expected to

- compare representative marine organisms and communities (MBIO-2)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Use string to construct a food web to represent a local ecosystem, with students in the class representing specific organisms. Identify the biotic and abiotic factors as well as the organisms.

Journal

- Is everything connected? What factors are involved? Are both biotic and abiotic factors useful? What ensures survival?
- What is your definition of a marine biome?

Paper and Pencil

- Choose a marine organism and explain its habitat.
- Identify connections between humans and the marine biome.
- How are humans, marine communities, and technology related?

Presentation

- Design a food web of a local ecosystem. Remove one organism and explain what happens to the system.
- Research typical food webs from different areas of the ocean: polar, temperate, and tropical. Post the webs. Compare the biodiversity in the webs. Discuss.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students can define the term **marine biome** through brainstorming the question, How do we recognize a biome? Students can list characteristics that differentiate one biome from another. They may explore the question, Explain why particular organisms live where they live. They can research, identify, and explain the abiotic and biotic factors that influence where a particular organism lives in the ocean. Students can match a list of marine organisms with their respective areas in the ocean and suggest reasons that they live there. Students should explain how a marine biome works. Students can identify the rich biodiversity of the ocean. Marine biomes are predominantly influenced by temperature, salinity, oxygen, and pollutants. A further extension of the discussion can be developed by exploring the question, Is it possible for organisms to be successfully transplanted from one habitat to another? Give reasons to support your answer.

Pairs of students can construct a food web of their local ocean ecosystem. They can present their work using a variety of formats, emphasizing the number of connections, the meaning behind the connections, and the significance of being in a certain position in the web. Students may investigate and construct a diagram of a known marine food web, such as the Bay of Fundy, polar marine, coral reef, or deep sea.

Discussion of the food webs should involve the possible consequences associated with the removal of an organism from the web. Students should suggest reasons for differences and comment on the fragility of the systems. Is one more susceptible to fluctuations or changes than another? What evidence is available to support your answer? Questions that probe the reasons or mechanisms for removal include, What can account for the removal? Are human beings part of the picture?

Students can explain a biomass pyramid and discuss why it is a pyramid rather than a square. Students' prior knowledge from Science 8 and Science 10 will be helpful in their understandings of life in the oceans.

Students should compare representative marine organisms in temperate, polar, and tropical communities. Students can identify the terminology associated with trophic levels by identifying the level of the organisms within the food web they have constructed. Students should know the terms **phytoplankton** and **zooplankton** and use them when describing the marine biome.

RESOURCES/NOTES

Software

- *The Sable Gully: A Virtual Tour,* CD-ROM. Department of Fisheries and Oceans

Open Ocean versus Coastal Areas

OUTCOME

Students will be expected to

- compare characteristics of the open ocean and coastal zones referencing terms and impact on local ecosystems (MBIO-3)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance/Presentation

- Construct a three-dimensional mural of a local coastal ecosystem as a class project. With a partner, construct a scale model of a chosen local organism along with a fact sheet that includes information such as life cycle, habitat preferences, food preferences, and role in the ecosystem. Display the results in the classroom.
- Plot and interpret information about the movement of right whales.
- Construct a diagram to represent the cycling of water movement and the restoration of nutrients to the photic zone of the ocean.
- Conduct a lab activity sampling various species found in local coastal water samples.

Journal

- What characteristics of the Bay of Fundy are useful to the right whales?
- Describe how you see the ocean. How are habitats interconnected?
- Select an organism. Describe its life cycle, including movement between life zones. How are the benthic and pelagic zones interconnected?

Paper and Pencil

- Design and complete an activity based on a particular species that follows migration patterns.
- Answer question sheets about plankton.
- What connections can be made among species in coastal water for temperate regions? polar? tropical?

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Teachers can pose a question that links the open ocean with coastal areas. For example, students can be asked, What are some reasons that right whales come to the Bay of Fundy? Students can be asked to respond to this question in their journals prior to discussion with the whole group. Students might have prior knowledge of the Bay of Fundy food web from previous discussions in class. A comprehensive answer to this question may not be achievable at this point. The question can be revisited at the end of the unit to see if students have gained an understanding of the relationships and dynamics between coastal zones and the oceans.

The migration of marine organisms can be used to link open ocean areas to coastal waters. The migration routes of northern right whales can be plotted and then interpreted. For example, small groups of students can plot the location latitude and longitude of whale sightings over a period of time on a map. Interpretation of the data can include the time of year of movement, the advantages and disadvantages that the migration might have provided for the whale, the average distance travelled between sightings, and the average speed of travel. Students should link differences in productivity between the open ocean and coastal waters to marine organism migration.

Links should be made between coastal circulation patterns from the Structure and Motion unit to the productivity associated with coastal areas. A diagram can be introduced which illustrates the cyclic relationship between water movement and the restoration of nutrients to the photic zone of the ocean. Students should be introduced to the terms **photic zone**, **aphotic zone**, and **upwelling**. Examination of this cycling of nutrients may provide students an opportunity to make the connection between runoff from terrestrial areas and productivity. This reinforces the idea that the interface between watershed and coastal waters is dynamic.

This constancy and change can be examined by addressing some questions related to the cycling and productivity, such as What are some of the effects/consequences of their increased productivity? What do you see in coastal areas? How does this relate to human activities?

Analysis of a graph that includes the variations in annual abundance of nutrients, biomass, plankton blooms, and sunlight in temperate areas will allow students to address the following questions:

- What patterns do you see?
- How are the patterns linked together?
- What accounts for these patterns?

Students can be asked to predict seasonal changes in nutrients, temperature, and availability of aquatic species in coastal waters. Consideration should be given as to whether their prediction holds true for temperate, polar, and tropical biomes. Students may predict the pattern of phytoplankton and zooplankton abundance in temperate areas.

Using a microscope, students can examine, draw, and identify various phytoplankton and zooplankton species found in samples taken from local coastal waters. Taxonomy directly related to the organisms being studied can be introduced at this point.

By continually making connections between the various biotic aspects of the ocean, students should construct a more complete image of the ocean and its area and depth. This three-dimensional aspect can be linked to biodiversity and the variety of niches and habitats. Students can construct a diagram that illustrates the various layers and regions of the ocean or life zones. These include neritic, pelagic, and benthic zones. Links can be made between the layers to demonstrate the continuum that exists in a discussion of the larval stages of marine organisms such as lobster. Students may be introduced to the distinction between holoplankton and meroplankton using local examples of each.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 1
  - Marine Regions of Canada
- Resources available from Department of Fisheries and Oceans, Bedford Institute of Oceanography
- Oceanography Equipment Kit (plankton net) available from Nova Scotia Museum of Natural History
- slides, cover slips, light
- microscopes

Teacher Information

- *Oceans 11: A Teaching Resource,* Volume 1
  - Freshwater or Marine—What's the Difference?

The Field Trip

OUTCOMES

Students will be expected to

- develop and report appropriate sampling procedures to obtain quantitative data on the abundance of marine organisms at a local coastal area and describe and apply classification systems and nomenclatures to organisms found in the marine biome (MBIO-4)
- explain how a particular organism functions in its habitat (MBIO-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Collect and organize various water samples. Determine plankton abundance. Record the place and date. Write a report.
- Conduct a field trip to a local coastal area. Organize your information.

Journal

- Submit a summary report of the field trip using guidelines provided by your teacher.

Paper and Pencil

- On a map of Nova Scotia, identify the different types of coastal zones.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should identify different types of coastal environments that exist in the province and locate them on a map of Nova Scotia. Completed maps can be examined for patterns. Students can identify and explain relationships between the locations of different types of coastal environments and other factors, such as geology, prevailing wind, and circulation patterns. Students can estimate the diversity and abundance of life in the coastal area.

Topics from the Structure and Motion unit can be revisited and connections made and strengthened. The characteristics of the different types of coastal environments should be compared by generating habitat cards. The habitat cards can be used to introduce students to the concept of a dichotomous key and its usefulness in identification. One particular coastal environment should be selected for detailed exploration and activities.

Data collection and interpretation is the focus of the field trip. A field trip is vital to this course and should be done.

Students should have adequate pre-trip preparation and planning to ensure a well-organized and worthwhile learning experience and a successful field trip. Teachers should visit the selected site prior to the trip to check conditions for suitability and safety. Pre-trip preparations should include a clear statement of purpose, activities to practise sampling and measuring procedures, familiarization with data collection sheets that have to be completed, identification of the common species representative of the local coastal environment students will encounter on their field trip, organization of groups and roles, and safety considerations, including proper clothing.

Discussion of the removal of materials and specimens from the field trip site can be linked to the concept of sustainability. Students can estimate the loss of materials from a site that is frequented by beachcombers and student visits. A field trip can be used as an opportunity to discuss and examine pollution issues first hand.

To meet the needs of learners, a beach sweep could be included in the field trip.

Students can identify and become acquainted with the taxonomy of the organisms under study using preserved specimens. At this time, they can also become familiar with the trophic level, habitat, and adaptations of the organisms. Students can make identification flash cards with a picture of the organism on one side and pertinent information on the other to take with them on the field trip for quick identification on site. Quantitative sampling techniques can be practised in the classroom. A model of a section of the rocky shore made from sheets of cardboard and types of pasta representing different types of organisms may be used. Students may watch a video illustrating how to lay transects and sample from a quadrant.

On the trip, each group should be responsible for recording data from one or two quadrants along a continuous transect line. Quadrants may be 1 m × 20 cm. Two teams can be assigned to collect abiotic data such as surface water temperature, air temperature, slope of shore, salinity, and length of zone for later use by the entire class. If a rocky shore field trip is planned, two different tidepools can be compared for air temperature, water temperature (including surface and bottom), volume, salinity, and types of flora and fauna. The field trip can be recorded using video or a digital camera.

Students should compile and analyze collected data. Students should tabulate and graph the data. Total abundance, average abundance, density, and species diversity can be determined. Students can reconstruct the food web and zonation with their data and compare. The opportunity should be taken to discuss data that were inconsistently collected.

Students can address the following in their analysis:

- abiotic factors related to biotic zonation
- a scale model of the coastal area (colour code organisms) to develop an appreciation for complexity and connections
- regions where organisms are successful
- the structures of organisms and their adaptations
- the consequences of moving an organism form one region to another (for example, an organism dislodged during a storm)
- some factors that would make an organism disappear
- the impact that humans have on the shore area

Students can identify and describe the components of a local coastal ecosystem. They may discuss and examine its function. Students can explain how a particular association of organisms function in a particular habitat.

A summary report including the students' notes and observations can be expected as a final product.

RESOURCES/NOTES

Curriculum Support Materials

- Resources available from Department of Fisheries and Oceans, Bedford Institute of Oceanography
- *Oceans 11: A Teaching Resource,* Volume 1
  - What's in a Name?
  - Cleaning up a Harbour
- Nova Scotia Museum of Natural History
- Environmental Studies Series
  - *Plants of the Rocky Shore*
  - *Barnacle Information*
  - *Plants and Animals of the Rocky Shore*
  - *Animals of the Rocky Shore*

Video

- Learning Resources and Technology Services: Media Library
  - *Rocky Shore Field Techniques* (V1997)

Organisms and Habitats

OUTCOME

Students will be expected to

- explain how a particular organism functions in its habitat (MBIO-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Conduct a dissection of a blue mussel and write a report.

Paper and Pencil

- Make a future wheel for life in the oceans. Compare it to the one you made at the beginning of this unit.

Presentation

- Using a poem, story, or other presentation technique, present your organism to the class. Include information on the organism's habitat and how it functions.

Portfolio

- Review the work you have done for this module and choose two or three pieces to include in your portfolio.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students can dissect a particular organism, such as the blue mussel. They should become familiar with parts of the external and internal anatomy. The context for the dissection should be, How does this animal fit into the habitat? What is the role of the organism in the habitat? What adaptations does the organism make that allow it to live in its habitat? What is the geographic distribution of the species? A written report should be submitted. To emphasize the connection these organisms have with humans, a particular species can be prepared for consumption—a mussel boil, for example, using blue mussels.

[insert caution graphic]

> **Caution: Mussels that don't open after steaming should not be eaten. Allergies to shellfish, such as progressive supranuclear palsy (PSP) should be discussed.**

Students can examine in detail an organism from each trophic level of the local coastal habitat they have previously investigated. Students can explain how the organism functions in its habitat. Small groups of students can be responsible for researching a particular organism and sharing their information with the class through a jigsaw activity.

The unit may be concluded by revisiting the question posed about understanding our dependence on the health of the oceans. This was the future-wheel activity done in Life in the Oceans. The question was, What if the ocean dried up and disappeared?

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 1
  - The Anatomy of a Crayfish

Module 3: Coastal Zones

The purpose of this module is to enable students to understand and appreciate the complex nature and diversity of coastal zones, issues facing coastal zones, and the mechanisms of integrated coastal zone management. Students have the opportunity to analyze a series of coastal resource scenarios that pose problems of increasing complexity. Each scenario examines the situation from individual, local, and global perspectives. The intent of the module is for students to propose a course of action on a social issue related to science and technology, taking into account an array of perspectives, including that of sustainability. Case studies, role-playing, debates, and problem-solving activities provide students with opportunities for primary data collection and analysis, exploration of values, consensus building, and co-operation.

Curriculum Outcomes

Students will be expected to

STSE	Skills	Knowledge
▪ **CZON-3** identify and explain sustainability and human use of an environment, including populations and resources, locally and globally ▪ **CZON-4** list and discuss human interactions with the processes involved in the coastal zone environment, and describe competing views	▪ **CZON-2** describe and explain the causes and characteristics of major types of coastal zones ▪ **CZON-5** discuss the purpose and process of integrated coastal zone management and analyze a coastal zone management structure and the interrelationships found in a local area	▪ **CZON-1** discuss the concept of coastal zones and how these vary around the world

Identifying Coastal Zones

OUTCOME

Students will be expected to

- discuss the concept of coastal zones and how these vary around the world (CZON-1)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Using a map of Nova Scotia and materials supplied by your teacher, determine the length of Nova Scotia's coastline.

Journal

- Write what you think coastal zone means. Who are the participants involved in coastal zone areas? What activities are involved?
- What country has the longest coastline in the world?

Paper and Pencil

- Report your group's findings on your coastal zone area.

Presentation

- Present your group results about "What is my coastal zone and how do I control it? Orally, in a chart, with multimedia, or in any other form you choose. The following may help with your presentation:
  - *functional*—What are the uses and marine interactions that take place in coastal zones?
  - *political*—Who controls and regulates the coastal zone?
  - *environmental*—What is the state of the marine biosphere for coastal zones?
  - *geographically*—What are the geographical characteristics of the coastal zones and what processes have formed them?

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students can use a KWL chart to discuss the concept of coastal zone. Students should be able to distinguish between coastline and coastal zone. They should be able to divide the coastal zone geographically, functionally, politically, and environmentally.

Students can compile a list of participants and activities involved in coastal zone areas such as Nova Scotia, the Maritimes, Canada, and the world as a whole. Students can describe coastal zones and how they vary greatly around the world—politically, functionally, geographically, and environmentally.

Student groups can report on each of the above areas. Students may do an activity based on Nova Scotia's coastline, such as answering the question, How long is our coastline? through a map/lab exercise.

Questions such as the following can be used to gauge the knowledge of students in relation to the coastal zone:

- What does the coastal zone mean to you?
- What does the coastal zone mean to your parents?
- What does the coastal zone mean to your community?
- What components make up the coastal zone?

To show the interconnections within the coastal zone, a mind map can be created by the whole class in a brainstorming session. The mind map can be revisited at the end of the module as one way to determine whether students' ideas have changed. An exchange of mind maps between students from different areas of the province may make for some interesting discussion. Questions that can be posed to students include What is meant by the coastal zone? What are the boundaries of the coastal zone? Is the coastal zone important? Explain.

Newspaper and magazine headlines that relate to the coastal zones can be collected and posted throughout the duration of the module for ongoing and final reflection.

RESOURCES/NOTES

Classroom Materials/Supplies

- regional, Canadian, and world maps on display
- regional, Canadian, and world atlases for student use
- Internet access
- map/lab exercise

Classroom Support Materials

- Oceans 11: A Teaching Resource, Volume 1
  - Defining the Coastal Zone
  - Nova Scotia's Coastline—Just How Long Is It?
  - Mapping the Coastal Zone

Variations in Coastal Zone Structure and Properties

OUTCOME

Students will be expected to

- describe and explain the causes and characteristics of major types of coastal zones (CZON-2)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Journal

- How typical is Nova Scotia's coastal zone when compared to those of other parts of the world?

Paper and Pencil

- Write a summary of the video *Plate Dynamics*.
- Design a puzzle or game using coastal zone terminology.
- From a series of photographs or images of various coastal features, identify which coastal zone type is present.

Presentation

- Summarize your findings about your coastal zone subsystem, using written text and illustrative material. Present and display your results to the class.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

From the coastline of Nova Scotia, students may try to classify the coastal zone into major types. Teachers may group students and assign a portion of the coastline for students to find information on the physical structure of their section. Classifications such as rocky shore, sandy beach, estuary, and salt marsh may be explored. Subsystems such as terrestrial, coast, and marine can also be explored. Students will have studied this in the Marine Biome module.

In-class research and discussion may help students identify coastal zone types found in other parts of the world. An assignment could involve the production of a collage of coastal zone types from around the world. A research project could have students study the coastal zones of an exotic location.

The video *Plate Dynamics* can be shown to demonstrate how differences in continental shelf size and coastal topography arise. The video *Waves, Beaches, and Coasts* demonstrates the factors affecting coastal zone structure.

Students should explain the roles of plate tectonic effects, terrestrial topography, rock composition, soil characteristics, currents, tide, and climatic influences such as precipitation, wind patterns, and temperature on a coastal zone.

RESOURCES/NOTES

Curriculum Support Materials

- Garrison, Tom. *Essentials of Oceanography*.
- *Oceans 11: A Teaching Resource,* Volume 1
  - Coastal Zone Properties and Structure
  - Coastal Zone Variations in Nova Scotia
  - Global Coastal Zone Variations

Videos

- Learning Resources and Technology Services: Media Library
  - *Plate Dynamics* (23457)
  - *Waves, Beaches, and Coasts* (23449)

The Importance of Coastal Zones to Humans

OUTCOME

Students will be expected to

- identify and explain sustainability and human use of an environment, including populations and resources, locally and globally (CZON-3)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Journal

- Consider our inland provinces. What is the importance of coastal zones to humidity?

Paper and Pencil

- Using population distributions, discuss why people are clustered near the coast in Nova Scotia, New Brunswick, Prince Edward Island, Newfoundland, and British Columbia.
- What makes seacoasts popular vacation destinations?
- Collect advertisements/photos intended to attract tourists to a region. With recent information on the monetary contribution of tourism to the Nova Scotia economy, communicate, in the form of a poster-sized table or bar graph, how money and tourism are related to coastal zones.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Teachers can introduce the importance of coastal zones to humans with a general discussion provoked by statistics such as that 60 percent of the world's population lives within 60 km of a coast and that two-thirds of the world's largest cities are located on a coast. Students may be asked to name some of these cities, starting with Canada, then North America, and finally the world. This can be expanded into an activity. Students can be placed in teams and given atlases to search for major coastal cities. Groups can be assigned continents or parts of continents. The general discussion can establish ahead of time what population a city must have to be considered as a "major" city. Students should appreciate the disproportionately large proportion of the world's population that lives near coasts.

Students can look at population distributions in Canadian provinces that have coastlines. A portion of this activity can also be used to produce information on the worldwide distribution of fishery and fossil fuel resources.

Students can examine the fishing resources with reference to industrial, commercial, artisanal, and subsistence. Other ocean-related resources may be examined, such as aquaculture, hydrocarbons, human populations, and tourism.

Students may start by answering the questions, What kind of fish do you eat? and How did it get to your plate?

Students can do an activity to examine tourism and recreation in coastal zones and the economic value that they provide to our region relative to other coastal economic sectors such as the fishery, oil and gas exploitation, and aquaculture.

Students can discuss sustainability as a theme for managing the resources in our environment.

RESOURCES/NOTES

Classroom Materials/Supplies

- regional, Canadian, and world atlases
- access to encyclopedias (text or online)
- use of GIS data sets for the ArcView K–12, or Nova Scotia data sets should be encouraged in schools having ArcView.

Teacher Information

- Use of E-STAT to examine and read about population statistics as well as other statistics is encouraged, using online access provided to all schools. Teachers and students can access this website's valuable information.

Curriculum Support Materials

- Garrison, Tom. *Essentials of Oceanography*. (pp. 487–89)
- *Estimating the Economic Value of Coastal and Ocean Resources: The Case of Nova Scotia*, Oceans Institute of Canada, 1998
- *Oceans 11: A Teaching Resource,* Volume 1
  - The Importance of Coastal Zones to Humans
  - Human Influences on Coastal Zones
  - Coastal Zones and Society

Keeping Our Coastal Zones

OUTCOME

Students will be expected to

- list and discuss human interactions with the processes involved in the coastal zone environment, and describe competing views (CZON-4)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Do a beach sweep or shoreline cleanup. Consider all safety precautions. Categorize the litter found. Analyze and graph the data. Dispose of trash in an appropriate manner.
- Role-play a news broadcast of a simulated major contaminant event on a stretch of Nova Scotia coastline and the response that could be brought to bear.

Paper and Pencil

- Write a brief research paper detailing the problems posed by a contaminant.
- Explain the potential causes and impacts of global climate on coastal zones.
- Discuss and evaluate a coastal zone plan based on management of the whole coastal zone and accomplishment of the objective(s). Sample issues could be
  - saving the right whale
  - integration of First Nations fishers into the commercial fishery
  - preparation for the projected impact of global climate change
  - your choice, with teacher approval

Presentation

- Compare similarities and differences among groups (players) concerning the coastal zone issues. Use a variety of presentation formats.
- Prepare a short oral presentation from the list of topics generated in class. This is an exploratory exercise. Expectations are that you are questioning, analyzing, describing, and evaluating the structure using the scientific principles with which you are familiar. Use a KWL chart.

KWL Chart
What I know: [add lines]
What I want to know: {add lines]
What I learned: [add lines]

Portfolio

- Review the work you have done for this module and choose two or three pieces to include in your portfolio.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students can look at the degree of environmental degradation resulting from littering along our shores. They can view videos on ocean contaminants and discuss oil spills. Lab activities that show the greenhouse effect can be carried out. The impact of a rise in sea level of one or two metres on one or more coastlines can be examined. The effects are particularly dramatic if a low-lying section of coast such as a salt marsh is considered.

The class can hold a discussion on the issue of population growth. The disproportionately rapid rate of increase in coastal areas should be emphasized. Consider how all forms of coastal zone degradation considered to this point can be made worse by population growth. Census data can be examined to determine trends in population changes in Atlantic Canada—showing how, in some ways, our population is going against the world trend. The implications for our region's future can be considered.

Students can make suggestions to improve our coastal zones, considering the following:

- the development of shorelines that replace the natural environment with pavement, lawns, buildings, piers, sea walls, and so on
- the intensive use of coastal areas by humans in a manner that destroys habitat or changes patterns of use by wildlife (for example, crowded beaches, parks)
- the use of dragging as a harvesting technique for benthic species and groundfish stocks

Students can identify how habitat destruction and degradation can result from human activity in coastal areas and from certain practices involved in the harvesting of marine resources.

Students can examine major sources of contaminants affecting coastal zones. A field trip doing a cleanup of a coastal zone may be done with the class or as part of the field trip in the Marine Biome module.

Students may refresh what has been learned so far by using their KWL chart that began this unit. Essentially, students have seen that coastal zones are

- complex environments made up of different subsystems and that there is no specific definition of the term but rather a loose functional definition that can vary greatly depending on the issue being addressed
- highly variable in their structure (in all three subsystems) and that their structural differences have a wide diversity of causes
- very important to humans as desirable places in which to live and holiday and as sources of resources
- threatened by a number of factors that combine to produce clear evidence of environmental degradation

Establish through questioning and discussion that past management practices have sometimes proven to be complicated. Bring in the idea of Integrated Coastal Zone Management (ICZM) and its philosophy, and discuss its potential.

Students can consider the diversity of stakeholders and interest groups that affect and are affected by coastal zone issues. The stakeholders implicated in the integrated management of coastal zone issues are diverse. Students may identify that what often first appears to be local issues require coordination and co-operation with provincial, regional, and international levels of government and organizations.

Teachers may place students into groups and allow them to select a coastal zone management issue. Teachers may wish to pick one issue so that the coordination and consensus-building can be arrived at from all the players. Students could wear hats based on the groups they represent. The students can draw up a plan for the resolution of their issue within the context of an ICZM environment. This large, detailed project is, in effect, the culmination of the course and should show how well the students have understood the principles taught and how well they are able to apply them. Projects can be presented in class in a conference format. They can be subject to peer review or evaluation in an open, constructive forum. Final products can be submitted after peer responses have been addressed.

RESOURCES/NOTES

Classroom Materials/Supplies

- access to library and Internet
- garbage bags
- clipboards
- hip boots
- pick-up truck

Curriculum Support Materials

- Atlantic Canada census data (available from Statistics Canada)
- Garrison, Tom. *Essentials of Oceanography*.
- *Oceans 11: A Teaching Resource,* Volume 1
  - Study of a Contaminant
  - Overharvesting of Marine Resources
  - Oil, Water, and Then What?
  - Coastal Zone Management
  - Problem Solving and Coastal Zones

Module 4: Aquaculture

As of 2004, aquaculture accounted for almost one third of the volume of seafood consumed globally, yet Canada's contribution to the aquaculture totals was less than 1 percent. As the global population grows while traditional fisheries decline, aquaculture will become increasingly more crucial in meeting world needs, and Canada will have to play a bigger role. This unit will explore the location of aquaculture sites currently in Nova Scotia and the Maritime provinces and determine what physical and biological features determine a suitable site. Species currently farmed and potential species will be identified, and the anatomy and physiology of representative species will be explored. We will look at aquacultures becoming an integral part of the Nova Scotian economy. The interrelationships among employment, business, related industries, special interest groups, environmental concerns, and health issues will be addressed.

The activities in this module enable students to practise and develop their laboratory skills while learning about the environmental factors influencing aquaculture operations. Students must also conduct research, present findings, and adopt an entrepreneurial spirit. Finally, this module has numerous connections to coastal zones and conflict resolution.

Curriculum Outcomes

Students will be expected to

STSE	Skills	Knowledge
▪ **AQUA-2** describe and identify groups of organisms raised through aquaculture and their geographic locations, referring to anatomy and physiology of a major species and ecology of cultured species ▪ **AQUA-4** analyze site planning from various perspectives and report on both the risks and benefits to society and the environment	▪ **AQUA-1** identify, and compare aquaculture—locations and species—grown in Nova Scotia, in the rest of Canada, and globally ▪ **AQUA-3** describe, measure, and analyze conditions for aquaculture operations	▪ **AQUA-5** identify, analyze, and evaluate various aquaculture business opportunities ▪ **AQUA-6** explain aquaculture-related issues

Farming, Fishing, and Food

OUTCOME

Students will be expected to

- identify, and compare aquaculture—locations and species—grown in Nova Scotia, in the rest of Canada, and globally (AQUA-1)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Journal

- Comment on the question, Is aquaculture fishing or farming?
- Investigate either the diploma couse in aquaculture offered by Nova Scotia Community College or the degree program offered by Nova Scotia Agricultural College.
- Write about the video *Farming the Bay* and the issues that industry might face with aquaculture and technology.
- Research changes and trends in Nova Scotia aquaculture on the Internet.

Paper and Pencil

- Do a futures wheel on the question, What would happen if all the wild fish stocks ...?
- Prepare a "Frequently Asked Questions on Aquaculture" flyer for consumer information.
- Prepare a chart comparing and contrasting aquaculture in Nova Scotia and British Columbia.
- Prepare a bar graph that shows the volume or weight and trade value of the various aquaculture species shipped from Nova Scotia.
- Research the historical developments in aquaculture in Nova Scotia, Canada, and other parts of the world.

Presentation

- Report on your Aquaculture Grocery Survey findings.
- Compare and contrast the factors involved in poultry farming and salmon farming, using a concept relationship frame. Factors may include obtaining young animals, production costs, feed, holding pens, diseases and parasites, processing, and marketing.
- In groups, illustrate the distribution and type of aquaculture species farmed globally. How does Canada rank?
- Use highlighters to identify map locations where various species are being cultured in Canada.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

This section is intended as an overview of the complexities involved in aquaculture, rather than presenting detailed information.

Students should develop a broad overview of aquaculture in this unit. A class cluster mind map on aquaculture might provide a good starting point. This could be used to develop individual KWL frames.

Students should compare and contrast fishing, farming and aquaculture and develop a working definition for aquaculture. The differences between aquaculture, mariculture, and fish ranching should also be identified.

Aquaculture is becoming increasingly more important as wild fish stocks diminish due to overfishing and habitat degradation. With the increase in population comes an increased appetite for protein. Many countries already rely heavily on aquaculture to meet their needs. Students should access United Nations FAO data to investigate global involvement and compare Canada's involvement with that of other countries. Canada's potential for further development and the associated problems should be explored. This could be tied in with previous work done in the Coastal Zones unit on coastlines.

Students should find the general locations of major aquaculture industries in Canada and identify the predominant species farmed in those areas. They should discuss the physical features of these areas. This could be related to the concepts of currents, tides, and upwelling that were covered in the Structure and Motion unit.

The areas in Nova Scotia where aquaculture is currently being practised should be identified along with the species being farmed there.

Teacher Information

- A good supply of maps, charts, and other relevant reference materials is required for this unit.
- Internet and library access are required, and the news media should be monitored on a daily basis for relevant material.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2
  - Fishing or Farming: An Introduction to Aquaculture
  - Where Do They Grow?
  - Grocery Survey
  - Aquaculture: A Global Perspective

Video

- Learning Resources and Technology Services: Media Library
  - *Aquaculture* (V1806)
  - *Farming the Bay* (V0482)

Websites

- Food and Agriculture Organization of the United Nations (FAO): http://www.fao.org
  - Fisheries, aquaculture
- Fisheries and Oceans Canada: http://www.dfo-mpo.gc.ca
  - Aquaculture

- Aquaculture in Eastern Canada—A Growing Opportunity (DFO)
  - Food conversion rate (FCR)
- Nova Scotia Department of Fisheries and Aquaculture: http://www.gov.ns.ca/fish/

Keywords

- FIGIS
- FAO

What Species? Where?

OUTCOME

Students will be expected to

- describe and identify groups of organisms raised through aquaculture and their geographic locations, referring to anatomy and physiology of a major species and ecology of cultured species (AQUA-2)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Perform a dissection of a fish and report your results.

Journal

- What problems face aquaculturists? Do you think there are viable solutions? Do you have any suggestions?
- Watch the video *Salmon Farms*, and use a concept relationship frame (blank 4.35) to identify problems and solutions involved in salmon aquaculture

Paper and Pencil

- Present your list of organisms with similar characteristics in chart form. Include distinguishing information.

Presentation

- On a map of Nova Scotia, illustrate the distribution of aquaculture species farmed in Nova Scotia and identify the physical characteristics of the environment.
- Develop a chart of species being farmed in three categories: finfish, shellfish, and aquatic plants. Students may examine questions such as What factors affect certain species farmed in some areas rather than others? What could be some reasons?

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Teachers can initiate a discussion asking the students to make a list of all organisms that are farmed in Nova Scotia. Students can categorize this large list into smaller groups that would have organisms with similar characteristics. They may include shellfish (molluscs), finfish, and aquatic plants.

Students should colour code a map of Nova Scotia illustrating the distribution and type of aquaculture species currently farmed in and around the province. Students should discuss issues surrounding the choices of site and species and develop a chart to begin to address these issues.

Students can further analyze the typical characteristics of each group of farmed organisms. Shellfish species such as mussel, scallop, or oyster; fish such as Atlantic salmon and rainbow trout; and aquatic plants such as Irish moss and dulse can be used. Diagrams of external and internal anatomy can be used to allow students to build a better understanding of a typical finfish. A dissection of a fish can be done here. Some fish presently cultured are Atlantic salmon and rainbow trout, and the life cycles of these two fish can be examined. Teachers should obtain material for students to dissect. In this way, students get a much more realistic impression of the different tissues and structures that they are examining.

Students can examine shellfish characteristics and physiology by observing live animals in water and performing a dissection. The life cycle of shellfish should be considered and emphasis placed on the importance of the planktonic phase. Aquatic plant characteristics and physiology can be discussed and outlined. Students should recognize that these plants can be used as a food source or in part for specific compounds to better aid humans.

Potential problems, such as predators and disease, can be introduced, discussed, and potential solutions outlined. The cases of problems with ISA (infectious salmon anaemia virus) in New Brunswick and red-tide-induced toxicity of shellfish should be considered.

RESOURCES/NOTES

Classroom Materials/Supplies

- Specimens for dissection

Teacher Information

- Presentations for research projects on the biology/ecology/cultivation of a species used in aquaculture can take place during this section

Classroom Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2
  - Grocery Survey
  - Design a Brochure
  - Farmed Marine Organisms
  - The External Anatomy of an Oyster
  - Where Do They Grow?

Video

- *Salmon Farms*, Land and Sea (V2228)

Water Quality

Outcome

Students will be expected to

- describe, measure, and analyze conditions for aquaculture operations (AQUA-3)

Tasks for Instructions and/or Assessment

Performance

- Conduct experiments on the water samples collected. Report your findings.
- Measure the respiration rate of a fish. Report your data and compare them to the class data.

Paper and Pencil

- Describe the optimal conditions for a finfish or a shellfish to exist.
- How are dissolved oxygen levels influenced? Explain.
- What is the relationship between dissolved oxygen content and temperature?
- Why were the currently farmed species chosen for aquaculture?

Presentation

- Bring in an aquaculturalist who can provide first-hand information on tests done and their importance.
- What factors should be examined for a specific species? Why would these be most important for that species?
- The Nova Scotia Department of Fisheries and Agriculture has a website with water-related information, including
  - species fact sheets
  - statistics
  - starting a farm
- Summarize the water quality requirements for aquaculture.

Elaborations—Strategies for Learning and Teaching

This section on water quality could become quite extensive if an attempt were made to address all factors but is important that students have an opportunity to do some hands-on basic chemical water testing and relate their findings to the health of aquatic organisms.

Some of the factors that affect water quality—such as temperature, dissolved oxygen, pH, temperature, salinity, ammonia, nitrates, and BOD—should be explored. The class could do in-depth testing of one or two factors, or they could form groups each specializing in one of many factors reporting back to the class.

Water samples could be taken from actual locations if they can be accessed or simply taken from fish bowls or local ponds, or even simulated if need be.

The correlations between water quality and stress, and disease and mortality of cultured species should be introduced. Students could construct a cause-and-effect frame for unfavorable conditions and their specific adverse effect on aquatic organisms.

Students should analyze data from the Department of Fisheries and Oceans and other sources on aquaculture sites in Nova Scotia. Students can then explore why certain sites are more suitable to certain species. Depth, current, temperature, and other factors should be identified and discussed as important variables in selecting sites for specific species.

Students should investigate successful aquaculture industries in other provinces such as New Brunswick and Prince Edward Island and identify what seem to be the predominate species farmed. The data should be correlated to the physical features of the coastlines involved. This information could then be applied to the features of our own coastline to see if we have coastal areas that are not yet utilized but might show promise for future aquaculture development.

Testing physical parameters of water, such as pH or temperature, can be done appropriately using available probeware.

A map can be created that illustrates the distribution and type of aquaculture species currently being farmed in Nova Scotia and the certain physical characteristics of the environment (e.g., temperature, salinity, exposure).

Students can look at a species suitability for aquaculture. They can consider a series of factors such as biology, distribution, nutritional requirements, and site selection criteria.

A common technological problem encountered when running an aquaculture facility may be addressed. For example, trout require a certain level of dissolved oxygen to thrive. Dissolved oxygen levels are influenced greatly by changes in temperature and fish density. Working in small groups, students can assess alternative solutions, such as calculating costs to determine the most profitable solution and determining whether dissolved oxygen should be added or the water flow increased when an aquaculture facility is faced with an increase in temperature.

The biological and physiological responses of organisms to changes in water quality such as temperature and dissolved oxygen can be investigated by measuring the respiration rate of a fish (indicated by counting the movements of the operculum) in water of different temperatures. The procedure for collecting and analyzing data can be discussed. Individual data can be compared to the class average and suggestions made for the variability observed. The relationship between dissolved oxygen content and temperature can be discussed and analyzed. Students should relate their findings to conditions that can exist in an aquaculture facility. Caution must be taken not to harm fish used or to cause them undue stress.

RESOURCES/NOTES

The Nova Scotia Department of Fisheries and Aquaculture has a website with water-related information, including

- species fact sheets
- statistics
- starting a farm

Classroom Materials/Supplies

- access to a chemistry or biology lab
- water samples from various water bodies
- chemicals and materials required for analysis of water quality indicators
- reasonably large goldfish

Classroom Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2
  - Water Quality in a Mini System

Site Acceptance by the Community

OUTCOME

Students will be expected to

- analyze site planning from various perspectives and report on both the risks and benefits to society and the environment (AQUA-4)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Defend your position on the seafood plant being developed in your community.

Presentation

- Design and present a technological improvement model that allows improvement in shellfish productivity.

ELABORATIONS—STRATEGIES FOR LEARNING AND LEARNING AND TEACHING

Students should participate in a realistic role-play of a site-leasing scenario. For example, they could ask the question, Should a medium-sized seafood company with established markets in central Canada and the United States be given a licence to revitalize an abandoned fish plant to grow mussels? This will provide students with the opportunity to become actively involved in decision-making situations and to develop an understanding of the various perspectives that different groups bring to a discussion. The class can be divided into the government and non-government review agencies and the applicant. Equipped with background information on their mandate and the scenario, each group must put forward a well-reasoned argument for or against the lease application. *Oceans 11: A Teaching Resource* includes a fictional scenario role-play activity. Students may investigate and describe the role of major organizations and associations affiliated with aquaculture in Atlantic Canada.

Students should develop a technological improvement model that allows higher productivity of a shellfish and present to their peers for review and feedback. This can be in the form of an aquaculture expo where the inventors (students) present their work. This process may be intimidating for the students, so they need to be prepared for the interaction between them and their peers. This project was introduced at the beginning of the module, in the section Farming, Fishing, and Food.

RESOURCES/NOTES

Classroom Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2
  - Aquaculture Entrepreneur Game

Marketing the Product

OUTCOME

Students will be expected to

- identify, analyze, and evaluate various aquaculture business opportunities (AQUA-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Journal

- Evaluate a marketing plan for an aquaculture business.
- Design a brochure.
- For enrichment: in conjunction with business education or entrepreneurship education, develop a business plan.

Paper and Pencil

- Produce a market survey as part of the overall plan for an aquaculture facility.
- Propose a solution to marketing your fish from your aquaculture site.
- Prepare a pie diagram of export countries showing percent exports of a selected species. Each group could add diagrams to a class display of all.

Presentation

- Give a financial analysis of your group’s business. Compare your analysis with another group.

- Analyze Statistics Canada data to see which species have grown in export over the most recent ten years of data. Report your findings for both weight in kilograms and dollar amount.
- Research the vaibility of a new species such as halibut or sea urchins. Is there any new research and development in these areas? Report on any research and development or market surveys.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

The basic principle of supply and demand should be discussed as it relates to aquaculture businesses. Student should be familiar with a market survey to access potential demand. The various stages involved in starting and running an aquaculture business should be explored. Some stages that should be included are market analysis and plan, site approval, funding, start-up, growing to market size, marketing and shipping.

Guest speakers, interviews, or field trips to sites can provide invaluable insights into the industry.

RESOURCES/NOTES

Classroom Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2
  - Moss Muffins and Seaweed Soup
  - The Business of Aquaculture

Teacher Information

- Statistics Canada has aquaculture statistics that include geography, sales of aquaculture products/services, numbers of finfish and molluscs, and other goods and services information.

Aquaculture-related Issues

OUTCOME

Students will be expected to

- explain aquaculture-related issues (AQUA-6)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Journal

- What does aquaculture now mean to you? Is it fishing, farming, food, a business, or something else? Discuss your thoughts.
- Write a job description to include the skills you believe are important to aquaculturists.
- Create a list of careers available in aquaculture.

Paper and Pencil

- Write a final reflection on the topic of aquaculture, including local, regional, Canadian, and global perspectives.

Presentation

- Present your research results on potential problems related to aquaculture.

Portfolio

- Review the work you have done for this module and choose two or three pieces to include in your portfolio.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Aquaculture continues to generate controversy. There have been questions about habitat degradation, mariculture sludge, genetic engineering, antibiotics, seascape aesthetics, parasites, and disease, to name a few. Proponents of aquaculture have introduced the topics of local economic benefits, food conversion ratios (FCRs), employment opportunities, omega-3 fatty acids, and export markets. As well, with a declining traditional fishery and an increasing demand for protein, there is anticipation and hope in the future of aquaculture. Students should explore some of the issues surrounding the industry and develop a comparison frame of pros and cons. Students could choose to debate the issue or have a panel discussion.

RESOURCES/NOTES

Teacher Information

Some issues relating to aquaculture include the spread of disease among cultured organisms and the spread of disease from cultured organisms to wild populations. Another is the escape into the wild of cultured species leading to establishment of non-native species with potentially negative impact on native species, interbreeding between wild and domesticated strains of the same species leading to a loss of evolutionary fitness in the wild strain, and potential release into the wild of genetically modified cultured species—the so-called “frankenfish.”

Also, damage to the benthic environment below aquaculture sites due to the accumulation and decomposition of large quantities of uneaten feed and feces may be discussed.

The implications for human populations of cultured species being treated with drugs to prevent disease may be interesting to look at.

Teachers should look at aquaculture websites for additional support.

Activity

- *Oceans 11: A Teaching Resource,* Volume 2
  - Food Conversion Ratios

Module 5: Fisheries

This module explores the marine fishing industry. Students will begin by developing a basic understanding of fisheries, fisheries management theory, and the current status of the world's fish stocks, with particular emphasis on those in Atlantic Canada. Students will examine management strategies for the future so they can discuss fish populations.

Curriculum Outcomes

Students will be expected to

STSE	Skills	Knowledge
▪ **FISH-4** compile and organize fish population data and explain the dynamic interrelationships among the physical environment, the biological environment, and the health and distribution of a fish stock ▪ **FISH-5** compare the risks and benefits to society and the environment of applying scientific knowledge or introducing a technology to the fisheries	▪ **FISH-2** describe, identify, and analyze the external and internal anatomy of a major finfish or shellfish species that is part of the commercial fishery ▪ **FISH-3** construct, interpret, and evaluate various ecological factors	▪ **FISH-1** explain the importance of a sustainable fishery as a resource to global and local food supply and employment with reference to terminology ▪ **FISH-6** identify, describe, and analyze multiple perspectives of the main organizations in research and decision making in fisheries management in Canada

Fisheries Are a Unique Resource

OUTCOMES

Students will be expected to

- explain the importance of a sustainable fishery as a resource to global and local food supply and employment with reference to terminology (FISH-1)
- describe, identify, and analyze the external and internal anatomy of a major finfish or shellfish species that is part of the commercial fishery (FISH-2)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- As a class, construct a timeline along the wall of the classroom showing major changes in the North Atlantic cod fishery from the time of early European fishing in the 1600s to the present. The introduction of limits and the EEZ, the cod decline, and the moratorium should be included, as well as other important events.

Journal

- Comment on fisheries as resource. Use evidence to support your answer.

Paper and Pencil

- Design a word puzzle using fisheries terminology. Exchange yours with another student. Do the puzzle and check the solution.
- Create a game to show some of the issues in the fishery.
- Construct a Cluster Mind Map or Category Concept Map.
- Using a graphic organizer, brainstorm ideas about your understanding of the sustainability of the fishery.
- Research the Statistics Canada website on Historical Statistics of Canada to find out the trend in the Canadian fishing industry in the early part of the 20th century. Compare the data to trends in the last quarter of the 20th century as found through Statistics Canada and Department of Fisheries and Oceans websites. Findings could be displayed using a graphic organizer or other presentation formats.

Presentation

- Present a question to the class, with possible economic, social, political, environmental, and/or biological aspects.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Student should familiarize themselves with fisheries terminology before proceeding with the unit. Terms such as **groundfish**, **pelagic**, **recruitment**, **year-class**, **fecundity**, **otter trawler**, **longlining**, **gillnet**,

purse seine, **bycatch**, **target catch**, **stock**, and **maximum sustainable yield** should be defined. As well, commonly used acronyms such as TAC, DFO, NAFO, CAT, SARA, and COSEWIC should be explored.

It is important that students gain an appreciation for the importance of trying to maintain a sustainable fishery and that although restrictions to protect a fishery often adversely affect certain stakeholders at the onset, the final result should benefit all. Management success stories such as the lobster fishery could be contrasted with management failures such as the northern cod fishery.

The fact that the open ocean has no physical boundaries complicates the issues of ownership and management. Students should explore the establishment of boundaries and EEZs (Exclusive Economic Zones) and discuss the complexities involved in setting a boundary that is fair to all involved.

Students should appreciate that the fishery is a dynamic and complex industry that is closely tied to local as well as global economics, employment, and food supplies. The fishery is a renewable resource only to the point where it becomes poorly managed. At this point decline, endangerment, and even extinction become real threats.

Fisheries statistics and graphs are available on the national level from Statistics Canada and on a global level from the United Nations Food and Agriculture Organization (FAO). Data on economic values, employment, and volumes could be compared on a global scale. The data could be used to construct graphs and charts to better display findings. The major players in the global fishery should be identified, and Canada's role in the global picture should be determined.

Over the past few decades, the global fishery has been poorly managed. Although Canada has been a part of this mismanagement, it also has taken steps to protect the fishery. Students should identify the key historical events that have shaped the present situation of the fishery in Atlantic Canada. Some key events to include would be the introduction of the 200-mile Exclusive Economic Zone (EEZ), the collapse of the Atlantic cod stock, the Brian Tobin turbot wars, the cod moratorium, the occupation of the DFO offices in New Brunswick and Nova Scotia, and the establishment of TAGS (The Atlantic Groundfish Strategy). Students could add other pertinent events as they get into the research. The events could be researched in groups, then used to construct a class timeline.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2
  - Commercial Fishery Project
  - Sustainable Fishery
  - Fisheries Terminology

Teachers and students can find relevant information at the following agencies:

- Nova Scotia Fisheries and Aquaculture
  - Fish Catch and Export Statistics
- Statistics Canada
  - Historical Statistics of Canada: Fisheries

- Depository Services Program, search: fishery

Life Cycle

OUTCOME

Students will be expected to

- describe, identify, and analyze the external and internal anatomy of a major finfish or shellfish species that is part of the commercial fishery (FISH-2)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Conduct an investigation of the external and internal anatomy of a fish, lobster, or crayfish

Paper and Pencil

- How is the age of a fish determined?
- What fisheries questions are in the news today? Does technology help solve them? Explain.
- Design a web ad or pamphlet to promote a commercial finfish or shellfish species to potential markets.

Presentation

- Present your “adopt a fish” information in a pamphlet.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

If students have already done a fish dissection in the Marine Biome or Aquaculture unit there is no need to repeat the exercise. Students should do a dissection and study of a lobster or crayfish if the fish has been previously done.

Perch can be obtained preserved from scientific supply companies. Perch dissection experiments are found in most high school biology manuals printed by textbook publishers. The internal anatomy of a perch and a cod is very similar, giving students a good feel for the anatomy and physiology of a fish.

As lobsters are expensive, a live lobster could be kept in a temporary seawater holding container so it’s behaviour could be observed, and if budgets don’t permit, a dissection of the crayfish could follow. Crayfish are also available through scientific supply companies, and the internal anatomy of the crayfish is very similar to that of the lobster.

Students should research, then sketch and label, the life cycle of the Atlantic cod as well as the life cycle of a lobster. Alternatively, student groups could each do different commercial species and present their life cycles to the class. Students should identify the biotic (predators, food, etc.) and abiotic (temperature, currents, etc.) factors that reduce the numbers of individuals during the life cycle.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2
  - Aging Fish
  - Anatomy

Videos

- Learning Resources and Technology Services: Media Library
  - *Long Way from Yesterday* (V7917)

Software

- Dissection Works, CD-ROM, Science Works (virtual dissection of five animals including perch and crayfish) NSSBB# 51323

Website Keywords

- Northern cod life cycle
- American lobster life cycle

Models of Fish Stocks

OUTCOME

Students will be expected to

- construct, interpret, and evaluate various ecological factors (FISH-3)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Demonstrate how the model of a fish stock works.

Paper and Pencil

- Explain the weaknesses of the fish stock model. In what ways does this model differ from reality?

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Population dynamics of a fishery, as they relate to management, should be introduced to students. Students should explore the various factors involved through either software or physical models. Recruitment would represents inputs to the model while predation, mortality, and fishing mortality would represent outputs. Immigration and emigration may or may not be included depending on the desired level of complexity. The model could be run using recruitment and mortality without fishing for a number of seasons then introducing new factors such as fishing, predators, low fecundity, disease, predator populations declining, etc.

Student should discuss and make note of biotic and abiotic factors that could not be modelled and suggest the possible effect each of these factors might have on the population.

The importance of not exceeding the maximum sustainable yield (MSY) in preserving a sustainable fishery should be addressed. As well, the accuracy of MSY estimates should be considered.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2
  - Sustainable Yield

Fish Population and Management

OUTCOME

Students will be expected to

- compile and organize fish population data and explain the dynamic interrelationships among the physical environment, the biological environment, and the health and distribution of a fish stock (FISH-4)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Paper and Pencil

- Draw and interpret histograms of fish stock.
- Evaluate the data collection methods for stock assessment.

Presentation

- Pretend you are a fisheries manager. Present your approach to your fish population management. Consider the following ideas when organizing your plan:
  - the character of the fish stock (to this point, fish stocks have been discussed as though they were single, homogeneous units)
  - the difference between species selection and size selection
  - that fishing gear can be designed to take some sizes of fish while leaving most fish of other sizes in the water
  - that a highly selective gear is one that is good at catching some sizes of fish while leaving others
  - that it is possible for fishers and fisheries managers to control the age selection of a fishery to protect small fish or large spawning fish

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should gain more familiarity with fish and with the work of fisheries scientists. They should identify the need for mass data collection and the importance of clear and accurate recording of data.

The types of data that are routinely collected by fisheries scientists such as catch, fish lengths and weights, fish ages, fishing effort, observer data, and research vessel surveys should be introduced, and the limitations associated with the data can be discussed. Students should discuss the idea that there is a great deal of concern over the accuracy of data.

Students should work with data to determine the relationships among length, frequency, and age. Histograms and graphs would enhance the concept.

Students should also experience methods used in estimating population size. Factors that can lead to inaccuracies in the estimates should be discussed.

Although activities and discussions have sometimes centred on singular stocks, students should be aware that each stock is intricately tied to other stocks and organisms that are part of its ecosystem, and that a change in one population can change things greatly in other populations.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2
  - Length/Frequency/Age Relationships
  - Size of a Fish Stock

Invite a guest speaker or a panel of fisheries officials, scientists, fishers, representatives from Department of Fisheries and Oceans to discuss data.

Access websites that give current information on cod fishery statistics.

Technology in the Fisheries

OUTCOME

Students will be expected to

- compare the risks and benefits to society and the environment of applying scientific knowledge or introducing a technology to the fisheries (FISH-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Journal

- What impact have technology changes had on the fishery?
- Research the turbot war with Spain and the keywords turbot, Brian Tobin, European Union, or *Estai*.

Paper and Pencil

- Fill in the chart below with the information you collect from your fisher during the interview.
- Ask your fisher whether he or she thinks the changes have been positive or negative and to give reasons.
- Does the technology of the mesh size have an impact on recruitment of the stock?

Fishing: Then and Now

Market	Technology	Effort	Regulation	Stock

Presentation

- Organize information on the fishing industry and the impact of technology. Use a variety of sources for information. Present your findings in a newsletter, web page, or any other medium you choose.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should compare how a fishery has changed—then and now. This activity could be an interview with an experienced fisher on topics such as technology, effort, regulations, markets, and stocks. Students might ask questions to help with their interview, such as, What does the future hold? What is the health of the stocks? Groundfish, mackerel, lobster, herring, snow crabs, and tuna might be examined for the interview.

Students can research information on the commercial fishing industry in their local area. This can include different fishing methods, including the gear and types of boats used, fishing people and the working life of fishers, processing, and marketing. The impact of technology on fishing intensity, biomass, catch rate, and profitability may be discussed, leading to the concept of responsible fishing. For example, a discussion on how technology is used to fish smarter instead of harder might be interesting.

A guest speaker can be invited to talk with students about the fishing activity within their own community.

Students might discuss how the mesh size has changed to allow smaller fish to escape.

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource,* Volume 2

- Fishing Technology
- Mesh—What Size Should We Use?

Video

- Learning Resources and Technology Services: Media Library
  - *Ocean Pollution* (V2484)

What Does Management Mean?

OUTCOME

Students will be expected to

- identify, describe, and analyze multiple perspectives of the main organizations in research and decision making in fisheries management in Canada (FISH-6)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Paper and Pencil

- Make a display to show all parties involved in fisheries management.
- Can a fishery be renewable without being sustainable, or sustainable without being renewable? Explain.
- Should the management of the seal population play a key role in the management of cod stocks?
- Is the term "harvester" better than the term "fisher"? Explain the implications of both words.
- How are science and management related to fisheries?
- Design a futures-wheel activity on unlimited access to the fishery.
- How do we come up with the best management plan? What factors must be explored? Who must be involved? The list of stakeholders includes commercial harvesters, recreational harvesters, aboriginal harvesters, DFO, plant workers, environmentalists, communities, petroleum industry, and other interested parties. Each stakeholder gets three minutes to present his or her position. After all the presentations, each player must pick one other group that would be his or her best ally. Determine whether there is a clear winner. Is a best choice one that would be the most acceptable to all? Discuss.

Presentation

- Debate the multiple perspectives that influence a fishery.
- Using information from a variety of sources and perspectives, track the management of a species of fish.

Portfolio

- Review the work you have done for this module and choose two or three pieces to include in your portfolio.

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

The causes and effects of the collapse of the North Atlantic cod fishery should be investigated. Students should investigate and discuss factors such as the use of advanced technology in trawlers, fish finding technologies, observance of the 200-mile EEZ, seal populations, errors in population density estimates and quotas, and other pertinent factors.

Students should familiarize themselves with the concept of the "tragedy of the commons" as it applies to the fishery. Global societies must come to grips with the tragedy of the commons if there is to be any hope for the future of the fishery or the environment. Students should assess any progress we have made in this regard and identify what is yet to be accomplished.

Students could be divided into groups, each one researching a management strategy used by fisheries managers. Reliability and effectiveness of the strategies should be assessed. Each group could them report back to the class as a whole. Some of the management tools that could be included are quotas, net sizes, TACs, individual total quotas or ITQs, closures, seasons, TURFs, and ownership.

Students should discuss the role of scientists and the role of managers. A connection should be made between fisheries science and fisheries management. The management tools may be discussed as tailored to the biology and dynamics of the resource. Scientists provide information on their understanding of the fishery system, which is of use to managers in the selection of appropriate tools.

Students can explore real-world fisheries management problems by undertaking a thorough analysis of one or more recent television documentaries. Students can collect articles or watch selected videos on controversial aspects of the fishery. Teachers must be careful that a balanced approach is taken. Students can take notes during the viewing. Following the viewing, working first in teams and then as a class, the students can analyze the video to determine the message it was trying to present, whose message it was, which parts of the information can be trusted, and which information is propaganda. The analysis can be extended to examine the issues raised during the discussion.

To come to some closure, students can be left to discuss the issues surrounding who should manage the fisheries and propose a well-reasoned solution. A futures-wheel activity can be done to address the questions such as, What would happen if there were unlimited access to the fishery?

Students can compare and contrast the management stories of two different species such as lobster and cod. Using graphs of licence numbers, employment, fishing effort, biomass, and landings plus timelines of major management decisions, students can track the development of the two fisheries. They may develop possible explanations for the problems or success and make predictions for the future.

Students could role-play the different players in a management scheme. Each player must identify major concerns. The question to address is, What are the potential risks of having only one of the players managing our marine resource?

Teacher Hints

- The harvesters—overexploitation
- Environment—closed areas, seal cull
- DFO—political decision making
- Petroleum exploration—oil spills

RESOURCES/NOTES

Curriculum Support Materials

- *Oceans 11: A Teaching Resource*, Volume 2
  - What Is the Fishery All About?

Videos

- Learning Resources and Technology Services: Media Library
  - *Fisheries Futures* (V1728)
  - *Fishermen's Panel* (V1554)

Website Keywords

- "Tragedy of the commons" fishery

Various sources and perspectives might be found through a search of EBSCO periodicals at http://search.epnet.com. This source includes articles, Canadian and international newspapers, and magazines. Students might find information on a fisher's perspective and species at risk.

Appendices

Appendix A: Equipment Lists

Laboratory

SUPPLY LIST

chemicals and materials required for analysis of water quality indicators

globes

lab access

magnetic compasses

nautical charts

regional, Canadian, and world maps on display

sample chart

slides/cover slips/light microscopes

use of GIS data sets for ArcView K–12, or Nova Scotia data sets should be encouraged in schools having ArcView

various large iron masses

Consumables

acetate and markers (various colours)

chemicals and materials required for analysis of water quality indicators

garbage bags

reasonably large goldfish

specimens for dissection

string (globe work)

water samples from various water bodies

Recyclables and Collectibles

maps of the Earth and the North Atlantic clipboards

compasses (pencil type) (math)

dividers (chart work)

hip boots

parallel rulers

Appendix B: Video Resources

Video Use in the Classroom

Used strategically, instructional video brings the outside world into the classroom and allows learners to experience firsthand what they might not otherwise be able to. Videos provide opportunities to enhance curricula for students. The Oceans 11 curriculum requires that integrated and well-balanced sets of experiences include both print and non-print resources. Videos are powerful tools that use the brain's preference for visually presented information to introduce and reinforce concepts.

Videos can be used to introduce a topic, to present different perspectives on an issue, to promote media literacy outcomes in the curriculum, to change the pace of a lesson, to offer an alternative format for conveying information, to provide a stimulus for further learning activities, to motivate students to further research or deeper analysis, to provide a concrete example of an abstract concept, to provide basic information about a subject, or to summarize a topic.

Education Media Library

The Education Media Library has over 5000 DVD and VHS titles in its video collection. All programs have been evaluated for curriculum fit and are intended to support the Nova Scotia Public School Program. They may be used by teachers and others engaged in public education in Nova Scotia. Public performance rights have been purchased so that all videos can be shown in classroom settings to students and educators.

The Media Library has two collections: loans and dubbing. Loan titles can be borrowed for up to 10 days at no cost (return postage is provided), and dubbing titles are sold to schools at "cost recovery" prices ($1.41 plus tax for a DVD). These videos then belong to the school and become a shared resource for all teachers at the school.

The Education Media Library catalogue can be found on the Learning Resources and Technology website at http://lrt.EDnet.ns.ca. This site offers a rich variety of curriculum-related resources to help teachers in their classrooms. Teachers can search the video database, find out about educational software, curriculum materials and related websites, access workshops on web safety, and find tips on integrating technology into the classroom.

Outcomes	Title	Description
Structure and Motion		
Oceans, Seas, Gulfs, and Straits		
OSM-1	*A Day in the Life of the People on the Hudson* Bedford Institute of Oceanography	This video talks about the research vessel *Hudson* and its journeys.
The Ocean Bottom: Origins and Bathymetry		
OSM-2	*Plate Dynamics* Call Number: 23457 Learning Resources and Technology Services: Media Library	Introduction to plate tectonics.
OSM-2	*Ocean Mapping* Call Number: V1680 Learning Resources and Technology Services: Media Library	CBC *Land and Sea*. A recent technological breakthrough makes it possible to take detailed pictures of the ocean floor using sonar readings processed through specialized computers. For the first time, accurate maps of huge areas of the sea floor are opened up to navigators, geologists, fishers, and telecommunications companies. It's a sophisticated and exciting new technology—the first of its kind in the world, developed right here in the Maritimes.
OSM-2	*Ocean Pollution* Call Number: V0431 Learning Resources and Technology Services: Media Library	What is the state of the ocean bottom of Nova Scotia? Underwater footage takes the viewer on a tour of a typical coastal bottom. Three scientists discuss the environmental impact of the organic and inorganic wastes that pollute our waters. Particular references are made to Halifax Harbour.
Ocean Currents (extension)		
OSM-5	*Adrift on the Gulf Stream* Call Number: 22801 Learning Resources and Technology Services: Media	The program describes the course of the Gulf Stream gyre in the North Atlantic Ocean. This gyre carries more heat from the tropics to the north pole than any other

Outcomes	Title	Description
	Library	current, affecting climate in Europe and weather along the North American coastline. Twentieth-century oceanographic instruments are increasingly sophisticated. Scientists now use instruments like expendable bathythermographs, which radio temperature readings to ships; inverted echo sounders and acoustictomography transceivers, which measure sound waves to determine water movement; and satellites to read ocean-surface heat, wind patterns, and biological productivity. With the data these instruments collect, we are beginning to understand the ocean—its depth, its life, and its movement.
OSM-5	*Waves, Beaches, and Coasts* Call Number: 23449 Learning Resources and Technology Services: Media Library	The program demonstrates the effects of waves on coastal landforms.
Tides		
OSM-6	*Touched by the Tide* Call Number: V1048/23161 Learning Resources and Technology Services: Media Library	The waters of the Bay of Fundy rock back and forth, pushed into continual motion by the twice daily pulse of the Atlantic tide. The result is the highest tides in the world and a diversity of shoreline habitats that supports a wonderful array of plant and animal life. Near the mouth of the bay, upwelling currents create marine pastures that attract great whales. Puffins and razorbills nest on rocky islands. In upper parts of the Bay, there are broad expanses of red mudflats that are surprisingly productive feeding areas for shorebirds and fish. Tidal bores force their way up rivers, reversing the flow of water and conducting schools of fish toward freshwater spawning

Outcomes	Title	Description
		areas. Fundy's salt marshes were once the largest in Canada, but most have been diked for agricultural use. Fundy's marshes, mudflats, and rivers have provided harvest for the region's human populations, from the Mi'kmaq on through 350 years of European settlement.
Marine Biome		
Life in the Oceans		
MBIO-1	*Shores of Life* Call Number: V1047/23160 Learning Resources and Technology Services: Media Library	Between the dry land habitats of New Brunswick, Prince Edward Island, and Nova Scotia and the salt water of the Atlantic, there is a vital band of wetland habitats. The shores are influenced by both the sea and the land and create ecological systems that are more diverse and more productive than either land or sea. At the heads of bays and along tidal rivers, broad cordgrass marshes are among the most biologically active places on earth. At lower elevations, sunlit shallows produce beds of eelgrass and algae that support an amazing abundance of animal life. These are nursery areas for many species of commercial fish. The sea claws at headlands to create cliffs that are used by nesting seabirds, while the eroded rock is redeposited to form beaches and sand dunes. The dunes may trap fresh water to create barrier beach ponds, unique additions to the complex of seashore habitats. *Shores of Life* explores the biological wealth of these Atlantic coastal wetlands.
The Field Trip		
MBIO-4	*Rocky Shore Field Techniques*	This resource is part of the Rocky Shore School kit

Outcomes	Title	Description
	Call Number: V1997 Learning Resources and Technology Services: Media Library	distributed to Nova Scotia schools by the Nova Scotia Museum. In it, senior high school students and teachers learn how to make a transect of a rocky beach from low to high water, how to map tidepools and other features, how to perform flora and fauna counts, and how to test the salinity and temperature of salt water. The video also features common species of life encountered during such work. The video, which is available in both French (Le Littoral V1998) and English, is based on a slide set formerly presented in the kit with printed instructions only.
Coastal Zones		
Variations in Coastal Zone Structure and Properties		
CZON-2	*Plate Dynamics* Call Number: 23457 Learning Resources and Technology Services: Media Library	Introduction to plate tectonics.
CZON-2	*Waves, Beaches, and Coasts* Call Number: 23449 Learning Resources and Technology Services: Media Library	The program demonstrates the effects of waves on coastal landforms.
Aquaculture		
Farming, Fishing, and Food		
AQUA-1	*Aquaculture* Call Number: V1806 Learning Resources and Technology Services: Media Library	Farmed salmon has been available at fish counters throughout the Maritimes for several years. Now, with the decline in the ground fishery, scientists and people in the fishing industry are working to develop methods of raising other species such as haddock, cod, and winter flounder with some

Outcomes	Title	Description
		success.
AQUA-1	*Farming the Bay* Call Number: V0482 Learning Resources and Technology Services: Media Library	Farming the Bay explores the controversy over a growing aquaculture industry. Landowners near the aquaculture farms worry about the aesthetics of the buoys that mark the farms, the use of antibiotics and chemicals in aquaculture, and the possible decline of property value. Traditional fishers are concerned that the amount of space used by aquaculture limits their capacity to manoeuvre in and out of the buoys.
Fisheries		
Life Cycle		
FISH-2	*Long Way from Yesterday* Call Number: V7917 Learning Resources and Technology Services: Media Library	This program documents the changes in the fishing industry in the Maritimes, with footage of an actual trip aboard the modern fleet of draggers compared with fishing on the smaller, inshore boats. The program demonstrates the onshore factories that process the fish for market.
Technology in the Fisheries		
FISH-5	*Ocean Pollution* Call Number: V2484 Learning Resources and Technology Services: Media Library	Ships at sea can cause up to 30 percent of the world's ocean pollution. Throwing bags of garbage overboard and discharging oily water, bilge water, and chemicals were common practices, but many countries have signed a United Nations marine pollution convention to stop this ocean dumping. Despite the UN convention, lots of junk is still being dumped, and the biggest potential offenders are cruise ships. Ships are required to keep a record log of all their garbage and how they have disposed of it, but that doesn't always mean that this requirement will stop ocean

Outcomes	Title	Description
		pollution. A small company in Nova Scotia has come up with a plan that could revolutionize world shipping and eliminate some of marine pollution for vessels at sea.
What Does Management Mean?		
FISH-6	*Fisheries Futures* Call Number: V1728 Learning Resources and Technology Services: Media Library	CBC Land and Sea series' host Peter Verner presents opposing views on the ownership and management of the fishery. Who owns the fish on the Scotian shelf? What is the future of Nova Scotia's fishing industry? The competitive quota system denotes common ownership of the fishery. The area can be fished until the season's quota is reached. Will individual quotas lead to concentration of the fishery in the hands of a few powerful owners or processors?
FISH-6	*Fishermen's Panel* Call Number: V1554 Learning Resources and Technology Services: Media Library	CBC Halifax 1st Edition host Jim Nunn talks to fishers concerning the state of the East Coast fishery. Longline fishers and dragger fishers participate. There are too few fish and too many fishers. Some Nova Scotians argue that it is time to change the way we fish and want to replace big trawlers and draggers with the more environmentally friendly fishing practice of hook and line. The panel of six fishers debate the idea.

Appendix C: Other Resources

Print Resources

Nova Scotia Department of Education. *Oceans 11: A Teaching Resource,* Volume 1. Halifax, Nova Scotia, 2012

Nova Scotia Department of Education. *Oceans 11: A Teaching Resource,* Volume 2. Halifax, Nova Scotia, 2012

Authorized Learning Resources (ALR)

Dissection Works, CD-ROM, Science Works, NSSBB# 51323, 51324

Software

The Sable Gully: A Virtual Tour CD ROM, Department of Fisheries and Oceans, Maritimes Region. Canada. 1999. Cat. # Fs23371/1999E-MRC

ESRI Canada Ltd., ArcVoyager

Appendix D: The Research Process

Research

The research process involves many different skills and strategies grouped within phases or stages. The process is cumulative in nature, each stage laying the groundwork for the next. The phases or stages are commonly identified as

- planning (or pre-research)
- accessing and gathering information (or information retrieval)
- evaluating and interacting with information
- organizing information
- creating new information
- preparing, sharing, and presenting information
- evaluating the research process

Students' use of the information process is not linear or purely sequential. A new piece of information, artifact, or conversation with a resource person may lead a student to revise a question under consideration, determine a perspective or point of view from which to examine critically the information available, or develop an alternative plan.

Planning

During the introductory stage of the research process, students usually

- identify the topic or question—decide on a general area of interest that warrants further investigation, then clarify or narrow the area of focus to make it manageable
- formulate broad and specific questions to guide their research
- identify a variety of potential sources of information
- decide what strategies they will use to record information and keep track of the materials they used

Accessing and Gathering Information

Students access appropriate resources (print, non-print, information technology, human, community). The actual resource is located, and the information is found within the resource. Students will need to learn and apply several important skills:

- search (with direction) a card catalogue, electronic catalogue, the Internet to identify potential information resources such as books, journals, newspapers, videos, audios, databases, or other media
- locate resources (e.g., community, text, magazines, artifacts from home, Internet sites) and determine appropriate ways of gaining access to them
- select appropriate resources in a range of media
- use organizational tools and features within a resource (e.g., table of contents, index, glossary, captions, menu prompts, knowledge tree for searching electronically, media (VCR, DVD) counter to identify video clips for specific relevance)

- skim, scan, view, and listen to information to determine the point of view or perspective from which the content is organized
- determine whether the content is relevant to the research question
- determine whether the information can be effectively shaped and communicated in the medium the student will use to complete the project

Teachers should help students realize that fewer appropriate resources are better than a multitude of inappropriate resources.

Interacting with Information

Students continue critical evaluation of the information they find to determine if it will be useful in answering their questions. Students apply reading, viewing, listening, and critical thinking skills:

- question, skim, read (QSR)
- use text features such as key words, headings, and captions
- use navigation features or software
- use pause points or topic-shift points in video
- read and interpret charts, graphs, maps, and pictures
- listen for relevant information
- scan videos, bookmark and highlight websites
- compare and evaluate content from multiple sources and media
- determine accuracy, relevance, and completeness of information

Teachers should help students develop a range of strategies for recording the information they need to explore their topic and answer their guiding questions. Simple point-form notes (facts, key words, phrases) should be written or recorded symbolically (pictures, numerical data) in an appropriate format, such as a concept map, website, matrix sheet, chart, computer database, or spreadsheet.

Teachers might also need to help students cite sources of information accurately and obtain appropriate copyright clearances for images, data, sounds, and text they intend to reference or include in their work.

Organizing Information

Students may use a variety of strategies to organize the information they have collected while exploring their topics and answering their guiding questions:

- numbering
- sequencing
- colouring, highlighting notes according to questions or categories
- establishing directories of files
- creating a webpage of annotated links to relevant Internet sources
- archiving e-mail collaborations using subject lines and correspondents' names
- creating a database of images and sound files, using a suitable software program

Students should review their information—in view of their guiding questions and the stated requirements of the activity—to determine whether they need additional information or further clarification before creating their products, planning their performance or presentation, or exhibiting their work. They may need to reframe the research in light of information and sources gathered.

Sharing Information

Students review and reflect on the information they have collected, connecting new ideas with their prior knowledge and evaluating new information that might not fit with their previous understandings. As they integrate new information into their current knowledge, students develop new understandings and draw conclusions.

Teachers may need to help students decide how best to convey the results of their research process to the intended audience.

Students should have many opportunities to share with a variety of audiences what they have learned, discovered, and created and to examine carefully the responses of those audiences to their work.

Evaluating the Research Process

Students should reflect on the skills and learning strategies they are using and examine and discuss their learning processes. Teachers and library professionals can help students with evaluation by

- providing time and encouragement for reflection and metacognition to occur (e.g., What did we/you learn about gathering information?)
- creating a climate of trust for self-assessment and peer assessment of process, creation, or performance (students tend to be realistic and have high expectations for their own work)
- asking questions, making observations, and guiding discussions throughout the process
- conferencing
- monitoring and providing feedback on student progress (e.g., demonstrated ability to organize notes)

Media Analysis

The development of media analysis skills is an important component of the public school program. Media studies can be integrated into the curriculum as a source of current information, as a means to stimulate student interest and discussion, and as a vehicle to present real-world issues and situations to students.

It is important for students to be able to evaluate media critically. Students should be able to distinguish fact from opinion and propaganda from responsible, objective reporting.

Analysis of media products requires students to consider the following:

- the purpose and qualifications of the author(s)
- the type of source and how that source is monitored (e.g., an established newspaper as opposed to an article appearing in an interest group's site on the Internet)
- the type of audience that the information is directed to

- the reasons a particular target audience was chosen
- the ways the author(s) chose to reach that audience
- identification of inaccuracies, contradictions, or illogical reasoning
- the presentation of opinions
- evidence of bias in the work
- the source(s) of and interpretation of information by the author
- the presentation of unsupported ideas or conclusions

When analyzing advertising, students should focus their attention on the use of unsupported conclusions, testimonials by unknown or unqualified people, and the use of unsubstantiated events or quotes to draw conclusions.

Evaluation of Media Analysis

The evaluation process for a media assignment in Oceans 11 will depend on the nature of the assignment and the criteria established by both the teacher and students. Criteria might include

- the inclusion of appropriate topic-related materials
- the use of a variety of relevant sources
- proper identification of sources
- identification of appropriate topic concepts
- proper identification of purpose(s) of material
- identification of target audience
- identification of point of view
- open, unbiased approach to analysis

Appendix E: Portfolios

A portfolio is a selection of work samples and other items that demonstrate a student's interests, abilities, skills, and achievements. The purpose of a portfolio is to show others—teachers, counsellors, parents, peers, possible employers—what the student has learned and accomplished or produced. Students should frequently update their portfolios and reflect on their progress and growth. Reflective writing is a key component of portfolios.

Portfolios at the high school level can be used to display and summarize a range of achievements and can serve to help students

- identify and acknowledge personal growth and achievement
- demonstrate their achievements to families, potential employers, and others
- apply to post-secondary institutions
- apply for scholarships and bursaries
- obtain a volunteer position
- make decisions concerning career-path choices

Creating Portfolios

There are four basic types of portfolios:

Student Portfolios demonstrate the skills, accomplishments, and achievements of students' academic careers over a specific time period. A portfolio can represent one area of study, or it can encompass a broad range of disciplines. Students are often encouraged to include materials that represent accomplishments and interests outside of the classroom.

Project Portfolios are designed to outline the steps or progress of specific projects or independent study. Students are required to record and comment on the process and outcome of their efforts.

Expert and Professional/Employability Portfolios identify students' skills and accomplishments related to their career interests. This type of portfolio is becoming popular as a useful addition to the standard resumé.

A *Personal Portfolio* is designed in a format similar to a scrapbook or a personal journal. It reflects the personal interests, ideas, and aspirations of the student. The most important factors for a successful portfolio format are durability, accessibility, and presentability. Whether a portfolio is in a binder, scrapbook, computer files, multimedia CD-ROMs, video or audio recordings, it must be easy to transport, showcase, and understand.

Students must be able to organize and maintain their portfolios effectively.

The decision of what to include in a portfolio is entirely dependent on the purpose of the portfolio. Here are some materials that could be included:

- essays, position papers
- reflective writing
- specific journal entries

- a sample of technical writing
- awards
- certificates
- evaluations/reviews
- articles, newspaper clippings
- rubrics, test results, assessment information
- photographs
- letters of invitation, thanks
- art and design work
- poems, video, multimedia

Assessing Portfolios

The assessment of portfolios should be discussed and negotiated with students before they begin to create them. Assessment criteria often reflect the design and purpose of the portfolio. The most important form of feedback to students may be in the form of dialoguing and conferencing. Students should aim to achieve these general qualities:

- clean format—easy to read and understand
- creativity
- thoughtful organization
- thoughtful self-evaluation
- clear representation of learning goals and achievements