

# THE EROSIONAL IMPACT OF GRAZING COMPARED TO SEVERE BLOWDOWN IN A COLORADO SUBALPINE WATERSHED AS RECORDED IN LAKE SEDIMENTS

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#### Abstract

Subalpine lakes in designated wilderness areas can be excellent archives of accelerated watershed erosion caused by human disturbances due to their often remote locations and the cessation of most human disturbances following wilderness designation. When logging, grazing and road-building cease, a natural disturbance regime, which includes fire, insect, disease and blowdown (or windthrow), is the dominant driver of accelerated erosion. To compare and quantify accelerated erosion due to human and natural disturbances, a sediment core from a subalpine lake in the Mt. Zirkel Wilderness Area, Colorado, USA was analyzed. The lake resides in a small watershed (0.39 km<sup>2</sup>) that was grazed since at least 1926 (first permit issued) and saw 50-89% of trees uprooted by the 1997 Routt-Divide Blowdown in approximately 25% of its watershed area. Based on watershed characteristics it is highly likely that most grazing occurred in the same area as the majority of the tree uprooting. The sediment core was dated using the <sup>210</sup>Pb method and sediment mass accumulation rates (MARs) were calculated. Between approximately 1920 and 1930 MARs increase more than 40%. For the next 40 years the average MAR decreases slightly until the mid-1960s when MARs drastically decrease until the 1980s when they appear to gradually approach a background rate through present time, a decrease of greater than 65%.



Figure 1 <sup>210</sup>Pb Date v. sediment mass accumulation in g cm<sup>-2</sup>yr<sup>-1</sup>

These results suggest that grazing resulted in accelerated erosion while mass tree uprooting resulted in little to no accelerated erosion. The decrease in MARs that begins in the mid-1960s is approximately concurrent with the designation of the Mt. Zirkel Wilderness Area. There were not roads in the watershed and no evidence of logging at that time so it may represent a decrease or cessation of grazing, though grazing was still allowed following wilderness designation. If there is another factor contributing to the decrease in MARs it may have subdued or erased any accelerated erosion that resulted from the 1997 blowdown. Analysis of historical grazing records and lake sediment organic and inorganic matter concentrations will be used to further refine and describe the influence of human and natural disturbances on the watershed erosion record.



**Figure 2** Map of study area showing the location of Lake Margaret in the Mt. Zirkel Wilderness Area, north-central Colorado and percent blowdown



**Figure 3** Trees uprooted by the 1997 Routt-Divide Blowdown in Lake Margaret's watershed.

### Methods

- Bathymetric map of Lake Margaret was produced in ArcGIS using data obtained from a GPS equipped echo sounder attached to an inflatable kayak (no motor in wilderness)
- Qualified coring areas (low energy depositional environments) were identifed by determining the mud deposition boundary (Rowan et al. 1992)
- Cores were obtained using a 6.8 cm diameter percussion corer
- Sampling intervals: 0.5 cm from 1-10 cm; 1 cm from 10-15 cm; 2 cm from 15-21 cm; 3 cm from 21-30 cm
- Dates and sedimentation rates determined according to the constant rate of supply model (Appleby 2001) at the St. Croix Watershed Research Station



**Figure 4** Lake Margaret bathymetry and watershed boundary with the location of the analyzed core. Most blowdown is in NW and SW areas of watershed.



## Findings

- Sediment mass accumulation rates (MARs) increase ~40% during and shortly after grazing permits were issued in the mid-1920s
- Average MARs decrease slightly for the next 40 years
- Beginning in the mid-1960s MARs decrease more than 65% through the 1980s
- MARs may be approaching a background rate through the end of the record
- No distinct signal in MARs at time of blowdown (1997)

#### **Future Work**

- Analyze sediment cores for organic (TOC, C/N) and inorganic (major and trace elements) matter concentrations to determine if blowdown event influenced trend of MARs
- Analyze historic grazing records to determine how much, if any, grazing occured in the Lake Margaret watershed following wilderness designation
- Investigate role that treefall orientation may play in the downslope movement of sediment



**Figure 5** Looking upslope on the northwest shore of Lake Margaret. Note the large number of downed trees resting perpendicular to slope.

## References

Appleby PG (2001) Chronostratigraphic techniques in recent sediments. In: WM Last and JP Smol (eds.), Tracking Environmental Change Using Lake Sediments. Volume 1: Basin Analysis, Coring, and Chronological Techniques. Kluwer Academic Publishers, Dordrecht: 171-203.

Rowan DJ, Kalff J, Rasumssen JB (1992) Estimating the Mud Deposition Boundary Depth in Lakes from Wave Theory. Can J Fish Aquat Sci 49: 2490-2497

Stroope TS, (2012)The impact of severe blowdown on sediment composition and sedimentation rates in lakes within blowdown patches created by the Routt-Divide Blowdown of 1997, Mt. Zirkel Wilderness Area, North-Central Colorado (Doctoral dissertation).