CENTRE FOR BOREAL RESEARCH
TECHNICAL NOTE #44
PEATLAND RESTORATION - SYNTHESIS OF TECHNIQUE – MAY 2021

Hydrology and Microtopography Importance for Wetland Reclamation

CONTEXT

Wetland communities assemble based on local hydrologic regimes and are influenced by the depth, duration, and frequency of anoxic soil conditions. Many of these species are stress tolerators. They rely on oxygen-deficient conditions in the rhizosphere to reduce their interspecies competition. The hydrologic regime acts as a filter preventing more competitive, ruderal upland species from enduring. Therefore, to successfully reclaim wetlands, it is essential to recreate a hydrological regime appropriate for the desired vegetation community. This parameter outweighs all other reclamation efforts, including the revegetation strategy. Site preparation must ensure sufficient but not excessive moisture for enough of the growing season, across multiple years, to sustain the target species.

In-situ reclamation practitioners face many challenges in determining the appropriate site conditions to maintain a targeted hydrologic regime under the current reclamation system.

- Site-specific, long term water table data on which to base target surface elevations are usually absent.
- Civil earthworks conducted in frozen conditions make it difficult to determine the water table position even at that single point in time.
- Sites should be self-regulating, and operational costs are prohibitive, providing practitioners with only one opportunity to create suitable conditions.
- Climate change adds uncertainty in predicting future moisture patterns.

We have incorporated various field techniques, including trenching and ripping, to create microsite heterogeneity that mimics natural peatland microtopography in our wetland reclamation field trials. These microforms increase species diversity by providing a range of moisture niches. Both techniques decompact the mineral surface to allow greater root penetration and vertical water fluctuation while connecting lateral water flow offsite. These measures can ensure appropriate moisture and microsite conditions to increase the wetland's resiliency against unpredictable weather.

Heterogeneity created by ripping and trenching of the surface provides a range of moisture conditions and microsites for ecosystem resiliency.

HOW TO INCORPORATE HYDROLOGY AND MICROTOPOGRAPHY FOR WETLAND RECLAMATION SUCCESS

1. Understand the local and regional topography, flow direction and moisture patterns prior to commencing civil earthworks. **The final elevation will determine long term moisture conditions.**
2. **Use microform elevation in the nearby wetlands**, rather than solely water table position, **to determine target surface elevation for the reclamation site.**
3. **Target the final surface elevation at or just below (0-10 cm below) the average of the low points in the nearby wetlands.**
4. **Introduce heterogeneity through ripping, trenching, or scraping.** Harness freeze-thaw processes to decompact the texturized mineral surface and account for settling.
5. **Pair microtopography creation with donor transfer if peatland communities are targeted, or active planting and natural ingress for mineral wetlands such as marsh and swamp.**

KEY FINDINGS

- Average surface elevation will determine the seasonal soil moisture regime, which controls the establishment of target wetland species, including mosses.
- Deviations as little as 30 cm from the target mean elevation can shift the wetland community type (i.e., meadow marsh to emergent marsh).
- Depression with >50 cm of standing water for most of the growing season over multiple years results in emergent marsh communities dominated by cattails, regardless of the species introduced.
- Herbaceous and graminoid species are sensitive to changes in soil moisture. Community fluctuation 1-3 years post reclamation is expected, particularly during excessively dry or wet years.
- Appropriate elevation and surface moisture can ensure long-term wetland establishment. One trial initially dominated by clover and ruderal upland weeds during two years of drought developed into a stable marsh following a return to the 10-year average annual rainfall in the third year.
- Soil decompaction is essential to improve moisture penetration, retention, and plant rooting capacity on mineral substrates.

COST ANALYSIS

- Estimated costs to lower and texturize wetland surfaces are highly variable depending on the restoration objectives and site constraints.
- Disposal location for excess fill and weather conditions have the most significant impact. Transportation of excess fill over longer distances influences machine selection and travel time; working in thawed, wet conditions reduces the machine size supported, decreasing efficacy.
- Costs to create microtopography are also highly variable depending on machine availability and site dimensions.
- Ripping under deeply frozen conditions by a dozer with ripper shanks is fastest for large areas but is not appropriate on narrow linear features. Instead, consider surface scrapping using a toothed excavator digging bucket, which is faster than traditional mounding used to promote tree growth.

PRACTICAL RECOMMENDATIONS

SELECTING TARGET ELEVATION

- Determine mean target elevation for the site during snow-free conditions using a survey laser.
- Use elevations in adjacent wetland areas to select the target elevation.
  - In very wet settings, use the elevation of the hummocks/high areas as the site mean target.
  - In very dry settings, use the elevation of the hollows/low areas as the site mean target.

CREATING TARGET ELEVATION

- Lower the surface to the target elevation before introducing heterogeneity.
- Work in frozen or very dry conditions to ensure machine accessibility to the entire site.
- Check elevation across the entire site using the survey laser. Small elevation differences are difficult to see with the eye but significantly impact final site performance.

CREATING MICROTOPOGRAPHY

- Use dozer ripper shanks or an excavator digging bucket to texturize the surface. Alternatively, use ripping for sites that also require flow channels/trenches to distribute moisture.
- Work crisscrossed across the site to slow flow through the site and increase moisture retention in all areas.
- Take advantage of freeze-thaw cycles to break up compacted soil, whether subsoil or mineral fill. Allow at least one winter of freeze-thaw cycles before revegetating. Rip the surface when frozen to pull up large soil chunks to create less defined trenches and more variable microsites. Conversely, double rip under thawed conditions to create a similar effect.
- Account for differences in soil texture (sand versus clay) in the amount of settling.

June 2014. Site surface lowered to desired elevation. Target elevation was 10 cm lower than the hollows/low points in a remaining wetland adjacent to the site.

June 2014. Dozer with 1 m ripper shanks created microtopography with trenches to connect water flow across the site.

June 2014. Completed site surface prior to winter freeze thaw action. Amplitude was 150 cm from the highest points to lowest in the trenches.

April 2015. Soil clods broken up from freeze-thaw processes, with moisture available across the entire site. Amplitude was reduced to 75 cm.

September 2019. Self-sustaining diverse wetland comprised of marsh and fen graminoid species.

Naturally ingressing moss established at the base of vascular species in areas of saturation without long-term inundation.

VISIT OUR WEBSITE
nait.ca/borealresearch
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CONTACT US
boreal@nait.ca
780.648.2600

AUTHORS
Melanie Bird and Bin Xu, Centre for Boreal Research, NAIT.
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