USGS
science for a changing world

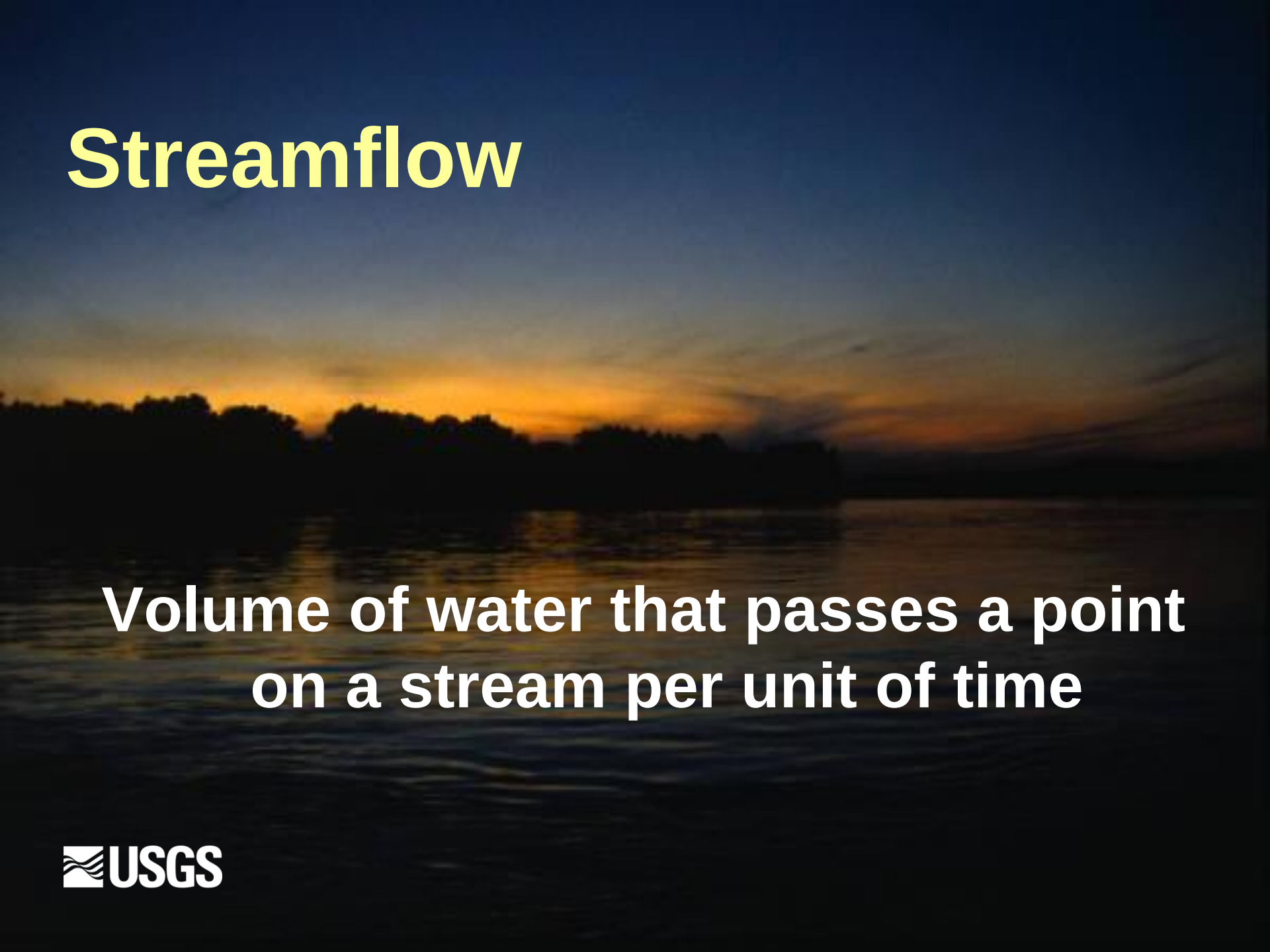
TO GO WITH THE FLOW

The importance of streamflow data for watershed management

Scott Morlock
Deputy Director
USGS Indiana Water Science Center

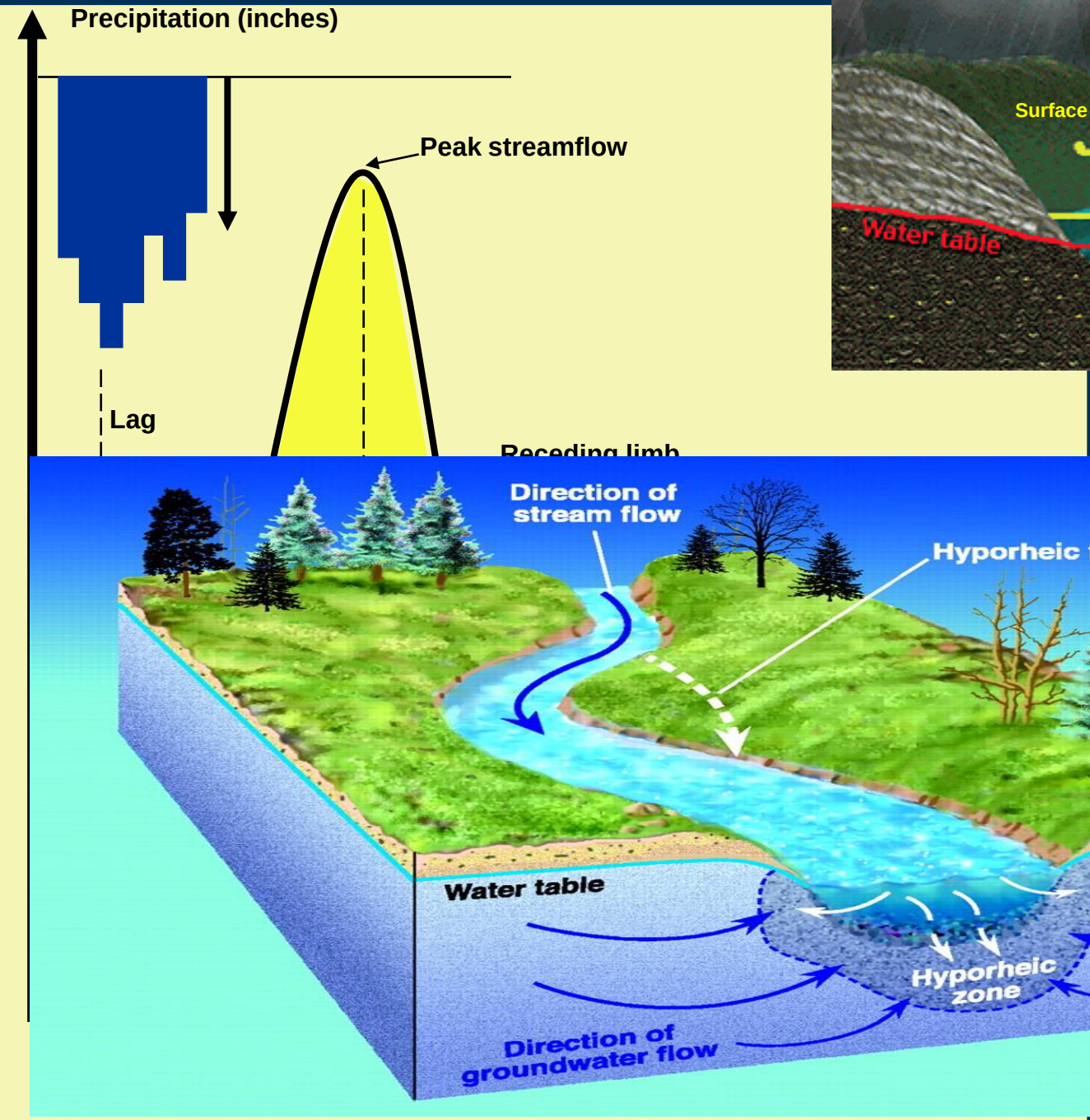
U.S. Department of the Interior
U.S. Geological Survey

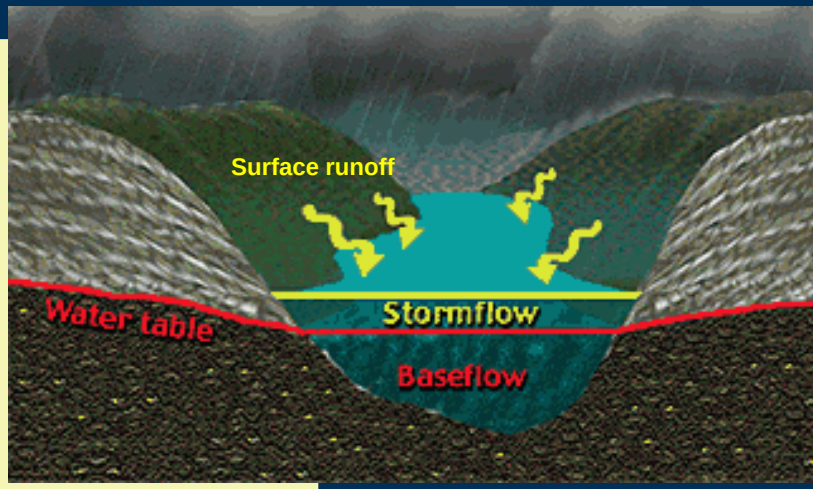
Streamflow



Volume of water that passes a point on a stream per unit of time

USGS


Precipitation (inches)
Peak streamflow
Lag
Receding limb
Streamflow

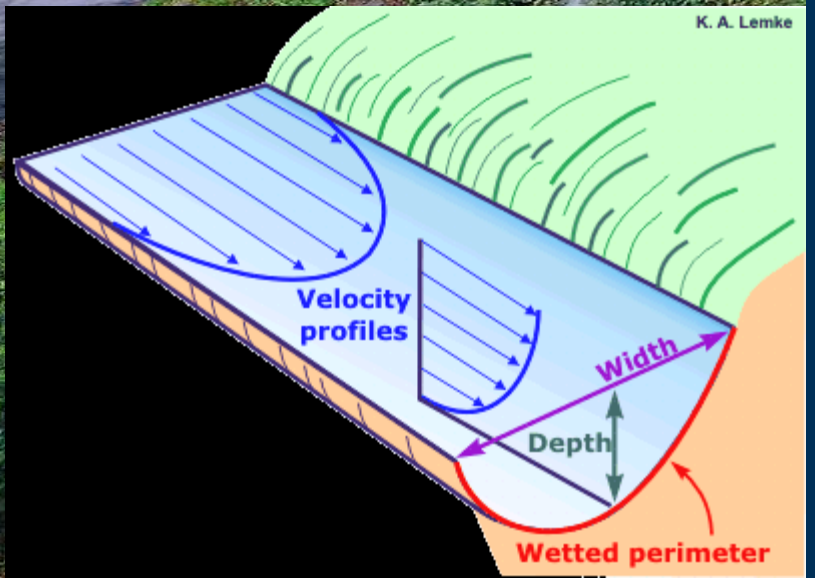

Surface runoff
Water table
Stormflow
Baseflow

Direction of stream flow
Hyporheic flow
Water table
Water table
Hyporheic zone
Direction of groundwater flow

Measuring Streamflow

$$Q = V\bar{A}$$

$$A = w \times \bar{d}$$



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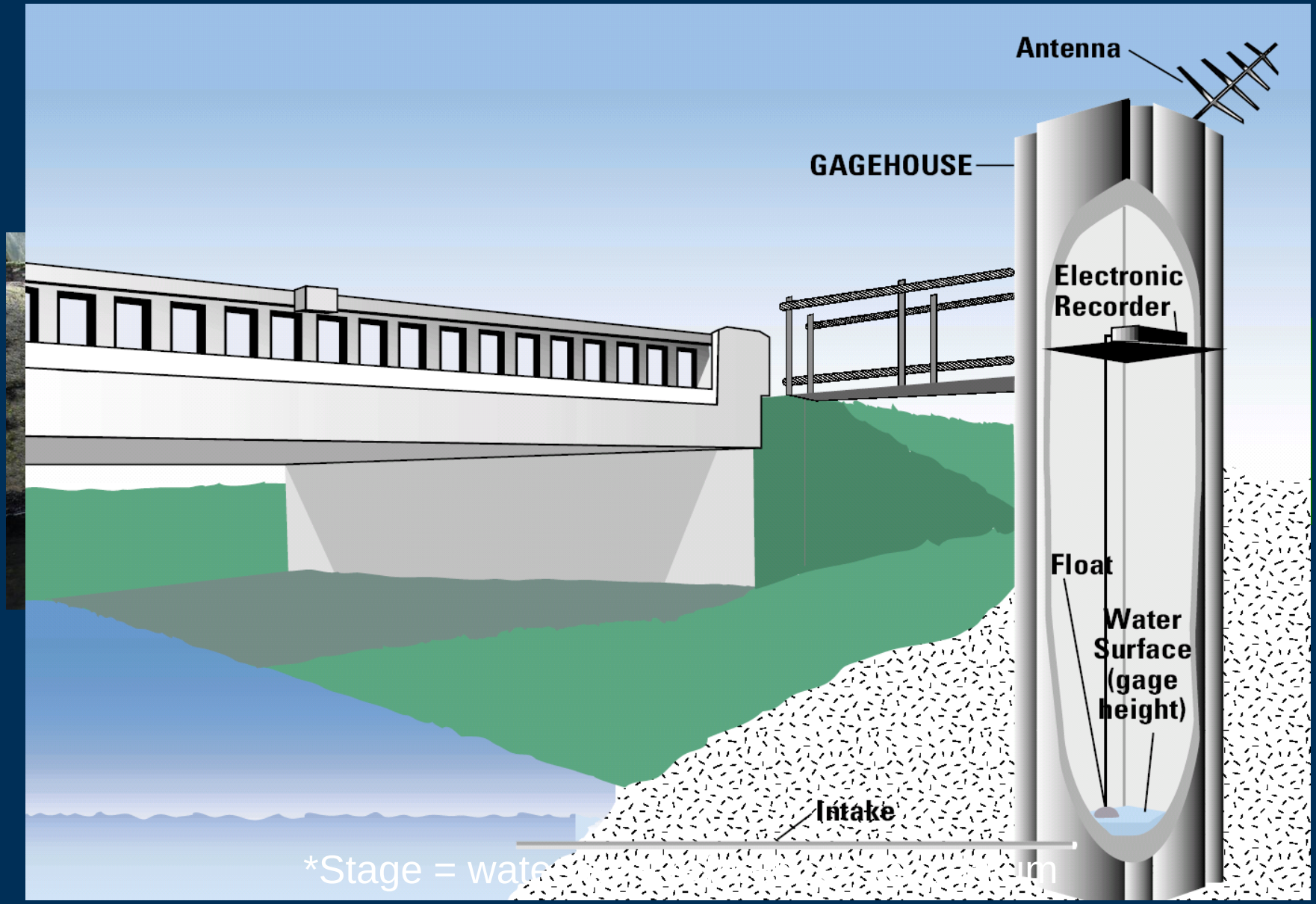
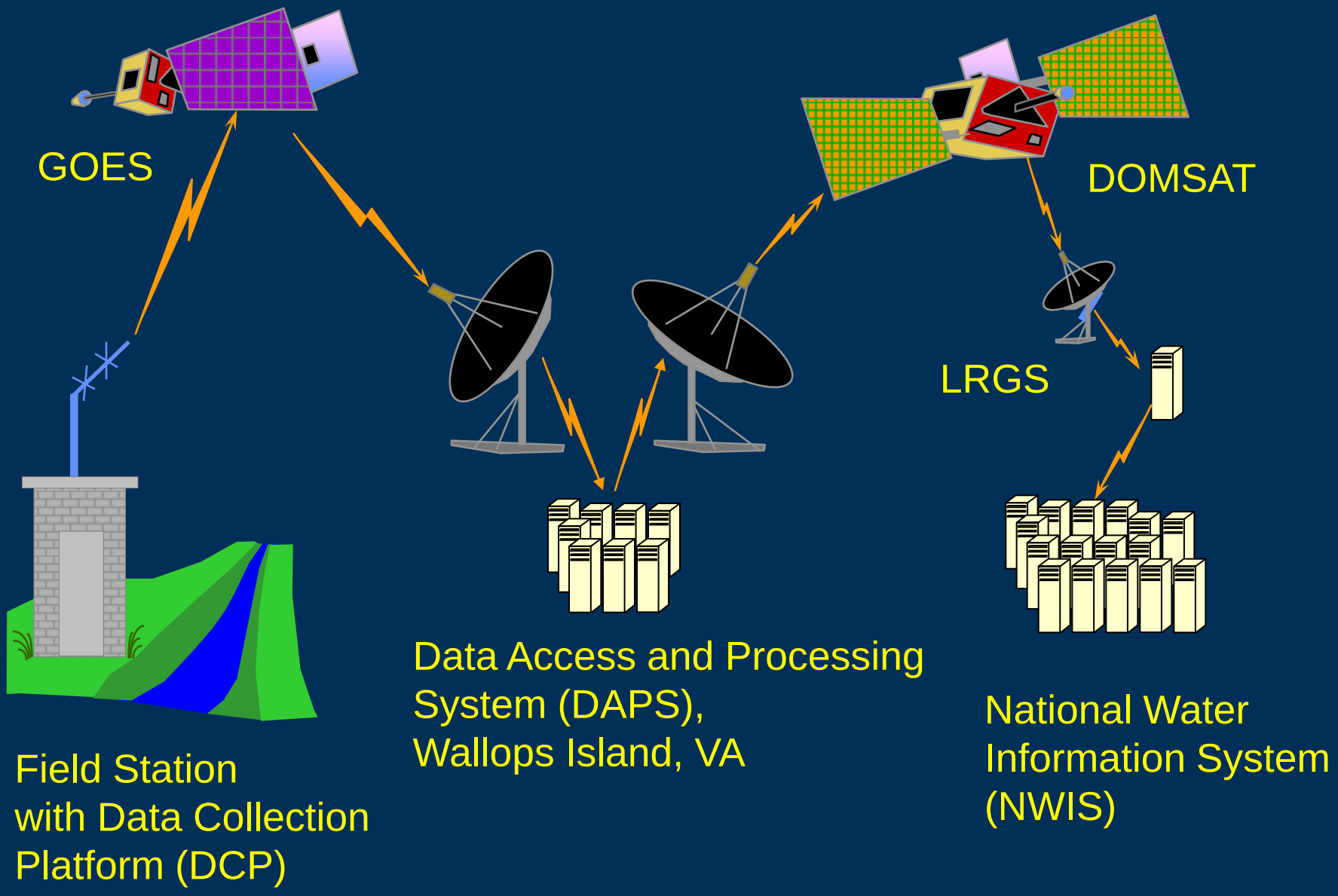
Transducers
Transducers
USGS
science for a changing world
Photo by Kevin Swank
Evansville Courier & Press

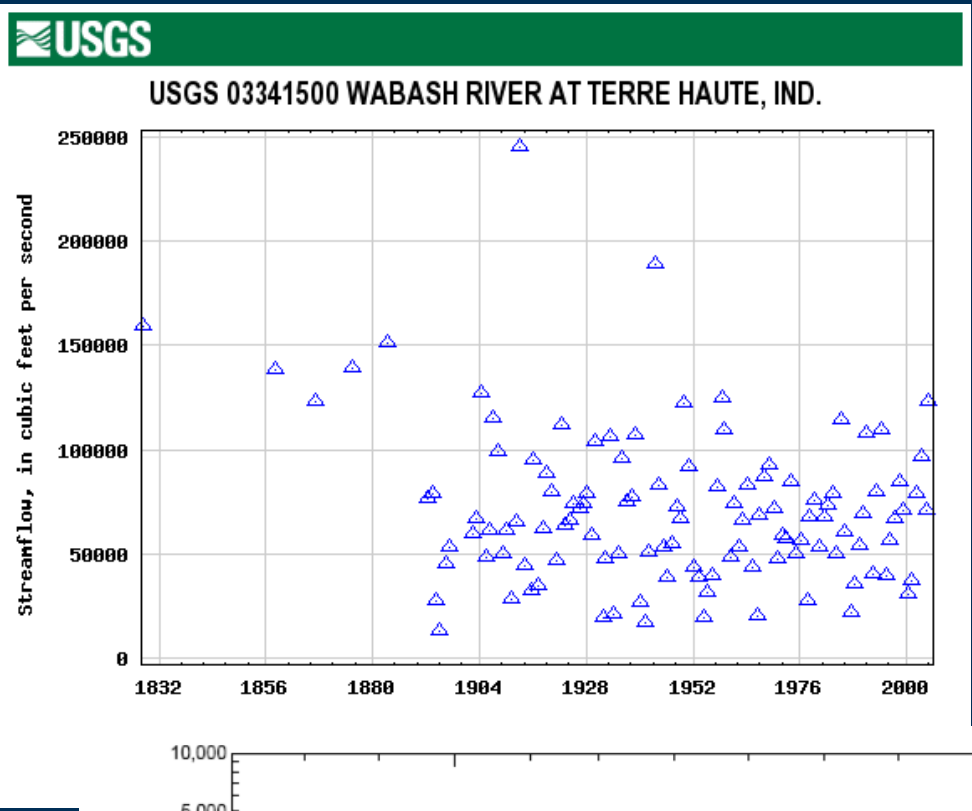

Antenna
GAGEHOUSE
Electronic Recorder
Float
Water Surface (gage height)
Intake

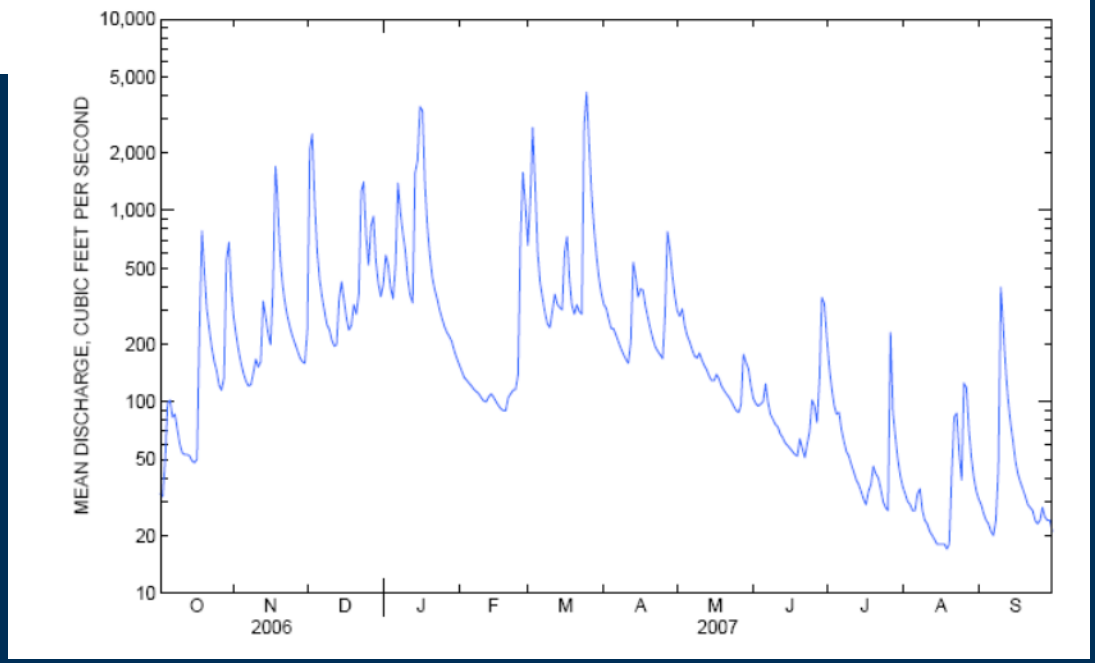
*Stage = wate

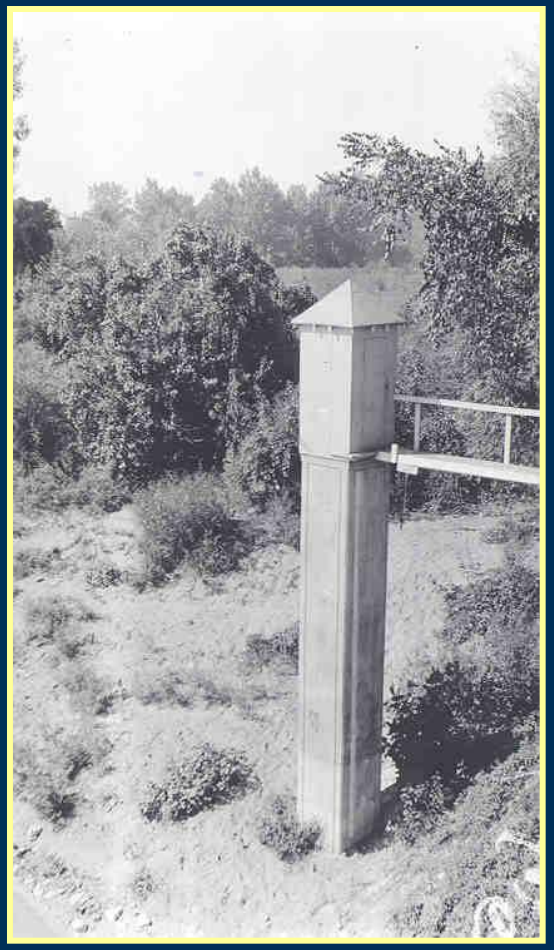


USGS

Real-time telemetry: 24/7/365

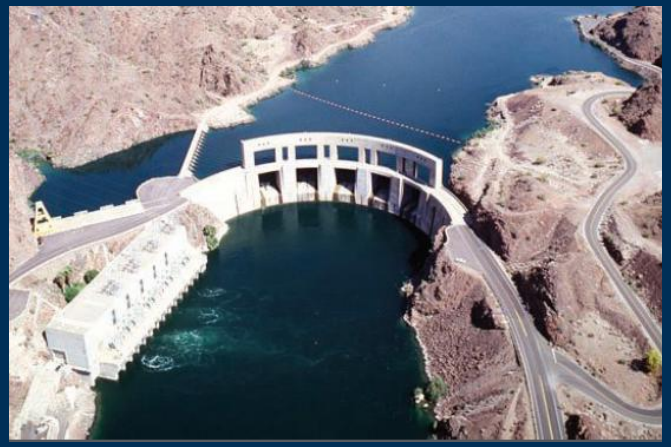






Wabash River at Lafayette, 1930

Real-time Streamflow



Reservoir operations

NPDES compliance

Spill tracking

Recreational boating

Flood response

Drought detection

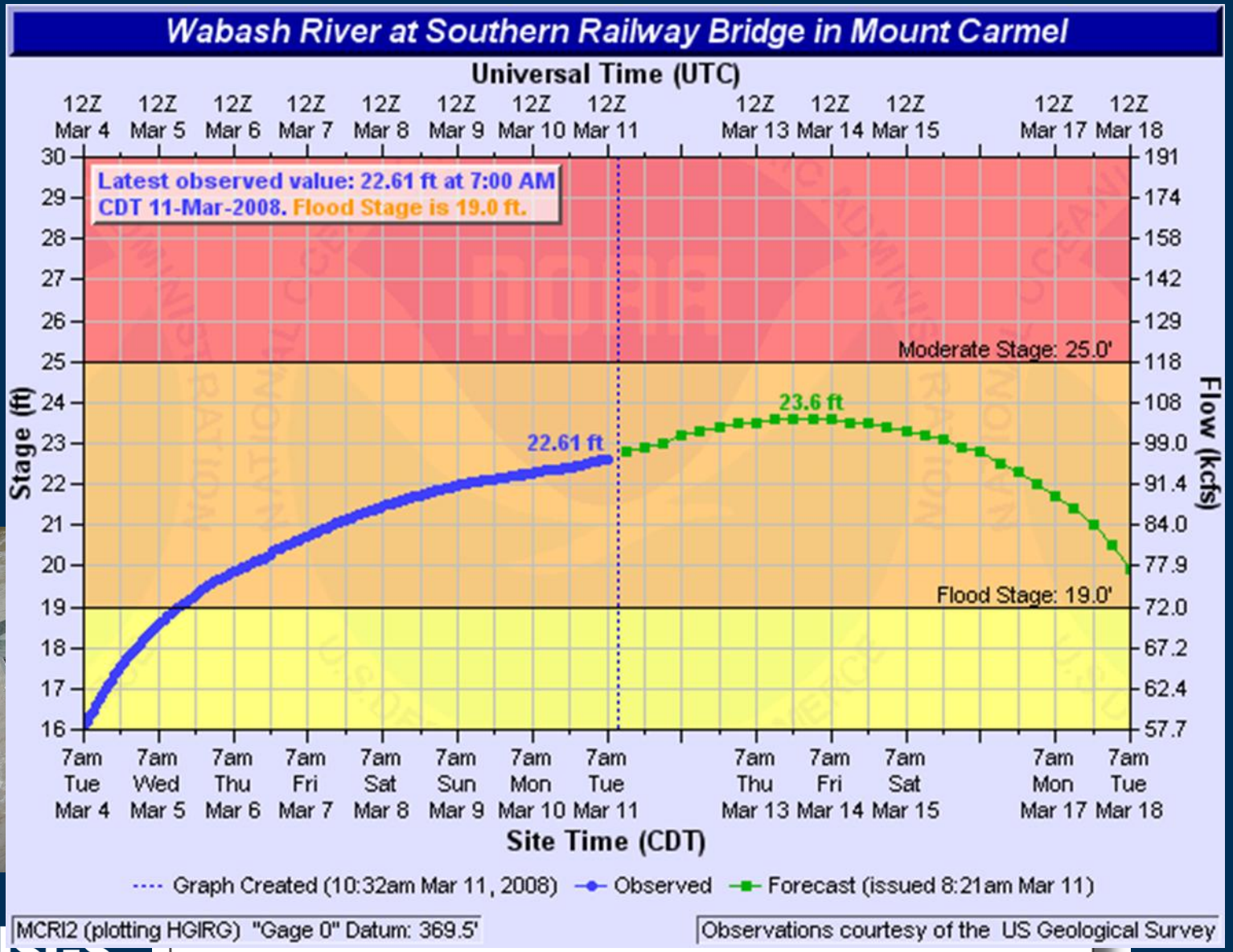
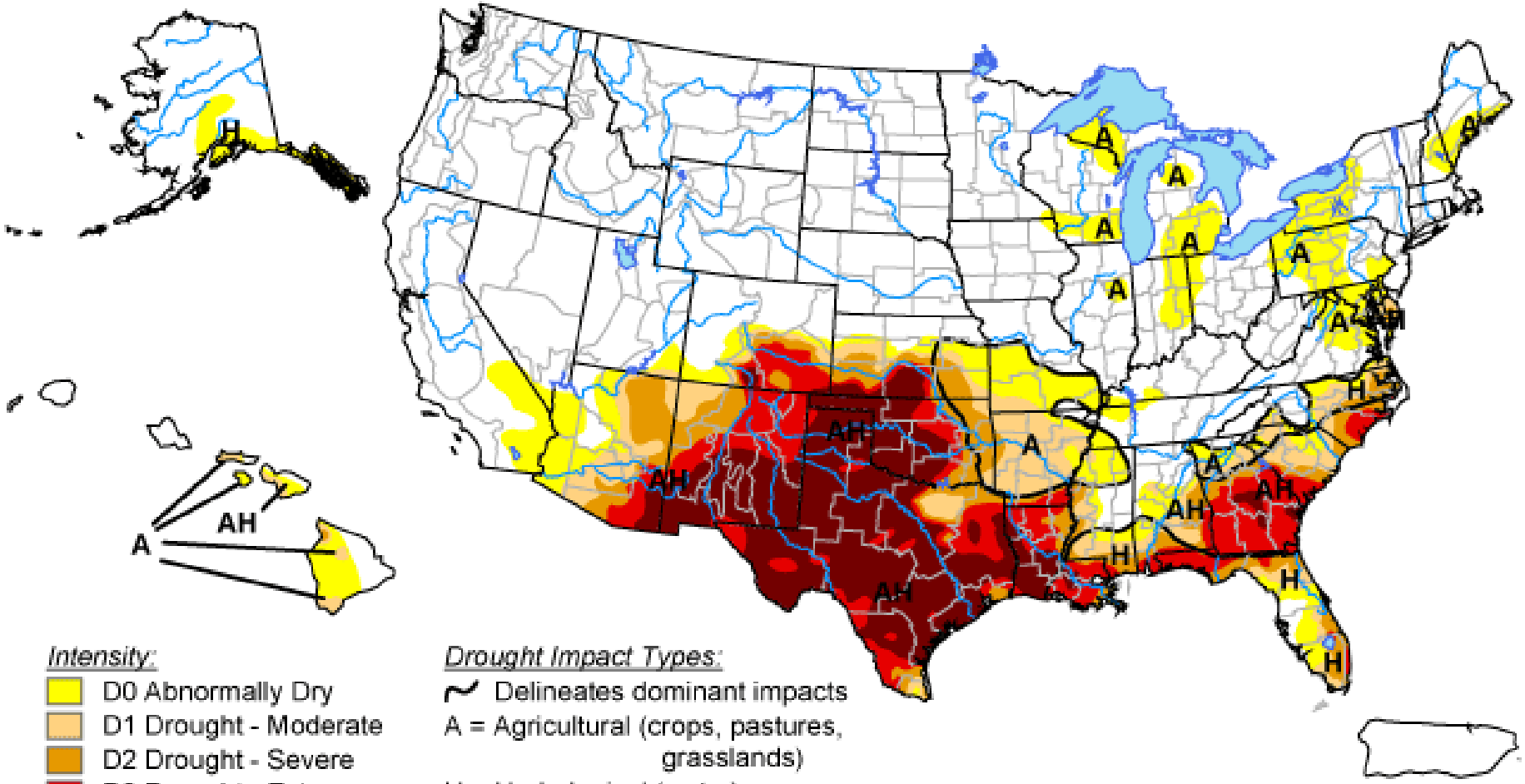


Figure 4. Typical NWSRFS configuration

U.S. Drought Monitor

July 26, 2011
Valid 8 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

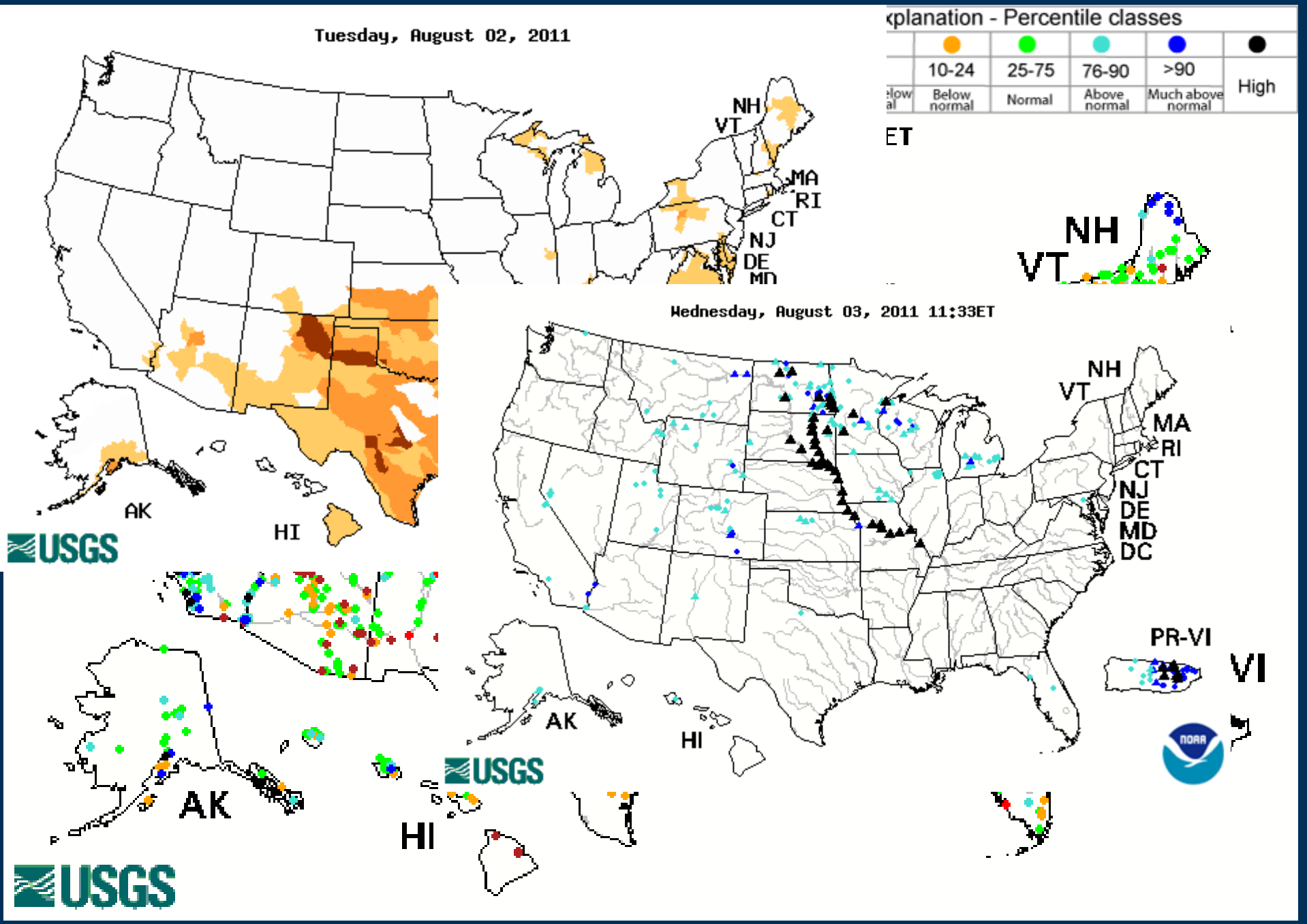
Drought Impact Types:
- ~ Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, July 28, 2011

Author: Brad Rippey, U.S. Department of Agriculture


Tuesday, August 02, 2011
NH
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xplanation - Percentile classes
10-24
Below normal
25-75
Normal
76-90
Above normal
>90
Much above normal
High
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WATER DATA FOR THE NATION

National Water Information System (NWIS)

View current and historical streamflow, groundwater level, and water-quality data

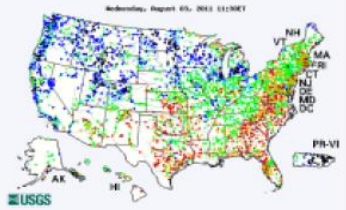
Data by State...

Data Discovery

For more data options, explore our data discovery tools.

Today's Water Conditions

View maps of current and historical conditions



- Streamflow
- Flood and high flow
- Drought
- Groundwater levels
- Surface water quality

Subscribe to hydrologic alerts:

- WaterAlert

WATER SCIENCE SPECIALTIES

- Surface Water

News updated April 19, 2011

USGS WaterAlert

The U.S. Geological Survey Wat when certain parameters, as measured by real-time data-collection statio and maintenance of the WaterAlert system supported by the USGS and its al agencies.

Real-time data from USGS gag USGS offices at various intervals; in most c once every 1 or 4 hours. Emer more frequent. *Notifications will be based on data received at these site-dep*

Instructions

SITE SELECTION

State or Territory

(select one or more)

Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
Dist. of Columbia
Florida
Georgia

Data Type

- ▲ Surface Water
- ○ Groundwater
- ▼ Water Quality
- □ Precipitation

Reset Search

▲ = real-time site

QUESTIONS?

USGS IN real-time streamgage data - http://waterdata.usgs.gov/in/nwis/rt/

Drought monitor – http://droughtmonitor.unl.edu/

WaterWatch - http://waterwatch.usgs.gov/new/

WaterAlert - http://water.usgs.gov/wateralert/

USGS

Historic Streamflow Records

Daily mean Q

Annual runoff

Peak of record

$7Q_{10}$

Q_{100}

Harmonic mean

Flow durations

Trend analyses

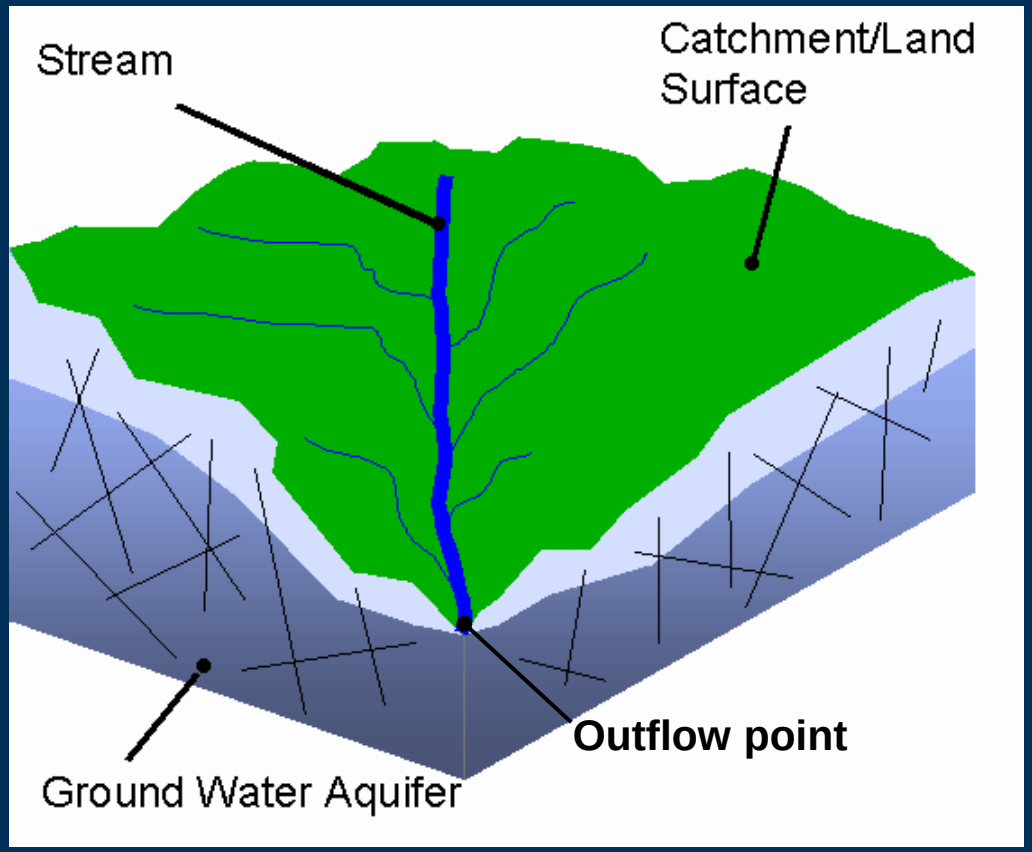
Streamflow and Watersheds

Physiography

Land-use

Stressors

- Development
- Contaminants
- Water use
- Climate change



USGS

Physiography

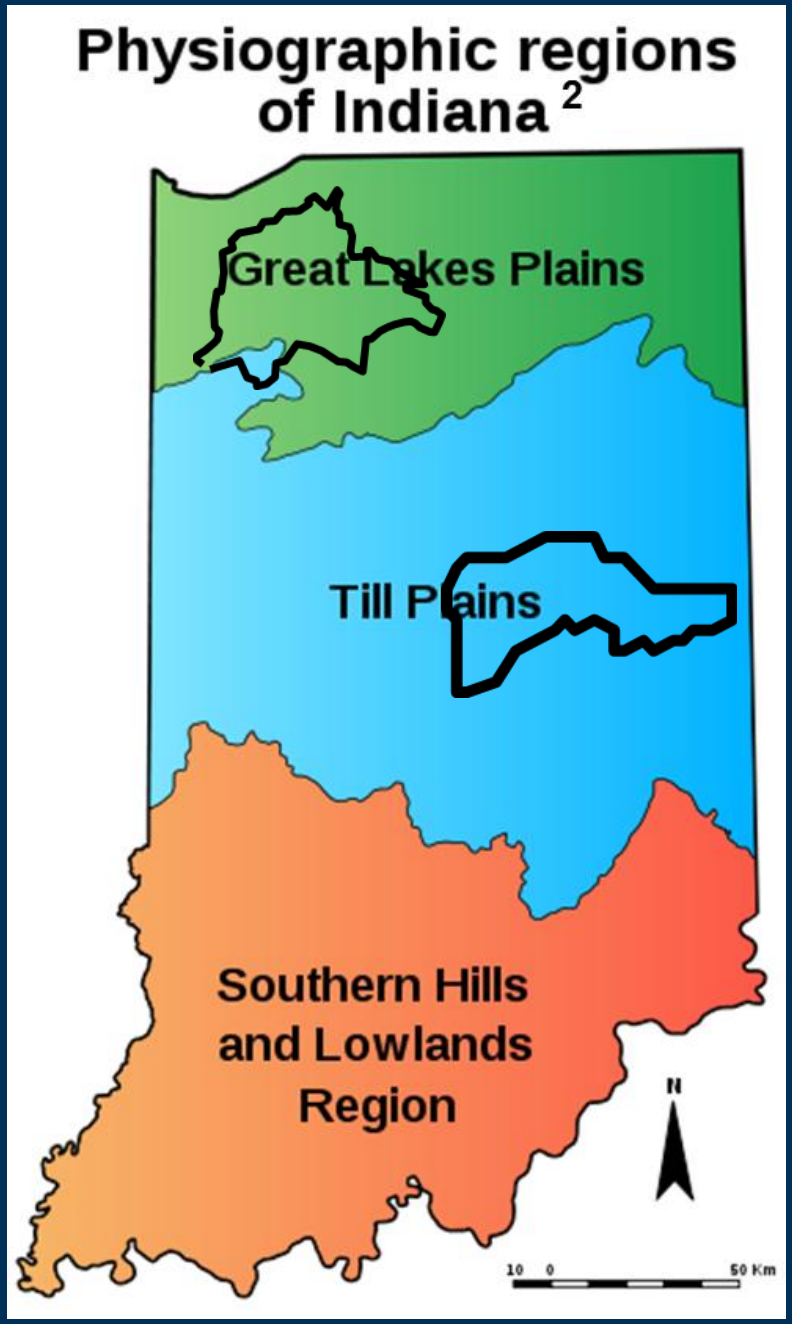
White River – Central
Kankakee River – North

Equivalent basin size

Base flow of Kankakee = 3X BF of White

Peak flows of White >> Kankakee

USGS



Land

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3 acre

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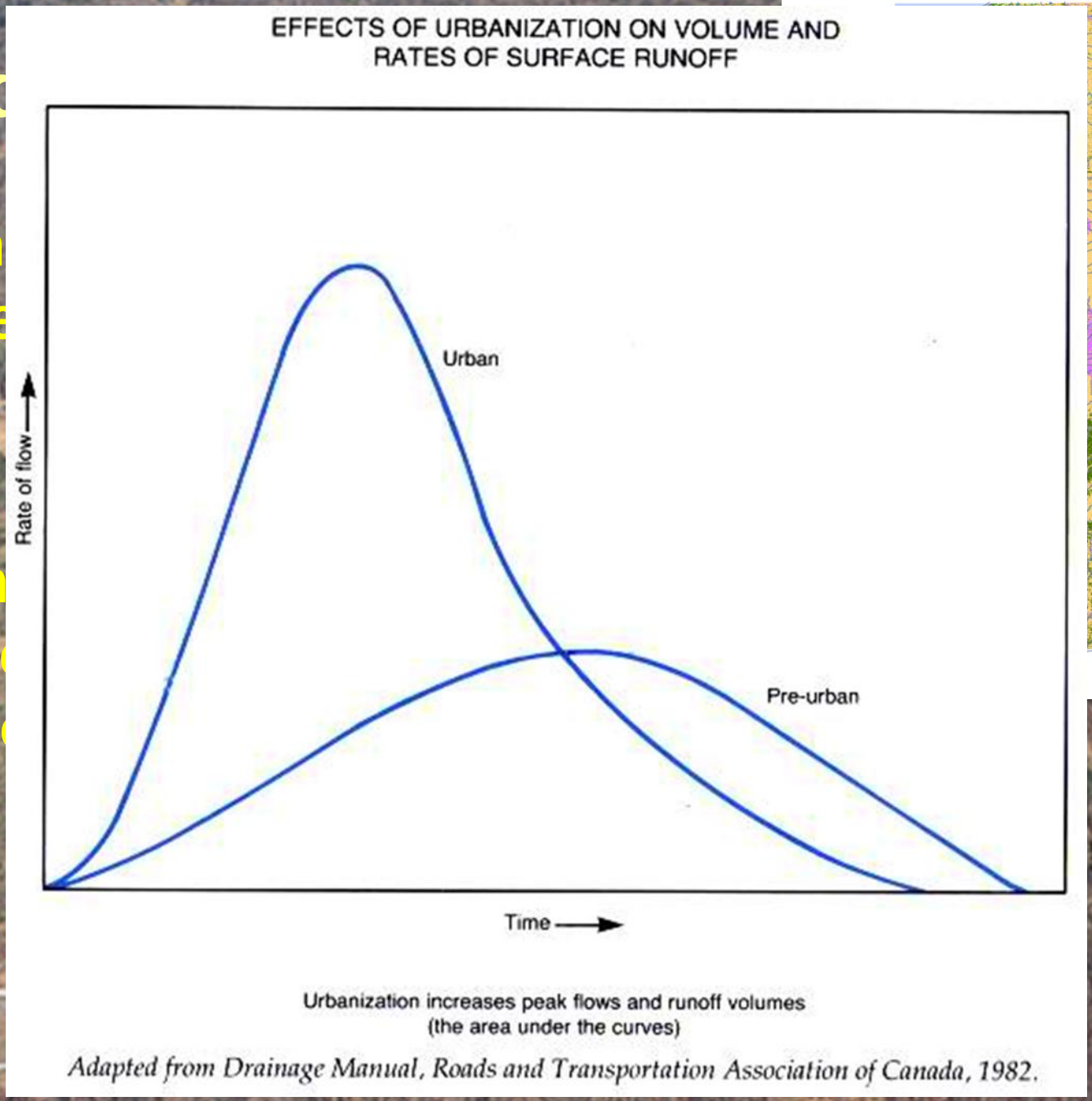
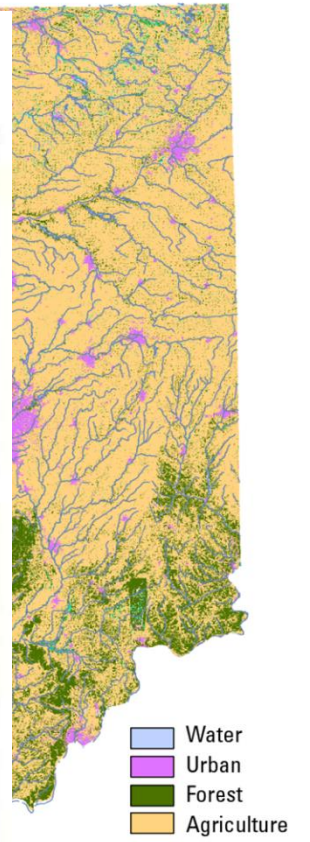
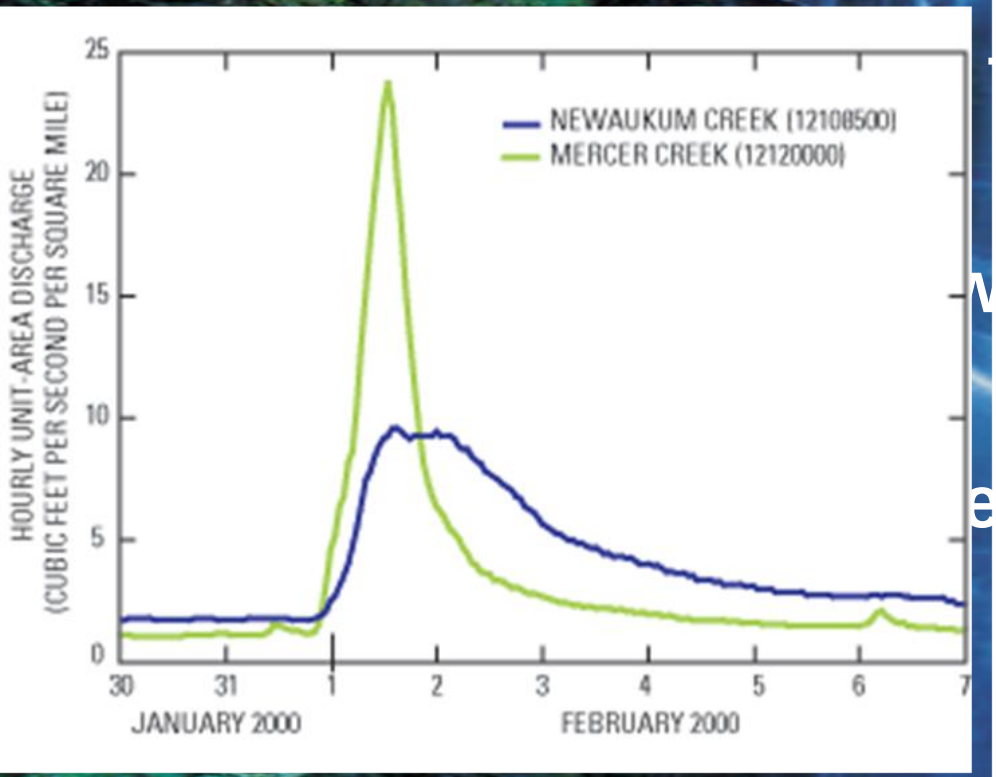
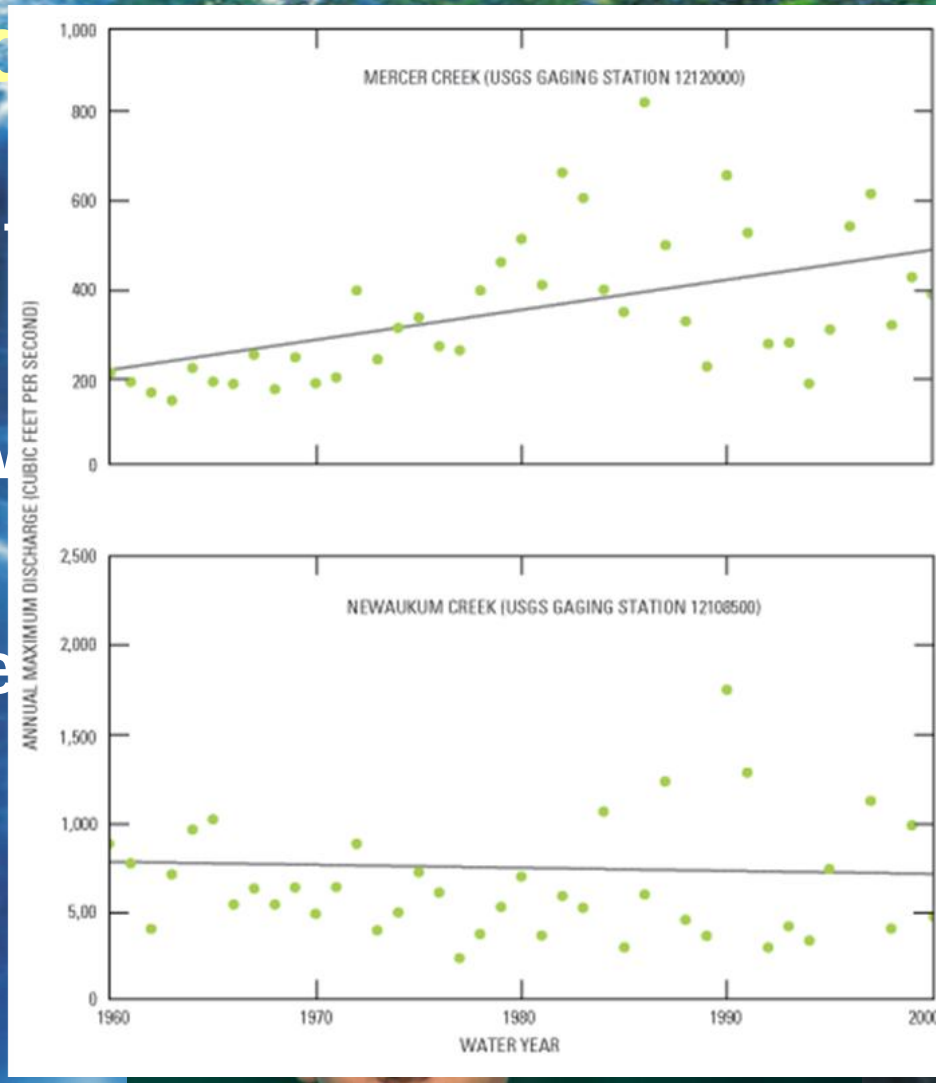




Forested Watershed





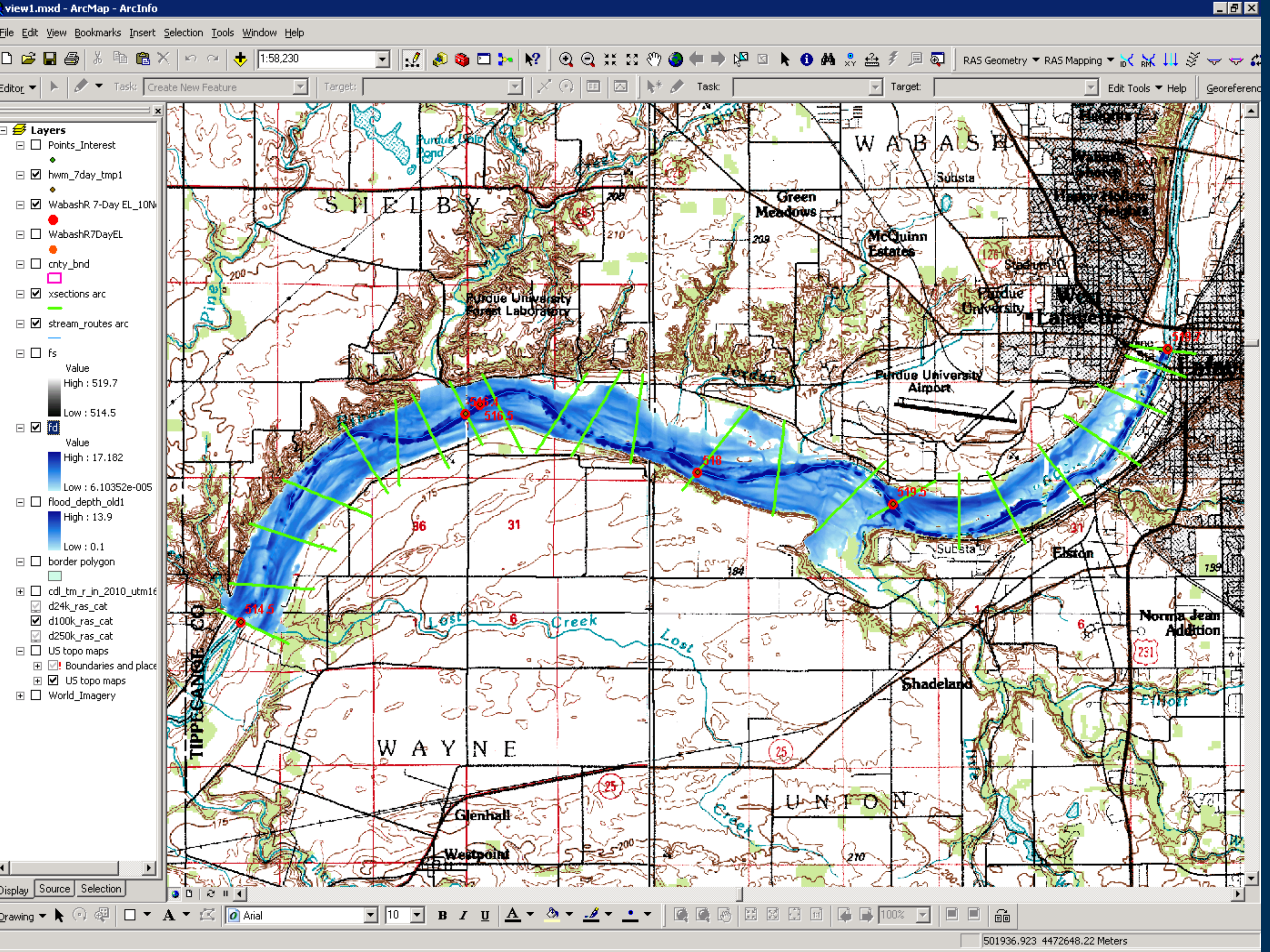
Wetland Reserve Program

Restore and enhance wetlands/wildlife habitat

Lessen stream flows due to flooding

Improve water quality

Specific Criteria: vegetation, soils and hydrology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WabashR 7-Day EL_10N
WabashR7DayEL
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stream_routes arc
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High : 519.7
Low : 514.5
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High : 17.182
Low : 6.10352e-005
flood_depth_old1
High : 13.9
Low : 0.1
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d100k_ras_cat
d250k_ras_cat
US topo maps
Boundaries and place
US topo maps
World_Imagery
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Purdue University Forest Laboratory
Green Meadows
McQuinn Estates
Purdue University
Purdue University Airport
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Questions?

Links:

USGS IN real-time streamgage data -
http://waterdata.usgs.gov/in/nwis/rt

Drought monitor -
http://droughtmonitor.unl.edu/

USGS WaterWatch -
http://waterwatch.usgs.gov/new/index.php

USGS

Low-flow Statistics

Water Use

Discharge permitting

Drought determination

Total Maximum Daily Loads

Aquatic Ecosystems – Ecological Flows

USGS

Ecological Flow

…long-term hydro-ecological research set within an adaptive management framework …is needed to improve predictions of the ecological consequences of flow regulation and to inform the intensifying debates about ecosystem responses to flow modification and climate change.

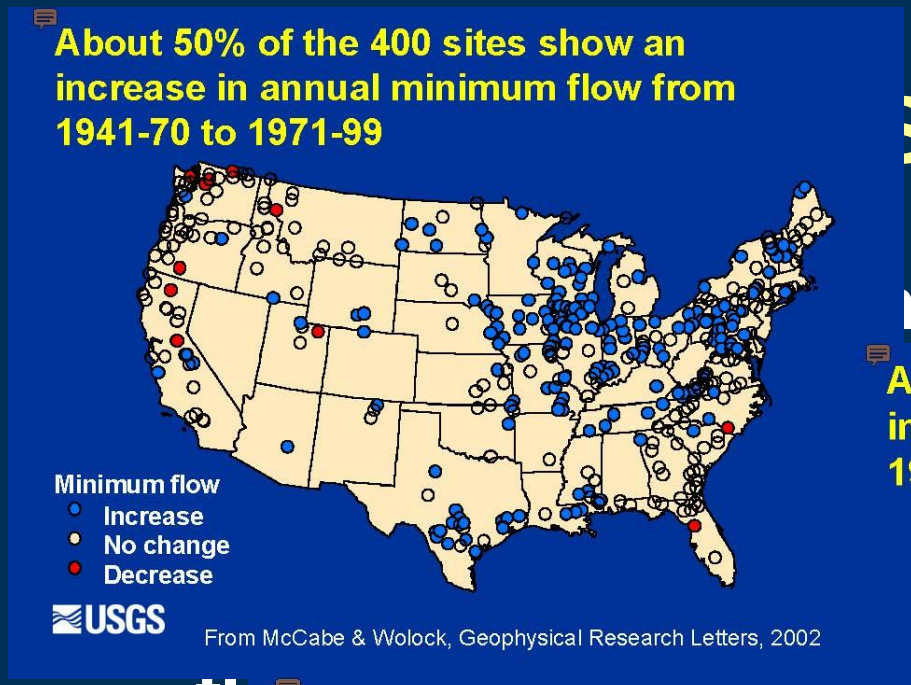
-Angela Arthington et al

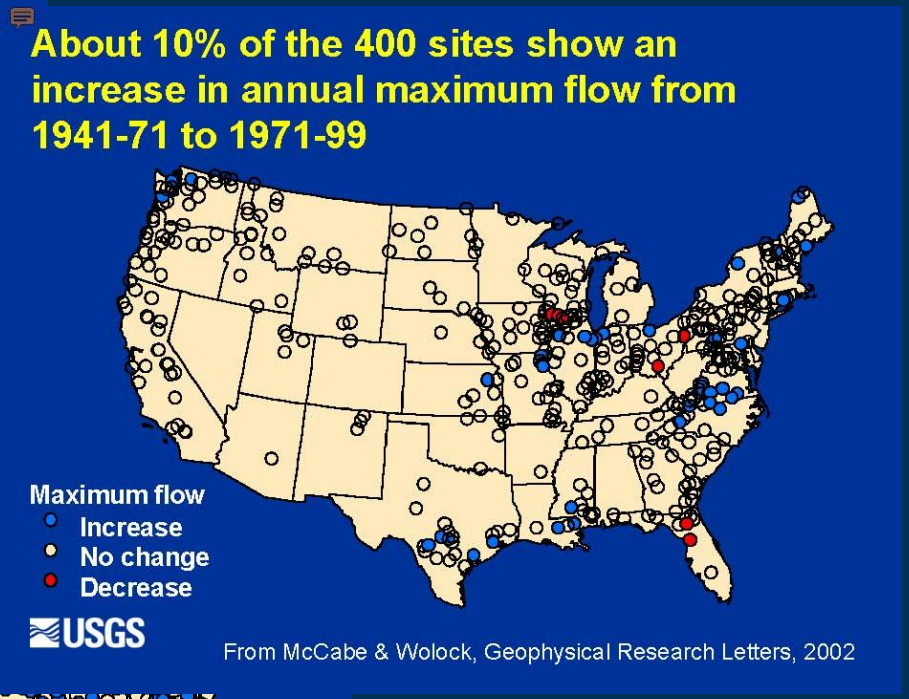
Arthington, A.H., Bunn, S.E., Poff, N.L., Naiman, R.J., 2006, The challenge of providing environmental flow rules to sustain river ecosystems, in Ecological Applications 16 (4), Ecological Society of America, pp. 1311-1318, http://intranet.iucn.org/webfiles/doc/Environmental_Flows/Challenge_of_providing_EFlows.pdf

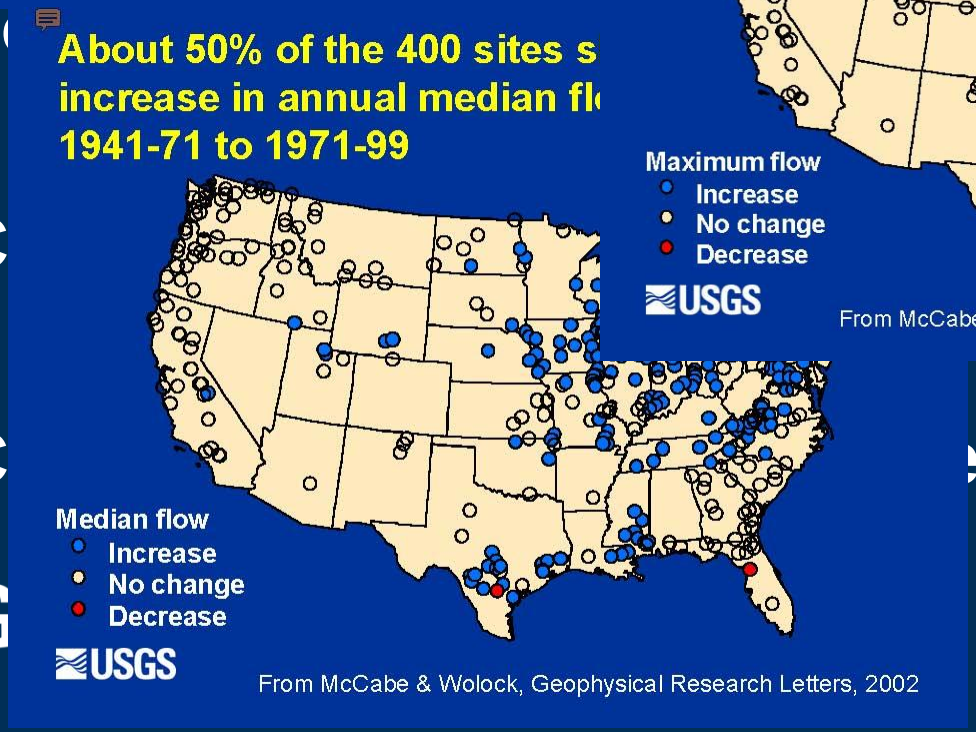
USGS

Streamflow

areas where snow has







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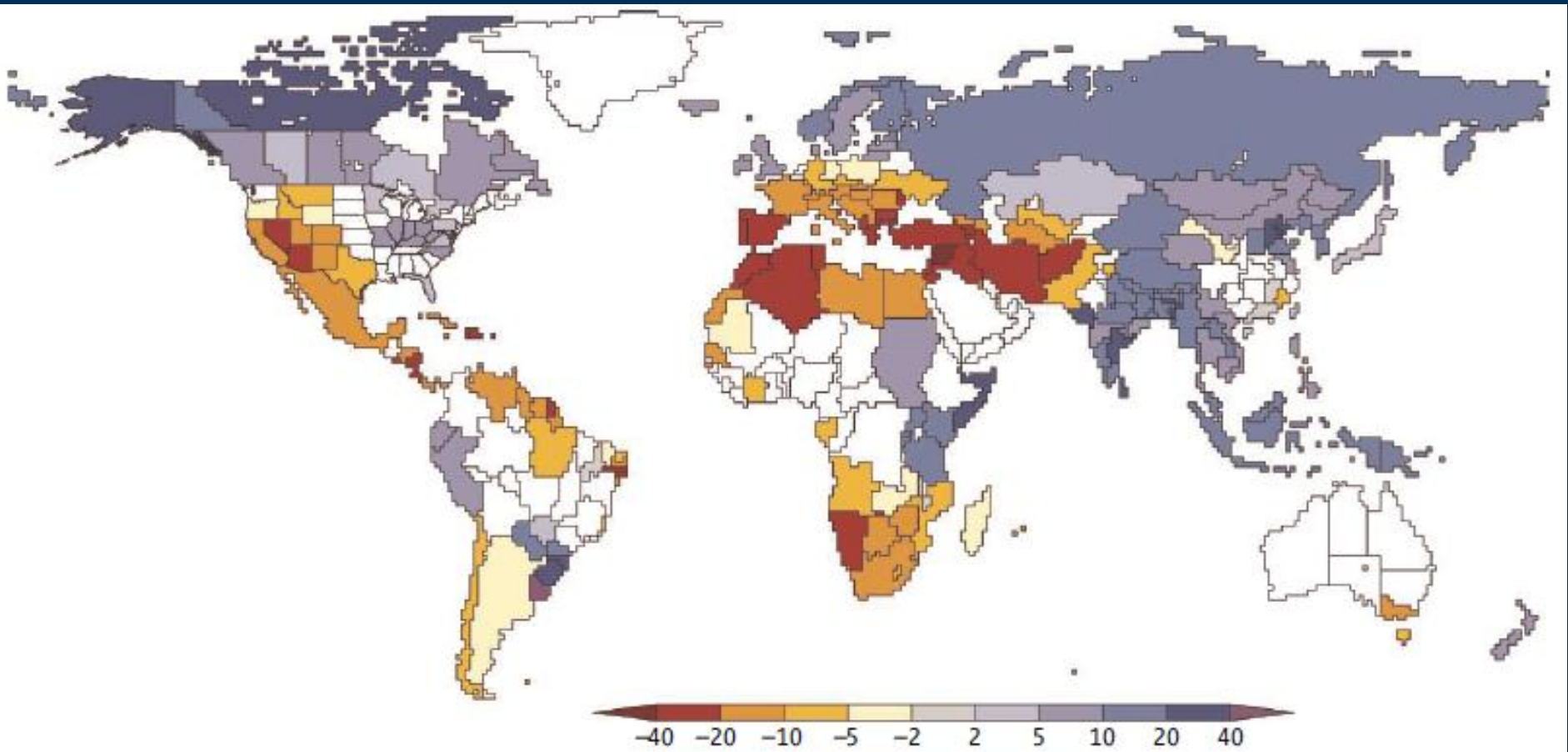


Human influences. Dramatic changes in runoff volume from ice-free land are projected in many parts of the world by the middle of the 21st century (relative to historical conditions from the 1900 to 1970 period). Color denotes percentage change (median value from 12 climate models). Where a country or smaller political unit is colored, 8 or more of 12 models agreed on the direction (increase versus decrease) of runoff change under the Intergovernmental Panel on Climate Change's "SRES A1B" emissions scenario.

USGS

Streamflow and Water Quality

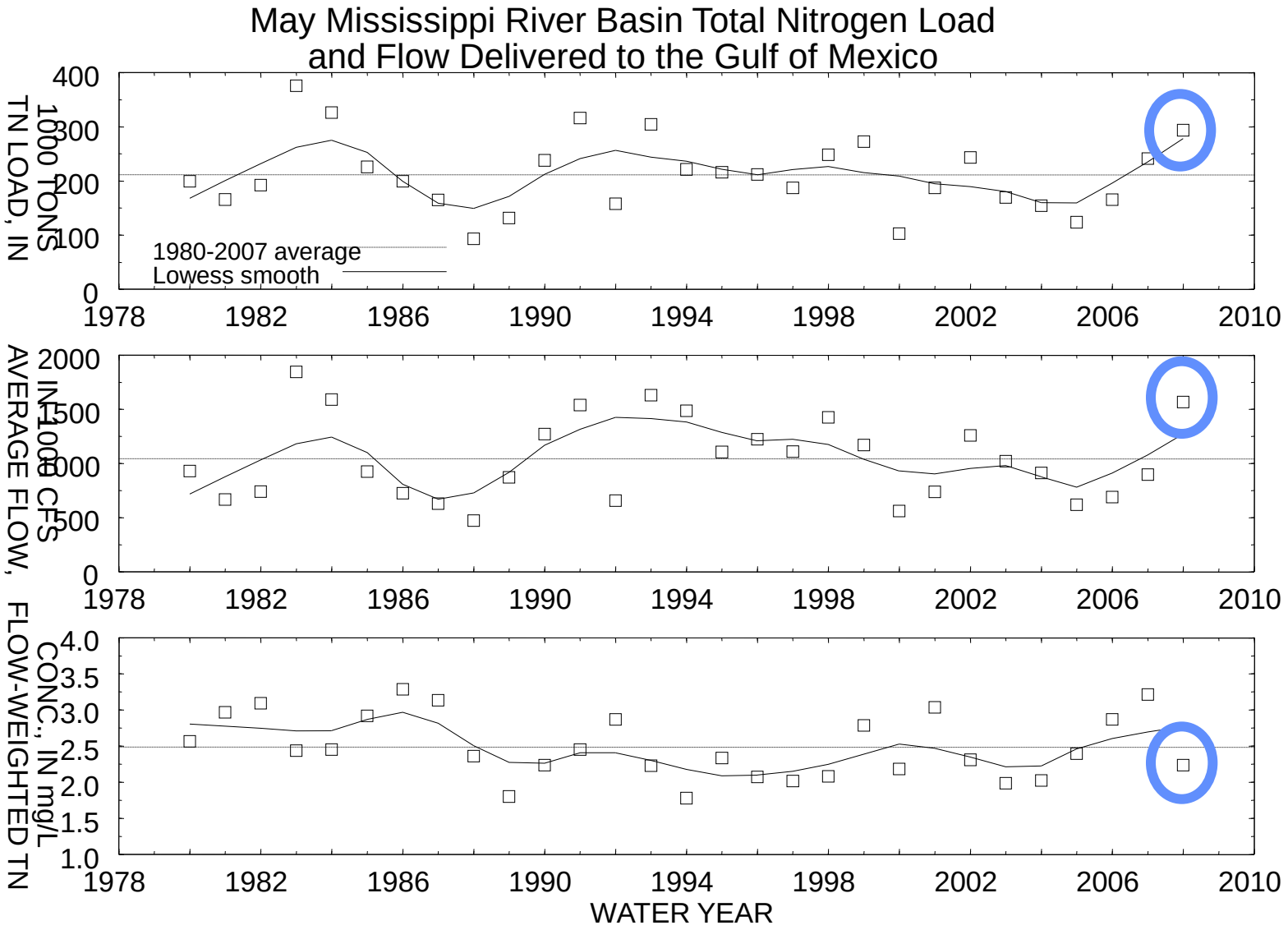
"Streamflow is one of most important ancillary variables that can be collected in stream or river quality studies. Having it allows us to remove the fluctuations in concentration data attributable only to variation in flow and helps us ascertain other effects (e.g. changes to landscape)."

Charles Crawford, USGS

Streamflow and Water Quality

- Load computation
  - Concentration x Streamflow
- Watershed diagnostics
- Trend assessments
- BMP evaluation

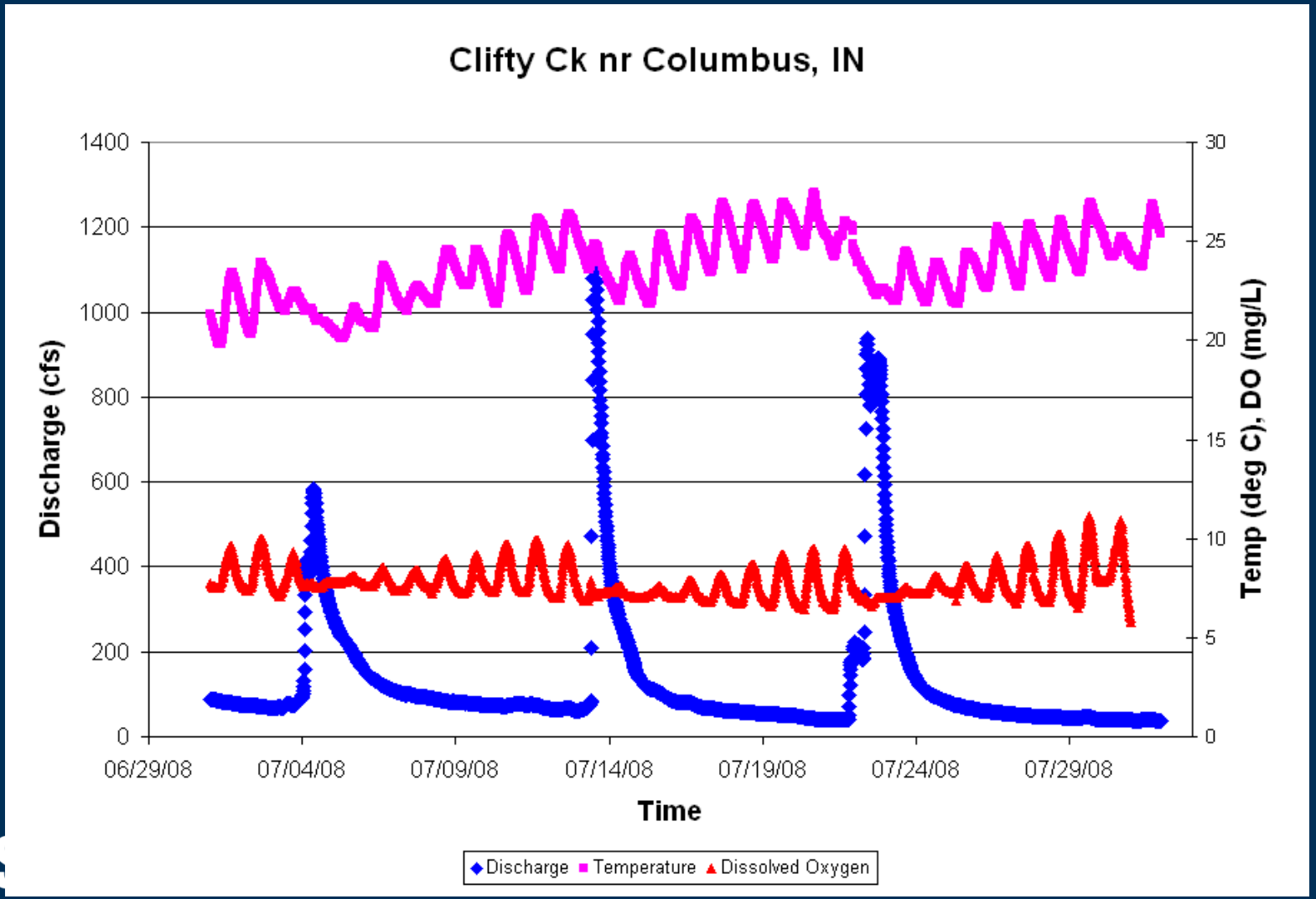
USGS


May Mississippi River Basin Total Nitrogen Load
and Flow Delivered to the Gulf of Mexico
TN LOAD, IN 1000 TONS
1980-2007 average
Lowess smooth
AVERAGE FLOW, IN 1000 CFS
FLOW-WEIGHTED TN CONC., IN mg/L
WATER YEAR
1978
1982
1986
1990
1994
1998
2002
2006
2010

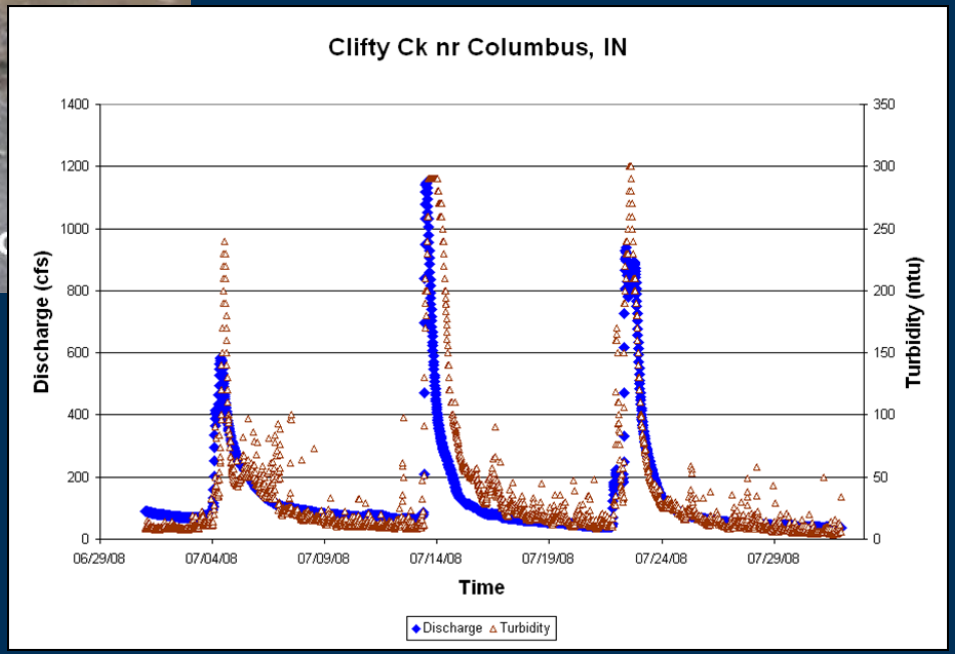

Source of image: http://www.esa.int/

USGS

Watershed Diagnostics



Suspended Sediment



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BMPs?

USGS

Bankfull flow

www.geograph.org.uk

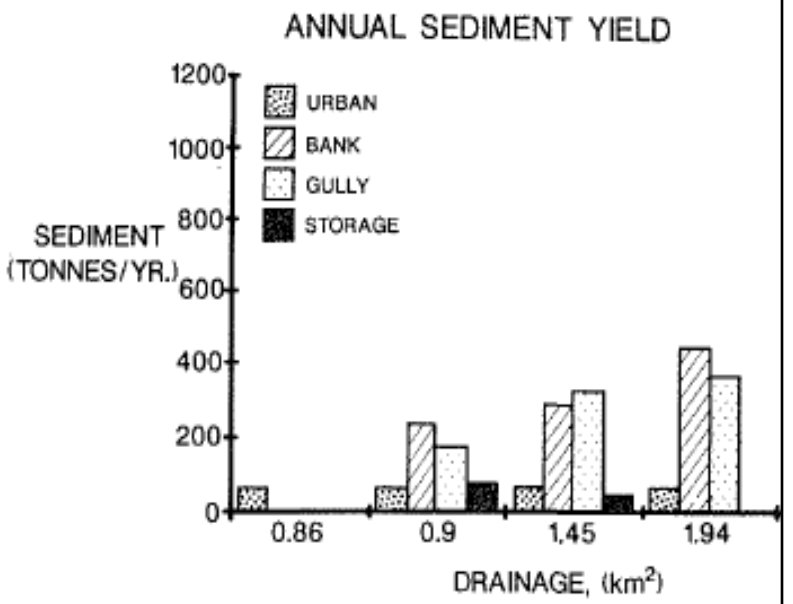


Fig. 3 Sediment sources for a small sub-b

KAREN L. PRESTEGAARD Sediment Budgets (Proceedings of the Porto Alegre Symposium, December 1988). IAHS Publ. no. 174, 1988.

Urbanization

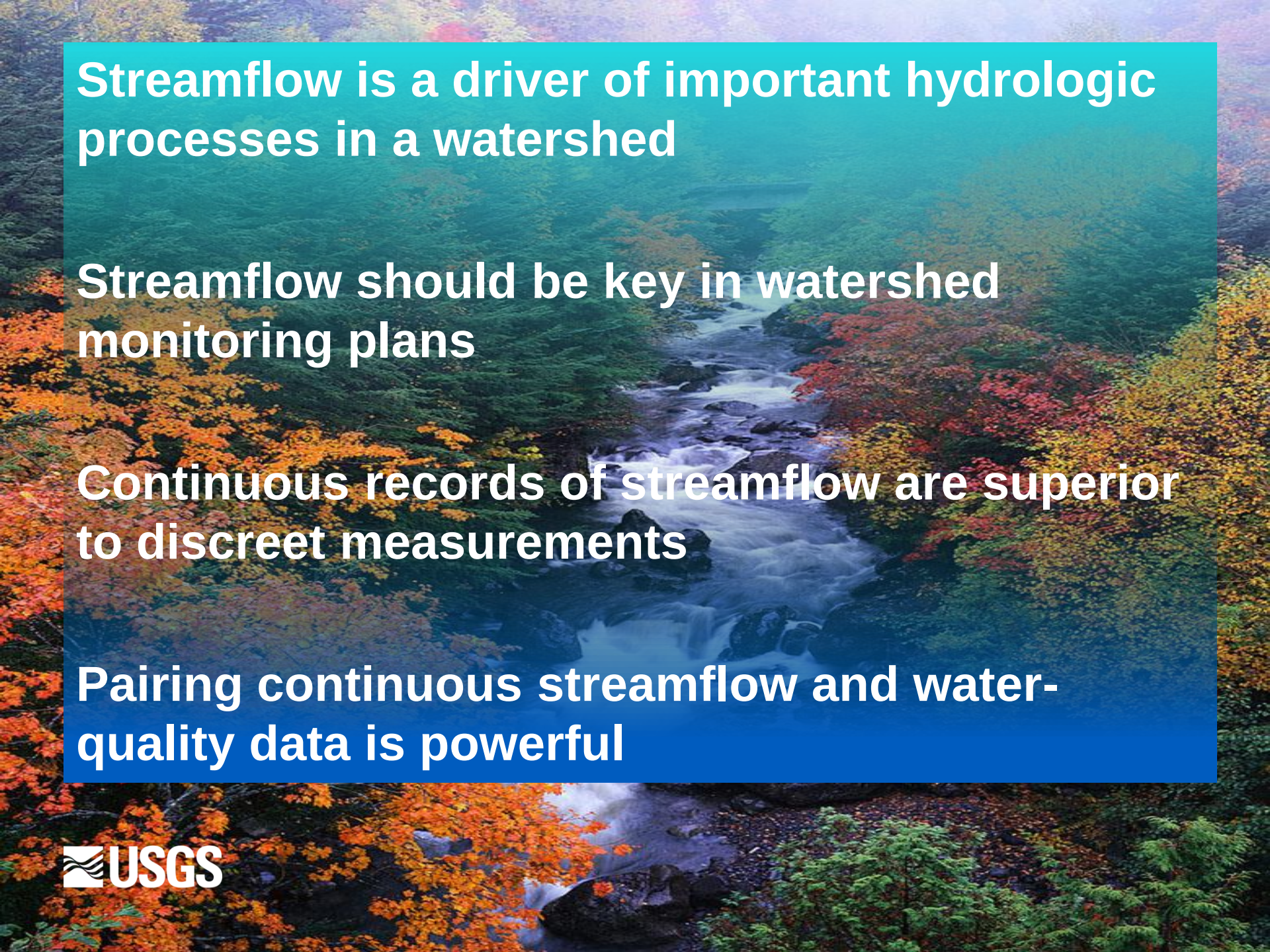
=more bankfull events

= increased bank erosion

=>sediment loads

= changed BMP focus – flow driven, in-stream process

USGS


Streamflow is a driver of important hydrologic processes in a watershed
Streamflow should be key in watershed monitoring plans
Continuous records of streamflow are superior to discreet measurements
Pairing continuous streamflow and water-quality data is powerful
USGS

Scott Morlock
317-290-3333 x153
smorlock@usgs.gov

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