

Groundwater and Streamflow Information Program

Interstate Council on Water Policy /
National Water Supply Alliance
2019 Spring Roundtable Meeting



Chad Wagner, Program Coordinator



Groundwater Streamflow Information Program (GWSIP)

Collects and delivers groundwater and streamflow information:

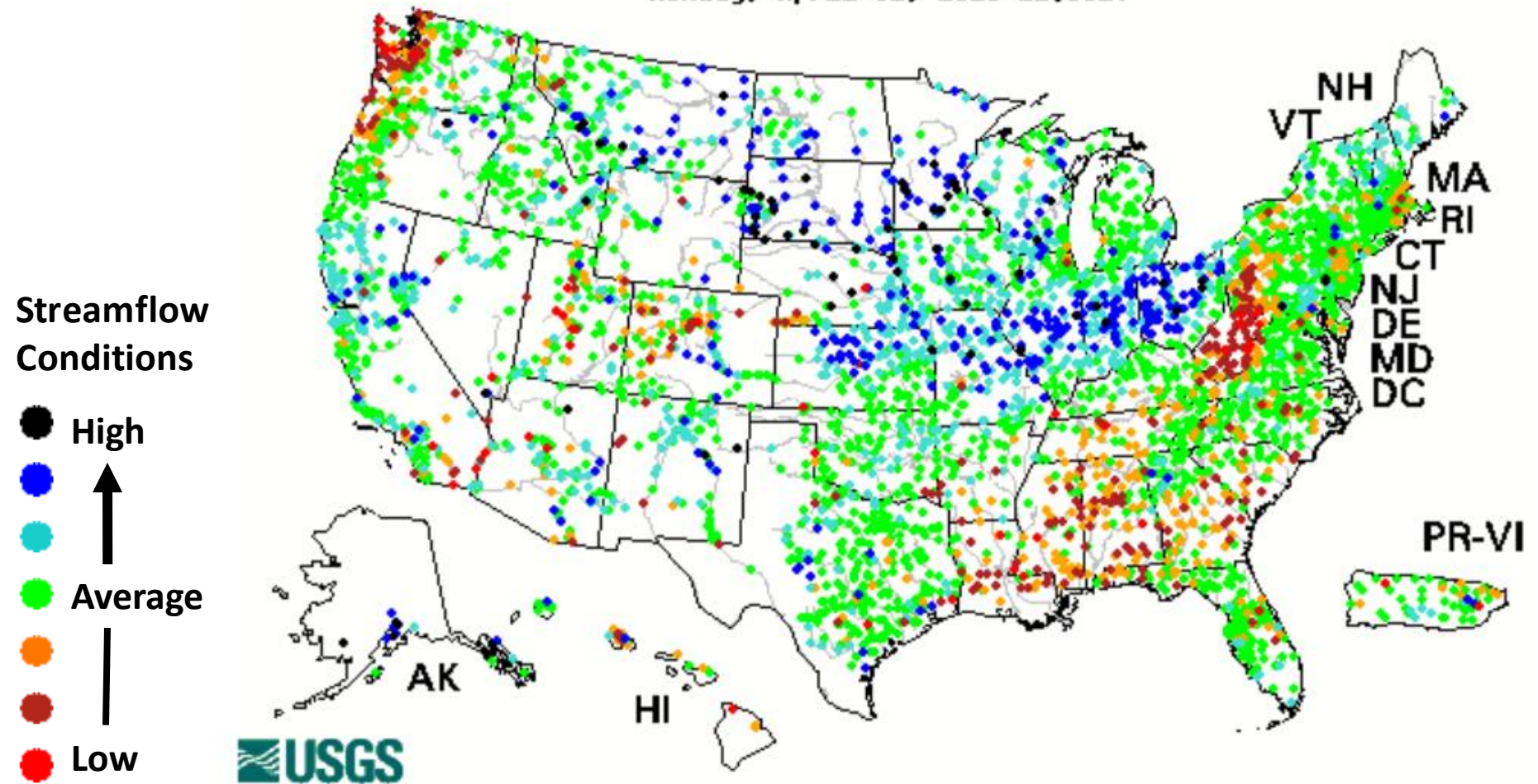
- to anticipate and respond to water emergencies and conflicts
- to support flood and drought planning and stream forecasting
- for infrastructure planning (roads, reservoirs, drinking water intakes, industrial needs)
- for recreational uses

National Streamflow Network

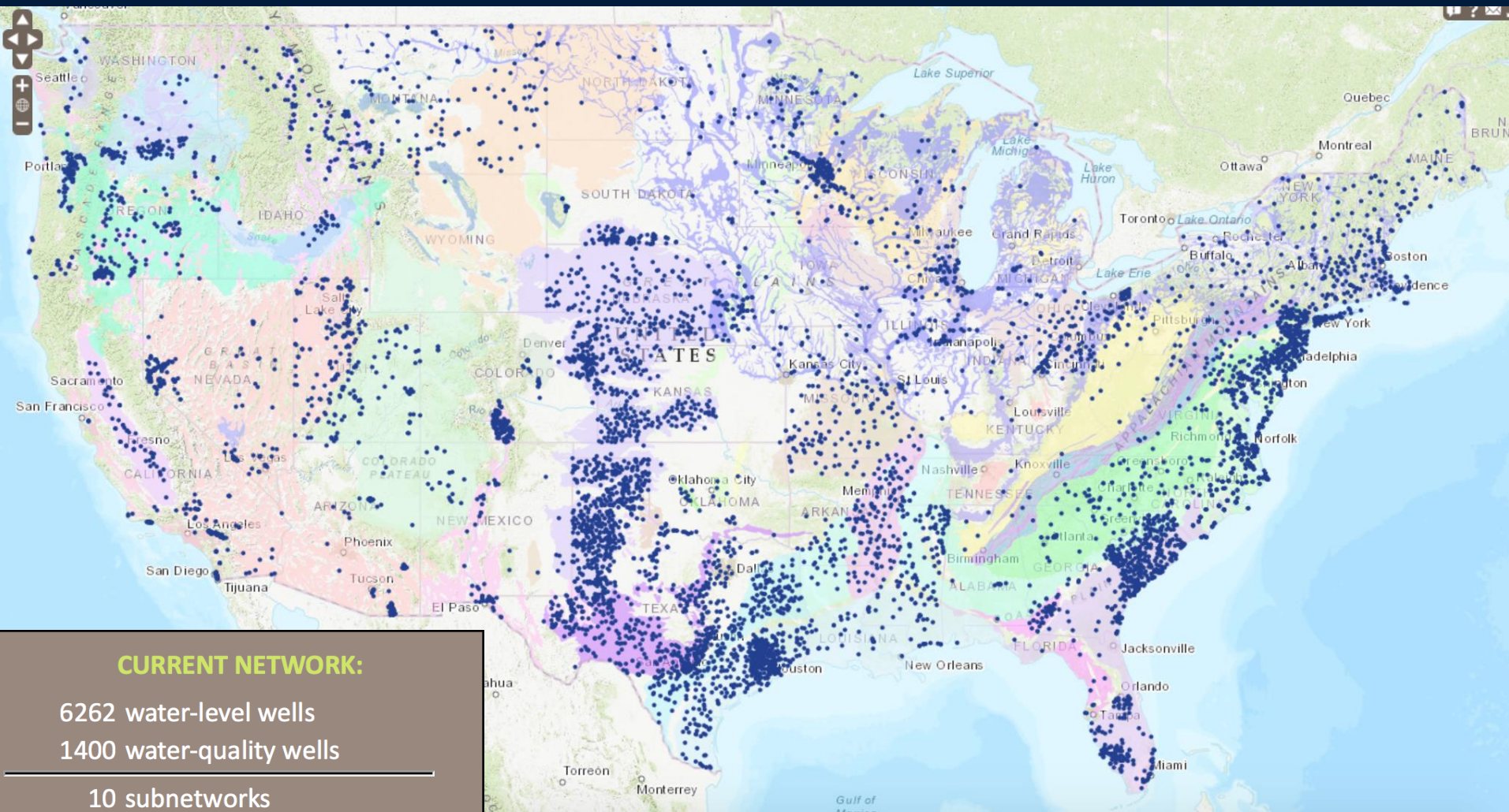
Current Conditions

(streamgages with 30+ years of data and no ice impacts)

Monday, April 01, 2019 22:30ET



National Groundwater Monitoring Network



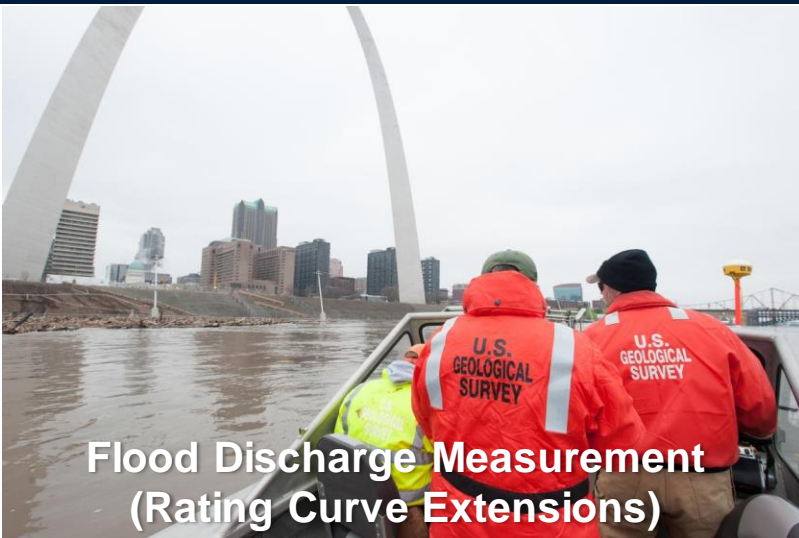
CURRENT NETWORK:

6262 water-level wells
1400 water-quality wells

10 subnetworks

25 contributing agencies
54 administrative units
62 principal aquifers

Hazards Response



Flood Discharge Measurement
(Rating Curve Extensions)



High Water Mark
Surveying



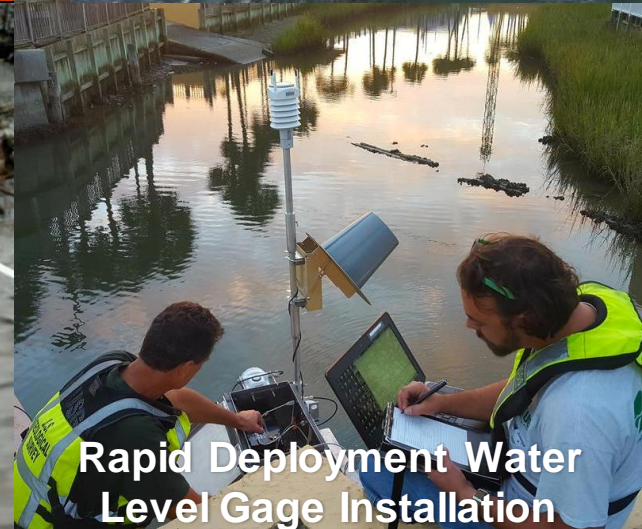
Storm Surge Sensor
Deployment



Post-Event High Water
Marking



Flood Discharge Measurement
(Rating Curve Extension)

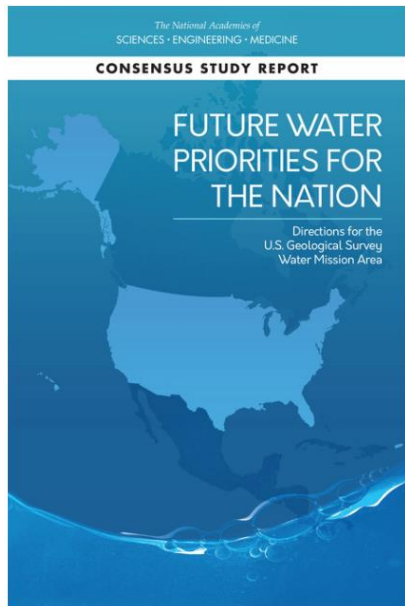


Rapid Deployment Water
Level Gage Installation

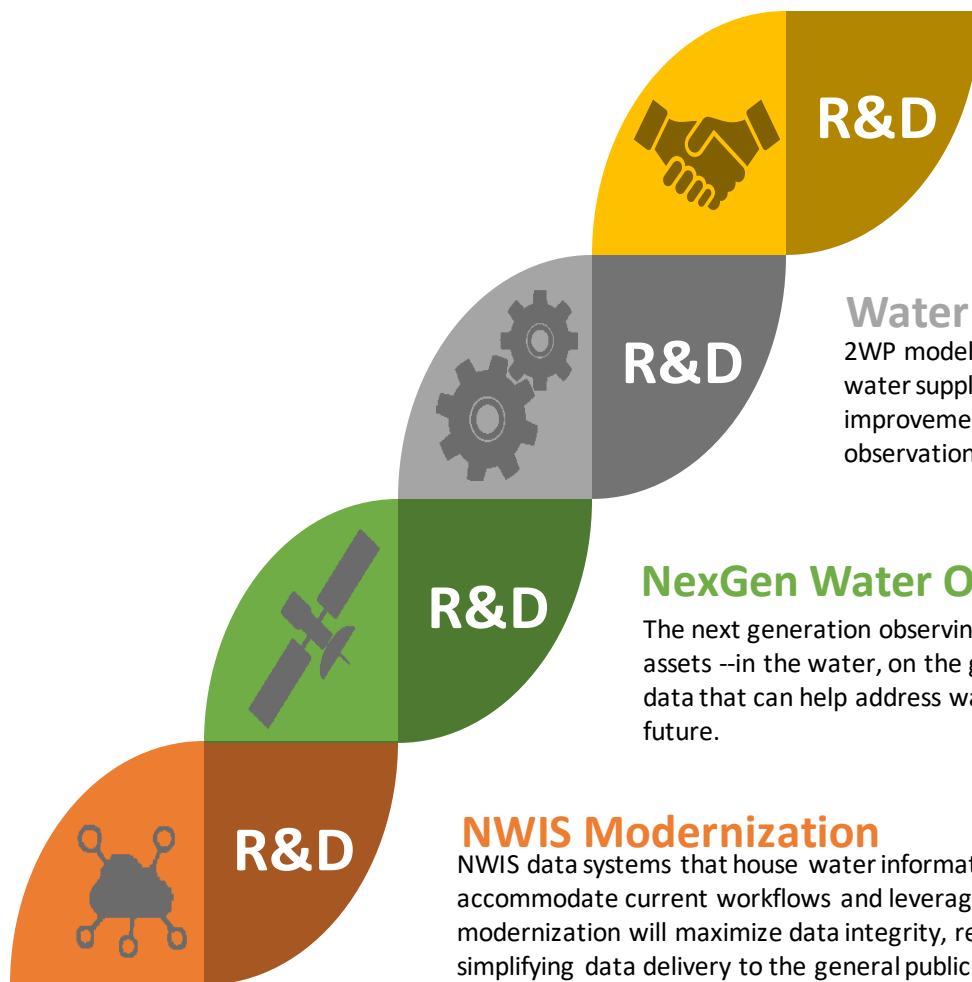
National Academy of Science - Future Water Priorities for the Nation

Over the next 25 years, new opportunities will emerge that will allow for observations that.....

- come from an array of sources,
- are more affordable,
- offer data from previously inaccessible locations,
- provide “fit-for-purpose” temporal and spatial resolution, and
- deliver continuous measurements of new parameters.



USGS Water Mission Area Priorities



Integrated Water Availability Assessments

IWAAs evaluate water availability in terms of the spatial and temporal distribution of water quantity and quality in both surface and groundwater, as related to human and ecosystem needs and as affected by human and natural influences.

Water Prediction Work Program

2WP model predictions will support daily to decadal forecast-based management of water supplies and infrastructure at a regional and National extent through improvement of existing tools and development of new capacity supported by our observational data and data collected by other monitoring organizations.

NexGen Water Observing System

The next generation observing systems (NGWOS) is an integrated set of fixed and mobile assets --in the water, on the ground and in the air-- that will measure, collect and deliver data that can help address water resource challenges and decision-making needs of the future.

NWIS Modernization

NWIS data systems that house water information will be modernized to accommodate current workflows and leverage latest technology. NWIS modernization will maximize data integrity, reliability, and accessibility while simplifying data delivery to the general public.

FY19 GWSIP Budget

Total Program Funding – \$82.7M (+\$8.5M over FY18)

- Cooperative Matching Funds – \$30.3M (+\$0)
- Federal Priority Streamgages – \$24.7M (+\$0)
- National Groundwater Monitoring Network – \$4.0M (+\$0)
- NextGen Water Observing System – \$8.5M (+\$7M)
- US-Canada Transboundary Streamgages – \$1.6M (+\$1.5M)
- Natural Hazard Science for Disaster Response – \$3.2M (+\$0)
- Research and Development (i.e. remote sensing) – \$2.5M (+\$0)

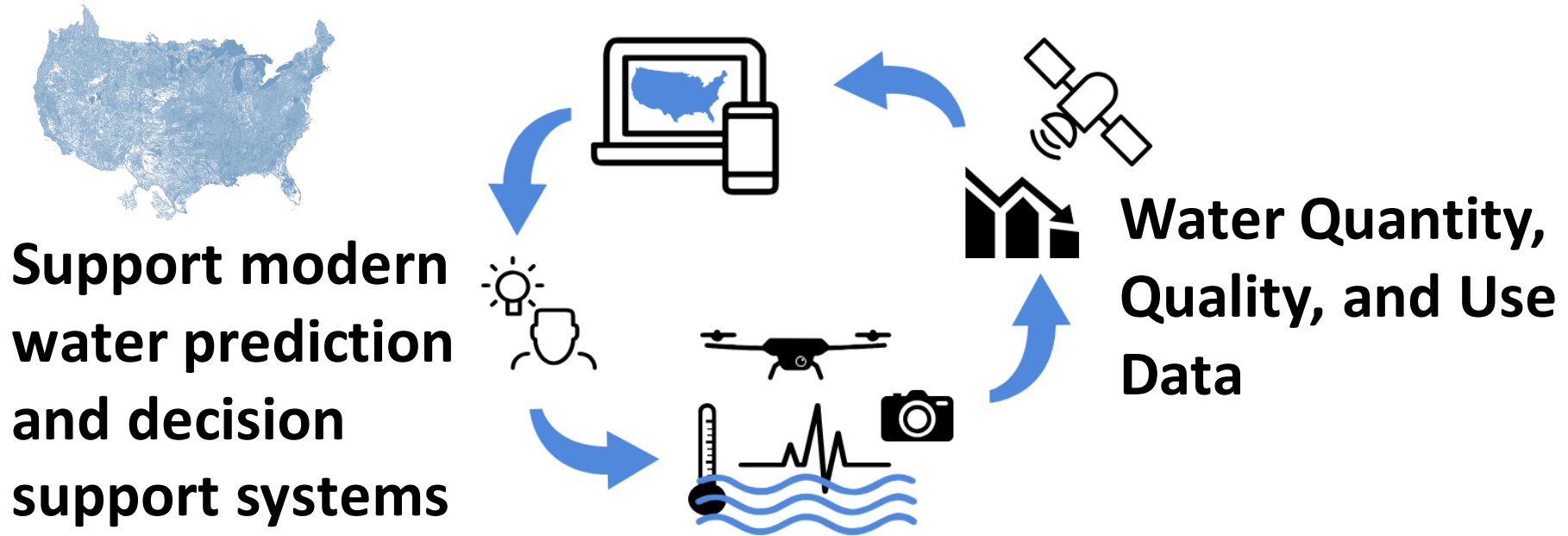
Advanced Water Models Require High-Density Data

Nearly 30 million stream reaches in U.S.

USGS operates about 10,000 streamgages
(about 3/100 of 1% of reaches)

- Modern models require high-density data describing all of the major hydrologic characteristics that the models represent, such as streamflow, evapotranspiration, water storage in snowpack, soil and groundwater, and many others.
- The density of our current monitoring networks limit the ability to accurately understand and predict water-resource conditions with these advanced models (i.e. National Water Model)

Next Generation Water Observing System (NGWOS)



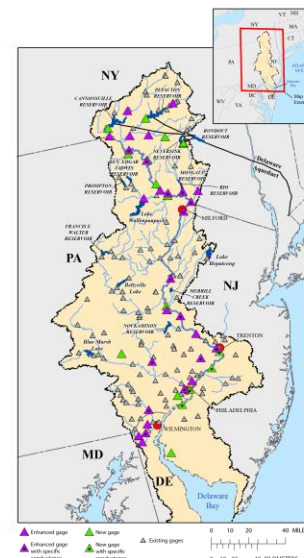
Integrated set of fixed and mobile monitoring assets in the water, ground, and air

NGWOS Components

1. **Water Observing Network Equipment & Operation**
2. Modernization of the USGS Data Management, Integration and Delivery Infrastructure (NWIS)
3. Hydrologic Instrumentation Facility

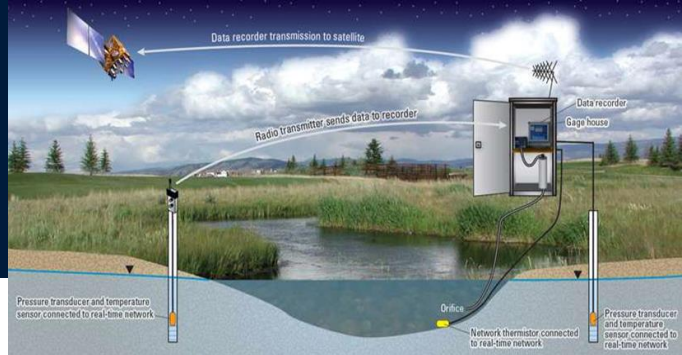
NGWOS Design Strategy

- We can't afford to monitor everywhere...
- Implement NGWOS in ~10 medium-sized watersheds (10,000-20,000 mi² each) that are representative of larger water-resource regions and augment the existing streamgage network elsewhere in the region with modest enhancements.

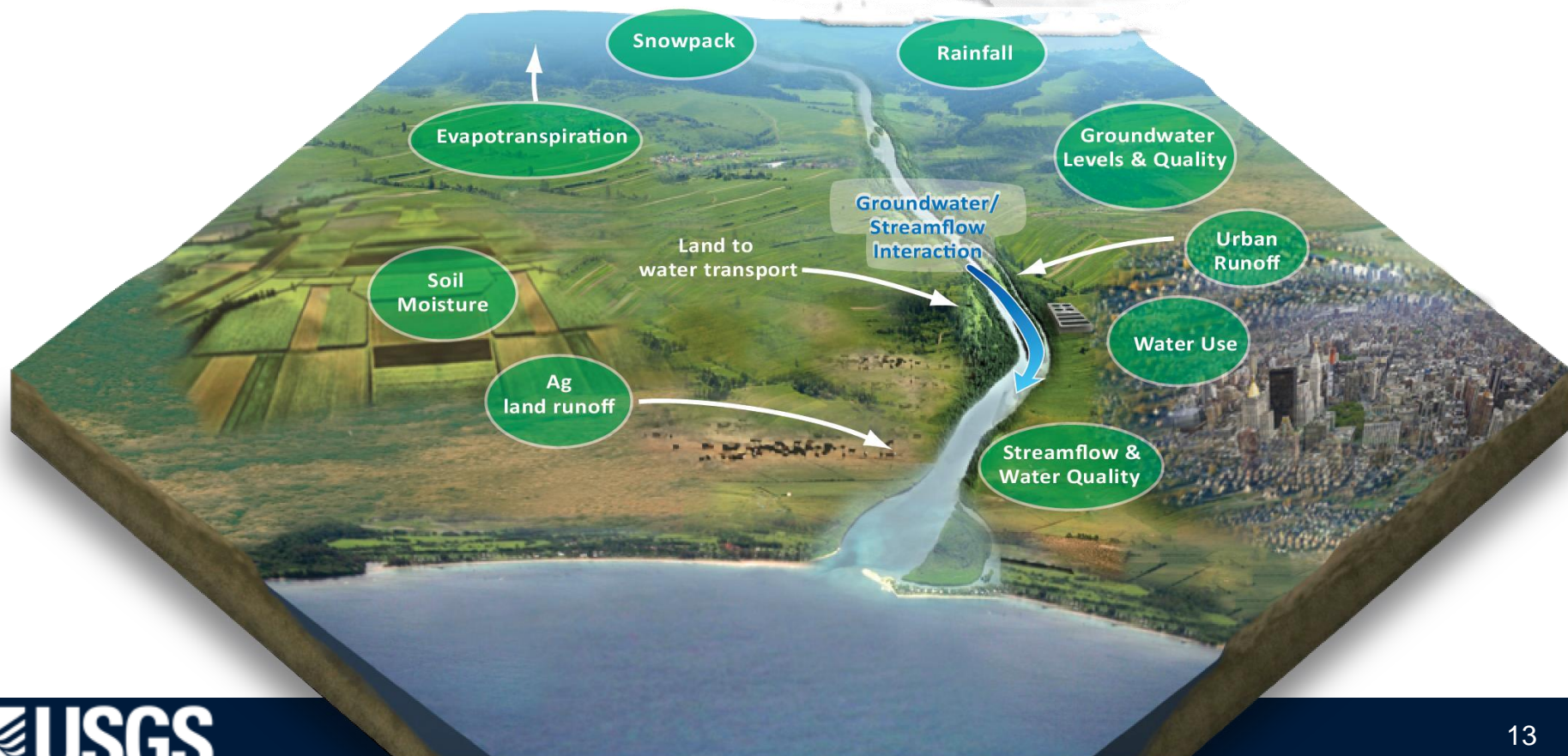


- Leads to more accurate predictions of streamflow, aquifer levels and water-quality conditions at unmonitored locations across the nation.

Next Generation Water Observing System (NGWOS)



When fully implemented, NGWOS will provide high temporal and spatial resolution real-time field and remote-sensing data on:



Practical NGWOS Applications

- Calibrate the National Water Model and other advanced regional/national models to improve predictions;
- Characterize and reduce uncertainty in field measurements and model prediction.
- These uncertainty estimates can also identify areas where additional streamgages are needed to reduce uncertainty.

This would allow for more strategic investment in long-term streamgages at key locations.

What can NGWOS help answer?

- What are the near-term and long-term risks of floods and droughts, and what scenarios change these risks?
- Are we in the early stages of a drought? How long will recovery take?
- How much water is stored in seasonal snow packs, and how will changes affect water supplies?
- How much does groundwater contribute to streamflow, or vice-versa?
- What is the quality of water and how does it change during wet/dry periods?
- How long will it take for a spill to reach a location?

NGWOS Monitoring Budget Design

Dollars in millions	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Individual Watershed Costs
Watershed 1	\$7.8	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$48.3
Watershed 2		\$7.8	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$43.8
Watershed 3			\$7.8	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$39.3
Watershed 4				\$7.8	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$34.8
Watershed 5					\$7.8	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$30.3
Watershed 6						\$7.8	\$4.5	\$4.5	\$4.5	\$4.5	\$25.8
Watershed 7							\$7.8	\$4.5	\$4.5	\$4.5	\$21.3
Watershed 8								\$7.8	\$4.5	\$4.5	\$16.8
Watershed 9									\$7.8	\$4.5	\$12.3
Watershed 10										\$7.8	\$7.8
Total Annual Cost	\$7.8	\$12.3	\$16.8	\$21.3	\$25.8	\$30.3	\$34.8	\$39.3	\$43.8	\$48.3	\$280.5

There is no plan to move funding from Federal Priority Streamgages or reallocate existing Cooperative Matching Funds to support NGWOS.

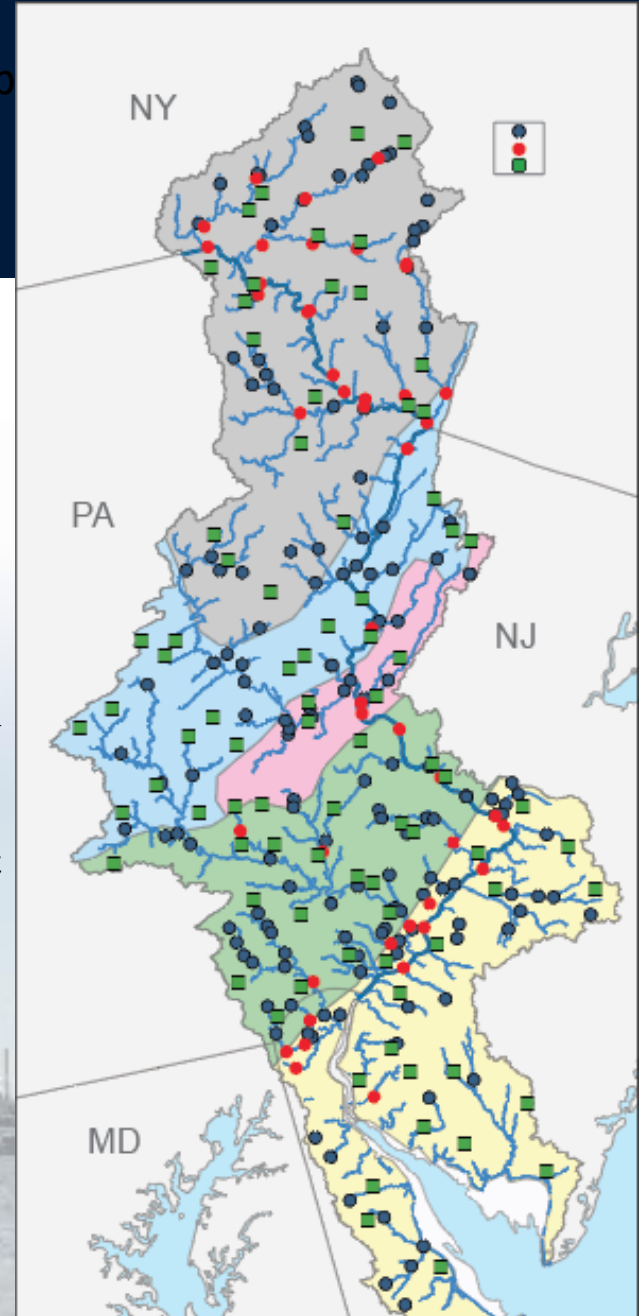
NGWOS Delaware River Basin Pilot

Enhanced Mainstem Monitoring

- Addition of temperature & salinity monitoring at more sites and new communication platforms

Small Stream Monitoring

- About 50 new gages in areas in basins less than about 50 mi² to characterize hydrologic dynamics and improve hydrologic and ecologic models;
- Current funds allowed for ~ 57% of the planned FY19 needs for NWIS modernization and nearly 50% of the NextGen network in DRB



Water Level, Velocity, and Discharge from Radars and Video

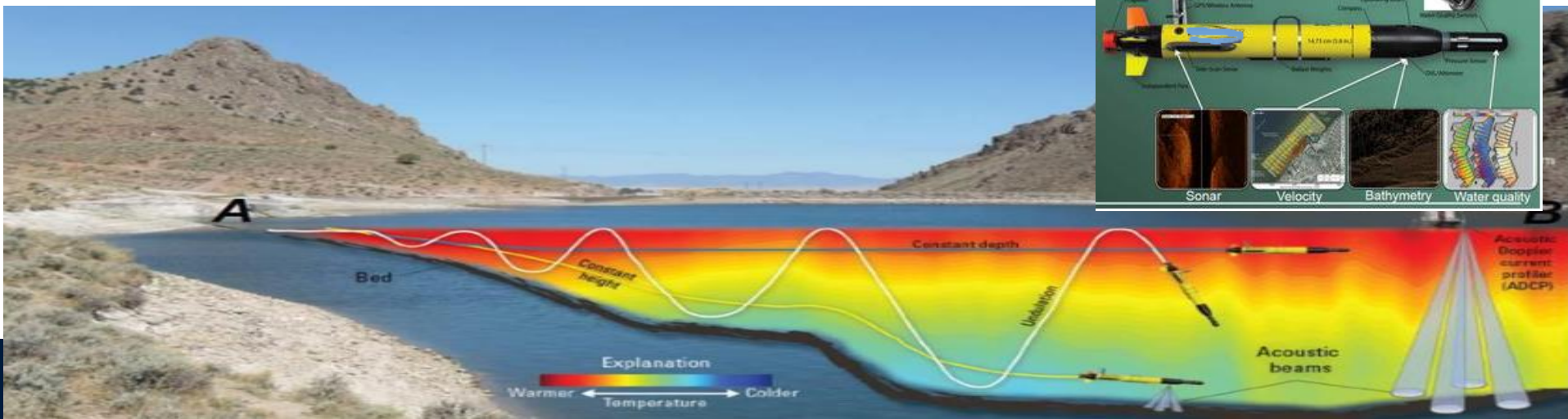


Generating techniques and methods to monitor water level, velocity distributions, and streamflow:

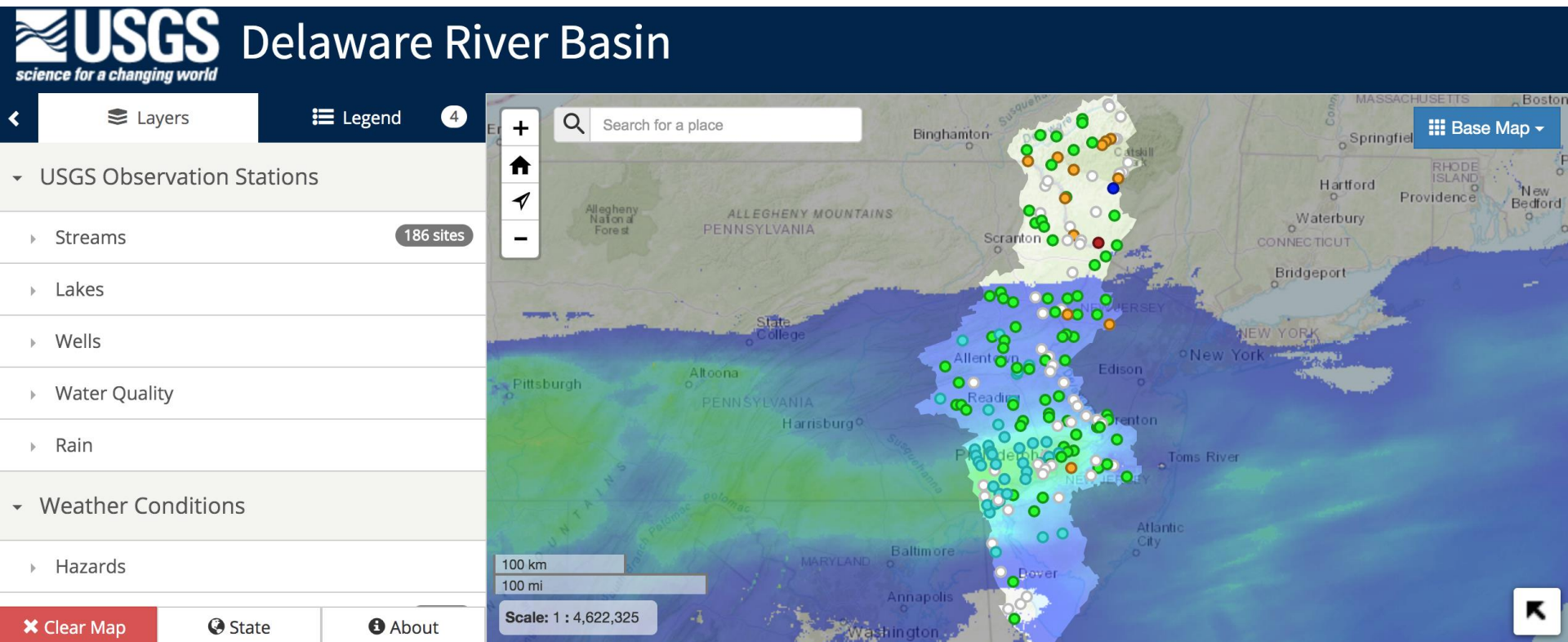
- More efficiently;
- In more detail;
- Understand changes in real-time



Integration of Drones and Satellites to Monitor Water Quantity, Quality, and Use



Integrated Data Delivery



Data Delivery – Web Cameras



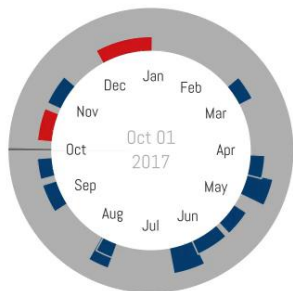
Data Delivery – Annual Water Conditions Summary

U.S. River Conditions

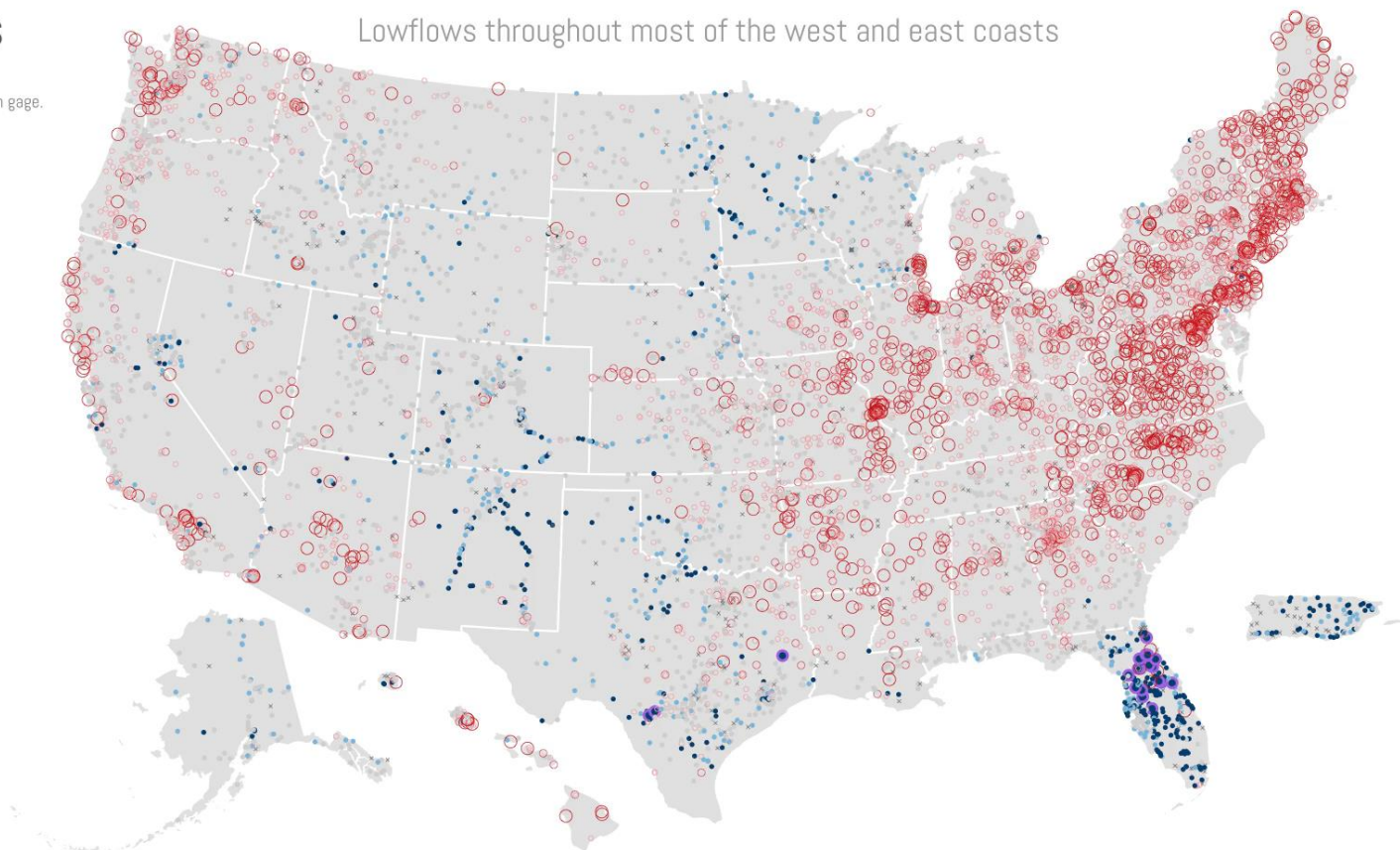
Water Year 2018

Conditions are relative to the historic daily record for each gage.

- Flooding* ●
- Wettest ●
- Wet ●
- Normal ●
- Dry ○
- Drier ○
- Driest ○
- No data ×



Lowflows throughout most of the west and east coasts



* Both USGS gage height and National Weather Service flood stage levels are necessary to determine flooding conditions and were available for 38% of gages at the time this graphic was produced. We used only publicly available data from NWISWeb and some gages are missing gage height even when they have flow.



[Animation Link](#)



Groundwater and Streamflow Information Program (GWSIP)



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USGS Streamgages Instagram: https://instagram.com/usgs_streamgages/

Mobile Water Data: <https://m.waterdata.usgs.gov>

WaterAlert: <https://water.usgs.gov/wateralert/parameters/>

Water Watch: <https://waterwatch.usgs.gov>

GW Watch: <https://groundwaterwatch.usgs.gov>

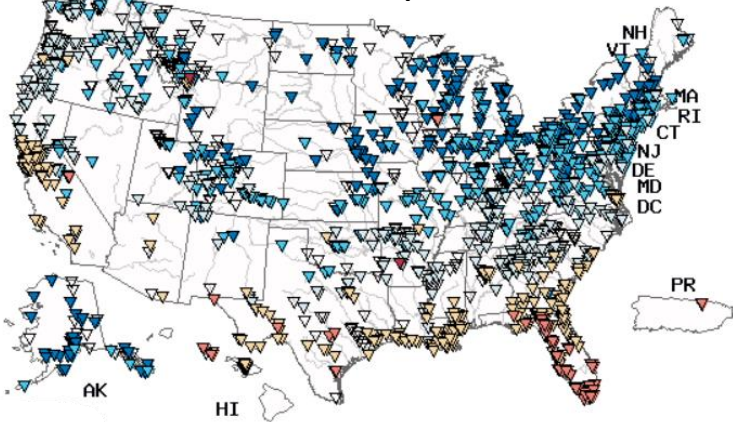
Flood Event Viewer: <https://stn.wim.usgs.gov/fev/>

Flood Inundation Mapper: <https://fim.wim.usgs.gov/fim>

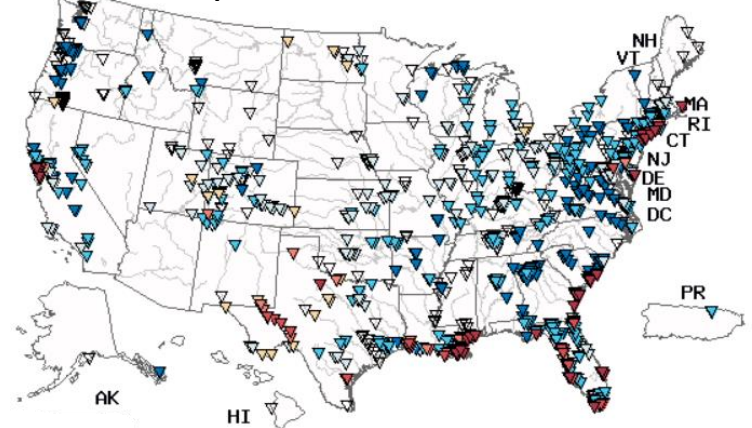
National Streamflow Network

Infrastructure for water-quality sensors

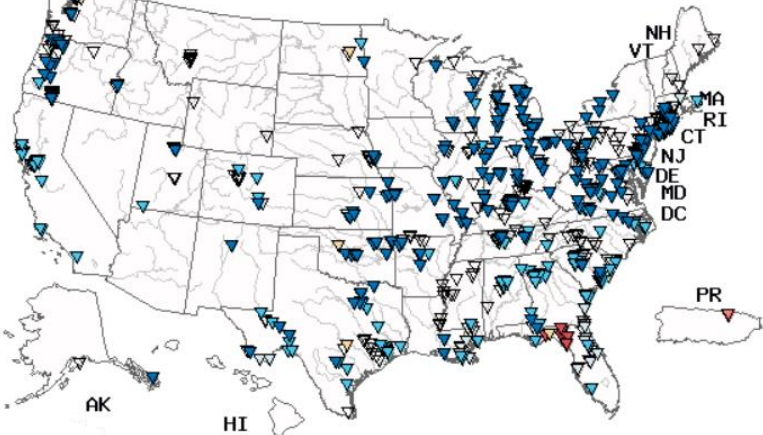
Water Temperature



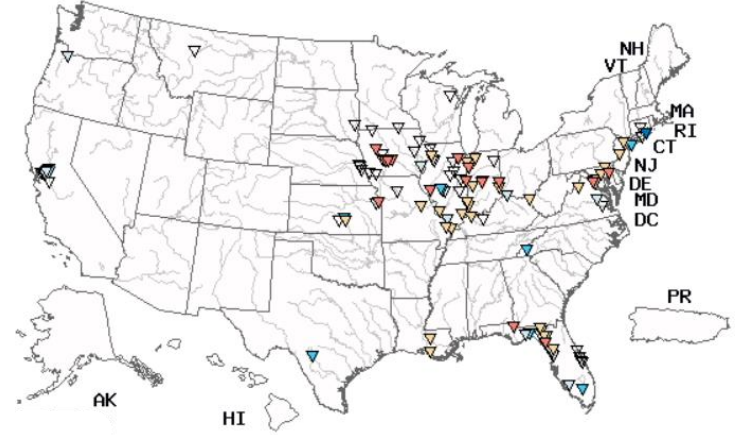
Specific Conductance



Dissolved Oxygen

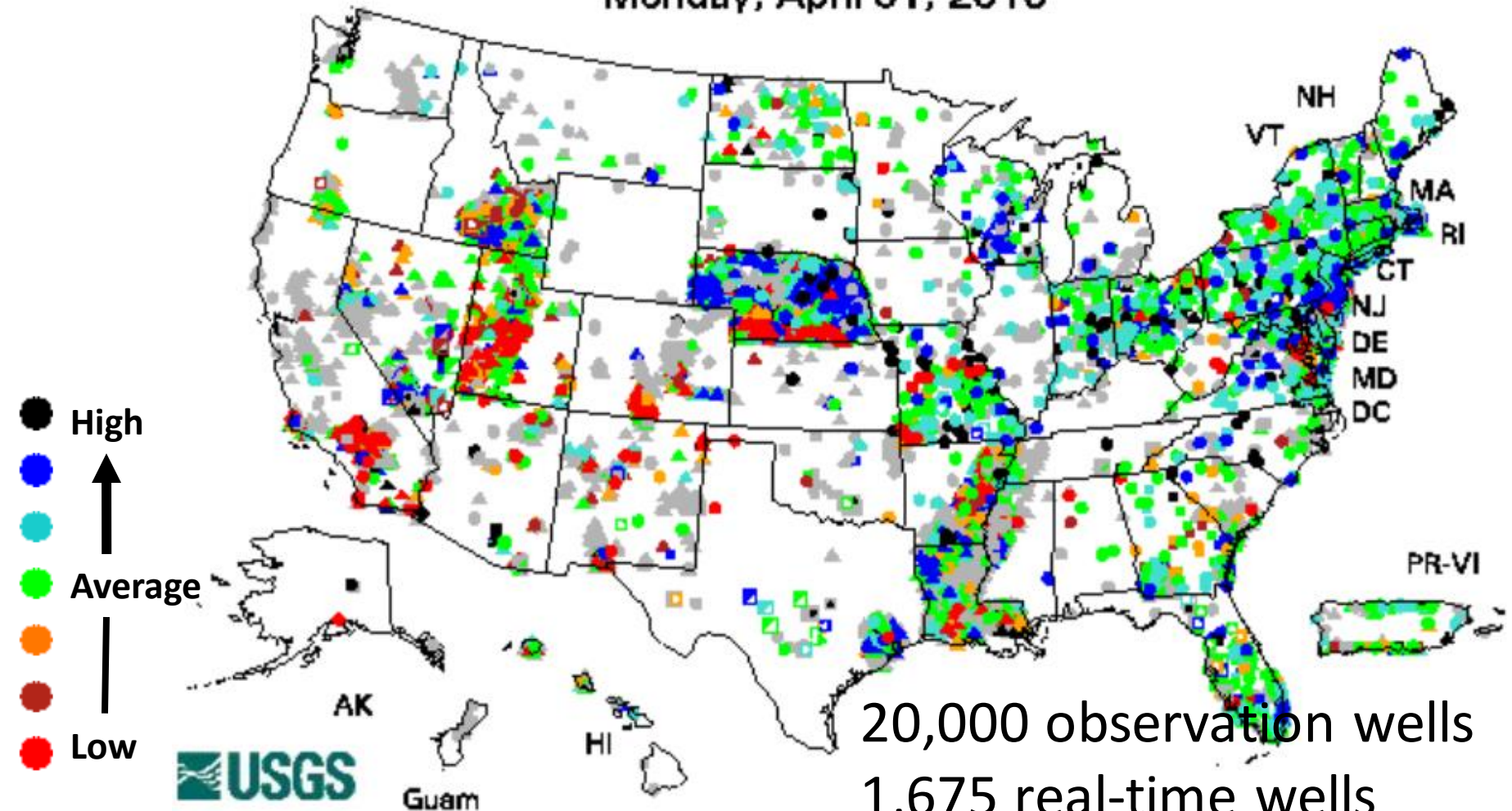


Nitrate



Groundwater Level Conditions

Monday, April 01, 2019



20,000 observation wells

1,675 real-time wells

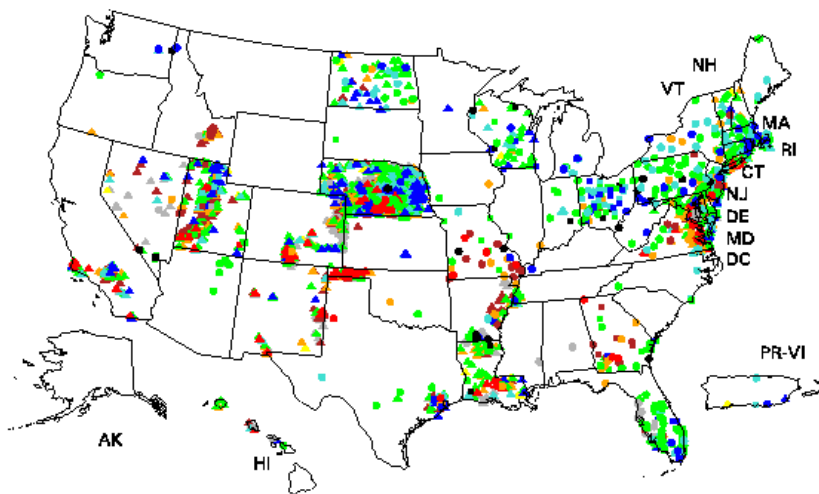
groundwaterwatch.ugsg.gov

Groundwater Level Conditions

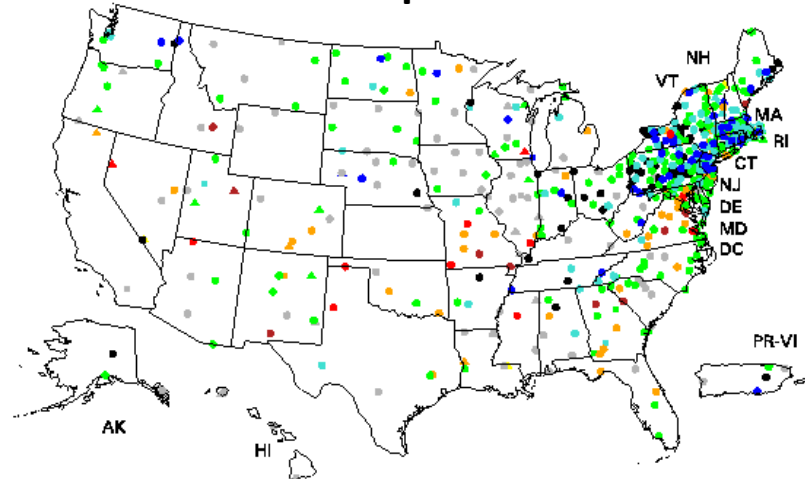
Long-Term Groundwater Data Network

Use the buttons above the map to select the data frequency and length of record.
NOTE: Javascript must be enabled for the map to work correctly.

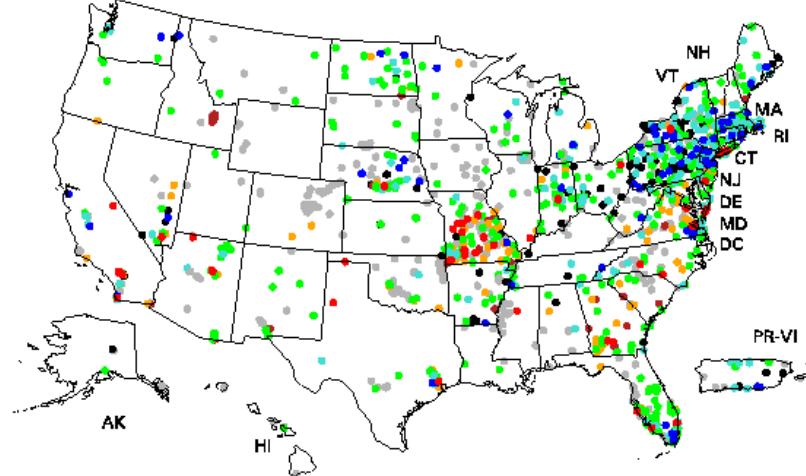
<input checked="" type="radio"/> Annual Data	<input type="radio"/> Monthly Data	<input type="radio"/> Daily Data
<input type="radio"/> 20 Years or More	<input type="radio"/> 30 Years or More	<input checked="" type="radio"/> 50 Years or More



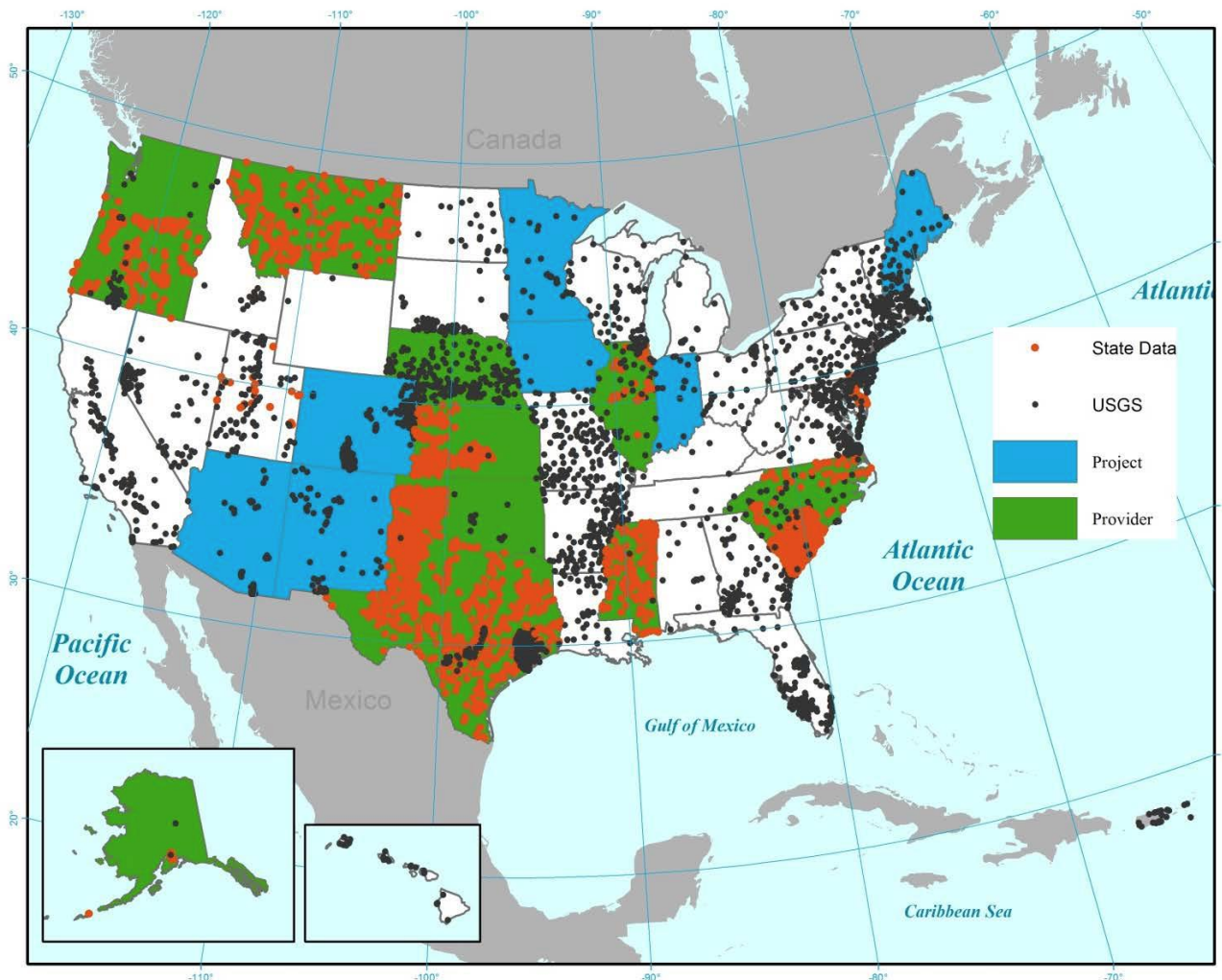
Climate Response Network



Real-Time GW Level Network



National Groundwater Monitoring Network



National Groundwater Monitoring Network Design Elements

- Principal and major aquifers
- GW levels and quality, focus on availability
- Priority on sites with long-term data
- Network, not a Warehouse or Master Database
- Willing data providers: State, Federal, Tribes, others
- Sites classified by local experts/data providers, and selected sites become part of the Network
- Data available to all without restriction or cost
- Data provider is the authoritative data source

2018 Hurricane Season

Hurricane Florence (Cat 1): Carolinas Deployment

- 16 water-level sensors
- 6 Rapid Deployment Gages
- Additional streamflow measurements to U.S. Army Corps of Engineers to help manage reservoir inflows
- Two FEMA Mission Assignments
 - 2123 High Water Marks flagged and 1288 HWM locations surveyed (as of Oct. 30)

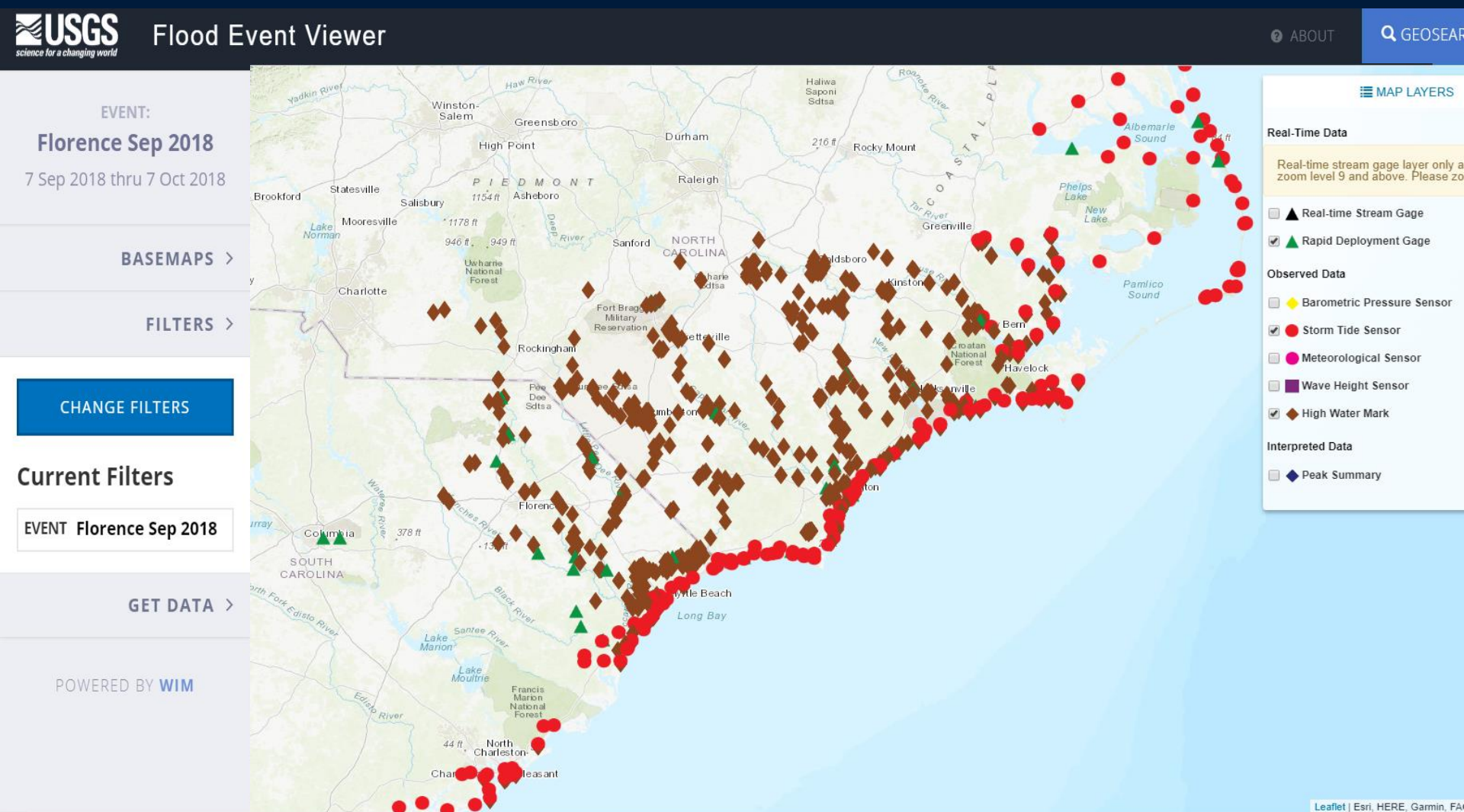
Post-Tropical Storm Jose: CT, RI, MA Deployment

- 17 water- or wave-level sensors

Hurricane Michael (Cat 5): Florida Deployment

- 230 water- or wave-level sensors
- 25 Rapid Deployment Gages
- Four FEMA Mission Assignments
 - 506 High Water Marks flagged and 453 HWM locations surveyed (as of Oct. 30)

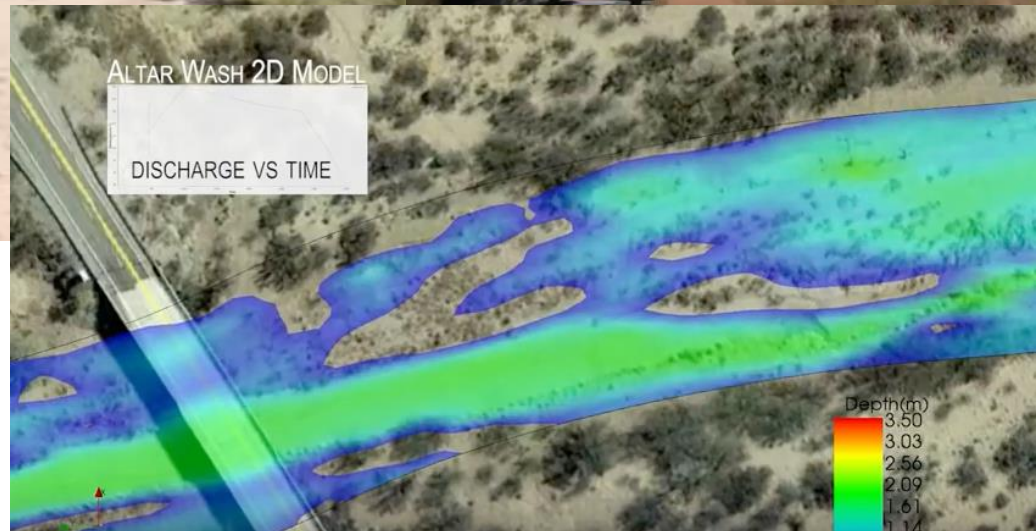
Hurricane Florence Deployment



Flood Inundation Mapper



Improving Streamflow Measurements



Next Generation Water Observing System (NGWOS)

- Provide high temporal and spatial resolution water data in real-time;
- Support modern water prediction and decision support systems to address current and future complex water challenges.

Key characteristics:

- Robust – operational under all conditions;
- Reliable – deliver data of a known quality;
- Flexible – evolve as technologies evolve;
- Efficient – easily serviced, standardized, operational efficiencies;
- Leveraged – accommodate partner and stakeholder needs



NGWOS Budget Components

Dollars in millions	Years											Total Cost
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	
Water Observing Network - Equipment	\$1.0	\$2.7	\$11.9	\$7.8	\$7.8	\$7.8	\$7.8	\$7.8	\$7.8	\$7.8	\$7.8	\$78.0
Water Observing Network - Operation & Maintenance	-	\$0.7	\$2.2	\$9.0	\$13.5	\$18.0	\$22.5	\$27.0	\$31.5	\$36.0	\$40.5	\$200.9
Modernization of USGS Data Management, Integration, and Delivery Infrastructure	\$0.5	\$5.1	\$10.1	\$4.6	\$3.8	\$2.4	\$1.9	\$1.9	\$1.9	\$1.9	\$1.9	\$36.0
Hydrologic Instrumentation Facility	-	\$3.0 ¹	\$50	-	-	-	-	-	-	-	-	\$53.0
Total Annual Cost	\$1.5	\$11.5	\$74.2	\$21.4	\$25.1	\$28.2	\$32.2	\$36.7	\$41.2	\$45.7	\$50.2	\$367.9

eDNA

environmental

Species Detection / Early Warning

► SNAKEHEAD—INVASIVE



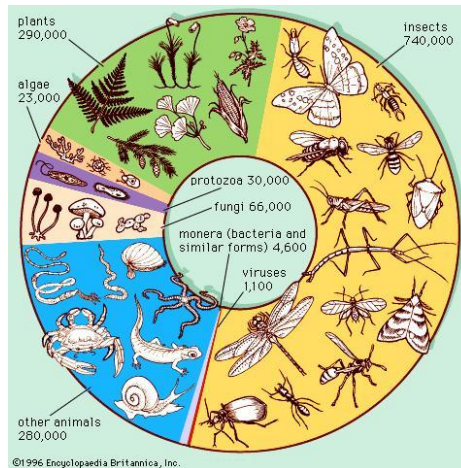
Long anal fin.

Painting: Susan Trammell
www.SusanTrammell.com



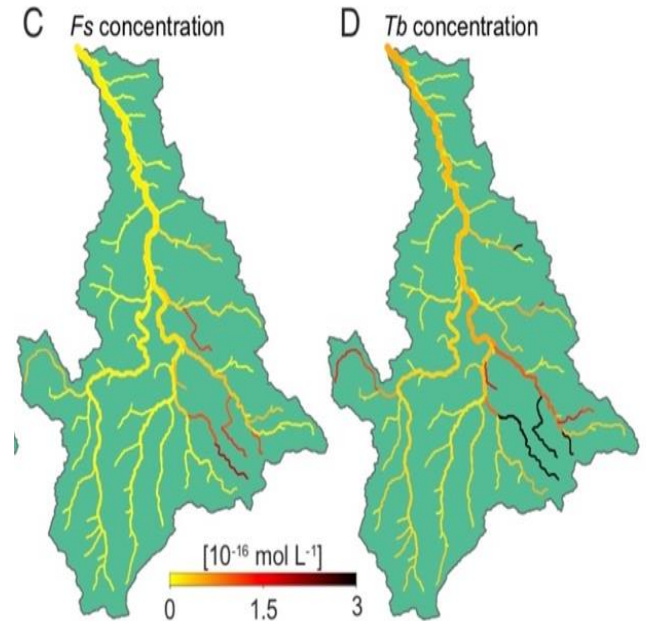
Most mature

Comprehensive Diversity Assessment (= Natural Capital)



Less mature; R2O investment

Mapping / Modeling Species Distributions



Carrero et al. 2018