Wetland Ecosystems

SALT MARSHES
Interactions & Ecosystems

GRADES 7-9

Student Journal

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Ducks Unlimited Canada
Conserving Canada's Wetlands

NB Wildlife Trust Fund
Fonds de fiducie de la faune du N.-B.

LESSON ONE

A Change! Succession of a Salt Marsh

Background Information

What are salt marshes?

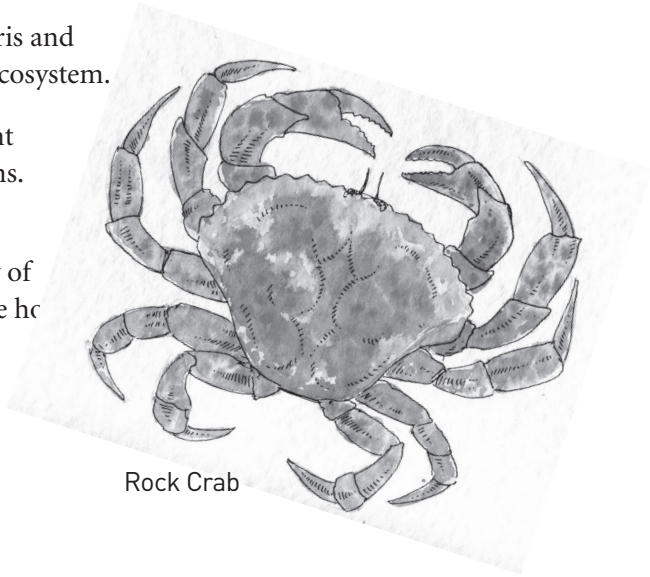
Salt marshes lie at the edge of land and sea, on wave-protected coasts. They are dominated by low-lying, salt-tolerant vegetation and are laced with networks of tidal channels and pools. Salt marshes are communities of plants, grasses, or low shrubs rooted in soils and alternately flooded and drained by tidal action. The plants' tolerance to salt water and the ocean organisms that live there make them different from fresh water wetlands.

Why are salt marshes important?

Scientists have determined that salt marshes are among the world's most productive ecosystems because of the large amount of nutrient-rich decaying plant material (**detritus**) they produce. Detritus is an important part of the food web for primary consumers and secondary consumers who feed off plant material and animal matter.

* Nearly 70 percent of all commercially harvested fish and shellfish use **estuaries** at some point in their life cycles.
* Salt marshes provide food and nesting sites for many species of migratory birds.
* Salt marsh bacteria clean the environment by breaking down waste and decaying organisms.
* Salt marsh grasses provide natural filtration of debris and impurities that help to neutralize and balance the ecosystem.
* The porous peat base of a salt marsh acts like a giant sponge by absorbing water during floods and storms.

There are 3 coastal salt marsh regions in New Brunswick: The Bay of Chaleur, the Gulf of St. Lawrence, and the Bay of Fundy. They constitute over 8,000 hectares of area and are ho to an interesting array of wildlife.



Rock Crab

Region	Number of Salt Marshes	Total Area in Hectares
Bay of Chaleur	38	1564.0
Gulf of St. Lawrence	67	4000.4
Bay of Fundy	33	2628.3
Overall	138	8192.7

Source: New Brunswick Department of Natural Resources

How are salt marshes formed?

Some of our Atlantic Coast salt marshes were formed by the glaciers of the last ice age. As the glaciers melted, the water eroded valleys as it flowed toward the rising sea. As sea levels rose, these valleys were swamped and slowly filled with sand and gravel from the streams. Over time, plant seeds and animals of the salt marsh found a fertile place to grow.

Salt marshes can form in shallow inlets where tidal flooding and streams deposit sediments gradually forming the base soil of the marsh. In the zone called low marsh, salt marsh plants grow and help hold the soil in place. The roots and stems slow and trap more sediment. As the plants die and become partially decomposed they form a bed of peat. Peat is formed by the lack of oxygen and saltiness of the soil which prevents complete decay of the plant from occurring. Some areas of peat provide a historical record over 3000-4000 years and are three meters thick. The peat layer can continue to support plant growth.

The salt marsh can be destroyed by the removal of plant root material which causes the tides to erode the soil and displace the sediment elsewhere. Interference with tidal action by dykes and causeways may destroy a salt marsh or cause one to form in another area.

Fungi

What characteristics do salt marsh zones exhibit?

Salt marshes are characteristically divided into **high marsh** and **low marsh** zones, each with a distinct plant community. The area that is not affected by the tides is called the **transition zone** where regular plants and trees may be found. The lowest area usually has no vegetation and is called a **mudflat.** As a result of being deposited by the tide, sediments in a salt marsh usually show layers that reveal the successive stages in marsh development. The lowest levels are freshwater peat, corresponding to the period when the area was above sea level. Successive levels follow the changes from mud flat, low marsh, and eventually to high marsh.

Mudflats, covered by the tide twice a day are in the **intertidal zone**. They have little plant growth, but the numerous invertebrates, fungi, and algae in and on the mud contribute to the food web.

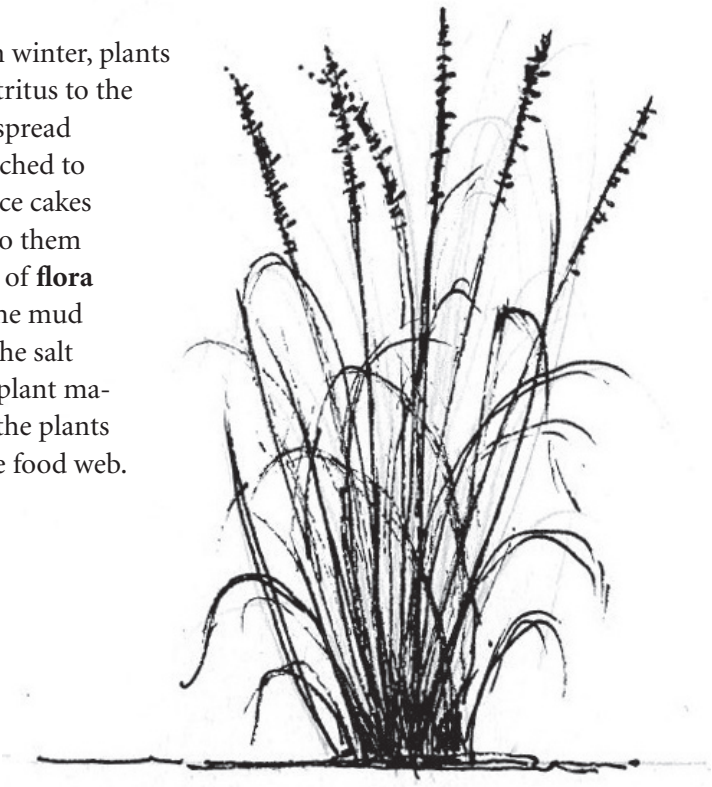
The **Low Marsh** is dominated by salt water cord grass which helps protect the soil from erosion. Sometimes algae and seaweed are also found here. This area of the marsh is covered by the tide twice a day.

The **High Marsh** is dominated by salt meadow grass. Other **halophytes**, such as sea-lavender, arrow grass, seaside plantain, milkwort, as well as various grasses, sedges, and rushes can also grow. The high marsh has more **biodiversity** because it is only covered by the tides during spring tides and full moons.

The **Transition Zone** is rarely covered by the tide except when severe storms and the highest tides occur at the same time. Plants and trees that grow here are extremely tolerant of the salt spray that is in the air and consist of the types of plants normally seen around coastal New Brunswick. These may include, but are not limited to, spruce trees, bayberry shrubs, pitcher plants, Labrador tea, and sheep laurel.

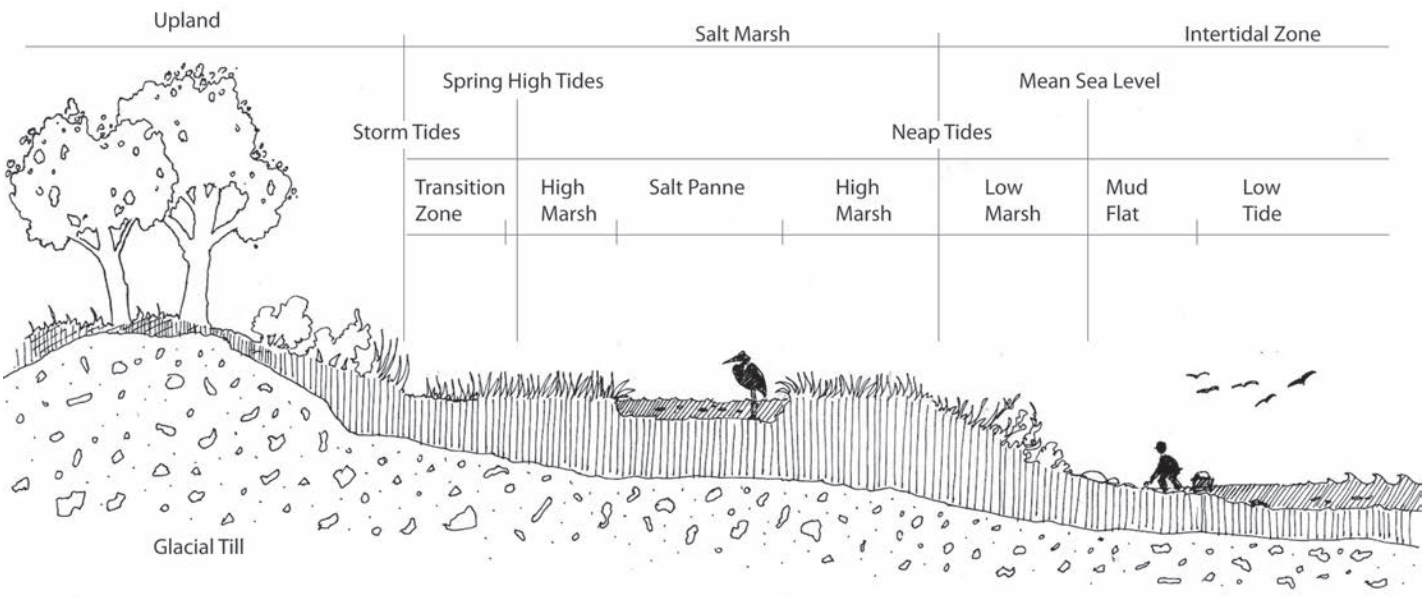
Seasonal Cycle

Atlantic salt marshes adapt to the changing seasons. In winter, plants die and are washed away by the tides spreading the detritus to the high marsh, low marsh, and out to sea. The tides also spread seeds and sediment especially when these become attached to the ice cakes that wash up on the salt marshes. When ice cakes stay on the salt marsh and melt, whatever is attached to them will be deposited on the marsh; this could be a variety of **flora** from inland rivers. The ice cakes sometimes damage the mud and sediment where some **fauna** live. In the summer the salt marsh becomes a carpet of green plant material. This plant material is not readily eaten by many animals. It is when the plants die and become detritus that they are important in the food web.



Cord Grass

Activity



Coastal Salt Marsh Profile (modified from Purinton and Mountain 1998)

1. Look at the picture of a salt marsh profile above. Does this picture accurately depict the succession of a salt marsh? _____

   What details have been left out? _____

   _____

   _____

   _____

   _____

2. Research your assigned salt marsh plant.

   Name of your salt marsh plant: _____

   Examine how field guides of plants are organized. What information do they provide and what types of pictures do they have? Organize your drawing and plant information like a field guide. Draw a picture of your plant, describe its physical characteristics

(colour, height, leaf shape, size, stem shape, etc.), identify the salt marsh zone where it is usually found, and state one role the plant plays in the ecology of a salt marsh.

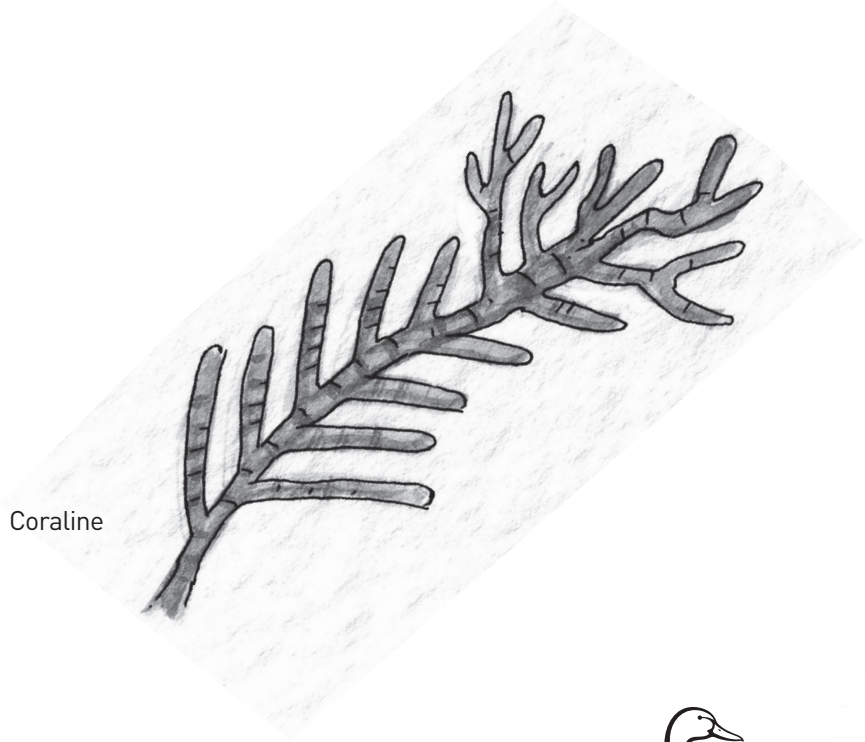
3. Work in pairs to make a poster or a model of the succession of a salt marsh. The model can be done in one dimension as a picture, multidimensional using clay or flour dough layers, or as a diorama.

   (A) Clearly indicate:

   - That the salt marsh is comprised of layers.
   - Its formation may take many thousands of years.
   - Differentiate between the high and low marsh zones.
   - Indicate the role that plants play in salt marsh formation.
   - Explain how the layers beneath the top of the salt marsh were formed.

   (B) Label:

   - the transition zone
   - the high marsh
   - the low marsh
   - mudflat/intertidal zone
   - the types of plants found in each area/zone



Coraline

LESSON TWO

Amazing Salt Marsh Adaptations

Background Information

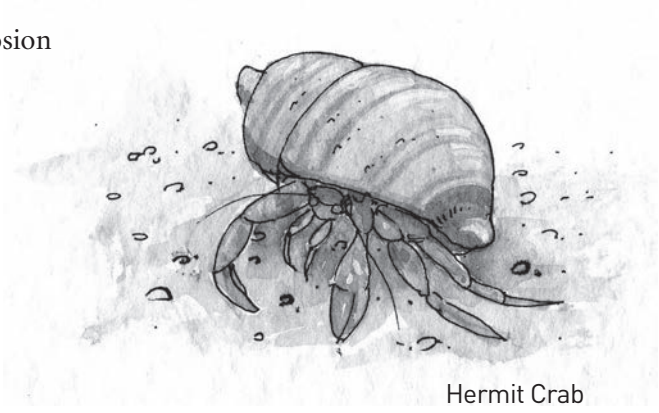
A salt marsh is a place of extremes. Variations in salt, oxygen, and temperature levels; wave and wind action; and scraping of the marsh surface by ice cakes require animals and plants to adapt. Organisms that live in salt marshes have amazing adaptations to cope with these challenges. These adaptations include the ability to excrete excess salt, store water, and unique methods of locomotion and protection.

Amazing Plants

Salt marshes are **intertidal** and are flooded by the ocean tides twice a day. This ecosystem is constantly changing and the wildlife that live on the salt marsh must have unique adaptations to cope with many factors. Plants on the low marsh are covered by the tides daily. Plants on the high marsh are flooded by salt water periodically such as during times of extreme high tides. Therefore; all salt marsh plants must be able to withstand high levels of **salinity**. Plants that are salt tolerant are called **halophytic**; they adapt to the salinity by excreting salt from their leaves and roots, trapping fresh water in their cells, and having narrow leaves which prevent water loss. They adapt to the lack of oxygen when covered by salt water by storing oxygen in their roots, or having air passages in the stems that take oxygen to the roots. This is also important since the soils of the salt marsh can be oxygen deprived from being flooded by the sea.

Many salt marsh plants are **perennial** and die off in the winter. Their root structure is strong and fibrous which holds them in place during severe storms or allows them to grow again even after ice cakes have scraped off the top of the soil.

Salt marsh plants play an important role in preventing erosion and in retaining particles that are left by the tides that compose the layers of the salt marsh. Few animals eat the plants on the salt marsh; however, the plants contribute to the ecosystem when they die and become **detritus** which is a food source for many salt marsh inhabitants.

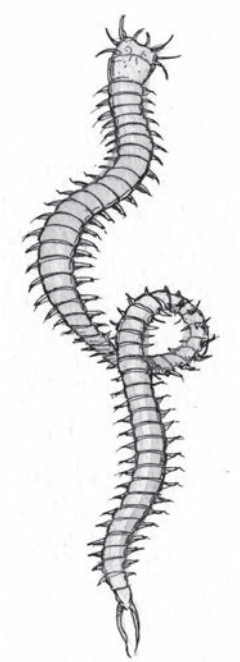


Hermit Crab

Amazing Creatures

The varied conditions that apply to salt marsh plants also apply to the animals that spend part or all of their life on the salt marsh.

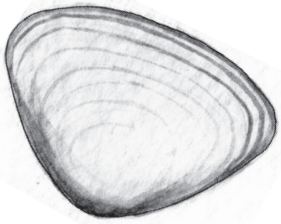
Some creatures such as mammals, birds, and fish use behavioural adaptations by moving in or out of the water to survive. Marine organisms that have shells use them for protection and close or seal their shells during low tide to conserve moisture and maintain proper levels of salinity. Some salt marsh worms and **amphipods** make burrows or dig under the sand and mud sediment. There are microscopic organisms that move in and out with the tide.



Clam Worm

There are many interesting physiological adaptations such as salt glands in birds and shellfish that remove the excess salt. Worms contract their bodies in order to expose less surface area to absorb salt and some can burrow themselves into the sediment to escape danger.

Some salt marsh organisms have unique food-catching **appendages**. Clams have tubes that reach into the surface of the sediment to obtain food and oxygen. They can quickly escape predators by scooting 30 cm under the sediment using their "foot" which is a muscular tongue-shaped organ that can expand and retract.



Soft Shell Clam

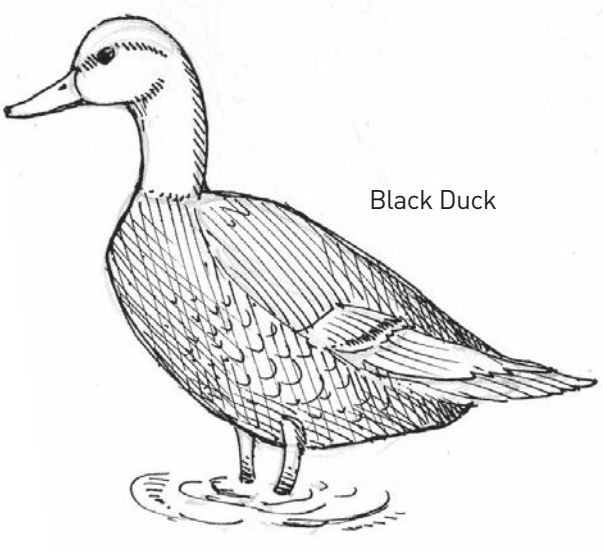
Maritime Ringlet Butterfly

The Maritime Ringlet Butterfly is a small orange butterfly that lives only in salt marshes. It is an **endangered** species in New Brunswick and can be found only in a very limited area around the Bay of Chaleur and nowhere else in the world. If that does not make it special, it has a very specific diet being one of the few creatures that gets its food from living salt marsh plants. The butterflies prefer to eat sea-lavender nectar but lay their eggs on the saltwater cord grass. This grass is what green **larva** (that hatch from the eggs) prefer to eat. It spends the winter under the dead plant leaves. The larva has an amazing ability to be completely submerged and survive under saltwater.

The Maritime Ringlet Butterfly faces many threats on the Maritime Coast. Salt marshes where the butterflies live are mostly privately owned and/or in residential areas. Since the Maritime Ringlet Butterfly is a **species at risk**, it is protected from anyone harming it or its habitat under regulation 96-26 of the New Brunswick Species at Risk Act. Key threats to the Maritime Ringlet Butterfly are habitat loss, habitat fragmentation, pesticide/herbicide run-off, pollutants, and all terrain vehicle use in salt marshes. Conservation groups have joined together to protect the butterfly's important habitat and there is research in progress to introduce the butterfly to other salt marshes that meet the habitat needs of this amazing creature.

Threats to the Maritime Ringlet Butterfly

- Limited distribution (found in a small region)
- Ice scraping
- Storm surges
- Salt marsh degradation
- Habitat fragmentation (when wildlife habitat gets divided into a smaller area)
- Pollution e.g. pesticides, herbicides, sewage, oil spills
- Specimen collection (of butterflies and sea lavender)
- Recreational vehicle use, such as ATVs, on the salt marsh
- Tourism
- Agriculture



Black Duck

Activity

Materials (per group of four):

- ❑ One copy of the salt marsh map (Appendix 2A)
- ❑ One threat card (Appendix 2B)
- ❑ Student journal

From your previous reading, please answer the following questions:

1. What makes salt marshes different from fresh water marshes?

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2. Give two examples of how plants adapt to a salt marsh ecosystem.

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3. Give two examples of how animals adapt to a salt marsh ecosystem.

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Challenge:

You are an active conservationist working with a team of environmental professionals in protecting the endangered Maritime Ringlet Butterfly in a local salt marsh.

4. Using the map (Appendix 2A), answer the following questions:

a) In what town is the salt marsh located?

_____

b) List possible threats to your salt marsh.

_____

_____

_____

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5. You and your conservation team must select a card describing a threat to the salt marsh.

   a) What is your team's threat? _____

   _____

   _____

   b) Is it natural or human-induced? _____

   c) If it is a natural threat, will global warming increase the effect? How? _____

   _____

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   d) If it is a human-induced threat, list two actions the team of environmental professionals could take in order to control or prevent the threat. _____

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e) Will the threat affect the high or low marsh zone? _____

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f) How could the threat affect salt marsh wildlife? _____

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g) What affect will this threat have on the Maritime Ringlet Butterfly? _____

_____

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h) What life stage of the butterfly do you think will be harmed the most by this threat?

_____

_____

Why? _____

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i) Is there anything your conservation team could do in order to help prevent this threat from harming the Maritime Ringlet Butterfly? What could the group do?

_____

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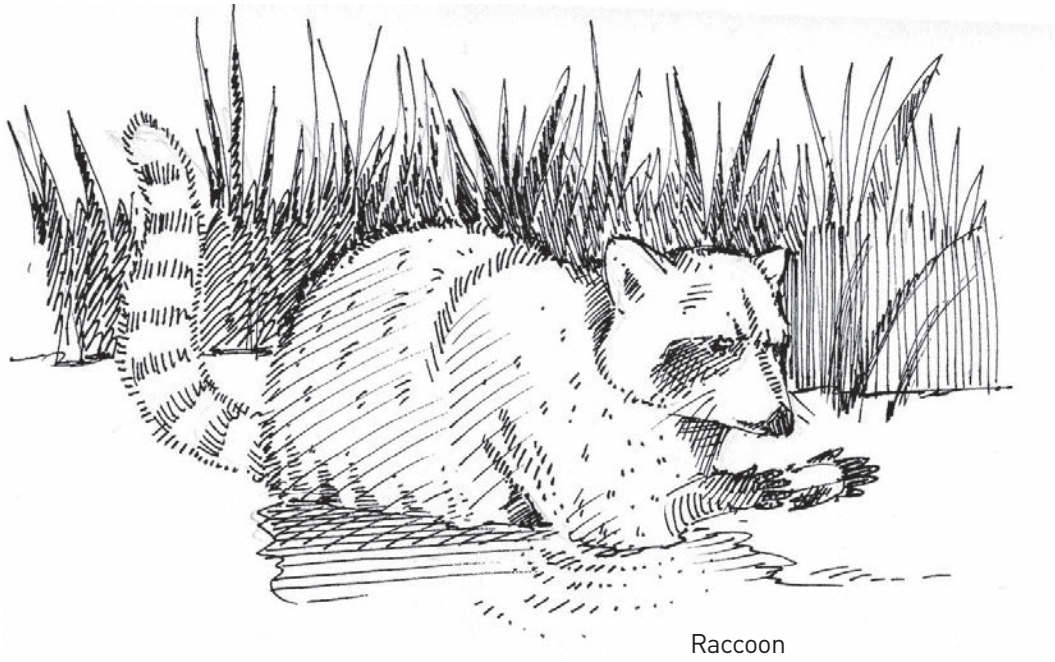
6. Prepare a report to present to your class. Tell your class what threat your salt marsh faced, how it could harm the butterflies, and any ideas you had for preventing this threat.



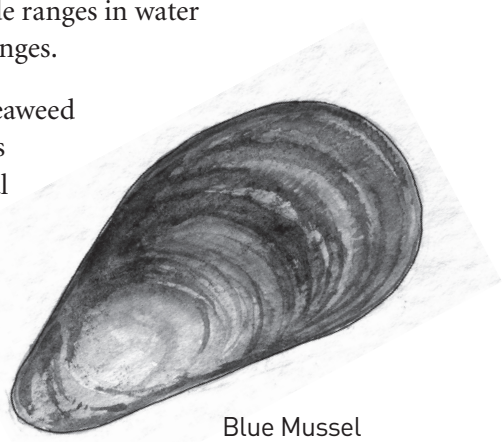
Raccoon

LESSON THREE

The Web of Life and Death

Background Information

Animals and plants that live in a healthy salt marsh reap the benefits of an ecosystem that has plenty of food to offer. They have adapted to a salty environment, wide ranges in water temperature, and being submerged or left high and dry when the tide changes.



Blue Mussel

The salt marsh ecosystem depends on primary producers like algae and seaweed in the water and the grasses in the salt marsh. Only a small amount of this vegetation is consumed when the plants are alive. When the plant material dies, decomposers such as bacteria and fungi disintegrate the particles into **detritus**. Many salt marsh organisms such as crabs, fish, mussels, and clams feed on detritus and are called detrivores.

A **food chain** represents how each living thing gets its food. Some animals eat plants (herbivores), some animals eat other animals (carnivores), and some eat both (omnivores). Plants capture the sun's energy and use it to convert **inorganic** compounds such as nutrients (from the soil) and water and oxygen (from the air) into **organic** compounds (such as sugar which is then stored in the leaves). Most food chains have no more than four or five links. For example, a simple food chain starts with the sun which gives energy to plants, (primary producer), which gives energy to an animal (primary consumer) which are eaten by other animals called secondary consumers. Each link in this chain is food for the next link. A food chain always starts with plant life and ends with an animal. You will find that arrows in a food chain always point in the direction of energy transfer.

Simple food chain: sun → salt marsh grass → shrimp → fish → bird.

A food chain depicts the transfer of energy from **trophic level** (the position the organism holds in a food chain) to trophic level.

Trophic Levels:

1. **Primary producers** are organisms that make their own food from sunlight and are one of the most important levels of every food chain (ex: plants). These organisms are called **autotrophs** (ex: salt marsh grass).

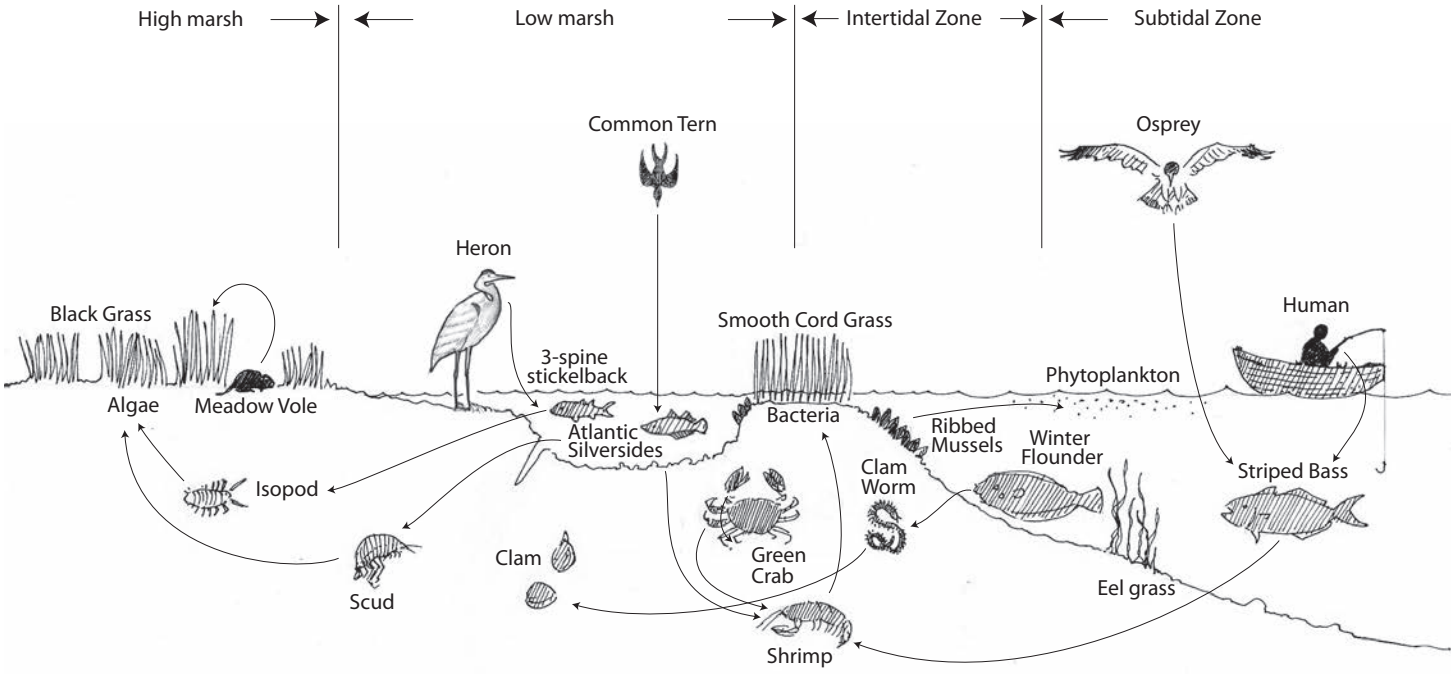
2. **Primary consumers** are animals that eat primary producers. They are called **herbivores** (ex: periwinkle).

3. **Secondary consumers** eat primary consumers. These consist of both **carnivores** (ex: whelk) and **omnivores** (ex: hermit crab).
4. **Tertiary consumers** are at the top of the food chain and eat secondary consumers. (ex: eagle)
5. **Decomposers** break down organic matter into another form that can be consumed by organisms directly or give nutrients to the soil for plant growth (ex: bacteria or fungi).
6. **Detrivores** are organisms that eat detritus formed from dead plants and animals (ex: scud).

Food chains "end" with top predators, animals that have few or no natural enemies.

The Food Web

Most organisms are part of one or more food chains. When food chains are connected, a food web is formed. The interconnected feeding relationships in a food web can be complex; some organisms may feed on more than one trophic level, or changes may occur depending on a species' life history stages or the availability of food.



Trophic levels of a Salt Marsh Food Web

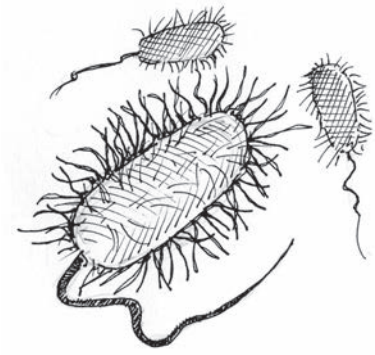
Plants *(Producers)*

Plants are the producers of organic material in the salt marsh which become detritus and food for other species or decompose into nutrients. Once the saltwater cord grass becomes established in a salt marsh, other salt-loving plants follow. Usually herbivores eat a substantial portion of green plants but in a salt marsh this is not true. Instead, the cord grass is broken down as dead material (detritus) by the actions of bacteria and fungi. As the plant material is broken down mechanically and then digested by organisms it becomes raw material for algae. The algae grow as free-floating forms called **phytoplankton** and attach to larger plants, the surface of rocks, and to sediments. This algae becomes food for microscopic animals and filter-feeding species such as mussels. Floating microscopic animals known as **zooplankton** feed on the algae.

Each drop of water may contain a variety of **plankton** which is eaten directly by zooplankton and filter feeders. **Diatoms**, which are one celled plants that produce the majority of oxygen on Earth, coat the mud surface and are the major food source for **amphipods** such as scuds.

Fungi and Bacteria *(Decomposers)*

There are decomposers (bacteria and fungi) on the salt marsh which feed on dead or decaying matter. These decomposers speed up the decaying process of dead plants that release mineral salts back into the food chain for absorption by plants as nutrients. When a plant dies and is partially decomposed by bacteria and fungi into detritus, the bacteria can double the protein content of the dead plant. Wildlife animals that eat detritus are called **detritivores**. Examples of detritivores are snails, crabs, scuds, and worms which provide food for other consumers.



Bacteria

Insects *(Primary and Secondary Consumers)*

Midges, mosquitoes, deer flies, black flies, no-see-ums (black gnats), sand flies, and grasshoppers are just a few of the insects that live in salt marshes. These insects and their larvae are important food for birds and fish. Spiders often invade saltwater cord grass.

Amphipods *(Primary Consumers and Detrivores)*

Food webs are supported by small organisms that can be overlooked**.** For example, scuds are a type of amphipod belonging to the crustacean family. They can be found under damp seaweed and on salt marsh mudflats. The scud is incredibly abundant in many salt marshes

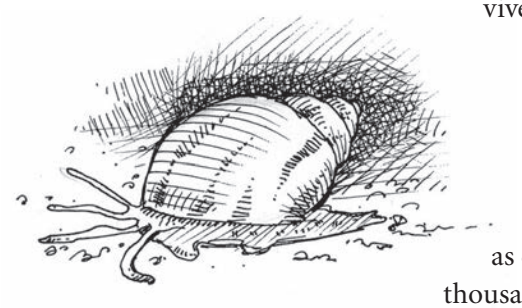
and mudflats so biologists consider it to be a **keystone species**. This means that it is critical to the survival of many other species on the salt marsh and the loss of this species results in the collapse of the ecosystem.

Scuds are very sensitive to toxic substances such as organic wastes, pesticides, crude oil, heavy metals, and PCBs (polychlorinated biphenyls). Environment Canada uses the scud as a standard test organism for assessing if there are any pollution problems in marine areas. This small creature is high on the menu for a wide range of hungry animals. At high tide, small fish dine on them and at low tide the birds are waiting to take their turn at dinner.

If something were to happen to decrease the scud population it could affect the marine organisms that prey on it such as fish and crabs. Many shorebird species eat large amounts of scuds to give them energy for their long migration. The scud feeds on sediment particles that are coated with organic matter such as bacteria, fungi, and algae. In summer, the most important food sources for scuds are diatoms (single-celled plants) that live on the surface of the mud. Detritus supplements the scud diet when diatoms are scarce.

Mollusks *(Primary and Secondary Consumers)*

Mollusks inhabit the sandbars and mudflats of salt marshes. The ribbed mussel, the periwinkle, and the mud dog whelk are found among the saltwater cord grass and some can survive out of the water between tides. Some mollusks feed by filtering small organisms and detritus from the water while others are carnivores. Some will graze on microscopic algae found in the mud and on the vegetation in the salt marsh. Others feed on detritus from dead or decaying animals and plants.



Mud Dog Whelk

Mollusks are an important source of food for other species such as crabs, fish and birds. Mud dog whelks are the snails you see by the thousands on mudflats at low tide. They are grazing on the layer of diatoms, bacteria, and blue-green microalgae that cover the mudflats. They also feed on **macroalgae** such as sea lettuce and scavenge dead fish when available.

Fish *(Primary and Secondary Consumers)*

Some fish such as small sticklebacks, killifish, mummichogs, and Atlantic silversides live in salt marshes throughout their entire lives. Fish such as the striped bass, gaspereaux, and American eels occasionally visit during high tide to feed or lay eggs. Some juvenile fish like to use salt marshes for shelter and food. Fish that inhabit salt marshes provide food for birds such as Greater Yellowlegs, Belted Kingfishers, Common Terns, and Great Blue Herons.

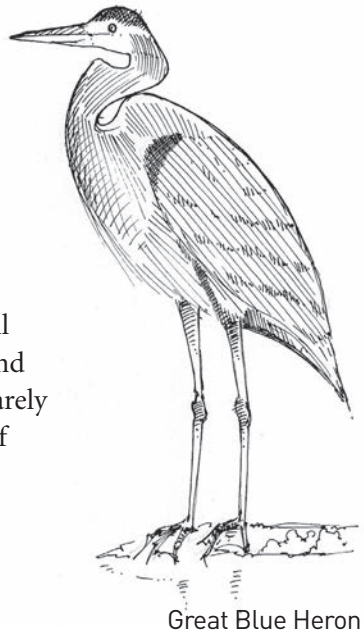
The mummichog, a salt marsh fish species, is an omnivore. It has been reported that one mummichog can eat as many as 2,000 mosquito larvae ("wrigglers") a day. This is why it has been used as a natural method of mosquito control in marsh ponds and ditches. The mummichog also feeds on other insects, small fish, crustaceans, and plant material.

Birds *(Primary and Secondary Consumers)*

The mud flat zone of the salt marsh is critical to the survival of the Semipalmated Sandpiper. The mudflats provide an important feeding habitat during migration stopovers by shorebirds. Flocks of Semipalmated Sandpipers totaling over 280,000 gather at the head of the Bay of Fundy to feed on the scuds of the mudflats before continuing their migration south.

The Great Blue Heron is the largest and most common of North American herons. It is often seen standing at the edge of a tidal pond watching for small fish, its favorite prey. It also feeds on small mammals, reptiles, amphibians, and occasionally birds. It is interesting to note that amphibians and reptiles are rarely found on the salt marshes of Atlantic Canada due to the cold temperatures of our ocean.

The American Black Duck can live near our salt marshes where the marine areas do not freeze in winter and eats seeds, eelgrass, insects, snails, mussels, periwinkles, mollusks, and crustaceans.



Great Blue Heron

Mammals *(Primary and Secondary Consumers)*

There are a variety of mammals that visit salt marshes to look for food and shelter. In the upper sections of the marsh voles and shrews forage for insects and seeds. Raccoons visit the tidal creeks in search of fish and mollusks. Muskrats live in tidal creeks, where they burrow into the banks and raise ten to fifteen young per season. Occasionally, deer and moose visit the marshes to look for salt and seaweed.

It is important to remember that a change in the size of one population in a food web will affect other populations. Experiments along the Virginia and Georgia coasts showed that over-harvesting of Blue Crabs by commercial fishermen can actually destroy entire salt marshes. Blue Crabs eat periwinkle snails which eat saltwater cord grass which anchors the salt marsh sediments. Without Blue Crabs the periwinkle snails flourish which destroys saltwater cord grass and the salt marsh quickly erodes and becomes a barren mudflat.

Activity

1. What is a "keystone species"? _____

_____

_____

_____

_____

_____

_____

_____

2. Which creature of the salt marsh is most sensitive to toxic substances and is used by Environment Canada as a test to measure pollution? _____

_____

_____

_____

3. What are the six trophic levels of a food chain? Give an example of a species from the salt marsh for each trophic level.

Level

1 _____ Example _____
2 _____ Example _____
3 _____ Example _____
4 _____ Example _____
5 _____ Example _____
6 _____ Example _____

4. Explain the difference between a food chain and a food web. _____

_____

_____

_____

_____

The Web of Life and Death

Working in pairs and using Appendix 3A, cut out the marsh wildlife with the number and label attached.

- Using your journal readings for clues, form a food chain with four or five links.
- Connect the links on your desk with Popsicle sticks (do not glue or tape them in place).
- Connect the remaining marsh wildlife to the food chain using more Popsicle sticks until all twelve marsh wildlife figures are connected to another figure and form a food web.

Everything is going smoothly on the salt marsh but what happens when your teacher rolls the die and that numbered figure is removed from your web?

Write the name of the species that is in trouble on the salt marsh.

_____

_____

What could have caused a problem for this species?

_____

_____

_____

_____

_____

What other marsh wildlife is affected and what do you think will happen?

_____

_____

_____

_____

Try to reconnect your web without the missing species.

The teacher rolls the die again and you must remove another part of your food web.

Write the name of the species that is in trouble on the salt marsh.

_____

_____

What could have caused a problem for this species?

_____

_____

_____

_____

_____

What other marsh wildlife is affected and what do you think will happen?

_____

_____

_____

_____

_____

When you have finished, use your twelve marsh wildlife figures to form a lasting food web. For this food web draw the direction of the energy flow by using arrows.

- Glue or tape the marsh figures and Popsicle sticks into their final connections on a piece of paper.
- Display the salt marsh food webs during your Salt Marsh Awareness Day.

LESSON FOUR

"You Have the Power" The Protection of a Salt Marsh

Background Information

Empowering Yourself with Knowledge

In this lesson, you will become **empowered**, which means you will become equipped with the knowledge, skills, and resources needed in order to change and improve the quality of the salt marsh community. You will learn about a salt marsh from several sources, assess the salt marsh, and make a plan of action to raise awareness of your salt marsh.

The tides wash away material, such as sediment, but they also bring material to the salt marsh. This constant give and take over the centuries has built up thick mudflats and salt marshes around the New Brunswick shoreline. If the rate of erosion or deposit of sediment changes, then a mudflat or salt marsh could decrease, expand, or move. Water flow is the force behind the sediment movement. Salt marshes and mudflats are products of the changing currents of the tides. As sea levels rise, the salt marshes and mud flats will move inland because the lower levels will be flooded. Human activities can further complicate the tidal currents and cause challenges to a salt marsh habitat.

Salt marshes have long been threatened by humans. Enclosure for agricultural use (**dykes**), ports and harbours, roads, railways, power lines, wharves, cottages, and other infrastructure have reduced many salt marshes. Recreational use, pollution, and wave action (including wash from boats) can further damage the marsh.

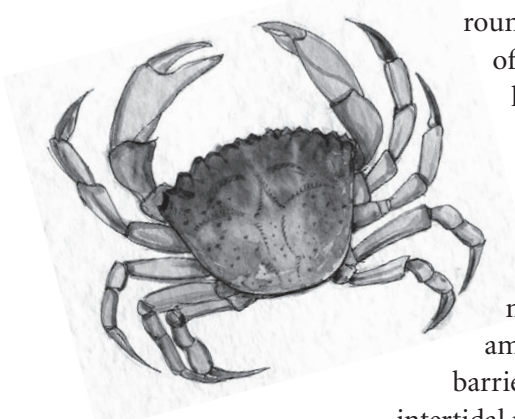
Protecting salt marshes means not only protecting habitat for wildlife, but protecting the economics and well being of our communities. This issue relates to the **sustainable development** of our resources, so they are available to future generations. The assignment for this lesson is to develop a plan of action to protect or restore a salt marsh.

Protection

A certain amount of unintentional salt marsh creation or restoration is happening all the time. An example is the huge mud flat that has developed downstream of the Petitcodiac River causeway since its construction in 1968. Over a few decades, soft muddy sediments have accumulated just below the barrier. Over time, salt marsh plants grew on the sediments and now the area below the causeway is considered to be a salt marsh. However; the salt marshes that were above this causeway have been reduced or have disappeared because of the restricted tidal flow through the causeway.

Dykeland that is neglected may eventually erode, allowing waves and currents to break through thus flooding abandoned fields and allowing salt marsh plants to slowly re-establish. Some oceanographers worry that rising sea levels will cause more dykes to fail and flood a great deal more of reclaimed land. Some protected dykelands are not only for agricultural use but can contain residential or commercial developments, roads and rail beds that all need to be protected from flooding.

There needs to be a balance between protecting dykeland and protecting the natural salt marsh. Anything that increases or decreases freshwater or saltwater movement on a tidal river will affect animals and plants in the water, on the sea floor, and in the surrounding salt marsh wetlands. We must remember that we are the stewards of the natural world around us and in the end protecting the natural world has many benefits to people. The salt marsh helps prevent flooding, absorbs toxins, provides a nursery for many species of fish, as well as provide many other opportunities that benefit all species.



Green Crab

There are reports of great changes in the types and abundance of bottom dwelling and planktonic animals living in some areas. On some mudflats the number of **amphipods** has decreased from close to 30,000 amphipods per square meter to almost none today. It is suspected that barriers such as causeways have contributed to changes in the composition of intertidal mud, which have resulted in these declines. Migrating birds rely on eating the amphipods to give them energy for migration.

Sewage contamination and excessive sedimentation have forced once productive shellfish flats to close. Scientists are finding more toxic chemicals in the seawater, bottom sediments, and tissues of some marine animals. Marine habitats are being degraded by intensive, highly mechanized and destructive marine harvesting methods, fishing, and other marine species harvesting methods. Causeways and dams obstruct rivers flowing into the ocean, and this has altered natural processes in many areas including the salt marshes. The causeway at Annapolis Royal, Nova Scotia, has spinning turbines of a tidal power plant which kill and injure large numbers of migrating fish each year.

Restoring and maintaining healthy salt marsh ecosystems must be a cooperative venture involving many partners. It is important to remember that salt marshes are owned by different people or businesses who must be involved in decisions affecting these ecosystems (Federal, Provincial and Municipal governments). Research institutions and universities need to collect and analyze marine ecosystem data to help everyone understand all processes involved. The active participation of resource users (ex: business, industry) and residents of communities near the ocean will be vitally important.

The way communities use the ocean and harvest its resources can be critical to the well-being of the salt marsh. Many residents have important information about the changing environment and wildlife populations of the ocean around them. Community groups and volunteers can collect scientific information and samples for a variety of environmental monitoring and research programs.

Listed below are some of the government policies that can help protect salt marshes. It must be realized that policies can be hard to monitor or enforce. You as an empowered citizen can investigate a salt marsh and interpret what you find to see if government policies or regulations are protecting your salt marsh. Part of your assignment is to compose a plan of action for your salt marsh to protect and/or restore. This will involve learning the particular situation at your salt marsh and taking action to empower yourself to make a difference.

New Brunswick Wetlands Conservation Policy

The Government of New Brunswick will ensure no loss of Provincially Significant Wetland habitat and promote and develop wetlands conservation education, stewardship, and securement initiatives.

Provincially Significant Wetlands (PSW) under the policy are wetlands that may include or contain remnants of formerly widespread wetland types (e.g. coastal marshes); sites managed or set aside for conservation; endangered species or those with special status; significant species diversity/assemblages; significant hydrologic value; or significant social or cultural value.

New Brunswick Clean Water Act

Any activity in or within 30m* of a wetland greater than 1 hectare (2.5 acres) in size or connected to a watercourse, requires a permit from the Department of the Environment.

If wetlands smaller than 1 hectare are part of a watercourse, they require a permit regardless of size. The size of the watercourse does not matter. If there is any flow into or out of a wetland at some point during the year, a permit is required.

**30 metres is measured from the outer edge of the wetland.*

Clean Environment Act

Department of Environment and Department of Natural Resources Ministers can designate Provincially Significant Wetlands as "protected areas" in law by the Wetland Designation order. The Environmental Impact Assessment Regulation falls under the Clean Environment Act and requires an Environmental Impact Assessment for any activity affecting a wetland greater than 2 hectares (5 acres) or more in size.

Available Tools:
There are several resources available to those with questions pertaining to the Clean Water Act and Clean Environment Act. Department of Natural Resources has developed a wetlands inventory which identifies wetlands that fall under the new regulations. Service New Brunswick has a data set of coastal features identifying coastal wetlands.

Federal Conservation Guidelines

It is the responsibility of each federal authority to develop plans and directives for wetland conservation specific to their operations. Various government agencies have developed wetland conservation and evaluation guidelines.

- Standard conditions for operating in and around wetland areas to be attached to permit approvals which may affect wetlands;
- Codes of practice for particular types of activities such as forest harvesting, shoreline stabilization projects, or routine maintenance in and around wetlands;
- Environmental assessment guidelines for wetlands such as checklists of functions or effects; guides to evaluating wetland values in the face of competing values; and to determine the most appropriate use;
- Environmental quality guidelines that establish acceptable standards for various wetland components, such as water quality;
- Marketing and communication strategies to increase public awareness of wetland values.

Activity #1

1. As a class select a salt marsh near your school using the map in Appendix 4A, which identifies salt marshes with dark shading along the coasts of New Brunswick.

   Use a New Brunswick atlas to find the names of the community near the salt marsh closest to your school. Here is a web site for a New Brunswick map: http://www.snb.ca/gdam_igec/e/2900e_1.asp

   Choose the square of New Brunswick that you want to look at closer. Zoom in and view the wetlands identified by a few green lines that look like vegetation. The green lines near the coast should be salt marshes.

2. Investigate the salt marsh and find clues to understand if there are threats (man-made and/or natural) to the natural balance of the salt marsh. Research your particular salt marsh on the internet. Identify how the Federal and Provincial protection policies could work to help protect the marsh.

   List any threats to the salt marsh you are investigating by internet research.

   _____

   _____

   _____

   How could the Federal Protection laws help?

   _____

   _____

   _____

   How could the Provincial Protection laws help?

   _____

   _____

   _____

3. Working in pairs, you will interview either by phone, email, or mail a stakeholder near the salt marsh. Some examples are: farmers, residents, fishers, business people, youth, and conservationists.

   If the salt marsh is located far away from your school your teacher may initiate contact with a school that is close to the salt marsh to establish a list of people to contact.

   You will have one week to identify who you will interview. Your teacher will then make a list of the people you have selected to interview to insure more than one side of the story is heard.

   As a class compile a list of questions about the salt marsh. Research the human activities that occur in and around the salt marsh and on the **watershed** that drains into the salt marsh. You must determine if any local industries depend on the health of the salt marsh. Check out the sample survey in your journal. Does your class want to add or delete some of the questions?

   Proceed to interview your contact person.

Salt Marsh Evaluation Survey (sample interview)

Name of community: _____

1. What is your occupation? _____
   _____

2. Do you work or do recreational activities on or near the salt marsh? _____
   _____
   If so, what activities do you perform on or near the salt marsh?_____
   _____
   _____
   _____

3. What wildlife have you seen on the salt marsh? _____
   _____
   _____
   _____

4. Are there or have there ever been any wharves or similar structures on or near the salt marsh? _____ How many?_____
   Where are they located?_____
   _____
   _____

5. Are there dykelands on or near the salt marsh?_____
   Are the dykelands used for agriculture?_____
   In what way? ❑ Animal grazing ❑ Crops
   Are there any aboiteaux? _____

6. Is there a highway or railway near the salt marsh?_____
   Do you know if there are culverts for tidal flow?_____
   How many? _____

7. Is there any industry close to the salt marsh or up river from it? _____
   What is the industry?_____

8. Do you think your salt marsh is protected from harmful human activities?_____
   If yes, how? _____
   _____
   _____
   If no, what suggestions do you have?_____
   _____
   _____
   _____

9. Over the years have you seen changes in the salt marsh? (Examples: water level, different plants, different wildlife, or human activities.) _____
   What kind of changes?_____
   _____
   _____
   _____
   _____

10. Would you be willing to help protect your salt marsh? _____
    How? Please check all that apply.

    - ❑ Write a letter to a politician
    - ❑ Volunteer time
    - ❑ Learn more about salt marshes
    - ❑ Join a salt marsh citizen's group

THANK YOU FOR YOUR TIME

Survey results

After interviewing your contact do you think this salt marsh needs protection? _____

If you answered yes, explain why. _____

_____

_____

_____

If you answered no, explain why._____

_____

_____

_____

Do you think existing government policies are protecting your salt marsh?_____

How? _____

_____

_____

_____

_____

The Big Picture

Did your opinion change after you compiled the information that the whole class gathered from their surveys? _____ How?_____

_____

_____

_____

_____

_____

Activity # 2

Description

You will become empowered to initiate a plan for your salt marsh. Brainstorm what actions you will need to take to involve the government, commercial interests, conservation groups, and the social community in the project to protect the salt marsh.

1. By completing Activity #1 you have started to gather information to get a community profile of your salt marsh. The surveys will help initiate community awareness.
2. Gather information from government about your salt marsh. Areas of government that may be of help include the Department of Natural Resources, Department of Fisheries and Oceans, Department of Agriculture, Canadian Wildlife Service, and Department of the Environment. Explain to these departments that you wish to promote awareness of your salt marsh. Ask them for ideas. Ask about available grants.
3. Gather information from community groups such as the New Brunswick Nature Trust

   Website http://conservationcouncil.ca/Chaleur-to-Tormentine/Salt-Marsh-Loss.aspx

   Explain to these groups that you wish to promote awareness of your salt marsh. Ask them for ideas. Ask about available grants.
4. Educate the stakeholders of the community about the importance of the salt marsh through a presentation or a salt marsh clean up day.

Activity

1. Your teacher will divide the class into these four sections: (1)government, (2)commercial, (3)conservation, and (4)social. You will be assigned one contact and as a class you will compile questions to ask your assigned contact.

Which section are you in? _____

What part of your section will you research? _____

_____

You have a week to compile information from your assigned contact and come up with an action that will help to protect the salt marsh. After one week you will have an hour to meet in your section [(1) government, (2) commercial, (3) conservation, and (4) social] to allow each section to share their knowledge and develop an outline of a plan of action for the protection of the salt marsh.

One student from each section will give an oral report of the actions their group recommends.

The outlines are passed into your teacher who decides which parts of the plans are feasible for your class to implement. Your class will take ACTION because YOU have the power of knowledge!

Government Section:

Federal or Provincial Department of Natural Resources, Department of Fisheries and Oceans, Department of Agriculture, Department of the Environment, the Department of Transportation (if there is culvert or other barrier preventing or restricting the flow of the tide), the Canadian Wildlife Service, and municipal government.

Commercial Section:

Fishers, farmers, tourism interests, and other industries.

Conservation Section:

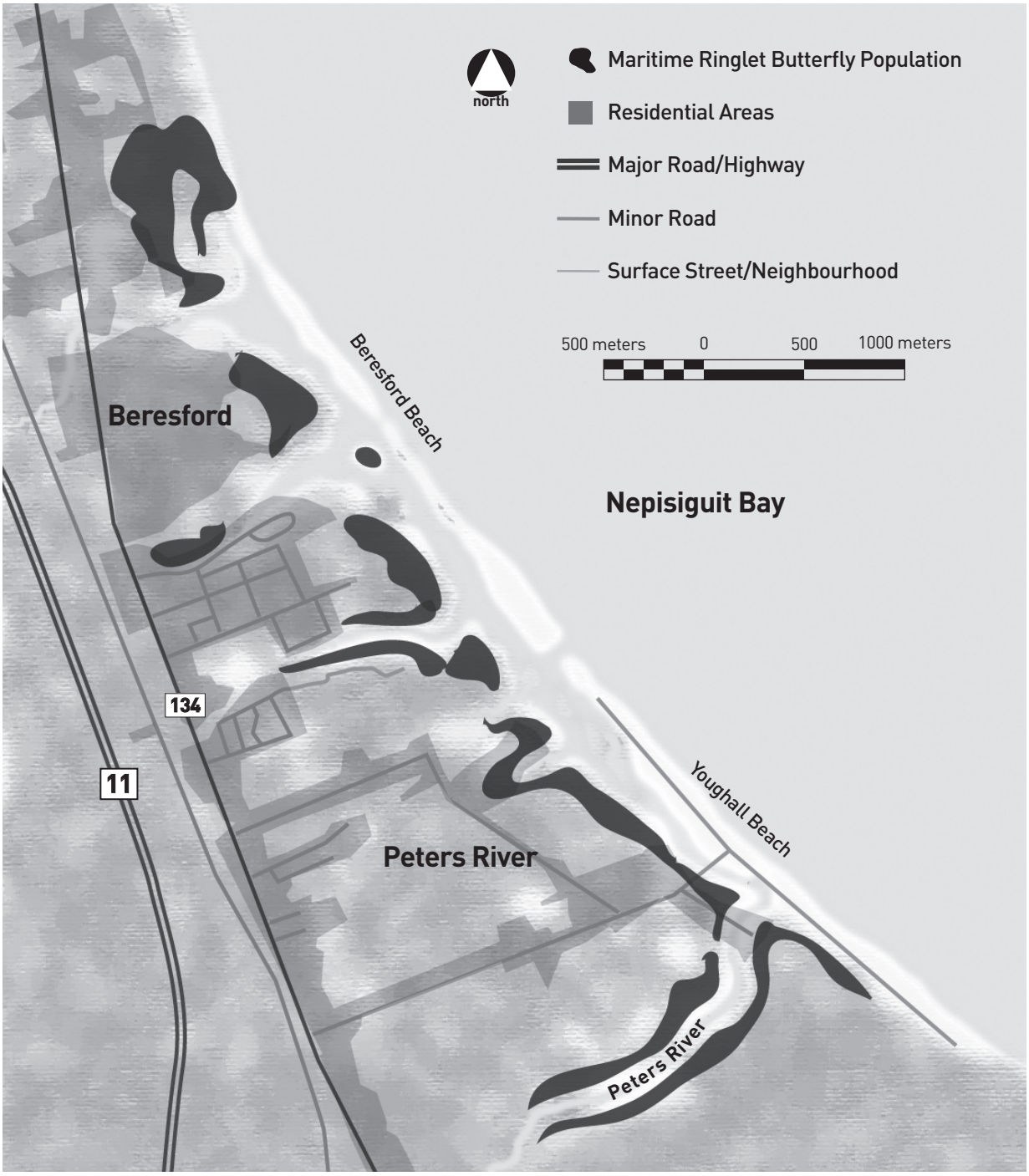
Ducks Unlimited Canada, New Brunswick Nature Trust, Petitcodiac Riverkeepers, Conservation Council of New Brunswick, Canadian Wildlife Federation, Sierra Club of Canada, Nature Canada and the Fundy Baykeeper.

Social Section:

Elders, youth, schools, New Brunswick universities (research of salt marshes), community organizations (4-H, scouts and guides, heritage societies).

Appendices

Appendix 2A:
Map of Salt Marsh with Maritime Ringlet Operations



Appendix 2B:
Threat Cards

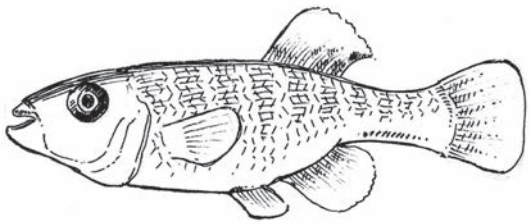
Winter without snowfall; marsh is exposed	Large ice cakes on marsh during winter
Sea level rises	Tourism operators want a boat launch at the marsh
Factory water treatment plant breaks down	Storm surges erodes tidal bank

Dry summer	Forest fire burns 50% of marsh
Cottage sewage drains into marsh	Oil tanker sinks off coast
Entrepreneur collects sea-lavender for sale	ATVs race throughout marsh
Residents spray for mosquitoes	Tourism operator offers guided hikes of the marsh

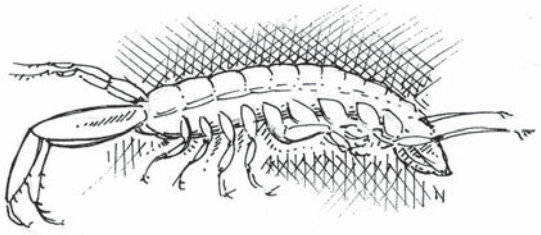
Farmers use insecticide on fields near the salt marsh	Butterfly collectors use nets to collect insects on the salt marsh
Garbage is dumped up river from the salt marsh	A resort is built along the edge of the salt marsh
Salmon aquaculture farm built near the salt marsh	

Appendix 3A : Food Web Species

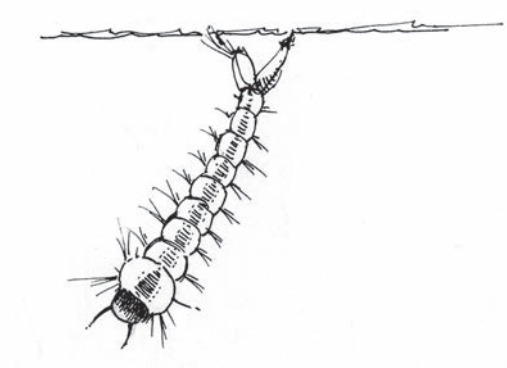
1. Cord grass



2. Mummichog

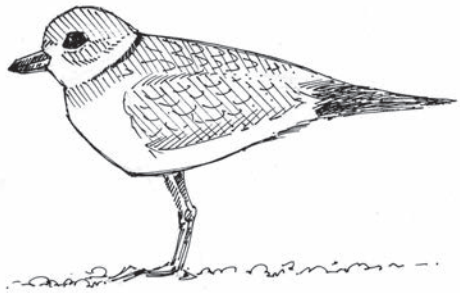


3. Corophium or scud

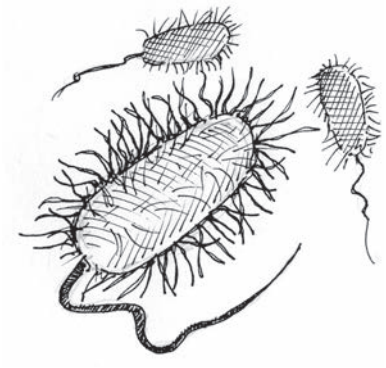


4. Mosquito larva

5. White-tailed deer

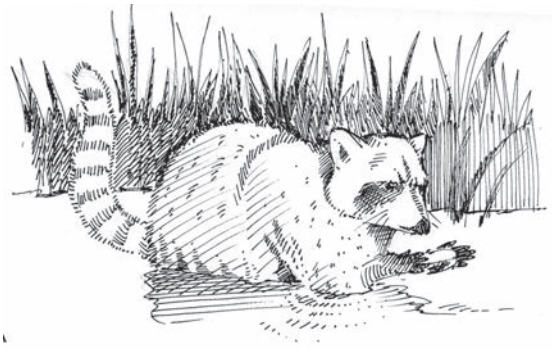


6. Semipalmated Plover

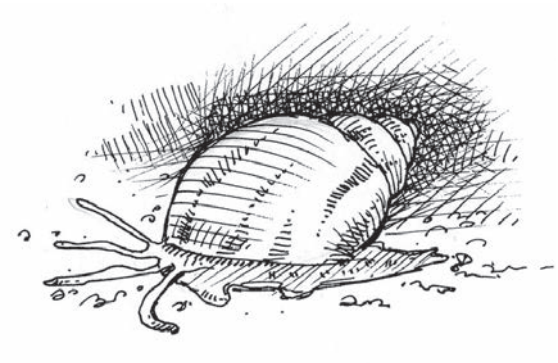


7. Bacteria

8. Great Blue Heron

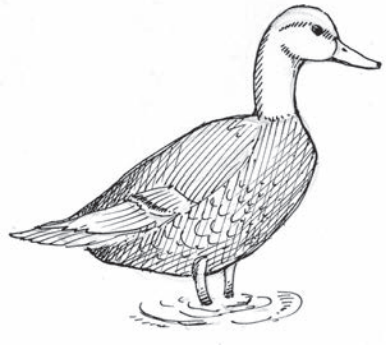


9. Raccoon



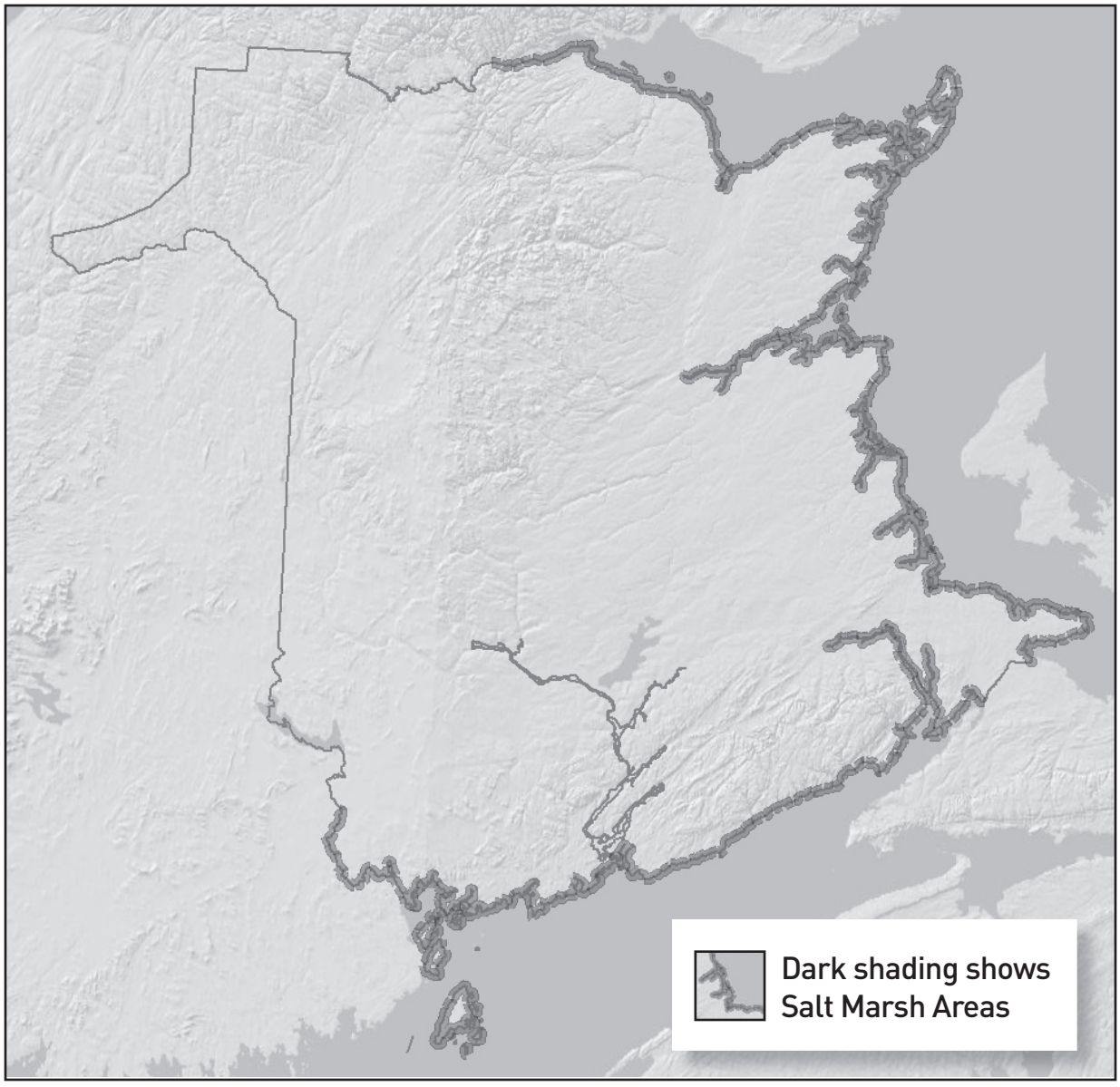
10. Mud dog whelk

11. Fungi



12. Black duck

Appendix 4A:
Map of New Brunswick Salt Marshes



Adapted from: Hanson, A.R. and Calkins L. 1996, *Wetlands of the Maritime Provinces,* Canadian Wildlife Services

Glossary

Aboiteaux: A sluice (man-made ditch) that was used by Acadians to drain salt marshes for the purposes of crop cultivation.

Amphipods: A group of small aquatic invertebrates that have an exoskeleton and are related to crabs and shrimp. They are sometimes called scuds.

Appendages: A part or organ, such as an arm, leg, tail, or fin that is joined to the axis or trunk of a body.

Biodiversity: The variety of plants and animals and other living things in a particular area or region.

Detritus: Dead plant and animal material.

Detritivores: Wildlife that eat detritus.

Diatoms: Single-celled plants with silica shells.

Dyke: A man-made structure of built up land created to prevent flooding of an area.

Dykeland: The dry land resulting in the creation of dykes often used for agriculture or development.

Ecology: The study of how organisms interact with each other and their physical environment.

Empowerment: To become equipped with knowledge and skills needed in order to take action for yourself or something you believe in.

Endangered: An organism that is in danger of becoming extinct.

Extinction: A living organism no longer found anywhere on the earth.

Estuary: Where the lower part of a river meets the sea and salt and fresh water mix.

Fauna: Animal life in a particular region.

Flora: Plant life in a particular region.

Halophytes: A plant adapted to living in a salty environment.

Halophytic: Salt water tolerant plants.

Hypo-osmotic: A solution with a lower salt concentration than the cells that the solution surrounds so water is drawn into the cells by osmosis causing the cells to swell.

Intertidal: The coastal zone measured from the lowest to the highest tide mark.

Inorganic: Not involving organisms or the products of their life processes; lacking the properties and characteristic of living organisms. Example: rocks.

Invertebrates: An organism without a spine.

Keystone species: A species that has a large effect on its ecosystem and determines the types and numbers of various other species present.

Larva: The newly hatched, wingless, wormlike form of many insects. For example a caterpillar.

Macroalgae: A biological term used to describe larger forms of algae such as seaweed.

Organic: Involving life or the products of life; being or relating to, derived from, or having properties characteristic of living organisms. Example: leaves.

Perennial: Plants that survive winter and produce new growth each spring.

Physiological: The science that studies the function of the body and the vital processes of living things.

Phytoplankton: Microscopic plant organisms that live in water.

Plankton: Drifting microscopic plant and animal organisms that inhabit water.

Policies: A course or plan of administrative action.

Salinity: The salt content calculated as the amount of salt (in grams) dissolved in 1,000 grams (1 kilogram) of seawater. The average ocean salinity is 35 ppt while fresh water is 0 ppt.

Special concern: An organism that may become threatened or endangered due to a combination of biological characteristics and identified threats.

Species at Risk: Plant and animal species that have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and are at risk of disappearing from their environment.

Sustainable development: Development that meets the needs of the present without compromising the needs of the future.

Watershed: All the land drained by rivers, creeks, streams or any other water system.

Zooplankton: Microscopic animal organisms that live in water.