Delaware River Basin
Water Census Focus Area Study

Susan Hutson, Jonathan Kennen, Kelly Maloney,
Marla Stuckey, Tanja Williamson, Jeff Fischer, Ward Freeman,
And many more

Jeff Fischer

DRBC Water Management Advisory Committee Meeting
October 2013

The National Water Census

* Part of the 

Initiative

- Objectives:

  To place technical information and tools in the hands of stakeholders, allowing them to answer two primary questions about water availability:

  Does the Nation have enough freshwater to meet both human and ecological needs?

  Will this water be present to meet future needs?

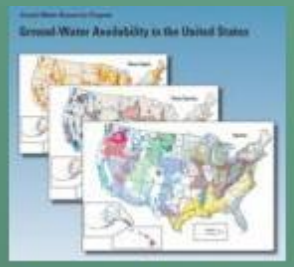
Enhanced Water Data for Water Availability Assessments

- **Precipitation**
- **Evapotranspiration**
- **Storage in Reservoirs, Lakes, Snow and Ice**
- **Surface Water**
  - **Flow Estimates**
- **Groundwater**
  - **Recharge rates**
  - **Water levels in aquifers**
- **Ecological Needs**
- **Water Withdrawals**
- **Return Flows**
- **Consumptive Uses**
- **Run-of-the-River Uses**

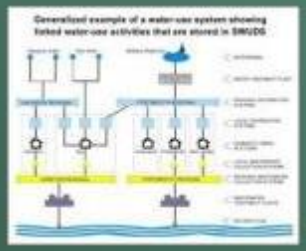
Data Delivery via National Data Portal

Focused Water Availability Assessments

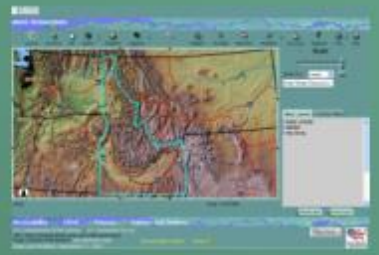
Water Quality



Groundwater Resources



Water Use



Surface Water Trends, Precipitation, etc

Eco Flows

Global Change

State, Local, Regional Stakeholder Involvement

Defined Technical Questions to be Answered

USGS
science for a changing world

Goals of the Delaware River Basin Focus Area Study

1. Acquisition, management, and integration of improved water-use and water-supply data.
2. Development of a hydrologic watershed model to evaluate water stressors such as population growth, land-use change, and climate variability on water resources in the basin.
3. Development of ecological-flow science
   - Defining relations between streamflow processes and aquatic assemblage responses in tributaries.
   - Enhancement of the existing Decision Support System for parts of the main-stem Delaware River.

Study started in 2012 and work concludes in 2014.

1.) Improved water-use and water-supply information

- Basin States collect slightly different water use information and have different reporting thresholds.
- Develop quality-assured and consistent water use estimates across the basin.
  - Site specific information, such as surface-water diversions and withdrawals, groundwater withdrawals, and surface-water return flows.
  - Develop areal estimates for unreported water uses, such as domestic, irrigation, livestock, and mining.
  - Provide data for modelers, ecologists, and others conducting water assessments in the basin.
  - Information will be available to the public via a web-based application.

Susan Hutson

Site-Specific Water Use

Using 2005 – 2010 data

1. Surface water and groundwater withdrawals by use type (ie public supply, commercial, agricultural, etc.)
2. Permitted point-source discharges
3. Out of basin transfers only (no within basin transfers)

Obtain yearly median and seasonal values where possible

State *	Surface Water (intakes)	Groundwater (wells)	Return Flow (permitted discharges)
New York	22	235	191
Pennsylvania	187	2019	1317
New Jersey	1341	3132	900
Delaware	22	294	31

* Reporting limits vary by state

Aggregate Withdrawal Estimates

- Based on category
  - Self-supplied domestic
  - Irrigation
  - Livestock
  - Aquaculture
- Estimates converted using GIS to HUC12 scale
- Annual average (no monthly or seasonal variability)
- Surface water and groundwater

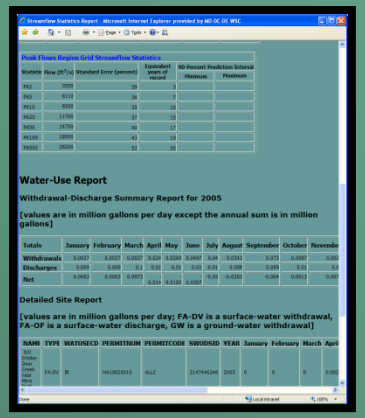
Aggregation
12-digit subbasins

Water Use Public Data Delivery

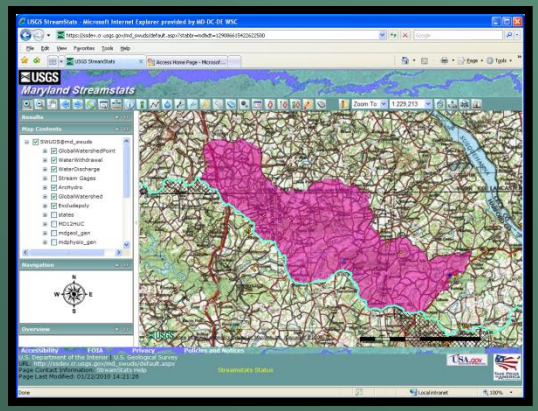
Report at HUC 12 scale and Web Based Delivery

Site-Specific Water-Use Data System (SWUDS)

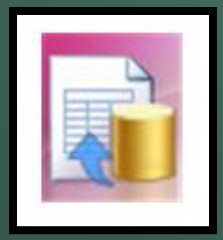
Output



StreamStats



Web service request



Data Warehouse

Water-use data sent

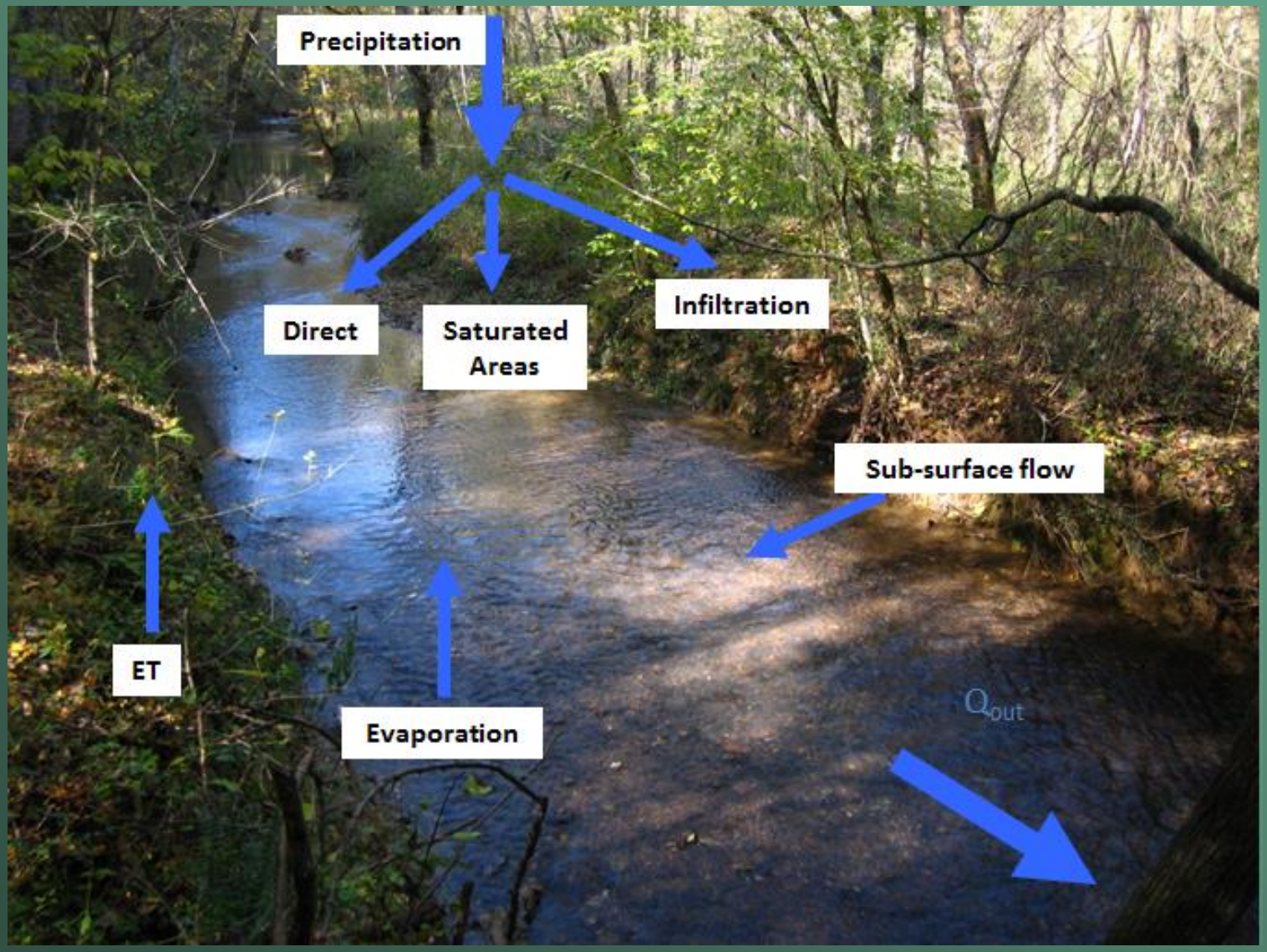
Management

2.) Develop a surface-water hydrologic model of the Delaware Basin to evaluate impacts of changing land-use, water demand, and climate

- Water Availability Tool for Environmental Resources (**WATER**)
- Model encompasses the whole non-tidal Delaware River Basin.
- Used as a decision support tool to evaluate how water stressors such as population growth, land-use change, and climate change affect the availability of water resources.
- Daily flow validated using precipitation, water-use, streamflow, and other information for the time period 2001 to 2011.
- Simulations of future daily streamflow and water-availability conditions centered on 2030 and 2060 will incorporate projected changes in water use, land use, and climate in the watershed.

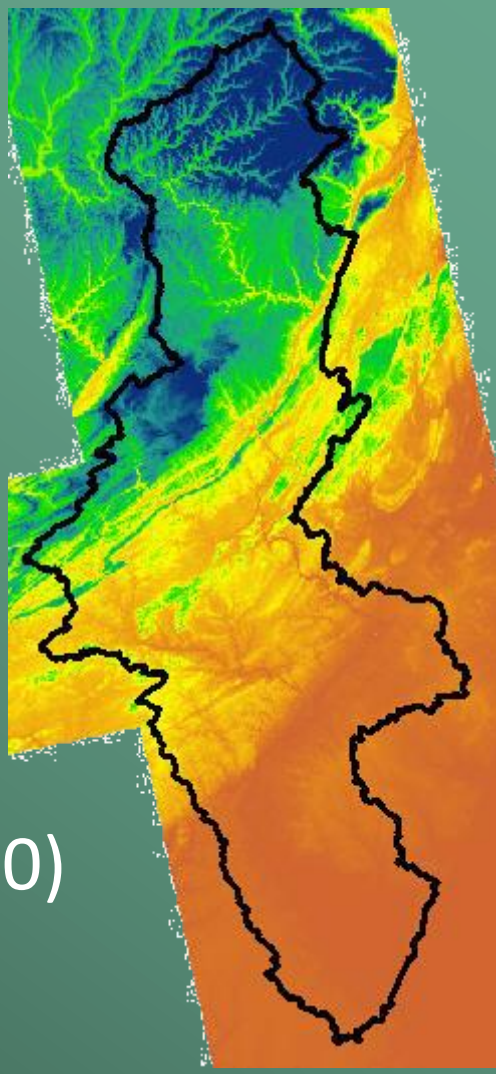
Tanja Williamson

Physically based model (Topmodel) that uses a water budget in each watershed



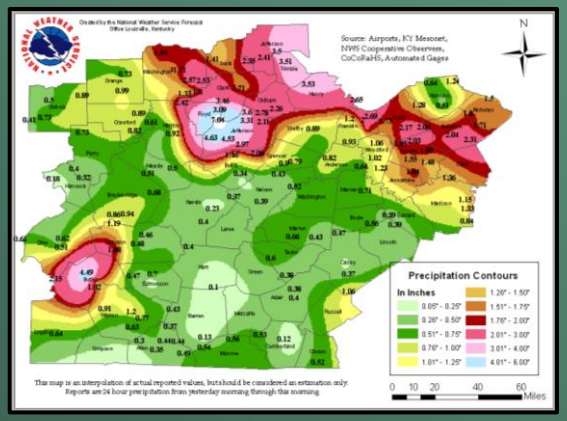
WATER Model Validation and Use

- Data Compilation
  - GIS: Elevation, Streams, Land Use, Soils
  - Stream Flow at gaged sites
  - Climate: historic and projected
  - Water use
- Model Validation at gaged streams
  - Unimpacted Basins
  - Developed Basins
  - Main-stem sites (OASIS)
- Predictions of Future Flow (2030 & 2060)
  - Climate
  - Land Use
  - Water Use?

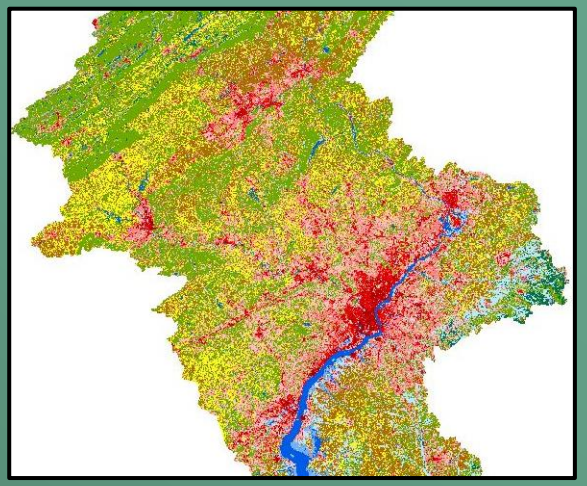


WATER – A decision support tool

Precipitation Record or Forecast



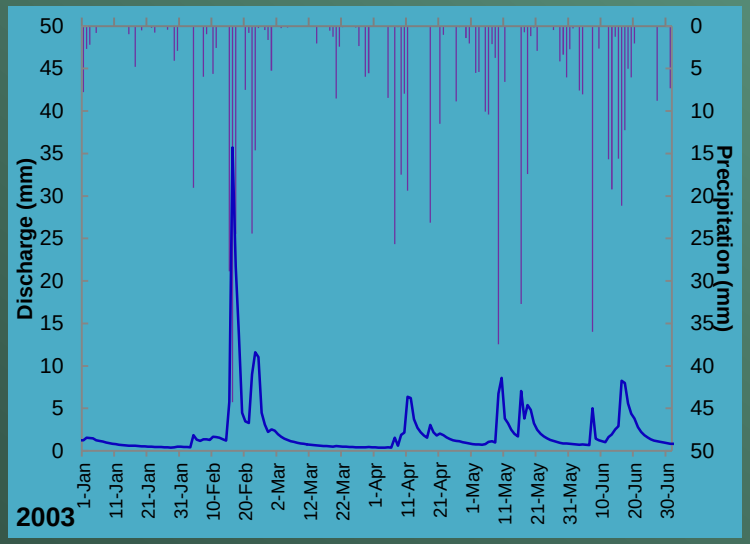
Landscape Characterization



Gaged Flow

Validated Model

Simulated Hydrograph



Scenarios

- Current conditions →
- Changed climate →
- Landscape change →

Potential Uses

- → Flow at ungaged sites
- → Water availability
- → Land management and water allocation decisions

WATER Model Products

- Report on model calibration and use. Discussion of water-use, land-use, and climate change scenarios tested.

- Downloadable model and data sets for stakeholders to conduct their own assessments.

3a.) Developing ecological-flow science in tributaries

Define relations that exist between major components of streamflow and the response of aquatic assemblages.

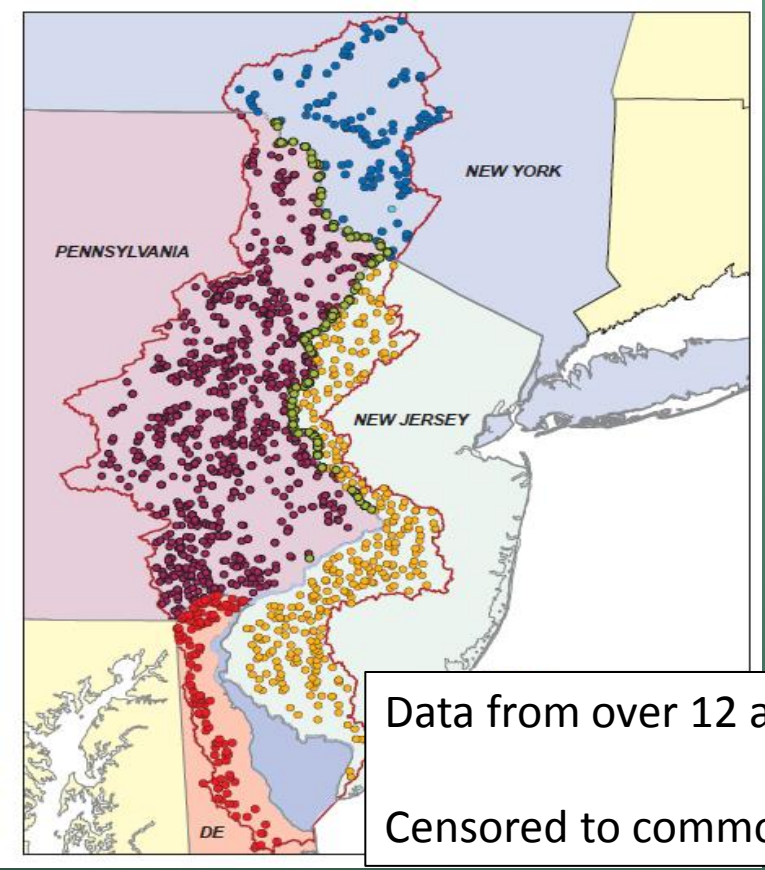
- Compile fish and invertebrate data and develop common taxonomic levels for analysis.
- Develop a flow model to estimate daily mean streamflow for ungaged ecology locations.
- Classify streams and develop flow and aquatic assemblage response relations.
- Use these relations, and future flow predictions, to assess how aquatic communities might respond to future changes in flow.

Information will assist managers in making decisions about meeting human water needs while maintaining healthy ecological communities in streams.

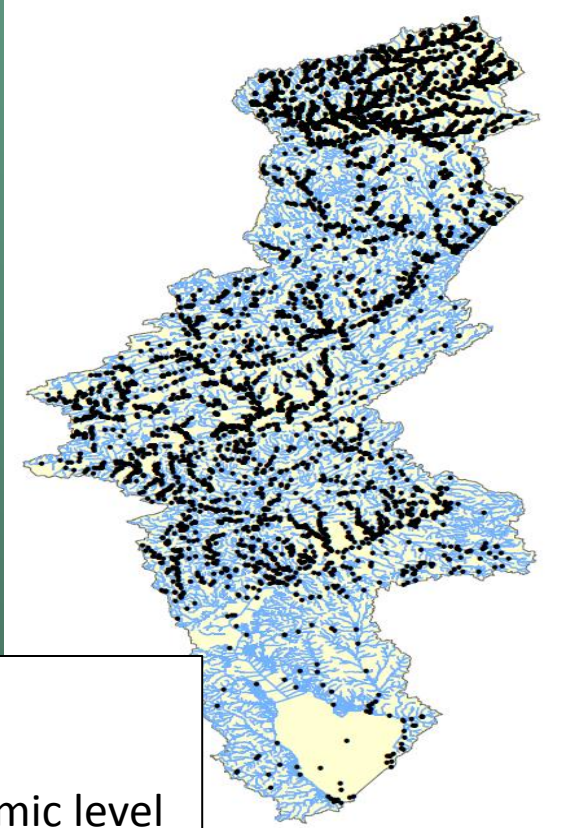
Jonathan Kennen & Marla Stuckey

Aggregation of biological data

Invertebrates
1760 sites



Fish
3400 sites



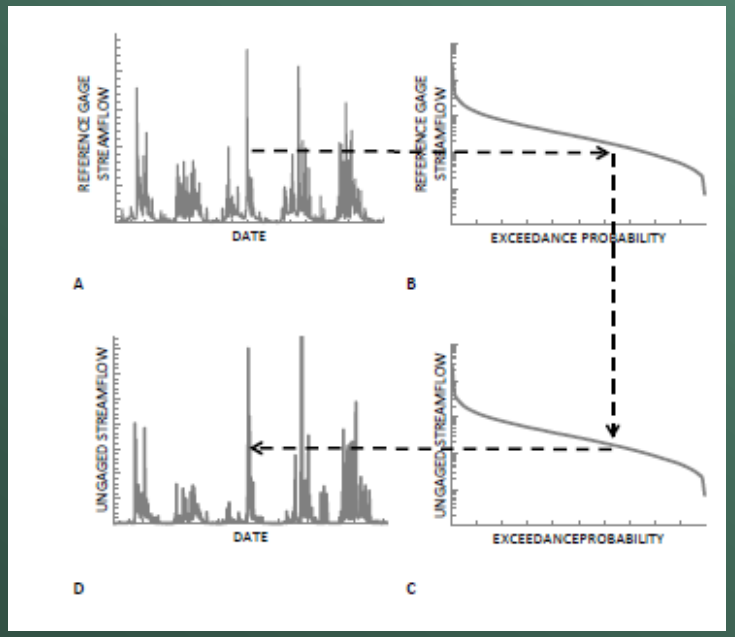
Data from over 12 agencies

Censored to common taxonomic level

Need to develop flow estimates at each site

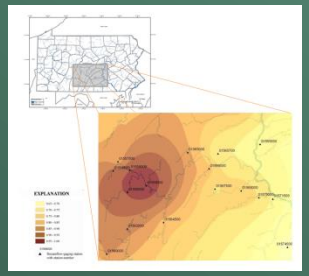
Estimating Daily Mean Streamflow at Ungaged Locations (1960 – 2010)

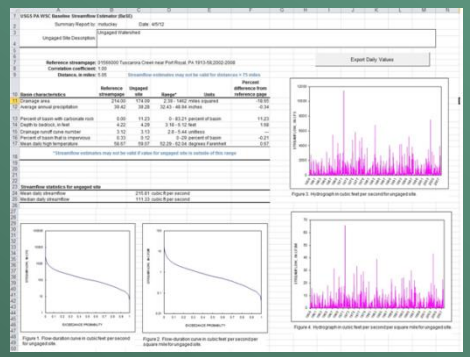
QPPQ method relates gaged streamflow to an ungaged site



Q =Discharge
P = Probability

- Streamflow Estimator Tool will use QPPQ and map correlation to estimate daily mean streamflow

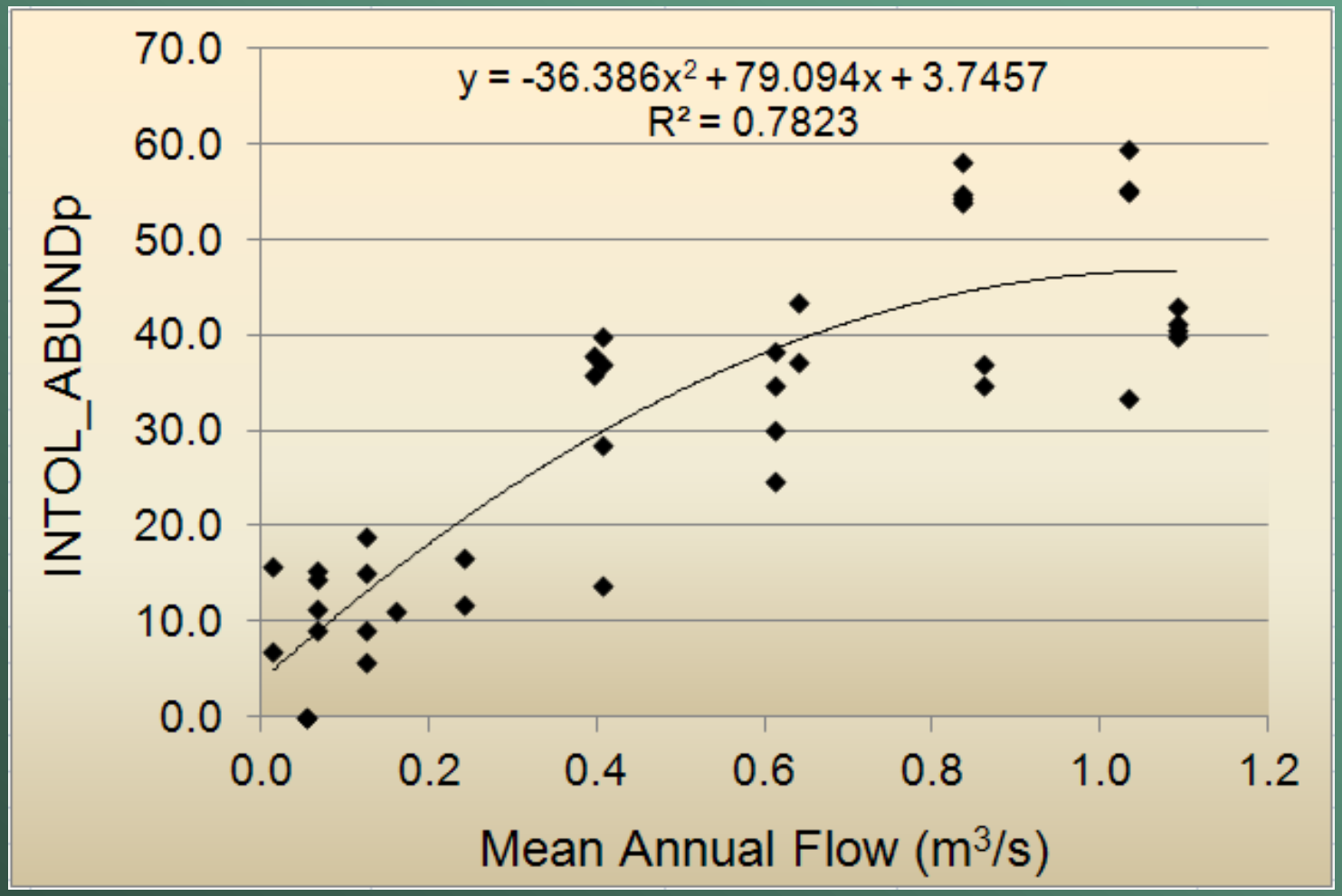




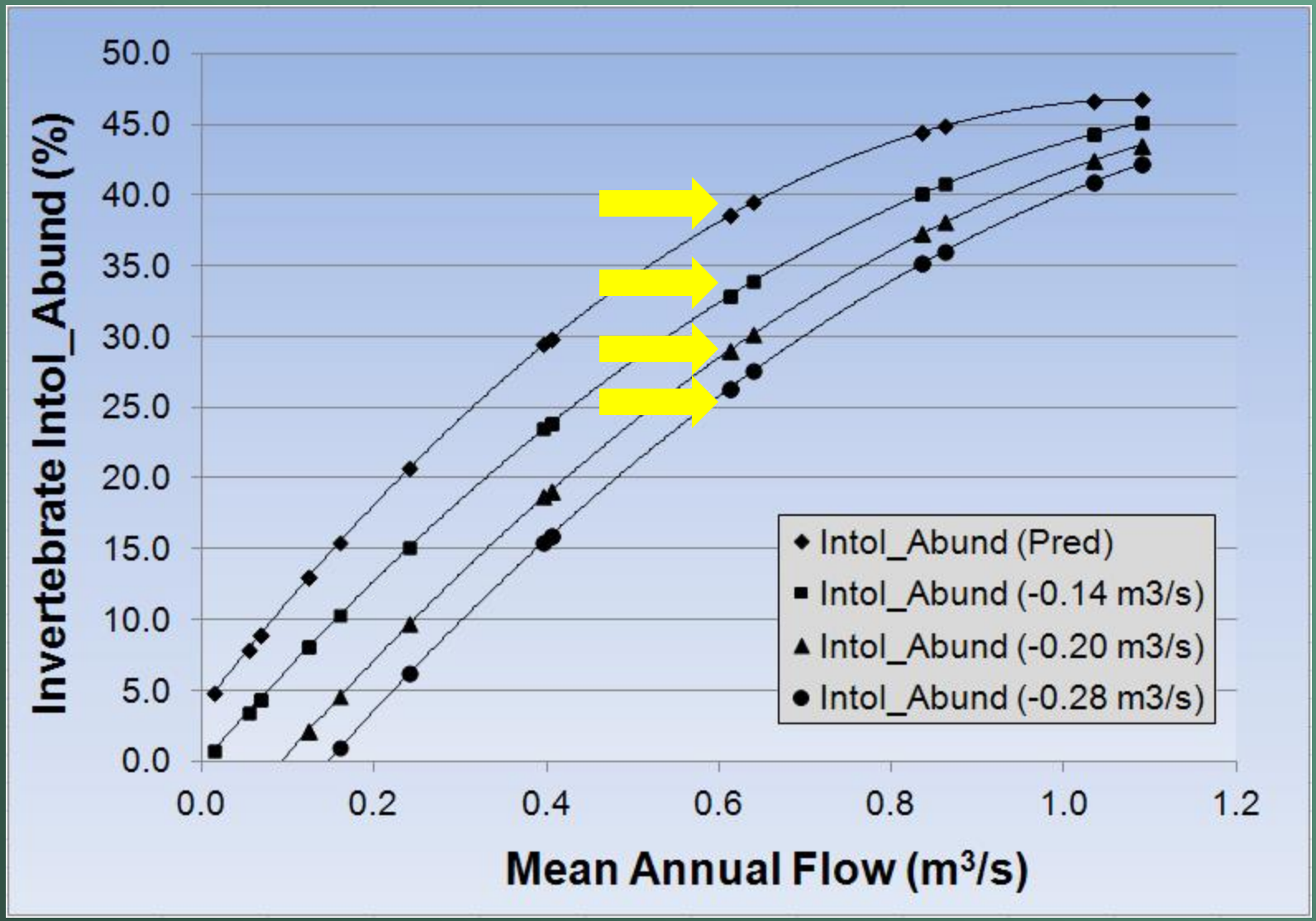
Approach to Stream Classification

1. Develop an integrated watershed classification system that combines biological and environmental characteristics (hydrologic and physical characteristics) to create a stable and scientifically defensible classification structure.
2. Assess the biologic and hydrologic characteristics that best characterize each watershed class and that differentiate among classes.
3. Determine the relations between biological responses (individual species, assemblage metrics, and guilds/functional groups) and hydrologic variables within each watershed class and for all sites combined.

Flow Ecology Response Models



Flow Alteration Models



Products

1. Methods paper describing how data from multiple State (PA, NY, NJ, DE) and Federal (US EPA, USGS, US NPS) agencies were combined to produce comparable data for ecological flow studies. (Cuffney & Kennen)
2. Paper describing relations between invertebrate / fish community and flow characteristics in the DRB. (Kennen, Campbell, Reilly, Stuckey, Williamson, and Riskin)

3b.) Ecological-Flow Science on the main-stem of the Delaware River

- Flow controlled primarily by releases from New York City (NYC) drinking-water and power-supply reservoirs.
- Releases for power generation, water supply, protection of fisheries habitat, and to maintain salt-water front in the Delaware Estuary.
- Basin states, NYC, the Federal Government, and the DRBC have developed a Flexible Flow Management Plan (FFMP). One goal of the FFMP is to protect the cold water fishery while maintaining aquatic community diversity, structure, and function.
- Unfortunately the relationship between flows, environmental variables (such as temperature), and ecological response are not well understood.

Kelly Maloney

Tool to Support Management

- Evaluate how different flow scenarios affect instream habitat for biota
- Incorporate a suite of taxa
- User-friendly, updateable, etc.

USGS

Improving Management of Ecological Water Needs - **Objectives**

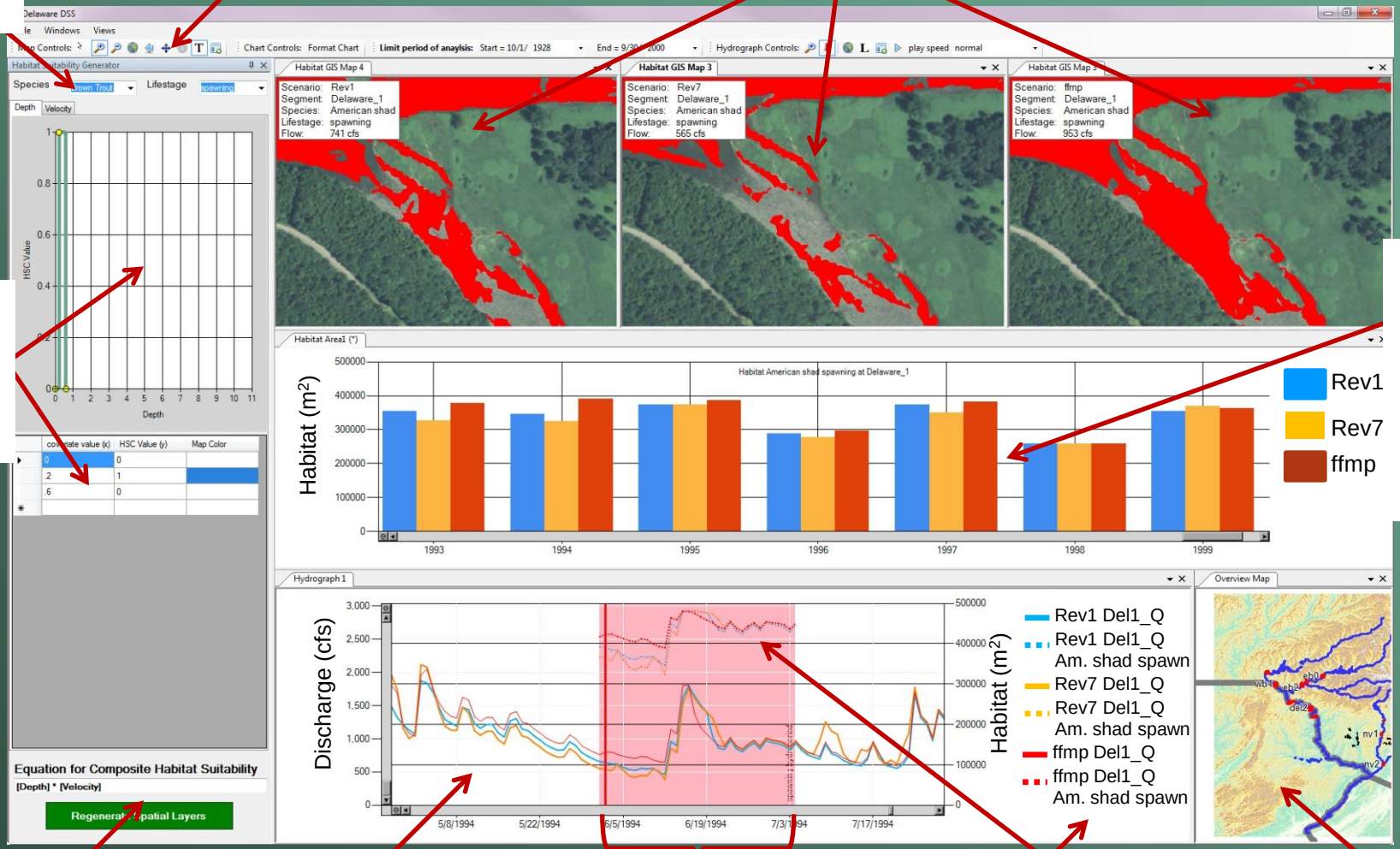
- Add 2010 hydrodynamic modeling data for three main stem reaches & extend time coverage
- Update habitat suitability criteria for biota and include additional species
- Extend meteorological data and test temperature model
- Develop an improved DSS platform
- Extend coverage – from dams to Trenton NJ

USGS

Selection of key species

Geographic Information System (GIS) functionality

Color coded habitat maps for each scenario



Habitat suitability criteria can be modified

Daily average amount of available habitat over period of interest

Equation for displayed habitat suitability maps

Display of hydrograph for all scenarios

Hydroperiod of interest

Amount of available habitat by scenario by date

Map of site location

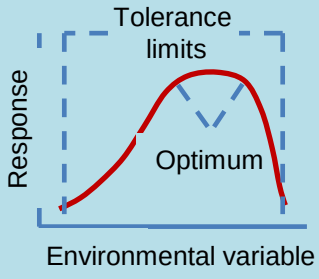
Putting it all Together

Flow Release Model (OASIS)

Temperature & Other Parameters

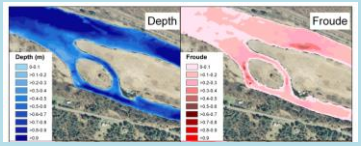
$$T_w = k + a_1 T_a + a_2 T_a^2 + a_3 H + a_4 W + a_5 S + a_6 Q_1 + a_7 (Q_2 - Q_1) + a_8 Y T_w$$

Habitat Suitability Criteria (HSCs)



Synthesis Tool (DSS)

Flow-Specific Estimates of Habitat



Delaware River Water-Census Focus Area Study Summary

- Improved water use estimates.
- Hydrologic model for steams to evaluate changes in flow related to land use or climate change.
- Ecological Flow Needs for tributaries and main stem.
- Studies conclude in 2014. Reports in 2015 or earlier.

Delaware River Water-Census Focus Area Study Information

- Contact information:

  Jeff Fischer

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  Email: fischer@usgs.gov

- More Information:

  http://water.usgs.gov/watercensus/delaware.html

  Stakeholder Webex update November 21