USGS Integrated Water Science

A presentation to the

Northwest Water Planning Alliance

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USGS Integrated Water Science Basin Activities in the Illinois River Basin

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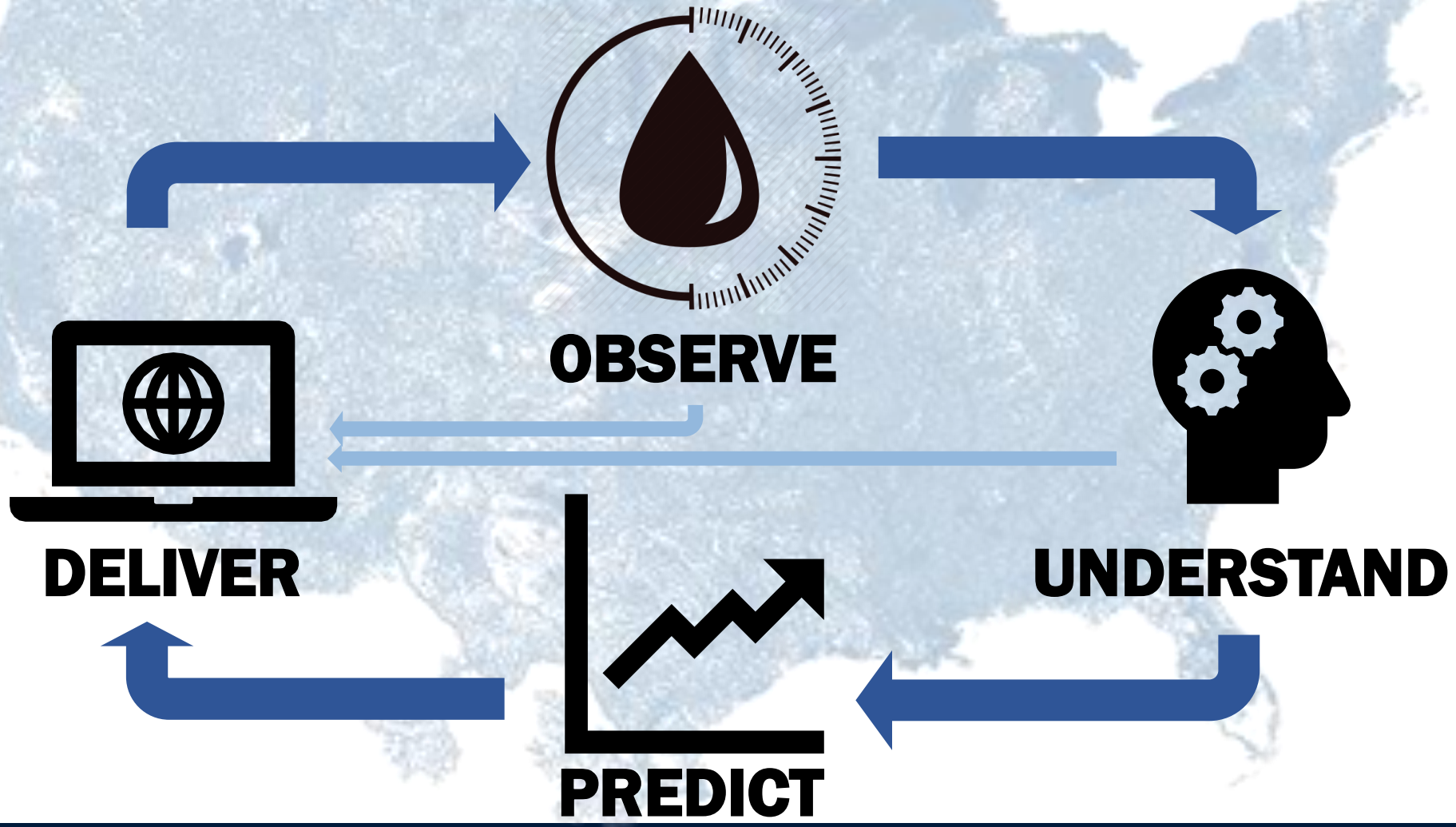
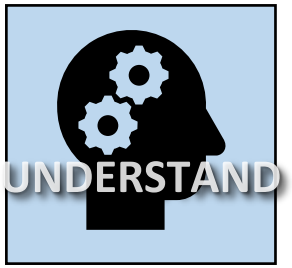
Integrated Water Science Process



Integrated Water Science Initiative

Next Generation Water Observing System (NGWOS)

NGWOS collects real-time data on water quantity and quality in more affordable, rapid, and intensive ways than has previously been possible. The flexible monitoring approach enables USGS networks to evolve with new technology and emerging threats.



Integrated Water Availability Assessments (IWAA)

IWAAs examine the supply, use, and availability of the nation's water. These regional and national assessments evaluate water quantity and quality in both surface and groundwater, as related to human and ecosystem needs and as affected by human and natural influences.

Integrated Water Prediction (IWP)

IWP builds a powerful set of modeling tools to predict the amount and quality of surface and groundwater, now and into the future. These models use the best available science to provide information for more rivers and aquifers than can be directly monitored.

National Water Information System (NWIS) Modernization; National Water Dashboard

NWIS data systems that house USGS water information are being modernized to maximize data integrity, simplify data delivery to the general public, automate early warning to enable faster response times during water emergencies, and support the new National Water Dashboard.

Integrated Water Science Basins

10 Intensive Reference Basins to Drive the Future of Integrated Water Science:

- Regional focus areas for intensive observation, assessments, modeling, and prediction
- 10 river basins (10,000-20,000 mi^2) representative of larger water-resource regions
- Goal: Establish 10 basins in 10 years
- Develop a deep, integrated understanding that can be extended to the broader region
- Basin selection process includes quantitative metrics and extensive stakeholder engagement

Illinois River Basin

- Extensive urban and agricultural land uses
- HABs occurrences are commonplace
- Estimated to be one of the largest geographic source of nutrients to the Gulf of Mexico

Illinois River Basin IWS Insights and Opportunities:

- Improve understanding of nutrient sources and climate and land-use change limits to water availability.
- Improve understanding of HABs occurrences in the broader Mississippi River Basin and Midwestern US.
- High transferability - inform nutrient management to reduce nutrient loads to the Gulf of Mexico and Great Lakes and evaluate conservation practices on water-quality trends at various spatial scales.
- Provide opportunities for integration within USGS activities and Mission Areas.
- Provide opportunities to leverage direct linkages with stakeholders and partners.

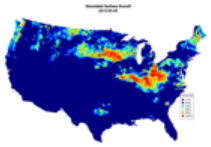
Components of the Integrated Water Science Basins

Catalog existing observational networks, models, and data repositories and identify monitoring and knowledge gaps.

Establish integrated set of fixed and mobile monitoring assets in the water, ground, and air to fill data gaps.

Conduct targeted hydrologic research to fill knowledge gaps.

Use new data and knowledge to develop improved basin models.



Use models to assess past, current, and future water availability – including water quantity, quality, and use.

Advanced Water Models Require High-Density Data

Nearly 30 million stream reaches in U.S.

USGS operates about 11,400 streamgages (0.004% of reaches)

About 143,000 Community Supply Wells and over 14 million domestic wells in U.S.

USGS and its cooperators measure water levels in about 17,000 wells

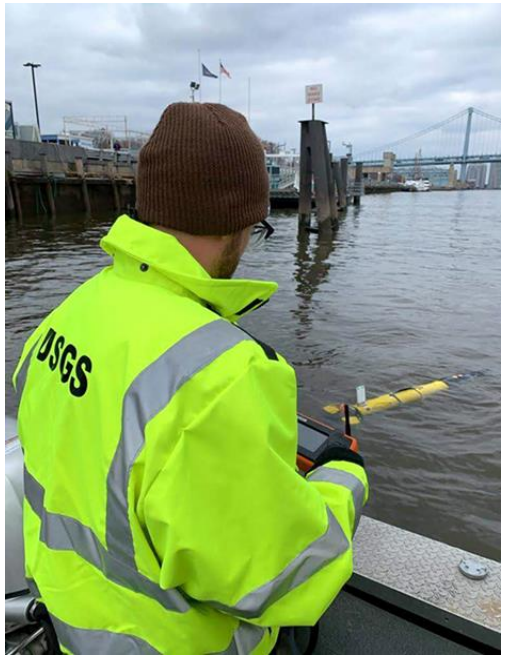
The density of our current monitoring networks limit the ability to accurately understand and predict water-resource conditions with advanced models

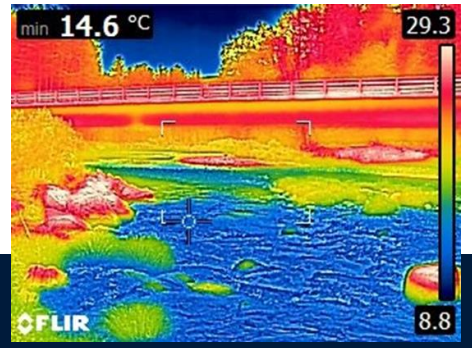
Next Generation Water Observing System (NGWOS)

The USGS Next Generation Water Observing System (NGWOS) will provide high-resolution, real-time data on water quantity, quality, and use in Integrated Water Science Basins to support National modern water-availability prediction and decision support systems

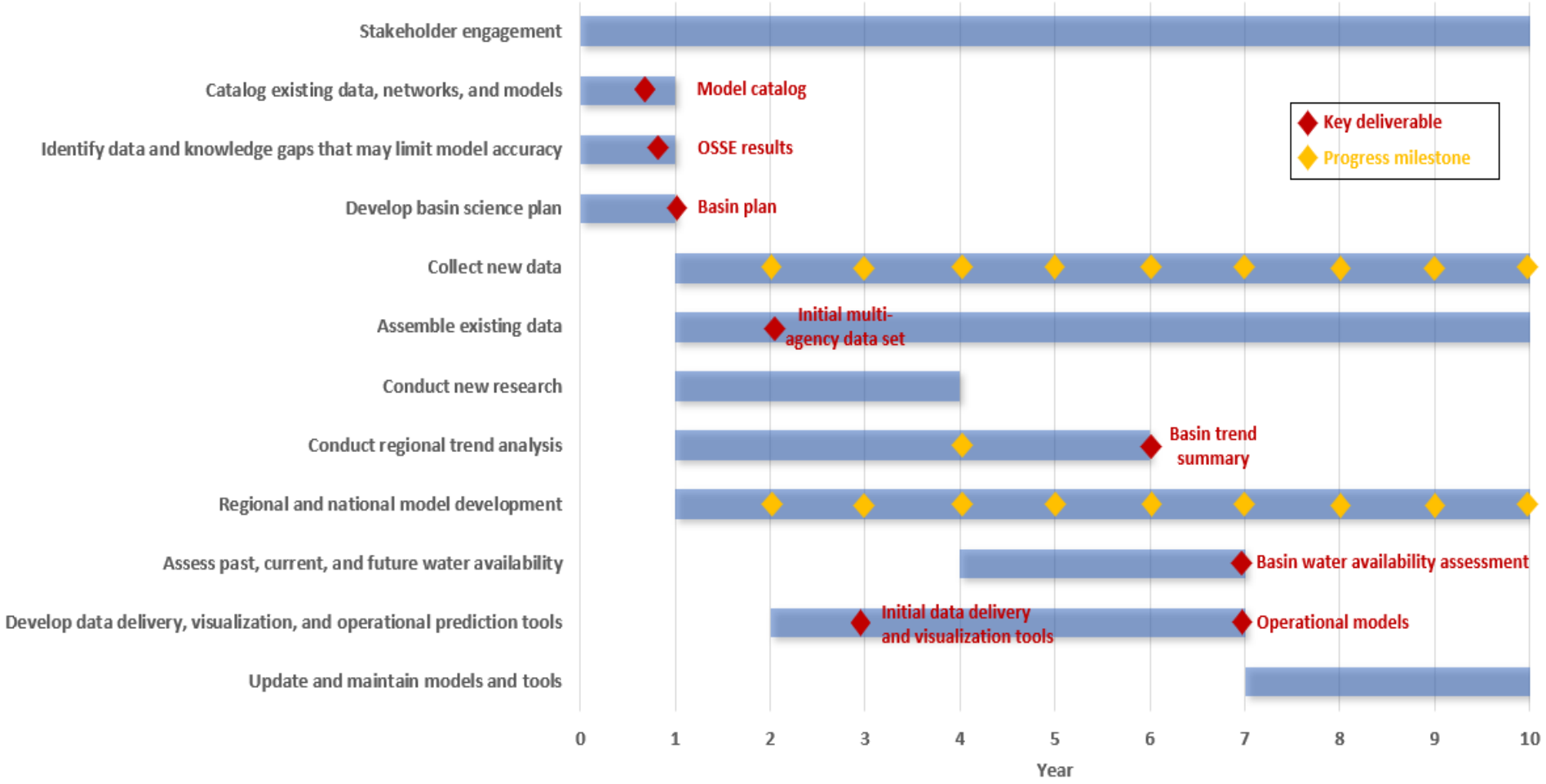
Approach

- Increases spatial and temporal coverage of critical data
- Dense array of sensors at selected sites
- Use state-of-the-art data collection methods
- Test and mature new technologies
- Improved USGS operational efficiency
- Modernized and timely data telemetry, storage, QA/QC and delivery



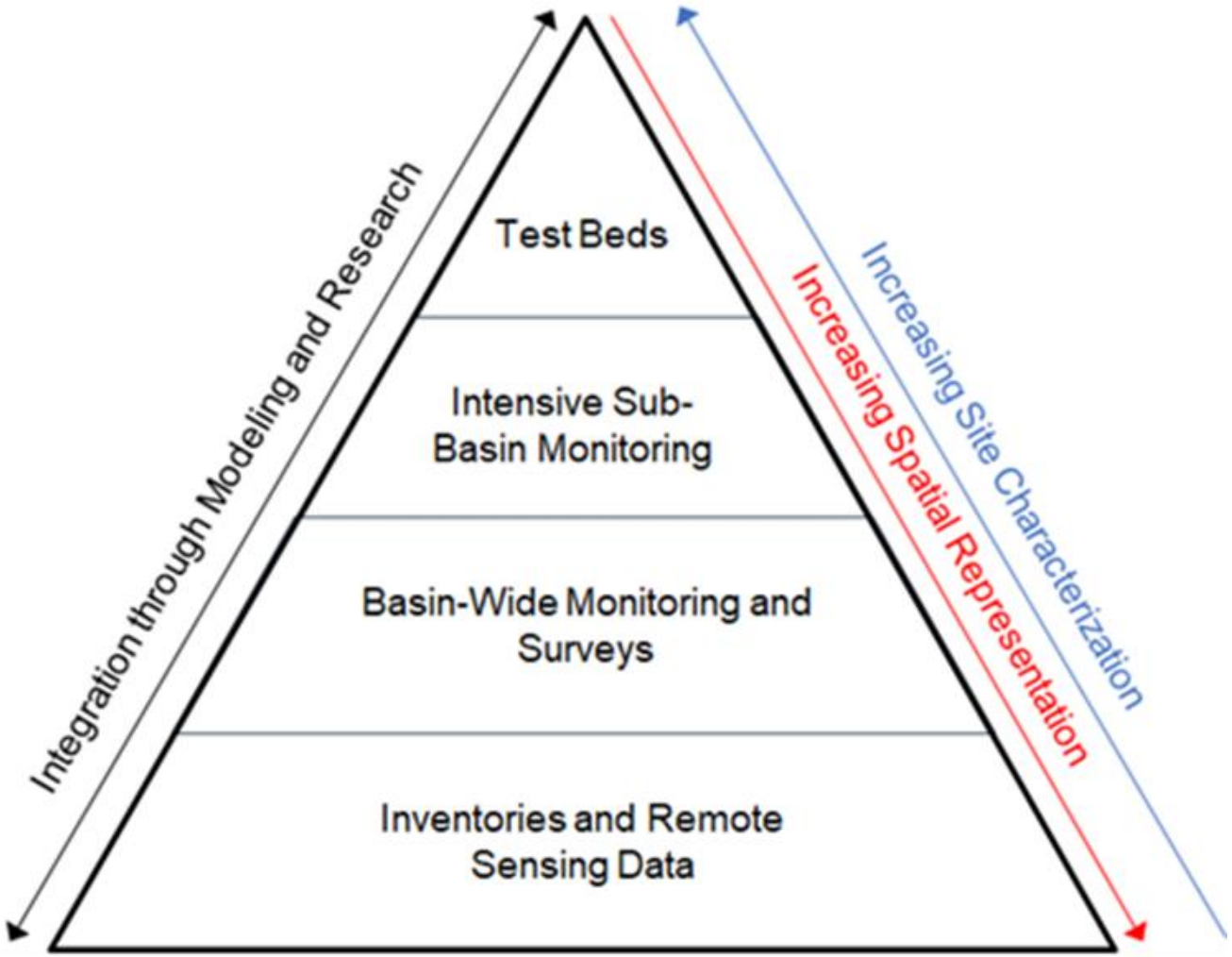


Standard approach



NGWOS

The pyramid shape of the framework represents the relative density of observations, with" few intensive sites measuring multiple parameters at a high frequency at the top and many survey points or remotely sensed pixels measured less frequently and for fewer parameters at the base" (Murdoch et al., 2014).



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NGWOS

- State-of-the-art measurements
- Dense array of sensors at selected sites
- Increased spatial and temporal data coverage of all primary components of the hydrologic cycle
- New monitoring technology testing and implementation
- Improved operational efficiency
- Modernized and timely data storage and delivery

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Illinois River Basin

- 28,756.6 square miles
- Covers 44 % of the state
- 90 % of the state's population
- Drainage basin extends into Wisconsin, Indiana and a very small portion of southwestern Michigan
- Large urban/suburban component in the upper part of the basin and a predominant agricultural component in the lower part of the basin

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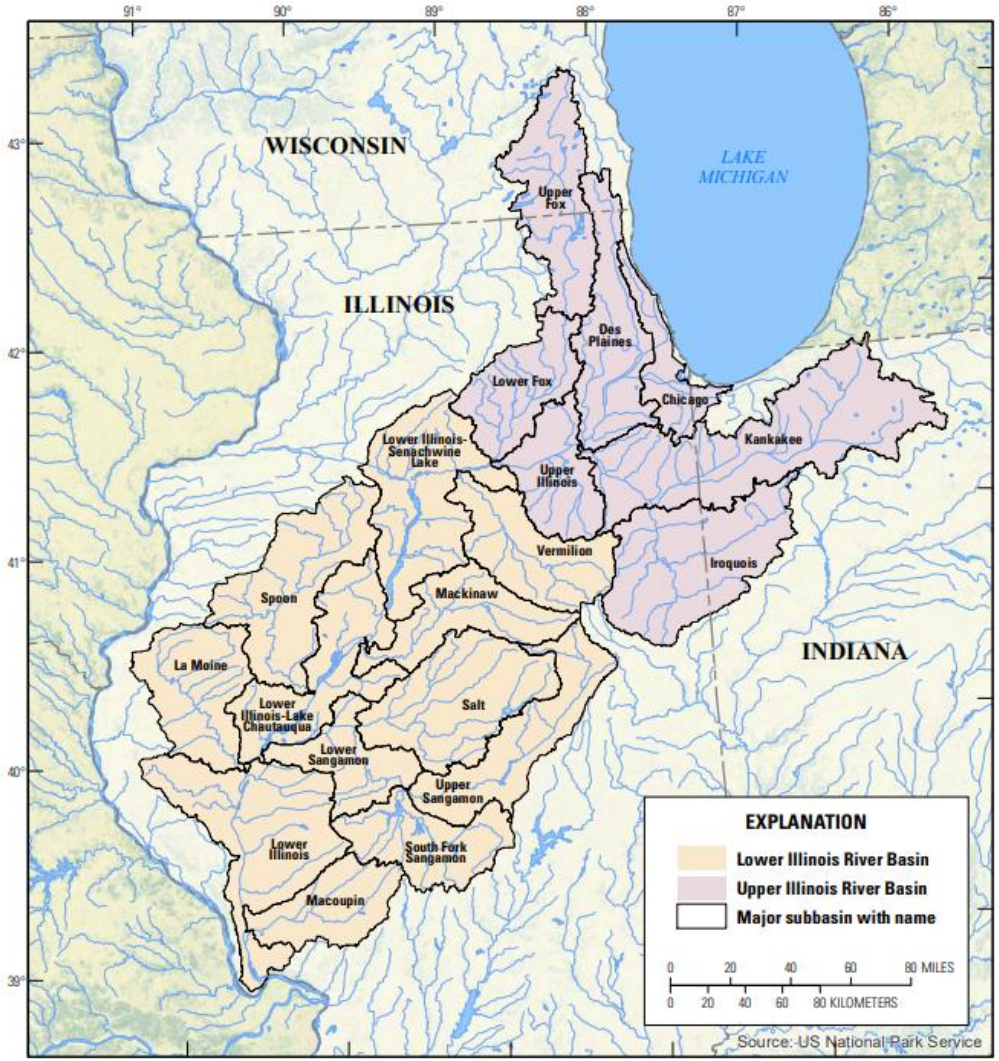
Illinois River Basin –major sub-basins

- Major sub-basins
- Drainage basin extends into Wisconsin, Indiana and a very small portion of southwestern Michigan
- Extensive monitoring in both the Upper and Lower Illinois River Basin
- Large urban/suburban component in the upper part of the basin and a predominant agricultural component in the lower part of the basin



Illinois Waterway-Profile view

- Illinois Waterway 273 miles in length
- Lock and dams form 8 pools
- Nearly 30 million tons of commodities move along the Illinois Waterway each year
- 3 National Wildlife Refuges

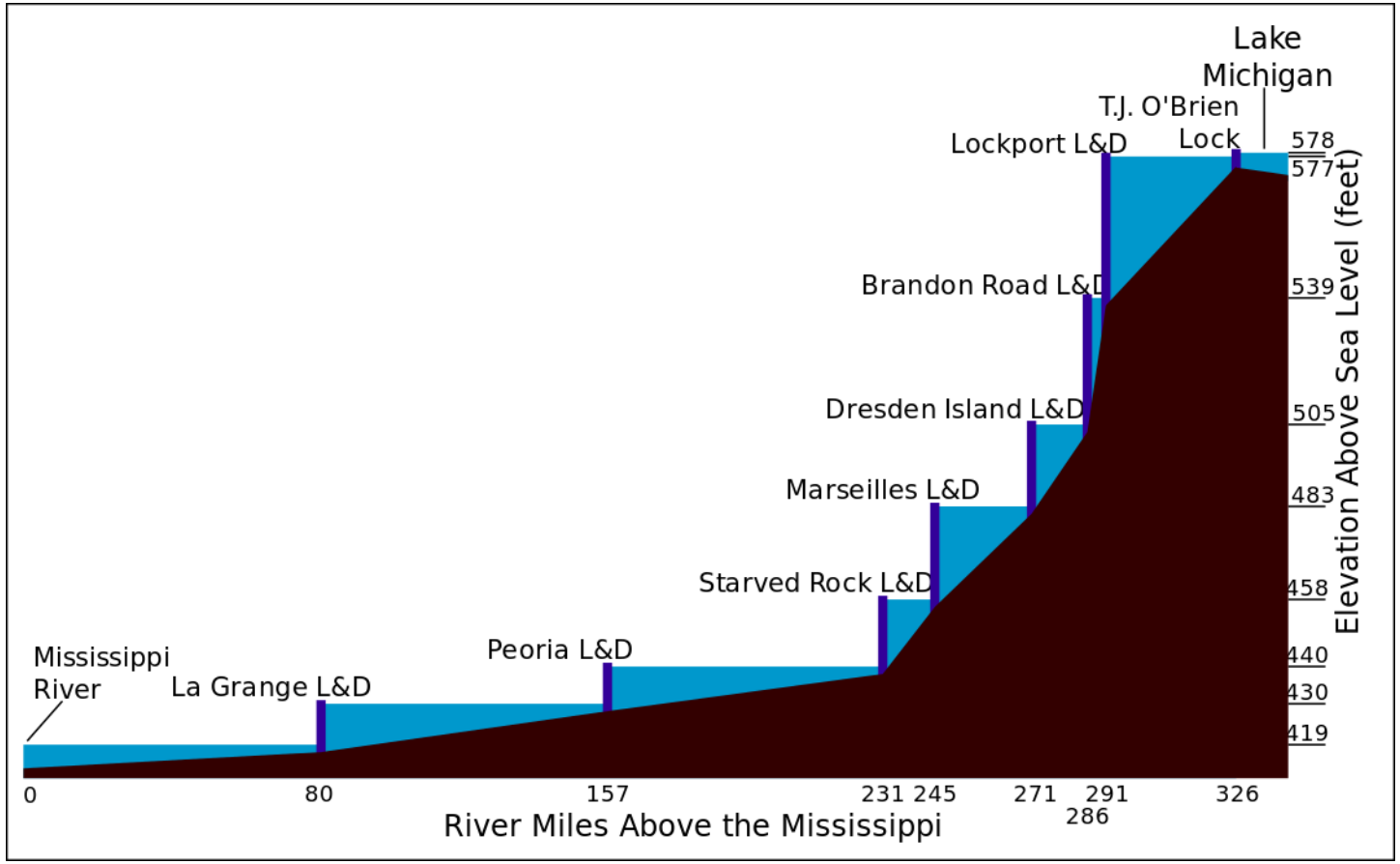


Figure from US Army Corps of Engineers

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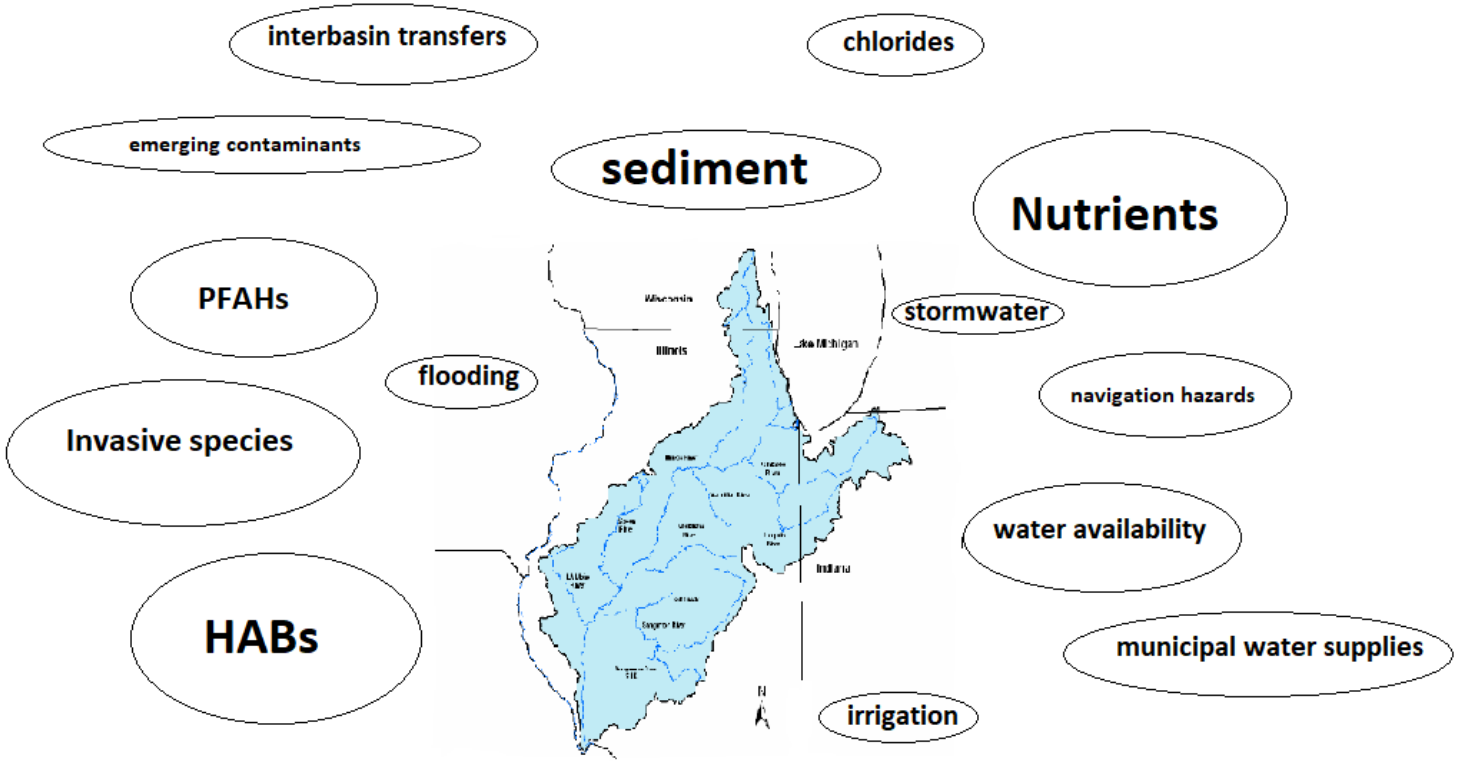
Illinois River Basin Issues

- Stakeholder priority issues
- Shared Illinois River Basin issues
- Transferability of NGWOS information



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Basin Issues

NUTRIENTS-

- Illinois River basin identified as major contributor to Gulf Hypoxia.
- IEPA-led Nutrient Loss Reduction Strategy
  - long-term goal of reducing loads from Illinois for total phosphorus and total nitrogen by 45%, with interim reduction goals of 15% nitrate-nitrogen and 25% total phosphorus by 2025.
- Monitoring 3 sectors
  - -ag stakeholder interest remains high
  - -point source reductions are due to improvements in WWTF.
  - -urban stormwater-green infrastructure.
- Additional continuous monitoring “supergages” provide more sub-basin

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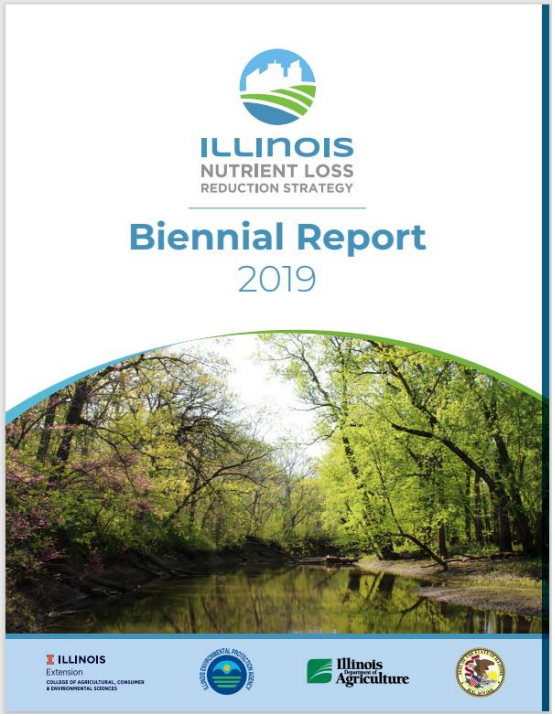

Figure from (IEPA, 2019)

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Basin Issues

HARMFUL ALGAL BLOOMS

- Identify the algal communities.
  - Baseline information
  - Compare to historical algal community assemblages
- Improve early detection.
  - Nuisance blooms and harmful algal blooms
- Deploy multi-spectral cameras.
- Link multi-spectral cameras to remote sensing data.

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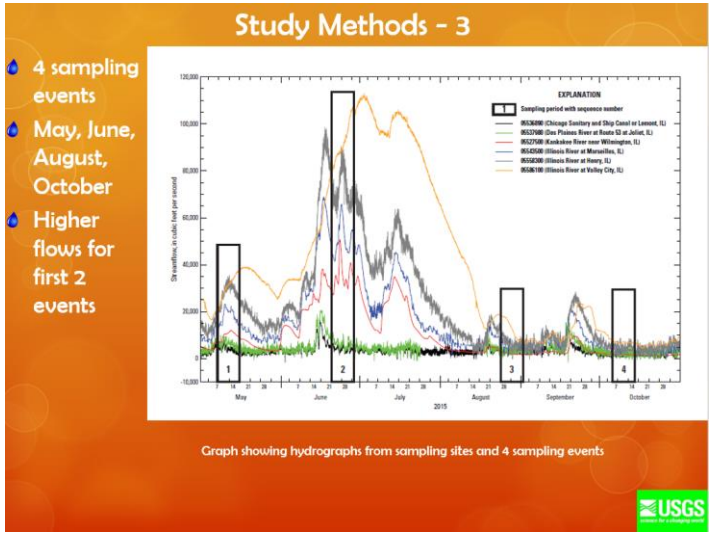
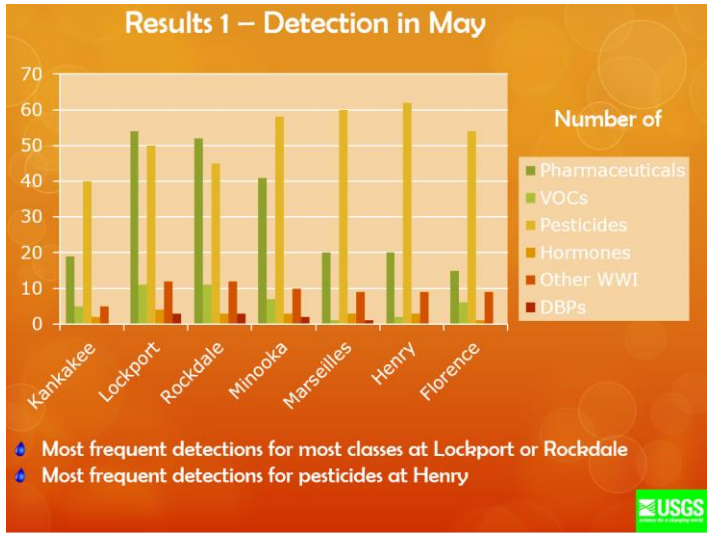
Basin Issues

EMERGING CONTAMINANTS

- USGS established baseline of emerging contaminants in 2015.
- Water samples were analyzed for over **639 constituents** of which **280 were detected** at least once, including many anthropogenic bioactive chemicals (ABCs) such as pesticides, pharmaceuticals, hormones, and volatile organic compounds (VOCs).
- Little known effects on algal community.





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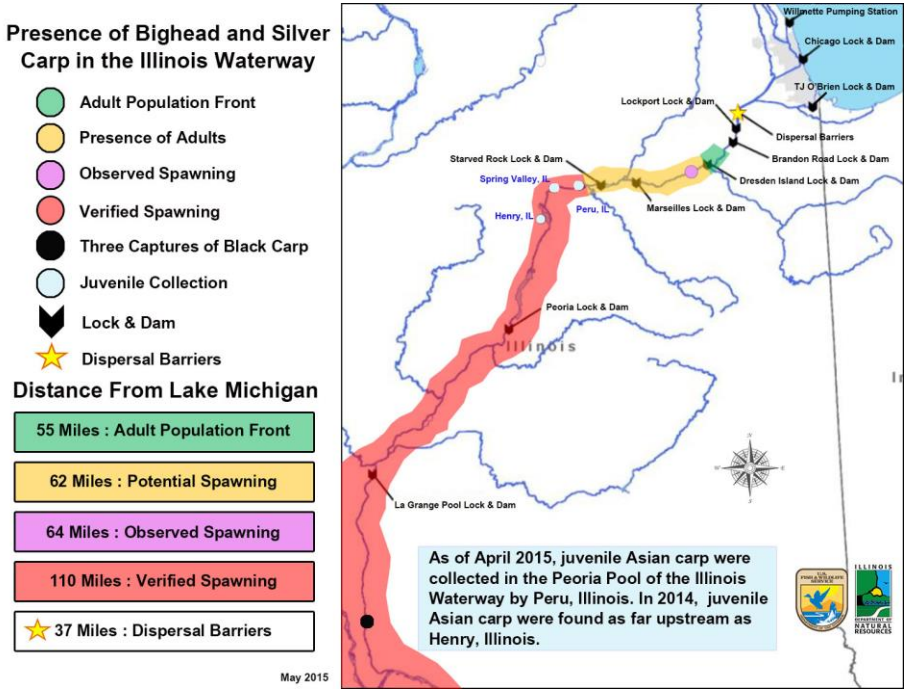
Basin Issues

INVASIVE SPECIES

- Asian carp were first detected in the Illinois Waterway in 1986.
- Population front stalled in the Dresden Island Pool
- Filter-feeders used to address algae issues in Asia.
- Represent a significant portion of the river biomass in the lower river.



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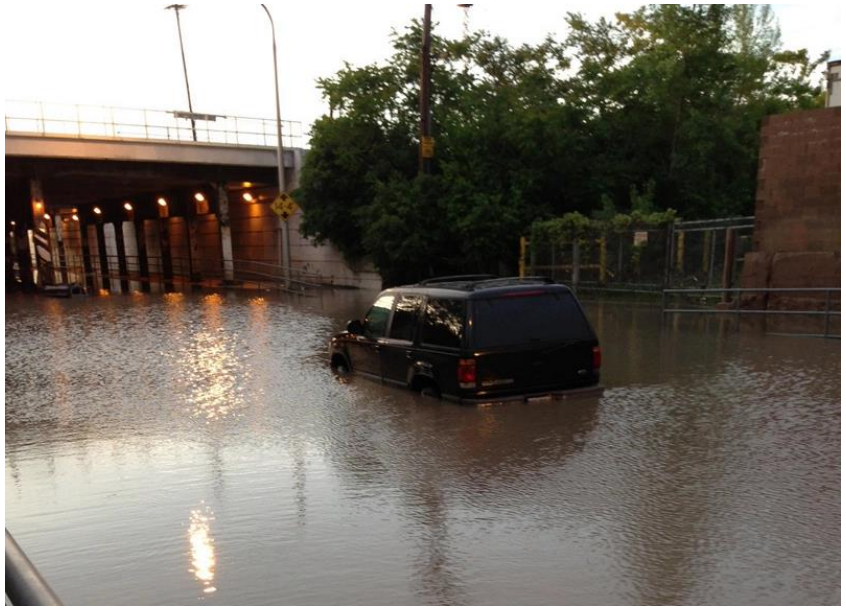
Basin Issues

FLOODING

- URBAN FLOODING
  - IDNR reports $2.3 Billion in non-riverine damages between 2007-2014
- FLOOD INUNDATION
  - Application of new instrumentation



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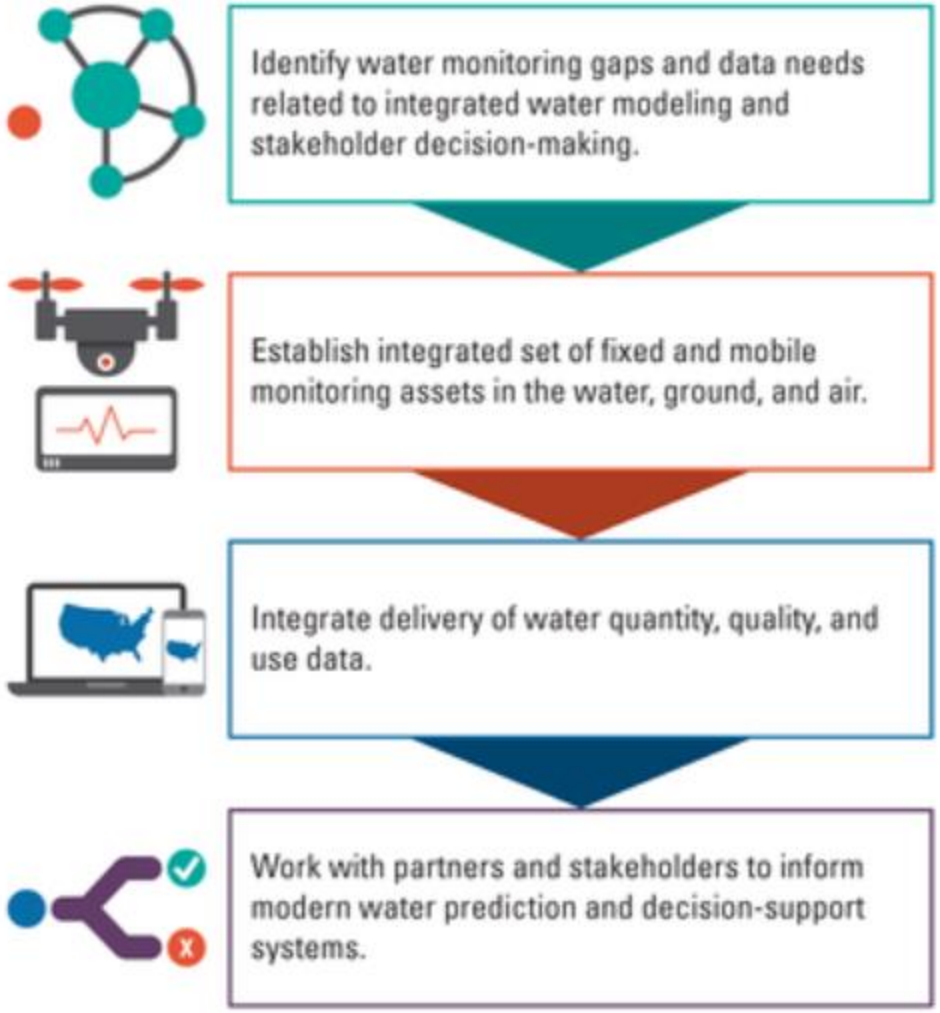
NGWOS Illinois River Basin-timeline

- Spring 2021 Stakeholder meetings.
- Spring 2021 Identify data gaps.
- Spring 2021 Develop Study Plan.
- Summer 2021 Procure equipment. Stand-up monitoring.
- Fall 2021- Field installations, data mining and compilation.
- Out years Predictive modeling



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Stakeholder input

Stakeholder priority issues-

Are existing tools and information adequate to meet the needs/plans/models to inform basin withdrawals? If not, what information do you need, or what uncertainty around information elements or models should be refined to better support or inform decision making?

USGS NGWOS contact information:
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