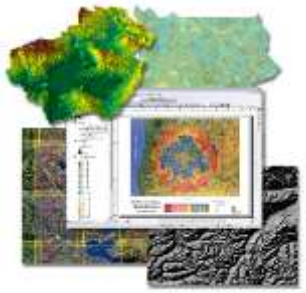
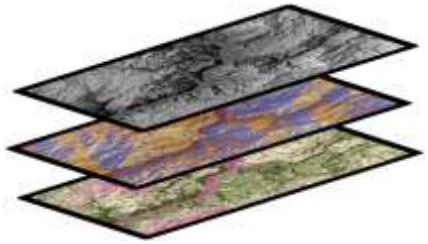




Geospatial Soil Risk Assessments and BMP Development for Biomass Harvesting

Mark Kimsey
Intermountain Forest·Tree Nutrition Cooperative

Northwest Bioenergy Research Symposium
November 13, 2012

Forest Site Quality

- Definition
  - *the productive capacity of a site, usually expressed as volume production of a given species*

- Drivers of Productive Capacity
  - *f*(Light, Moisture, Temperature, Nutrients)

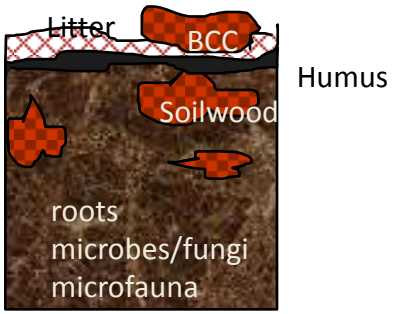
Driver Impacts on Site Productivity

Generally Well-Known

- Light
  - Species Specific
    - Shade Tolerant/Intolerant
    - Seral vs. Climax
  - Stand Density
- Moisture – Temperature
  - Warm + Wet = High Prod.
  - Cold + Wet = Low Prod.
  - Hot + Dry = Low Prod.

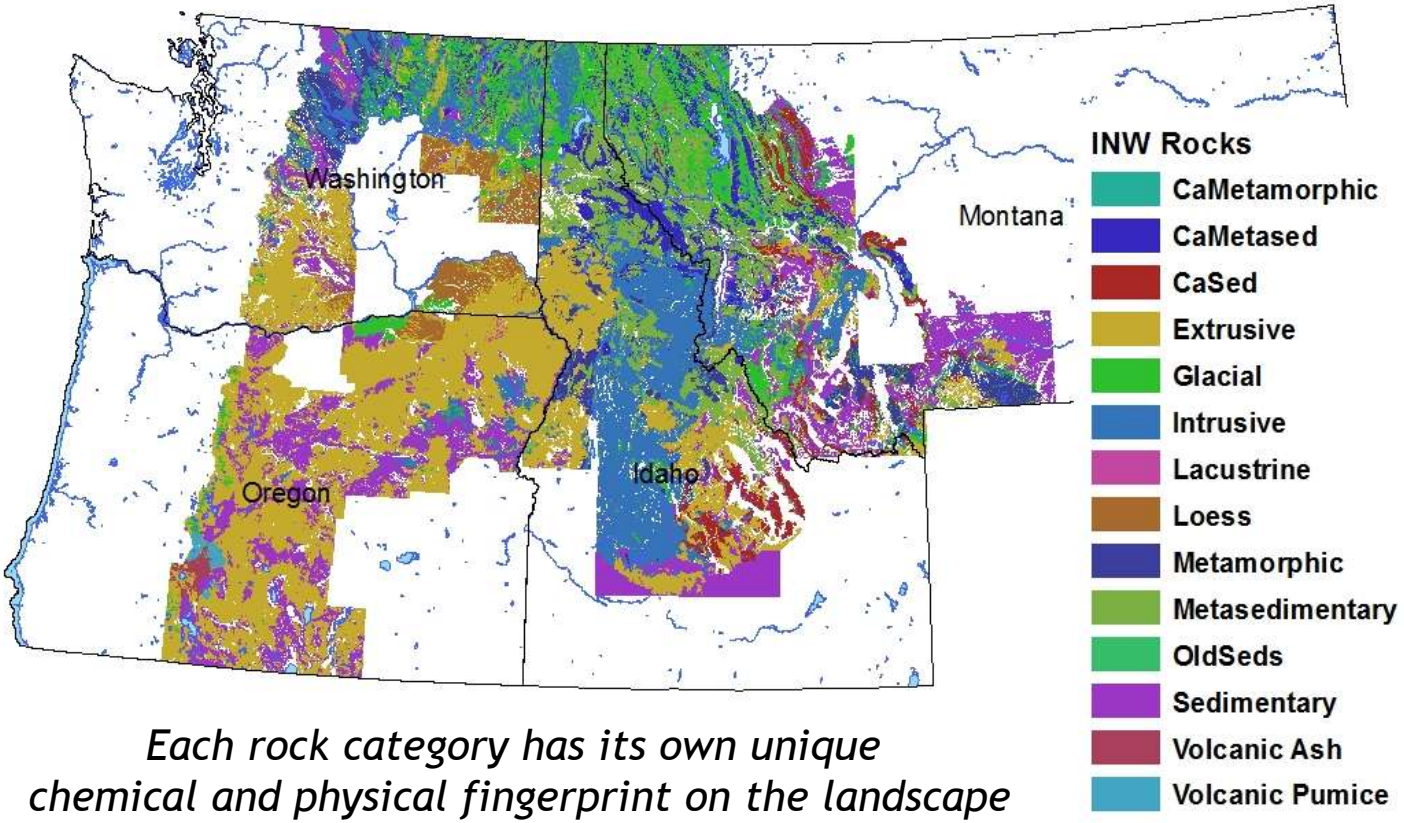
Less Well-Known

- Nutrients
  - Primary Source: Rocks
  - Secondary Source: Organics



Research From Ground Up

- Define INW Rocks and Basic Properties



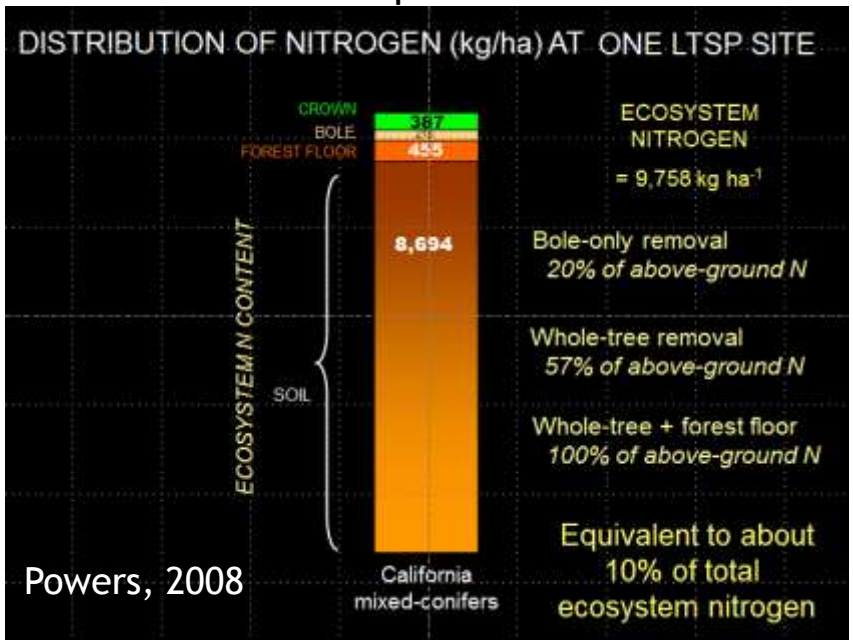
Each rock category has its own unique chemical and physical fingerprint on the landscape

Rock Properties

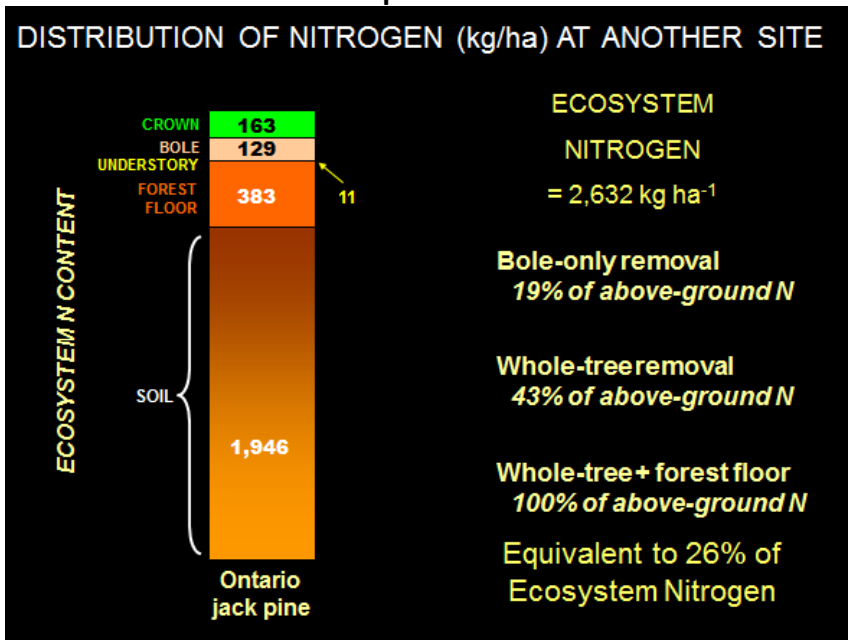
Rock Type	Rock Nutrient Status	Soil Particle Size	Soil Nutrient Status
Basalts	Good	Fine-Clayey	High
Granites	Medium	Coarse-Sandy	Medium-Low
<u>Metamorphic</u>			
-Schist	Medium-Poor	Fine-Silty	Medium-Low
-Gneiss	Medium-Poor	Coarse-Sandy	Medium-Low
-Sedimentary	Variable (poor)	Variable	Low
<u>Mixed</u>			
-Glacial Till	Variable	Variable	Variable
-Alluvial	Variable	Variable	Variable
-Surficial	Variable	Fine-Silty	Variable
<u>Sedimentary</u>			
-Shale	Medium-Poor	Fine-Clayey	Medium-Low
-Sandstone	Medium-Poor	Variable	Variable
-Limestone	Medium-Poor	Variable	Medium-Low

Soil-Site Nutrition & Biomass Removal

Granitic soil parent material



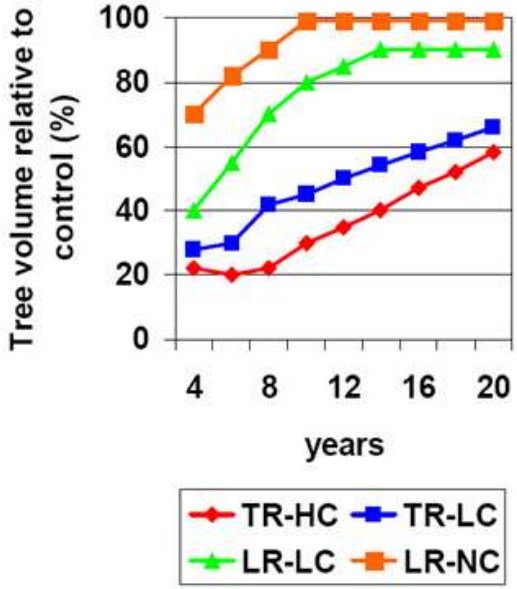
Glacial soil parent material



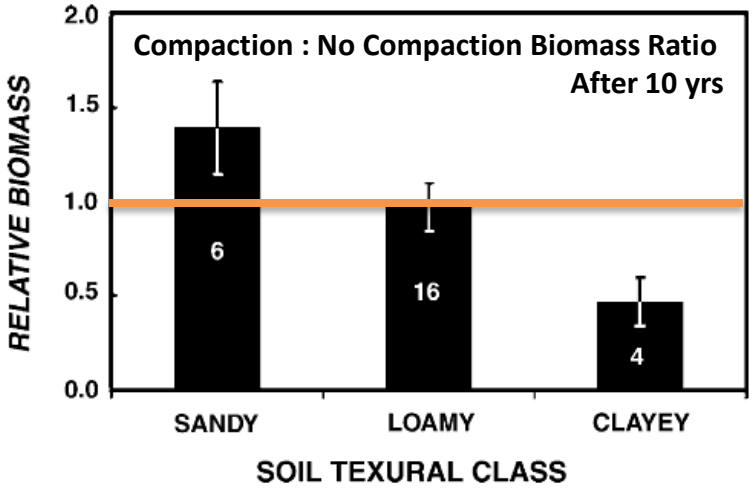
Removing 25% of the N capital degrades productivity capacity

10% may be small in comparison, but over time it may degrade productivity too.

Soil Disturbance & Biomass Production



Murphy et al. 2004
Pinus radiata on Silt Loam soils in New Zealand



Powers et. al. 2005
Forest Ecol. & Management

SOM does matter

10-Yr LTSP data suggests that soil type determines site productivity response to disturbance

So, is all soil-site disturbance bad?

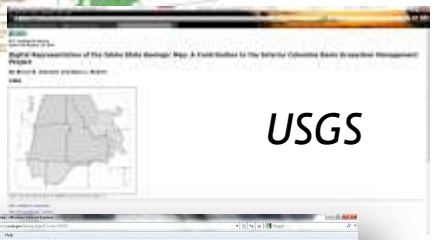
- Depends on:
  - Soil type
    - Texture
    - Coarse fragments
    - Moisture/Temperature
    - Inherent nutrient stocks
      - Primary, secondary

  - Harvest method
    - Whole Tree vs. Bole Only
    - Level of litter/mineral soil displacement/removal
    - Biomass for bioenergy extraction?

Research to Application

Existing research can be refined into geospatially explicit forest management risk assessments

IFTNC

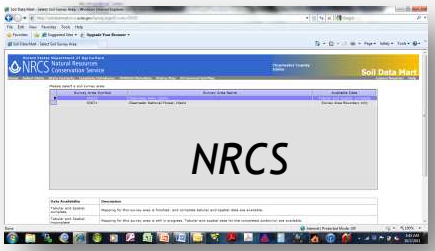


USGS

+

ArcGIS 10.x + Soil Data Viewer

→



Activity Risk Assessments

College of Natural Resources

University of Idaho

Soil Parent Material (SPM) Guides

Northern Idaho and Western Montana
Nutrition Guidelines By Rock Type

Nutrition guidelines for use in conjunction with curre
Idaho and Montana

September, 2007

Intermountain Forest Tree Nutrition Coop
Forest Resources Department
University of Idaho

Authors: Mariann T. Garrison-Johnston, Research S
Reed Lewis, Associate Research Geologist,
Leonard R. Johnson, Interim Director, IFT

Reviewers: Jeff Collins, Montana Department of Natural Res
Jeff Lonn, Montana Bureau of Mines and Geology
John Mandzak, Potlatch Forest Holdings
Scott McLeod, Washington Department of Natura
Terry Shaw, Intermountain Forest Tree Nutrition

Northeast Oregon IFTNC Region
Nutrition Guidelines By Rock Type

Nutrition guidelines for use in conjunction with digital geology fo
northeastern portion of the state of Oregon

April, 2010

Intermountain Forest Tree Nutrition Cooperative
Forest Resources Department
University of Idaho

Author: Mariann T. Garrison-Johnston, Research Scientist, IFTNC

Washington State IFTNC Regions
Nutrition Guidelines By Rock Type

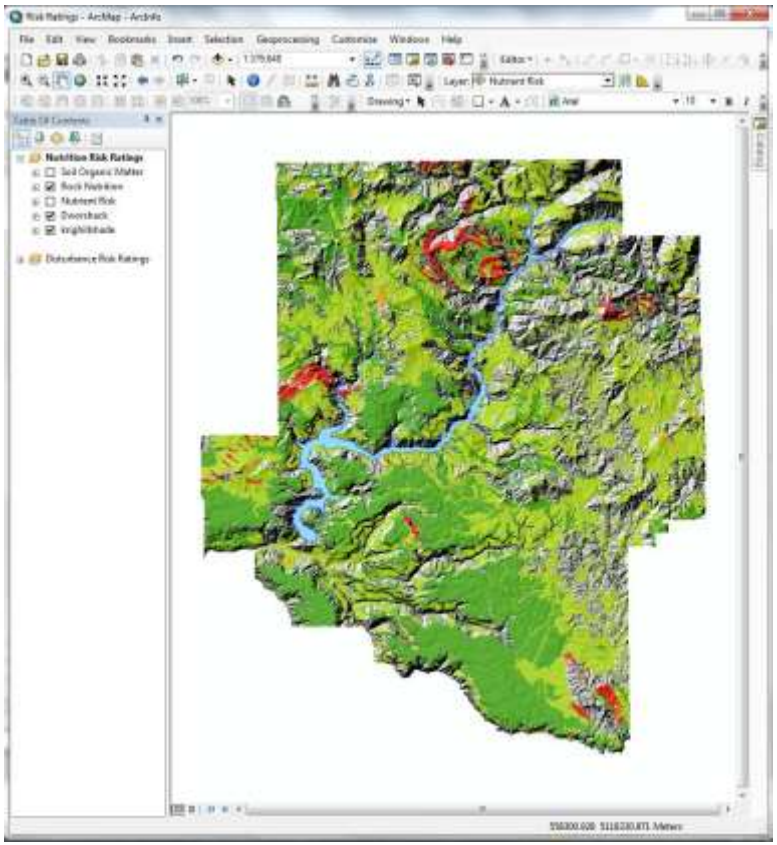
Nutrition guidelines for use in conjunction with 2005 digital geology for
Washington state

April, 2008

Intermountain Forest Tree Nutrition Cooperative
Forest Resources Department
University of Idaho

Authors: Mariann T. Garrison-Johnston, Research Scientist, IFTNC
Leonard R. Johnson, Interim Director, IFTNC

Nutrient Risk Assessment – SPM

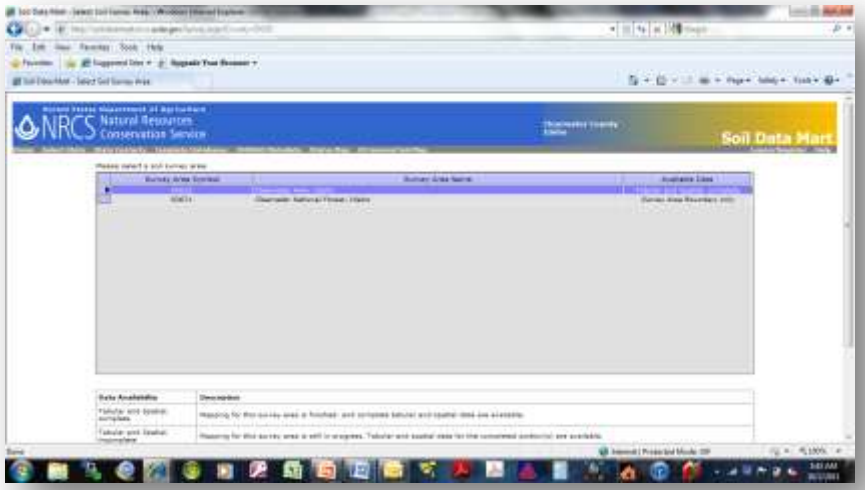


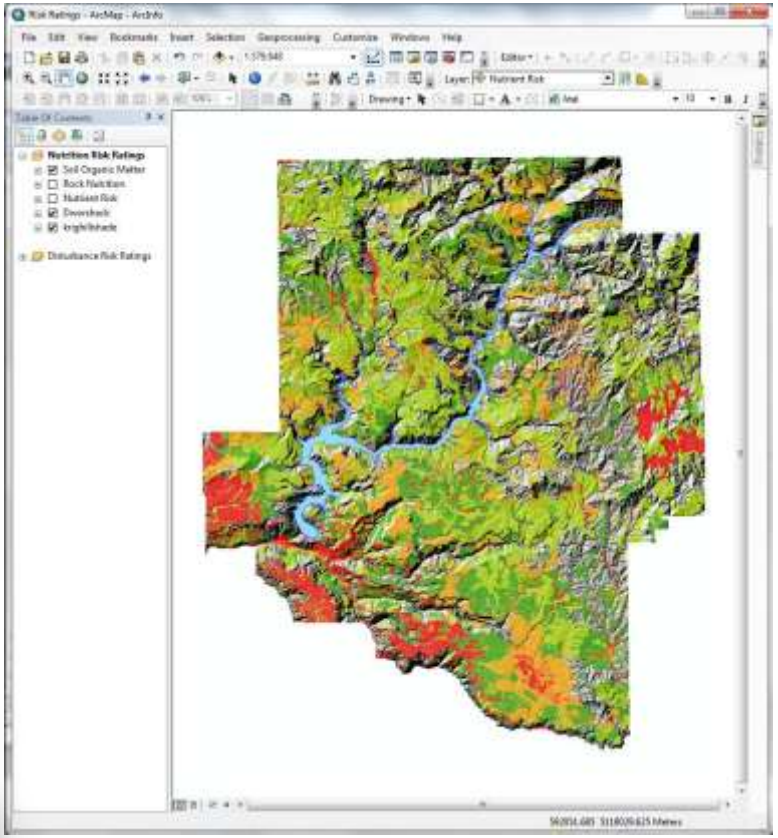
Rock nutrient status as a function of weathering potential and forest soil nutrition research across the ID612 survey area.

Rock Nutrient Status

Good (1)	Moderate (2)	Poor (3)	Very Poor (4)
Basalt, Calc-silicate	Alluvium, Felsic gneiss, Granite, Granodiorite, Quartz Diorite, Schist, Siltite/Argillite, Tonalite	Amphibolite, Andesite, Dacite, Diorite/Gabbro, Feldspathic Quartzite, Flesic Dikes/Sills, Gravels, Marble, Pegmatite, Quartz Diorite Gneiss, Rhyolite, Ultramafics	Quartzite

Nutrient Risk Assessment - SOM



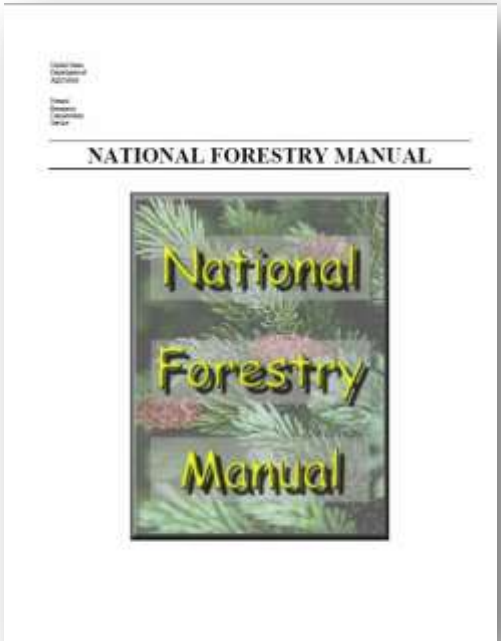


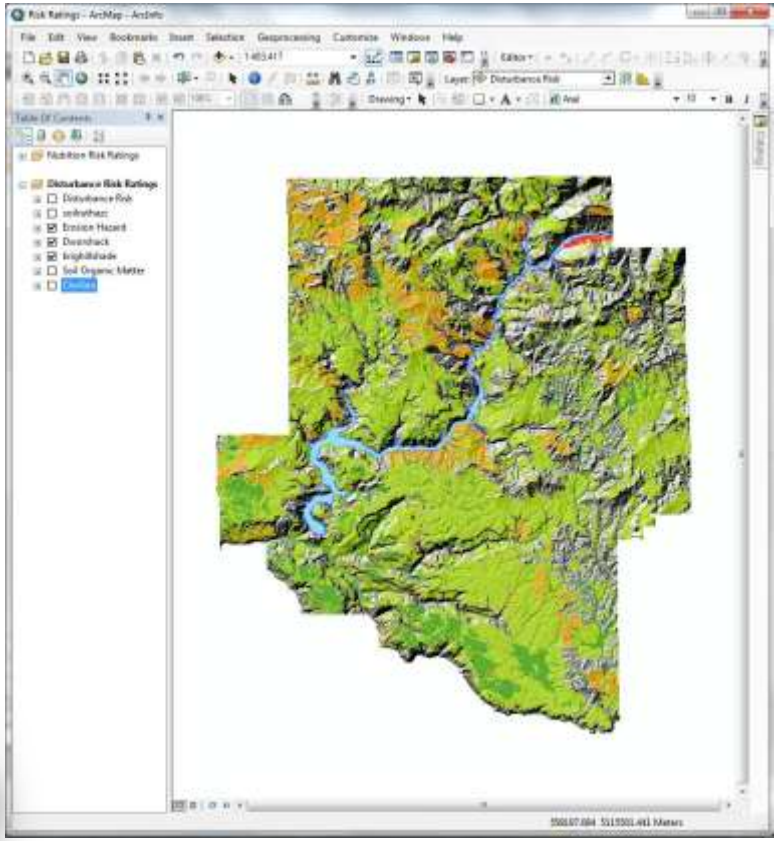
Soil organic matter content across the ID612 survey area of the Northern Rockies ecoregion, USA.

Soil Organic Matter

Very High (1)	High 2)	Medium (3)	Low (4)
>12%	8-12%	4-8%	<4%

Disturbance Risk Assessment – Soil Erosion





NRCS soil erosion hazard as a function of slope and the soil erosion factor K_w for the ID612 survey area.

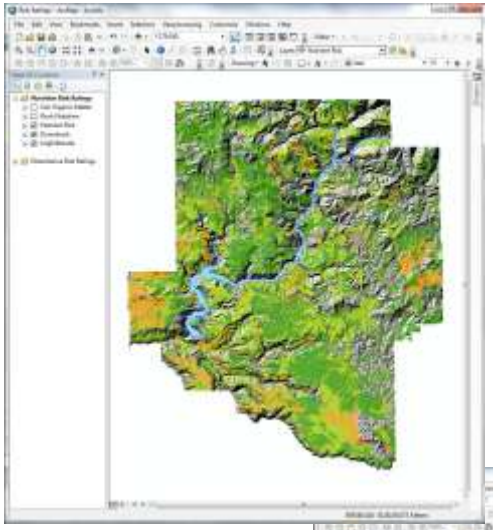
	Soil Erosion Hazard			
	Slight (1)	Moderate (2)	Severe (3)	Very Severe (4)
K_w	Slope (%)			
$K_w < 0.35$	0–14	15–35	36–50	>50
$K_w \geq 0.35$	0–9	10–25	26–40	>40

Disturbance Risk Assessment – Soil Compaction/Displacement

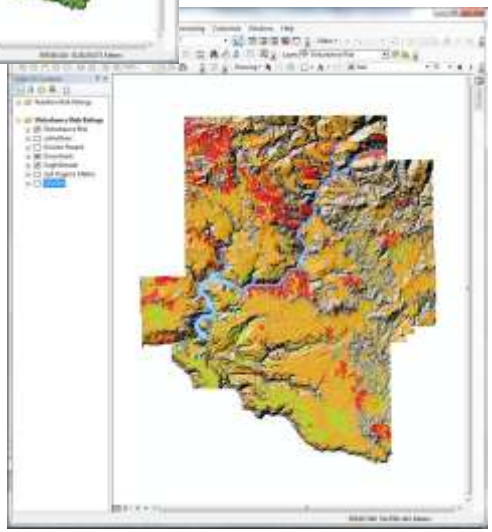
NRCS soil rutting hazard as a function of soil texture, depth to water table and soil rock fragment content for the ID612 survey. Steeper slope classes (e.g., >20%) may shift ratings to one class more limiting.

	Soil Rutting Hazard		
	Unified Soil Texture Classification† (thickest layer with upper boundary ≤10 cm of the surface)		
	Slight (1)	Moderate (2)	Severe (3)
Water Table			
Maximum depth to wet layer <30 cm for 12 months of the year	--	--	All Groups
Rock Fragments			
>75 mm in size, <20% by volume	GW, GP, GM, GW-GM, GCGM,GW-GC,GP-GM, GP-GC	GC, SW, SP,SM, SC, SWSM, SW-SC, SP-SM, SP-SC, SC-SM	CL, CH, CLML, ML, MH, OL, OH, PT
>75 mm in size, >20% by volume; OR >3% to <10% surface cover, >75 mm in size; OR depth to top of bedrock paralithic, bedrock lithic; OR duripan restrictive layer <15 cm	GW, GP, GM, GW-GM, GCGM, GW-GC, GP-GM, GP-GC, GC, SW, SP, SM, SC, SWSM, SW-SC, SPSM, SP-SC, SCSM	CL, CH, CLML, ML, MH, OL, OH, PT	--
>10% surface cover	All Groups	--	--

Best Management Guides by RA



Soil Chemical RA



Soil Physical RA

Risk Assessment	Soil Chemical BMPs	Soil Physical BMPs
Low	• Any ground-based harvest method acceptable • Fertilization not necessary to maintain soil nutrient status • Minimize forest floor disturbance	• Feller buncher or cut-to-length harvesters acceptable on shallow slopes • Cut-to-length harvesters and forwarders (with travel corridors and biomass mats) preferred on steeper slopes • Ensure soils are not at high water capacity before harvest activities • Minimize forest floor disturbance to reduce soil erosion, compaction and other soil disturbance
Moderate	• Bole only harvesting recommended • Whole tree harvesting acceptable with post-harvest fertilization recommended on nutrient poor soils • Minimize forest floor disturbance	• Manual felling or cut-to-length harvesting (with travel corridors and biomass mats) preferred on all slope conditions • Late summer to early fall harvesting only • Minimize forest floor disturbance to reduce soil erosion, compaction and other soil disturbance
High	• Bole only harvesting recommended • Post-harvest fertilization recommended • Maintain the forest floor, minimize removal of branches, twigs and dead wood.	• Feller buncher harvesting not recommended • Manual felling preferred • Cut-to-length harvesting and forwarding, or shovel/tractor yarding acceptable when limited to designated skid trails with biomass mats no less than 12 inches thick • Late summer to early fall harvesting only • Consider winter logging to reduce compaction, rutting and erosion • Maintain the forest floor
Severe	• Intensive biomass harvesting not recommended • Forest health maintenance harvesting only • Leave all branches, twigs and maintain the forest floor • Consider fertilization	• Manual felling only • Shovel/Tractor yarding limited to winter only • Ensure equipment is matched to site • Monitor soil moisture • Maintain forest floor • Use slash mats and/or balloon tires on wet soil

Thank You, Any Questions?

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