

## Case Histories

Natural landscapes that have been turned into brownfields

- Athy, E.R., C.H. Keiffer and M.H. Stevens. 2006. Effects of mulch on seedlings and soil on a closed landfill. Restoration Ecology 14(2):233-241.

- Capped landfills often highly-engineered
  - Modified with nutrient-poor clay soil
  - This limits cover; grassland common state
  - Trees do not colonize or survive well.

- Tree growth has been discouraged
  - Designers thought roots would pierce cap
  - Windthrow would expose fill material
- Recent studies have discredited this idea as a hard rule.
  - Depending on depth of cap, tree roots may stay within the cap material

- Potential tree uses
  - Short-rotation forests
  - Bio-remediation
  - Wildlife habitat
  - Recreation
  - Local climate modification

- Mulch
  - Commonly used in horticulture to modify soils
    - Improves moisture, nutrients, temperature
    - Evaporation decreased

### Site

- Center Hill landfill, Cincinnati, Ohio
- 11 ha, 12 km north of downtown
- Monthly summer precip 7.6 mm
- Gravel pit in 1950's, landfill in 1960's
- Filled with incinerated urban and construction refuse
- Closed in 1977; covered with 1.5 m clay till



Center Hill landfill, Cincinnati, Ohio



- In 2000, thousands of hybrid poplars planted.
  - Installed in parallel trenches
  - 83% mortality

## Experiment

- In April 2002, five species planted.
  - 1750 trees in all
  - 35 circular clusters of 50 (5.5 m diam)
  - Planted into a compost product
  - Osmocote added to planting hole
  - Mesh guard added to retard rodents

## Treatments

- Mulch
  - Aged woodchips
  - Leaf mulch
  - Mix of the two
- Depth
  - 5 cm
  - 15 cm
- Control
  - No mulch

## Irrigation

- 50 gal barrel on each plot
- Gravity delivered soaker hose
- Filled once a week when precip is less than an inch a week.
- Used only first growing season

## Survival in response to mulch was species-specific

- *Populus* and *Robinia* survival increased with mulch.
- Mulch had no effect on growth rate
  - *Robinia*>*Populus*>*Fraxinus*>*Prunus*>*Quercus*
- Mulch depth did have effect
  - 15cm>5cm>no mulch

## Conclusions

- *Fraxinus* best
  - High survivorship
  - Needs no mulch
- For diversity
  - Include *Populus* and *Robinia*
  - Those that survived grew large and fast
- *Quercus* not recommended
  - Moderate survival, slow growth

## Results

### Survival

	First season	Second season
<i>Prunus serotina</i>	11%	7%
<i>Quercus macrocarpus</i>	56%	33%
<i>Populus spp</i>	80%	42%
<i>Robinia pseudoacacia</i>	75%	30%
<i>Fraxinus pennsylvanica</i>	97%	80%

- Rebele, F. and C. Lehman. 2002. Restoration of a landfill site in Berlin, Germany by spontaneous and directed succession. *Restoration Ecology* 10(2):340-347.



Malchow

- Urban development creates large amounts of excavated soil that is landfilled.
  - Traditional approach is to sow grasses and legumes.
  - Sometimes trees and shrubs are planted.
- Alternate suggested is to use spontaneous succession
  - Also known as “unassisted natural recovery”.

- Site is a landfill for Berlin.
  - Located in Malchow, 80 mi northeast of Berlin
  - 6 ha landfill, used 1985-90
  - 50 m elev, fill 6m, capped with 0.5 m subsoil in 1995.
  - Climate transitional between marine and continental; supports woodland
  - Annual precip 580 mm

- Climatically suited for woodlands, but colonization of bare sites depends on:
  - Local species pool
  - Soil fertility
  - Site factors
  - Plant-plant (competition) and plant-animal (herbivory) interactions.

### Experiment

- Permanent 3x3 m plots established on flat top of landfill, on bare soil, in 1996.
  - 5 plots mowed twice a year.
    - Early June and late August
    - Litter removed
  - 5 plots not mowed.
  - Measured annually until 2000.

## Results

- Bare soil colonized by herbaceous spp of grassland and ruderal communities.
  - Woody plants present from the start (mostly willow and poplar)
- Spp richness did not change in unmown plots over 5 yrs
  - Did change seasonally.
- Mowing increased diversity from yr 3-5.

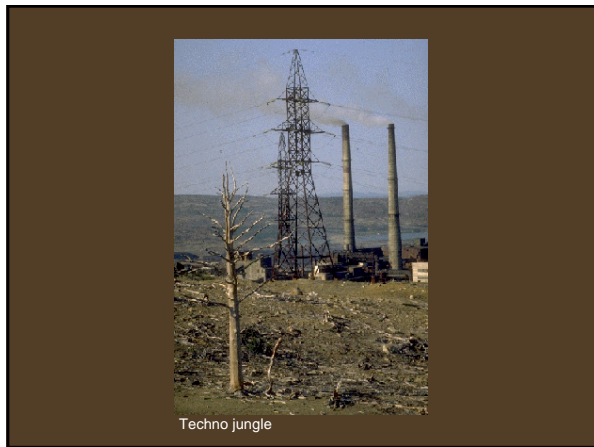
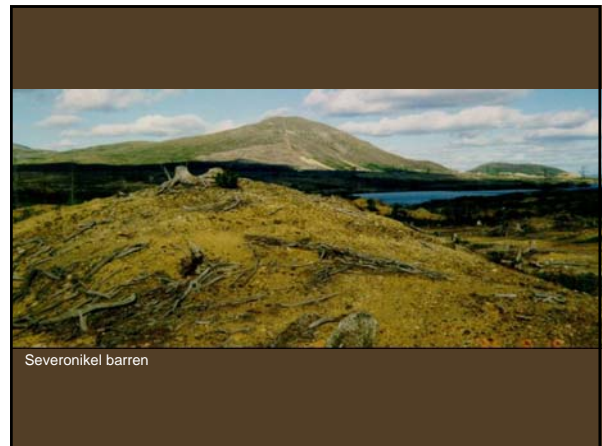
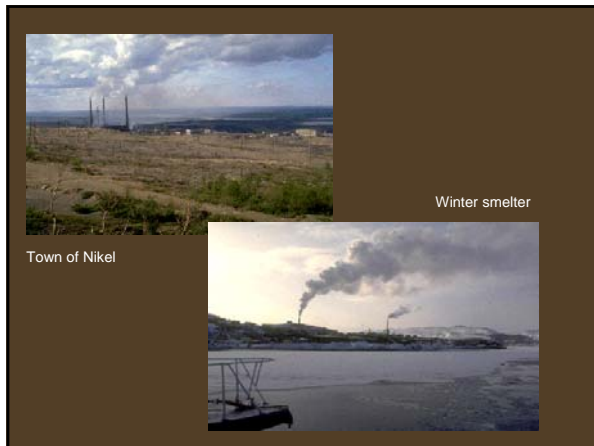
- Total cover
  - Increased from 10 to 80% on unmowed plots.
  - On mowed plots, increased from 10 to 60%, then down to 45%.
    - Mostly clover which died during a dry summer.

- Total woody cover
  - Increased to 23% on unmowed plots.
    - Mostly willow
  - 3% on mowed plots.
  - Some Scots pine (*Pinus sylvestris*) and silver birch (*Betula pendula*) colonized unmowed plots.



- Eranen, J.K. and M.V. Kozlov. 2006. Physical sheltering and liming improve survival and performance of mountain birch seedlings: a 5-year study in a heavily polluted industrial barren. *Restoration Ecology* 14(1):77-86.





- Severonikel nickle-copper smelter operates above Arctic circle near Monchegorsk, nw Russia.
  - Heavy metals and sulfur dioxide emissions have impacted 10,000 km<sup>2</sup> of trees, with forest death over 400 km<sup>2</sup>.
    - Now open habitat
    - Called “industrial barrens”.
    - <5% vegetation cover; highly stressful habitat

- Located on Kola peninsula.
  - Just south of Murmansk
- One of top polluters in Europe.
- Started operation in 1938.

- Mountain birch is Arctic treeline species.
  - Will grow in barrens as a multistem bush.
  - No natural recruitment in barrens for decades
    - Sowing seed resulted in 100% mortality
    - Planting unprotected seedlings resulted in 0-10% survival.
- Sites have low nutrients, toxic metals, cold climate, deep soil freezing, high winds.

- Two experimental sites
  - 1. Formerly Scots pine
    - Sandy soil, dry
    - Currently 40-60 y old pines, 1-2 m tall
  - 2. Formerly Norway spruce
    - Wet site, podzols
    - Now sparse willow and mountain birch.

### Experiment

- 5 blocks each site, 8x5 m
- 9 treatments each block
- 530 seedlings planted
  - 10 cm apart
  - Seedlings 3-10 cm tall
  - Planted bare root

### Treatments

C	Control
L	Liming (dolomitic limestone)
B	Boxing (seedling enclosed on sides)
LB	Liming and boxing
W	Watering
WB	Watering and boxing
PS	Partial windbreak, windward side of plant
FS	Full windbreak, windward side of plant
St	Large stone, windward side of plant

### Results

- Boxing and FS reduced wind velocity.
- Both reduced solar energy input.
- Liming
  - Strong positive effect
  - Only limed seedlings survived, Site 1
  - Liming doubled survival, Site 2

- Boxing increased photosynthesis rates.
  - But had not positive effect on survival and small effect on performance.
- Liming produced best results.
- FS, PS and St had positive effect on performance and survival at Site 2.