USGS Water Programs in Washington State

Presented at the University of Washington's
fall 2009 Water Center Seminars

By Dr. Cynthia Barton, Director
USGS Washington Water Science Center
October 27, 2009
http://wa.water.usgs.gov

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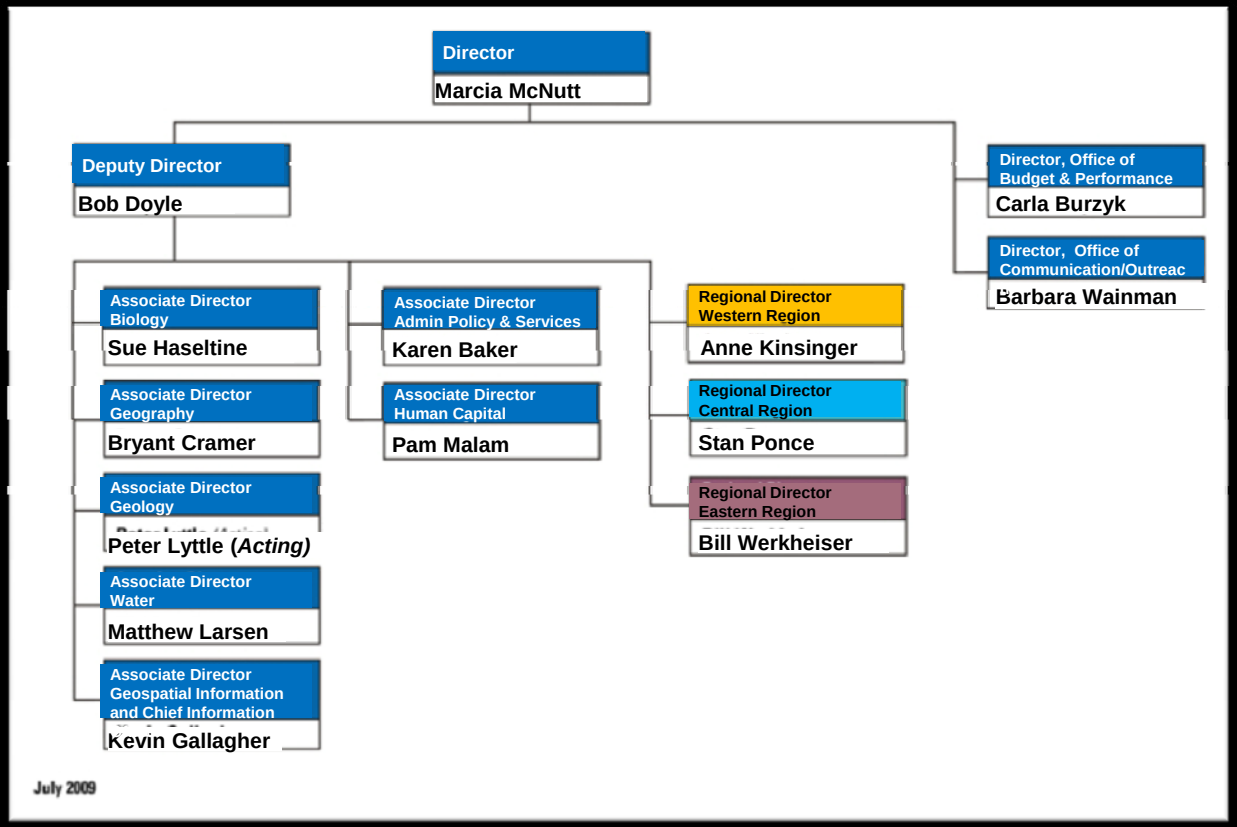
About the USGS

- Science agency in the Department of the Interior
- 130 years old
- Consists of four science areas
  - Biology
  - Geography
  - Geology
  - Water




About the USGS (cont'd)

- In striving to combine these four science areas, the USGS has recently undergone a reorganization



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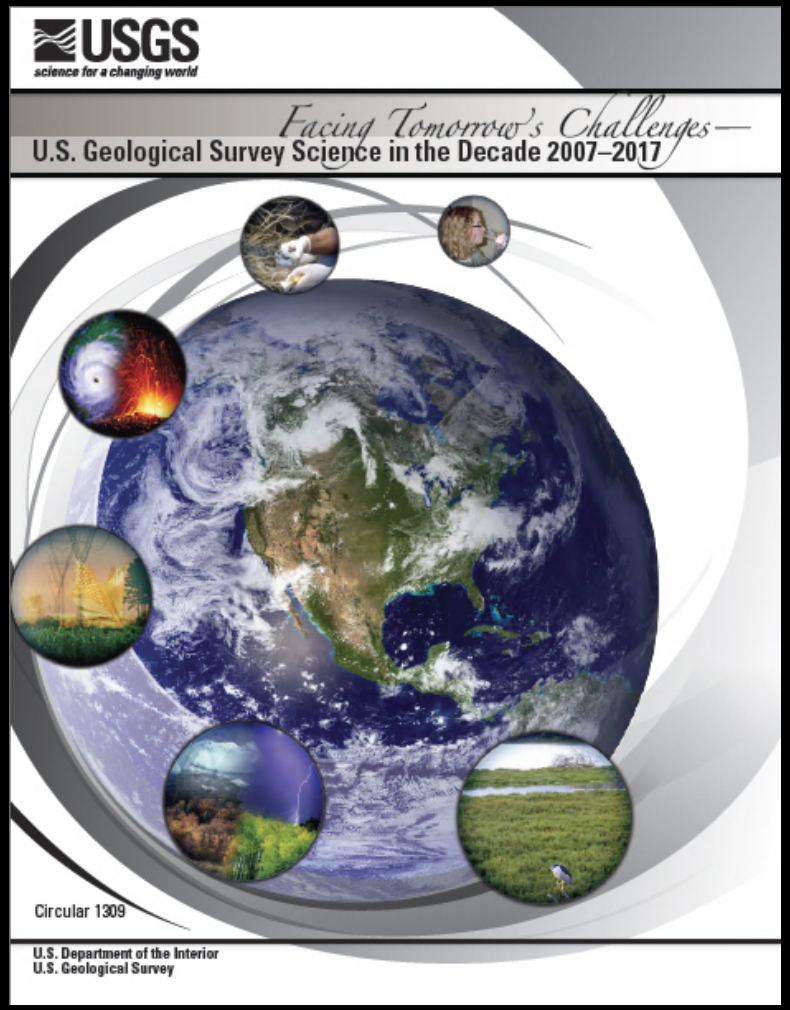
About the USGS (cont'd)

- **Mission**

  The USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.



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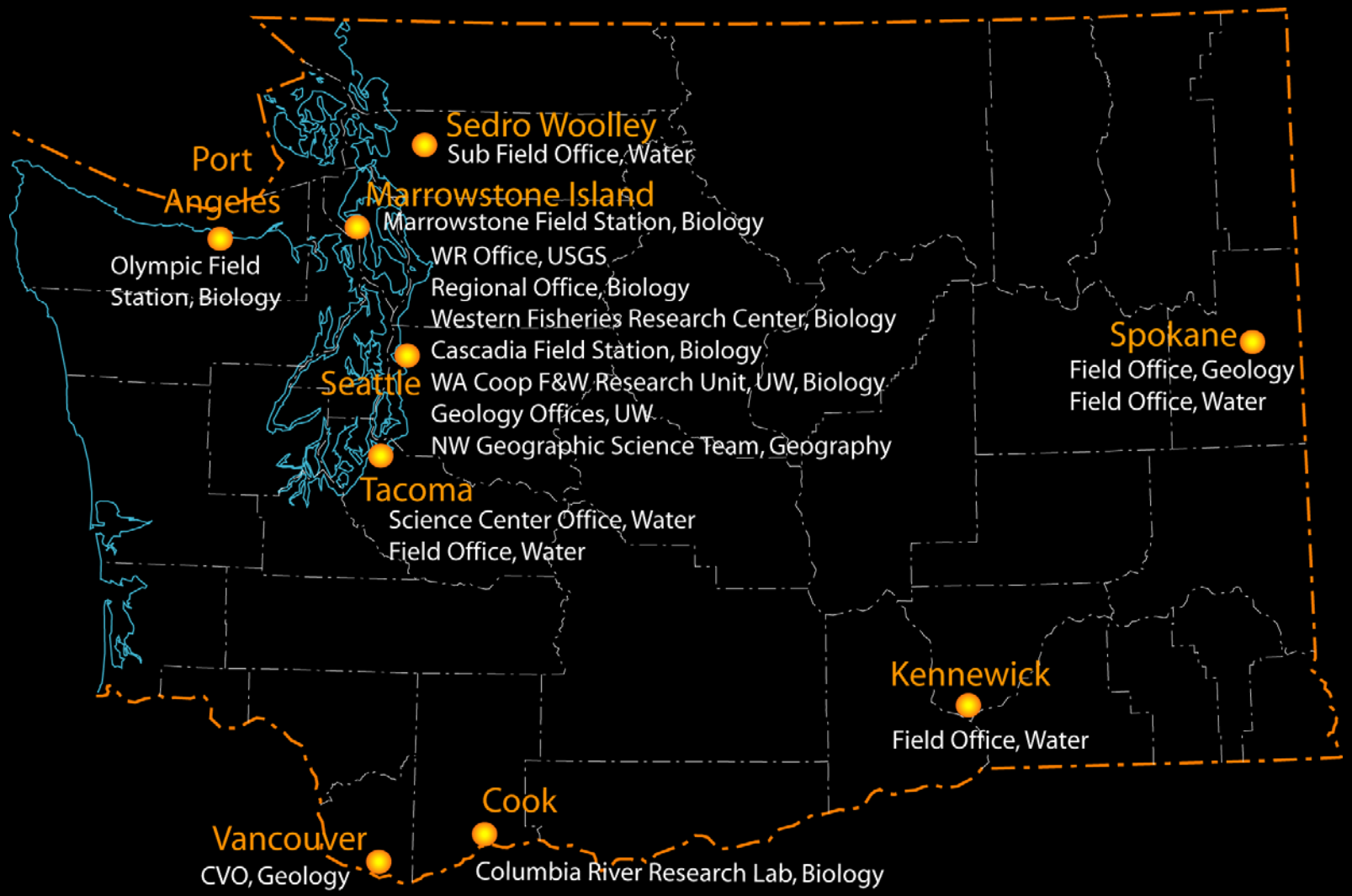
USGS Offices in Washington



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Water

- USGS carries out the *Water* program through a structure that consists of:
  - Headquarters
    - Technical
    - Program
    - Support
  - Science Center (one in each state)

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Water's National Research Program

- Conducts basic and problem-oriented hydrologic research
- Research sciences include

Water Chemistry
GW Hydrology
SW Hydrology
Geomorphology & Sediment Transport
Ecology

USGS Washington Water Science Center

Director

Associate Director for Hydrologic Studies

- Environmental Hydrology & Geochemistry Section
- NAWQA Section
  - CCYK Study Unit
  - Puget Sound Study Unit
- Physical Hydrology Section
- Watersheds & Ecology Section

NAWQA National Synthesis Team

Assistant Director for Hydrologic Data

- Construction Unit
- Hydrologic Analysis & Data Management Unit
- Mid Columbia Field Office
- Upper Columbia Field Office
- Western Washington Field Office
  - Operations North
  - Operations South
- Northwest Field Office

Technical Specialists

Administrative Services Section

IT Services

Tacoma Publish-ing Services

Outside Center Representatives

Approximately 100 people

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WAWSC Staff

- Three parts: *data*, *studies*, and support
- Expertise: hydrologic technicians, hydrologists, biologists, chemists, ecologists, engineers, glaciologists, geologists, geomorphologists, oceanographers, limnologists, statisticians, IT, computer programmers, etc.

Publications

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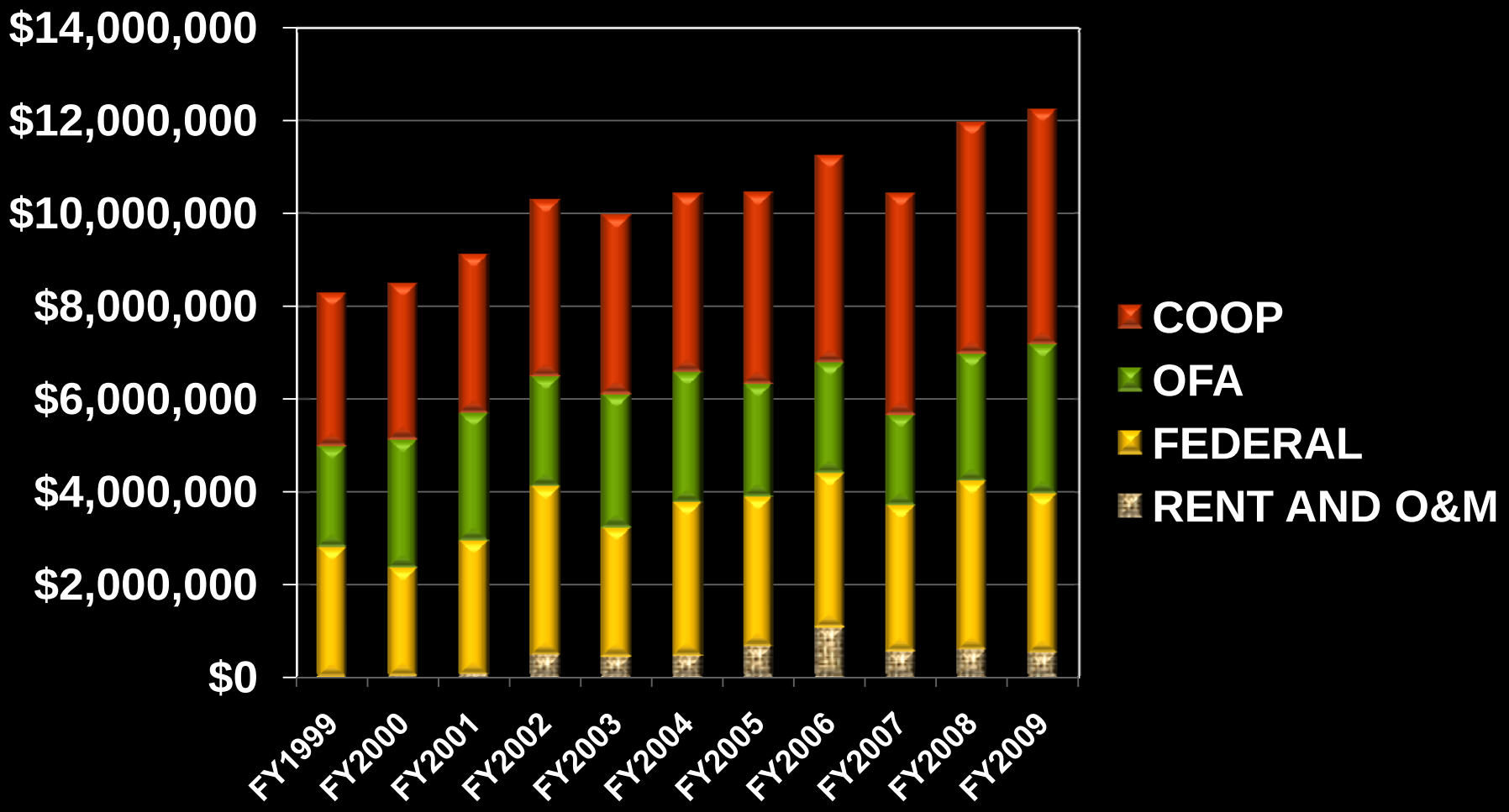
WAWSC Funding



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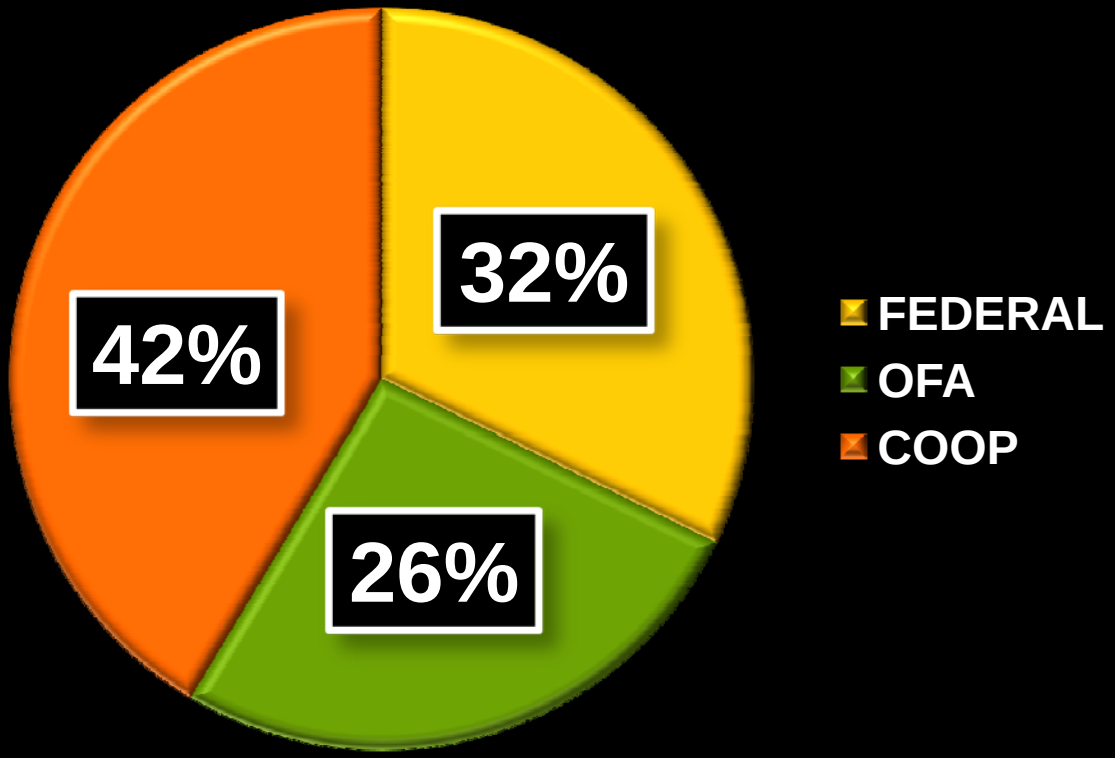
Description of WAWSC Program

- Three parts to the USGS *Water* program
- No base funding



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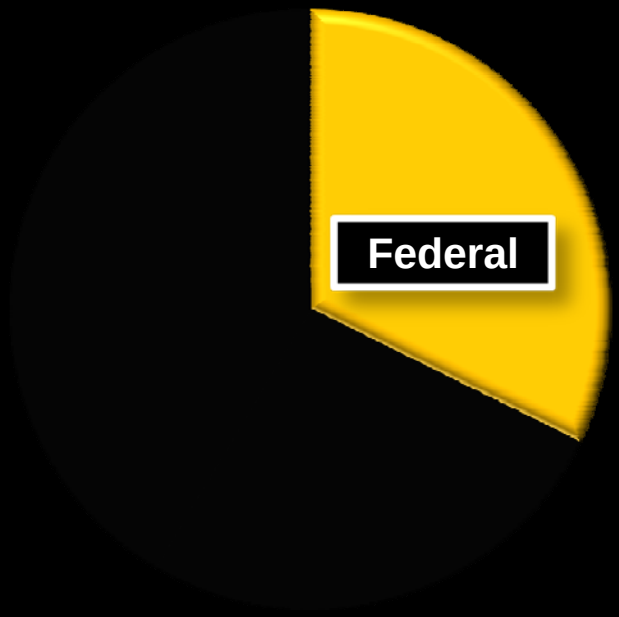
Federal Program

- Funding appropriated by Congress
- Funding allocated from HQ to WSCs based on:
  - Scientific program needs
  - Expertise in Center
  - Outside partnerships
  - Politics



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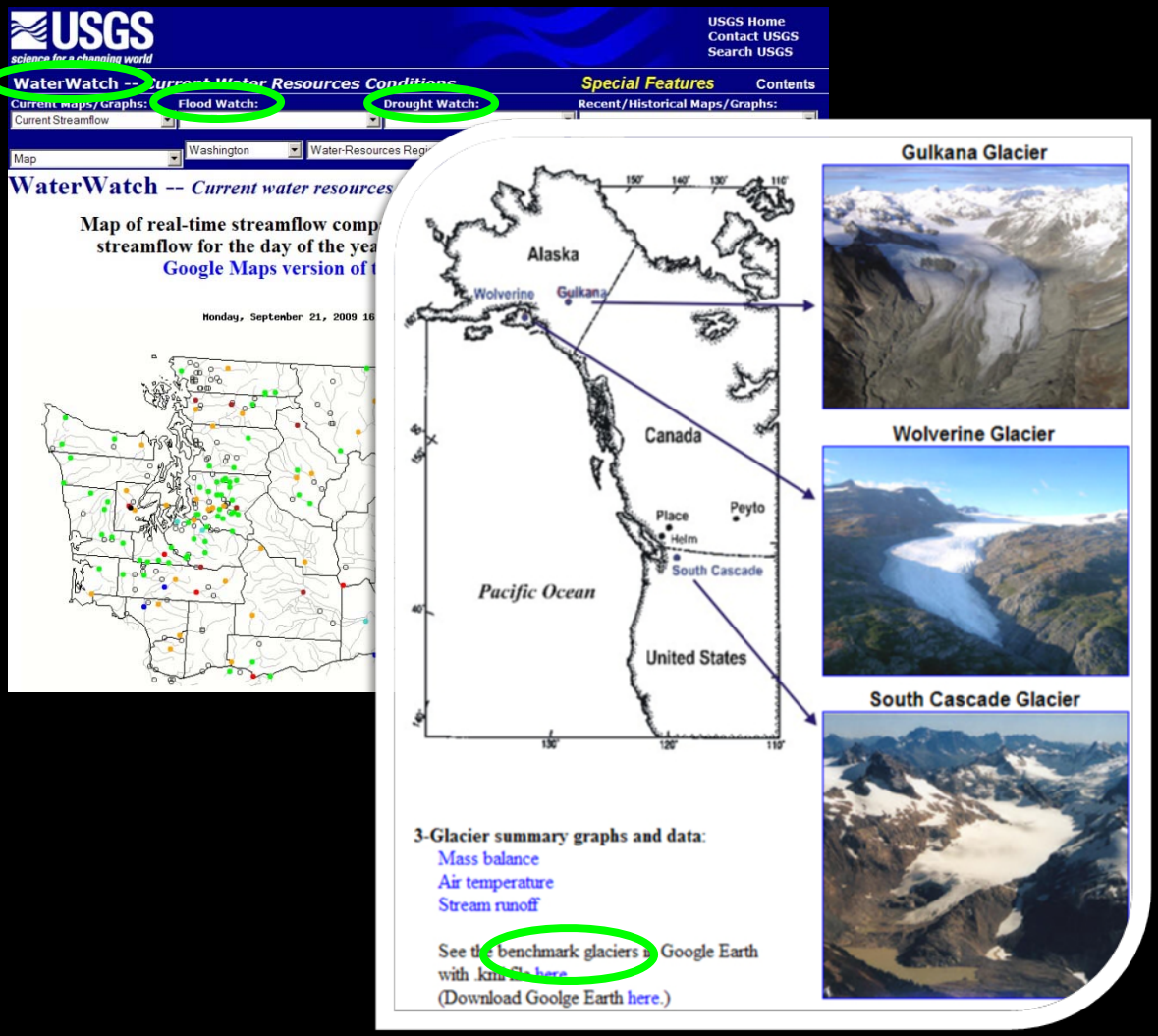
Federal Program – WAWSC Data Examples

- National Streamflow Information Program (NSIP)
- WaterWatch
- Benchmark Glacier Program



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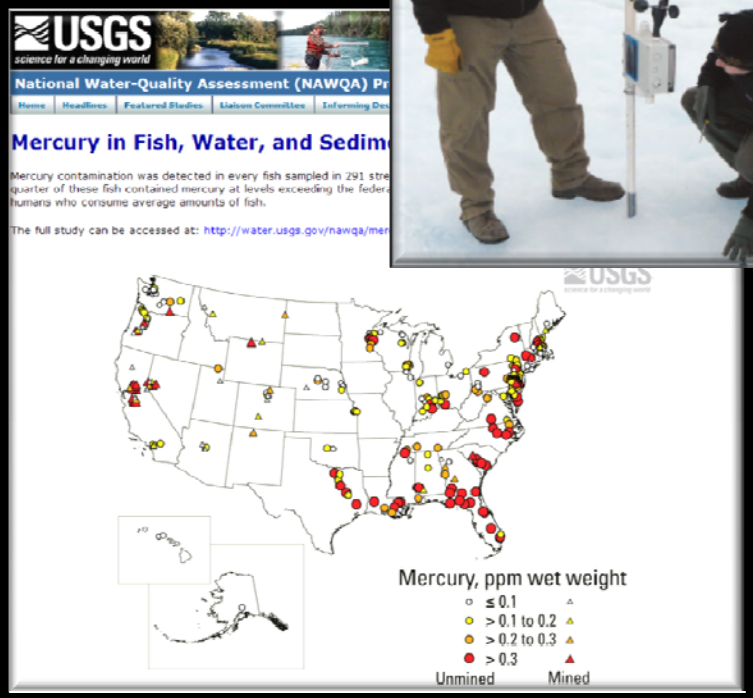
Federal Program – WAWSC Studies Examples

- Global Climate Change Program
- NAWQA
- CPlat



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Cooperative Water Program (CWP)

- Has existed for more than 100 years
- Funding appropriated by Congress to match local partners (over 1,400 nationwide; ~100 in WA)

Congress → USGS ↔ Cooperator

DEPARTMENT OF ECOLOGY State of Washington

Grant County PUBLIC UTILITY DISTRICT

Seattle Public Utilities

CONFEDERATED TRIBES AND BANDS YAKAMA NATION TREATY OF 1855

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CWP – WAWSC Data Examples

- **Hydrologic Monitoring**
  - **380 sites**
    - **>400 records**
    - **Streamflow (272)**
    - **Stream stage (34)**
    - **Reservoirs (34)**
    - **Water Quality (44)**
    - **Precipitation (27)**
    - **Ground Water (6)**
    - **Sediment (2)**

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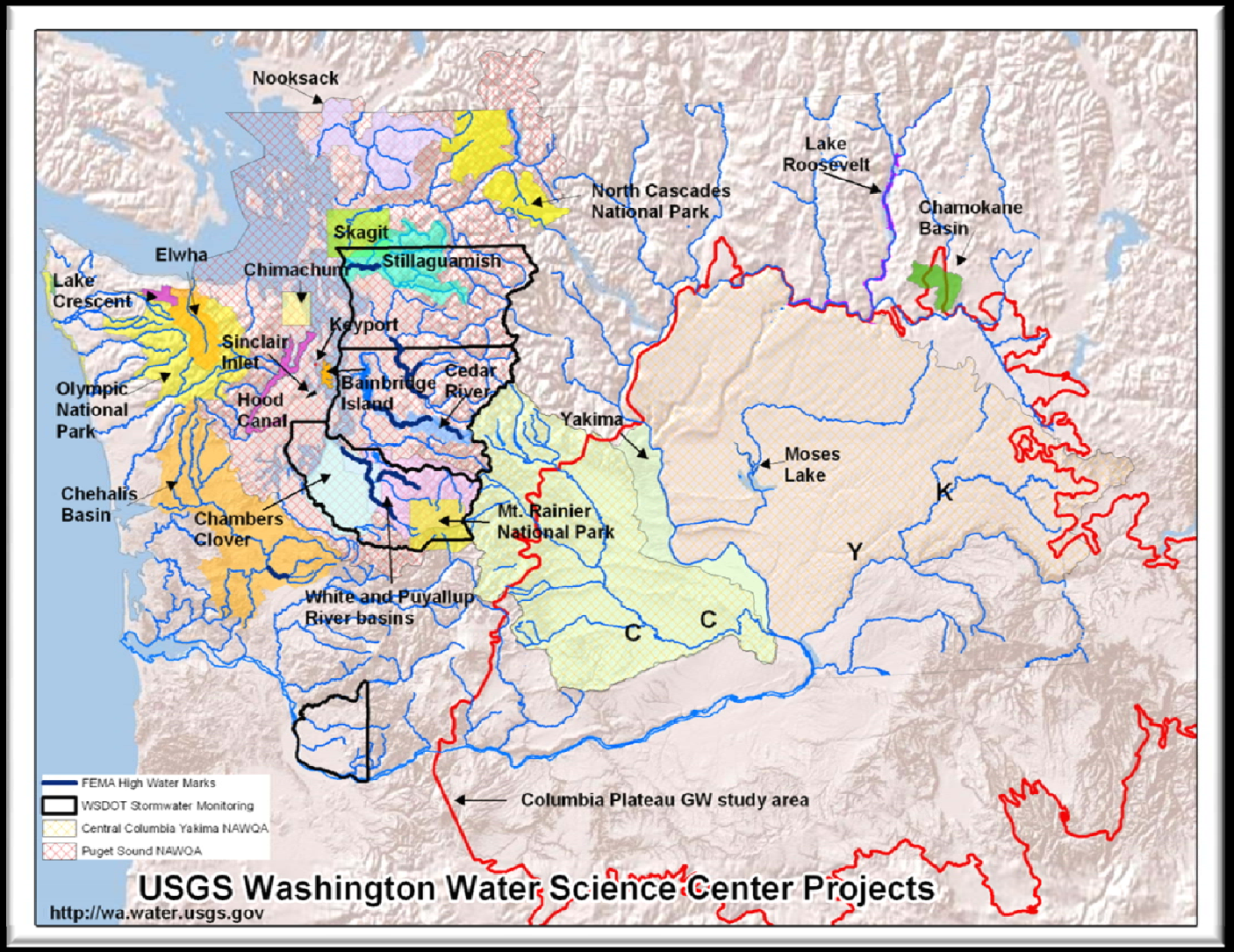
CWP – WAWSC Studies Examples



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CWP – WAWSC Studies Examples (cont'd)

- **Broadly address any water quantity or quality issue**

Surface Water	Ecology & Aquatic Habitat
Groundwater	Aquatic Biota Toxicology
River-Aquifer Interactions	Aquifer Storage & Recovery
Reservoirs	Contaminant Migration & Mitigation
Climate Change Impacts	Drinking-Water Quality
Floods & Droughts	Bacterial Contamination
Channel Migration	Remote Sensing Data Acquisition & Use
Glaciers	Database Development
Watersheds Modeling	TMDLs
Unsaturated Zone Hydrology	Water Use
Coastal & Estuary Hydrology	Water Supply
Stormwater	

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Other Federal Agencies Program

- Funding is predominantly reimbursable
- Exception – DOI Cooperative Program

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

National Weather Service
Seattle, Washington

DEPARTMENT OF THE NAVY
UNITED STATES OF AMERICA

NOAA National Marine Fisheries Service

NASA

U.S. DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

OFA

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OFA Program Examples

- **Work in two capacities for OFAs**

  1) **Assist in water-related mission**

     WAWSC Data Example

     - **USACE: provide stream-flow information for dam operation; monitoring total dissolved gas**

  2) **Assist OFA in addressing environmental concerns on Federal lands**

     WAWSC Studies Examples

     - **Hanford**
     - **UCR/LR**
     - **Keyport**
     - **Sinclair Inlet**

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Critical Water Issues in the State of Washington

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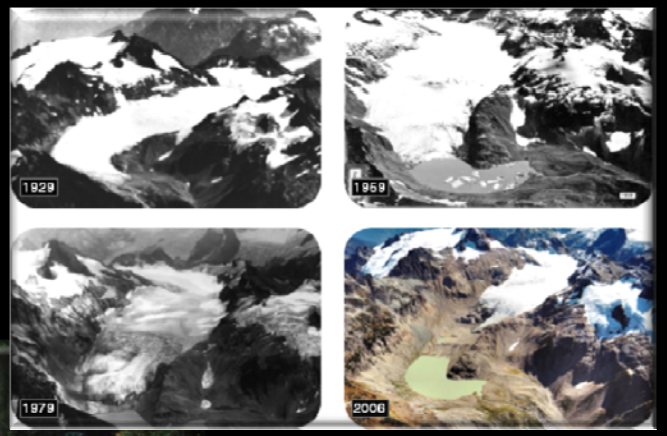
USGS Science Strategies in Washington State

- Understanding Ecosystems
- Climate Change
- Energy & Minerals
- National Hazards
- Human Health
- Water Census
- Data Integration



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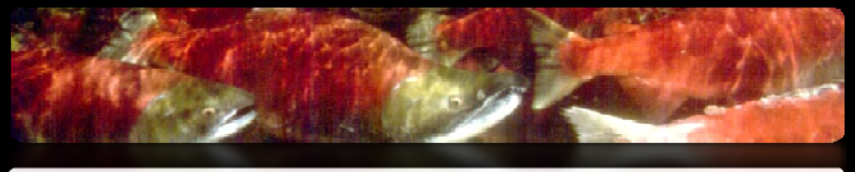
Understanding Ecosystems

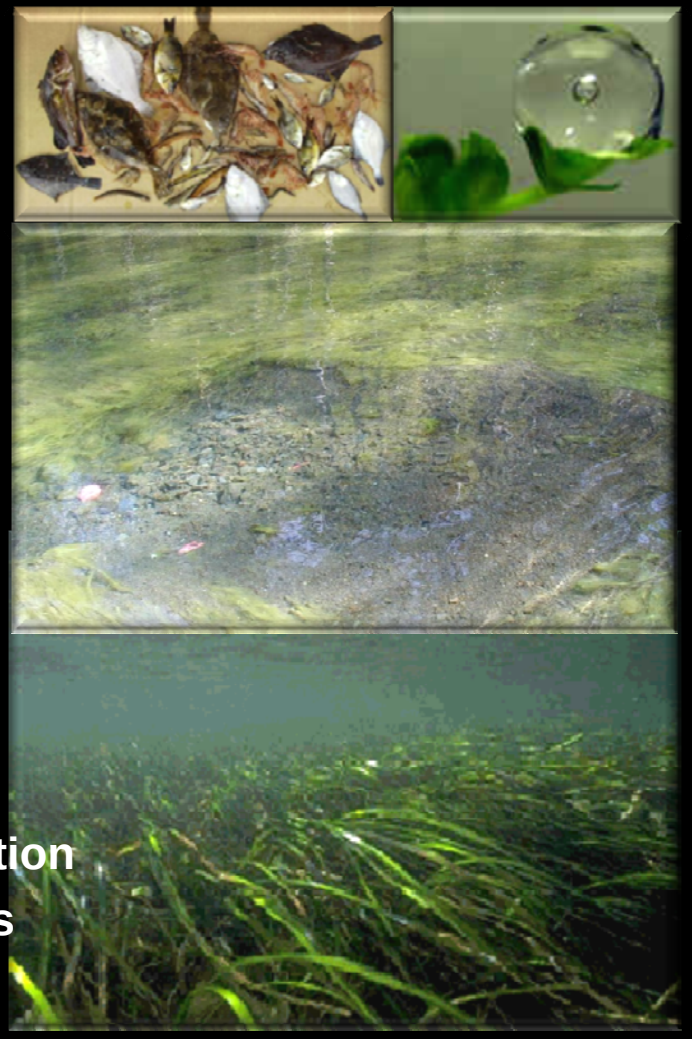
- **Key Issues**
  - Land use impacts on fish habitat
  - Instream flows for healthy ecosystems
  - Impacts of toxics
  - Fish passage barriers
  - Restoring coastal habitats
  - Elevated temperatures, sediment, bacteria, nutrients, and pesticides in streams
  - GW inputs
  - Bacteria in shellfish beds
  - Contaminants in sediment
  - Stormwater runoff
  - Establishing & monitoring for TMDLs



Salmon Recovery Regions – Areas with Salmon, Trout, or Steelhead that are Listed, proposed for Listing, or have High Potential for Future Listing ESA (Source: Governor's Salmon Recovery web page)

Understanding Ecosystems (cont'd)

- **WAWSC Programs**
  - Coastal Habitats in Puget Sound
  - Elwha River basin sediment
  - Lake Crescent nearshore effects & nutrient budget
  - Green River
  - Moses Lake sediment
  - NAWQA
  - NWIFC regional low-flow analyses
  - Mercury in Sinclair Inlet
  - Yakima River watershed
  - Hood Canal hypoxia and fish mortality
  - Mid-Columbia abandoned channels evaluation
  - North Coast Cascade Network critical loads



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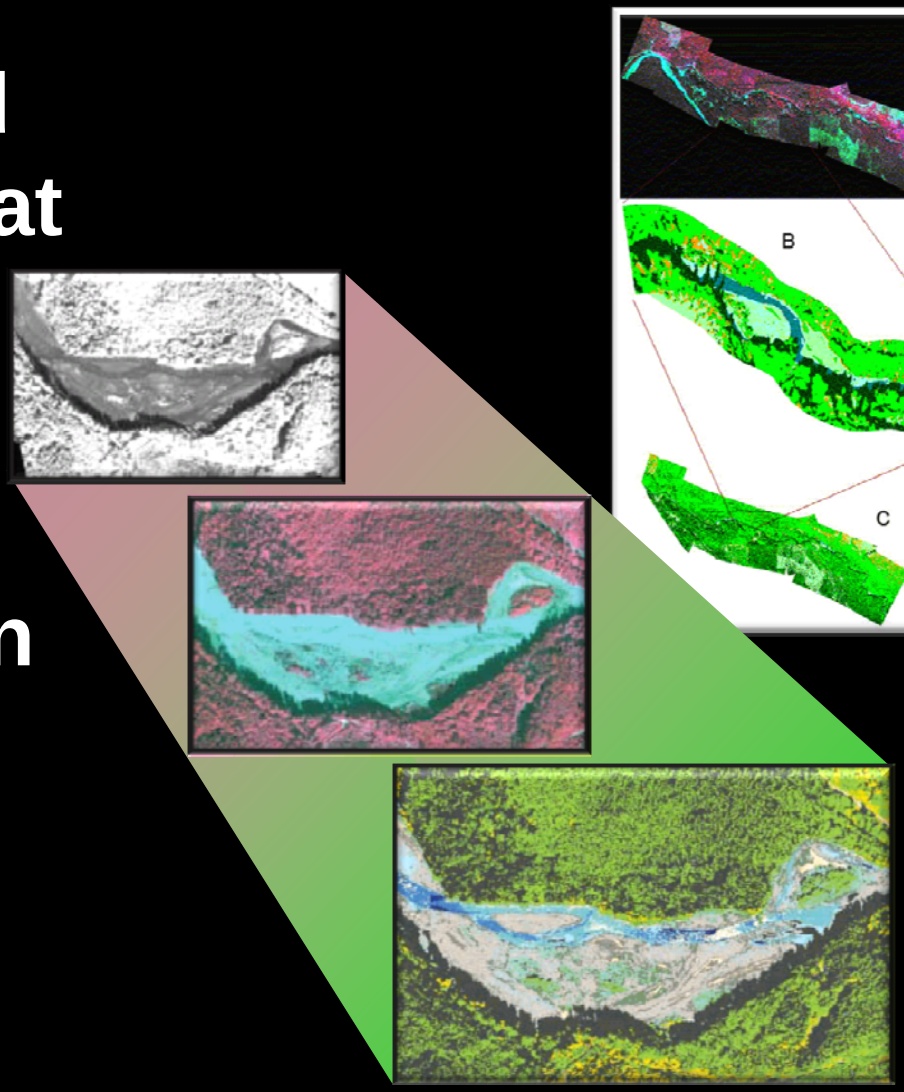
Understanding Ecosystems (cont'd)

- Hydraulic and riparian habitat classification methods
- Impacts of dam operation on riparian habitat



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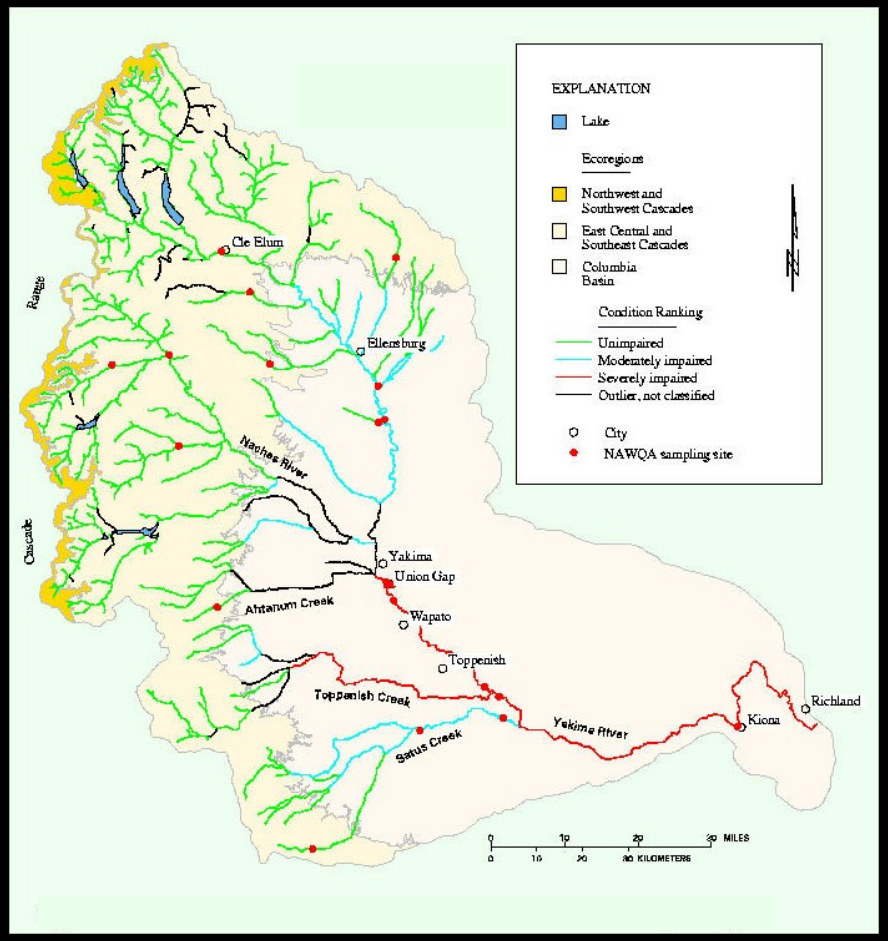
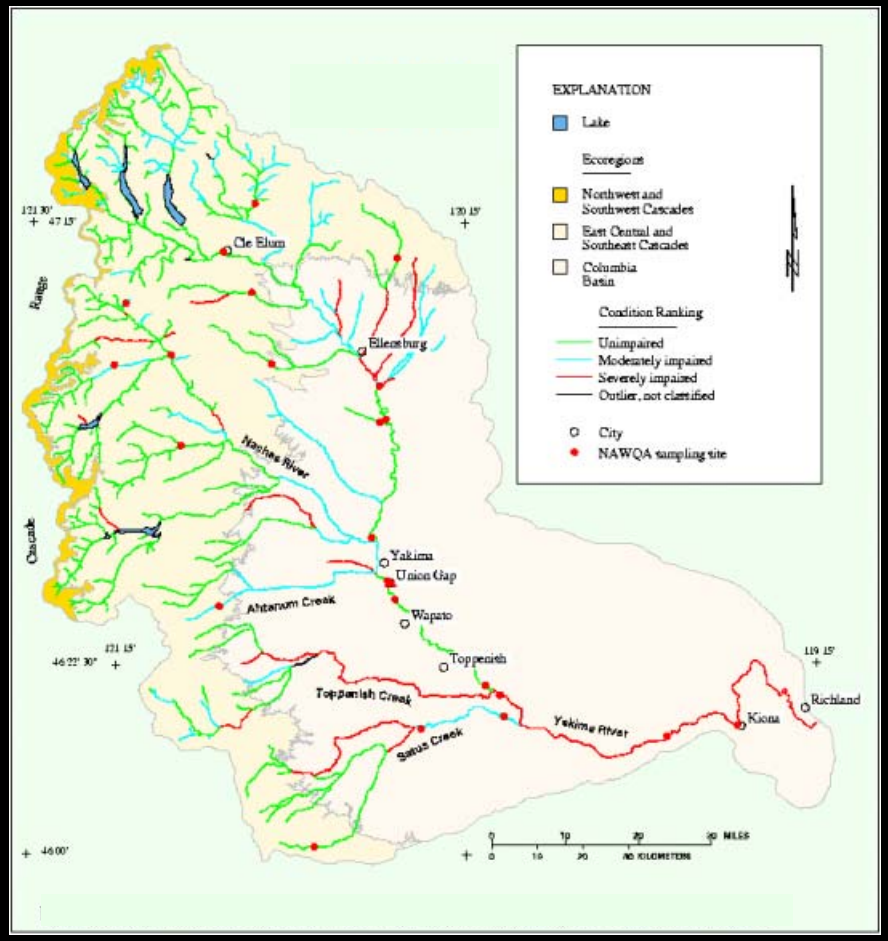
Understanding Ecosystems (cont'd)



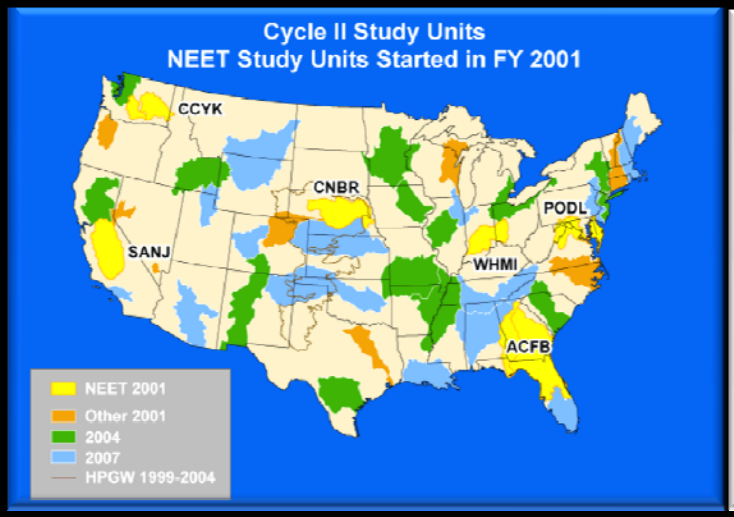
Potential Condition of **Fish Communities** for the Yakima River Basin

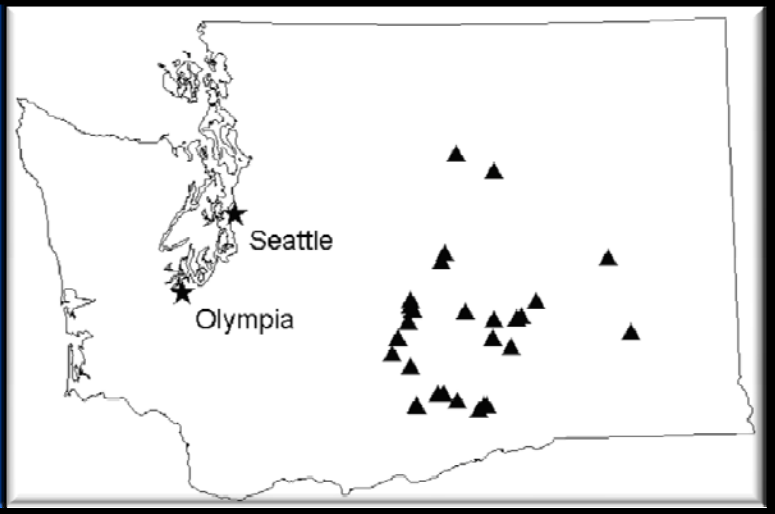


Potential Condition of **Algal Communities** for the Yakima River Basin

Understanding Ecosystems (cont'd)

- **Habitat Factors**
  - **CCYK NAWQA— NEET, Effects of Nutrient Enrichment on Aquatic Communities & Processes**





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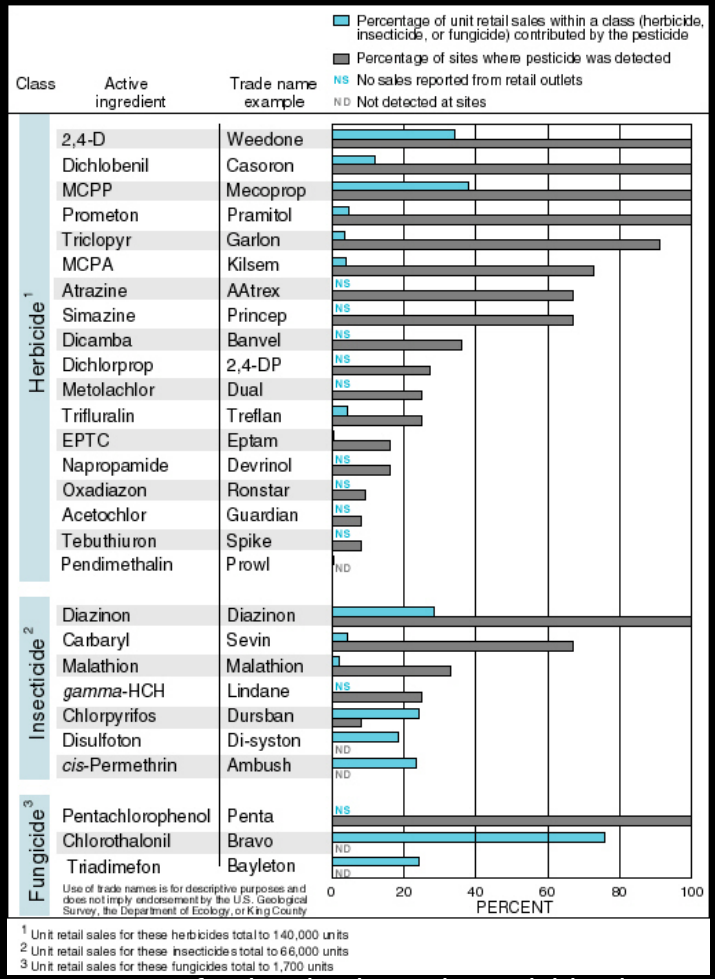
Understanding Ecosystems (cont'd)

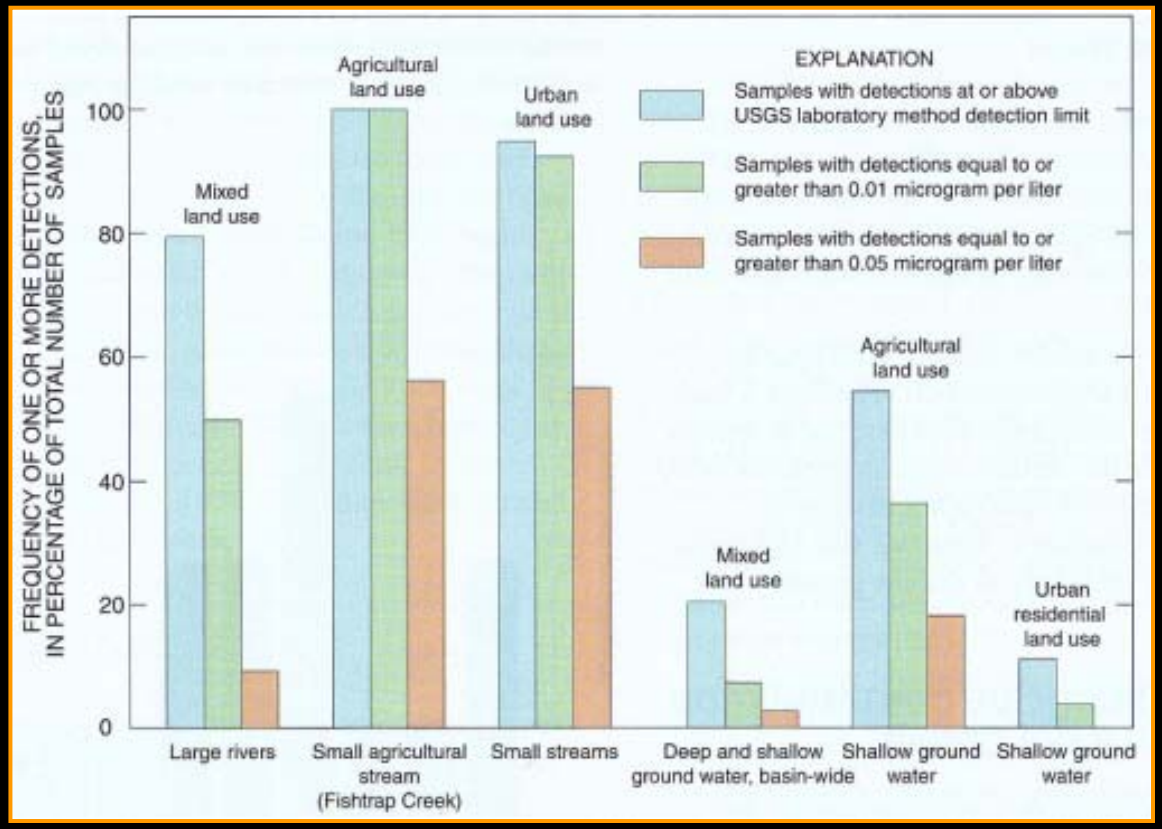
- **Effects of land use on QW**
- **Pesticides**
  - **Relation to urban sales in King Co.**
  - **Monitoring in King Co.**
  - **Pesticides in Alpine Lakes in National Parks**
  - **National and statewide pesticides susceptibility**



Percentage of unit sales in each pesticide class contributed by each pesticide and percentage of sites where pesticide was detected.

Understanding Ecosystems (cont'd)

- **Pesticides (cont'd)**
  - NAWQA Studies
  - Columbia Basin GWMA



Pesticide detections in SW and GW in the Puget Sound

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Understanding Ecosystems (cont'd)

- **Mercury**
  - NPS Alpine lakes
  - Lake Roosevelt
  - Lake Whatcom
  - Sinclair Inlet

Cleaning the nets, Flapjack Lake

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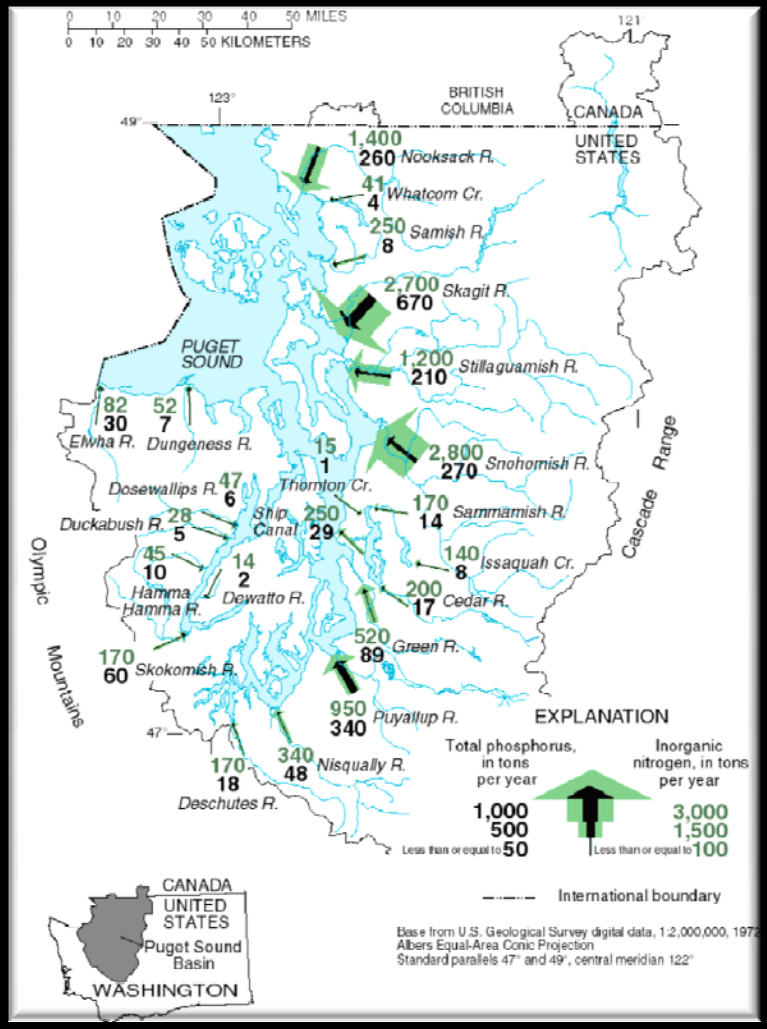
Understanding Ecosystems (cont'd)

- **Nutrients**
  - Vulnerability nationwide and statewide
  - Columbia Basin GWMA
  - Puget Sound Basin
- **Hazardous waste**
  - Fort Lewis
  - Navy facilities at Keyport, Bangor, & Whidbey Isand
  - Hanford Facility
- **TMDLs**



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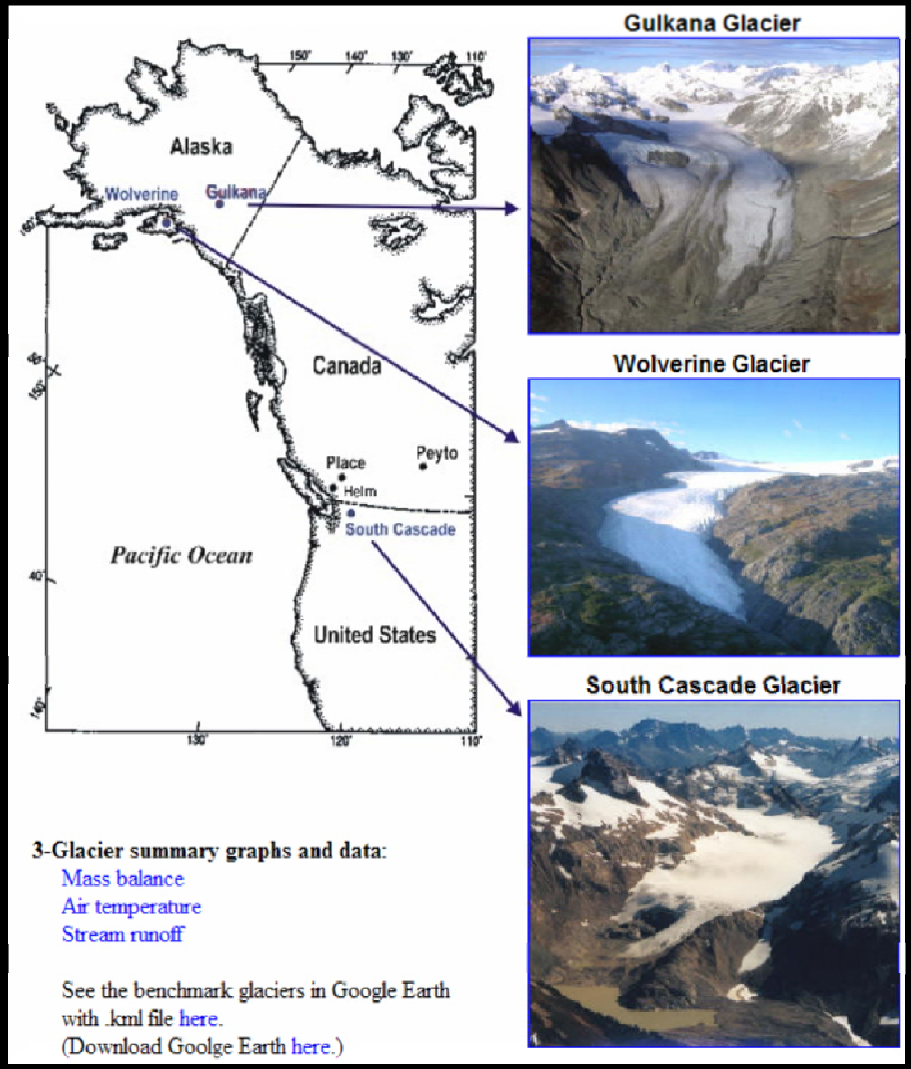
Climate Change

- **Key Issues**
  - Glaciers & snowpack as a water resource
  - Indicators of climate variations
  - Sea-level effects
  - Ecological effects
  - Effects on recharge
  - Effects on freshwater delivery to Sound
  - Effects on drinking water supplies



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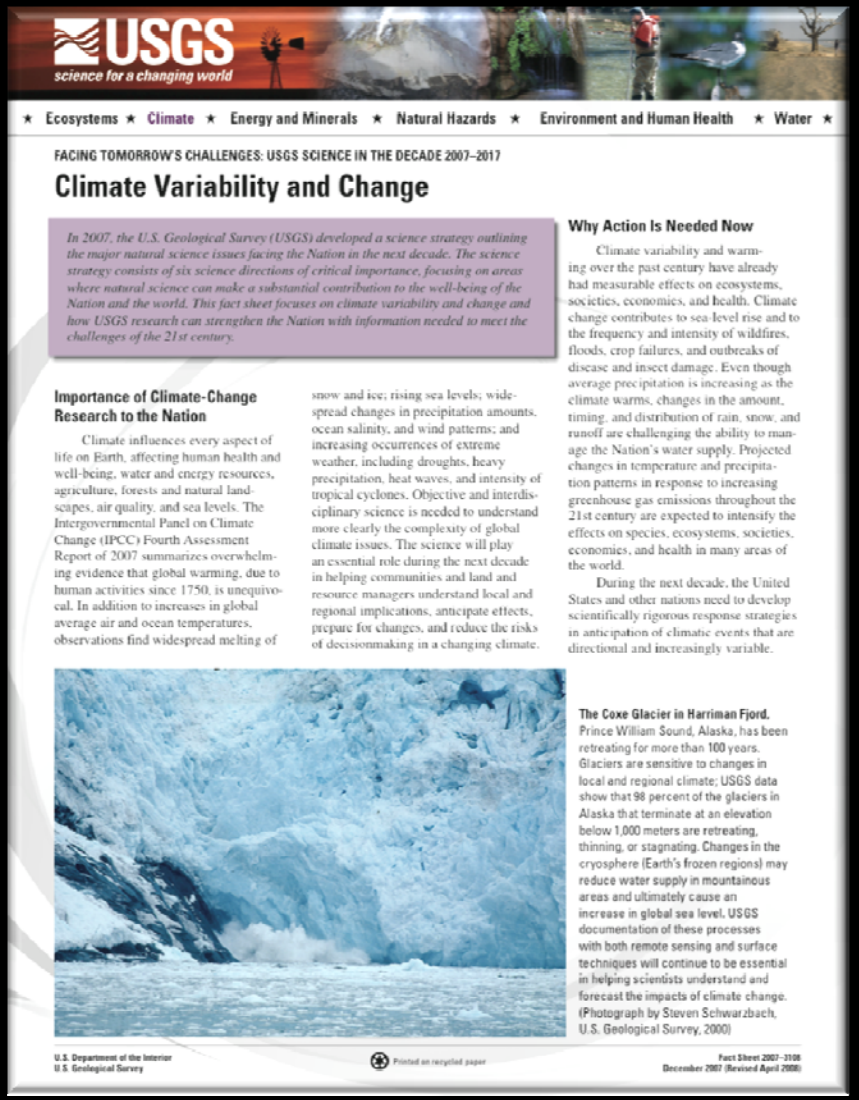
Climate Change (cont'd)

- **WAWSC Studies**
  - Enhancing snow hydrology models
  - Rain-on-snow events
  - Passive microwave snowpack assessments
  - Bering Glacier
  - USGS benchmark glaciers monitoring
  - Columbia Basin watershed modeling
  - Columbia Basin recharge effects
  - GW effects



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★ Ecosystems ★ Climate ★ Energy and Minerals ★ Natural Hazards ★ Environment and Human Health ★ Water ★

FACING TOMORROW'S CHALLENGES: USGS SCIENCE IN THE DECADE 2007–2017

Climate Variability and Change

In 2007, the U.S. Geological Survey (USGS) developed a science strategy outlining the major natural science issues facing the Nation in the next decade. The science strategy consists of six science directions of critical importance, focusing on areas where natural science can make a substantial contribution to the well-being of the Nation and the world. This fact sheet focuses on climate variability and change and how USGS research can strengthen the Nation with information needed to meet the challenges of the 21st century.

Importance of Climate-Change Research to the Nation

Climate influences every aspect of life on Earth, affecting human health and well-being, water and energy resources, agriculture, forests and natural landscapes, air quality, and sea levels. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report of 2007 summarizes overwhelming evidence that global warming, due to human activities since 1750, is unequivocal. In addition to increases in global average air and ocean temperatures, observations find widespread melting of snow and ice; rising sea levels; widespread changes in precipitation amounts, ocean salinity, and wind patterns; and increasing occurrences of extreme weather, including droughts, heavy precipitation, heat waves, and intensity of tropical cyclones. Objective and interdisciplinary science is needed to understand more clearly the complexity of global climate issues. The science will play an essential role during the next decade in helping communities and land and resource managers understand local and regional implications, anticipate effects, prepare for changes, and reduce the risks of decisionmaking in a changing climate.

Why Action Is Needed Now

Climate variability and warming over the past century have already had measurable effects on ecosystems, societies, economies, and health. Climate change contributes to sea-level rise and to the frequency and intensity of wildfires, floods, crop failures, and outbreaks of disease and insect damage. Even though average precipitation is increasing as the climate warms, changes in the amount, timing, and distribution of rain, snow, and runoff are challenging the ability to manage the Nation's water supply. Projected changes in temperature and precipitation patterns in response to increasing greenhouse gas emissions throughout the 21st century are expected to intensify the effects on species, ecosystems, societies, economies, and health in many areas of the world.

During the next decade, the United States and other nations need to develop scientifically rigorous response strategies in anticipation of climatic events that are directional and increasingly variable.

The Coxe Glacier in Harriman Fjord, Prince William Sound, Alaska, has been retreating for more than 100 years. Glaciers are sensitive to changes in local and regional climate; USGS data show that 98 percent of the glaciers in Alaska that terminate at an elevation below 1,000 meters are retreating, thinning, or stagnating. Changes in the cryosphere (Earth's frozen regions) may reduce water supply in mountainous areas and ultimately cause an increase in global sea level. USGS documentation of these processes with both remote sensing and surface techniques will continue to be essential in helping scientists understand and forecast the impacts of climate change. (Photograph by Steven Schwarzbach, U.S. Geological Survey, 2000)

U.S. Department of the Interior
U.S. Geological Survey

Printed on recycled paper

Fact Sheet 2007–3108
December 2007 (Revised April 2008)

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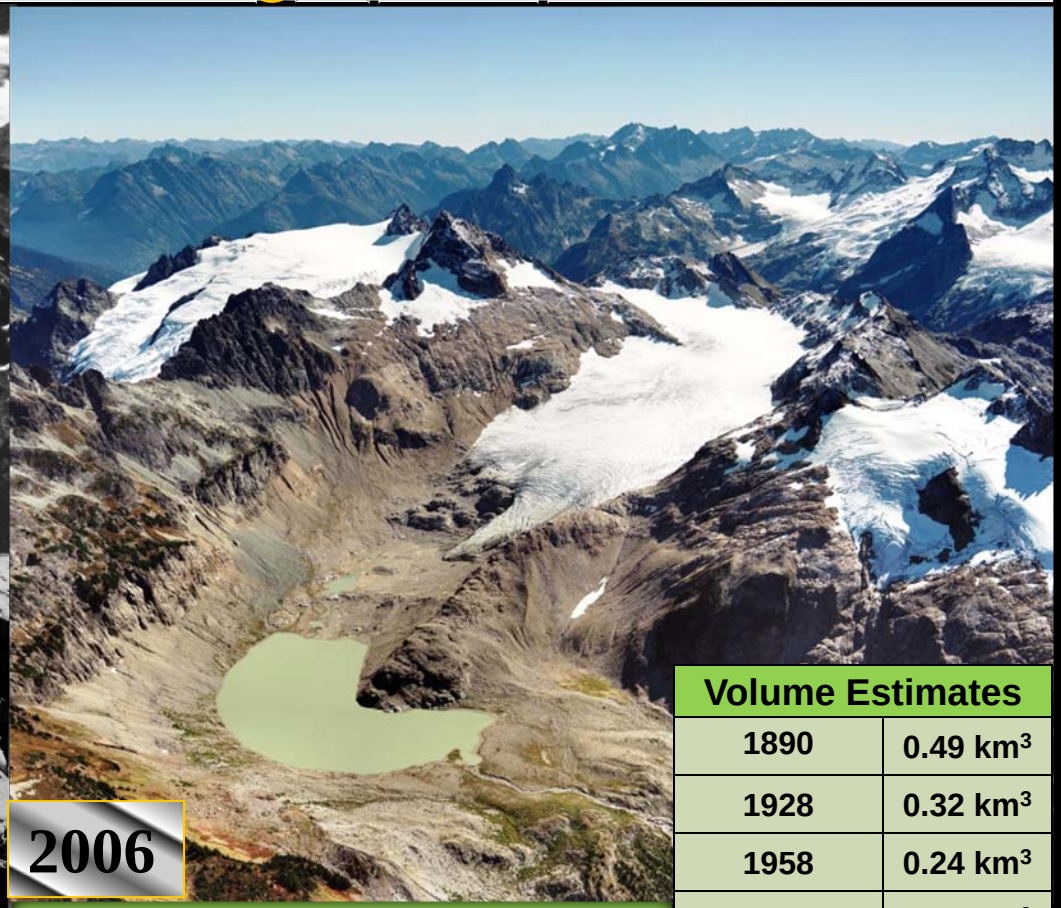
Climate Change (cont'd)

1928

1959



2006

Click to view Glacier Erasure video

Volume Estimates	
1890	0.49 km^3
1928	0.32 km^3
1958	0.24 km^3
1970	0.22 km^3
1985	0.19 km^3
2001	0.16 km^3
2005	0.14 km^3

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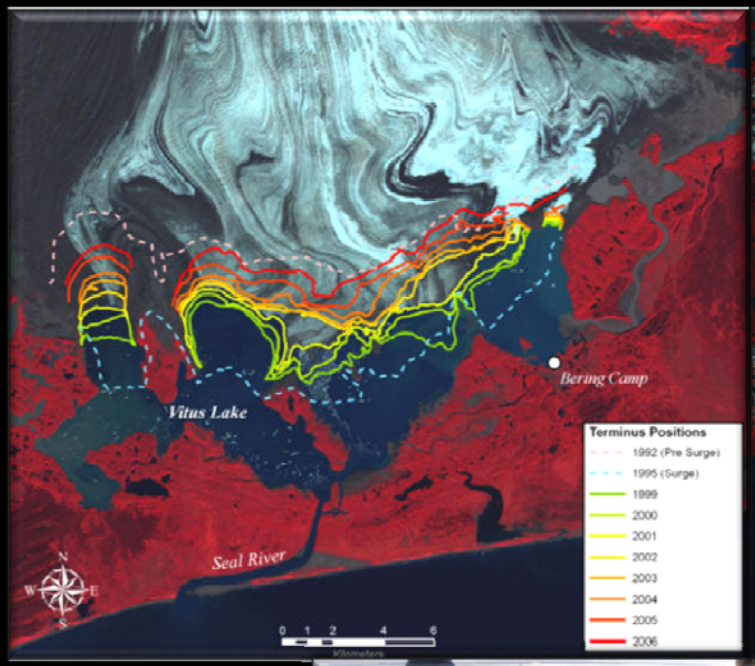
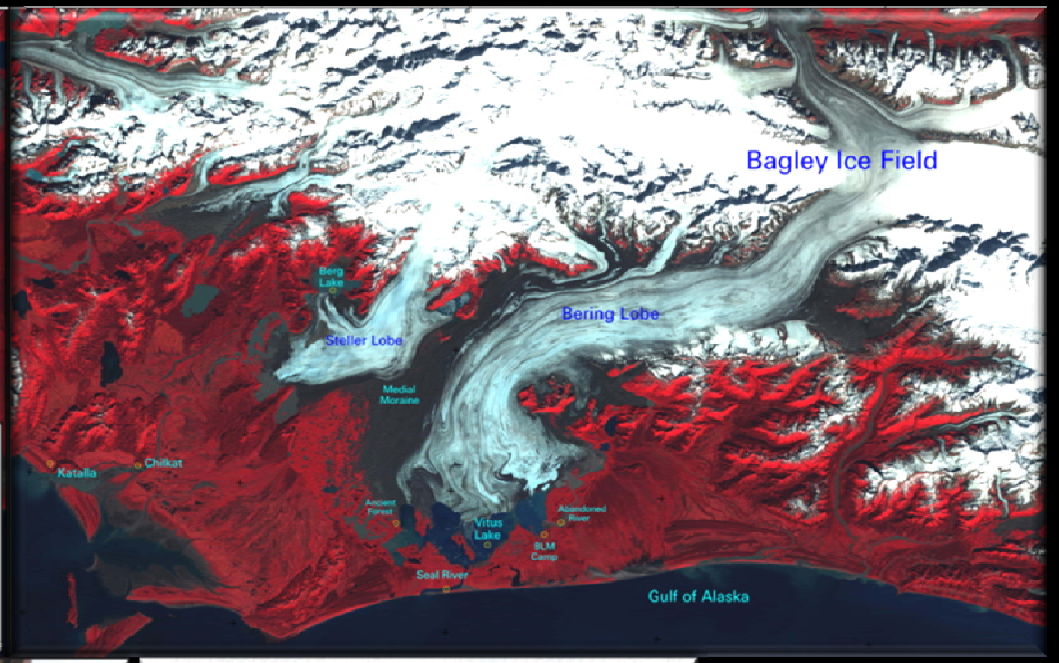
Climate Change (cont'd)





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Energy & Minerals

- Key Issues
  - Effects of Dams on Fish Recovery, Sediment Quality, Nitrogen Super-saturation, Water Temperature, Flow & Habitat
  - Irrigation Supply
  - Hydroelectric Power Supply
  - Flood control
  - Water Management Tools
  - Forecasting Reservoir Storage

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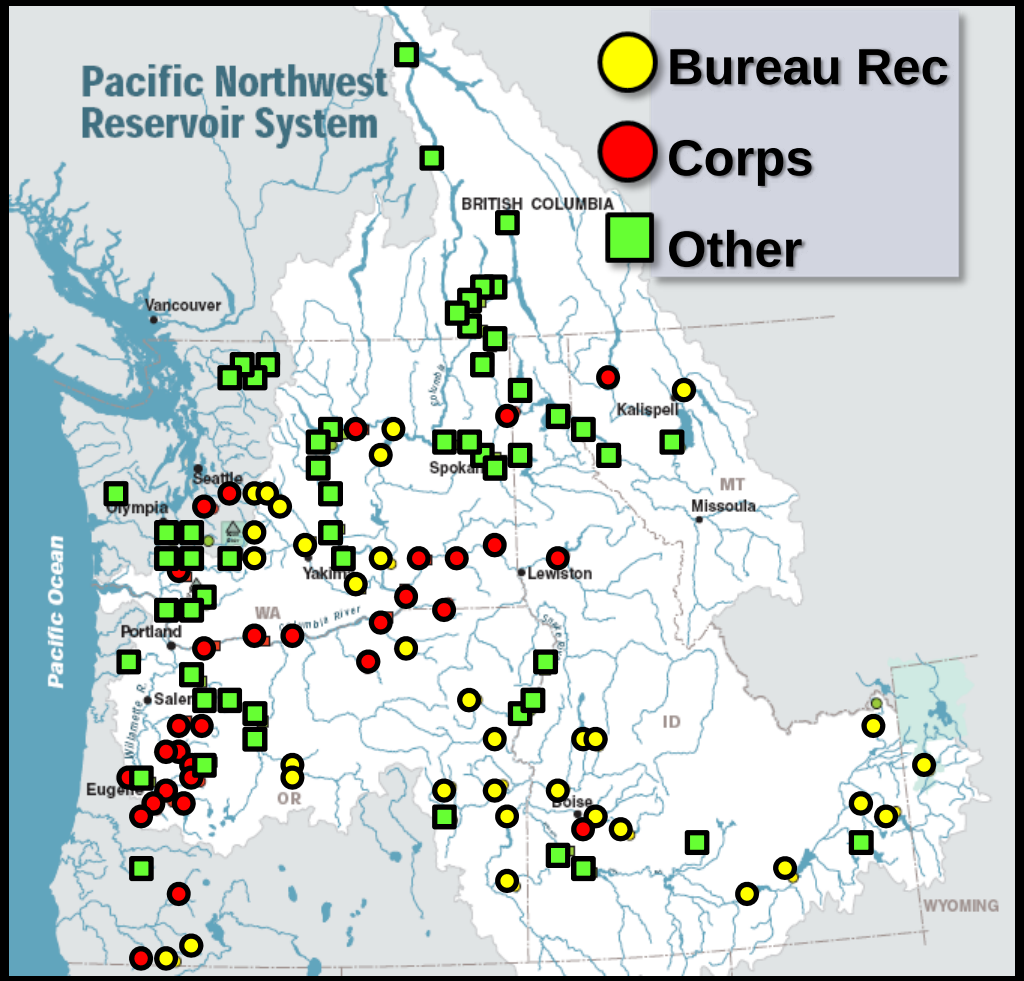
Energy & Minerals (cont'd)

- **WAWSC Studies**
  - Elwha River restoration
  - Howard Hanson Dam issues
  - Lake Roosevelt CERCLA & NRDAR
  - Nitrogen supersaturation
  - Dam operations & environmental flows (TNC & USACE)



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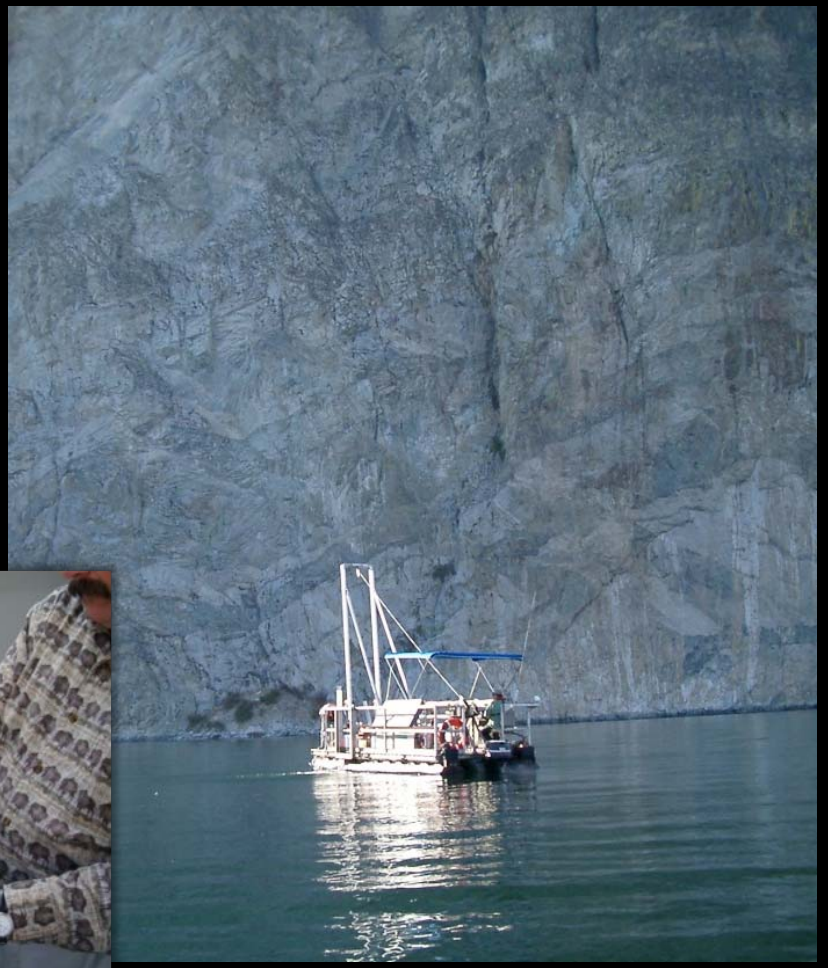
Energy & Minerals (cont'd)

- **Dam Removal**
  - Elwha dams
  - Sediment data collection
  - Sediment transport modeling

Left: Elwha River at mouth. Center: Elwha Dam. Right: Elwha Aerial.

Energy & Minerals (cont'd)

- **Sediment Chemistry**
  - **Lake Roosevelt**



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National Hazards

- **Key Issues**
  - Flood monitoring, forecasting, warning, frequency, and magnitude
  - Effects of urbanization, forestry, and other land uses
  - Sea-level rise
  - Droughts
  - Landslides
  - Dam failure
  - Tsunamis
  - Channel migration

National Hazards (cont'd)

- **WAWSC Studies**
  - Real-time streamflow
  - 24-7 flood-alert program
  - FLOODPATH forecasting
  - Middle Green River geomorphic responses to floods
  - Nooksack River early flood warning
  - Pierce Co. flood warning
  - Puyallup River flood-carrying capacity
  - Puyallup River multispectral imaging
  - Western Washington flood, January 2009

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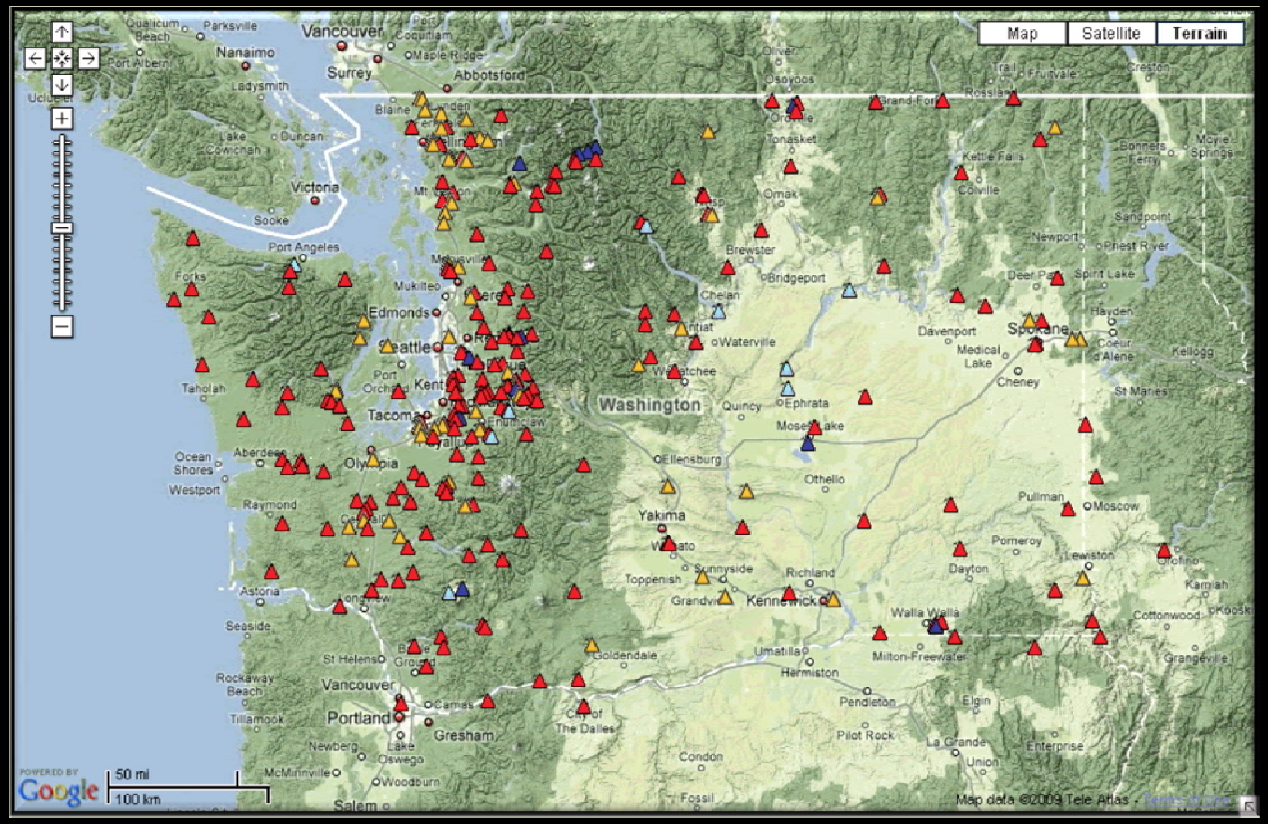
National Hazards (cont'd)

- **Real-time stream monitoring program**

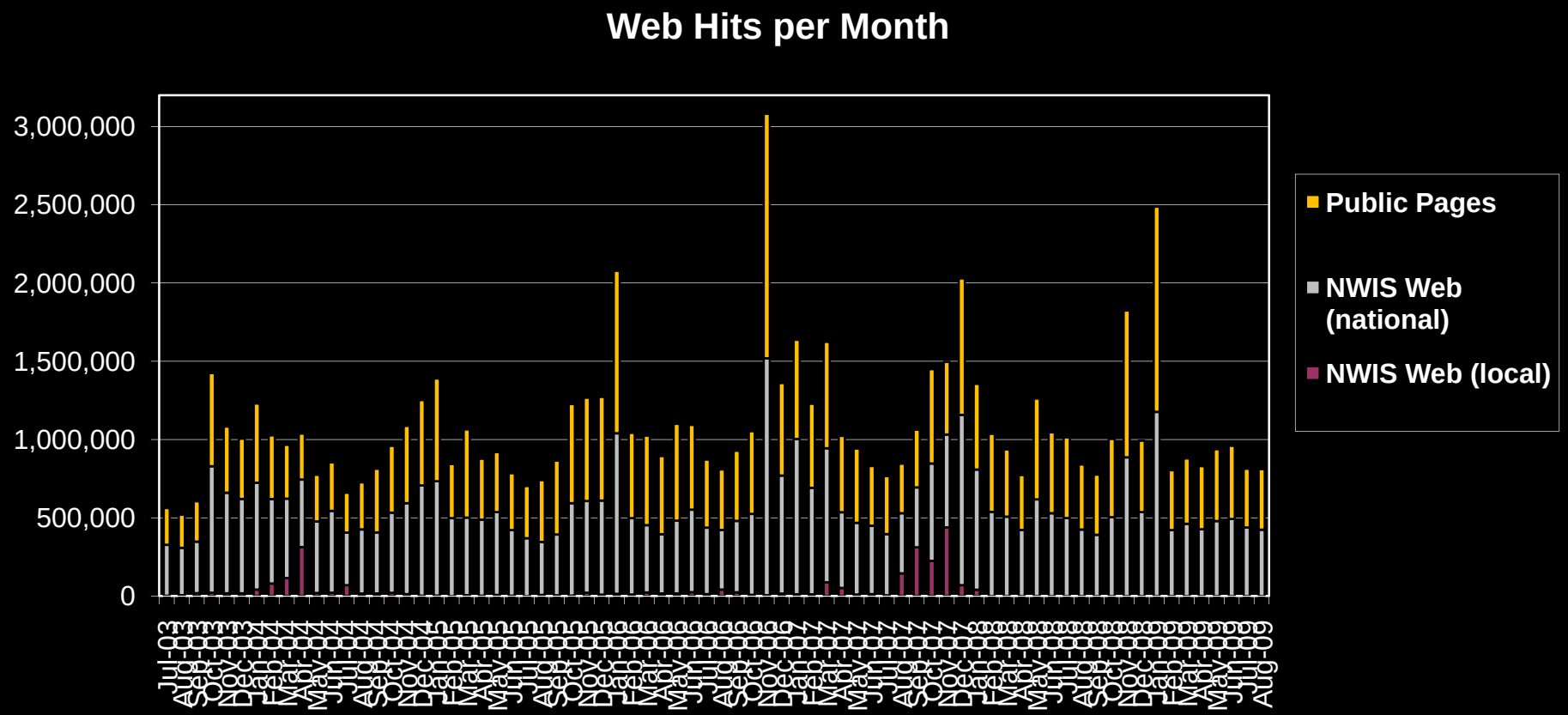


Explanation

- RT data available
- No RT data available
- Lake – RT data available
- Lake – No RT data available

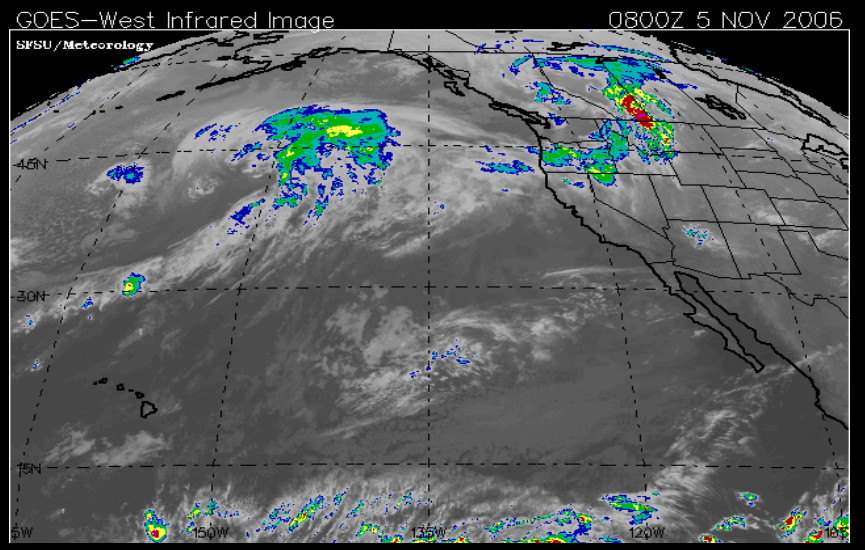
National Hazards (cont'd)

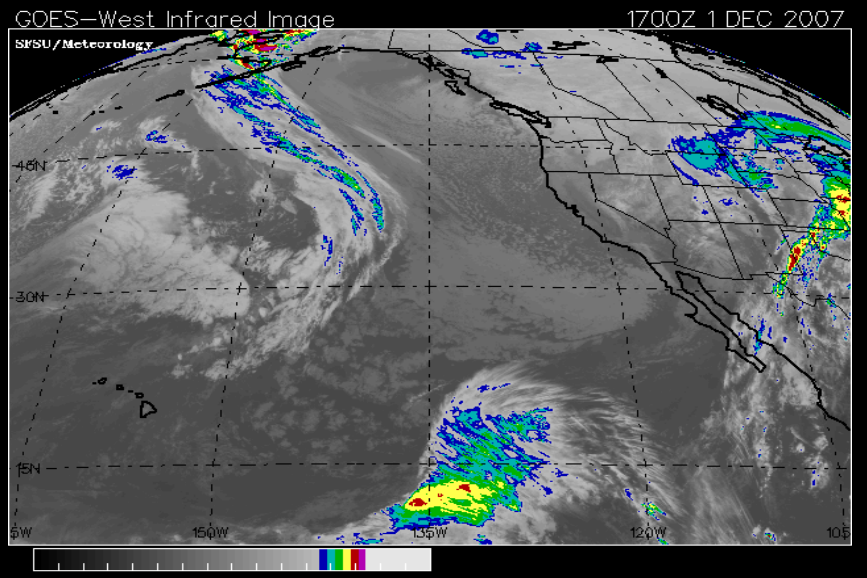
- **Real-time stream monitoring (cont'd)**



National Hazards (cont'd)

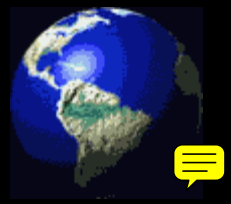
- **Flooding**
  - **Large floods caused by "Pineapple Express" or "Atmospheric Rivers"**
  - **20+ inches rainfall in 3 days is typical**





National Hazards (cont'd)

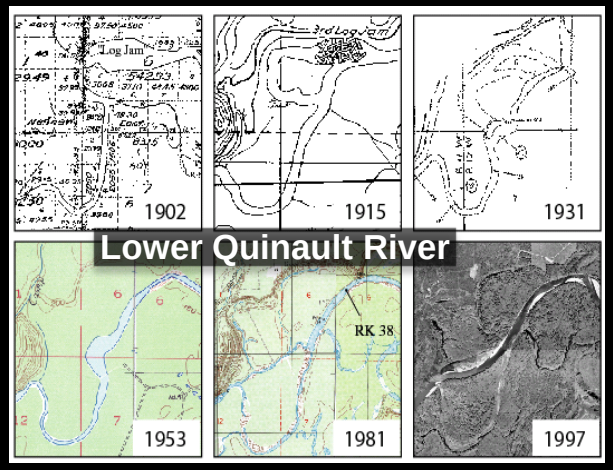
- **FlOODPATH Forecast Mapping**

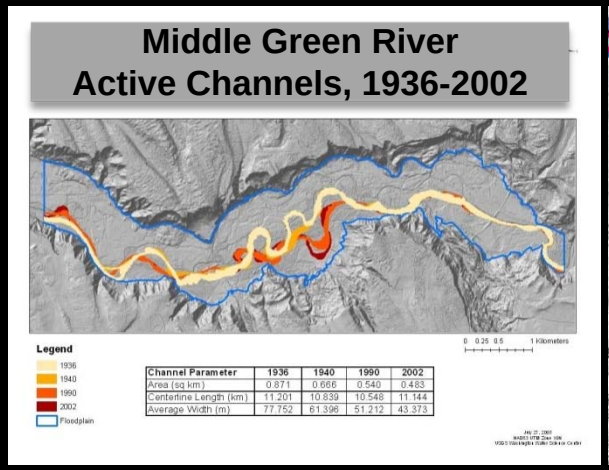


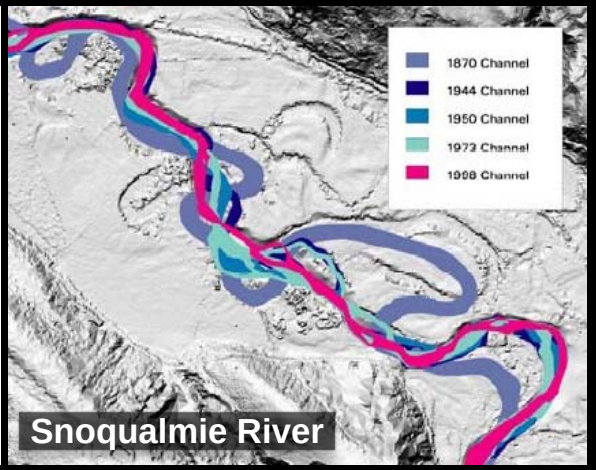
1. **NWS flow forecasts (based on precipitation forecast) are input to hydraulic model**
2. **Model results to Geographic Information System (GIS) to generate maps of peak flood depth, & arrival and peak times**
3. **Flood maps are "served" via the internet**
4. **Run for every new forecast**

National Hazards (cont'd)

- **Channel Migration**
  - **Cedar, Green, Puyallup, Quinault, and Snoqualmie Rivers**







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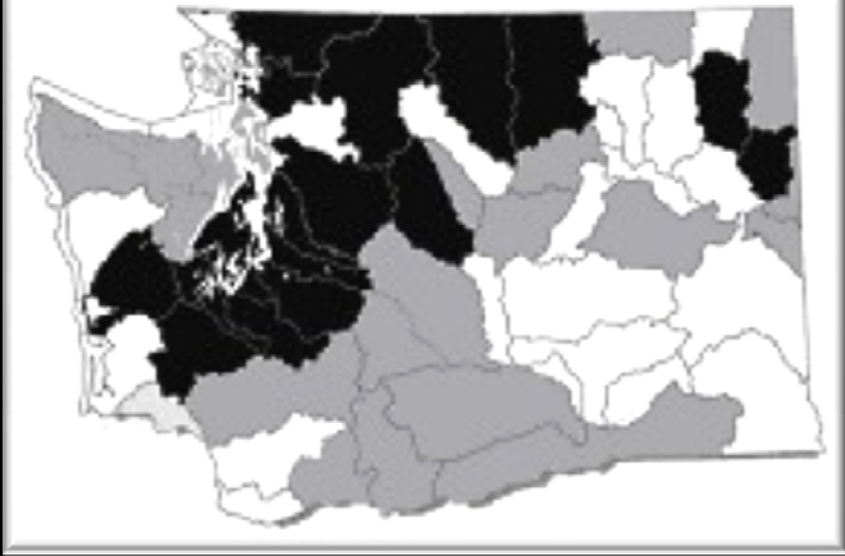
WA WSC

Water Census

- **Key Issues**
  - Competitive Allocations
  - Biologically based instream flows
  - Saltwater intrusion
  - GW recharge
  - Effects of climate change



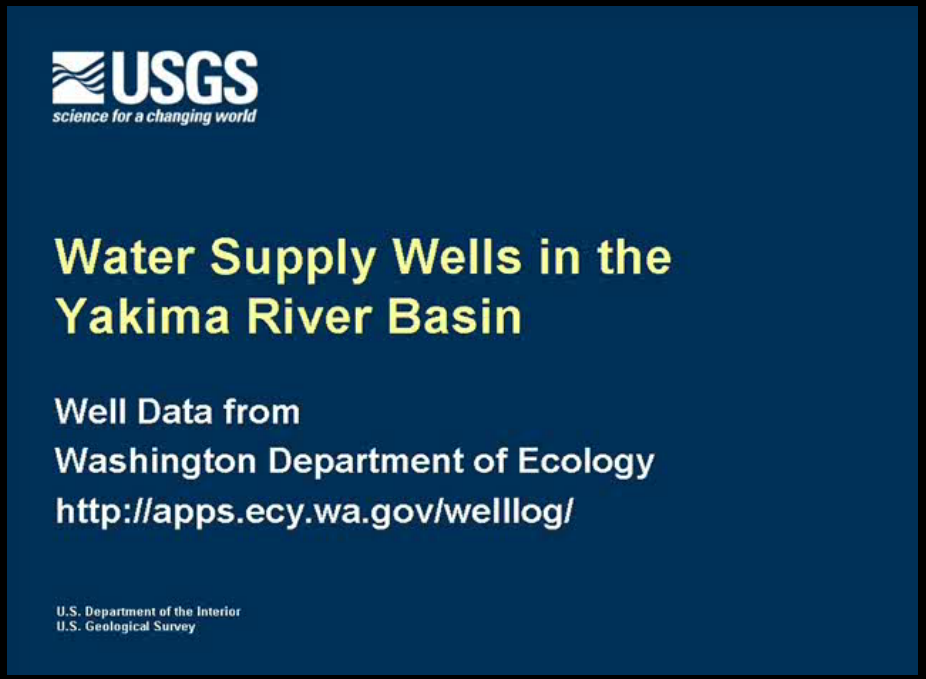
Black: Watersheds with flows and/or closure set
Gray: Watersheds planning to address flows
Source: WA Department of Ecology, 2001

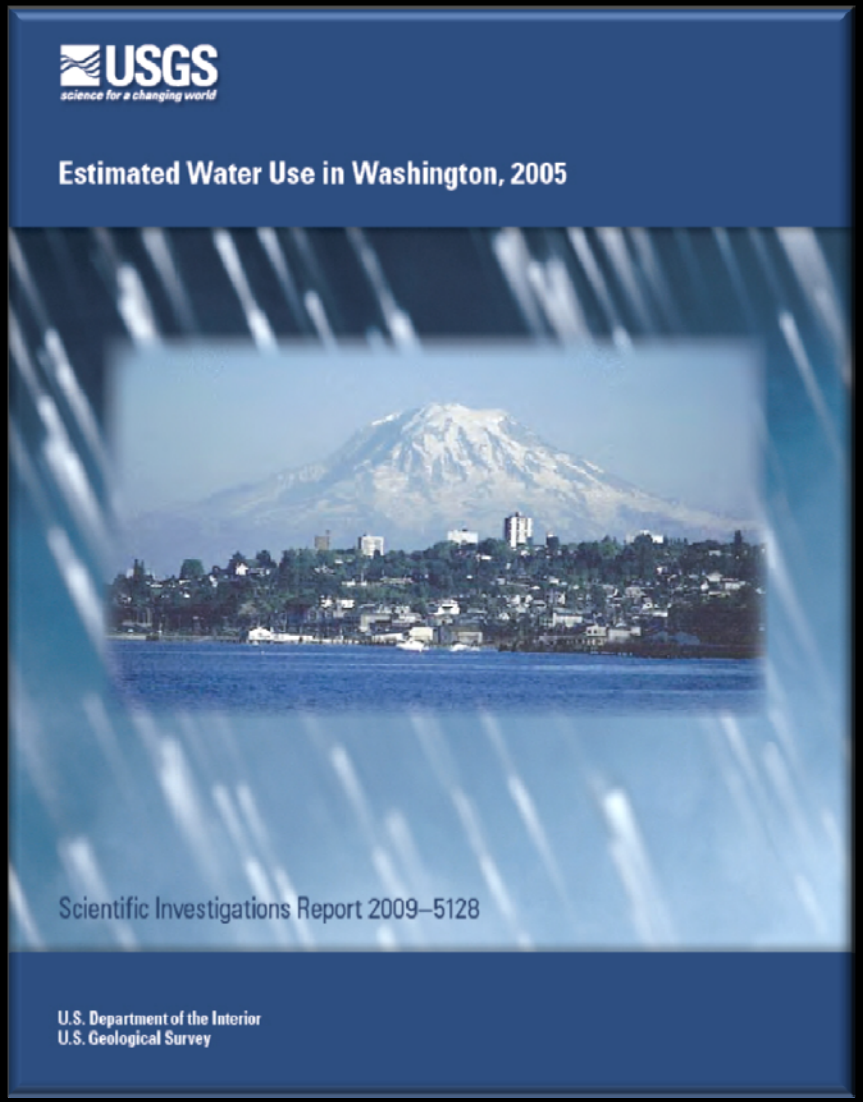
USGS science for a changing world

WA WSC

Water Census (cont'd)

- **Key Issues** (cont'd)
  - Water use data
  - Water management tools



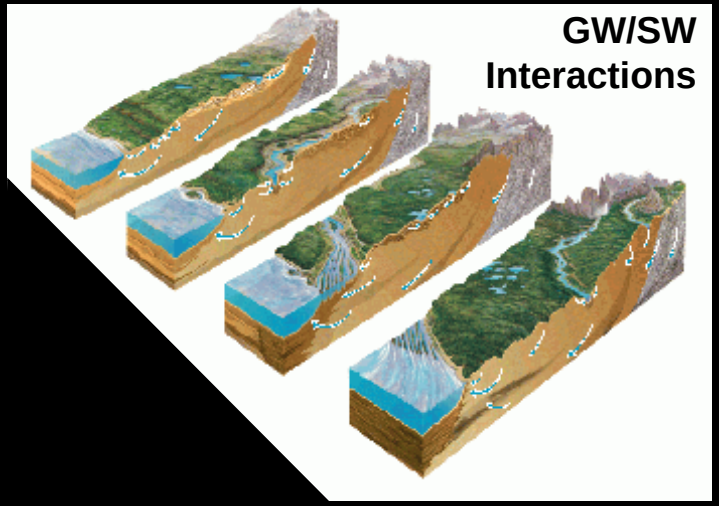


USGS science for a changing world

WA WSC

Water Census (cont'd)

- **WAWSC Projects**
  - RASA & County Studies
  - WARSMP & Watershed Studies
  - Yakima GW
  - Chambers-Clover GW
  - Bainbridge Island GW
  - Chimacum GW
  - Chamokane GW
  - Skagit GW Model
  - DPM Development
  - Bonaparte SW/GW
  - Columbia Plateau



USGS science for a changing world

WA WSC

Water Census (cont'd)

RiverWare System

River and Reservoir Management Models

Long-Term Policy Policy & Planning

Mid-Term Operations

Short-Term Operations

Data Sources

Hydrometeorological

Environmental

Physical / Chemical

Spatial

Data Management System

Hydrologic Database (HDB)

Query, Display, and Analysis

GIS

Statistics

Risk

GIS Weasel

Modular Modeling System (MMS)

Watershed and Ecosystem Models

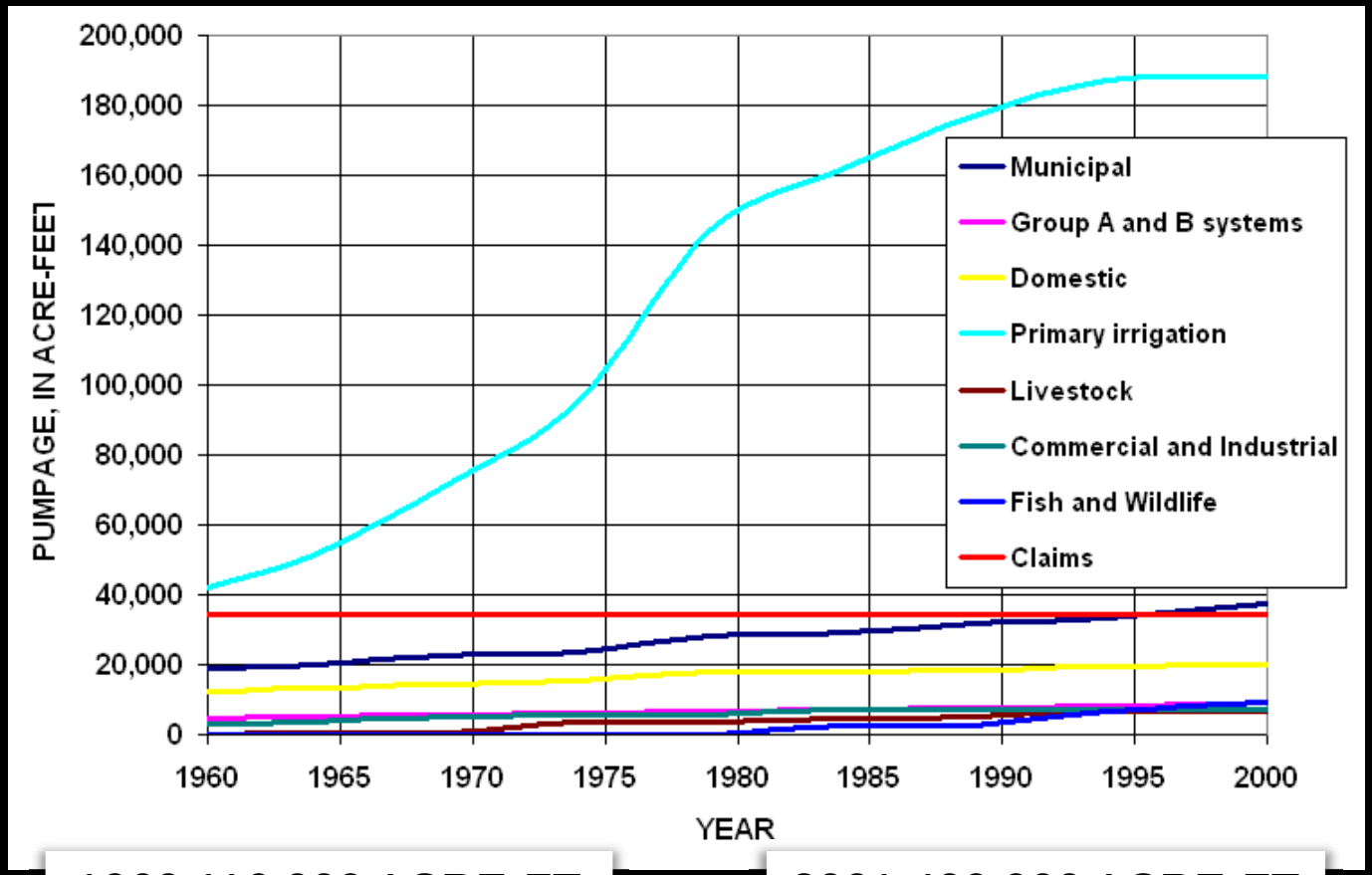
USGS/USBR
Yakima
WARSMP

Water Census (cont'd)

- Yakima GW

Water Census (cont'd)

- **Yakima GW** (cont'd)



1960 116,000 ACRE-FT

2001 400,000 ACRE-FT

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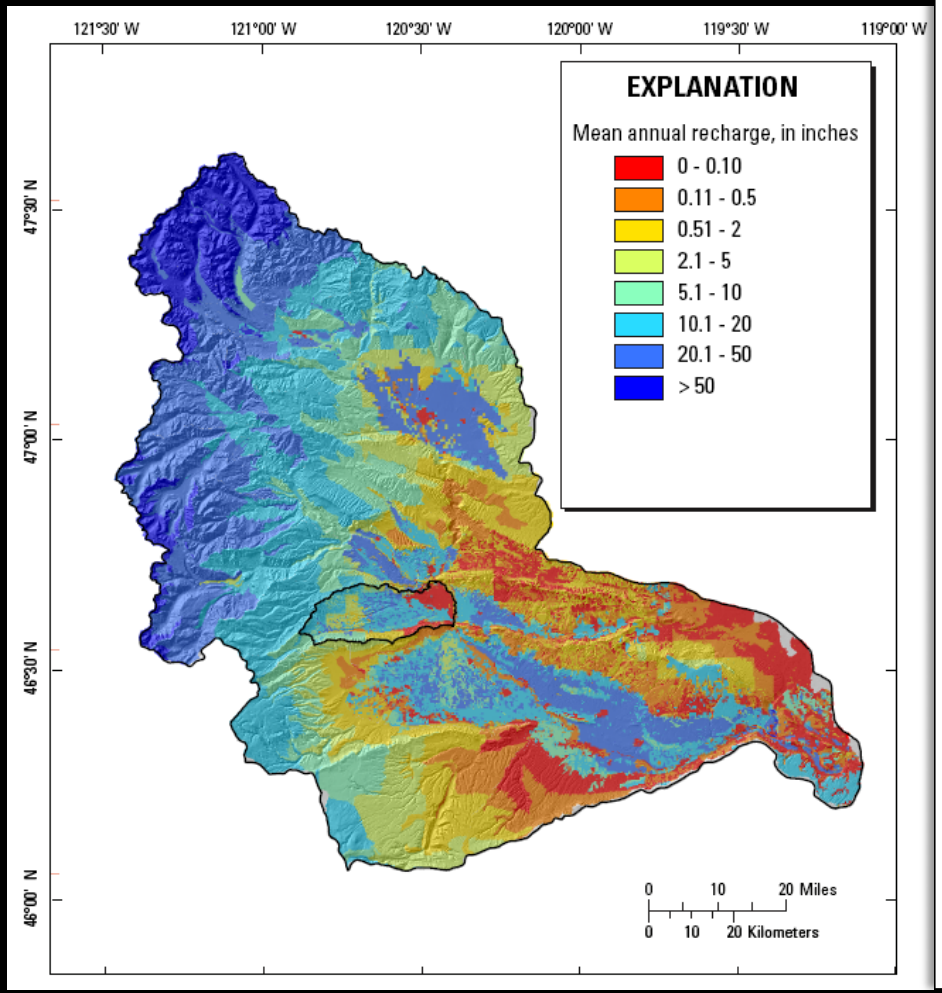
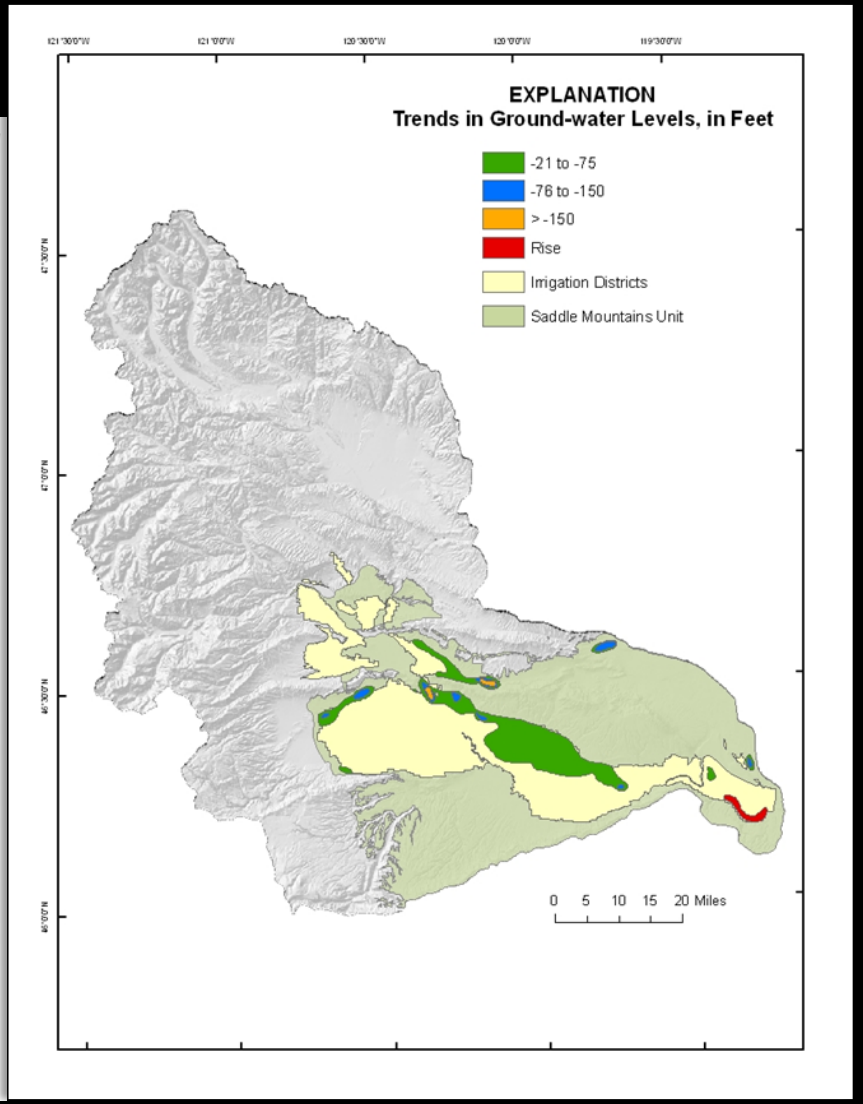
WA WSC

Water Census (cont'd)

- **Yakima GW** (cont'd)



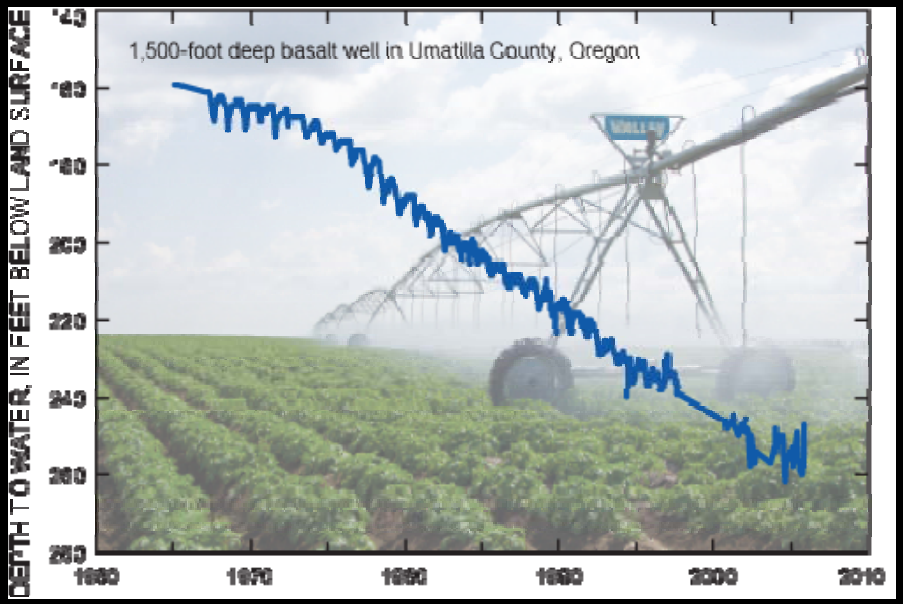


Water Census (cont'd)

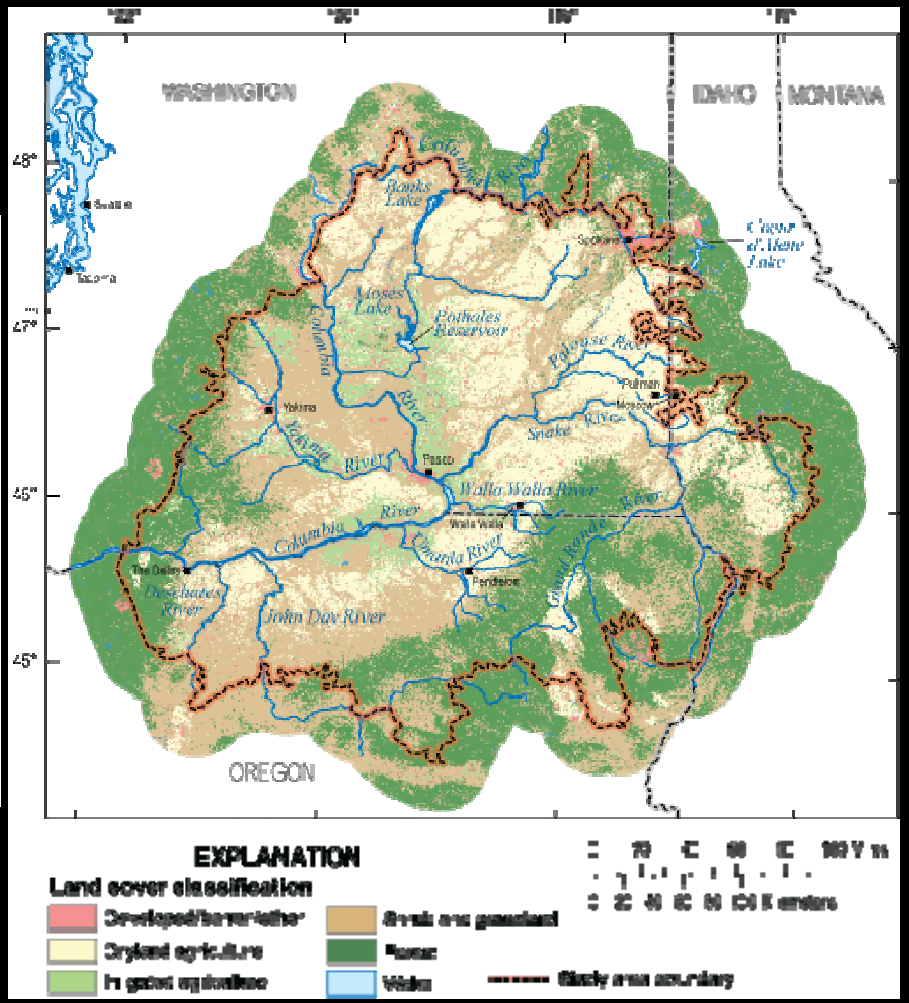
- **Yakima GW – USGS Series Publications**
  - Jones, M.A., Vaccaro, J.J., and Watkins, A.M., 2006, Hydrogeologic Framework of Sedimentary Deposits in Six Structural Basins, Yakima River Basin, Washington: USGSScientific Investigations Report 2006-5116, 24 p.
  - Jones, M.A., and Vaccaro, J.J., 2008, Extent and Depth to Top of Basalt and Interbed Hydrogeologic Units, Yakima River Basin Aquifer System, Washington: USGS scientific Investigations Report 2008–5045, 22 p., 5 pls.
  - Keys, M.E., Vaccaro, J.J., Jones, M.A., and Julich, R.J., 2008, Hydrographs showing ground-water level trends for selected wells in the Yakima River basin aquifer system, Washington: USGS Data Series 343
  - Magirl, C.S., Julich, R.J., Welch, W.B., Curran, C.R., Mastin, M.C., and Vaccaro, J.J., 2009, Summary of Seepage Investigations in the Yakima River Basin, Washington: USGS Data Series 473
  - Vaccaro, J.J., 2007, A deep percolation model for estimating ground-water recharge: Documentation of modules for the modular modeling system of the U.S. Geological Survey: USGS Scientific Investigations Report 2006-5318, 30 p
  - Vaccaro, J.J., Jones, M.A., Ely, D.M., Keys, M.E., Olsen, T.D., Welch, W.B., and Cox, S.E., 2009, Hydrogeologic framework of the Yakima River basin aquifer system, Washington: USGS Scientific Investigations Report 2009-5152, 106 p.
  - Vaccaro, J.J., Keys, M.E., Julich, R.J., and Welch, W.B., 2008, Thermal profiles for selected river reaches in the Yakima River basin, Washington: USGS Data Series 342
  - Vaccaro, J.J., and Maloy, K.J., 2006, A method to thermally profile long river reaches to identify potential areas of ground-water discharge and preferred salmonid habitat: USGS Scientific Investigations Report 2006-5136, 16 p
  - Vaccaro, J.J., and Olsen, T.D., 2007, Estimates of ground-water recharge to the Yakima River Basin aquifer system, Washington, for predevelopment and current land-use and land-cover conditions: USGSScientific Investigations Report 2007-5007, 30 p.
  - Vaccaro, J.J., and Olsen, T.D., 2007, Estimates of monthly ground-water recharge to the Yakima River Basin aquifer system, Washington, 1960-2001, for current land-use and land-cover conditions: USGS Open-File Report 2007-1238, 2 p.
  - Vaccaro, J.J., and Sumioka, S.S., 2006, Estimates of ground-water pumpage from the Yakima River Basin Aquifer System, Washington, 1960-2000: USGS Scientific Investigations Report 2006-5205, 56 p
  - Vaccaro, J.J., Jones, M.A., Ely, D.M., Keys, M.E., Olsen, T.D., Welch, W.B., and Cox, S.E., 2009, Hydrogeologic framework of the Yakima River basin aquifer system, Washington: USGSScientific Investigations Report 2009–5152, 106 p.

Water Census (cont'd)

- **Columbia Plateau GW**



Pumping has removed water from storage in basalt aquifers and caused declines in many areas of the Columbia Plateau



Land use and cover in the Columbia Plateau study area.

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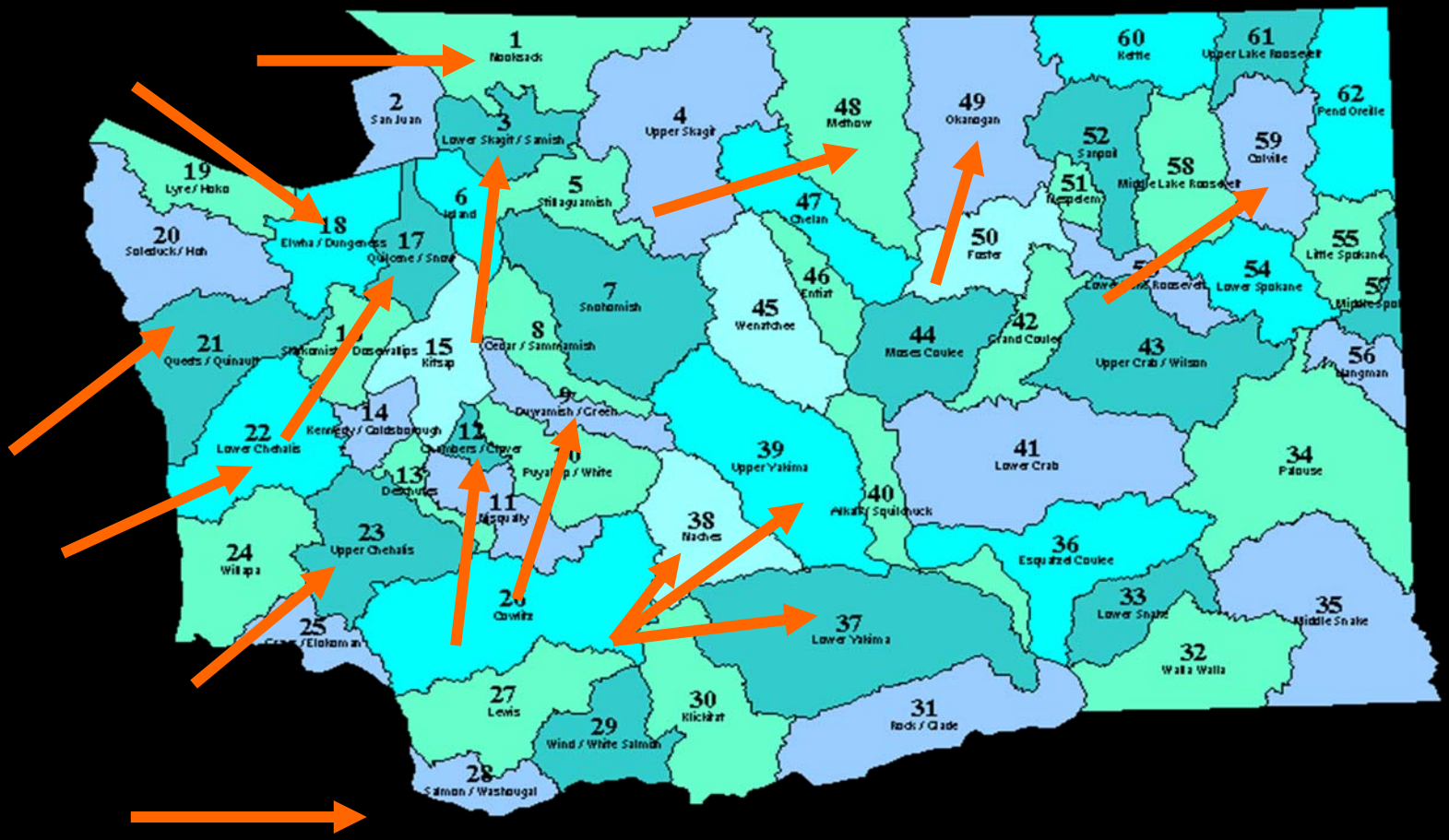
WA WSC

Water Census (cont'd)

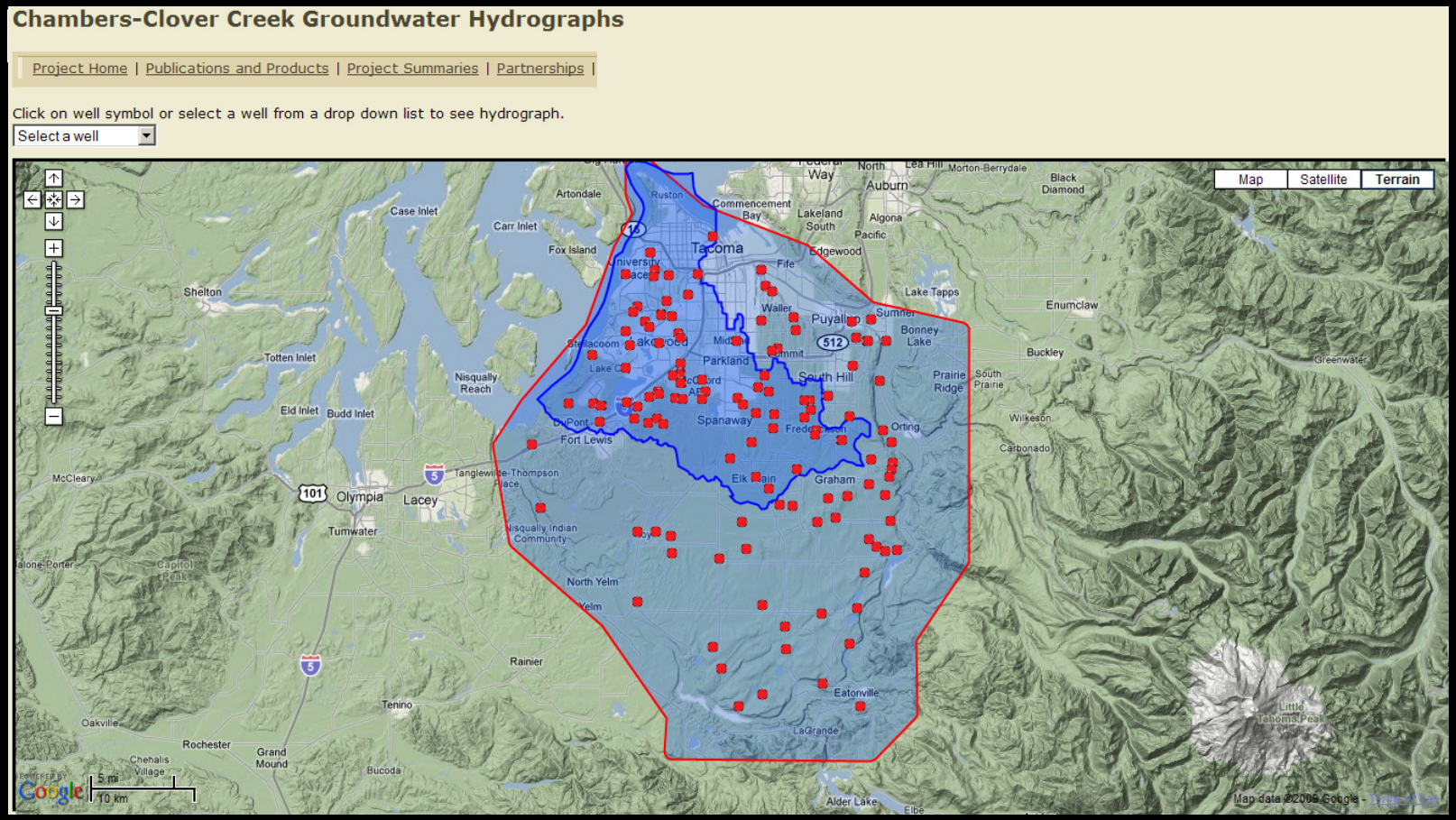
Water Resource Inventory Areas (WRIAs)



WA Water Science Center WRIA Water Quantity Assessments

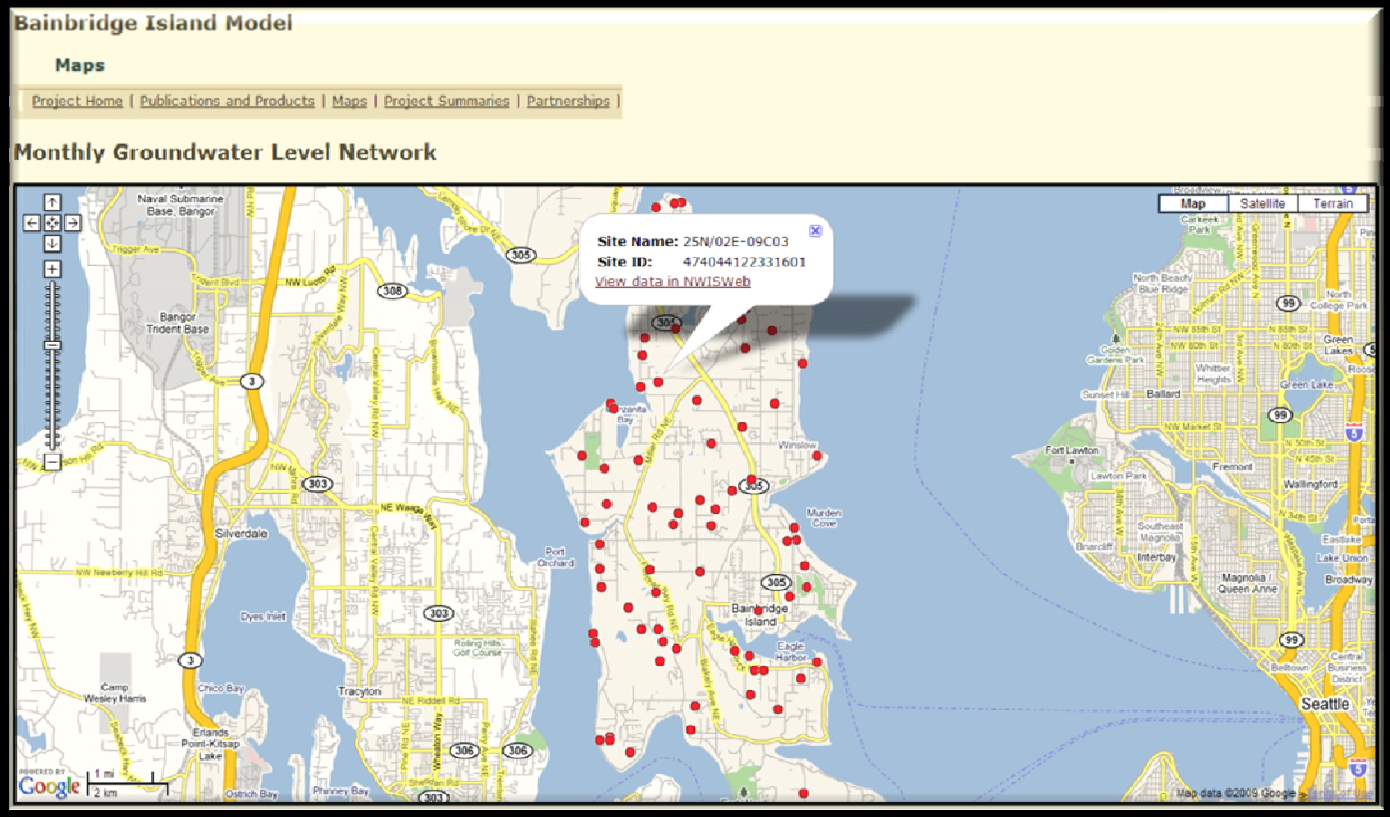
Water Census

- **Chambers-Clover Creek GW**



Water Census (cont'd)

- **Saltwater Intrusion**
  - **Bainbridge Island & coastal communities**



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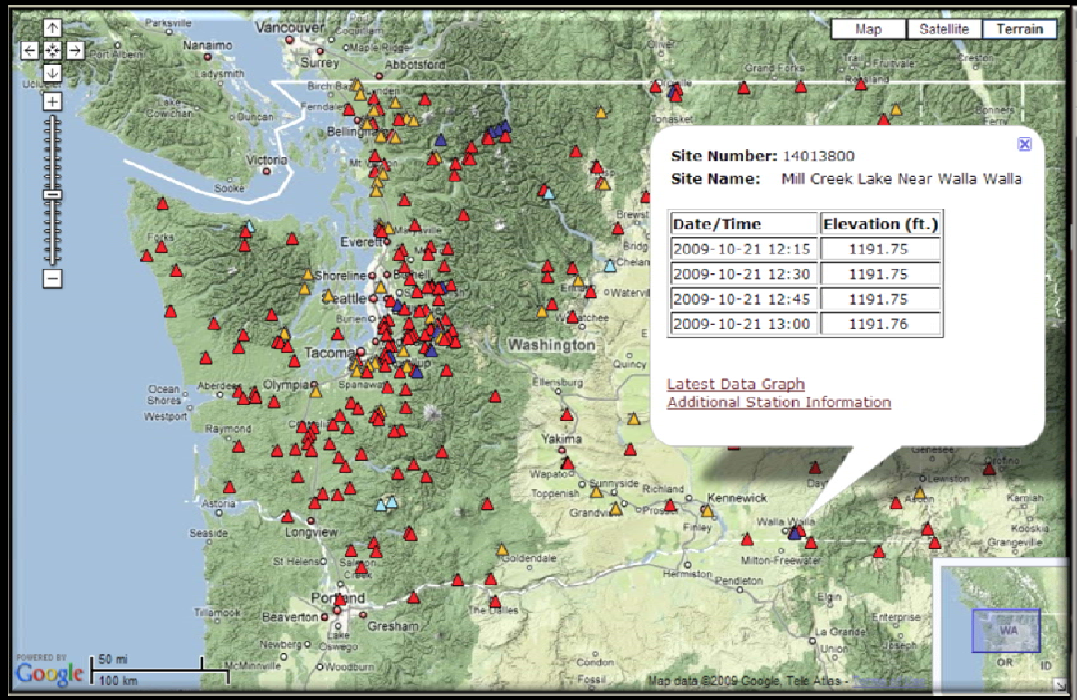
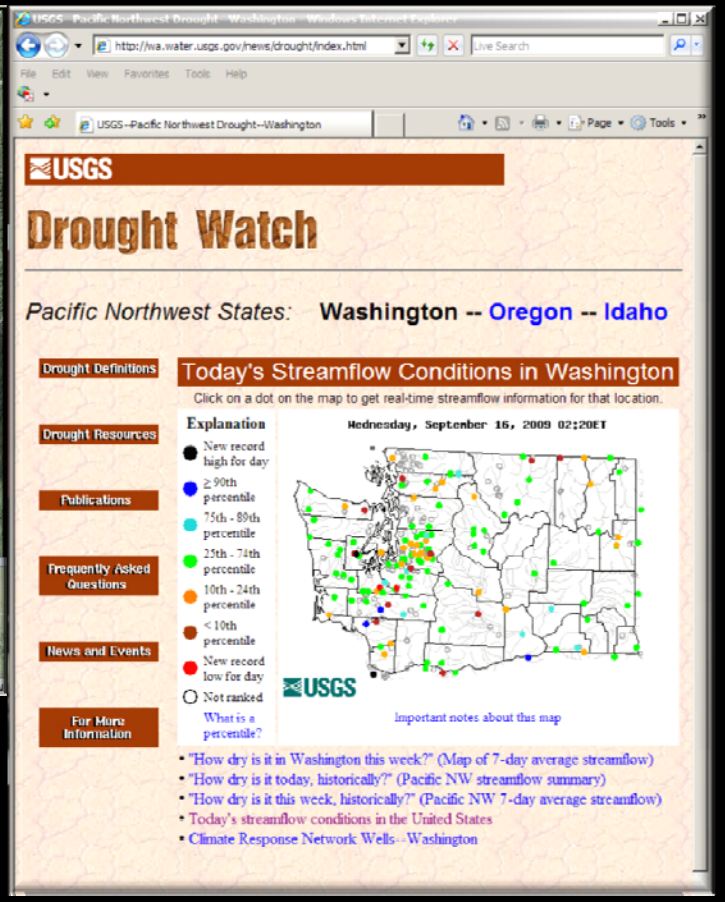
WA WSC

Water Census (cont'd)

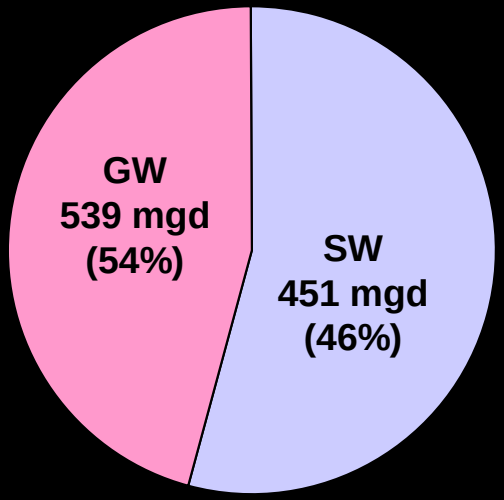
- **Water Monitoring Programs**



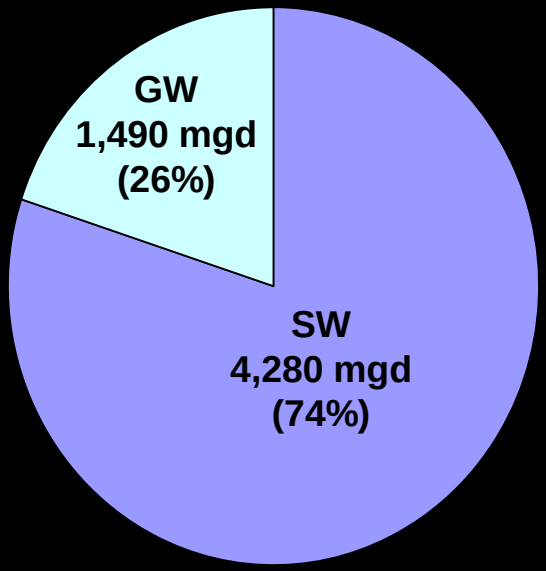


Water Census (cont'd)

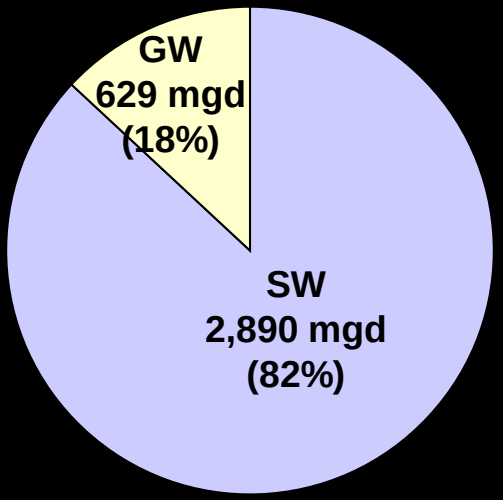
- **Water Use - 2005**



Public Supply (990 mgd – 17%)



Total Water Use (5,780 mgd)



Irrigation (3,520 mgd – 61%)

The End