BNZ LTER: Wildfire Working Group

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OBJECTIVE:
Assess how intensifying fire regimes are reshaping the structure and function of Alaskan boreal forests
Question W1: How do black spruce ecosystem legacies and post-fire climate conditions impact successional trajectories?

Question W2: How do the information legacies of regeneration strategies interact with wildfire and climate to drive alternative successional trajectories?

Question W3: What are the ecosystem consequences of alternative successional trajectories?

Question W4: How have humans historically modified the boreal fire regime, and how can this inform current fire and fuels management?
1. Across field research working groups
   • Consumers
   • Permafrost

2. Social-Ecological Systems and Dynamic Modeling

3. Outreach & Inreach
   • Education
   • Arts & Humanities
     • ANAC

4. Collaboration with other wildfire research

5. Other cool research questions

• One Jam board per research question
• Populate with ideas/pictures/research questions/collaborations etc.
Question W1: How do black spruce ecosystem legacies and post-fire climate conditions impact successional trajectories?

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Question W4: How have humans historically modified the boreal fire regime, and how can this inform current fire and fuels management?
Question W1: How do black spruce ecosystem legacies and post-fire climate conditions impact successional trajectories?

**Hypothesis W1a:**

warm and dry post-fire conditions will reduce spruce establishment and lead to deciduous dominance or recruitment failure independent of fire severity

**Approach:**

1) CCE: new sites capturing interactions of climate, combustion, and establishment
   - 162 new, mature, burned black spruce sites
   - 2023: new sites established by Walker NSF
   - Stand age at time of fire, burn depth, combustion (year 1)
   - Seedling densities, understory vegetation, SOL, active layer, soil moisture (year 1, 3, 5, 10, 20)

2) Resurvey JFSP sites in 2024
Question W1: How do black spruce ecosystem legacies and post-fire climate conditions impact successional trajectories?

**Hypothesis W1b:** As fire frequency increases so will the loss of SOL legacies, resulting in alternative successional trajectories.

**Approach:**
- 54 “reburned” stands from 2021-2024
- Choose 18 sites/year to resurvey (Walker NSF)
- CCE protocol
Question W1: How do black spruce ecosystem legacies and post-fire climate conditions impact successional trajectories?

**Hypothesis W1c:**
the effects of increasing fire severity on microbial legacies of black spruce forests will reduce the establishment and growth of spruce seedlings, reinforcing alternative successional trajectories

**Approach:**
- 5 high-severity & 5 low-severity newly established burned sites
- Sample soils & 20 regenerating seedlings: ~1 month, 3, 5, and 10 years post-fire

**Seedling establishment:**
- Quantify mycorrhizal association
- Compare root-associated fungi to the fungi that are present as inoculum in soil

**Microbial community composition and survivorship:**
- Sample entire active layer and ~1m of permafrost
- Depth-wise sampling within each core
- Amplicon sequencing
- Use PMA and/or DNase treatment
Question W1: How do black spruce ecosystem legacies and post-fire climate conditions impact successional trajectories?
Question W2: How do the information legacies of regeneration strategies interact with wildfire and climate to drive alternative successional trajectories?

**Hypothesis W2a:**
white spruce regeneration following wildfire is dependent on the climatic drivers (i.e., warm and dry) that synchronize seed masting with large fire years

**Approach:**
- Continue monitoring seed traps @ seven sites (white spruce)
- Test aspen and birch protocol @ subset of RSN
Question W2: How do the information legacies of regeneration strategies interact with wildfire and climate to drive alternative successional trajectories?

**Hypothesis W2b:**
pre-fire deciduous presence and regeneration via suckers will result in post-fire deciduous dominance

**Approach:**
Add 54 sites to CCE from recently burned deciduous or mixed stands (established in 2022 – Mack NSF)
Question W2: How do the information legacies of regeneration strategies interact with wildfire and climate to drive alternative successional trajectories?
Question W3: What are the ecosystem consequences of alternative successional trajectories?

**Hypothesis W3a:**
black spruce forests promote high N fixation inputs coupled with slow decomposition of moss litter, N will accumulate over time leading to N x P co-limitation or P limitation as permafrost reaccumulates over succession

**Approach (2023-2024):**
- continue studies across RSN+ sites, filling data gaps in our chronosequence with new long-term monitoring plots in mixed and deciduous stands from the oldest age class

**Approach (long-term):**
- combine foliar and litterfall data with tree inventories to estimate stand-level plant nutrient uptake, loss, and nutrient use efficiency for deciduous and black spruce successional trajectories
Question W3: What are the ecosystem consequences of alternative successional trajectories?

Hypothesis W3b:
on alternative deciduous trajectories, low N inputs and rapid decomposition will enhance lateral and gaseous losses of N, leading to N limitation over succession

Approach:
• Estimate N inputs and turnover across the RSN+
• continue our studies of gaseous N losses and N and P transfer to aquatic ecosystems
• compare rates of loss
• Previous synoptic sampling:
  ↓ DOM in extensively burned catchments
  ↑ NH4+ and NO3− in absence of shallow (1 m) permafrost
• Repeat sampling in years 1 & 5
  • Trends in solute concentration indicating recovery from fire
Question W3: What are the ecosystem consequences of alternative successional trajectories?

**Hypothesis W3c:**
outbreaks of leaf-mining herbivores will reinforce plant-soil-microbial feedbacks in the deciduous domain, while lethal pathogens will push deciduous ecosystems into the spruce domain

**Approach:**
examine the impact of leaf mining on plant-level foliar nutrients, nutrient loss, and nutrient retranslocation by assessing nutrient concentrations and leaf miner damage on foliage and freshly senesced litter of aspen and birch
Question W3: What are the ecosystem consequences of alternative successional trajectories?
Question W4: How have humans historically modified the boreal fire regime, and how can this inform current fire and fuels management?

Hypothesis W4a:
the historic use of fire as a land management tool shifted species dominance, stimulated understory productivity, and increased permafrost thaw

Approach:
collect and archive data related to IK:
1) on fire history and cultural uses of fire
2) landscape fragmentation and connectivity
3) key plant and animal species impacted by fire
Question W4: How have humans historically modified the boreal fire regime, and how can this inform current fire and fuels management?

**Hypothesis W4b:**

experimental ground disturbance and seeding of deciduous trees will promote deciduous tree dominance in fuel breaks

**Approach:**

- In fuel reduction treatments, we will establish experimental manipulations of tree seed sources and seedbeds, soil fertility, and conifer density to test mechanisms of community assembly in 2023 (Mack NSF).
- Resurvey these treatments in 2028.
Question W4: How have humans historically modified the boreal fire regime, and how can this inform current fire and fuels management?
Integration across field research working groups

Consumers Q3:
- Establish and monitor the RSN+ sites, examine interactions of consumers with successional trajectories (W3)

Permafrost Q4:
- Revisit JFSP sites in 2024 (W1)
- Stream chemistry (W3)
Integration with SES and Modeling

Dynamic Modeling Q1:
- compare model outputs with field observations of recruitment, pre- and post-fire SOL depth, vegetation and soil C and N pools, and active layer thickness in early-, mid-, and late-successional stages from the CCE and RSN+ (W1, W3)

Social-Ecological System
- use of historical fuel breaks (W4)
Integration with Inreach & Outreach

- **Education**
  - Summer REU students (W1 and W3)
- **Arts and Humanities**
  - Potential to pair with artists (ITOC) and non-scientists to visit recent road network fires (W1), JFSP sites (W1), new deciduous sites (W2), streams (W3), and fuel breaks (W4) depending on collaborator interests
- **Alaska Native Advisory Council**
  - Historical use of fire
  - Changes in ecosystem services with increasing wildfire
- **DEIJ**
  - Focused recruitment of graduate and undergraduate students to increase DEIJ goals
**Breakout Rooms**

**W1:** How do black spruce ecosystem legacies and post-fire climate conditions impact successional trajectories?

**W2:** How do the information legacies of regeneration strategies interact with wildfire and climate to drive alternative successional trajectories?

**W3:** Question W3: What are the ecosystem consequences of alternative successional trajectories?

**W4:** How have humans historically modified the boreal fire regime, and how can this inform current fire and fuels management?

**Tasks:**

1. Identify a **presenter** – report back to the larger group
2. Identify a **manager** - ensure that the group stays on task and that there is room for everyone in the conversation
3. Identify a **timekeeper** – keep track of time
4. **EVERYONE** records on the jam board

**10 minutes discussion and jam board ideas:**

1. collaboration across WGs and other wildfire researchers
2. integration with inreach/outreach
3. Any thought/ideas related to the Q