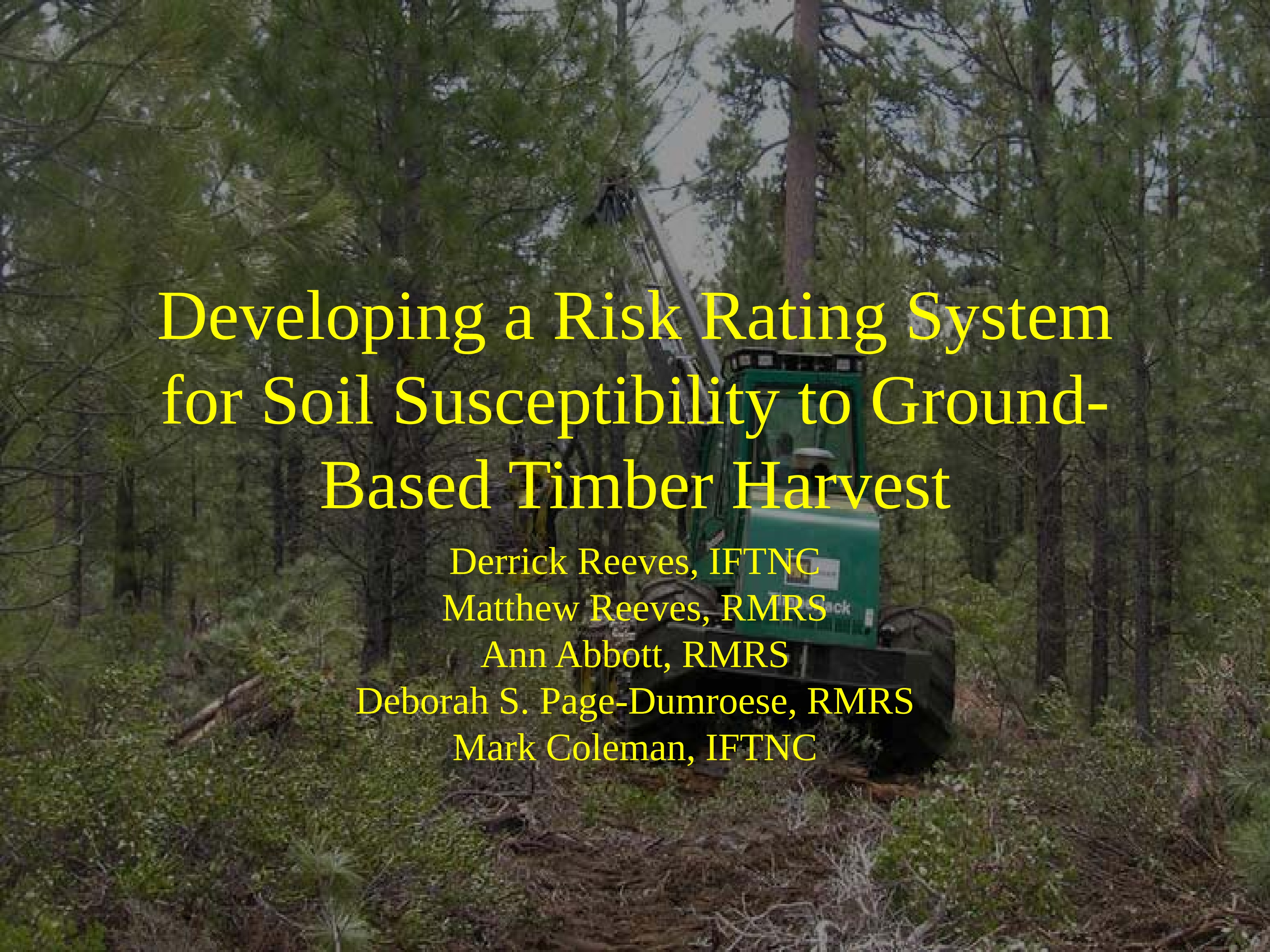

Developing a Risk Rating System for Soil Susceptibility to Ground-Based Timber Harvest

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Presentation Outline

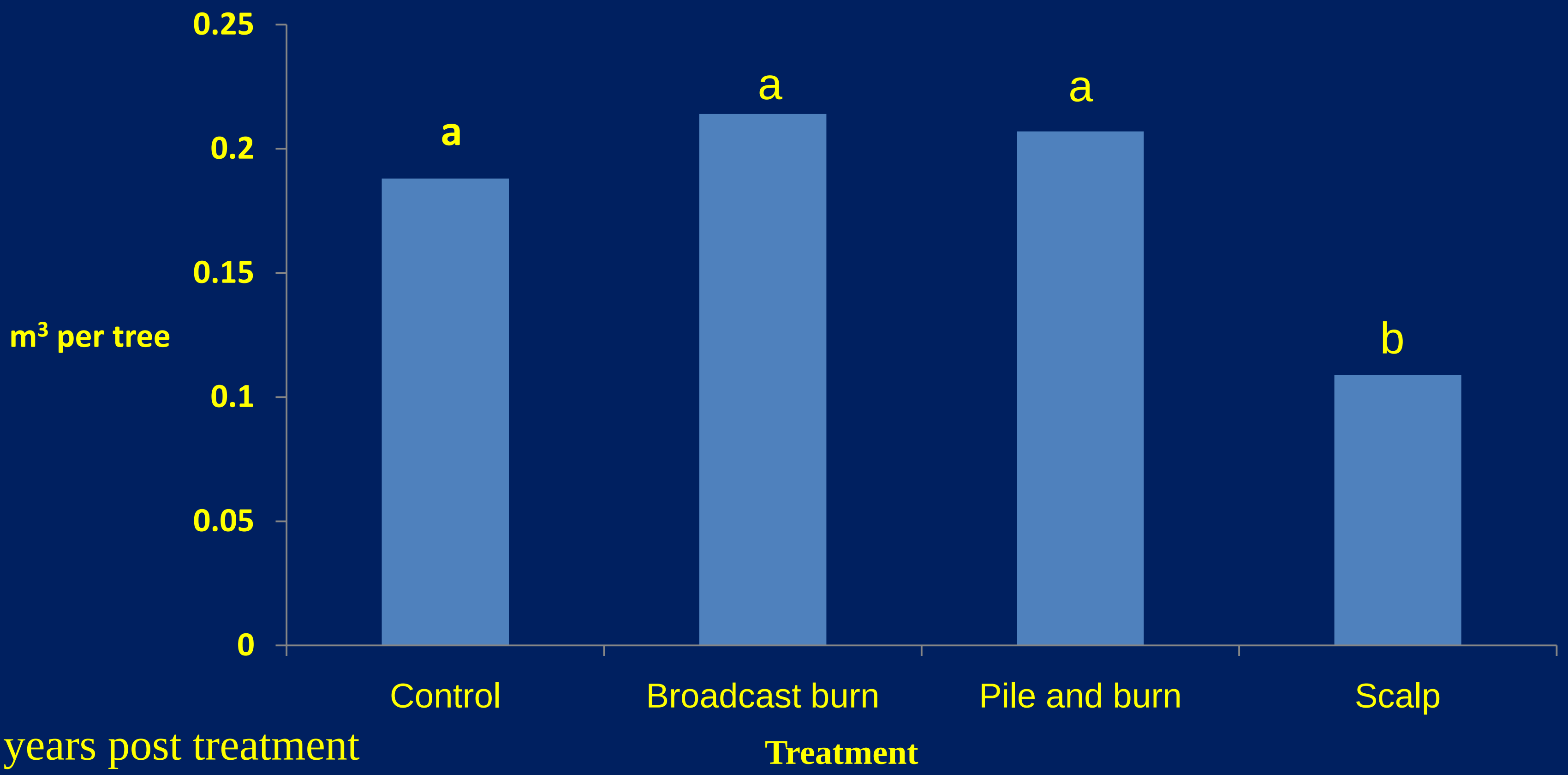
- Soil matters
- Initial efforts
- Intro to detrimental soil disturbance
- Intro to Kootenai Forest
- Landtype designation
- Statistical analysis
- Modeling parameters
- Conclusions

Why Soil Matters

Man - despite his artistic pretensions, his sophistication, and his many accomplishments - owes his existence to a six inch layer of topsoil and the fact that it rains.

~Author Unknown

Does soil disturbance matter?



24 years post treatment
Kimsey and Roche, (*in prep.)*

Project Introduction

- Primary objective: Correlate soil disturbance levels to physical site characteristics, harvest season, and harvest systems in Region 1 of the USFS.
- Secondary objective: Develop a method for utilizing Region 1 legacy soil monitoring data.

Results-All Harvest Systems

- Data conversion to consistent format
- All units were assigned a “mean soil disturbance value”
- MSD= $\sum (P_c \times C) \div P_t$ (Reeves model)

Variable	p-Value
Forest	**<.0001**
Slope class	.6407
Aspect	.1214
Season of harvest	.5733
Soil texture	.6388
Harvest system	**<.0001**

MSD Associated with Ground-Based Harvest

- 112 units- harvested from 1999- 2009
- When ground-based harvest is analyzed alone, only Forest is significant

Variable	p-Value
Forest	**<.0001**
Slope class	.1304
Aspect	.7770
Season	.4005
Soil texture	.6653
Harvest system	.4744

Conclusions From Initial Study

- Ground-based harvest results in significantly more MSD than helicopter or skyline harvest
- Significant differences exist among forests using similar harvest systems
- Correlating soil disturbance to site variables will require standard monitoring protocol

Objectives

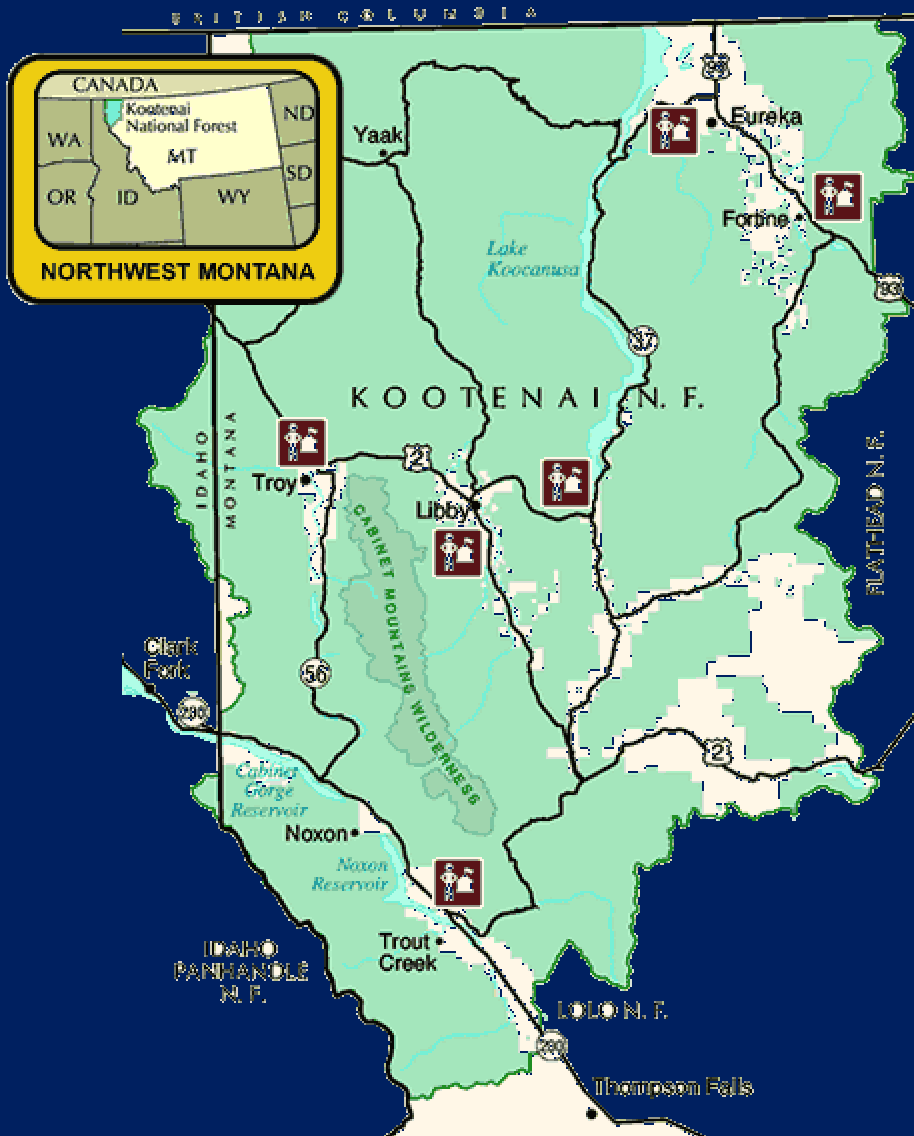
- Predictive model of detrimental soil disturbance due to ground-based timber harvest based on landscape characteristics, harvest season, and equipment type
- Produce geo-spatial model useful in timber harvest planning on the Kootenai National Forest
- Provide a methodology that could be used to produce a predictive model of soil disturbance based on landscape characteristics, harvest season, and harvest equipment

Intro to Detrimental Soil Disturbance (DSD)

- Maintenance of site productivity mandated by NFMA (1976)
- Soil quality standards (SQS) developed for each Region (last revision 1999)
- Areal extent of DSD defined as a combination of rutting, compaction, topsoil displacement, severe burning, erosion, and mass movement
- DSD as defined by R1 SQS must not exceed 15% of areal extent of harvest unit
- 85% of harvest unit must be in “satisfactory condition”

Kootenai National Forest

- 2.9 million acres within admin boundaries
- 93,000 acres designated wilderness (1)
- 6500 acres designated scenic areas (2)
- 200 mmbf timber sold FY 2006- present
- 5 year average of 41.34 mmbf sold


BRITISH COLUMBIA
CANADA
Kootenai
National Forest
WA
ND
MT
SD
OR
ID
WY
NORTHWEST MONTANA
Yaak
Eureka
Fortine
93
37
Lake
Koocanusa
KOOTENAI N. F.
IDAHO
MONTANA
Troy
2
Libby
CABINET MOUNTAINS WILDERNESS
FLATHEAD N. F.
Clark
Fork
56
200
Cabinet
Gorge
Reservoir
Noxon
Noxon
Reservoir
Trout
Creek
IDAHO
PANHANDLE
N. F.
LOLO N. F.
Thompson Falls


PROPERTY
BOUNDARY
National
Forest
LAND
BEHIND
THIS SIGN

Data Collection

- DSD data collected for 196 ground-based harvest units
- Final data set includes 167 ground-based harvest units
- 87,744 monitoring points
- Only harvest units monitored for DSD post 1999 considered for study
- 9 landtypes
- 47.5% of Kootenai National Forest




UGA1172008


Stratification Factors

- slope
- aspect
- harvest equipment used
- harvest type (intermediate or regeneration)
- landtype
- harvest season
- soil texture

Landtypes

- KNF comprised of 50 landtypes
- 7 landtypes classified as "soils of special concern" (Kuennen 2006)
- Stratified by:
- Physiography (landform, slope, aspect, elevation)
- Geology (parent material, rock outcrop)
- Vegetation

Landtype	Slope	Aspect	Elevation	Area	Number of harvest units	
	%		m	ha	Winter	Non-winter
302	30-60	southerly	914-1280	17912	0	3
321	10-40	variable	762-1158	13050	5	1
322	15-35	variable	762-1524	32225	1	5
323	15-35	variable	762-1524	35754	7	23
324	15-35	variable	762-1219	37306	3	19
328	15-35	northerly	914-1646	20877	3	7
329	15-35	variable	914-1676	27414	7	10
352	20-60	northerly	671-1707	201000	15	28
355	20-50	northerly	914-1676	187336	23	7

(Reproduced from Kuennen and Neilsen-Gerhardt 1995)

Landtype	Soil parent material	Dominant landform	Habitat type
302	compact glacial till	glaciated mountain slopes	Douglas fir/ snowberry
321	calcareous glacial till	drumlins/ moraines	Douglas fir/ pine grass
322	loess and volcanic ash over compact glacial till	moraines	western hemlock/ queencup beadlilly
323	loess and volcanic ash over calcareous glacial till	moraines	Douglas fir/ pine grass
324	calcareous glacial till	moraines	Douglas fir/ pine grass
328	loess and volcanic ash over calcareous glacial till	glaciated mountain slopes	subalpine fir/ twinflower
329	loess and volcanic ash over calcareous glacial till	moraines	subalpine fir/ twinflower
352	loess and volcanic ash over compact glacial till	glaciated linear mountain slopes	western red cedar/ queencup beadlilly
355	loess and volcanic ash over compact glacial till	glaciated rounded mountain slopes	western red cedar/ queencup beadlilly

(Reproduced from Kuennen and Neilsen-Gerhardt 1995)

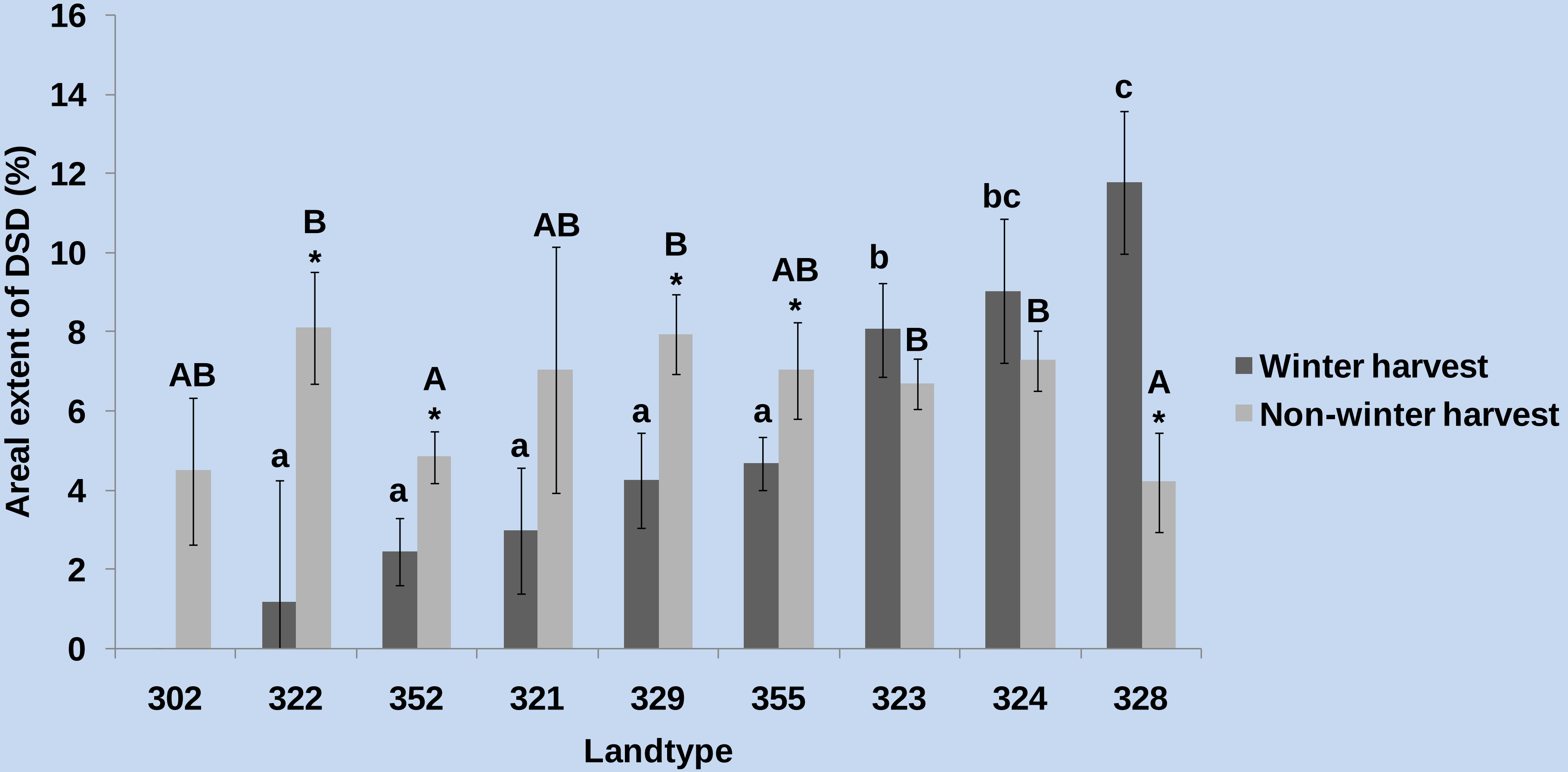
Statistical Analysis

- ANOVA model:
- DSD= aspect, slope, harvest season, landtype, harvest season*landtype

Variable	p-Value
Aspect	0.0217
Slope	0.0738
Harvest season	0.1637
Landtype	0.0002
Harvest season*landtype	0.0002

r^2= .376085
α= 0.10

Results

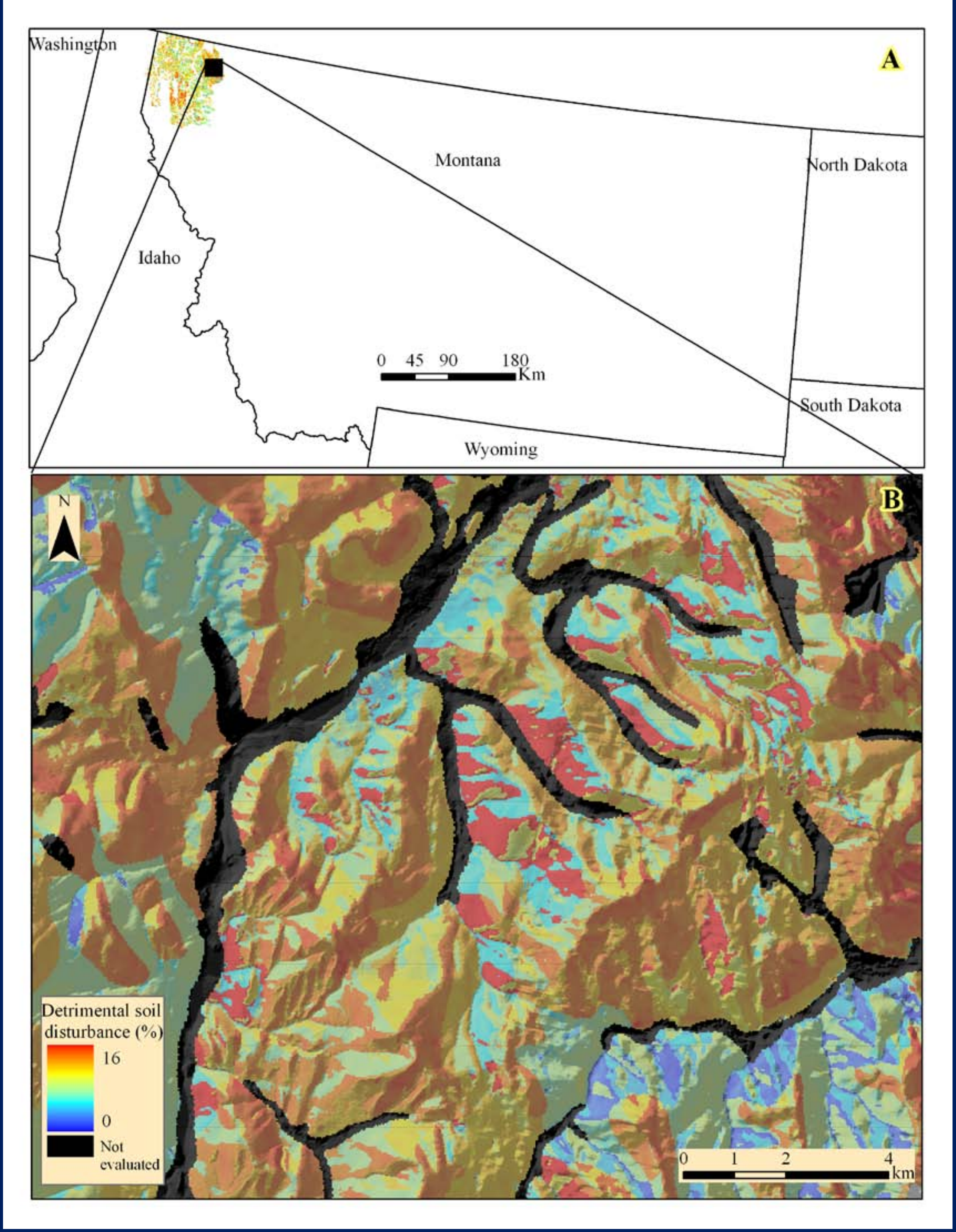


Areal extent of DSD (%)
16
14
12
10
8
6
4
2
0
AB
a
B
*
a
A
*
a
AB
a
B
*
a
AB
*
b
B
bc
B
c
A
*
302
322
352
321
329
355
323
324
328
Landtype
Winter harvest
Non-winter harvest

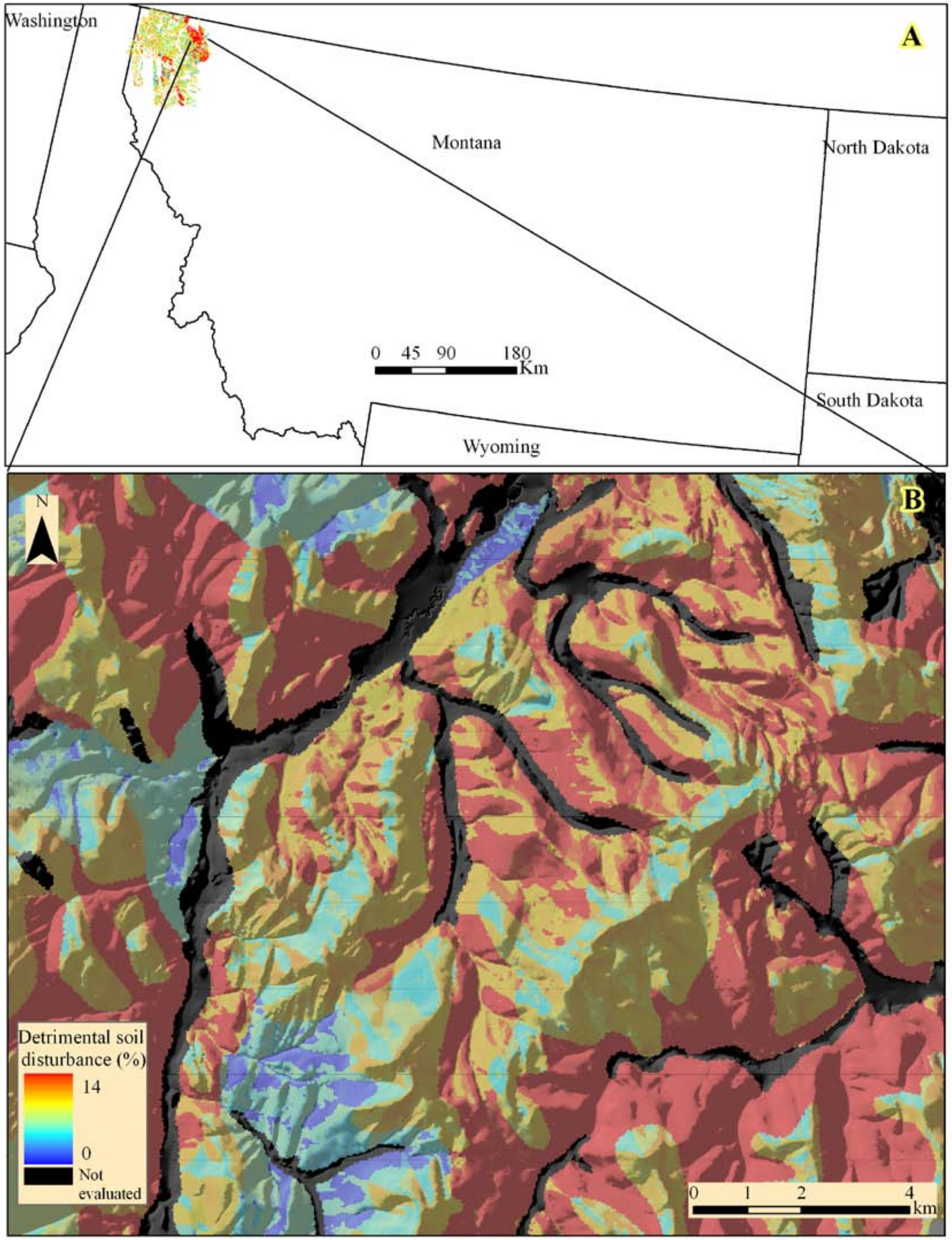
Modeling Equation

- Areal extent of DSD (%)= intercept + aspect + (slope (%)* .0596) + harvest season + landtype + landtype*harvest season

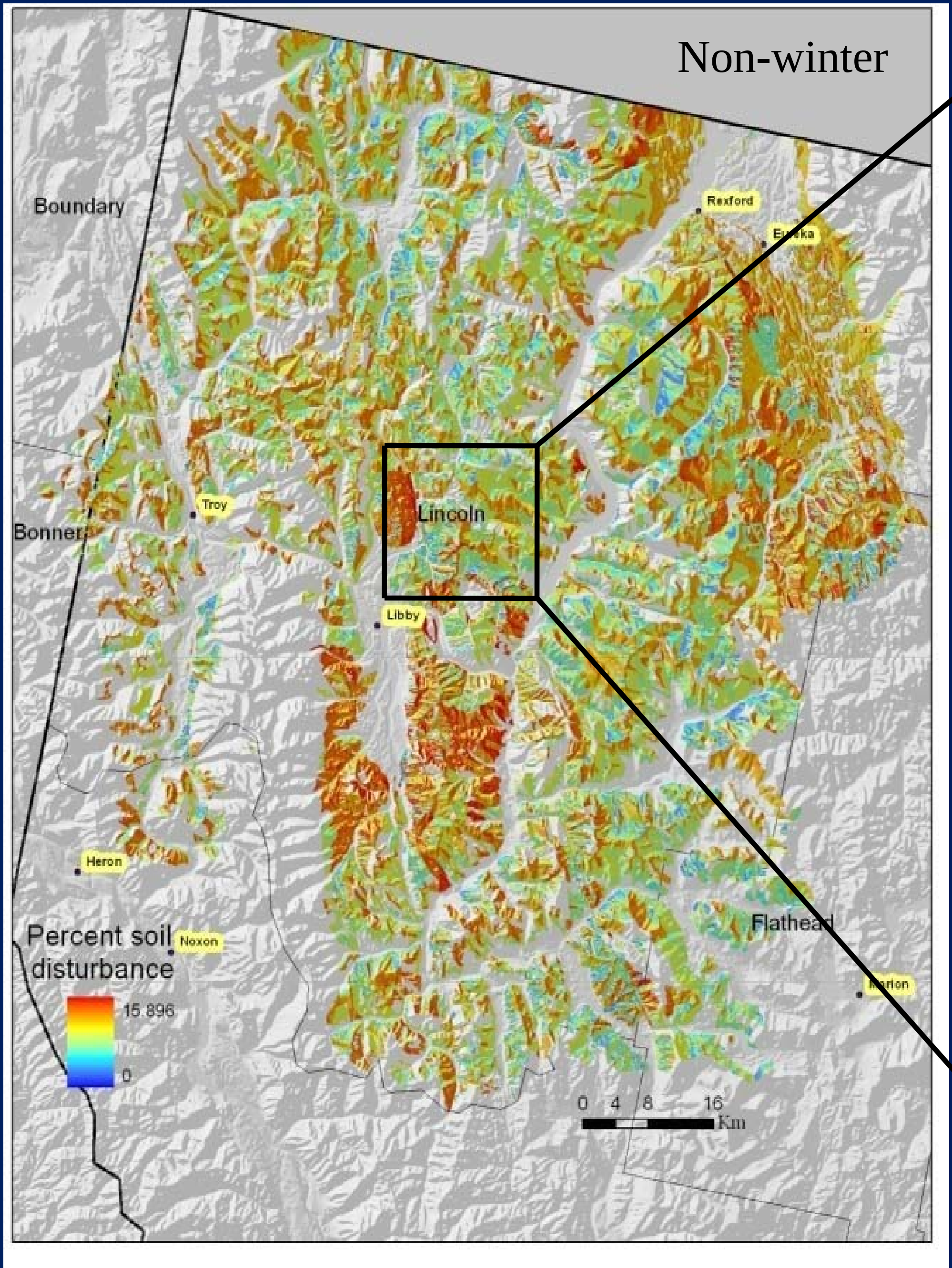
Variable	Parameter estimate range
B_0	4.22
Slope	0.06
Aspect	-3.67 (NW), 0.51 (NE)
Season	0.00 (Winter), 2.36 (Non-W)
Landtype	-3.49 (322), 7.11 (328)
LT* season (non-winter)	-9.94 (328), 4.57 (322)
LT* season (winter)	0.00

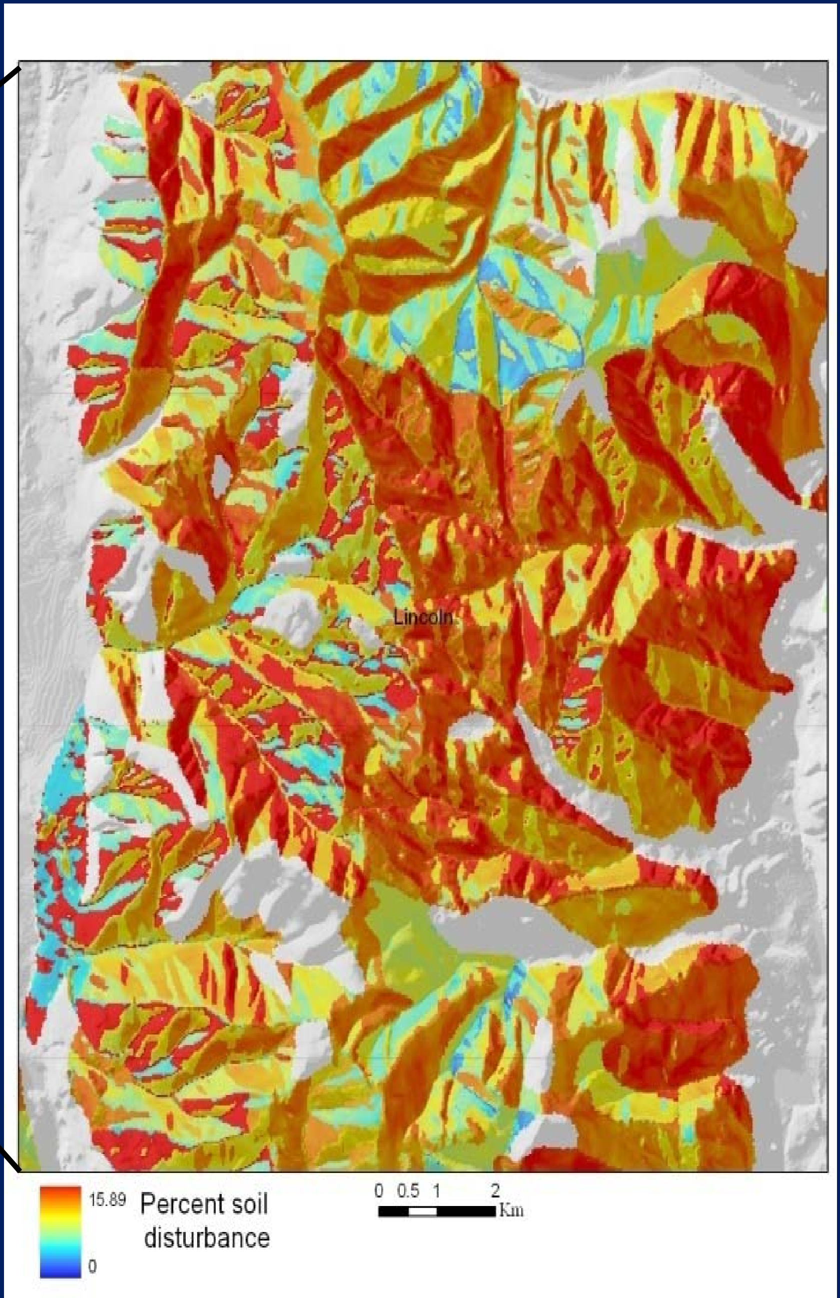


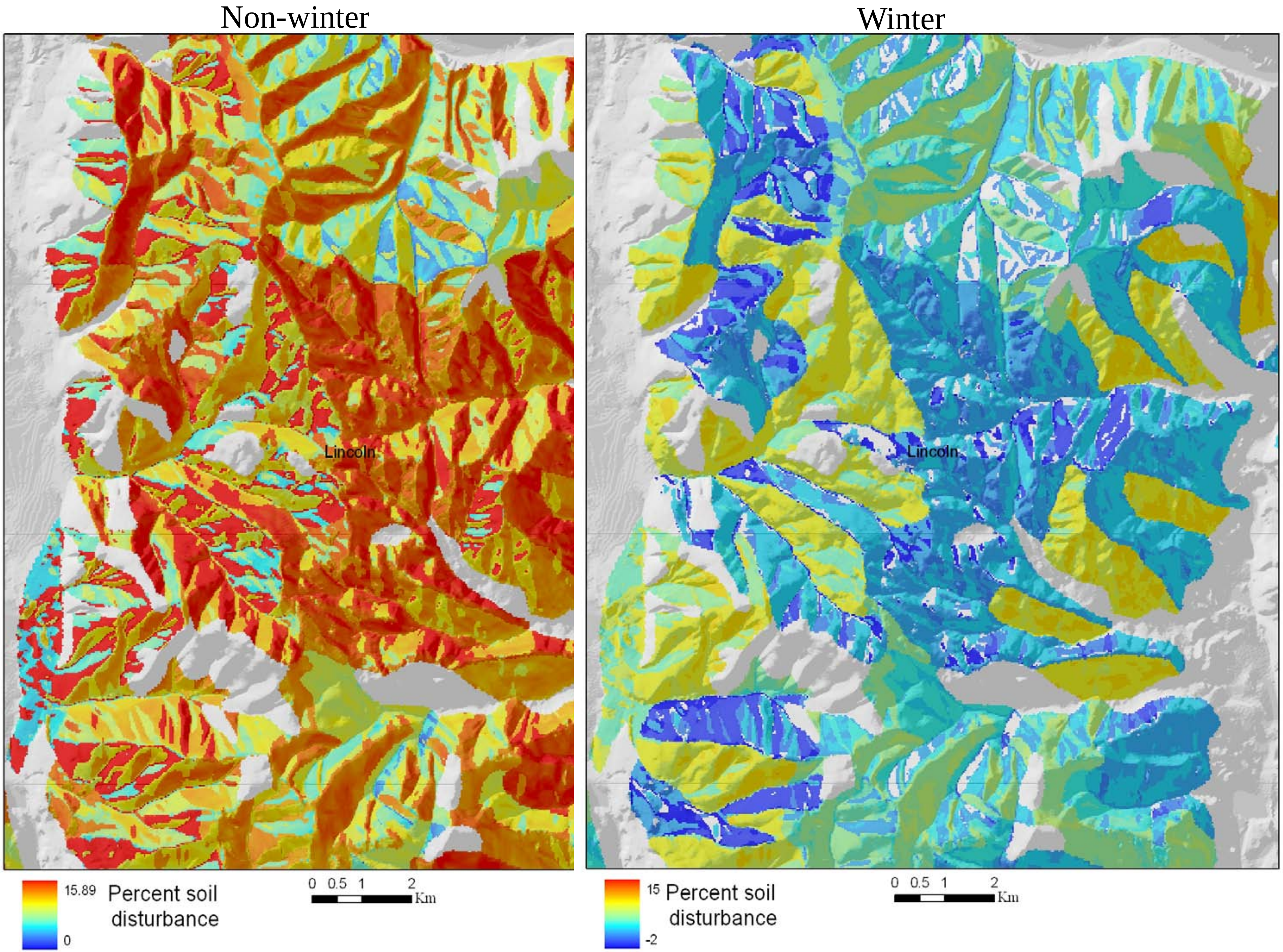
Geo-spatial representation of the statistical model predicting areal extent of DSD resulting from winter ground-based timber harvest



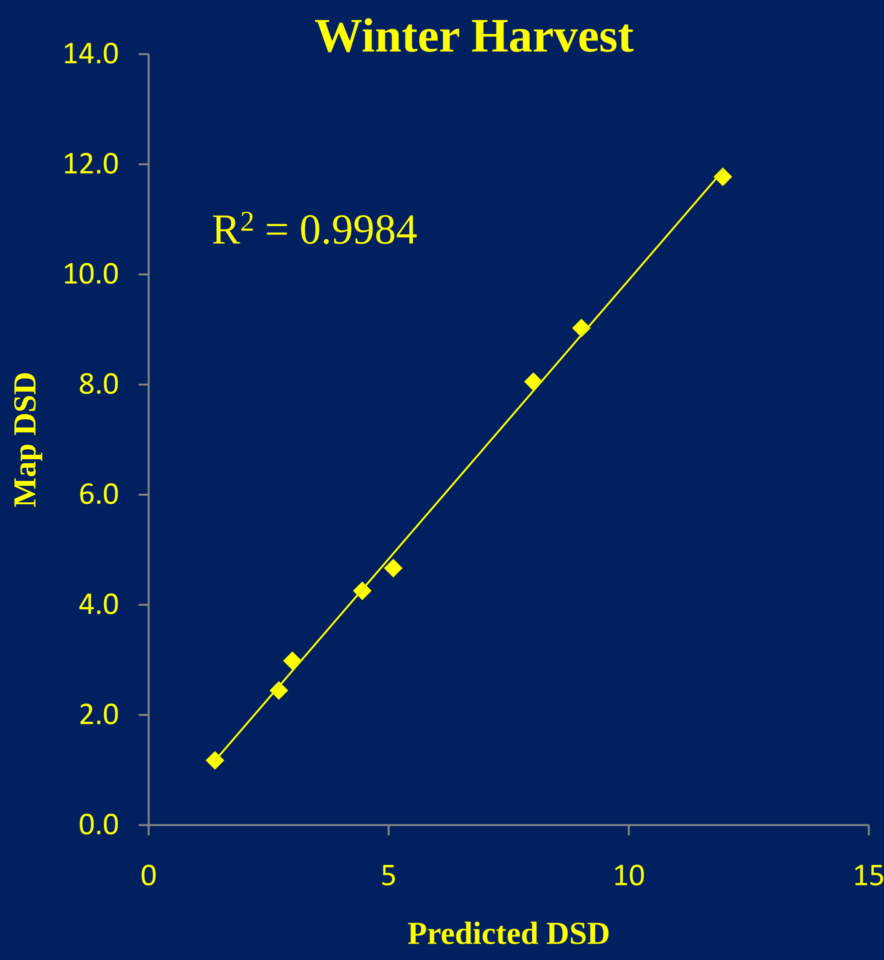
Geo-spatial representation of the statistical model predicting areal extent of DSD resulting from non-winter ground-based timber harvest.

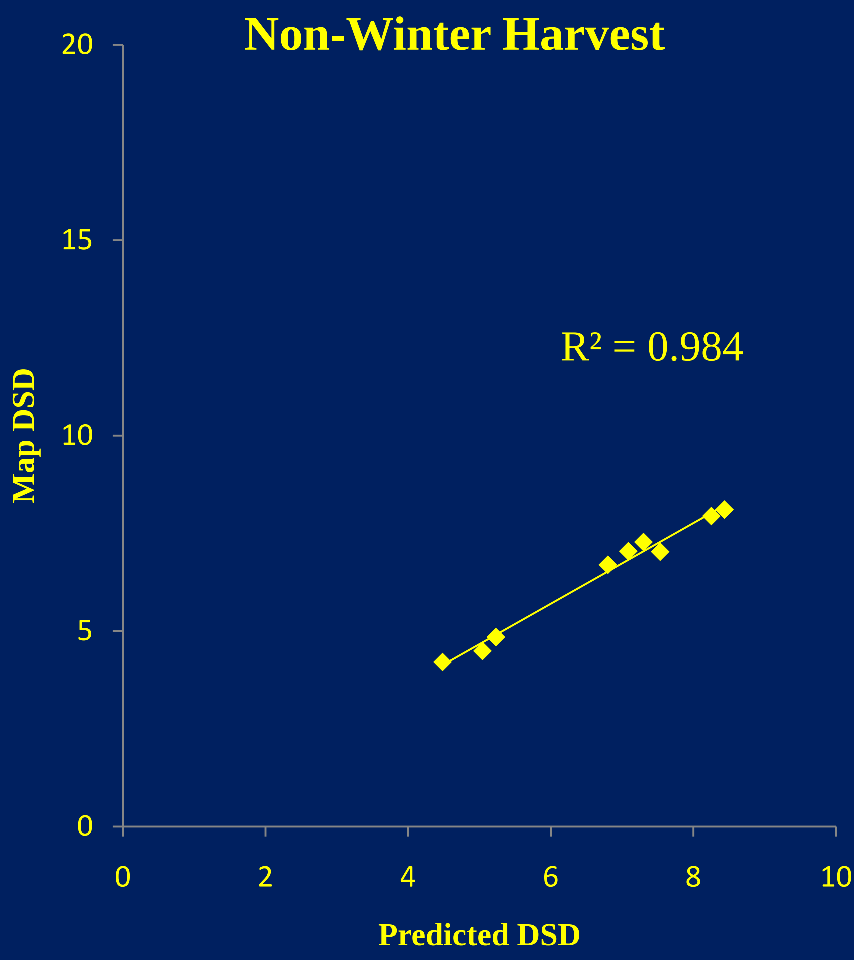

Non-winter
Boundary
Rexford
Eureka
Lincoln
Troy
Bonner
Libby
Heron
Percent soil disturbance
Noxon
15.896
0
Flathead
Marion
0 4 8 16
Km


Lincoln
15.89
0
Percent soil disturbance
0 0.5 1 2
Km


Non-winter
Winter
Lincoln
Lincoln
15.89
0
Percent soil disturbance
0 0.5 1 2 Km
15
-2
Percent soil disturbance
0 0.5 1 2 Km

Statistical and Geospatial Correlation





About Models

"All models are wrong, some are useful"

-George Box 1979

Conclusions

- Correlating site characteristics with disturbance levels requires consistent monitoring and application of SQS
- Model appears to produce reasonable values over a broad spectrum
- More data collection needs to occur to validate the model
- Accurate documentation of harvest equipment is a necessity
- This risk analysis methodology can be used to:
  - create models predicting soil disturbance levels due to management activities
  - identify areas susceptible to increased disturbance levels where alternative management activities may be warranted

Acknowledgements

- Thanks to my collaborators, Matt Reeves, Ann Abbott, Deborah Page-Dumroese, Mark Coleman
- This project is funded by Region 1 of the USFS

References

Kuennen, L.J. and M.L. Neilsen-Gerhardt. 1995. Soil Survey of Kootenai National Forest Area, Montana and Idaho. USDA. Washington, D.C. 122 pp.

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