THE GREAT BAY ESTUARY

The Great Bay Estuary* transforms New Hampshire's modest 18 mile coastal shoreline into 150 miles of tidal shoreline, rich in salt and freshwater diversity. This is where freshwater from many of New Hampshire's inland lakes and rivers mingle with seawater pushed up the Piscataqua River on a eight foot tide. The Great Bay Estuary has its origin at the mouth of the Piscataqua River, the gateway to the ocean. Moving upstream, the Estuarine system angles sharply into Broad Cove and Little Bay, and then squeezes through the bottleneck known as the Furber Strait at Adams Point into Great Bay proper. Included in the Estuarine system are the tidal rivers. Likened to "spindling fingers" on an ancient hand, the Squamscott, Lamprey, Oyster, Bellamy Cochecho and Salmons Falls Rivers (the latter two join for become the Piscataqua River) empty their load of freshwater into the Estuary. A smaller contributor is the Winnicut River. The Great Bay Estuary is one of the largest estuaries on the Atlantic Coast.

Tidal flow dominates the Great Bay Estuarine system with freshwater inflows from the tidal rivers averaging only 2% of the volume of water, although this does vary seasonally, increasing during wetter periods such as spring snowmelt. The tide lags significantly as one moves further up the Estuary e.g. in the Lower Squamscott River at the far end of Great Bay, low tide is 2.5 hours later than low tide at Portland. Similarly, the tidal range (the difference between low tide and high tide) generally decreases as one moves up the Estuary.

BIRTH OF AN ESTUARY

The Great Bay Estuary had its beginnings approximately 14,500 years ago following the melting of the last glaciers. The tremendous quantity of water released by the melting glaciers contributed to rising ocean waters which flooded the land, "drowning" the ancient river valleys that make up the Estuary that we see today. As the glaciers melted, the release of their tremendous weight from the land surface caused the depressed land to slowly rebound to existing levels - a process that has taken many thousands of years. The Great Bay Estuary has had a complicated sea level history since the melting of the glaciers, being flooded by the rising sea, then partially exposed, and later flooded by high sea levels once more. The shoreline of the Estuary probably arrived close to its present day position a few thousand years ago when the rate of sea level rise slowed down. Since then, slowly rising sea levels (estimated at 1/16 inch/year) have continued to modify the Estuarine shoreline. It is estimated that the Great Bay Estuary has existed as an estuary for the last 8,000 years, which is comparatively young in terms of geological time (which spans millions of years).

Ice has continued to play an important role in shaping the characteristics of the shoreline. During winter, much of the shoreline and the intertidal zone (areas that are alternately flooded and exposed by tides) are iced over. During periods of ice movement, large amounts of shoreline sediments are dislodged and transported to other parts of the Estuary. Chunks of saltmarsh vegetation and marsh peat and shallow eelgrass beds are torn loose by ice and "rafted" to other parts of the Estuary during periods of thaw. Many of these chunks can be seen stranded on the mudflats at low tide. The movement of these rooted chunks of vegetation can facilitate the spread of saltmarsh vegetation and eelgrass beds.

* Estuary with a capital "E" refers to the entire Great Bay Estuarine system.
HABITATS AND INHABITANTS OF THE ESTUARY

The Great Bay Estuary includes five major water-dominated habitats: eelgrass, mudflats, saltmarsh, channel bottom, and rocky intertidal (in order of abundance). These rich and diverse Estuarine habitats are home to a variety of species, including 52 species of fish and 110 bird species. Several endangered and threatened bird species, such as bald eagles and ospreys also use the Estuary at various times of the year. Invertebrate populations include Eastern Oysters, lobsters, crabs and soft shell clams. Harbor seals may be observed in winter and spring especially near the mouth of the Oyster River and in the channel at Forber Strait.

Eelgrass

Eelgrass (Zostera Marina) is a submerged marine flowering plant growing in shallow waters and rooted in the estuarine sediments. Eelgrass communities occur as large "meadows" or in smaller beds, and are the most extensive habitat in the Estuarine system. This habitat forms an important base of the Estuarine food chain, with a number of invertebrates feeding on decomposing eelgrass leaves. These invertebrates in turn provide food for larger life forms such as fish and crabs, which in turn are predated on. Eelgrass habitat is a rich microcosm of estuarine life. Small animals are anchored to the blades; larval organisms are suspended in the water; many species of finfish and shellfish (e.g. silversides, sticklebacks, smelt, scallops and crabs) use eelgrass meadows as important breeding and nursery grounds; and predatory fish, such as striped bass, are attracted to eelgrass beds for feeding. Many waterfowl and wading birds feed in the eelgrass meadows. Ducks and geese consume eelgrass leaves and seeds while wading birds and diving ducks feed on the fish and other food sources.

In addition to providing valuable habitat for a variety of species, eelgrass communities play an important role in maintaining estuarine water quality and clarity. In this low energy environment the eelgrass plants filter the estuarine waters, allowing sediments to settle out, and using excess nutrients for their growth (although too many nutrients can be harmful to eelgrass communities). Eelgrass communities also play a role in stabilizing bottom sediments (rooted vegetation binds the sediments), which affects both water clarity and water quality.

The health of eelgrass is important to the overall health of the estuarine ecosystem. However, eelgrass communities are threatened by two factors: estuarine pollution and a wasting disease. Algal growth caused by nutrient loading (e.g. from sewage outflows) reduces the amount of light reaching the plants, and an excess of suspended sediments can shade or smother eelgrass plants. Both of these conditions adversely affect eelgrass growth. The second factor affecting the health of eelgrass communities is a wasting disease, caused by a marine slime mold. This disease devastated much of the North Atlantic eelgrass population in the 1930's, and is today again threatening eelgrass communities. Much still needs to be learned about the spread of this disease.

Mudflats

Large mud (tidal) flats dominate the shallower portions of Great and Little Bays. At low tide, approximately 50% of Great Bay is exposed as mudflat. These unvegetated mudflats are the second most extensive habitat in the Estuary. Estuarine mudflats are exposed at low tide and covered by shallow water at high tide. They are extremely important areas of benthic invertebrate (invertebrates that occur on the bottom of a body of water) production, and as such are a significant contributor to primary productivity in the Estuary. Mudsnaills, numbering tens of thousands, feed on the highly productive benthic layer. Wading birds feed on clams and worms at low tide, while fish and crabs prey on mudflat invertebrates at high tide.
Horseshoe crabs, survivors of ancient history pre-dating the dinosaurs to 200 million years ago, also feed extensively in mudflats at high tide. Despite its name, the horseshoe crab is not in fact a crab - its nearest relative is the spider!

Saltmarshes

Large areas of saltmarsh are found throughout the Estuary, being most abundant along the Squamscott River. These saltmarshes are enormously productive, producing large quantities of organic material (which enters the detrital cycle) and providing habitat for a variety of species. There are two types of marsh habitat: high marsh and low marsh. Low marsh is dominated by saltwater cordgrass (*Spartina alterniflora*) and is flooded twice daily by the tides. High marsh is the typical New England saltmarsh, and is flooded irregularly, being beyond the reach of daily tides. The high marsh is dominated by salt hay grass (*Spartina patens*) that lies flat and grows in characteristic "cow licked" mats.

The extensive networks of tidal creeks that meander through the saltmarshes are an important link in estuarine ecology. These waterways transport large quantities of organic detritus (particles that result from the decomposition of organic material) into the Estuary. They also provide valuable habitat for juvenile fish and a number of insect species (including the ubiquitous saltmarsh mosquito!). Abundant populations of mummichogs found in the tidal creeks are an important link in the saltmarsh food chain. These small fish, which have no commercial or recreational value, provide a major food source for wading birds. A variety of birds such as glossy ibis, herons, snowy egrets, and yellowlegs, use saltmarshes during some portion of their life cycle. Terrestrial species, e.g. deer, raccoons, and mink are also attracted to the saltmarsh for foraging.

Channel Bottom habitat

The channels in the Estuary are relics of ancient river beds that were originally cut by streams draining massive quantities of water from the melting glaciers. These old river channels now lie along the bottom of the Great Bay Estuary. This habitat varies from soft mud to sand to gravelly cobble and rock areas. The deeper channel areas provide refuge for fish and invertebrates retreating from the eelgrass meadows, mudflats, and saltmarshes at low tide. Extensive oyster beds are found throughout this habitat. Oyster beds are also found at the mouths of tidal rivers, in shallow creeks and at the edges of mudflats. Oysters are among the few highly specialized creatures that only inhabit estuaries.

Rocky Intertidal habitat

This rocky habitat, so common along the Atlantic coast, only sporadically punctuates the estuarine shoreline. These rocky areas are dominated by seaweeds, which add fragmented tissue to the estuarine detrital cycle. These intertidal areas (i.e. exposed at low tide) are important areas for crustaceans, such as green crabs, and provide feeding grounds for some birds at low tide. Predatory fish feed here at high tide.