The Role of Sediments in the Nutrient Budget of Spirit Lake, WA

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Introduction

The 1980 eruption of Mount St. Helens caused the bathymetry of Spirit Lake to change drastically, resulting in an increase in surface area and a decrease in average depth. Subsequently, Spirit Lake is experiencing an increase in productivity. This study measures concentrations of nitrogen, carbon and phosphorus in sediments in order to understand the source of the lake’s increasing productivity. Over the summers of 2010 and 2011, we collected surface sediment samples, retrieved a yearlong sediment deposition sample and collected a sediment core. The results of these analyses are used to estimate the role of sediments in nutrient cycling in Spirit Lake.

Methods

• Lake surface sediment samples were collected with a Petite Ponor Grab (Fig. 1).

• Newly deposited sediments (Fig. 2a&b) were collected using a sediment trap constructed out of 4” black PVC pipe, a funnel, and a 125 mL collection bottle (Fig. 2a&b); the trap was anchored and held 10 ft above the sediments with a submerged buoy to avoid damage from floating log mat.

• The sediment core was taken using a gravity corer and sliced into 2 cm sections.

• Sediment samples were dried and homogenized using a Wiley mill and analyzed for C and N (CHN analysis) and P (ICP-OES) by the UW School of Forest Resources Analytical Lab.

Figures 7a&b Nitrogen nutrient models for 2009 and 2010.

Discussion

• The mass balance model for N in 2010 (Fig. 7b) is nearly balanced with losses to sediments calculated from our sediment trap data (Table 1). In Fig. 8b, our mass balance model for P is also nearly balanced with almost all P flux into Spirit Lake being lost to sediments. This is to be expected since P adsorbs to particles and sinks out of the water column. We did not have sediment data for 2009 N and P models (Figs. 7a and 8a).

• Higher loads of nutrients are found in the sediments in the East arm of Spirit Lake (Table 2) compared to the West arm and the South shore area.

• This pattern of higher N and P in the East arm and the far northern end of the West arm appears to correlate with the presence of the floating log mat in that region over the summer, and may indicate a role for biofilm formation and mechanical removal as an important source of N and P to Spirit Lake (Figs. 4, 5, and 6). The West arm trap was deployed for one month (27 days) during the period of high biological productivity, whereas the East arm trap was deployed for just about one year (364 days). The higher value for N, P and C during the summer deployment suggests that in the colder months mineral sediments (i.e. silt) with lower nutrient and C content dilute the nutrients deposited during the warmer months (Table 1).

• Sediment trap and surface N:P molar ratios are much less than 16:1, ranging from 6.6-11.9:1. All of our results indicate N limitation.

• The sediment cores show that new sediment being deposited in Spirit Lake is higher in N, P and C than blast/landslide material (Figs. 9, 10 and 11). Although there is a correlation between lake depth and nutrient concentrations (Table 3), this may be an artifact of winds pushing the log mat into the regions of the lake with greater depths (East and West arms).

• Future studies:
  o Investigate the role of aquatic plants in removal of nutrients from the South shore sediments.
  o Quantify atmospheric deposition of nutrients to Spirit Lake.
  o Study the rate of biofilm production on the floating log mat and study the spatial distribution of new sediment under the log mat and in regions outside in the summer.
  o Determine the sources of nutrients from the contributing watershed and the biofilm using isotopic analysis for N.

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