

UNIT 3 LECTURE 5

VARIOUS ECOSYSTEMS

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Throughout the southern half of Canada, parts of northern Europe, and much of Russia, there is a **northern coniferous forest** or **boreal forest**.

Among the dominant conifers are pine, hemlock, spruce, cedar, and fir. Some common deciduous trees are birches, aspens, and maples, while mosses and lichens form much of the ground cover. The trees are specifically adapted to winter conditions. The needles shaped leaves are adapted to prevent water loss. The branches of these trees are flexible allowing the snow to slide off the pyramid shaped leaves without damaging them. The climate is one of short, cool summers and long winters with abundant snowfall. The winters are extremely harsh and can last as long as six months. Typically, the soil freezes during the winter. Precipitation ranges between 25 and 100 cm per year, but the climate is humid because the generally low temperatures during all parts of the year reduce evaporation. Many lakes, ponds and bogs abound this landscape.

Dominant animals of these forests include a few large mammals (moose, deer, wolves, and bears), small rodents (squirrels and rabbits), small carnivores (foxes), many insects, and migratory birds, especially waterfowl and carnivorous land birds, such as owls and eagles. A few woodpeckers are permanent residents. Because of the cold, few reptiles and amphibians live in this ecosystem.

Disturbances particularly fires, storms, and outbreaks of insects – are common in these forests.

SLIDE 3

These occur along the west coast of North America from central California to Alaska. Here the temperatures are higher, seasonal range is relatively small and humidity is very high. Rainfall ranges from 75 to 125 cm per year, fog compensates for the lower rainfall in the southern areas. Western hemlock, Western arborvitae, grand fir, and Douglas fir are the dominant trees. The magnificent red woods, spruces are also prominent. The understory vegetation is well developed; mosses and other moisture loving lesser plants are abundant

SLIDE 4

Forest in temperate areas of the world that have a winter-summer change of seasons typically have trees that lose their leaves during the winter and replace them the following spring. This kind of forest is called the temperate deciduous forest found in the eastern half of the United States, parts of south central and south eastern Canada, southern Africa and many areas of Europe and Asia.

These areas receive 100 or more cms of relatively evenly distributed precipitation per year.

The common plant species are maples, aspen, birch, beech, oak and hickories. These tall trees shade the forest floor, where many small flowering plants bloom in the spring. These spring wildflowers store food in underground structures. Many smaller shrubs may also be found in these forests. These forests are home to a great variety of insects, many of which use the leaves and woods of trees as food. Beetles, moth larvae, wasps, and ants are examples. The birds that live in these forests are primarily migratory in nature. Many of these birds rely on the large summer insect population for their food. A few kinds of birds including woodpeckers, grouse, turkeys, and some of the finches, are year round residents. Several kinds of small and large mammals including mice, squirrel, deer, moles and rabbits inhabit these areas. Major predators are foxes, badgers, weasels, coyotes, and birds of prey.

SLIDE 5

These forests occur throughout the world where the rainfall is plentiful. In temperate regions, the climate supports lush summer plant growth when water is plentiful but requires survival adaptation for the frozen season. A key adaptation of deciduous trees is the ability to produce summer leaves and then shed them at the growing season.

The tree species include oak, maple, birch, beech, elm, ash, and other hard woods. These tall trees form a forest canopy over a diverse undercover of smaller trees, shrubs, and herbaceous plants. In regions where the climate is warm year-round, forests are dominated by evergreen trees such as the live oaks and cypresses of the southern United States.

As the forests disappear, so too do Siberian tigers, bears, cranes and a host of other unique and endangered species.

Found in Western Ghats, North East India, and Andaman & Nicobar Islands

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These are located near the equator in central and south America, Africa, south east Asia, and some islands in the Caribbean sea and Pacific ocean.

The temperature is normally warm and relatively constant. There is no frost, and it rains nearly everyday. Most areas receive an excess of 200 cm of rain per year. Some receive 500 cm or more. Because of the warm temperatures and abundant rainfall, most plants grow very rapidly; however, soils are often poor in nutrients.

The trees have extensive root network, associated with fungi, near the surface of the soil that allow them to capture nutrients from decaying vegetation before they can be carried away.

These forests have a very large number of plant species including balsa, teak wood, and many other ornamental roots. The trees are usually in two or three layers, with some taller trees. Since the trees capture most of the sunlight, many shade tolerant plants like ferns, mosses, orchids and vines live beneath the trees' canopy.

A large variety of animals are also found here. Insects, such as ants, termites, moths, butterflies and beetles are particularly abundant. Birds are also extremely common, as are many climbing mammals, lizards and tree frogs. Many kinds of nectar and fruit feeding birds and mammals are also common.

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Grasslands, also known as prairies or steppes, are widely distributed over the world. They generally receive between 25 and 75 cms of precipitation per year. These areas are windy with hot summers and cold to mild winters. Fire is an important force in this ecosystem.

Trees, which generally require greater amounts of water, are rare in these areas except along watercourses. Grasses make up 60 to 90% of the vegetation. Many other kinds of flowering plants are interspersed with the grasses.

Characteristics of these areas are large herds of migratory, grazing mammals like bison, wild horses, and various kinds of sheep, cattle and goats. Many kinds of insects, including grasshoppers and other herbivorous insects, dung beetles, and flies, are common. Small herbivorous mammals, such as mice, and ground squirrels, are also common. Birds are often associated with grazing mammals. Reptiles like snakes and lizards often feed on small mammals and insects.

Found in Western India, parts of Central India and Deccan plateau

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Deserts are areas that generally receive fewer than 25 cm of precipitation per year. Although most deserts, such as the Sahara and the deserts of the south western United States, Mexico, and Australia, occur at lower latitudes, cold deserts occur in the basin and range area of Utah and Nevada and in parts of western Asia.

Lack of water is the primary factor that determines that an area will be a desert. Rain comes in the form of thundershowers at infrequent intervals. Deserts are also likely to be windy. Deserts may be either hot, dry wastelands devoid of life or quite cool during the major part of the year. The Sahara desert are hot during much of the year while the Gobi desert in central Asia can be extremely cold during winter months and have relative cool summers. The temperature varies greatly during a 24-hour period.

Deserts have limited species diversity. Many types of organisms live in deserts that are specially adapted to survive in dry, often hot environments. Since water evaporates from the surfaces of leaves many plants have very small leaves that allow them to conserve water. Many desert plants are spiny, like cactus has the ability to store water in their spongy bodies for use during drier periods. Other plants have parts or seeds that lie dormant until the rains come, when they grow rapidly, reproduce and die, or become dormant until the next rains.

The deserts have many kinds of animals, often inconspicuous and overlooked because they are small or inactive during the hot part of the day. Many lizards, snakes, small mammals, grazing mammals, carnivorous mammals and birds are common in desert areas. All of the animals that live in deserts are able to survive with a minimal amount of water. They have a waterproof outer skin or cuticle, so they use little water. They often limit their activities to the cooler part of the day and may spend considerable amounts of time in underground burrows during the day, which allows them to avoid extreme temperatures and to conserve water.

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Aquatic ecosystems are shaped by primary determiners. Four such factors are ability of the sun's rays to penetrate the water, the nature of the bottom substrate, the water temperature, and the amount of dissolved materials.

An important determiner of the nature of aquatic systems is the amount of salt dissolved in the water. Those that have little dissolved salts are called **freshwater ecosystems** and those that have a high salt content are called **marine ecosystems**. Freshwater ecosystems differ from marine ecosystems in several ways. The amount of salt present is much less, the temperature of the can change greatly, the water is in the process of moving down hill, oxygen can often be in short supply, and the organisms that inhabit freshwater ecosystems are different.

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This can be divided into two categories: those in which the water is relatively stationary, such as lakes and ponds, and those in which the water is running downhill, such as streams and rivers.

The zones that are evident in a lake ecosystem are as follows:

SL no.	Zone	Characteristics
1.	Littoral	Shallower water region with light penetration to the bottom; typically occupied by rooted plants.
2.	Limnetic	Open water zone to the depth of effective light penetration, called the compensation level, which is the depth at which photosynthesis just balances respiration. Community in this zone is composed of plankton (floating organisms) nekton (swimming organisms), and sometimes neuston (resting or swimming organisms on the surface). The term euphotic zone refers to the total illuminated stratum including littoral and limnetic.
3.	Profundal	The bottom and deep-water area, which is beyond the depth of effective light penetration.

In lakes the limnetic and profundal zones are relatively large compared with the littoral zone.

Along the shores and in the shallower parts of the lakes the euphotic zone contains many kinds of flowering plants. They are rooted in the bottom and some have leaves that float on the surface or protrude above the water. These are called emergent plants. Cattails, bulrushes, arrowhead plants, and water lilies are examples. Rooted plants that stay submerged below the surface of the water are called submerged plants. *Elodea* and *Chara* are examples.

In the littoral zone many kinds of freshwater algae also grow in the shallow water. Associated with the plants and algae are a large number of different kinds of animals. Fish, crayfish and many kinds of aquatic insects are common inhabitants of this mixture of plants and animals.

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Thermal Stratification – During the summer the top waters become warmer than the bottom waters, as a result only the warm top layer circulates and it does not mix with the more viscous colder water, creating a zone with a steep temperature gradient in between called the **thermocline**. The upper warm circulating water is the **epilimnion** while the colder non-circulating water is the **hypolimnion**. The oxygen supply becomes depleted in the hypolimnion since both the green plant and the surface source is cut off.

With the onset of cooler weather, the temperature of the epilimnion drops until it is the same as that of the hypolimnion. Then the water of the entire lake begins circulating and oxygen is again returned to the depths. As the surface water-cools below 4°C, it expands, becomes lighter, and remains on the surface and freezes, bringing on winter stratification. In the spring, as ice melts and water becomes warmer, it becomes heavier and sinks to the bottom. Thus, when the surface temperature rises to 4°C, it takes the spring overturn. The productivity of the lake is determined by several factors. Temperature is important, since cold temperatures tend to reduce the amount of photosynthesis. Shallow lakes tend to be more productive because most of the water has sunlight penetrating it and, therefore, photosynthesis can occur to the bottom of the lake. Shallow lakes tend to be warmer as a result of the warming effects of the sun's rays. A third factor that influences the productivity of lakes is the amount of nutrients present. This is primarily determined by the rivers and streams that carry nutrients to the lake. Deep, cold, nutrient-poor lakes are low in productivity and are called **oligotrophic lakes**. Shallow, warm, nutrient-rich lakes are called **eutrophic lakes**.

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Ponds

Ponds are small bodies of water in which the littoral zone is relatively large and the limnetic and the profundal zones are small or absent. Stratification is of minor importance. Ponds may be found in regions of adequate rainfall.

Ox-bow – They are continually being formed, for example, as a stream shifts position, leaving the former bed isolated as a body of standing water or 'ox-bow'. Because of the accumulation of organic materials and periodic flooding, flood-plain ox-bow ponds may be quite productive. Natural ponds are also numerous in limestone regions when depression or 'sinks' develop because of solution of the underlying strata.

Temporary pond – they are dry for part of the year and support an unique community. Organisms in such ponds may be able to survive in a dormant stage during dry periods or be able to move in and out of ponds, as can amphibians and adult aquatic insects. The fairy shrimps are well adapted and largely restricted to temporary ponds. The eggs

survive in the dry soil for many months, whereas development and reproduction occur in a short time in late winter and spring when water is present.

The temporary pond is a favourable place for those organisms adapted because interspecific competition and predation are reduced. Even though it contains water for only a few weeks, a definite seasonal succession of organisms may occur, thus enabling a large variety of organisms to utilize a very limited amount of physical habitat.

Farm ponds – these are created artificially by detouring a stream around a pond or the pond is constructed in a basin without a permanent stream. Such ponds have relatively little water flowing through them and are often artificially fertilized, stocked with game fishes, and managed so as to discourage rooted vegetation. Such ponds are not deep enough for stratification. It contains a large biomass of fish but the variety of organisms is reduced to favour large number of the desired species.

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Beaver pond – these are created by damming of a stream or basin by animals such as beaver. Beaver ponds are a characteristic feature of the North American continent. These have a short ecological life history, as they are abandoned when the supply of food trees in the vicinity becomes reduced. Beaver ponds are a very useful component of natural areas since they act as water reservoirs, fire breaks, and provide habitat for fur-bearers and fish. However, flooding of forest or farmland often relegates the poor beaver to the pest category.

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Streams and rivers are a second category of freshwater ecosystem. Since the water is moving, plankton organisms are less important than are attached organisms. Most algae grow attached to rocks and other objects on the bottom. This collection of algae, animals, and fungi is called periphyton. Since the water is shallow, light can penetrate easily to the bottom (except for large or extremely muddy rivers). Even so, it is difficult for photosynthetic organisms to accumulate the nutrients necessary for growth. As a matter of fact, the major input of nutrients is from organic matter that falls into the stream from terrestrial sources. These are primarily the leaves from trees and other vegetation, as well as the bodies of living and dead insects. Within the stream is a community of organisms that are specifically adapted to use the debris as a source of food. Bacteria and fungi colonize the organic matter, and many kinds of insect shred the material as they eat it and the fungal bacteria living on it. The intestinal waste of these insects and the tiny particles produced during the eating process become food for other insects that build nets to capture the tiny bits of organic matter that drift their way. Carnivorous insects and fish in turn eat these insects.

In streams two major zones are mainly evident:

SL no.	Zone	Characteristics
1.	Rapid	Shallow water where velocity of current is great enough to keep the bottom clear of silt and other loose materials, thus providing a firm substrate. This zone is largely occupied by specialized benthic

		or periphytic organisms, which become firmly attached or cling to a firm substrate, and by strong swimmers such as darters (fish).
2.	Pool	Deeper water where velocity of current is reduced and silt and other loose materials tend to settle to the bottom, thus providing the soft bottom, unfavourable for surface benthos but favourable for burrowing forms, nekton, and, and in some cases plankton.

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In general differences between streams and ponds revolve around a triad of conditions:

1. Current is much more of a major controlling and limiting factor in streams.
2. Land-water interchange is relatively more extensive in streams, resulting in a more open ecosystem and a heterotrophic type of community metabolism.
3. Oxygen tension is more uniform in streams, and there is little or no thermal or chemical stratification.

Streams have producers of their own, such as fixed filamentous green algae, encrusted diatoms, and aquatic mosses, but these are usually inadequate to support the large array of consumers found in streams. Many of the primary consumers in streams are detritus feeders that depend in large part on organic materials, which fall in from terrestrial vegetation. Thus streams form an open ecosystem that is interdigitated with terrestrial and lentic (stagnant) systems.

Because of the small depth, large surface exposed to the air, and constant motion streams generally contain an abundant supply of oxygen, even where there are no green plants. For this reason stream animals generally have a narrow tolerance and are especially sensitive to reduced oxygen. Therefore, stream communities are especially susceptible to and quickly modified by any type of organic pollution, which reduces the oxygen supply.

Organisms in large rivers, which have less light penetration, rely on the accumulation of food that drifts their ways from the many streams that empty into the river. These larger rivers tend to be warmer and to have slower moving water. Consequently, the amount of oxygen is usually less, and the species of plants and animals change. Plants may become established and contribute to the ecosystem by carrying on photosynthesis and providing hiding places for animals.

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The oceans cover 70% of earth's surface and play an important role in our global environment. Oceans buffer and modulate climate, reduce the extremes in temperature that would otherwise be experienced on earth. Ocean currents can absorb heat from the atmosphere, thus delaying its warming, warm currents can give up heat to the atmosphere, thus delaying its cooling. They affect the global cycling of chemical elements. They are a major storehouse and exchange carbon dioxide rapidly with the atmosphere, and play a major role in the rate of global warming.

The features of the ocean which are of major ecological interest are as follows:

1. The ocean is big, covering 70% of the earth's surface.
2. It is deep and life extends to all its depths. Although apparently there are no abiotic zones in the ocean, life is much denser around the margins of continents and islands.
3. It is continuous, not separated as land and fresh water habitats. All the oceans are connected. Temperatures, salinity, and depth are the chief barriers to free movement of marine organisms.
4. It is in continuous circulation, air temperature differences between poles and equator set up strong winds such as the trade winds, which create definite currents.
5. It is dominated by waves of many kinds and by tides produced by the pull of moon and sun.
6. Ocean is salty. The average salinity is 35 parts of salt by weight per 1000 parts of water, or 3.5%. About 27% is sodium chloride and most of the rest consists of calcium, magnesium, and potassium salts.
7. The concentration of dissolved nutrients is low and constitutes an important limiting factor in determining the size of marine population.
8. Paradoxically, the oceans and some groups of organisms that live in it are older than the ocean floor, which is constantly being altered and renewed by tectonic and sedimentary processes.

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The ocean consists of two ecosystems. They are as follows:

Pelagic Ecosystem

In the open ocean, many kinds of crustaceans, fish, and whales swim actively as they pursue food. These kinds of animals are called pelagic, and the ecosystem they are a part of it is called pelagic ecosystem. In ocean a majority of the producer organisms are small, microscopic, floating algae called **phytoplankton**. Since sunlight cannot penetrate to great depths in water, these phytoplankton are located in the upper regions. This region where the sun's rays penetrates is known as the **euphotic zone**. Small, weakly swimming animals of many kinds, known as **zooplankton**, feed on the phytoplankton. Zooplankton are often located at a greater depth in the ocean than the phytoplankton but migrate upward at night and feed on the large population of phytoplankton. The zooplankton are in turn eaten by larger animals like fish and larger shrimp, which are eaten by larger fish like salmon, tuna, sharks and mackerel.

A major factor that influences the nature of marine community is the kind and amount of material dissolved in the water. Phosphorous, nitrogen, and carbon are all required for the construction of new living material.

Benthic Ecosystem

Organisms that live on the ocean bottom, whether attached or not, are known as benthic organisms, and the kind of ecosystem that consists of these organisms is called a benthic ecosystem. Some fish, oysters, sponges, crustaceans, sea anemones, and many other kinds of organisms live on the bottom. In shallow water, sunlight can penetrate to the

bottom, and a variety of attached photosynthetic organisms like sea weeds are common. The substrate is the determining factor for the development of benthic community. Sand tends to shift and move, making it difficult for large plants and algae to become established, although burrowing worms and small crustaceans find it to be a suitable habitat. Muds may provide suitable habitat for some kinds of rooted plants. Muds generally have little oxygen in them but still may be inhabited by a variety of burrowing organisms that feed by filtering the water above them or feed on other animals in the mud. Rocky surfaces in the ocean provide a good substrate for many kinds of large algae. Associated with this profuse growth of algae is a large variety of animals. At great depths in the ocean is an ecosystem that relies on a continuous rain of organic matter from the euphotic zone. These areas are known as **abyssal** areas, and the ecosystem is known as an **abyssal ecosystem**. All of the organisms in this environment are scavengers that feed on whatever drifts their way.

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Ocean Food Webs

There are many different food webs in the ocean. These are as follows:

Planktonic Food Webs

They have small floating algae and photosynthetic blue green bacteria as the primary producers. These are feed on by small, drifting herbivores. Other small, drifting, predatory animals, along with the floating herbivores, make up the zooplankton. Some large vertebrates such as whales and shark are also planktonic feeders. Planktonic food webs can exist only where there is light, oxygen, and an ample supply of other chemical elements required for life. Light penetrates only a relatively short distance into the column of water in the oceans, and surface waters in the center of large ocean basins are generally nutrient poor. Thus, the most productive planktonic food chains are on continental shelf.

Intertidal Food Webs

The intertidal region is made up of areas exposed alternately to the air during low tide and to ocean waters during high tide. The constant movement of water transport nutrients into and out of these areas, which are usually rich in life and are major economic resources.

The bases of intertidal food webs are attached, rather than floating or drifting, algae and photosynthetic blue green bacteria. Kelp beds are examples of attached algae that form the base of an intertidal food chain. Intertidal ecosystems, especially salt marshes, are important habitats in the life cycle in the life cycles of many fish and shellfish that are sources of food, have commercial value, are endangered species, or are otherwise important for biological diversity.

Reef Food Webs

Coral reefs are structures that appear to be made of rocks but are actually formed of the hard material deposited by living organisms. These reef-building organisms include coralline algae and animals that have microscopic algae as symbionts. Corals produce

calcium carbonate material that forms the structure of the reef. The reefs provide a habitat for a great diversity of organisms and are among the most diverse of all kinds of ecosystems.

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It is a special category of marine ecosystem consisting of shallow, partially enclosed areas where freshwater enters the ocean. It is a good example of a coupled system that achieves a good balance between physical and biotic components, and thereby a high rate of biological productivity.

It consists of several basic subsystems linked together by the ebb and flow of water that is driven by the hydrological and the tidal cycles. The chief sub systems are:

1. The shallow water production zone in which the rate of primary production exceeds the rate of community respiration.
2. The sedimentary subsystem in the deeper channels, and lagoons in which respiration exceeds production. Here nutrients are regenerated, recycled and stored and vitamins and growth regulators are manufactured.
3. The plankton and nekton which moves freely between the two fixed subsystems producing, converting, and transporting nutrients and energy.

The saltiness of the water in the estuary changes with tides and the flow of water from rivers. The organisms that live here are specially adapted to this set of physical conditions, and the number of species is less than in the ocean or in fresh water.

Estuaries are particularly productive ecosystems because of the large amounts of nutrients introduced into the basin from the rivers that run into them. This is further enhanced by the fact that the shallow water allows light to penetrate to most of the water in the basin. Phytoplankton and attached algae and plants are able to use the sunlight and the nutrients for rapid growth. This photosynthetic activity supports many kinds of organisms in the estuary. Estuaries are especially important as nursery sites for fish and crustaceans. The adults enter these productive, sheltered areas to reproduce and then return to the ocean. The young spend their early life in the estuary and eventually leave as they get larger and are more able to survive in the ocean. Estuaries also trap sediments, which tend to prevent many kinds of pollutants from reaching the ocean and also results in the gradual filling in of the estuary, which may eventually become a salt marsh.

Biota and productivity of an estuarine ecosystem

Typically, estuarine communities are composed of a mixture of endemic species and those which come from the sea, plus a very few species with the osmoregulatory capabilities for penetrating to or from the freshwater environment. Seafood populations are good examples of mixed endemic and marine species. For e.g., the spotted sea trout is largely restricted to estuaries, while menhaden are found in estuaries mostly in the juvenile stage. In fact, coastal nektons use estuaries as nursery grounds where young growth can take advantage of the protection and abundant food. Anadromous fishes such

as salmon and eels also depend on estuaries where they may reside for considerable time during their migration from salt to freshwater.

Consumers are often versatile in their feeding behaviour. The ubiquitous mullet, species of which are found in the estuaries throughout the world, can feed at several trophic levels. The rich estuarine sediment helps in the metabolism of organisms.

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The reasons for high productivity in an estuarine ecosystem can be summarized as follows:

1. It is a nutrient trap that is partly physical and partly biological. The natural tendency towards eutrophication makes estuaries especially vulnerable to pollution, since pollutants get trapped just as do useful nutrients.
2. They benefit from a diversity of producer types programmed for virtually year around photosynthesis. Estuaries often have all three types of producers namely macrophytes, benthic microphytes, and phytoplankton.
3. Tidal action is important in creating a fluctuating water level ecosystem. In general, the higher the tidal amplitude the greater the production potential, provided that the ensuing currents are not too abrasive.

Estuaries are considered as multiple use environments. Modification or pollution at one point of the estuaries affects distant points in both tidal directions and even in the adjacent oceans. Accordingly, the entire estuarine ecosystem must be studied, monitored, managed, and zoned and human uses regulated in terms of the whole. Otherwise estuaries can only suffer the “tragedy of the commons”.