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Biomass supply estimates for the Confederated Salish and Kootenai Tribes based on harvest planning and management goals

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May 8, 2015

Tribal biomass assessment overview

- **Estimate the availability and costs of transporting biomass from planned forest management sites to Pablo**

- Typical assessment of biomass supply chains uses regional average statistics
  - e.g., 1.1 BDT biomass/MBF[1]

- Ecologically-based forest management (CSKT) takes place on the landscape scale

1. Fitzpatrick, J. *et al*. Developing a Business Case for Sustainable Biomass Generation: A Regional Model for Western Montana. Report for NorthWestern Energy (2010).

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CSKT Management decisions are based on two ecological descriptors

- Management goal is to return forests to near pre-European contact conditions
- CSKT Forest Management Plan directs treatment prescriptions based on seral clusters and fire regimes

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Seral Clusters

- Describe structure and composition of the forest
  - size and age of trees
  - proximity of trees
  - single- or multi-layered stands
  - shade tolerant or intolerant species

- Thirteen seral clusters, A-L, are defined and mapped using both CFI and imagery data

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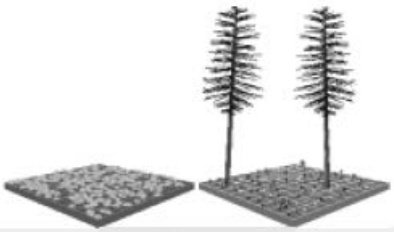
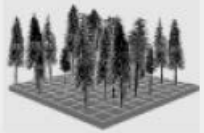
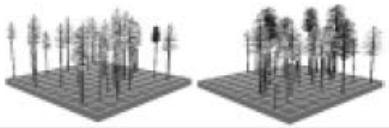
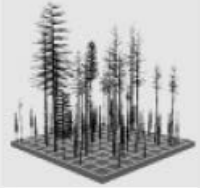
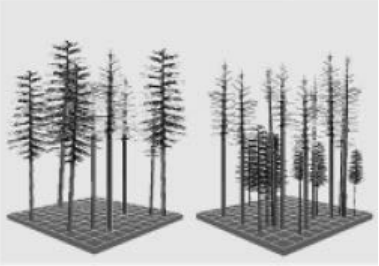
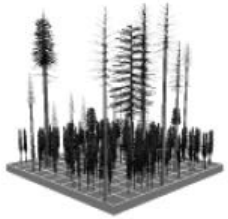
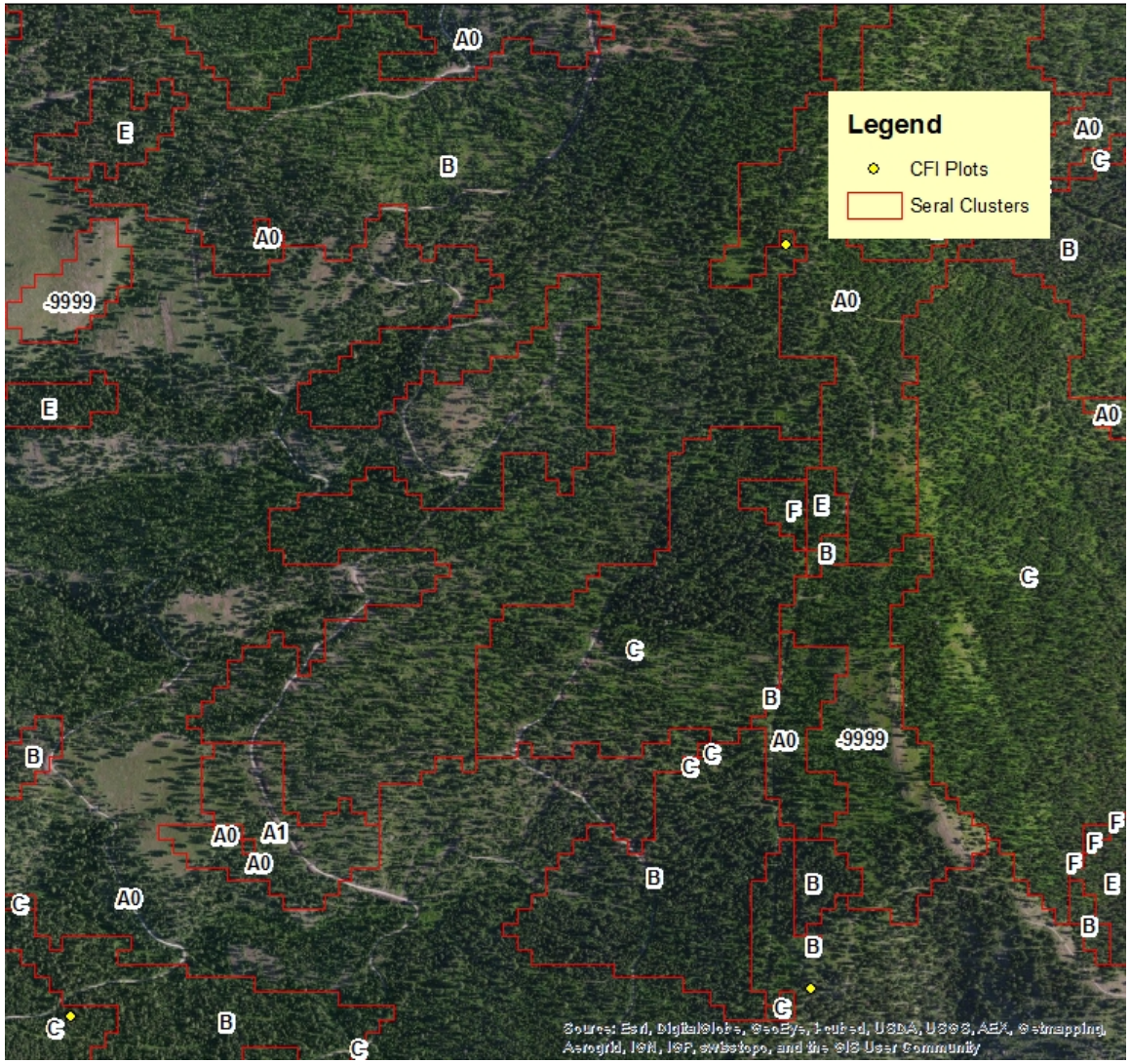
Examples	Cluster	General Description
	Cluster A	Cluster A1: Young and recenlty disturbed, open canopy, mostly pine and larch. Cluster A2: mature and old, frequently disturbed, open canopy, mostly pine and larch.
	Cluster B	Young, undisturbed since regeneration, moderate canopy, mostly fir.
	Cluster C	Young, frequently disturbed to undisturbed, moderate canopy, mostly pine and larch.
	Cluster D	Young, frequently disturbed to undisturbed, closed canopy, mostly pine and larch.
	Cluster E	Mature, undisturbed, moderate canopy, moslty fir and spruce.
	Cluster F	Mature, undisturbed, moderate canopy, mostly pine and larch. Potential for lodgepole old growth.
	Cluster G	Mature, less frequently disturbed, closed canopy, mostly pine and larch. Potential for lodgepole pine old growth.

Cluster	General Description	Examples
Cluster H	Mature, undisturbed, closed canopy, mostly fir and spruce	
Cluster I	Old, undisturbed, moderate canopy, mostly fir and spruce. Potential for old growth	
Cluster J	Old, undisturbed, moderate canopy, mostly pine and larch. Potential for old growth.	
Cluster K	Old, undisturbed, closed canopy, mostly pine and larch. Potential for old growth.	
Cluster L	Old, undisturbed, closed canopy, mostly fir and spruce. Potential for old growth.	

Source: CSKT Forest Management Plan

Seral Cluster Example



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Fire Regimes

- Refer to the type of fires that occurred during pre-European times
- Provide information about ecosystem function before fire suppression

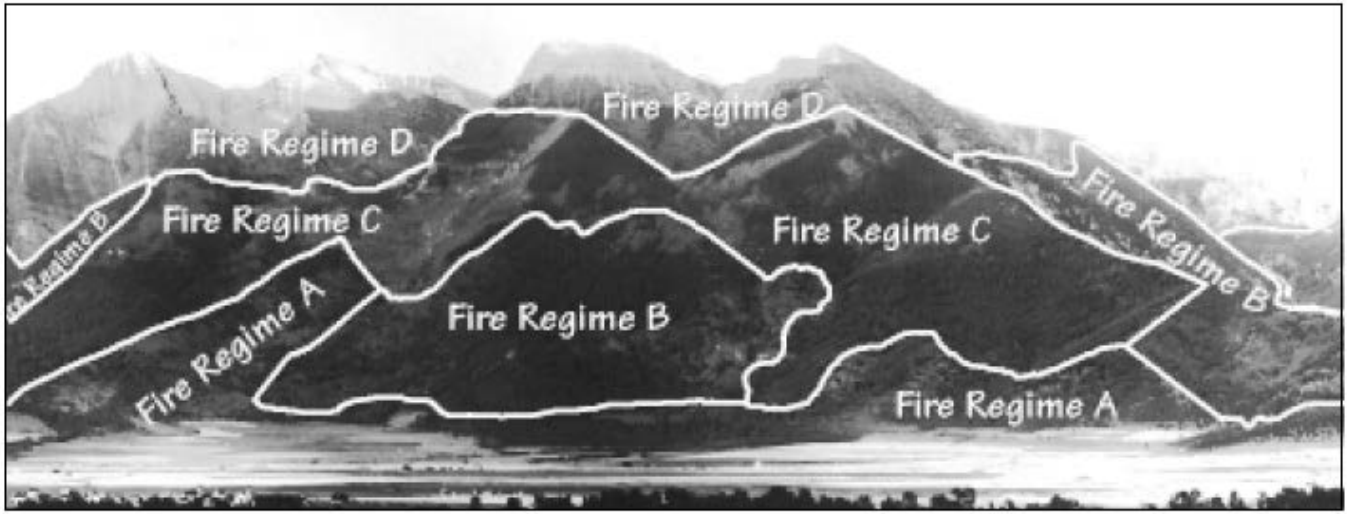

Figure 2-3. The Reservation's four main fire regimes as they occur on the Mission face. They include: Fire Regime A, the Nonlethal FR; Fire Regime B, the Mixed FR; Fire Regime C, the Lethal FR; and Fire Regime D, the Timberline FR.

- Four fire regimes defined based on fire frequency, fire intensity, and the pattern of vegetation that fires created

Figure from CSKT Forest Management Plan

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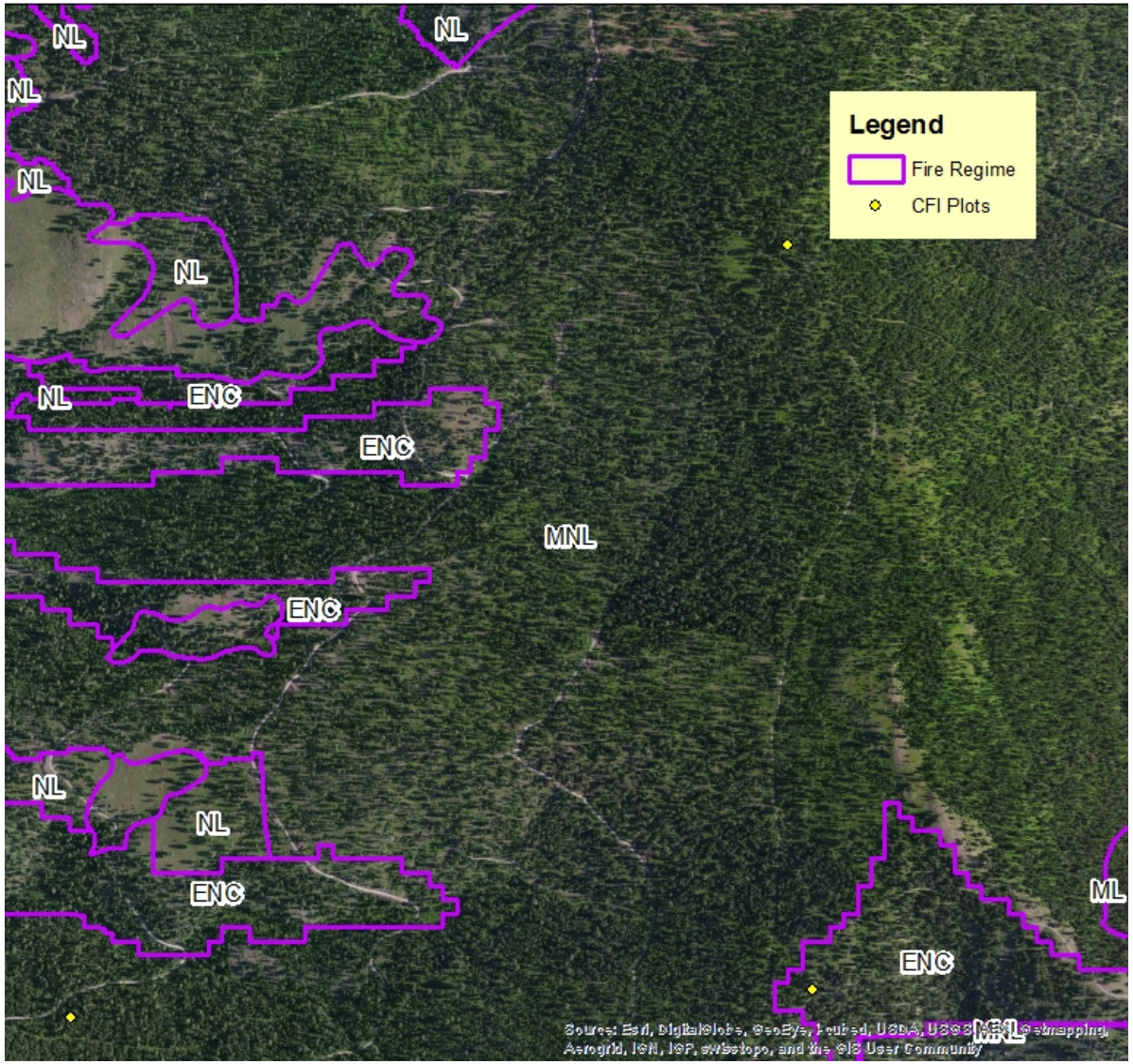
Fire Regime Example



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Silvicultural prescriptions are determined from fire regime and seral cluster at the stand level

Seral Cluster	Fire Regime				
	Encroachment	Non-Lethal	Mixed Severity	Lethal	High Elevation
A	No Harvest	No Harvest	No Harvest	No Harvest	No Harvest
B & C	No Harvest	Pre-Commercial Thin - 300 TPA	Pre-Commercial Thin - 300 TPA	Pre-Commercial Thin - 300 TPA	No Harvest
D	No Harvest	Commercial Thin - 300 TPA	Commercial Thin - 300 TPA	Even-Aged Clear cut - 20% of area	No Harvest
E & I	No Harvest	Even-aged Clear cut - 20% of area	Even-Aged Clear cut - 20% of area	Even-Aged Clear cut - 20% of area	No Harvest
F	No Harvest	Uneven-aged Q of 1.1 - to 45 BA	Uneven-aged Q of 1.1 - to 60 BA	Even-Aged Seed Tree - 20% of area	No Harvest
G	No Harvest	Uneven-aged Q of 1.1 - to 45 BA	Even-Aged SW - 25% of area (30 BA), Uneven-aged - 50% of area (60 BA)	Even-Aged Seed Tree - 20% of area	Even-Aged Clear cut - 20% of area
H	No Harvest	No Harvest	No Harvest	Even-Aged Seed Tree - 20% of area	Even-Aged Clear cut - 20% of area
J	No Harvest	Thin from below to 70 BA	Uneven-aged Q of 1.1 - to 70 BA	Even-Aged Clear cut - 20% of area	Even-Aged Clear cut - 20% of area
K	No Harvest	Thin from below to 80 BA	Uneven-aged Q of 1.1 - to 80 BA	Even-Aged Clear cut - 20% of area	No Harvest
L	No Harvest	No Harvest	No Harvest	Even-Aged Clear cut - 20% of area	No Harvest

Key steps toward biomass assessment

FVS → **Biomass** → **GIS** → **Results**

FVS: Predict forest growth and projected harvest from stands of each possible silvicultural prescription

Biomass: Estimate the residual biomass on the landscape after treatment

GIS: Determine the geospatial distribution of silvicultural prescriptions within harvest areas

Results: Apply biomass estimates to specific harvest areas/years and calculate transportation costs

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FVS used to predict harvest (board feet/acre)

- The Forest Vegetation Simulator (FVS) is a set of forest growth simulation models
- Modeled growth and anticipated harvests from 396 CFI plots for each of the 26 possible silvicultural prescriptions over 10 years
- Output is the volume of merchantable wood per acre harvested in a given year from stands of each prescription, broken down by tree species

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Continuous Forest Inventory Plot Data

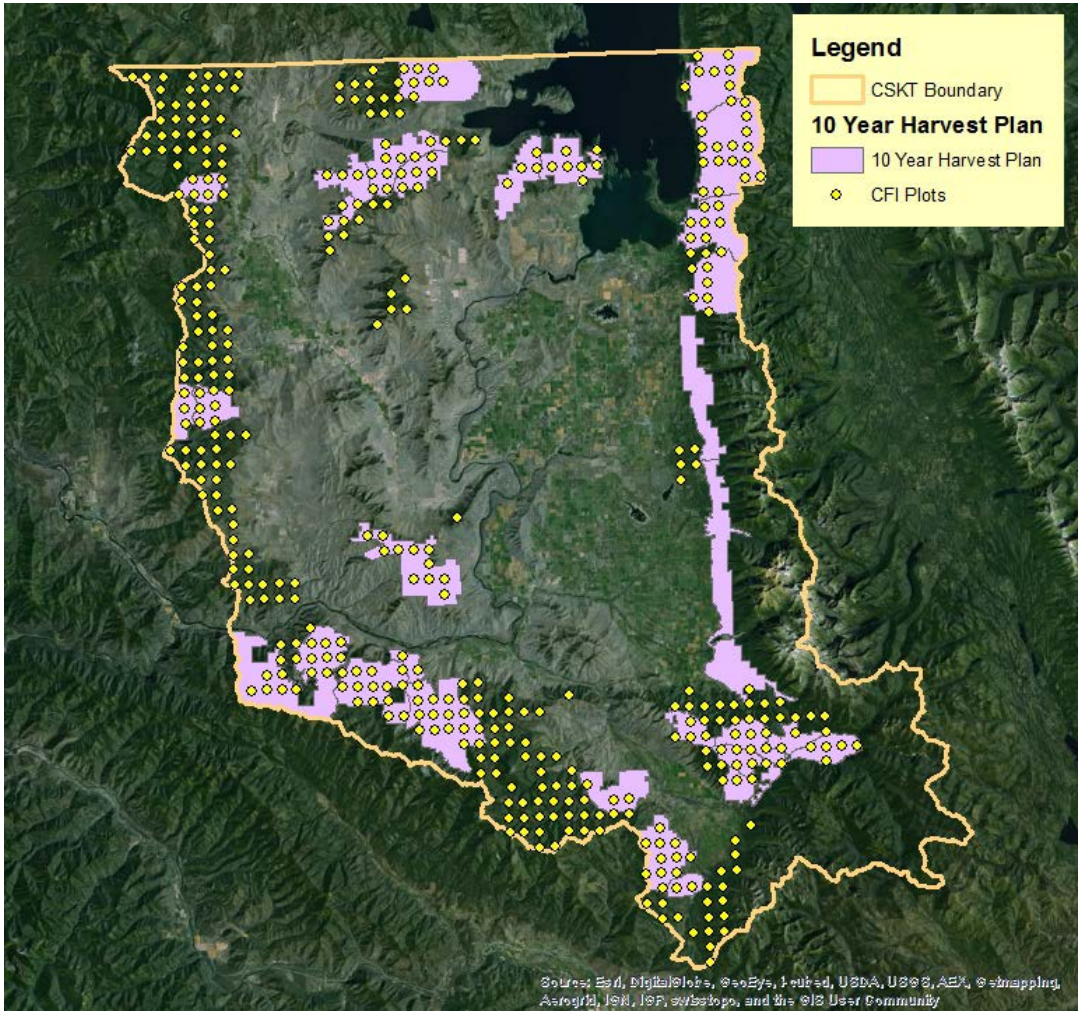
396 CFI Plots

Measurement Year – 1999

Small and large tree data

Tree Measurements – diameter, total height, crown ratio, age, 10 years diameter growth.

1/5th acre plot size



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Estimating biomass volume

- Biomass residuals for W. Montana were estimated using the RPA TPO database:

Volume of biomass per board foot of merchantable wood delivered

Species	Biomass (ft^3)/Board foot delivered to mill
Western Red Cedar	0.0944
Ponderosa Pine	0.0868
Whitebark Pine	0.0739
Engelmann Spruce	0.0695
Aspen	0.0715
Douglas Fir	0.0667
True Firs (Grand & Subalpine)	0.0841
Western Larch	0.0649
Lodgepole Pine	0.0700

- Combining these estimates with the FVS output provides an estimate of the total volume of biomass generated per acre for each silvicultural prescription

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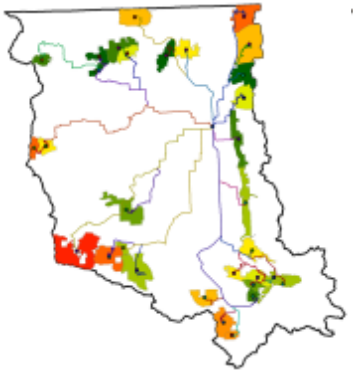
GIS analysis provides acreage of each silvicultural treatment within harvest areas

- CSKT provided GIS layers:



Management Areas

Road Network

Seral Clusters & Fire Regimes

- Each seral cluster/fire regime designation leads to a unique estimate of slash volume

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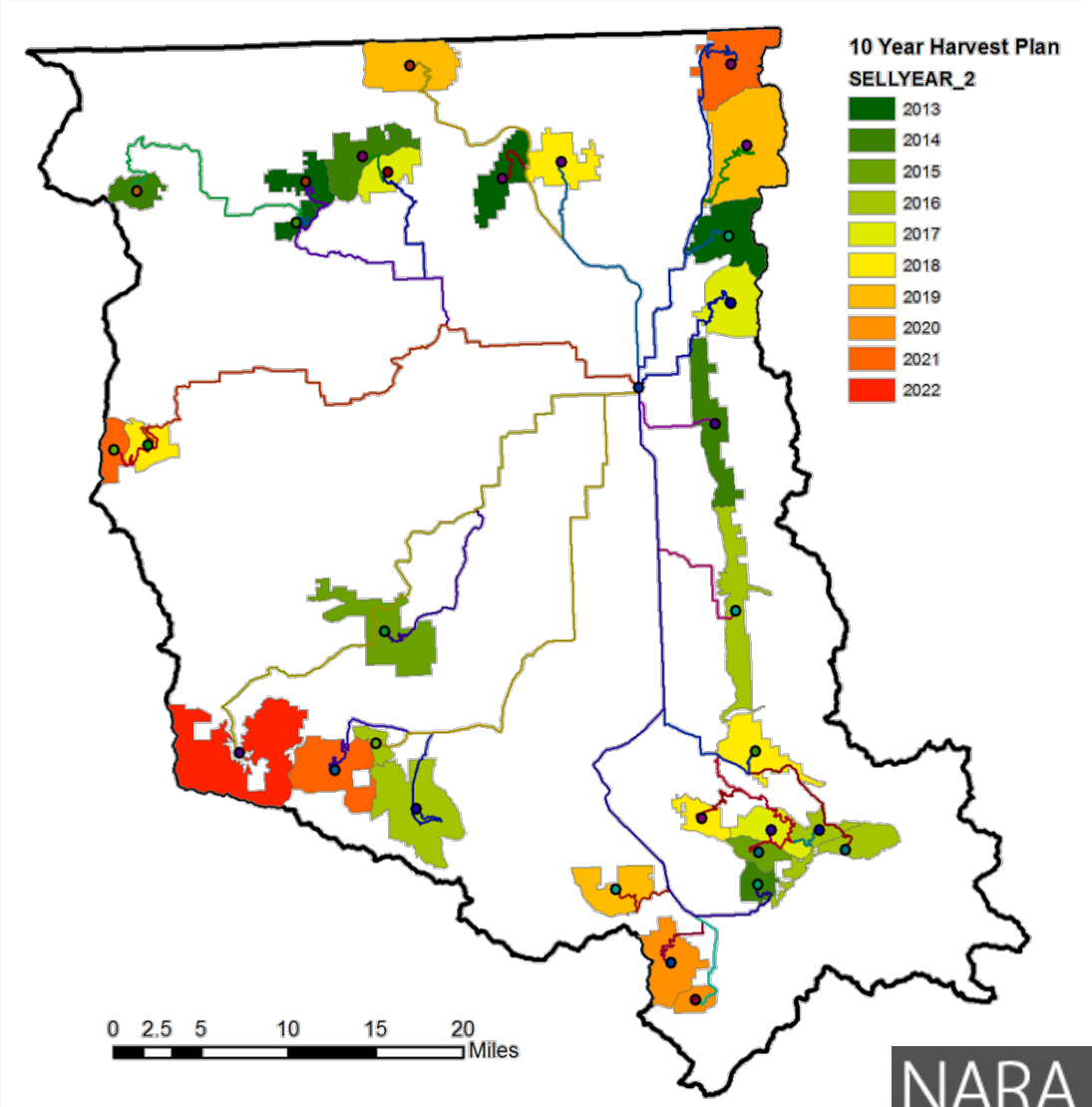
10 Year Plan for Forest Management Areas

Roads connecting the centroid of each harvest area to a potential biomass processing site in Pablo are shown



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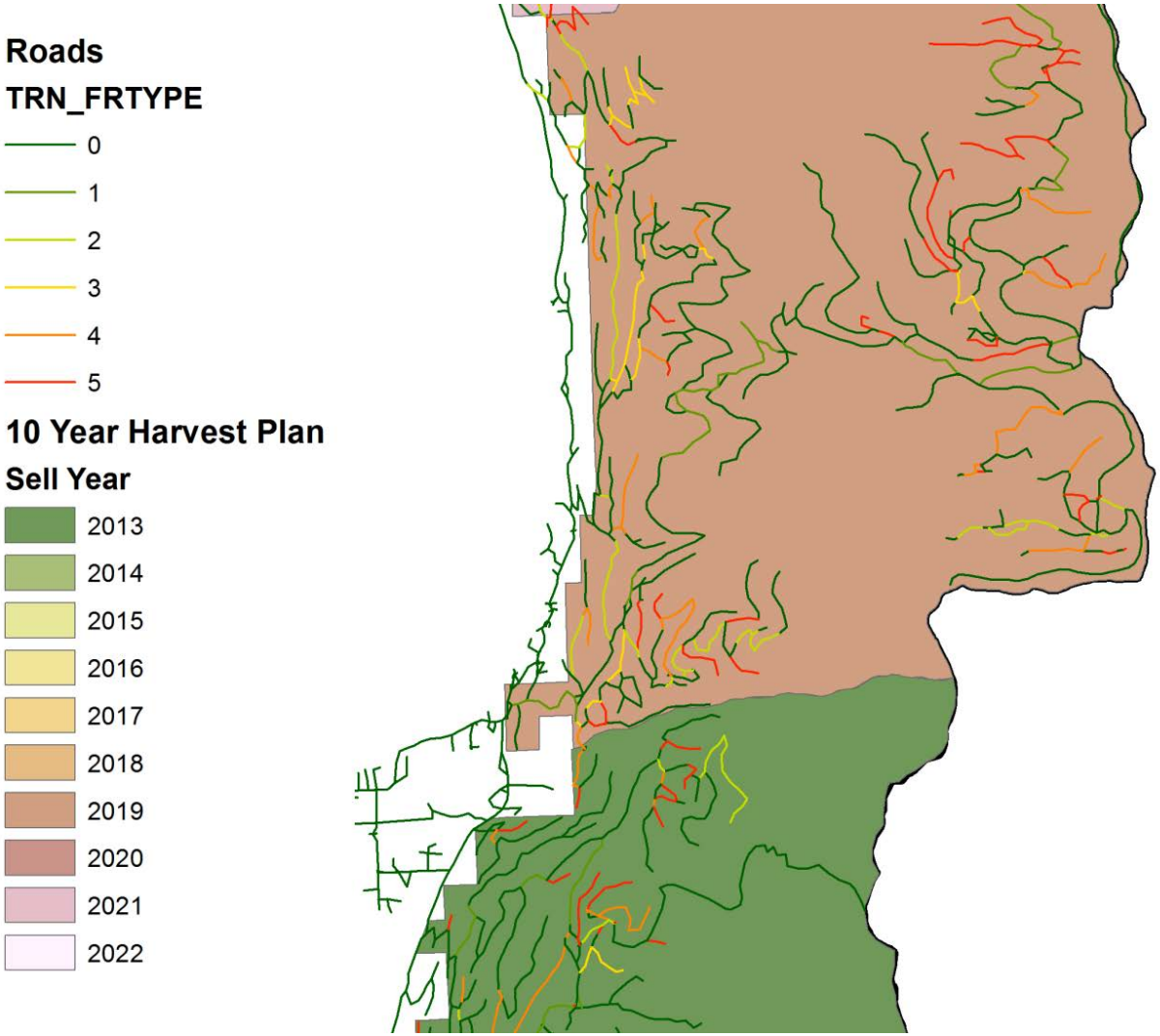
Road layer showing road classes



- CSKT's road layer defines 6 classes of road
- Class 0-3 roads are accessible to chip vans and can be used to remove biomass from the forest

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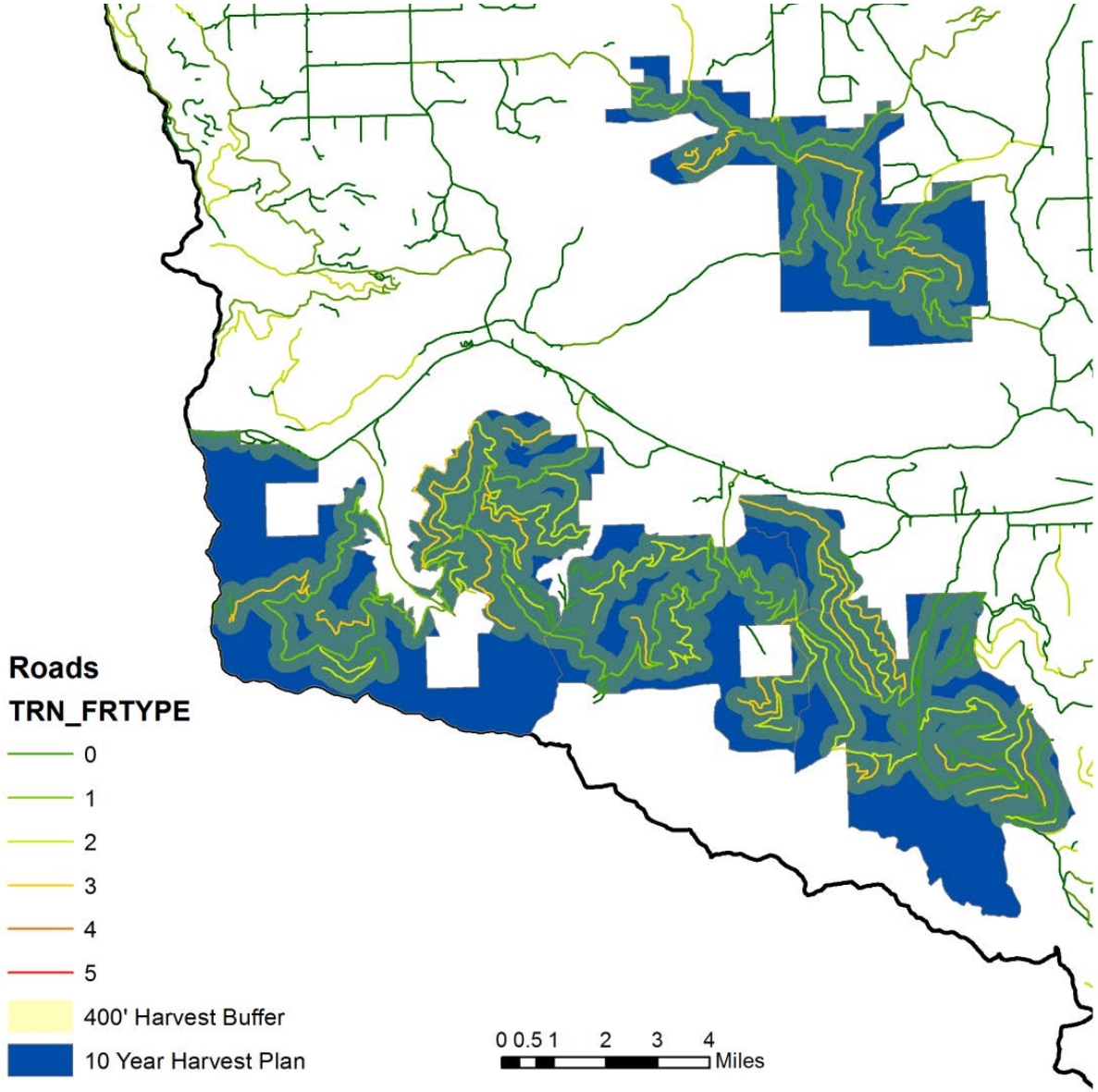
400’ Harvest Buffer



- Applied a 400’ harvest buffer around chip van-accessible roads within harvest areas
- This defines the harvestable area where biomass will be available to extract

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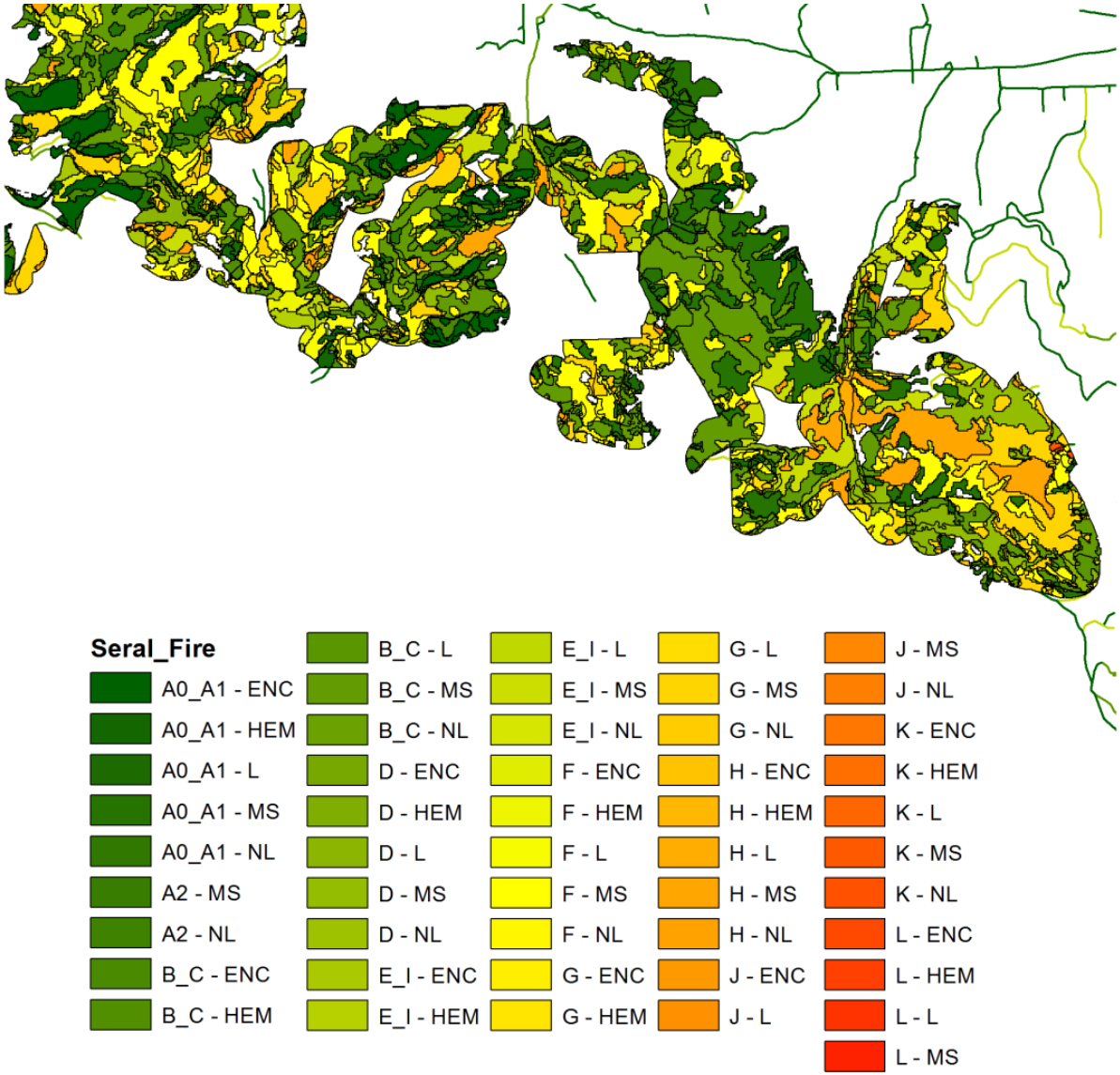
Seral Cluster/Fire Regime Combination

- Most seral cluster/fire regime combinations have different silvicultural prescriptions

- We mapped the 50 seral cluster/fire regime designations by finding the overlapping intersections of the original seral cluster and fire regime layers within the harvest buffer zone.



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Generating results

- To determine the predicted biomass volume and board feet of timber harvested each year we wrote a program that does the following:
  - Calculate the total acreage of each seral cluster/fire regime designation within a given harvest area and year
  - Apply the silviculturally specific biomass and harvest estimates from FVS and the RPA TPO database
    - Assume 65% of biomass is recoverable
  - Calculate the amount of biomass that will result from harvesting the maximum annual allowable cut of 18.1 million board feet
  - Estimate biomass processing, collection, and transportation costs

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Timber harvest & recoverable biomass

Year	Harvested Area (Acres)	Harvest (Board Feet)	Recovered Biomass (BDT)	Avg. Cost Delivered to Pablo
2013	11,049	18,100,026	12,946	$32/BDT
2014	7,554	18,100,066	13,059	$39/BDT
2015	10,431	18,100,065	12,957	$41/BDT
2016	9,459	18,100,247	13,029	$36/BDT
2017	8,822	18,100,078	13,075	$36/BDT
2018	7,836	18,100,099	13,099	$35/BDT
2019	9,482	18,100,070	13,068	$38/BDT
2020	7,826	16,783,789	12,242	$39/BDT
2021	9,541	18,100,086	13,108	$39/BDT
2022	9,318	18,100,010	14,628	$39/BDT

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Comparison with regional conversion factor

Total annual biomass supply calculated from landscape-level data agrees well with estimates using a regional conversion factor for MT of 1,096 BDT per 1MMBF[1]

Year	Biomass predicted using our method (BDT)	Biomass predicted using regional factor (BDT)
2013	12,946	12,894
2014	13,059	12,894
2015	12,957	12,894
2016	13,029	12,895
2017	13,075	12,894
2018	13,099	12,895
2019	13,068	12,894
2020	12,242	11,957
2021	13,108	12,895
2022	14,628	12,894

Regional conversion factor estimate is generally within 1.6% for annual totals, but for individual harvest areas it ranges between ±0.1-12%

1 Morgan, T. An Assessment of Forest-based Woody Biomass Supply and Use in Montana. Report for Montana Department of Natural Resources and Conservation. Missoula (MT): 2009.

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Conclusions

- Approximately 13,000 BDT of biomass is available per year given current management plans
- The average delivered cost to Pablo is $37/BDT
- Estimating available biomass based on CSKT's landscape-level approach produced similar overall results to estimates using regional average approaches
  - Results for individual harvest areas or stands occasionally differed significantly from regional average estimates

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Acknowledgments

Special thanks to Jim Durglo and the CSKT Forestry Department for providing GIS and CFI data, and for their discussions about silvicultural treatments and Tribal forestry practices.

FVS analysis was done by Tom Richards from Northwest Management, Inc.

Todd Morgan, Erik Berg, and Eric Simmons from the University of Montana for help getting biomass estimates from the RPA TPO database.

Funding provided by the Agriculture and Food Research Initiative Competitive Grant no. 2011-68005-30416 from the USDA National Institute of Food and Agriculture.

Questions?