Monitoring Landscape Dynamics using LandTrendr in North Coast and Cascades Network Parks

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National Park Service

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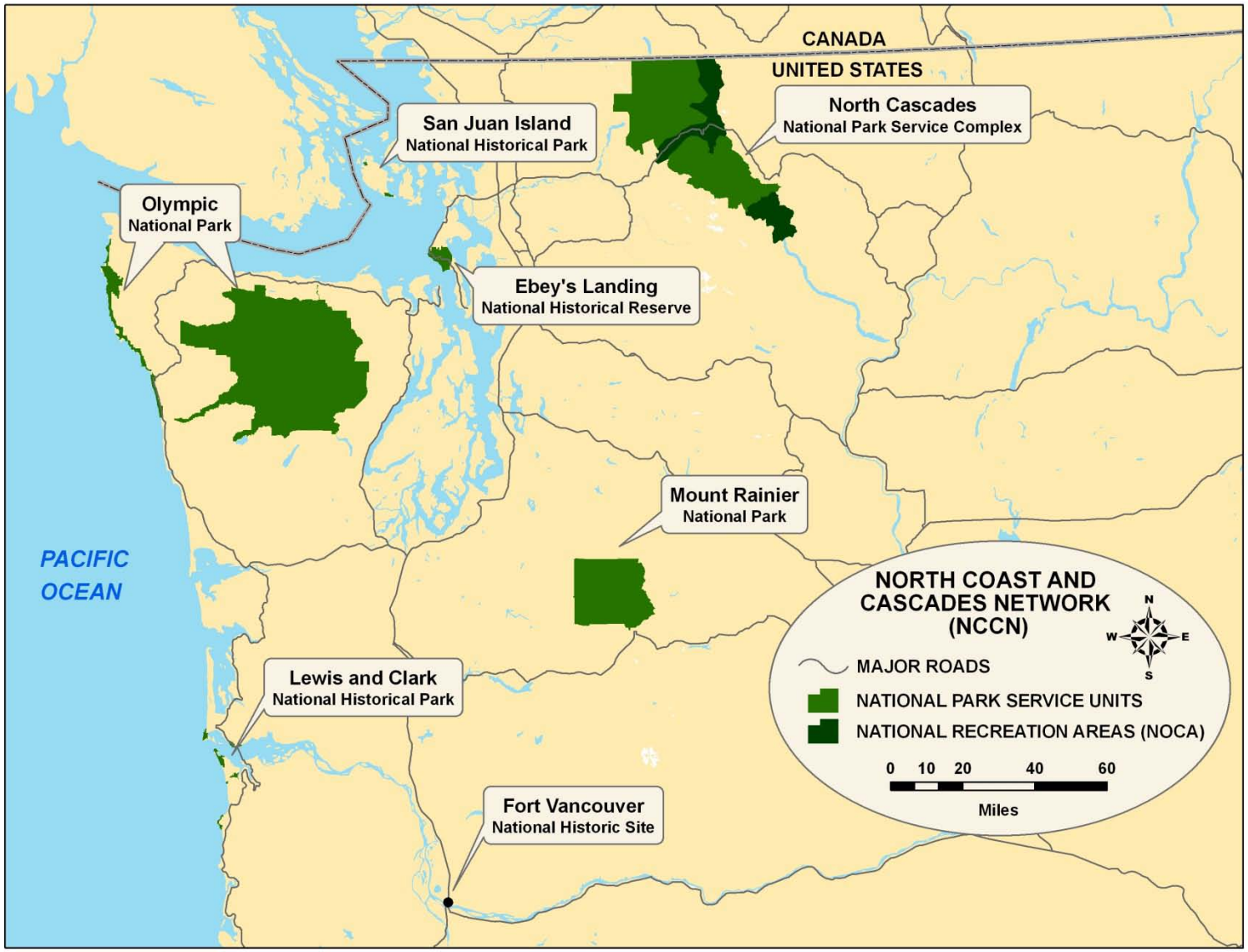
Forestry Sciences Laboratory
Oregon State University

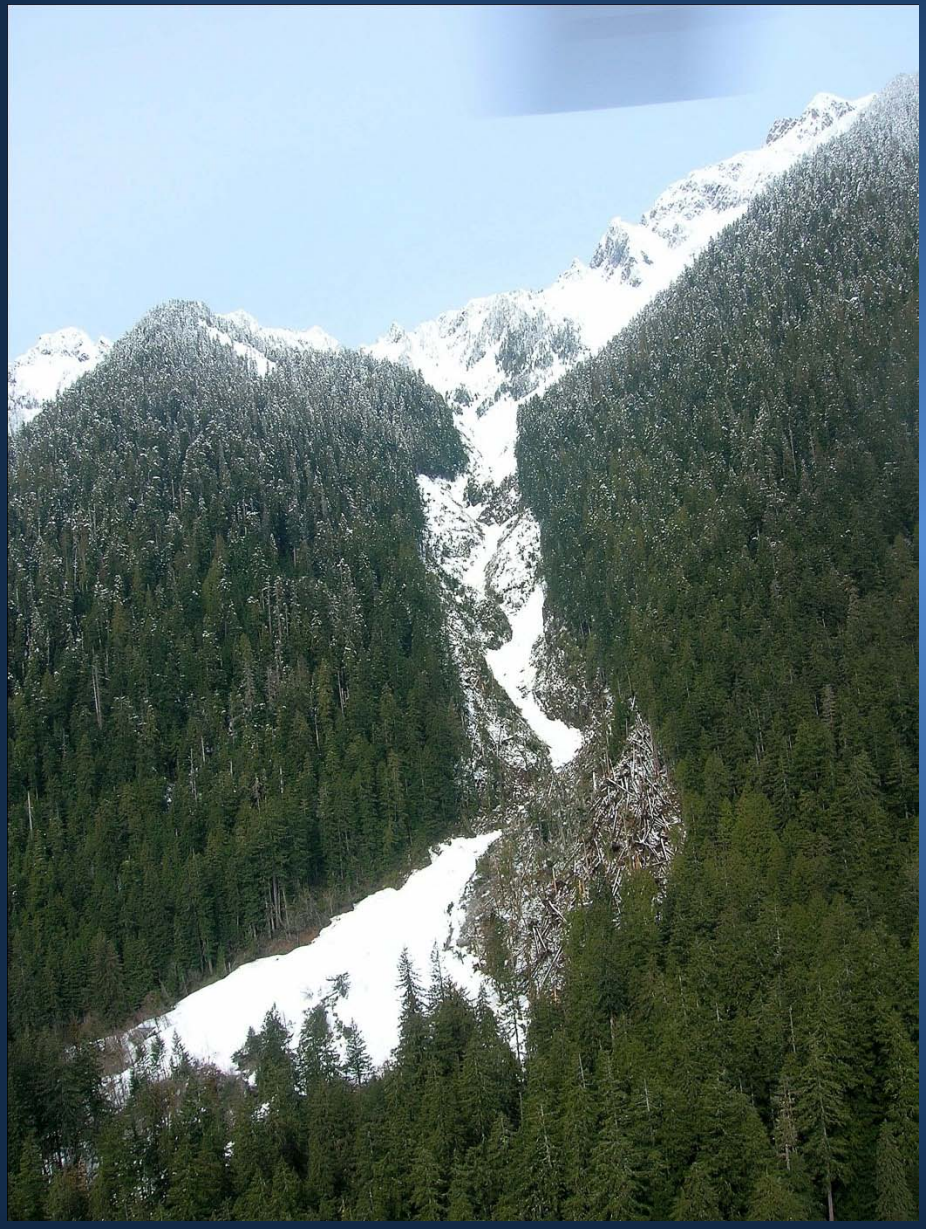
North Coast and Cascades Network

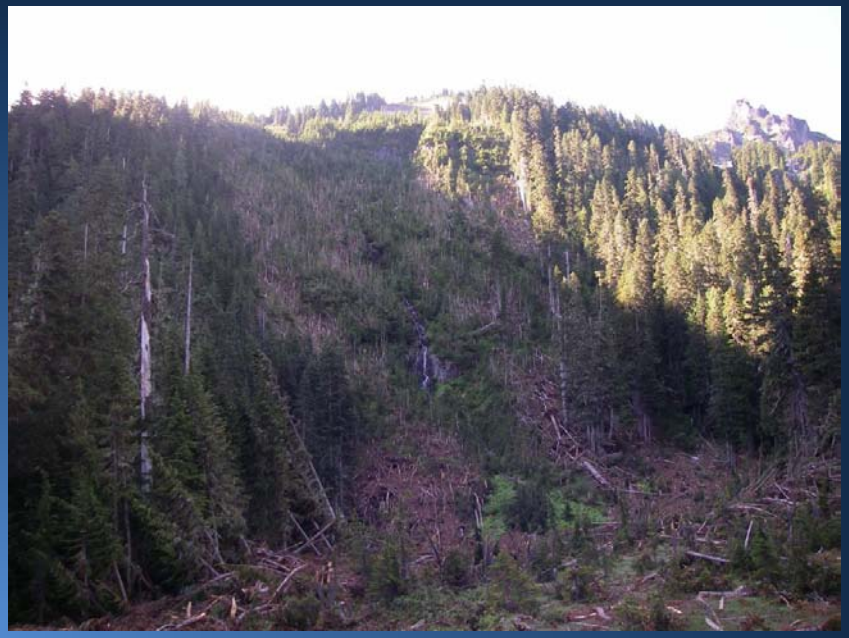


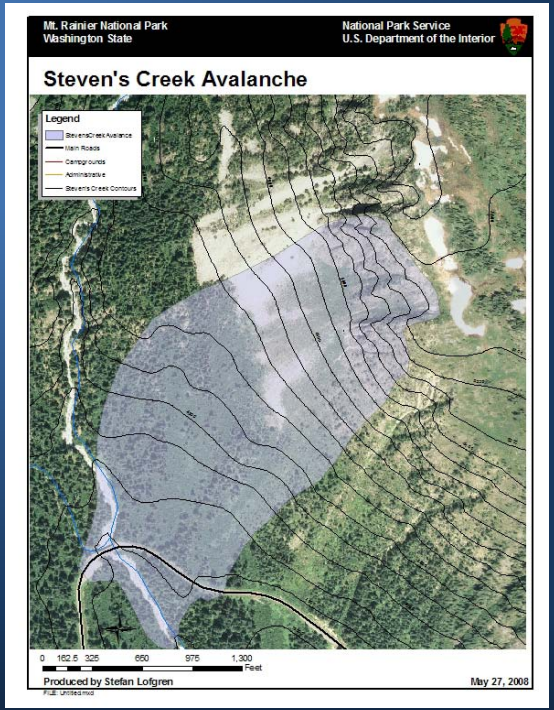
NCCN Landscape Dynamics Monitoring Goals

- Primarily inside park boundaries:
  - Avalanche chute clearing
  - Fire
  - Insect/disease defoliation in forests
  - Landslides
  - Riparian
  - Windthrow
- Primarily outside:
  - Clearcuts
  - Rural development

Avalanche chute clearing

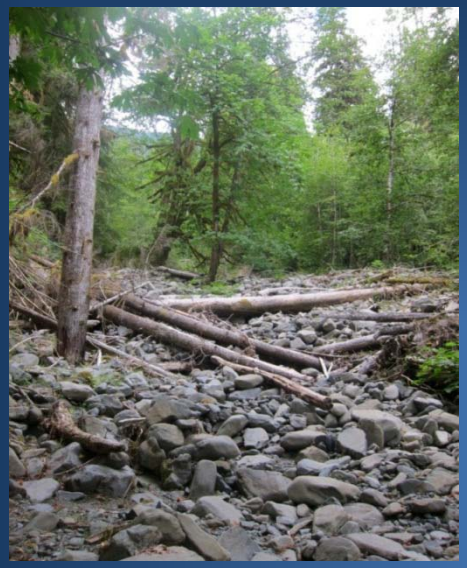


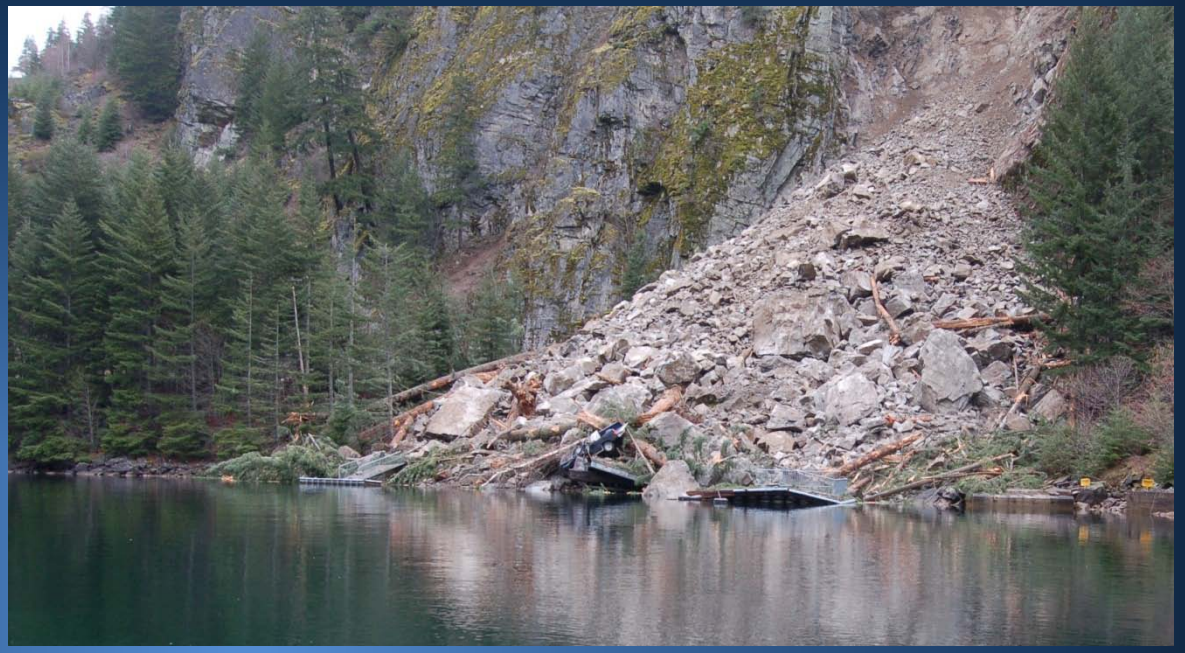




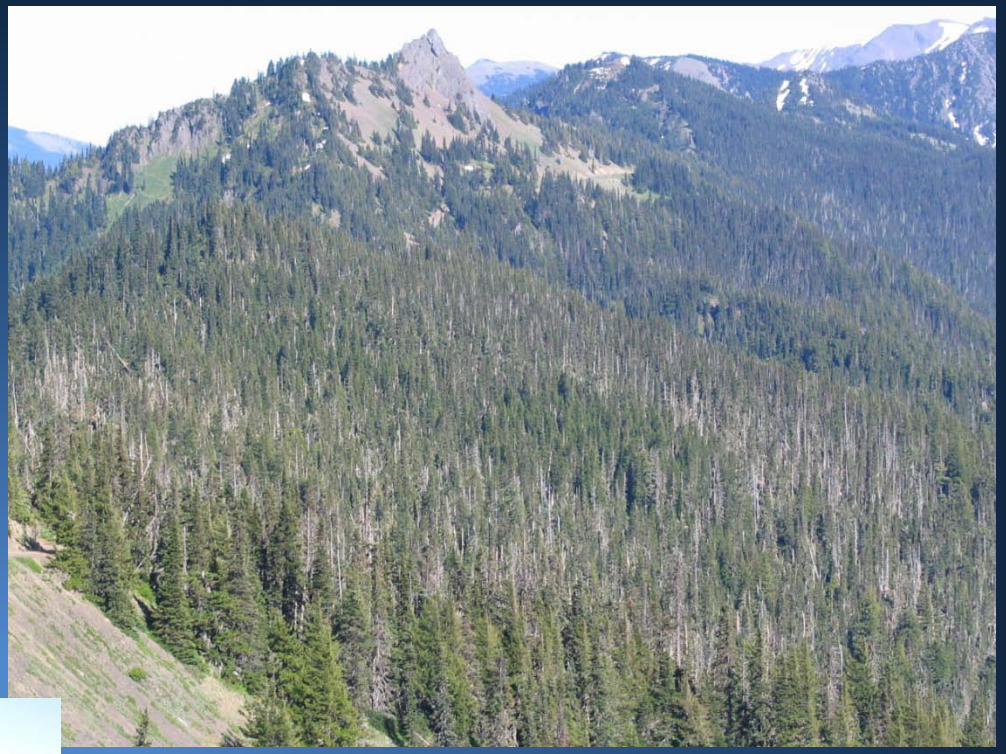
Fire

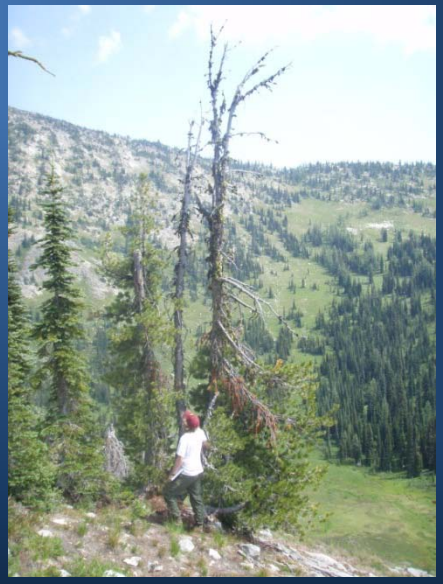
Landslides



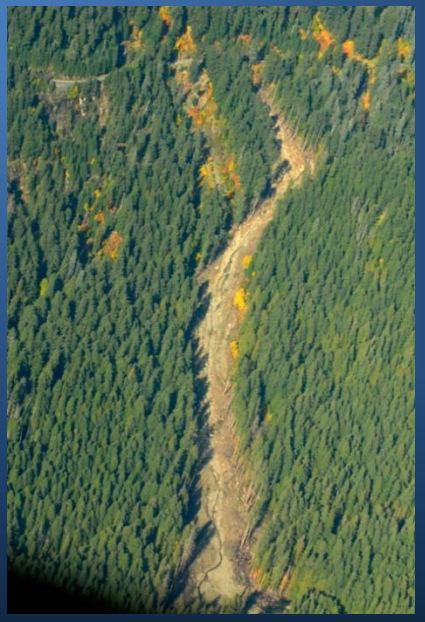


Insect/disease





Riparian



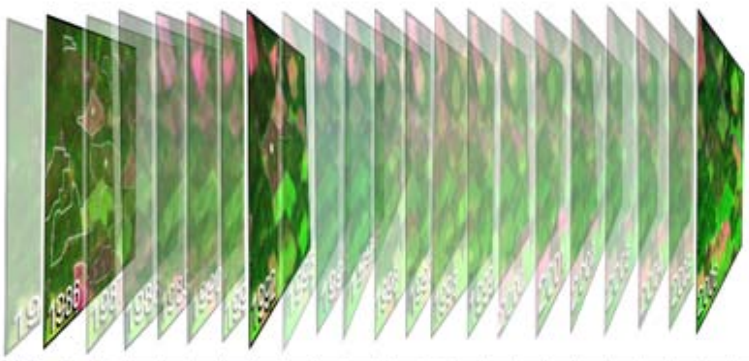
Windthrow

Clearcuts

Rural Development

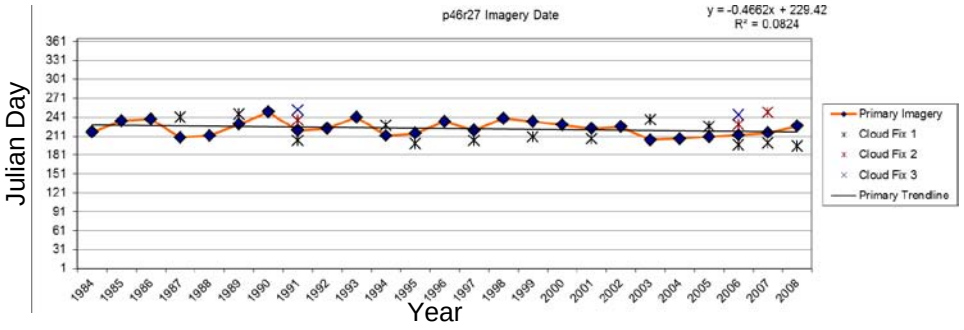
Steps in the LandTrendr Process

1. Prepare stack of yearly imagery



- Atmospheric Correction
- Radiometric calibration
- Cloud and shadow masking

2. Extract spectral trajectories for pixels



3. Statistically identify and fit segments with consistent trends

4. Extract summary information from segments

5. Validate selected events

Steps in the LandTrendr Process

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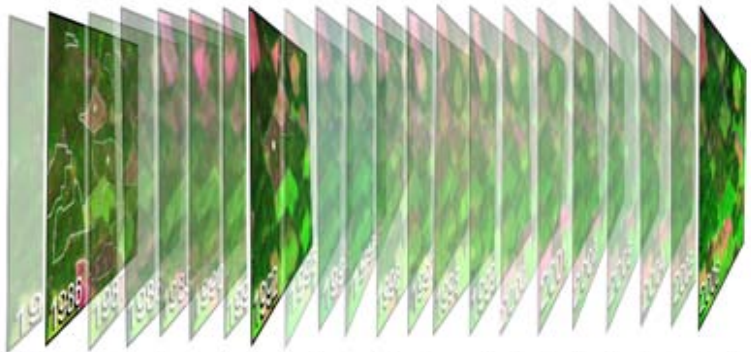

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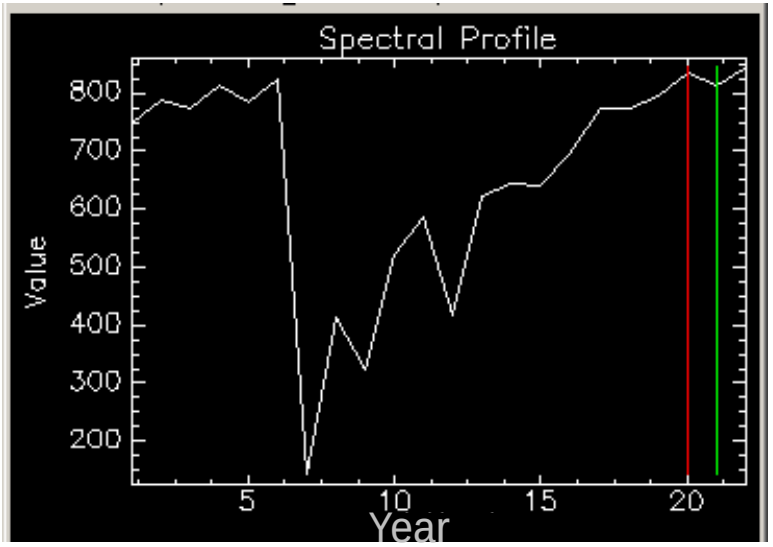

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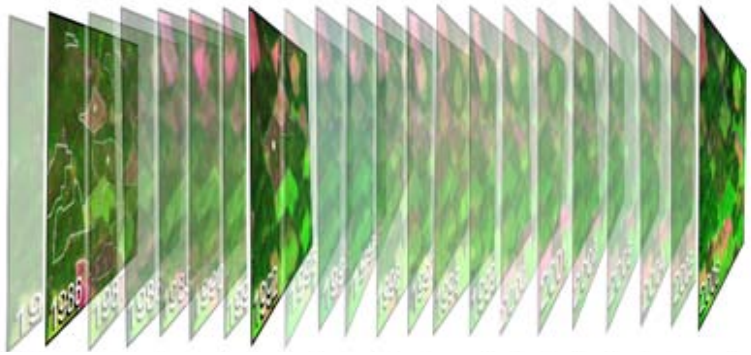

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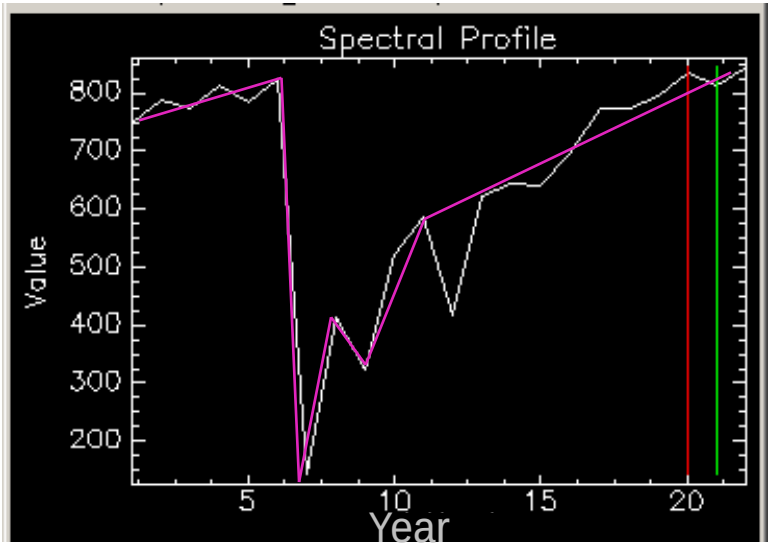

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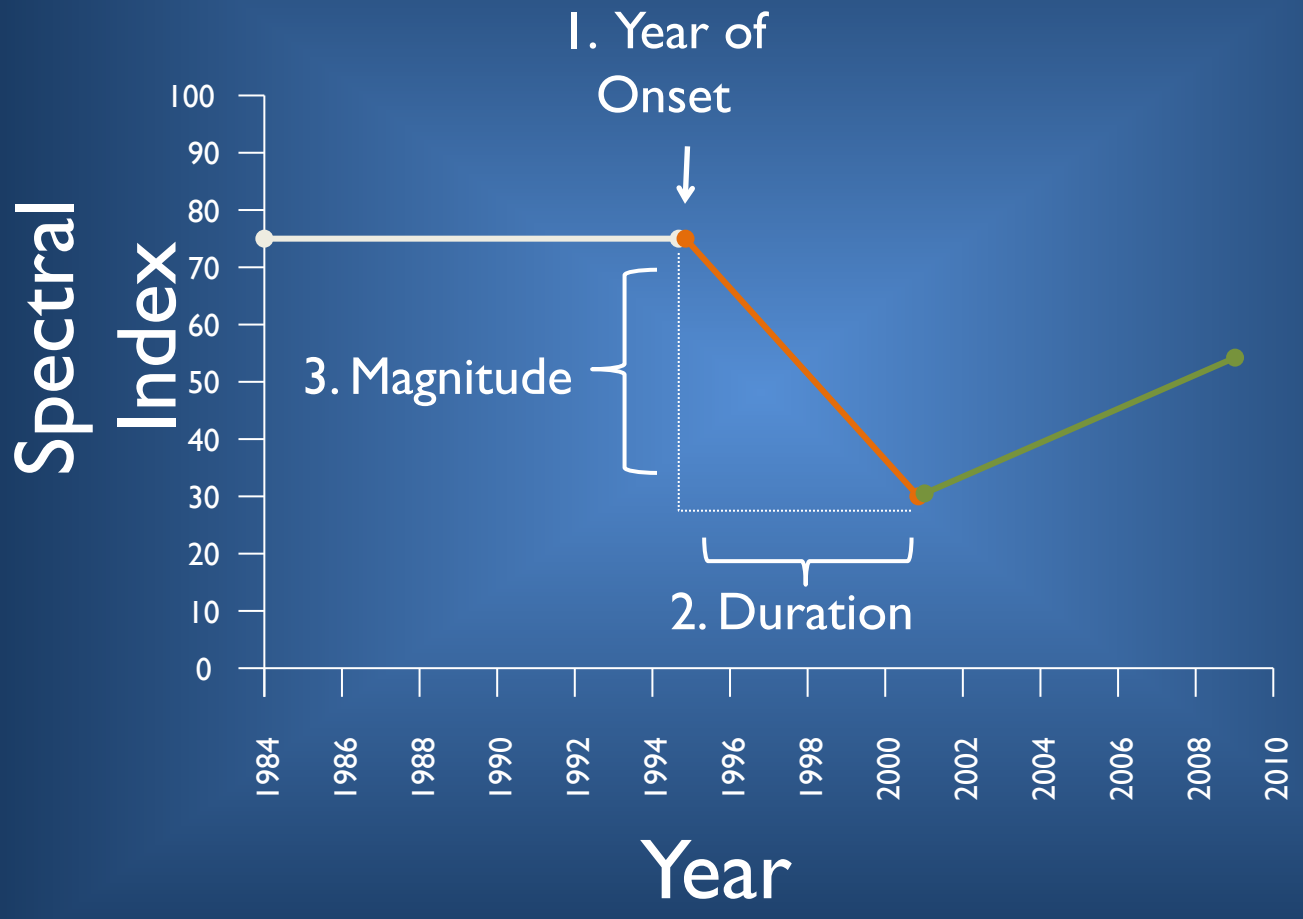
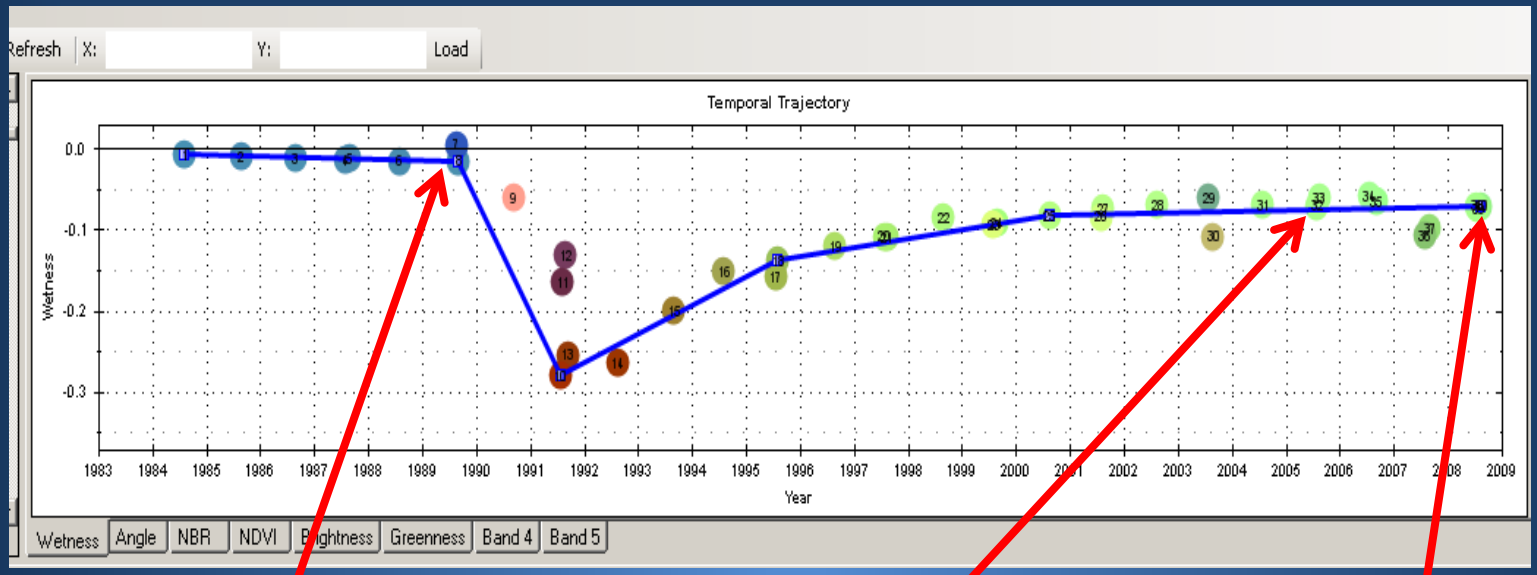
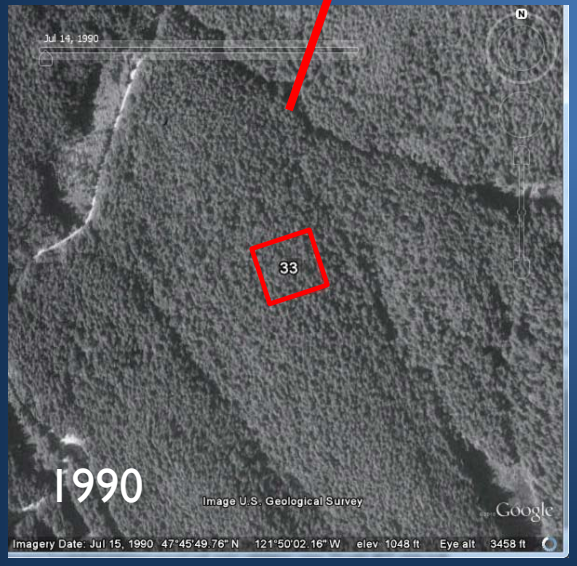
LandTrendr outputs

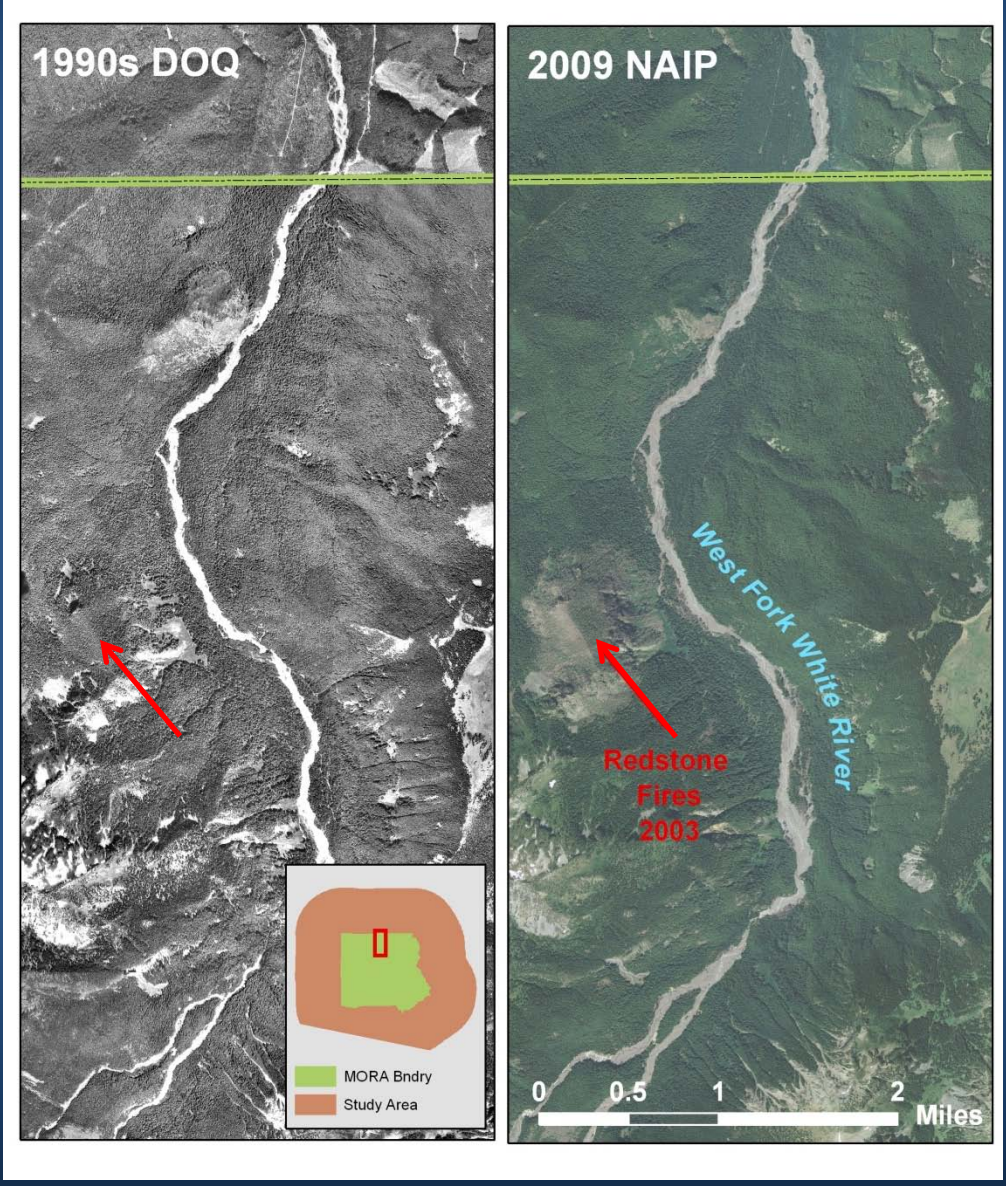


Spectral trajectory

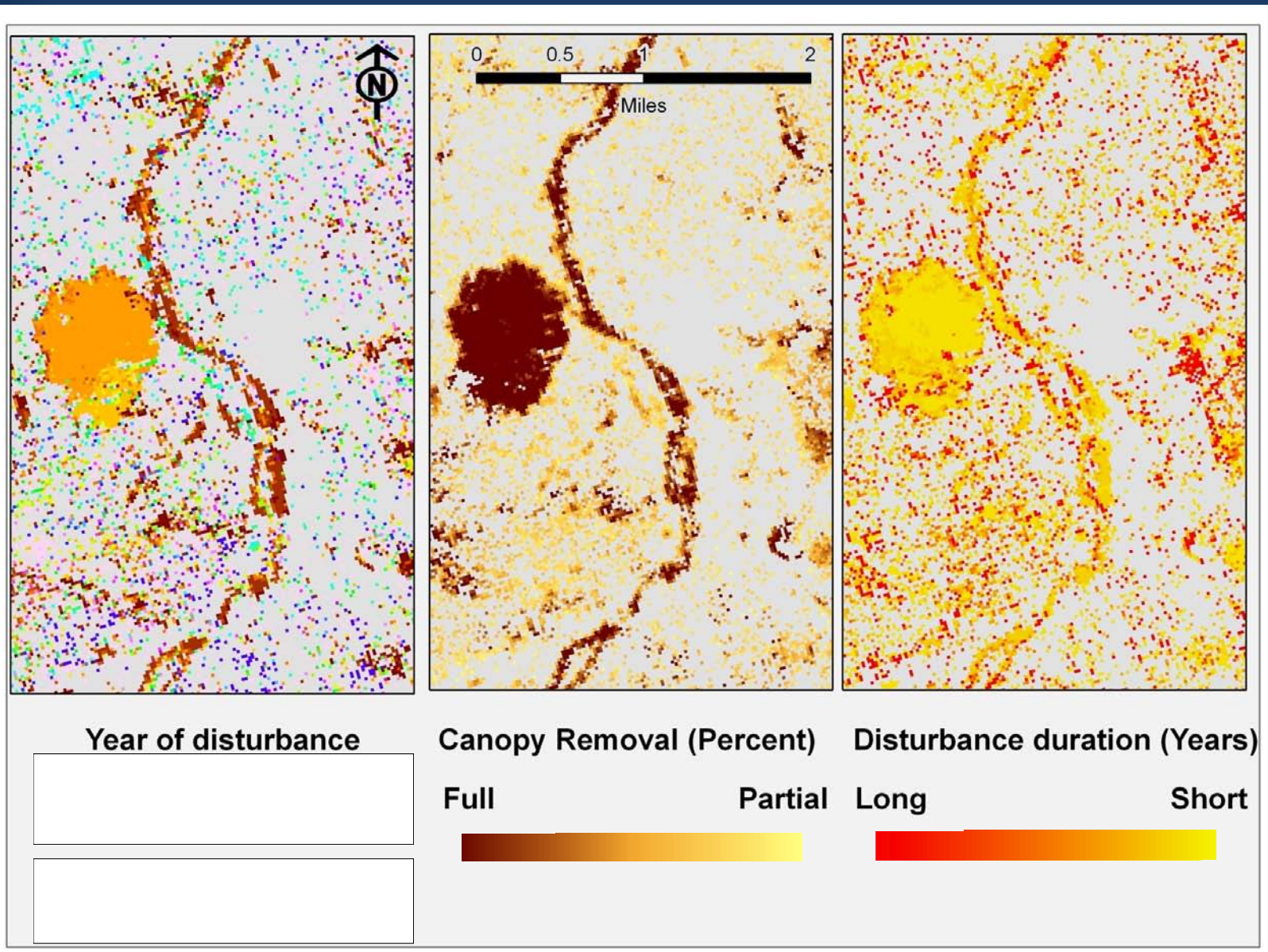




LandTrendr outputs-



LandTrendr outputs- unfiltered



LandTrendr for monitoring

LandTrendr is a remarkably sensitive tool for detecting vegetation change

Steps needed to apply to NCCN monitoring:

1. Filter results to define disturbance events
2. Attribute event with disturbance agent
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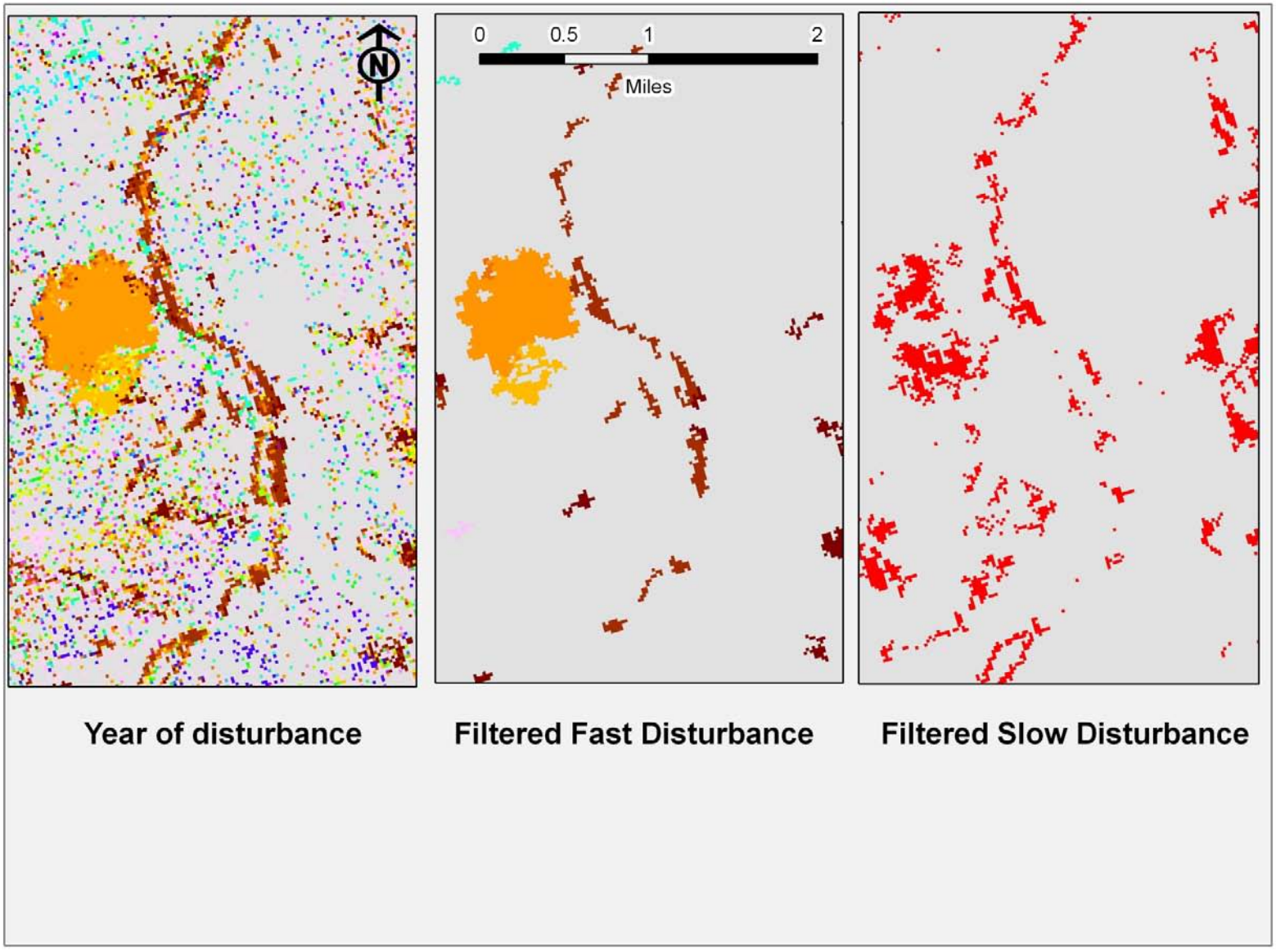
LandTrendr outputs- filtered



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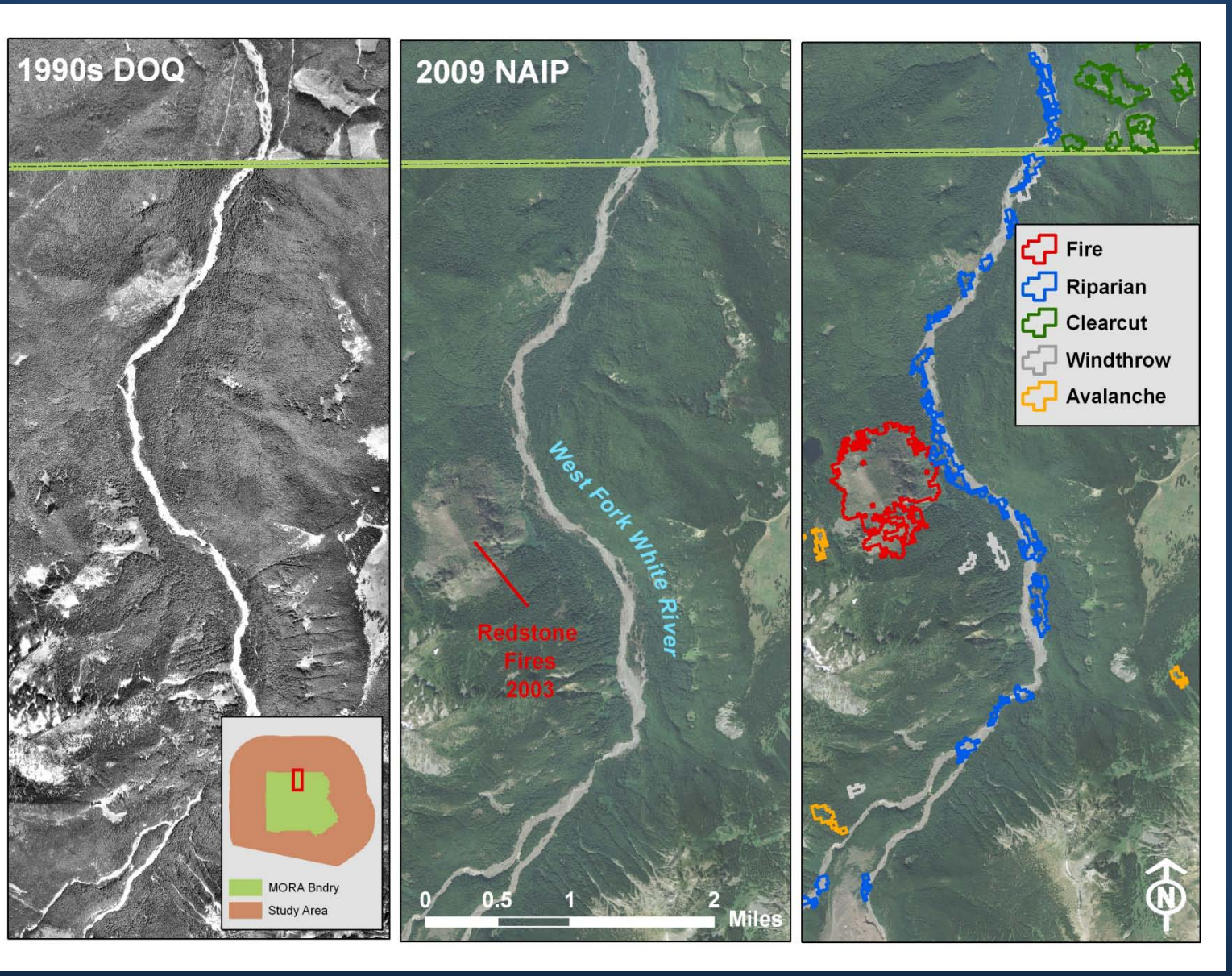
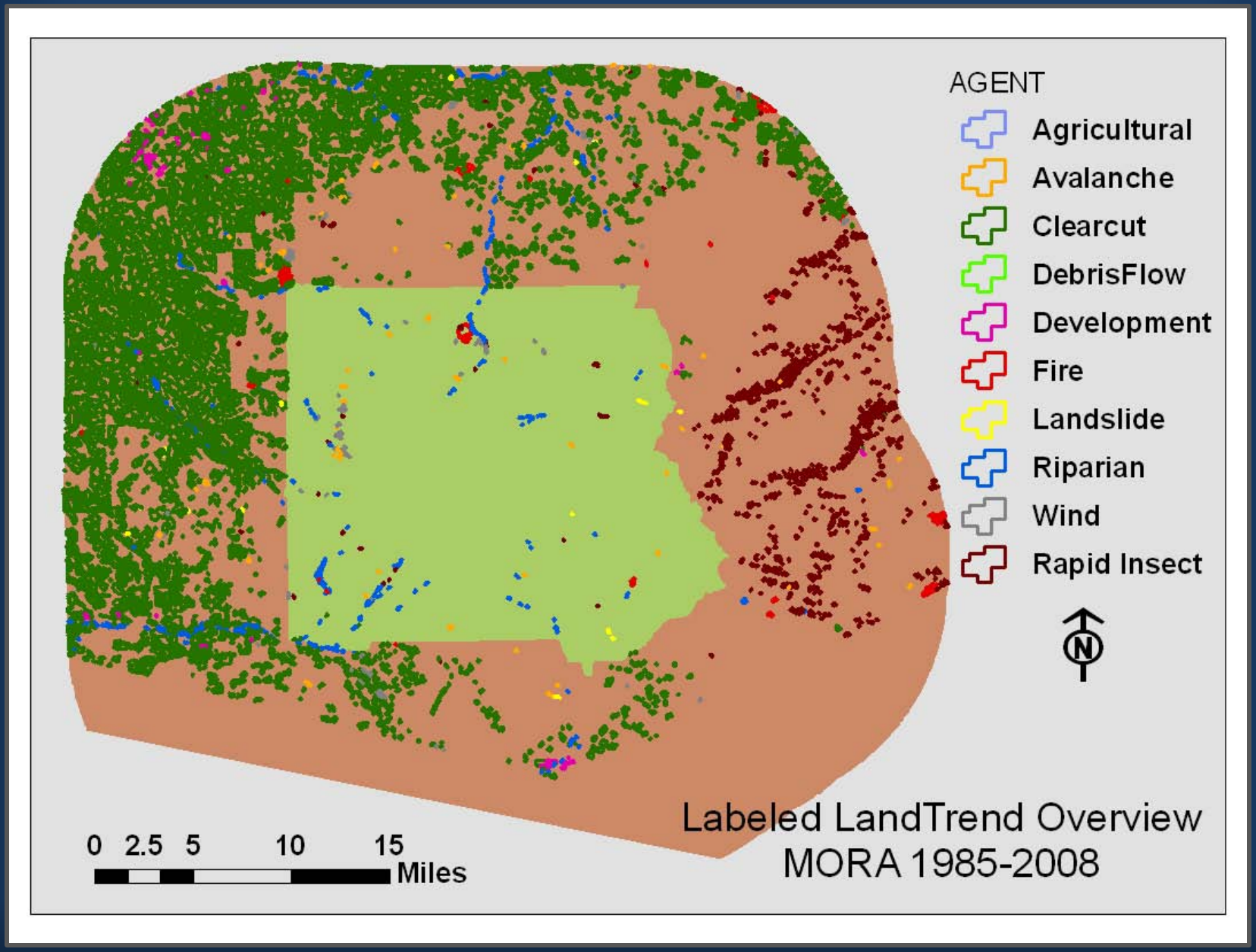
Modeling disturbance agents

- Create training data set of disturbance polygons
- Extract predictive variables for each polygon
  - GIS Data
    - Elevation, slope and aspect
    - Distance to stream
    - Polygon area and geometry
  - LandTrendr Data
    - Magnitude, duration
    - Pre and post-disturbance reflectance
- Use Random Forests to classify training data
  - Overall model error 17.4
  - Per class errors ranged from 0.08 for clearcuts to 0.49 for avalanches
- Apply model to entire dataset

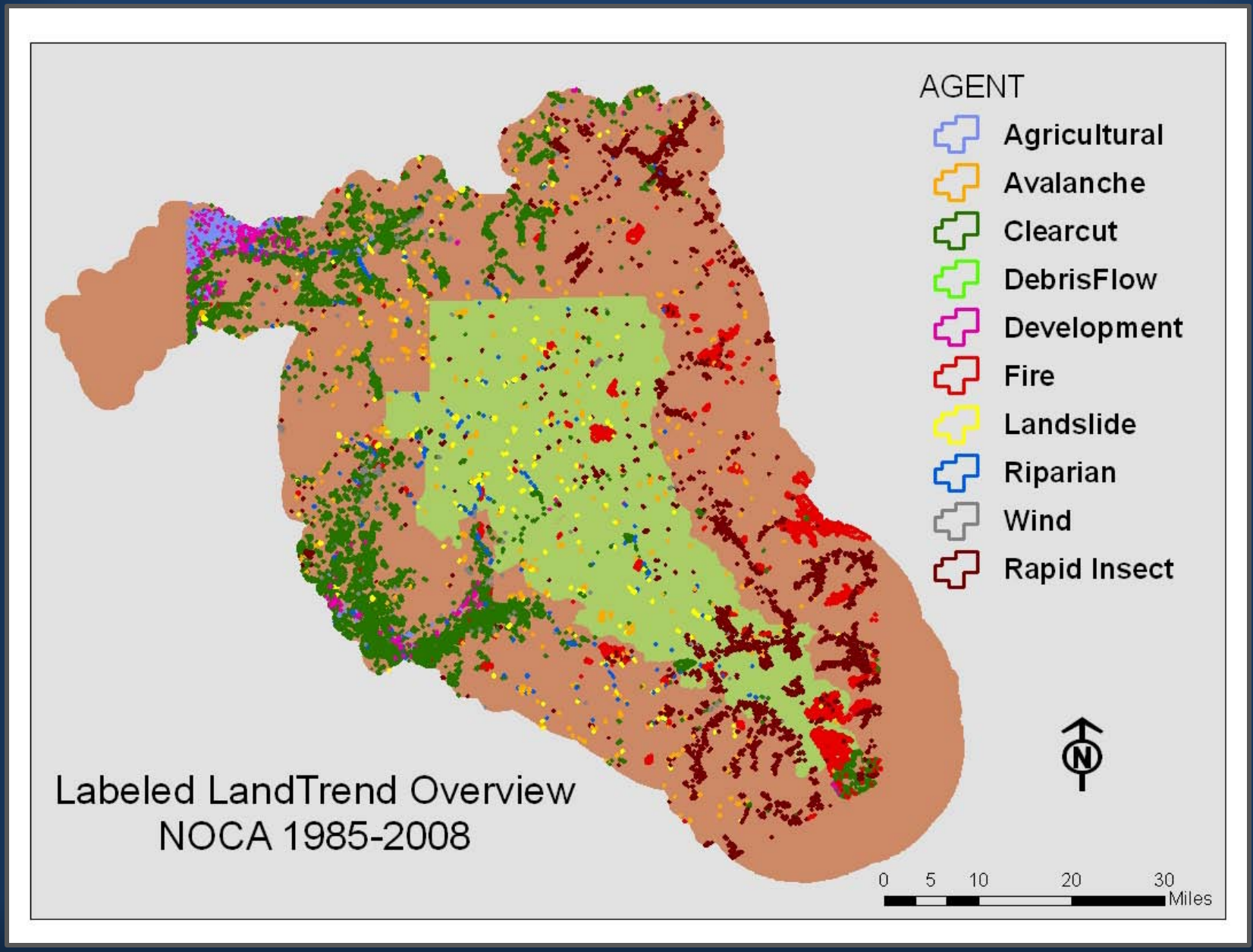
LandTrendr outputs- filtered and labeled maps



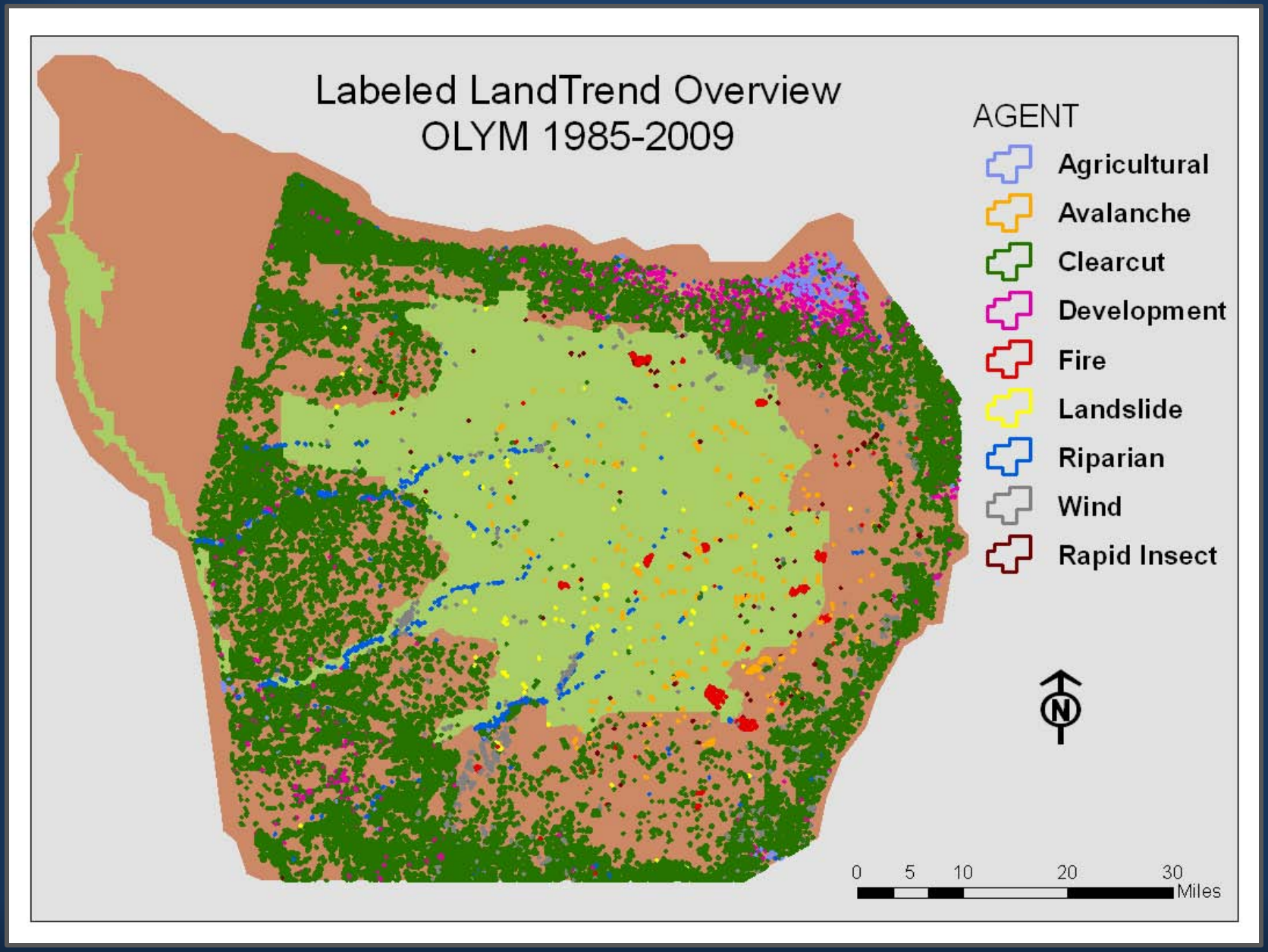
Results- Mount Rainier 1985 to 2008



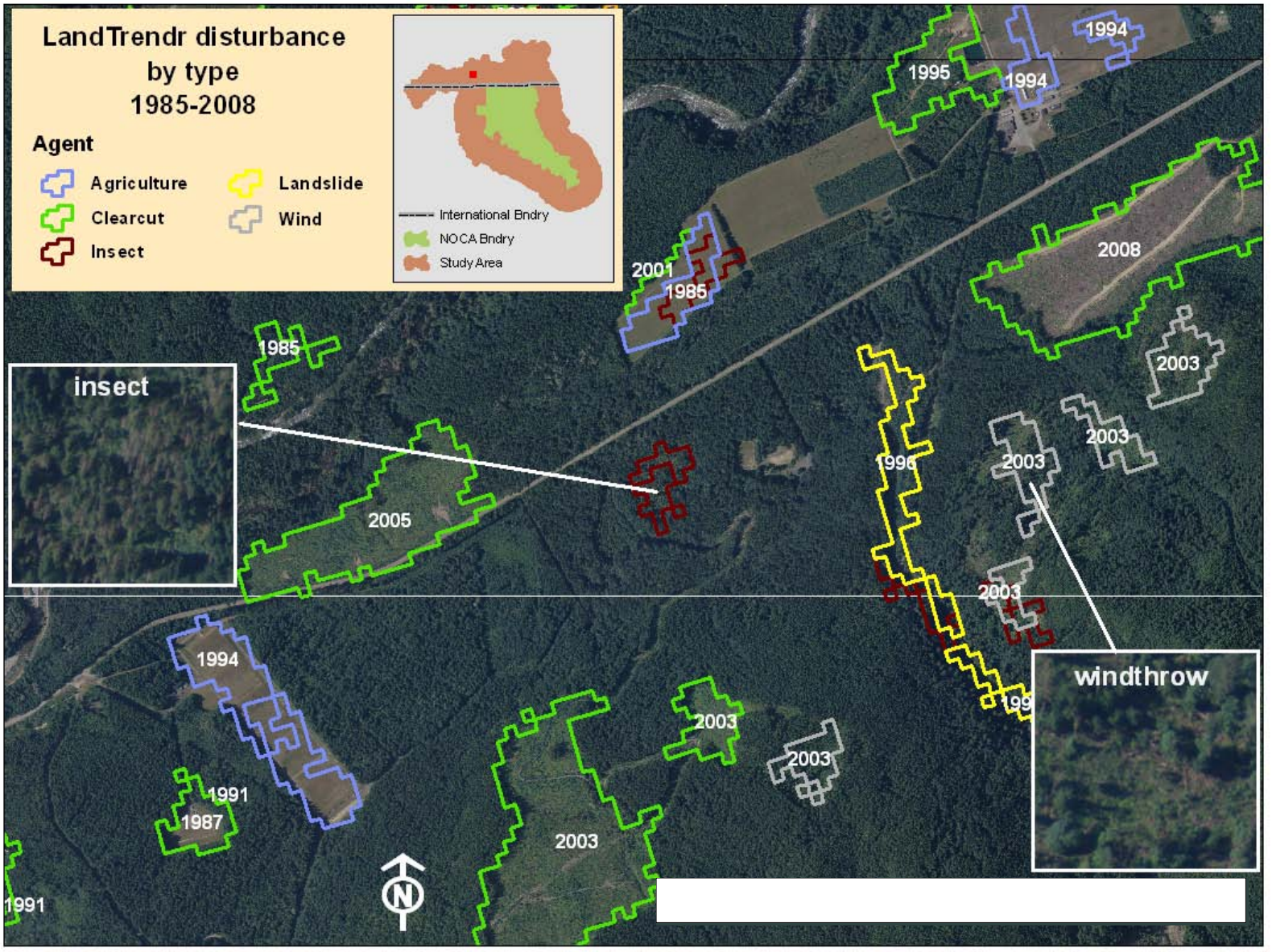
Results- North Cascades 1985-2008



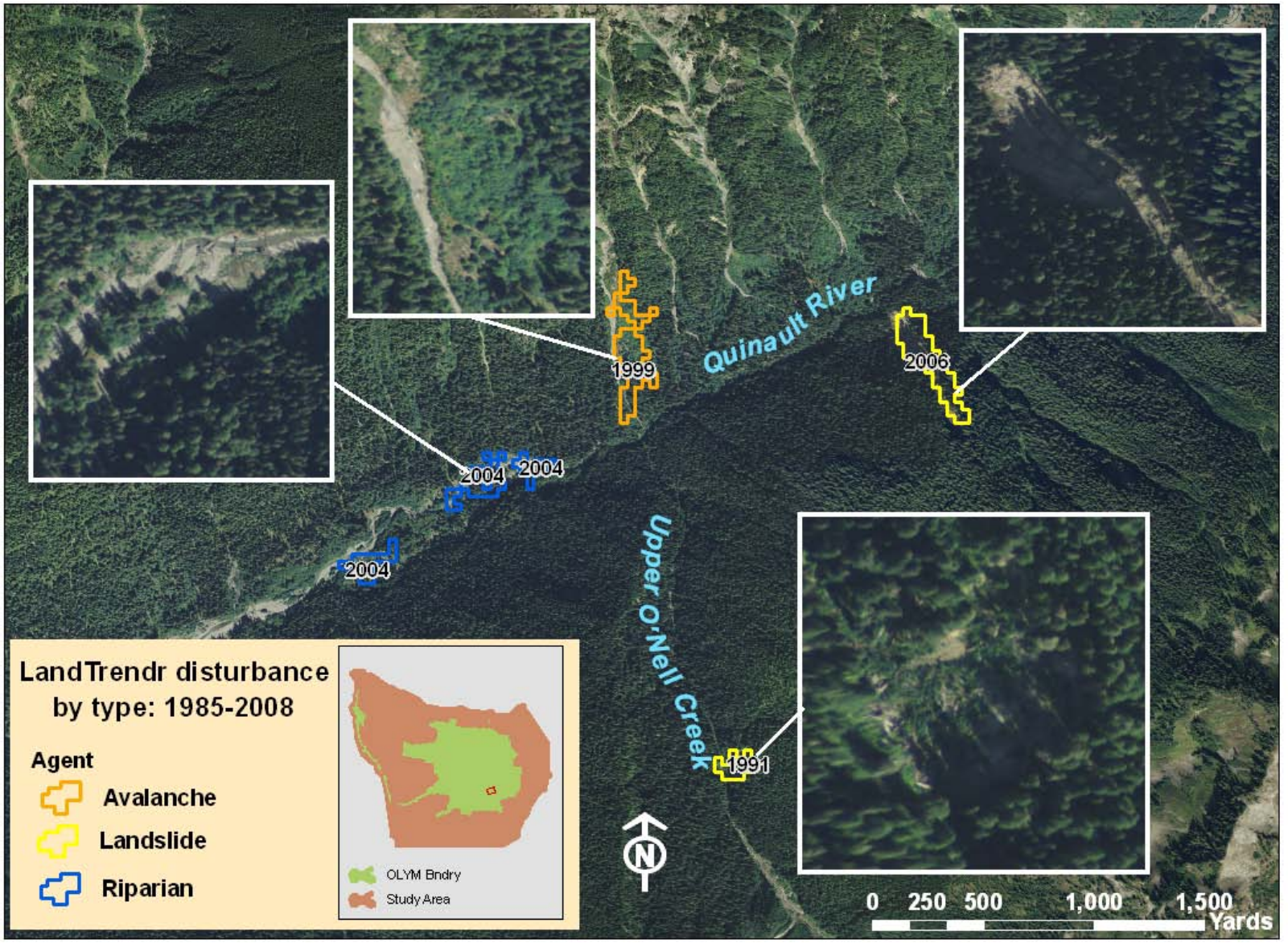
Results- Olympic 1985-2009



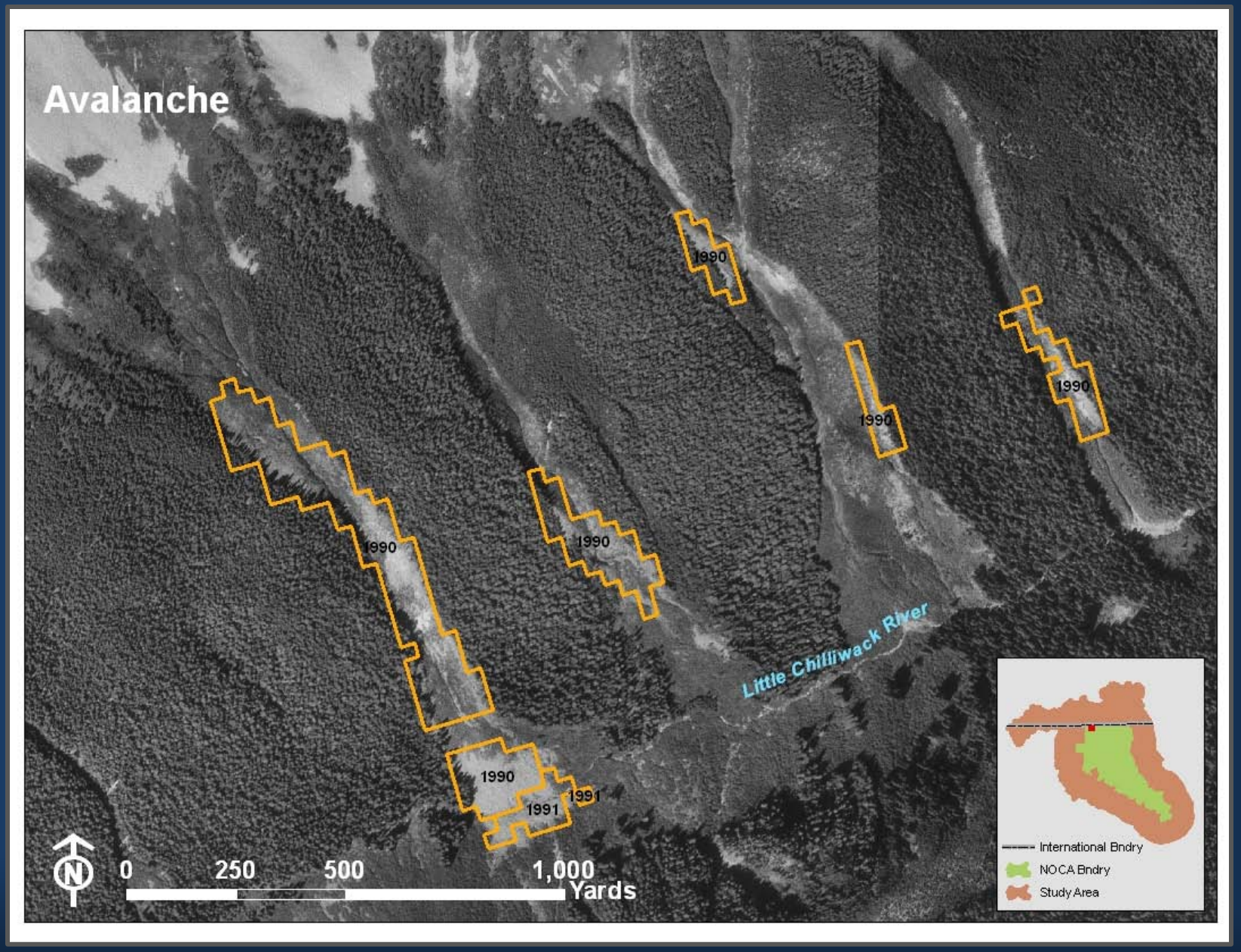
Results - outside park boundary



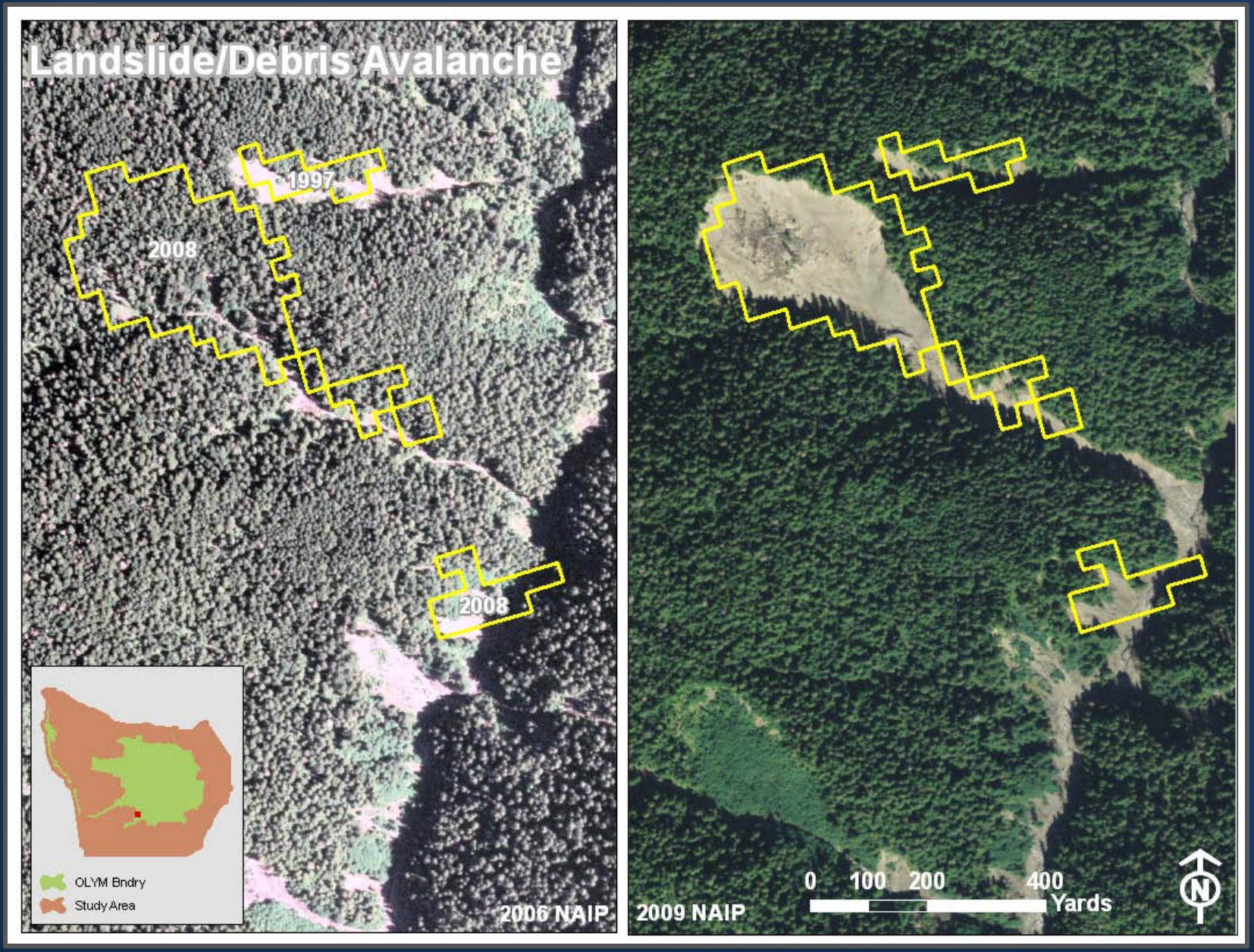
Results- inside park boundary



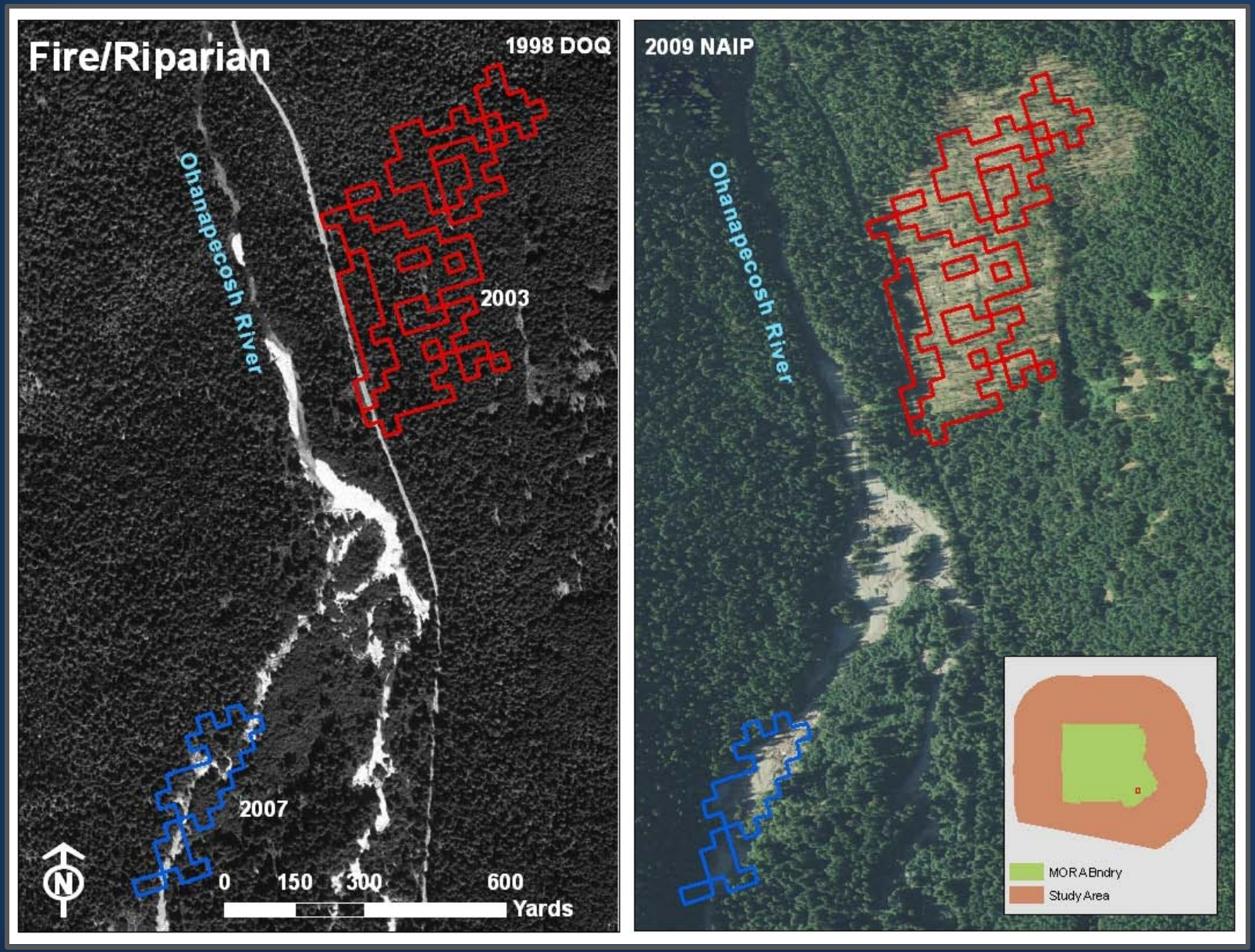
Results- Avalanche chute clearing



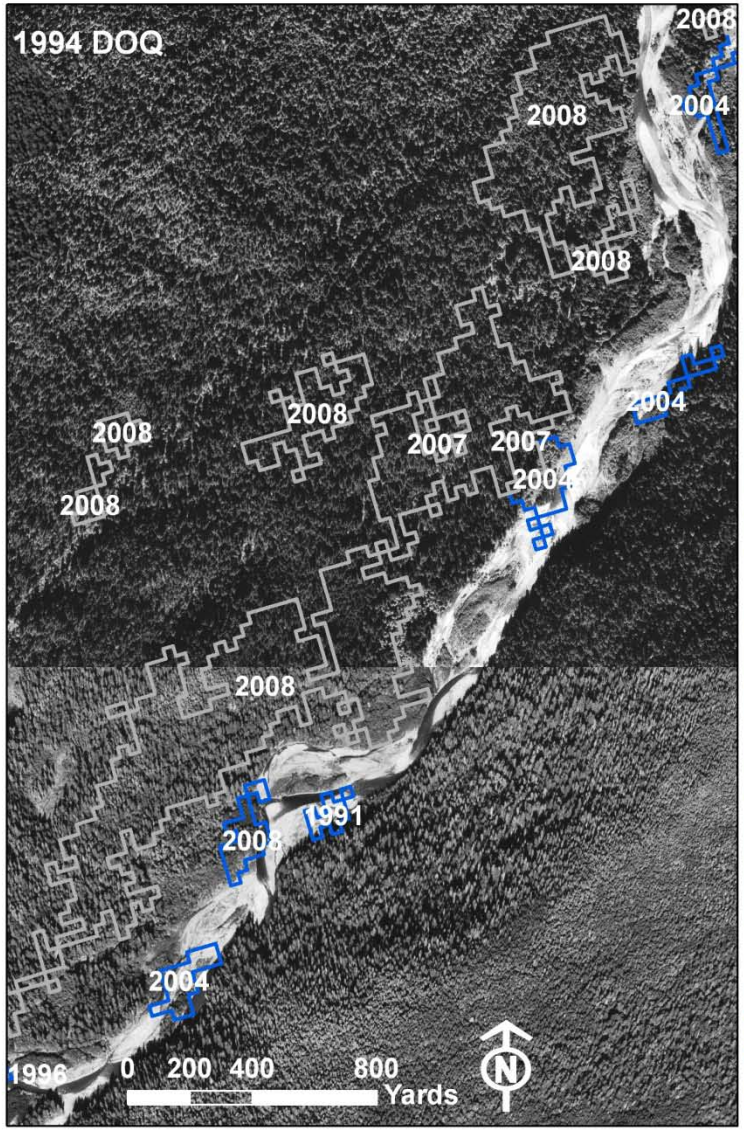
Results- Landslides

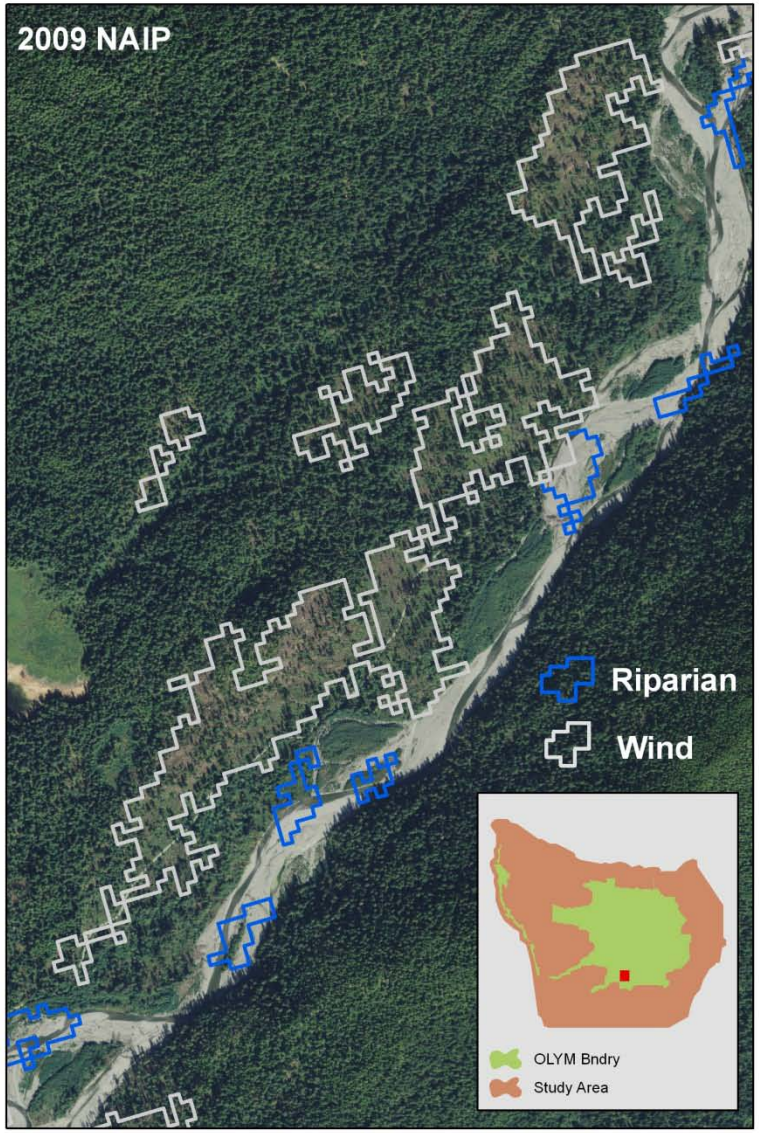


Results- Fire/Riparian

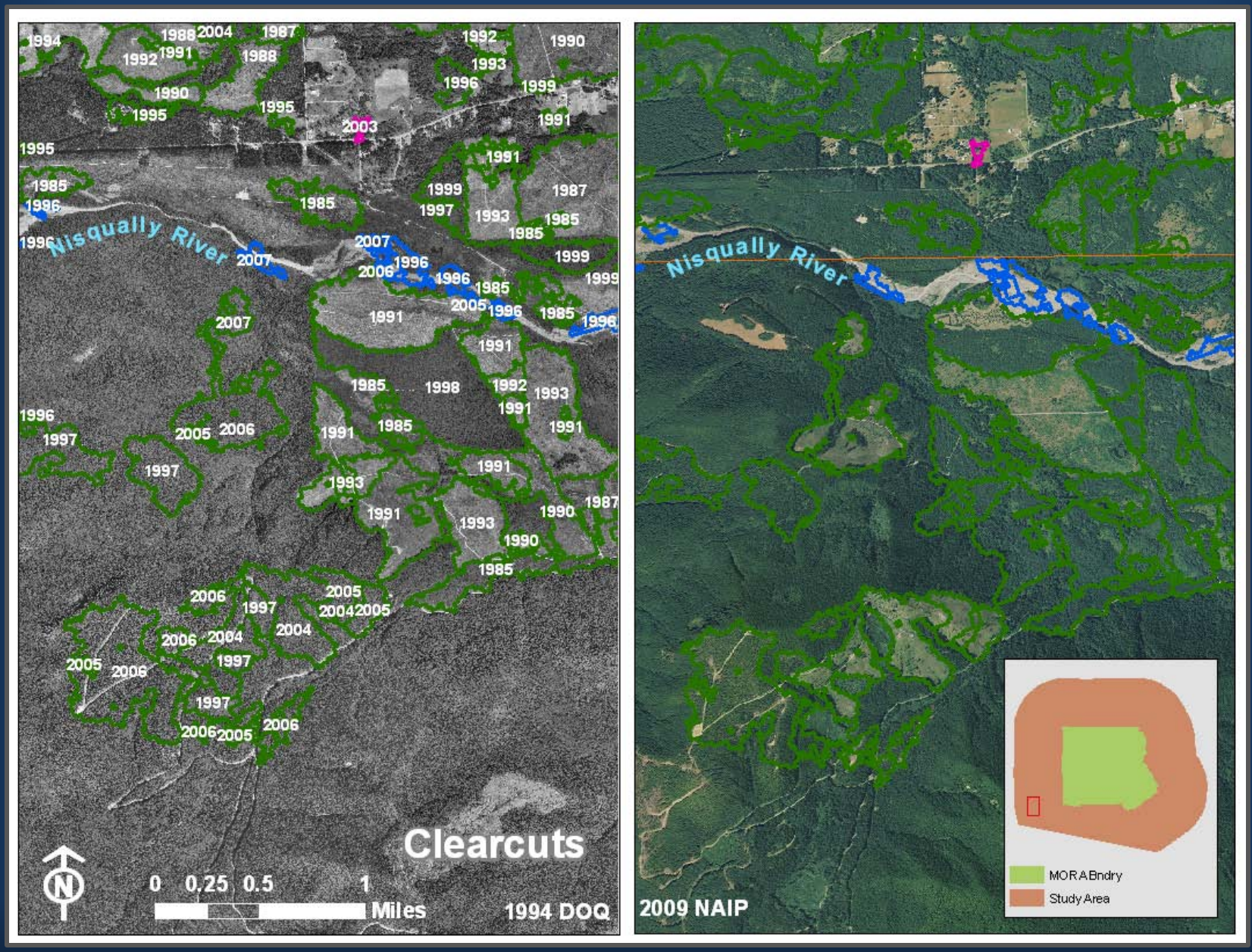


Results- Windthrow

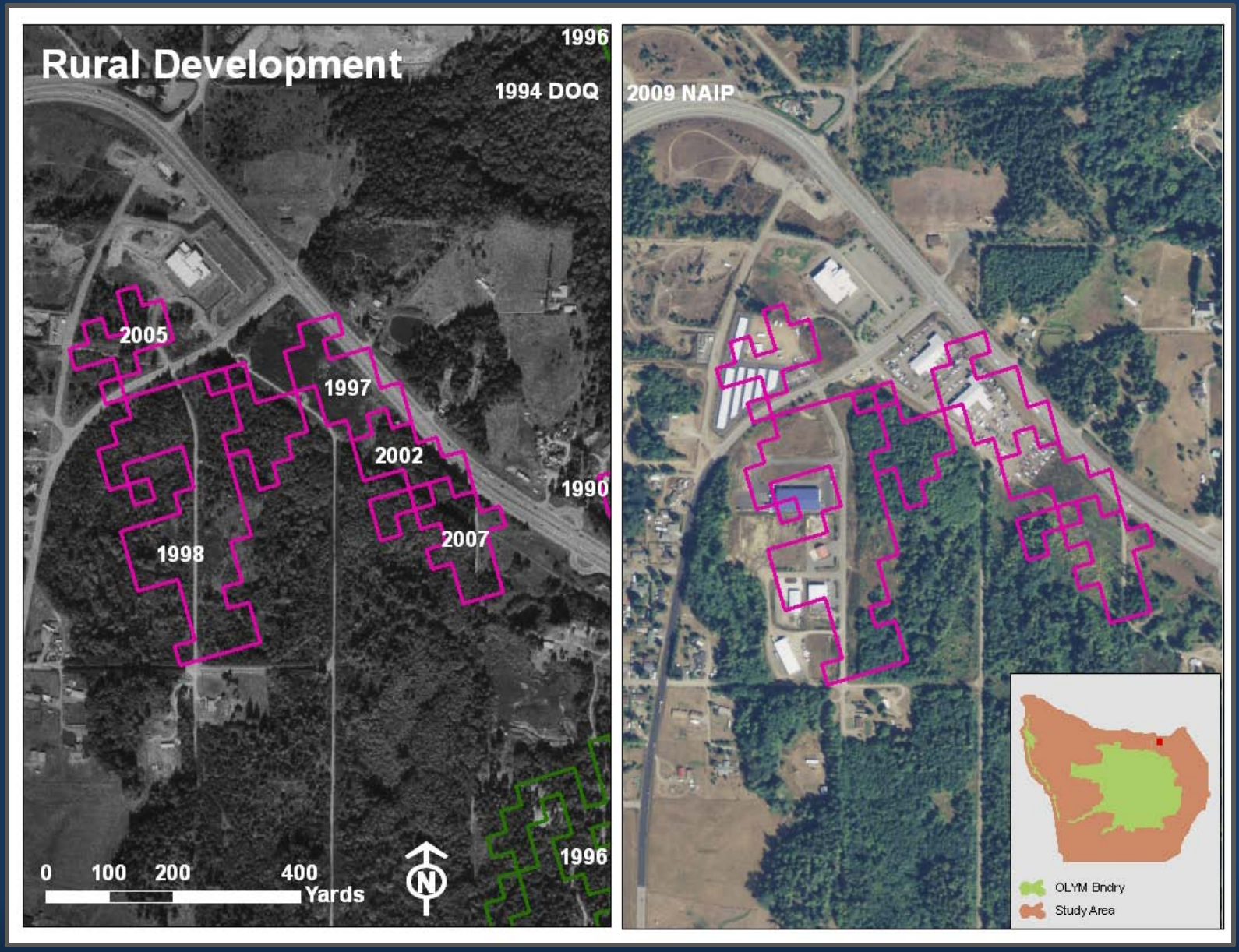




Results- Clearcuts



Results- Rural development



LandTrendr for monitoring

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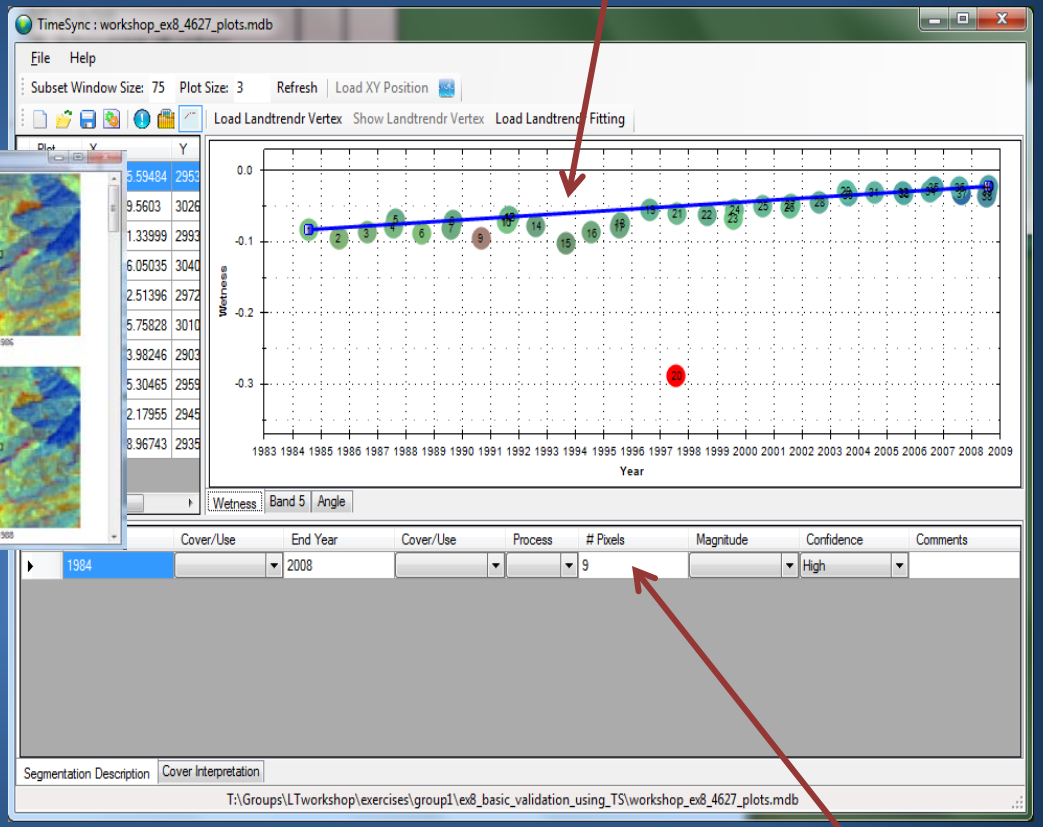
Steps needed to apply to NCCN monitoring

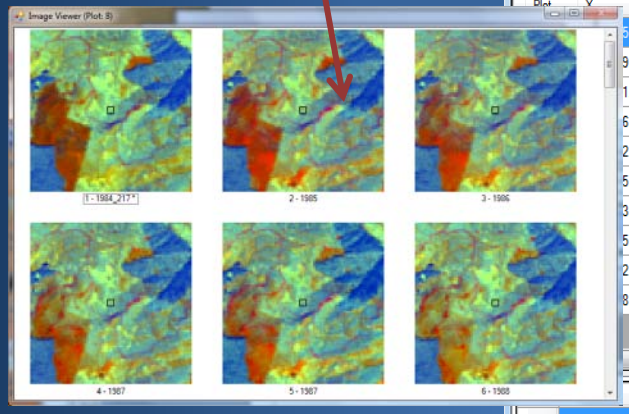
1. Filter results to define disturbance events
2. Attribute event with disturbance agent
3. Validate using available aerial imagery

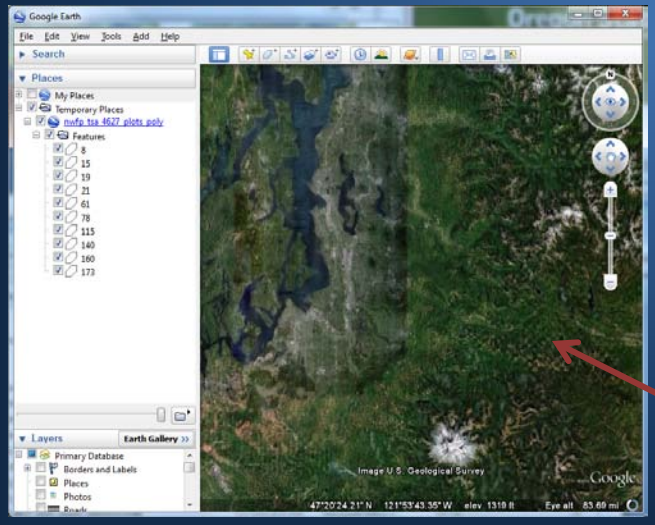
Validation with TimeSync

1) Visualize entire image stack

2) Visualize vertices







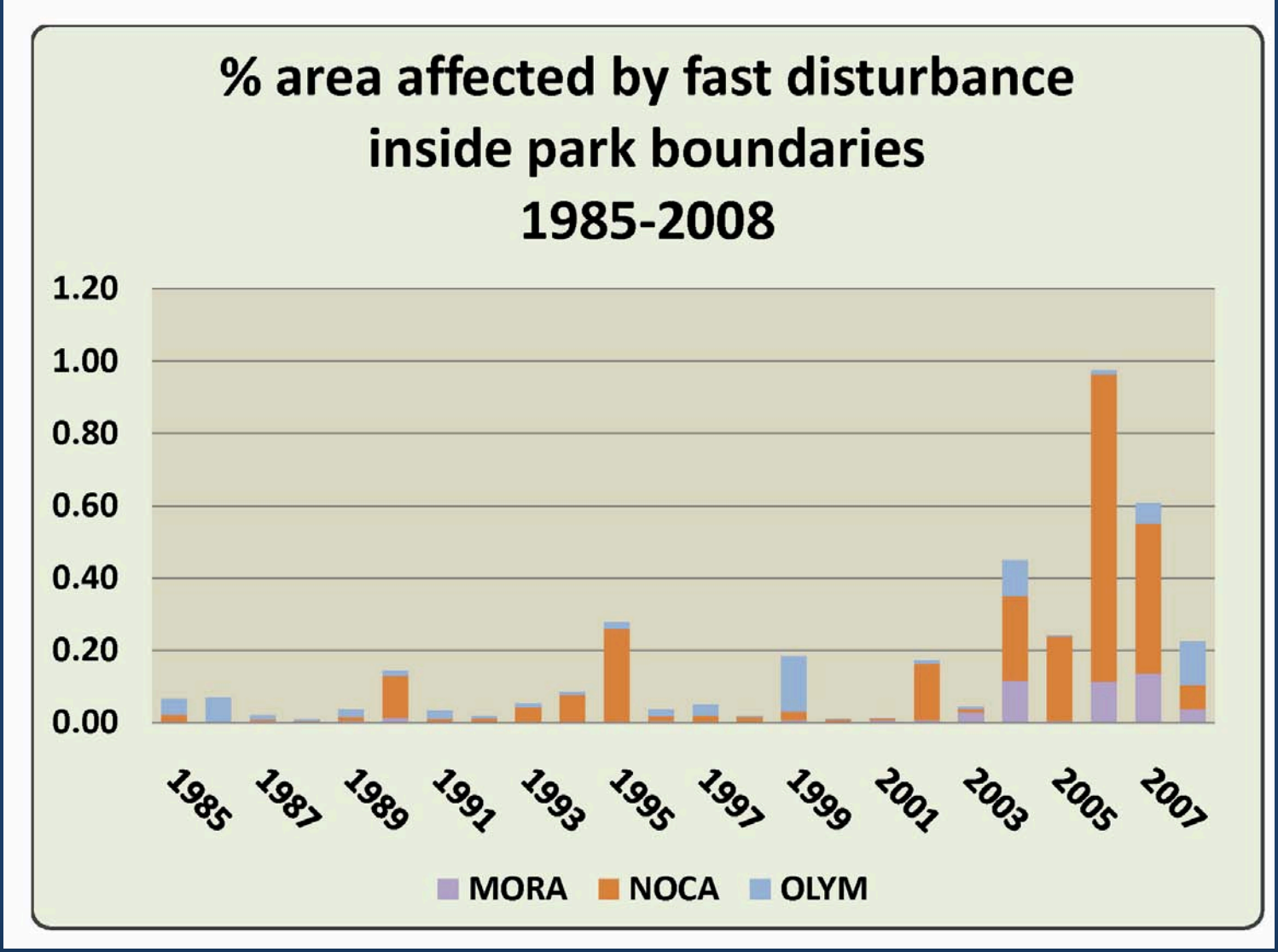
3) Link with Google Earth for corroboration

4) Populate interpretation database

LandTrendr for NCCN monitoring

- Total area affected by disturbance by year
- Area and number of each disturbance type
- Top events by size, magnitude
- Disturbance interactions
  - Slow change followed by wind or fire
- Climate interactions
  - Events in relation to temperature or precipitation anomalies

Example data summaries



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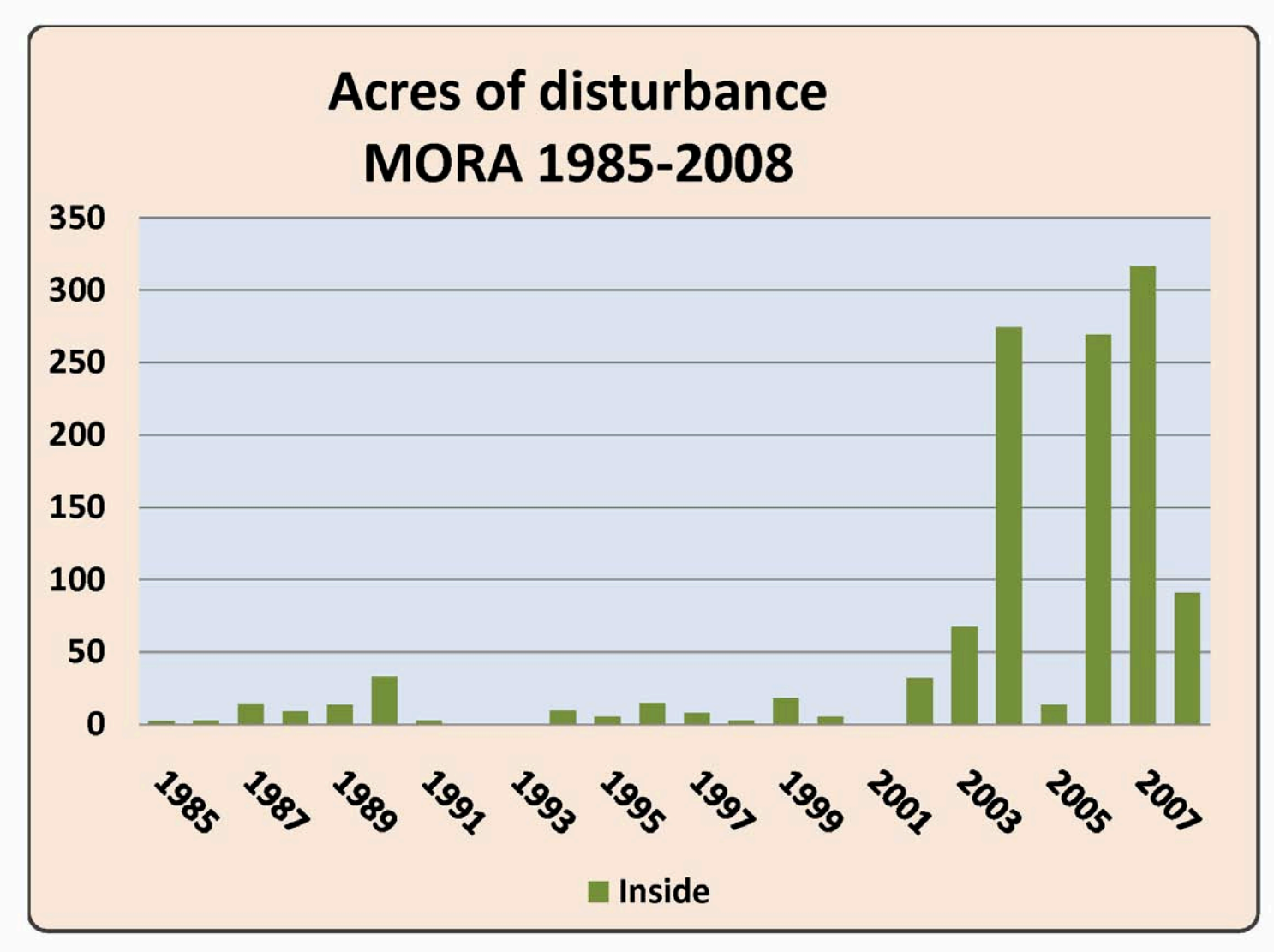

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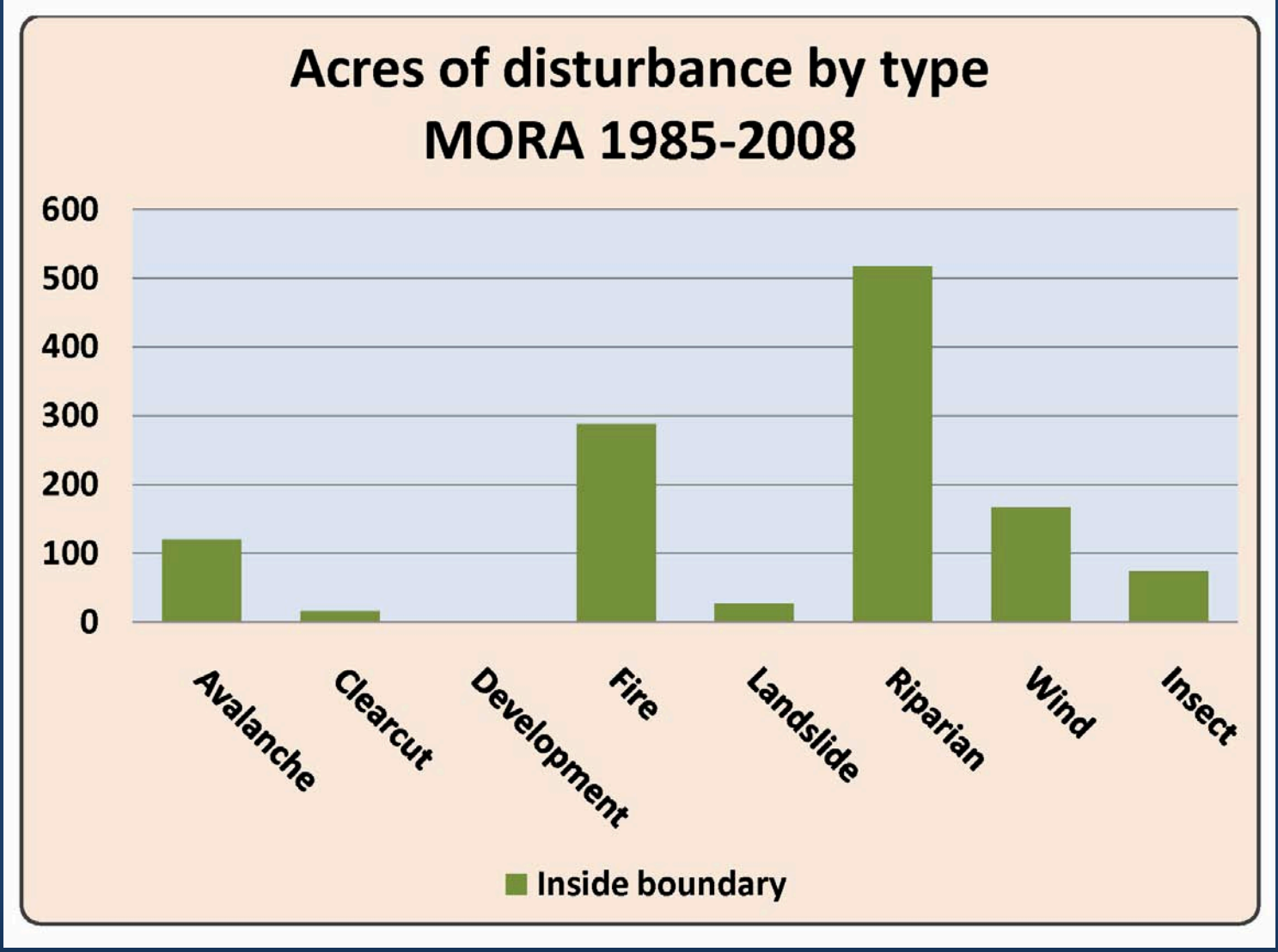

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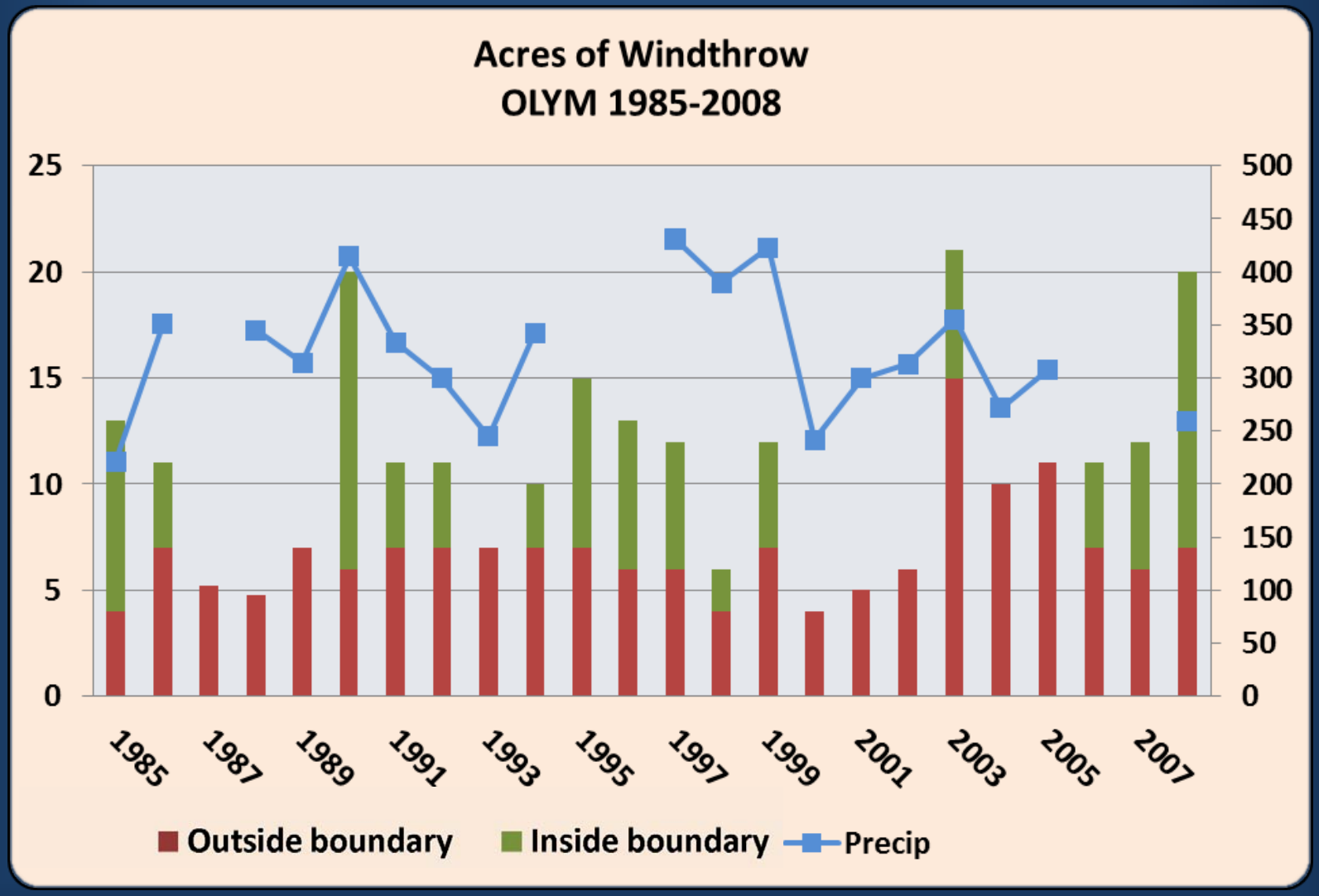

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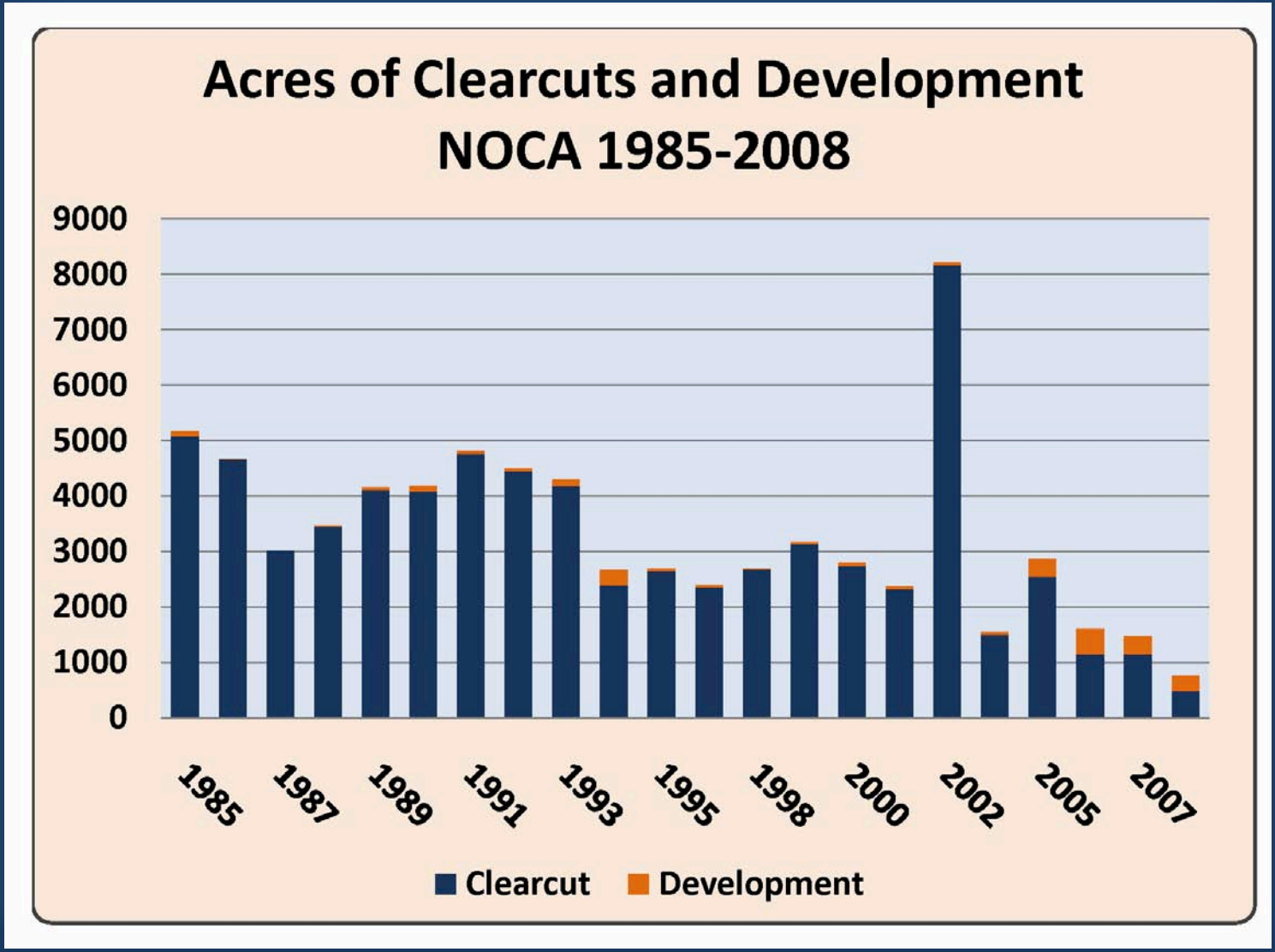


Example data summaries

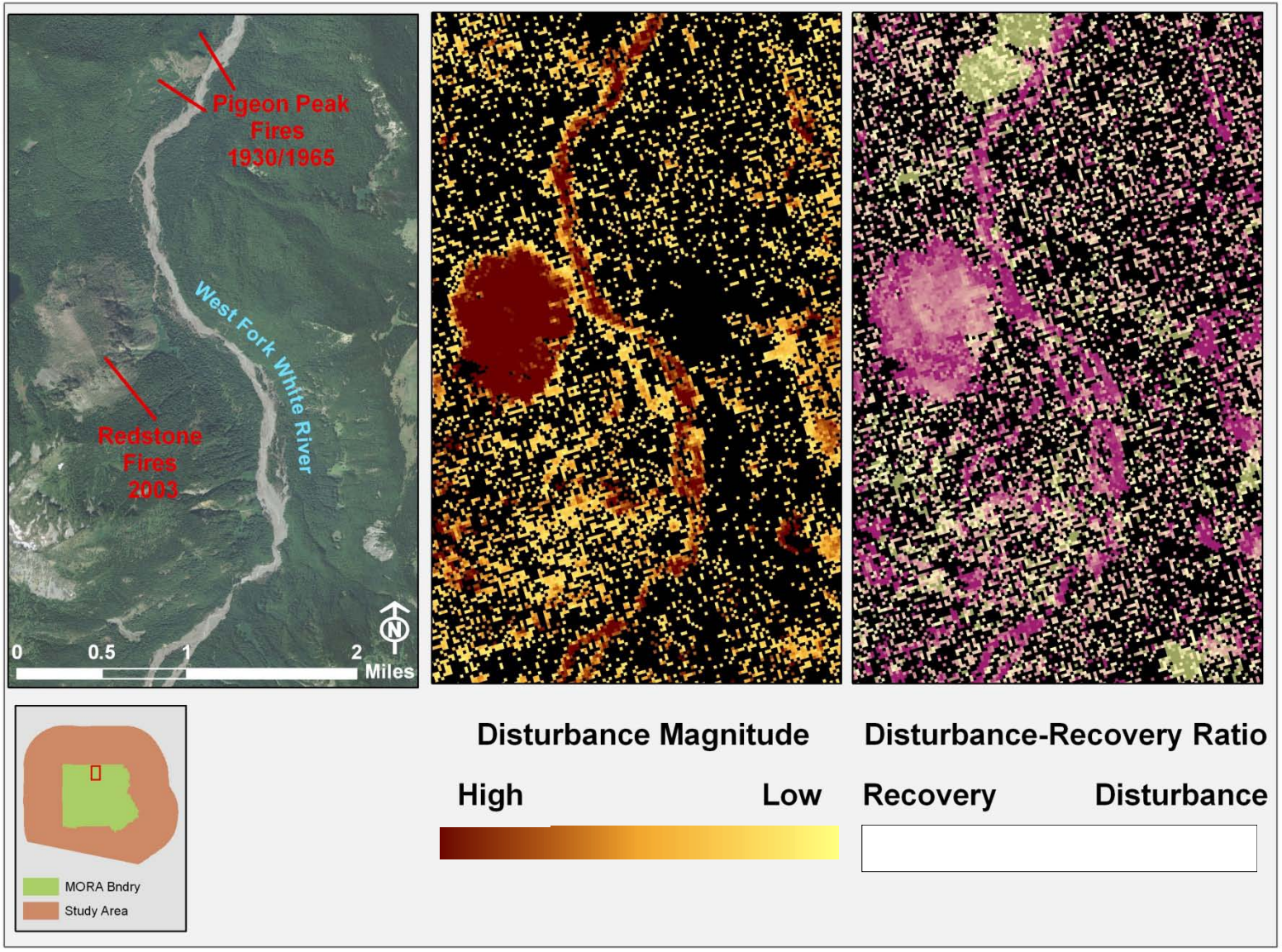
Top 10 events by size by park in 2007

NOCA		MORA		OLYM	
Agent	**Acres**	**Agent**	**Acres**	**Agent**	**Acres**
Fire	1284.78	Riparian	23.13	Wind	44.70
Fire	161.46	Wind	18.24	Wind	27.58
Rapid Insect	59.38	Wind	15.35	Wind	23.13
Rapid Insect	49.37	Riparian	13.34	Wind	17.35
Rapid Insect	45.81	Riparian	12.68	Wind	16.23
Rapid Insect	27.80	Riparian	8.90	Riparian	14.01
Rapid Insect	25.13	Riparian	8.01	Wind	12.45
Rapid Insect	20.46	Riparian	7.78	Wind	11.12
Fire	20.46	Wind	7.78	Wind	10.45
Rapid Insect	19.79	Riparian	7.34	Riparian	9.34

Challenges left to address:

- Agent model development
- Agent model validation
  - Field accuracy assessment this summer
- Insects and other slow changes
  - Difficult to validate
- Adding growth and recovery component

LandTrendr- Growth



Thank you!