Effective Water Quality BMP Monitoring Tools

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

Overview

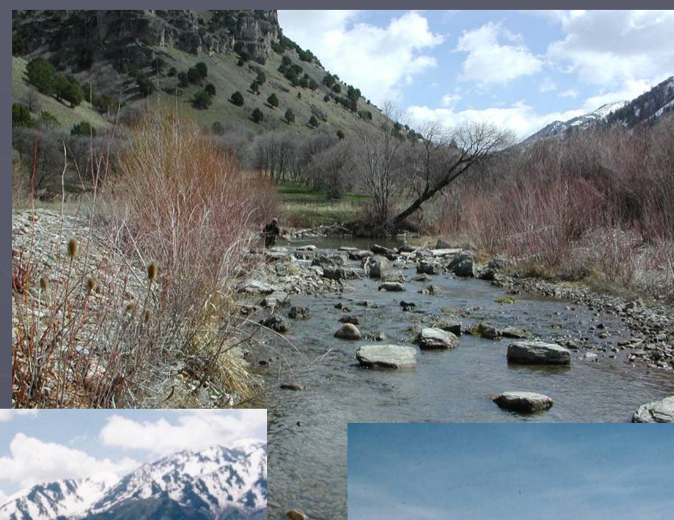
BMP Monitoring Guidance Document for Stream Systems

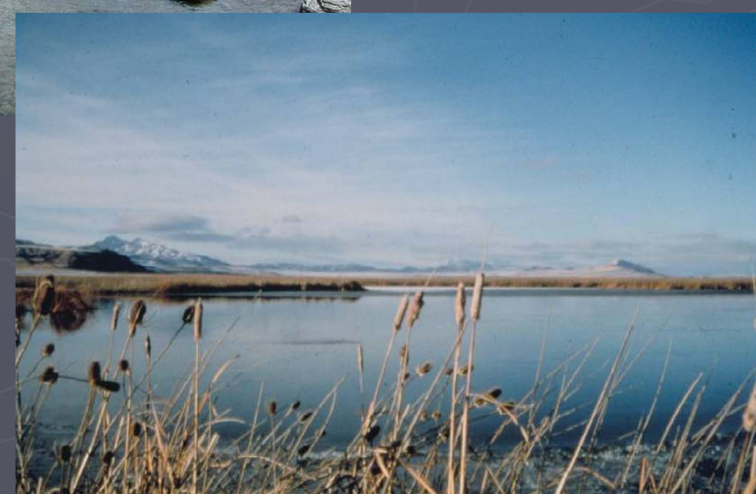
- Lessons learned
  - CEAP

    Conservation Effects Assessment Project
- The Guidance Document & Tools

    Water Quality Monitoring Training Resources
  - Components and key links…

Examples from the
Little Bear River CEAP Project

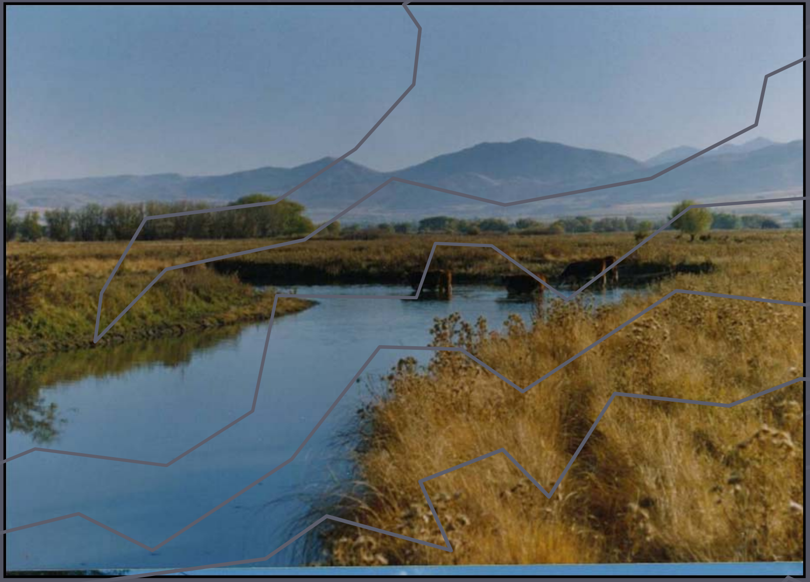




Little Bear Watershed

- 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

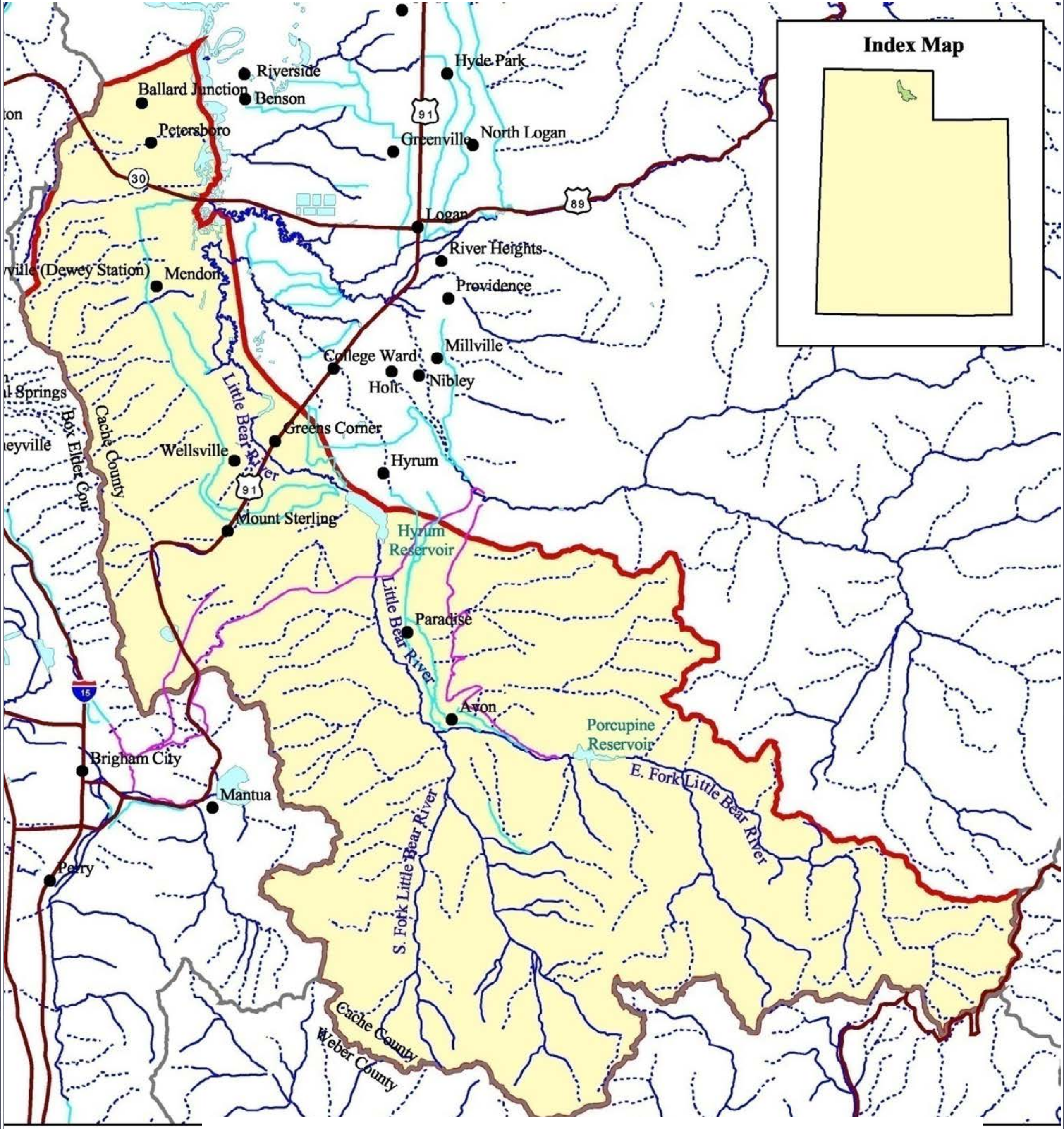
Common problems in BMP monitoring programs:

- 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

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



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

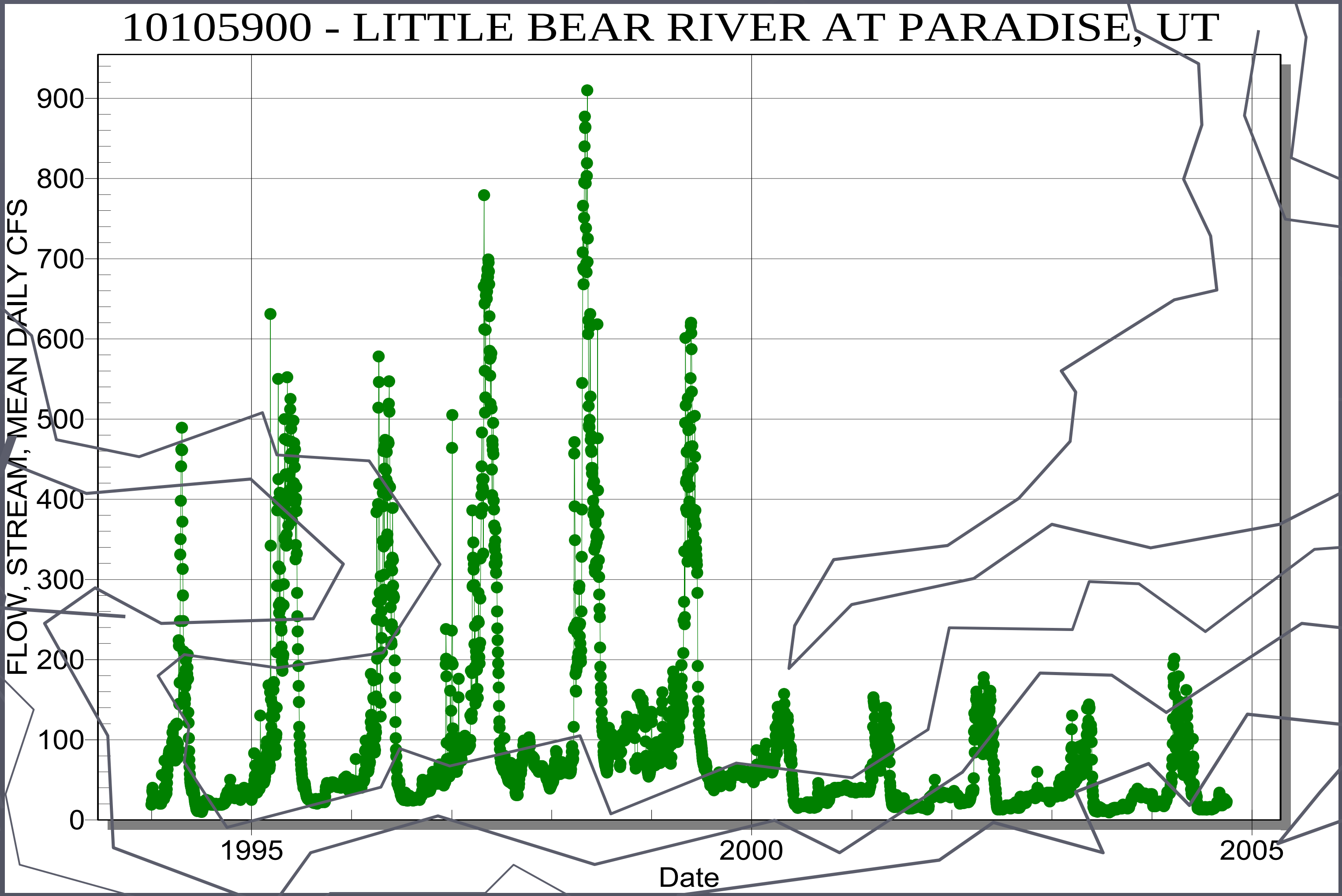
Number of observations each year

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

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

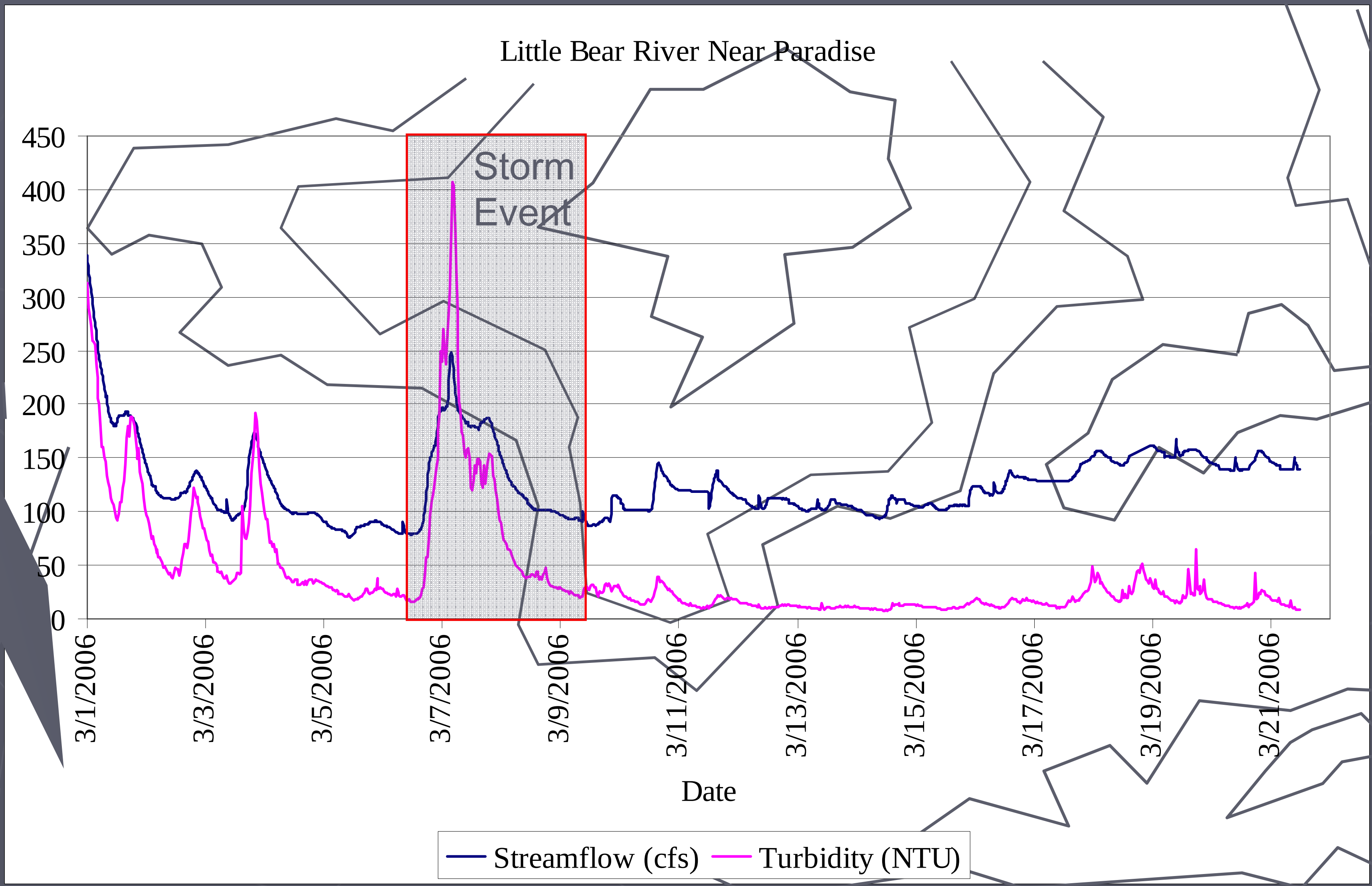
Turbidity sensors

http://www.ftsinc.com/

Dataloggers and telemetry equipment

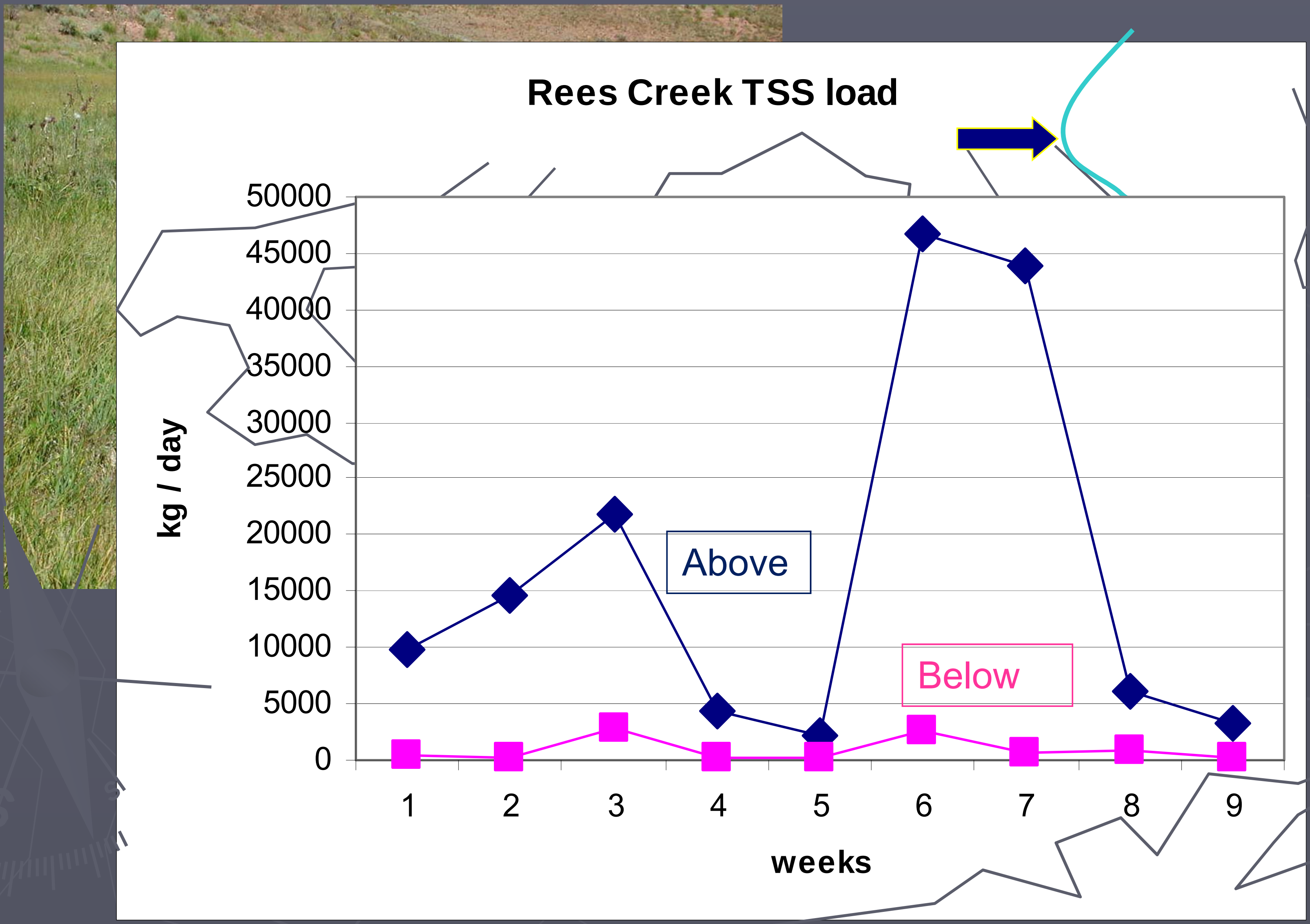
http://www.campbellsci.com

Capturing pollutant movement from source to waterbody.



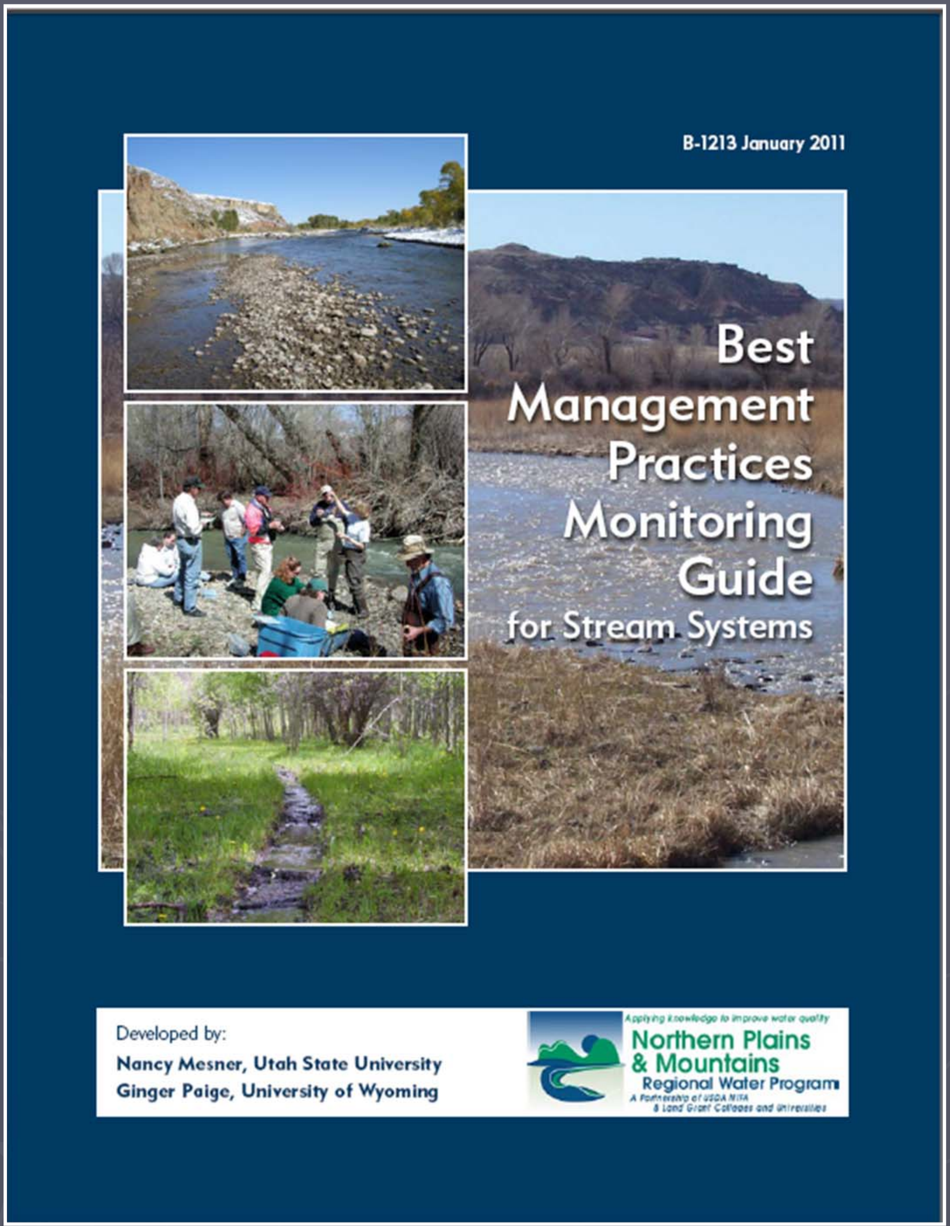
- Failure to design monitoring plan around BMP objectives
- A failure to understand pollutant pathways and transformations and sources of variability in these dynamic system.
- **Tend to draw on a limited set or inappropriate approaches**

Above and Below monitoring design….



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


50
0
1
2
3
4
5
6
7
8
9
weeks



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

NOT a "how-to" manual of protocols

Website:
http://www.uwyo.edu/bmp-water/

Target Audience

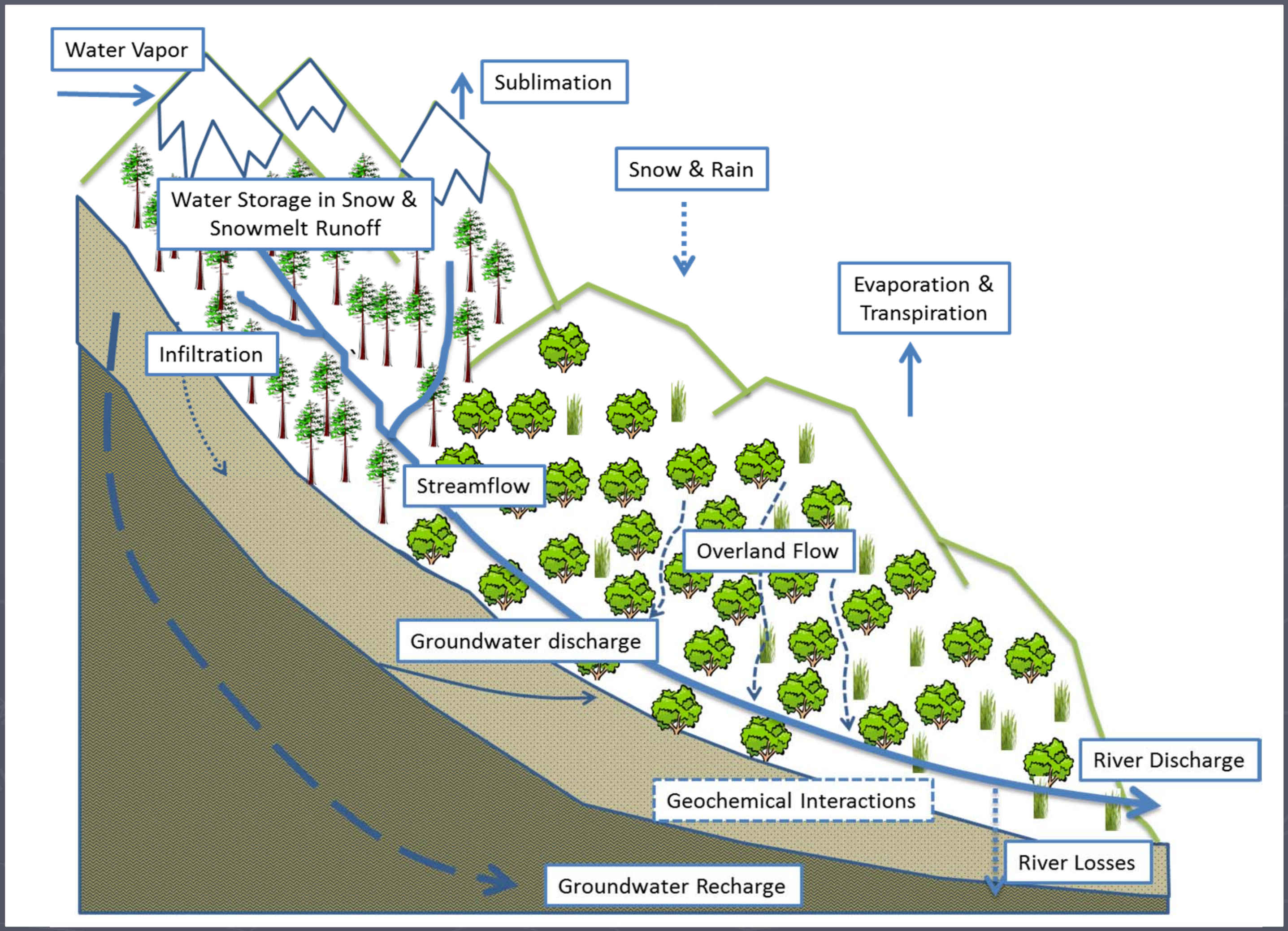
- State Environmental Agencies
- Conservation Groups
- Land Management Agencies
- Volunteer Monitoring Groups

What is your monitoring objective?

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

How do pollutants "behave" within the watershed?

- ✓ How does the pollutant move from the source to the waterbody?



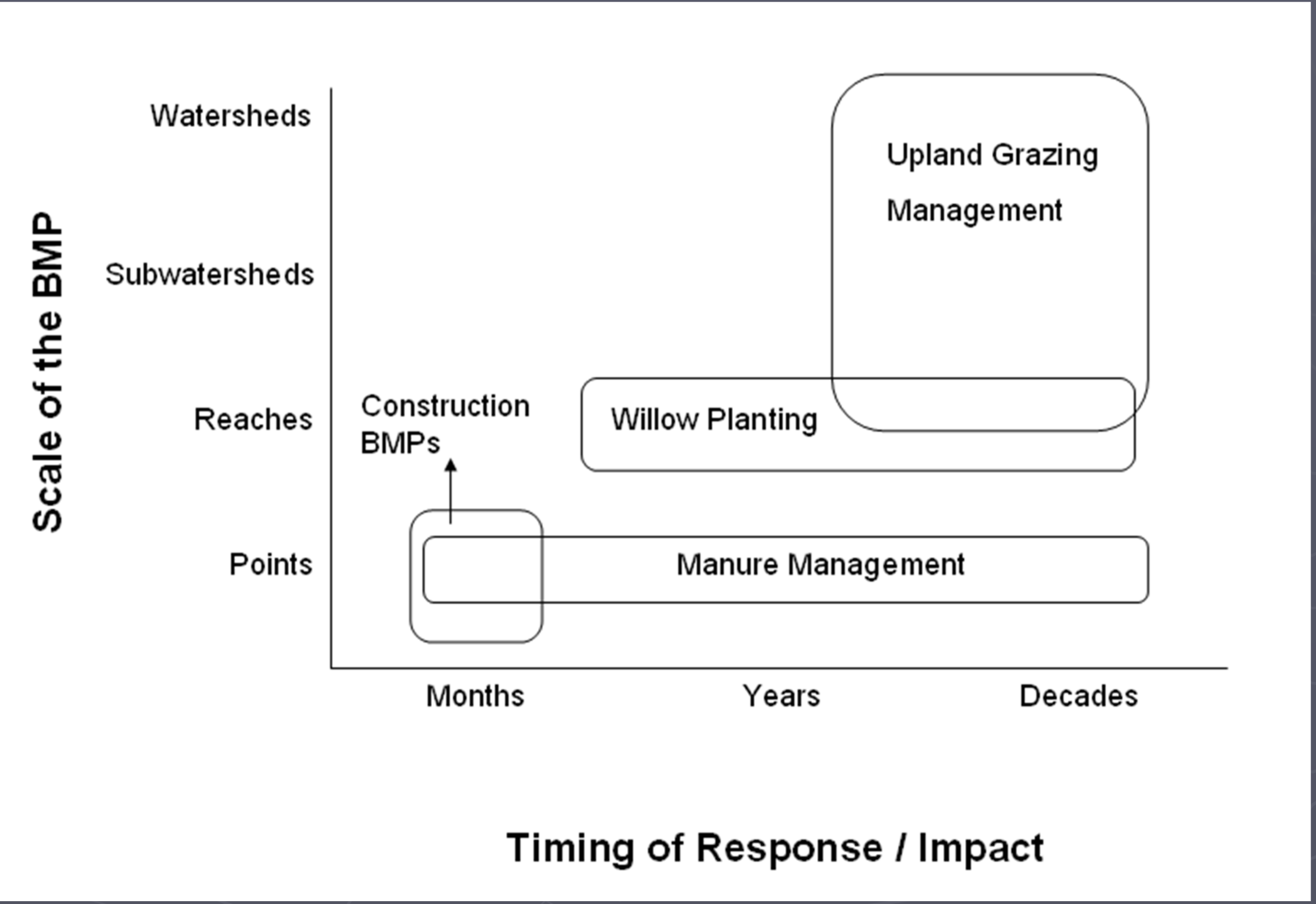
How do pollutants "behave" within the watershed?

- ✓ 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 or day?
- ✓ What long term changes within the watershed may also affect this pollutant?
- ✓ What else must be monitored to help interpret the 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?

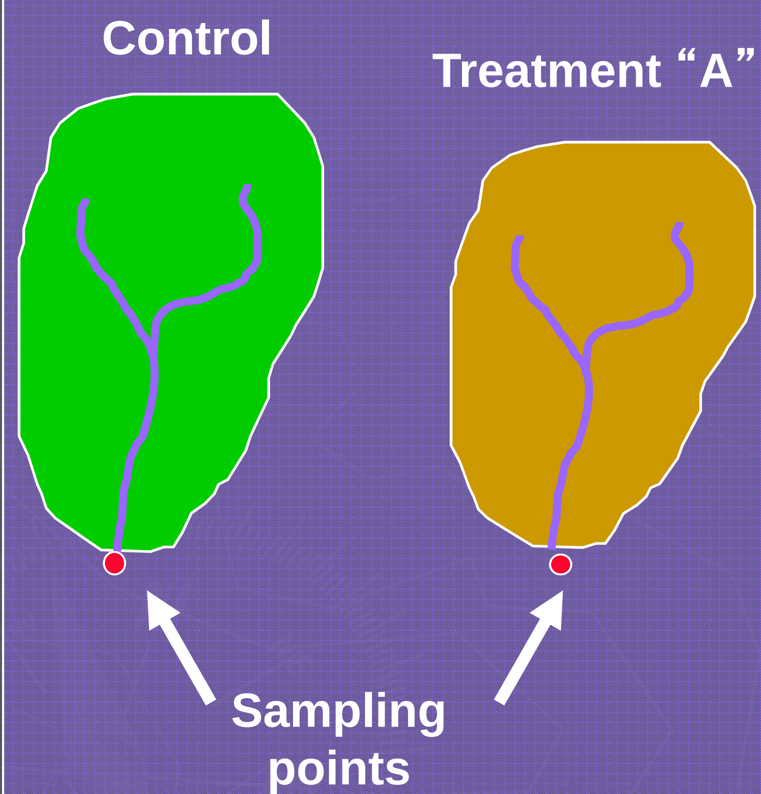
Where and when to monitor?



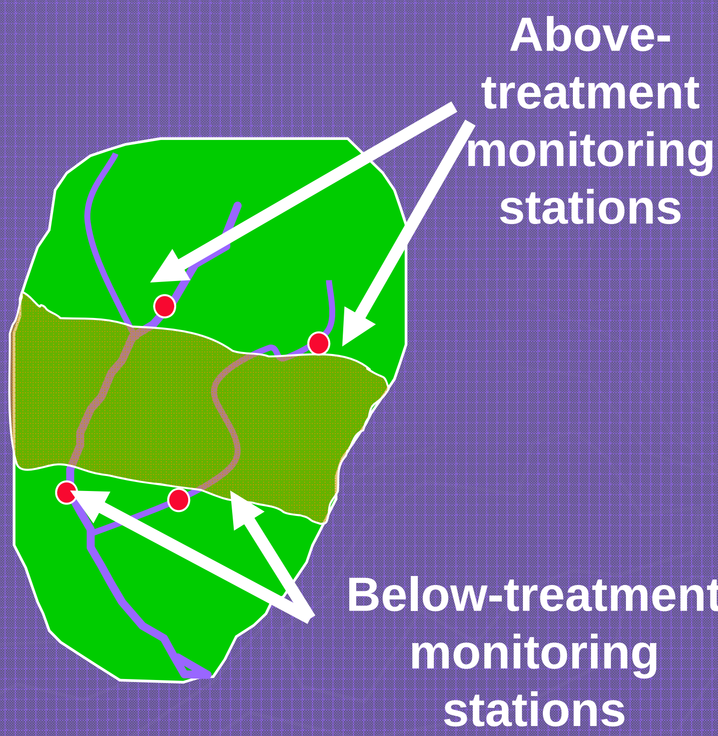
How to monitor?

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

Appropriate monitoring or modeling methods



BACI Design



Above and below
treatment design

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, flow, time of day, depth, turbidity, cloud cover	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, depth, flow, velocity	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 surrogates	Turbidity or sediment	pH, temperature, and DO might affect the solubility of phosphorus, flow, sediment transport	Algae, macros, and fish	UAFRI SWAT QUAL2K
Sediment	Grab samples and integrated samples	Turbidity	Flow	Physical characteristics, embeddedness, macros, and algae	PSIAC /AgNPS SWAT KINEROS2 SELOAD
Salts / TDS	Probes and grab samples	Riparian vegetation	Flow	Macros and fish	QUAL2K
Pathogens	Grab samples and integrated samples	Fecal Coliform Bacteria, *E.coli*	Turbidity, nutrients	Human health, livestock health	
Metals	Grab samples	Bioaccumulation in living organisms	DO might affect total hardness	Bacteria in the sediments	MINTEQAQ
Organic pesticides	Grab samples	Bioaccumulation in living organisms		Bacteria in the sediments	WINPST

Links to modeling resources

US EPA Water Quality Models and Tools: This site includes information and guidance on several simulation models and tools for watershed and water quality monitoring (http://www.epa.gov/waterscience/models/).>

AGricultural Non-Point Source Pollution Model (AGNPS): continuous simulation surface runoff model designed to assist with determining BMPs, the setting of TMDLs, and for risk & cost/benefit analyses ttp://www.ars.usda.gov/Research/docs.htm?docid=5199).

Soil Water Assessment Tool (SWAT): a river basin scale model developed to quantify the impact of land management practices in large and complex watersheds. SWAT is a public domain model supported by the USDA Agricultural Research Service (http://www.brc.tamus.edu/swat/).

Kinematic runoff and erosion model (KINEROS2): is an event oriented, physically based model describing the processes of interception, infiltration, surface runoff and erosion from small agricultural and urban watersheds (http://www.tucson.ars.ag.gov/kineros/).

River and Stream Water Quality Model (QUAL2K): a one dimensional river and stream water quality model for a well mixed, vertically and laterally channel with steady state hydraulics (http://www.epa.gov/athens/wwqtsc/html/qual2k.html).

Links to monitoring resources

NRCS products and tools from the National Waters and Climate Center: http://www.wcc.nrcs.usda.gov/products.html

Monitoring protocols: National Water Quality Monitoring Handbook, specifically Section 614
http://policy.nrcs.usda.gov/media/pdf/H_450_600_a.pdf

US Environmental Protection Agency. "The Volunteer Monitor's Guide to Quality Assurance Plans." 1996.
http://www.epa.gov/owow/monitoring/volunteer/qapp/vol_qapp.pdf

US Environmental Protection Agency. "Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Measures – Urban." 2001.
http://yosemite.epa.gov/ee/epa/riafile.nsf/Attachment+Names/W.2001.16.pdf/$File/W.2001.16.pdf?OpenElement

US Environmental Protection Agency. "Guidance for Preparing Standard Operating Procedures." 2007.
<http://www.epa.gov/QUALITY/qs-docs/g6-final.pdf>

Table of Contents

Additional Resources - Tools

- Check list
  - identify KEY components of a monitoring program
- Decision Tree
  - non- linear process – very interactive
- Web Version of the Guidance Document:
  - active links to the information and references in the Guidance Document

Best Management Practices Monitoring Guide - Home - Windows Internet Explorer

http://www.uwyo.edu/bmp-water/

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Best Management Practices: Monitoring Guidance

Introduction

These monitoring guidance tools are designed to help identify appropriate and effective monitoring strategies for water quality implementation projects. In particular, this site focuses on the effectiveness of Best Management Practices (BMPs) implemented to address water quality impairments in a watershed. These practices may range from site-specific installations, such as a manure bunker, to large-scale efforts such as improved grazing management over thousands of acres of rangeland. In all cases, however, we need to understand and quantify the effectiveness of these practices. This website provides agencies, watershed managers and field practitioners with tools and techniques to develop and implement a monitoring program that will meet this critical need.

The most common mistakes in developing a monitoring program

Quick Links

- Home
- Decision Tools
  - Objective
  - Temporal & Spatial Scale
  - Monitoring Considerations
  - Sampling Design
  - Data Analysis
  - Pollutant Properties
- Resources
  - Additional Information
  - Glossary
- Monitoring Checklist
- BMP Document
- National Water Quality Handbook
- Water Quality Contacts

Contacts:

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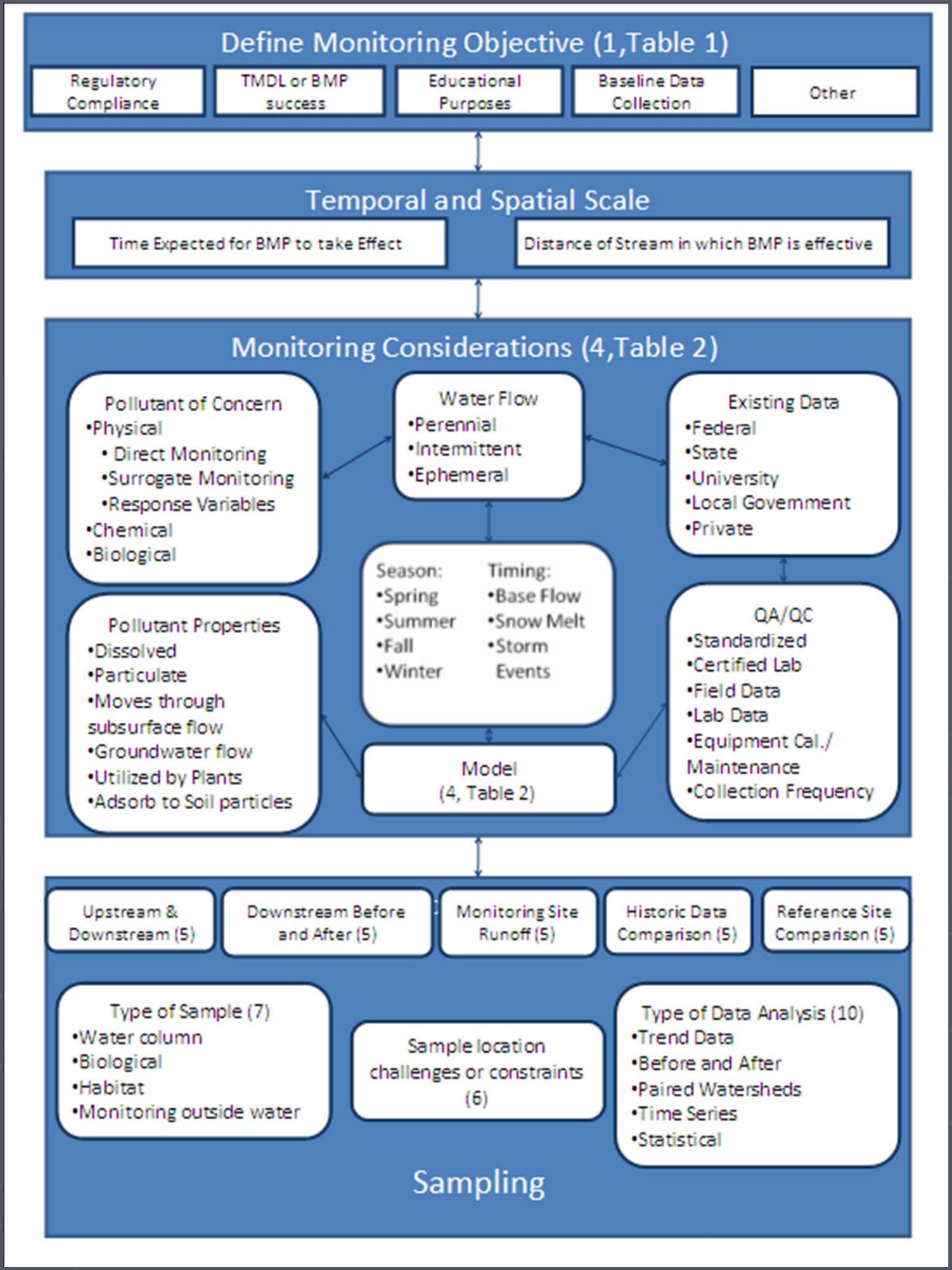
http://www.uwyo.edu/bmp-water/

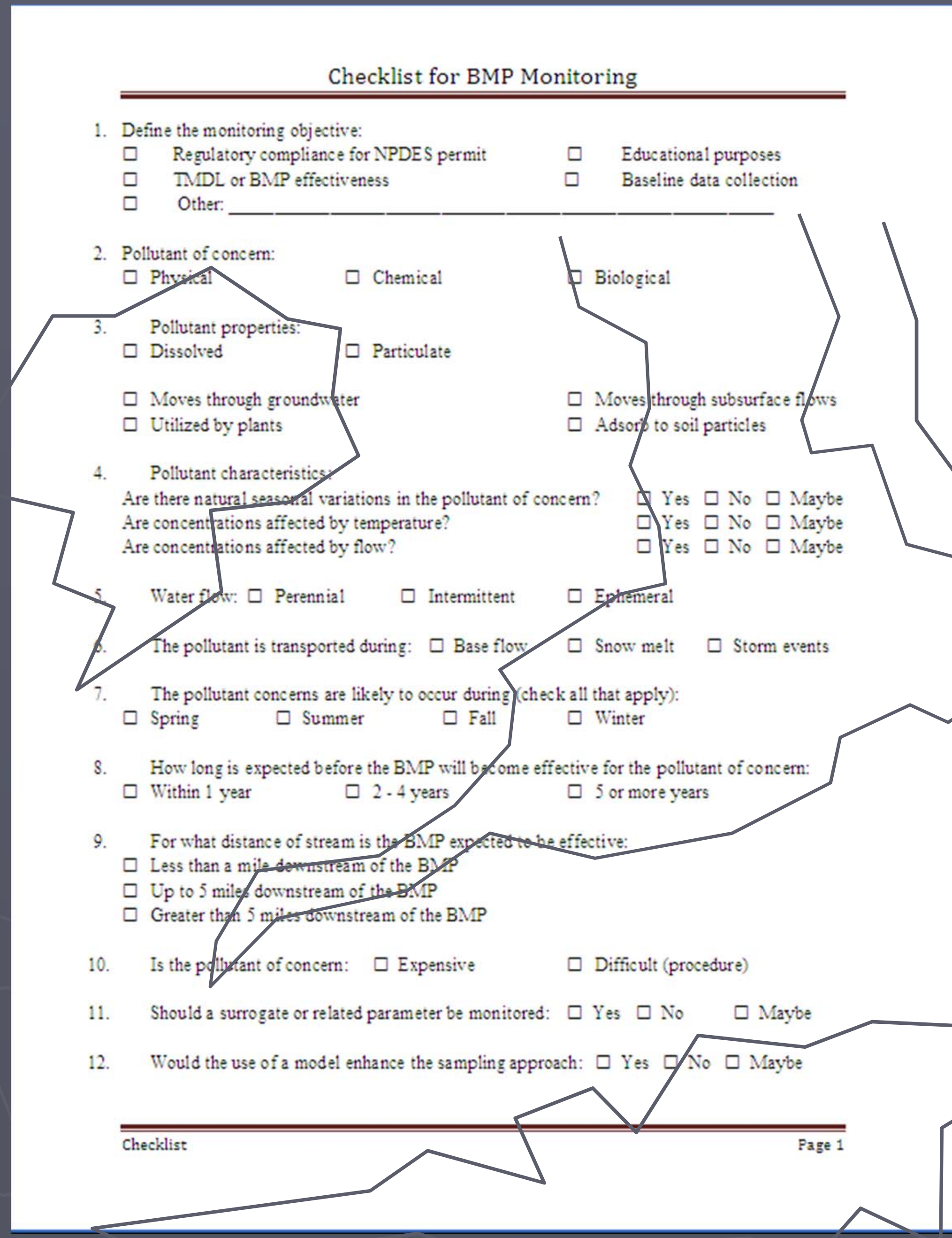
Decision Tree

- Identifies KEY components
- Shows links between components
- Links to information in the Guidance doc
- Non - linear!!



Check List

- Method to help identify KEY components that need to be considered
- Takes one through the thought process.



Checklist for BMP Monitoring

1. Define the monitoring objective:
   - ☐ Regulatory compliance for NPDES permit
   - ☐ Educational purposes
   - ☐ TMDL or BMP effectiveness
   - ☐ Baseline data collection
   - ☐ Other: ____________________

2. Pollutant of concern:
   ☐ Physical ☐ Chemical ☐ Biological

3. Pollutant properties:
   - ☐ Dissolved ☐ Particulate
   - ☐ Moves through groundwater ☐ Moves through subsurface flows
   - ☐ Utilized by plants ☐ Adsorb to soil particles

4. Pollutant characteristics:
   - Are there natural seasonal variations in the pollutant of concern? ☐ Yes ☐ No ☐ Maybe
   - Are concentrations affected by temperature? ☐ Yes ☐ No ☐ Maybe
   - Are concentrations affected by flow? ☐ Yes ☐ No ☐ Maybe

5. Water flow: ☐ Perennial ☐ Intermittent ☐ Ephemeral

6. The pollutant is transported during: ☐ Base flow ☐ Snow melt ☐ Storm events

7. The pollutant concerns are likely to occur during (check all that apply):
   ☐ Spring ☐ Summer ☐ Fall ☐ Winter

8. How long is expected before the BMP will become effective for the pollutant of concern:
   ☐ Within 1 year ☐ 2 - 4 years ☐ 5 or more years

9. For what distance of stream is the BMP expected to be effective:
   - ☐ Less than a mile downstream of the BMP
   - ☐ Up to 5 miles downstream of the BMP
   - ☐ Greater than 5 miles downstream of the BMP

10. Is the pollutant of concern: ☐ Expensive ☐ Difficult (procedure)

11. Should a surrogate or related parameter be monitored: ☐ Yes ☐ No ☐ Maybe

12. Would the use of a model enhance the sampling approach: ☐ Yes ☐ No ☐ Maybe

Checklist Page 1

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 the watershed and how the pollutants of concern behave to target monitoring most effectively.
- Use different approaches for different BMPs.

- Keep project goals in mind when monitoring BMPs
- Monitor at an appropriate scale
- Keep time lags in mind
- Be selective, consider individual situations
- Monitor surrogates when appropriate
- Control or measure human behaviors / other watershed changes.


Questions?