

Background/Previous Work

Land clearance in forested mountain catchments can result in increased peak flows and landsliding, whether by fire (Jackson & Roering 2009) or by road building and timber harvest (Jones & Grant, 1996; Grant & Wolff, 1991). Sedimentary sinks capture a record of such catchment events, and an expression of their associated delivery mechanisms. Recent work shows that in sediment cores taken off-shore at the mouth of the Umpqua River (upper arrow in Fig. 1), an apparent sediment accumulation rate increase occurs at a mean age of 1967 (Wheatcroft et al. 2013). This coincides with peak timber harvest in the basin as well as a time of increased discharge (Fig. 2).

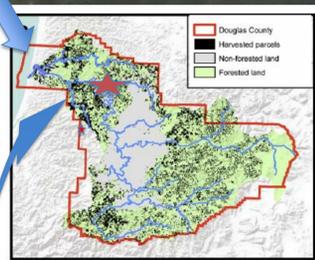
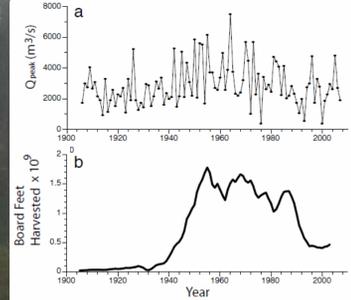


Figure 1. Umpqua River, tributaries and spatial distribution of logged parcels and Douglas County boundary (Wheatcroft et al. 2013). Red star = Elktion gauging station.

However, the attenuation of signals in the fluvial system confounds the interpretation of the sedimentary record. The Umpqua River basin is large (12103 km²), draining four geologic provinces and enduring a range of hydroclimatic conditions. How can the sources of the increased sediment flux be better constrained?

Figure 2. Panel (a) Peak annual Q at Elktion; (b) Board ft of timber harvest, Douglas Co., Oregon (Wheatcroft et al. 2013).



How can we increase the resolution of the record? USE A LAKE!
So, work has begun to formulate specific questions and hypotheses, and also methods to test the ideas.

Developing Questions & Hypotheses

Loon Lake in the Oregon Coast Range is a unique sedimentary sink to test hypotheses concerning the fidelity of the stratigraphic record, and to better understand the response of a catchment to perturbations such as timber harvest, fires, floods, as well as earthquakes. Created by a landslide dam 1400 years ago, it lies in the Tye and Elktion Formation of marine sedimentary rock, which is susceptible to shallow landsliding (Roering et al., 2005). It is in the Cascadian subduction zone, and could have experienced four strong earthquakes in its lifetime (Kelsey et al., 2005). Most recently, its forests have been heavily harvested (Fig. 3). Extreme precipitation can occur during the winter (mean annual precipitation is between 1400 and 2000 mm), which mobilizes much sediment.

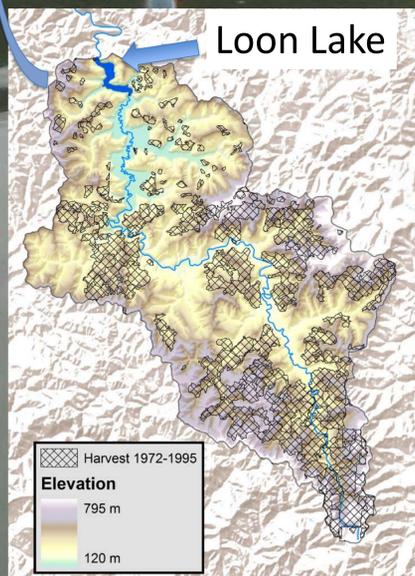


Figure 3. Elevation and area of timber harvest of Lake Creek catchment. From 1972 to 1995, ~30% of the catchment area was cut (Cohen et al. 2002).

Guiding questions for which hypotheses are being developed:

- How are events in the catchment recorded in the lake sediments?
- Have sediment accumulation rates changed over time, and if so, what processes have contributed to the changes?
- How does the morphology of the lake affect the deposition of sediment, and thus the recording of events?
- What determines the fidelity of the record – is it the magnitude, frequency, or type of event, or is it the position of deposition within the lake?

Anticipated Methodology

- Obtain short cores which preserve the sediment-water interface, long cores which extend back in time, and a transect of very short cores, extending up-lake
- Analyze the cores by tests of magnetic susceptibility, bulk density, grain size, charcoal abundance, x-ray CT, TOC, C/N, other biogeochemical analysis; correlate cores by stratigraphy and evidence
- Construct an age-depth model to constrain sediment accumulation rates, using radionuclides of ²¹⁰Pb and ¹³⁷Cs, total lead, and ¹⁴C
- Investigate climate, fire, and harvest records
- Measure inflow and outflow of Q_s and Q_w during winters of 2014 and 2015

Reconnaissance – April 19, 2013

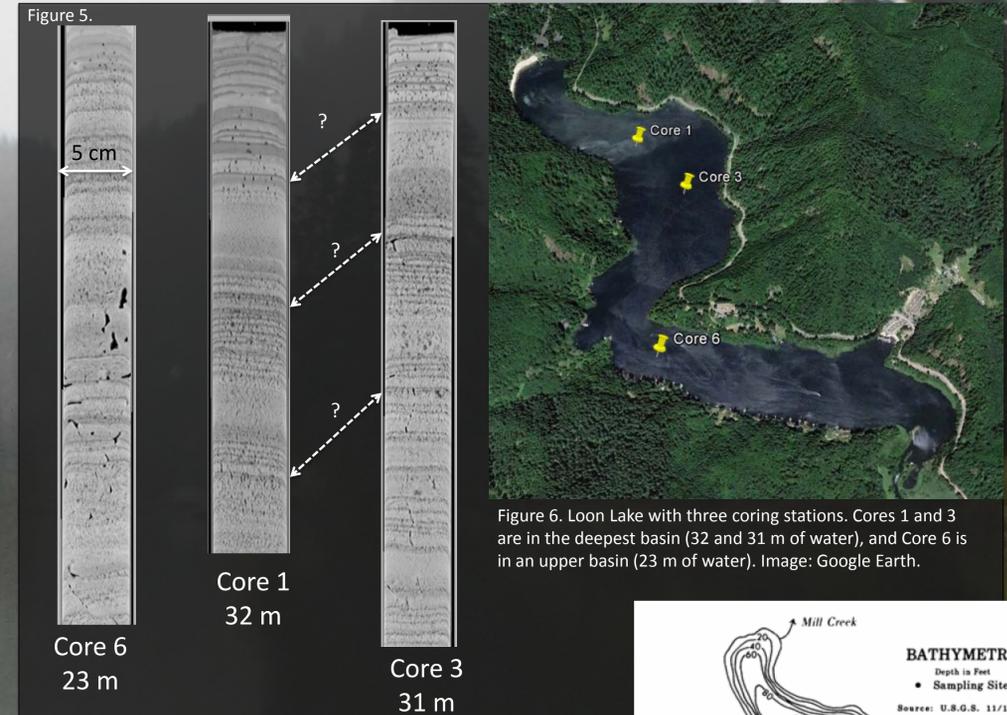


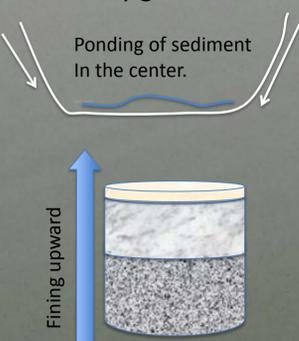
Figure 7: Gravity corer on left. Photo by F. Guerrero

In April 2013, several cores were taken from Loon Lake. Three were CT-scanned (Fig.5), and others have been sectioned for analysis, currently radionuclides with gamma ray spectroscopy. Bathymetric measurements and water quality measurements were made on-site to compare to existing data. Fig. 5 shows how cores can be visually correlated.

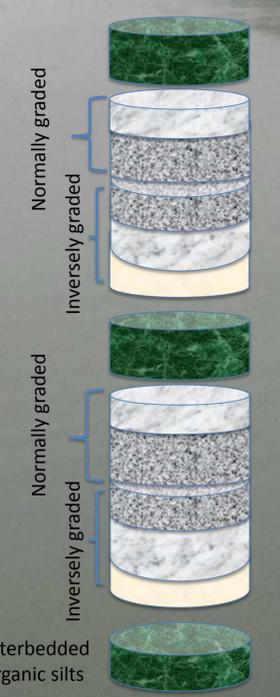
Figure 4. An example hypothesis:

It is expected that different events in the catchment will result in characteristic deposits in the sediments. For example, earthquakes will produce two types of deposits (Howarth et al., 2012): a co-seismic slumping of lake walls, and for several years, post-seismic increased sediment accumulation by widespread landsliding. These deposits can be distinguished based on their material composition, grain size, gradation, and temporal patterns as shown below.

a) Co-seismic slumping: Normally graded



b) Post-seismic: alternating landsliding layers and in-lake organic silts.



References

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