



# SEPARATING DEFOLIATOR AND BARK BEETLE DISTURBANCES USING LANDSAT TIME SERIES

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Source: rapidcityjournal.com



Source: news.ubc.ca

## Bark beetles



Source: Washington State University



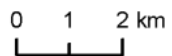
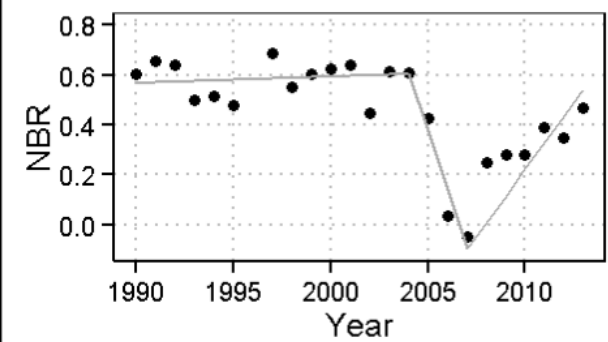
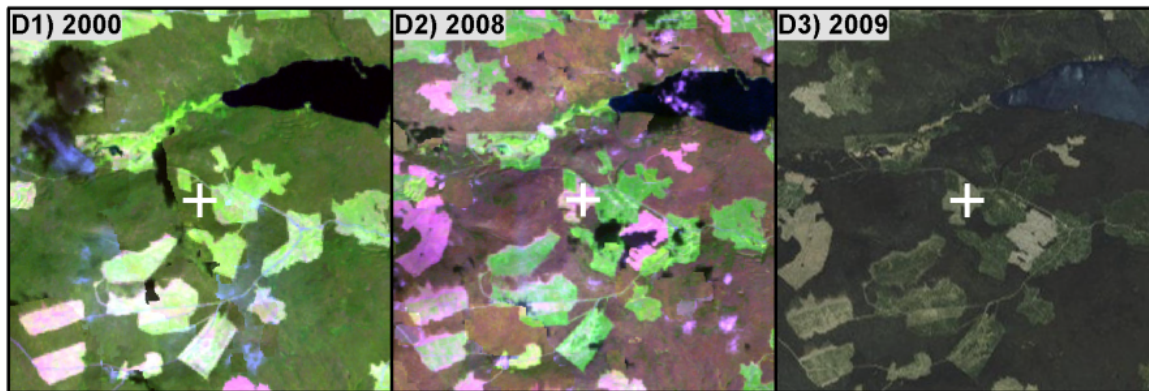
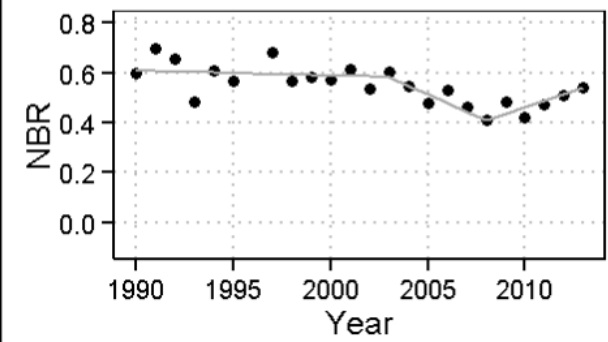
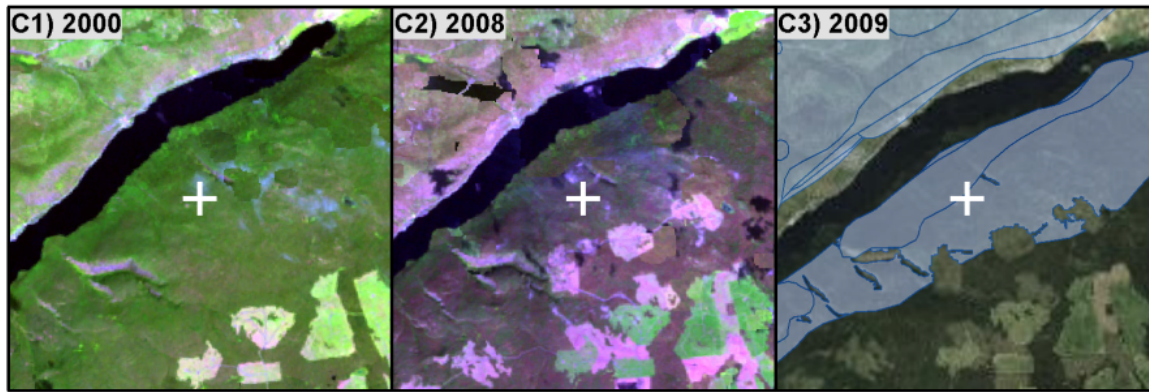
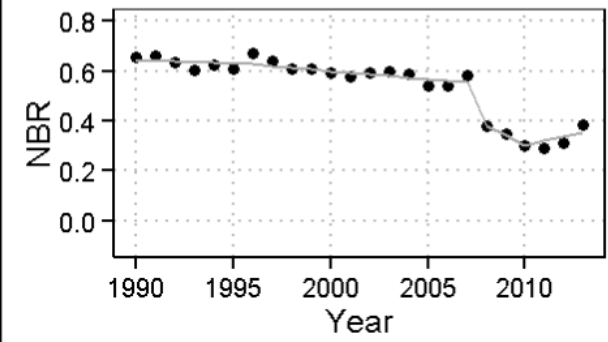
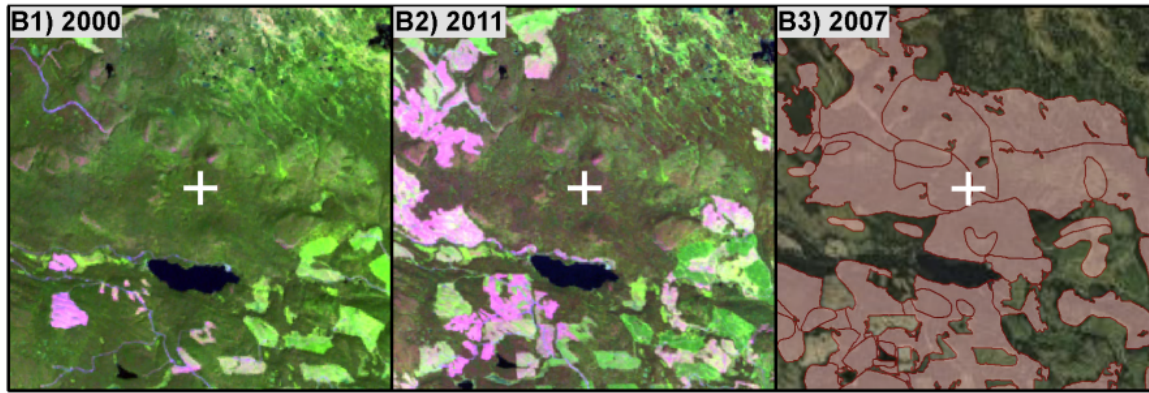
Source: Paul Williams/ironammonite.com

## Defoliators

**Bark beetle**

**Defoliator**

**Harvest**



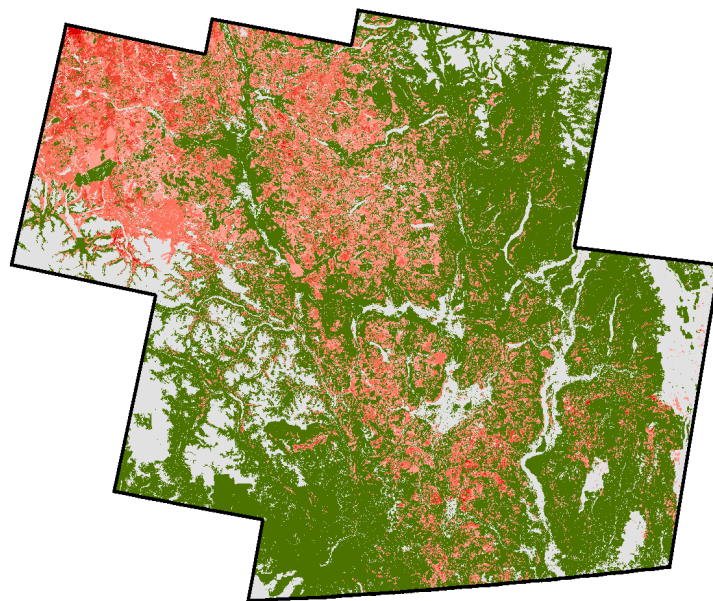
## Research questions

**Question 1:** Can we utilize Landsat time series for separating between bark beetle and defoliator disturbances?

**Question 2:** What are the spectral-temporal characteristics of bark beetle and defoliator disturbances

## Study area

- Study area of ~150,000 km<sup>2</sup> (8 Landsat footprints) covering the central and southern interior of British Columbia, Canada
- Major bark beetle and defoliator outbreaks 2000-2012

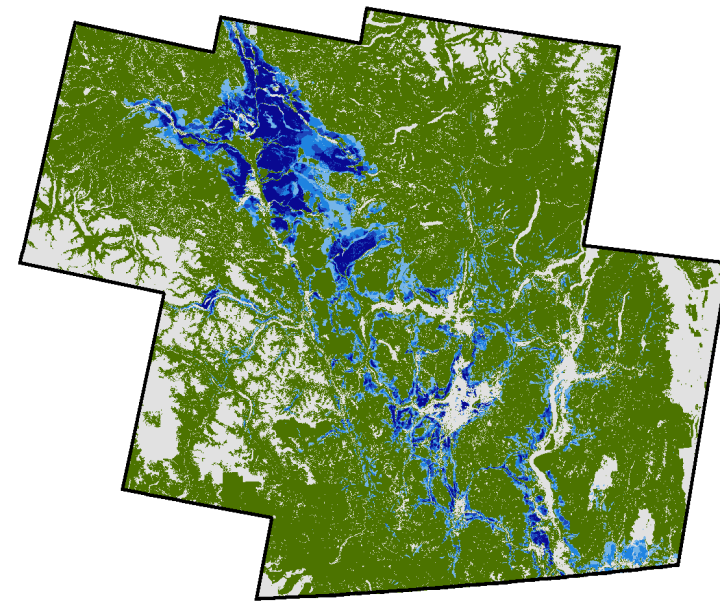


Cummulative years



Mountain pine beetle

(*Dendroctonus ponderosae* Hopkins)



Cummulative years

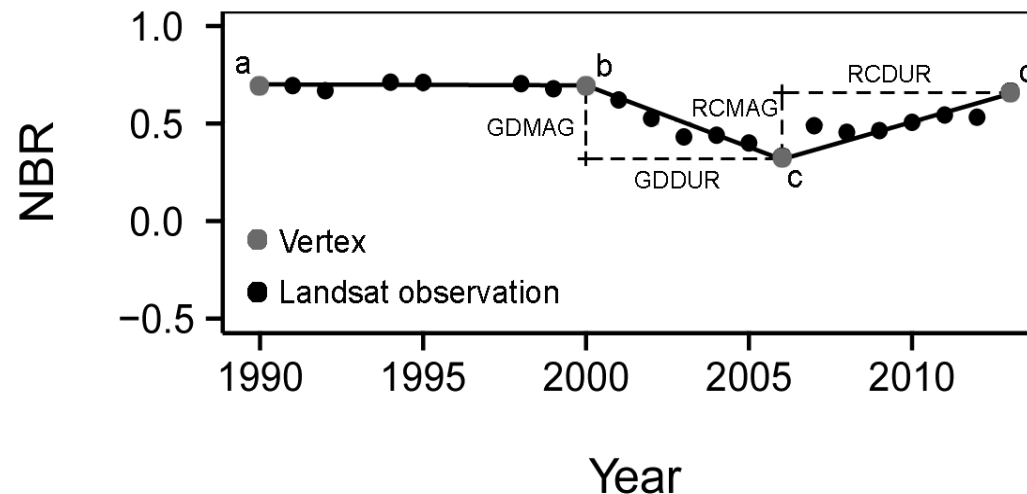


Western spruce budworm

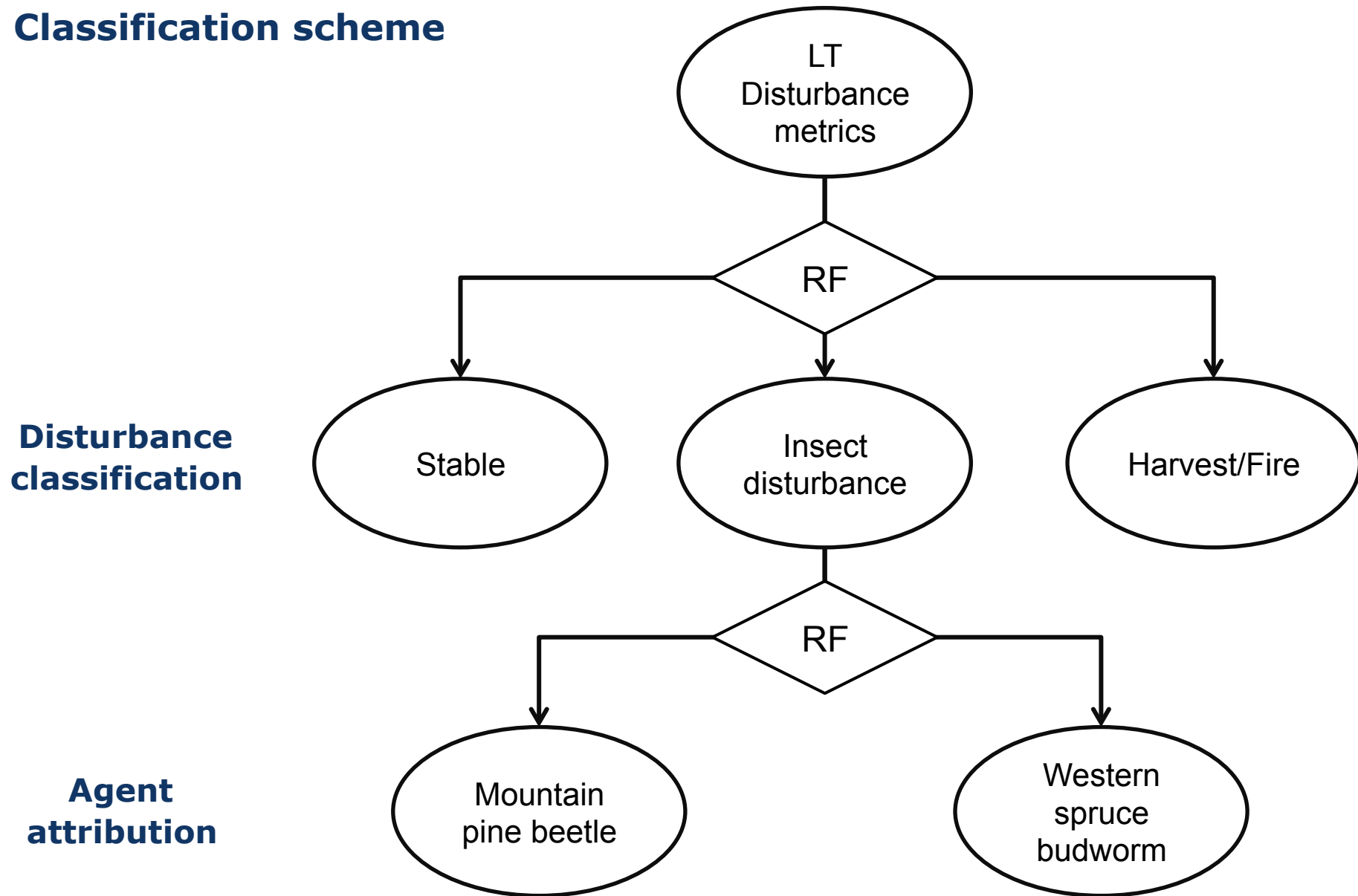
(*Choristoneura freemani* Razowski)

## Data and processing

- 3461 Landsat TM/ETM+ scenes (1990-2013; 8 footprints)
- LEDAPS and Fmask preprocessing chain
- LandTrendr (LT) segmentation algorithm (Kennedy et al. 2012 *RSE*)
- Normalized burn ration (NBR) for segmentation
- NBR and Tasseled Cap (TC) for deriving disturbance metrics



## Classification scheme



RF = Random Forest

## Classification accuracies

- The overall classification accuracy for the **disturbance classification** was 77%, with insect disturbances likely (36%) being confused with undisturbed areas

		Reference					
	Agent	Stable	Insect	Harvest/Fire		User's accuracy	Error of commission
<b>Map</b>	Stable	298	74	6	378	78.8	29.2
	Insect	54	170	16	240	70.8	21.2
	Harvest/Fire	6	23	123	152	80.9	19.1
		358	267	145			
	Producer's accuracy	83.2	63.7	84.8		Overall accuracy	
	Error of omission	16.8	36.3	15.2		76.8	

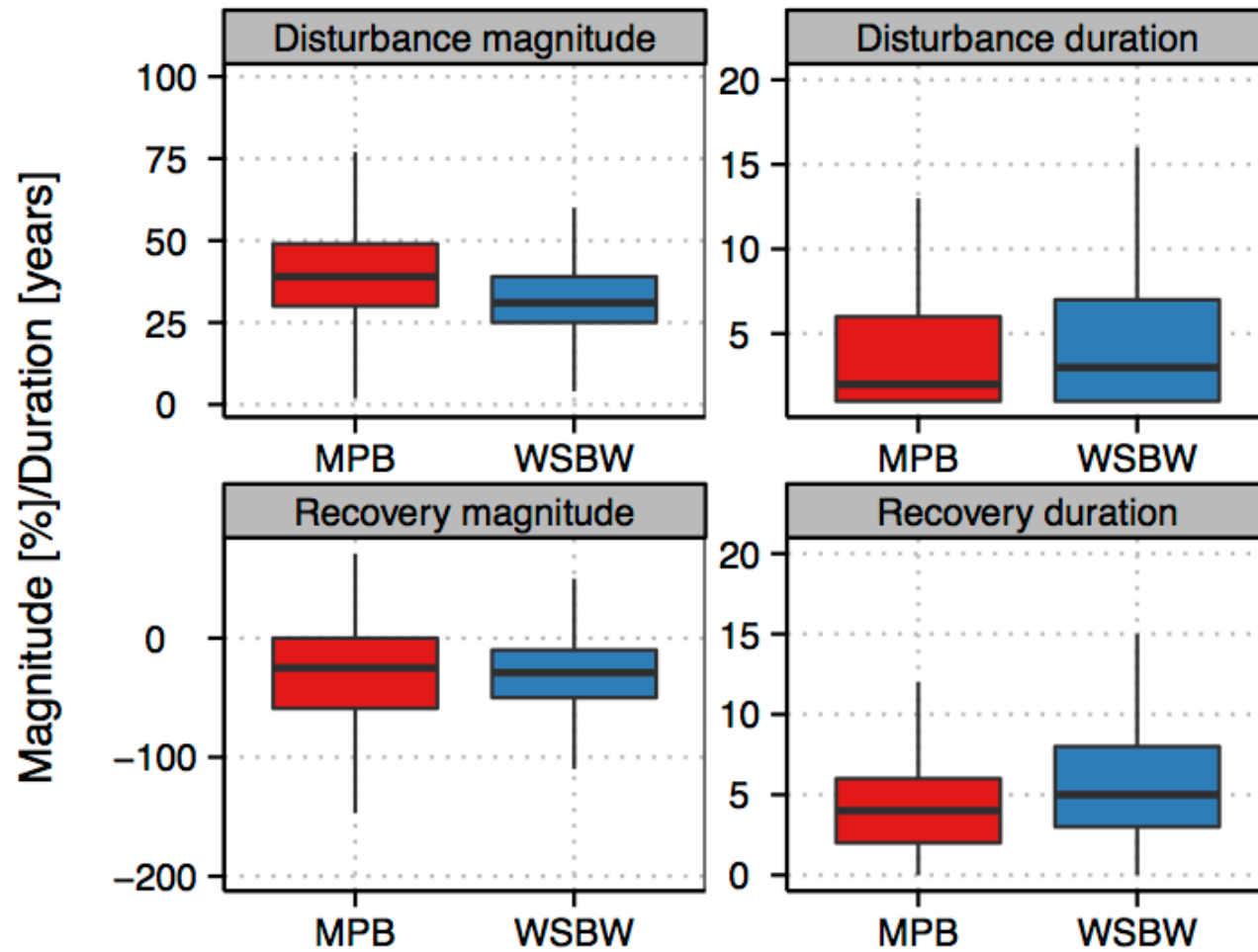


## Classification accuracies

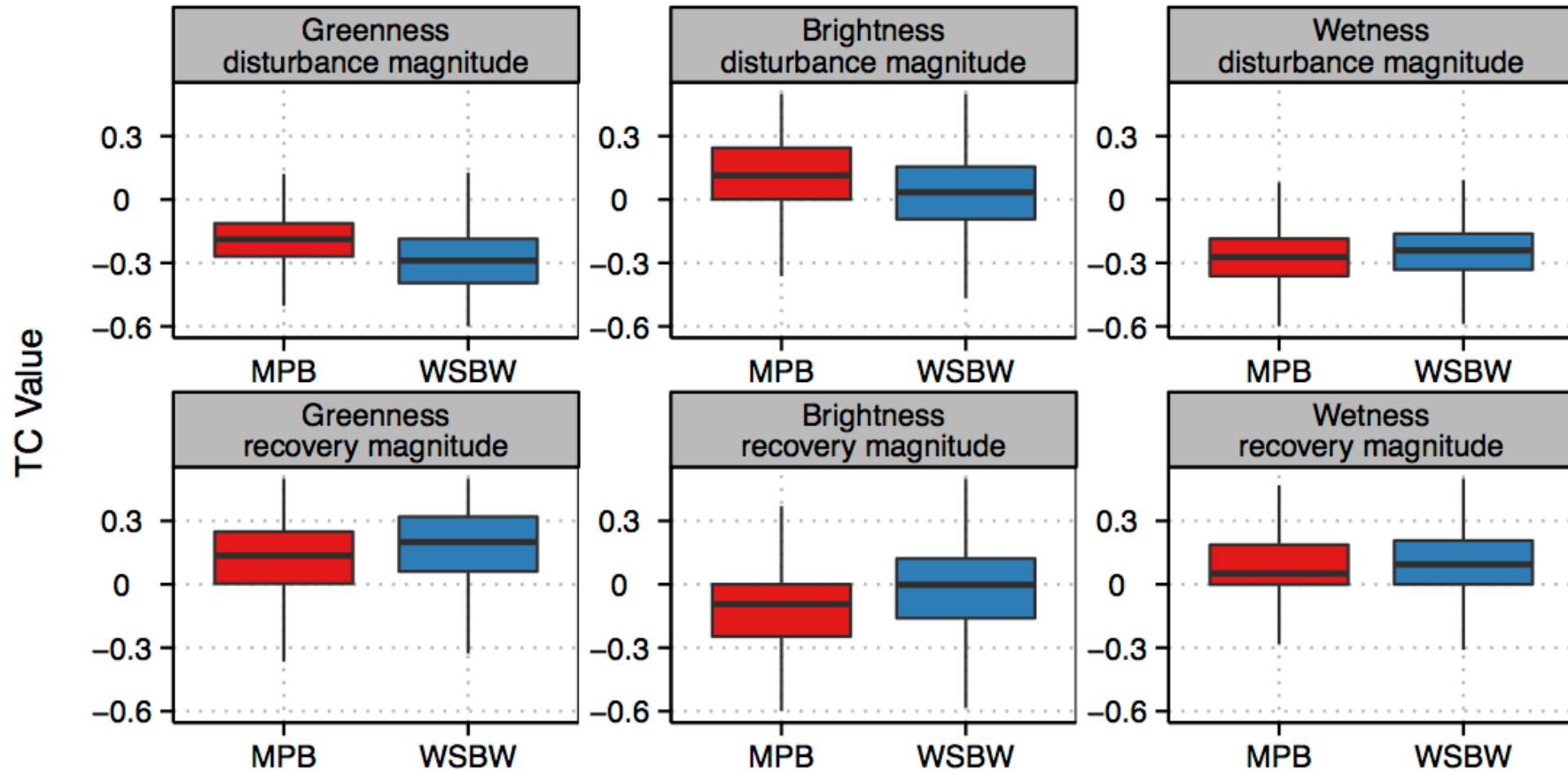
- For the **agent attribution**, mountain pine beetle and western spruce budworm disturbances could be reliably separated (overall accuracy: 88%)

		Reference				
	Agent	WSBW	MPB	Total	User's accuracy	Error of commission
<b>Map</b>	WSBW	4996	563	5559	89.9	10.1
	MPB	636	3805	4441	85.7	14.3
	Total	5632	4368			
	Producer's accuracy	88.7	87.1		Overall accuracy	
	Error of omission	11.3	12.9		88.0	

## Spectral-temporal characteristics

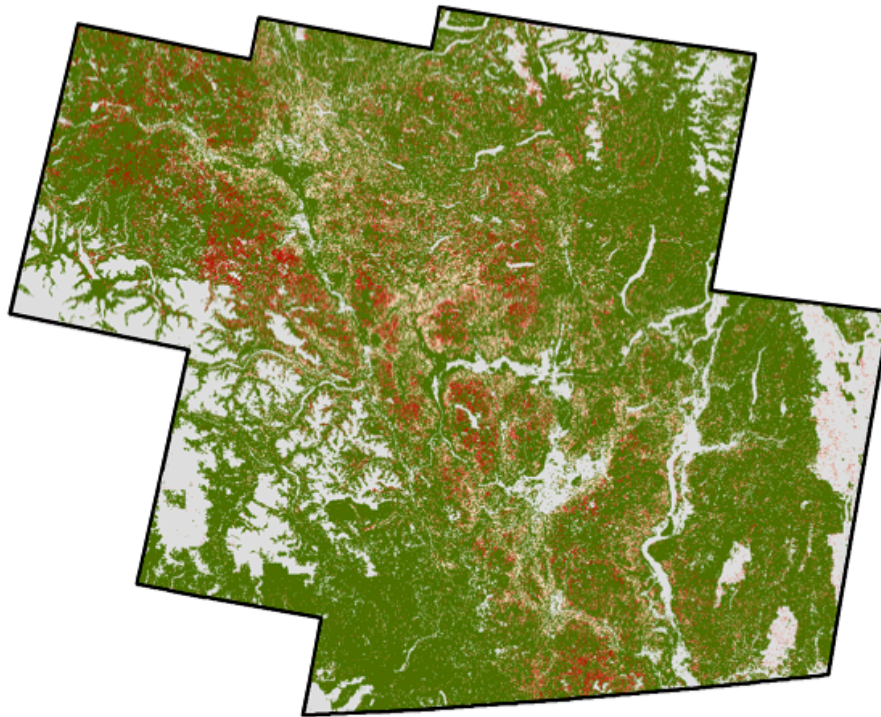


## Spectral-temporal characteristics



## Maps of agent probability

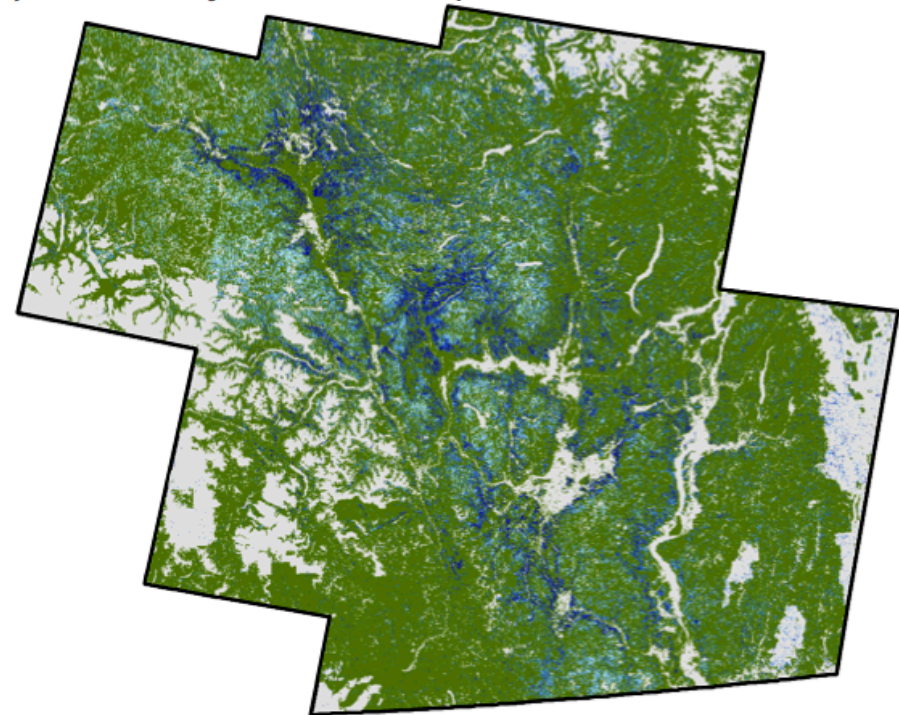
a) Probability of mountain pine beetle



Probability



b) Probability of western spruce budworm



Probability



## Conclusion

- Defoliator and bark beetle disturbances were successfully separated with Landsat time series data
- Disturbance magnitude and duration were both important for separation, though magnitude was more important in our study
- Defoliators caused changes in greenness, likely associated to chlorosis and loss in foliage
- Bark beetles caused changes in wetness and brightness, likely associated to complete defoliation and tree mortality



**Thank you!**

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This work contributes to the Landsat Science Team.

Background image: Nina Berman ([www.ninaberman.com](http://www.ninaberman.com))