Supplementary Information for "A new approach to ecosystem disturbance detection and attribution (*disturbr*) using temporal and spatial information"

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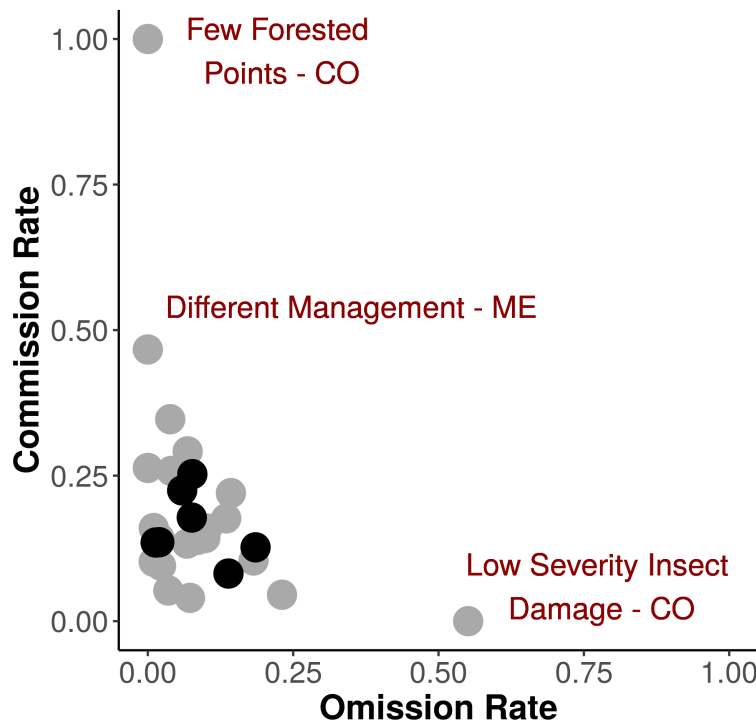[4]*Corresponding Author:* coope378@msu.edu

Figure S1: Commission and omission errors for each Landsat scene. Black points indicate the overall commission and omission errors for each Landsat scene. Grey points indicate the accuracies of individual validation blocks within scenes. Red text indicates potential reasons for outlying error rates, along with the abbreviation of the state in which the block errors occurred.
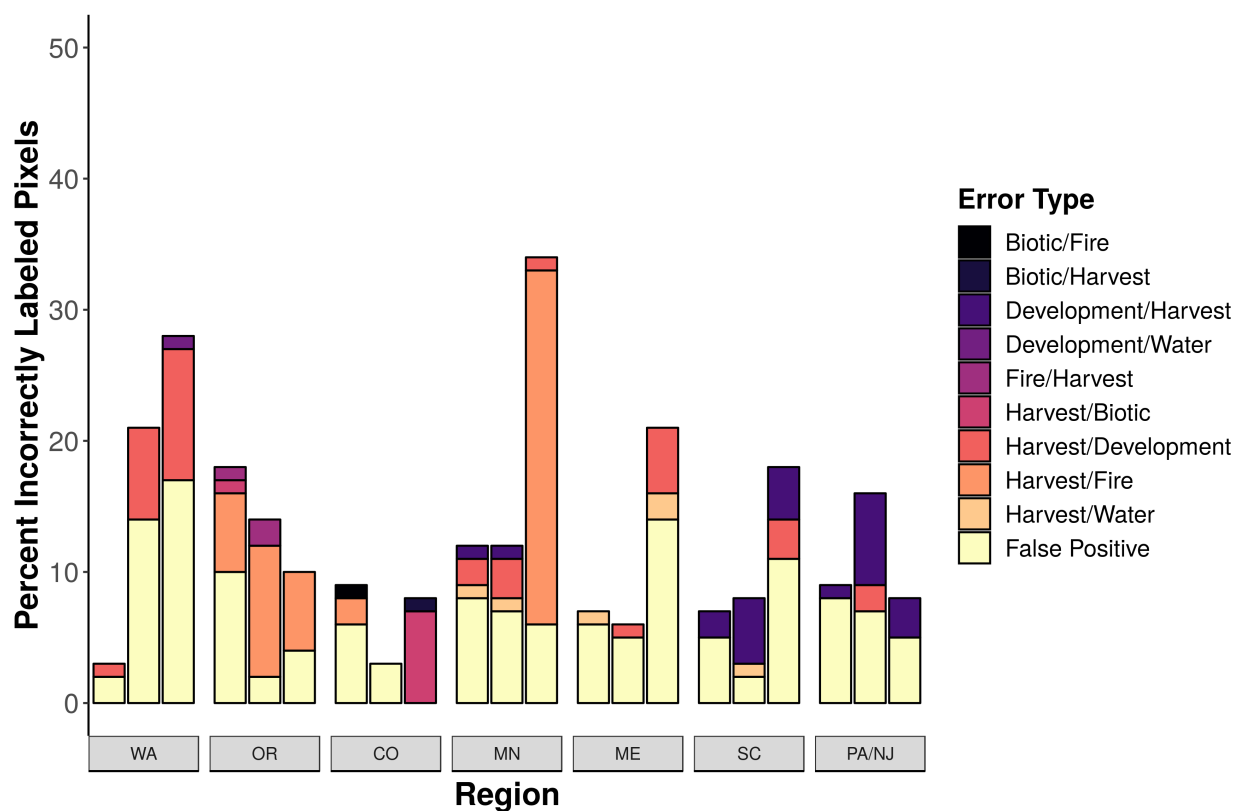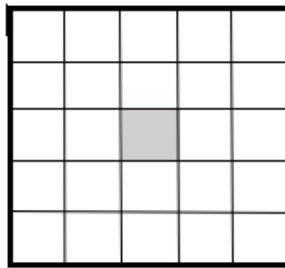
Figure S2: Types of errors in pixels labeled disturbance for each validation block within each Landsat scene. The bars for each region correspond to the order of validation blocks in Table 2.

Temporal Variables

- Magnitude
- Duration
- Overall TS slope
- Minimum TS slope
- Variance in TS slope
- Overall loess slope
- Minimum loess slope
- Maximum loess slope
- Median loess slope
- Variance in loess slope
- Date of loess minimum
- Range of loess fitted NDVI
- NDVI Range
- NDVI mean average deviance (MAD)
- NDVI Variance
- Median NDVI
- Maximum NDVI
- Minimum NDVI
- Ratio of NDVI MAD to mean
- Pre- dist. NDVI variance
- Post-dist. NDVI variance
- Ratio of pre- to post-dist. variance
- Detected TS break date
- Min. slope of RPART model
- Max. Slope of RPART model
- Date of RPART minimum
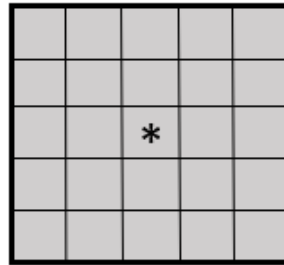
Spatial Variables

- Median magnitude
- Range in magnitude
- Ratio of magnitude
- Median duration
- Range in duration
- Ratio of duration
- Median minimum loess slope
- Range in minimum loess slope
- Ratio of minimum loess slope
- Median maximum loess slope
- Range in maximum loess slope
- Ratio of maximum loess slope
- Median median loess slope
- Range in median loess slope
- Ratio of median loess slope
- Range of date of loess minimum
- Range of detected TS break date
- Median ratio of pre- to post-dist. variance
- Range in ratio of pre- to post-dist. variance
- Ratio of ratio of pre- to post-dist. variance
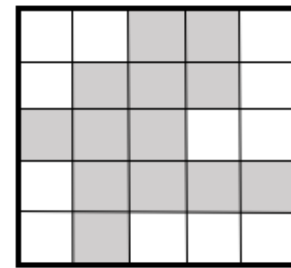
Disturbance Spatial Variables

- Median magnitude
- Range in magnitude
- Median duration
- Range in duration
- Median minimum loess slope
- Range in minimum loess slope
- Median maximum loess slope
- Range in maximum loess slope
- Median median loess slope
- Range of median loess slope
- Median date of loess minimum
- Range in date of loess minimum
- Median detected TS break date
- Range in detected TS break date
- Median overall TS slope
- Range in overall TS slope
- Number of pixels

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Figure S3: Full set of variables considered for the Random Forest detection and attribution models. Gridded boxes show the rough spatial domain of each variables (in grey). For disturbance spatial variables, the grey-shaded boxes represent pixels in which example disturbances were detected during the detection phase of the pipeline. These variables were not considered for the detection model as they are derived from that model. The asterisk in the spatial variable gridded box shows the pixel of interest, used to calculate the ratio of that pixels value relative to all values in the box.
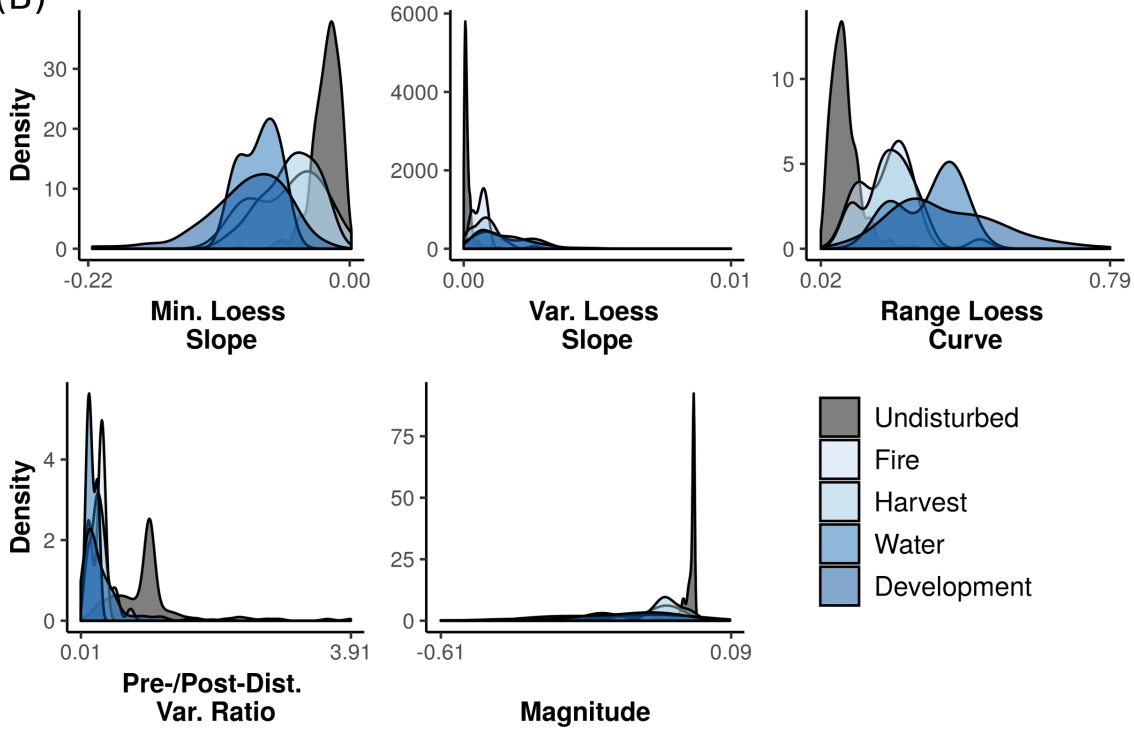
(A)
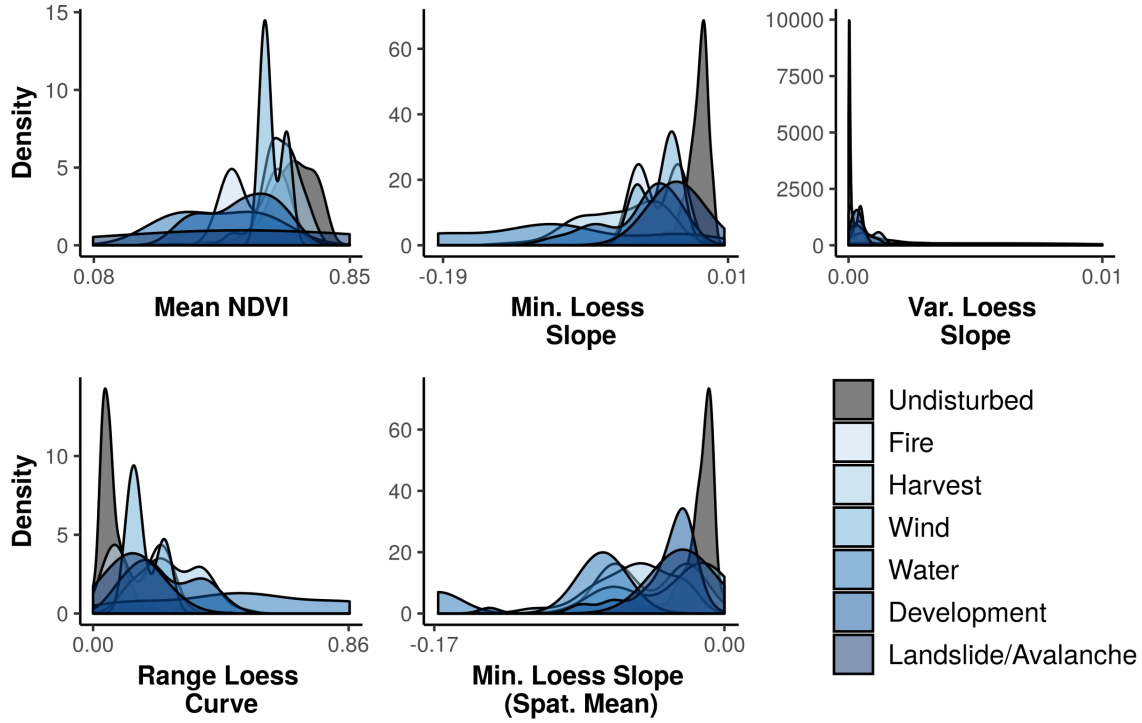
(B)

Figure S4: Density diagram of the top five most important variables for detection in the (A) Washington Landsat scene (path 47, row 27), and (B) Pennsylvania/New Jersey Landsat scene (path 14, row 32).

Table S1: Detection model results using only POI (temporal model type) and both POI and NPI (spatial model type). Shading indicates NPI models. Pixels from the attribution model validation that overlapped the detection results were used for detection validation.

Region Name	Validation Block	Commission Rate (%)	Omission Rate (%)	Kappa Accuracy (%)	n Disturbed	n Undisturbed
WA	2	10.0	5.8	84.8	50	69
	3	25.0	9.6	67.7	48	73
	6	34.7	6.4	62.4	49	78
	all	*23.1*	*7.3*	*71.7*	*147*	*220*
WA	2	6.0	7.3	86.7	50	69
	3	29.2	9.6	64.0	48	73
	6	30.6	3.9	69.0	49	78
	all	*21.8*	*6.8*	*73.4*	*147*	*220*
OR	1	29.0	0	77.0	38	81
	4	13.2	2.4	86.5	38	85
	5	9.5	3.4	87.7	42	88
	all	*16.9*	*2.0*	*84.0*	*118*	*254*
OR	1	26.3	0	79.2	38	81
	4	5.3	3.5	90.7	38	85
	5	11.9	2.3	87.5	42	88
	all	*14.4*	*2.0*	*86.0*	*118*	*254*
CO	2	26.7	7.9	68.1	45	89
	7	66.7	0	49.3	3	100
	9	38.7	49.0	28.4	62	49
	all	*34.5*	*13.0*	*55.0*	*110*	*238*
CO	2	13.3	5.6	81.8	45	89
	7	100	0	0	3	100
	9	0	51.0	64.1	62	49
	all	*8.2*	*12.6*	*76.3*	*110*	*238*
MN	1	29.0	5.1	69.3	31	99
	4	25.0	8.2	68.8	33	98
	6	32.6	8.5	62.1	43	94
	all	*28.8*	*7.2*	*66.7*	*118*	*291*
MN	1	25.8	4.0	73.6	31	99
	4	13.6	10.2	75.1	33	98
	6	14.0	8.5	77.2	43	94
	all	*16.9*	*7.6*	*75.6*	*118*	*291*

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Region Name	Validation Block	Commission Rate (%)	Omission Rate (%)	Kappa Accuracy (%)	n Disturbed	n Undisturbed
ME	2	35.3	14.6	51.5	34	89
	3	17.1	13.2	67.4	35	91
	7	43.3	0	66.5	30	94
	all	*31.3*	*9.1*	*61.6*	*99*	*274*
ME	2	20.6	12.4	65.9	34	89
	3	14.3	12.1	70.9	35	91
	7	50.0	1.1	58.3	30	94
	all	*27.3*	*8.4*	*65.9*	*99*	*274*
SC	1	16.7	19.5	64.8	48	77
	4	11.4	19.2	68.4	44	78
	5	36.0	14.3	53.1	50	77
	all	*21.8*	*17.7*	*62.1*	*142*	*232*
SC	1	10.4	20.8	68.6	48	77
	4	2.3	21.8	72.7	44	78
	5	22.0	13.0	66.8	50	77
	all	*12.0*	*18.5*	*69.3*	*142*	*232*
PA/NJ	1	20.0	1.0	82.7	50	98
	7	10.2	2.0	89.3	49	100
	8	20.4	1.0	82.5	49	99
	all	*16.9*	*1.3*	*84.8*	*148*	*297*
PA/NJ	1	16.0	1.0	86.0	50	98
	7	14.3	2.0	86.0	49	100
	8	10.2	2.0	89.2	49	99
	all	*13.5*	*1.7*	*87.1*	*148*	*297*