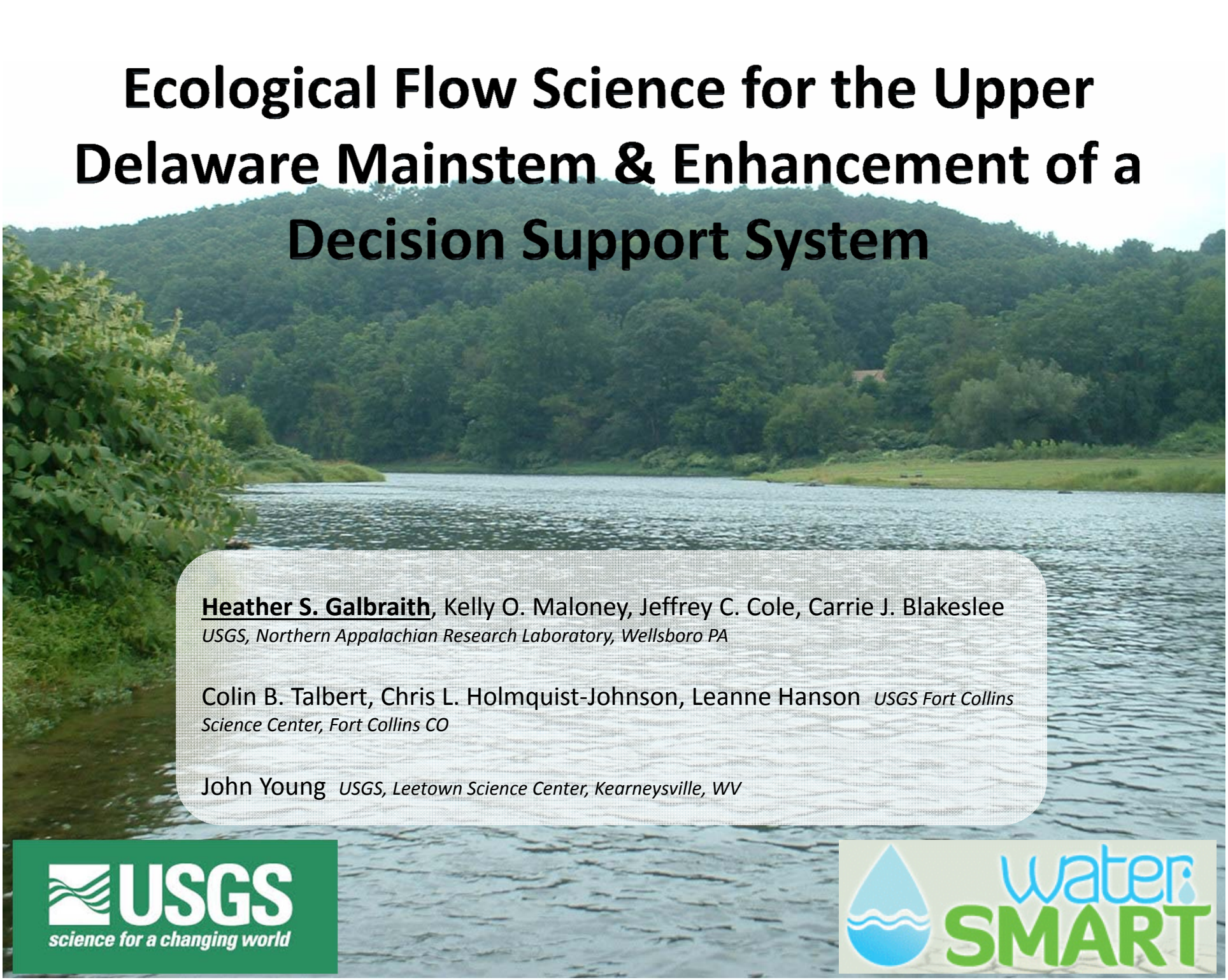
Ecological Flow Science for the Upper Delaware Mainstem & Enhancement of a Decision Support System



Heather S. Galbraith, Kelly O. Maloney, Jeffrey C. Cole, Carrie J. Blakeslee
USGS, Northern Appalachian Research Laboratory, Wellsboro PA

Colin B. Talbert, Chris L. Holmquist-Johnson, Leanne Hanson *USGS Fort Collins Science Center, Fort Collins CO*

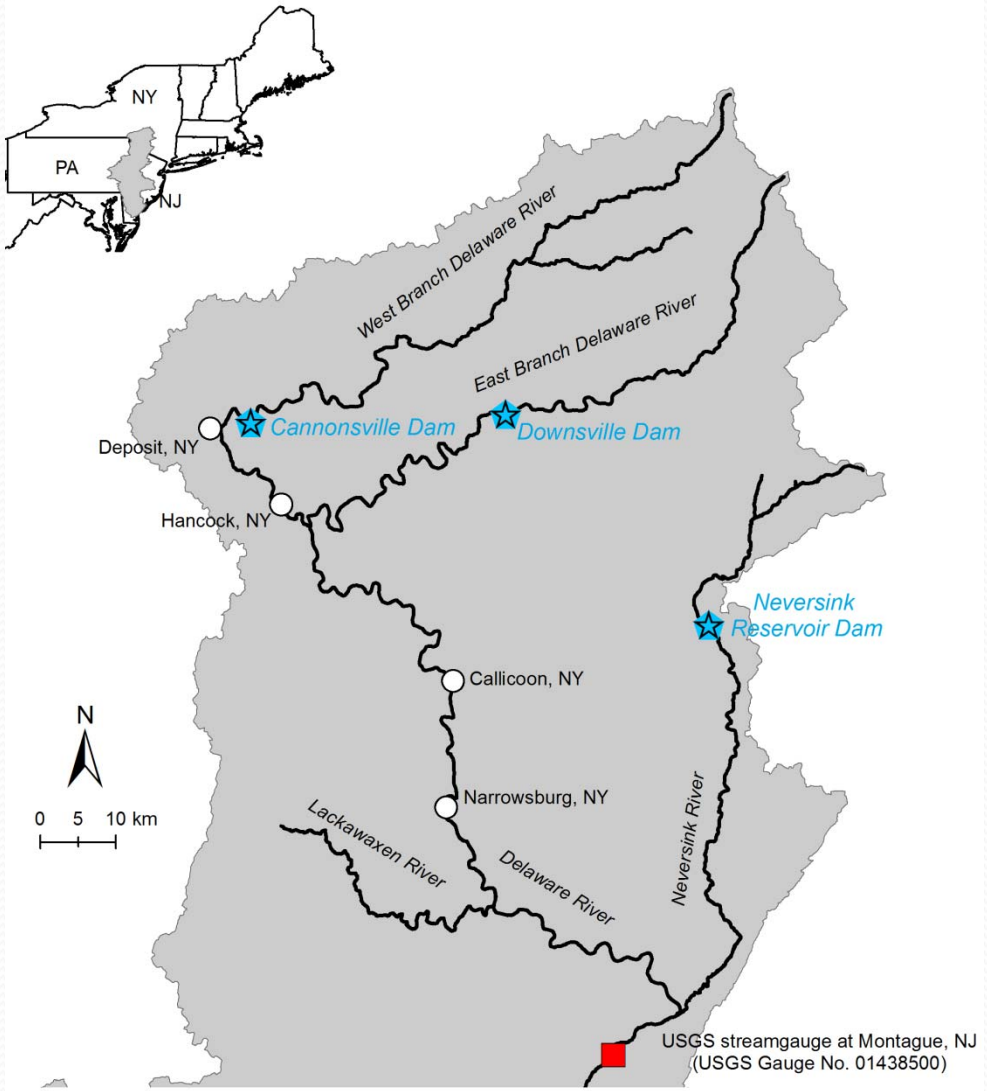
John Young *USGS, Leetown Science Center, Kearneysville, WV*

USGS science for a changing world

water SMART

The Upper Delaware River (UPDE)

- Competing water needs:
  - Human use
  - Key threatened, endangered, and migratory species
  - World class cold water fishery
  - Other recreation



Decision Support System (DSS)

Bovee et al. 2007

- Evaluate flow scenarios on instream habitat
- Suite of taxa
- 11 sites in 4 branches
- Excel-based

Target Organism
Brown trout adult
Brown trout juvenile
Brown trout spawning
Brown trout incubation
Rainbow trout adult
Rainbow trout juvenile
American shad spawning
American shad juvenile
Shallow-fast guild
Shallow-slow guild[2]

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A Decision Support Framework for Water Management in the Upper Delaware River

By Ken D. Bovee, Terry J. Waddle, John Bartholow, and Lucy Burris

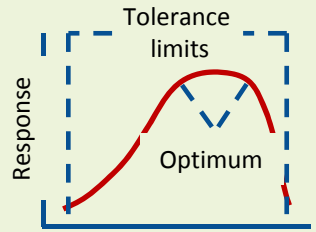
Open-File Report 2007-1172

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

DSS – Bovee et al. 2007

Flow Release Model (OASIS)

Habitat Suitability Criteria (HSCs) **Depth & Velocity**



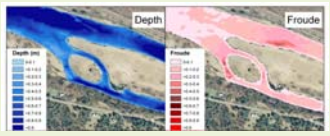
Expert opinion (6 panel members)

Synthesis Tool (DSS)

Temperature & Other Parameters

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

Flow-Specific Estimates of Habitat (**Depth & Velocity**)



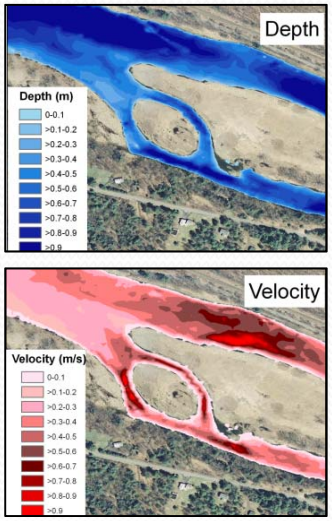
Potentially Available Habitat

DSS – Bovee et al. 2007

2D models

Flows (e.g. Del1)

342 cfs
423
565
741
953
1236
1589
2083
2683
3496
4520
5862
7557
9817
12713



1 m
1
1 m

Depth: 0.3-100 m ✓
Velocity: 0.0-1.0 m/s ✓

1 m
0
1 m

Depth: 0.3-100 m X
Velocity: 0.0-1.0 m/s ✓

Iterated and summed

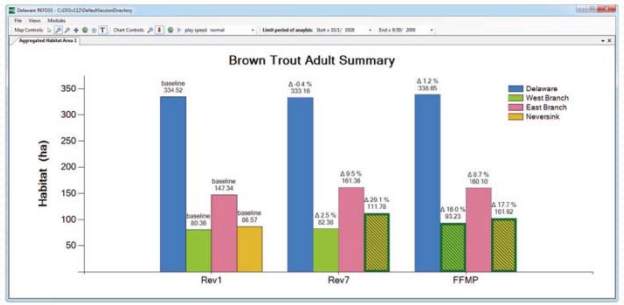
0	0	X	X
0	X	X	X
0	X	X	X

2014
April

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

Daily flow from OASIS (Rev1)-- e.g. 4750

Temperature filter: >75°F



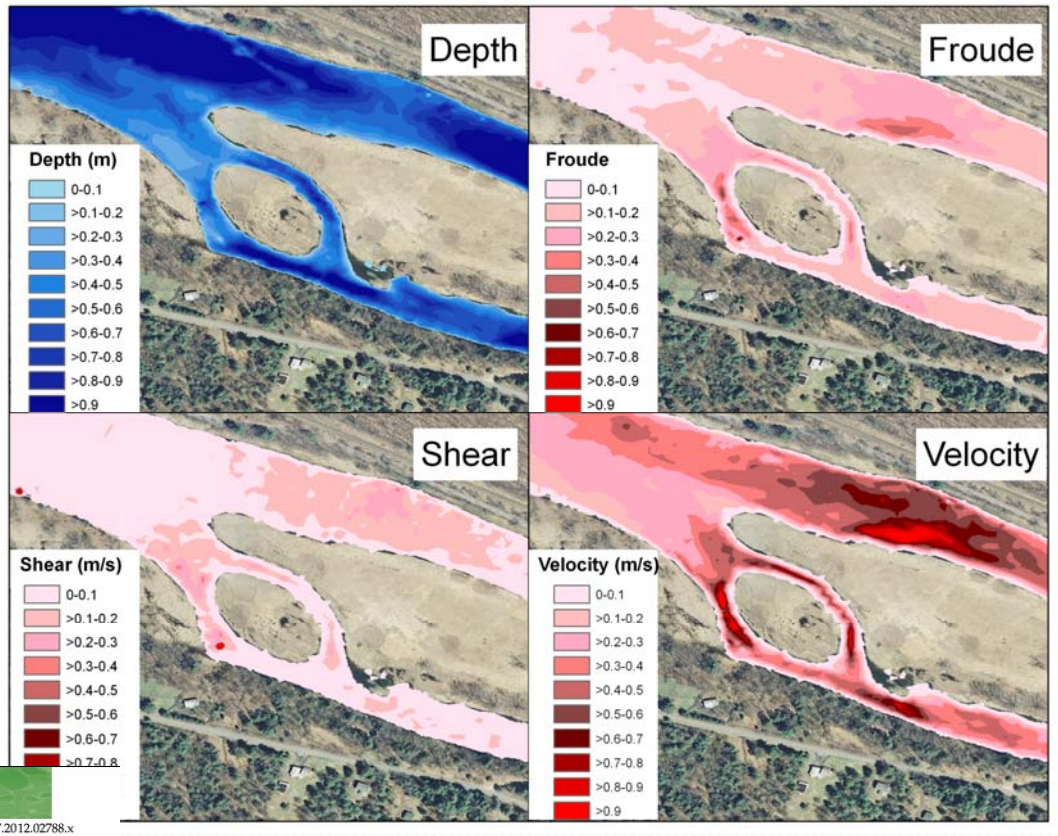
Update and Enhance DSS

- Riverine Environmental Flow Decision Support System (REFDSS)
- Update and improve DSS
  - Add updated hydrodynamic modelling data
  - Increased time coverage flexibility
  - Validate habitat suitability criteria (HSC)
  - Expand and test temperature model
  - Develop an improved DSS platform


Dwarf wedgemussel

Updated Modelling Data--2010

- 2010 high resolution bathymetry
  - 3 main stem reaches
- Better hydrodynamic model estimates for sedentary taxa/life stage
- Updated HSC for dwarf wedgemussel in REFDSS



Freshwater Biology

Freshwater Biology (2012) **57**, 1315–1327 doi:10.1111/j.1365-2427.2012.02788.x

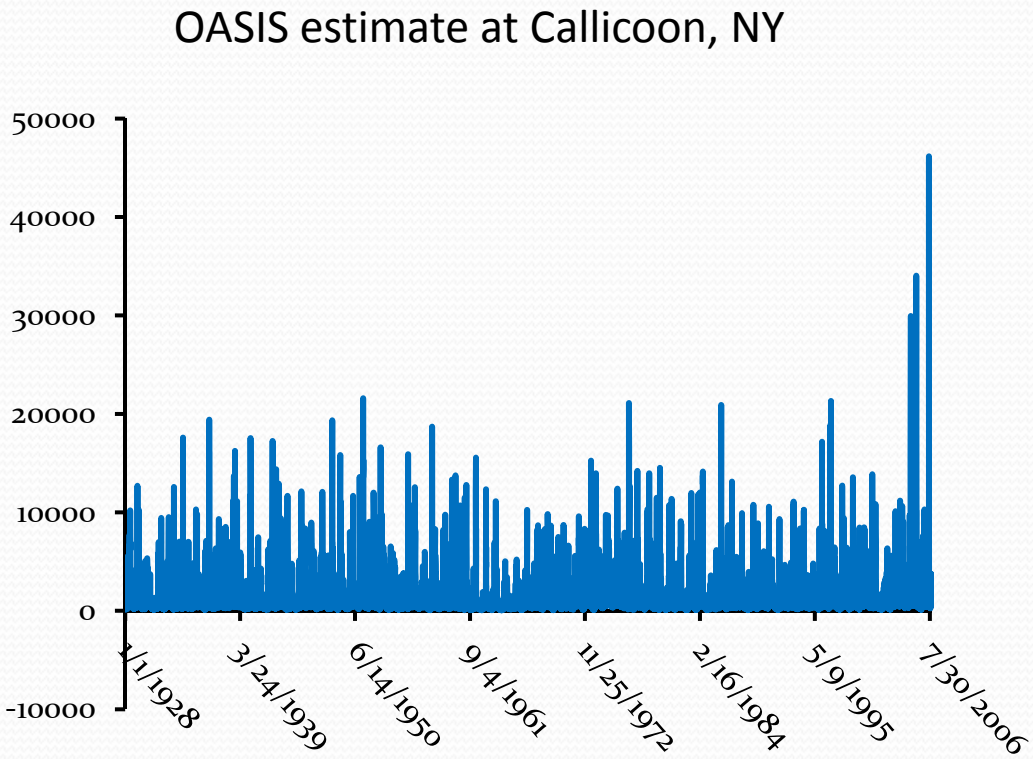
APPLIED ISSUE

Habitat persistence for sedentary organisms in managed rivers: the case for the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*) in the Delaware River

KELLY O. MALONEY*, WILLIAM A. LELLIS*, RANDY M. BENNETT* AND TERRY J. WADDLE†
*U.S. Geological Survey, Leetown Science Center, Northern Appalachian Research Laboratory, Wellsboro, PA, U.S.A.
†U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO, U.S.A.

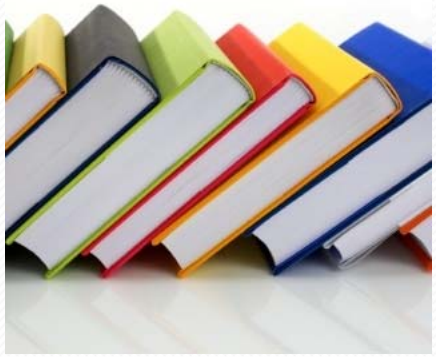
Increased time coverage flexibility

- Dynamic output covering any range of dates from 1928 – 2000
- Added FFMP



Validate HSC: Delphi vs. Literature

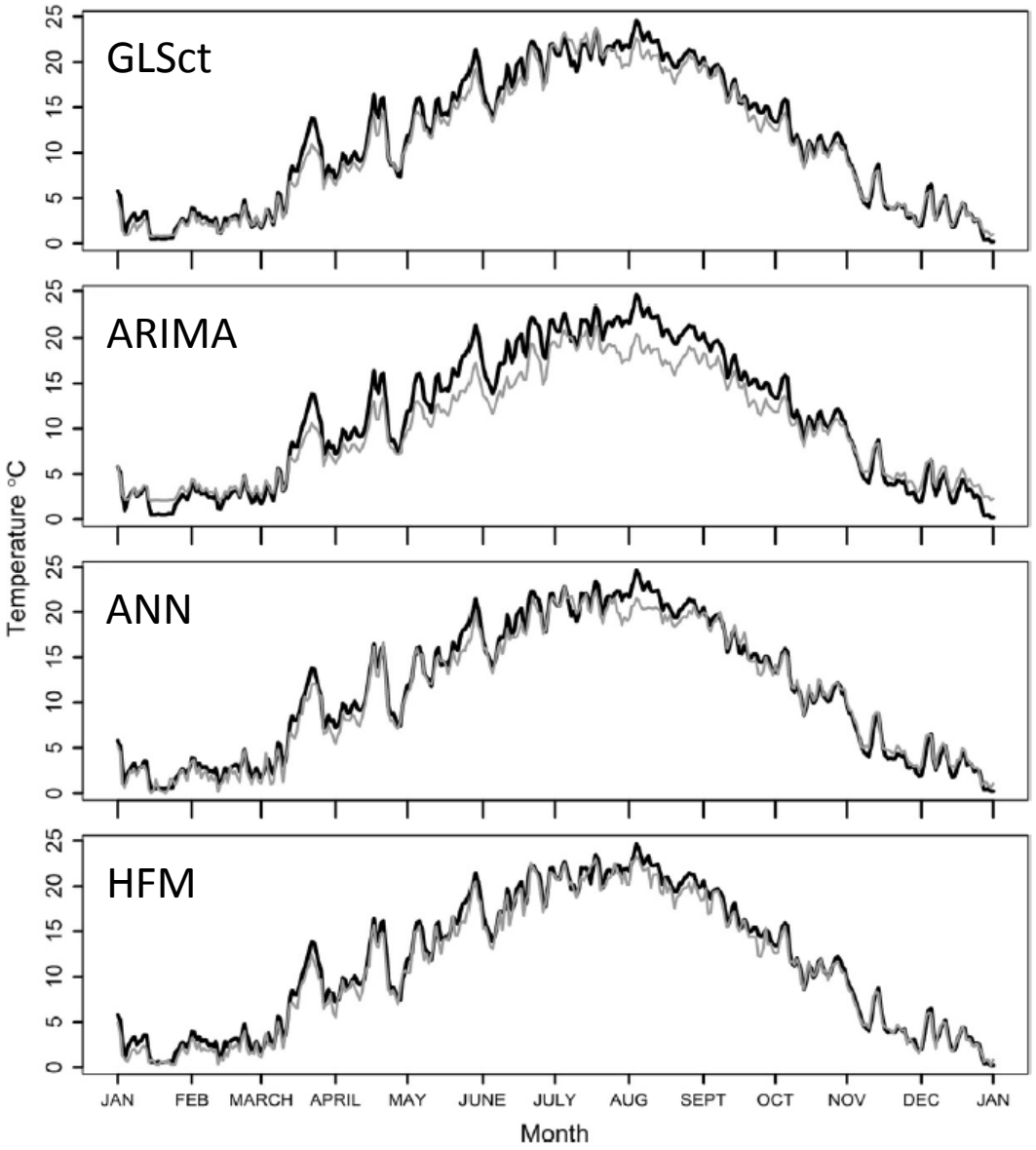
- Do the Delphi and literature HSC:
  - Agree?
  - Result in the same management decisions?
  - Predicted the same amount of habitat?
    - Where are the deviations?
      - Between sites
      - Within a site



- General agreement (best for velocity)
  - Delphi predicts more habitat in channel
  - Literature predicts more shallow habitat *Galbraith et al. (in prep)*

Expand Temperature Model

- Water temperature at Lordville based on climate data and hydrologic data
  - HFM strongest although all performed well
  - Highest deviations at extreme temps
  - Working on probabilistic model to address this *(Maloney, in prep)*



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journal homepage: www.elsevier.com/locate/jhydrol

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Developing and testing temperature models for regulated systems: A case study on the Upper Delaware River

Jeffrey C. Cole [a,*], Kelly O. Maloney [a], Matthias Schmid [b], James E. McKenna Jr. [c]

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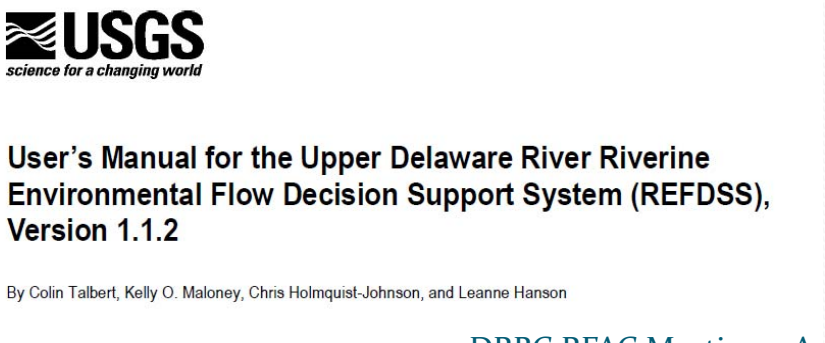
[b] Department of Medical Biometry, University of Bonn, Sigmund-Freud-Strasse 25, 53105 Bonn, Germany
[c] Tunison Laboratory of Aquatic Science, USGS Great Lakes Science Center, Cortland, NY 13045, USA

Improved DSS platform

- REFDSS available for download at: www.sciencebase.gov/DelawareREFDSS
- System requirements:
  - 64-bit computer
  - Administrative privileges
  - 20 GB of hard drive for input storage
  - Additional storage for model output
- Work in progress—we need your help!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User's Manual for the Upper Delaware River Riverine Environmental Flow Decision Support System (REFDSS), Version 1.1.2

By Colin Talbert, Kelly O. Maloney, Chris Holmquist-Johnson, and Leanne Hanson


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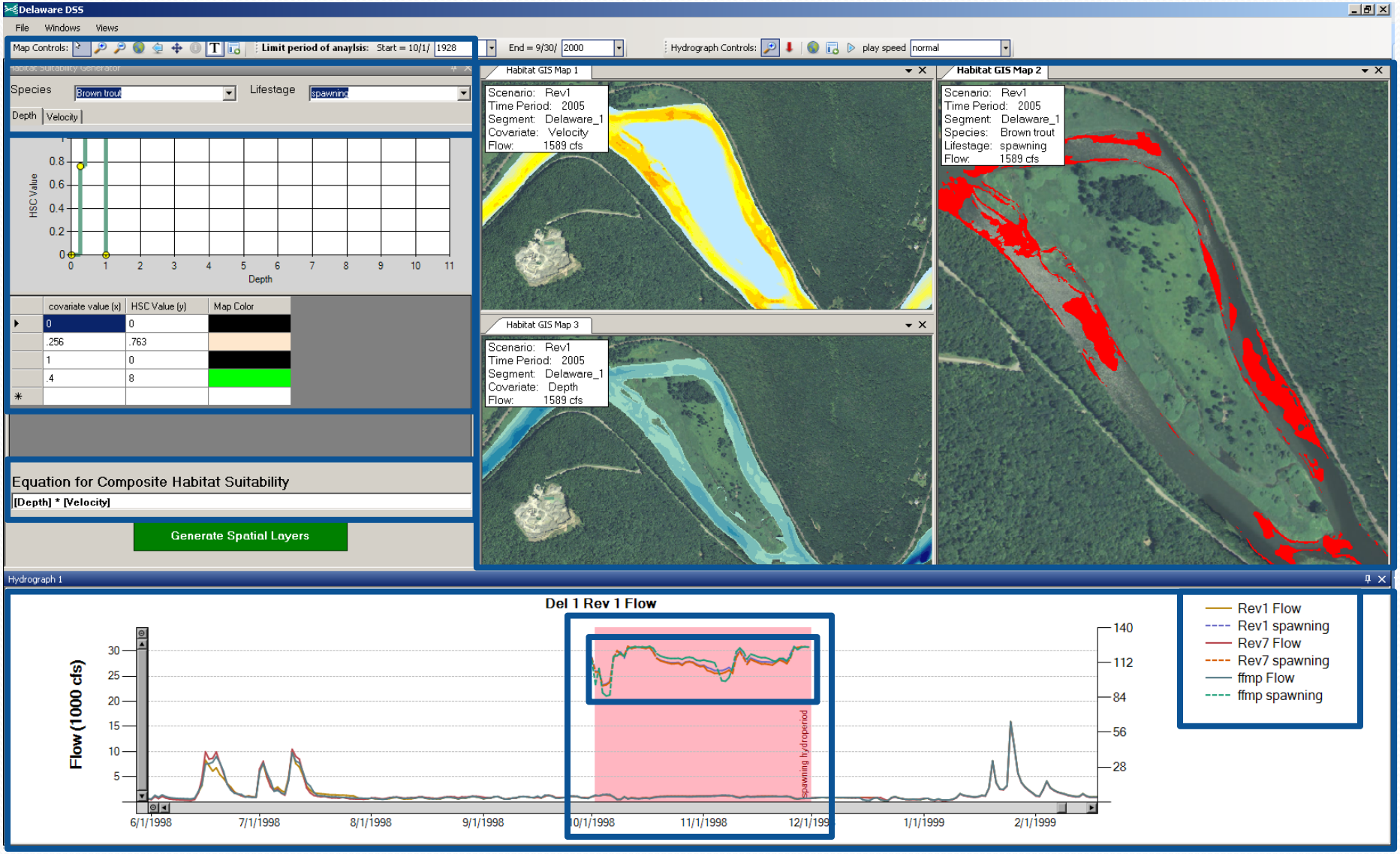
Article

An integrated Riverine Environmental Flow Decision Support System (REFDSS) to evaluate the ecological effects of alternative flow scenarios on river ecosystems

Kelly O. Maloney[1, *], Colin B. Talbert[2], Jeffrey C. Cole[1], Heather S. Galbraith[1], Carrie J. Blakeslee[1], Leanne Hanson[2] and Christopher L. Holmquist-Johnson[2]

Improved DSS platform



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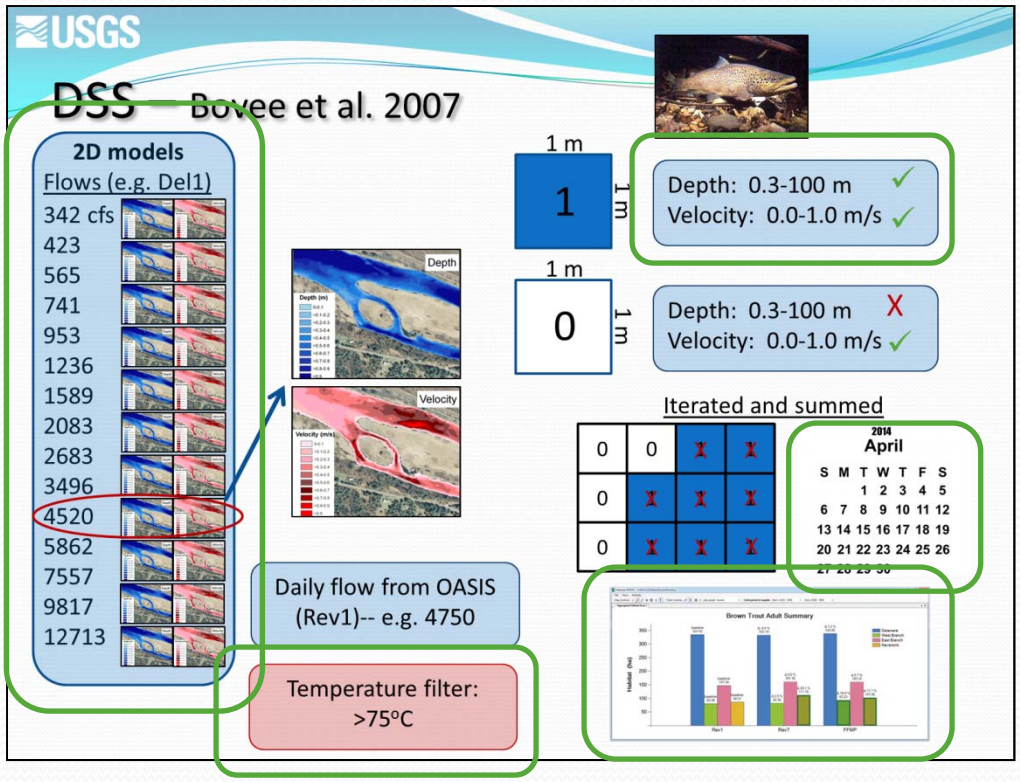
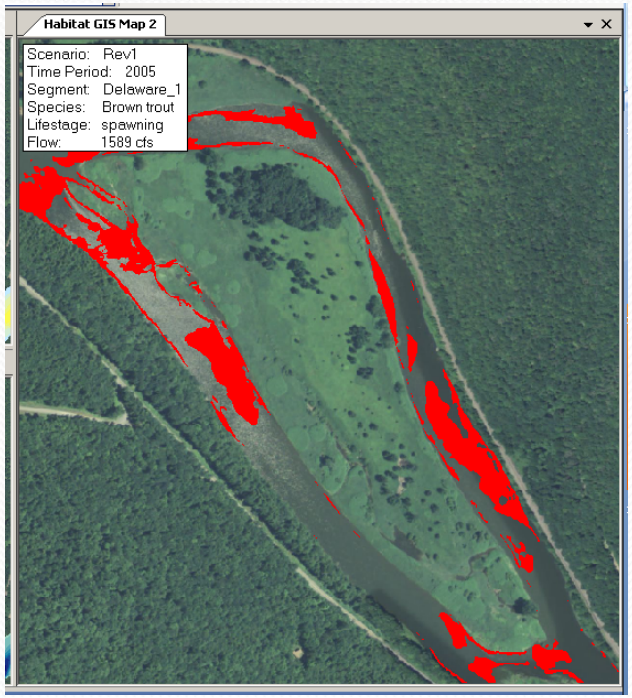


Future Directions

- WaterSMART has moved, but we're staying!
  - **Ground-truth model output with biological data**
  - Continue temperature model
  - Explore habitat persistence
  - Update flow management scenarios to include PST
  - Add SAV
  - Extend aerial coverage (LiDAR)
  - Ecosystem services modelling



Thank you!

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- Mark Hartle, PAFBC
- Jen Krstolic, USGS
- William Lellis, USGS
- Daryl Pierce, PAFBC
- Erik Silldorff, DRBC
- Terry Waddle, USGS
- Subcommittee on Ecological Flows
- And many others!

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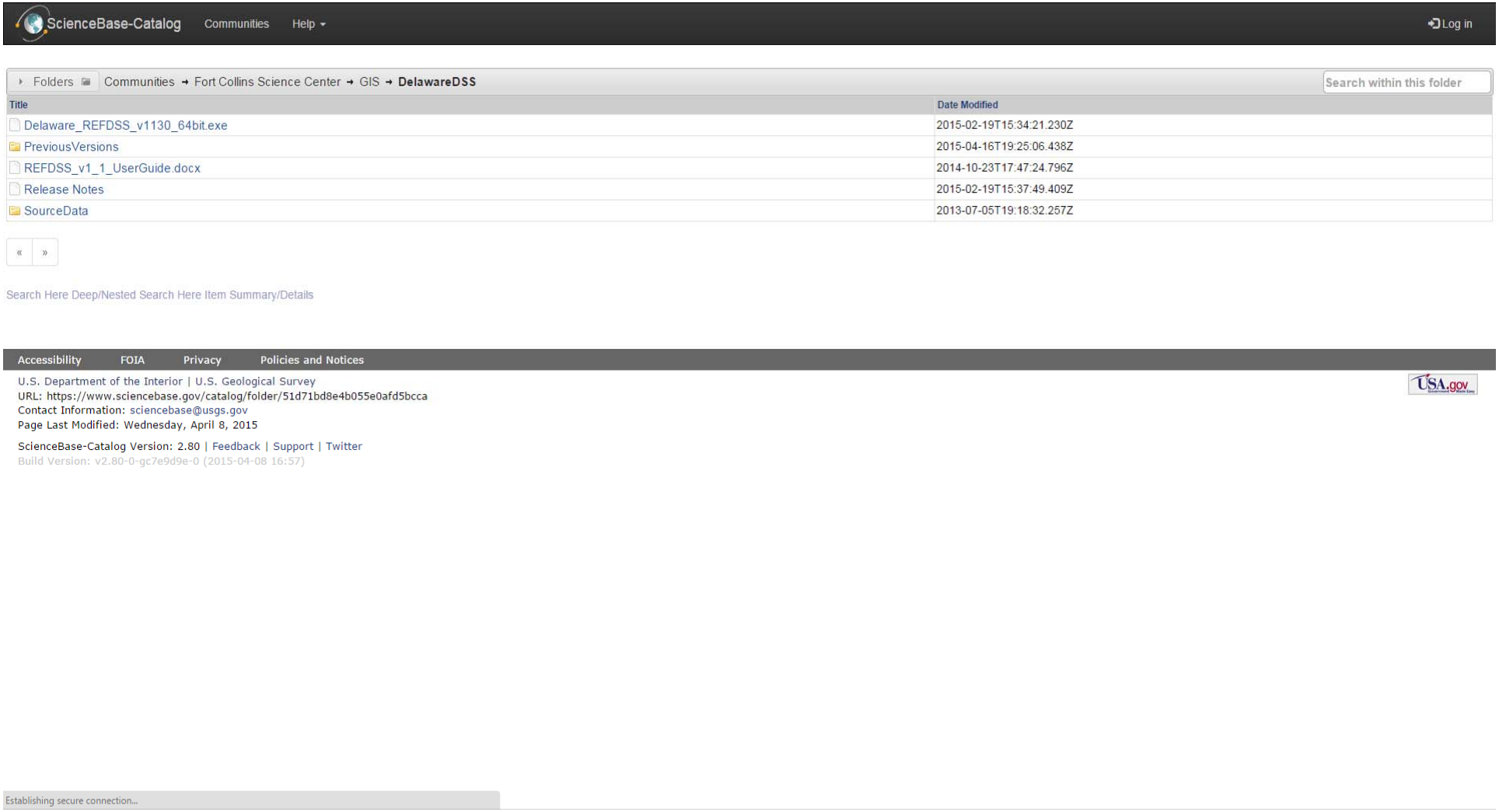
REFDSS download:
www.sciencebase.gov/DelawareREFDSS

REFDSS questions:
refdss_help@usgs.gov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