Taking a long-term approach: a case study of non-chemical noxious weed management on an in-situ facility soil stockpile

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Introduction

- This presentation is based on an ongoing case study that was initiated in 2016 to demonstrate the potential benefits of temporary reforestation on soil stockpiles.
- The 8 hectare study site is located at an operating in-situ facility SE of Fort McMurray AB. The key purpose of the study is to evaluate how variation in plant density impacts the pace of forest re-establishment.
- A unique feature of this study is that both the AER and the regional municipality agreed to accept the use of native plant communities as a weed control strategy.
- This non-chemical herbicide approach, historically, has run counter to prevailing practices for noxious weed management. This strategy allows the forest canopy cover to do the work of weed management but requires time for the forest canopy to develop and buy in from regulatory authorities.
- This presentation will focus on changes in the understory plant community, with particular emphasis on non-native plant development, over a 6-year period.

The temporary reforestation case study

- Construction of the soil stockpile began in 2010 and was completed by 2013 where conventional approaches were initially employed (track packed and seeded to grass).

Short-term goals: quantify planted and natural establishment of a range of woody species under a wide array of environmental conditions. Relate planting density to rates of forest cover development.

Long-term goals: demonstrate that a reforested stockpile will reduce requirements for ongoing weed management, increase plant and animal biodiversity and enhance final reclamation.

For more information on the history of this project and core research goals refer to:

https://www.ser.org/news/499780/Open-Access-Interim-Reforestation-of-Soil-Stockpiles.htm

Case study information – site preparation and planting

- The entire site was 'rough and loosed' in October 2015 utilizing a combination of furrowing (dozer) and mounding (excavator).
- Coarse woody materials were placed strategically across the study area in areas deemed highest risk for soil erosion.
- The primary experimental treatment was initial planting density: 0, 2500, 5000 or 10000 stems ha^{-1}. A mixture of native tree and shrubs (~44,000 seedlings) were planted in June 2016:
  - Trees: aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), jack pine (*Pinus banksiana*), white spruce (*Picea glauca*)
  - Shrubs: green alder (*Alnus viridis*), Bebb's willow (*Salix bebbiana*)

Methods – vegetation surveys

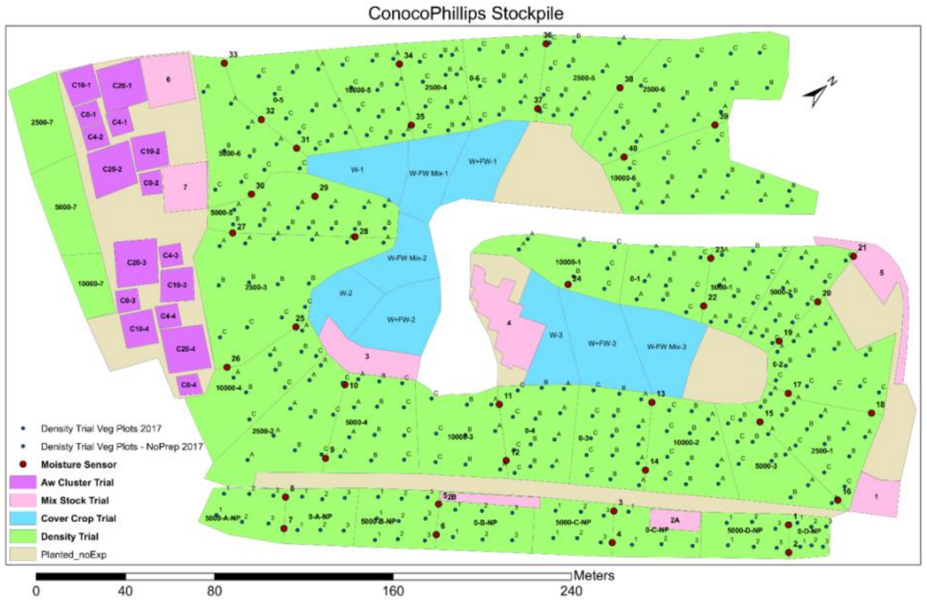
Vegetation cover by species was assessed within 0.5 x 0.5 m quadrats.

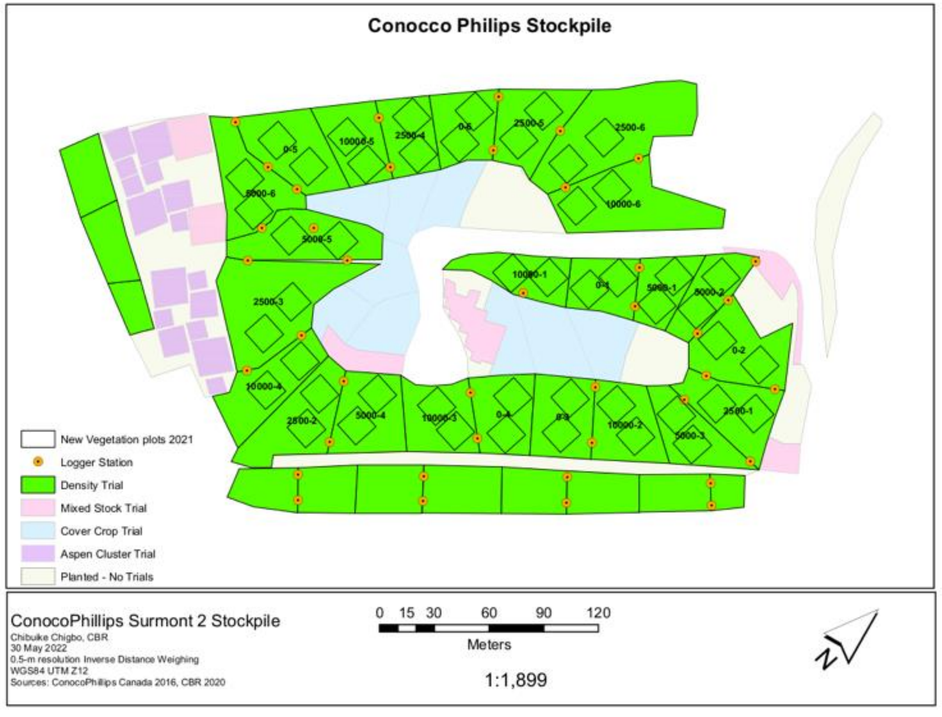
Year 1 - 4

- Within each of the 24 plots (density treatment within block) circular plots were distributed along linear transects.

Year 6

- Measurements were conducted within two 15 x 15 m subplots located within each of the 24 main plots.
- Each subplot contained 11 quadrats points.





Methods - Statistics

- Data was analyzed using R statistical software (R Core Team, 2022).
- Generalized linear mixed effects models were utilized:
  - Fixed effects: time (ordinal factor) X density treatment
  - Random effects: replicate block
- Presence/absence of natural regeneration were analyzed using a binomial distribution.
- Percentage cover and relative abundance were analyzed using a beta distribution.
- Model assumptions were checked with diagnostic plots of fitted and residual values and histogram of residuals. Non-linear model diagnostics were evaluated using residual plots from the DHARMa package (Hartig 2022).

October 2013: Stockpile complete

October 2015: rough and loosing of soil

July 2017: 1.5 years post-planting

July 2019: 3.5 years post-planting

July 2021: 5.5 years post-planting

July 2021:
5.5 years post-planting

Now for some pictures – evolution of vegetation over time in the absence of other interventions (aside from site preparation and planting)

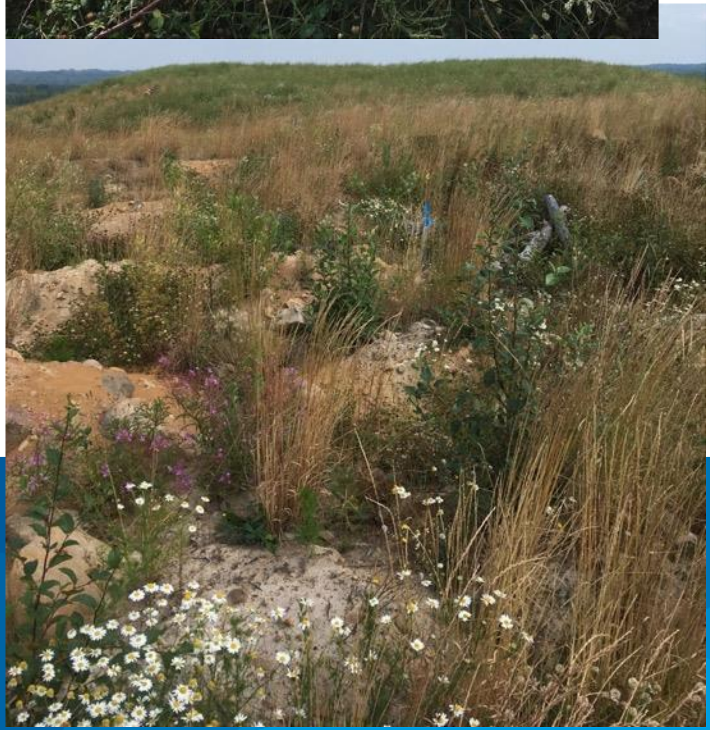
Year 1





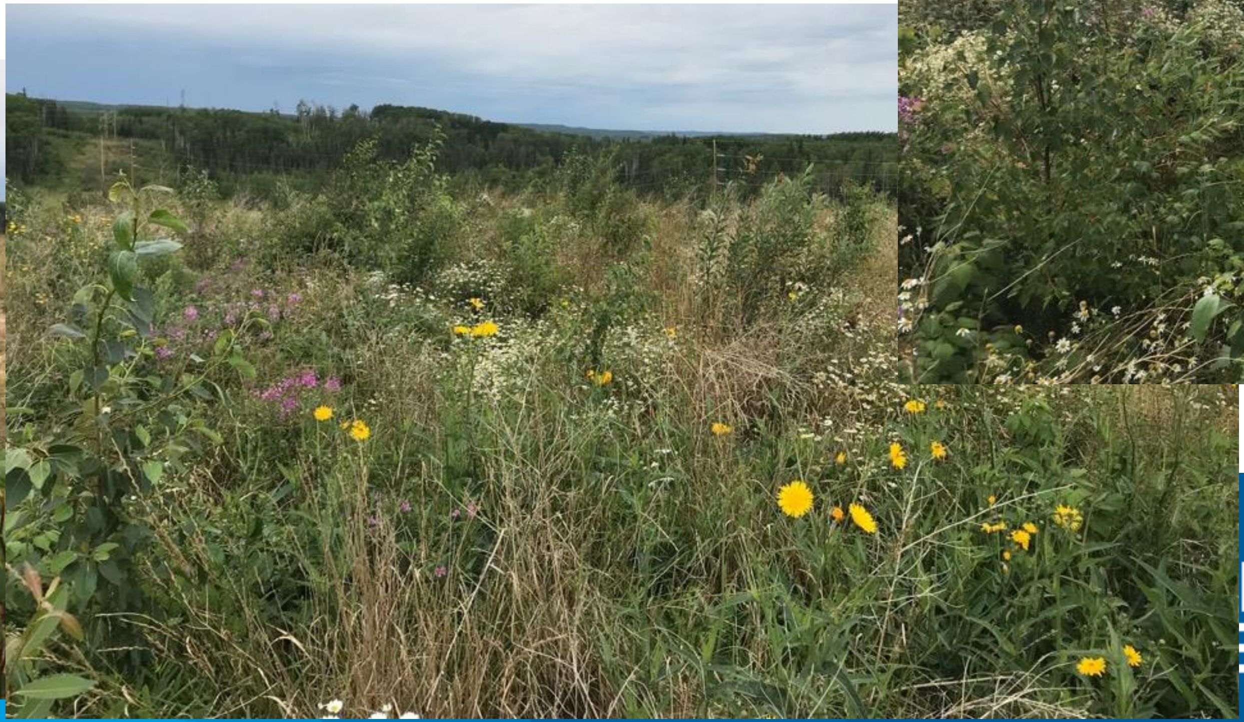

Year 1




Year 2


Year 2

Year 3



Year 3

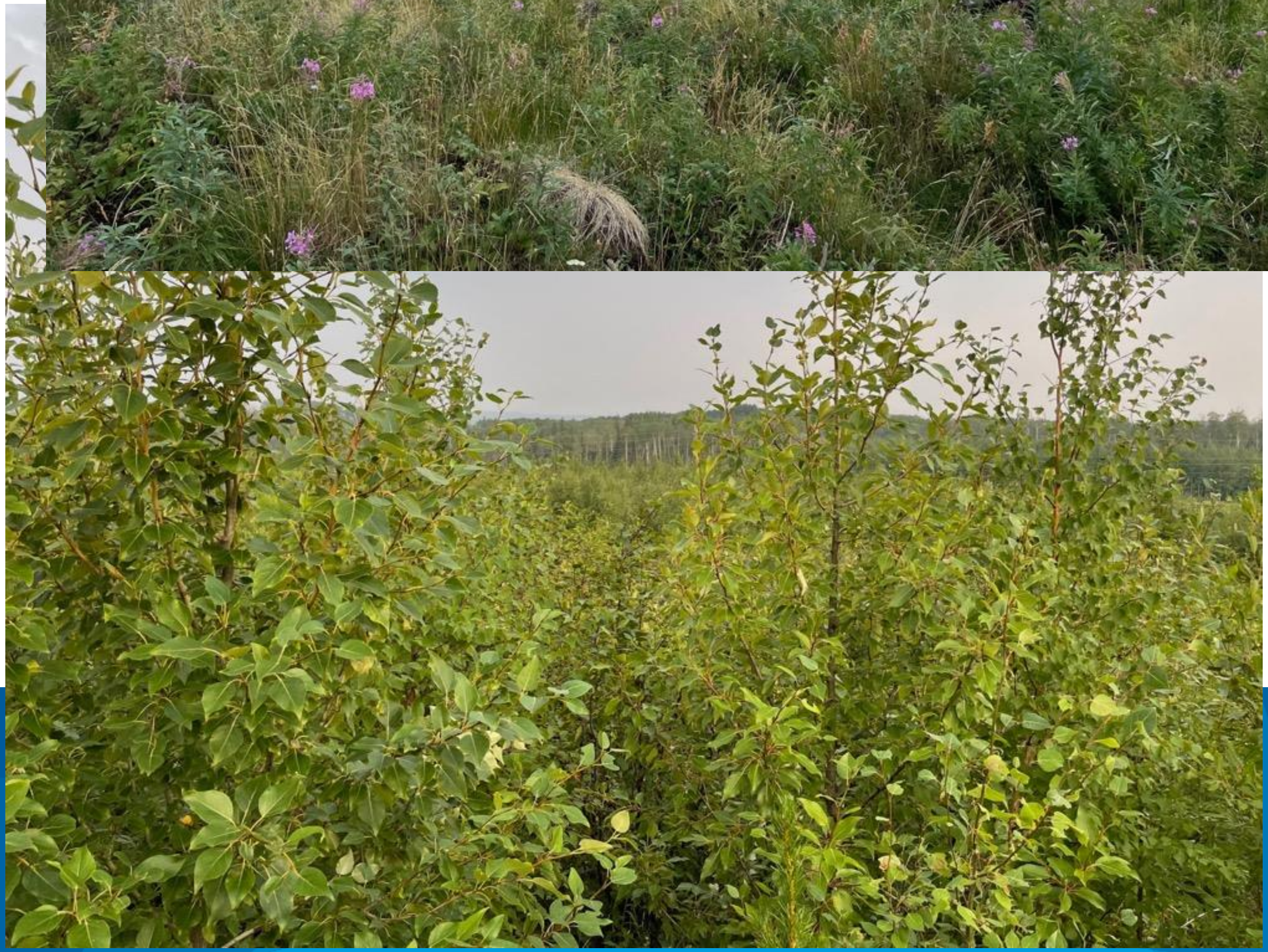
Year 3

Year 4

Year 4

Year 6

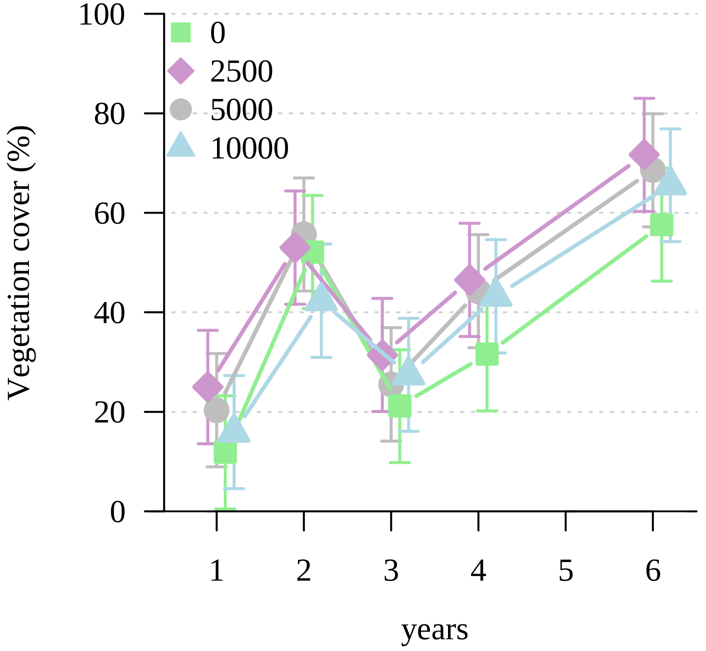
Year 6

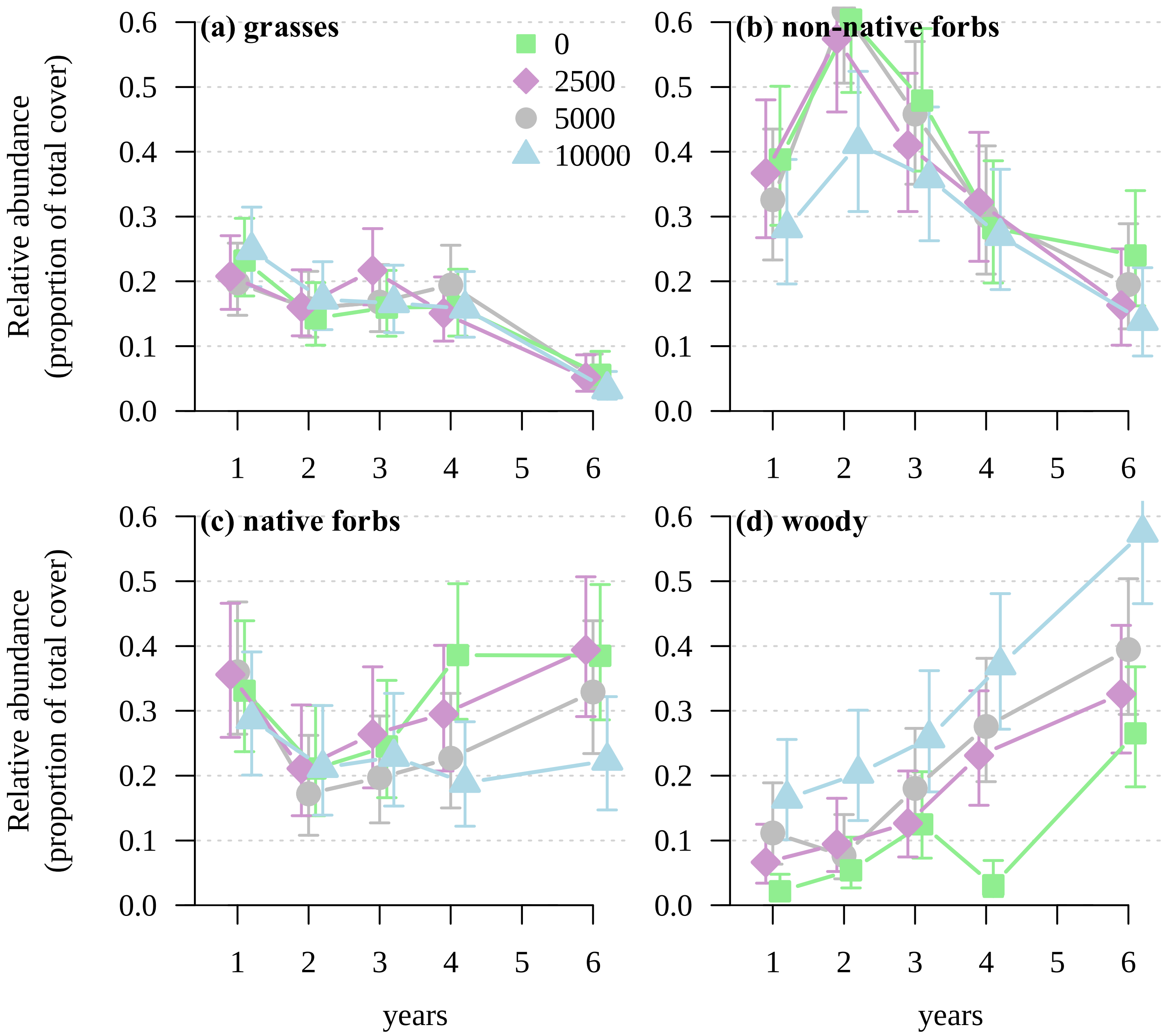


The data!

Relative abundance of vegetation cover by density treatment

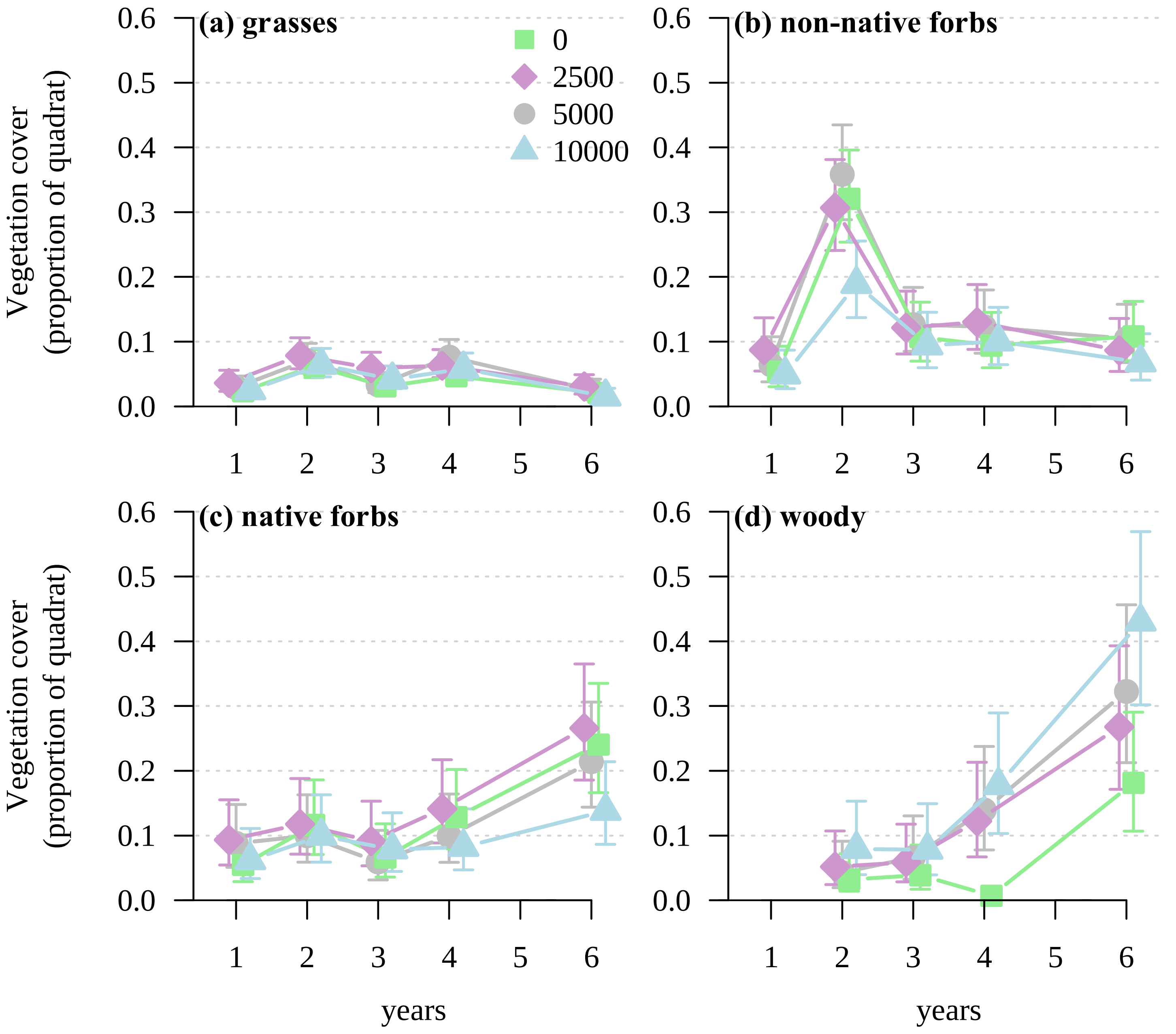
- Relative abundance tells us how ‘dominant’ vegetation groups are.
- In general, the RA patterns follow absolute cover (shown in the next slide).





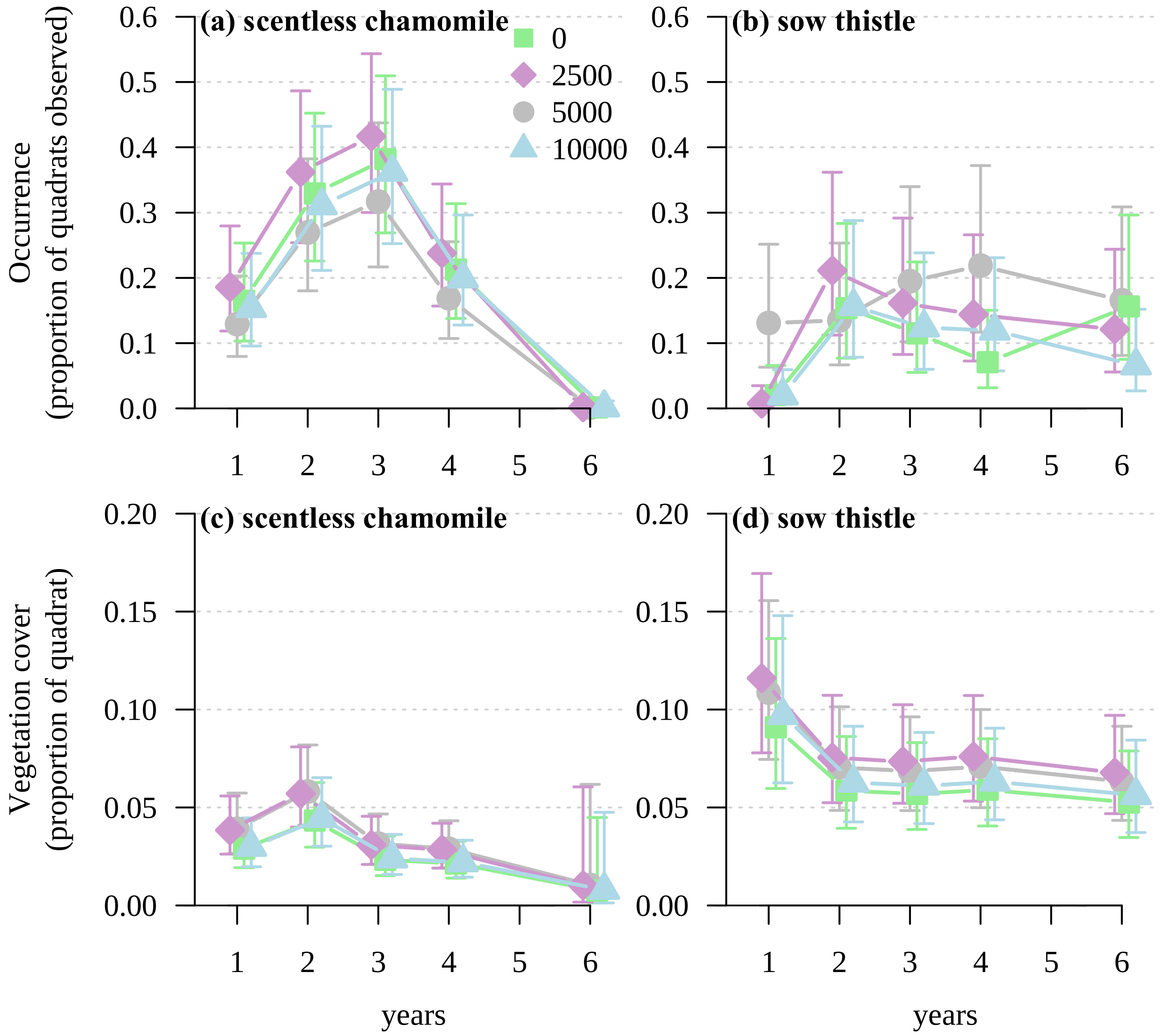
Absolute vegetation cover by density treatment

- Woody vegetation cover over time strongly tied to planting density treatment.
- The 10,000 stems treatment is closing canopy (lower native forb cover); this treatment also contains the lowest quantity of non-native forbs from year 2 onwards.



Noxious weeds over time by density treatment

- Occurrence = proportion of quadrats (or % if X by 100) where the species was found.
- Vegetation cover here represent the average cover for the quadrats where the species was observed (rather than including all the 0 values where it was not observed).



Lessons learned:

- High density planting can reduce the cover and relative abundance of non-native forbs – even as early as 2-years post-planting with sustained differences observed 6 years later.
- Scentless chamomile, regardless of planting treatment, is falling out of this site ~ without any secondary intervention.
  - Given time, the mixture of native vegetation (forbs, woody) appear to be outcompeting this species.
- Sow thistle has been more persistent though there are early signs that it is also on the decline (more so with the 10,000 stems treatment).

Acknowledgements

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