**Reference Estuary Study continued**

**Sediment**
The predicted sediment textures for a restored Deschutes estuary (Capitol Lake) were similar to those sampled within the reference estuaries. Sediment samples were collected from each of the 90 reference sites. Silt loam was the most common sediment texture with both the reference estuaries and the modeled Deschutes estuary. Sandy loam sediments was the second most common sediment texture in the five reference estuaries and would be abundant within the modeled Capitol Lake. Silt and silty clay loam were predicted to be common in a restored Deschutes estuary but were found only at 2 of 90 sampling sites. The silt loam sediments will be an important factor in the formation of the estuarine communities within a restored estuary.

**Shells and Invertebrate Collection**
Shells were collected which were on top of the sediment at the sampling sites. The following organisms were found at the five reference estuary sampling sites:

- barnacles
- butter clam
- Japanese littleneck clam
- native littleneck clam
- soft-shelled clam
- bent-nosed macoma
- Nuttall's cockle
- unknown species of cockles
- moon snail
- slipper snail

**Vegetation**
The majority of sampled sites were unvegetated flats of either sand, mud, or mixed sand and mud. Several plots contained a layer of diatoms (microscopic, one-celled algae) or algal mats on the surface. Sites with salt marsh vegetation were very limited. A majority of the marsh vegetation was found at only 12 of the 90 reference sites. The vegetation and plant species identified at the reference estuary sites are characteristic of those typically found in estuarine, intertidal and salt marsh community types within Puget Sound.

**Southern Puget Sound**
The Biological Conditions Report describes what habitats would be expected in a restored Deschutes estuary. Capitol Lake used to be part of southern Budd Inlet. Today, Budd Inlet is seven miles long, one mile wide at its mouth, and two miles wide near its center. At the south are East and West Bays which are divided by the Port of Olympia peninsula. West Bay is the mouth of the Deschutes River Estuary. Budd Inlet and southern Puget Sound estuaries are characterized by:

- Shallow depths,
- Soft, and silty sediments,
- Slow flushing times,
- “Layering” of freshwater on top of saltwater,
- Warmer summer surface water,
  - Complexity in shape,
  - Limited water exchange with other parts of the Puget Sound,
  - Tide ranges of 13 to 15 feet between high and low tides,
  - Limited dilution of nutrients, and
  - Lower oxygen concentrations.

These physical conditions lead to some differences between the flora and fauna of southern Puget Sound as compared with other estuaries in Puget Sound. For example, some species assemblages such as kelp and other algae and invertebrate species are not as diverse as other parts of Puget Sound. Eelgrass, a key habitat of juvenile salmon, is also not found south of the Nisqually Delta.
The Biological Conditions Report combined the field data, scientific literature, and statistical modeling. It identifies what sort of estuarine communities might recolonize a restored Deschutes estuary.

- Mud Flats would dominate the restored estuary. They would be similar to those of Mud Bay in Eld Inlet. Mud flats are characterized predominantly by silt and clay sediments that are regularly flooded by high tides, drained and flooded by a diffuse pattern of channels. At high and low tides, mudflats can be a source of food for waterfowl and food and refuge for juvenile fishes. Organisms expected in mud flat habitats include burrowing crustaceans and polychaetes, mud shrimp, and clams. Diatoms and algal mats may be found where salinities are higher.

- Mixed Sand and Mud Flats would occur at varying elevations and salinities throughout a restored estuary. At higher elevations, these habitats form a transition zone up to high marsh areas and are populated with vascular plants and even some trees. At lower elevations and low salinities, plants such as bulrush and arrowgrass may also occur. In lower elevation/high salinity areas, microalgae, salt-tolerant plants such as pickleweed, and animals such as ghost shrimp will likely exist.

- Sand Flats would also be expected within the basin. Sand flats are found along exposed boundaries of mud flats in estuarine river deltas, adjacent to river channels. They typically occur in higher energy areas than mud flats where the substrate is predominantly sand and is exposed to sorting from wave and current action. Flooded by most high tides, sand flats are covered by scattered vegetation near the tidal edges, with more vegetation farther away from water. Clams, polychaetes, and young fish are typical animals that inhabit sand flats. In high salinity areas salt grass could be expected, while less salt-tolerant common three square and Lyngbye’s sedge would be expected closer to Percival Cove and Tumwater Falls.

- Sand Channels would form in the North and Middle Basins. The main channel would reform quickly after dam removal. It would be expected to be deeper and sandier than those found at Kennedy Creek. Sand channels generally occur in open, deeper areas where channels form. These open areas are typically inhabited by clams, polychaetes, young flat fish, salmon, and sand-loving algae. They are also important for provision of refugia and food for anadromous, resident, and marine fishes and transport of sediments.

- Vegetated marsh would likely be limited to a band around the periphery of the basin (similar to Mud Bay). This area would support the type of saltmarsh plants described for the mud and sand flats above. Higher elevations may also support trees and shrubs common to Puget Sound shorelines.

The Reference Estuary Study sampled five estuaries within southern Puget Sound. These including Woodward Bay, Ellis Cove, and Mud Bay in Thurston County; and Kennedy Creek and Little Skookum Inlet in Mason County. All are relatively close to Capitol Lake and were chosen to represent the range of conditions present in estuaries within Southern Puget Sound. While the reference estuaries were from smaller drainages (creeks rather than a river), each watershed had a similar diversity of land uses and forest cover as compared to the entire Deschutes River watershed.

At each estuary a total of 16 to 21 field sampling points were randomly located. There were a total of 90 sites across the five estuaries. Measurements were taken on the following: 1) Vegetation - percent cover, species, and type. 2) Sediment texture - sand, silt, and clay. 3) Salinity. 4) Temperature. 5) Dissolved oxygen concentration, and 6) pH. The location and elevation of each sampling point was established using global positioning system (GPS). Sediment cores and empty or dead invertebrate (insects and shellfish) shells were collected for later lab analysis. The field work was undertaken during August and September 2005.