Designing Habitat for a Changing Climate: A Quantitative Approach

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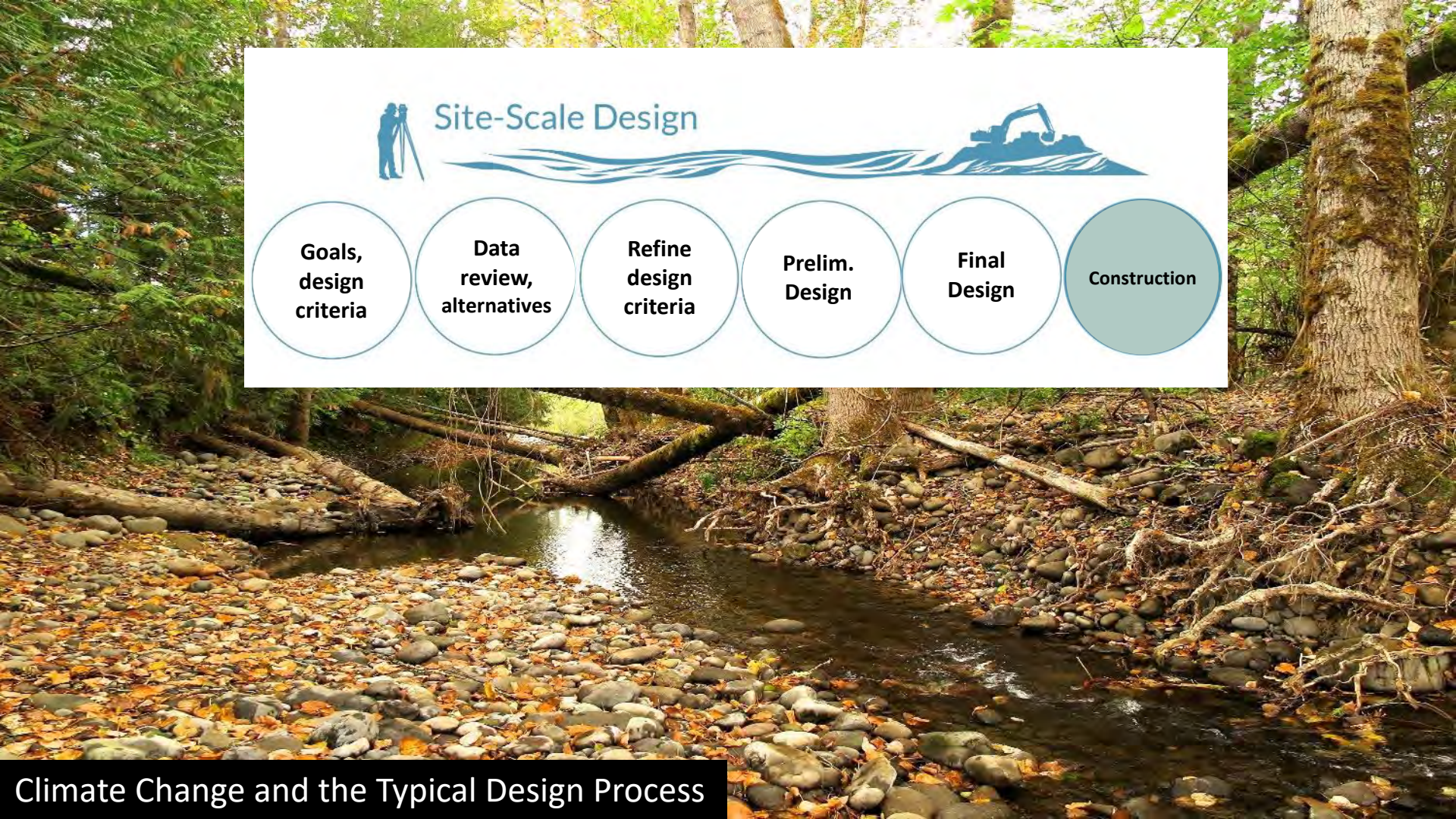
Milo McIver side channel, Clackamas, OR

Example project: Methow River at Fawn Creek

Overview

1. **Introduction:** Climate change and the current design process
2. **Methods**: Calculating future flow conditions for our project site
3. **Results:** Flood magnitudes and hydrograph timing
4. **Conclusions**



Climate Change and the Typical Design Process

Table III. Summary of restoration action types and their ability to ameliorate climate change effects on peak flow, low flow, stream temperature, or to increase salmon population resilience

Category	Common techniques	Ameliorates temperature increase	Ameliorates base flow decrease	Ameliorates peak flow increase	Increases salmon resilience
Longitudinal connectivity (barrier removal)					
	Removal or breaching of dam	●	●	○	●
	Barrier or culvert replacement/removal	○	○	○	●
Lateral connectivity (floodplain reconnection)					
	Levee removal	●	○	●	●
	Reconnection of floodplain features (e.g. channels, ponds)	●	○	●	●
	Creation of new floodplain habitats	●	○	●	●
Vertical connectivity (incised channel restoration)					
	Reintroduce beaver (dams increase sediment storage)	●	●	●	●
	Remove cattle (restored vegetation stores sediment)	●	●	●	○
	Install grade controls	●	●	●	○
Stream flow regimes					
	Restoration of natural flood regime	●	●	○	◒
	Reduce water withdrawals, restore summer baseflow	●	●	○	○
	Reduce upland grazing	○	◒	◒	○
	Disconnect road drainage from streams	○	○	●	○
	Natural drainage systems, retention ponds, other urban stormwater techniques	○	◒	●	○
Erosion and sediment delivery					
	Road resurfacing	○	○	○	○
	Landslide hazard reduction (sidecast removal, fill removal)	○	○	○	○
	Reduced cropland erosion (e.g. no-till seeding)	○	○	○	○
	Reduced grazing (e.g. fencing livestock away from streams)	◒	○	○	○
Riparian functions					
	Grazing removal, fencing, controlled grazing	●	○	○	○
	Planting (trees, other vegetation)	●	○	○	○
	Thinning or removal of understory	○	○	○	○
	Remove non-native plants	◒	◒	○	○
Instream rehabilitation					
	Re-meandering of straightened stream, channel realignment	◒	○	○	◒
	Addition of log structures, log jams	◒	○	○	○
	Boulder weirs and boulders	◒			
	Brush bundles, cover structures	○	○	○	○
	Gravel addition	○	○	○	○
Nutrient enrichment					
	Addition of organic and inorganic nutrients	○	○	○	○

Actions are grouped by major processes or functions they attempt to restore: connectivity (longitudinal, lateral and vertical), watershed-scale processes (stream flow and erosion regimes), riparian processes, instream rehabilitation, and nutrient enrichment. Filled circles indicate positive effect, empty circles indicate no effect, and partially filled circles indicate context-dependent effects. See text for supporting citations.

Beechie et al. 2012

Climate Change and the Typical Design Process

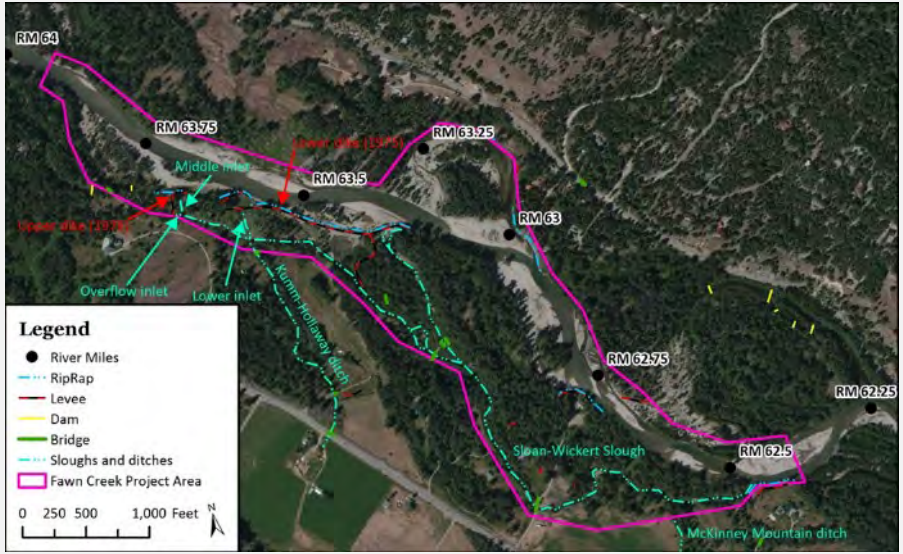
Site-Scale Design

- Goals, design criteria
- Data review, alternatives
- Refine design criteria
- **Prelim. Design**
- Final Design
- Construction

Climate Change and the Typical Design Process

Incorporating climate change into design

- What does climate change look like for our project site in terms of high flow events and hydrograph timing?
- Can we use these data to inform our design?



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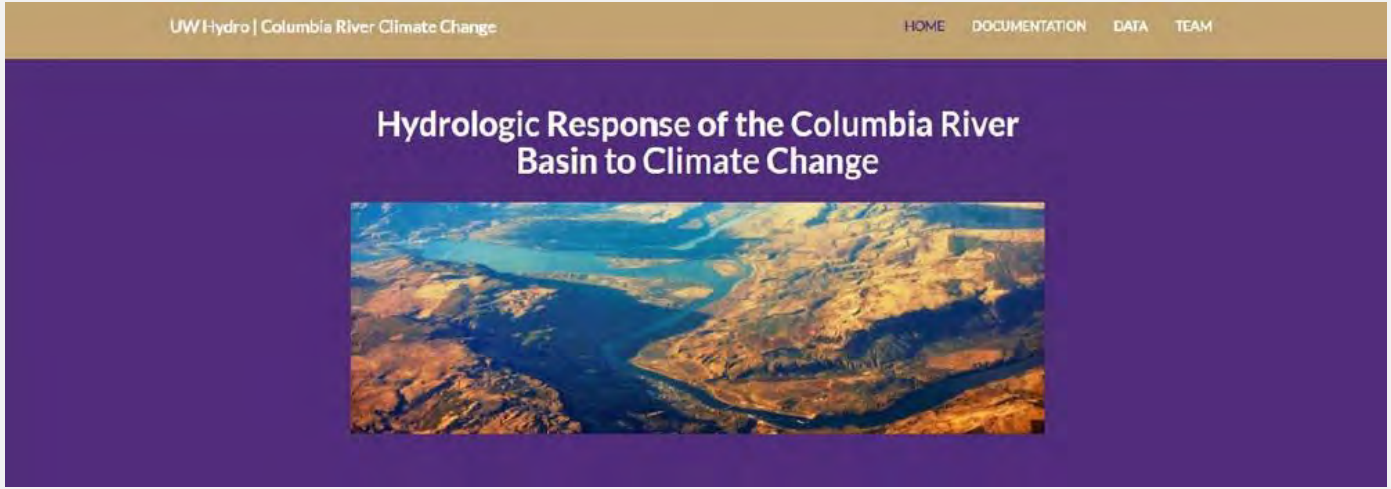
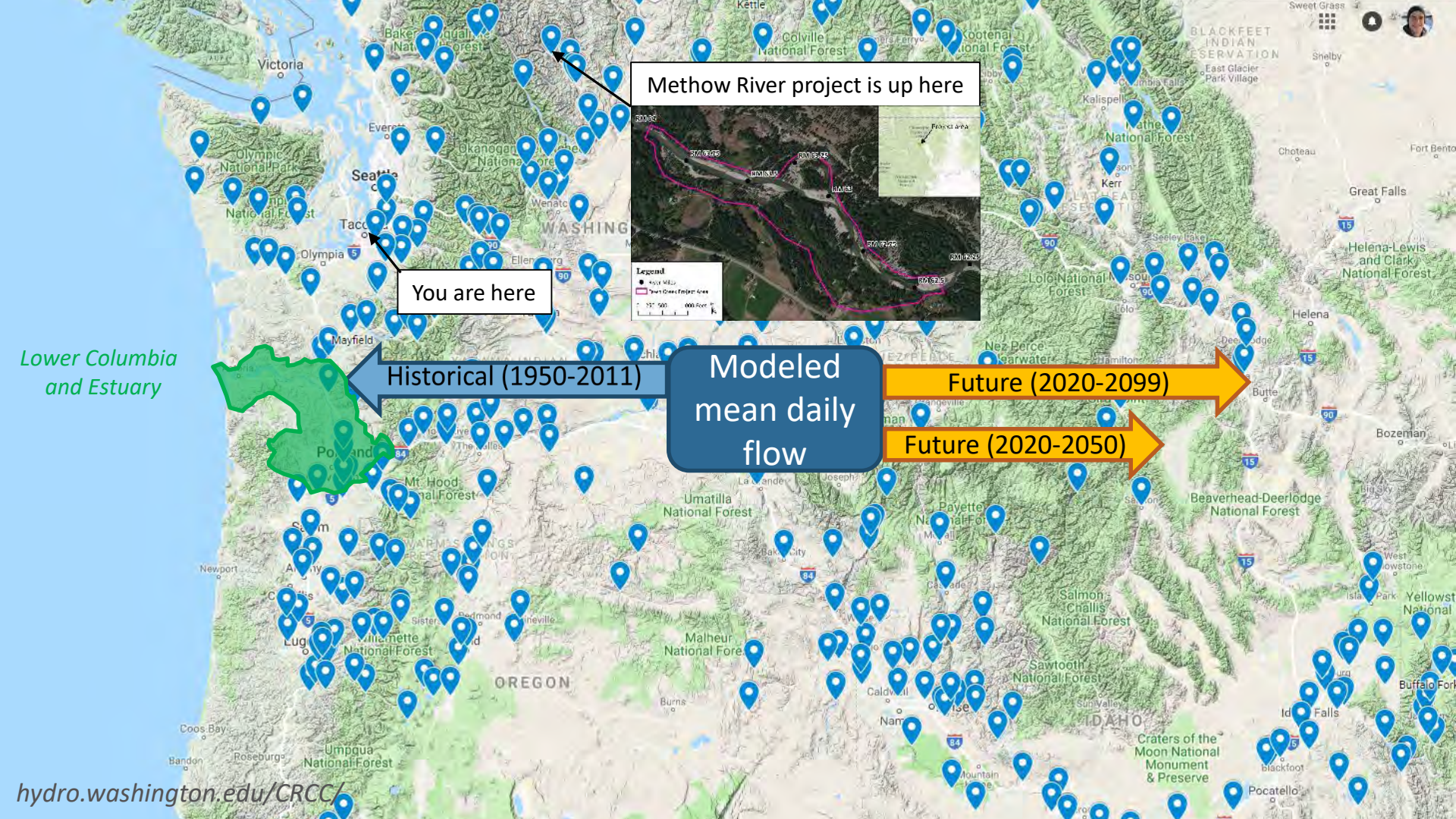


hydro.washington.edu/CRCC/


Methow River project is up here
You are here
Lower Columbia and Estuary
Historical (1950-2011)
Modeled mean daily flow
Future (2020-2099)
Future (2020-2050)
Legend
Victoria
Seattle
Tacoma
Olympia
Mayfield
Portland
Mt. Hood National Forest
Umpqua National Forest
Willamette National Forest
Umatilla National Forest
Malheur National Forest
Payette National Forest
Salmon-Challis National Forest
Sawtooth National Forest
Beaverhead-Deerlodge National Forest
Helena-Lewis and Clark National Forest
Lolo National Forest
Colville National Forest
Okanogan National Forest
Olympic National Park
Kootenai National Forest
Flathead National Forest
Nez Perce National Forest
Craters of the Moon National Monument & Preserve
WASHINGTON
OREGON
IDAHO
Great Falls
Helena
Butte
Bozeman
Kalispell
Pocatello
Idaho Falls
Coos Bay
Roseburg
Bandon
Newport
Burns
Caldwell
Nampa
Boise
Sweet Grass
Shelby
Choteau
Fort Benton
Kerr
Seeley Lake
Hamilton
Dillon
Big Sky
West Yellowstone
Yellowstone National
Buffalo Fork
Blackfoot
Mountain Home
Sun Valley
Ellensburg
Wenatchee
Bellingham
Kettle
Bay Ferry
Sandpoint
Libby
Columbia Falls
East Glacier Park Village
BLACKFEET INDIAN RESERVATION
Sisters
Redmond
Bend
Madras
Lebanon
Salem
Newport
Lugo
Hood River
The Dalles
Baker City
La Grande
Joseph
Cascade
Mission
Sun Valley
Hydro.washington.edu/CRCC/

How are mean daily flows developed?

Emission scenarios

172 different traces!

We filtered down to 20

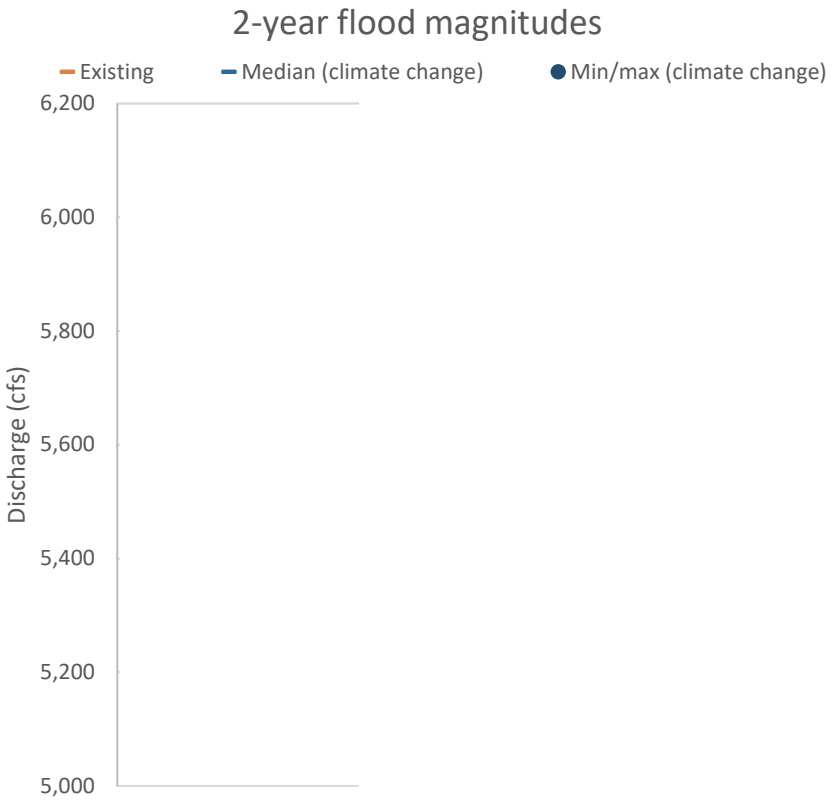
Looked at climate change scenario (2030-2050)

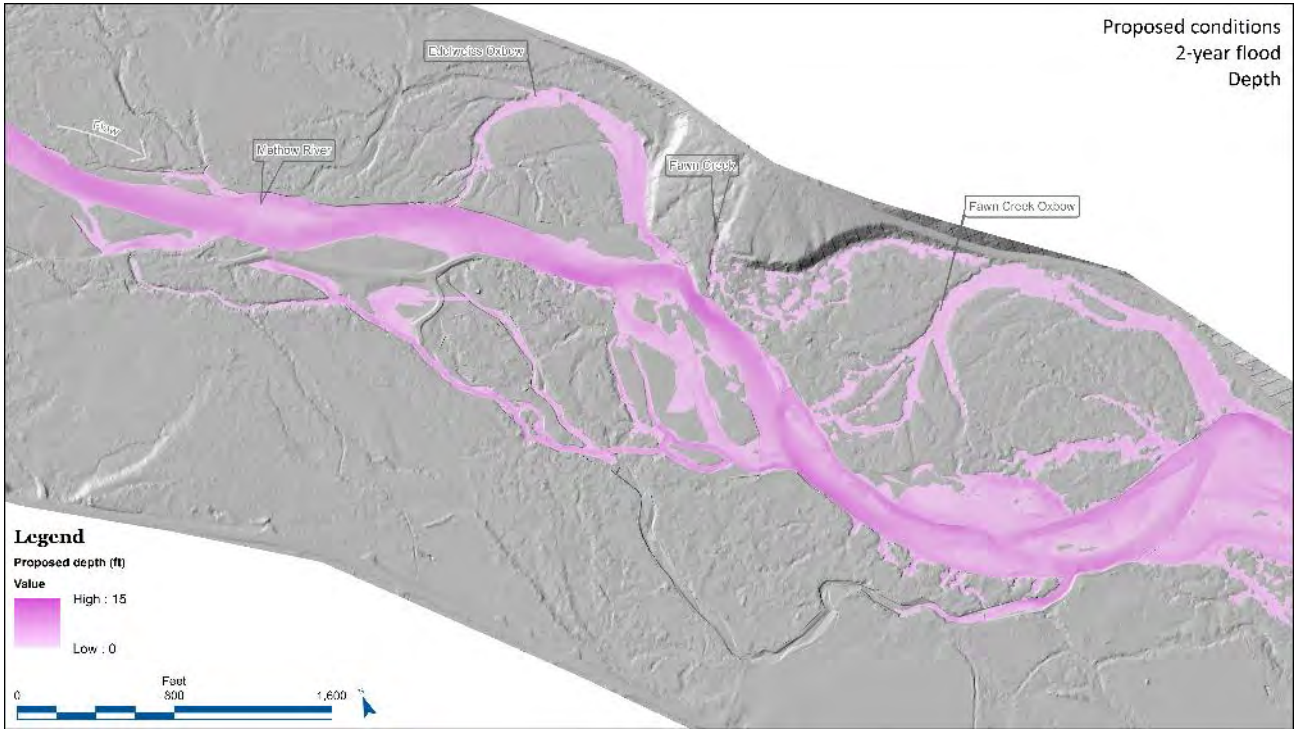
(Flood magnitudes and hydrograph timing)

UW HYDRO
COMPUTATIONAL HYDROLOGY

Nijssen 2017

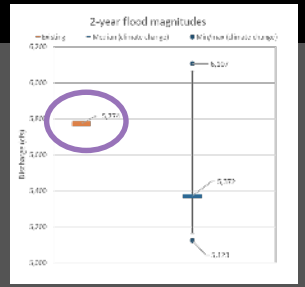
Results: 2-year flood magnitudes



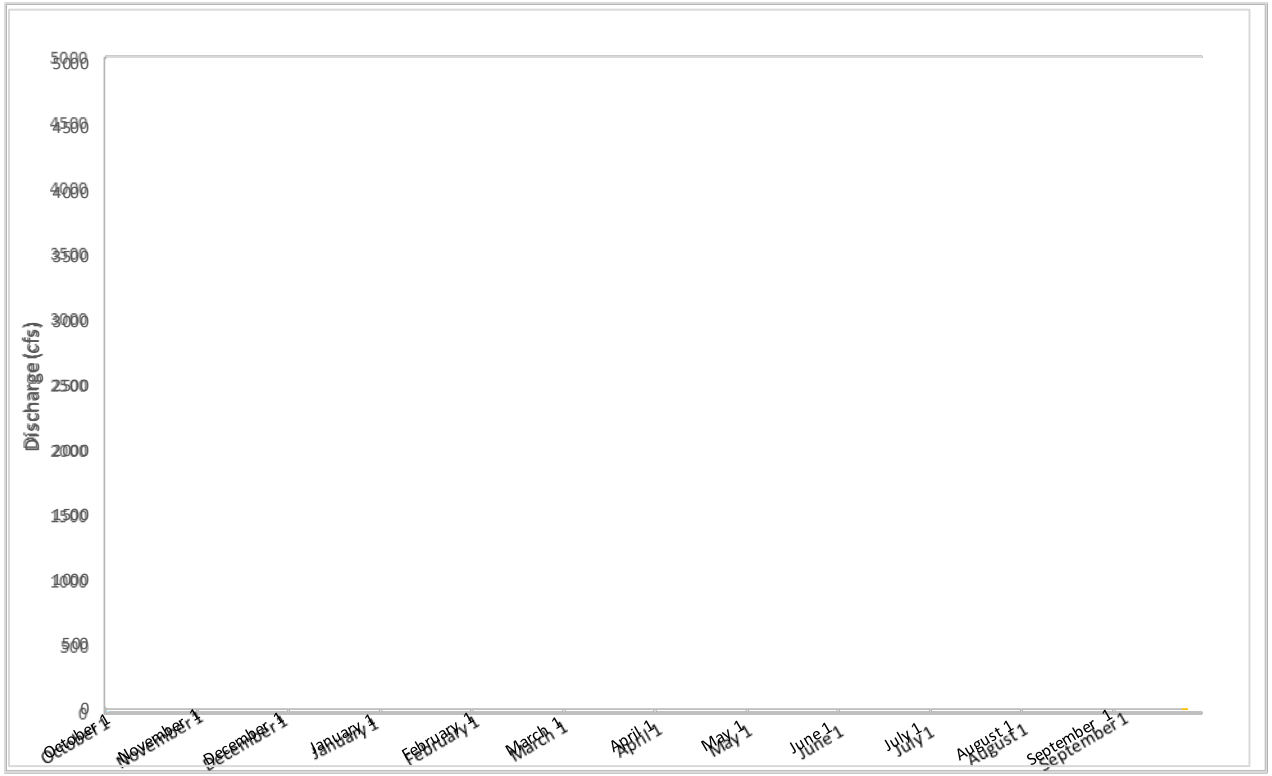


2-year flood inundations

Modeled existing and climate change inundations.



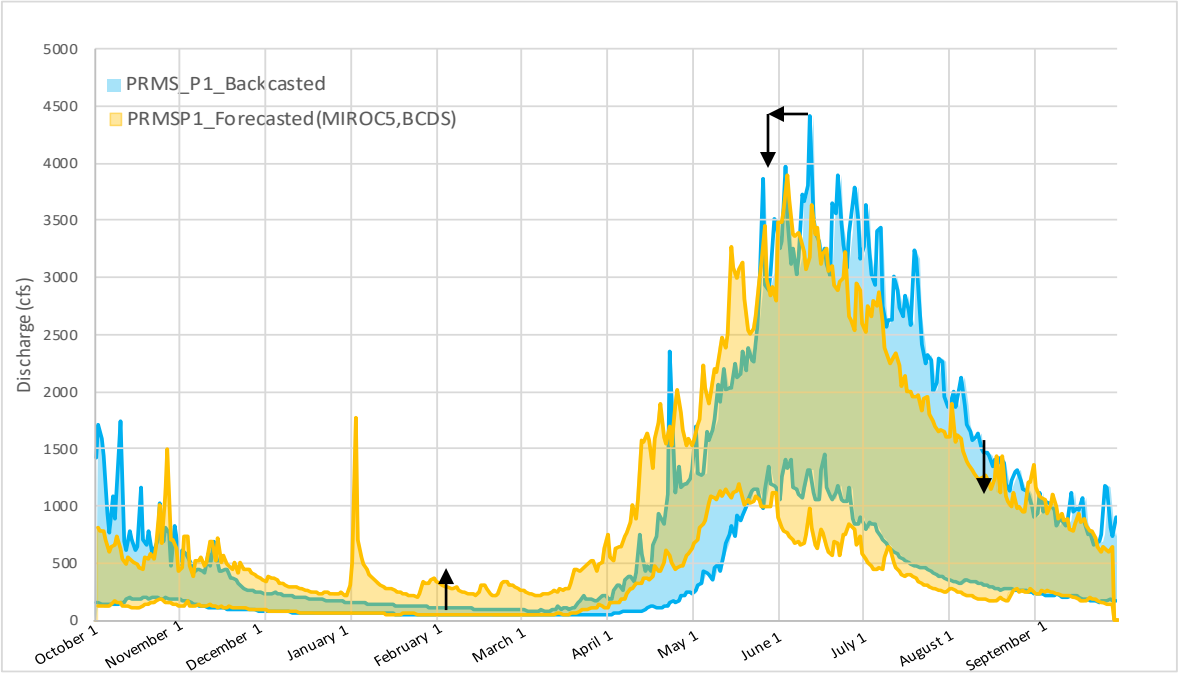
Results: Hydrograph timing



Historical (1992-2010)

Modeled mean daily flow

Future (2030-2050)



Hydrograph timing (2030-2050)

Winter baseflow increased.

Late summer flows decreased.

Peak flood occurred ~2 weeks earlier.

Peak flows decreased in magnitude.

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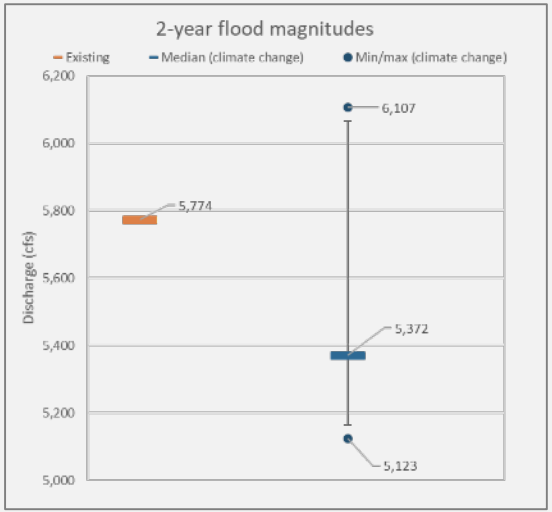
Conclusions

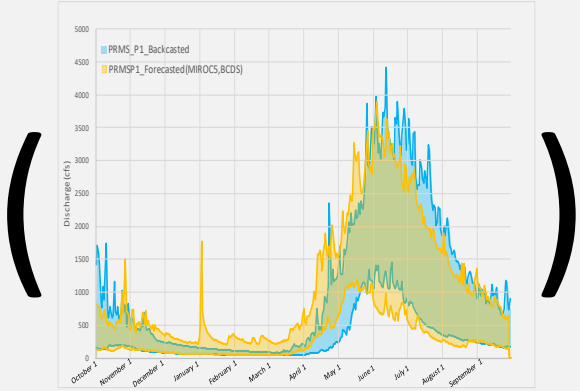
Flood magnitudes

- 5-7% decrease in flood magnitudes (median)
- Variability is large



Hydrograph timing

- Snowmelt -> snowmelt with more rain
- 20 potential future scenarios



X 20!

Takeaways: informing design

- Activation flows for high flow off-channel habitats
- Summer low flow habitats
- Increase floodplain habitat diversity
- Bake adaptability into the project!
- Effects are variable depending on hydrologic regime (Beechie et al. 2012)

Thank you.

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