DESIGNING MONITORING PROGRAMS TO EVALUATE BMP EFFECTIVENESS

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University of Wyoming
New Thinking

Applying knowledge to improve water quality
Northern Plains & Mountains
Regional Water Program
A Partnership of USDA CSREES
& Land Grant Colleges and Universities

UtahState University

Overview

BMP Monitoring Guidance Document for Stream Systems

- Lessons learned
  - CEAP

    Conservation Effects Assessment Project
- The Guidance Document

  Water Quality Monitoring Training Resources
  - Components and key links…
  - Next steps

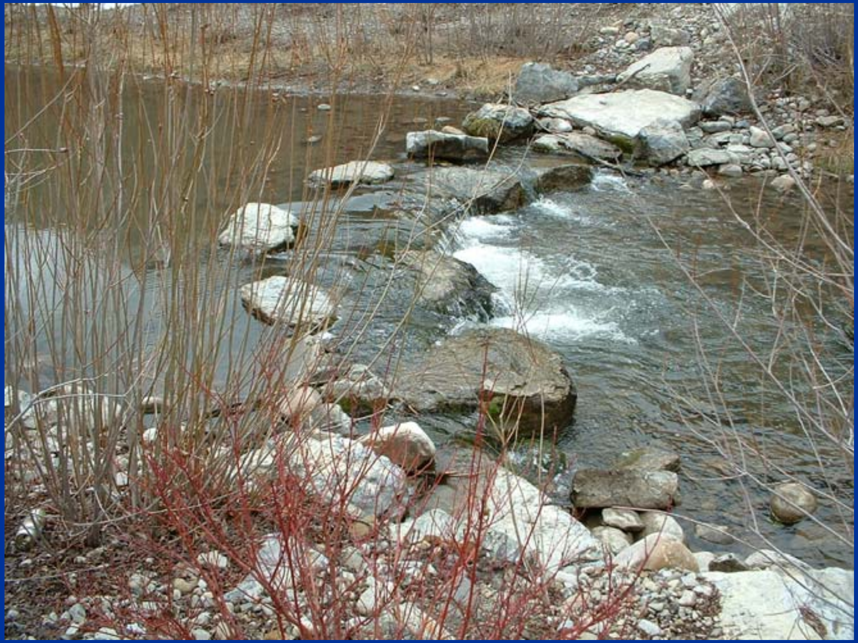
Examples from the Little Bear River CEAP Project

Little Bear Watershed

- 74,000 ha (182,000 acres)
  - 70% range / wild lands
  - 20% irrigated land
  - 5% cropland
  - 5% urban and other
- High Elevation Watershed: 4,400 to 9,000 ft
  - Precipitation: winter snow, summer storms
  - 32% pop growth between 90-2000
- Two main drainages….2 impoundments.
  - 122 miles of perennial stream
  - 228 miles of intermittent streams

Pre-treatment problems:
Bank erosion, manure management, flood irrigation



Treatments:

- bank stabilization,
- river reach restoration,
- off-stream watering,
- improved manure and water management

Common problems in BMP monitoring programs:

- Failure to design monitoring plan around BMP objectives
- A failure to understand pollutant pathways and transformations and sources of variability in these dynamic system.
- Tend to draw on a limited set or inappropriate approaches

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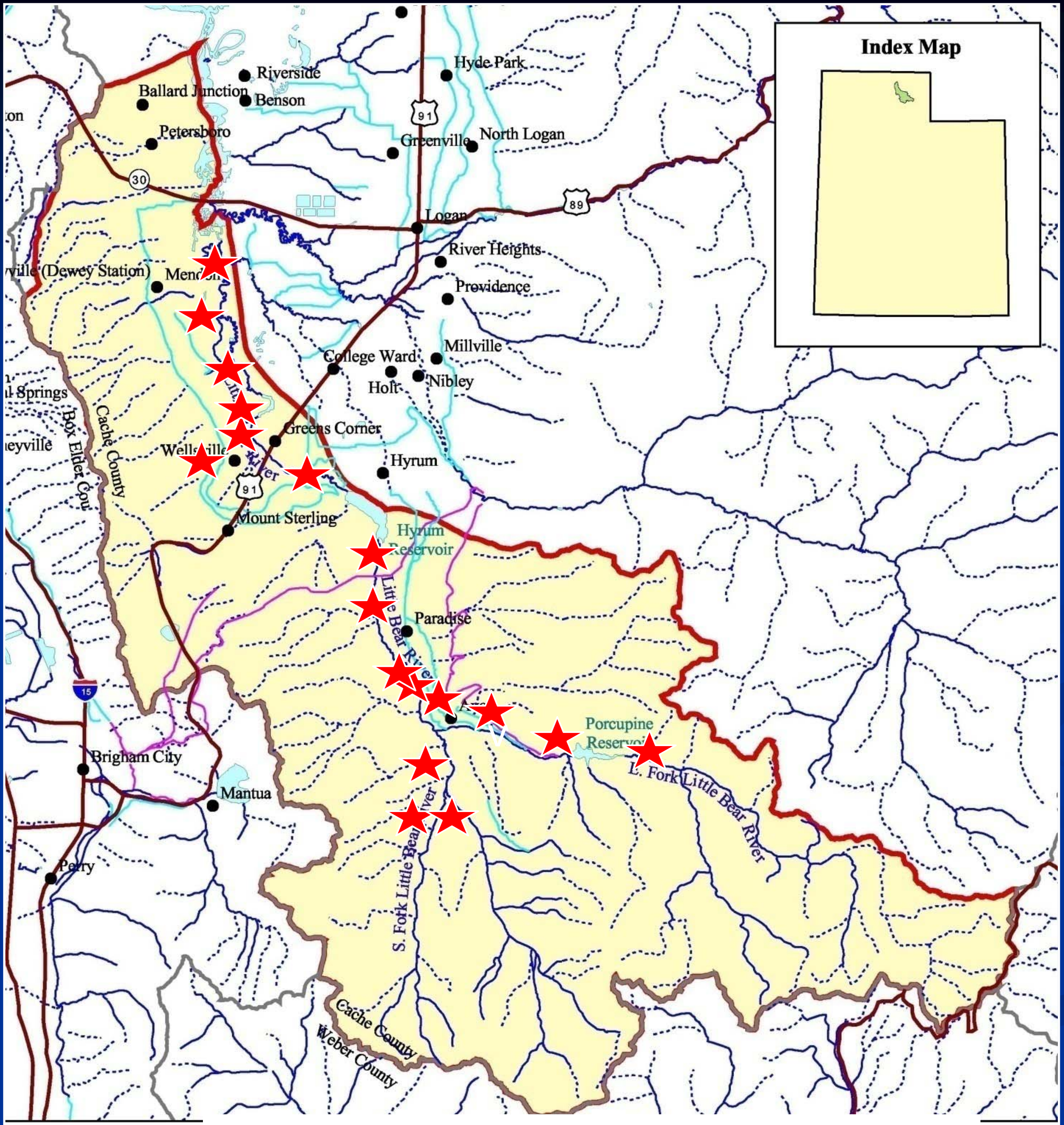

Little Bear River Watershed, Utah

Total Observations at Watershed Outlet

	Discharge	Total phosphorus
1976 - 2004:	162	241
1994 - 2004:	72	99
1994	11	13
1995	10	13
1996	10	13
1997	11	4
1998	6	10
1999	7	10
2000	6	5
2001	4	7
2002	2	8
2003	4	8
2004	1	8

Number of observations each year

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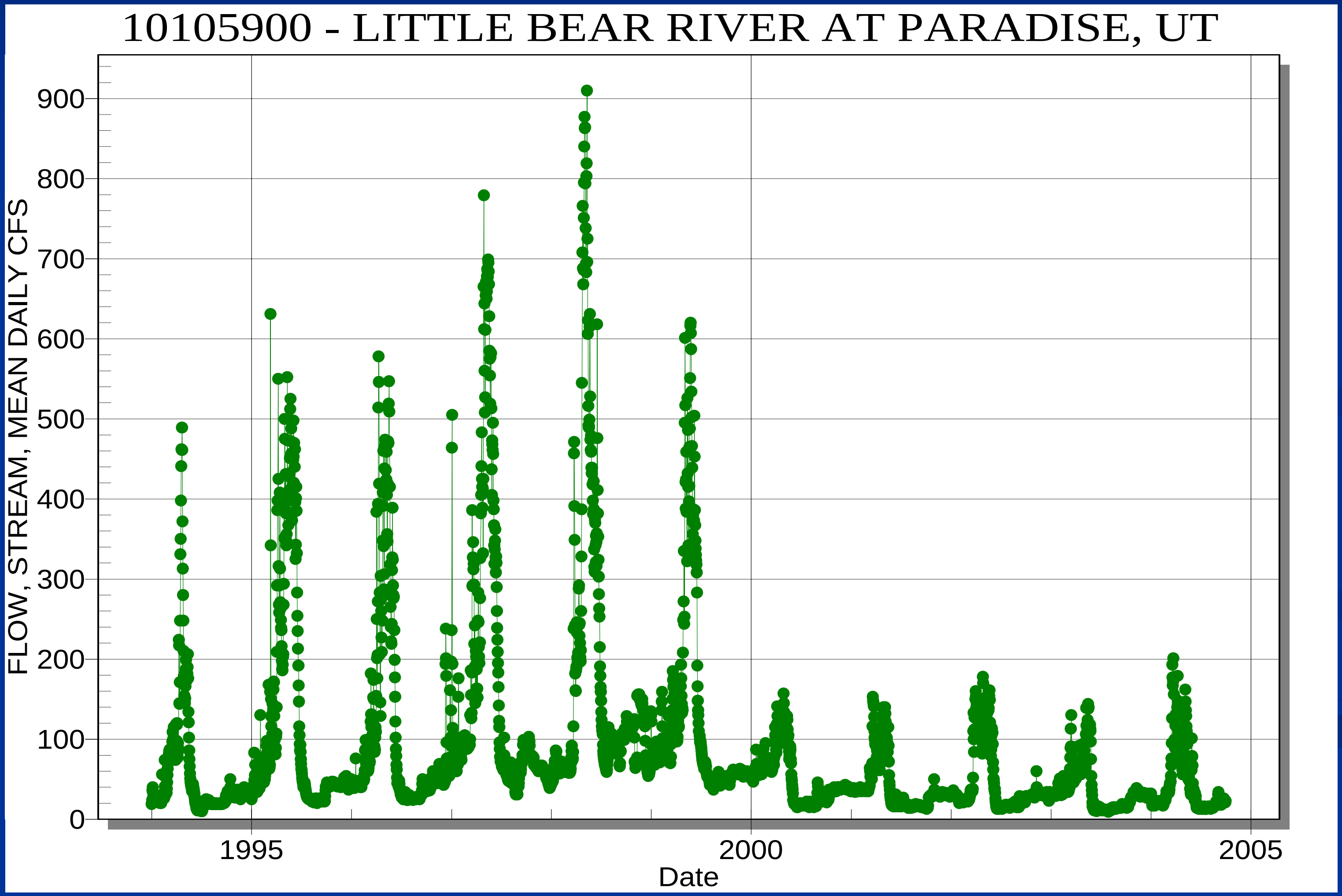
Understanding natural variability – annual variation



Since 2005, measure flow and turbidity at 30 minute intervals

Stage recording devices to estimate discharge

http://www.campbellsci.com

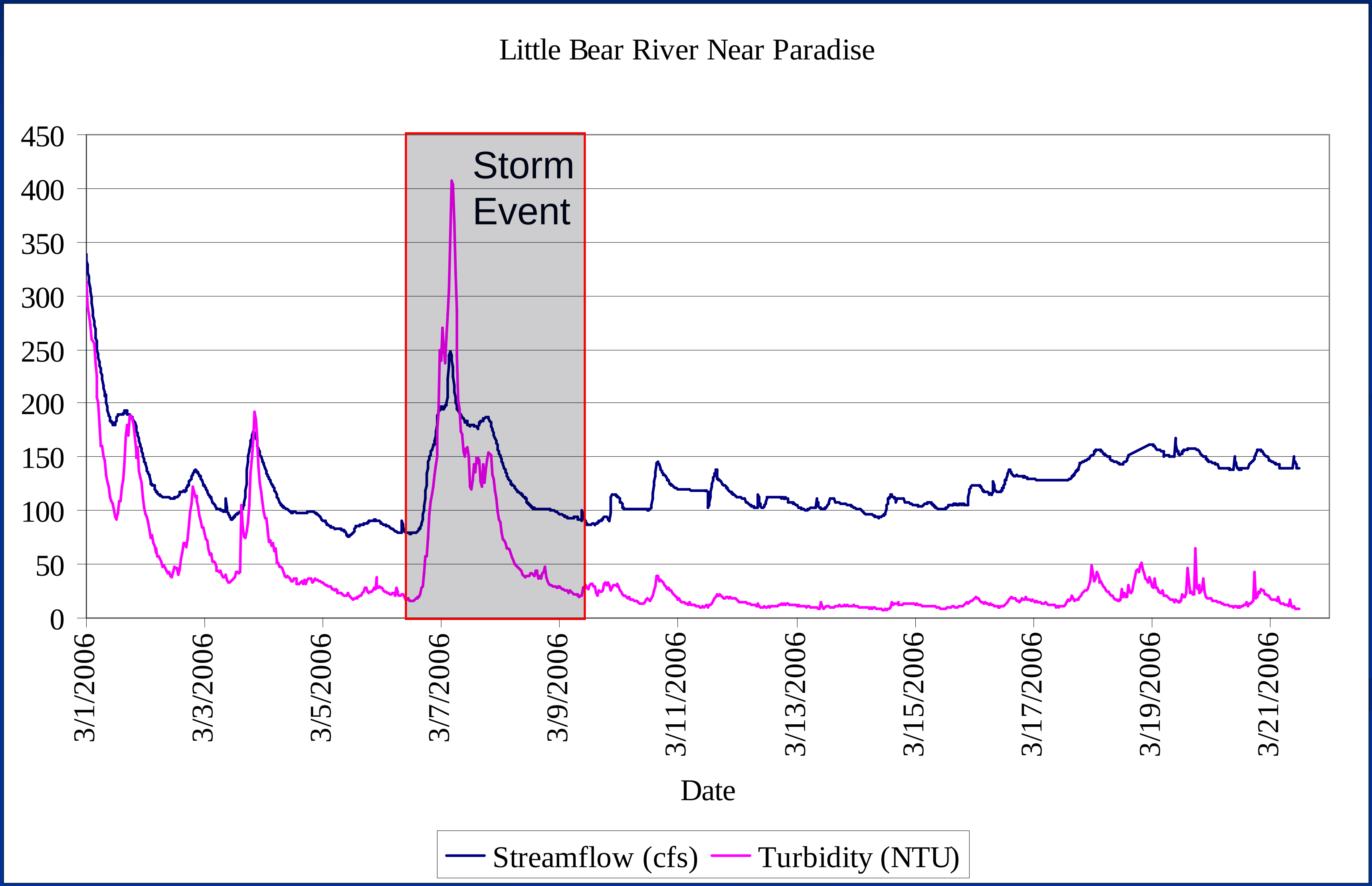
Turbidity sensors

http://www.ftsinc.com/

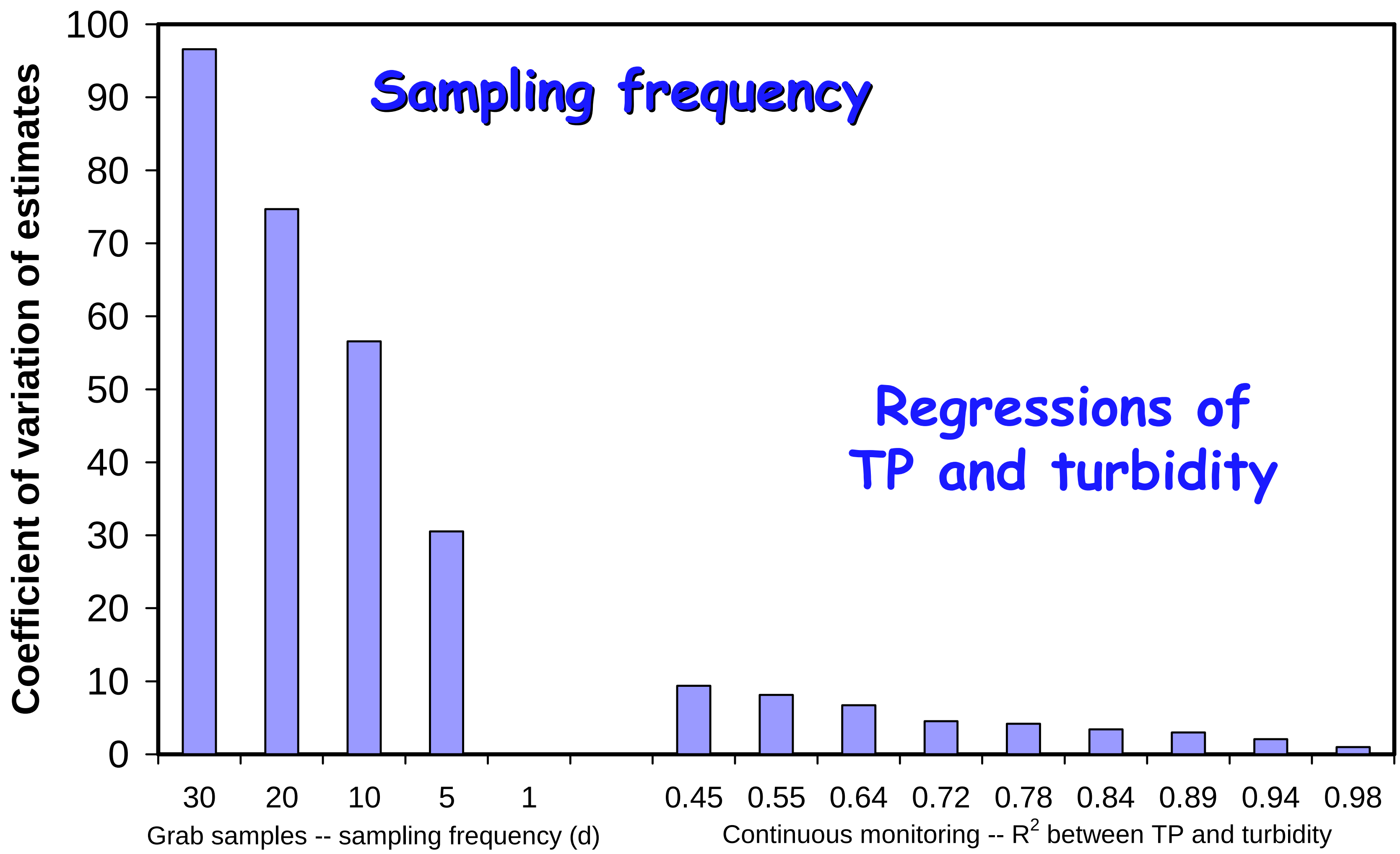
Dataloggers and telemetry equipment

http://www.campbellsci.com

Capturing pollutant movement from source to waterbody.



The relative importance of different sources of variability



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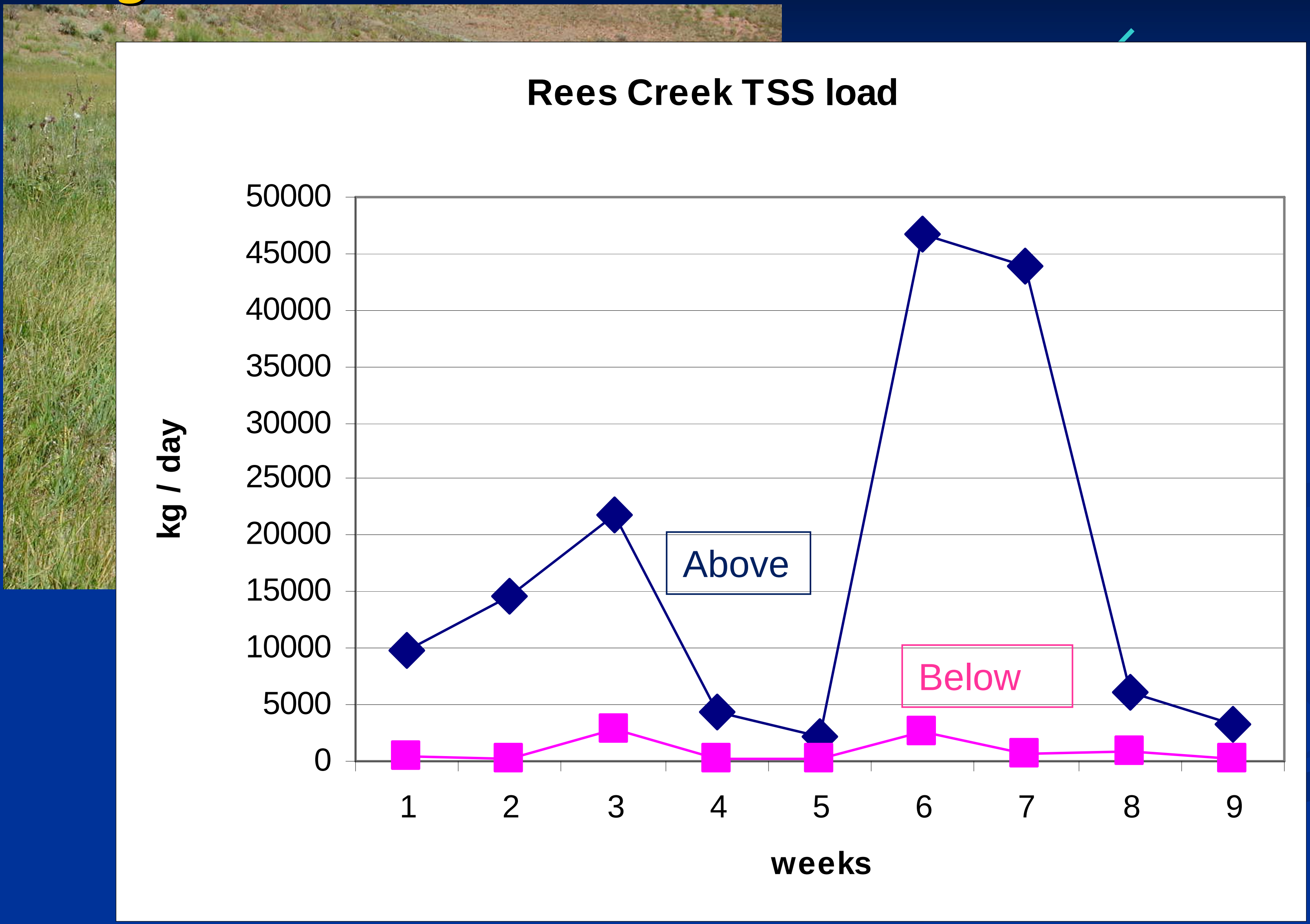
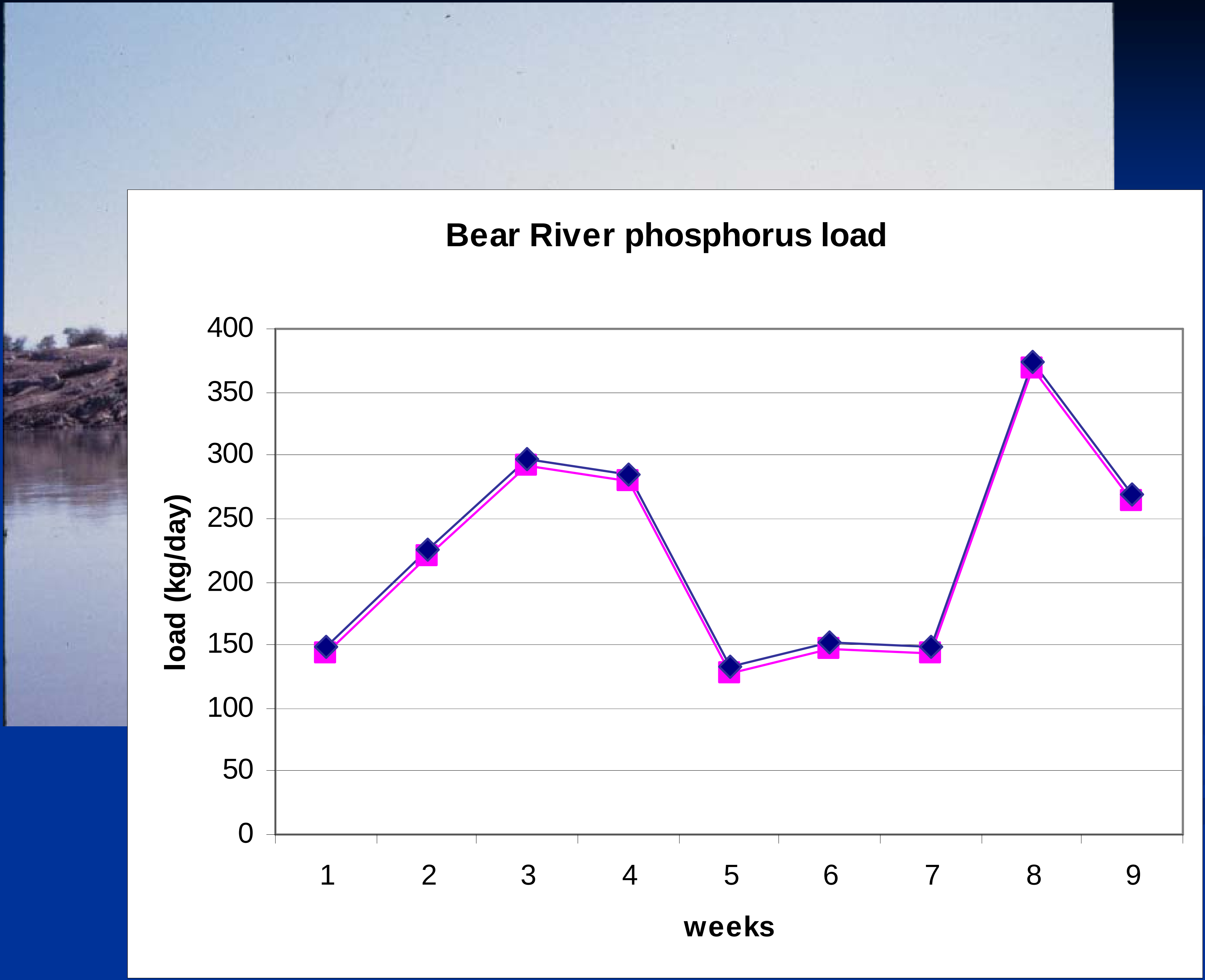
Problems with "one-size-fits-all" monitoring design




Bear River phosphorus load
load (kg/day)
0
50
100
150
200
250
300
350
400
1
2
3
4
5
6
7
8
9
weeks

DRAFT

Best Management Practices Monitoring Guidance Document

For Stream Systems

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Northern Plains & Mountains Regional Water Program

WATER QUALITY

Water is Life : Quality Matters

Considerations and decisions necessary as a project is first being considered.

NOT a "how-to" manual of protocols

Document in review
Training workshops underway

Target Audience

- State Environmental Agencies
- Conservation Groups
- Land Management Agencies
- Volunteer Monitoring Groups

What is your monitoring objective?

- ✓ Long term trends?
- ✓ PDES compliance?
- ✓ Educational?
- ✓ Assessment for impairment?
- ✓ Track response from an implementation?

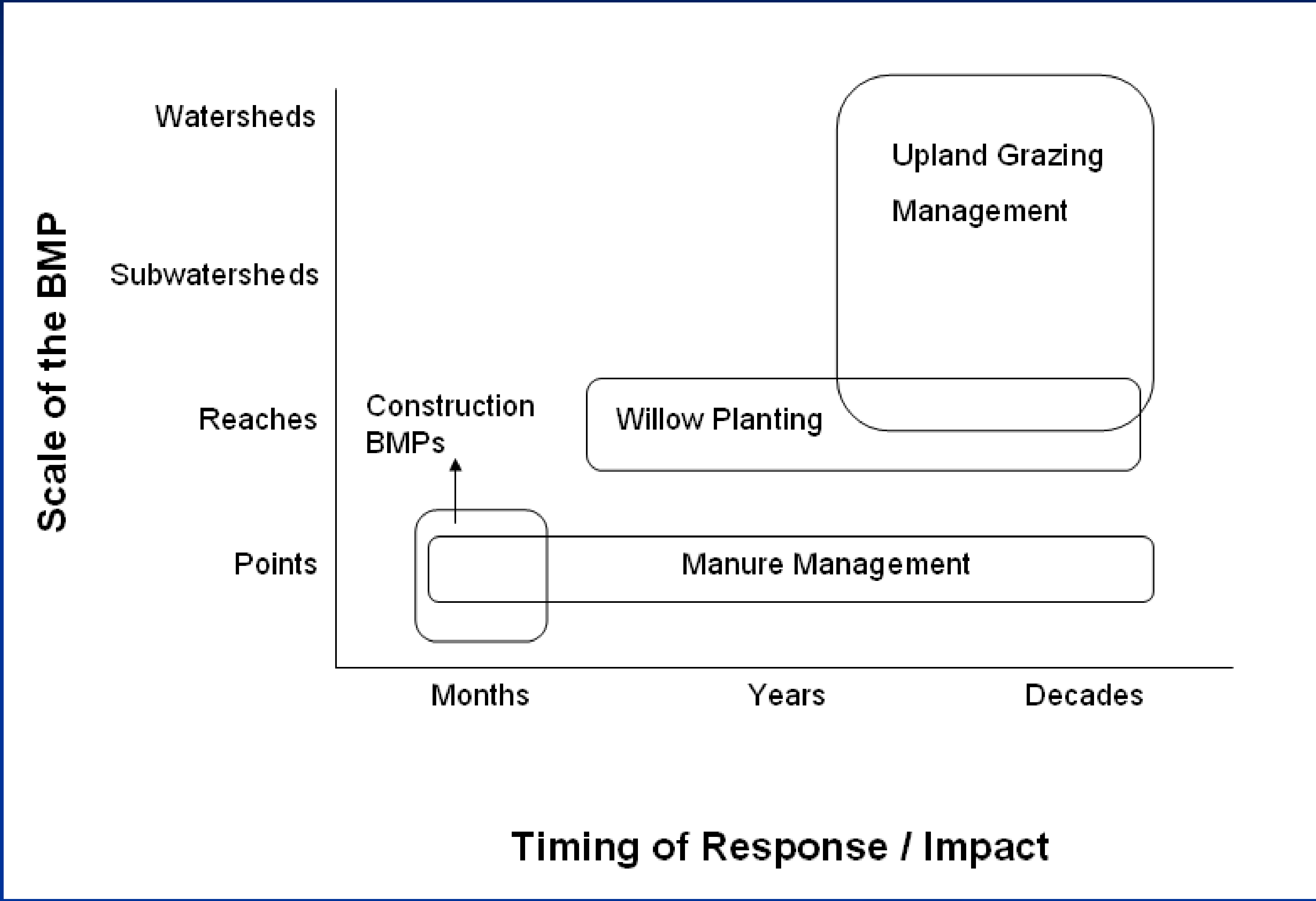
How do pollutants "behave" within your watershed?

- ✓ How does the pollutant move from the source to the waterbody?
- ✓ How is the pollutant processed or transformed within a waterbody?
- ✓ What is the natural variability of the pollutant? Will concentrations change throughout a season? Throughout a day?
- ✓ What long term changes within your watershed may also affect this pollutant?
- ✓ What else must be monitored to help interpret your data?

What to monitor?

- ✓ Monitor the pollutant(s) of concern?
- ✓ Monitor a "surrogate" variable?
- ✓ Monitor a response variables?
- ✓ Monitor the impacted beneficial use?
- ✓ Monitor the BMP itself?
- ✓ Monitor human behavior?
- ✓ Model the response to a BMP implementation.
- ✓ Collect other data necessary to interpret monitoring results OR calibrate and validate the model?

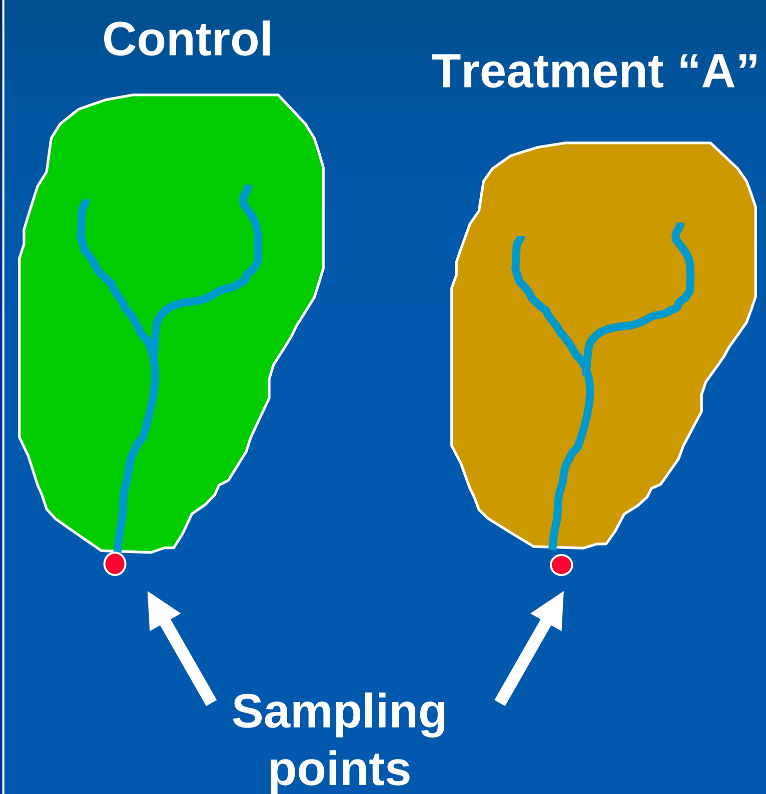
Where and when to monitor?



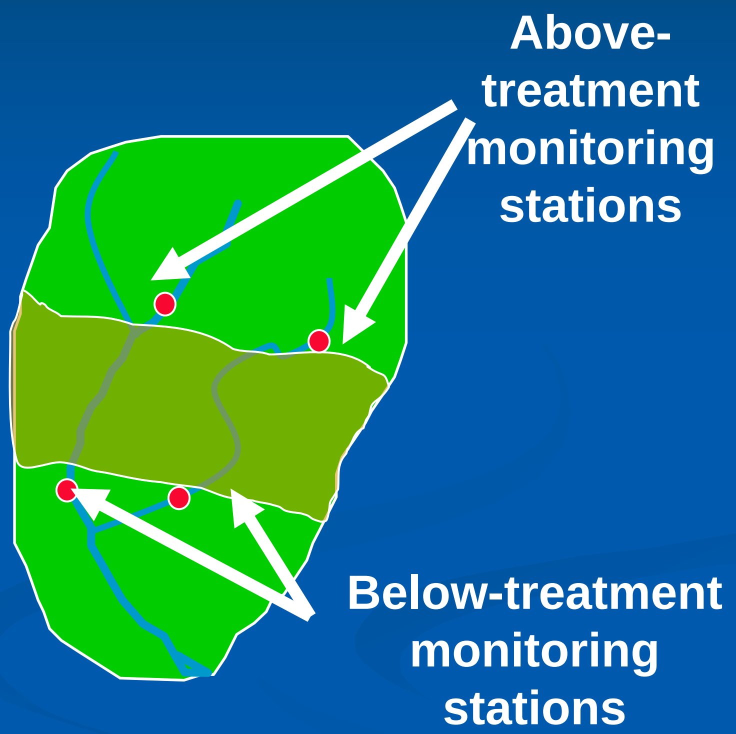
How to monitor?

- ✓ Points in time versus continuous?
- ✓ Integrated versus grab samples?
- ✓ Consider:
  - Cost
  - Skill and training required
  - Accessibility of sites

Choose appropriate monitoring or modeling



BACI Design



Above and below treatment design

Links to model resources

Pollutant	Direct Monitoring	Surrogate Monitoring	Other important variables *	Response variables	Models
Temperature	Probes, launched monitors (e.g. hobo), and direct measurements	Light / shading, ground water signal (stable isotope variables)	Air temperature	Algae, macros, and fish	CEQual WASP(7) SNTEMP (USGS)
Dissolved Oxygen (DO)	Probes and direct measurements	Temperature, redox, and Flow/temperature/algal biomass	Temperature will affect percent saturation	Macros and fish	Streeter Phelps
Nutrients (phosphorus and nitrogen)	Grab samples and integrated samples In some cases use probes, or streamside auto-analyzers to collect surrogate samples	Turbidity or sediment	pH, temperature, and DO might affect the solubility of phosphorus	Algae, macros, and fish	UAFRI SWAT QUAL2K
Sediment	Grab samples and integrated samples	Turbidity		Physical characteristics, embeddedness, macros, and algae	PSIAC AgNPS SWAT KINEROS2
Salts / TDS	Probes and grab samples	Riparian vegetation		Macros and fish	QUAL2K
Pathogens	Grab samples and integrated samples	Fecal Coliform Bacteria, *E.coli*	Turbidity, nutrients		
Metals	Grabs samples	Bioaccumulation in living organisms	DO might affect total hardness	Bacteria in the sediments	
Organics	Grabs samples	Bioaccumulation in living organisms		Bacteria in the sediments	

Table of Contents

The road to more effective monitoring….

- Monitoring plans require careful thought before anything is implemented.
- Consider how the data will be used to demonstrate change.
- Use your understanding of your watershed and how the pollutants of concern behave to target monitoring most effectively
- Use different approaches for different BMPs

Next Steps

- Finalizing document & review process
- Available as a document & online as pdf
- Northern Plains and Mountains Website
  http://region8water.colostate.edu/

- Links to "key" information
  - models
  - websites
  - water quality standards


Thank You
Questions?