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MOUNTAIN FEN RESTORATION IN COLORADO: AN OVERVIEW

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SUMMARY

Peatlands and disturbances to peatlands are common in many mountain ranges. This talk is an overview of restoration approaches that have been conducted in the mountains of Western North America, especially Colorado. Ditches are one of the most common disturbances in mountain fens. The two main methods of ditch restoration are ditch plugging and filling, however, both are more difficult on steep slopes of mountain fens. Successful ditch restoration has been found to improve both water and carbon cycling in the fens, but peat physical properties were still not restored 20 years post-restoration. Other restoration techniques that will be covered include: burial, frost heaving, and erosion control of fens.

KEYWORDS: peatlands, ditching, frost heave, carbon, hydrology

OVERVIEW

Peatlands and disturbances to peatlands are common in many mountain ranges. A four year assessment of the San Juan Mountains, in southwestern Colorado found that approximately 2,000 fens occur in the subalpine zone (~3000–4000 m) (Chimner et al. 2010). The majority of fens were in excellent condition; however 10% of our sampled fens were in need of restoration due to impacts from roads, mining, and ditching. Erosion, ditches and gullies are especially problematic in mountain fens because most fens have surface slopes of 2 to 10%, although some have slopes greater than 20%. Furthermore, the remoteness of mountain fens limits restoration options.

Ditches are common disturbances in many wetland types, including mountain fens (Cooper et al. 1998, Chimner et al. 2010). Ditches cause severe impacts because they lower the water table allowing peat to oxidize and the peat surface to subside (Schimelpfenig 2012). Mountain fens are particularly susceptible to the impacts of ditching because they are predominantly occur on slopes and are dominated by groundwater (Chimner et al. 2010). Therefore, a ditch perpendicular to the slope can dewater a large area of fen downslope of the ditch. Subsequent dewatering can cause large changes to the vegetation community and make peatlands more susceptible to burning from forest fires.

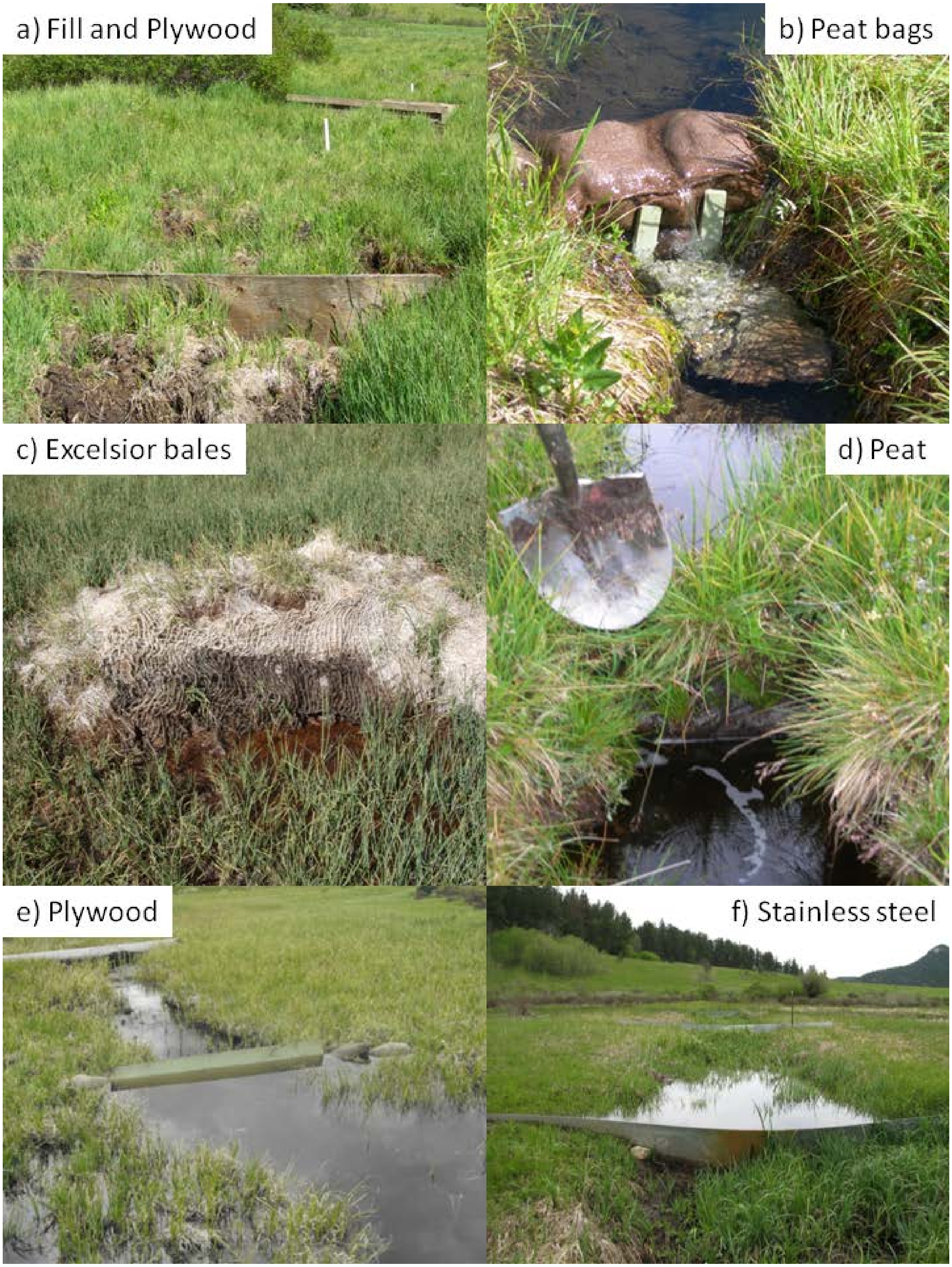

Figure 1. Examples of ditch filling and plugging techniques used in the Rocky Mountains, USA.

There have been two common ways that ditches have been restored in Colorado and many other mountain regions. The most common method is by partially blocking the ditches with ditch plugs (see Armstrong 2009 for a review of ditch plugging methods used in the UK). In general, smaller ditches on low slopes have been successfully blocked using a variety of material. Native peat, native peat in bags “peat bags”, shredded aspen “Excelsior” bales, wood, and stainless steel have all been used to create ditch plugs (Figure 1). Each material has benefits and drawbacks associated with it and correct installation is important. However, plugging ditches has been found to be problematic on steeper slopes with faster flowing water. For example, several ditches in a fen were plugged with native peat rolled in geotextile fabric “peat burritos” in the early 2000’s near Aspen, Colorado. The site was assessed ~10 years later and only one ditch plug was found to still be intact out of the 30-40 ditch plugs installed.

To document the effectiveness of small ditch plugs in restoration, we studied the change in water table levels and CO_2 fluxes at three small fens (< 10 ha) in SW Colorado for one year before and after restoring with ditch plugs (Schimelpfenig 2012). Water table levels responded positively to installation of ditch plugs by being wetter during the driest periods of the summer, increasing from -45 cm to -15 cm below the surface. Mean carbon storage (net ecosystem exchange “NEE”) also increased positively by increasing from -1.28 g CO_2 m^{-2} hr^{-1} in the disturbed areas to -2.19 g CO_2 m^{-2} hr^{-1} in the restored areas, compared to -1.74 g CO_2 m^{-2} hr^{-1} in the reference areas. This data suggest that restoration using ditch plugs was successful in restoring hydrologic conditions and carbon storage, however, a more in-depth look at the peat properties in a chronosequence of restored fens using ditch plugs shows that soil recovery will take much longer.

Our analysis indicated that ditching has caused significant changes peat physical properties by reducing organic matter by 25%, increasing bulk density, decreasing porosity, and reducing saturated hydraulic conductivity (Schimelpfenig 2012). These effects were found to persist for at least 20 years after restoration. We also calculated that the ditching caused a loss of 5 – 20 kgC m^{-2}, or roughly 108 to 800 tons OM from each of these fens.

Due to the difficulties of plugging ditches on large and steep ditches, we tested a ditch filling method on a large sloping fen by filling the ditch with non-native material (Figure 1A). For this method, we first removed all the sedges from in the ditches and on the berms. The removed plant sod was carefully set aside and placed back on the bare soil when backfilling in that section was completed. After the plants were removed, bales of Excelsior were placed by hand into the ditch. We used roughly 75 bales of Excelsior for the 75’ of restored ditch. After the bales were in place, peat from the ditch berm was used to pack around the bales. We also put at least 15 cm of peat on top of the bales for the plants to grow into. After the bales were in place, we inserted pieces of plywood, perpendicularly across the ditch, to keep the new fill from moving. Plant sod was then placed on top of the ditch fill, which revegetated most of the ditch. Any remaining bare areas were planted by hand.

Pre- and post-monitoring of water table levels and vegetation indicates that this ditch filling technique was very successful in restoring hydrologic condition downstream of the ditch. The water table level down slope from the ditch went from being 5-15 cm lower than just upslope from the ditch, to being almost identical after the restoration (Figure 2). We have not seen a shift in vegetation yet, but we did not expect to since it has only been two years since the restoration occurred. Although this technique was found to be very successful, the downside is the high cost associated with both the cost of the Excelsior bales and the heavy equipment time.

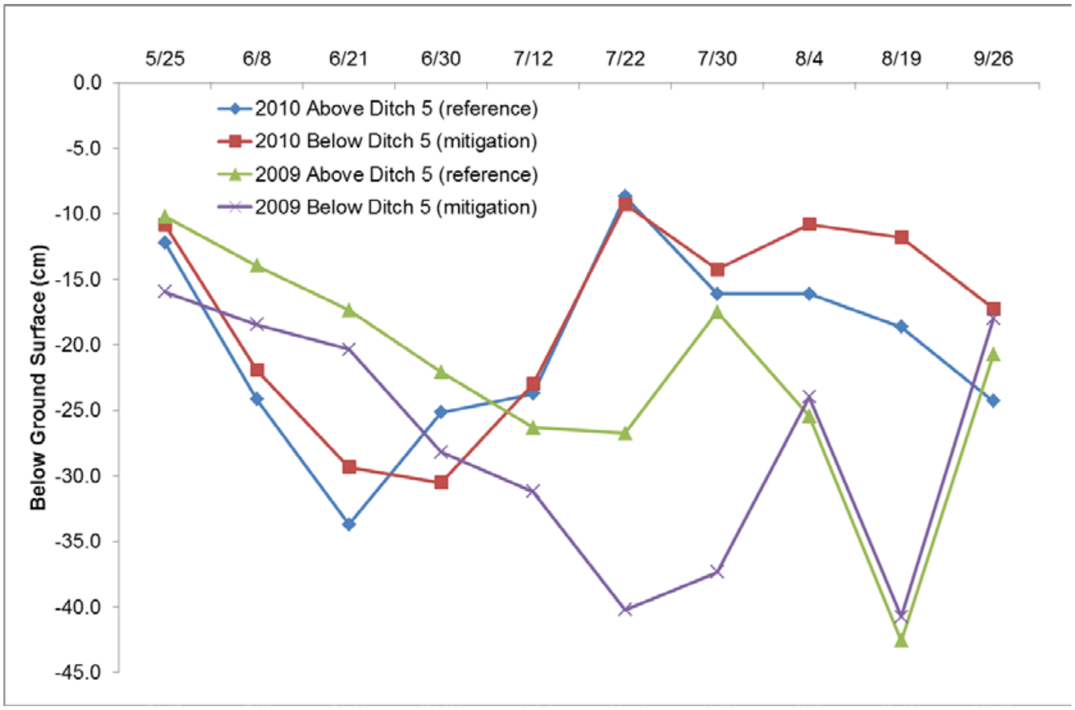

Figure 2. Ground water levels above and below a filled ditch in Colorado.

Another disturbance to fens that can require restoration is from burial. The best example of this occurred in the 1990's near the towns of Telluride/Mountain Village (Cooper unpublished data). Several fens were buried by fill material without a permit to construct a golf course in the 1980's. Over a period of ten years, roughly 10 ha of fens were monitored to determine location of original peat soil and residual hydrology, excavated with heavy machinery, and planted with native plants. Post restoration monitoring indicated that the restoration was very successful with fens having a natural hydrological regime and a dense cover of native fen plants.

One of the major outcomes of many types of fen disturbance is the development of large un-vegetated areas that do not regenerate naturally. These bare areas were observed in many fens in the San Juan Mountains of Colorado that were disturbed. Many processes create bare areas in fens, including fire, mining, grazing and trampling (Chimner et al. 2010). However, the harsh conditions of bare peat surfaces in high elevations (e.g., frost heave, poor water availability, exposure to desiccation, erosion and lack of seeds or diaspores) makes it very difficult for plants to re-vegetate naturally (Quinty and Rochefort 2003). Consequently, active restoration is needed to restore fens from frost heave in the short term.

An experimental planting at 3 fens with large bare areas was conducted to test methods of getting sedges and mosses established (Chimner 2011). Plantings were done in a factorial design with mulching (Excelsor ‘shredded aspen’ bales) and no mulching, crossed with moss, sedge, and moss and sedge planting. Mulching influenced surface soil temperatures by reducing the midday highs and increasing the nighttime lows. Surface soils dropped below freezing on average 22 days per spring without mulch, whereas only ~5 days per spring dropped below freezing under the mulch. Vertical displacement from frost heave was also reduced, with the greatest frost heaving occurring near 75% soil moisture content (a water table level of ~10-20 cm) and dropping when soils were wetter or drier. Moss was dependant on mulch, with no moss survival in plots without mulch. Mulching also increased sedge transplant survival. The peat moisture content also influenced plant survival, with greater moss and sedge survival occurring in wetter peat soils.

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