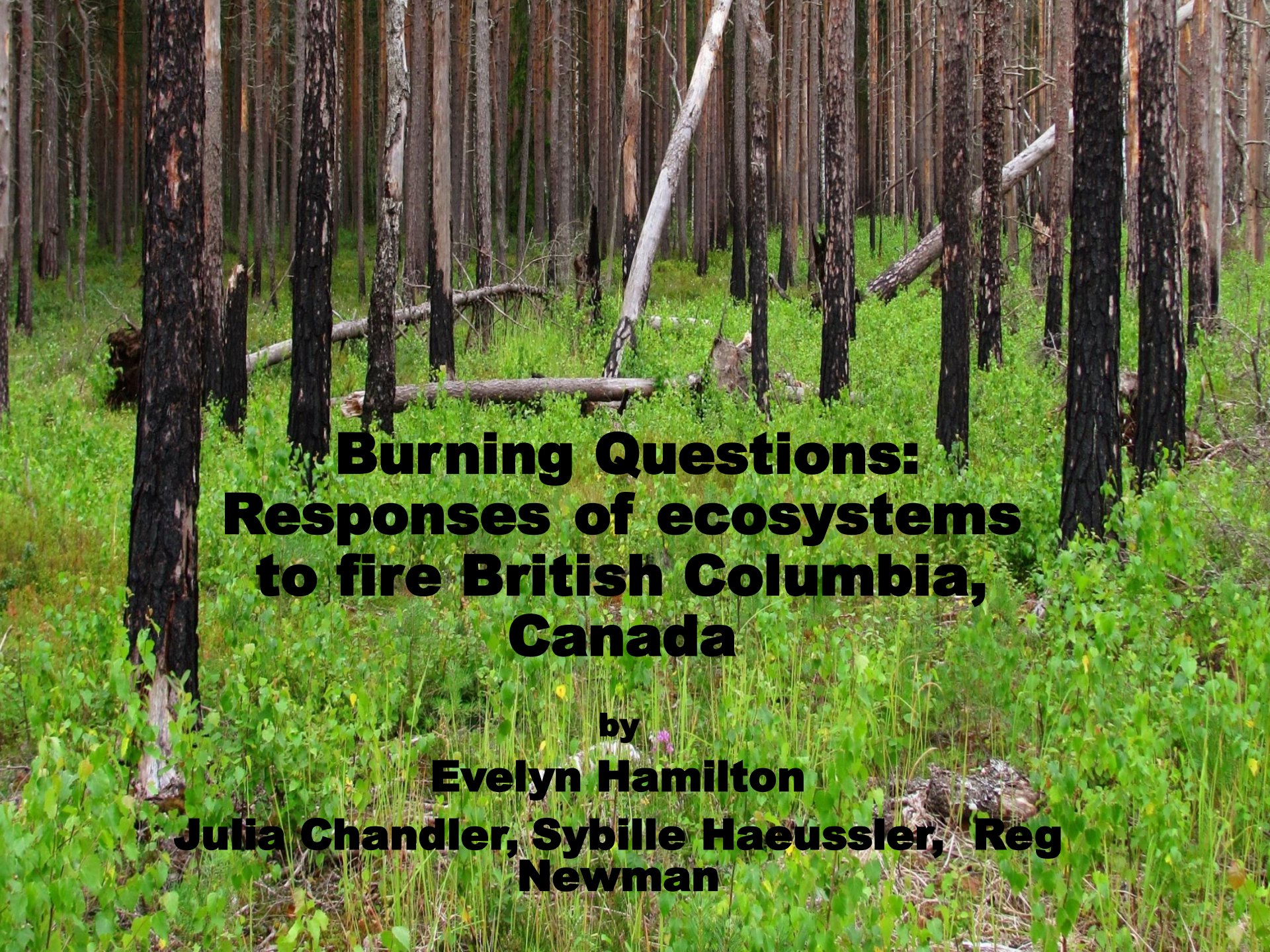


Burning Questions: Responses of ecosystems to fire British Columbia, Canada

by

Evelyn Hamilton

Julia Chandler, Sybille Haeussler, Reg Newman

Outline

- Project background
- Methods, Locations
- Burning Questions
- Results – examples
- Conclusions
- Next Steps
- Contacts & thanks

Project background

- Climate change
- Understanding response of ecosystems to fire is a priority.
- 2 worst fire seasons
- Effects of fire on fuels, soils, vegetation, tree growth studied since 1970s.
- Limited meta-analysis and synthesis relevant to current priorities.
- Data at risk of being lost.
- New questions

Methods

1. Determined key questions and data sources
2. Compiled data
   - 78 datasets, 3770 plots, 400 plant species
   - Plant species composition, cover
   - Ecosystem, site, soil, regeneration
   - Fire (FWI, fuel loading & consumption)
   - Up to >20 yrs post-fire
3. Analysis
   - Ecosystem classification to group sites
   - Ordinations to explore data
   - Plant functional traits to group species
   - Specific analysis - mixed effects models

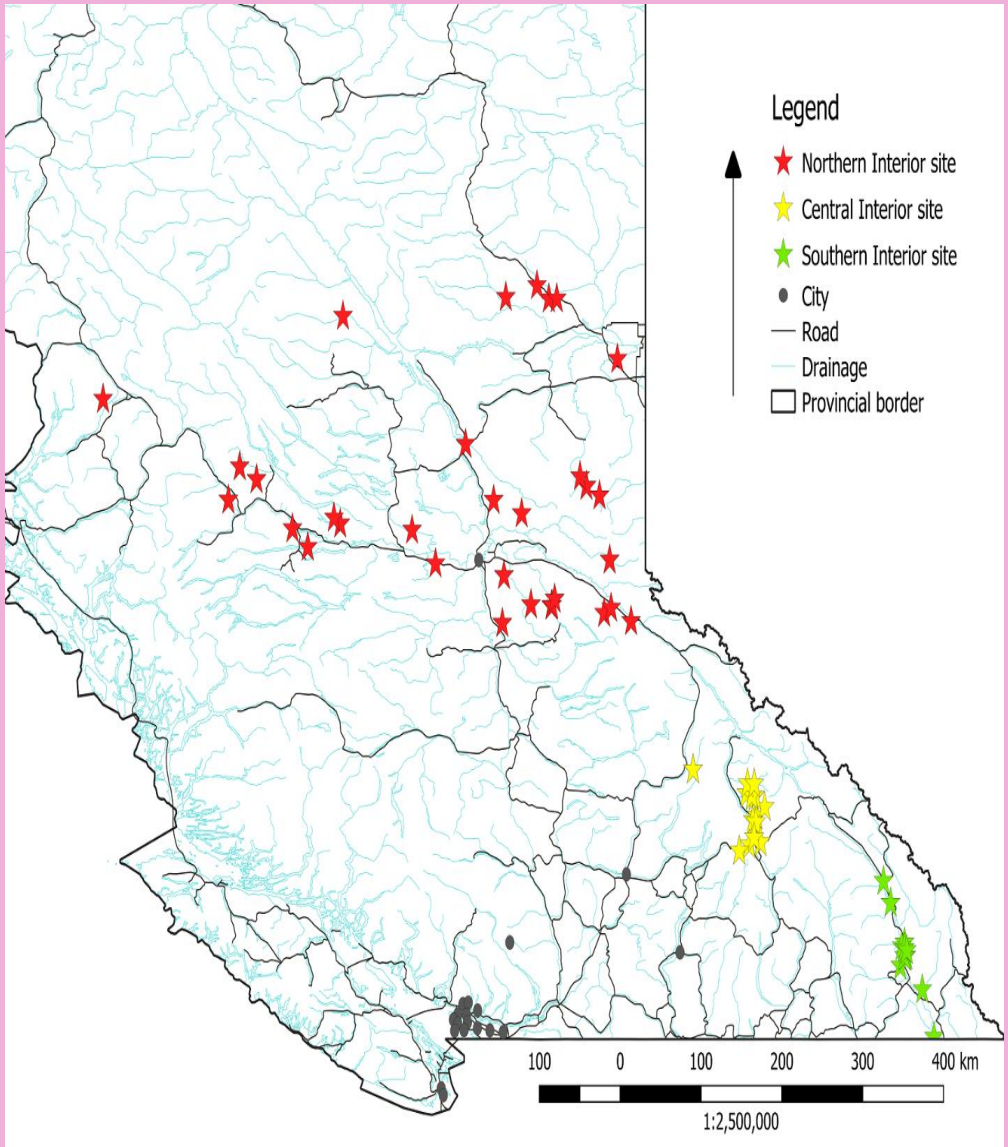
Questions

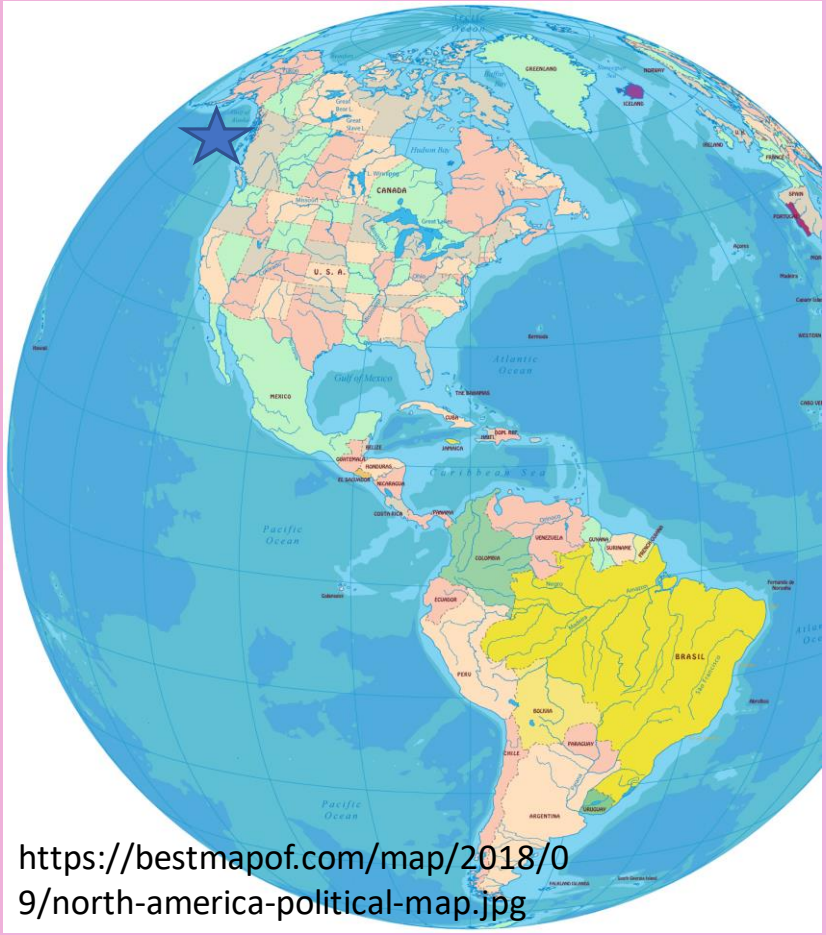
1. General effects of fire
2. Vegetation response
3. Landscape flammability
4. Watershed integrity
5. Reforestation, restoration
6. Climate change, carbon

Questions

2. Vegetation response
   - reforestation success
   - restoration success
   - wildfire/livestock forage (e.g. grasses, moose browse, berries, lichens)
   - people food (e.g. berries, medicinal)
   - weedy invasive species
   - intermediate hosts for rusts

Location of study sites





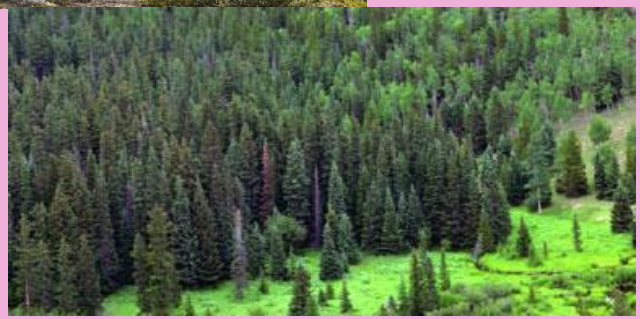
https://bestmapof.com/map/2018/09/north-america-political-map.jpg

Broad Community Landscape Types

BCLT 4 - Dry Ponderosa pine Douglas-fir in Southern Interior

BCLT 3 - Aspen Mixedwood and Aspen-Grassland in (Sub)Boreal

BCLT 2 - Dry Lodgepole Pine Spruce on Plateau



BCLT 1 - Mesic and Wetter Spruce, Subalpine Fir (Hemlock) in Mountains

Broad Community Landscape Types

BCLT 4 - Dry Ponderosa pine Douglas-fir in Southern Interior - frequent low severity and some mixed severity wildfire

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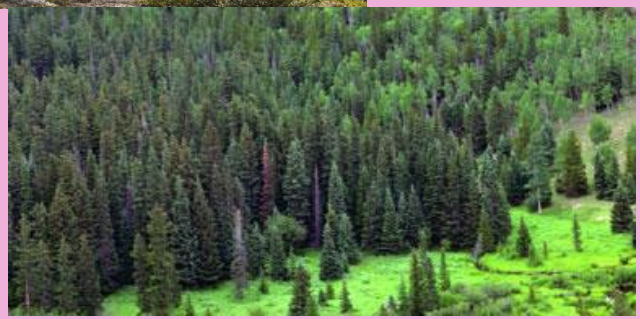

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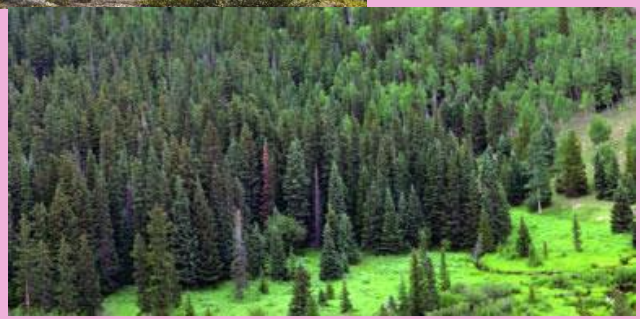
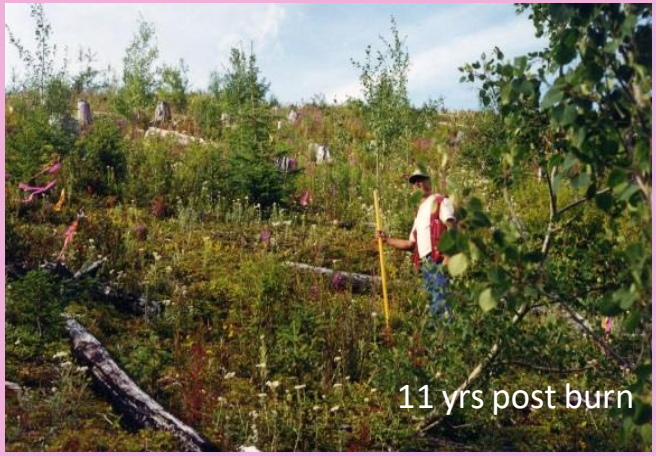


BCLT 1 - Mesic and Wetter Spruce, Subalpine Fir (Hemlock) in Mountains - infrequent high severity wildfires

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains

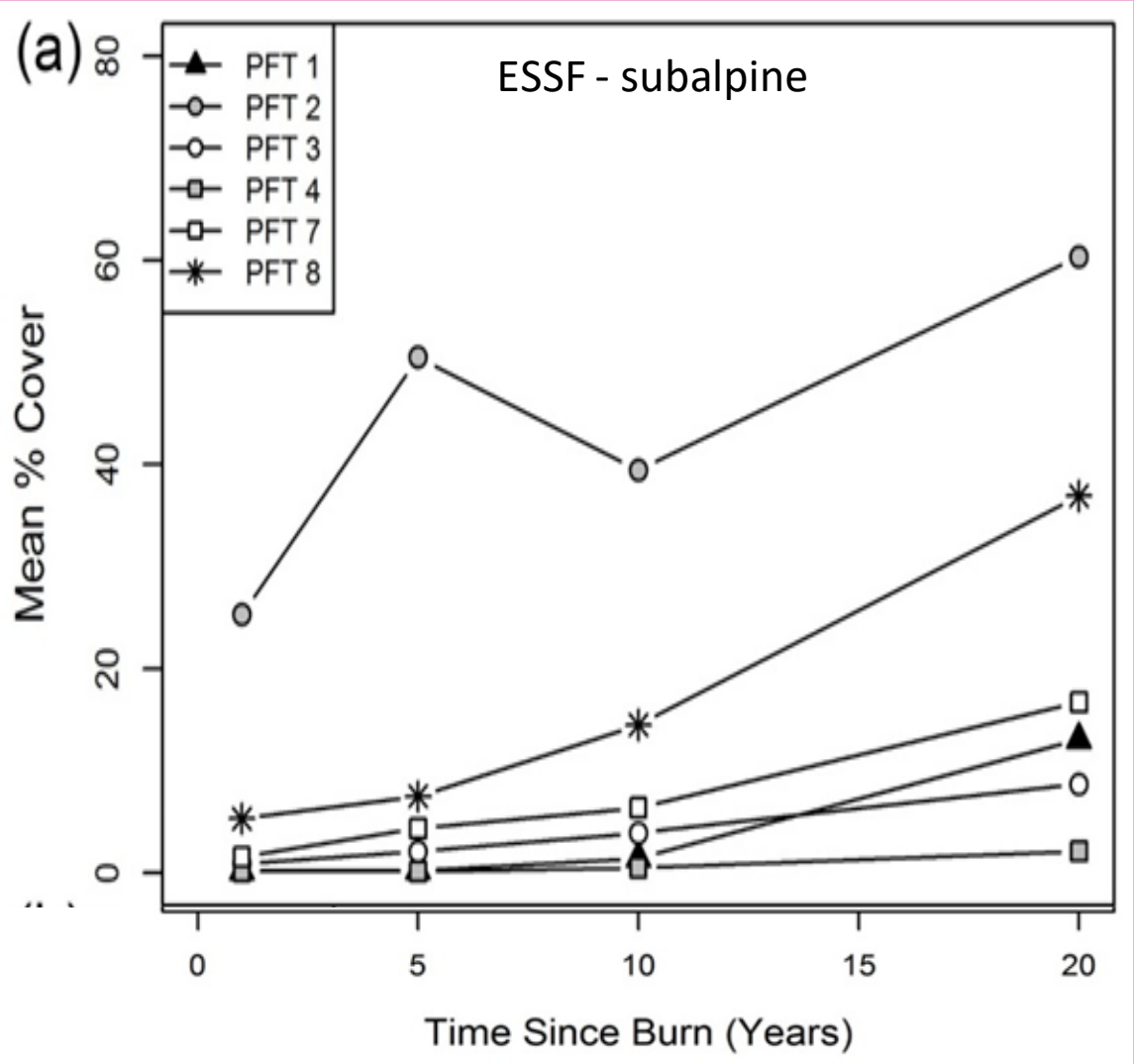
Vegetation 10 years after prescribed burning



ESSF zone – subalpine

SBS – sub boreal

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains



semi-shade tolerant gap species

ericaceous species

shade tolerant herbs

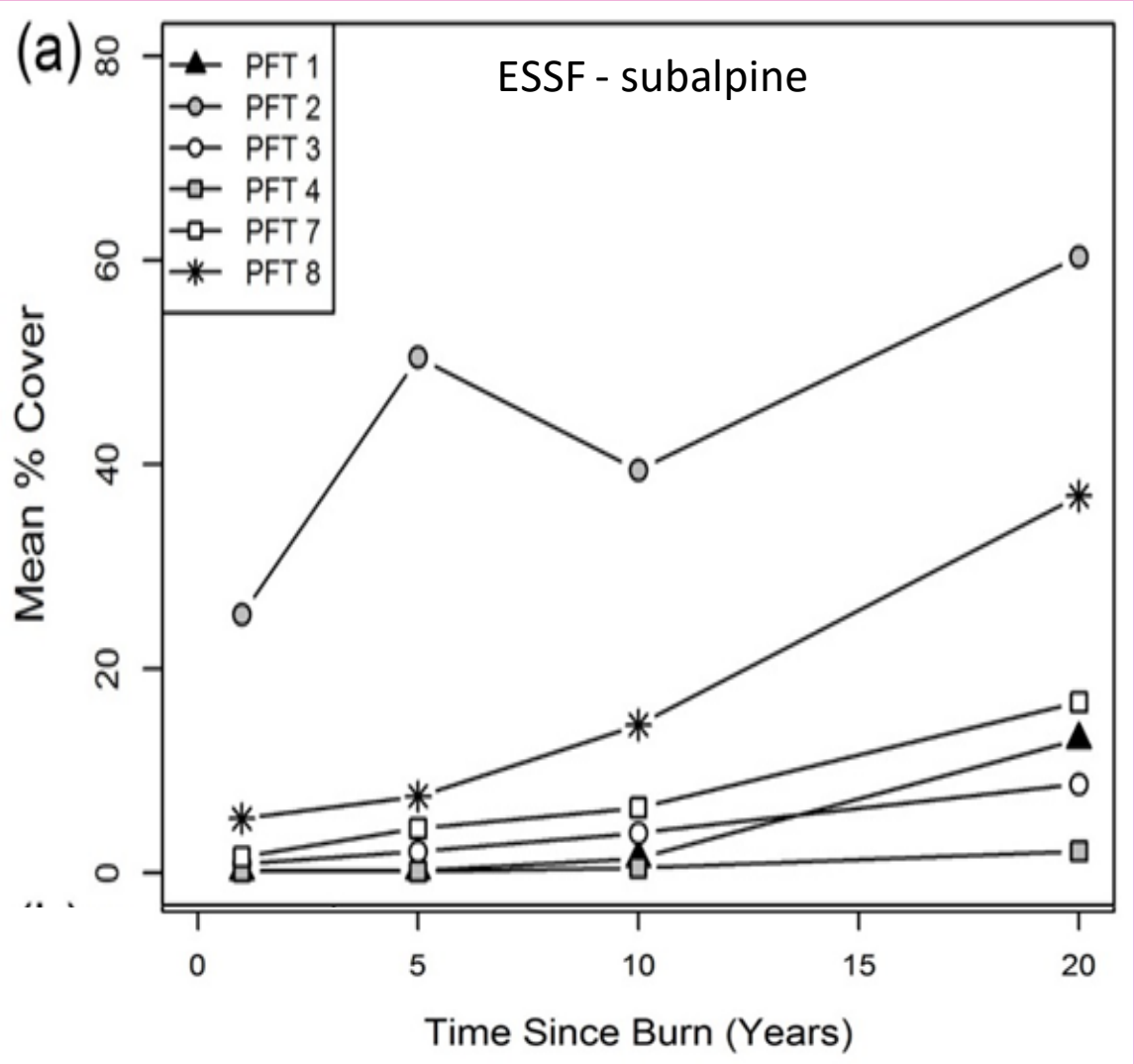
conifers

shade intolerant gap species

deciduous trees and tall shrubs

Change in cover of plant functional types (PFT) in burned sites (ESSF)

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains



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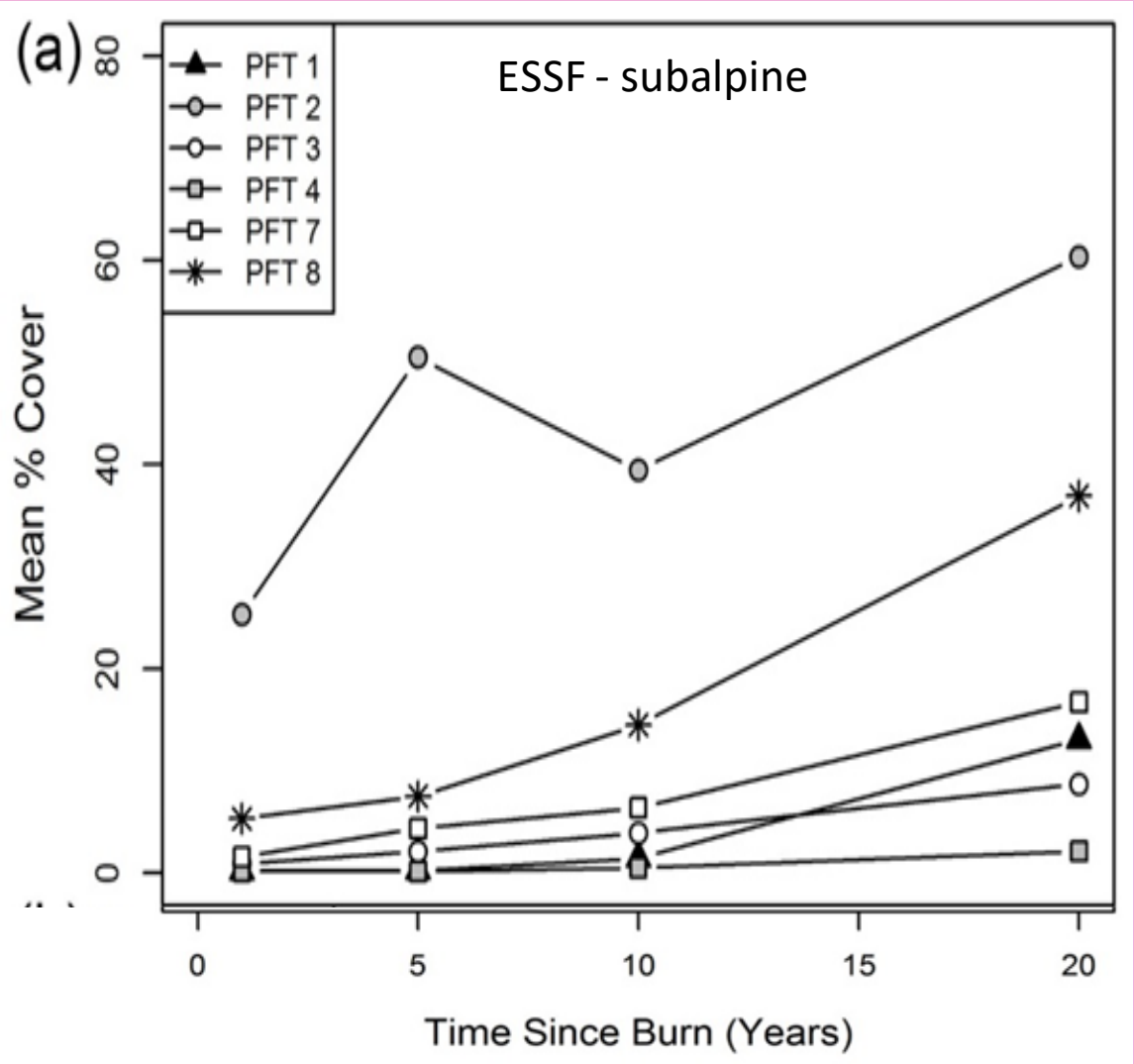
BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains

semi-shade tolerant gap (e.g. *Petasites frigidus* - coltsfoot)

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains



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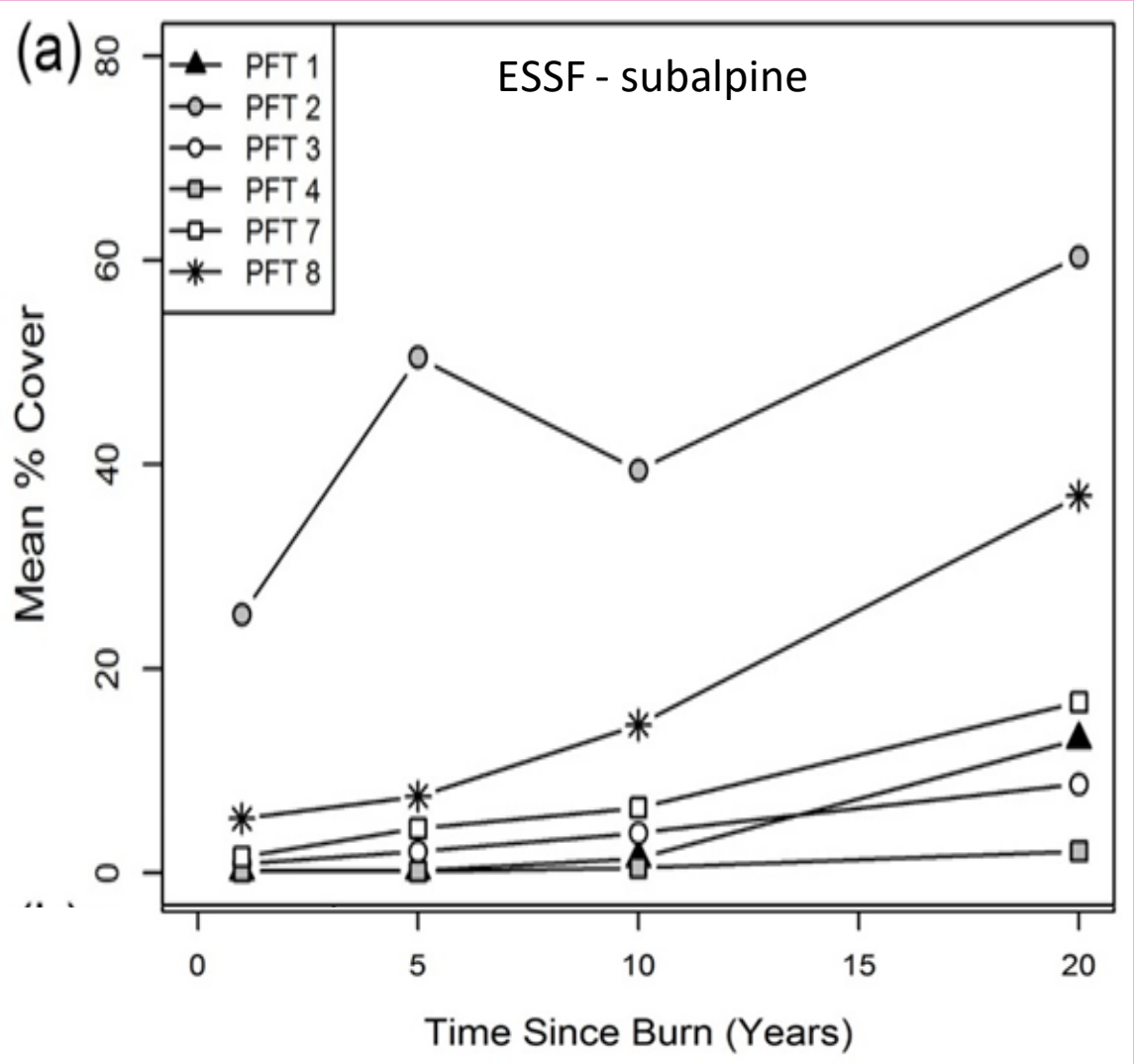
deciduous trees and tall shrubs

Change in cover of plant functional types (PFT) post-burn in burned sites (ESSF)

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains

ericaceous species (e.g. Rhodendron albiflorum –white flowered rhododendron

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains



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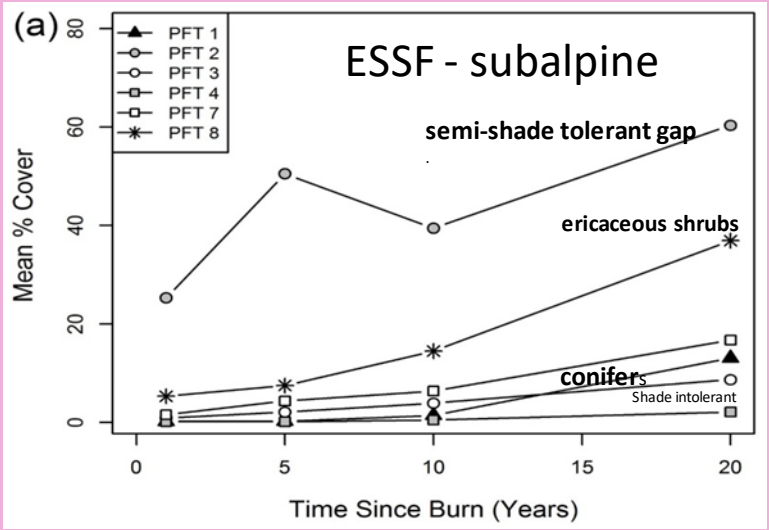
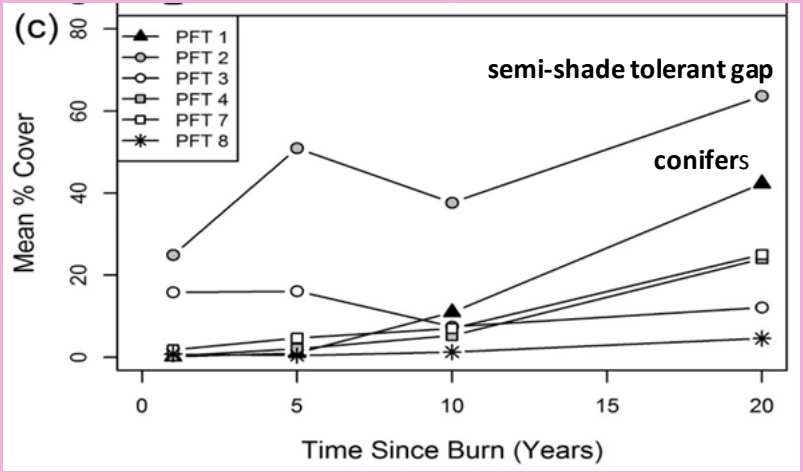
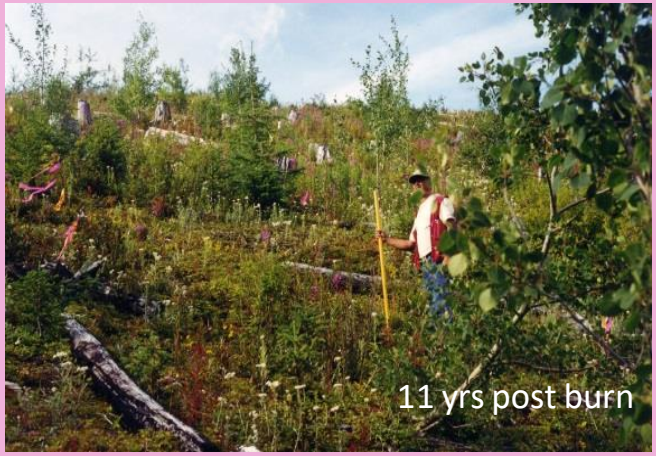


SBS sub-boreal



BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains

Vegetation 10 years after prescribed burning

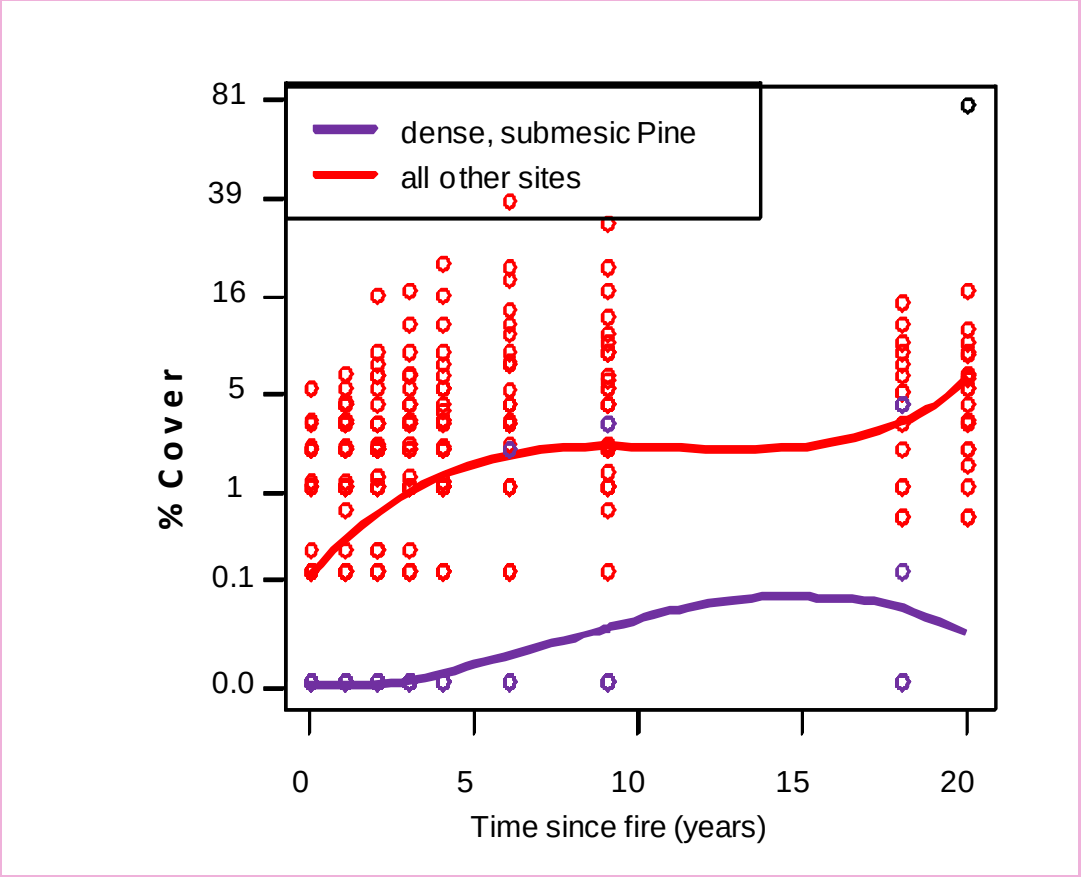


ESSF – subalpine
Slower grow of conifer, more open sites

SBS – sub boreal
Faster conifer growth, more closed stands

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains

Cover of moose browse species in drier SBS after wildfire



Moose browse (i.e. deciduous trees, shrubs) cover increased slowly after burning, persisting for at least 20 years.

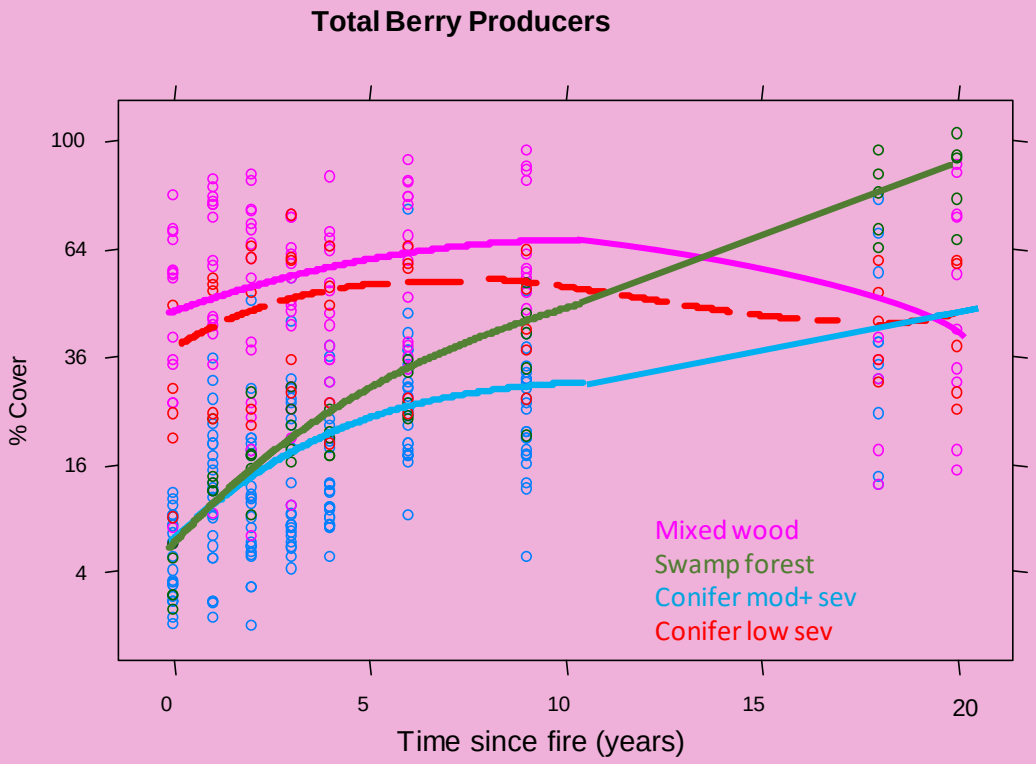
Very little in dense pine sites.

Conifer abundance has negative impact on browse abundance.

This part of the Swiss Fire was not replanted, only natural regeneration

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains

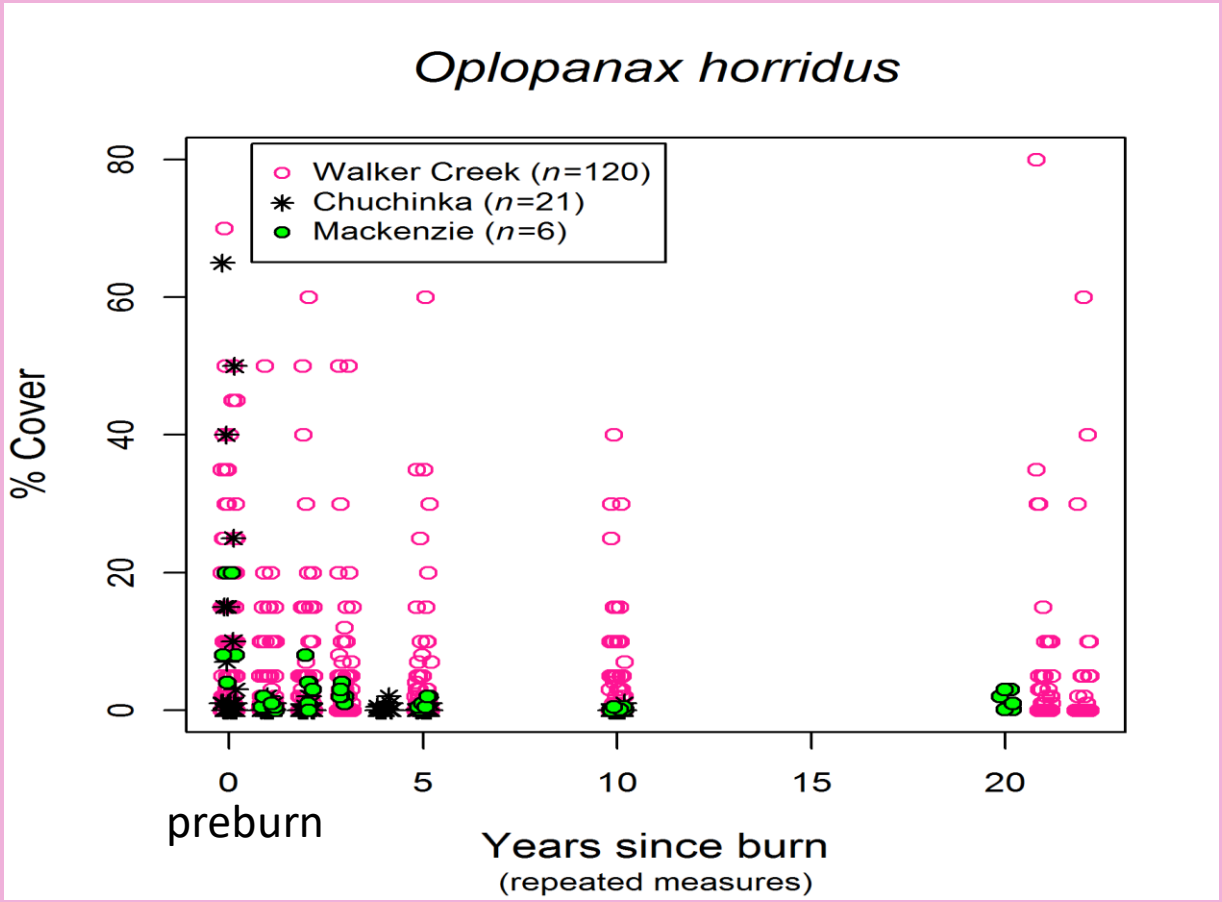
Cover of berry producing plants after fire

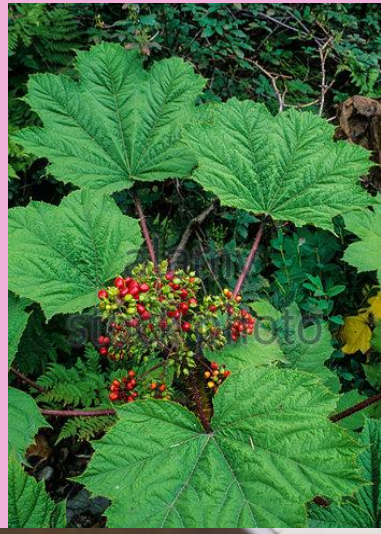


Berry producing shrub cover increased after burning in all ecosystem for at least 10 years

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains

Cover of *Oplopanax horridus* (Devil's club) after burning





Typically occurs on moist rich sites.
Resprouted and increased in cover very slowly over time.
Did not achieve pre-burn cover after 20 years.

Roots used as a medicine by some aboriginal people

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains - Summary

- Successful regeneration of planted trees after burns
- Semi-shade tolerant and ericaceous shrubs prominent in ESSF zone by year 20
- Significant cover of berry producing plants by yr 20
- Moose browse species increased after fire for 20 yrs
- Some species like devil's club are sensitive to fire

- *Conclusion:* These ecosystems have been fairly resilient to prescribed burning in the past.

Broad Community Landscape Types

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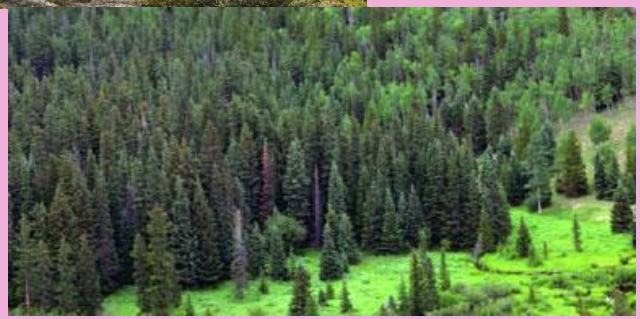
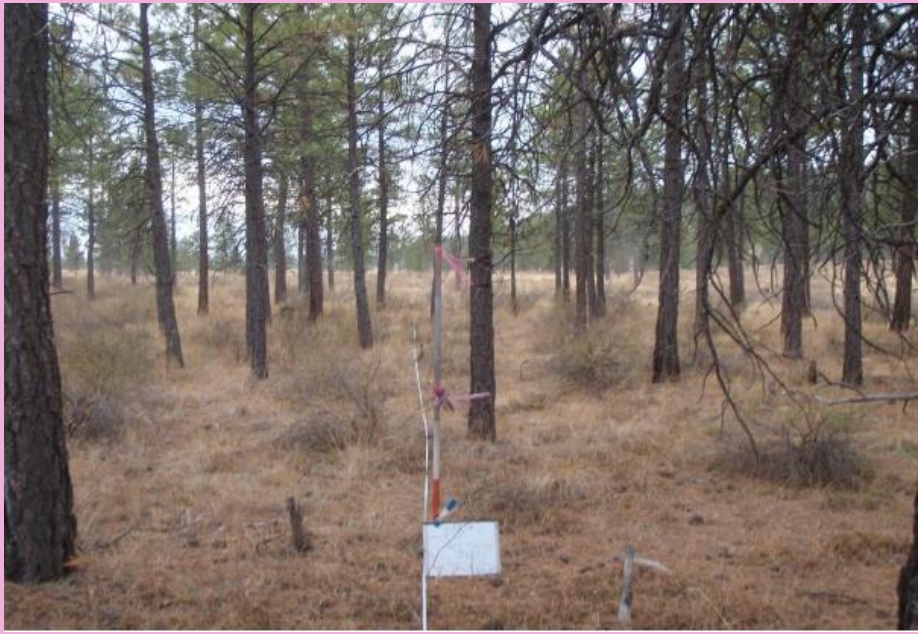


BCLT 1 - Mesic and Wetter Spruce, Subalpine Fir (Hemlock) in Mountains - infrequent high severity wildfires

BCLT 4 - Dry Ponderosa pine Douglas-fir Southern Interior restoration burns

IFD5 1997 – prior to burning

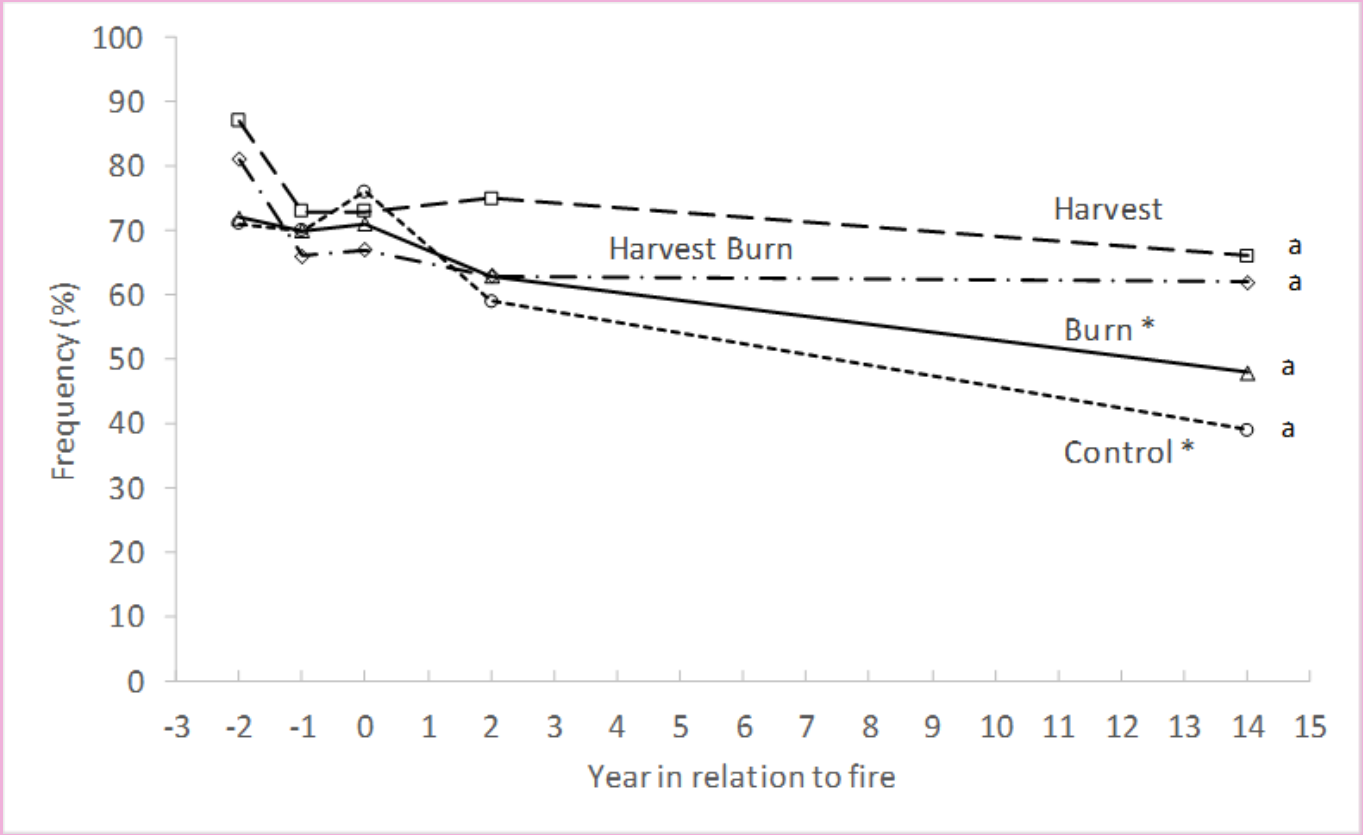
IFD5 2017 – after thinning to 700 sph and burning



From Ross et al. 2018

BCLT 4 - Dry Ponderosa pine Douglas-fir Southern Interior

Frequency of late seral bunchgrasses at Miller Road site.



No significant in late seral bunchgrasses difference due to treatment ($p<.05$) at year 14

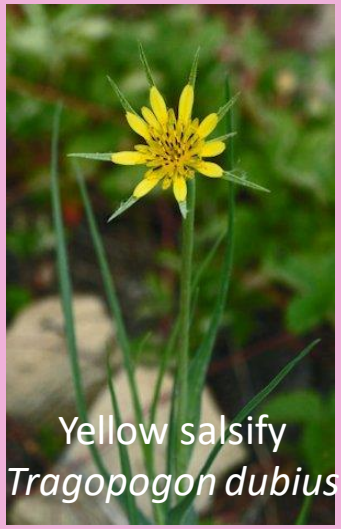
BCLT 4 - Dry Ponderosa pine Douglas-fir
Southern Interior - restoration burns

Responses of some non-native plant species over time on 21 restoration burns

Non-native species	Category	Common Response
common dandelion	nuisance	Increased
black medic	nuisance	Incr/decr
yellow salsify	tracked	Increased
Canada bluegrass	agronomic	variable
cheatgrass	tracked	variable
field filago	nuisance	variable
Kentucky bluegrass	agronomic	Lost
perennial sow-thistle	tracked	Decreased
Canada thistle	FRPA listed	Incr/decr
quackgrass	agronomic	variable
red clover	agronomic	variable
bull thistle	FRPA listed	Incr/decr
common St. John's-wort	FRPA listed	Increased
white sweet-clover	agronomic	Lost
sulphur cinquefoil	FRPA listed	Increased
alsike clover	agronomic	Lost

Increasers


Sulphur cinquefoil
Potentilla recta


Yellow salsify
Tragopogon dubius

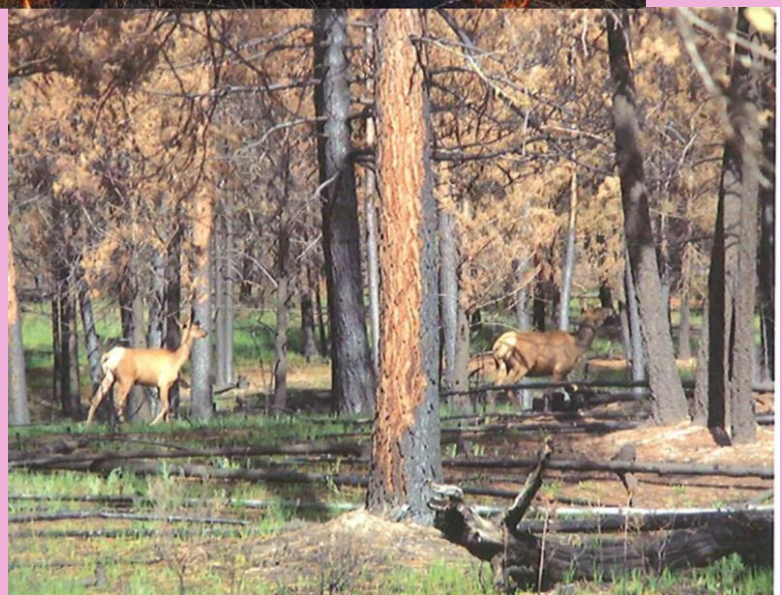
Decreasers


White sweet-clover
Melilotius albus


Kentucky blue-grass
Poa pratensis

Some non-native species increased in frequency – most were not serious concerns. Others decreased, varied or disappeared.

BCLT 4 - Dry Ponderosa pine Douglas-fir Southern Interior – Summary



- Fire opened stands, reduced tree regeneration layer
- Limited mineral soil exposure
- Limited non-native (weedy) species, some concerns
- Late seral bunchgrasses recovery was very slow, more successful in the moister zones.
- Grazing by livestock and wild ungulates likely interfering with restoration

Conclusions

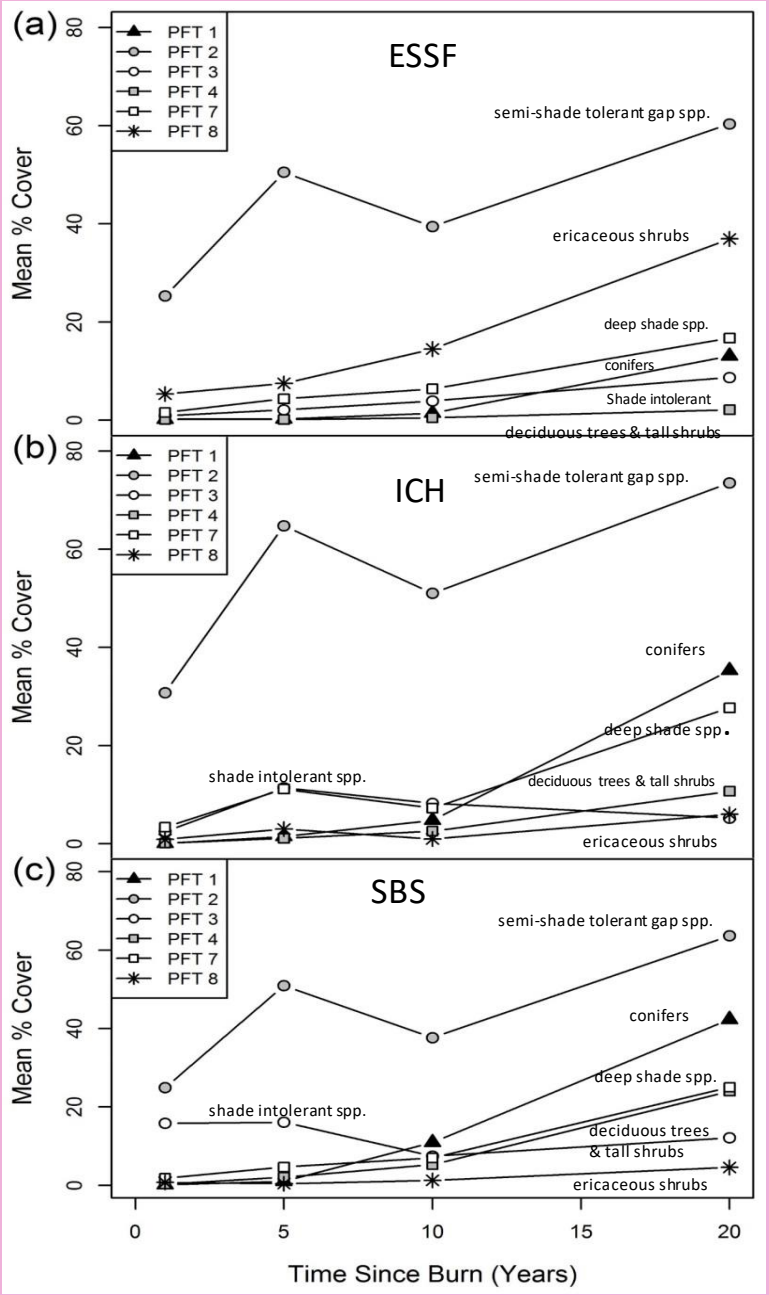
- Most BC ecosystems are adapted to and fairly resilient to fire.
- Burning can lead to development of desired plant species (e.g. conifers moose browse, berry producers)
- Responses varied by ecosystem type.

For more information, contact Evelyn Hamilton at ehhamilton16@gmail.com (p) CC 01 (250 514 4887)

Reports and talks at www.db2020.net

Thanks to

- Forest Enhancement Society of BC (FESBC)
- BC Ministry of Forests Lands, Natural Resource Operations & Rural Development (MFLRNORD)
- Numerous people who provided data, questions, and insight.



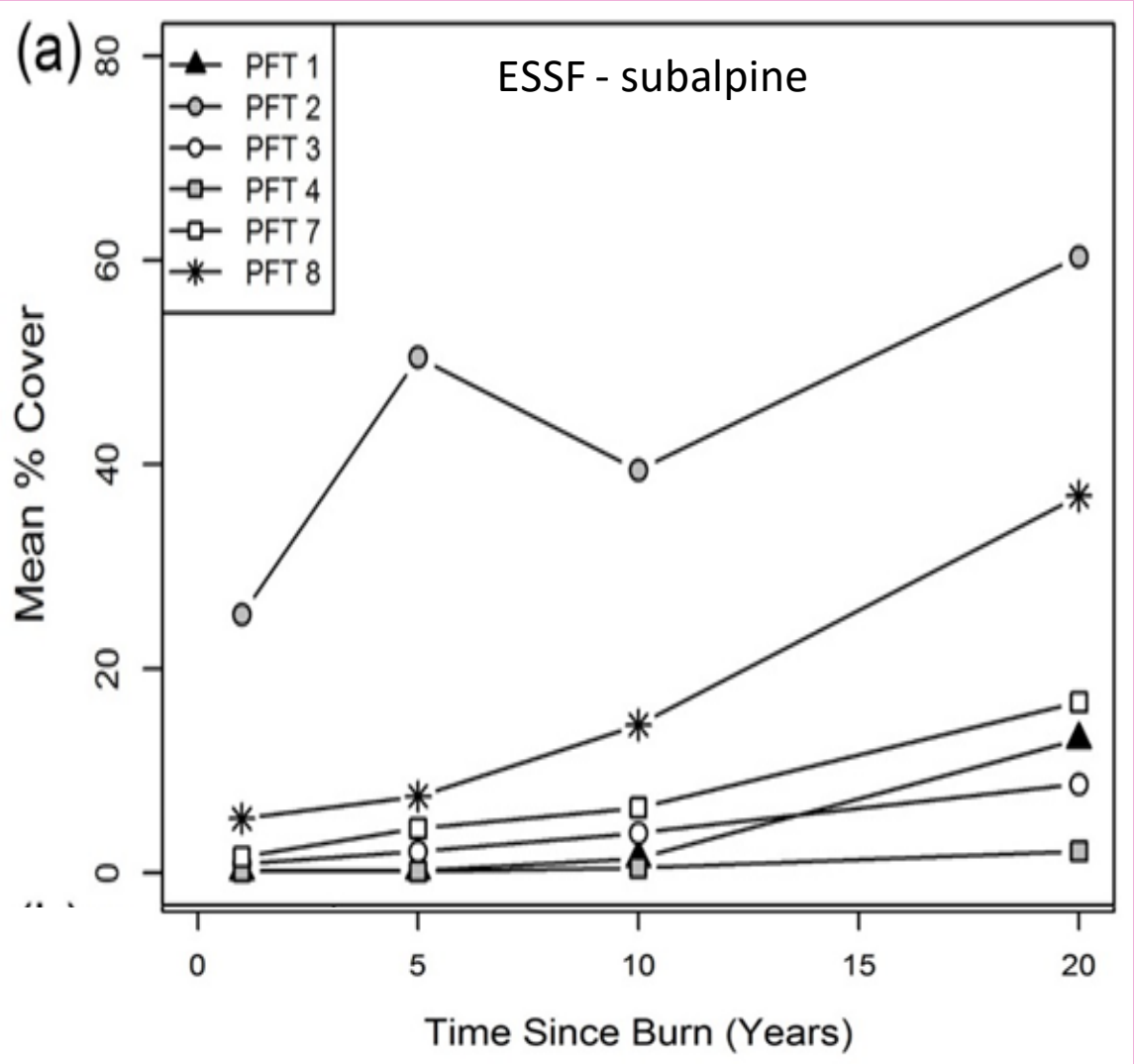
BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains

Change in cover of lifeforms over 20 years in broadcast burned sites in ESSF, ICH, & SBS zones

- Cover of plants associated with mature forests increased forming >40% of cover by year 20
- Faster recovery & conifer growth in lower elevation sub-boreal (SBS) vs. subalpine (ESSF)
- Greater, more persistent deciduous tree & tall shrub cover in SBS vs. ESSF
- Ericaceous shrubs prominent in ESSF by yr. 20
- Few invasive weeds

Conclusions: These ecosystems are fairly resilient to burning

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains



semi-shade tolerant gap species

ericaceous species

shade tolerant herbs

conifers

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deciduous trees and tall shrubs

Change in cover of plant functional types (PFT) post-burn in burned sites (ESSF)

Results – Summary

	BCLT 4. Dry very fire-prone Ponderosa Pine, Douglas-fir in Southern interior	BLCT 1. Infrequently burned – Moist Spruce, Fir, Cedar, Hemlock in Mountains
1. General - What are the general ecological effects of fire on ecosystems?	• Ecosystems are resilient to restoration burns • Fire opened stands, reduced tree regeneration • Limited mineral soil exposure & non-native species • Slow return to reference condition. • Late seral bunchgrass regrowth was slow if it occurred	• Most ecosystems are fairly resilient to broadcast burning • Cover of mature forest species returning to preburn levels by year 20 • More conifer & deciduous tree/shrub in SBS vs. ESSF by year 20 • Ericaceous shrubs prominent in ESSF by year 20 • Moose browse species increase after fire for 20 yrs, more abundant where conifer density is lower • Berry producing plants increase post fire for 20 years, more abundant on wetter sites and low fire severity sites • Species like devil's club are sensitive to

Results

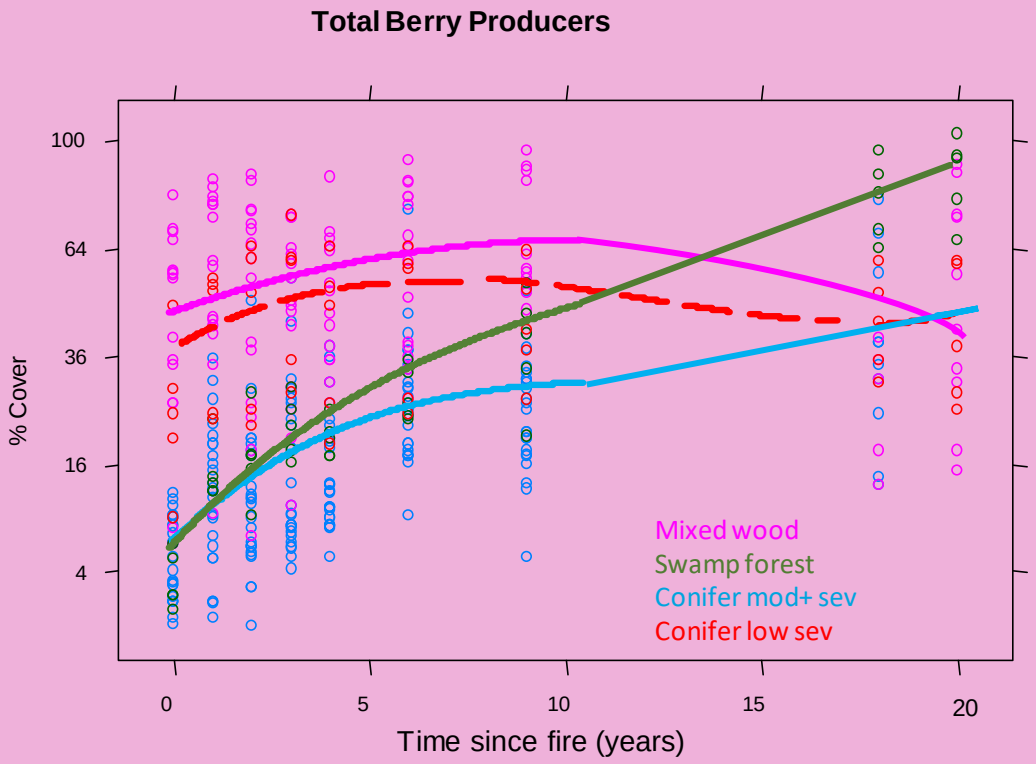
1. Broad Community Landscape Types (BCLT)
2. BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains
3. BLCT 2 - Dry Lodgepole Pine Spruce on Plateau
4. BCLT 3 - Aspen Mixedwood and Aspen-Grassland
5. BCLT 4 - Dry Ponderosa pine Douglas-fir Southern Interior

Lessons learned – Monitoring

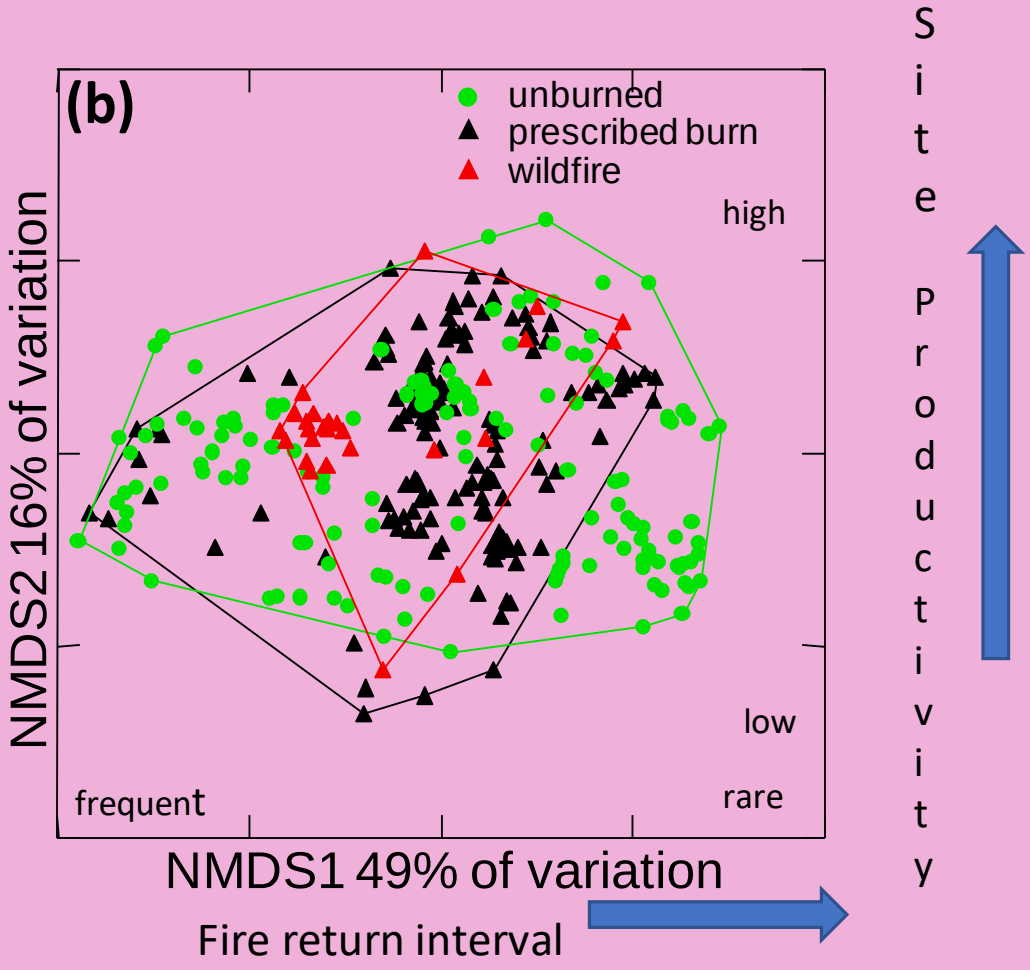
- Importance of well-designed long-term monitoring with controls (including exclosures), pre- and post-treatment, multi-year sampling.
- Value of long-term fundamental monitoring data to meet new needs – not previously identified
- Need for dedicated programs and staff to collect, QA, archive and extend information to users.
- Role of end-users of data

BCLT 1 - Moist Spruce, Subalpine Fir, Hemlock in Mountains

Cover of berry producing plants after fire

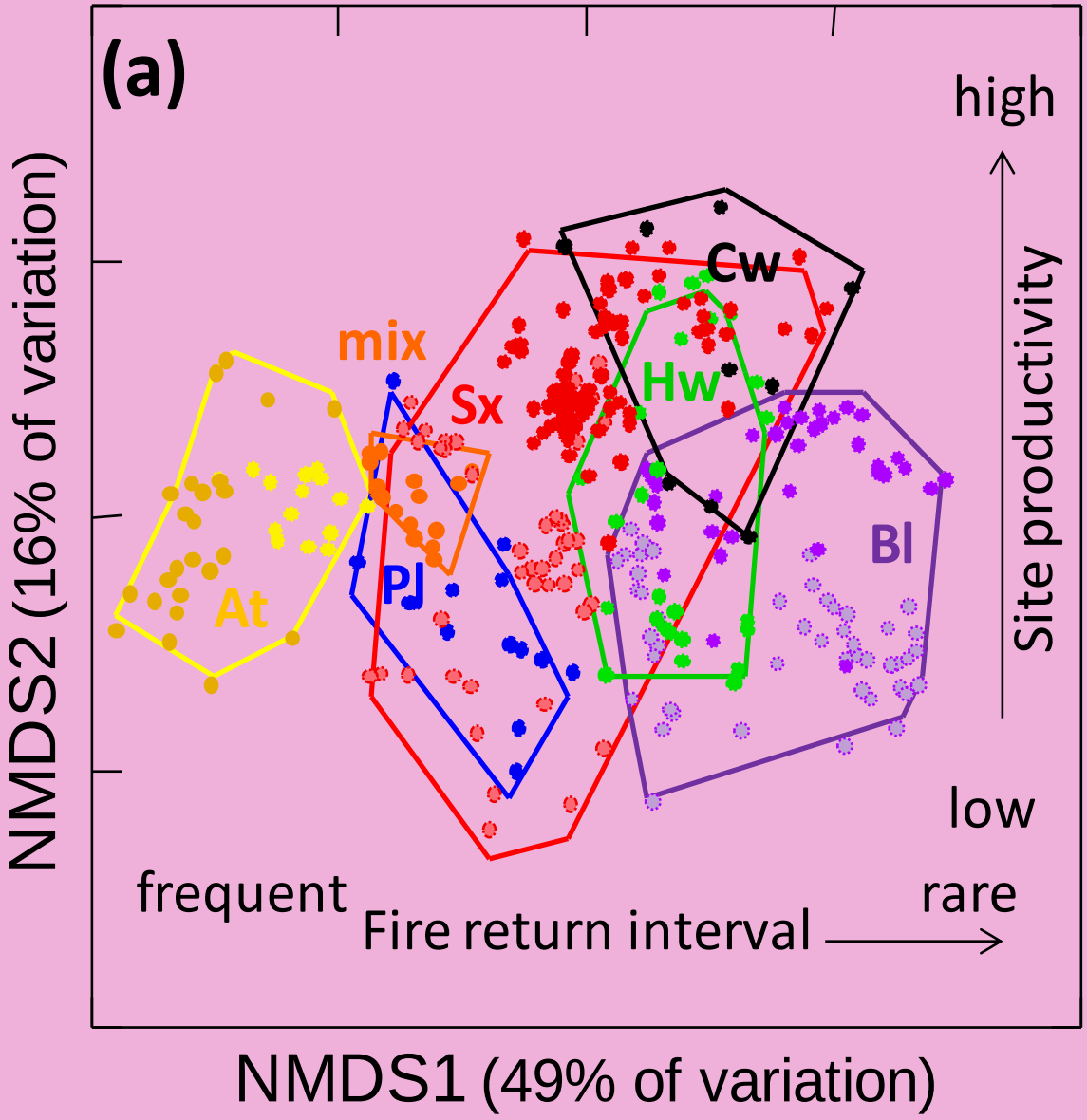


Non-metric multidimensional scaling (NMDS) ordination of plot data



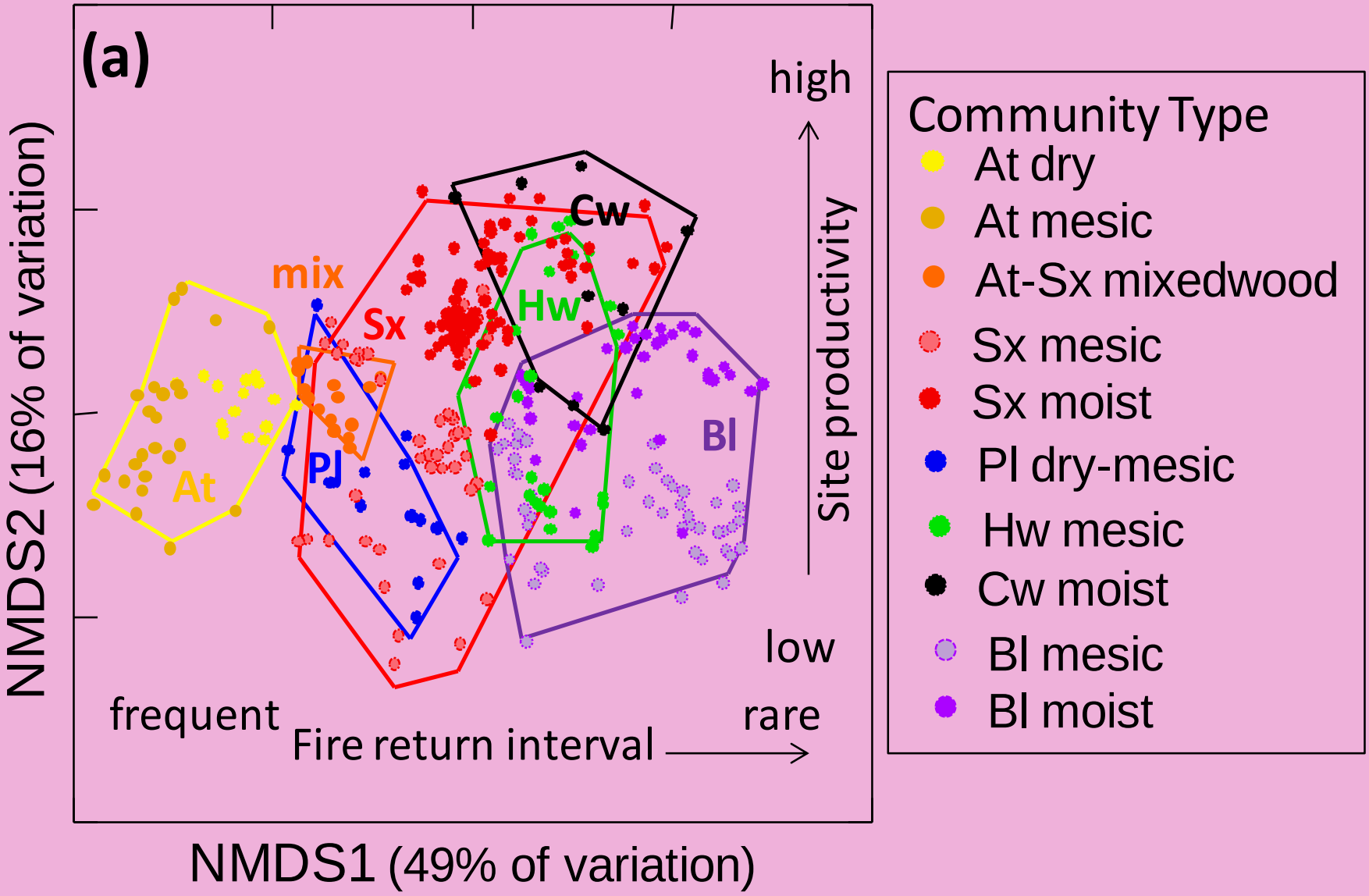
Ordination across gradients of fire history (Axis 1) and site productivity (Axis 2). 49 sites. Stress = .137

Broad Plant Community Types - N & C BC

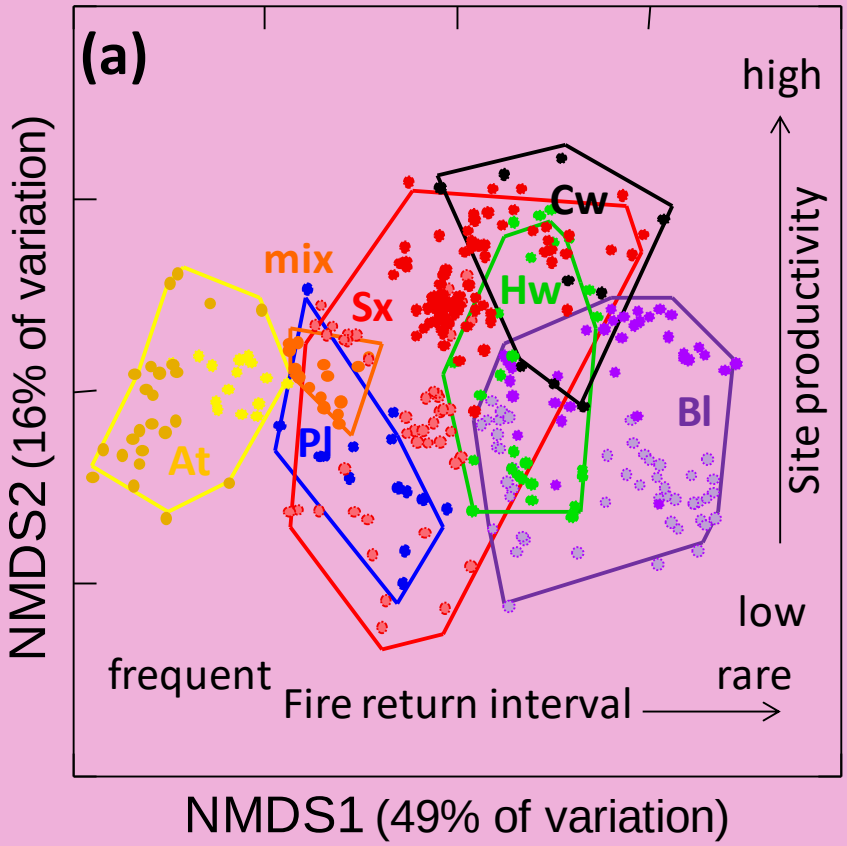


Ordination of central and northern plant communities across gradients of fire history (NMDS Axis 1) and site productivity (NMDS Axis 2).

Broad Community Types -N & C BC

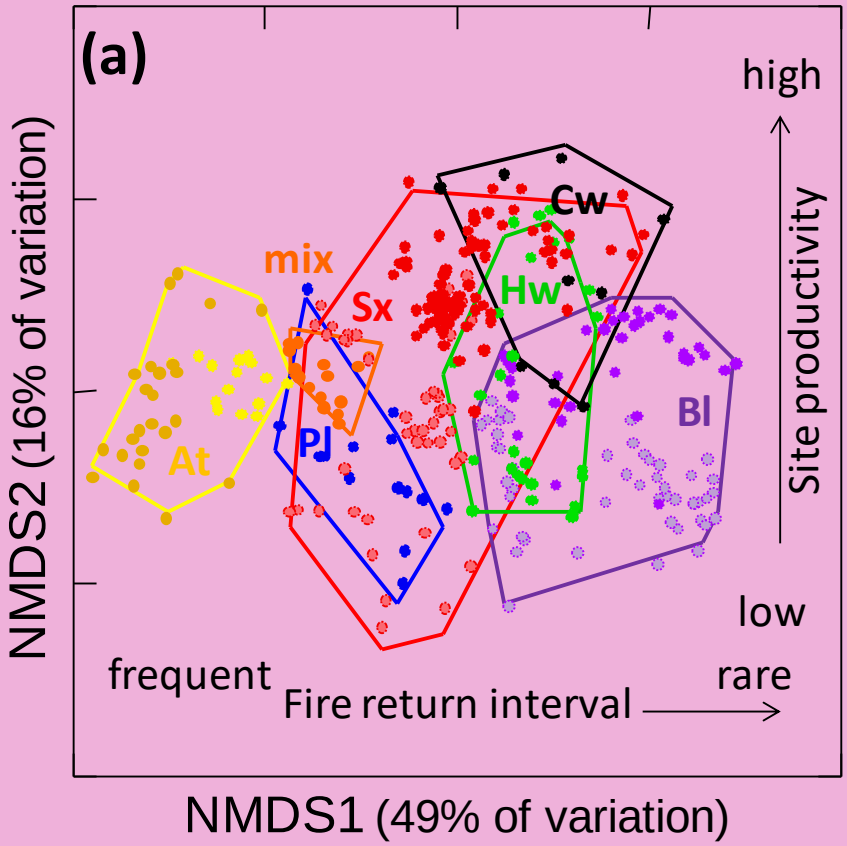


Broad Community Landscape Types – N & C BC



Community Type	
At dry	BCLT 3 - Aspen Mixedwood and Aspen-Grassland in (Sub)Boreal
At mesic	
At-Sx mixedwood	
Sx mesic	BCLT 2- Dry Lodgepole Pine Spruce on Plateau
Sx moist	
Pl dry-mesic	
Hw mesic	BCLT 1 - Moist Spruce, Subalpine Fir (Hemlock) in Mountains
Cw moist	
Bl mesic	
Bl moist	

Broad Community Landscape Types – N & C BC



Community Type
- At dry
- At mesic
- At-Sx mixedwood
- Sx mesic
- Sx moist
- Pl dry-mesic
- Hw mesic
- Cw moist
- Bl mesic
- Bl moist

BCLT 3 - Aspen Mixedwood and Aspen-Grassland in (Sub)Boreal

BCLT 2- Dry Lodgepole Pine Spruce on Plateau

BCLT 1 - Moist Spruce, Subalpine Fir, (Hemlock) in Mountains

ESSF – subalpine
SBS – sub-boreal
ICH – wet interior

Next Steps

- Develop collaborations
- Further analysis to answer key questions
- Carbon – Provide data to support carbon models (e.g. residue levels, consumption, biomass, regrowth)
- Fire and landscape flammability – Provide data for fuel load analysis
- Linking plot data to landscape level through satellite imagery