BIOCHAR APPLICATION FOR REVEGETATION PURPOSES IN NORTHERN SASKATCHEWAN

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Gunnar Uranium Mine Site

- uranium mines and mills
- established in 1953
- ceased in 1964
Gunnar Site Remediation Project

- SRC has been contracted by the Saskatchewan government to manage decommission and rehabilitation activities at the site.
- 82 ha of unconfined tailings in 3 locations.
- To be capped by ~1 m engineered cover.
- Native plant communities are to be established on the cover.
Gunnar Revegetation Research

- Greenhouse & Field trials
- Soil source:
  - Borrow Material proposed for the tailing cover (mainly sand-gravel, poor in organic matter and nutrients)
- Organic amendments:
  - Peat and Biochar
- Nutrient Source:
  - Mineral Fertilizer NPK(S)
- Native plant species
Greenhouse trials

- Sphagnum peat
- Willow dust biochar (slow pyrolysis)
- Organic Matter - 2%
  - Peat - 80 t/ha
  - Biochar - 95 t/ha
- Mineral Fertilizer
  - 45 N kg/ha
  - 84 P$_2$O$_5$ kg/ha
  - 112 K$_2$O kg/ha
- 4 treatments
- 2 L pots
Greenhouse trials

- Native plants
  - Slender Wheatgrass (*Elymus trachycaulus*) – 6 PLS per pot
  - Rocky Mountain Fescue (*Festuca saximontana*) – 22 PLS per pot
  - American Vetch (*Vicia americana*) – 4 PLS per pot
  - Common Yarrow (*Achillea millefolium*) – 11 PLS per pot

- 16 plant-soil combinations
  - x 5 replicates

- 12 weeks simulating typical summer conditions at Gunnar
  - Light
  - Temperature
  - Precipitation

- Collected data
  - number of seedlings (weekly)
  - aboveground dry biomass (at the end of the experiment)
Greenhouse trials

Aboveground biomass (dry weight)

Seedling emergence

Seedling survival

Plant establishment
Greenhouse trials

- peat and biochar both boost plant establishment and growth, but plant response can differ depending on a species
- biochar can be a good substitute for peat as a soil amendment
Field trials

- Sphagnum peat
- Pine chunky biochar (slow pyrolysis)
- Organic matter - 2, 4, 6%
  - Peat - 80, 160, and 240 t/ha
  - Biochar - 90, 190, and 280 t/ha
- 1 m² plots
  - 7 Wooden Boxes (each with 12 cells)
- Mineral Fertilizer
  - Low rate
    - 22 N kg/ha
    - 56 P₂O₅ kg/ha
    - 56 K₂O kg/ha
    - 10 S kg/ha
  - High rate
    - 45 N kg/ha
    - 84 P₂O₅ kg/ha
    - 112 K₂O kg/ha
    - 20 S kg/ha
- 21 combinations x 4 replicates
Field trials

Native plant seed mix
- 20% Rocky Mountain Fescue (*Festuca saximontana*)
- 20% American Vetch (*Vicia americana*)
- 10% Streambank Wheatgrass (*Elymus lanceolatus* ssp. *riparius*)
- 10% Slender Wheatgrass (*Elymus trachycaulus*)
- 10% Violet Wheatgrass (*Elymus violaceus*)
- 7% Tufted Hairgrass (*Deschampsia caespitosa*)
- 7% Rough Hair Grass (*Agrostis scabra*)
- 6% Canada Buffaloberry (*Shepherdia canadensis*)
- 4% Canadian Milkvetch (*Astragalus canadensis*)
- 3% Marsh Reed Grass (*Calamagrostis canadensis*)
- 1% White Bluegrass (*Poa glauca*)
- 1% Alpine Milkvetch (*Astragalus alpinus*)
- 1% Prairie Crocus (*Anemone patens*)
- 0.1% Fireweed (*Chamerion angustifolium*)

2000 PLS/m² seeded in June 2012

Vegetation survey in August 2012
- total vegetation cover
- seeded plant cover
- cover of dominant invaders
  - rough cinquefoil (*Potentilla norvegica*)
  - strawberry blite (*Chenopodium capitatum*)

Independent expertise
Field trials

Highest indexes
(no statistically significant difference between the treatments)

- Fertilizer alone at the high rate >> Peat/Biochar alone
- Peat/Fertilizer >> Biochar/Fertilizer
- Increased biochar rate decreases the total vegetation cover
Field trials

- Peat promoted rough cinquefoil cover
- Biochar promoted strawberry blite cover
Independent expertise

- Northern leopard frogs (*Lithobates pipiens*)
  - SARA Status: Special Concern
  - SK CDC Rank: S3 (rare to uncommon in Saskatchewan)
- Inhabited peat plots
Greenhouse vs. Field trials

**Greenhouse trials:**
- peat and biochar effects depend on plant species
- biochar is a good substitute for peat as a soil amendment

**Field trials:**
- peat and biochar effects depend on plant species
- peat promotes plant establishment and growth to a larger extent than biochar

**Controversial results:**
- May be due to biochar variability, i.e. its water holding capacity

<table>
<thead>
<tr>
<th>GH Trials</th>
<th>WHC</th>
<th>Field Trials</th>
<th>WHC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphagnum peat</td>
<td>509%</td>
<td>Sphagnum peat</td>
<td>523%</td>
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<tr>
<td>Willow Biochar</td>
<td>454%</td>
<td>Pine Biochar</td>
<td>68%</td>
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Conclusion

Peat appears to be a more suitable and reliable organic amendment for revegetation projects
But

Use of biochar may provide a more sustainable approach to land reclamation.

So

Sustainability appraisal has been completed.
Paper “Biochar Application for Revegetation Purposes in Northern Saskatchewan” (Petelina et al., 2013) is available in proceedings of the 2013 Northern Latitudes Mining Reclamation Workshop
Back up slide: Field plot set-up

Borrow material screening

Preparation of the soil mixture from borrow material and biochar
Back up slide: Field plot set-up

1m² frame installation

Raking the soil

Fertilizer application
Back up slide: Field plot set-up

Seeding

Soil compaction

Plot mark-up