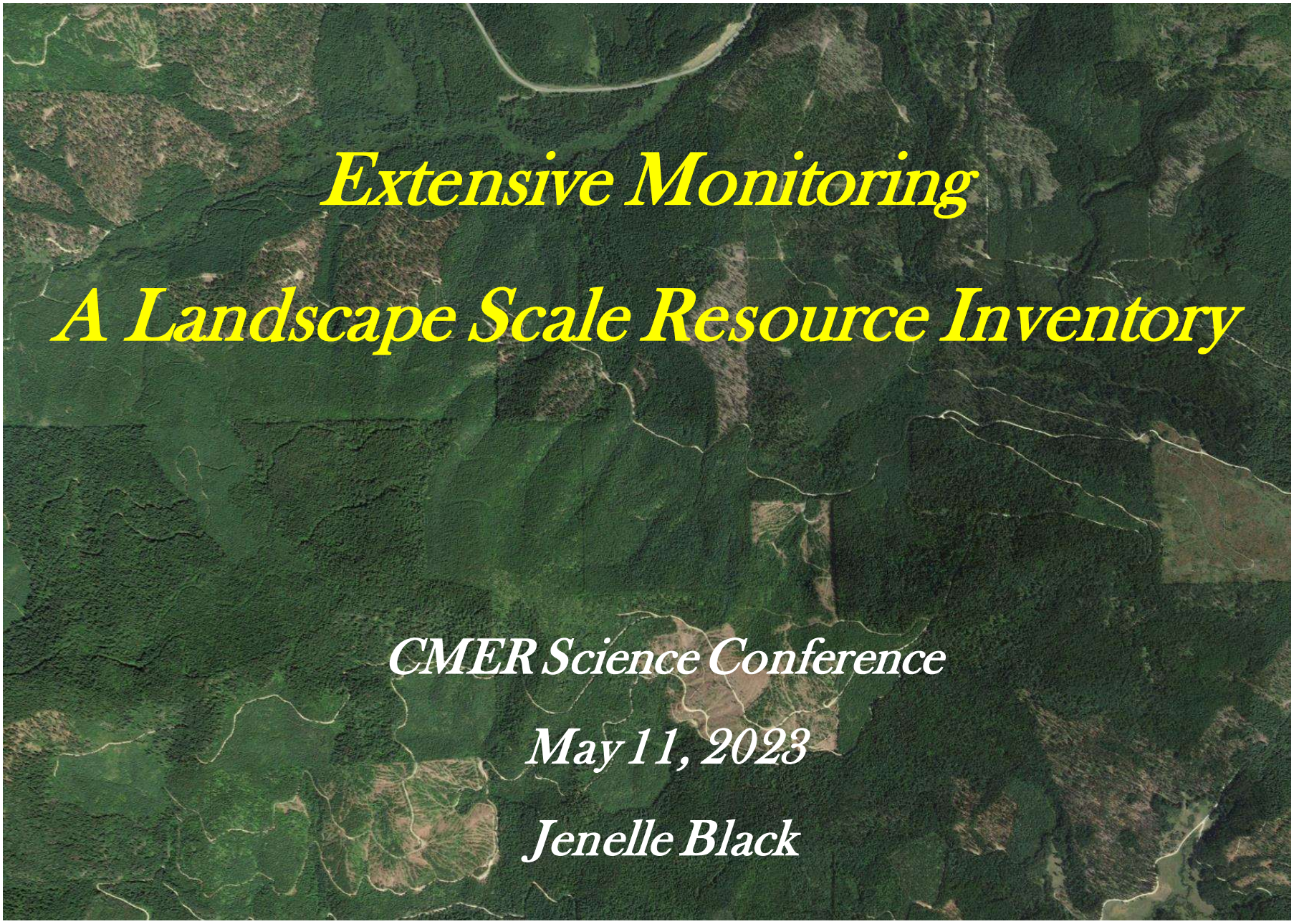


Extensive Monitoring

A Landscape Scale Resource Inventory

CMER Science Conference

May 11, 2023

Jenelle Black

Extensive Monitoring in the Forest Practices Adaptive Management Program

Photo courtesy of Joe Murray

The Forest Practices Habitat Conservation Plan (FPHCP):

- "Extensive monitoring evaluates the statewide status and trends of key watershed processes and habitat conditions across lands covered under the FPHCP.
- Extensive monitoring is a landscape-scale assessment of the effectiveness of forest practices rules to attain specific performance targets.
- This is different from 'effectiveness monitoring', which evaluates the effect of specific prescriptions or practices at the site scale."

The CMER Work Plan includes four extensive monitoring programs:

- Extensive Status and Trends Stream Typing Monitoring (5.1.5),
- Mass Wasting Landscape Scale Extensive Monitoring (5.5.6.6),
- Extensive Fish Passage Monitoring (5.7.5),
- **Riparian Status and Trends Monitoring for Vegetation and Temperature in Type F & N Streams (5.2.5).**

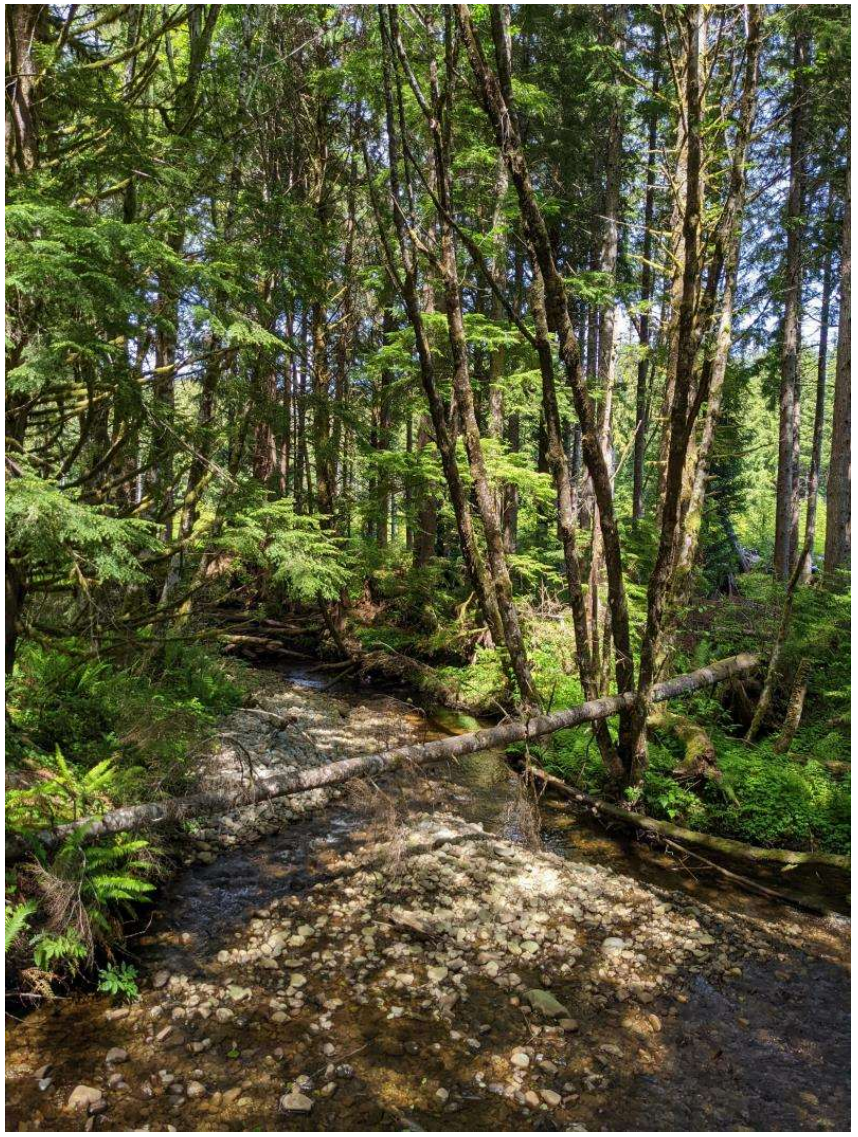


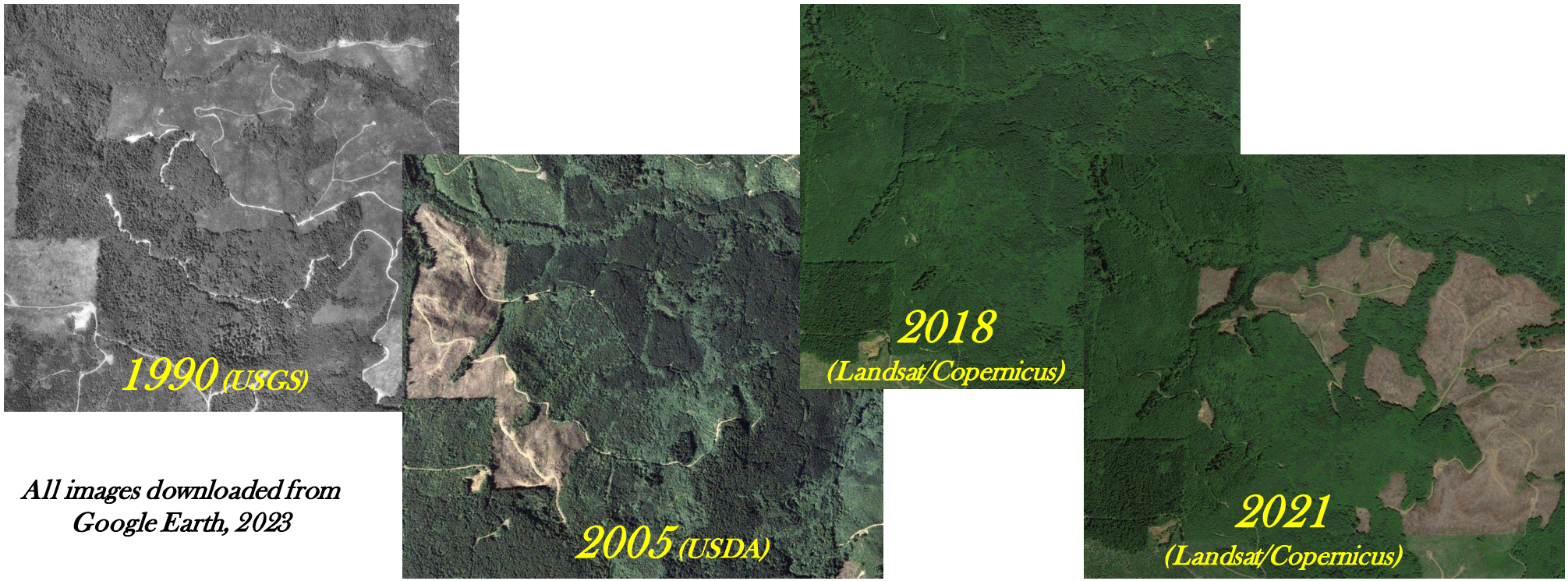
Photo courtesy of Tanner Williamson

Riparian Status and Trends Monitoring for Vegetation and Temperature

Purpose:

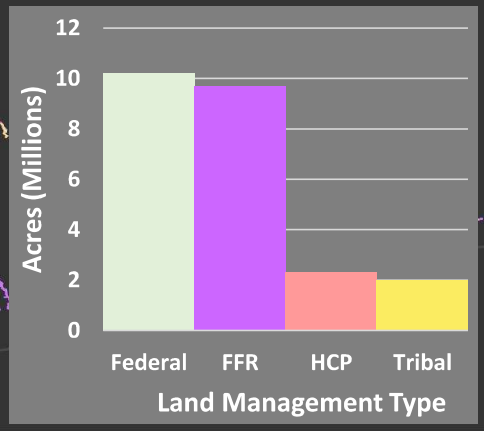
Monitor distribution and trend through time of stream temperatures and riparian conditions across all lands managed under the FFR [forest practices] rules.

(Extensive Riparian Status and Trends Monitoring – Riparian Vegetation and Stream Temperature, Type F/N Westside and Eastside Program Charter Draft of April, 2023)

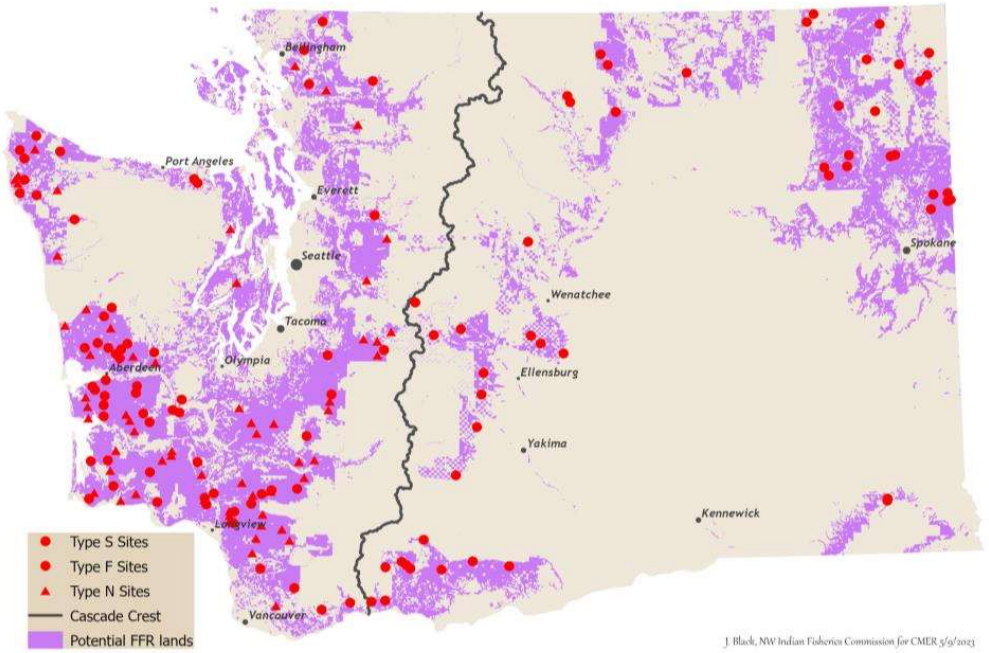


All images downloaded from Google Earth, 2023

Over 9 Million Acres of Potential FFR Lands (purple)



Riparian Status and Trends Monitoring for Vegetation and Temperature



Work Completed to Date:

- Stream Temperature Phase I Status (2008 and 2009)
- Exploratory Riparian Vegetation Characterization
- Vegetation Methods Development
- Workshops with TFW Policy committee to define objectives and questions

Stream Temperature Phase I Status – Eastern Washington

Stream temperature and associated channel conditions in 50 streams of Eastern Washington in 2007 and 2008 (Ehinger 2013)

- 2008 Results (medians)

Stream Type	N	Stream Length Scope of Inference	Tmax	7-day Avg Max Temp	Canopy Closure
F/S	45	1,786 km	15.9 °C	14.9 °C	82%

- Maximum temperatures were correlated with air temperature and catchment area and inversely correlated with canopy cover and suspended LW
- Results cannot be confidently applied to SFLOs due to low SFLO participation
  - Details of sample population and frame definition
  - nuances of GRTS sampling and associated scope of inference

Stream Temperature Phase I Status - Western Washington

Stream temperature and associated channel conditions in 115 Type F & N streams of Western Washington in 2009 (WA Dept. of Ecology 2019)

- **Results (medians):**

Stream Type	N	Stream Length Scope of Inference	Tmax	7-day Avg Max Temp	Canopy Closure
F/S	61	**17,952 km**	18.7 °C	18.1 °C	78%
Np	54	**33,581 km**	16.2 °C	15.2 °C	93%

- **Maximum temperatures in Type F streams were correlated with air temperatures and stream channel geometry and negatively correlated with canopy closure on Type F streams**
- **Max temps in Type N streams correlated only with the mean channel depth and width:depth ratio on Type Np streams**
- **Max temps did not correlate to elevation for either stream type**

Work Completed to Date – Riparian Vegetation Methods

Eastern Washington Riparian Assessment Project (Schuett-Hames 2015)

- Exploratory characterization of riparian vegetation conditions on 102 Type F streams

  - High diversity and variability in characteristics among riparian buffer stands

Pilot study evaluating riparian and stream characteristics at different scales of aerial photos (Grotefendt 2007)

- Importance of using multiple scales of evaluation, including ground-based
- Financial advantage to using remote methods to characterize riparian stands across large areas

Literature Review of Remote Methods (Moskal and Cooke 2015)

		Aerial Imagery		Aerial LIDAR		Aerial IfSAR	High Resolution Satellite		Low Resolution Satellite		
Metrics	Direct Measure or Model	NAIP	NAIP Stereo	pre 2005	post 2005		GeoEye/DigitalGlobe/ IKONOS	Spot	EOS(Terra)	LandSAT	EOS(Terra)
Minimum Sensor Spatial Resolution		1m	1m	sub-meter	sub-meter	5m	0.5m (pan)	1.5m (pan)	15m (ASTER)	30m	250m (MODIS)
Data Cost/Availability		$/yearly, older dates more sporadic	$/varies	$/varies	$$$/on-demand	$$/on-demand	$$/varies on satellite availability	$$$/varies on satellite availability	$$$/varies on satellite availability	$/varies on satellite availability since 1972	$/varies on satellite availability since 2000
Hydrology/Streams (channel locations, channel edge locations)	direct	(5) ($$$)	*($$$$)	(23) ($$$)	(36) ($$$)	(21, 23, 34, 48) ($$$)	(36) ($$$)	* ($$$)	(34) ($$$)	(21, 48) ($$$)	*
Height (feet)	direct	(5) ($$$)	*($$$$)	(35, 46) ($)	(2, 12) ($)	(6) ($)	(70) ($$$)	* ($$$)	*	*	*
Crown Diameter (feet)	both direct and model	(5) ($$$)	*($$$$)	(3, 19, 54, 58) ($$)	*($$)	* ($$)	(20, 40, 41, 49, 70, 71) ($$)	*	*	*	*
Snag Detection (number)	direct (model w/satellite data)	(5) ($$$)	*	(52) ($$$)	(7, 8, 55) ($)	*	*	*	*	(16) ($$$)	*
Canopy Percent Cover (percent)	direct (model w/satellite data)	(5) ($$$)	*($$$$)	(1, 13, 27, 35, 46, 63, 65) ($)	* ($)	* ($)	(38) ($$)	* ($$)	(63) ($)	(1, 16) ($)	* ($$$)
Stand Density (trees per acre)	direct	(5) ($$$)	*($$$$)	(3, 19, 28, 29, 46, 54, 58) ($)	(61) ($)	* ($)	(44, 53) ($$)	* ($$)	* ($)	(1, 16) ($)	*
Conifer/Deciduous Classification (class)	direct	(5) ($$$)	$$$)	* ($$)	(22, 24, 26, 42, 43, 60, 68, 69) ($$)	*	(26, 59) ($$)	* ($$)	* ($$)	(1, 16) ($$)	* ($$$)
Vegetation Class (Seral Stage)	model	(5, 57) ($$$)	*($$$$)	(14, 52, 65) ($$)	(7) ($$)	*	(18, 37) ($$)	* ($$)	* ($)	(1, 16) ($)	* ($$$)
Species	model	(5, 17) ($$$)	*($$$$)	*($$$)	(22, 24, 25, 42, 66, 68, 69) ($$$)	*	(10, 17, 20, 41) ($$)	* ($$)	* ($$$)	(1, 16) ($$$)	*
Basal Area (square feet/acre)	model	(5) ($$$)	*($$$$)	(12, 28, 29, 30, 35, 64) ($)	* ($)	* ($$$)	(44, 53, 56) ($$)	* ($$)	*	(1, 16) ($$)	*
Large Woody Debris	model	(5, 11, 62) ($$$)	*($$$$)	* ($$$)	(31, 39, 55, 67) ($$$)	(4) ($$$)	(45, 51) ($$$)	*	*	*	*
Age (years)	model	*($$$)	*($$$)	* ($)	* ($$)	* ($$$)	(15) ($$$)	* ($$$)	*	(32, 33, 47) ($$)	*
DBH (inches)	model	(5) ($$$)	*($$$$)	(12, 35) ($)	(9, 50) ($$)	* ($$$)	(70) ($$$)	* ($$$)	*	* ($$$)	*

Codes

- not effective
- possibly effective (based on limited or no previous research, desired results, and costs)
- possibly effective (based on desired results, and costs)
- likely effective (based on limited or no previous research, desired results, and costs)
- likely effective (based on previous research desired results, and costs)

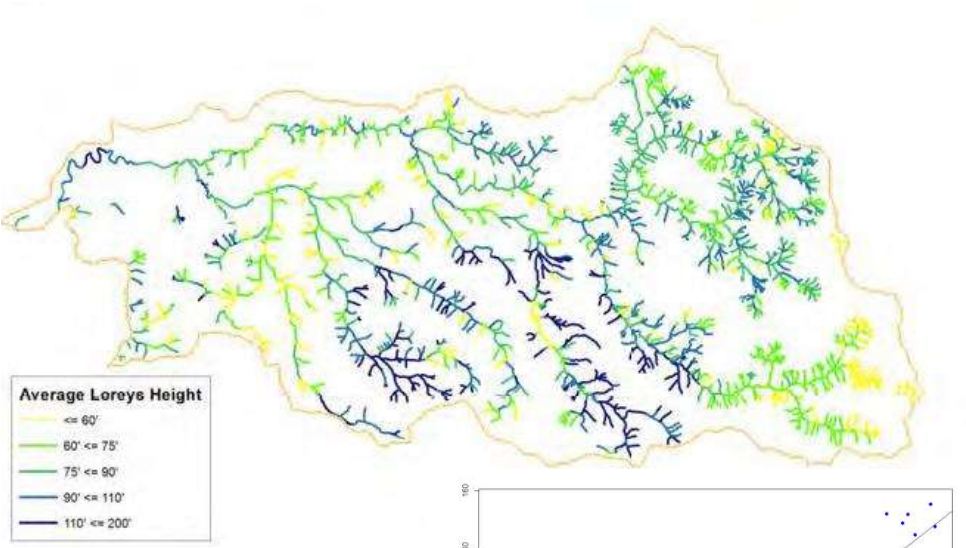
Extensive Riparian Vegetation Monitoring Remote Sensing Pilot Study

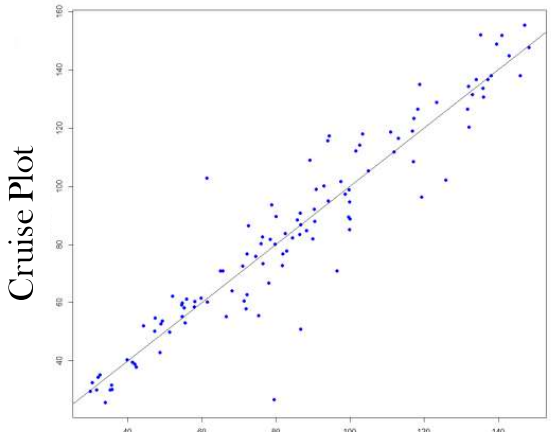
- (Moskal et al. 2017)
- Compared the effectiveness of LiDAR and optical imagery for assessing riparian stand metrics
- Developed a model to predict stand characteristics using lidar data based on timber cruise data

Conclusions:

- LiDAR is best tool for mapping height, and canopy cover
- LiDAR also good for basal area and DBH
- Imagery better for distinguishing conifer from hardwood
- LiDAR best option for establishing baseline conditions because concurrently measures ground

  - Photo methods might be best for trend monitoring after baseline





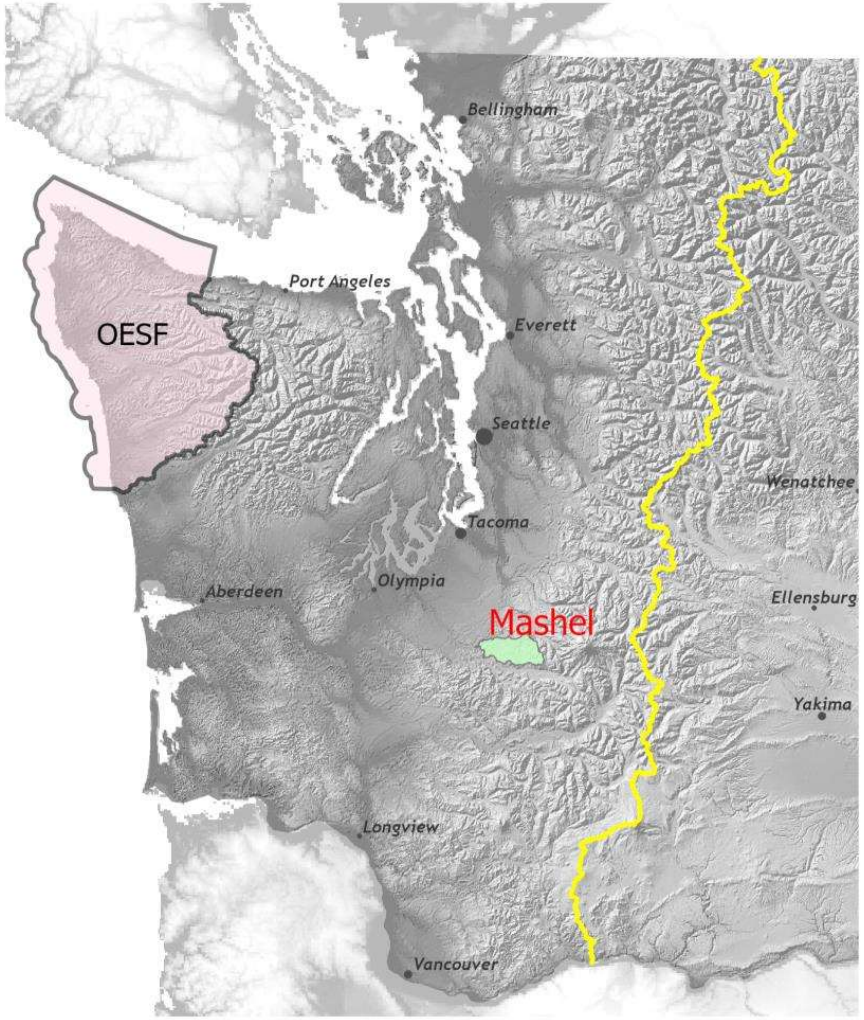
LiDAR model $R^2 = 0.89$

Work Completed to Date – Methods Development (cont'd)

Extensive Riparian Vegetation Monitoring, LiDAR Model Transferability Study

(Cooke and Devine 2020)

- Evaluated performance of Mashel pilot models for basal area, diameter, and stand density to very different forest stands on western Olympic Peninsula (OESF)
- Generated a new lidar prediction model for OESF stands using OESF timber cruise data and evaluated performance of that model in Mashel watershed



Work Completed to Date – Methods Development (cont'd)

LiDAR Model Transferability Study Findings

- Models did not transfer between these different forest types very well
  - DBH was the exception ($R^2 = 0.7$)

	Mashel Model to Mashel (native)		Mashel Model to OESF		OESF Model to Mashel		OESF Model to OESF (native)	
Metric	**R^2**	**RMSE**	**R^2**	**RMSE**	**R^2**	**RMSE**	**R^2**	**RMSE**
Basal Area	0.72	63.12	0.32	59.50	0.68	68.06	0.61	44.87
Stem Density	0.46	68.96	0.44	57.40	0.17	85.66	0.71	41.51
Diameter	**0.70**	**2.77**	**0.70**	**2.28**	**0.58**	**3.29**	**0.86**	**1.55**

- Models are sensitive to the forest types to which they are being applied
  - Work best on forest types most similar to those from which they were developed
- The number of models required for statewide assessment will depend on the level of precision and accuracy required to answer questions

Scoping New Extensive Monitoring Plan

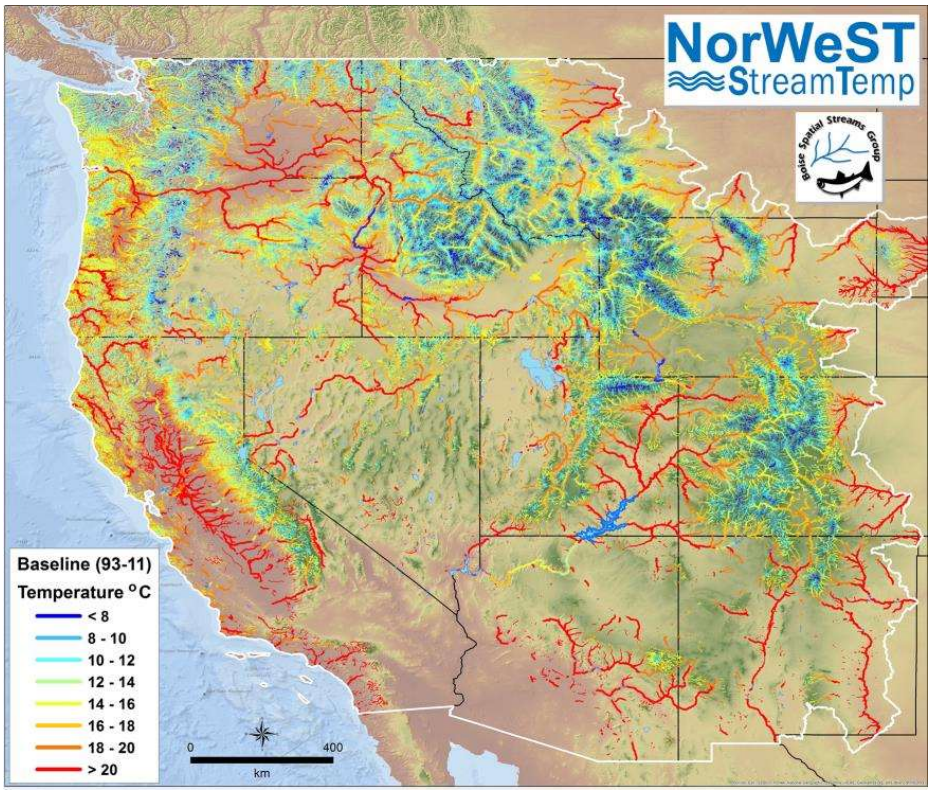
- Policy directed CMER to
  - "develop options for a monitoring program to help determine how stream temperature and riparian functions have changed or are changing in association with the application of forest practice rules."

- CMER and Policy working together to really define objectives and scope of the program
  - Finalize critical questions
  - Decide what is the land base and stream population of interest
    - Type S waters?
    - Mixed use forested residential properties?
  - Define what metrics and target values of those metrics indicate "success" of the FFR rules (prior to conducting study); what level of detail?

Scoping (cont'd)

- *CMER continuing to explore and track development of new methods*
  - Remote sensing methods that give us the ability to develop complete inventories rather than spot-sampling
  - Metrics we couldn't calculate using old methods
  - Increasing understanding of riparian and aquatic relationships

- Investigating other landscape-scale monitoring efforts and data sources
  - Might have data to incorporate into the FFR monitoring context
  - Integrate with to leverage all our data and understanding



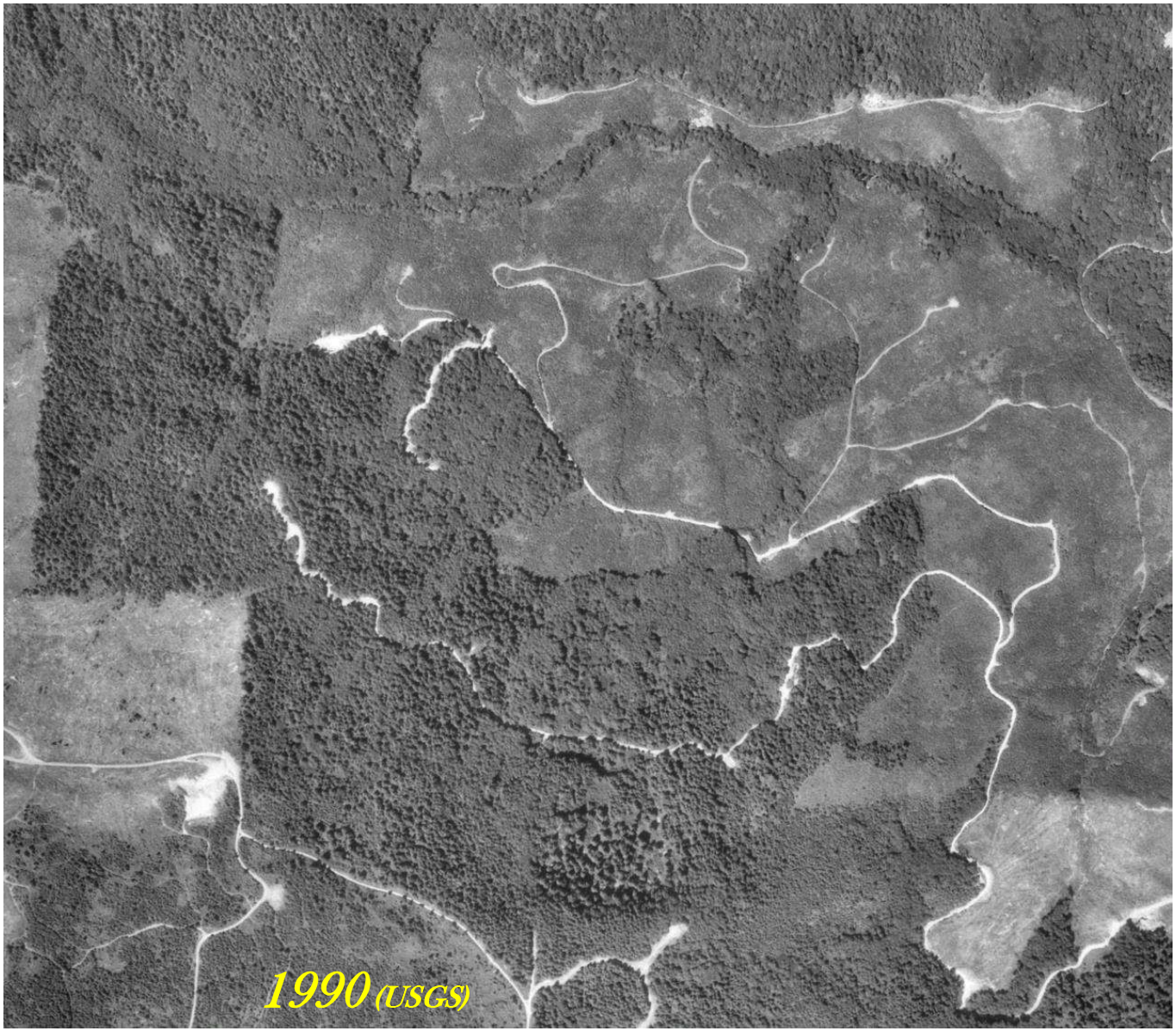
Scoping (cont'd)

- Resolving challenges
  - How to characterize, categorize, and summarize diverse, multi-cohort buffer forests
  - How to relate measured metrics to riparian functional objectives
  - How to incorporate effects of changing climate into understanding of FFR trend monitoring
  - Need accurate hydrography!

Extensive Monitoring Document Links

- *Monitoring Design Team (MDT) Report* 2002.
  - https://www.dnr.wa.gov/publications/fp_cmer_gov_salmon_plan.pdf
- Schuett-Hames 2015. *Characteristics of Riparian Management Zones Adjacent to Eastern Washington Fish-Bearing Streams Managed Under the Washington Forest Practices HCP*
  - Exploratory Study - no link
- Ehinger 2013. *ERST – Eastside Type F/S Phase 1 Stream Temperature report*
  - https://www.dnr.wa.gov/publications/fp_cmer_10_1001.pdf
- WA Dept of Ecology 2019. *ERST – Westside Type F/S and Np Phase 1 Stream Temperature report*
  - https://www.dnr.wa.gov/publications/fp_cmer_erst_wes_tem_2020.pdf
- Grotefendt 2007. *Suitability of Aerial Photography for Riparian Buffer Monitoring*
  - https://www.dnr.wa.gov/publications/fp_cmer_06_604.pdf
- Moskal and Cooke 2015. *Feasibility of applying remote sensing to a riparian stand conditions assessment – literature review*
- Moskal et al. 2017. *Extensive Riparian Vegetation Monitoring – Remote Sensing Pilot Study*
  - Pilot Method Development - no link
- Cooke and Devine 2020. *Extensive Riparian Vegetation Monitoring, Model Transferability Study*
  - https://www.dnr.wa.gov/publications/fp_cmer_ervm_model_2020.pdf

1990



2005

2018

2021