

Watershed Monitoring Techniques

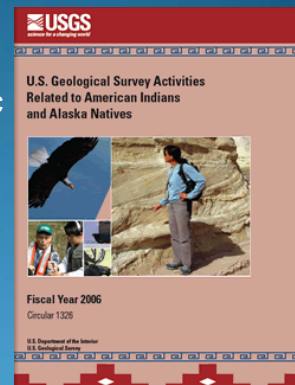


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Oklahoma City, OK
Tribal Nonpoint Source Program Workshop
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U.S. Geological Survey

- Bureau of the U.S. Department of the Interior, established in 1879.
- Comprised of Water Resources, Geologic Resources, Geospatial, and Biological Resources Disciplines.
- Headquarters in Reston, VA, with office in most States.
- All Disciplines work under cooperative/collaborative jointly-funded project agreements with Tribal Nations, other Federal Agencies, State, Regional, and local agencies.



Watersheds...

- Watersheds are the areas over which water drains to streams and lakes.
- The quality and health of streams and lakes are of great interest for:
 - a) aesthetic/recreational reasons/property value reasons,
 - b) cultural/stewardship issues,
 - c) sources of food and water

Arkansas Watershed Advisory Group image



Watersheds...

- Are also known as “basins”
- Can be divided into sub-units, depending on the order of the stream of interest
- Are affected by land uses
- Serve as living laboratories for investigation of the effects of interactions between man and nature

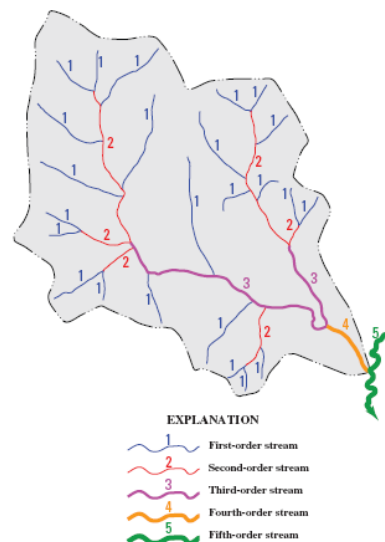
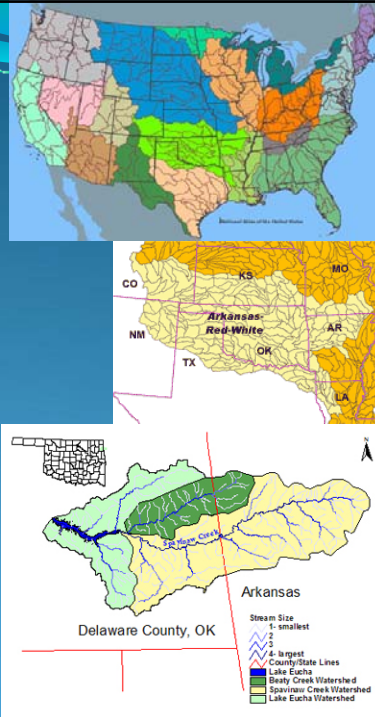


Figure 6. Method of designating stream order (modified from Strahler, 1957, p. 344).

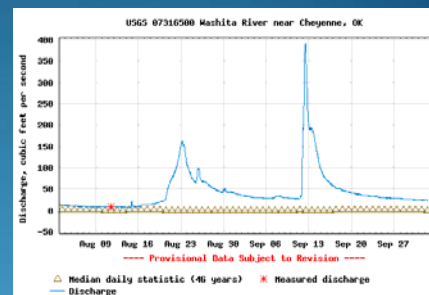
Watersheds...

- Watersheds are named after the streams that drain them.
- Most of the south-central U.S. (Oklahoma and portions of surrounding states) are in the Arkansas-Red-White Watershed.
- Watershed boundaries are flexible, being comprised of all of the area draining to a stream upstream of ANY chosen point!



Sampling watersheds

- One can sample/measure streamflow, water quality, aquatic habitat, aquatic biota, soils, vegetation, air, precipitation, etc.
- Streams, like their surrounding watersheds, are **DYNAMIC!** They change on a minute-by-minute basis!
- Streamwater-quality data without streamflow data are essentially USELESS!



Rainfall causes runoff, commonly increasing streamflows by orders of magnitude. Water-quality parameters may decrease, stay the same, or increase notably under varying flow conditions.

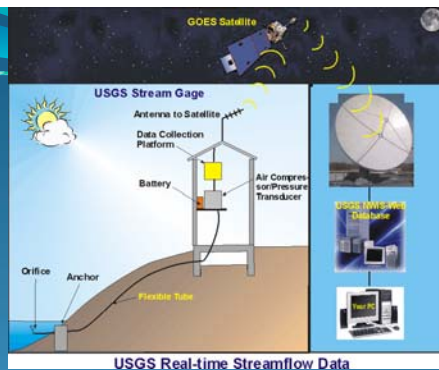
How can you obtain streamflow data?

- You can directly measure streamflow by wading or from a crane on a bridge, using Price AA (rotating propeller) or doppler-based methods.
- You can obtain continuous (every 15 minutes) streamflow estimates from nearby stream gages operated by USGS and other agencies via on-line interfaces.
- If a sampling site is between or below gages, you can estimate streamflows at given dates and times by regression or additive methods.



Black Hills State University , Sontek, and USGS images

What's a stream gage?



- Stream gages record water height at regular time intervals using floats, pressure transducers, sonic signals, or radar.
- Streamflows are estimated by regressions with water height.
- Data is transmitted by satellite to databases such as the USGS NWIS Web site, from which real-time data can be downloaded as data tables and graphs.
- Sampling locations, dates, AND times are critical data to be collected in association with water-quality data.

Water-quality sampling tips

- Consistency in the field and the lab is VITAL!!!!
- Cleaning of sampling equipment between sampling sites is critical to avoid cross-contamination.
- Calibrate field instruments frequently and record calibrations in notebooks.
- Collect QC samples per your QAPP and review those data carefully on receipt!



USGS images

Where to sample?

- What is the purpose/hypothesis of your sampling?
- Are you monitoring a specific source?
- Are you assessing a portion of a watershed or an entire watershed?
- Can you coordinate with other agencies to make the most of limited sampling funding?



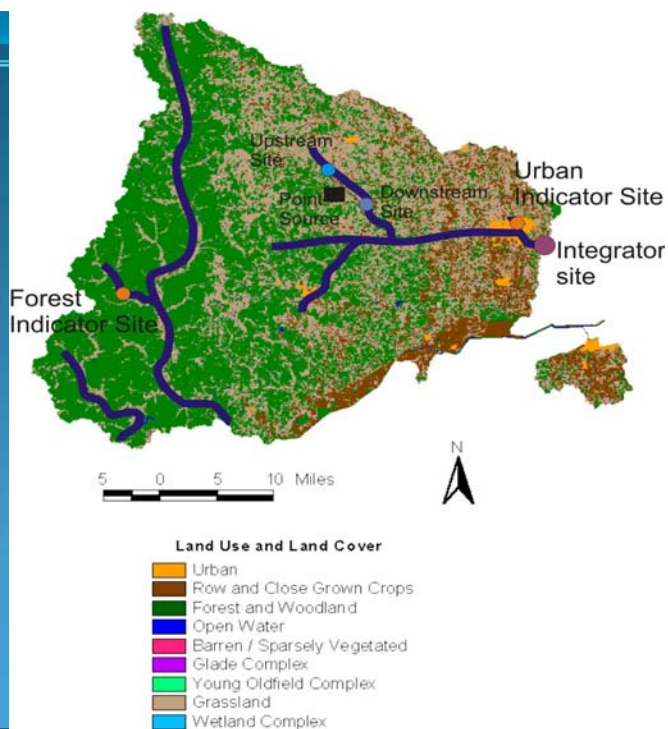
Harford County, MD and USGS images

Indicator versus Integrator?

- An indicator site is selected to monitor the effects of a specific type of land use or discharge, commonly in an upstream stream segment. Upstream/control indicator sites are VITAL!
- An integrator site is usually at the downstream end of a basin and is representative of the effects of a variety of land-use and other variables on metrics such as water quality or biological communities.
- Additional sites may be upstream and downstream of specific point sources to monitor their effects (see next slide).

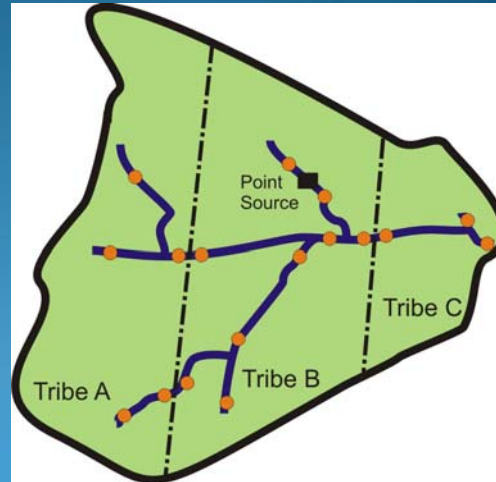
Examples of indicator and integrator sampling sites and sampling sites upstream and downstream of a point source.

Modified from MO Dept. of Conservation image



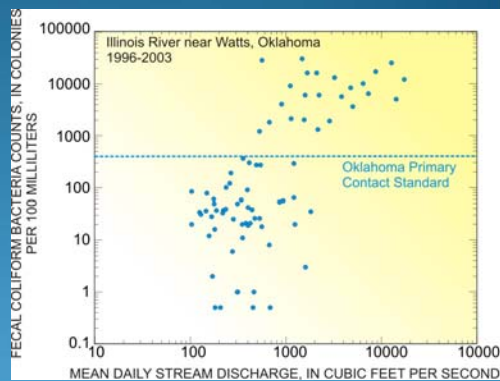
Collaboration for efficiency

- Many agencies such as Tribal governments wish to know what's entering and leaving their jurisdictional areas.
- Is it possible to collaborate with neighboring Tribes to view a basin in a more holistic basis, gathering the necessary information for characterization with fewer sites?



When to sample?

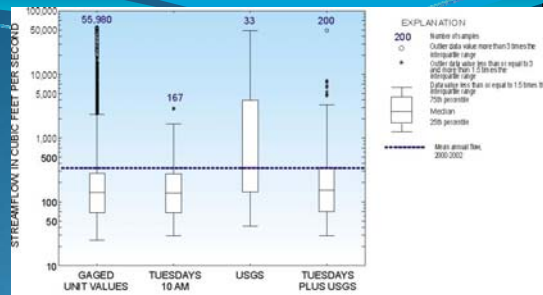
- Concentrations of a constituent may or may not change as streamflows change.
- Many parameters such as turbidity, metals, phosphorus, and bacteria increase exponentially in concentration at greater streamflows due to runoff and/or re-suspension of streambed sediments.



In basins such as Eucha-Spavinaw or the Illinois River, bacteria and phosphorus associated with animal wastes increase exponentially with streamflow.

When to sample?

- If you sample on a regular basis (e.g. weekly, monthly, quarterly), the odds are that you will mostly sample baseflow (ground-water seepage).
- Most of the loads (masses) of contaminants such as phosphorus, metals, and bacteria are transported by streams during high flow (runoff).



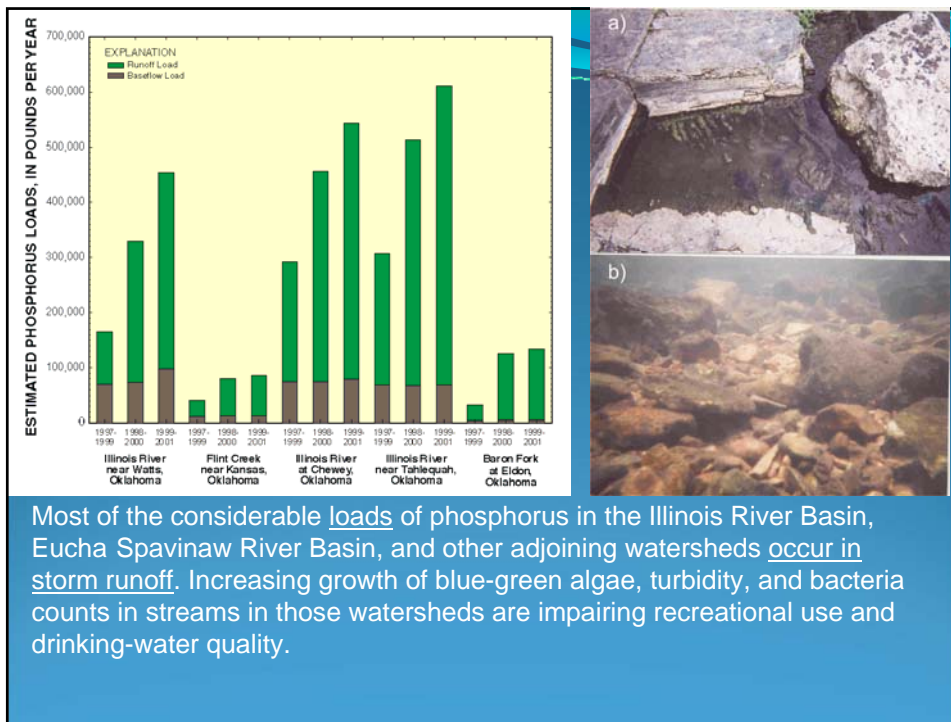
Comparisons of streamflow for different sampling plans, Barren Fork at Eldon, OK, 1/1/2000-4/1/2003.

By doing “event sampling” to capture about ½ of samples at high flows, much better estimates can be made of the ranges of concentrations and loads of contaminants. Estimation of flow-weighted concentrations from those data enables accurate determination of water-quality trends with time and estimation of continuous water quality.

Loads and yields

- Loads are the masses of contaminants flowing past a given point on a stream per unit of time (e.g. pounds/day).
- Yields are loads divided by contributing watershed area (e.g. pounds/acre/year).
- Estimation of loads can be used to evaluate impacts to downstream lakes.
- Estimation of yields can be used to optimize reduction of contaminant discharges.



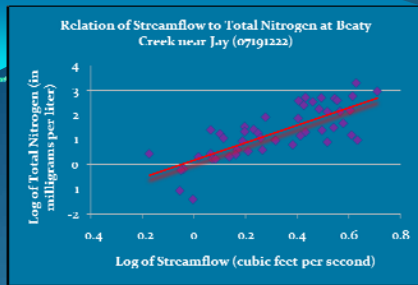


Monitoring loads and yields

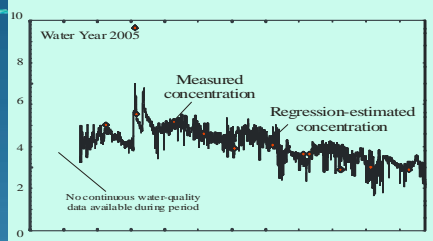
Contribution of nutrients (nitrogen and phosphorus, for example) promote algae growth in streams and accelerate *eutrophication* excessive plant growth and decay which results in a lack of oxygen and reductions in water quality, fish, and other animal populations.

Nutrients can enter streams from point sources such as waste water treatment plants, and phosphorus-rich animal waste products. But *how much is being contributed*, and *does that contribution change* when best-management practices are implemented?

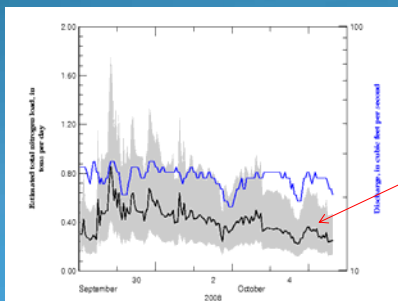
By conducting long-term monitoring, we can quantify a *trend* in loads and yields of nutrients over time and across watersheds in order to understand if, when and where, conditions are improving.



A. Spavinaw Creek near Colcord, Oklahoma (station 071912213)



These relations can be used to **estimate the load of nutrients and other constituents in real-time over the internet** – so that the public can see how individual storm events contribute to nutrient concentrations and loads...



As with any statistical model there is uncertainty – the gray area is the 90% prediction interval; 90% of the actual values are expected to be in this range

USGS can help you...

- Work cooperatively (sometimes cost share) with Tribes to:
 - a) Design sampling networks and evaluate data needs,
 - b) Conduct specialized sampling for a wide range of compounds, tracers, isotopes, and bacteria;
 - c) Provide data analysis expertise in streamflow, water-quality, runoff, and trends, surrogates;
 - d) Operate stream gages, and
 - e) Co-author reports and journal articles.
 - f) Student programs and funding



Thank you for your time!

