Sierra Nevada Adaptive Management Project:

Design, methods and current research

Board of Forestry and Fire Protection Monitoring Study Group
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Topics Covered

Background, overview, & objectives

- What and why of SNAMP

Research questions, study design

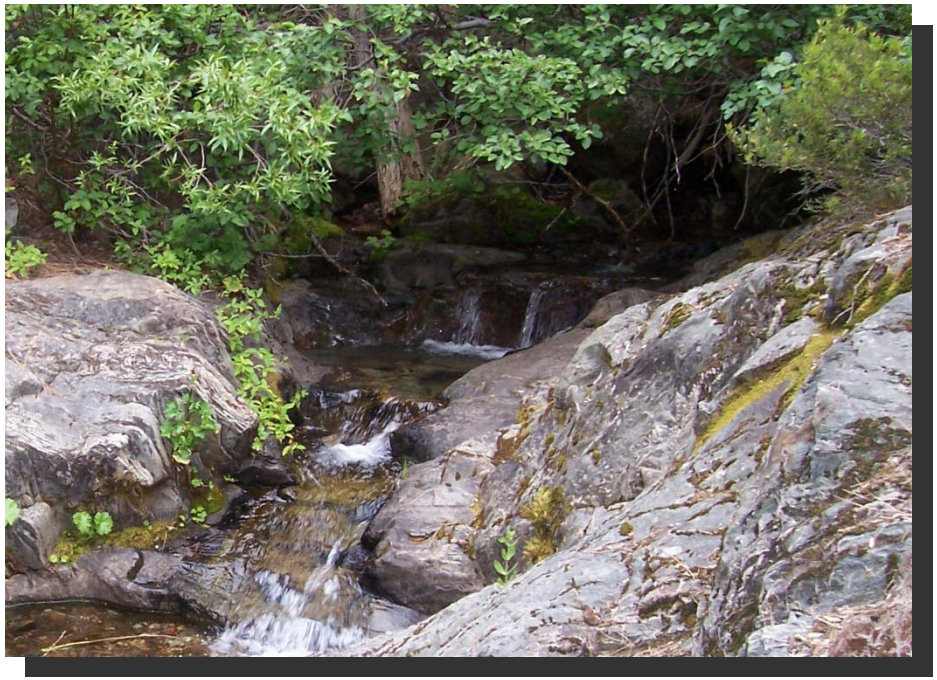
- What do we hope to learn?
- What approach are we using? how?

Results, challenges, & next steps

- Were there challenges to collecting data?
- What did we find?
- What are our future plans?

Data sharing

- How to reach us?
- Where to find data?



SNAMP Background

Consensus that forests are at risk from fire & uncertainty on how best to reduce risk

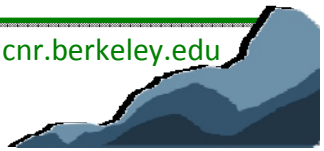
- USFS Sierra Nevada Forest Plan Amendment (2001)
  - Outlines "regional planning efforts aimed at managing species and ecosystems of the Sierra Nevada bioregion" (USFS)
- Record of Decision (2004)
  - Updates SNFPA to "improve protection of old forests, wildlife habitats, watersheds and communities"

Controversy over USFS management

- Lawsuit by State of California
  - Not sufficiently practicing 'Adaptive Management'

An acknowledged need to learn more

- UC involved as neutral third party



Adaptive Management Framework

"Adaptive management must be a participatory process that engages scientists, stakeholders, and managers in a long-term relationship grounded in shared learning about the ecosystem and society." UC Science Team

Research Teams

SNAMP was formed to develop, implement and test Adaptive Management processes through testing the efficacy of Strategically Placed Landscape Treatments (SPLATs) across four response variables, including:

Public participation

Wildlife

- Pacific Fisher
- California Spotted Owl

Water

Fire/forest health

Each of these groups has an associated research team, and all are supported by a **Spatial Team**.

SNAMP MOU Partners

California State Resources Agency

Dept. Fish and Game

Dept. Water Resources

Dept. Forestry & Fire Protection

U.S. Forest Service

Region 5, Sierra and Tahoe National Forests

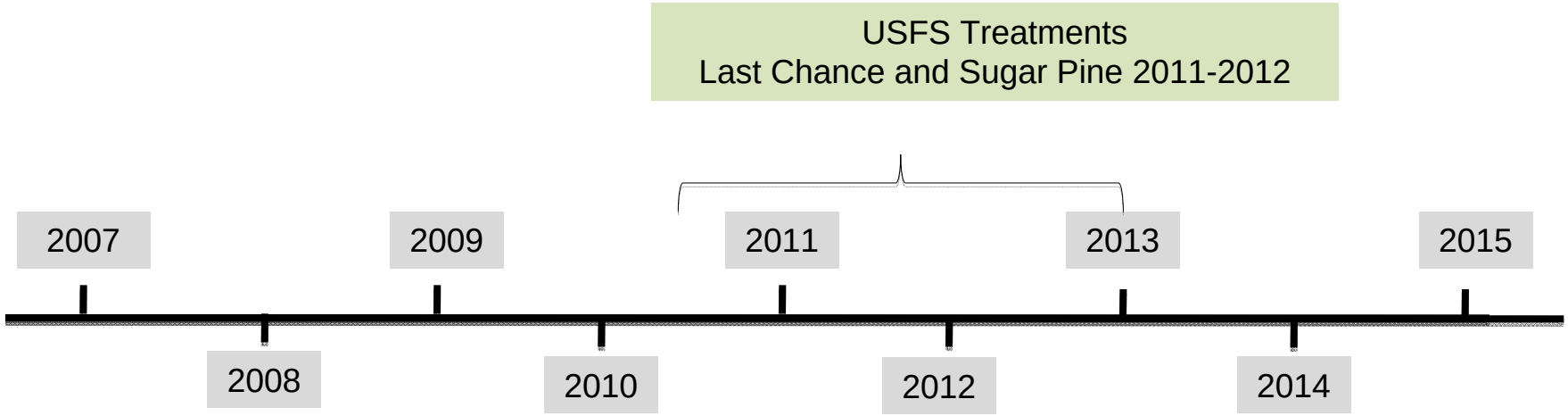
Pacific Southwest Research Station

U.S. Fish and Wildlife Service

Additional funding support (not MOUP)

Sierra Nevada Conservancy

SNAMP General Research Timeline



Pre-treatment data collection .....

Post-treatment data collection .....

Wildlife, Water, PPT data collection during treatments

Model Building / Paramaterization

Public outreach and mutual learning .....

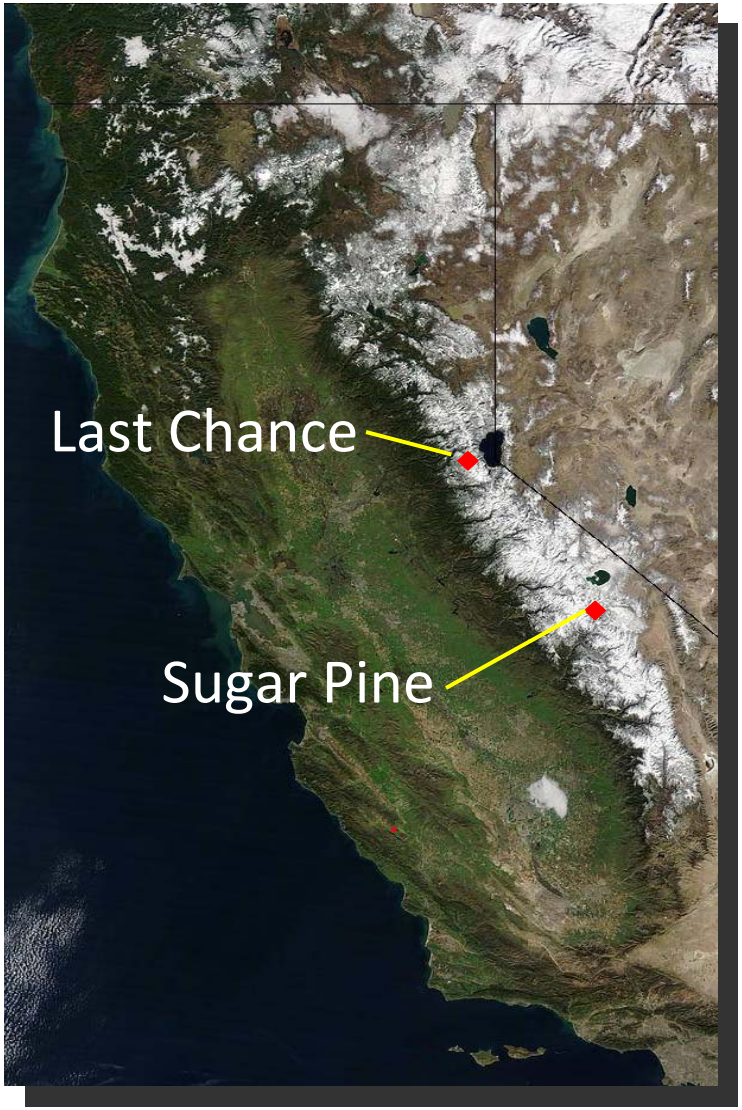
Sampling design

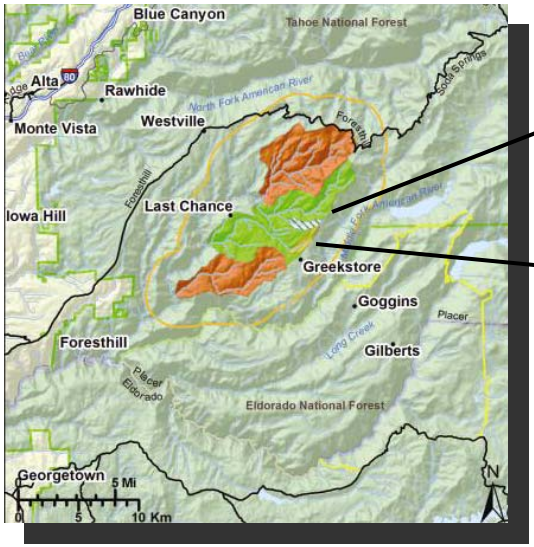
BACI design

Final Criteria:

- ~1 km^2 headwater catchments
- perennial stream reach
- nested within fireshed of 40-200 km^2
- Similar vegetation, slope, stream length, aspect
- Near rain-snow transition

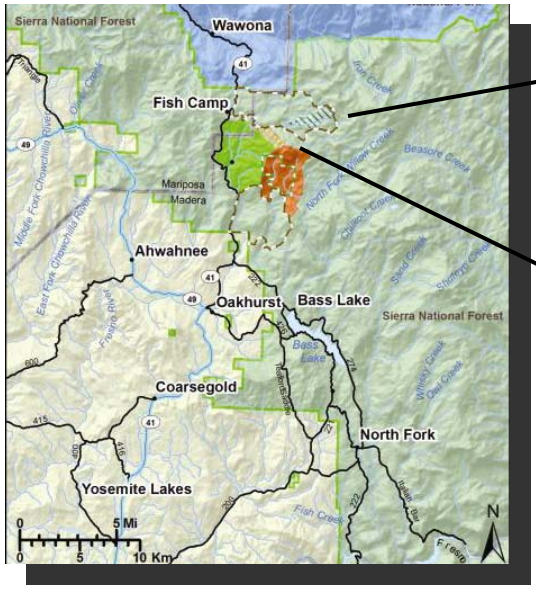
Study locations





Bear Trap
1.76 km^2

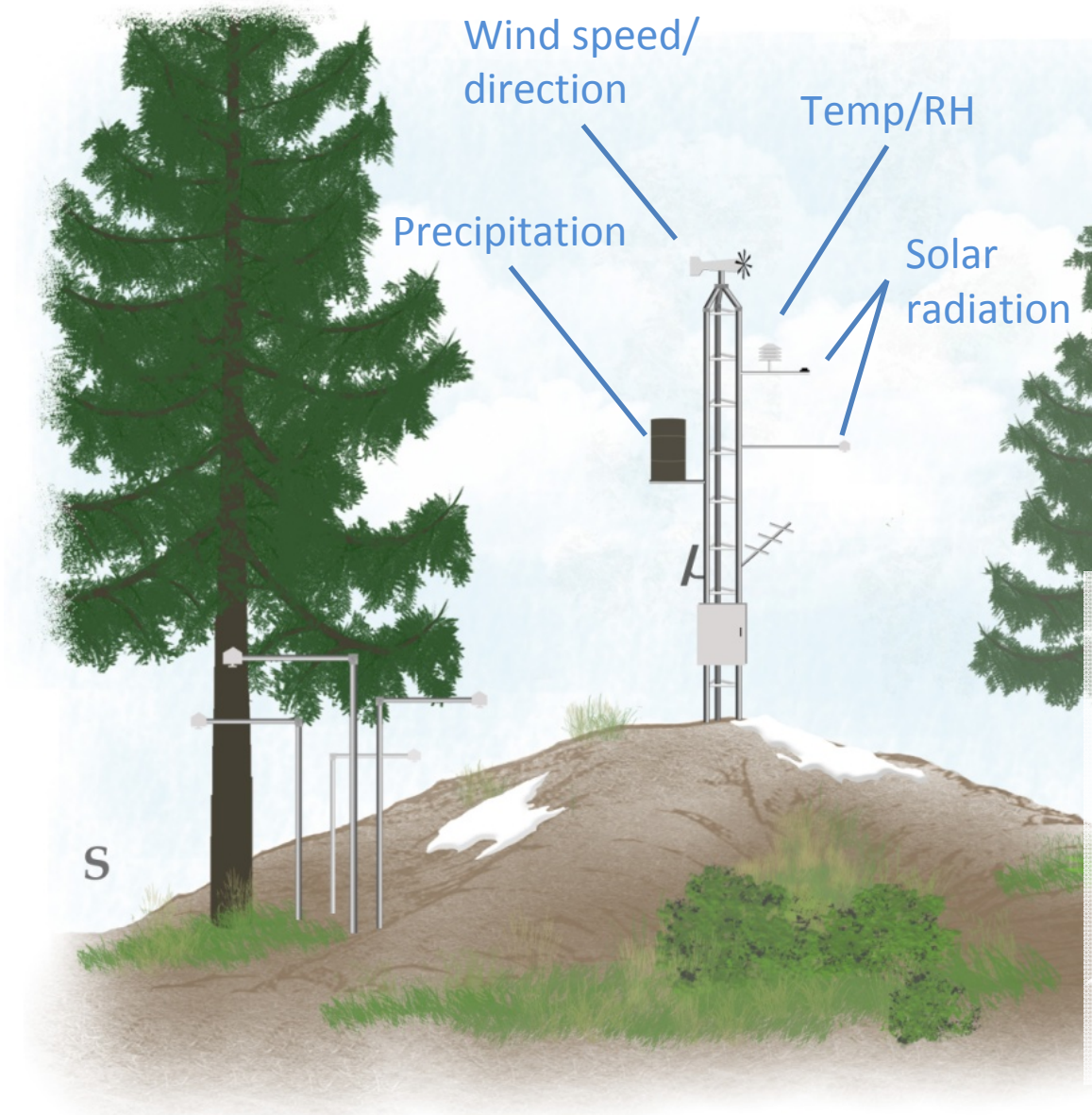
Frazier
1.68 km^2



Big Sandy
2.47 km^2

Speckerman
1.62 km^2

Meteorological Stations



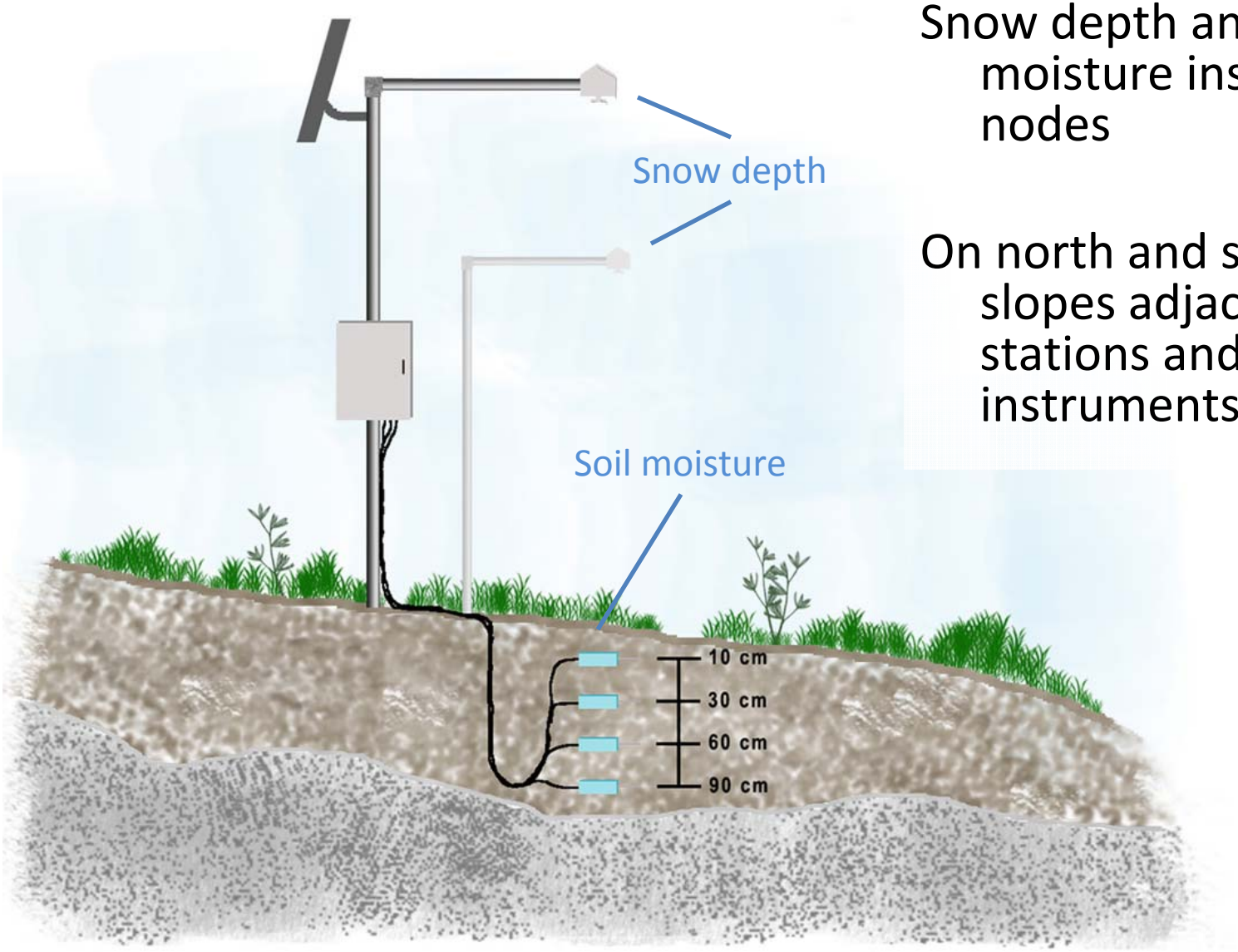
4 Stations

- northern and southern sites
- lower and higher elevation

Open areas on ridge tops

Weather measurements

Hillslope Instruments



Snow depth and soil moisture instrument nodes

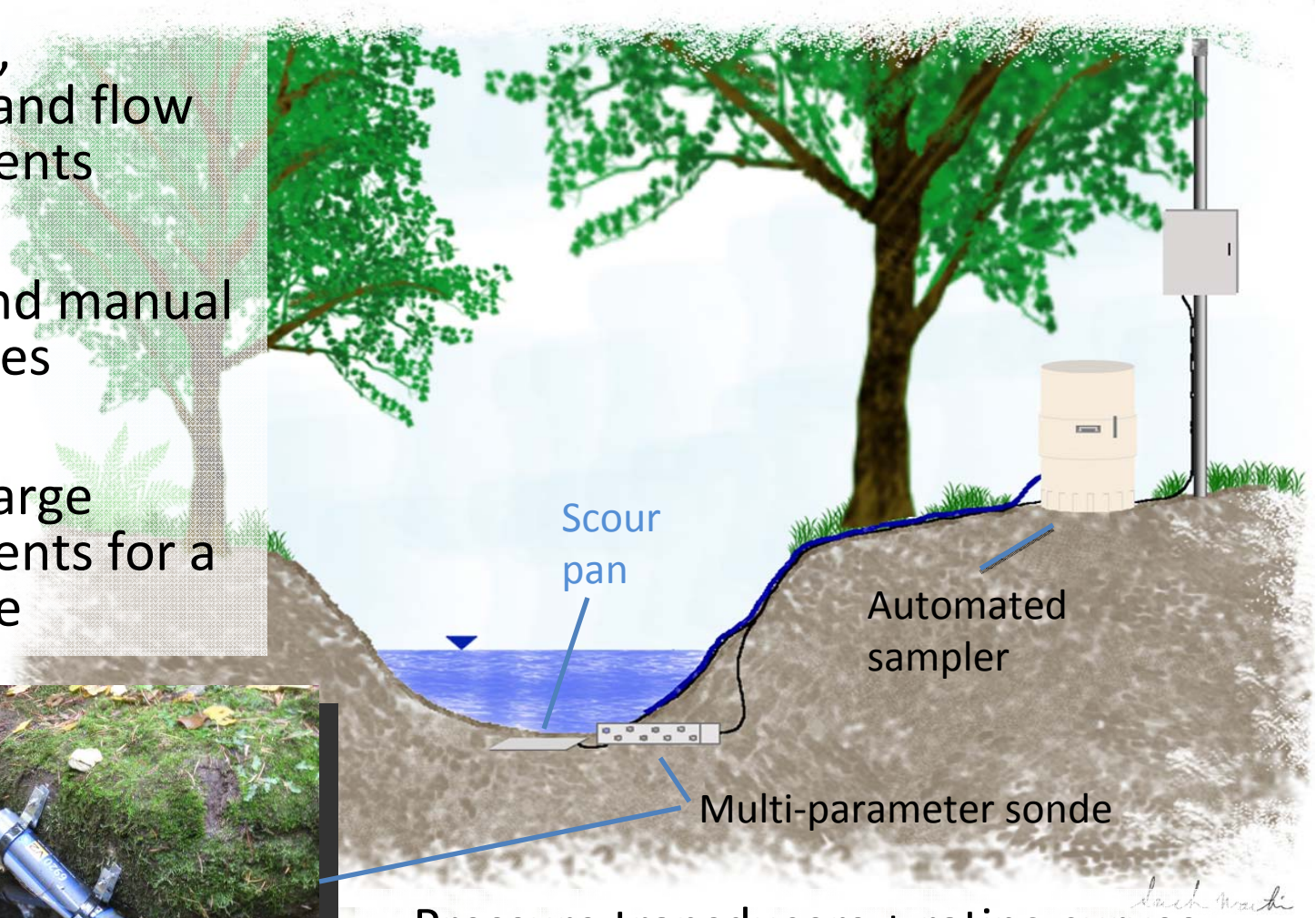
On north and south facing slopes adjacent to met stations and stream instruments

Stream Instrumentation

Water quality, sediment, and flow measurements

Automated and manual grab samples

Manual discharge measurements for a rating curve



Pressure transducers + rating curves

Weir/stilling wells

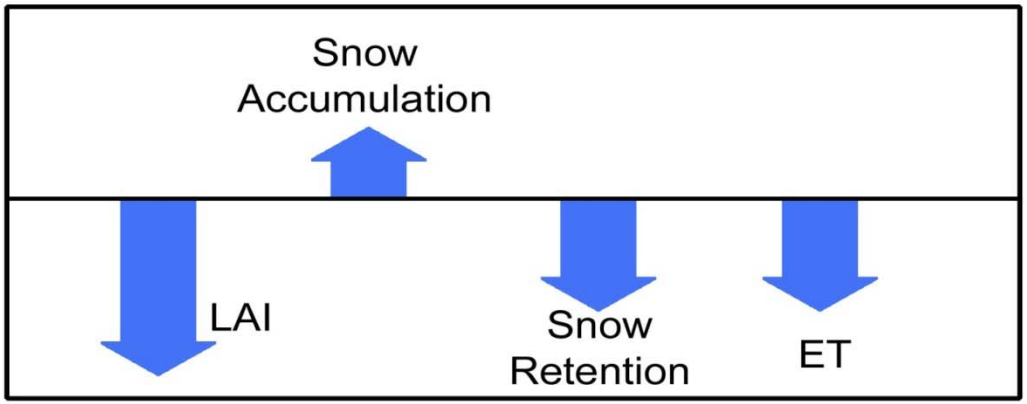
Research Questions

Where and when is water stored and how is it routed through the catchments?

What effects do forest treatments have on water quality, quantity, storage and routing through the catchments?

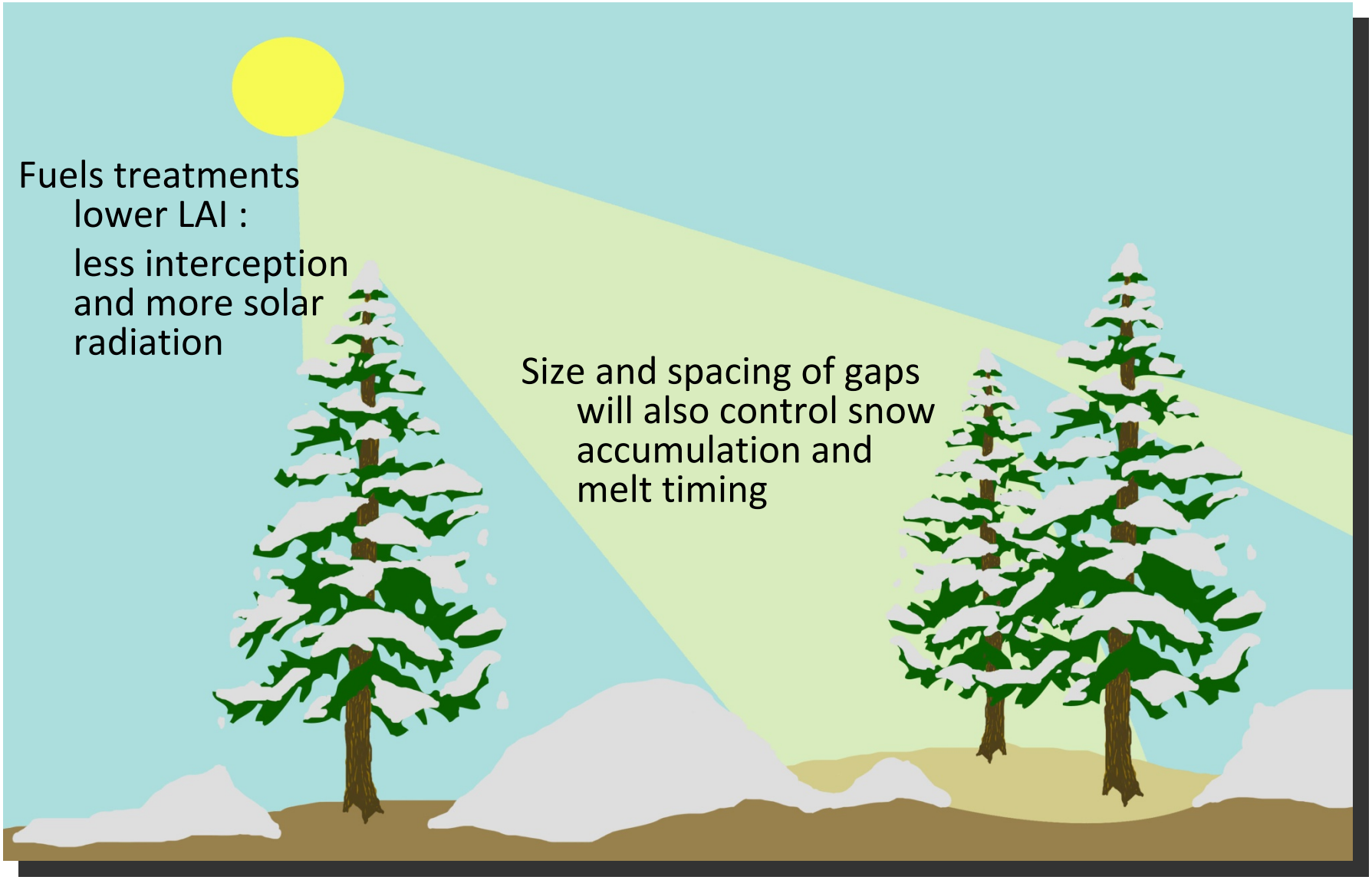
What is the transferability of 1 km^2 watersheds to fireshed response?

What do we expect to see?



Fuels treatments will reduce LAI

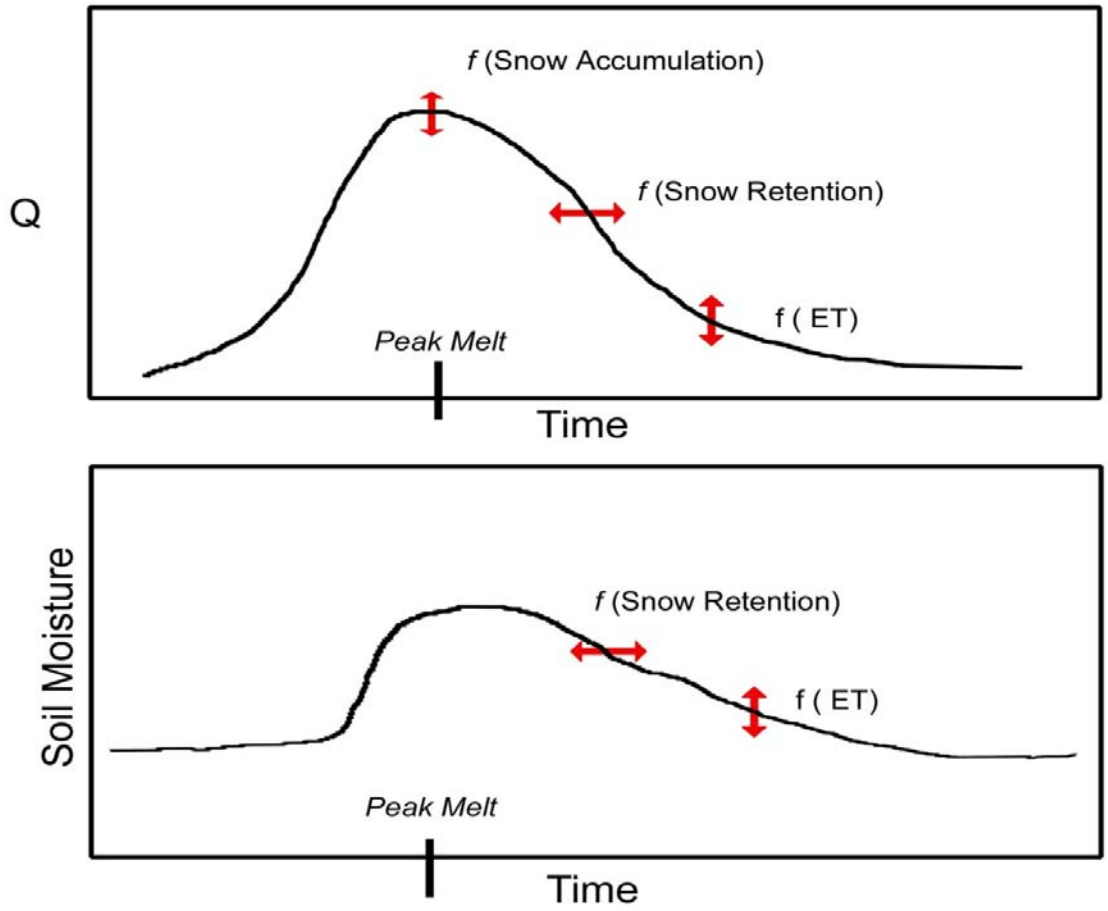
As Leaf Area Index (LAI) decreases, snow accumulation on the ground will increase, while evapotranspiration (ET) and snow retention in late spring will decrease.


Fuels treatments lower LAI :
less interception and more solar radiation
Size and spacing of gaps will also control snow accumulation and melt timing

What do we expect to see?

A change in snow accumulation will be seen in the magnitude of peak stream flow.

Changes in snow retention, will be observed in the recession limb of the hydrograph and the soil moisture curves.



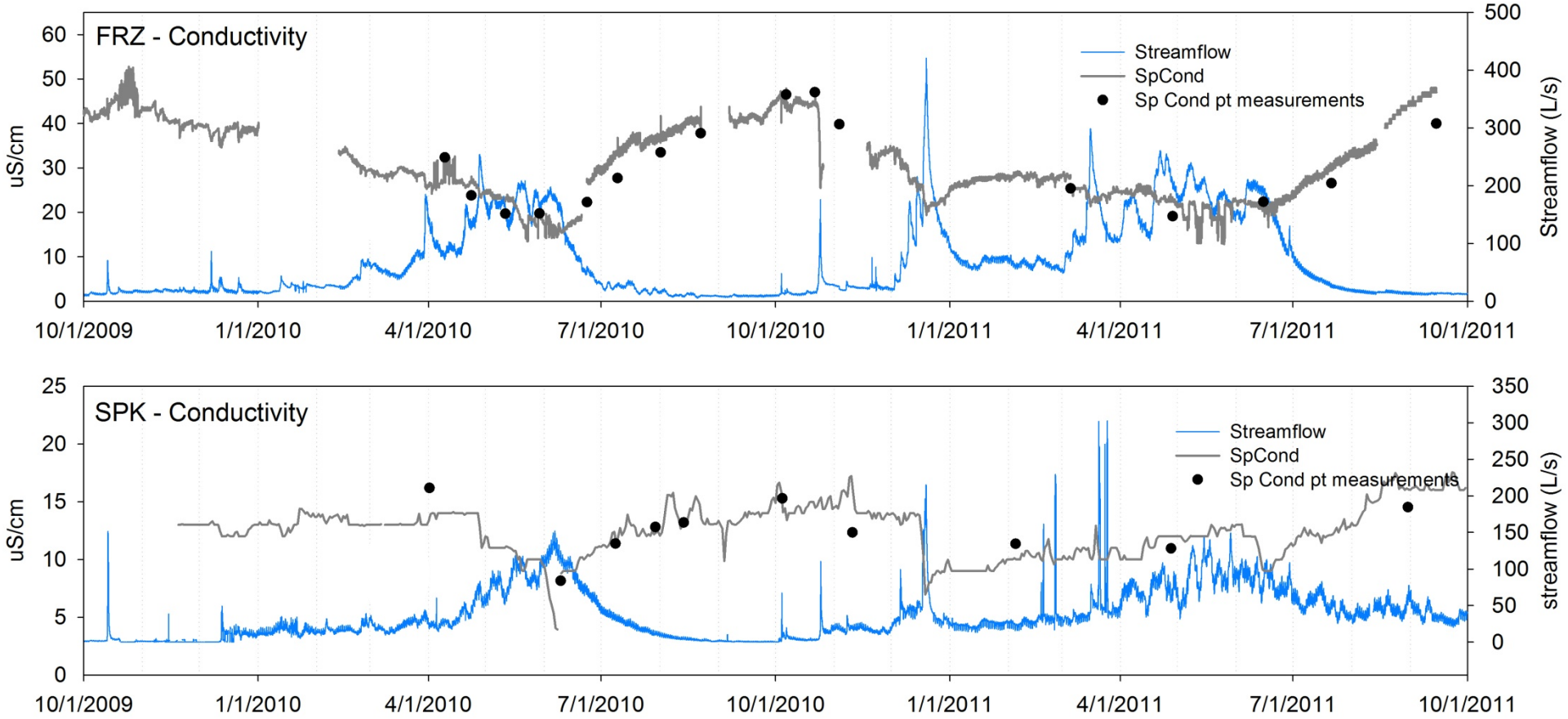
Changes in ET will affect both the timing and the magnitude of late season base stream flow.

What do we expect to see?

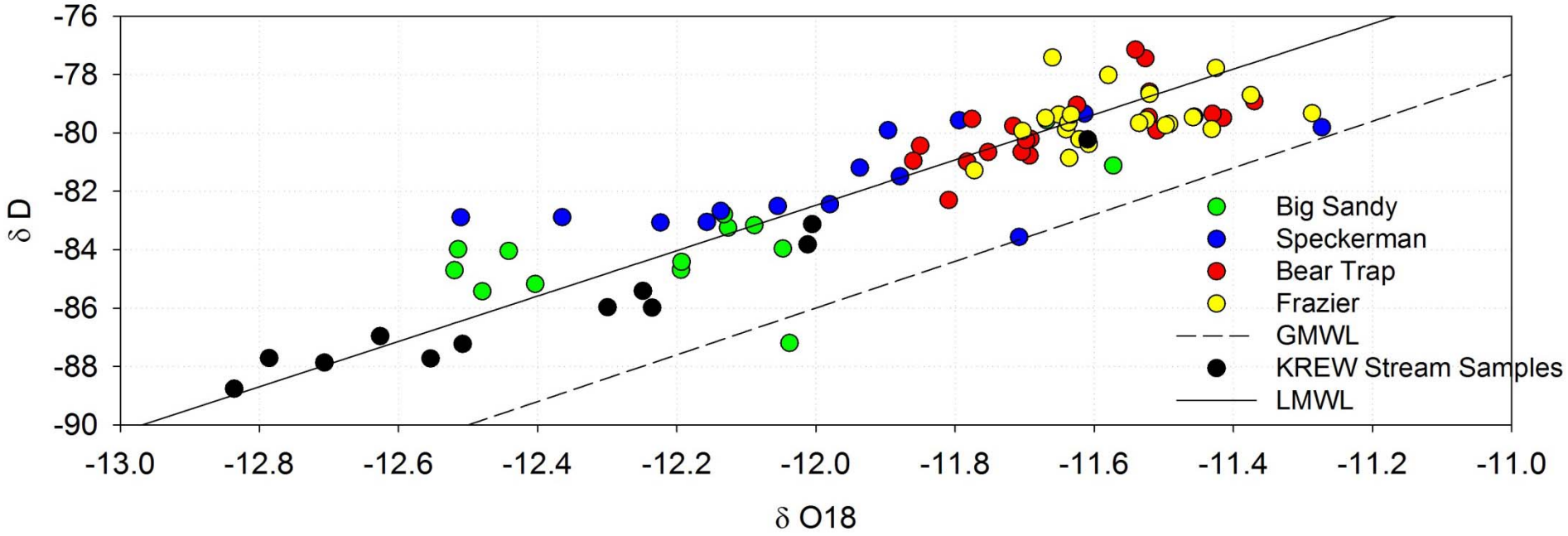
Changes in water chemistry will be a function of changes in discharge

Increased turbidity will be a function of stream discharge as opposed to hillslope erosion.

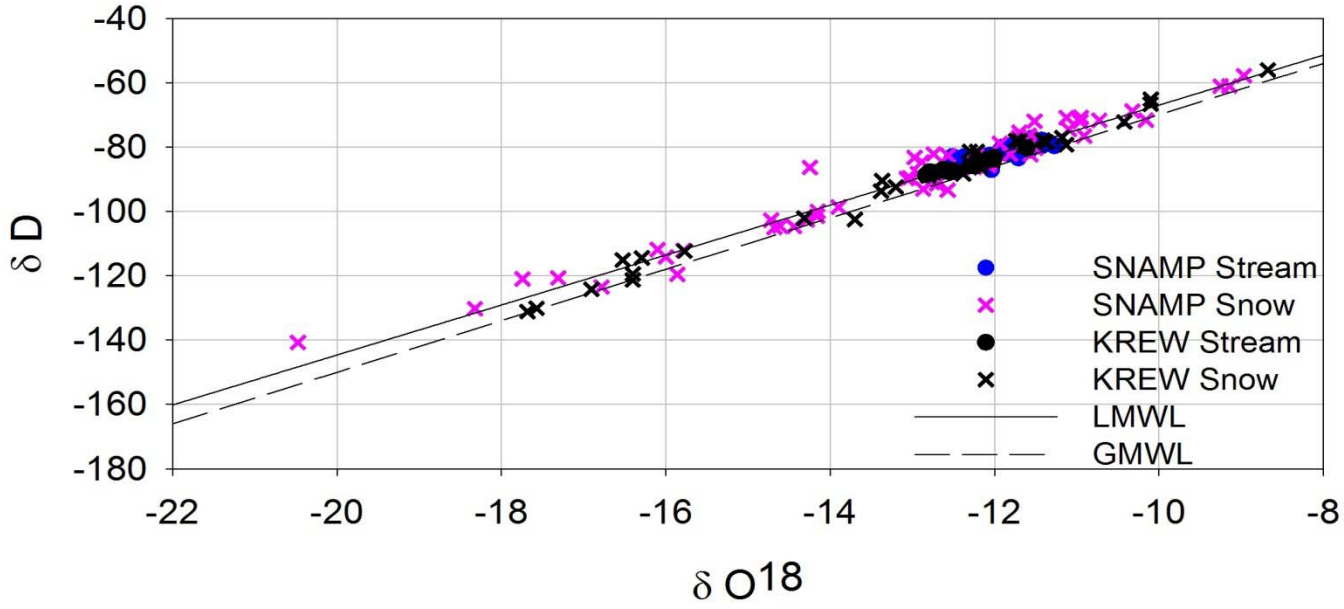
Water quality



Water quality

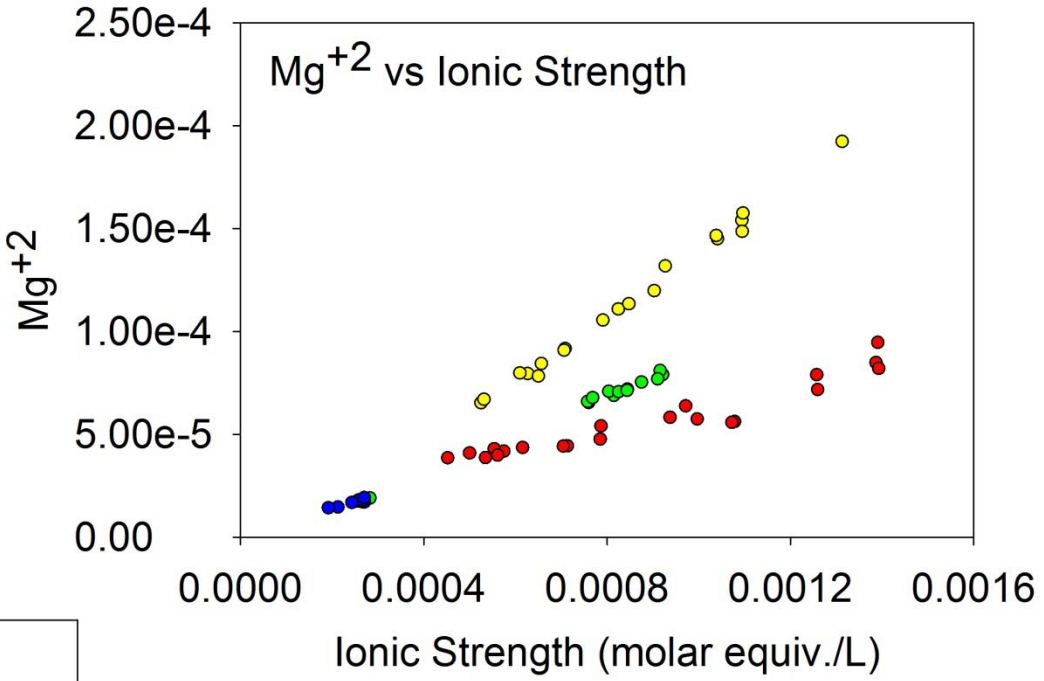


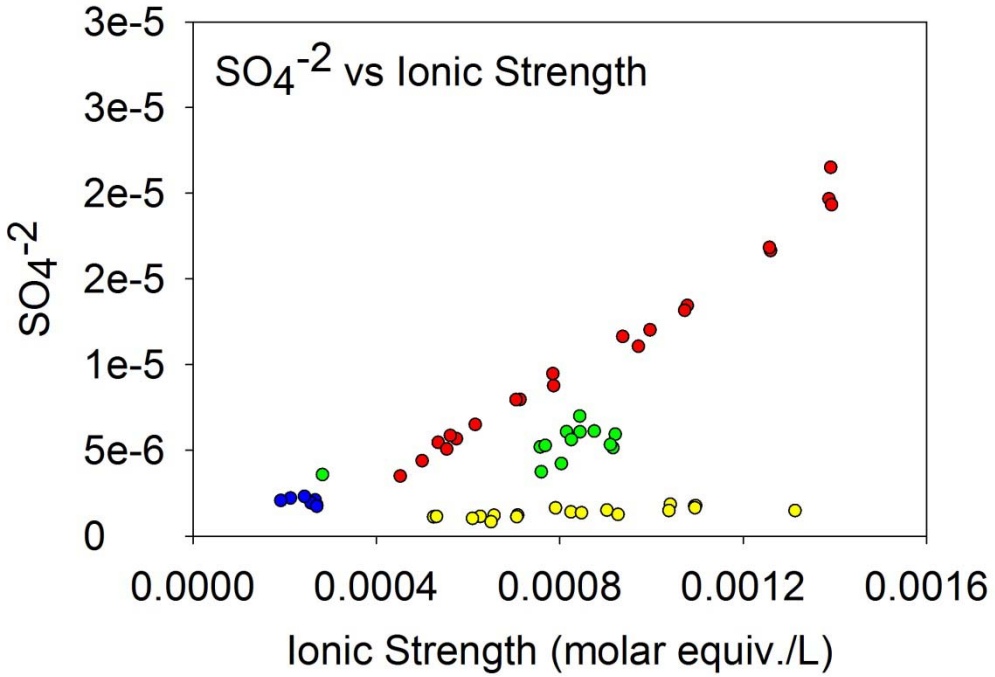
Elevational trends for water chemistry



Water quality

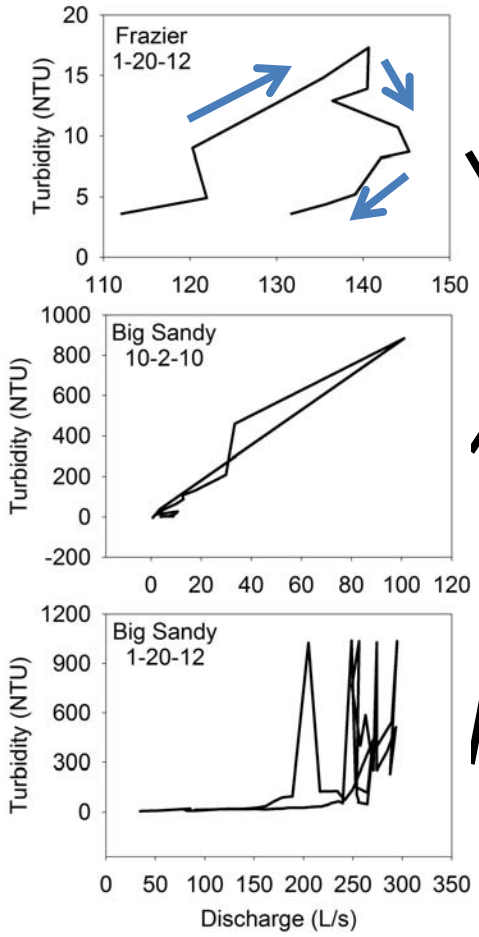
Currently analyzing water chemistry data for use with mixing models and determining flow paths



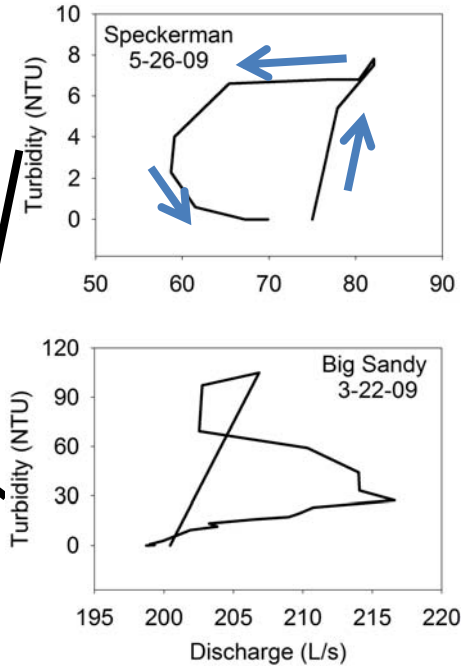


- Big Sandy
- Speckerman
- Bear Trap
- Frazier

Sediment timing and hysteresis



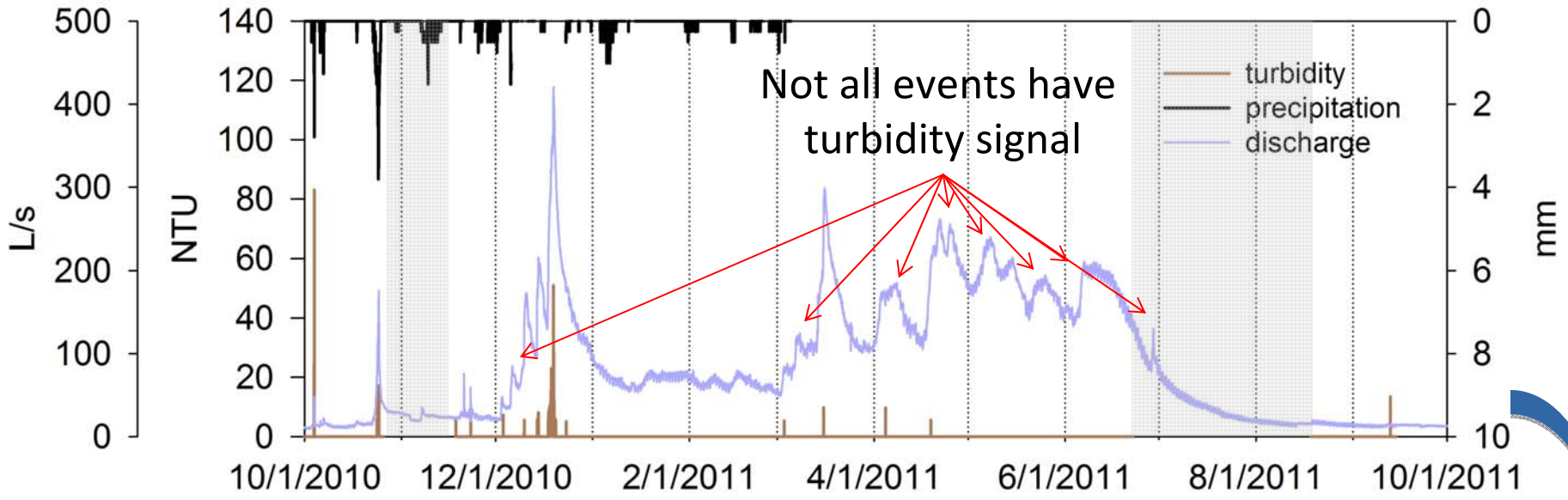
	Big Sandy	Specker-man	Bear Trap	Frazier
Clockwise	14	11	5	16
Counter-clockwise	3	3	2	0
Linear	3	1	0	0
Figure Eight	2	4	0	0
Complex	3	1	1	1



	Fall	Early/Mid Winter	Snow Melt	Base Flow
Clockwise	18	19	8	1
Counter-clockwise	2	2	1	3
Linear	3	0	0	1
Figure Eight	0	2	2	2
Complex	1	3	2	0

Clockwise pattern is dominant in all watersheds especially fall and winter

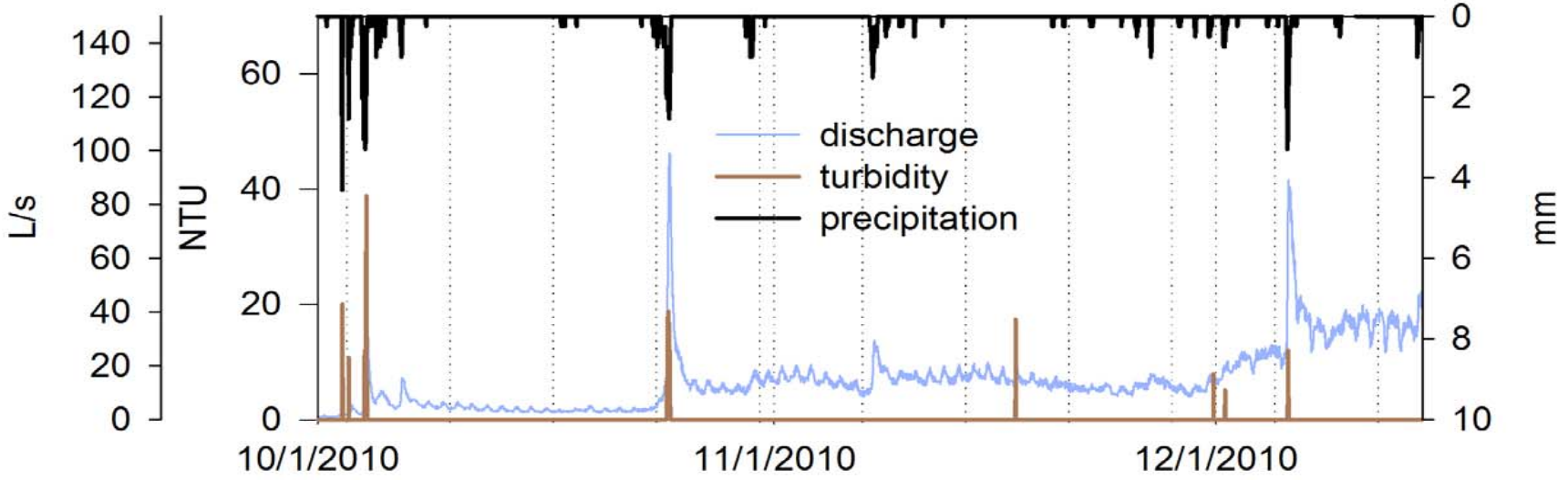
Sediment timing and hysteresis



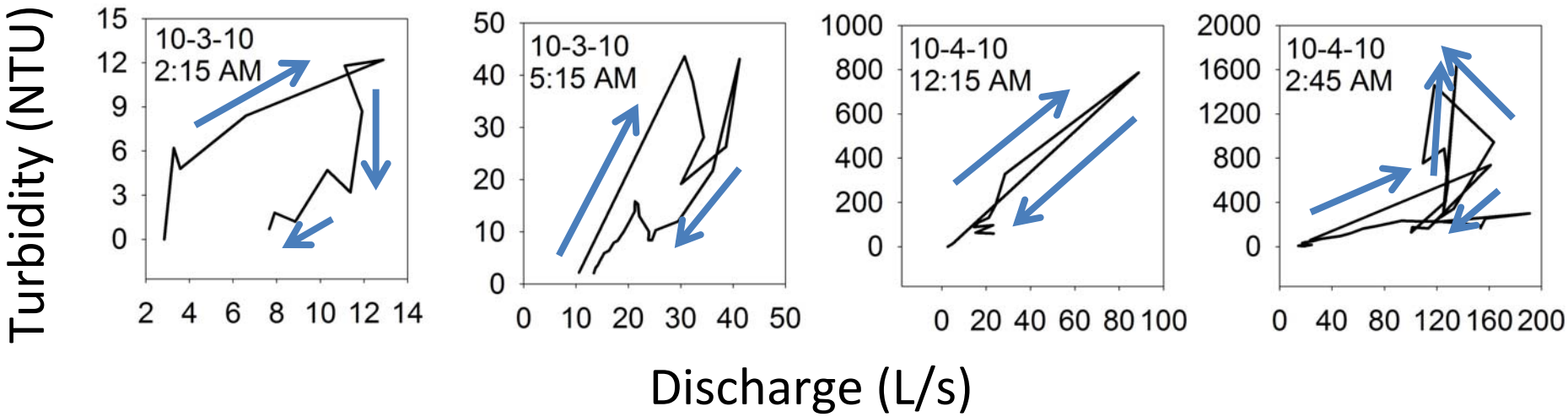
	Flow events producing turbidity signal	Number of large flow events
Fall	84.2 %	0
Early/Mid Winter	55.6 %	11
Snow Melt	49.0 %	18
Base Flow	44.4 %	4

Sediment timing and hysteresis

Seasonal depletion of sediment

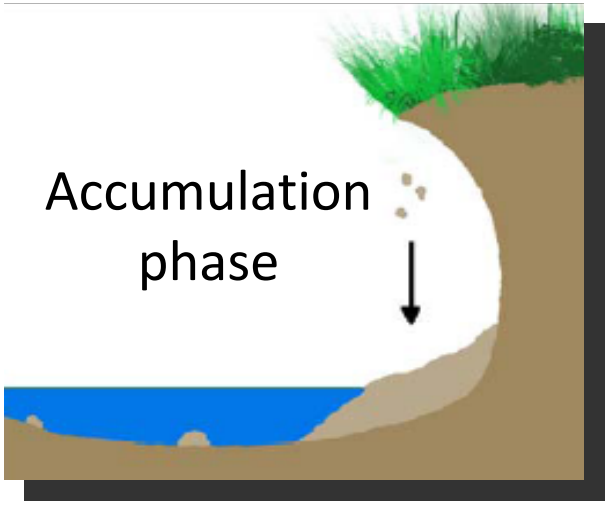


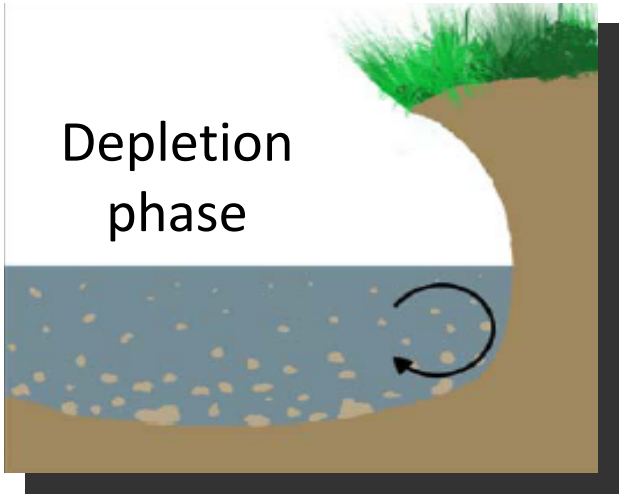
Hysteresis pattern progression in storm event sequence



Sediment timing and hysteresis

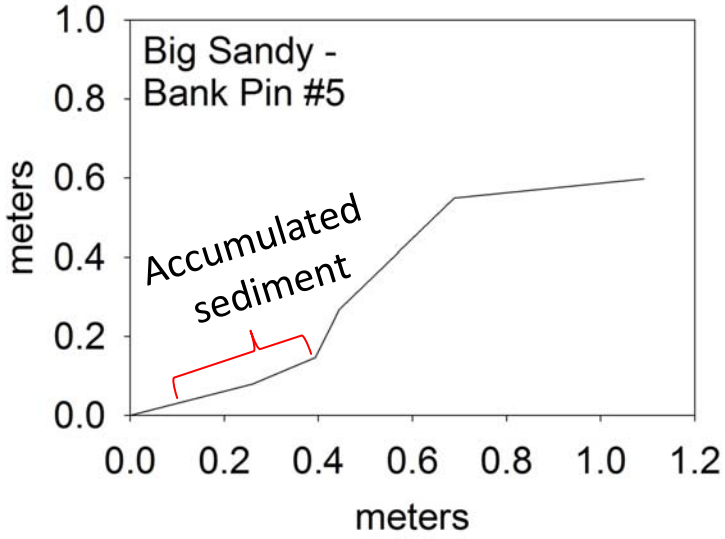
Conceptual model of localized sediment processes





Sediment accumulates at toe of banks during low flow

Its entrained and transported during high flow

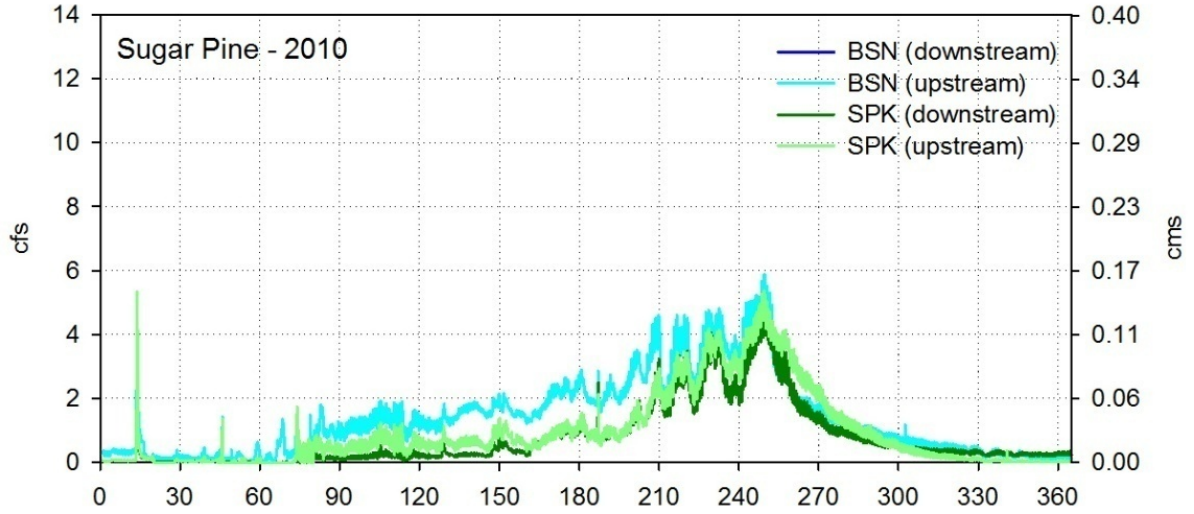


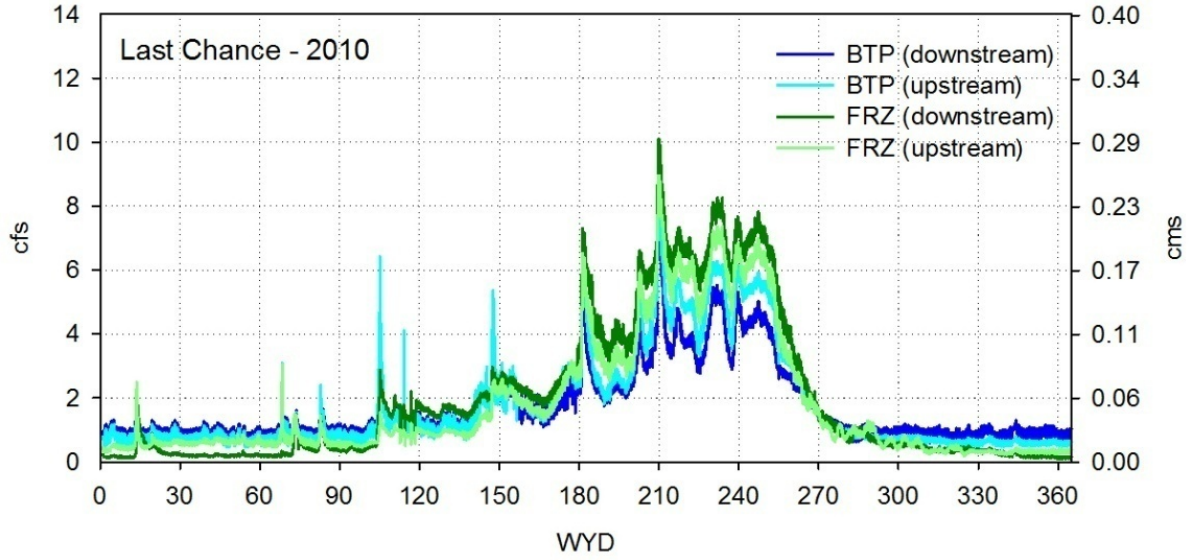
Discharge

Sensors show good agreement

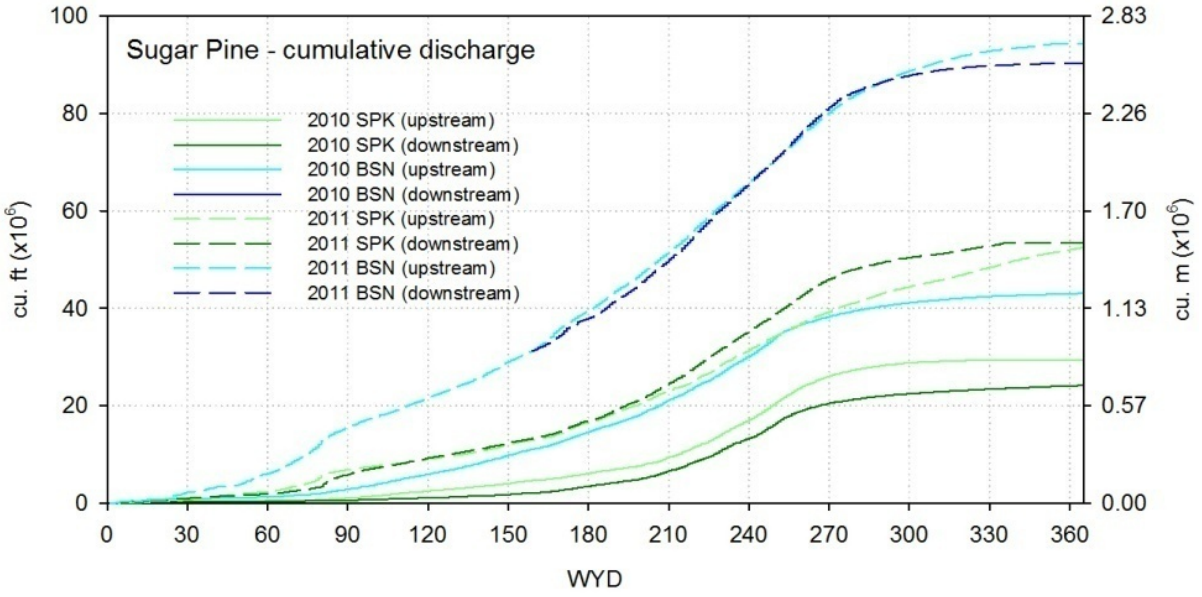
BSN and FRZ have higher peak flows

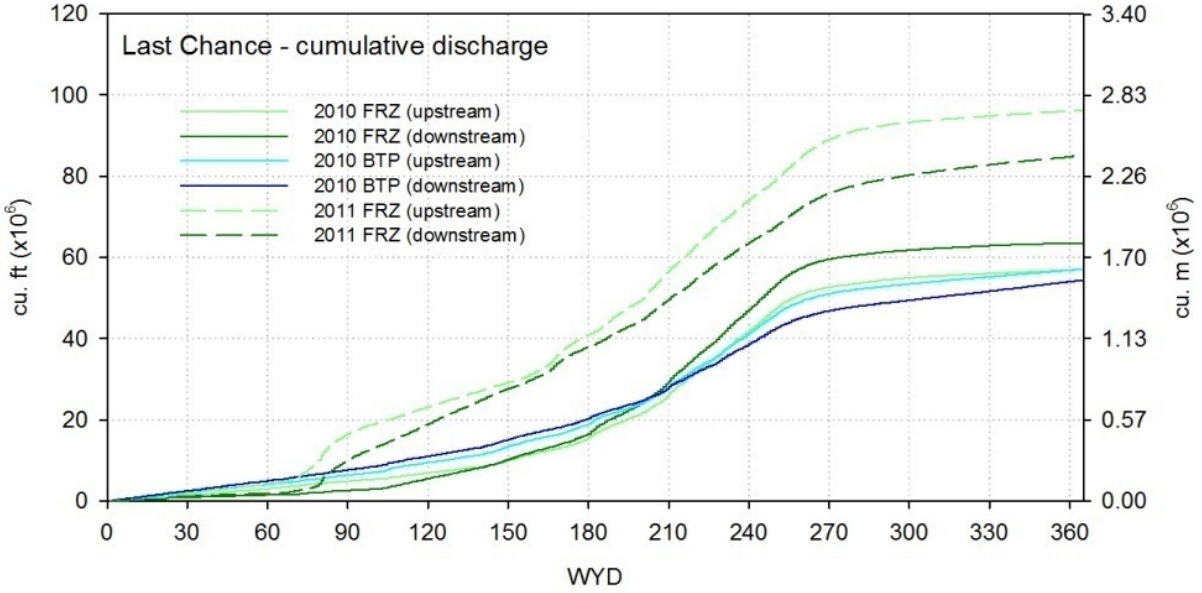
SPK and BTP have higher base flows – more groundwater dominated?





Discharge





WY 2011 a much wetter year than 2010

Currently finishing QA/QC of WY 2012 data

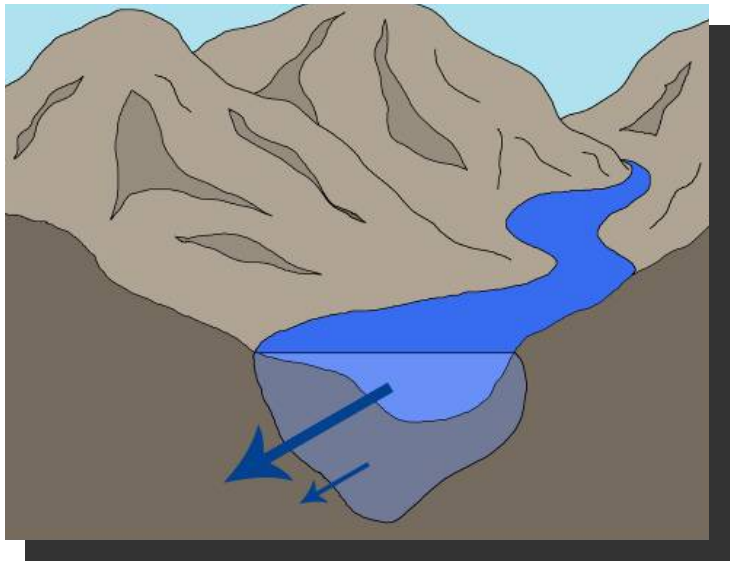
Discharge: challenges

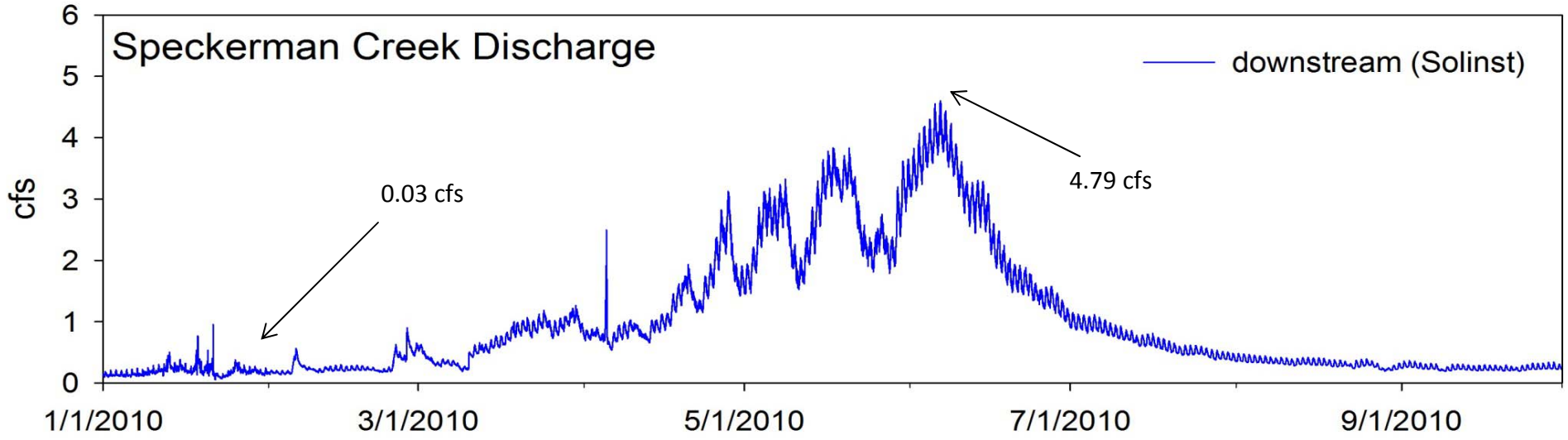
Pressure transducer and rating curve approach is problematic…

Orders of magnitude difference between base and peak flows

Subsurface flow

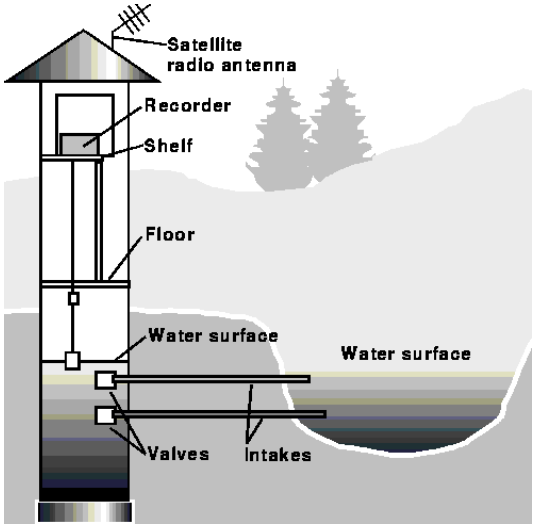
Potential for change in a natural channel cross-section



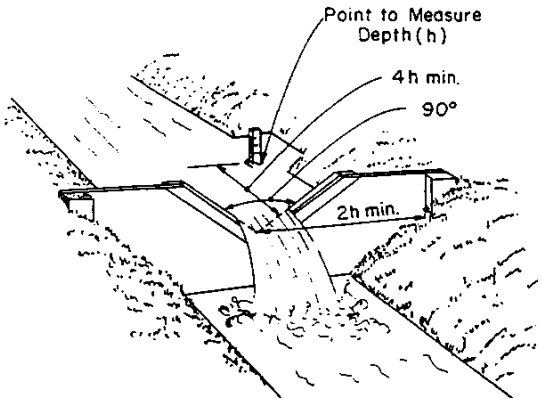


Numerous approaches but often..

- expensive install
- maintenance requirements
- personnel time required for rating curves
- biological concerns



http://virtual.yosemite.cc.ca.us/ghayes/images/Gage_Diagram.gif



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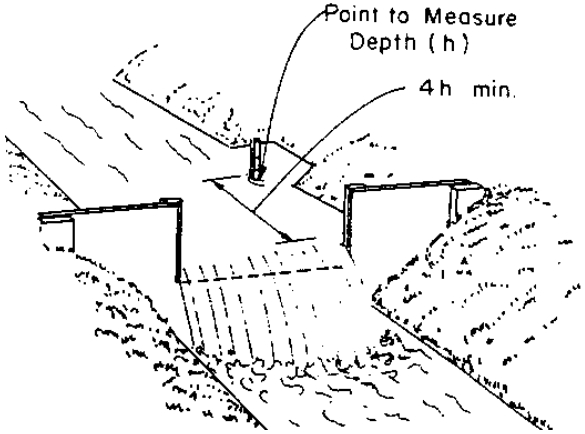

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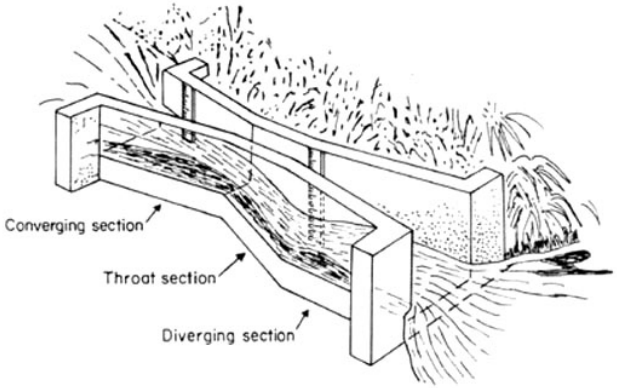
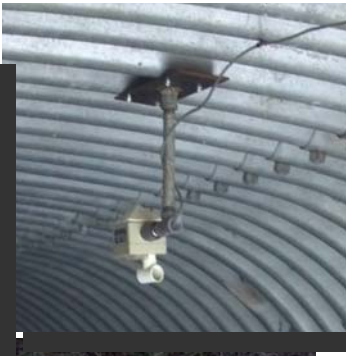


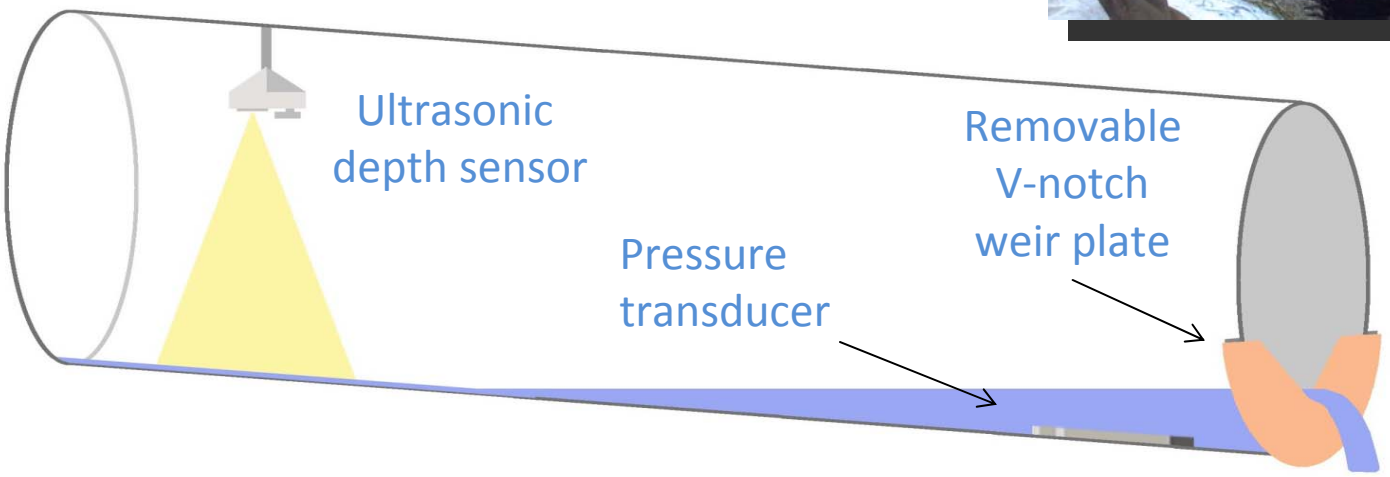
http://www.fao.org/docrep/T0848E/t0848e36.jpg

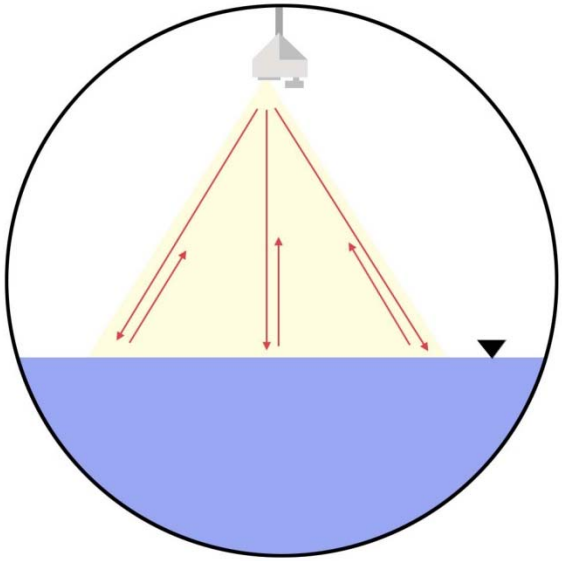
Solution: a two part approach….

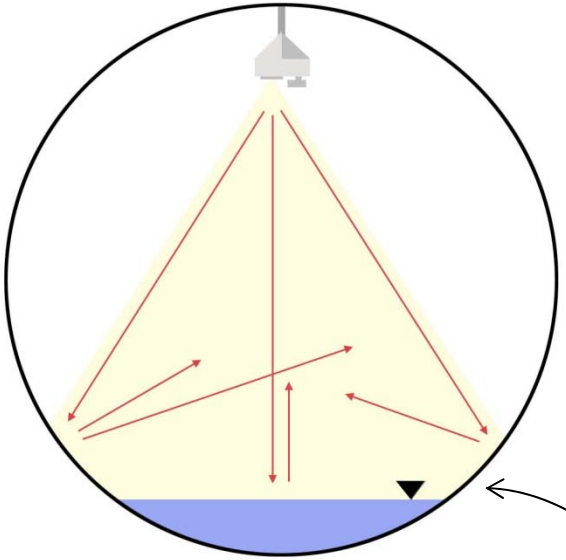
- High flows measured by ultrasonic depth sensor
- Low flows measured by seasonal V-notch weir
- Test site at Speckerman Creek -
  - *ultrasonic sensor (Jan 2011)*
  - *V-notch collar (Dec 2011)*
  - *plate placed (Jul 2012)*

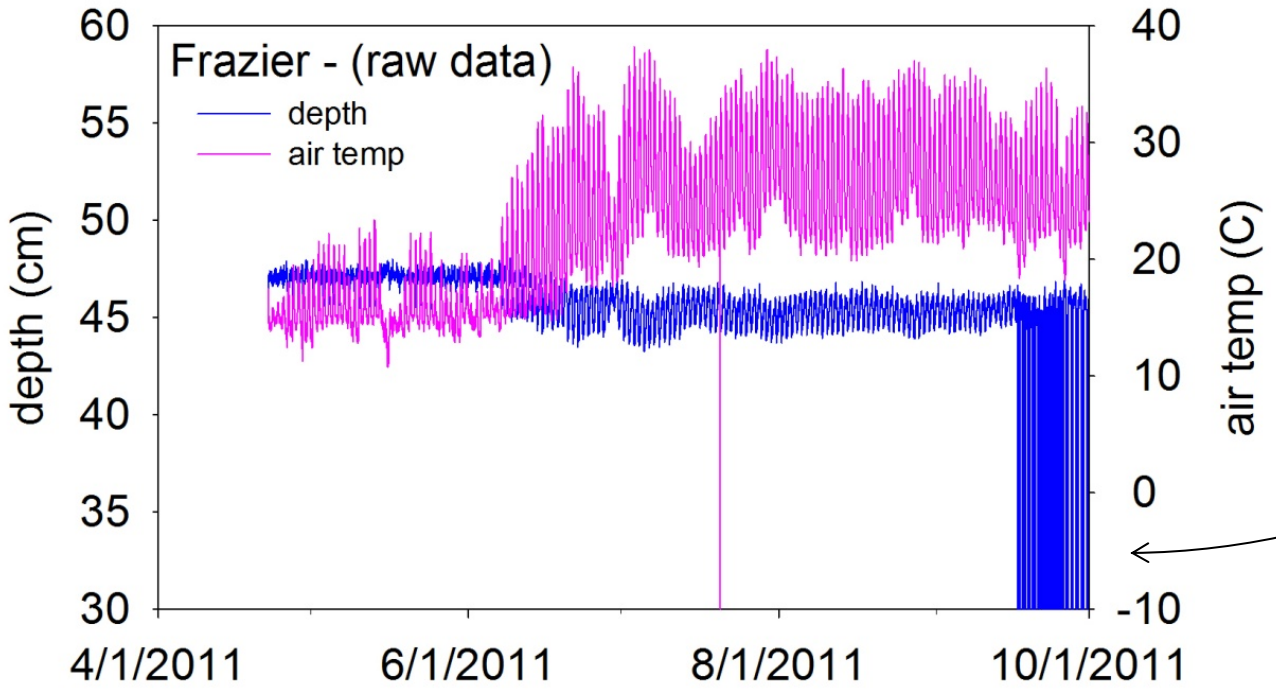


4 ft diameter corrugated steel culvert at road crossing









At low flows culvert sides may interfere with signal

Measuring low flows with V-notch solves this issue

Criteria for culvert:

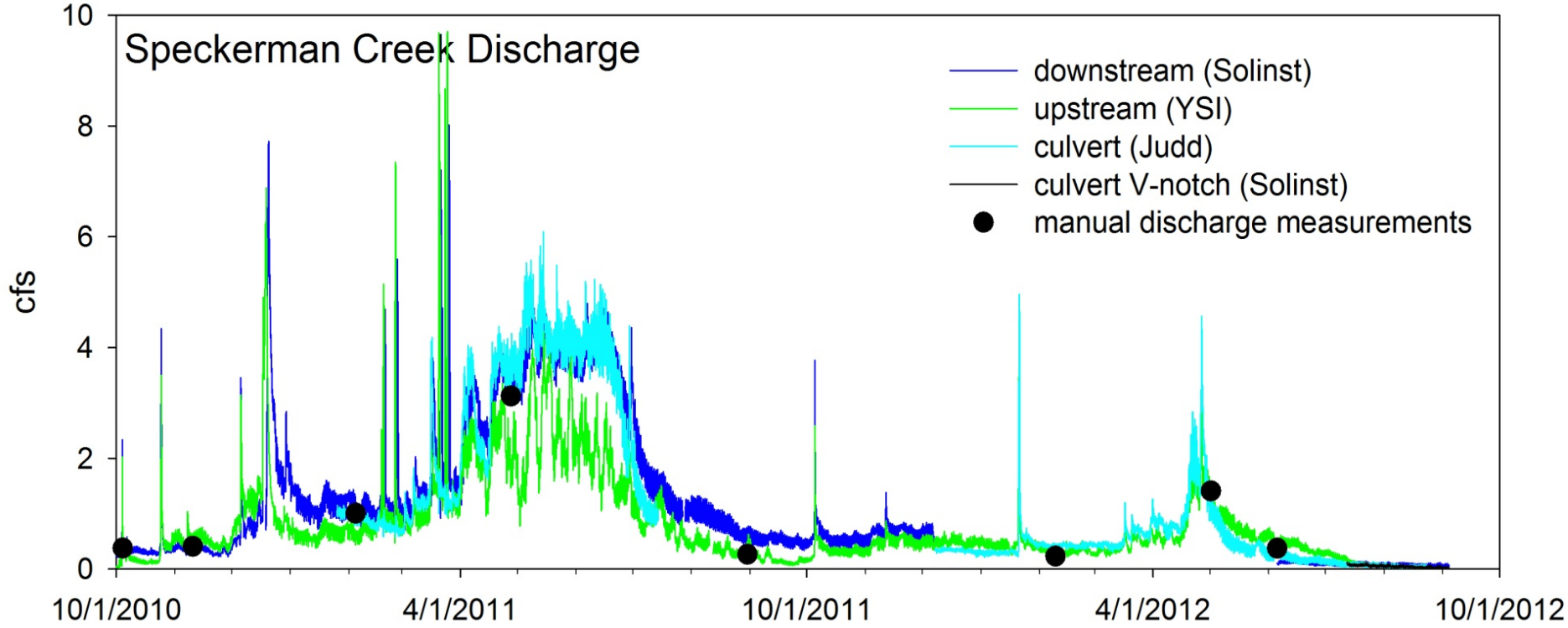
1. Closed bottom
2. Fill well compacted
3. Power or solar available
4. Suitable drop for weir

Benefits:

1. Cost
2. Minimal maintenance
   - -Sediment flushed out when plate removed
   - -Minimal debris movement at low flow when plate in place – free flowing during high flow season
3. Uses culvert geometry so rating curves not required
4. Plate can be installed after spawning season minimizing impacts to fish
5. Minimize permitting process

Discharge

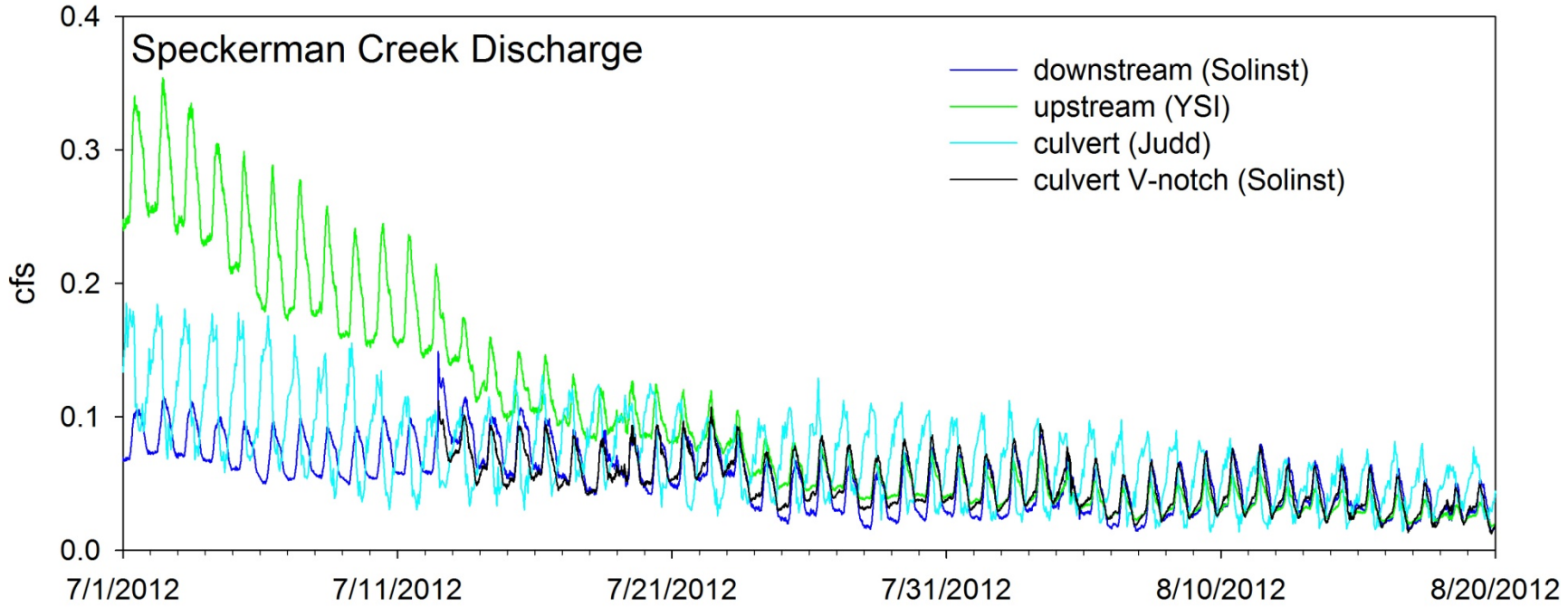
Both depth sensor and v-notch measurements match well with independent discharge readings



Discharge

Good agreement between various sensors

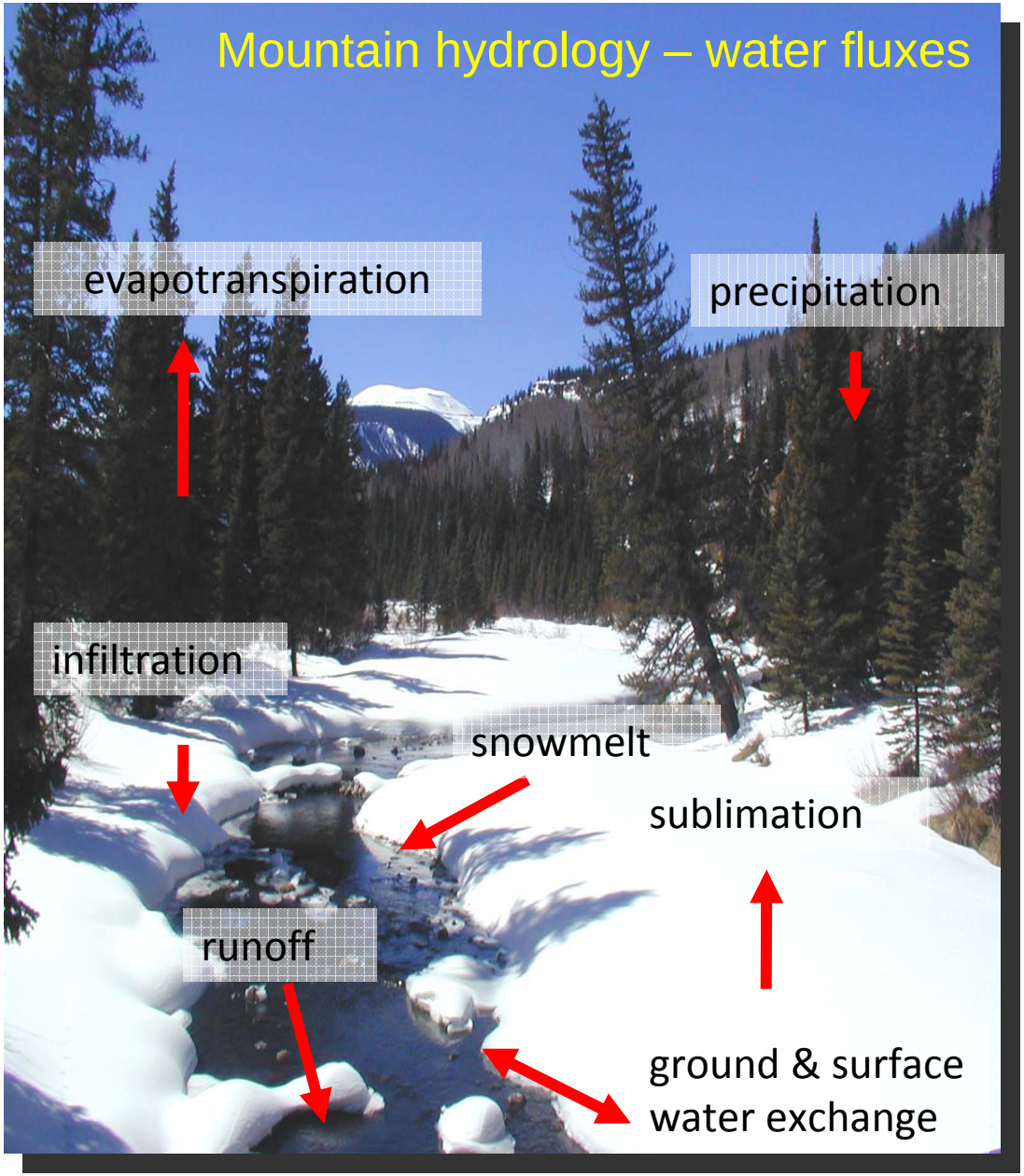
Sonic depth sensor also worked well for low flow in this catchment



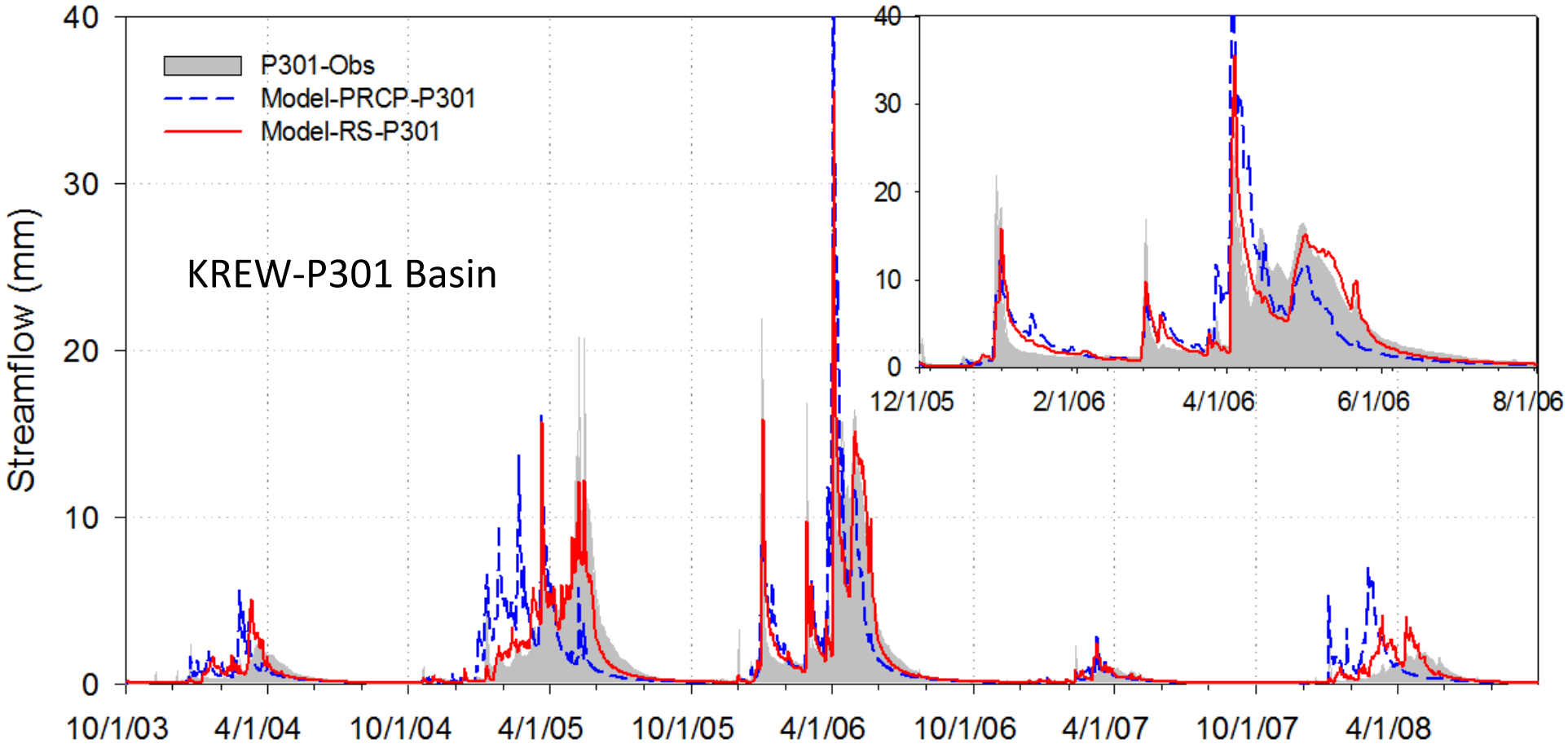
Hydrologic Modeling

Water Balance &
Energy Balance

RHESSys – Regional
Hydro-Ecological
Simulation System



Modeling challenges

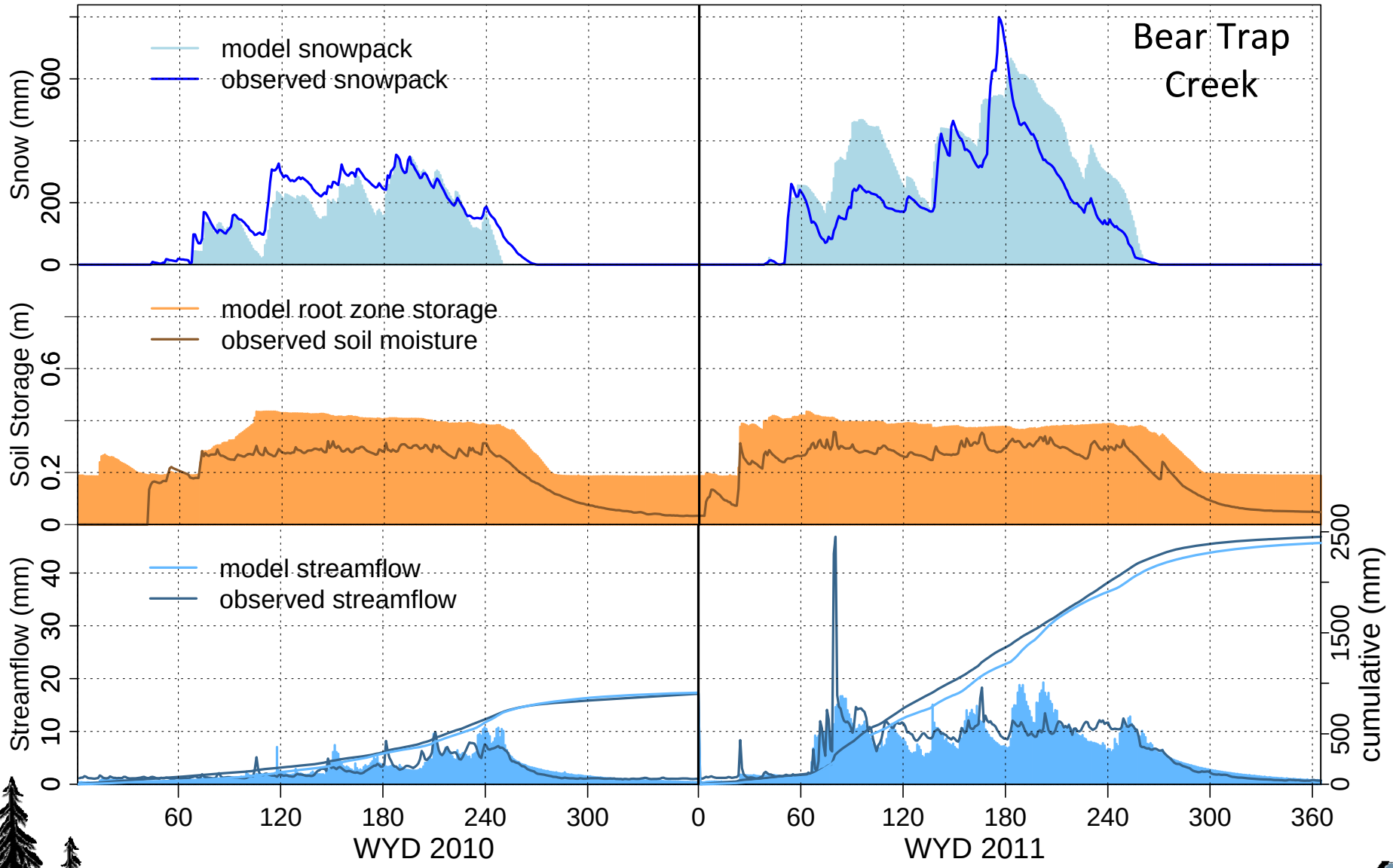


Snow/rain input (red) simulates better than single precipitation (blue)

Nash-Sutcliffe (NS) values:

P301	Precip - 0.50	Snow/Rain - 0.82
P303	Precip - 0.50	Snow/Rain - 0.80

Modeling results



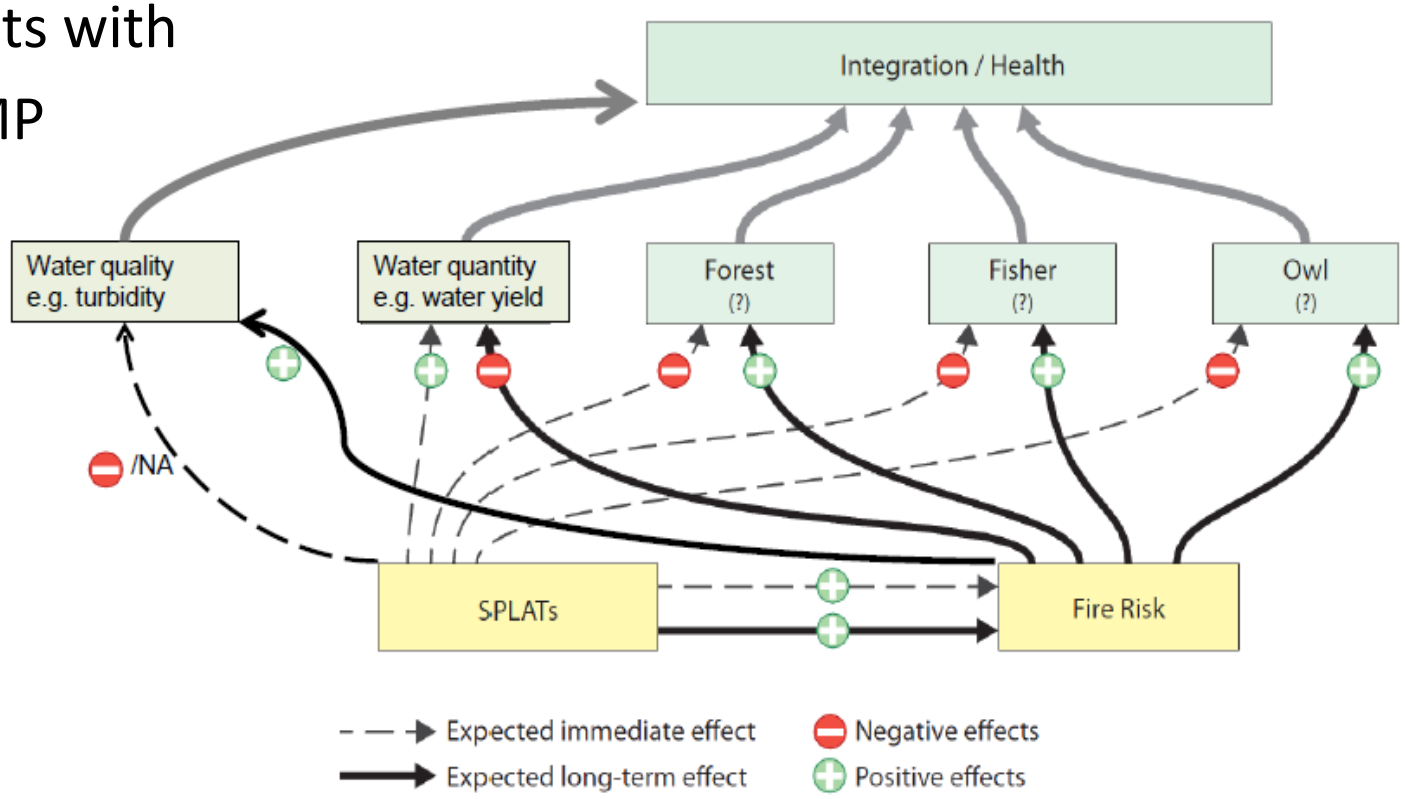
Modeling next steps

Refine parameters to optimize fit

Run model under various thinning and climate scenarios to see how water yield responds

Can we design forest treatments to optimize water yield or offset climate change response?

Integrate results with other SNAMP teams



Data sharing

http://cdec.water.ca.gov/

California Data Exchange Center

All met station data in real-time

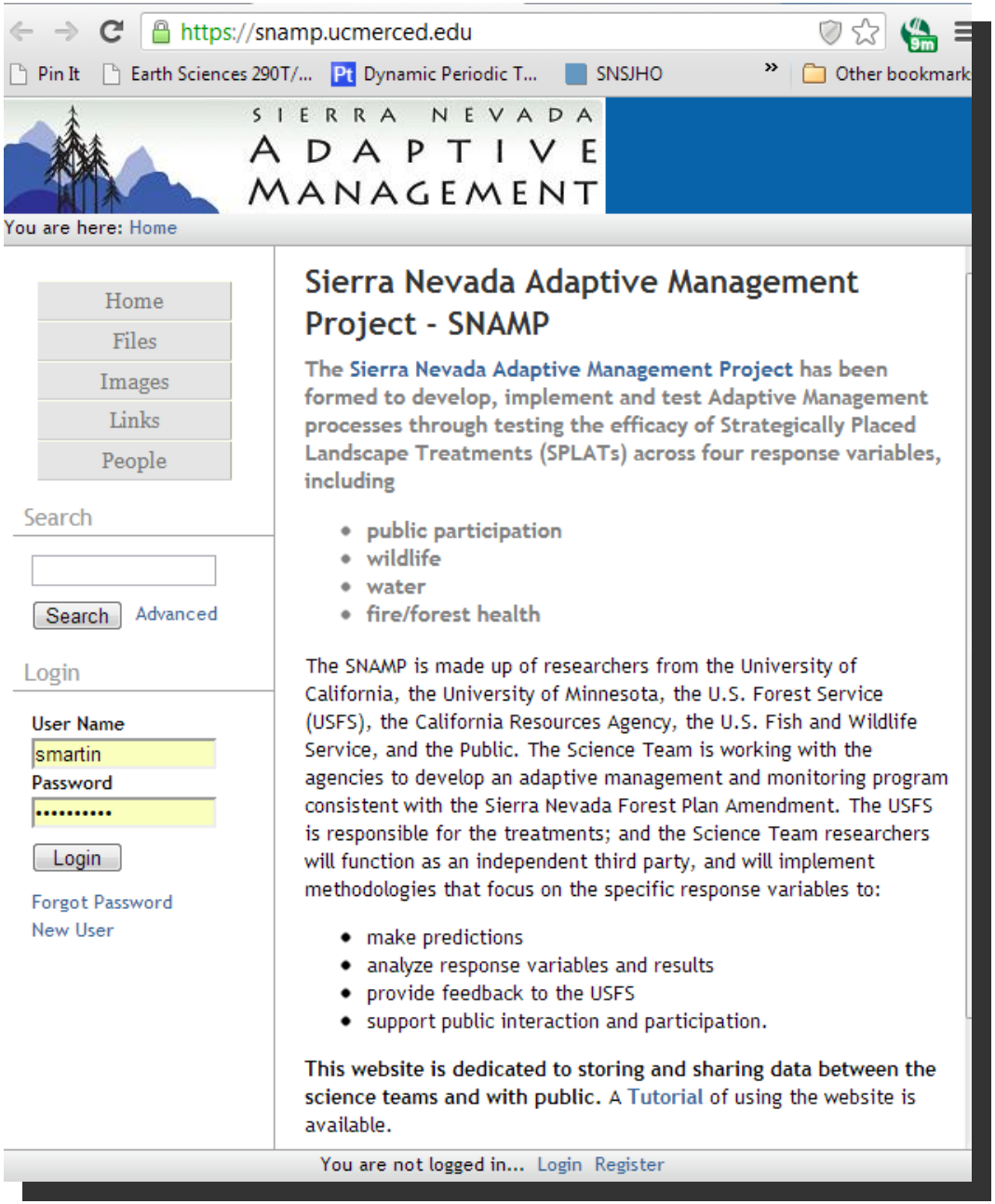
BSN – Big Sandy
FRS – Fresno Dome
BTP – Bear Trap
DPK – Duncan Peak

Data sharing

https://snamp.ucmerced.edu/

SNAMP Digital Library

Raw and QA/QC data
for all sites



A special thanks to……

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Funding Partners

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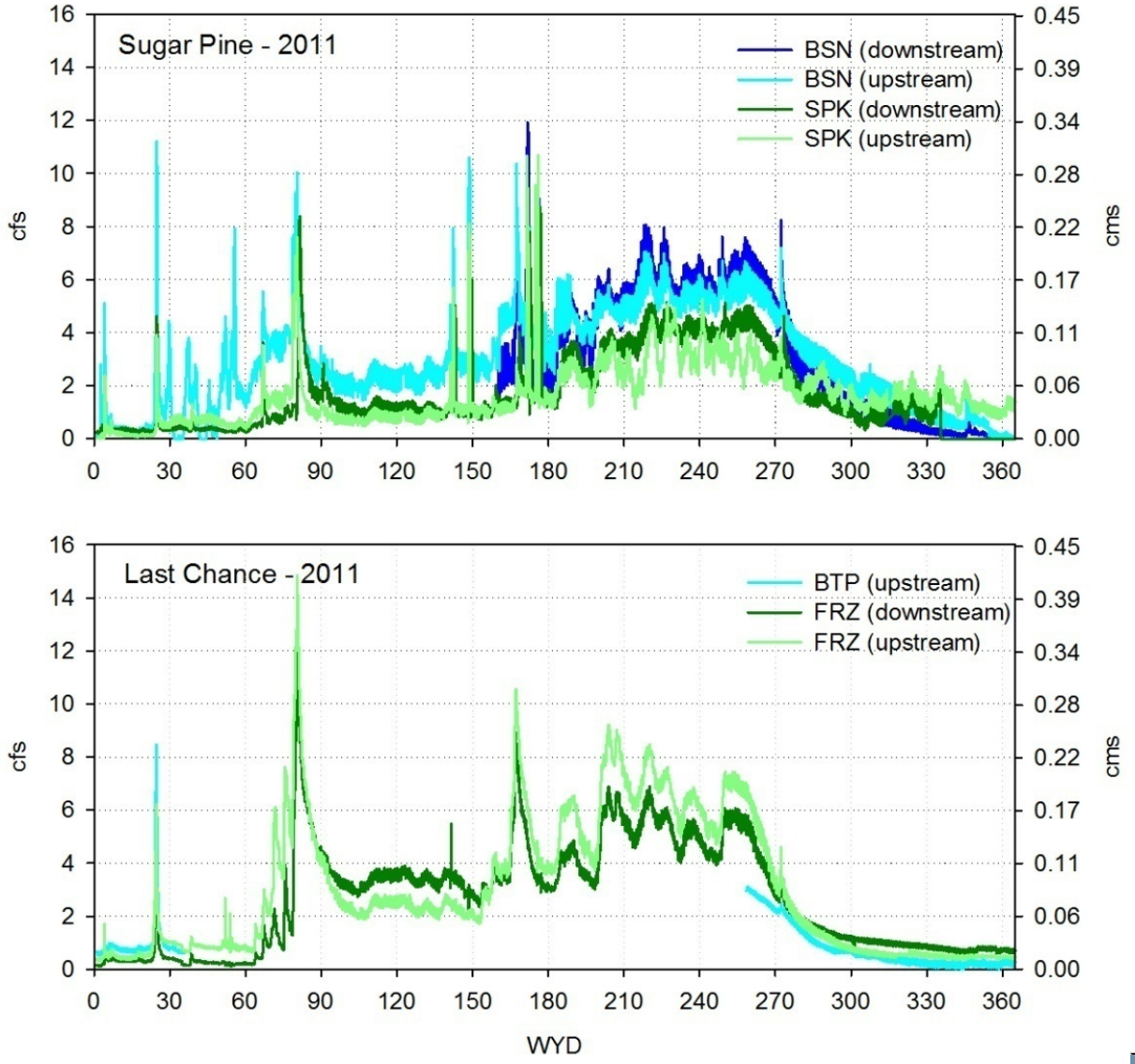
Discharge: results