# SECTION 5.0. ESTUARIES AND COASTAL SALT MARSHES

THIS SECTION CONTAINS:

- An introduction to estuaries
- How an estuary works
- Problems affecting estuaries
- A quiz to test your knowledge

## 5.1. Introduction

A smelly tidal flat or saltwater marsh may seem unimportant but these areas provide food and shelter for many fish, shellfish, birds, plants, and small animals.

In addition, a large percentage of the world's people live close to an estuary or its river. Natural harbours, fertile river basins, and plentiful fish and animal life are some of the underlying reasons. In Nova Scotia, most people live in the Halifax-Dartmouth area and along our coasts, where rivers and streams empty at the sea.

An estuary is where fresh water from a river mixes with salt water from the sea. Freshwater flowing out over the surface sets up a circulation pattern, drawing nutrient-rich water up from the bottom. The combination of nutrients and light produces plankton, a major food source for life in the estuary.

Many Nova Scotians have daily contact with an estuary or salt marsh. This makes it especially important to understand how human activity affects this ecosystem.

Estuary ecosystems are extremely fragile and vulnerable to human interference. Any change in river flow or water quality can dramatically affect the health of the ecosystem.

Over 70% of all commercial fish species use estuaries and coastal zones at the critical **juvenile** (youth) stage of their lives.

Each estuary has its own unique ecosystem and there are many kinds. The Bedford Basin near Halifax, West Petpeswick and the Bras d'Or Lakes are examples of estuaries known as **fjords**. These were originally lake and river channels.

It's estimated that Nova Scotia has 7,442 km (4,625 miles) of coastline!

## 5.2. How an Estuary Works

In the estuary, dead plants, plankton, fish, and other organic material sink to the bottom and decay. This produces nutrients such as nitrogen and phosphorus for new plant growth. However, these nutrients must be brought to the surface to be recycled. Under natural conditions, the mixing of tides and river flows acts like a pump bringing nutrient-rich bottom water to the surface and the sun. There, the sun, penetrating the water, encourages the growth of small microscopic plants (called phytoplankton). These plants are extremely important as

food sources for many animals. In fact, phytoplankton is very important for human survival. Without them we would not have fish, and without fish, many people in the world would be without a food source.

These important phytoplankton that form the basis of food chains in estuaries are extremely dependent on the constant mixing of the water in the estuary.

Three main forces create this mixing: water movement created by river run-off, the daily tidal movement, and wind currents.

**Water Movement Created by River Run-Off**

Fresh water is lighter than salt water and flows in by way of the river. Because it is lighter, it floats over the surface of the sea water. As it moves out to sea it entrains salt water making the outward flow many times greater than the river flow. This draws saltwater in along the bottom of the estuary to replace the water moving out across the surface. This creates an upward mixing area near the head of the estuary which mixes the water like a pump, bringing the bottom water to the top. This mixing moves the bottom water with its nutrients to the surface feeding the phytoplankton. This mixing is strongest in spring and fall when the river flows are the strongest. Many fish species have adapted to take advantage of this abundant source of food, laying their eggs in the spring so that the newly hatched young will have a rich food source. The young ride in on the bottom flow, come to the top and feed as they ride out, then drop down again to repeat the cycle. There is lots of food with very little effort.

**Tidal Changes**

Daily tide changes, flowing in and out twice a day, also bring nutrients to the surface. This daily mixing is important in large estuaries where small amounts of fresh water are flowing in, or in places of high tides (the Bay of Fundy). Tides moving over banks on the sea bottom also cause upward mixing of nutrients. In this way, ocean banks (such as the edge of the Scotian Shelf or George Bank) produce more fish.

**Wind Currents**

When a southwest wind blows along the coast of Nova Scotia for a few days, the surface waters along the coast turn to the right and are blown out to sea. This water is replaced by the nutrient-rich bottom water, which up-wells along the coast bringing cold nutrient rich water to the surface.

Parts of the estuary and coastal zone are very important places for food production. These are estuaries comprised of freshwater source (river), tidal wetlands (tidal fresh, brackish, salt marshes), rocky intertidal, mudflats, kelp beds, and eelgrass flats. These areas are often

buried or reduced in size by coastal developments. This reduces the juvenile habitat for many species of anadromous and marine fish.

### 5.3. Salt Marshes

Rivers flowing into estuaries have carried heavy loads of silt over long periods of time. The silt is deposited where fresh water meets salt water. This creates extensive mud banks. In many of these places salt marsh plants begin to grow quickly. Rising and falling tides in the salt marsh provide nutrients to the plants and they grow quickly. A well-developed salt marsh is more productive than a good hay or wheat field. Salt marshes, especially ones around the Bay of Fundy, support a rich variety of fish and birds.

### 5.4. Kelp Beds

Seaweeds are often found in or near the estuary. The large seaweeds known as **Kelps** are particularly important. Kelp beds are really underwater "forests" that grow rapidly, creating shelter for many fish. Their growth and decay creates a rich food source for many fish and shellfish (lobster, mussels).

Kelp beds are dense along parts of the Atlantic coast of Nova Scotia. Lobster populations have a direct relationship to the health of kelp beds. The sea urchin feeds on kelp and can cause beds to decline. However, lobsters eat sea urchins so if lobster populations are kept in balance, this will limit the damage caused by sea urchins.

### 5.5 Rocky intertidal

Along the shore there is a zone covered with rockweeds. This area is very high in primary productivity and is home to bacteria and snail when the tide is out and full of juvenile fish when the tide lets them back in to feed.

These areas are often buried or reduced in size by coastal developments. This reduces the juvenile habitat for many species of marine fish which are food for larger fish such as sea trout.

### 5.6. Zones in the Estuary

An estuary has several zones with differing proportions of fresh water mixed with salt. At the head or upper part of the estuary, where rivers flow into the sea, freshwater is abundant and saltwater is scarce. At the mouth, where the estuary joins the sea, tides are strong and there is more salt water than fresh. Different fish and animals inhabit these various parts of the estuary as illustrated in the next section.

Many fish and animals have found ways to make the best use of the different zones of an estuary.

- Herring ride the flow of bottom water until they reach the end (head) of the estuary where they surface to feed on the rich plankton as they drift out again.

- Flounder don't seem to mind low levels of salt and are often abundant in estuaries. Flounders bury themselves in the bottom as the tide goes out and then use the incoming tides to ride up into the small creeks in salt marshes where food is abundant.

- Shrimp are especially adapted to estuaries. Young shrimp travel up the estuary in the bottom water and then surface to feed. Later they settle to the bottom to be carried back up the estuary.

- Young cod, haddock, herring and other fish come into estuaries to feed.

- Estuaries are often ideal growing areas for oysters and mussels because the food is abundant. They can close up when the salt content of the water is not to their liking.

- Atlantic salmon, sea trout, alewife, stripped bass, and shad use the estuary to adjust to changes in water while on their way upstream to spawn, or when they're young and going to sea for the first time.

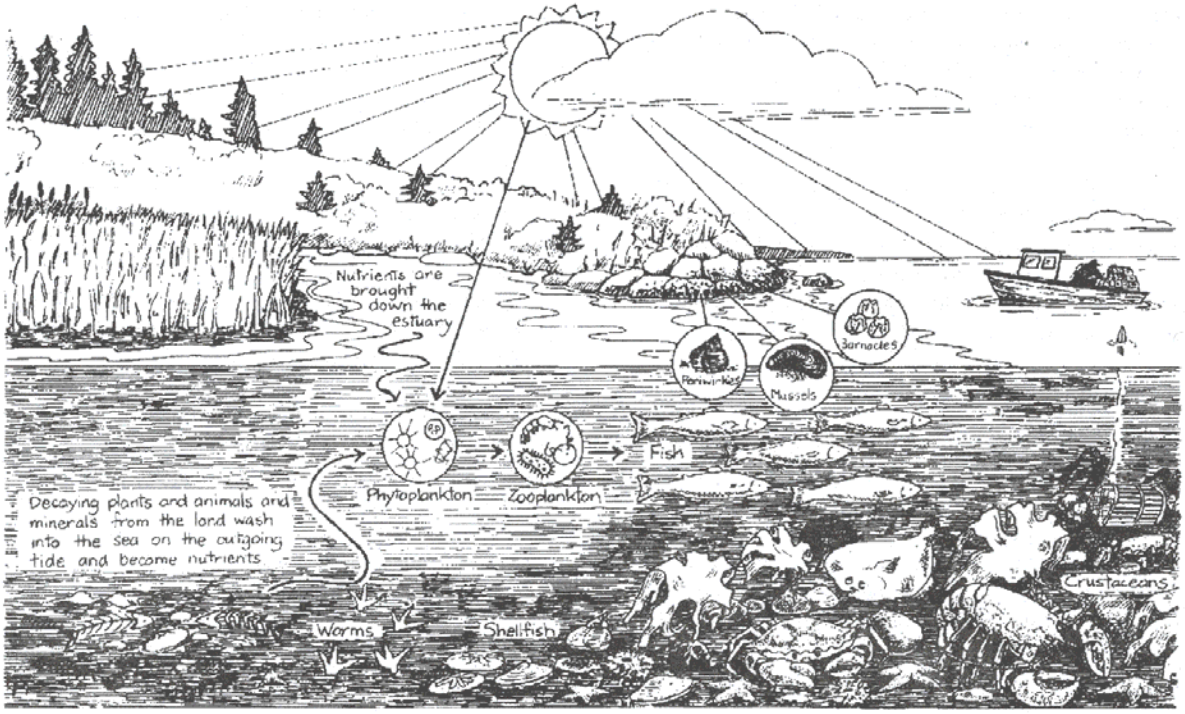
- Sea trout feed on the abundant food sources in the estuaries and costal areas.

Because of biological processes, chemicals become magnified or concentrated as they move up the food chain. A clam, for example, concentrates toxins as it filters the water. As water and plant material in the water (plankton) wash by the clam, it filters the plant material out. The toxins in the plant concentrate in the clam and are passed on to whoever eats the clam, including humans.

**5.7. Food Web in the Estuary**

Because an estuary produces so much food, many life forms are found there, creating special ecosystems. Estuaries are generally considered prime bird-watching areas and many land animals can also be found there. Food, of course, is the reason. A **food web** is the story of "who eats who". A **food web** is how food chains are linked together.

An example of typical estuary food web is shown in the following illustration.




## 5.8. Problems Affecting Habitat

In the section on **The Watershed** we looked at all of the impacts on watercourses in our province. A few of these impacts should be mentioned again with regards to estuaries and coastal areas. Because estuaries form where fresh water comes into the sea, problems in the streams or rivers that flow into the estuary affect water quality and habitat. Other human activities along the coast and in the watersheds that have created problems in estuaries include:

***There are many large areas of closed shellfish beds in Nova Scotia. Much of this is directly due to sewage. If sewage input stops, the estuary cleans itself up in several months.***

- **The use of a fast-flowing river for a power source** can slow and reduce water flow, cutting down on the amount of fresh and salt water mixing in the spring and the fall, because spring and fall flows are held back in the storage dams.

- **Pollutants put into streams and rivers** make their way to the estuary and become a part of the food web.

- **Decaying matter from industries and untreated sewage** increase the demand on the available supply of oxygen and can smother healthy aquatic life. Shellfish are particularly sensitive to contamination from sewage because they filter its harmful bacteria (fecal coliform) and particles from the sewage and these become concentrated in their digestive systems.

- **Infilling, such as causeway construction**, upsets a balance that has taken thousands of years to develop. When parts of an estuary are filled in, flow patterns are upset, interrupting critical circulation patterns. Infilling can also cause erosion and the deposit of silt can greatly disturb parts of the ecosystem. Clam beds, for example, cannot tolerate significant amounts of silt. Infilling also buries salt marshes.

- **The dyking of salt marshes for farmland** has resulted in a loss of over 80% of Nova Scotia's salt marshes, where much food is produced for coastal fish. This kind of dyking has also caused coastal erosion.

- **Dredging** changes the shape of the estuary but only temporarily. Eventually water flows will move materials from other areas to fill the dredged area back in and dredging must be done again. By disrupting the balance between the flows and the sediments you can damage sensitive habitats not directly impacted by the dredging or dumping of the sediments. Full consideration has to be given to on site and offsite impacts.

- **Construction of wharves, breakwaters, and bridges** changes water currents often resulting in erosion on the upstream or up-current side, and deposition down current side. This construction work also affects the mixing actions of currents in estuaries.

- **Wood, bark, debris and other wastes from lumbering, sawmills, and pulp and paper industries** reduce the clarity of the water and the amount of sunlight reaching underwater plants. This debris can also overload the bottom waters, using up valuable oxygen, resulting in winterkills of fish.

- **Chemical pollutants from household cleaning products, farming and industrial waste** can kill or harm life in the estuary. In many food chains chemicals or pollutants are passed up through the system.

- **Sewage and fertilizers from farming** encourage the growth of algae that can produce a toxin called domoic acid. When this situation develops, the area will be unfit for shellfish or commercial aquaculture. Sometimes the extra nutrients can cause certain toxic microscopic plants (dinoflagellates) to flourish, making the water look red. This is called a "red tide".

- **Tidal barriers** Coastal wetlands have been dyked and flows restricted by undersized culverts and bridges for hundreds of years. This ahs resulted in extensive loss of wetland area, function, productivity, fish, fish passage, and in general fish and wildlife

habitat. There are projects underway to restore these wetlands and prevent further losses. For more information contact the Ecology Action Center in Halifax http://www.ecologyaction.ca/coastal_issues/coastal_issues.shtm

- **Coastal Squeeze** – coastal development (rural, urban, commercial, infrastructure) can result in the loss of coastal wetlands by preventing the natural landward migration of coastal habitats in response to rising sea levels. Coastal development is drawing a hard-line in the sand and coastal features are being squeezed and lost.

Fortunately, estuaries tend to be quite resilient to chemical pollution and can recover quickly when the source of the pollution stops. The safest way to prevent ecological problems is to use preventive and enhancement procedures when considering development.

**Here are some things for you and group to do:**

- Get to know your estuary and its history. If you know the estuary well you will be more able to observe and be aware of changes.
- Make sure that natural flow patterns are not interrupted by development or work along the coast.
- Use environmentally friendly cleaning products in homes and businesses.
- Ensure that toxic chemicals are properly disposed of.
- Control the use of chemicals and fertilizers, especially near any watercourse.
- Make sure that too many nutrients don't get into the system through sewage and/or fertilizer run-off.
- Be certain there are low levels of bacteria in water that flows into the estuary. Chlorinating the bacteria away is not a good solution, as chlorine is toxic to young fish and shellfish.

For ways you can help the coastal ecosystems see “50 ways to save the Gulf of Maine” http://www.gpac-gom.org/Task_Groups/50_Ways/webbook.pdf

Make sure you read the following sections on how to research and enhance your water area.

**TEST YOUR KNOWLEDGE!**
**HOW WELL HAVE YOU READ THIS SECTION?**

TRUE AND FALSE QUIZ

| | True | False |
|---|---|---|
| 1. An estuary is where fresh and salt water mix. | | |
| 2. Only about 30 % of commercial fish species use estuaries but they're still very important. | | |
| 3. Phytoplankton are a product of pollution and we should be trying to get rid of them. | | |
| 4. Freshwater is lighter than salt water. | | |
| 5. The mixing of water is very important in an estuary and this mixing is strongest in the spring and fall. | | |
| 6. Rivers coming into estuaries bring silt and other nutrients. | | |
| 7. Kelp is of little use to fish and estuaries are cleaner and better if there are small amounts of kelp. | | |
| 8. Pollutants and toxins tend to collect in shellfish. | | |
| 9. Atlantic salmon are not usually found in an estuary. | | |
| 10. A food chain is another way of describing, "who eats who". | | |

**ANSWERS CAN BE FOUND AT THE END OF THIS MANUAL**