Wildfire and Invasive Plants in Alaska's Boreal Forest

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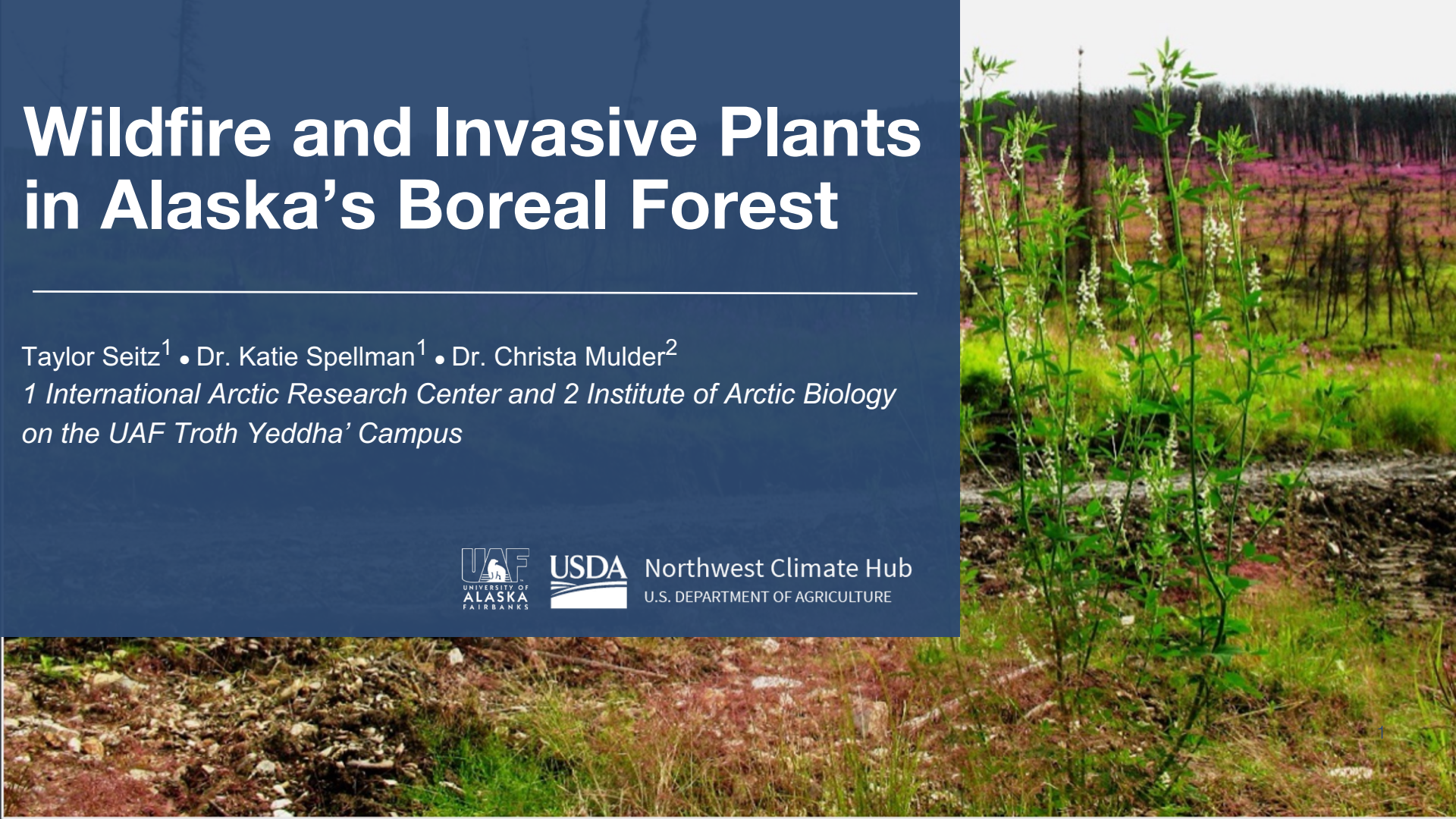
U.S. Department of Agriculture



Project overview

1. Forest vulnerability and climate change
2. Current status of non-natives in burned land
3. Re-survey findings
4. Seed bank study

Project Team

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Thank you!

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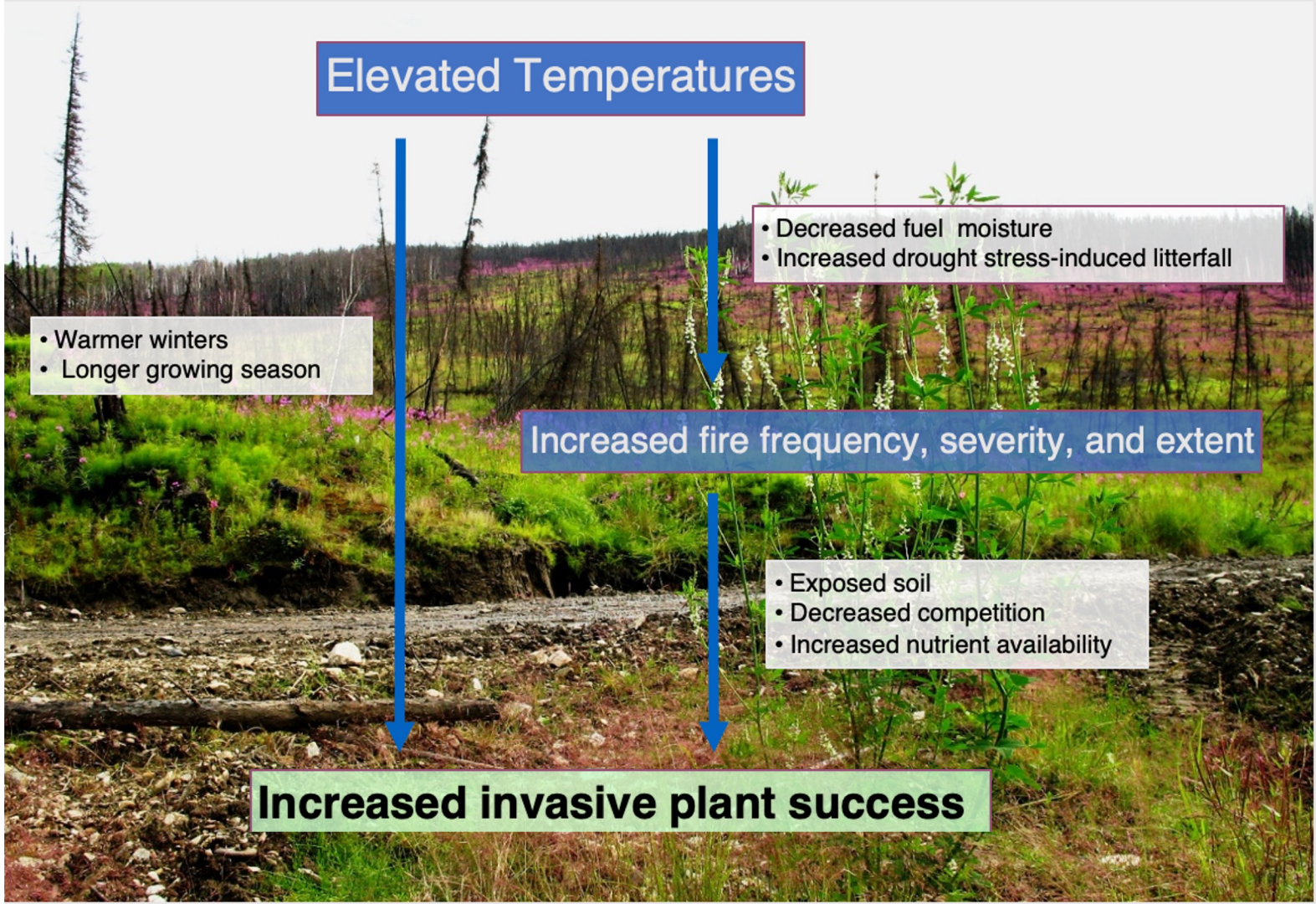
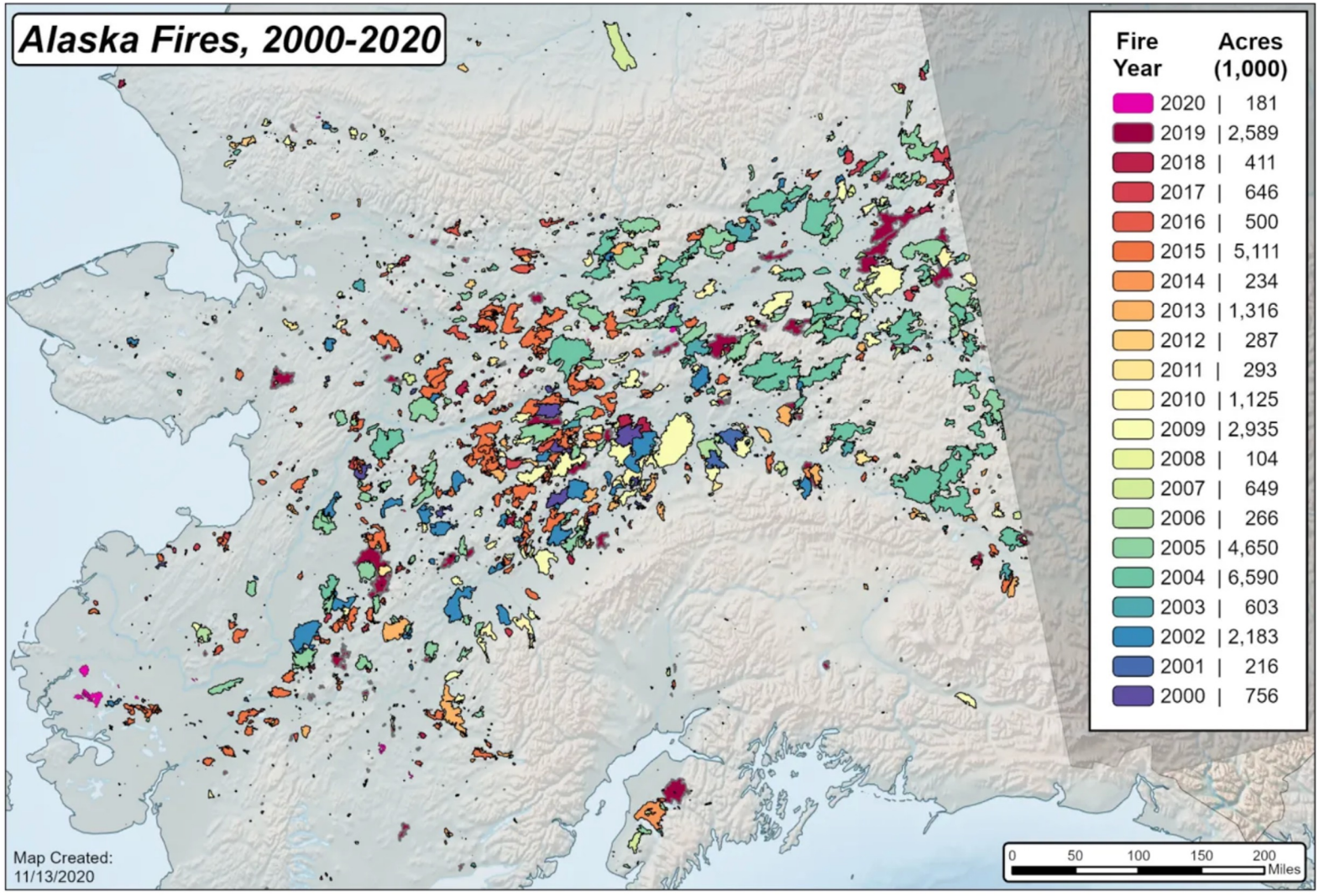
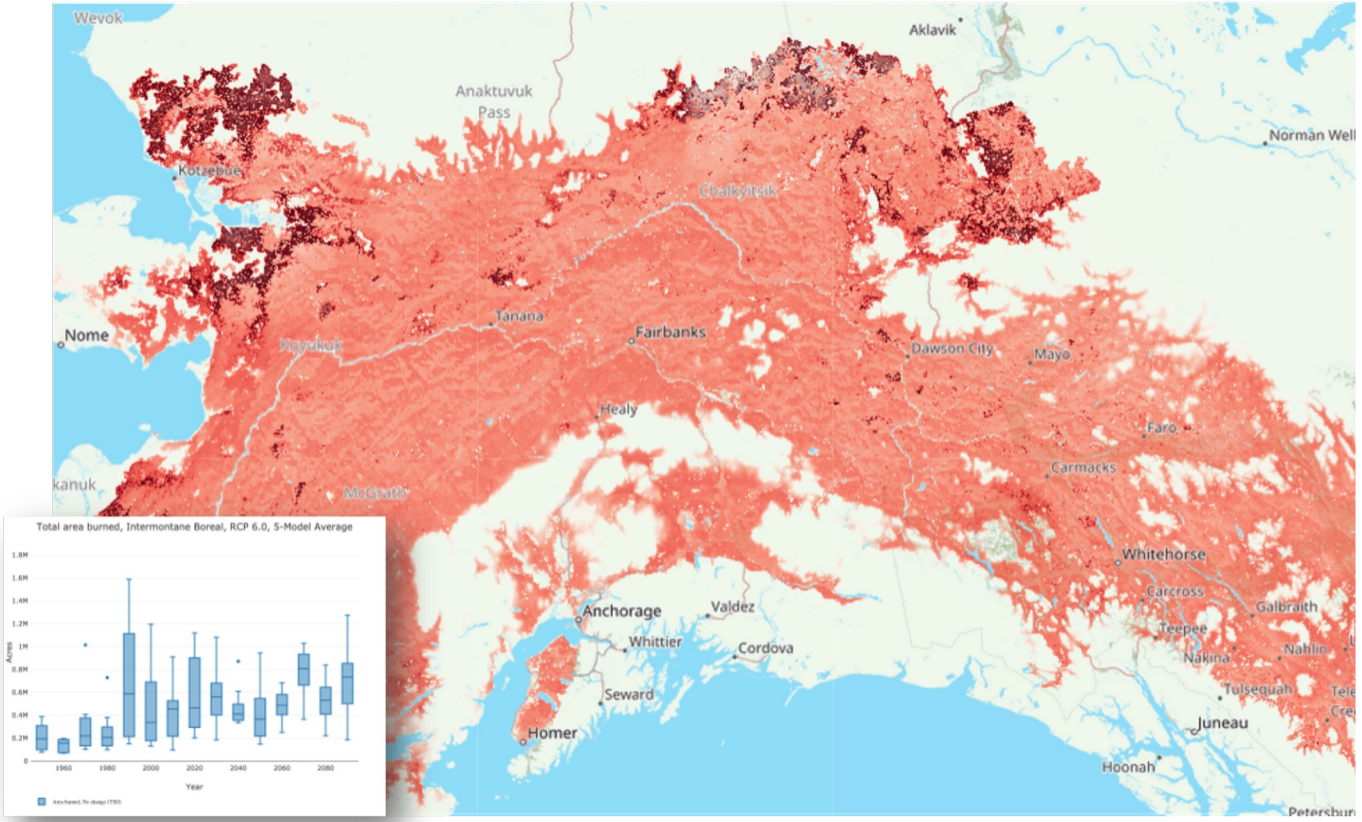
Gino Graziano, UAF CES
Holly Prendeville, USFS

The boreal forest's vulnerability to invasive species is changing.




Alaska Fires, 2000-2020
Fire Year
Acres (1,000)
2020 | 181
2019 | 2,589
2018 | 411
2017 | 646
2016 | 500
2015 | 5,111
2014 | 234
2013 | 1,316
2012 | 287
2011 | 293
2010 | 1,125
2009 | 2,935
2008 | 104
2007 | 649
2006 | 266
2005 | 4,650
2004 | 6,590
2003 | 603
2002 | 2,183
2001 | 216
2000 | 756
Map Created:
11/13/2020
0 50 100 150 200
Miles

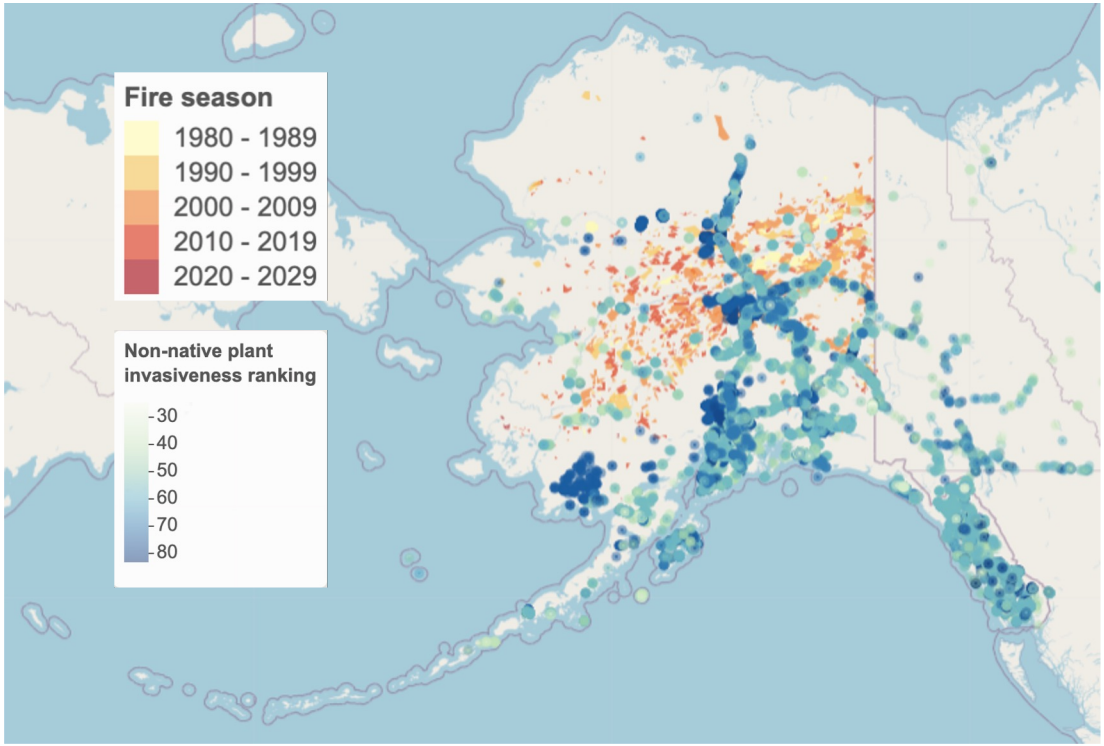
Future Flammability Projection



ALFRESCO Model, 2000-2099, UAF Scenarios Network for Alaska and Arctic Planning

Non-native plants across Alaska

- In 1941, First edition on Flora of Alaska- 154 non-native species
- Today, 349 non-native plant species observed in Alaska in AKEPIC
- 8 species make up ~50% of the observations:
  - Common dandelion (*Taraxacum officinale*)
  - Common plantain (*Plantago major* L.)
  - Waterweed (*Elodea sp.*)
  - White sweetclover (*Melilotus albus* Medik.)
  - Reed canary grass (*Phalaris arundinacea* L.)
  - White clover (*Trifolium repens* L.)
  - Annual bluegrass (*Poa annua* L.)
  - Timothy (*Phleum pratense* L.)



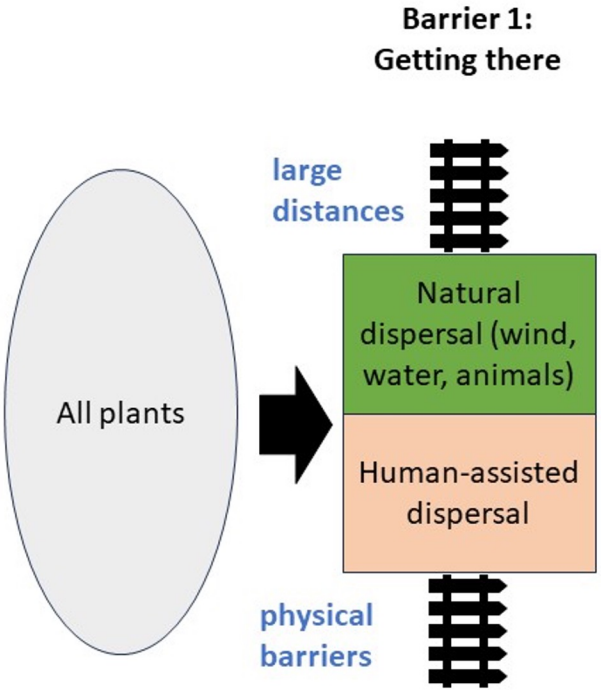
Increasing Wildfire

The perfect storm?

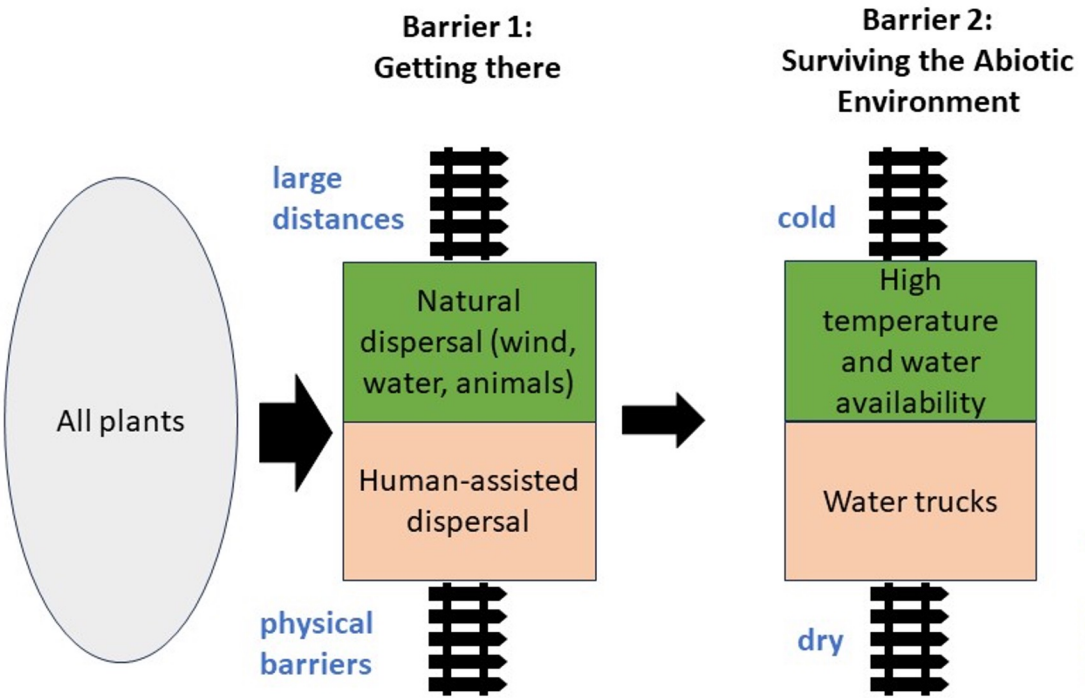
Increasing Non-native Plants

Increasing Human disturbances

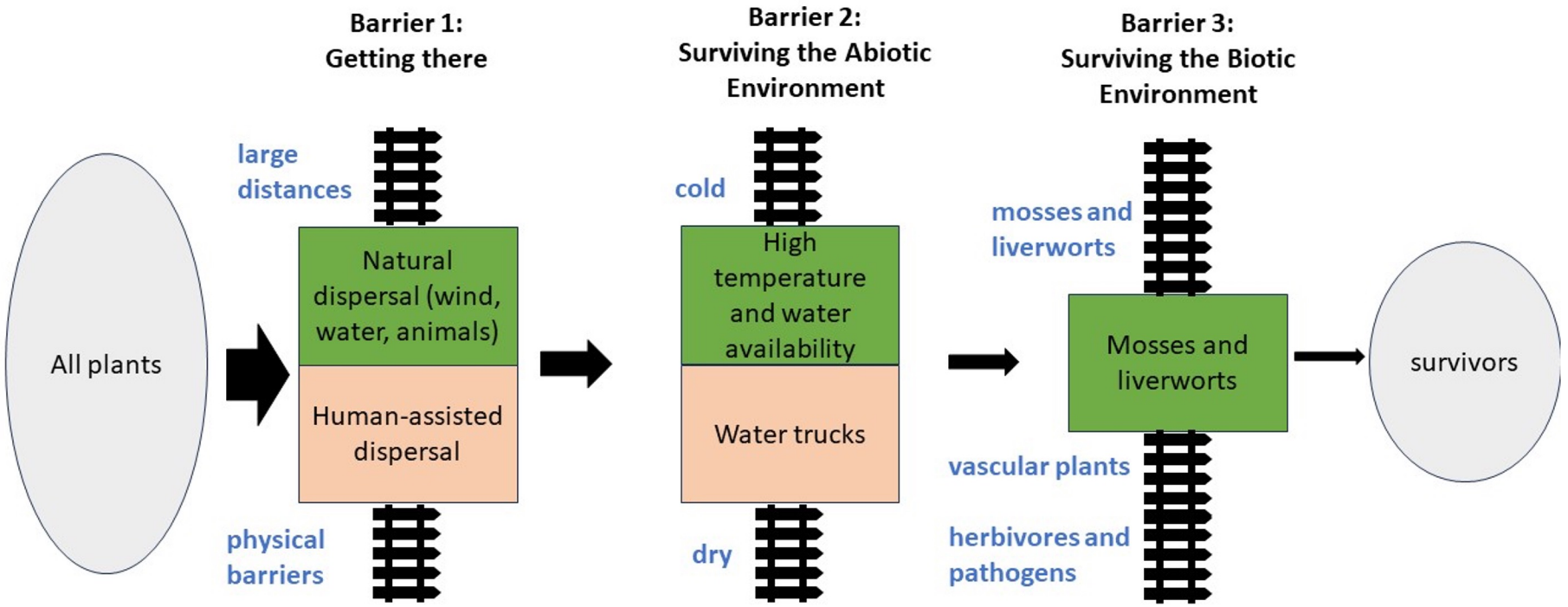
Factors influencing populations of invasives



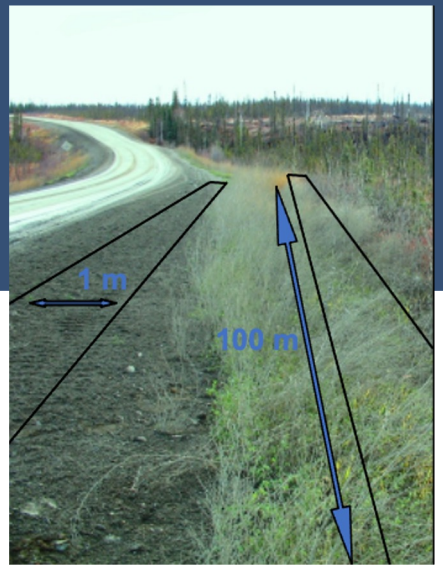
Factors influencing populations of invasives



Factors influencing populations of invasives



Prior research on vulnerability
Methods



Roadside survey

In burn survey

Intact soil cores from burns

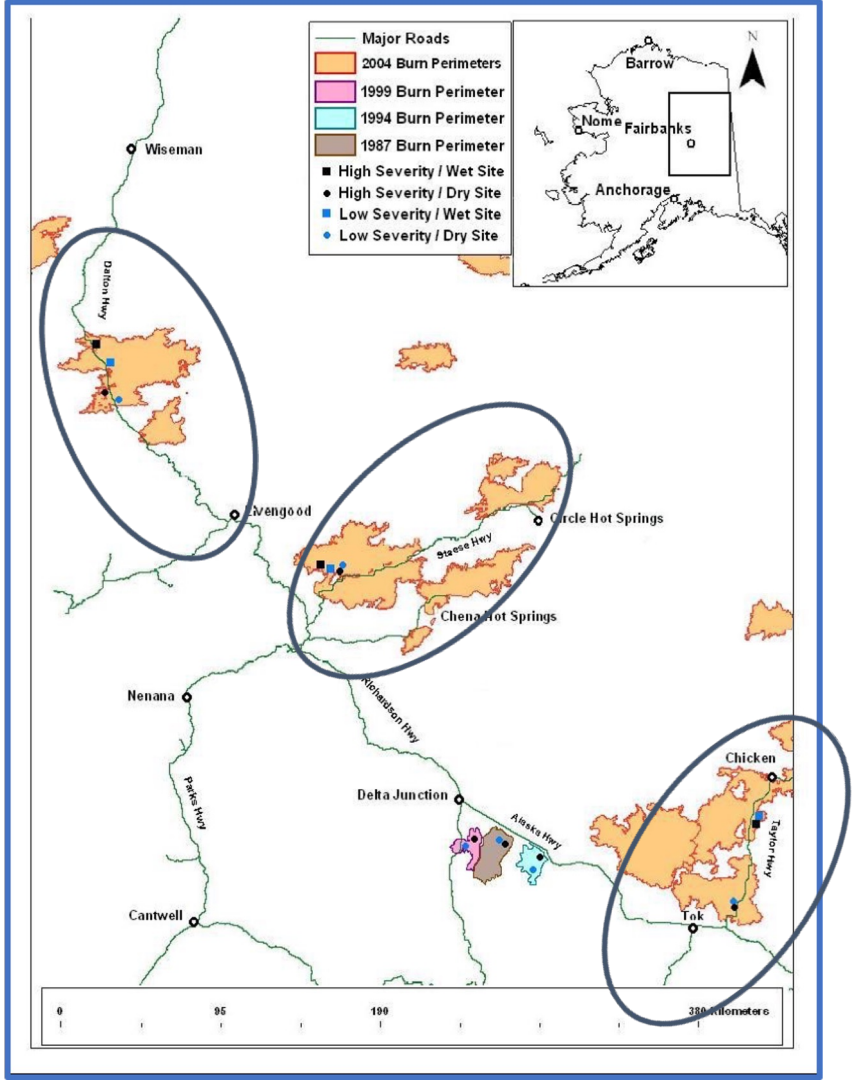
Seeded invasives in greenhouse

Prior research on vulnerability

Field survey and greenhouse study:
>100 Black Spruce areas burned in 2004 along Steese, Taylor, Dalton Highways

A chronosequence of sites burned in 1999, 1994, and 1987 near Delta Junction

Follow-up systematic survey every ¼ mile in all burn perimeters

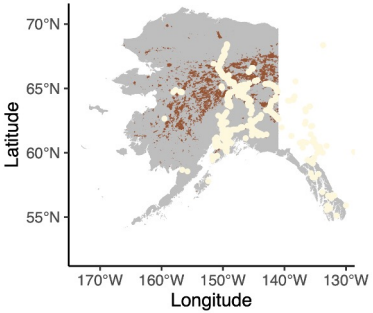


Species of interest

White sweetclover

Melilotus albus

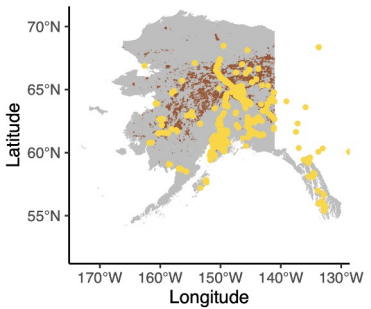
Invasiveness ranking: 81



Narrowleaf hawksbeard

Crepis tectorum

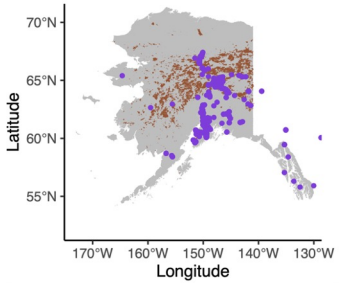
Invasiveness ranking: 56



Bird vetch

Vicia cracca

Invasiveness ranking: 73



Also Orange Hawkweed (*Hieracium aurantiacum*) and Smooth Brome (*Bromus inermis ssp. inermis*)

Key prior results:
Wildfire vulnerability, resistance, and resilience

Propagule Pressure–Invasives only occur in burns if they are on the roadside or pipeline corridor

Altitude–Non-native plants near and in burns decreased as altitude increased, increasing latitude and slope also decreased non-native plants

Region–Some regions are less vulnerable, soil pH

Spellman et al. 2014, Biol. Inv. 16: 1879-1895,
Villano and Mulder 2008 National Parks Service/ NASA Survey Technical Report.

Key prior results:
Wildfire vulnerability, resistance, and resilience

Burn severity–Low severity are dry, high severity have mosses that come in agressively; Moderate and light burns had highest hawksbeard and vetch occurance, high severity burns had highest occurrence of sweetclover

Soil moisture–all three non-native species grew better in soils that had higher water holding capacity

Burn age–In the field, highest richness and abundance of non-native species occurred in Chronosequence sites; Invasive plants grew better in soils from the 12 and 19 year old low severity burns.

High severity and low severity sites in the Delta Chronosequence fire burned in 1994 (12 year old burn at the time)

Spellman et al. 2014, Biol. Inv. 16: 1879-1895,
Villano and Mulder 2008 National Parks Service/ NASA Survey Technical Report.

Biotic environment:

Vascular plants, mosses and liverworts can reduce germination and survival following a burn

- Planted seeds of sweetclover, orange hawkweed, and smooth brome
- Found lower germination and growth of orange hawkweed and brome in cores with lower biomass of mosses and liverworts

M. Carlson

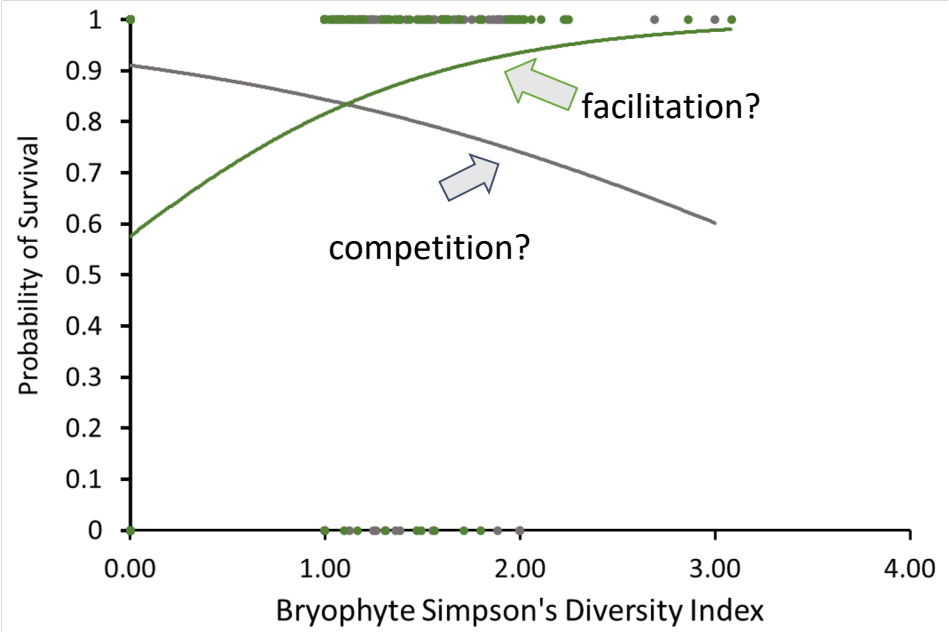
Michael Shepherd, FS

Dave Powell, FS

Spellman et al. 2014, Biol. Inv. 16: 1879-1895.

Abiotic environment interacts with biotic environment

- Orange hawkweed grows **better** with higher moss diversity under **high moisture**, but **worse** under l**ow moisture**
- Effects of species can be complex



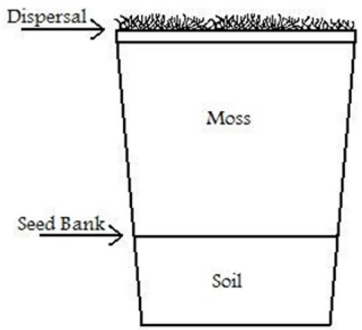
Biotic environment:

Mosses and liverworts can enhance germination and survival

Luke Ponchione planted seeds underneath and on top of mosses of four species.

When seeded form the top:

- Sweetclover had reduced germination
- Orange hawkweed had increased germination
- Smooth brome has slightly reduced germination or no change



Current Research

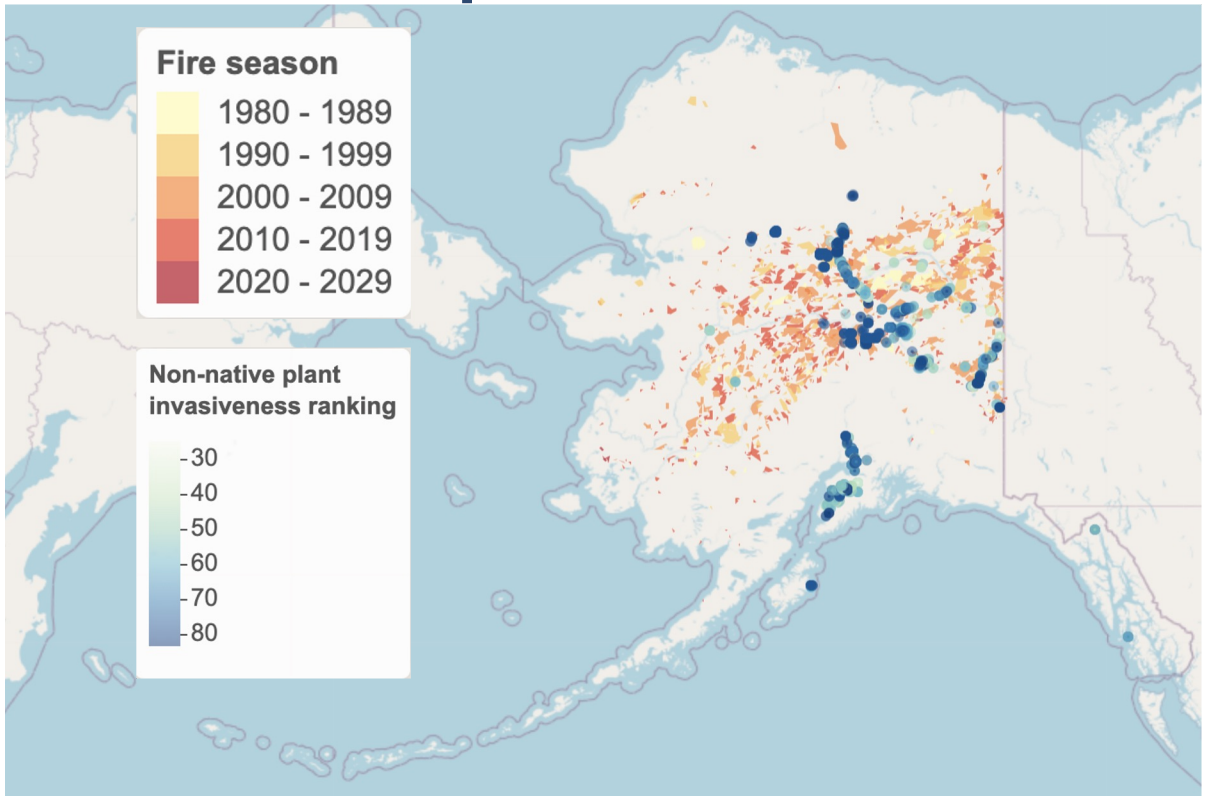
- Data synthesis
- Re-survey
- Seed bank study

Current Research Questions

- **Data synthesis**
  - Are there taxonomic or geographic patterns in the current non-native plant occurrences in burn perimeters in boreal Alaska?
- **Re-survey**
- **Seed bank study**

Non-native plants within burn perimeters

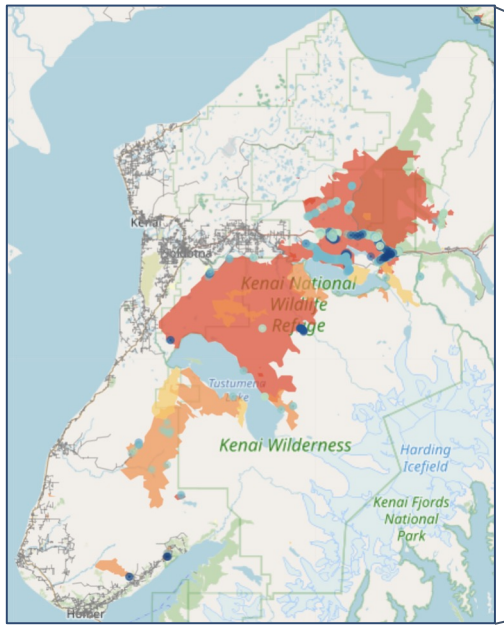
- 77 non-native plant species observed **within burn perimeters**
- 31 non-native plant species observed more than 10 times

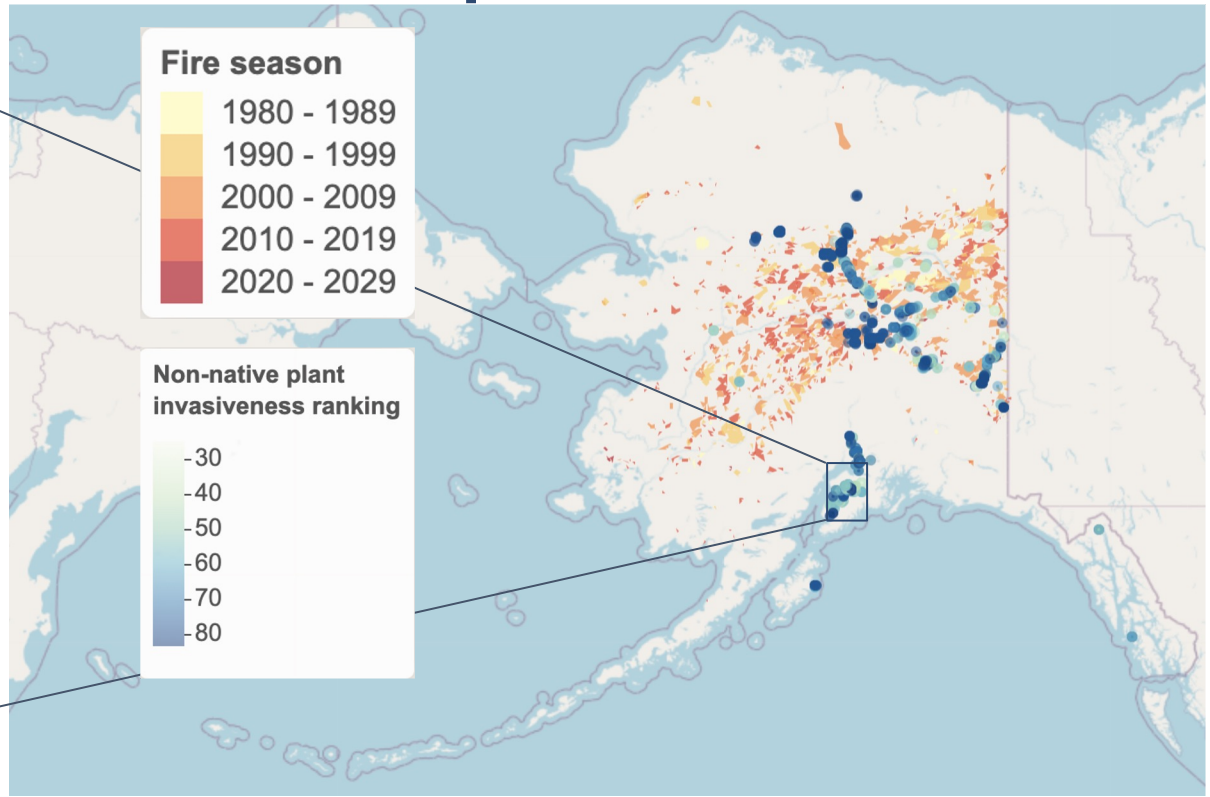


Alaska Exotic Plants Information Clearinghouse 2023

Non-native plants within burn perimeters

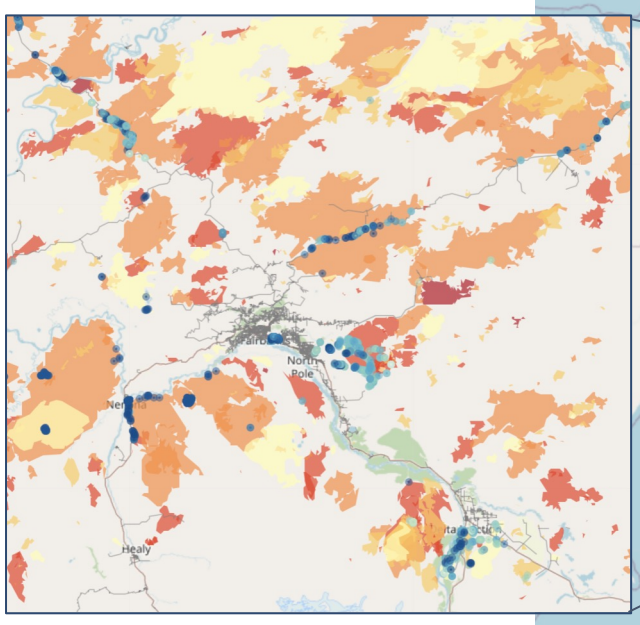
Southcentral Alaska

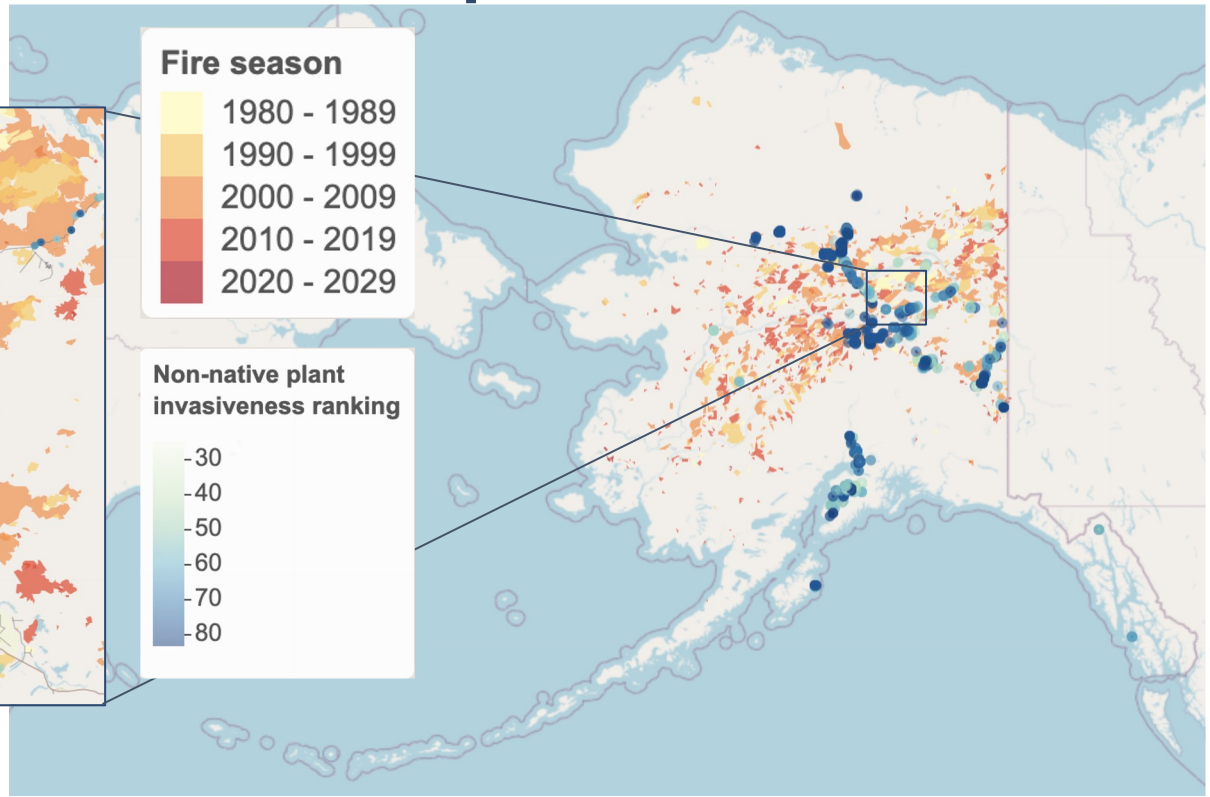




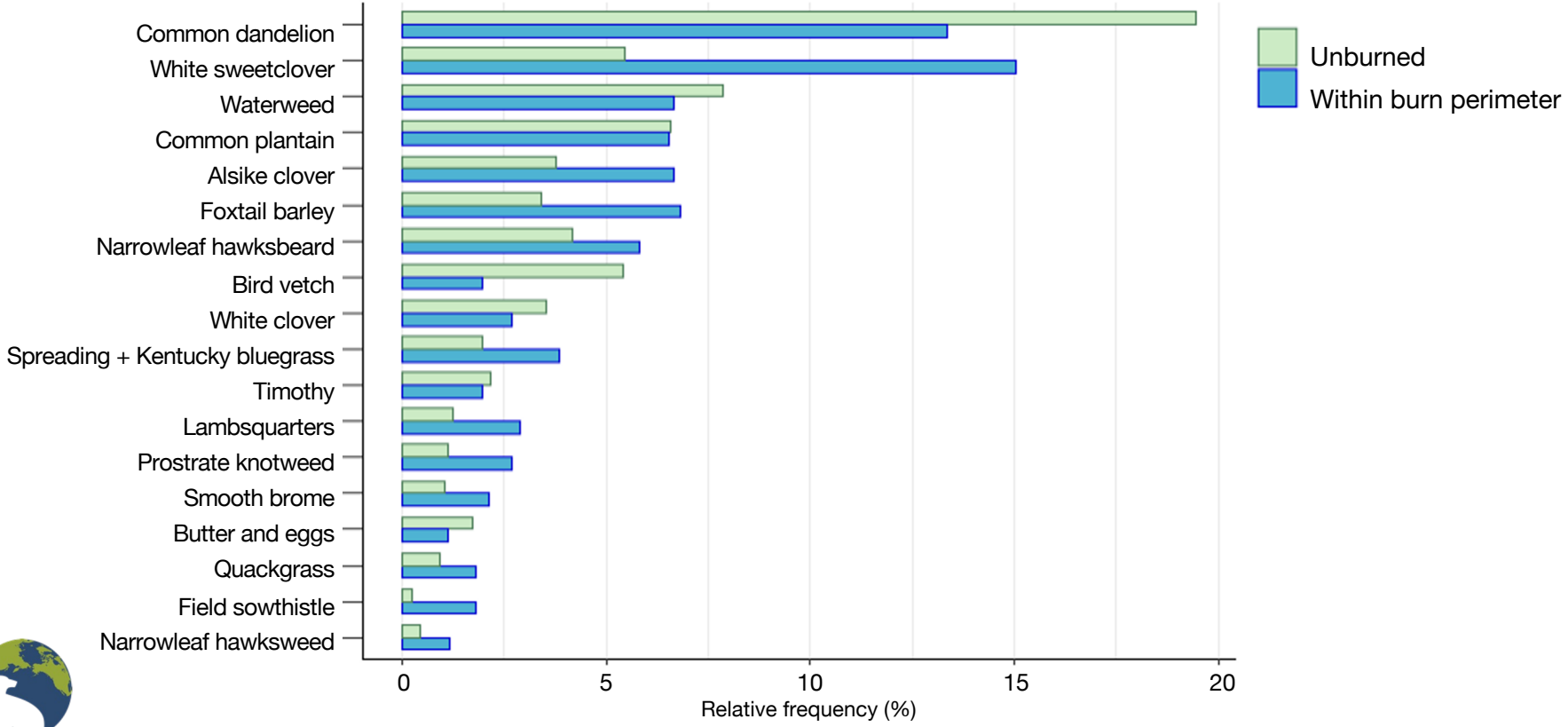
Non-native plants within burn perimeters

Interior Alaska

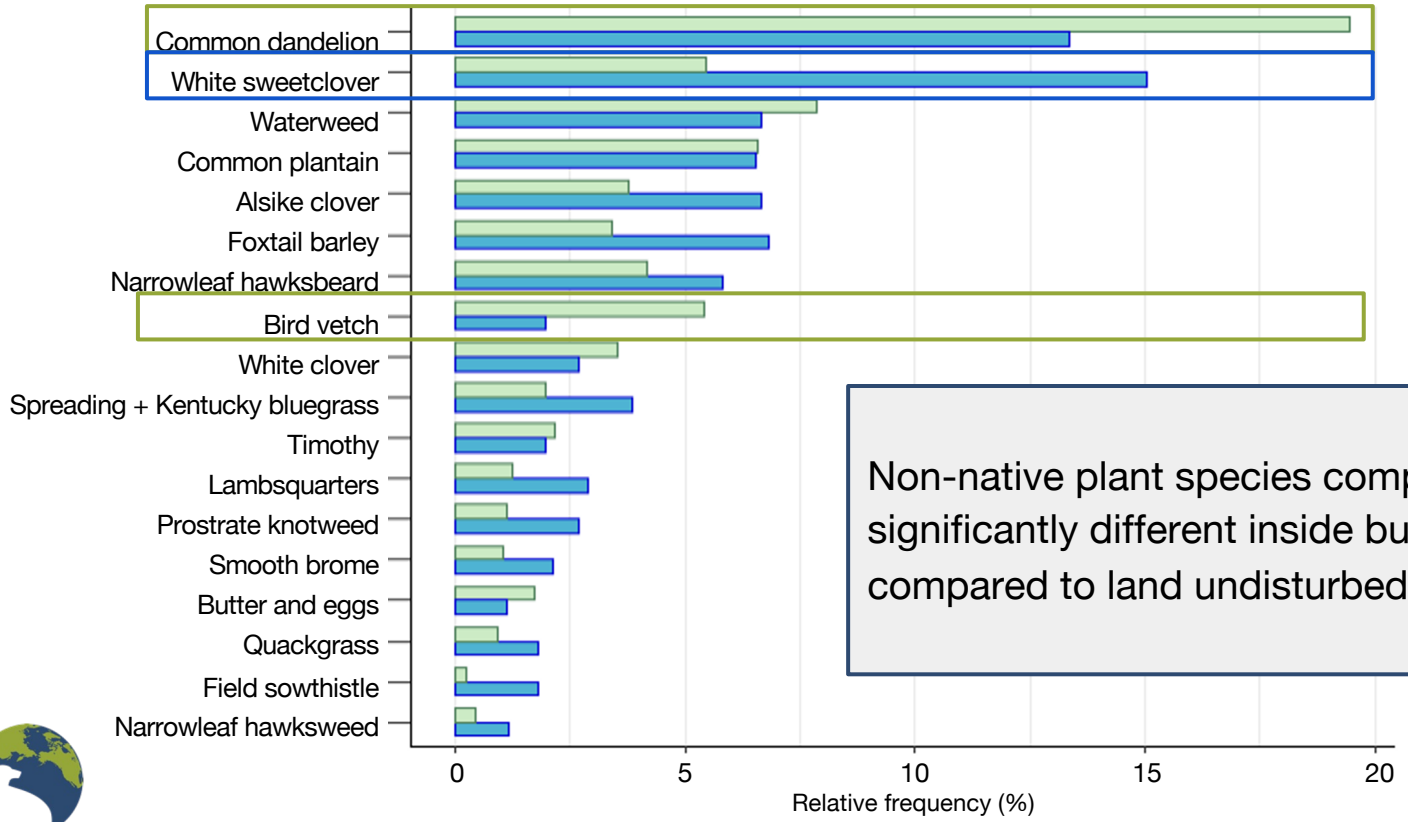




Non-native plants within burned and unburned land



Non-native plants within burned and unburned land



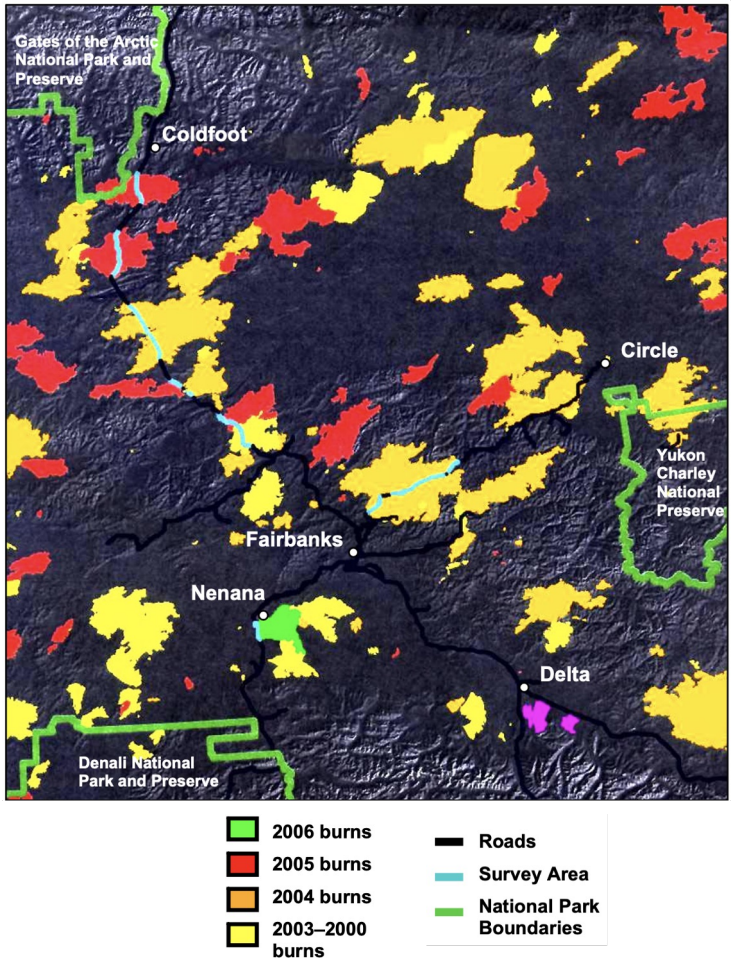
Non-native plant species composition is significantly different inside burn perimeters compared to land undisturbed by fire.

Current Research Questions

- Data synthesis
- **Re-survey**
  - Have any infestations in burned areas persisted?
  - Which species? Where?
- Seed bank study

Original burn survey: Summer 2006

- Surveyed 200 miles along the Parks, Steese, and Dalton Highways
- Survey focused on three non-native species:
  - White sweetclover (*Melilotus albus*)
  - Narrowleaf hawksbeard (*Crepis tectorum*)
  - Bird vetch (*Vicia cracca*)



Revisit burn survey: Summer 2023

- Visited 27 sites along the Parks and Dalton Highways
- Previous infestations in burned areas
  - Narrowleaf hawksbeard: 55%
  - White sweetclover : 45%

Revisit burn survey: New infestations

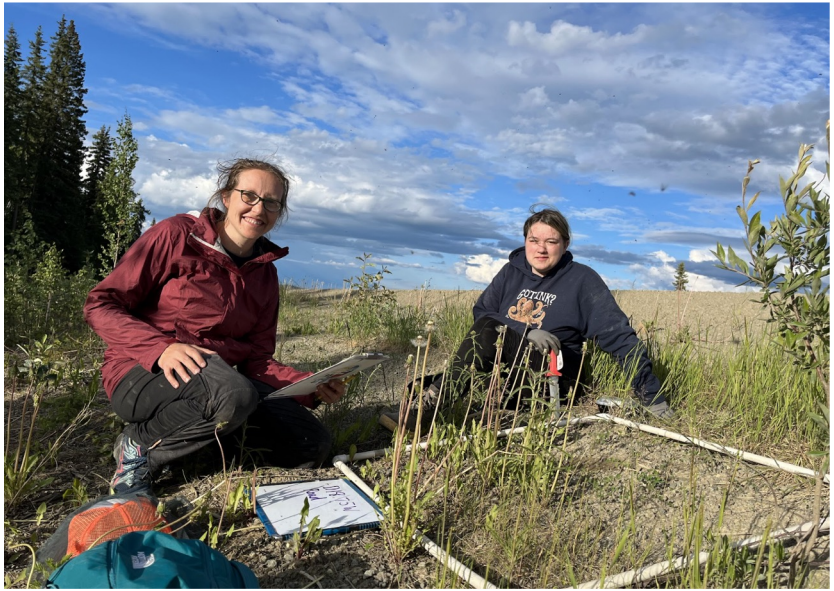
2023 Most recent revisit surveys

- Observed infestations along **roadside** at 100% of sites

White sweetclover:	100%
Common dandelion:	30%
Narrowleaf hawksbeard:	26%
Bird vetch:	26%

- Observed infestations in **burned areas** at 26% of sites

White sweetclover:	22%
Bird vetch:	9%
White clover:	4%

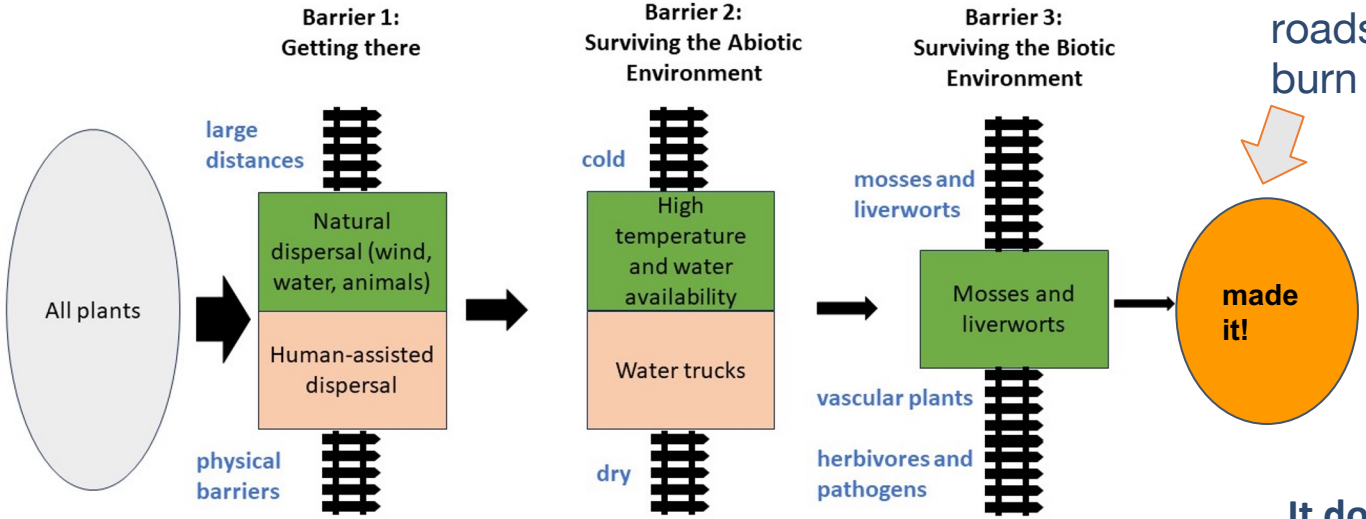


Current Research Questions

- Data synthesis
- Re-survey
- **Seed bank study**
  - Is a viable non-native seedbank developing?
  - Is the ratio of non-native to native seeds in the seedbank changing?

Identifying barriers:
Combining field and greenhouse studies

Field data shows us who survived at the roadside and in the burn



It does not tell us which barrier stopped the other seeds from making it

Greenhouse Seedbank Study Part 1:
Surface and subsurface germination

Methods:

- Remove the vascular cover
- Split soil into top and bottom layer
- Place in the greenhouse (nice temperature and high water)
- Identify and count seedlings emerging

Seedlings emerging from **bottom** layer

Seedlings emerging from **top** layer

Greenhouse Seedbank Study Part 1:
Surface and subsurface germination

- *Top:* seedlings that would have emerged if conditions were good and there was no vascular competition
- *Bottom:* seedlings that would have emerged if conditions were good and there was no other vegetation of any kind
- Seedlings emerging from bottom layer suggests populations are persistent, not dependent on reintroduction

Seedlings emerging from **bottom** layer

Seedlings emerging from **top** layer

Greenhouse Seedbank Study Part 2:
Soil bank and seed viability

Methods:
Identify seeds in the soil bank and test for viability

What this identifies:

- Seeds that made it there but soil conditions were not right for germination
- Allows us to compare % germination in top vs bottom layers because we know how many seeds there were to start with

Seed bank study: Very early results

- Native seedling emergence was high, especially fireweed, bluebells, birch, and bluejoint grass
- Only a few non-native species emerged: sweetclover, Norwegian cinquefoil, bird vetch, quackgrass, lambsquarter
- All non-native seedlings were present in the vegetation except lambsquarter

Very early results suggest:

- No evidence for persistent viable seed banks of invasives
- Native species are better represented (likely due to better dispersal mechanisms)

Take home message:

- Boreal forest burn sites have high resilience to non-native plant infestation.
- Multiple disturbance events affect forest resiliency and vulnerability to invasions.