USE OF LIDAR-DERIVED LANDSCAPE PARAMETERS TO CHARACTERIZE ALTERNATIVE HARVEST SYSTEM OPTIONS IN THE INLAND NORTHWEST

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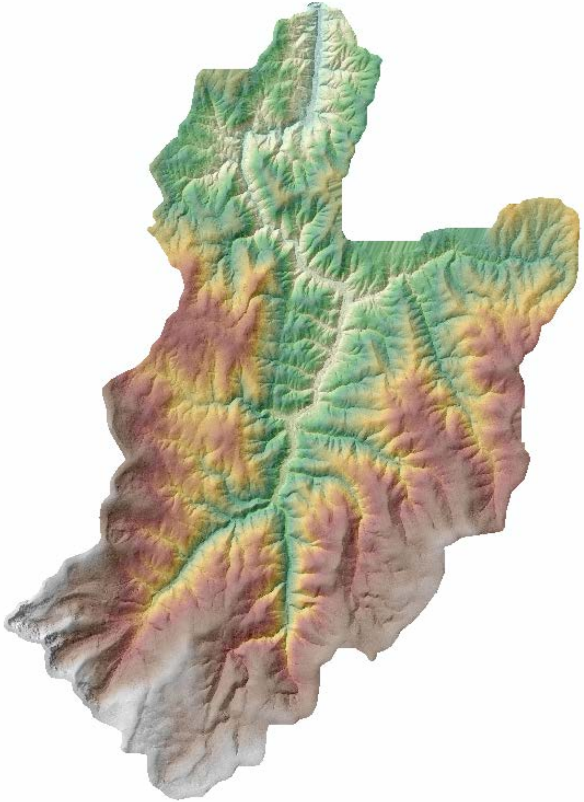
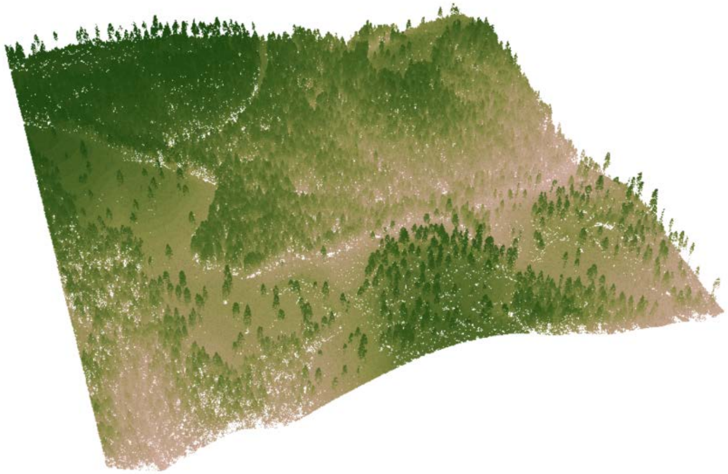
INTRODUCTION

- Inland northwest forest management presents interesting challenges in harvest system selection due to **variable, broken terrain**.
- Technology and innovative machinery is increasingly incorporated into management planning and implementation.
  - These resources assist in the decision-making and operational processes



REMOTELY SENSED DATA

- High resolution remotely sensed data is a powerful resource in forest management
  - Used extensively for forest inventory
- Provide means to accurately represent landscape scale topographic features as well as the derivation of additional products
  - Forest metrics
  - Individual tree metrics



Self-leveling shovels

INNOVATION IN FOREST OPERATIONS

- New machinery introduced in the Inland Northwest is increasingly being incorporated into harvest scenarios
- Self-leveling shovels are gaining traction as attractive new alternatives to existing harvest systems
  - Capable of working on variable terrain
  - Both fell and forward material to the landing
  - Tethering capabilities increasing

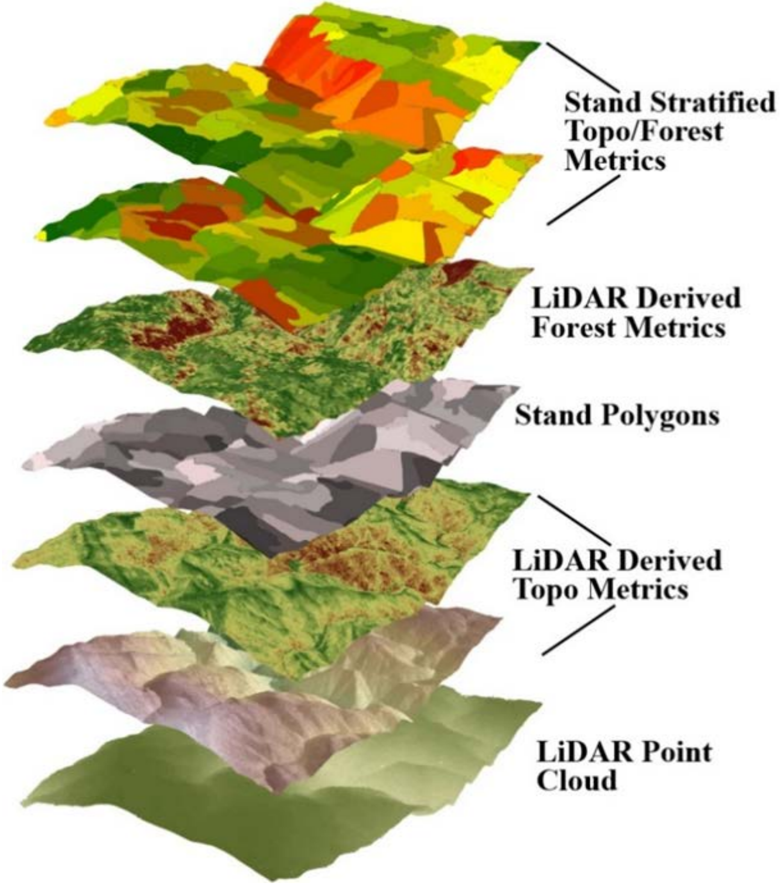
Research Objectives

SO WHAT?

- Develop new uses of LiDAR for operational harvest planning
- Develop a way to accurately and efficiently classify treatment areas by feasible harvest systems
- Quantify areas where introducing new innovative harvest systems is possible based on machine operational thresholds

DECISION SUPPORT MODEL

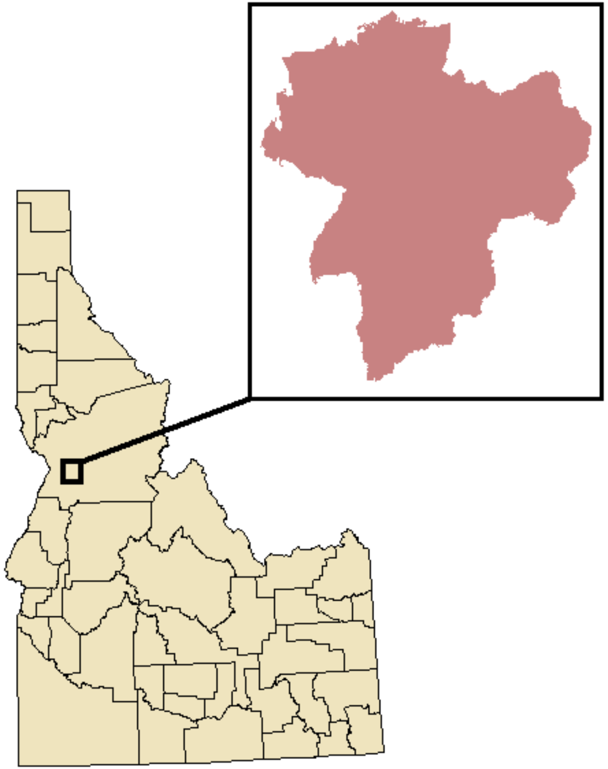
- Combine input from various data sources to aid management decisions at a landscape scale
- Quantify the impact introducing new harvest systems at the landscape scale has on harvest system classification



Slate Creek

STUDY AREA

- Nez Perce- Clearwater National Forest, ID
- ~ 74,000 Acres (30,000 ha)
- 2627 Delineated Stands
- Relatively actively managed forest
- Stands average ~30 acres with a majority in the 5-15 acre range



Sampled Forest Data

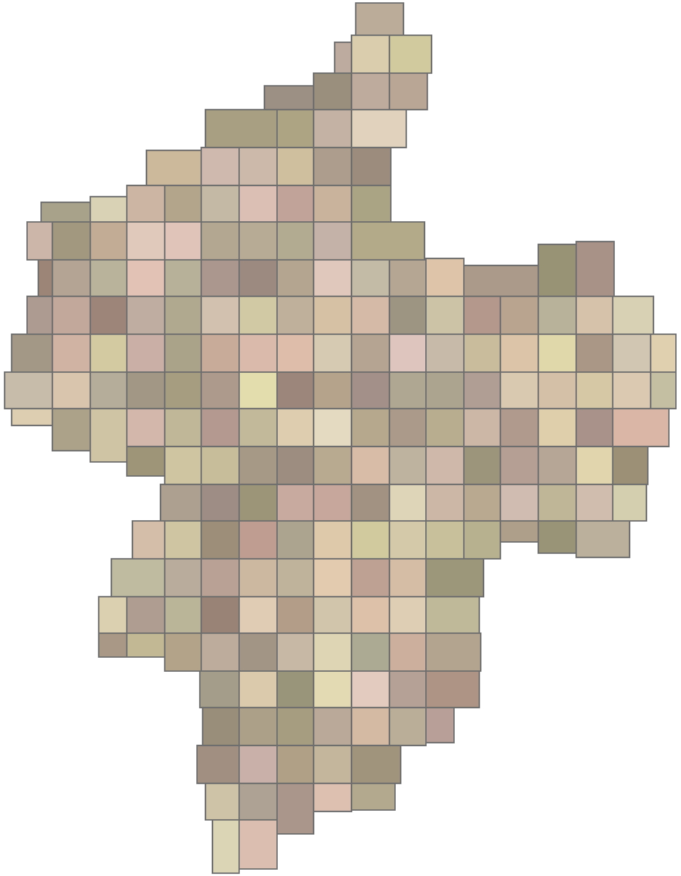
INVENTORY PLOTS

- 91 1/10th acre inventory plots
  - DBH, Specie, Height, Basal Area, etc.
- 91 1/10th acre LIDAR plots encompassing identical extent of inventory plots
- Provide information regarding forest characteristics

Light Detection and Ranging

LIDAR ACQUISITION

- Aerial acquisition
- Consists of over 4 billion point returns
- 217 LiDAR point cloud tiles
- Each return represents an XYZ point in space
- LiDAR metrics developed as 1/10th acre cells
- All point cloud processing performed in FUSION



Correlating LiDAR Point Clouds and Forest Metrics

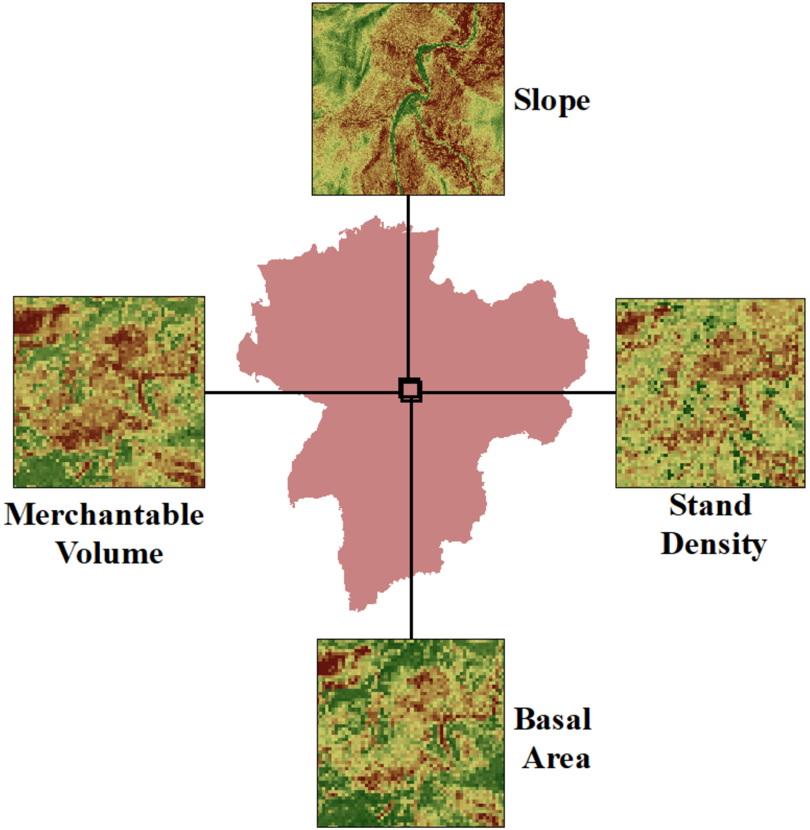
RANDOM FORESTS

- Used to develop a correlative model between the LiDAR metrics and inventoried stand metrics
  - Merchantable volume
  - Basal area
  - Stocking density (TPA)
- 177 LiDAR metrics available
  - Unique regression for each forest characteristic

Landscape Extrapolation

FOREST METRICS

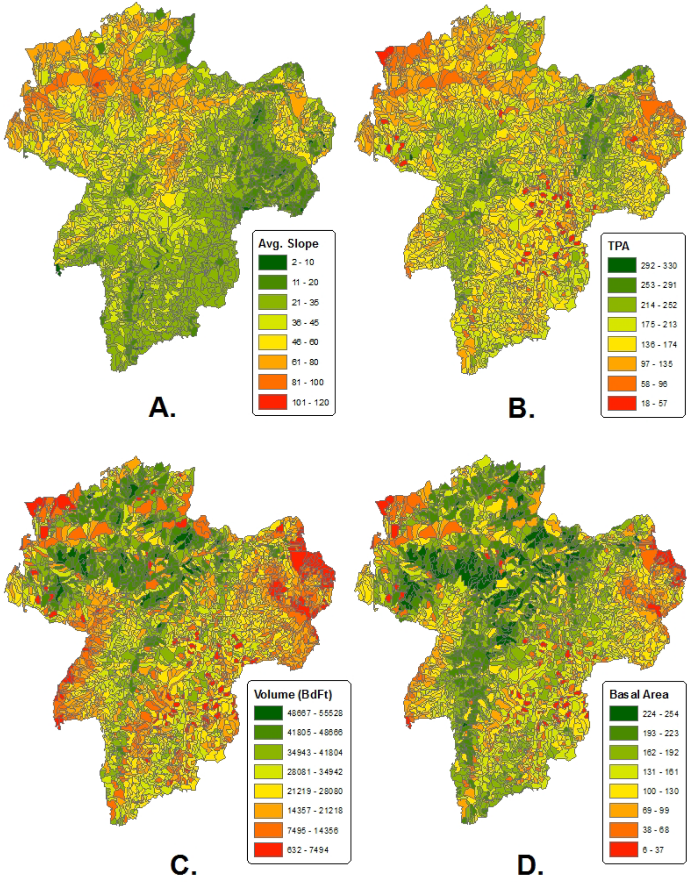
- Developed Random Forest models for each forest metric used to predict values across study site
- Results in 1/10th acre prediction pixels for forest metrics
- 1m resolution DEM and DEM-derived slope raster also developed



Forest and Topographic Metrics

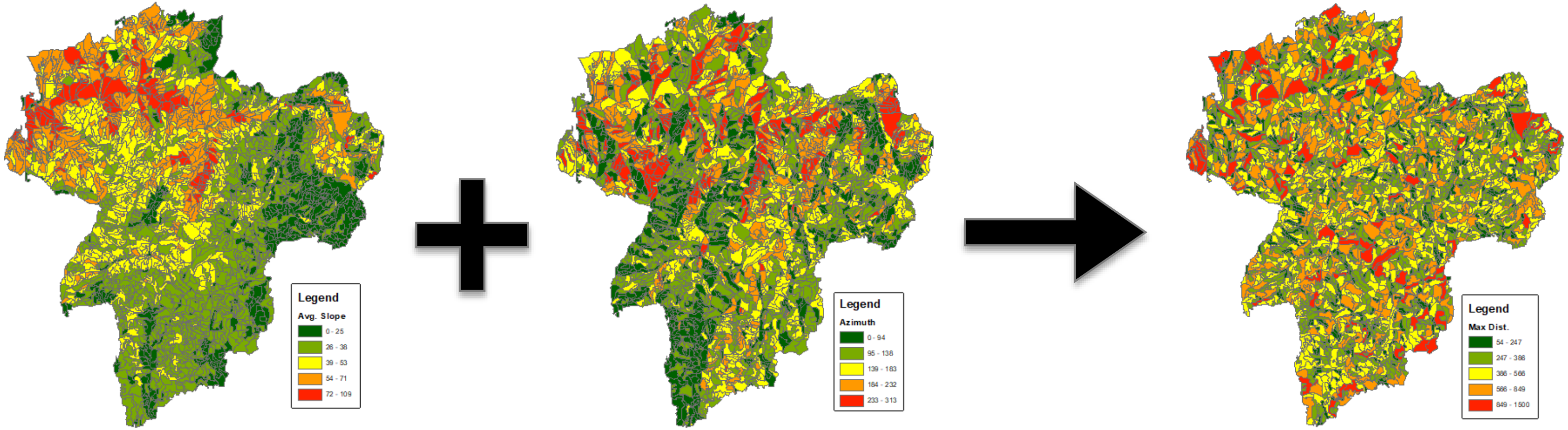
LIDAR-DERIVED DATA

- Average values for metrics determined for all 2627 stands within the study area
- Derived from LiDAR point-cloud, random forest and additional spatial shapefile resources
- Provide the means to conduct stand level harvest system classification



LIDAR-DERIVED SKIDDING/YARDING DISTANCES

- Utilized LiDAR-derived slope, aspect and stand shapefiles to determine distribution of yarding distances for each individual stand



HARVEST SYSTEMS ASSESSED

1.) Feller Buncher/ Skidder

2.) Shovel Harvester

3.) Tethered Shovel Harvester

4.) Excaliner/ Hand-Fell

5.) Swing Yarder/ Hand-Fell

Selection Criteria

HARVEST SYSTEM SCENARIOS

- Operational thresholds used for site selection were developed for each harvest system
- Additional harvest system added in each subsequent scenario is preferentially selected over systems with common thresholds
  - Ex.) Shovel Harvester (Scenario 2)

Scenario 1

Harvest System	Operable Slope	Forwarding/ Skidding Distance	Minimum Merchantable Volume
Buncher/Skidder	0 – 45%	< / > 180 m	5,000 BF/Acre
Excaliner/ Hand Fell	> 45%	< 250 m	5,000 BF/Acre
Swing Yarder	> 45%	> 250 m	5,000 BF/Acre

Scenario 2

Harvest System	Operable Slope	Forwarding/ Skidding Distance	Minimum Merchantable Volume
Buncher/Skidder	0 – 45%	> 180 m	5,000 MBF
Shovel Harvester	0 – 45%	< 180 m	5,000 MBF
Excaliner/ Hand Fell	> 45%	< 250 m	5,000 MBF
Swing Yarder/ Hand Fell	> 45%	> 250 m	5,000 MBF

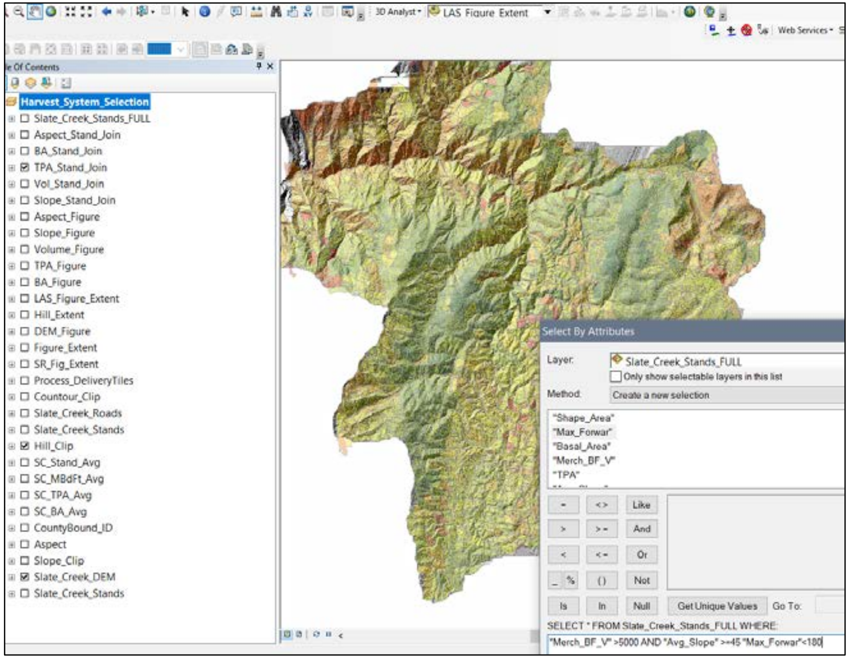
Scenario 3

Harvest System	Operable Slope	Forwarding/ Skidding Distance	Minimum Merchantable Volume
Buncher/Skidder	0 – 45%	> 180 m	5,000 MBF
Shovel Harvester	0 – 45%	< 180 m	5,000 MBF
Tethered Shovel	45 – 80%	< 180 m	5,000 MBF
Excaliner/ Hand Fell	> 45%	< 250 m	5,000 MBF
Swing Yarder/ Hand Fell	> 45%	> 250 m	5,000 MBF

Selection Process

HARVEST SYSTEM SELECTION

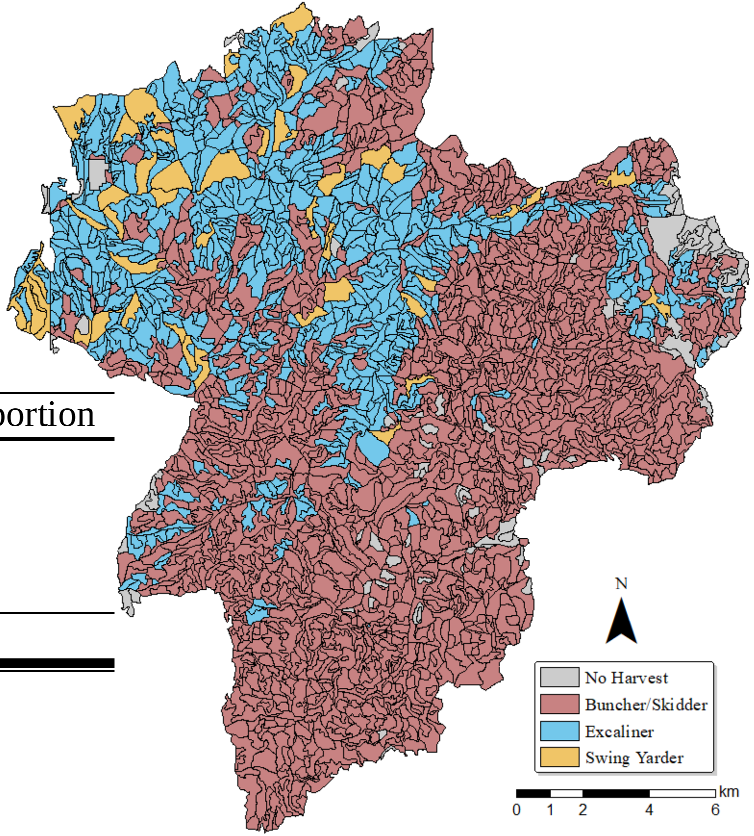
- Landscape selection queries were performed in ArcMap on a per scenario basis
- Shapefiles developed for each harvest system within each scenario and merged to develop scenario summaries



Classification Results

SCENARIO 1

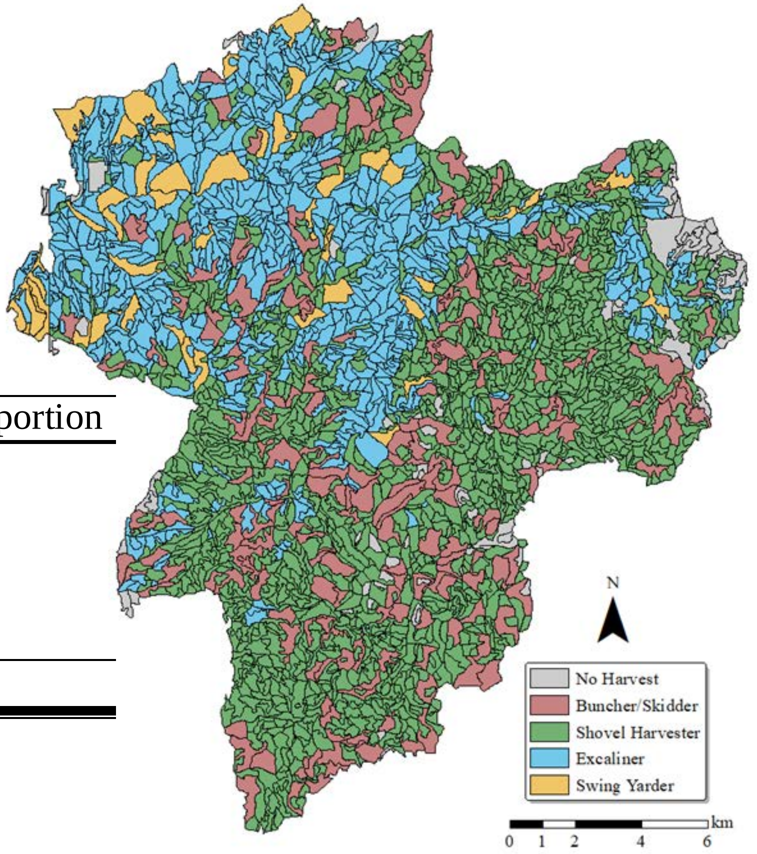
Harvest System	Stands	Hectares (Acres)	Area Proportion
No Harvest	91	1109 (2740)	0.04
Feller-Buncher/ Skidder	1726	18940 (46801)	0.63
Excaliner/ Hand Fell	767	8422 (20810)	0.28
Swing Yarder/ Hand Fell	43	1571 (3881)	0.05
	2627	30042 (74232)	1.00



Classification Results

SCENARIO 2

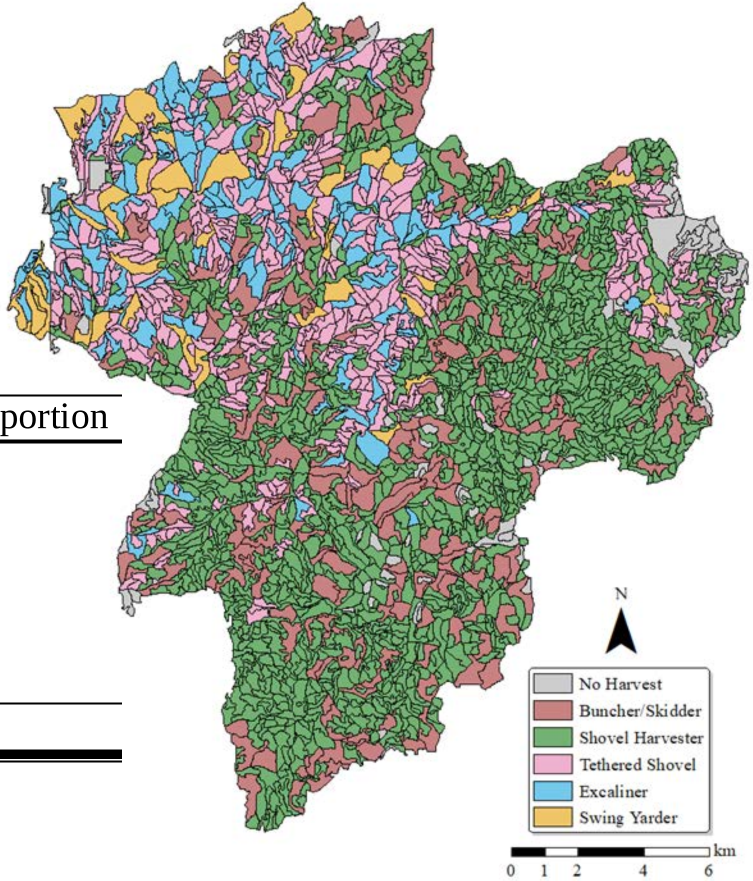
Harvest System	Stands	Hectares (Acres)	Area Proportion
No Harvest	91	1109 (2740)	0.04
Feller-Buncher/ Skidder	218	5222 (12904)	0.17
Shovel Harvester	1508	13718 (33897)	0.46
Excaliner/ Hand Fell	767	8422 (20810)	0.28
Swing Yarder/ Hand Fell	43	1571 (3881)	0.05
	2627	30042 (74232)	1.00



Classification Results

SCENARIO 3

Harvest System	Stands	Hectares (Acres)	Area Proportion
No Harvest	91	1109 (2740)	0.04
Feller-Buncher/ Skidder	218	5222 (12904)	0.17
Shovel Harvester	1508	13718 (33897)	0.46
Tethered Shovel	618	5830 (14405)	0.19
Excaliner/ Hand Fell	149	2592 (6405)	0.09
Swing Yarder/ Hand Fell	43	1571 (3881)	0.05
	2627	30042 (74232)	1.00



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Testing Consistency in Responses

MCNEMAR TEST

- The McNemar is testing consistency in responses between two variables, which in our case is the land classification of a single harvest system between two harvest system scenarios
- We addressed, in terms of area, whether stands were (1) or were not (0) classified as:
  - Feller-buncher/ Skidder- Scenario 1 to Scenario 2
  - Excaliner/ Hand-fell- Scenario 2 to Scenario 3

MCNEMAR CONTINUED

- Did introducing shovel harvester and tethered shovel systems in Scenario 2 and 3 respectively have a significant impact on land classified as feller-buncher/ skidder and excaliner/ hand-fell respectively?

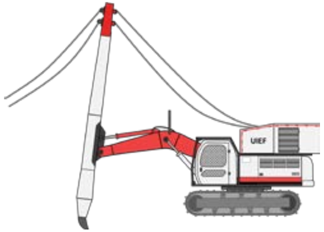
- In turn, this will determine if the alternative systems are a significant and feasible alternative to traditional systems at the landscape scale.

McNemar

TEST RESULTS

- In both instances, the introduction of the shovel harvester and tethered shovel systems as alternatives had significant impacts on the classification of area as feller-buncher/ skidder and excaliner/ hand fell
- Provides land managers with valuable insight into areas where inclusion of new, innovative harvest systems is possible

vs.

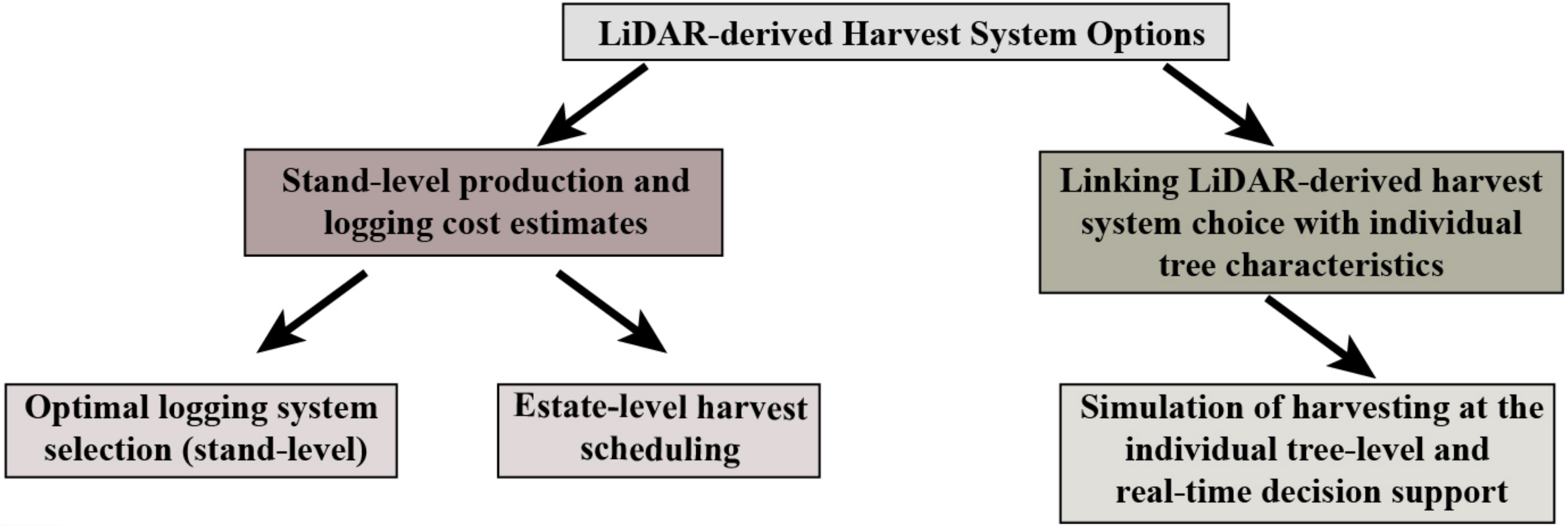


vs.

CONCLUSIONS

- Landscape scale decision support model provides means to further explore increased implementation of innovative systems into harvest scenarios in the Inland Northwest
- Ease of use and efficiency of the harvest system selection model makes application and implementation in additional landscapes simple

OPERATIONAL APPLICATIONS



Future Application

CONCLUSION CONT.

- Increased availability and resolution of remotely sensed data further increases the utility of these data for operational planning
- In turn, the ability to develop accurate forest and topographic metrics to aid in the decision making processes increases
- Precision forestry is now looking to tree-level model developments for pre-planning and production simulations

THANK YOU!

QUESTIONS?