The 2004 RISE study surveyed the plume in July during a period of decreasing river flow and variable winds. The river discharge peaked at the beginning of June and averaged approximately 450 m$^3$ s$^{-1}$ during the study period (Figure 2). The largest sediment input to the Columbia plume typically occurs immediately prior to and during the spring freshet. Our study corresponded to a period when the sediment input to the system was likely to be relatively low. We expect, therefore, that most particles in the plume will be organic rather than mineral.

**Sampling**

Plume sampling was performed during the cruise (August 2004) on the Columbia River plume as part of RISE (River Influences on Shelf Ecosystems). A primary objective of RISE is to determine the influence of the plume on the coastal ecosystem. The plume has an impact on the coastal ecosystem by transporting and redistributing river-borne matter. In particular, mixing of plume water with ambient ocean water typically results in increased productivity in the vicinity of the plume. We describe data taken in August 2004 on the Columbia River plume as part of RISE (River Influences on Shelf Ecosystems). A primary objective of RISE is to determine why the Washington shelf to the north of the Columbia is more productive than the Oregon shelf to the south. The answer to this question involves the coupling of biological, geophysical and physical processes in the plume.

**Objectives of the present study**

The goal of this component of the RISE project is to understand the dynamics of particles in the plume. Much of the organic and inorganic material in the plume exists in suspended form and includes sediments and various types of organic particles. Particle movement in the plume is an important component of the transport and dispersal of nutrients, carbon and contaminants in the plume and surrounding waters. Particle movement and concentration dynamics are very complex, however, depending on size, density, turbulence, flocculation and disaggregation. Initially, we focus on the role of fronts in plume and ambient dynamics, since they are a dominant mechanism for exchange between plume and ambient coastal waters.

**Plume forcing**

Figure 1: Columbia River discharge measured upstream at the Beaver monitoring station.

Plume forcing

The Columbia River discharge consists of two distinct phases, a northern phase during the spring freshet and a southern phase during the summer freshet. The spring freshet is characterized by high discharge rates and short duration, while the summer freshet is characterized by lower discharge rates and longer duration. The spring freshet typically occurs in March and April, while the summer freshet occurs in June and July.

**Plume in upwelling conditions**

As expected, downwelling winds forced the plume into a narrow band close to the Columbia River mouth during the first month (Figure 3). However, the plume extended over the southern side of the plume where the gravitational expansion of the plume was blocked by onshore winds and onshore-driven flow. These trends were not as strong as those observed during upwelling periods due to residual, buoyant plume water that was forced back onshore south of the plume.

**Plume in downwelling conditions**

Figure 2: Columbia River discharge measured upstream at the Beaver monitoring station.

Upwelling winds force the plume into the natural tendency to move north along the Columbia River and out into the Strait of Juan de Fuca.

**Synopsis**

The Columbia River plume is a large, complex ecosystem that extends from the Columbia River mouth to the Strait of Juan de Fuca. The plume is characterized by high nutrient and organic matter concentrations, which support a productive marine ecosystem. The plume is an important component of the transport and dispersal of nutrients, carbon and contaminants in the plume and surrounding waters. Particle movement and concentration dynamics are very complex, however, depending on size, density, turbulence, flocculation and disaggregation. Initially, we focus on the role of fronts in plume and ambient dynamics, since they are a dominant mechanism for exchange between plume and ambient coastal waters.