

# Designing Hydrologic Modeling Studies to Support Diverse Climate Change Planning Needs in the Columbia River Basin

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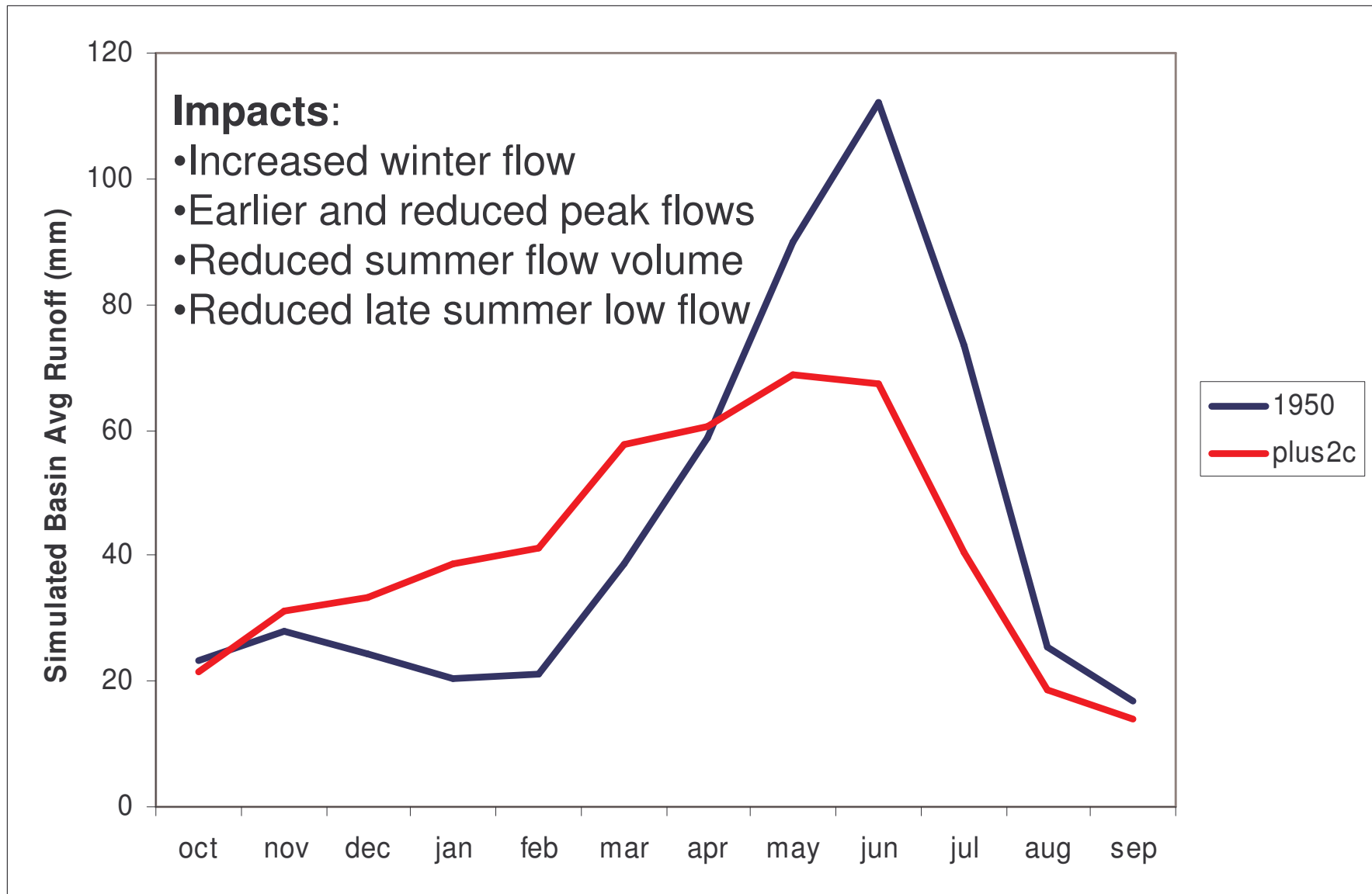


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WA State Department of Ecology



**Department of Civil  
and Environmental  
Engineering**

# Simulated Changes in Natural Runoff Timing in the Naches River Basin Associated with 2 C Warming



# PNW Pilot Climate Change Planning Efforts:

## **West Side Cascades Partnerships:**

Portland Water Bureau

Seattle Public Utilities

Tualitin Basin

White River-Lake Tapps

Snohomish River Basin

King Co.

## **Columbia Basin Partnerships:**

Northwest Power and Conservation Council (BPA)

US Bureau of Reclamation (Boise)

Seattle District Corps of Engineers

Idaho Department of Water Resources

# Recession of the Muir Glacier

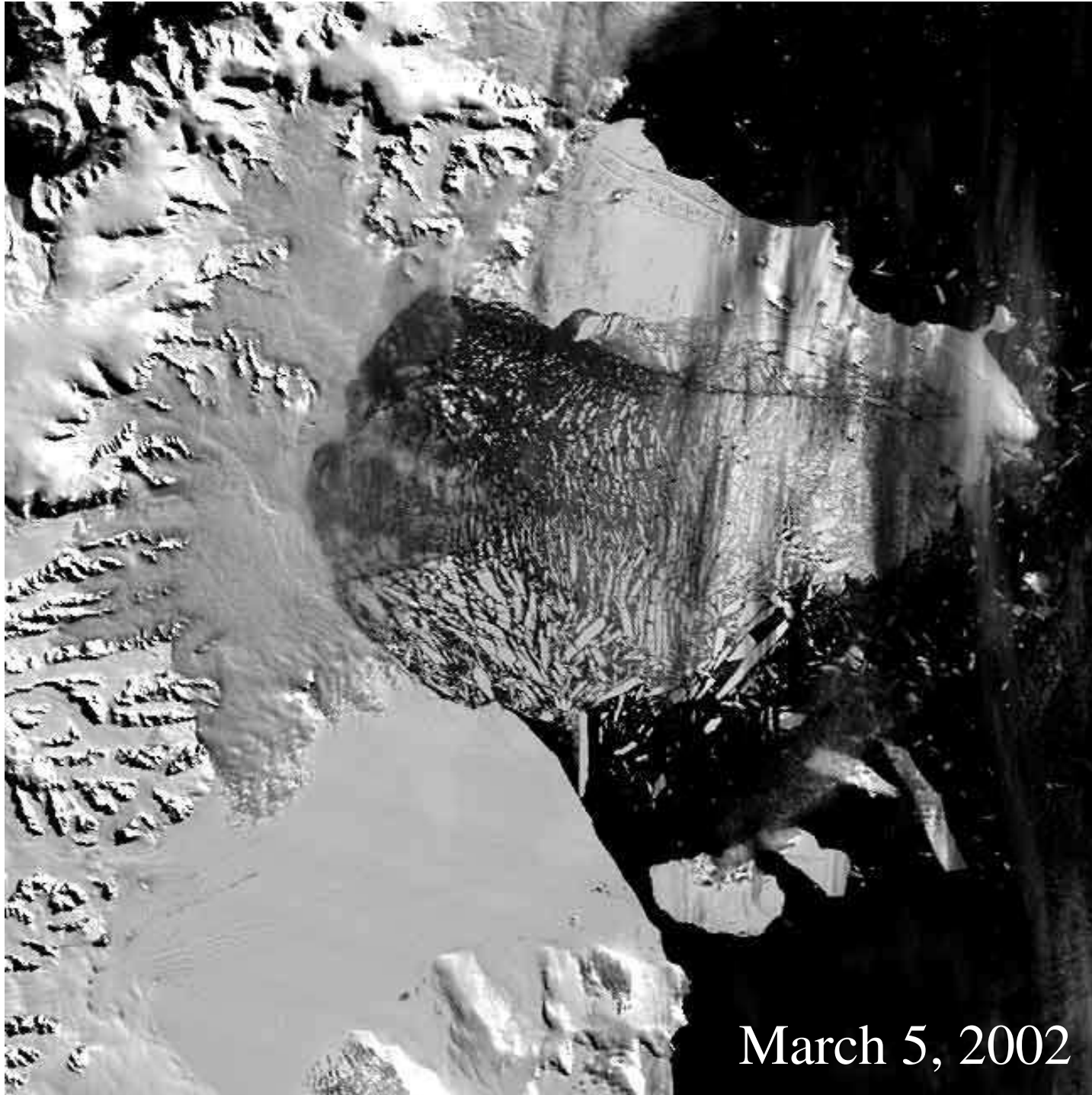


Aug, 13, 1941



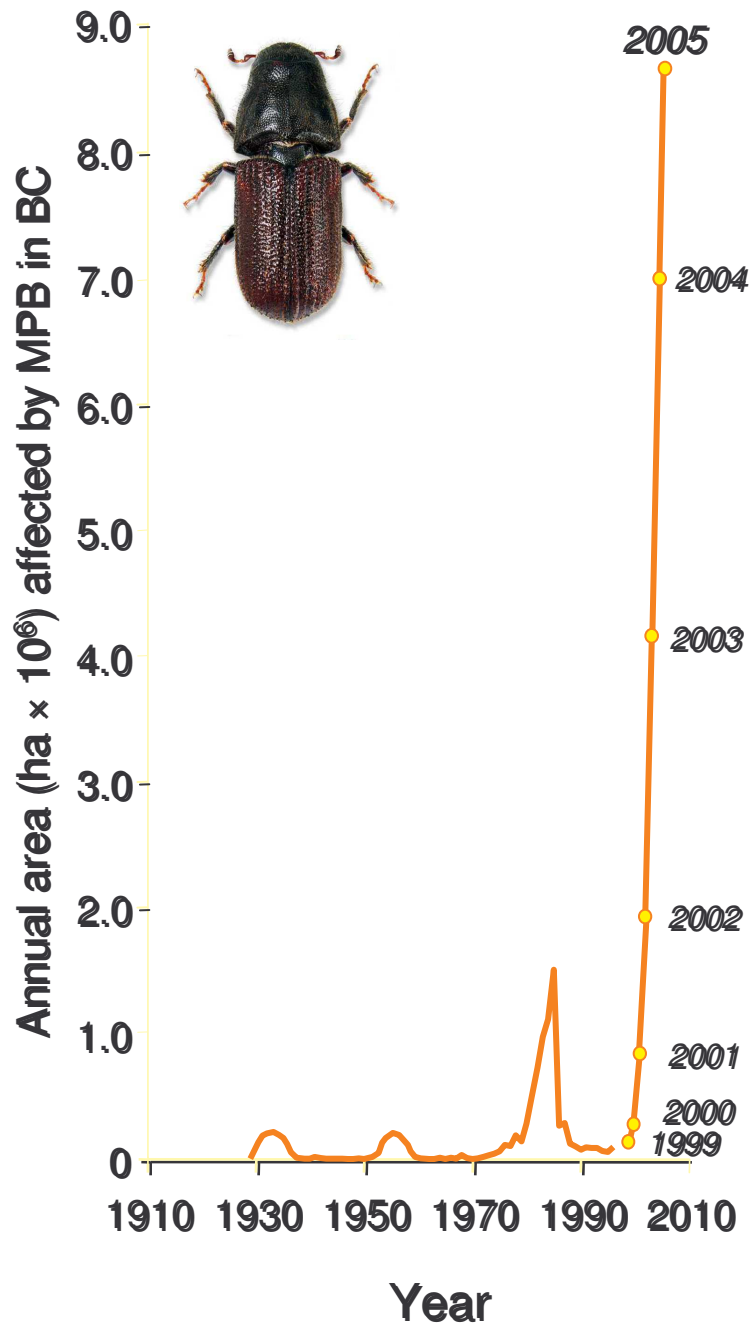
Aug, 31, 2004

Image Credit: *National Snow and Ice Data Center, W. O. Field, B. F. Molnia*  
[http://nsidc.org/data/glacier\\_photo/special\\_high\\_res.html](http://nsidc.org/data/glacier_photo/special_high_res.html)

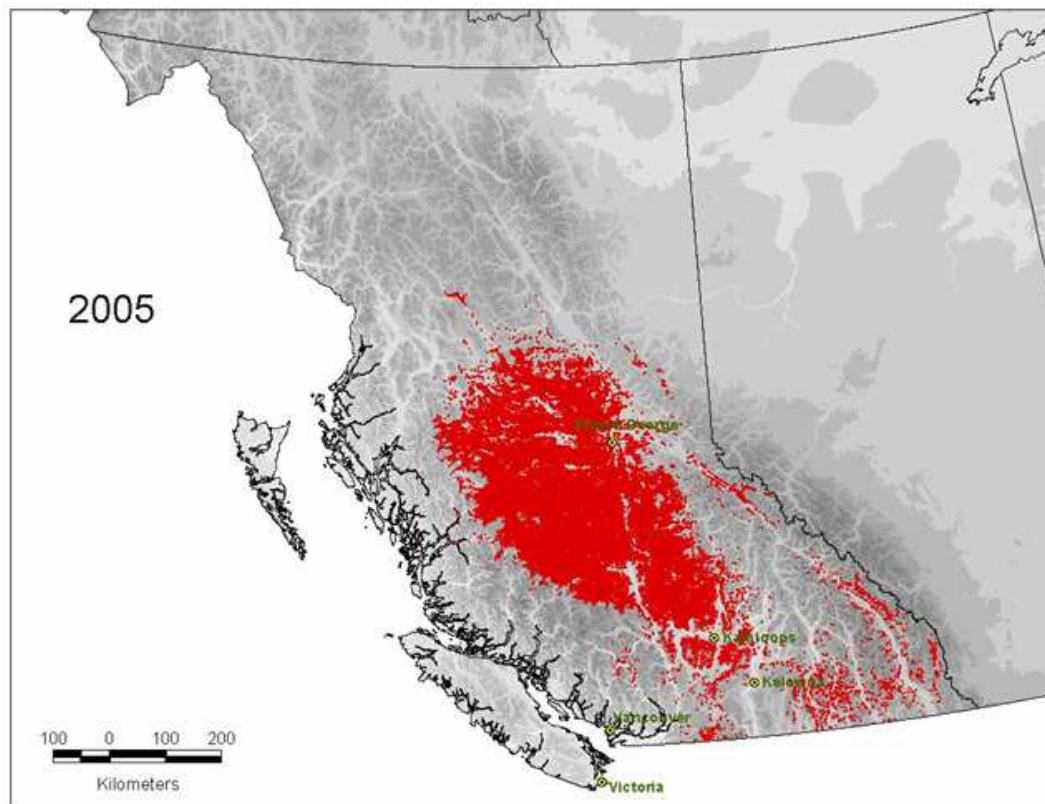


Collapse of the  
Larsen B  
Ice shelf,  
Antarctica

March 5, 2002

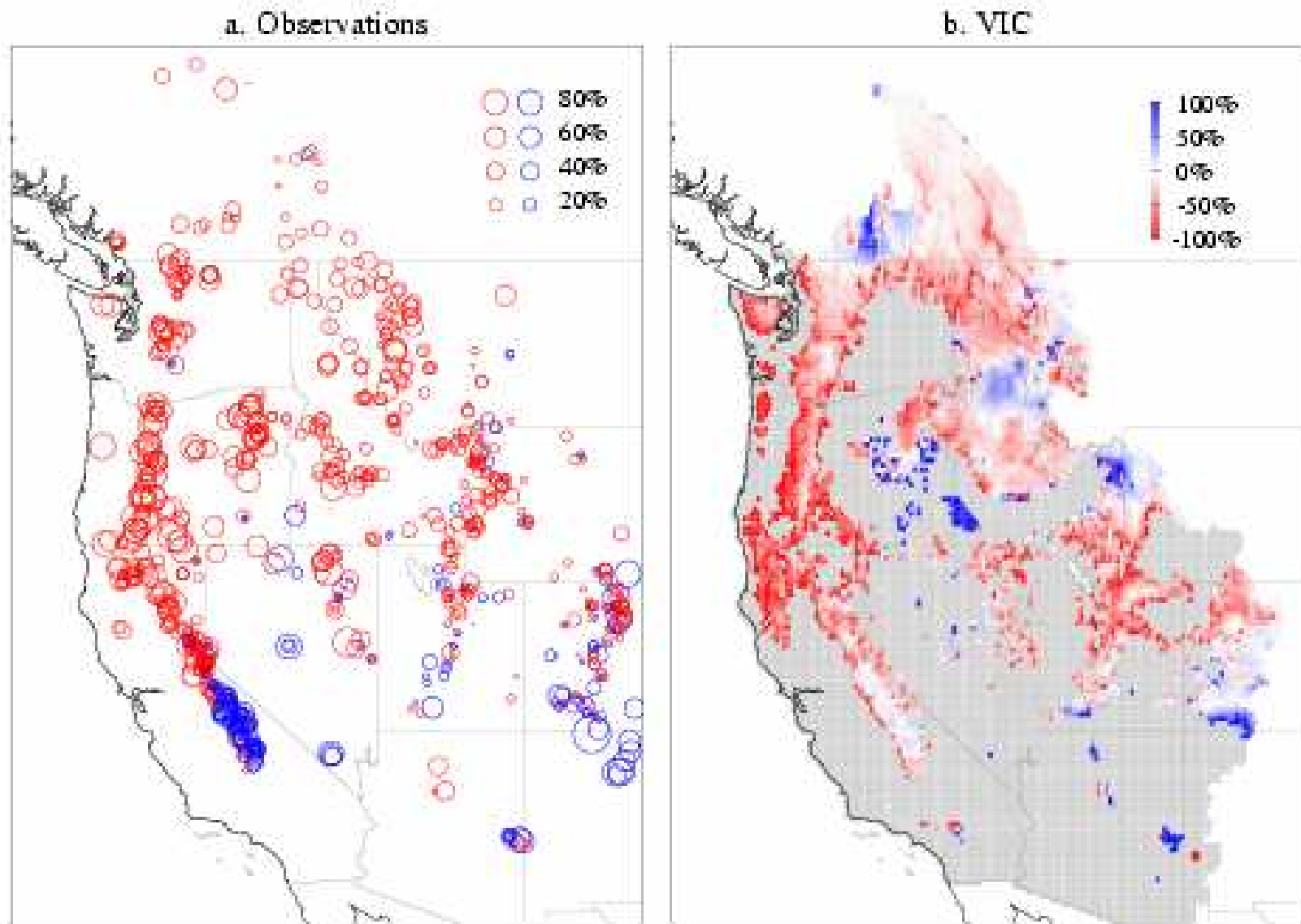


## Bark Beetle Outbreak in British Columbia

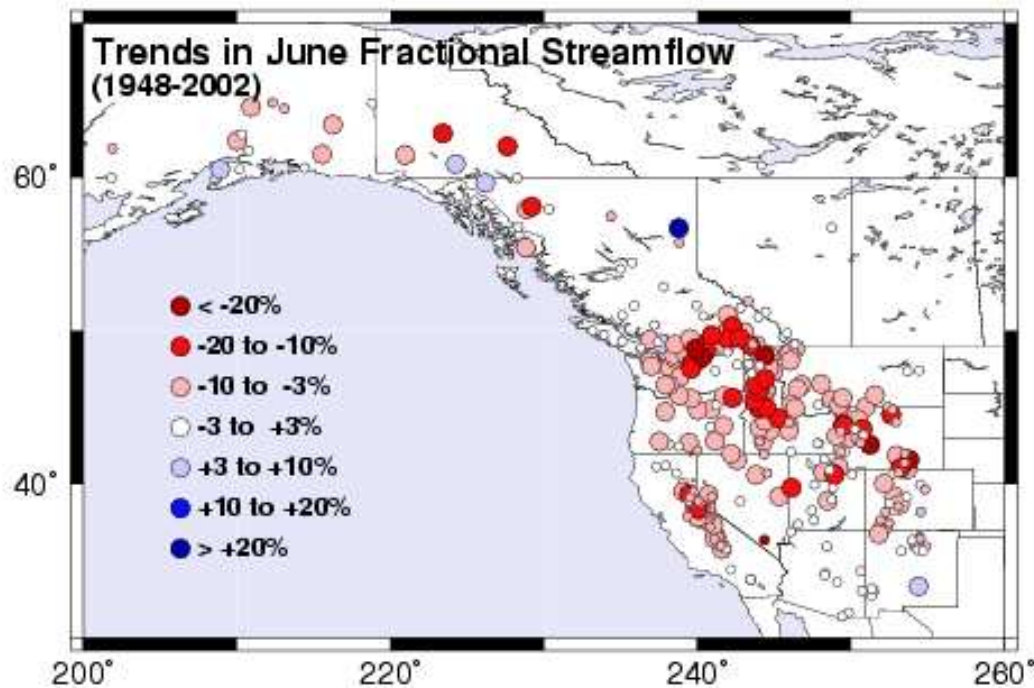
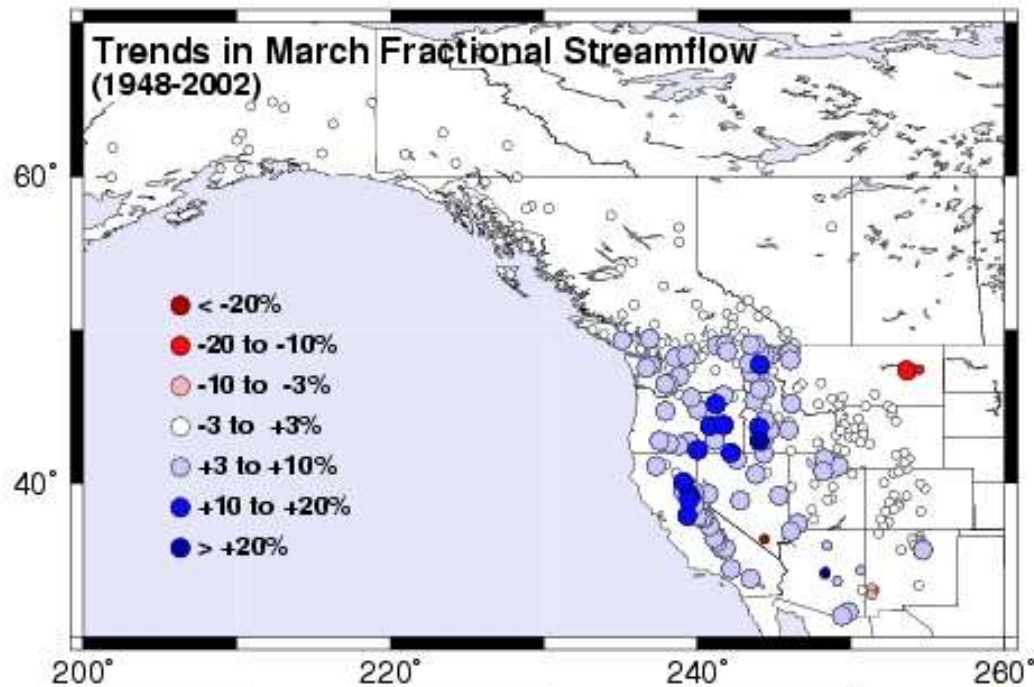


(Figure courtesy Allen Carroll)

# Trends in April 1 SWE 1950-1997



Mote P.W., Hamlet A.F., Clark M.P., Lettenmaier D.P., 2005, Declining mountain snowpack in western North America, BAMS, 86 (1): 39-49



As the West warms,  
spring flows rise  
and summer flows  
drop

Stewart IT, Cayan DR,  
Dettinger MD, 2005:  
Changes toward earlier  
streamflow timing across  
western North America, *J.  
Climate*, 18 (8): 1136-1155

# An Opportunity to Provide Improved Access to Hydrologic Scenarios for Planning

As the public and professionals in the water management and policy arenas have become increasingly concerned about the impacts of climate change on PNW water resources, demand for hydrologic scenarios suitable for planning purposes at a range of spatial scales has increased dramatically.

Currently there does not exist an up-to-date, comprehensive, and self-consistent data base of hydrologic scenarios for the Columbia River basin that is suitable for the range of planning activities the Climate Impacts Group is being asked to support.

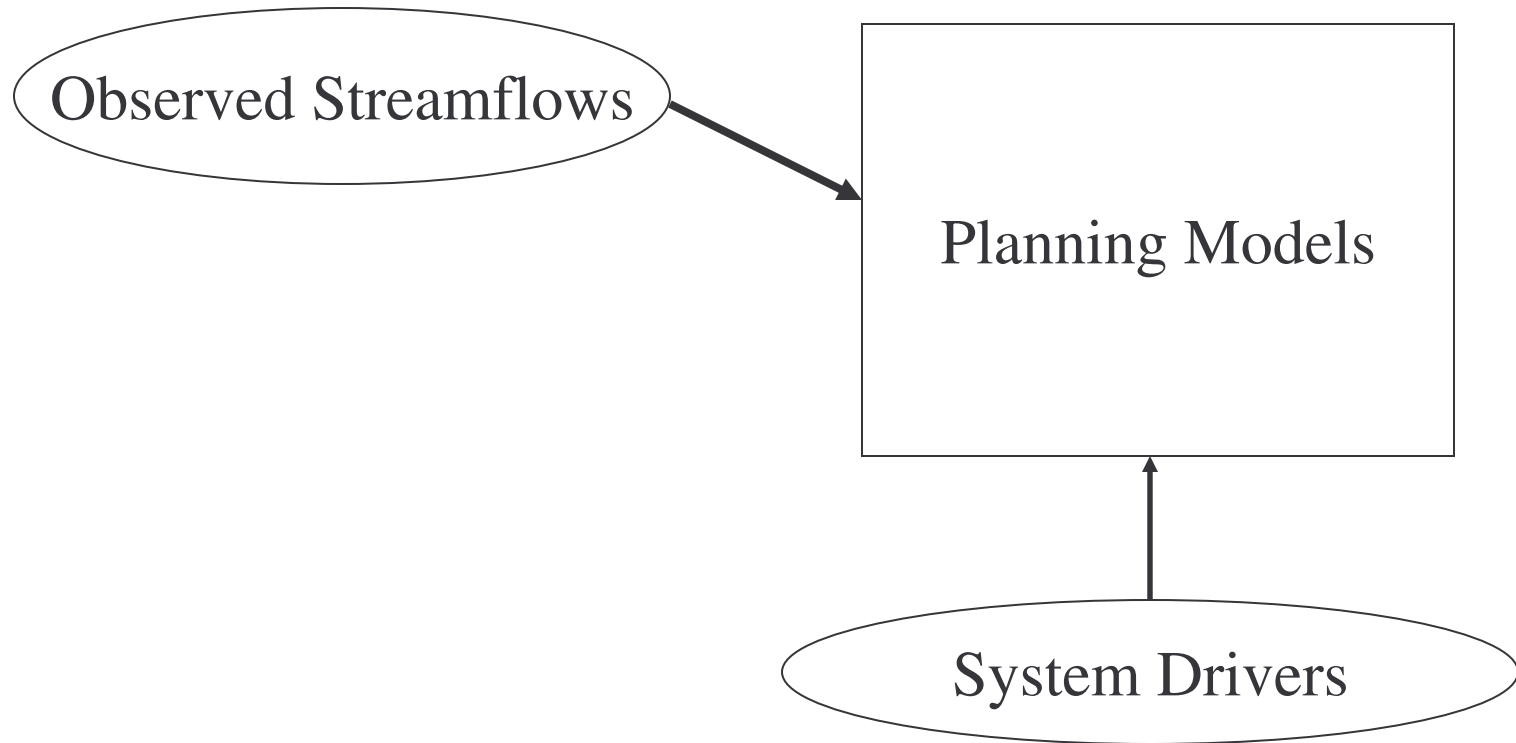
# WA House Bill 2860

- \$16 Million for studies related to enhancing water supplies in the Columbia River basin for irrigation and municipal water supply.
- Up to \$200 Million for implementing improvements identified by these studies.

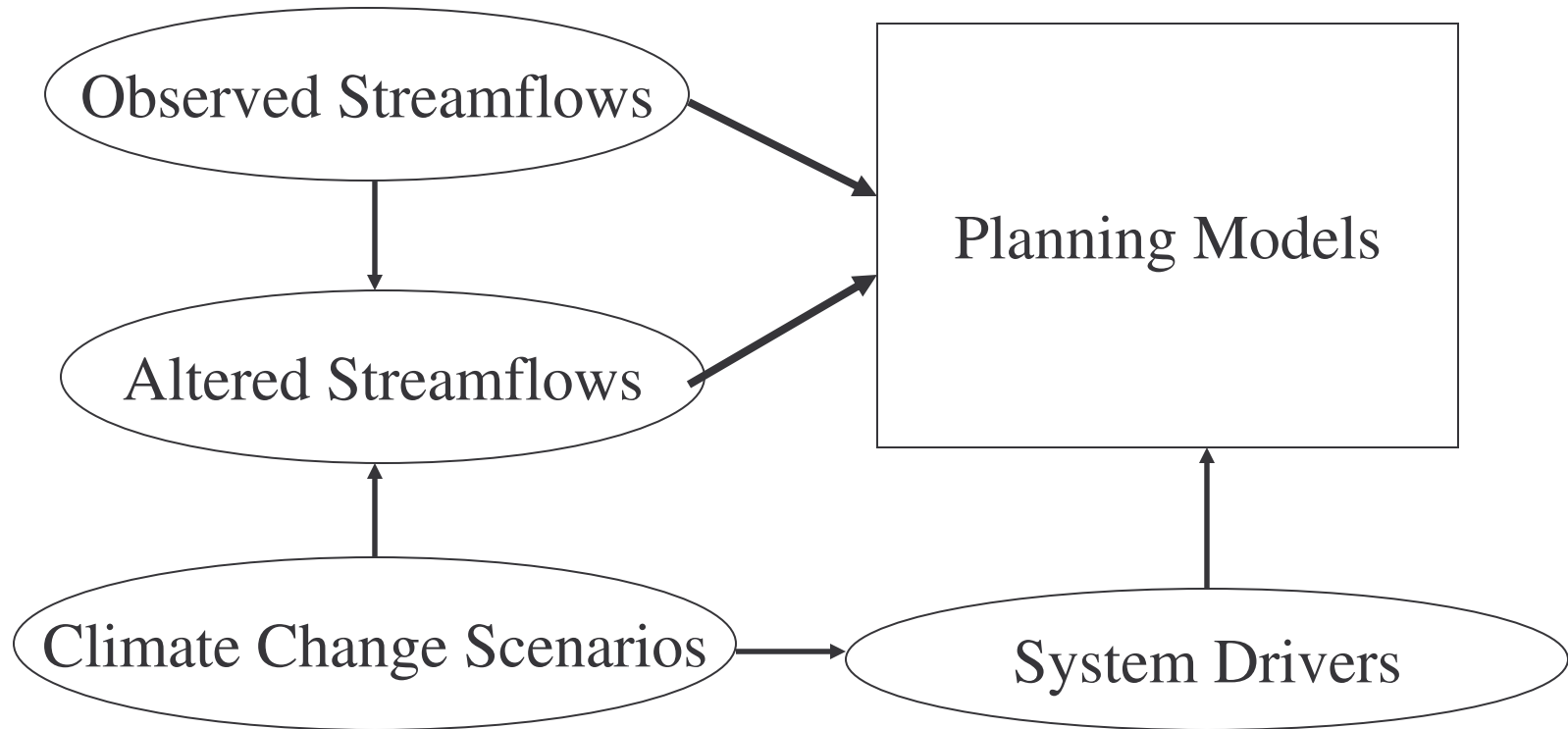
Answers to FAQ regarding WA 2860 from the Department of Ecology website:

<http://www.ecy.wa.gov/pubs/0611014.pdf>

# Schematic of a Typical Water Planning Framework

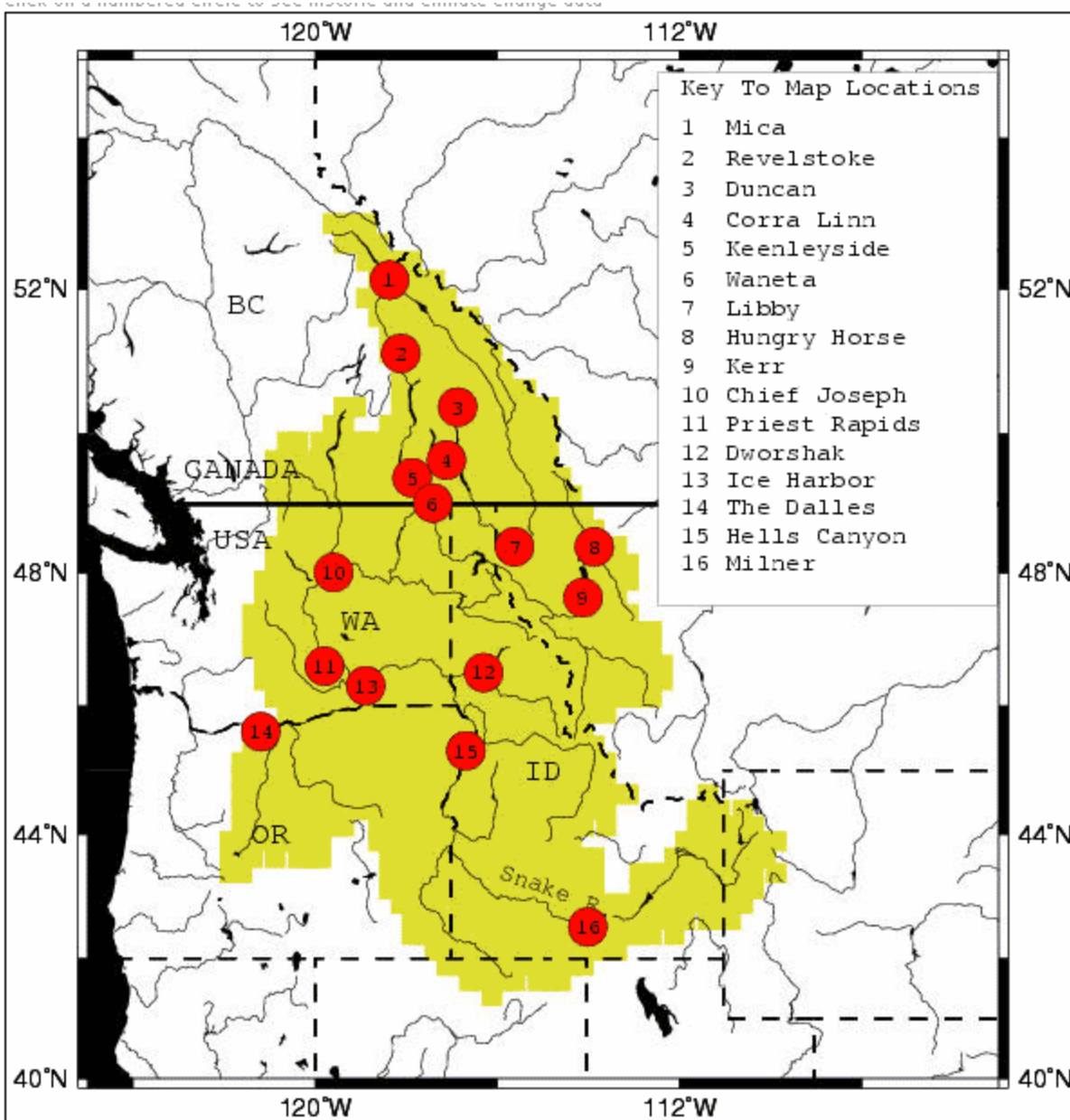


# Schematic of Climate Change Water Planning Framework



# The Need to Encompass Multiple Spatial Scales

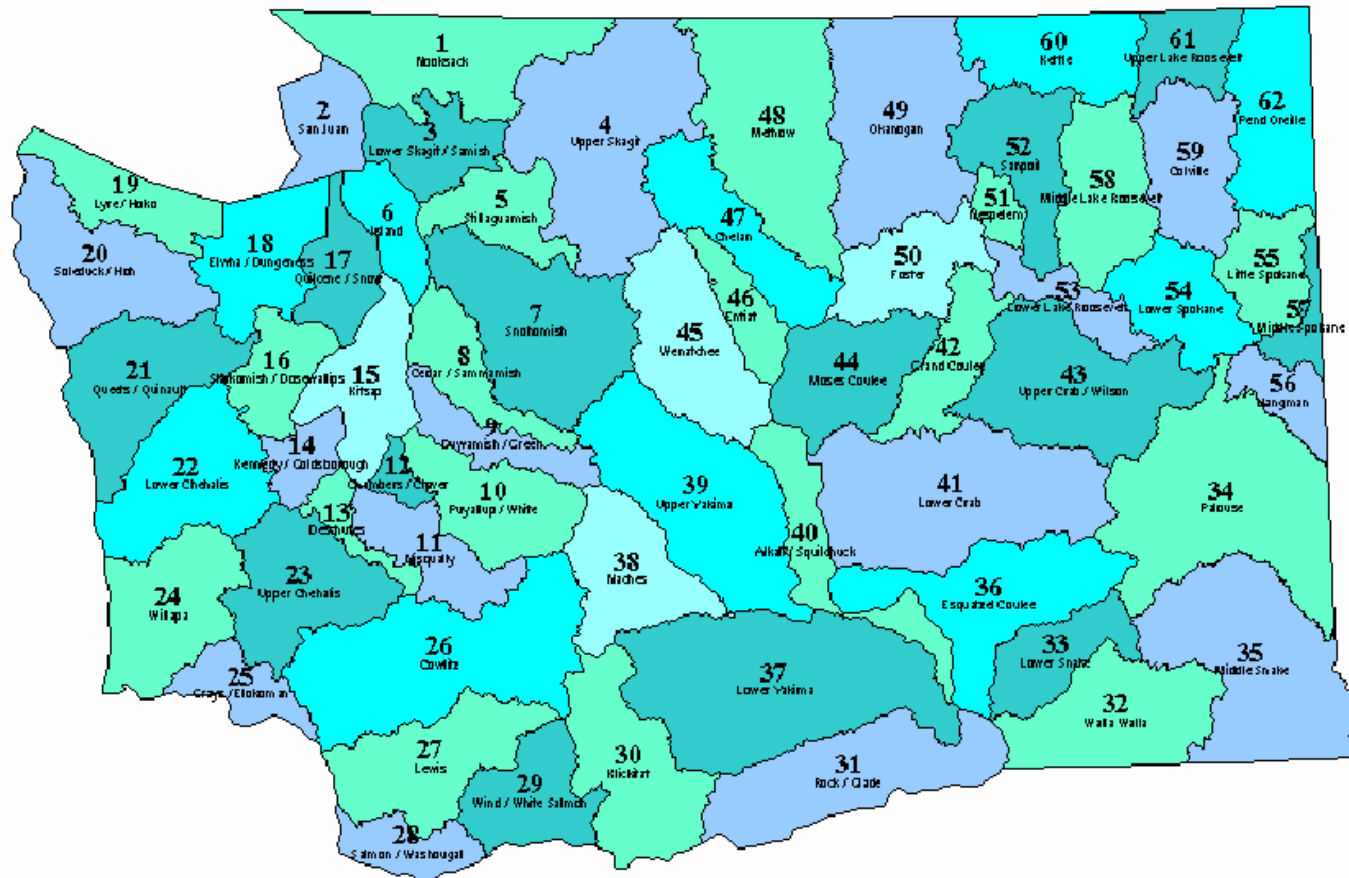
# Large Scale Planning Studies



## Examples:

- Hydro System Performance
- Flood Control
- Main Stem ESA
- Transboundary Issues
- Large-Scale Irrigation Impacts

# Medium Scale Planning Studies



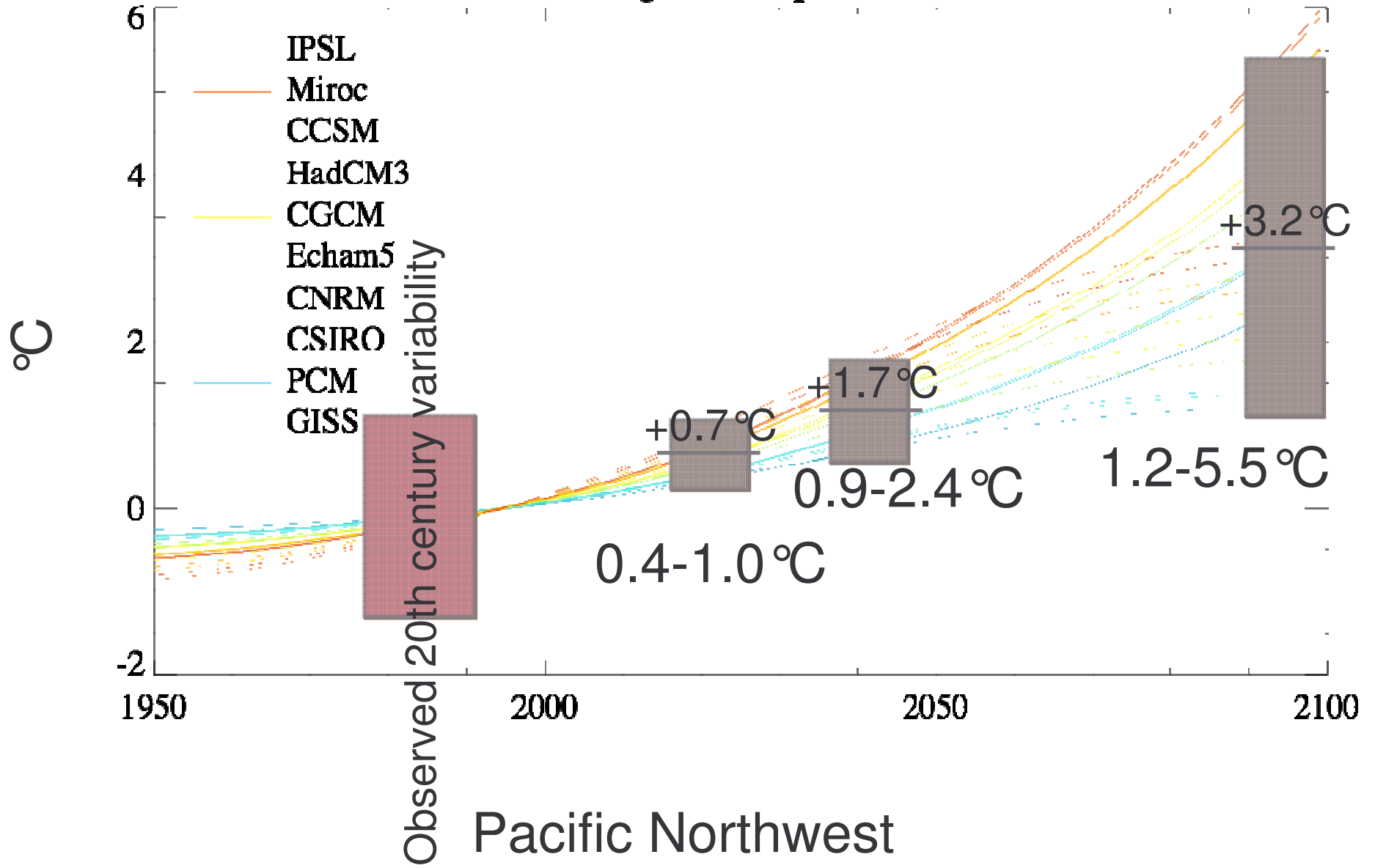
Examples:

Water Supply Planning

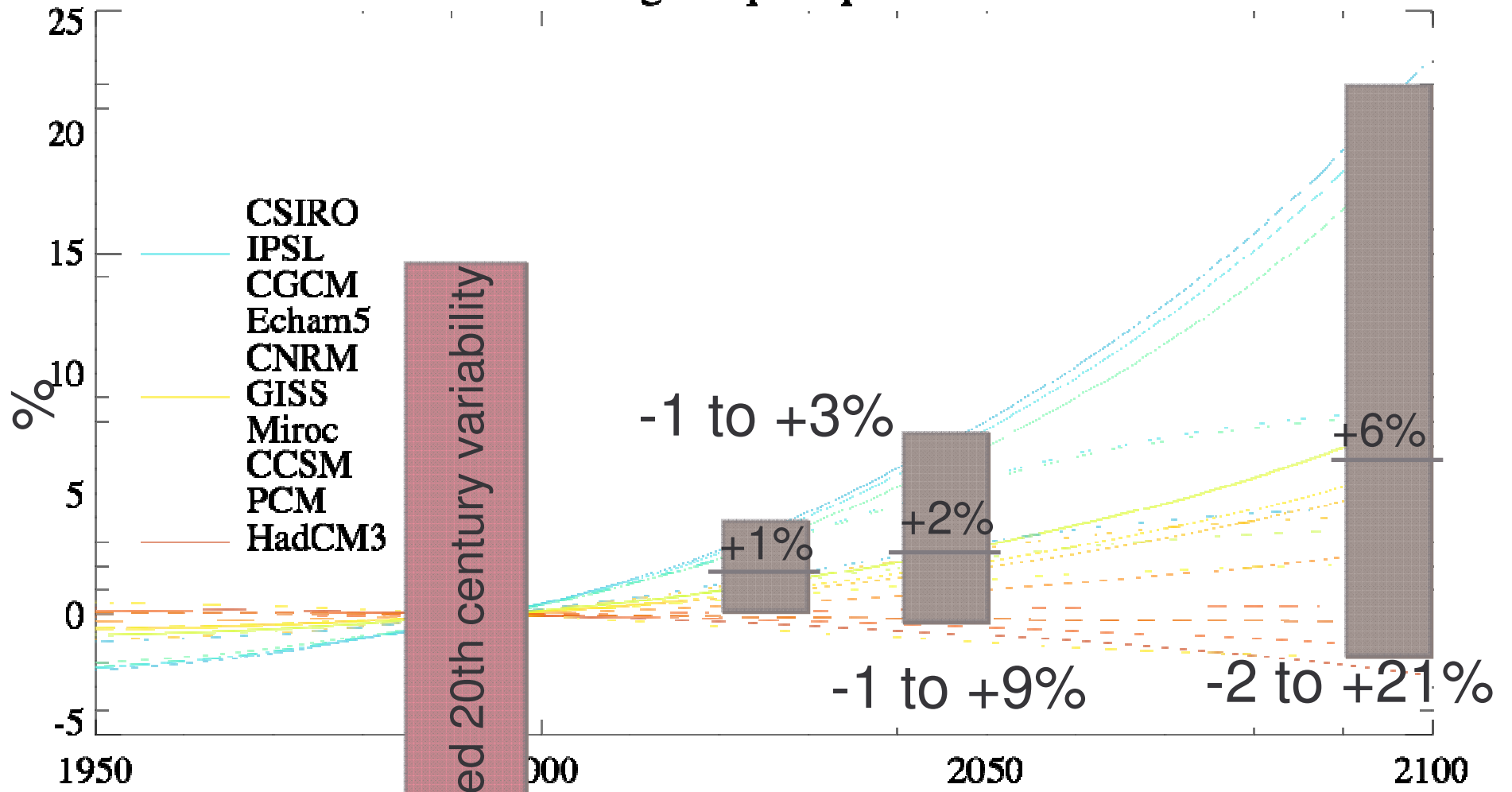
- Yakima Basin
- Okanogan Basin
- Methow
- Walla Walla Basin

WA State Water Resources Inventory Areas

# Change in temperature

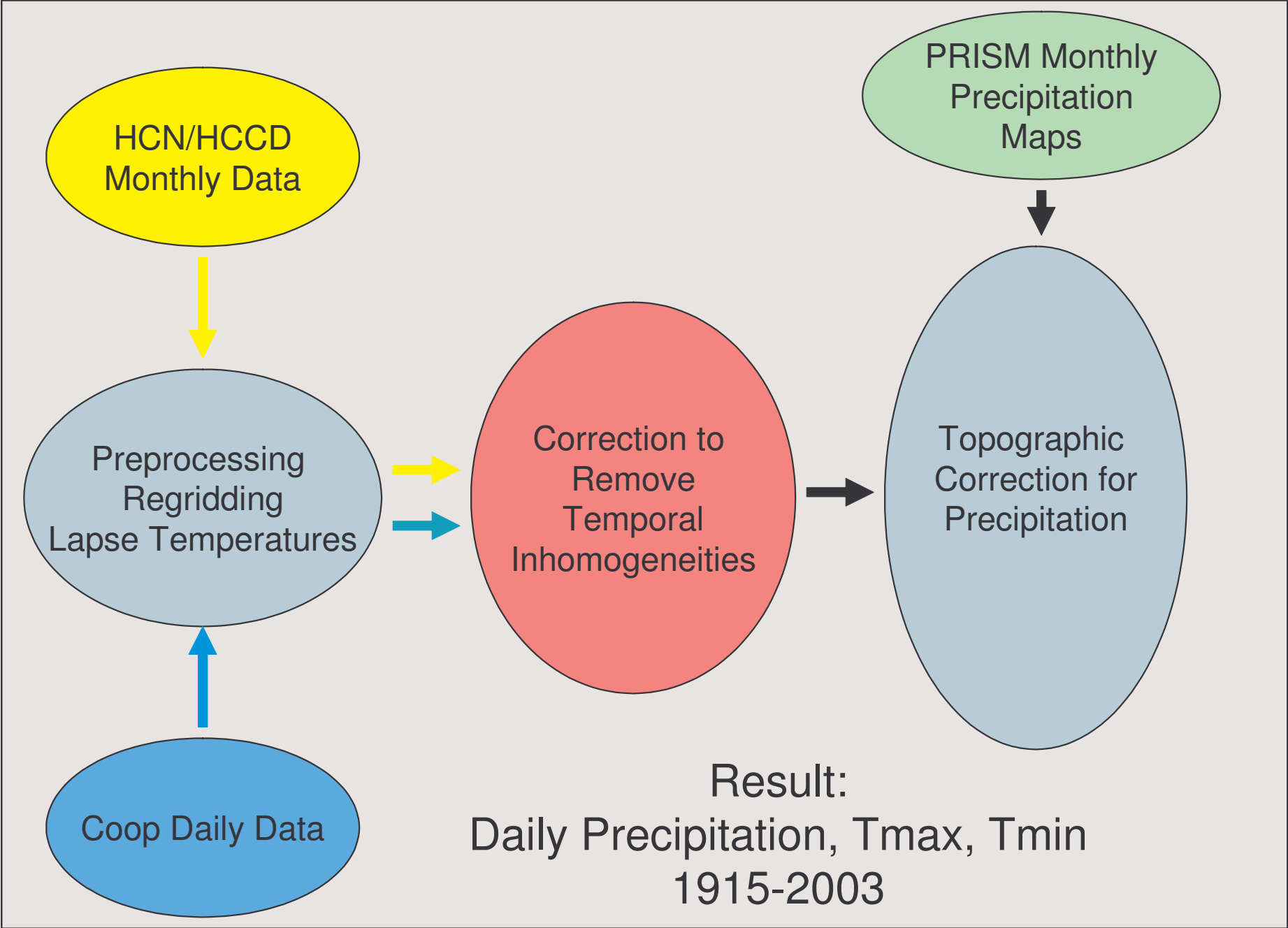


# Change in precipitation



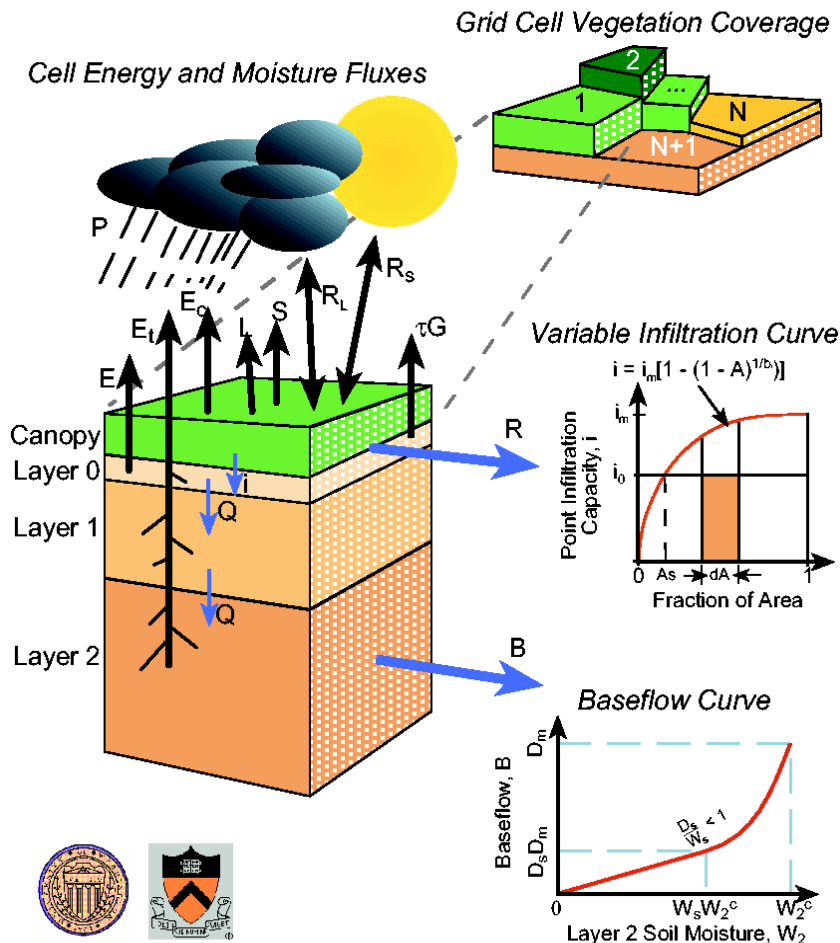
Pacific Northwest

# Schematic Diagram for Data Processing of VIC Meteorological Driving Data

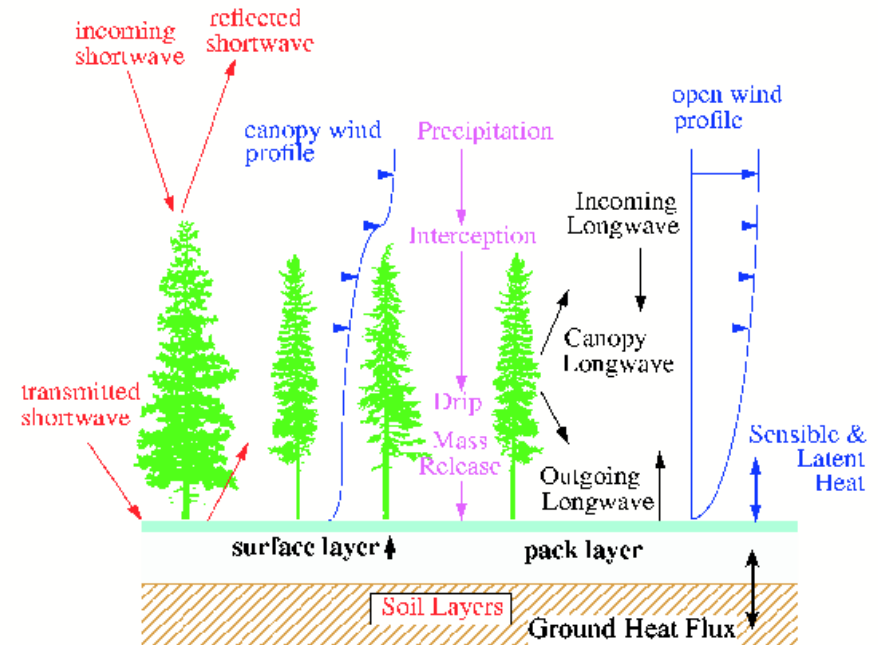
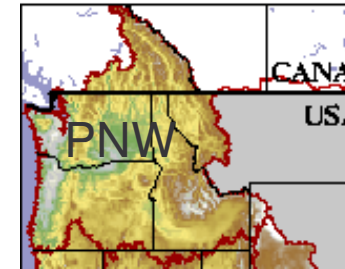


# Schematic of VIC Hydrologic Model and Energy Balance Snow Model

## Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model

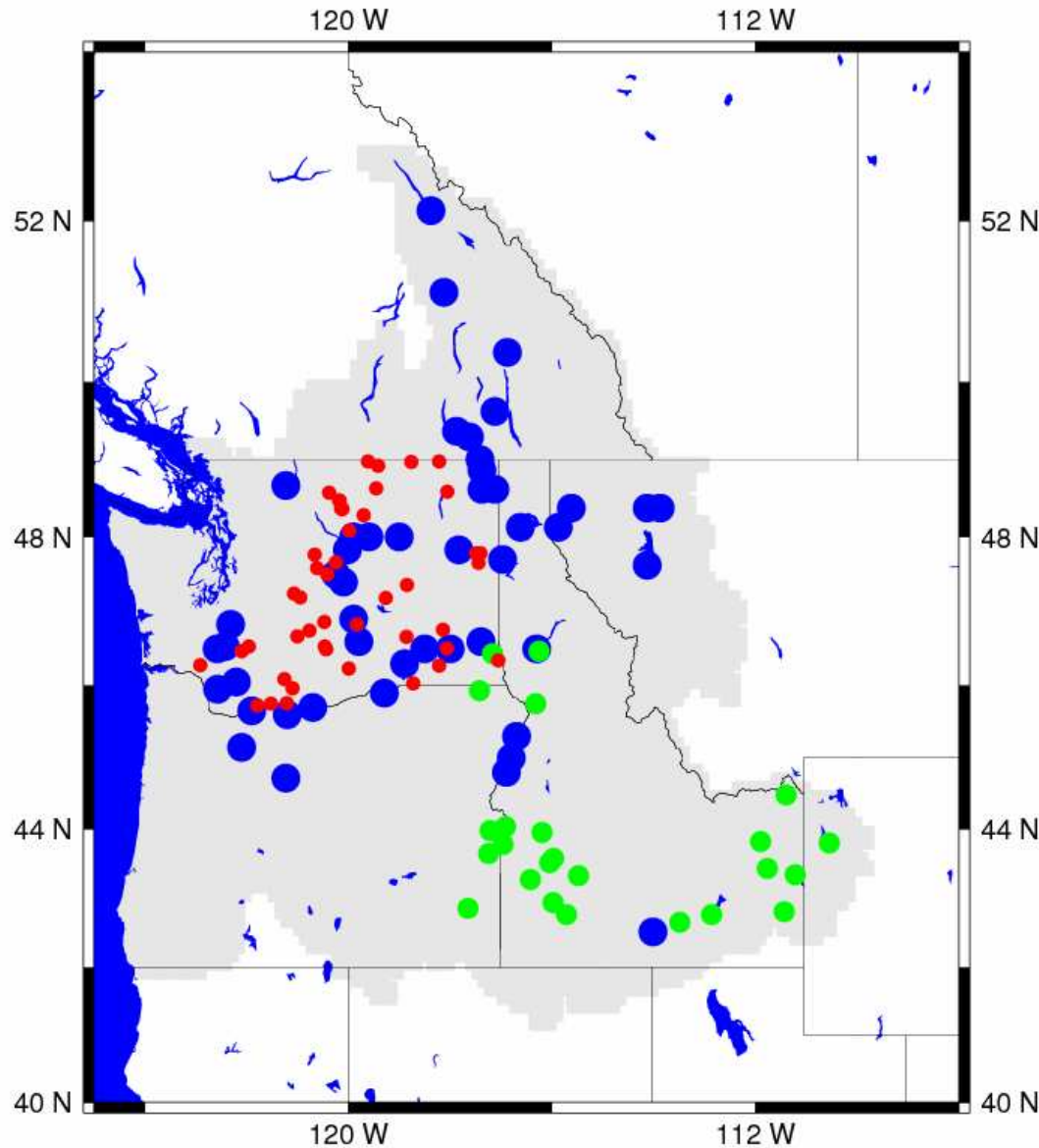


6 km  
6 km  
1/16<sup>th</sup>  
Deg.



## Snow Model

# Streamflow Locations Currently Under Consideration



Blue = Large Scale Planning Sites

Green = Snake River Sites

Red = Additional Sites in WA

Partnerships with OR, ID, and BC are being discussed with the intent to extend the number of sites in these areas.

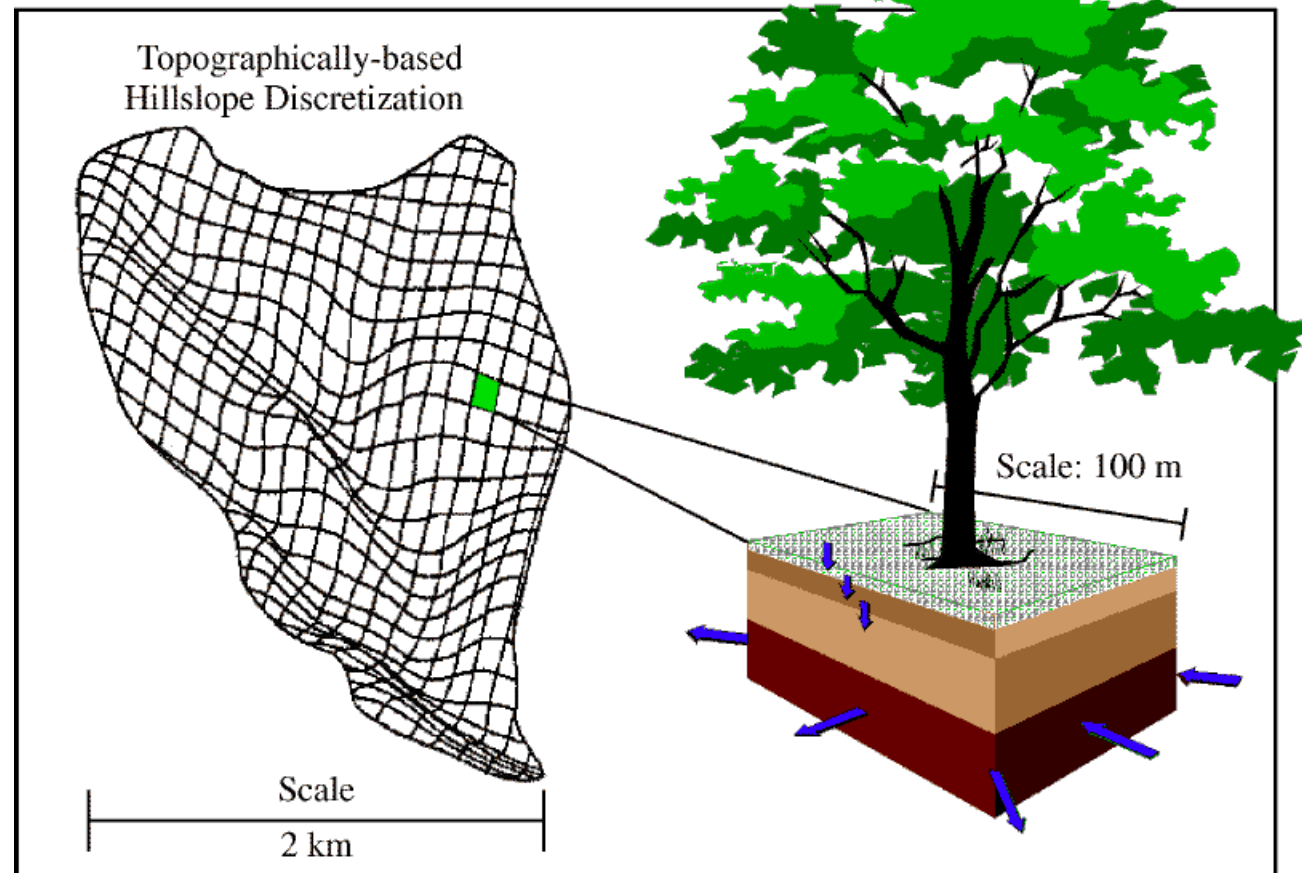
# Alternate Approach: DHSVM

Developed in the  
UW Land Surface  
Hydrology Research  
Group at UW for over  
a decade

a research tool, also  
is used operationally

applied to small  
catchments

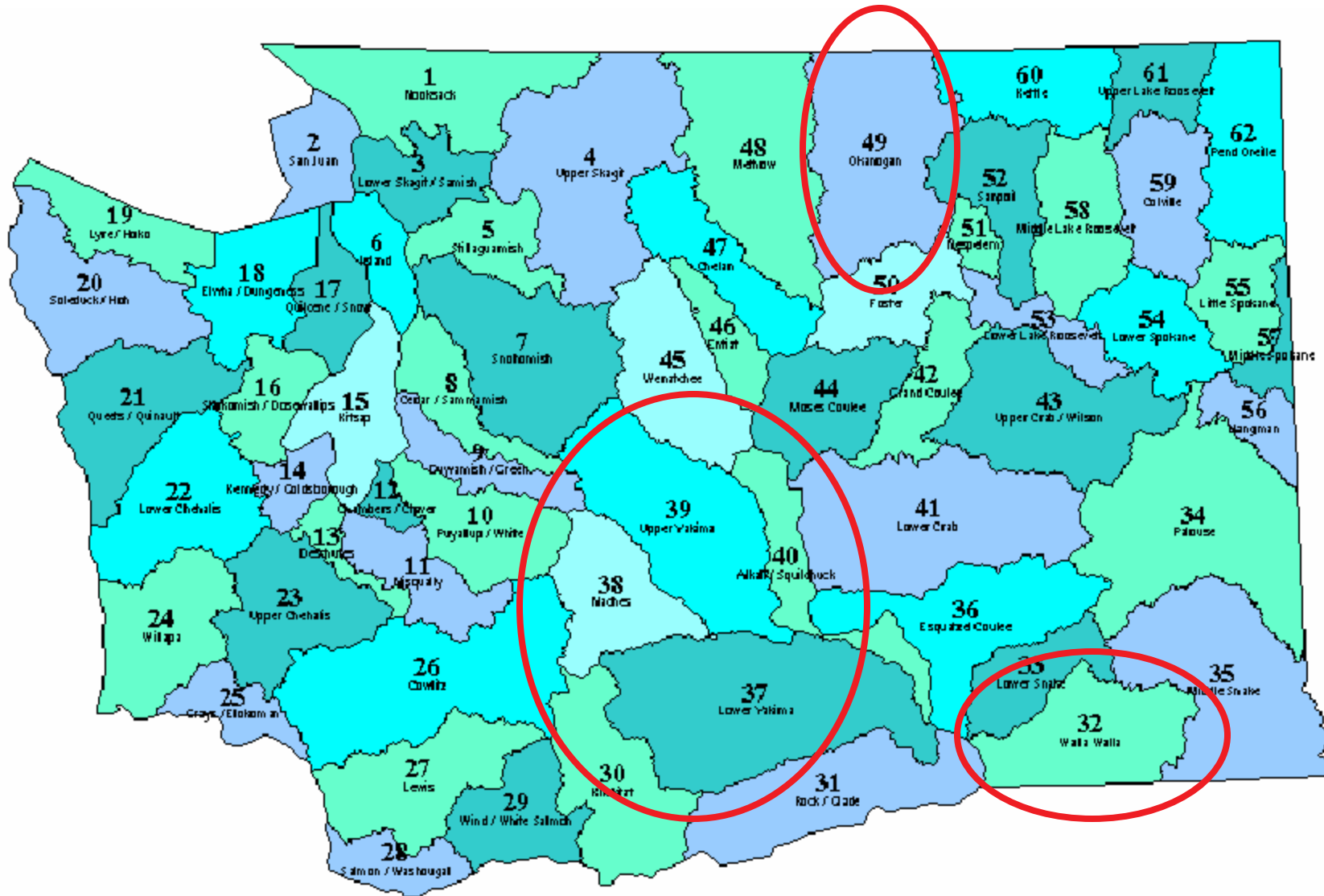
DHSVM Model Representation



Surface / Subsurface Flow  
Redistribution to / from  
Neighboring Pixels

*DHSVM: Distributed Hydrology-Soil-Vegetation Model*

# Medium Scale Planning Studies



WA State Water Resources Inventory Areas

# Some Potential Advantages of DHSVM Approach

- Increased spatial resolution down to the watershed scale
- Increased temporal resolution (high and low flow extremes)
- Water temperature simulations
- Simple ground water scheme improves base flow simulations
- Future access to sediment transport capability (research)

# Proposed Downscaling Approaches

## **Statistical Downscaling (GCM)**

10 scenarios

## **Dynamic Downscaling (nested MM 5)**

2 scenarios

Improvements in downscaling techniques will be implemented to allow evaluation of daily effects on flooding and low flow events.