Discover Your Estuary

Understanding and exploring the aquatic environment of the Fraser River Estuary

Canada

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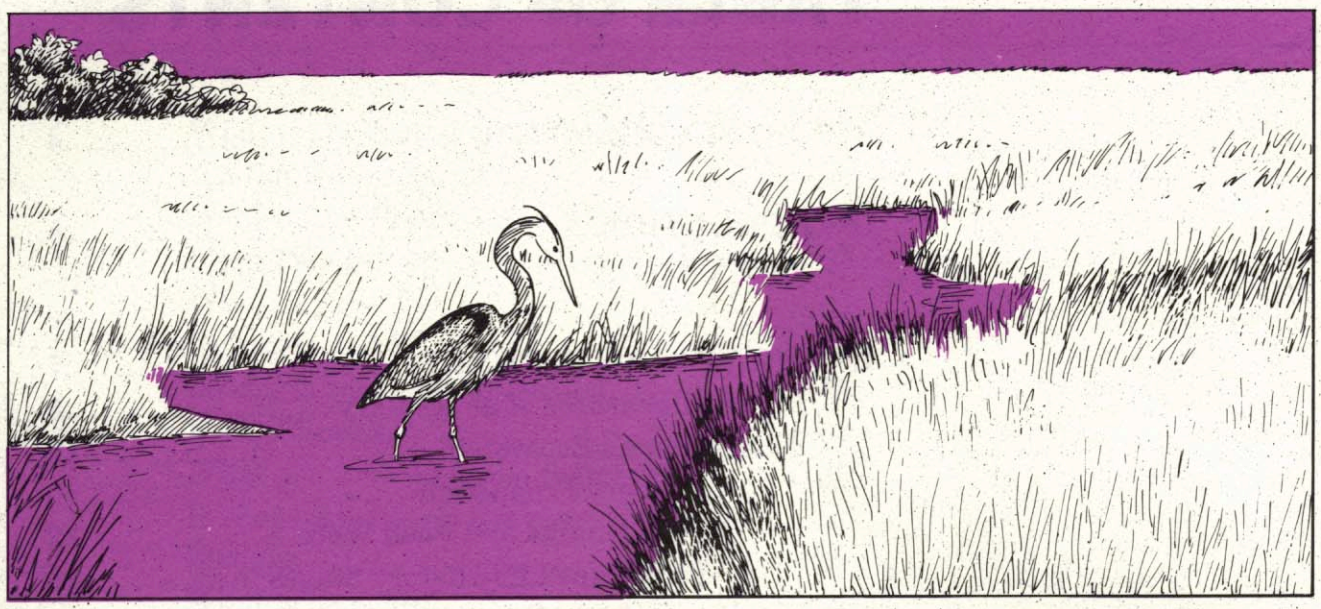

Discover Your Estuary

UNDERSTANDING AND EXPLORING THE AQUATIC ENVIRONMENT OF THE FRASER RIVER ESTUARY

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Coordinator

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Illustrator

LE PLAN VERT DU CANADA
CANADA'S GREEN PLAN

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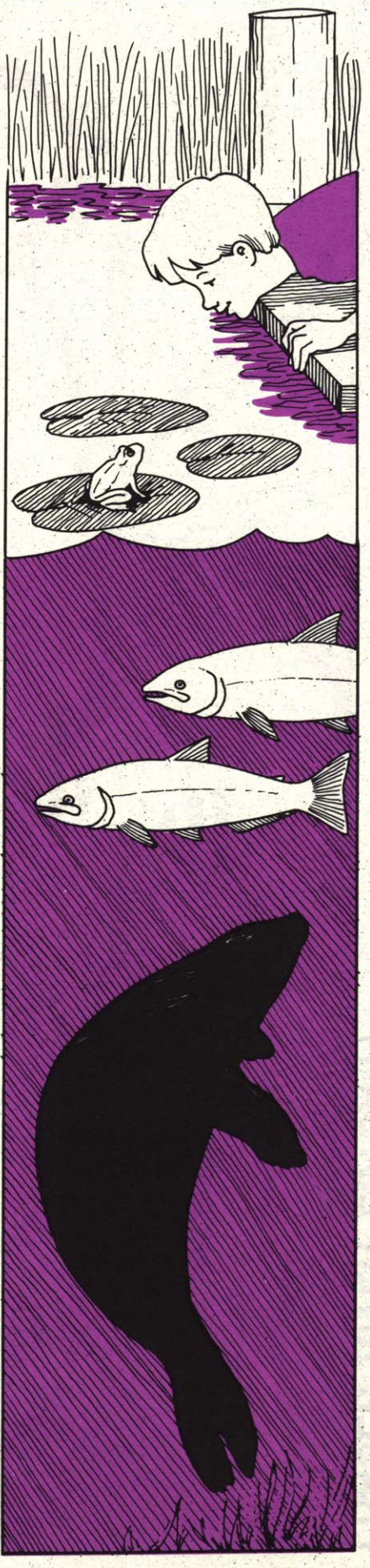
INTRODUCTION



This book is a journey into one of the most rich and diverse places on earth — the estuary, where freshwater meets the sea. It's a place where plants, animals and people are vitally linked with each other.

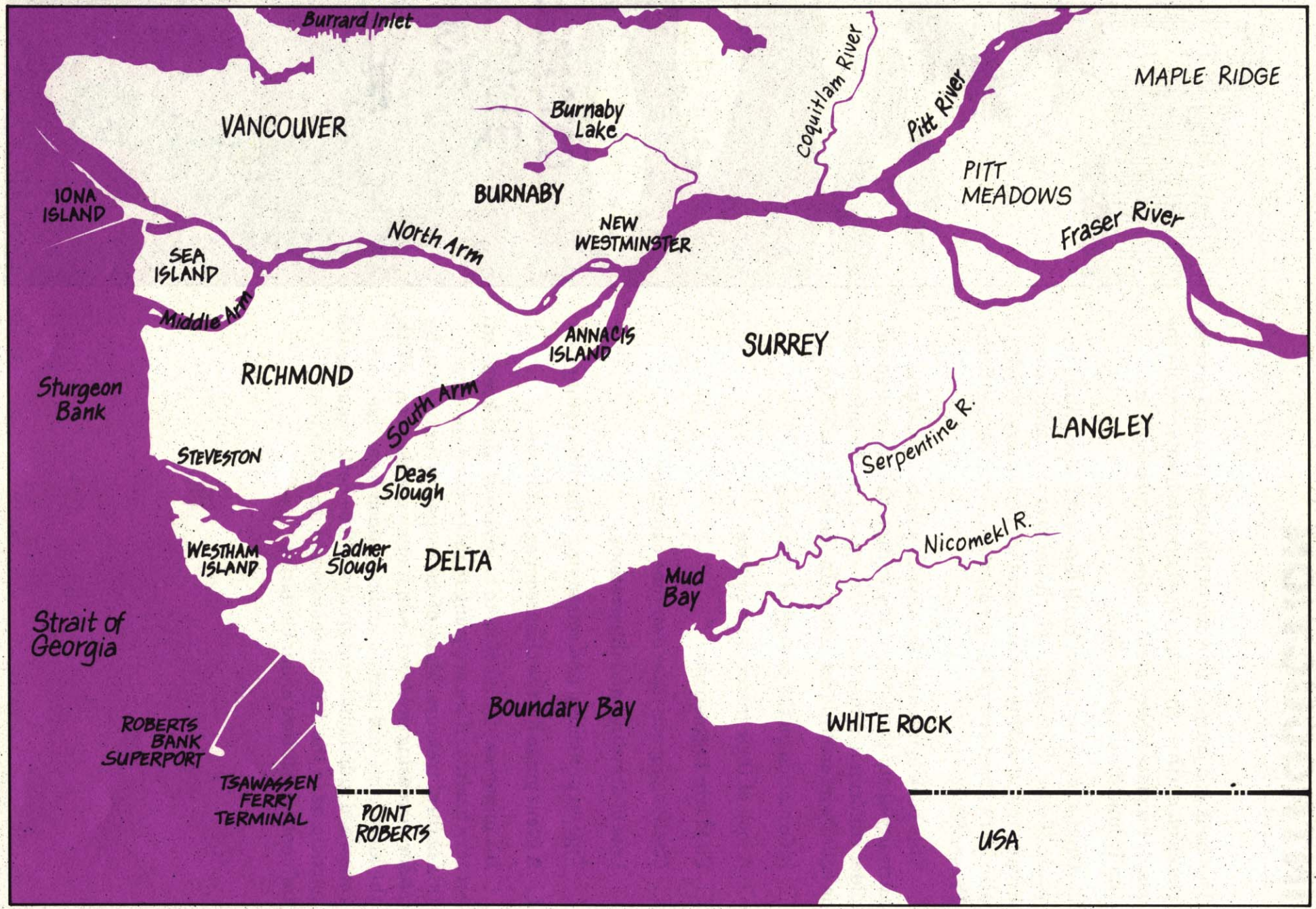
On the pages to follow, you'll discover a fascinating world of unique life forms which you probably didn't know existed in the muddy environment of the estuary. You'll also learn about one of the greatest estuaries on earth, the Fraser River.

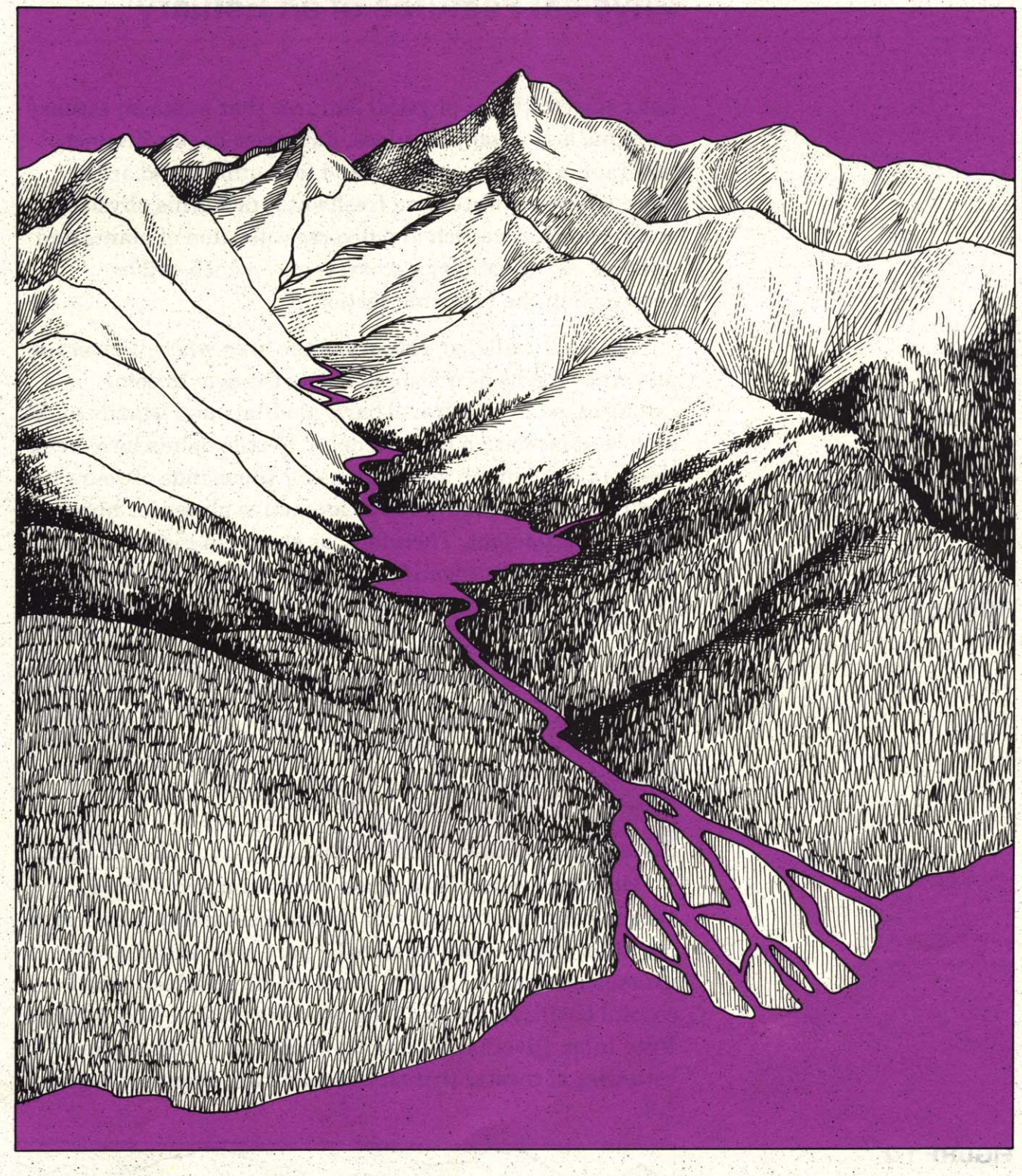
This book is intended for anyone who has a natural curiosity about the estuary. It's written clearly enough for older children to understand and enjoy, but the information is equally interesting for adults. In the book you'll find:

- ☐ Information on the ecology of estuaries
- ☐ A look at their history and culture
- ☐ Field trip suggestions
- ☐ Challenging activities everyone can enjoy
- ☐ Lots of drawings and illustrations
- ☐ Tips on protecting and conserving a healthy estuary
- ☐ A great guide for the classroom and at home

It's important for all of us to be aware of what keeps an estuary healthy, if we are going to protect and conserve this natural treasure. Many of our estuaries continue to be under increasing pressure from human development. With the knowledge and understanding gained from this book, concerned individuals and groups will be better equipped to participate in the difficult choices and decisions that influence the future of our estuaries.

FRASER RIVER ESTUARY





1. WHAT IS AN ESTUARY ?

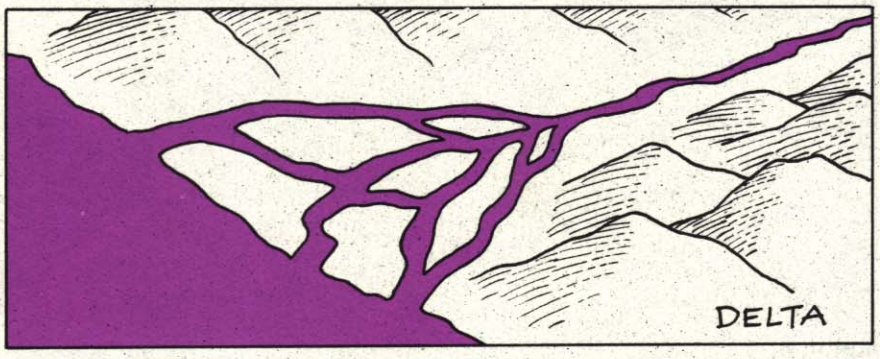
An estuary is a special place with some unique and important physical and ecological features. This book focuses on the Fraser River Estuary, one of the largest and most important estuaries on the coast of British Columbia. To begin with, though, let's look at some of the basic physical and ecological features of estuaries.

Physical Features of an Estuary

Let's start with the physical features that make an estuary a unique and important place. Estuaries have a distinct geographic location, unique land formations, and are a place where seawater and freshwater mix. This physical setting supports a rich and diverse collection of plants and animals — the estuary's ecosystem — which will be described in the following section.

Geographically, an estuary is the area where a river (or any other freshwater source) meets the sea. In some estuaries, sand and gravel bars, mudflats and islands make up a land formation called a delta. Fertile deltas have been the cradle of human civilizations for thousands of years, and to this day continue to be attractive places for human use and settlement. Therefore, as shown in Figure 1-1, an estuary is usually identified and defined by its delta.

FIGURE 1-1



However, estuaries include more than just a delta, because any open water area where freshwater mixes with seawater is also considered to be part of an estuary. For example, estuaries include areas inside the steep-sided coastal basins or fiords of our province (Figure 1-2), such as Bute Inlet, Rivers Inlet and Howe Sound. Other major estuaries of coastal British Columbia are shown in Figure 1.3.

FIGURE 1-2

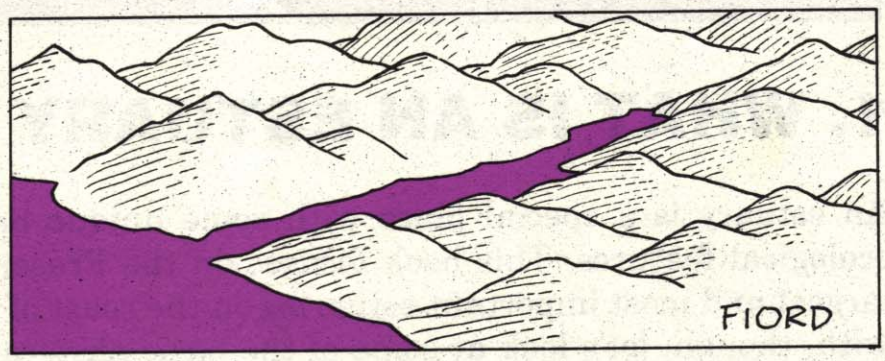
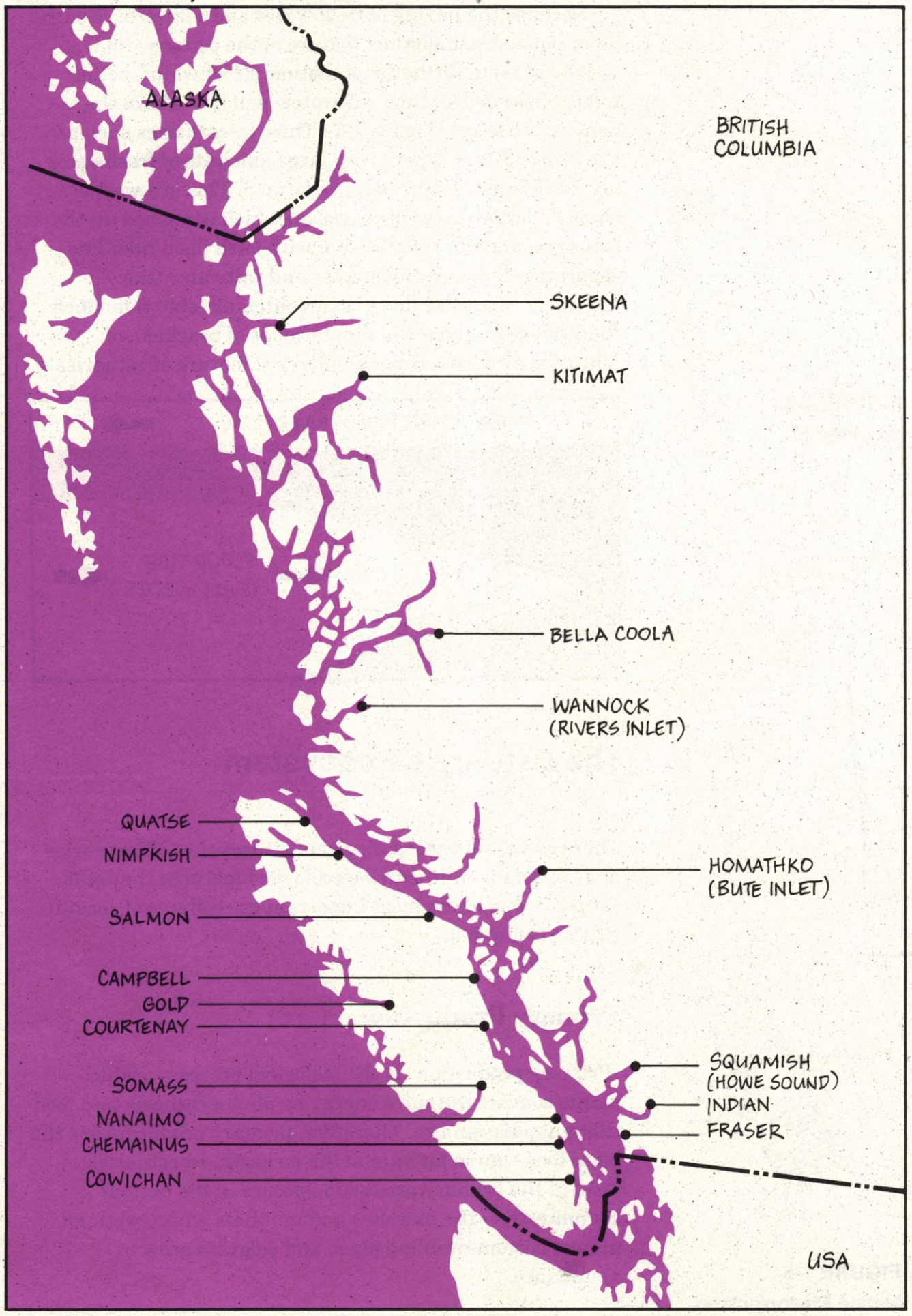


FIGURE 1-3 Major Estuaries of British Columbia



Because the mixing of freshwater and seawater is such an important and distinct feature of the estuary, it is worthy of some further explanation. Freshwater, being lighter (less dense) than saltwater, will flow above the heavier seawater (Figure 1-4). Thus, in estuaries such as the Fraser River, where very large amounts of freshwater are discharged, a salt wedge is formed. This is a wedge-shaped, bottom layer of seawater, which is pushed up the estuary along the river bottom with each flood tide. The separation between freshwater and saltwater (the interface) can break down on an outgoing (ebb) tide. Such conditions of mixing will create zones of brackish, or diluted seawater, a common physical feature of estuaries.

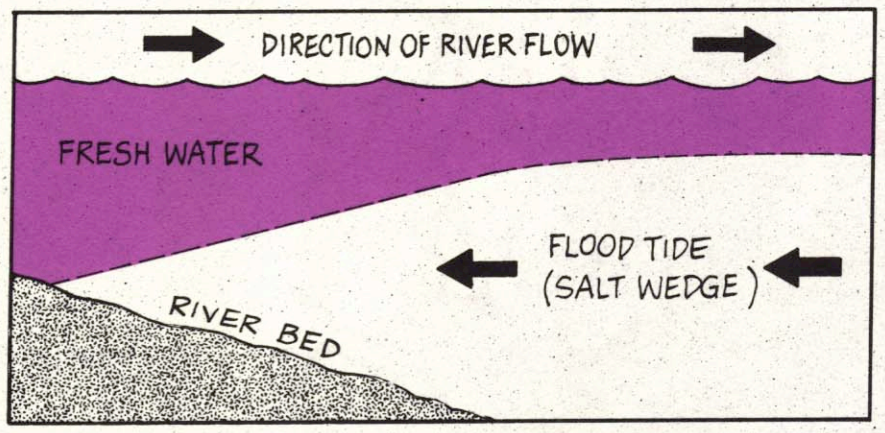


FIGURE 1-4
Salt Wedge

The Estuary's Ecosystem

There are some basic ecological features that all estuaries have in common. It is these ecological features that make estuaries one of the most important ecosystems of coastal British Columbia.

Primary Production

"Primary production" is the biological process in which plants convert the sun's energy by photosynthesis into food that animals can use. Therefore, primary producers are the basic food source for animal life on earth. In estuaries, most of the primary production occurs in the bottom community — the marshes and mudflats where wetland plants, bottom-dwelling algae and eelgrass grow in abundance.

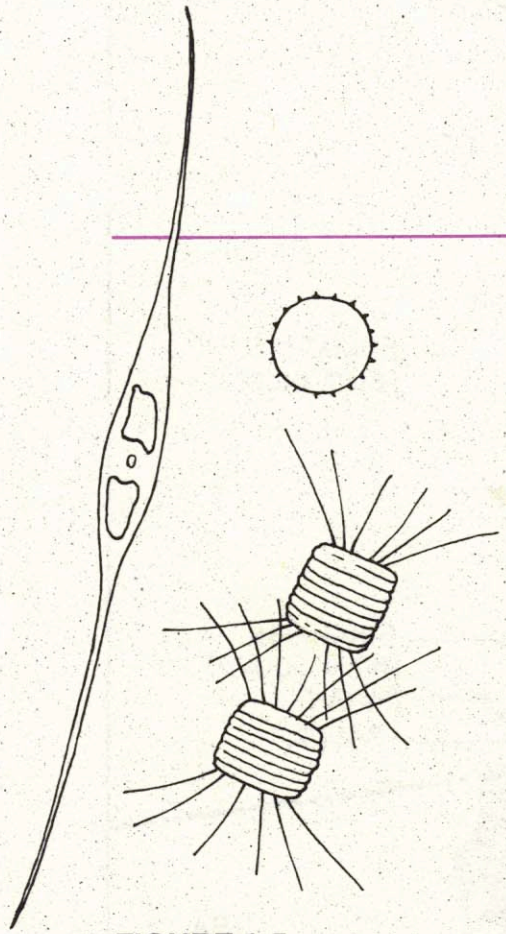
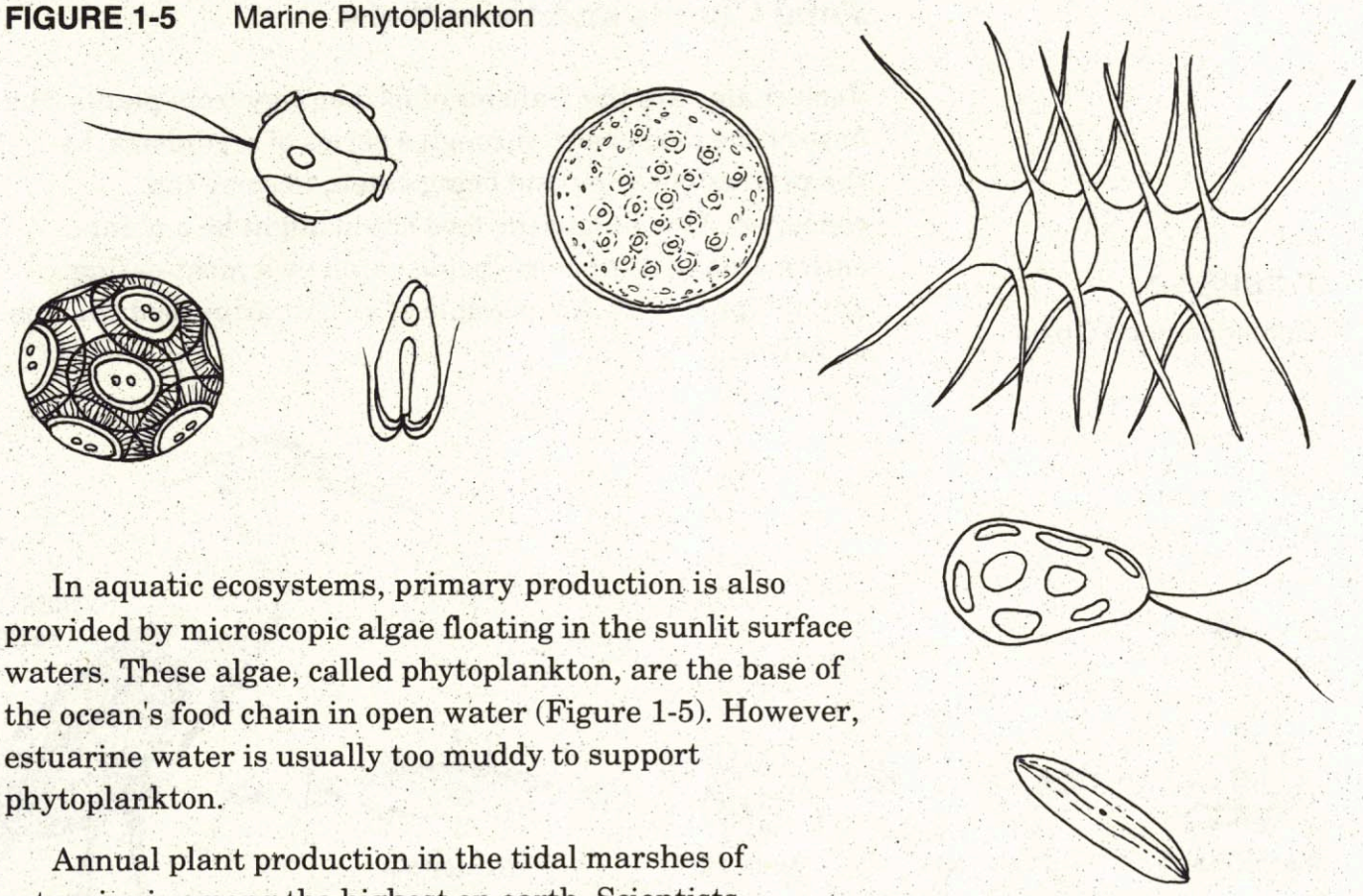


FIGURE 1-5
Marine Phytoplankton

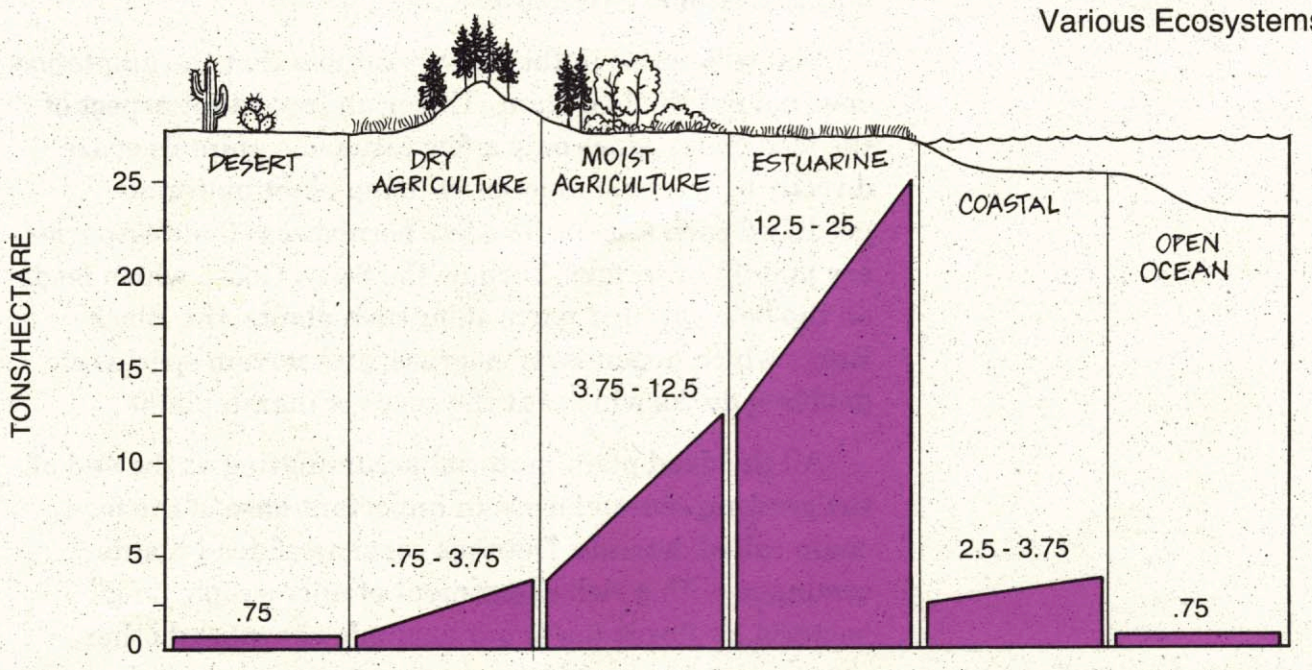
FIGURE 1-5 Marine Phytoplankton



In aquatic ecosystems, primary production is also provided by microscopic algae floating in the sunlit surface waters. These algae, called phytoplankton, are the base of the ocean's food chain in open water (Figure 1-5). However, estuarine water is usually too muddy to support phytoplankton.

Annual plant production in the tidal marshes of estuaries is among the highest on earth. Scientists measure annual plant production according to the total amount of leaves and stems produced in a unit area (square metre or hectare) of marsh per year. Estuaries, with annual production rates that range from 12.5 to 25 tons/ha, exceed even that which can be produced by the most intensive agriculture (Figure 1-6).

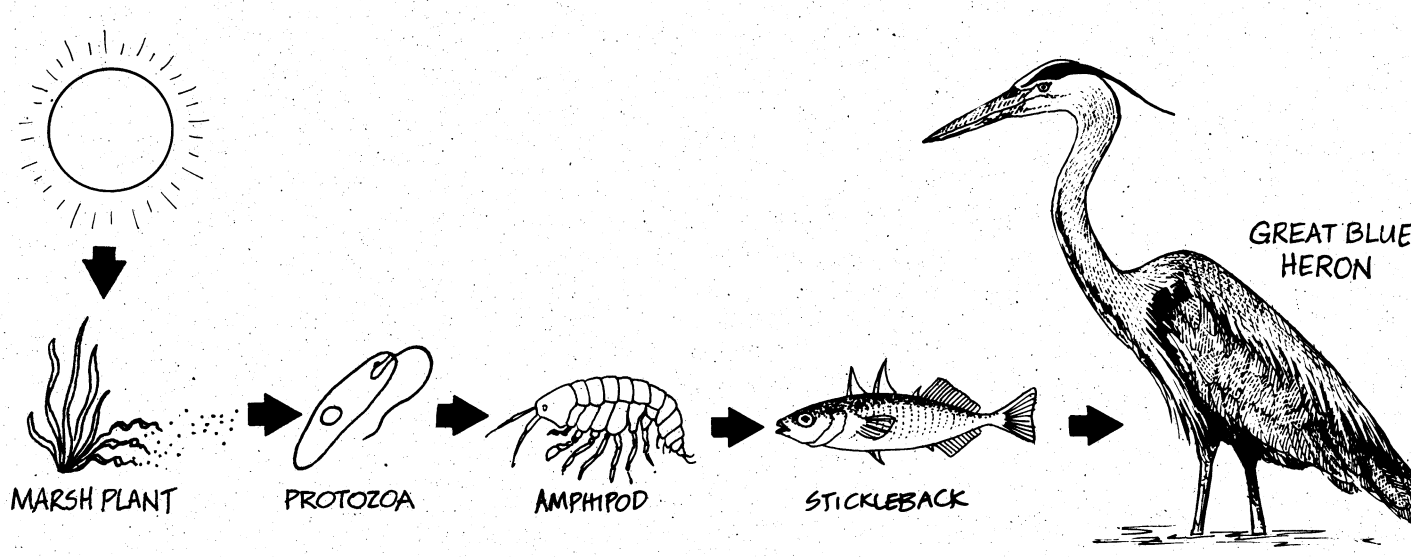
FIGURE 1-6
Primary Production of Various Ecosystems



Food Chains and Food Webs

Food chains are the transfer of food energy from plants (the base of the food chain) through a series of organisms, by the process of eating and being eaten, to some top consumer. One link in the food chain might be a plant-eating animal (herbivore) being eaten by a meat-eating animal (predator). An example of an estuarine food chain is as follows:

FIGURE 1-7
Estuarine Food Chain



In the food chain above, the transfer of food energy between each organism is shown by an arrow pointing from the food source to the consumer. The arrows represent the links of the food chain. Food chains are based on what biologists observe in the field about the feeding habits of animals, or what they analyze in the laboratory from the animals' stomach contents.

You will notice in the above example that the amphipod does not eat the live plant. This is an important aspect of the food chain, since only a few estuarine animals graze directly on the vast amount of living plant material produced each season. The few herbivores of our estuaries are mainly waterfowl, such as the Snow Goose which feeds on the belowground parts of bulrush plants, the Black Brant which depends on eelgrass, and certain species of dabbling ducks which eat the seeds of marsh plants.

All the dead plant material accumulating at the end of the growing season forms an important base of the food chain called detritus. Detritus consists of dead plants combined with a rich assortment of microscopic fungi, bacteria, protozoa (as in our example above) and other

microorganisms. Small invertebrates such as worms, snails, and crustaceans (e.g. amphipods) thrive on this detritus. Anyone who has ever poked around in the compost pile of their garden, in a pile of rotten leaves, or in a rotten log will recall the teeming invertebrate life in these detritus-rich habitats.

The millions of small invertebrates living in the estuary are eaten by fish, birds, and amphibians. Small fish and amphibians are in turn eaten by larger fish, birds and mammals. Much of the estuary's food chain is therefore supported by the rich organic detritus of the marshes, shallow sloughs and tidal channels.

ACTIVITY 1: ESTUARINE FOOD CHAIN

1. Design a food chain that illustrates the following short story (adapted from: *Discover Wetlands, A Curriculum Guide*, Washington Department of Ecology, 1988). Remember to connect each link in the chain with arrows pointing from what is being eaten to what is doing the eating.

A clam that filtered microscopic detritus particles from the estuary's water was caught by a Glaucous-winged Gull, dropped on the rocky beach, and cracked open. The clam meat was then fed to the gull's hungry chick. Soon, a Bald Eagle searching for food captured and ate the chick. The food energy the clam first obtained from the detritus was transferred to the gull chick and finally to the eagle.

2. To the base of the food chain add two more links to illustrate how the detritus was derived. The third paragraph under the heading **Food Chains and Food Webs** will give you a clue. Finally, don't forget the ultimate energy source -- the sun.

Answer provided in Appendix 1, page 109.

In reality, the estuary consists of an interconnection of different food chains. This pattern of interconnecting food chains is called a food web. To better understand the significance of food webs, do the following activity.

ACTIVITY 2:
ESTUARINE FOOD WEB

Complete the simplified food web for an estuarine marsh habitat shown in Figure 1-8 by using the words below to fill in the correct numbered circles (adapted from: *Discover Wetlands, A Curriculum Guide, Washington Department of Ecology*, 1988). Read the numbered clues to help you. To show the flow of energy, the arrows point away from a food source and toward the organism that eats it. The answers to the food web diagram are given in Appendix 1, page 109.

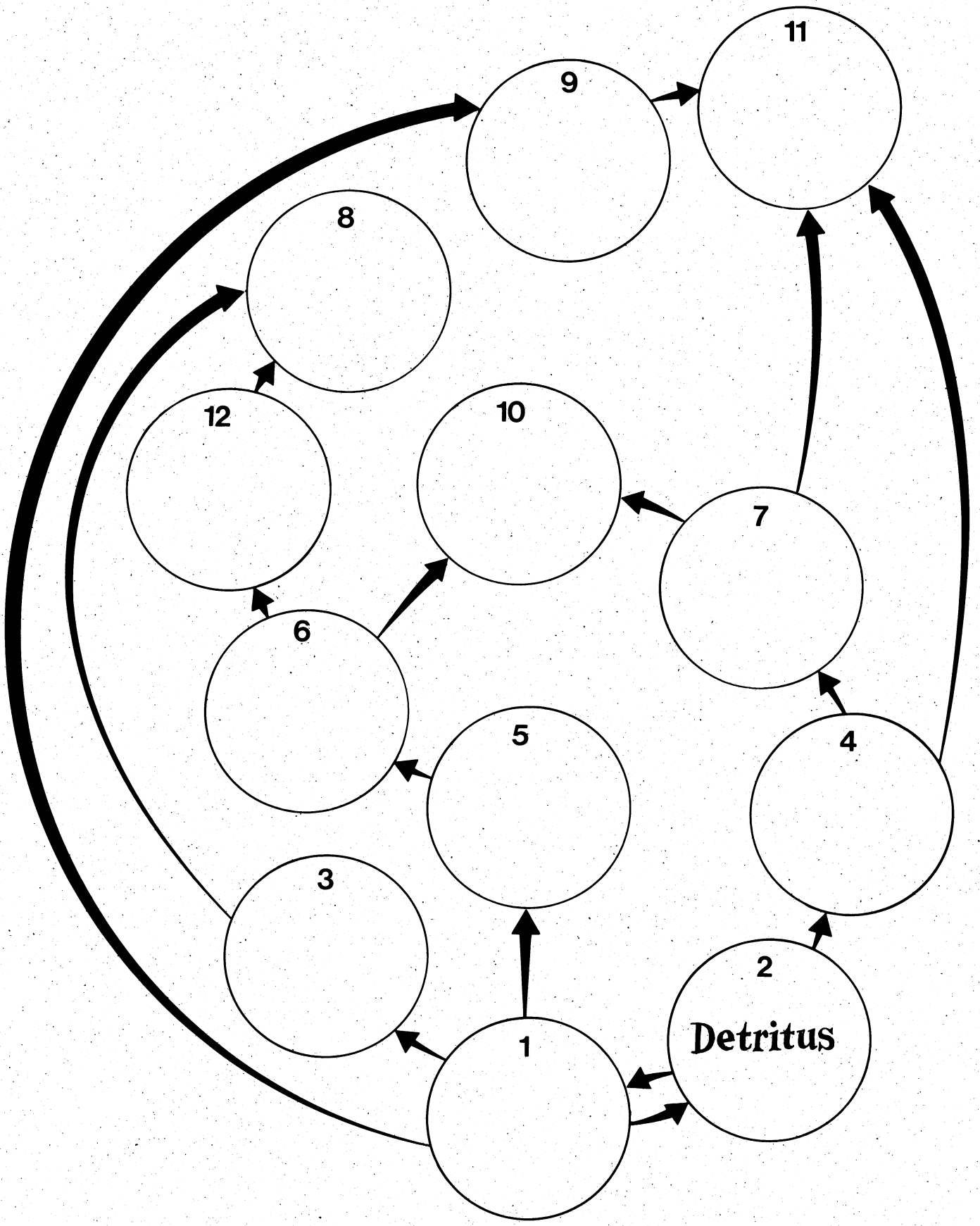
WORDS TO FILL INTO CIRCLES:

Clam	Heron	Mayfly	Owl
Humans	Plants	Snake	Frog
Flounder	Detritus	Vole	Beaver

CLUES FOR NUMBERED CIRCLES:

1. These organisms use energy from the sun to make food.
2. This is dead plant material enriched with bacteria and fungi. It returns plant nutrients back to the marsh.
3. This small rodent eats mainly plants and sometimes insects.
4. These shelled animals live in the mud and sand and filter small particles of organic matter.
5. The larva of this flying insect feeds on organic matter.
6. This amphibian eats any small moving invertebrate.
7. This flat-looking animal lives underwater and feeds on small bottom-dwelling invertebrates.
8. This animal hunts at night for snakes and voles.
9. This small mammal was hunted in the past for its fur and it eats mainly plants.
10. This long-legged animal can be seen patiently standing in shallow water for a fish or frog to eat.
11. If it wants to, this creature can find and eat almost anything in the estuary. Nothing in the estuary can kill and eat this animal.
12. This reptile slithers around to hunt for frogs.

FIGURE 1-8 Estuarine Food Web



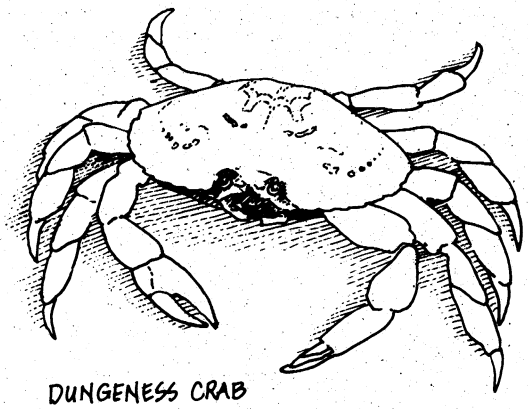
Important Life-History Stages

The estuary plays an essential role in the life history of many fish and wildlife species. For example, our estuaries provide important rearing and feeding habitats for juvenile Chum and Chinook salmon. The brackish water of the estuary gives juvenile salmon time to gradually adjust to saltwater conditions before they migrate into the ocean.

Especially in larger estuaries such as the Fraser River and Skeena River, juvenile salmon spend several weeks feeding in sloughs and tidal channels as they slowly migrate out into the ocean in early spring. This feeding and rearing period represents an important life-history stage for juvenile salmon. Other fish species such as smelt and Starry Flounder spawn in the estuary and also use its protected backwaters for the nursing and rearing of juvenile stages.

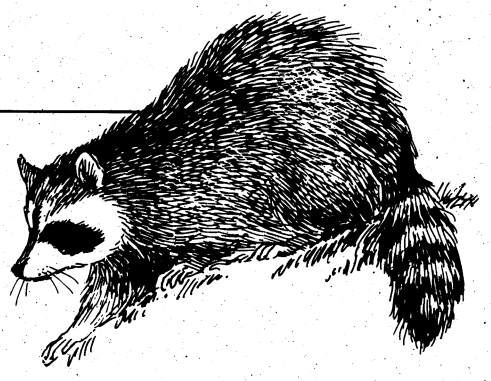
Dungeness crab move into shallow subtidal areas of the estuary to burrow into soft bottom areas, seeking protection from predators while the crab's shell is soft during its moulting and mating stage. Juvenile Dungeness Crab will use the shelter and food provided by the estuary to go through various stages of development before moving offshore as adults.

All of our coastal estuaries provide essential resting and feeding habitat for waterfowl migrating from their northern breeding ranges along the Pacific Flyway to their southern wintering habitats. Without the critical resting and feeding habitats provided by estuaries, some species of migrating birds would probably disappear.



DUNGENESS CRAB

The Fraser River Estuary



The Fraser River Estuary is one of the largest, most interesting, and perhaps most important estuaries on the coast of British Columbia. We will begin our introduction to the Fraser Estuary by describing some of its physical features. Chapter 2 will then describe the aquatic habitats of the estuary and its abundance of plants and animals.

At the point where the Fraser River exits the mountains at Hope, it has drained over 200 000 square kilometres of very diverse terrain (Figure 1-9). At this point, the river is rich in sediments eroded from across southern and central British Columbia.

As the river enters the Fraser Valley lowland, its speed is checked by the change in slope of the river bed, and great volumes of sediment drop out of suspension to form gravel and sand bars, islands, sloughs and mudflats. The finer and lighter the sediment, the further it will be transported out into the estuary, eventually settling out onto Sturgeon and Roberts Banks.

During the spring and early summer snowmelt, the Fraser River surges, and this pushes back the tidal inflow of salt water to the lower reaches of the delta. During this peak flow period in May, June or July, river flows at Hope are from 10 000 up to 15 000 cubic metres per second. This is equivalent to about 50 000 to 75 000 full bathtubs of water per second. In winter, when the river flow is at its lowest, the tide has less opposing force from the river and will therefore push salt water inland as far as New Westminster. Normal winter flows are approximately 700 cubic metres per second.

Freshwater flows far into the Strait of Georgia and is clearly visible from an airplane or space satellite as a distinct light colored plume against the darker marine waters of the Strait. This is because the sediment-laden freshwater plume reflects more light than the clearer marine water. The influence of the Fraser River plume reaches across the Strait of Georgia, all the way to the Gulf Islands (Figure 1-10).

FIGURE 1-9 Fraser River Drainage Basin

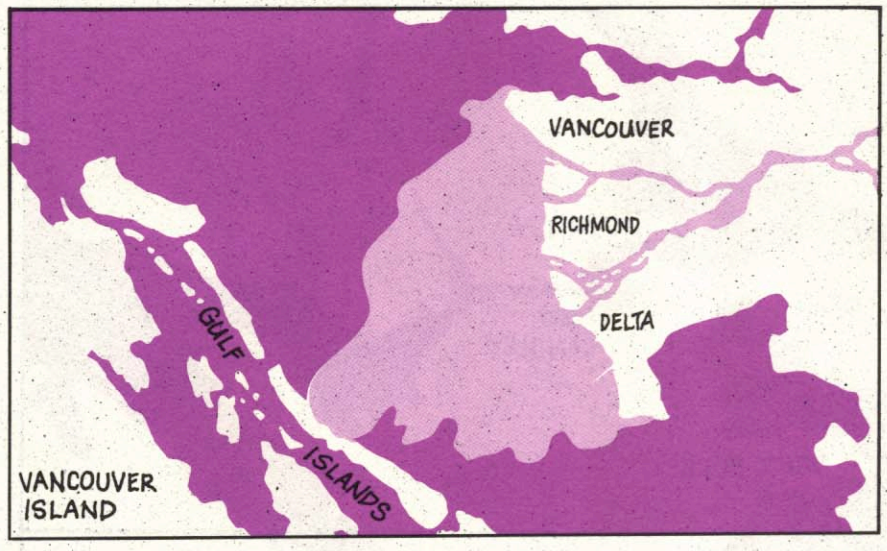
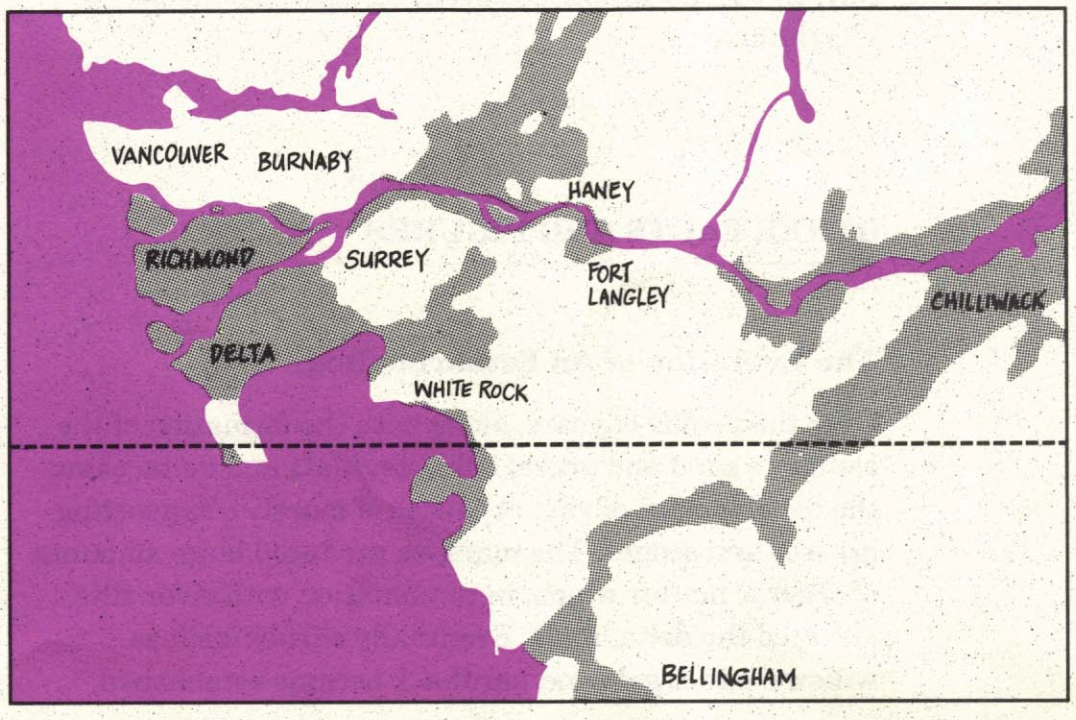


FIGURE 1-10
Fraser River Plume

The present-day physical setting of the Fraser Estuary is the result of sediments accumulating over thousands of years. The Fraser River has been building and expanding its delta at the rate of 13 million cubic metres per year, resulting in sediment deposits which are now 100 to 230 metres deep.

The terrestrial and intertidal portion of the estuary includes the delta created from river sediments since the last ice age. As you can see in Figure 1-11 and on the map of page 6, this includes all of South Delta, Ladner, Tsawwassen, Richmond, including Sea Island, as well as the smaller mid-river islands downstream from New Westminster. Sturgeon and Roberts Banks, and Boundary Bay make up the outer areas of the delta.

FIGURE 1-11
Present-Day Delta Formations



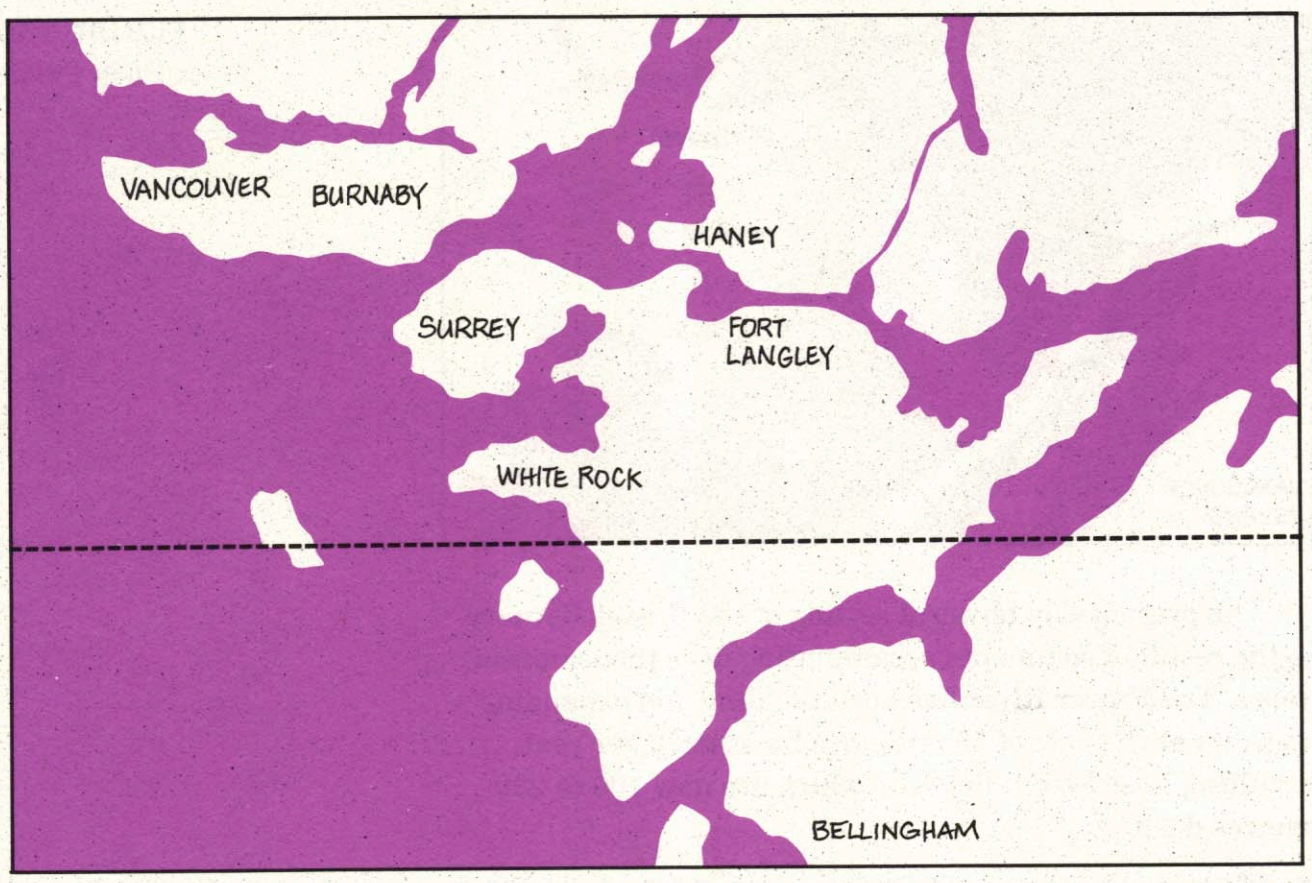


FIGURE 1-12
Delta Formations
11 000 Years Ago

Terrestrial areas of the Fraser River Estuary looked much different just after the last ice age, some 10 000 years ago (Figure 1-12). At that time, the estuary extended up into Pitt Lake, up Bellingham Bay, and into the eastern Fraser Lowland — an area that had previously been occupied by ice, but was replaced by water. There was an open-water connection between Chilliwack and Bellingham Bay, as well as perhaps one coming down past New Westminster.

OTHER FACTS AND FIGURES

The Evolution of An Estuarine Bog

Over thousands of years, along with the formation of the estuary's sand and gravel bars, mudflats and delta, came the development of vast expanses of marshes supporting grasses and sedges. The marshes produced large amounts of organic matter which, in combination with river silts, elevated the delta lands. Eventually shrubs such as willows, sweet gale and hardhack became established.

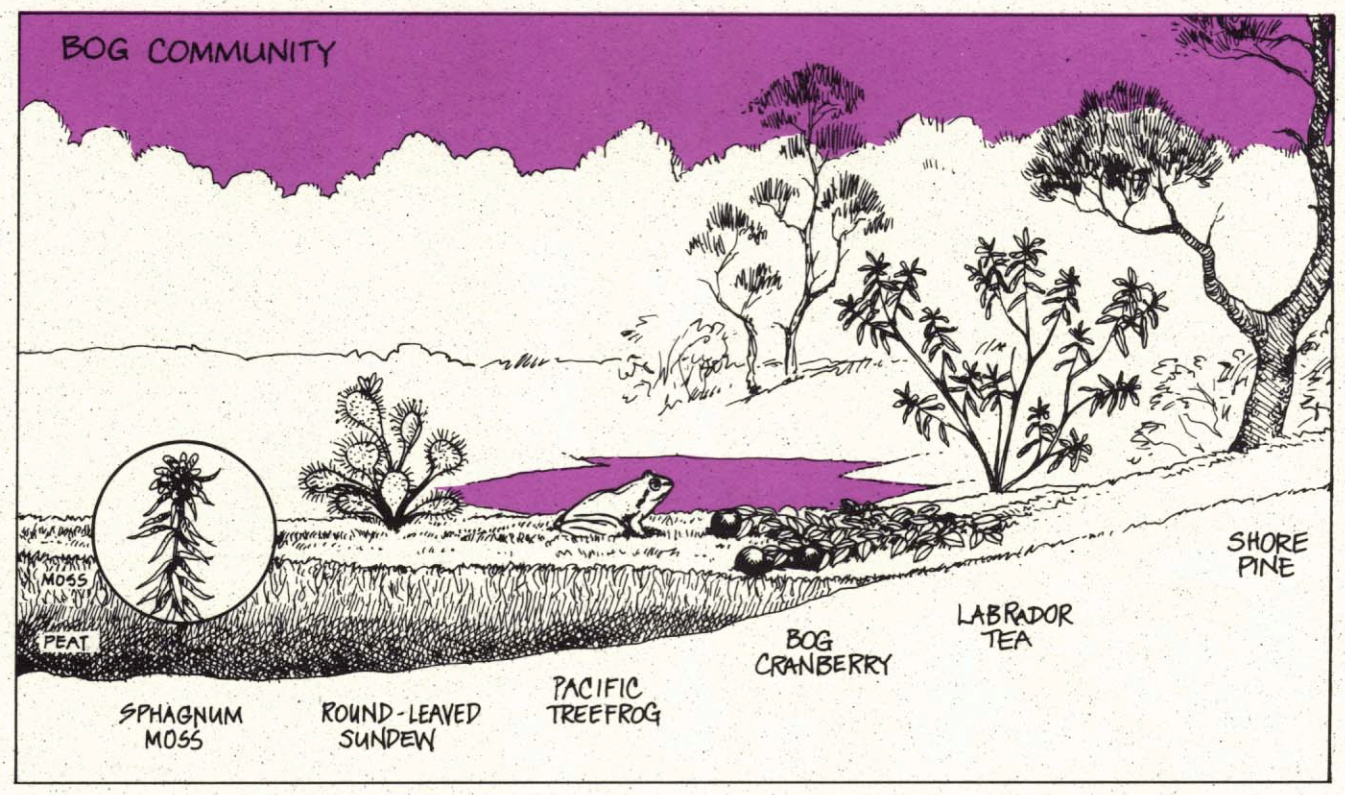


FIGURE 1-13
Bog Community

In certain poorly drained areas of the estuary, the accumulating organic matter formed large deposits of peat. These areas were cut off from river flooding and therefore did not receive their annual supply of nutrient-rich floodwater. However, heavy winter rains kept these areas saturated with water. Soon, these wet, nutrient-poor, peat-dominated areas developed into bogs. Burns Bog and Surrey Bend are two areas where bogs have survived to the present day. The presence of large peat bogs is a unique feature of the Fraser River Estuary.