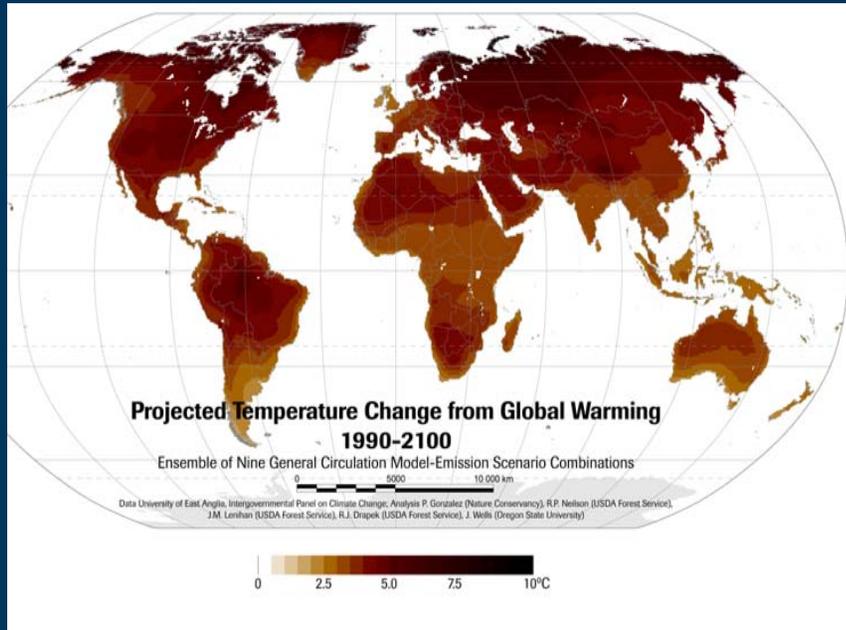


Climate Change and the Columbia Basin

Allison Aldous – June 2008



**Adaptation Strategies to Mitigate
Climate Change Impacts to
Freshwater Species and Ecosystems**



spatial scale

uncertainty

annual averages

complex responses



Are conservation strategies resilient to climate change?

Is climate adaptation = conservation BAU?

Do we need to do anything differently?

Some Definitions

Resilience: the property of a system to absorb change and yet persist over time (Holling 1973)

Adaptive capacity: the property of a system to shift to another state as smoothly as possible when a state change is inevitable.

Adaptation strategy: developing proactive conservation strategies that are informed by models and empirical data on climate change impacts

Why act now?

- Climate change is happening now
- Treat actions as testable hypotheses
- Adaptive management

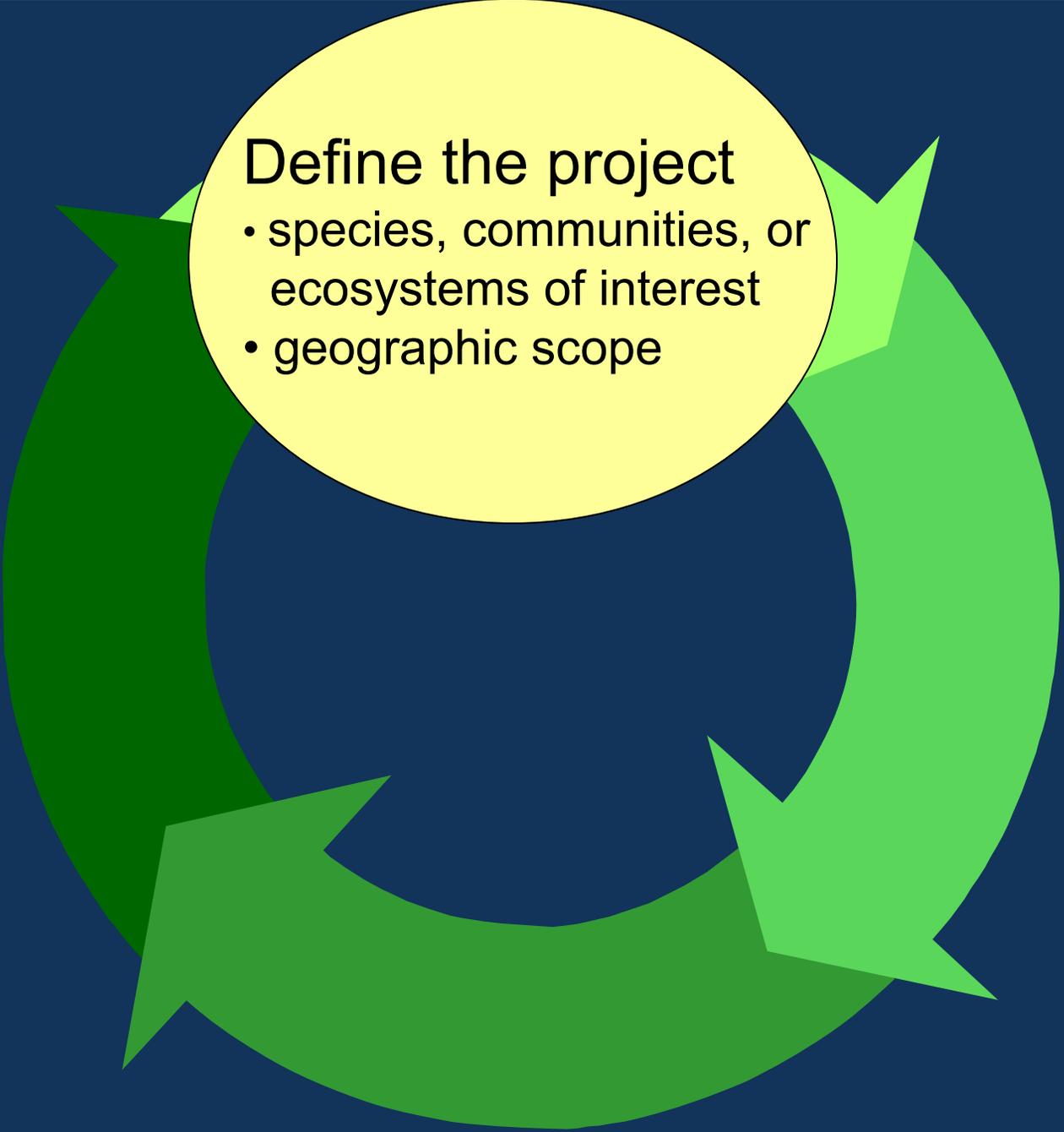
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graph TD; A(Define the project) --> B(Develop strategies); B --> C(Implement strategies & monitor); C --> D(Use results to adapt & improve); D --> A;
```

Define the project

Develop strategies

Implement
strategies
& monitor

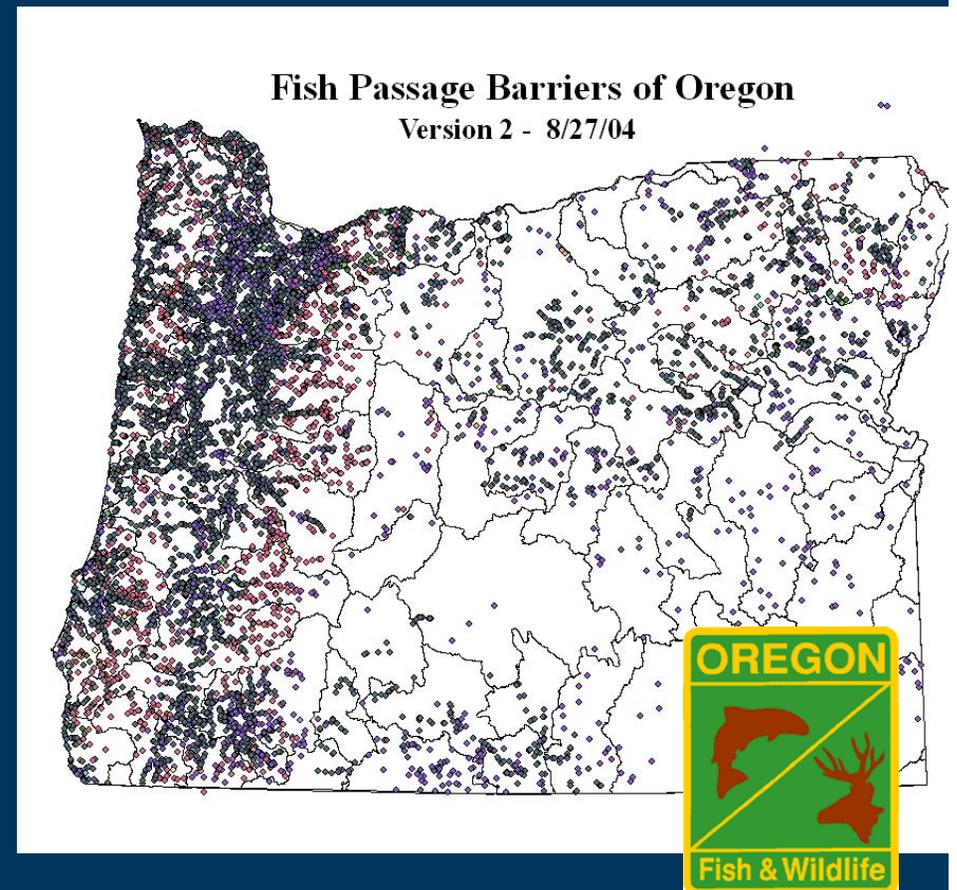
Use results
to adapt &
improve



Define the project

- species, communities, or ecosystems of interest
- geographic scope

1. Where is the species or ecosystem in relation to its distribution?
2. What environmental gradients affect it?
3. How well connected are ecosystem patches or suitable habitat across the landscape?
4. How does the degree of connectivity compare to the dispersal capabilities?

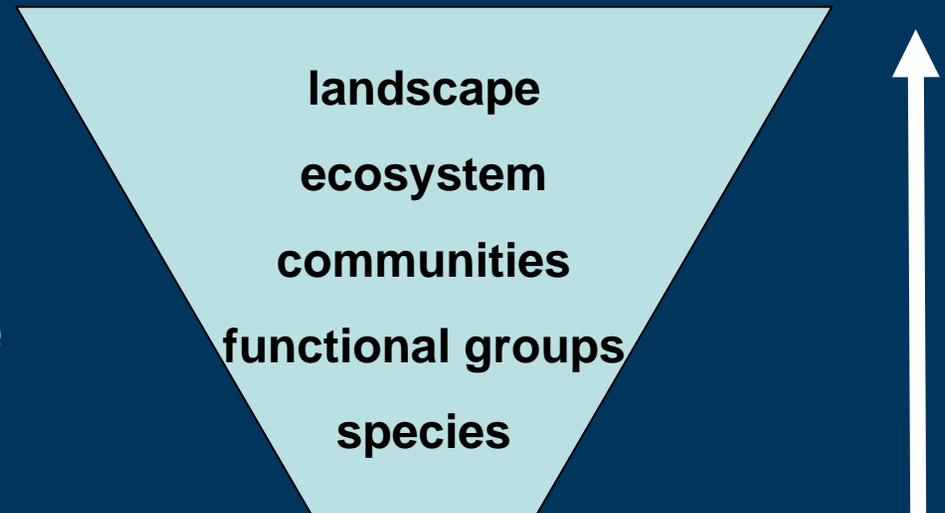


Shift in scope from
species to landscapes

Plan strategies over large
areas

Triage...priority of
imperiled species?

Plan for functional
redundancy

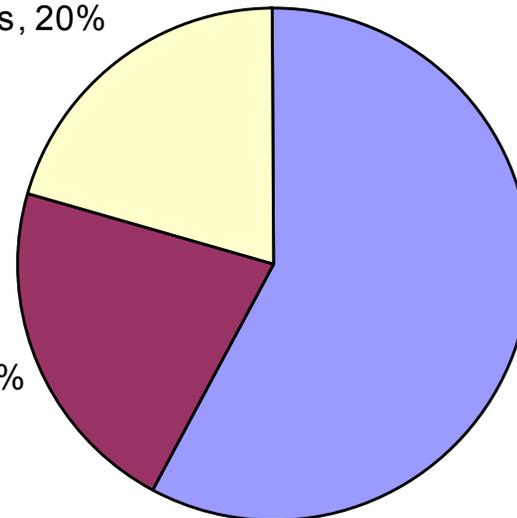


904 conservation plans (5237 targets)

assemblages, 20%

species, 22%

ecosystems, 58%





Develop strategies

Viability

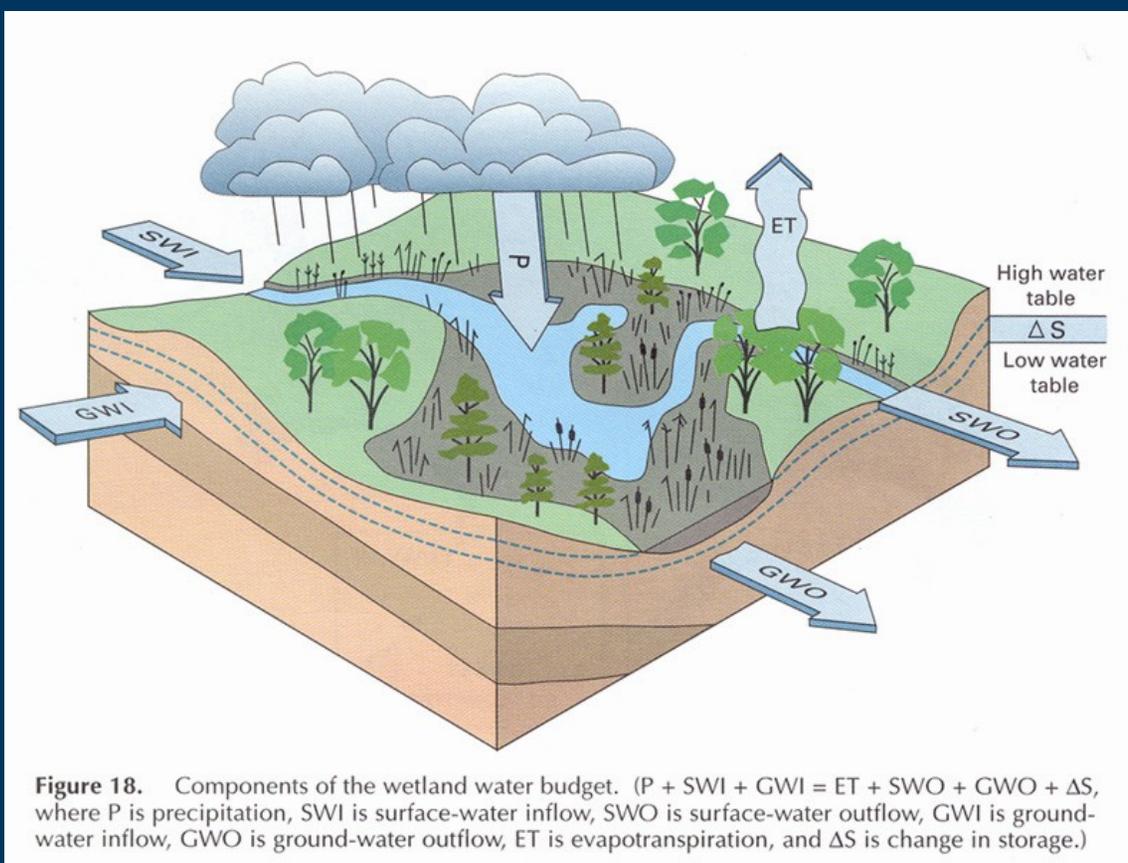
Threats

Objectives

Actions

Water, the master variable

hydropattern:
when?
how much?
what quality?

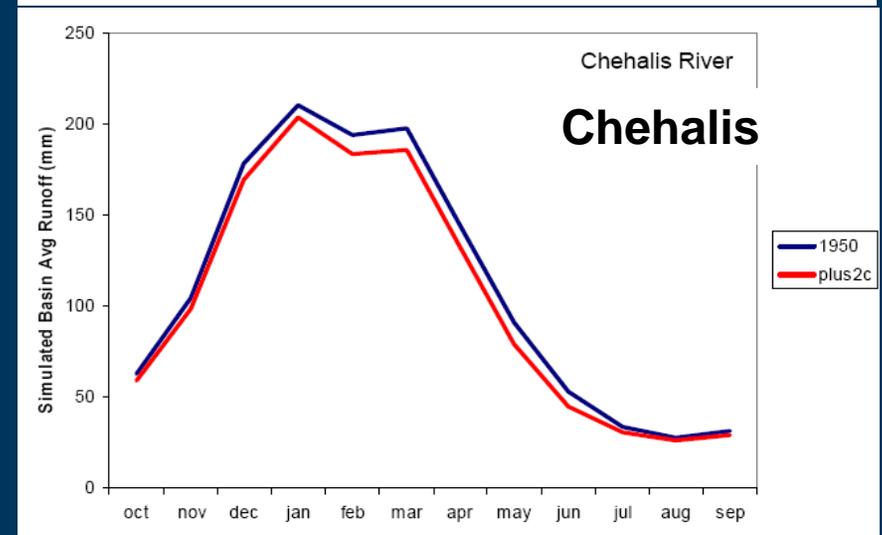
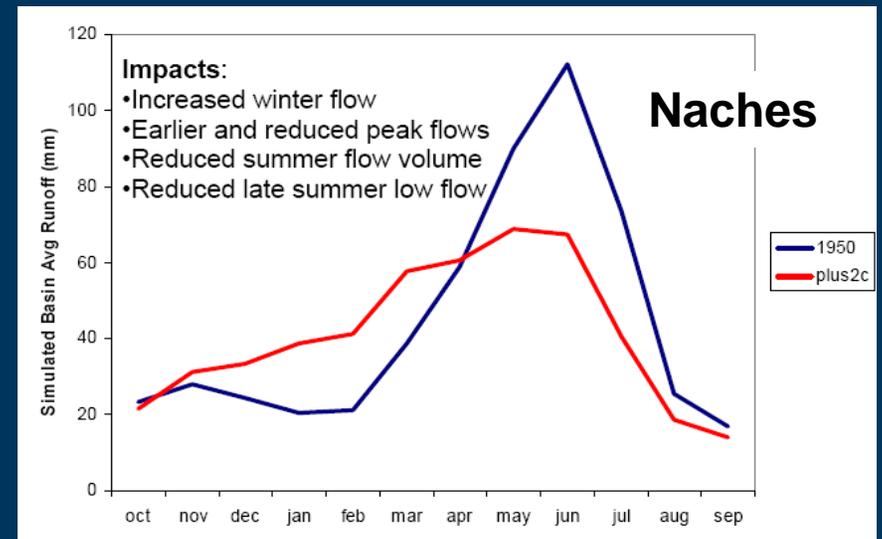


Changes to water quality

- higher water temperature
- sediments, nutrients, DOC, etc.
- turbidity
- salinity

CC-Hydrologic impacts

- winter flow: ↑
- peak flow: earlier, ↓
- summer flow volume: ↓
- late summer low flow: ↓



Some hypotheses (Matthews and Aldous)

More resilient	More vulnerable
Old water	New water
Large	Small
Deep	Shallow
High variability	low variability
Permanent	Temporary
Low altitude/latitude	High altitude/latitude
Mineral substrate	Peat substrate

Water Source: Old vs. New



groundwater-fed
stable water source
lag time for impacts*

precipitation-fed
change in timing & amount of
precipitation
impacts felt immediately



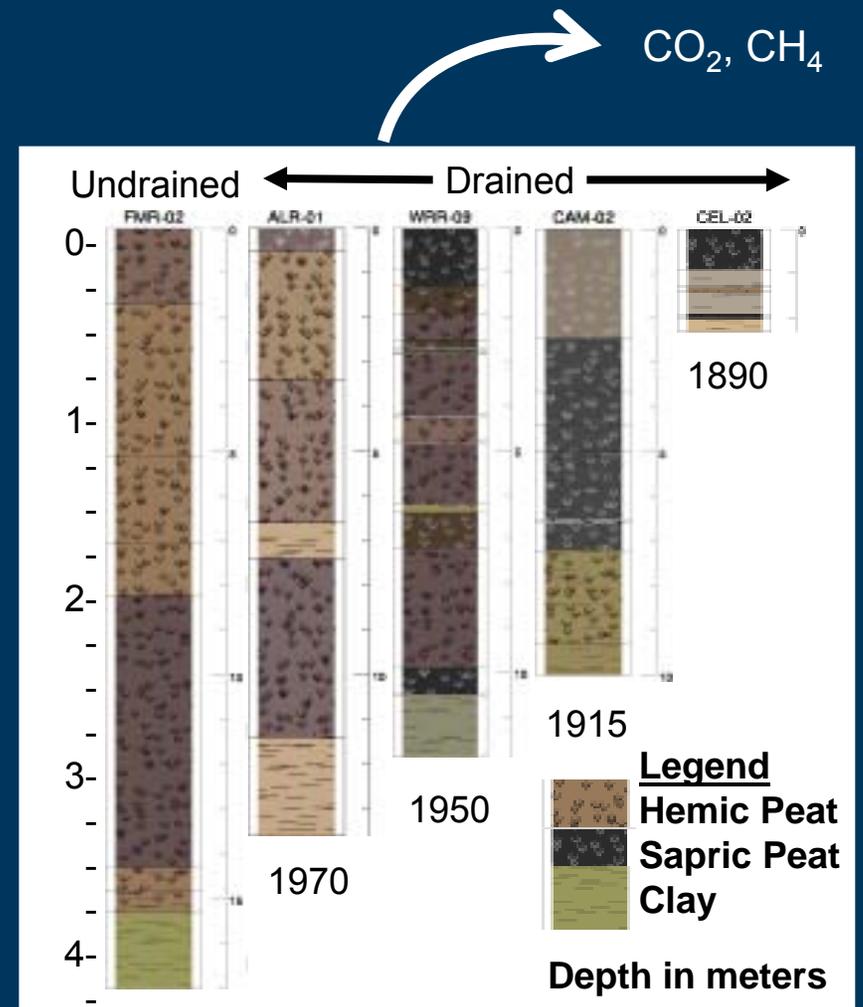
Substrate: mineral vs. organic

Peat

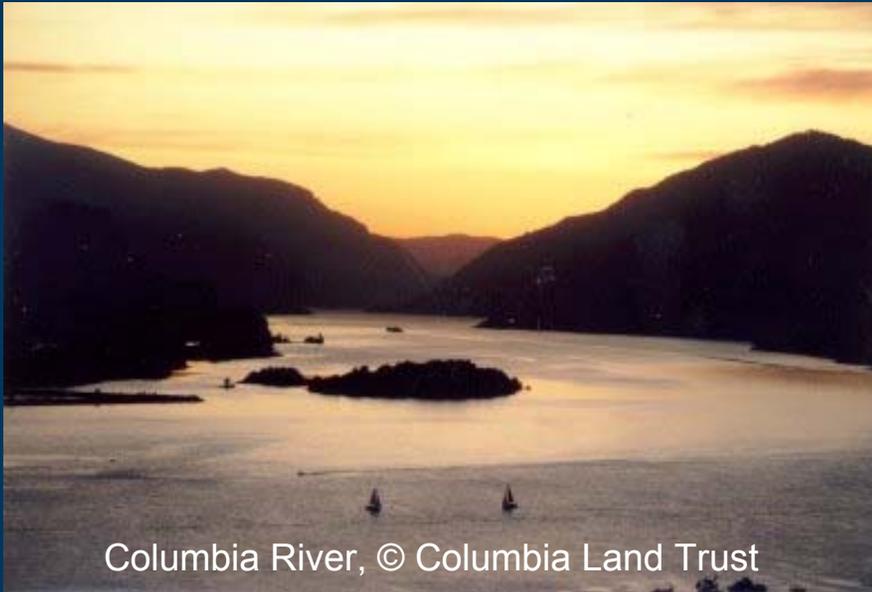
- organic substrate sensitive to water levels
- water table dictates balance between production & decomposition

Mineral soil

- mineral substrate less sensitive to water table fluctuations



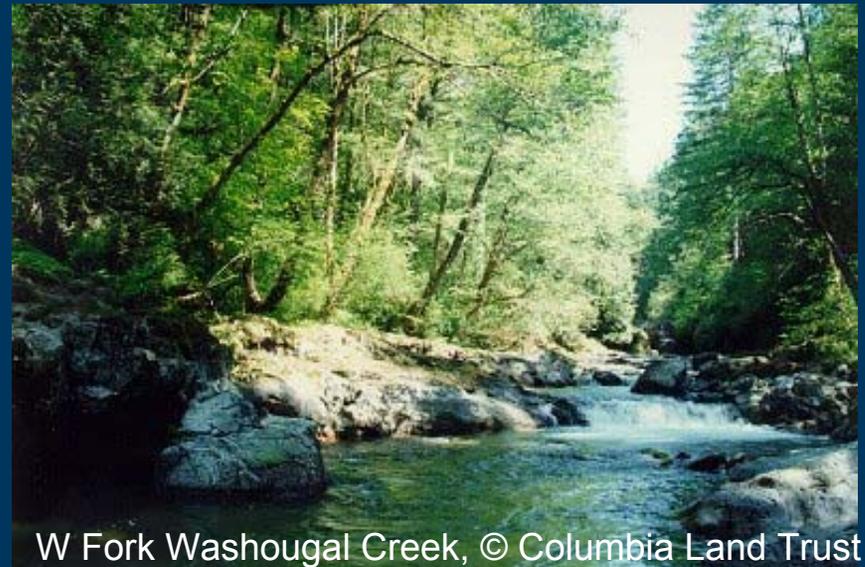
Ecosystems size: large vs. small



Columbia River, © Columbia Land Trust

- higher order stream; large lake or wetland
- lesser edge effect
- lower surface:volume ratio
- lesser impact for a given volumetric change in flow, precipitation, or ET

- lower order stream; small lake or wetland
- greater edge effect
- higher surface:volume ratio
- greater impact for a given volumetric change in water



W Fork Washougal Creek, © Columbia Land Trust



Develop strategies

Viability

Threats

Objectives

Actions



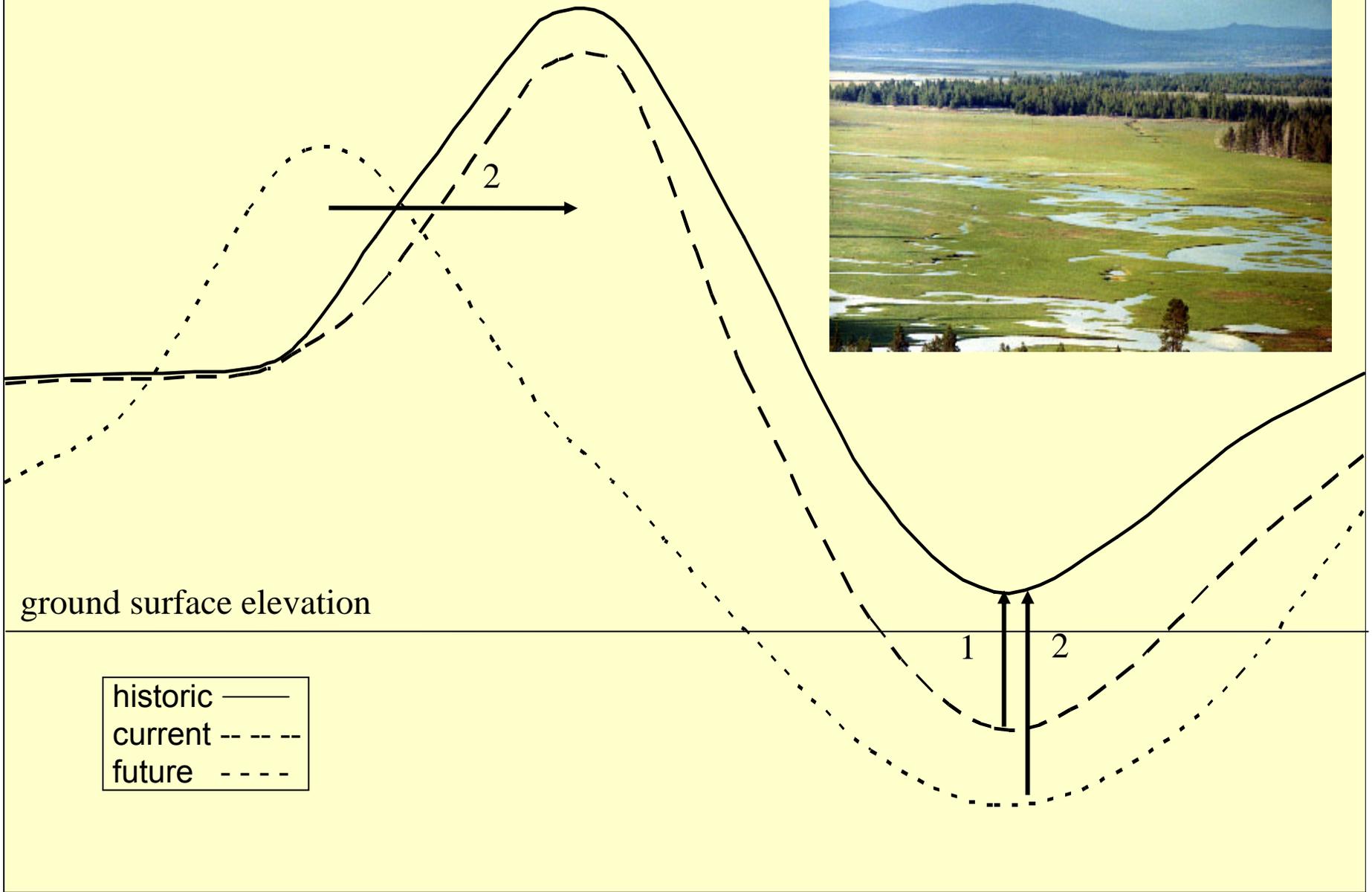
1. Structure

- a. connectivity within aquatic ecosystem**
- b. connectivity between aquatic ecosystem & transitional ecosystem**
- c. riparian/lacustrine vegetation**
- d. absence of invasives**

2. Function

- a. adequate hydrologic flows**
- b. appropriate timing of flow**
- c. sufficient water quality**

Hypothetical future hydroperiod, emergent montane marsh



Jan

Mar

May

Jul

Sep

Nov



Develop strategies

Viability

Threats

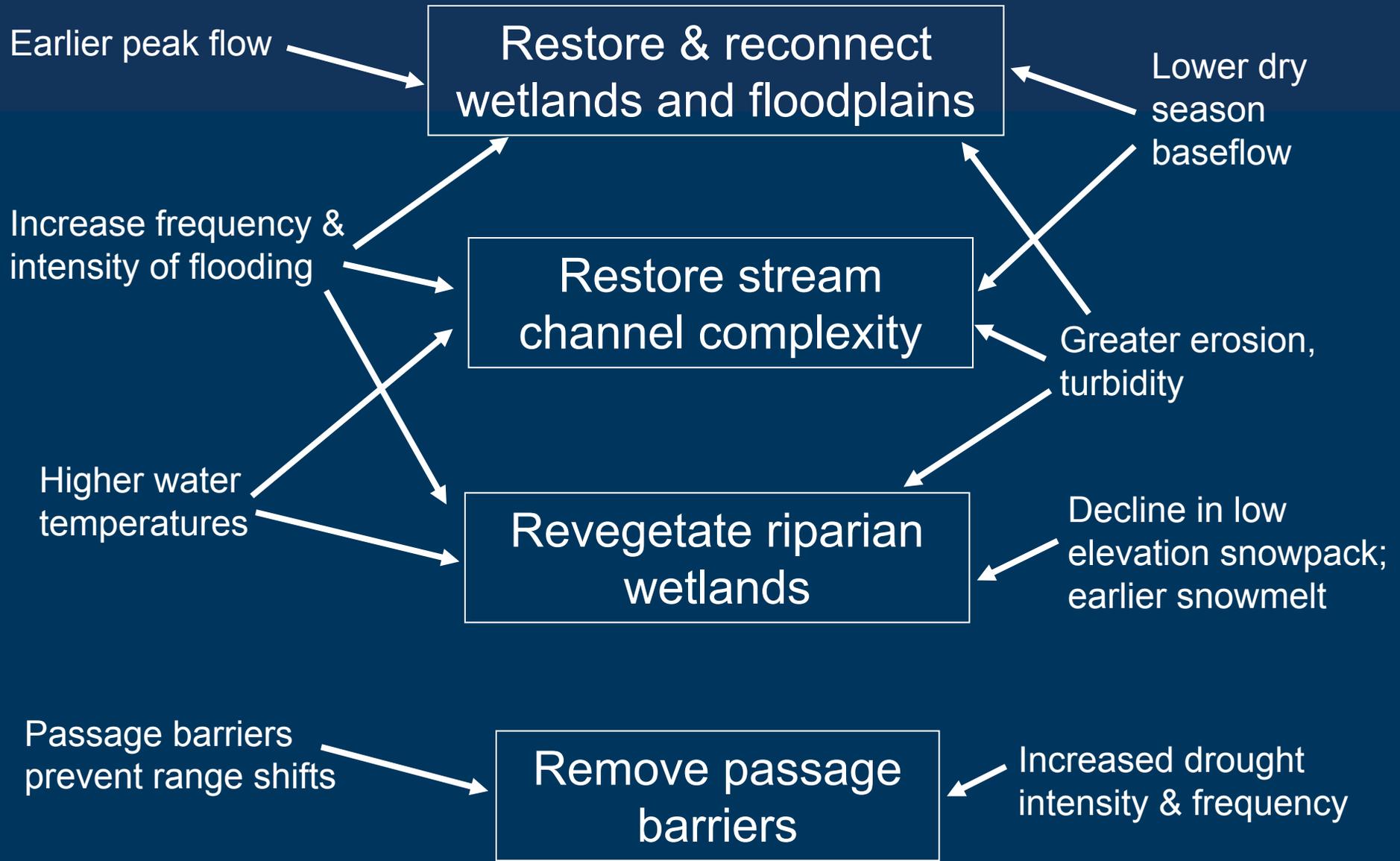
Objectives

Actions

Climate change adaptation strategies:

- **ecosystem-based strategies**
- water management strategies

Tried and True – Restoration Strategies



No Regrets, Tried and True

Species stressed
by the sum of
climate impacts

Reduce invasive species

Increase frequency &
intensity of flooding

Protect snowpack by
avoiding cutting at
and above snowline

Lower dry
season
baseflow

Earlier peak flow

Decline in low
elevation snowpack;
earlier snowmelt

Higher water
temperatures

Protect critical
groundwater
recharge areas

Increased drought
intensity & frequency

Proceed with Caution!!

Range shifts in response to higher temperatures

Shift target area for protection & restoration

Increase frequency & intensity of flooding

Engineer peak flow events

lower peak flow

Increase frequency and intensity of flooding

More reservoir storage

Create new wetlands

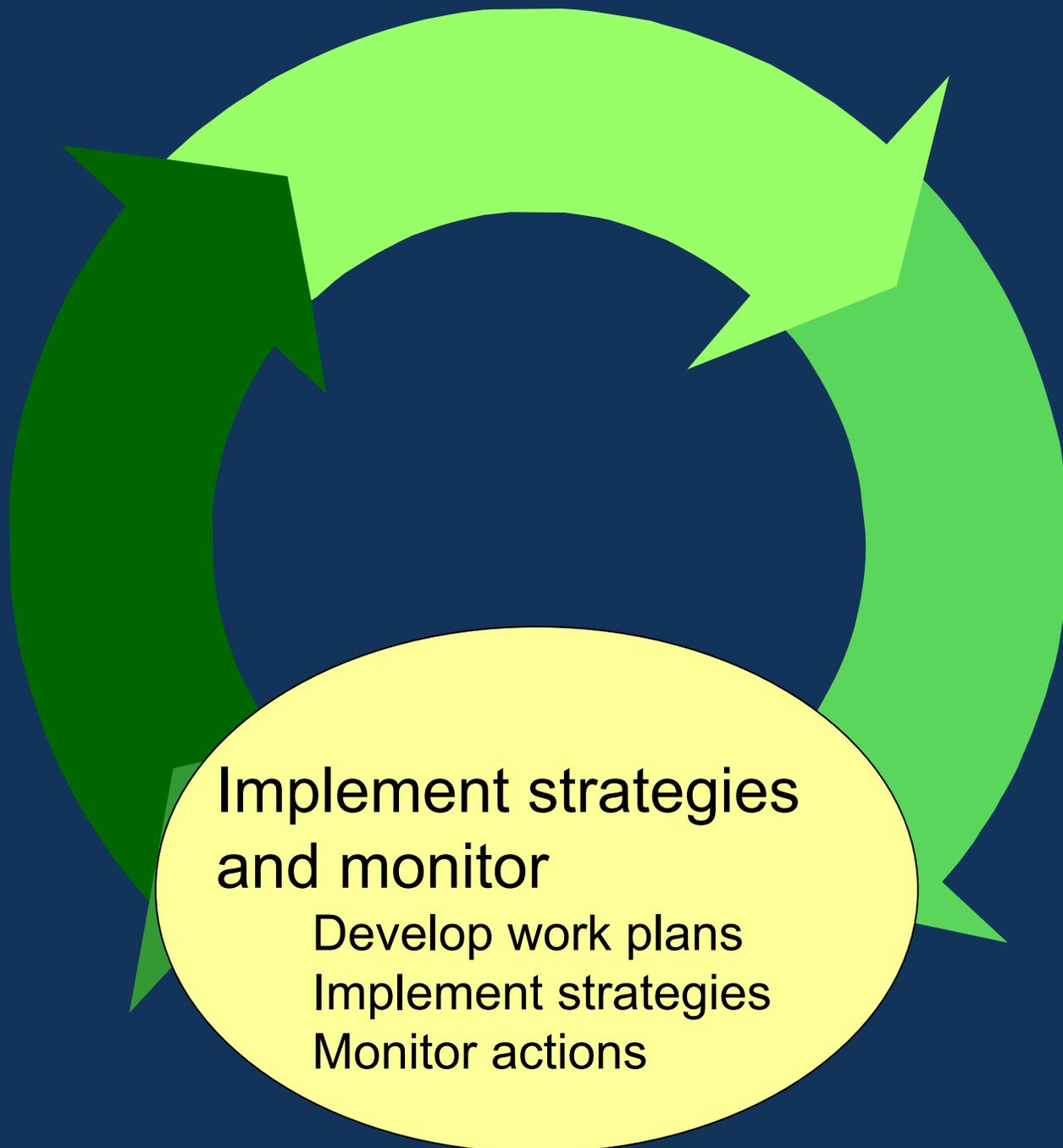
Increased drought intensity & frequency

Aquifer storage & recovery

Climate change adaptation strategies:

- ecosystem-based strategies
- water management strategies

- Water conservation
 - individuals -- low flow and water efficient appliances
 - municipalities -- urban stormwater capture, active groundwater storage
 - industries -- wastewater recycling, groundwater cleanup
 - agricultural -- more efficient irrigation systems, irrigation timing guided by accurate weather data, fallowing, shifting to less water-intensive crops
- Re-operate dams – environmental flows
- Manage water over entire watersheds
- Manage water rate structures
 - increasing volumetric block rate
 - seasonal rate system



Monitoring

Monitoring is more critical than ever:

- uncertainties of climate projections
- model validation
- potential large impacts to freshwater biodiversity
- interactions of climate change with current threats (e.g. water quality impairment, habitat loss, loss of connectivity)



Use results to
adapt & improve
Analyze
Interpret
Adapt
Share

Is climate adaptation =
conservation BAU?

When is climate adaptation \neq BAU?

Will existing strategies still work under different climatic conditions?

Strategy prioritization

- landscape position
- addresses multiple threats

Triage?

Do we need new strategies?

Strategies that are contra-indicated?

