ABoVE SCIENCE TEAM MEETING
ASTM 8 | May 9-13, 2022
FAIRBANKS, ALASKA

Multi-Disturbance Working Group





Adrianna Foster, Amanda Armstrong, Brendan Rogers, Chris Potter, Elizabeth Campbell, Elizabeth Hoy, Howie Epstein, JJ Frost, Jon Wang, Katie Orndahl, Kevin Turner, Kimberly Miner, Laura Bourgeau-Chavez, Logan Berner, Mary Kang, Oliver Sonnentag, Scott Davidson, etc...






Disturbances are dominant driver of ecosystem dynamics ABoVE region

Many predicted to intensify with climate change

Kwethluk Fire – April 2022 tundra fire in Alaska
>10,000 acres

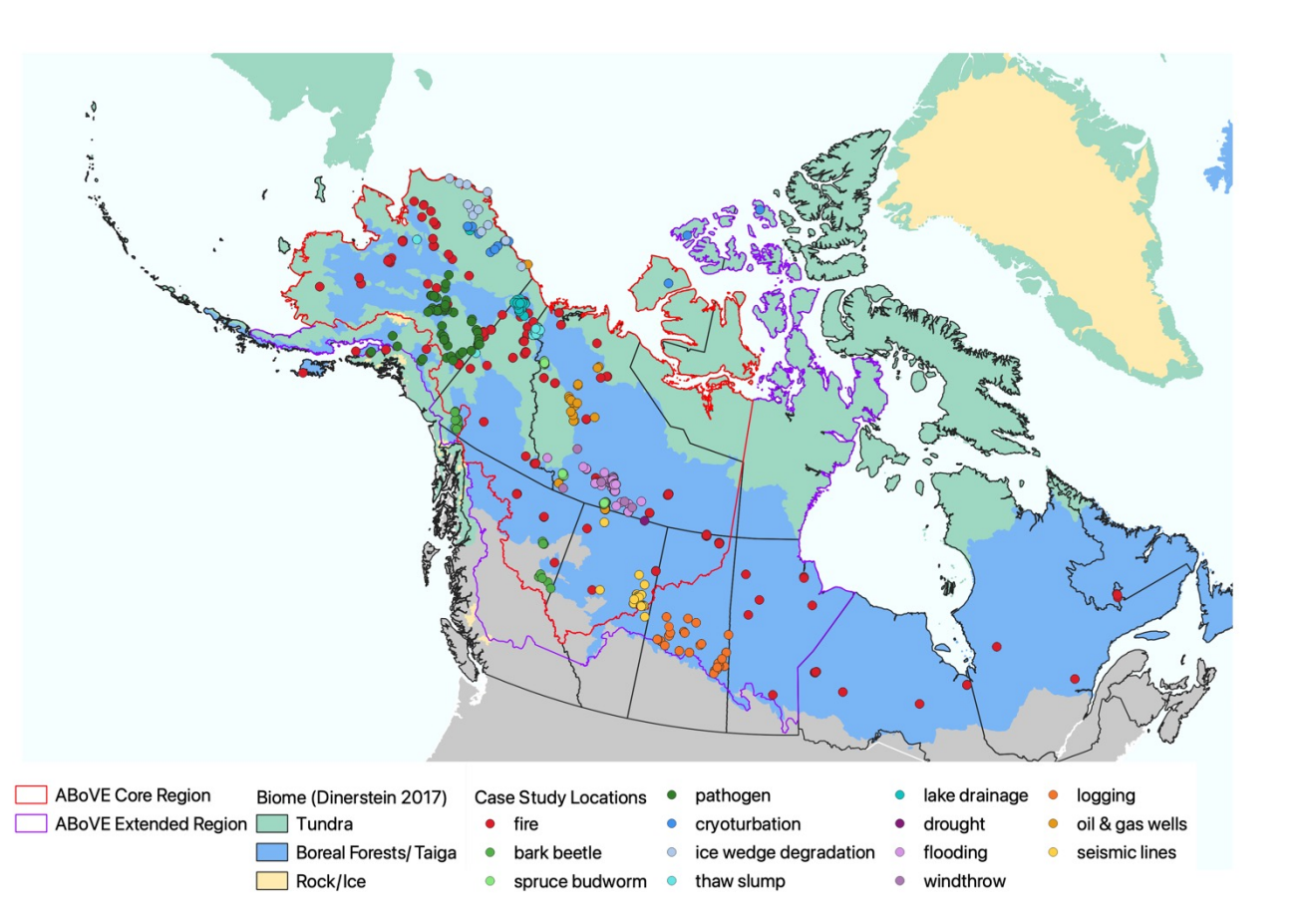
Photo by Matt Snyder/Alaska Division of Forestry

Objectives

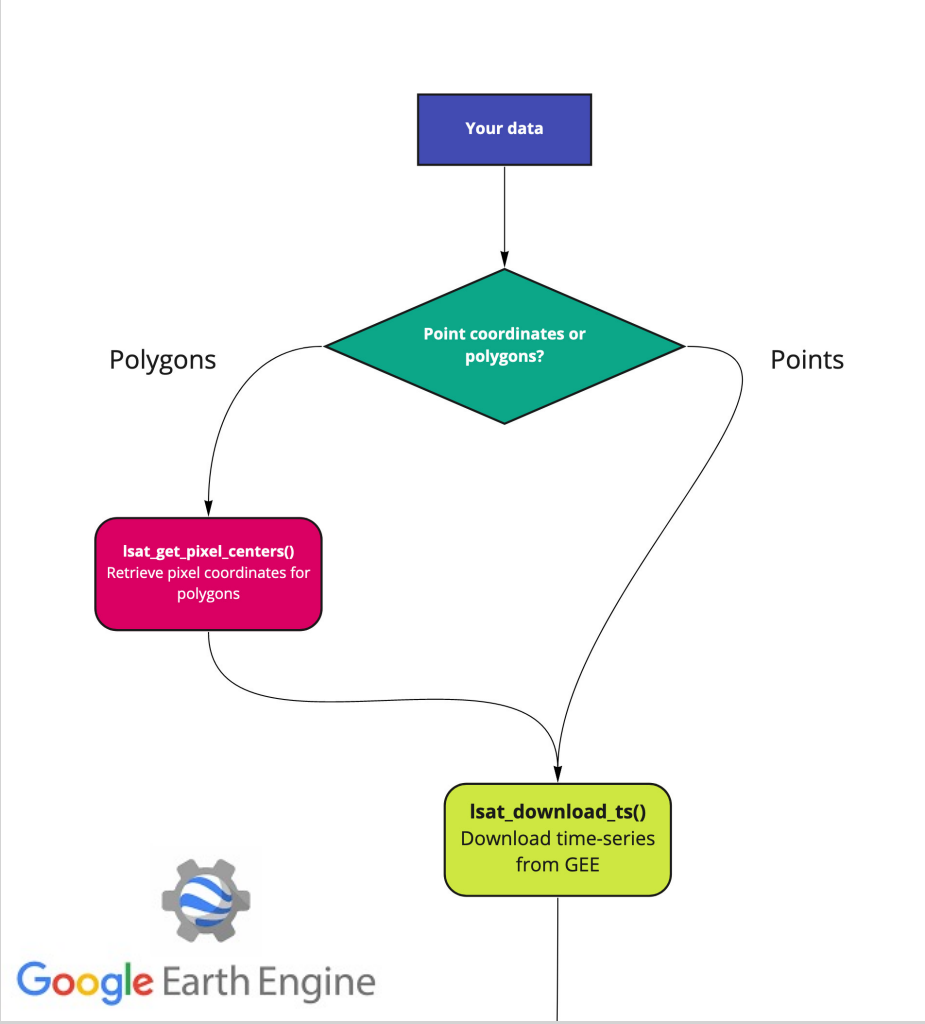
- Synthesis of main disturbances within the North American Arctic and boreal regions
  - Summary of each disturbance
  - Temporal dynamics of vegetation loss and recovery
  - Future needs (e.g. data, studies, tools)
  - Case studies showcasing vegetation trajectories pre- and post-disturbance
- Disturbance interactions
- Spatial and temporal characteristics

Group	Disturbance
Fire	Fire
Biotic	Needleleaf defoliators
	Broadleaf defoliators
	Bark beetles
	Pathogens
Permafrost	Cryoturbation
	Ice-wedge degradation
	Cryogenic landslides
	Lake drainage
Anthropogenic	Logging
	Seismic lines
	Oil & gas wells
Weather	Rain on snow
	Heat waves/drought
	Windthrow
Riverine processes	Riverine processes
Herbivore activity	Herbivore activity

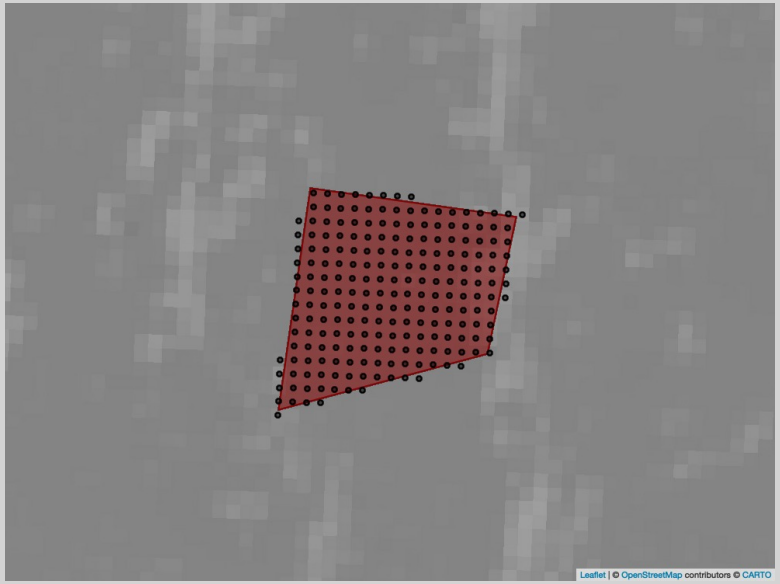
Case studies



Landsat trajectories pre- and post-disturbance



lsatTS R package: Berner et al. (2021, 2020)



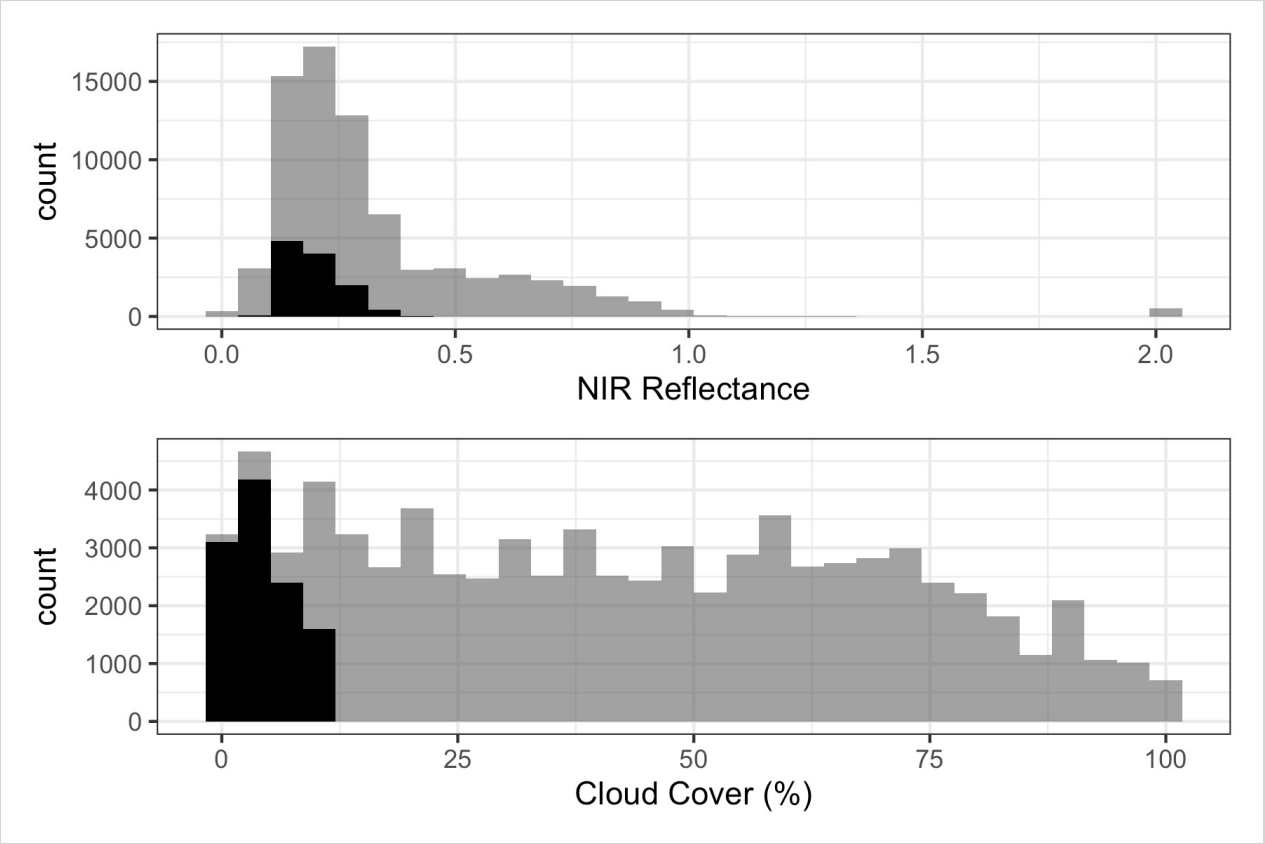
Extract Landsat 5, 7, and 8 pixels over polygons and points

- 100 m buffer around points
- 25-pixel sample of 25 sampled polygons

16,000 + pixels (30 m) from 1984 to 2020

Clean and cross-calibrate

Filter out clouds, snow, water, radiometric and geometric errors



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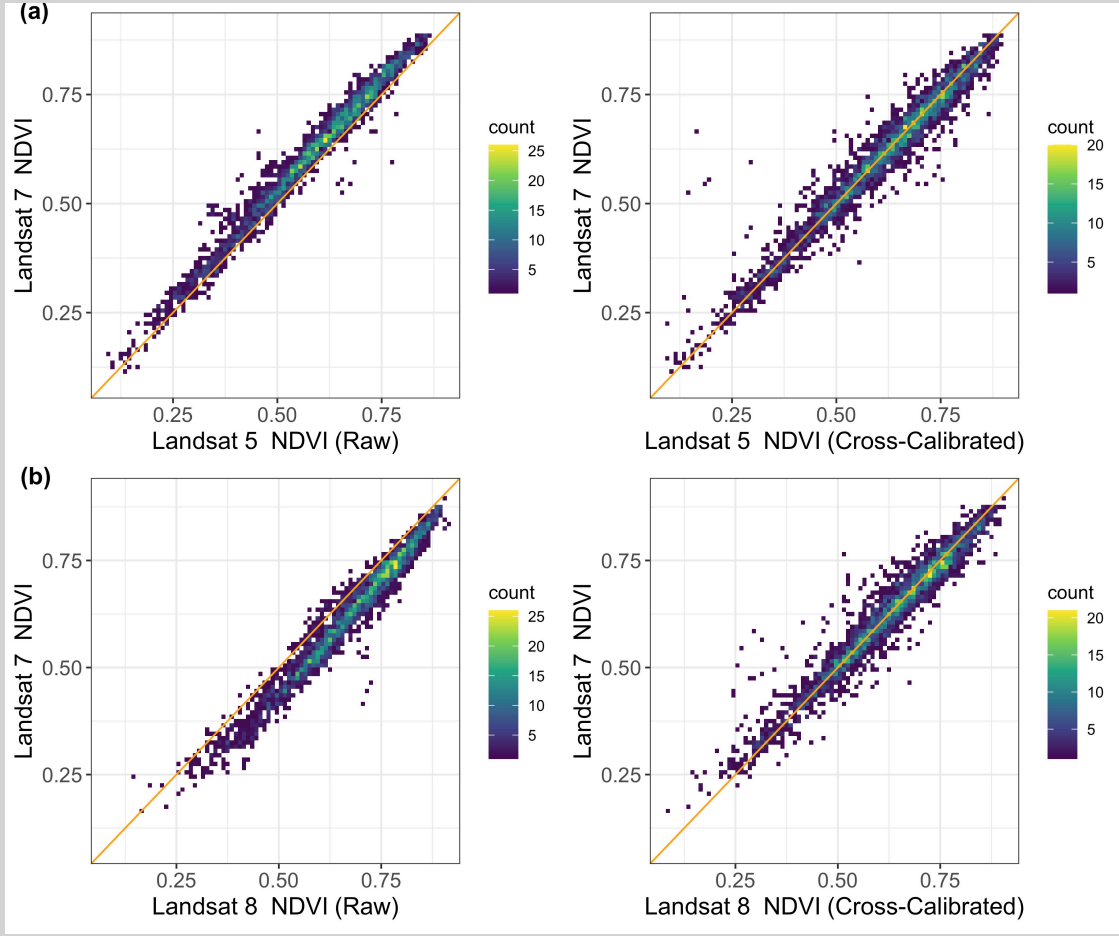
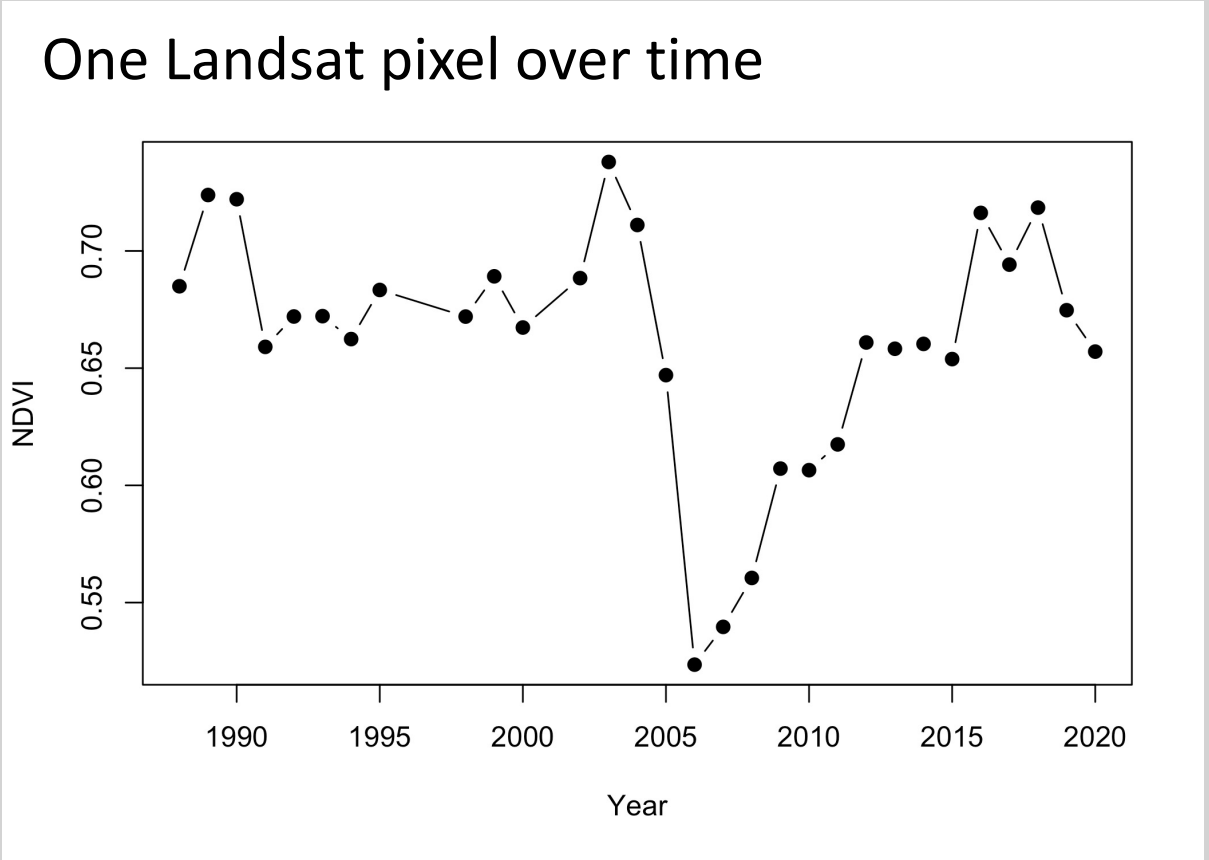


Cross-calibrate across sensors

Detect breakpoints

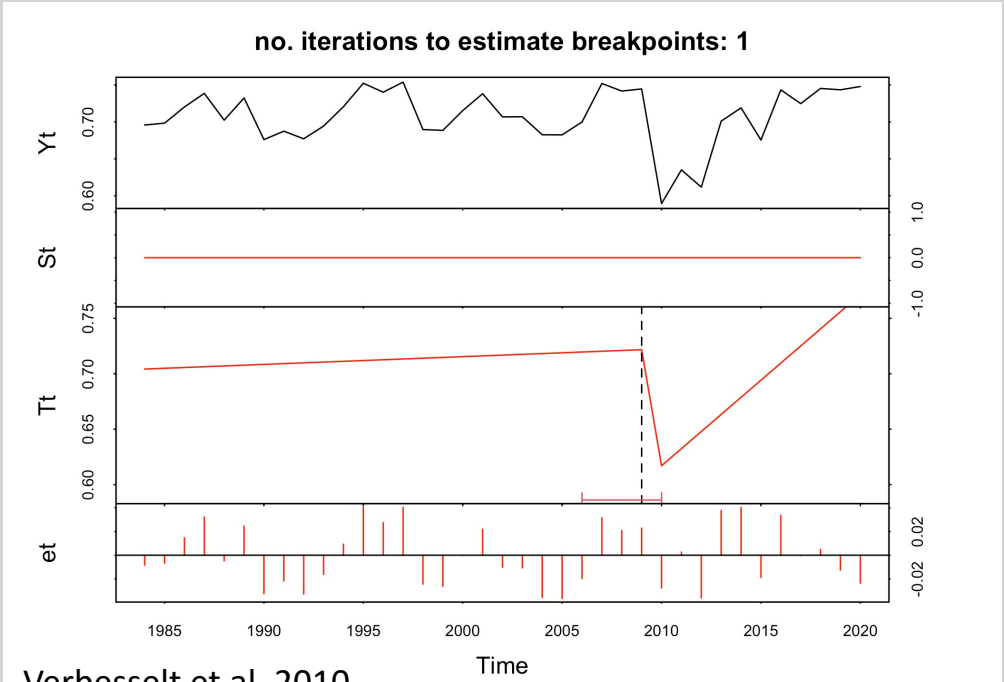
Calculate max summer NDVI and NDMI



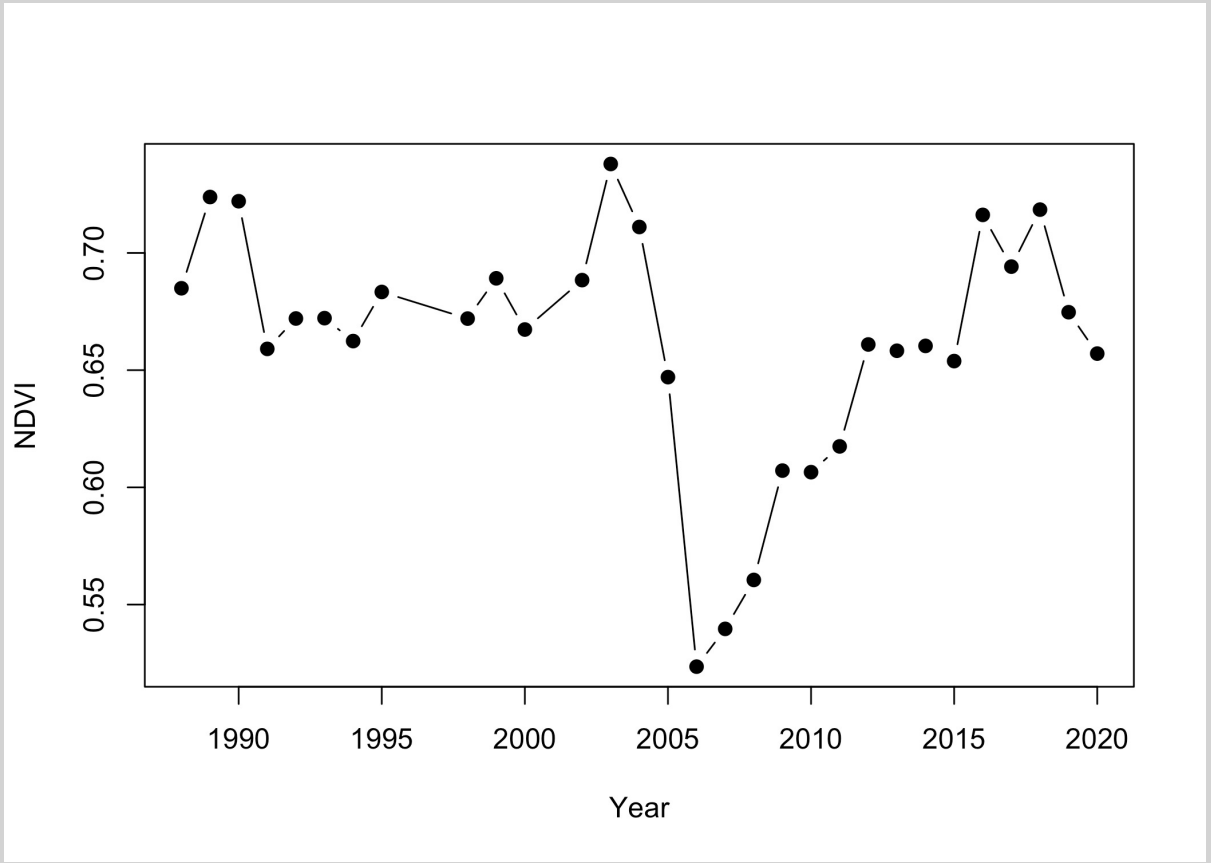
Detect breakpoints

Calculate max summer NDVI and NDMI

Bfast algorithm to detect pixels with breakpoints around the time of known disturbance



Verbesselt et al. 2010



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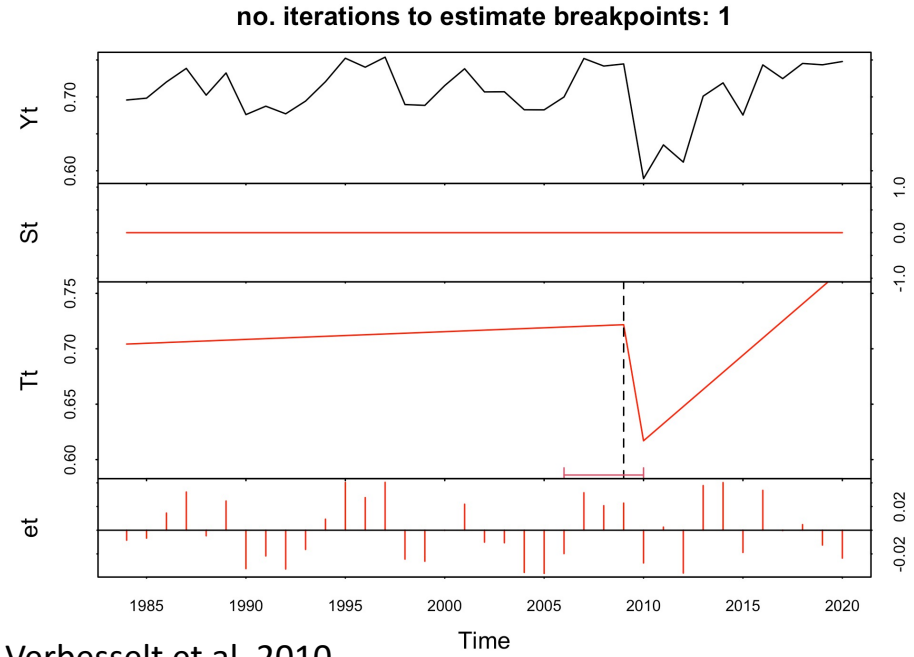

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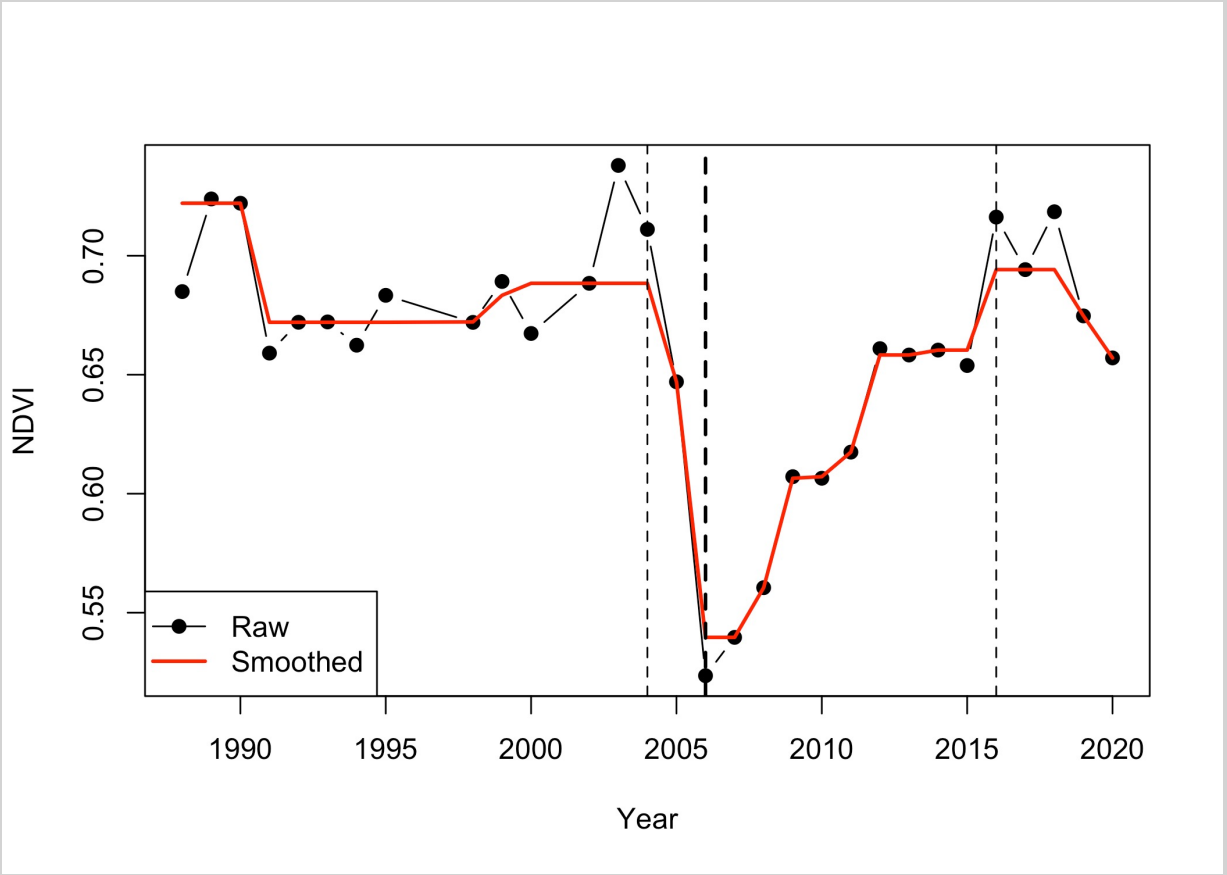

Smooth trajectory to see inflection points

Detect breakpoints

Calculate max summer NDVI and NDMI

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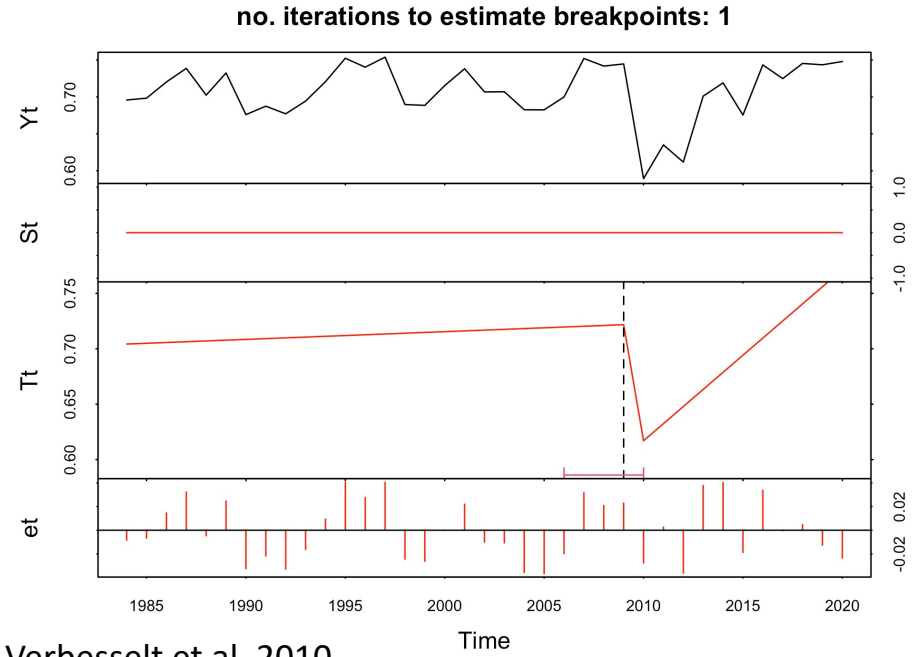

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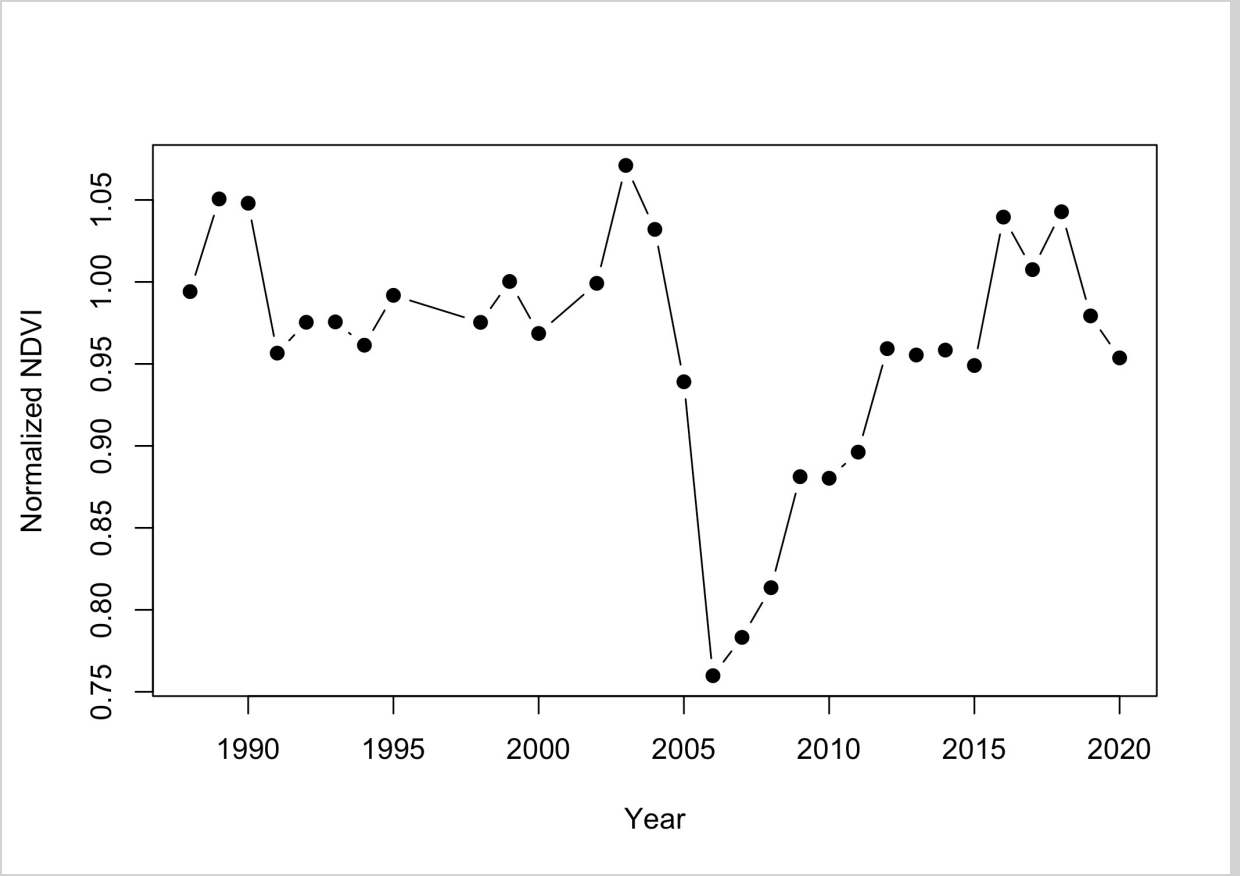
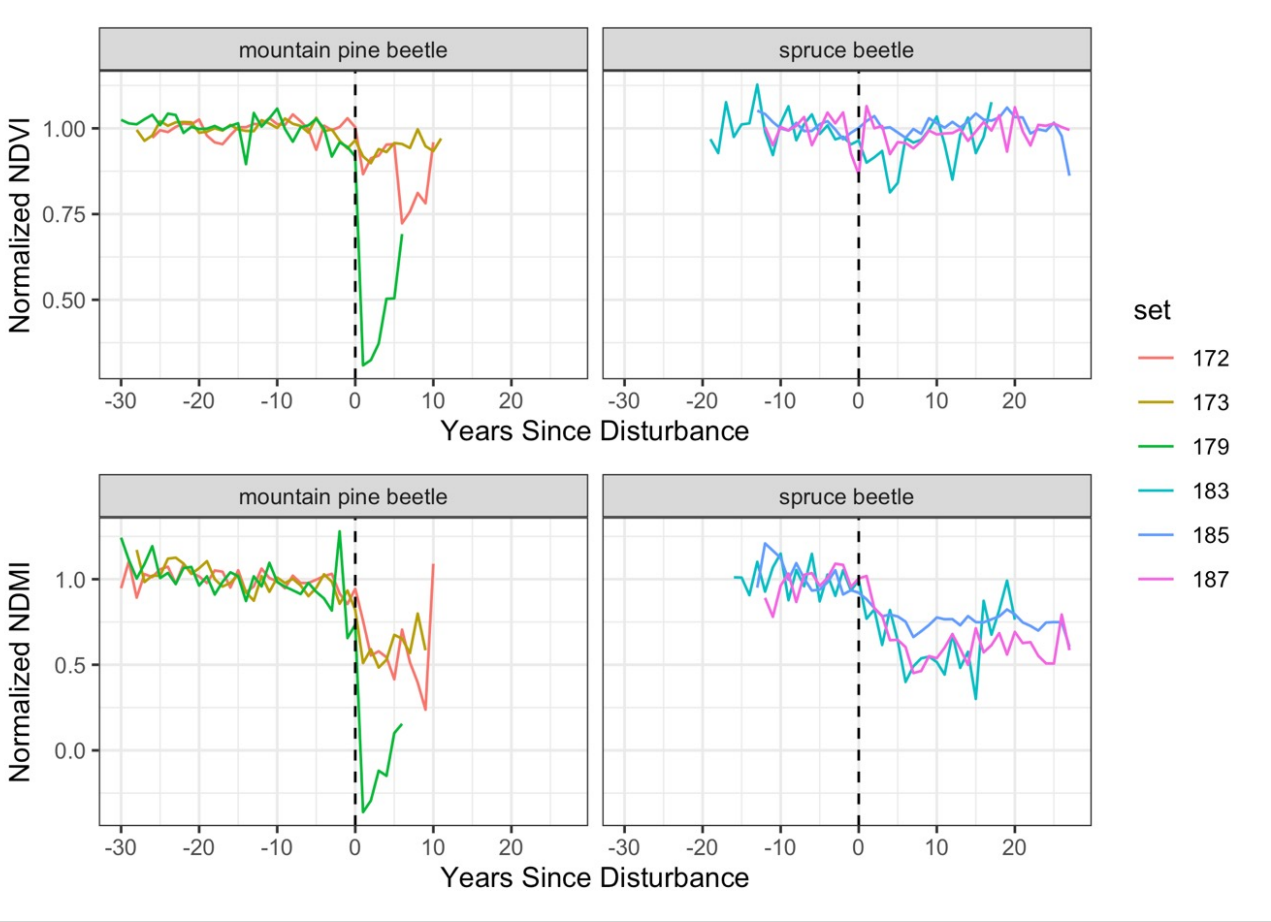


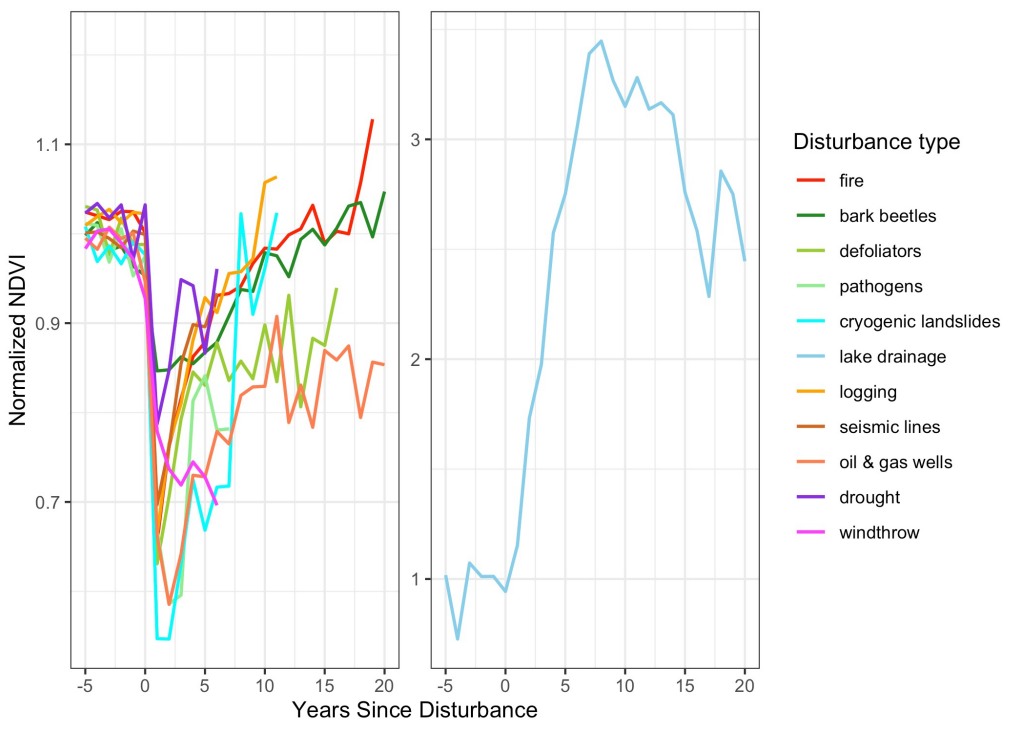
Smooth trajectory to see inflection points

Calculate normalized vegetation index to pre-disturbance mean

Example trajectories



Comparing disturbances



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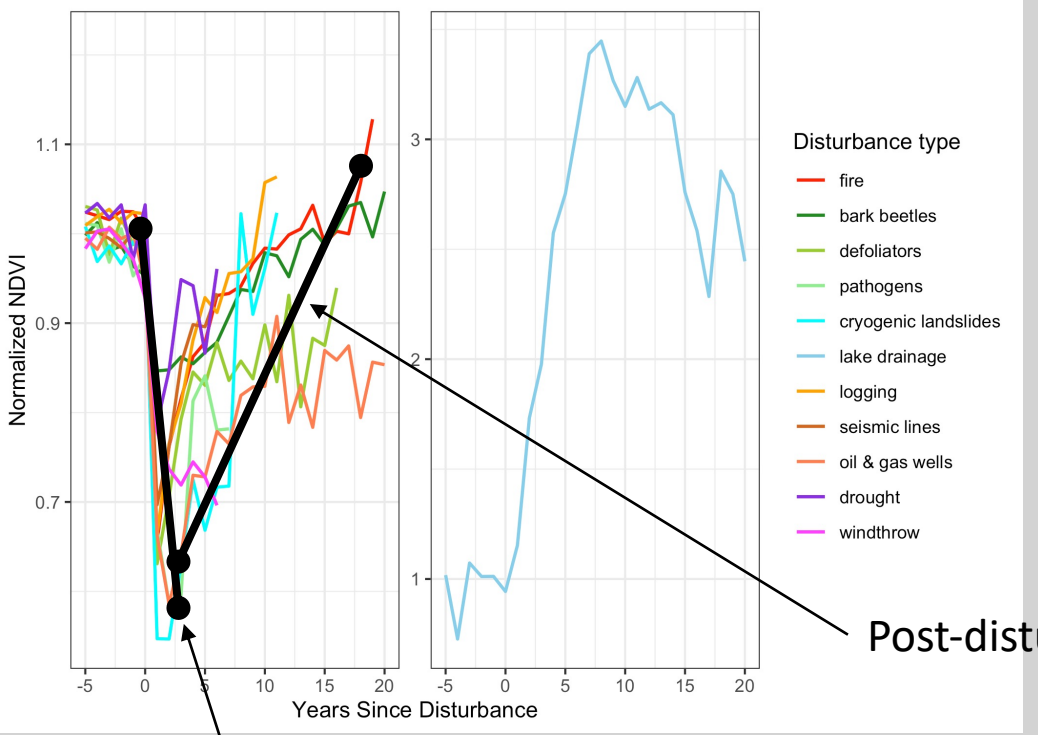

Post-disturbance slope

Disturbance slope
& number of years

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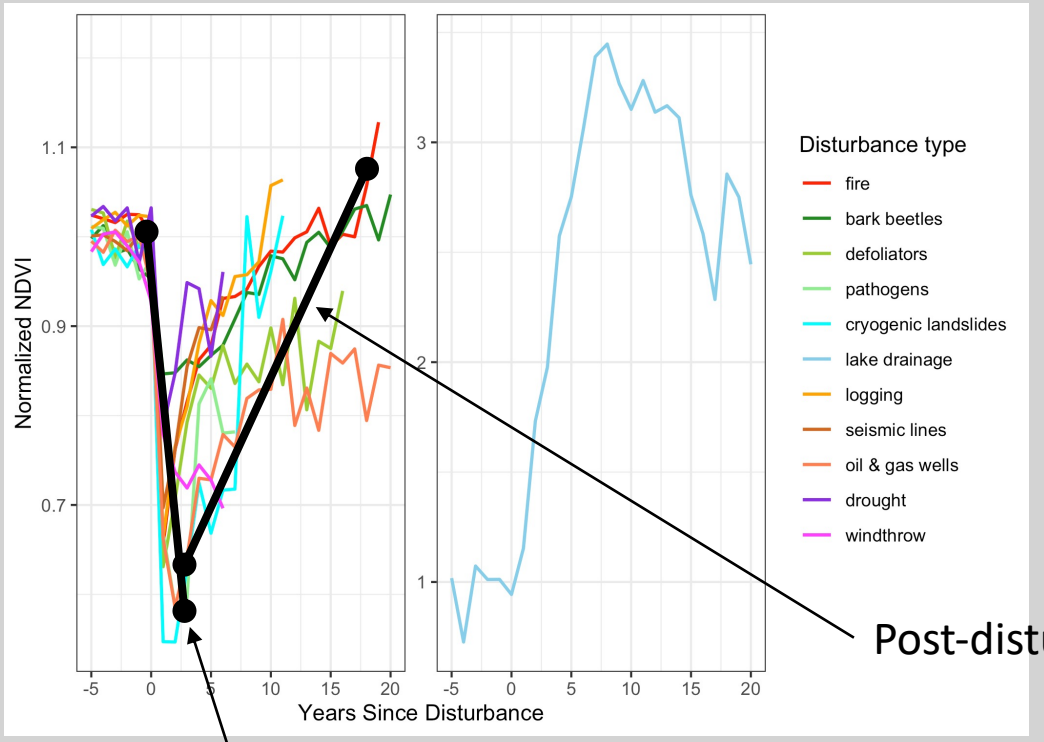

Post-disturbance slope

Disturbance slope
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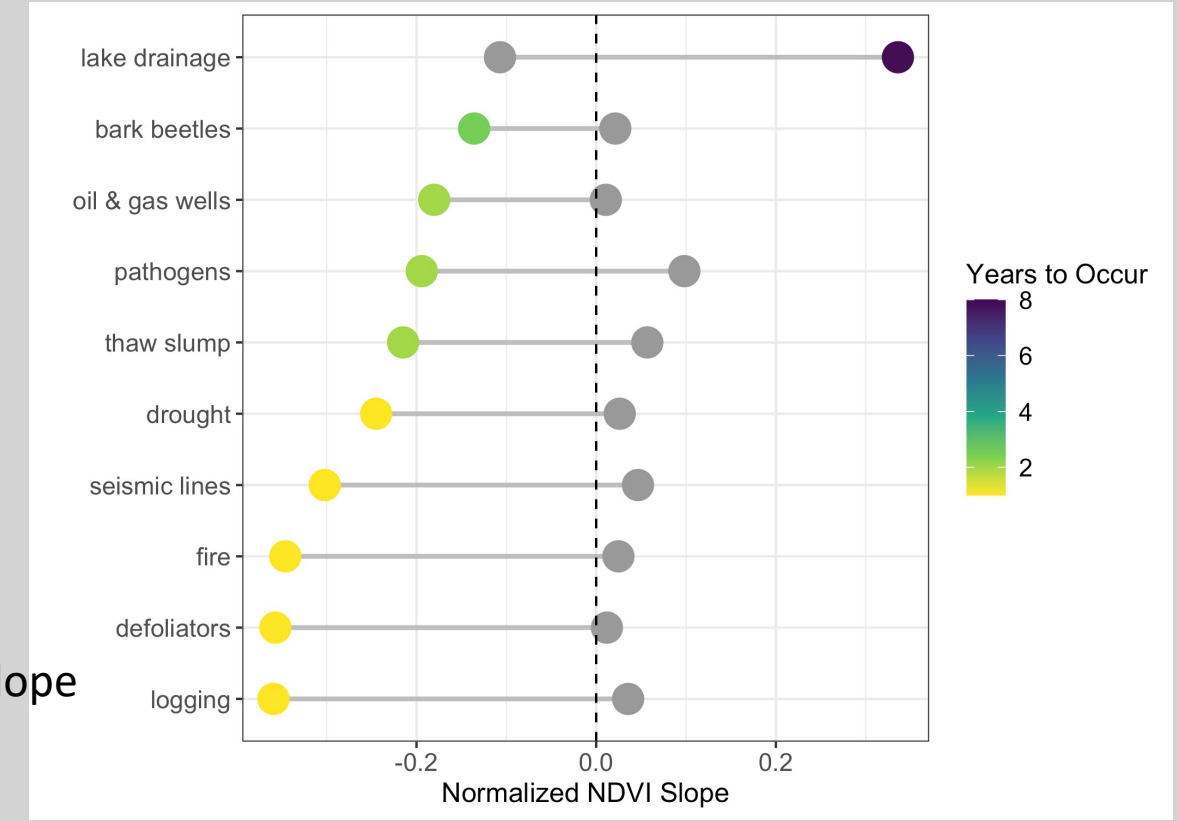

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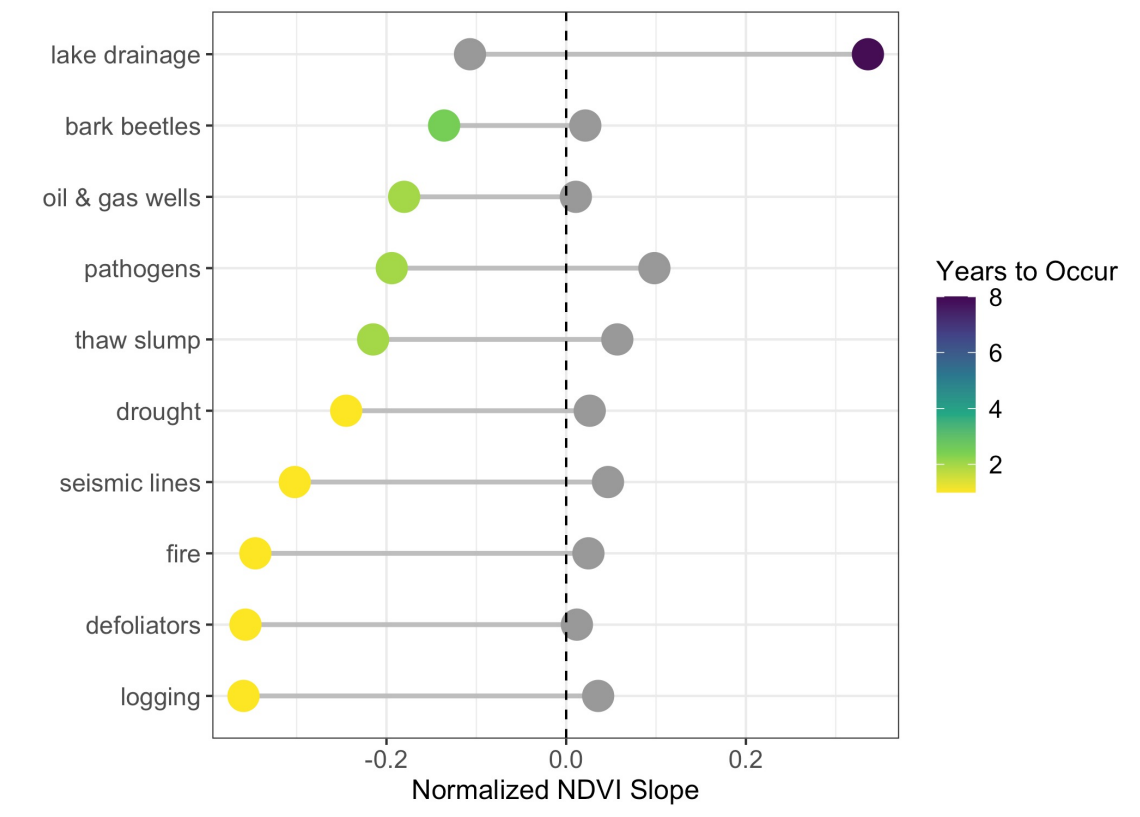
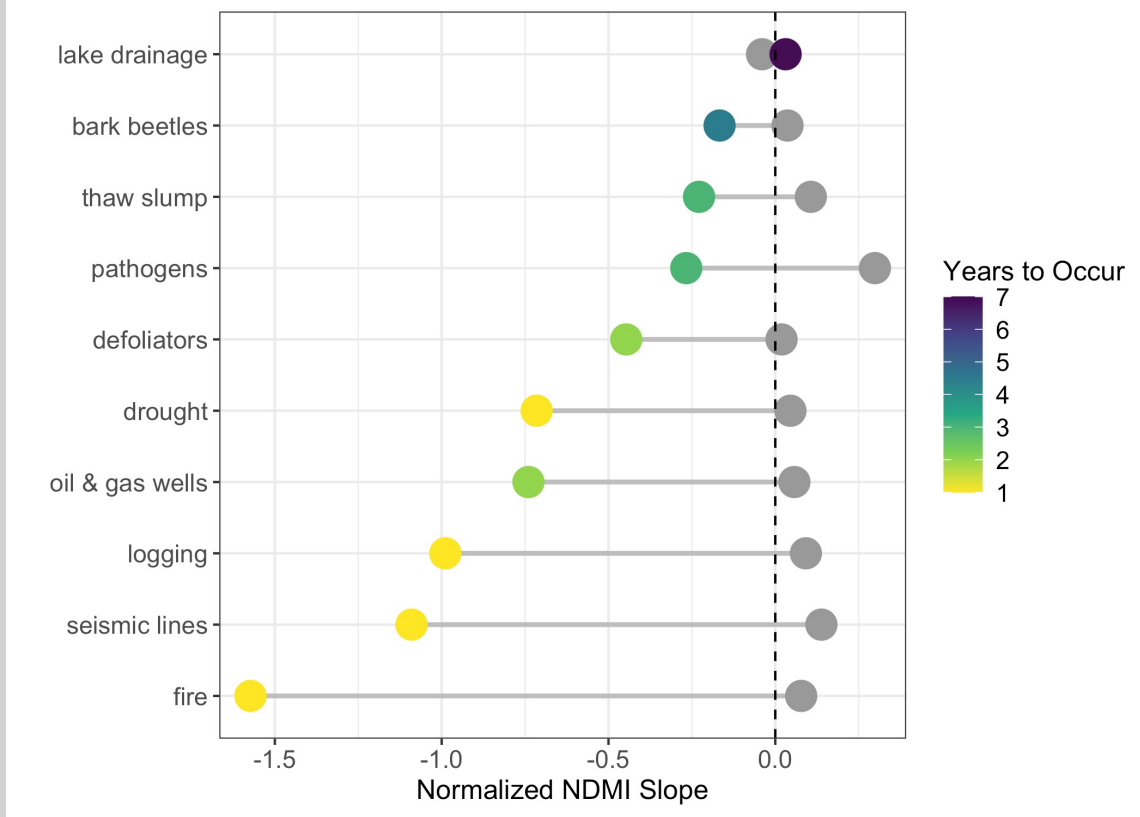
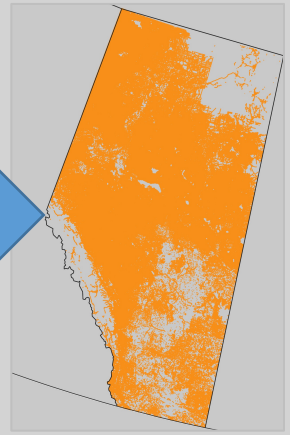
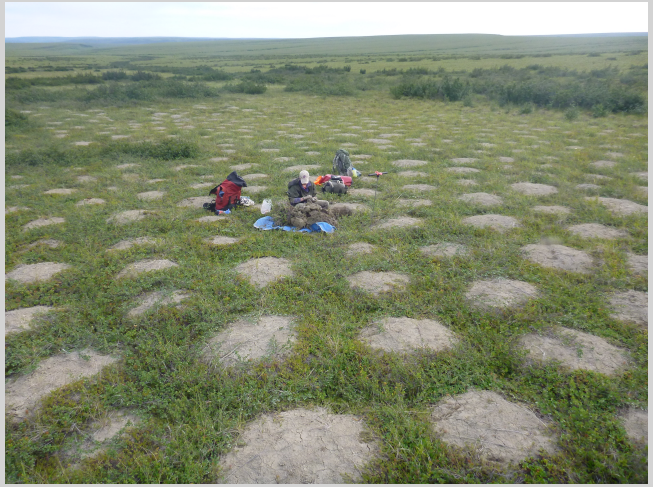
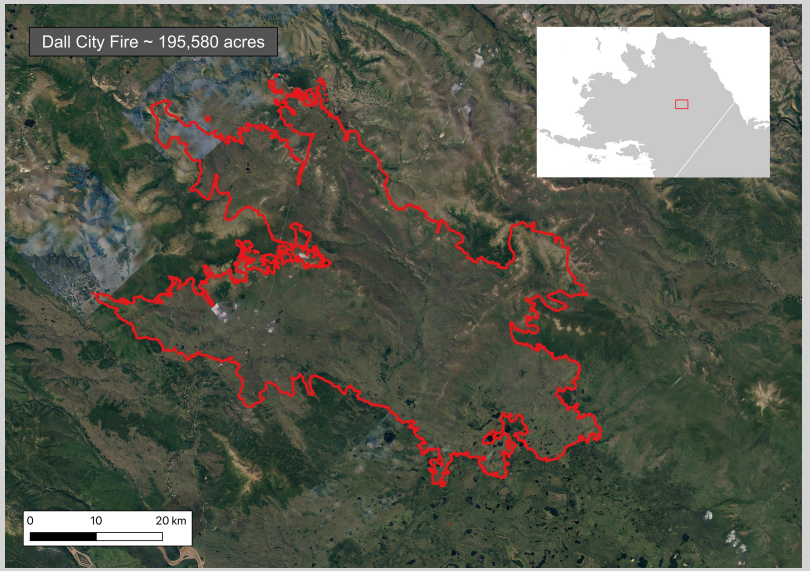


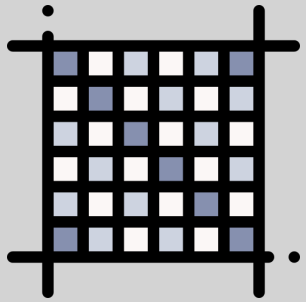


Spatial and temporal dynamics









Spatial grain

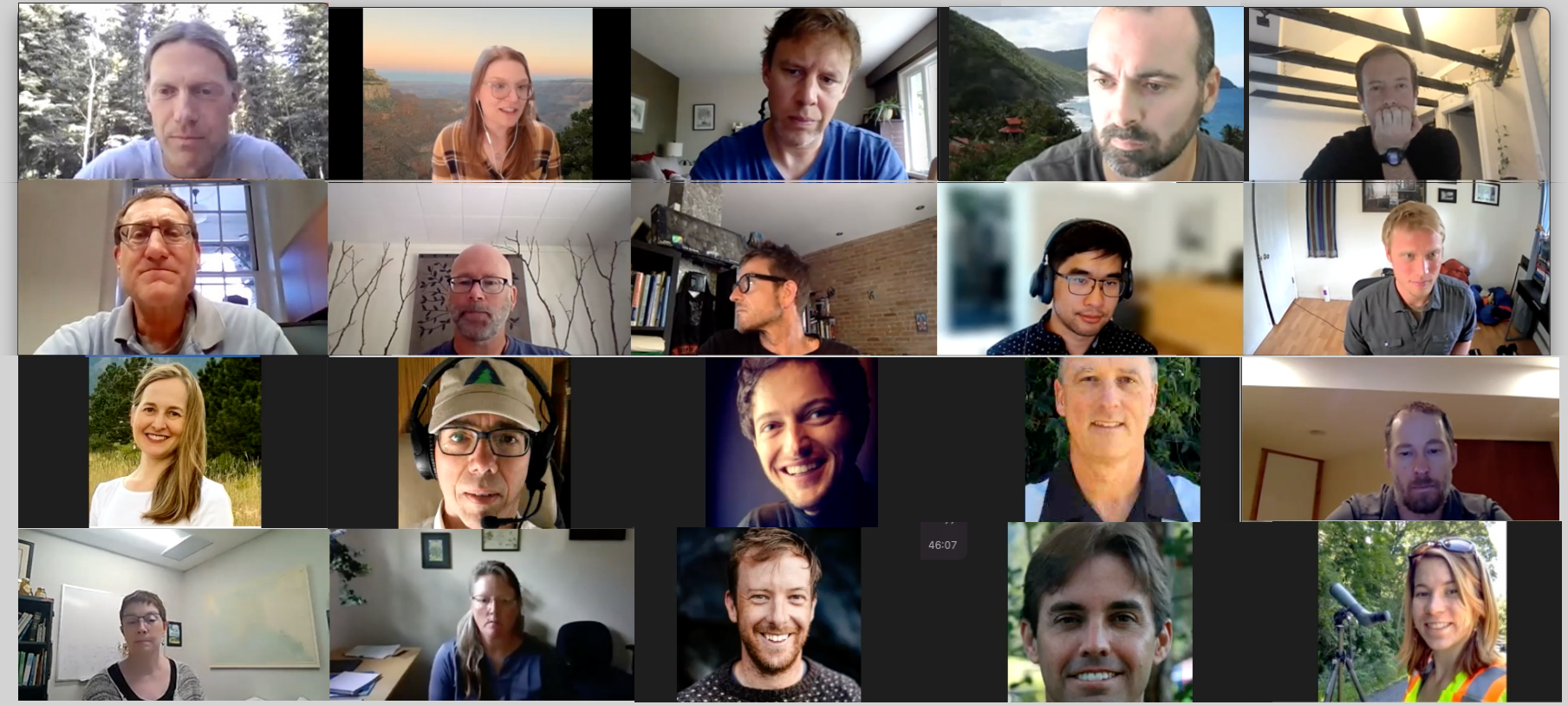
Return interval

Occurrence timeline

Recovery timeline

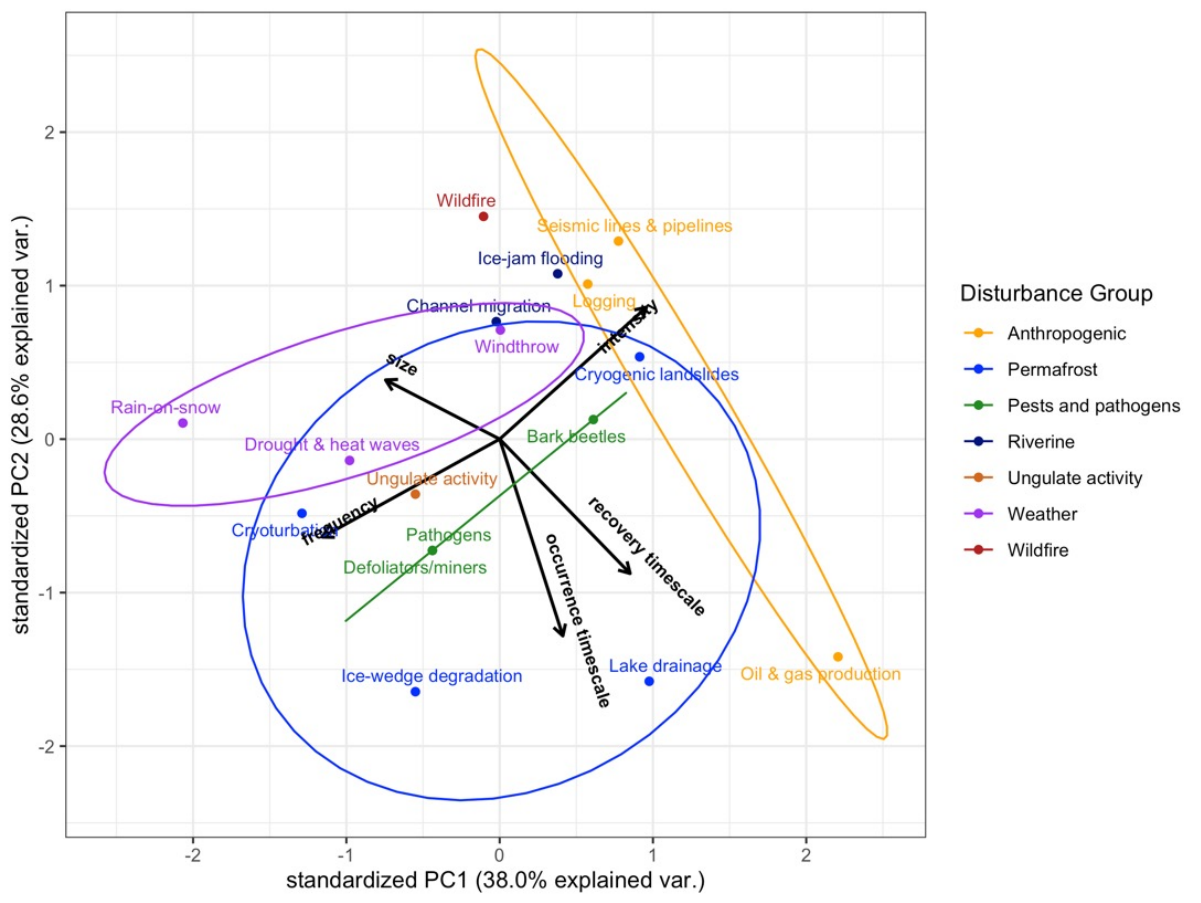
Intensity/impact

Workshop

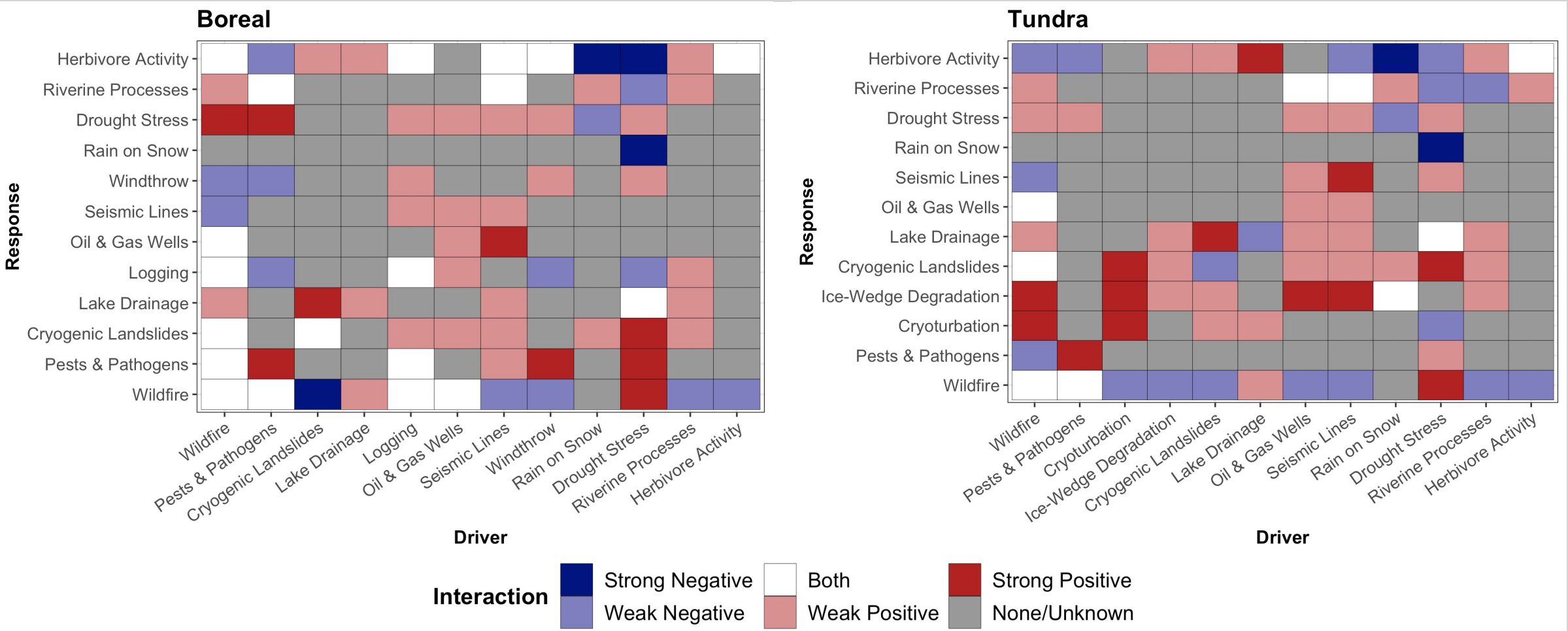


Multi-Disturbance Workshop
June 30, 2021
~65 participants
Facilitated by ARCUS

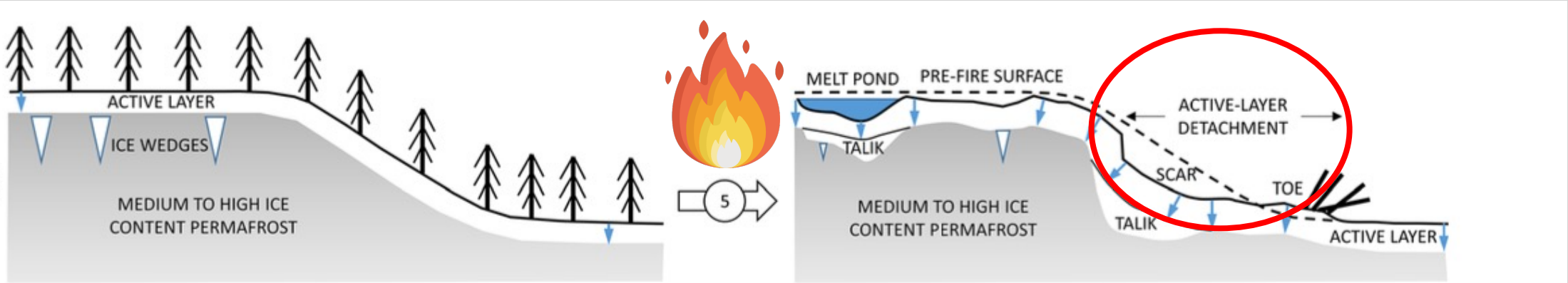
Spatiotemporal PCA



Disturbance interactions



Disturbance interactions: wildfire and permafrost

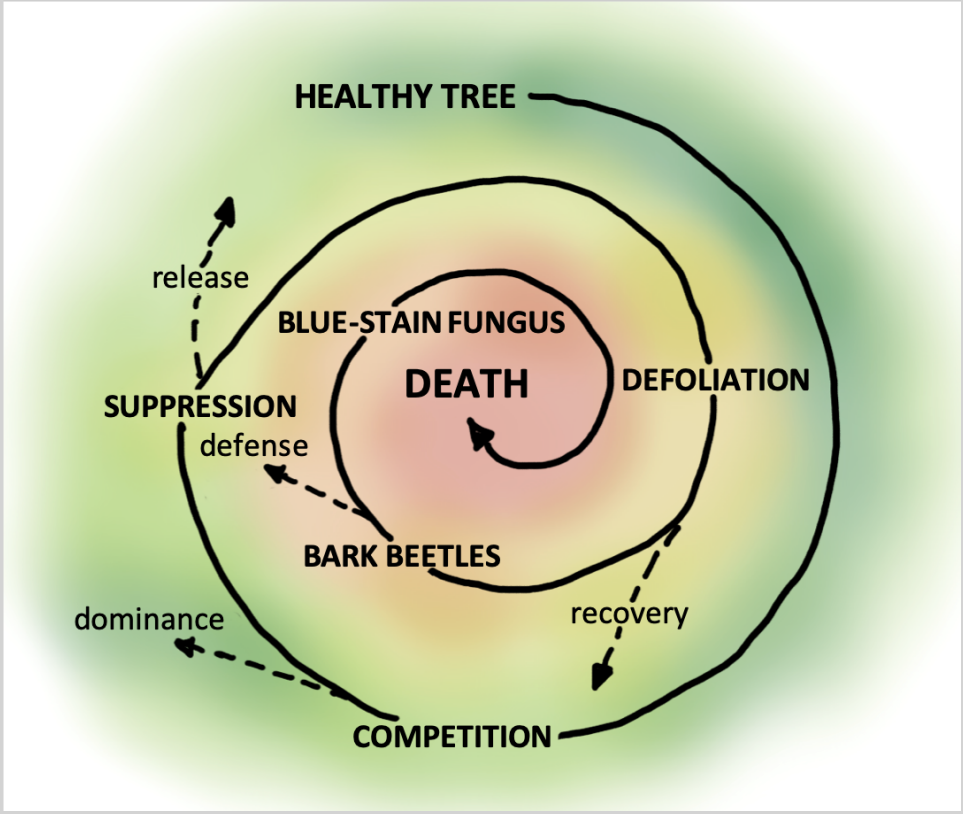


Holloway et al. 2020

Rapid thaw following wildfire → formation of active layer detachment

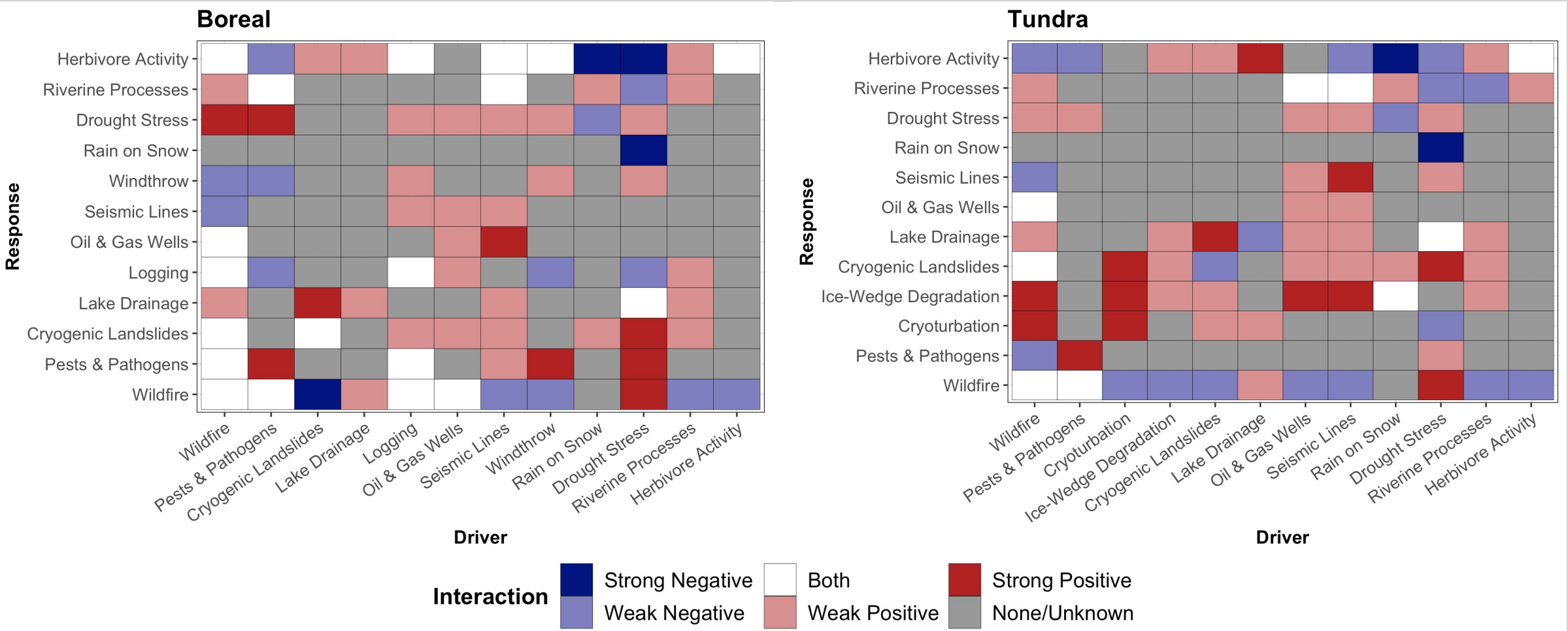
Disturbance interactions: biotic interactions

Drought → bark beetle infestation → defoliation stress → mortality



Franklin et al. 1987

Disturbance interactions



Conclusions

- Most of these disturbances are predicted to increase
  - Some notable exceptions (e.g. cryoturbation)
- Disturbances as hotspots of vegetation change
- Important impacts on society, feedbacks to climate
- Key unknowns about future trajectories, future interactions

Current Status

- Submitting manuscript to ERL Reviews this month (May 2022)
- Look out for request for comments/edits

Acknowledgments

NASA ABoVE Multi-Disturbance Working Group

References

Berner L T, Assmann J J, Massey R, Normand S and Goetz S J 2021 lsatTS - an R package for deriving vegetation greenness time series using Landsat satellite data Online: https://github.com/logan-berner/lsatTS

Franklin F F, Shugart H H and Harmon M E 1987 Tree Death as an Ecological Process: The causes, consequences, and variability of tree mortality *BioScience* **37** 550–6

Holloway J E, Lewkowicz A G, Douglas T A, Li X, Turetsky M R, Baltzer J L and Jin H 2020 Impact of wildfire on permafrost landscapes: a review of recent advances and future prospects *Permafrost and Periglacial Processes* **31** 371–82

Verbesselt J, Hyndman R, Newnham G and Culvenor D 2010 Detecting trend and seasonal changes in satellite image time series *Remote Sensing of Environment* **114** 106–15

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