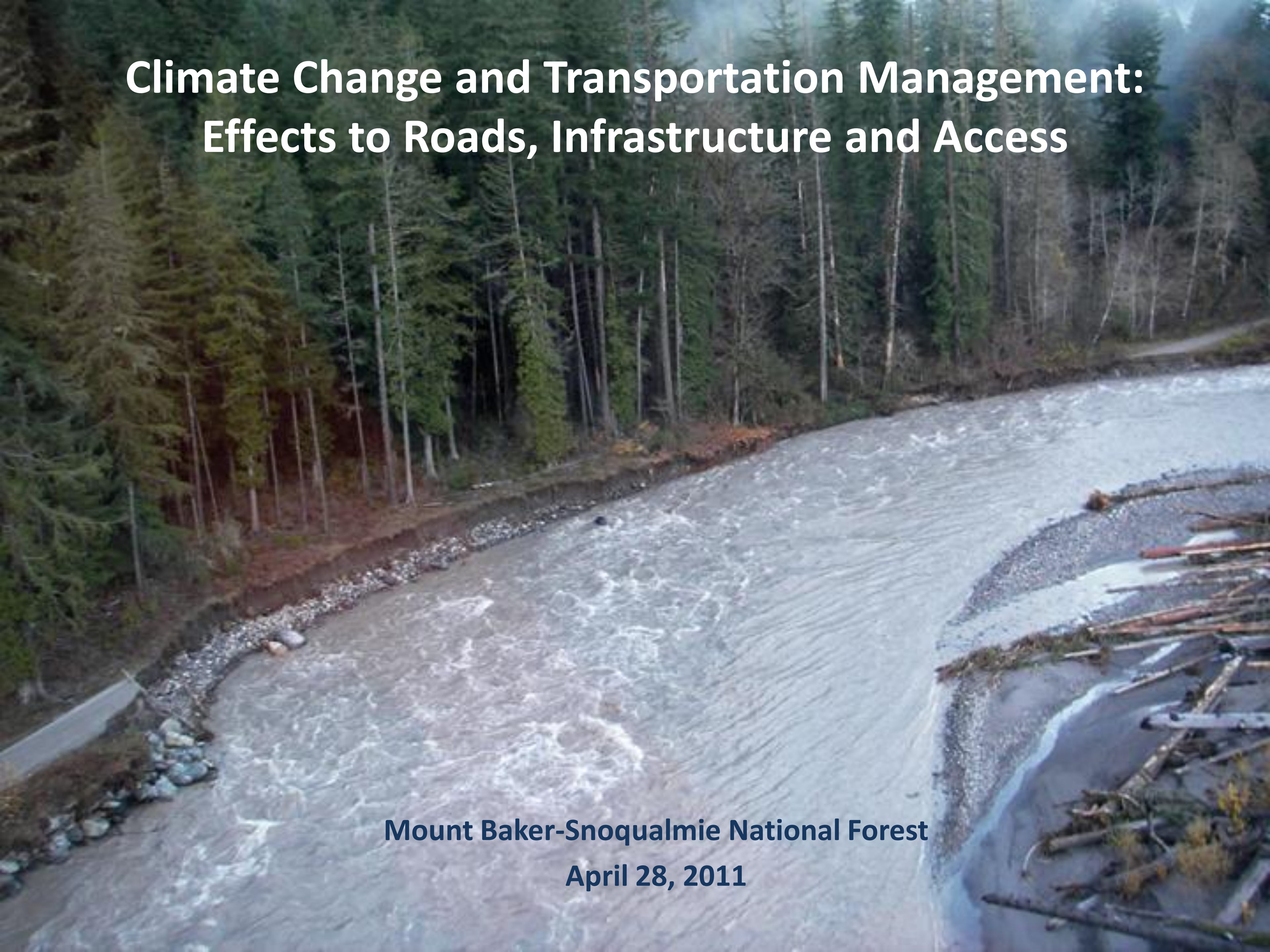
Climate Change and Transportation Management: Effects to Roads, Infrastructure and Access



Mount Baker-Snoqualmie National Forest

April 28, 2011

Climate and Transportation Management: Hydrologic data use

Objectives:

1. To review use of hydrologic data typically used for/ by ONF(USFS) engineering.
2. Highlight specific areas where data or standard assumptions should be questioned or modified given potential future changes.
3. Kick off open discussion that follows for how to address change.

Olympic National Forest

January 15, 2009

Climate and Transportation Management: Hydrologic data use

Some things to think about – some key questions

- If the past is a poor predictor of the future then what do we use and why?
- What is good science/ information and what is not? What can be supported?
- How much information is or will be available to support a change?
- Rather than modifying something already in use do we need to change our paradigm (s) and/ or assumptions?

Climate and Transportation Management: Hydrologic data use

Background: The project development process

1. Strategic planning and prioritization — Planning level 1
2. Feasibility and alternative identification… NEPA — Planning level 2
3. Design

Road Management

Olympic National Forest

Aquatic Risk Factors

- **Geologic Hazard**

  Percentage of road segment within geologic hazard area.

- **Proximity (Delivery) to Fish Habitat**

  Degree to which road segment is connected to fish-bearing stream with respect to sediment delivery.

- **Stream Crossing Density**

  Number of stream crossings per road mile per road segment.

- **Riparian Zone Proximity**

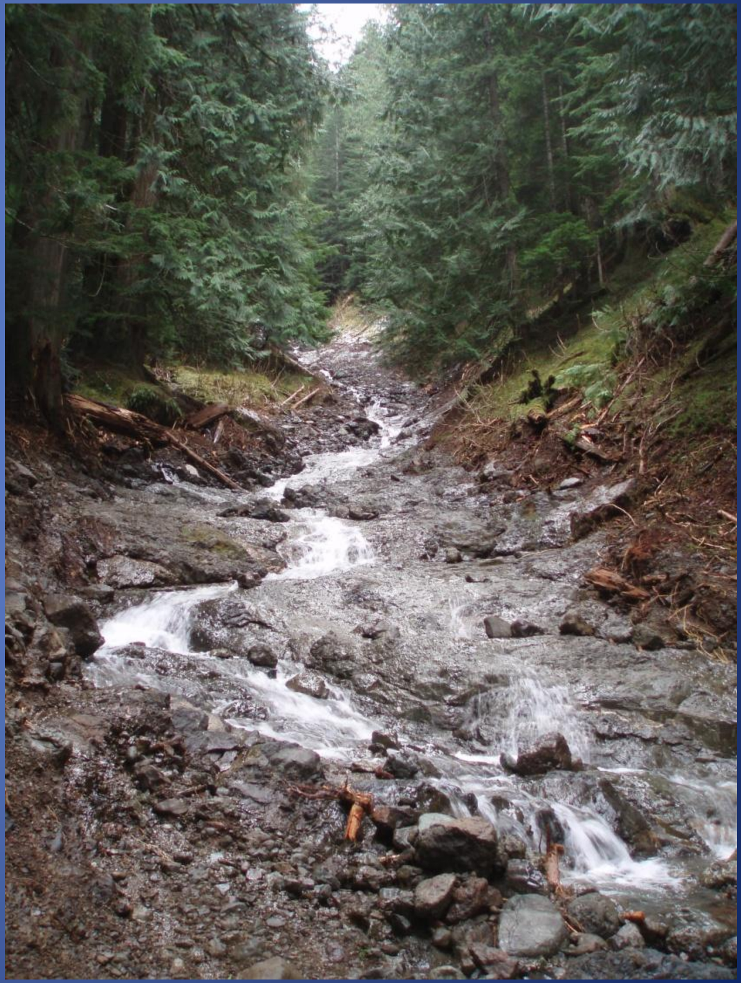
  Percentage of road segment within 50-meters of the stream.

- **Upslope Hazard**

  Amount of area above the road segment with hazards upslope.

Climate and Transportation Management: Hydrologic data use

- How will change in water availability influence stability of slopes?
- Debris transport and runout?



Climate and Transportation Management: Hydrologic data use

Example for NEPA – river margin roads

Replace/ repair in former location… Design life or replacement cycle?

Climate and Transportation Management: Hydrologic data use

Replace in kind alternative

What level of analysis is appropriate?

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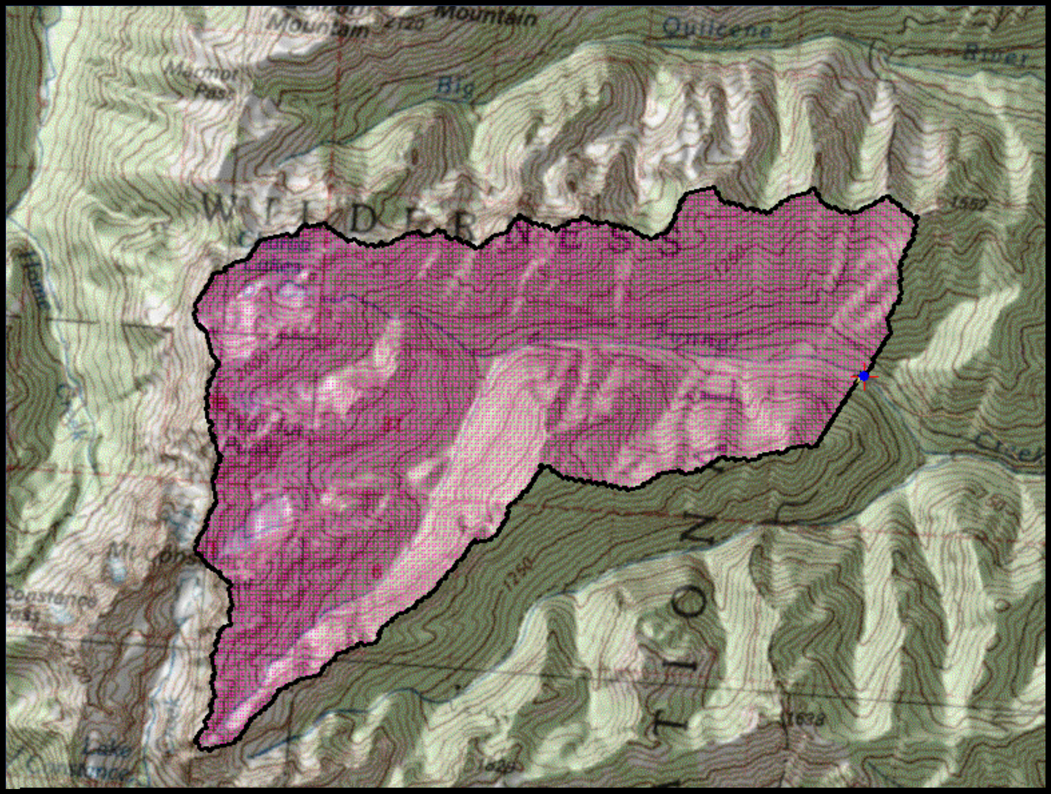
Phase 3: Design – water crossing structures (culverts)

- NWFP Standard: Q_{100} + debris

USGS

Stream Stats



Basin Characteristics Report

Date: Wed Apr 27 2011 11:58:15 Mountain Daylight Time
NAD27 Latitude: 47.7963 (47 47 47)
NAD27 Longitude: -123.0421 (-123 02 32)

Parameter	Value
Area that drains to a point on a stream, in square miles	9.39
Mean Basin Elevation in feet	4610
Minimum Basin Elevation in feet	1950
Maximum Basin Elevation in feet	7660
Relief (maximum - minimum elevation), in feet	5700
Mean basin slope in percent	80
Percent of area with slope greater than 30 percent	96.5
Percent of area with slope greater than 30 %facing N	26
Area-weighted forest canopy, in percent	57
Mean annual precipitation, in inches	71.1

$$Q = aA^{b}\, bP^{c}$$

RI	exceedance probability	a	A	b	P	c	Q	standard error	Q high	Q low
2	0.5	0.09	9.44	0.877	70	1.51	393.9	56	614.5	173.3
10	0.1	0.129	9.44	0.868	70	1.57	714.0	53	1092.3	335.6
25	0.04	0.148	9.44	0.864	70	1.59	883.8	53	1352.2	415.4
50	0.02	0.161	9.44	0.862	70	1.61	1042.0	53	1594.2	489.7
100	0.01	0.174	9.44	0.861	70	1.62	1172.4	54	1805.4	539.3

Climate and Transportation Management: Hydrologic data use

Example for design: Stream Simulation (AOP)

- Reference Reaches: channel dimensions
- Streambed: Reference + hydraulics

- Low Flow

Climate and Transportation Management: Hydrologic data use

Example for design: Bank Protection

- Channel Capacity - encroachment
- Rock Size – wood balast/size
- Inundation, water surface height, scour depth

Climate and Transportation Management: Hydrologic data use

Storm Damage repair – replace in kind (ERFO)

- 100 yr + debris
- Decommission in lieu of repair – minimum Rd system
- Replace in kind

Quantifying the Effects of Climate Variability and Change on Hydrologic Extremes in the Pacific Northwest

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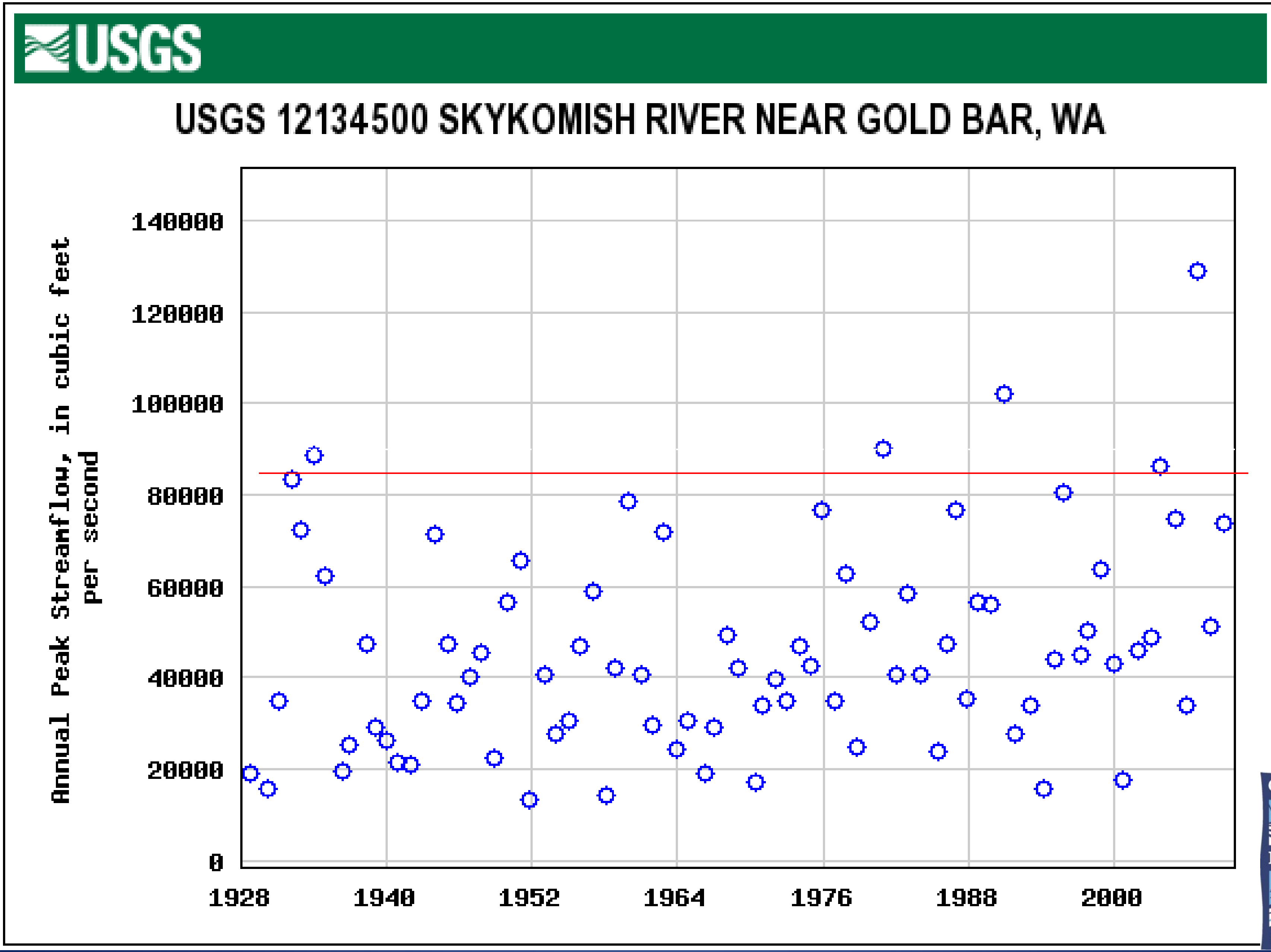
CLIMATE IMPACTS GROUP

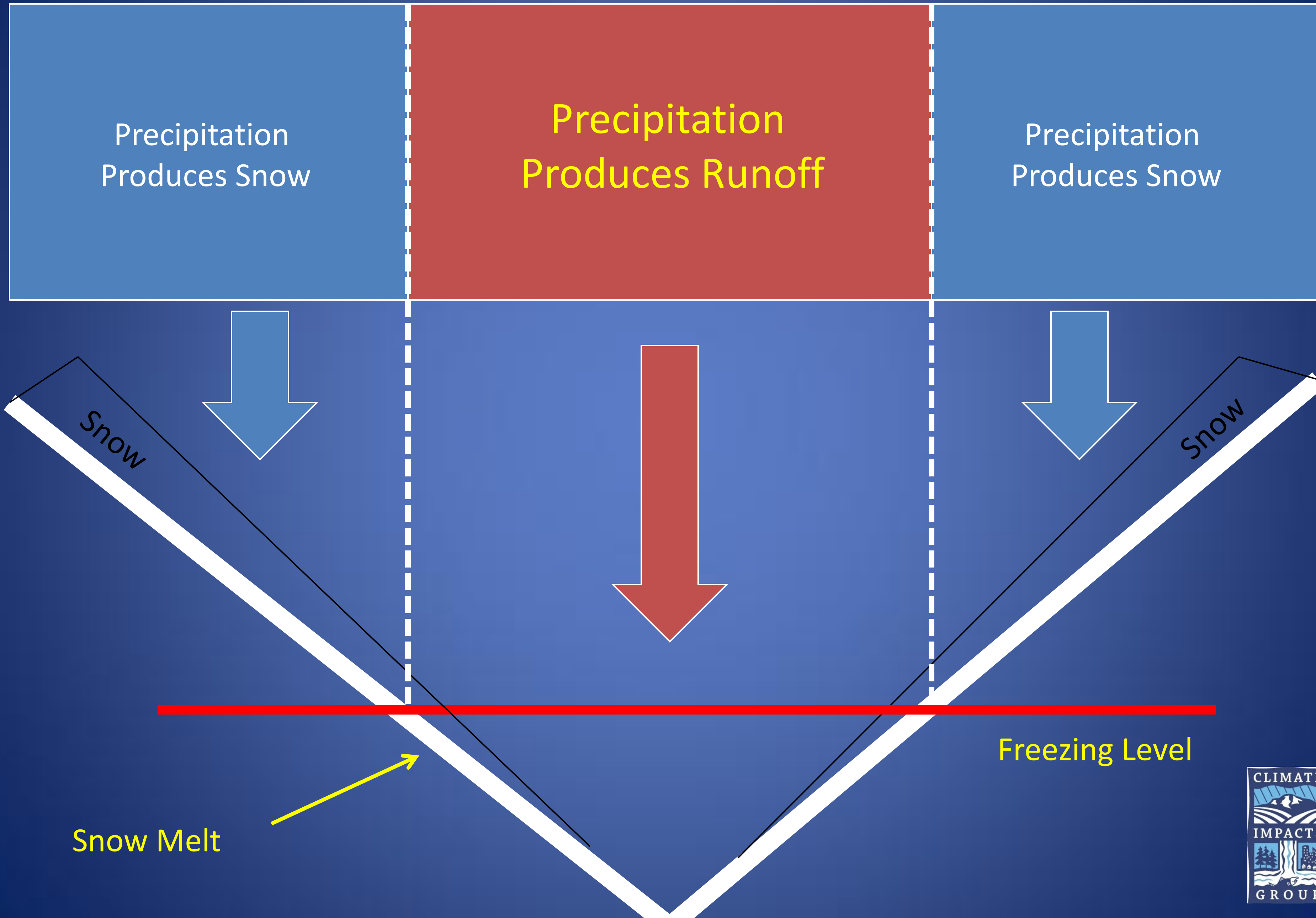
Department of Civil and Environmental Engineering

http://cses.washington.edu/cig/outreach/workshops.shtml

Evidence of Changing Flood Statistics



Schematic of a Cool Climate Flood



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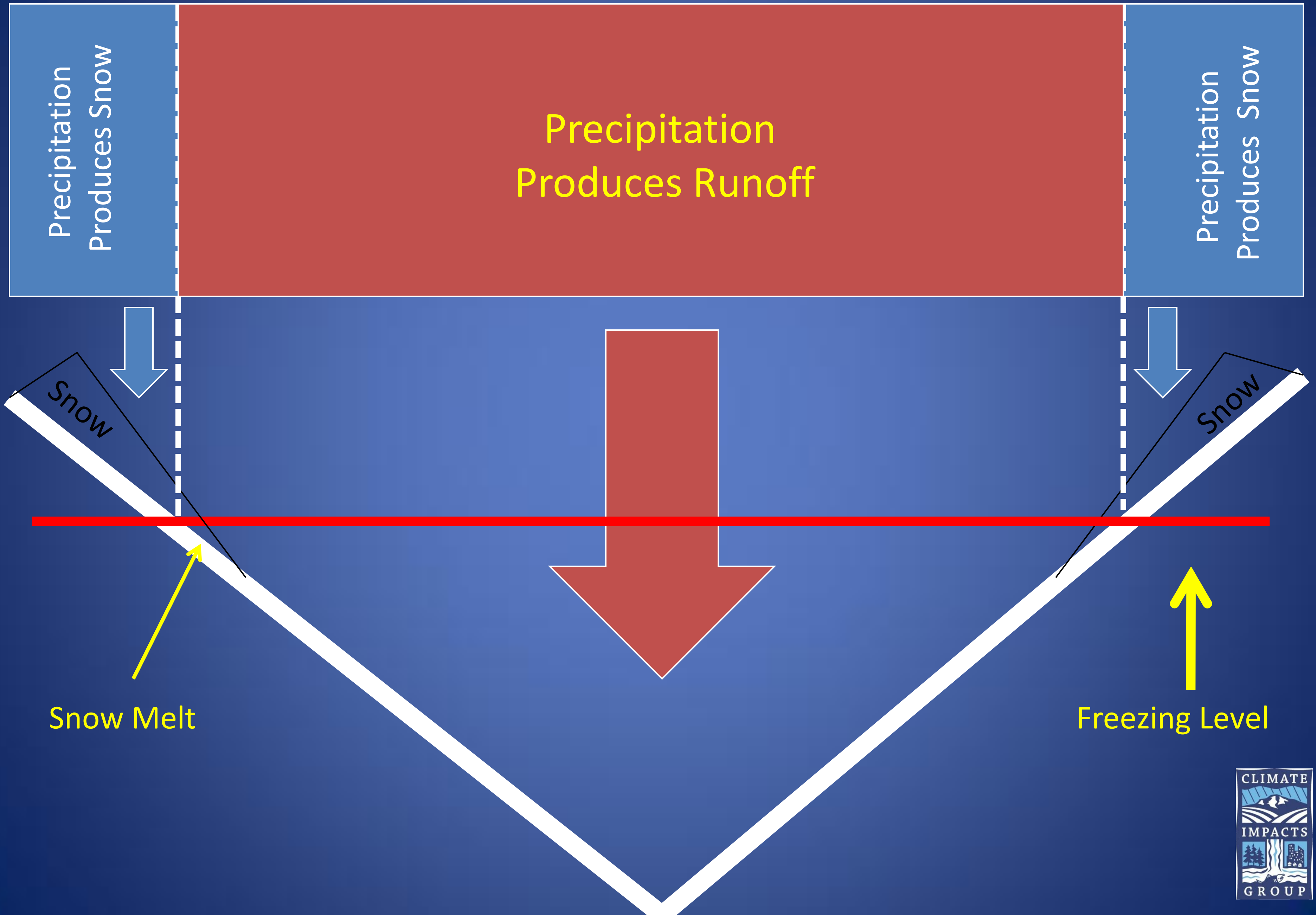
Schematic of a Warm Climate Flood



Summary of Flooding Impacts

Rain Dominant Basins:
Increases in flooding due to increased precipitation intensity, but no significant change from warming alone.

Mixed Rain and Snow Basins Along the Coast:
Strong increases due to warming and increased precipitation intensity (both effects increase flood risk)

Inland Snowmelt Dominant Basins:
Relatively small overall changes because effects of warming (decreased risks) and increased precipitation intensity (increased risks) are typically in the opposite directions.

Improving Estimates of the 100-year Flood: Methodology and Applications to the Olympic National Forest

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Robin Stoddard
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UW Team:

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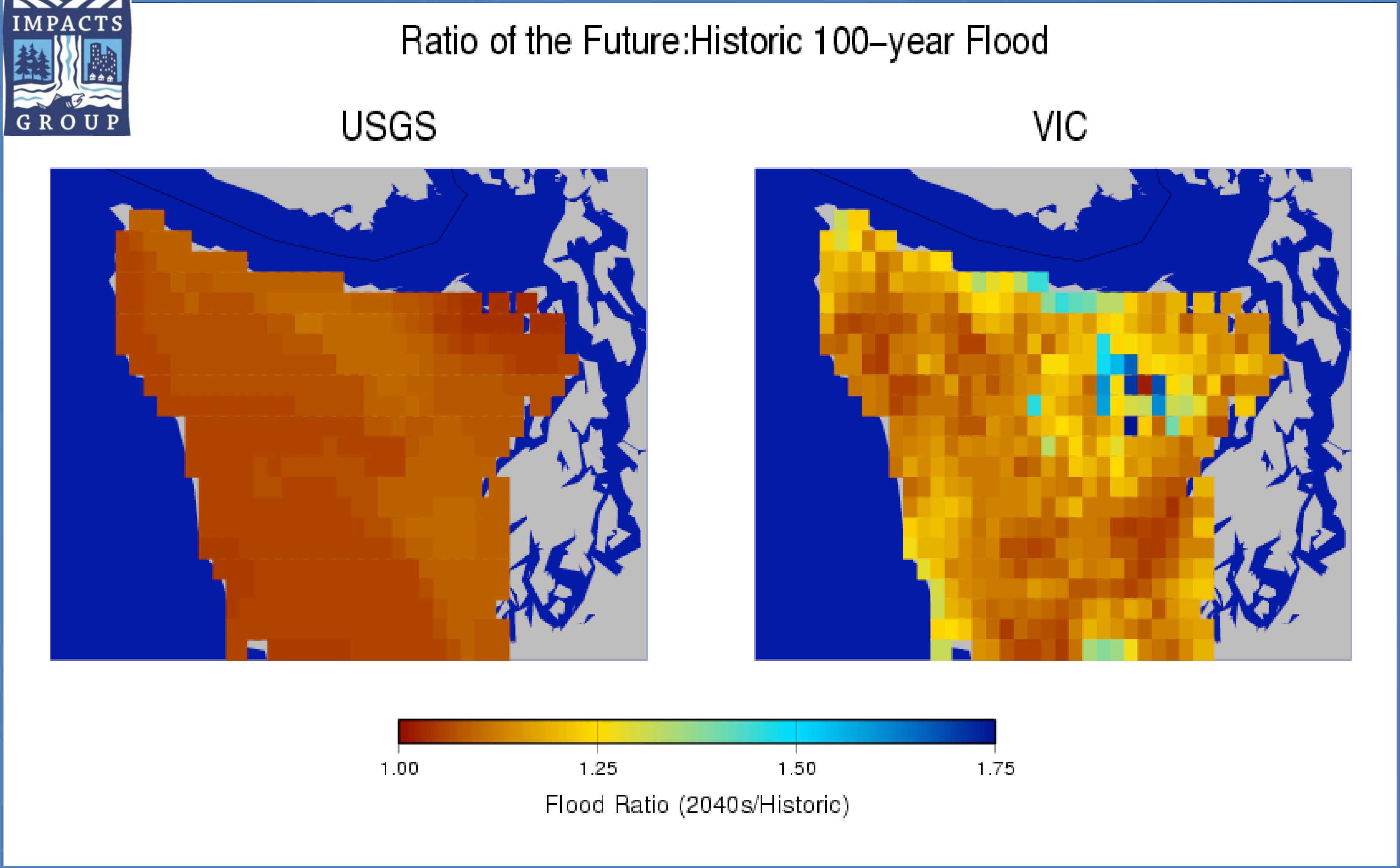
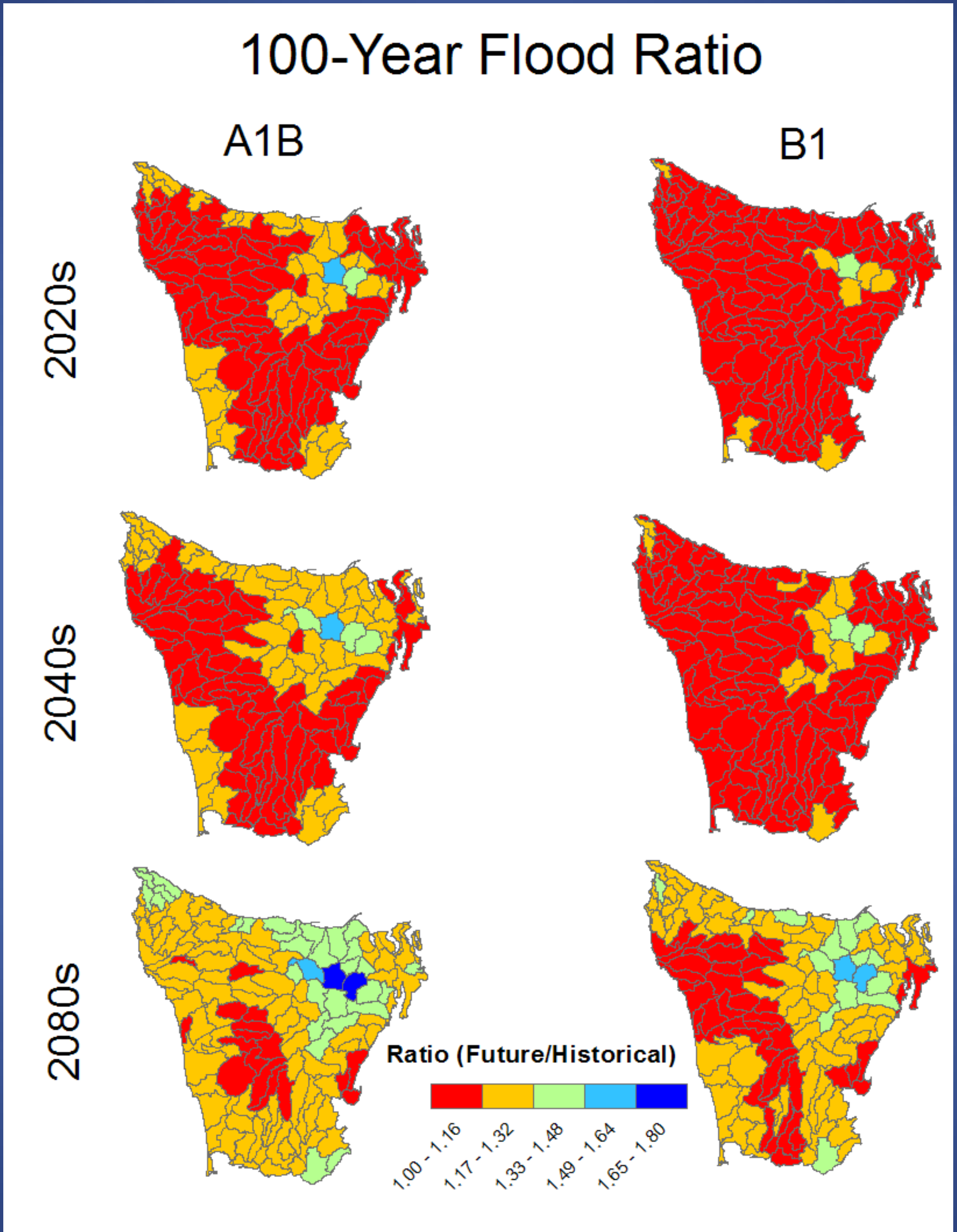
http://cses.washington.edu/cig/outreach/workshops.shtml

Use of Flood Estimates in the Design Process

- Road management uses 100-year flood
- Current estimates use regression equations, using annual precipitation and basin size as parameters
- Flood baselines will shift with projected changes in temperature and precipitation

Intercomparison of Change in Q100 from USGS and VIC Models




100-Year Flood Ratio
A1B
B1
2020s
2040s
2080s
Ratio (Future/Historical)
1.00 - 1.16
1.17 - 1.32
1.33 - 1.48
1.49 - 1.64
1.65 - 1.80

Extensions and Next Steps

- Develop a decision support tool for assessing changing risk at any point or spatial scale (similar to the basic functionality of Streamstats in delineating the basin, etc.)

- Collaborate with design professionals in the Olympic National Forest to further develop and refine the tool

- Extend to other PNW National Forests

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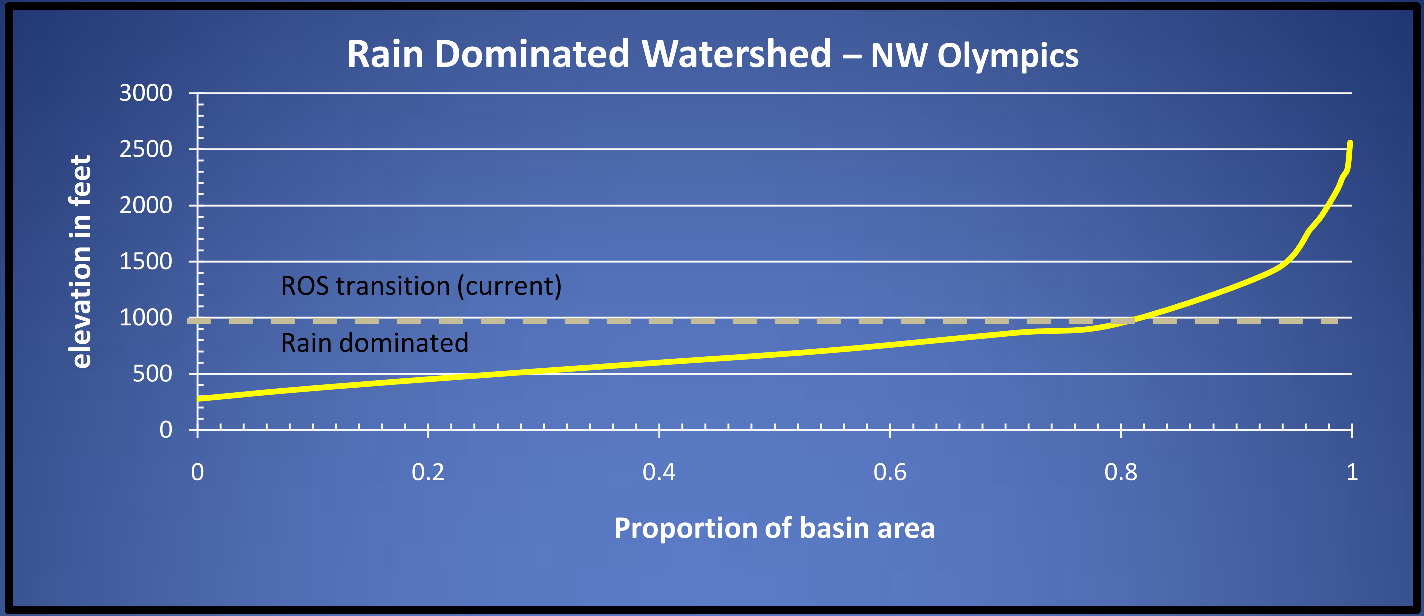
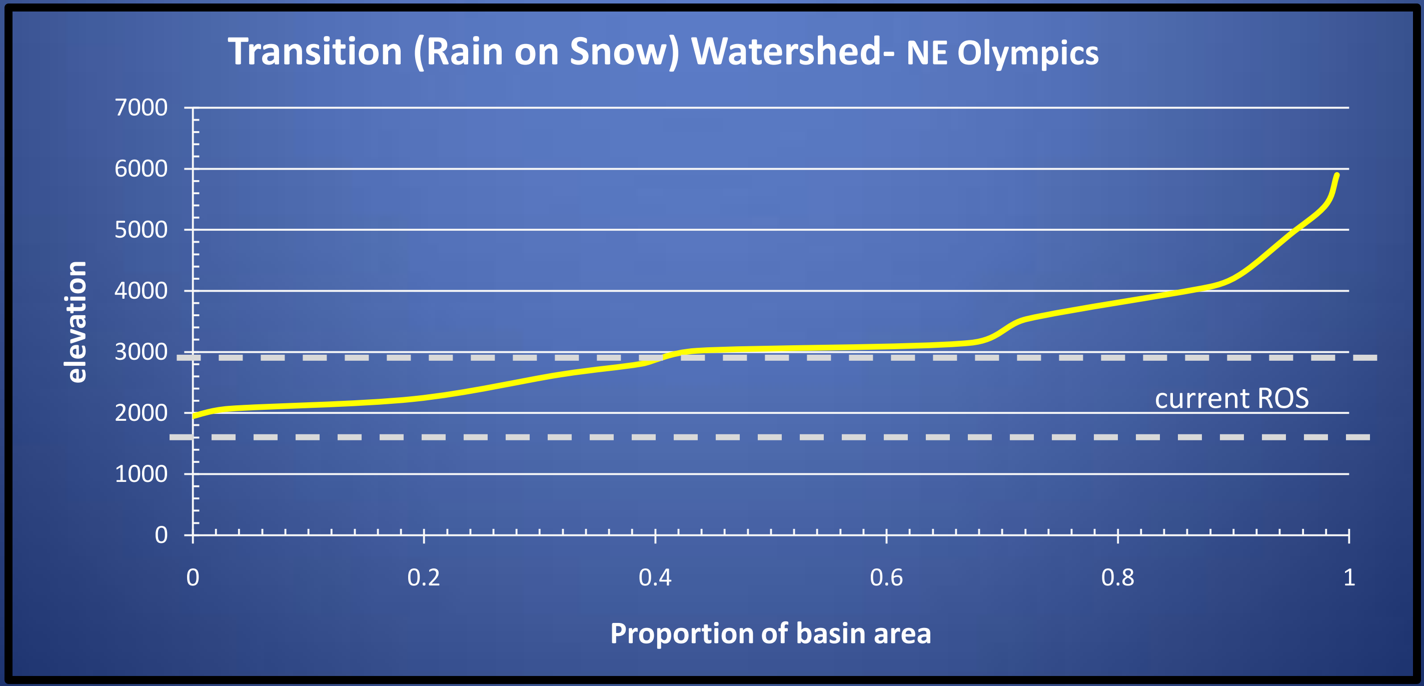
Change in persistent snow (freezing) line by watershed type





- How will change in water availability influence stability of slopes?

- Existing Slides/ slumps (infiltration/ shallow GW)
- Susceptible materials (silt/ clay)
- Stream erosion at toe
- Basins subject to large shifts in freezing line/ effective basin area

Climate Change and Transportation Management: Effects to Roads, Infrastructure and Access

- Were still working on it but we think we are getting closer

Preliminary Conclusions

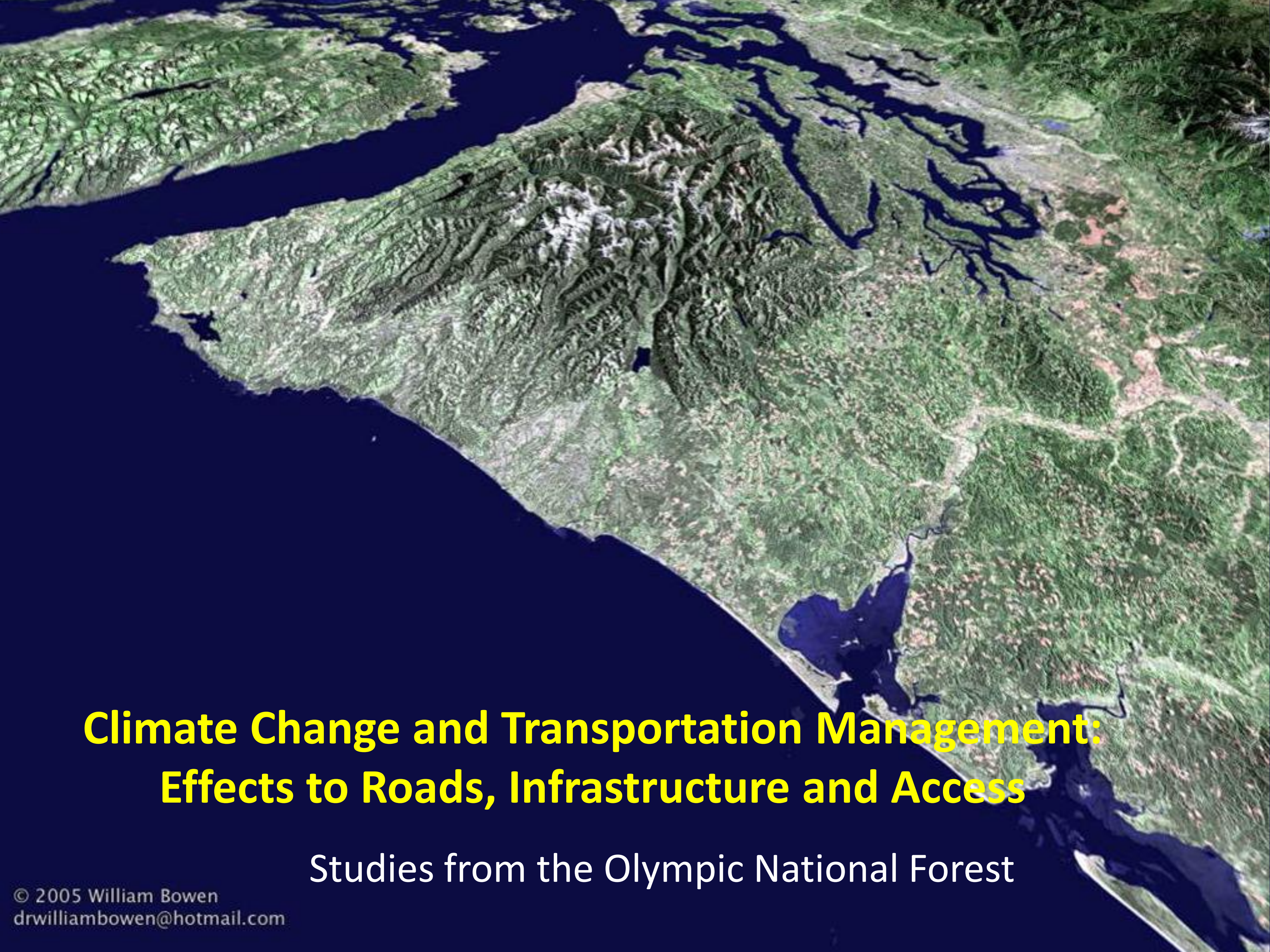
1. Access and travel management – Roads analysis
   A. Modify risk assessment for ROS and upslope hazards
   B. Risk and vulnerability assessment: structures and routes
   C. Identification of minimum road system: Will modified risk assessment and potential for higher maintenance costs provide insights for which roads and how many to keep?
2. NEPA
   A. At a minimum identify areas, locations, and alternatives most at risk due to predicted change. (relative risk)
3. Design
   A. Prioritization and risk assessment
   B. More attention to designs with large change and high values
   C. What about low flows?

END

The following slides are outtakes that were not used

Climate Change and Transportation Management: Effects to Roads, Infrastructure and Access

Studies from the Olympic National Forest



Design life or expected service life

- What will the design/ flow conditions be toward the end of the service life?

Effects to existing deep-seated slope movements

- How will change in water availability influence stability of slopes?

Preliminary Conclusions from: “Q100” or extreme flow studies (Ongoing):

1. Increases in effective drainage area in
2. Change is seasonality/ timing of precipitation
3. High variability of extremes

Conclusions:

1. Some areas are more risky than others we will check, but are unlikely to apply a modified strategy everywhere.
2. Product will be available in June that will allow for comparative assessment of extreme flows (both peak and low flow).
3. Likewise this will allow for assessing the predicted magnitude change at points in the future that are comparable to structure design life.

Climate and Transportation Management: The next steps for the Olympic NF

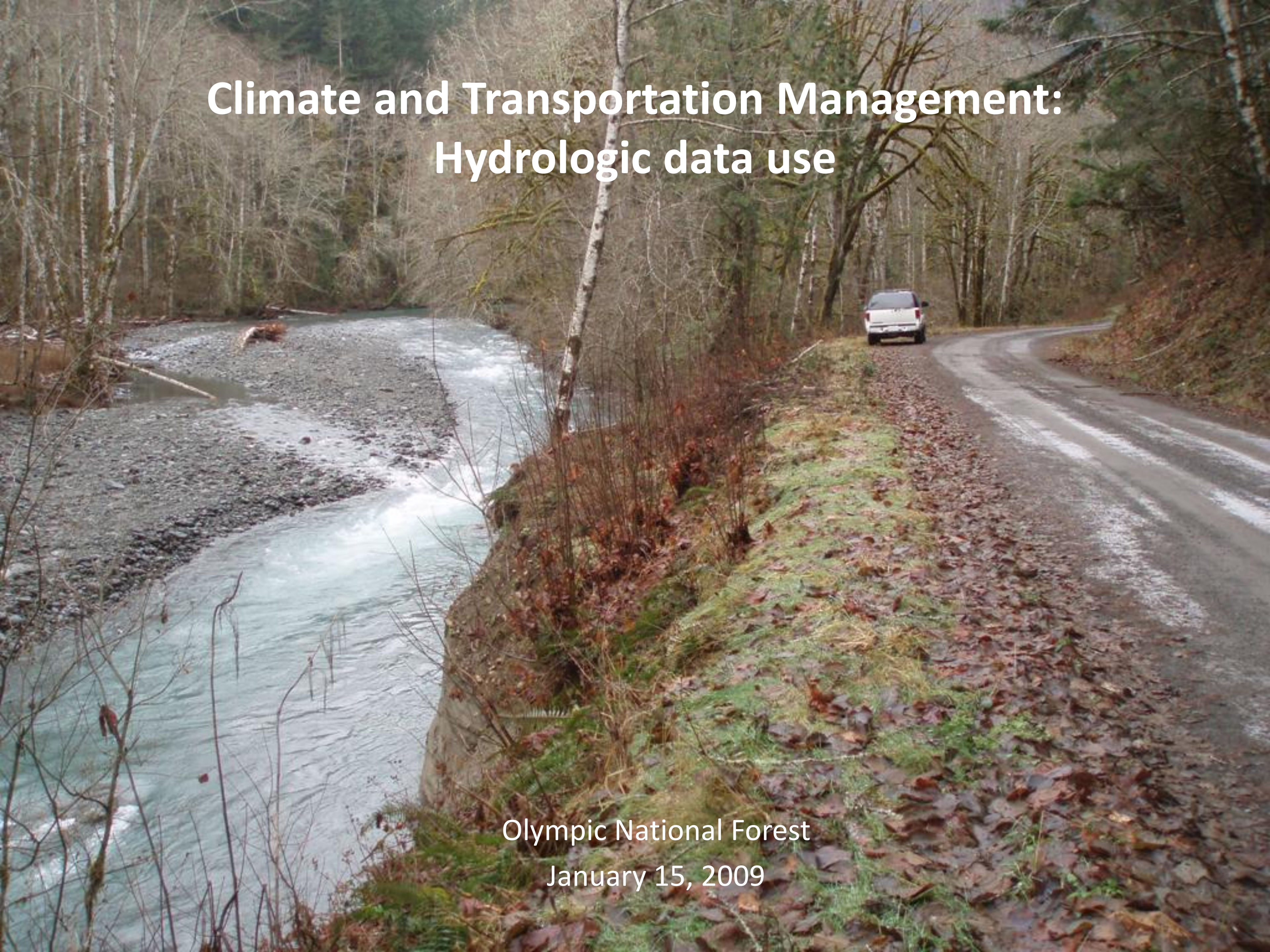
- Were still working on it but we think we are getting close

Preliminary Conclusions

Design (emphasis of our recent “Q 100 assessment)

- Where change is large and values are high:
  - Basic procedure: more thoughtful design: I.E.
    - Design as per NW Forest Plan (Q 100 + debris)
    - Compare for increase change in flow (2040 -2060)
    - Compare with geomorphic expression of channel
      - reasonable?

Climate and Transportation Management: Hydrologic data use



Olympic National Forest

January 15, 2009

Climate and Transportation Management: Hydrologic data use

Roads in the river margin environment - CMZ