Beyond the Blue Lines

The New Hampshire Hydrography Dataset (NHHD) as a Framework for Data Discovery and Analysis

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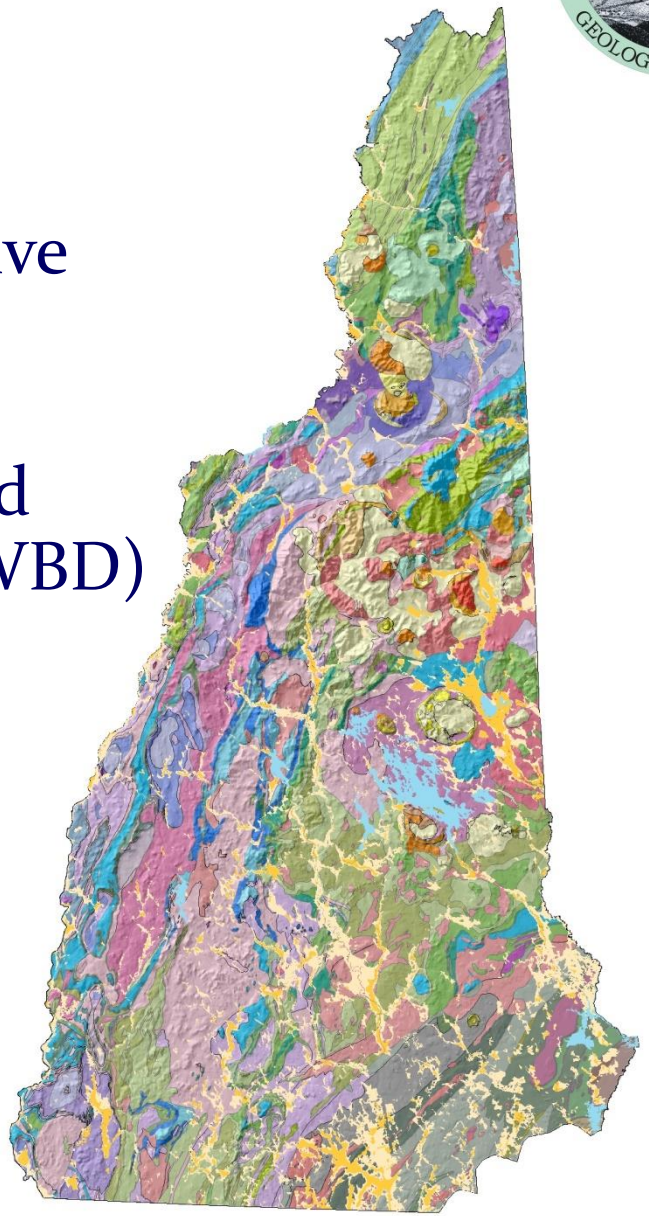
NEW HAMPSHIRE DEPARTMENT OF Environmental Services

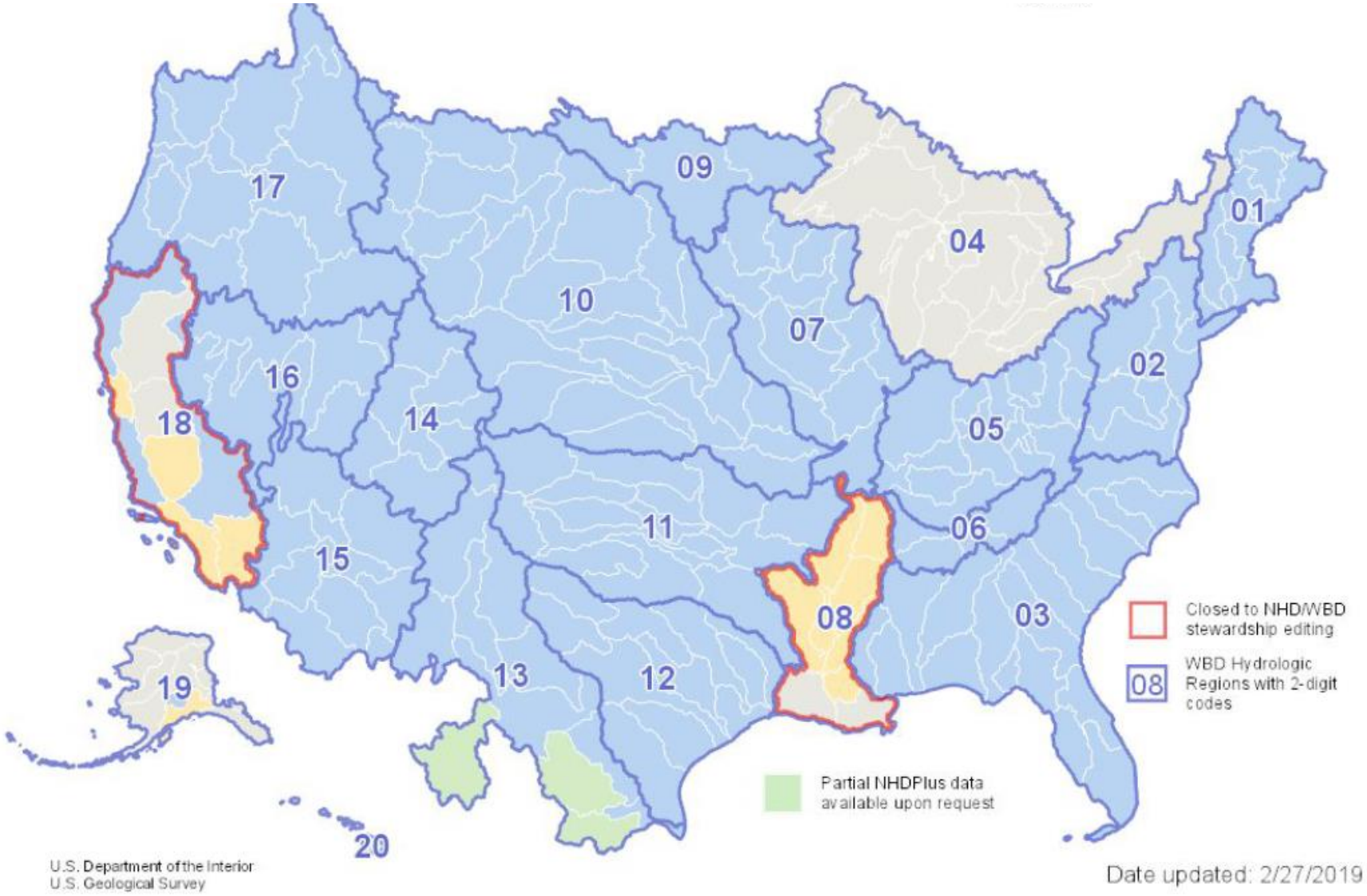
NEW HAMPSHIRE 1839 2001 GEOLOGICAL SURVEY

Programs of the NHGS

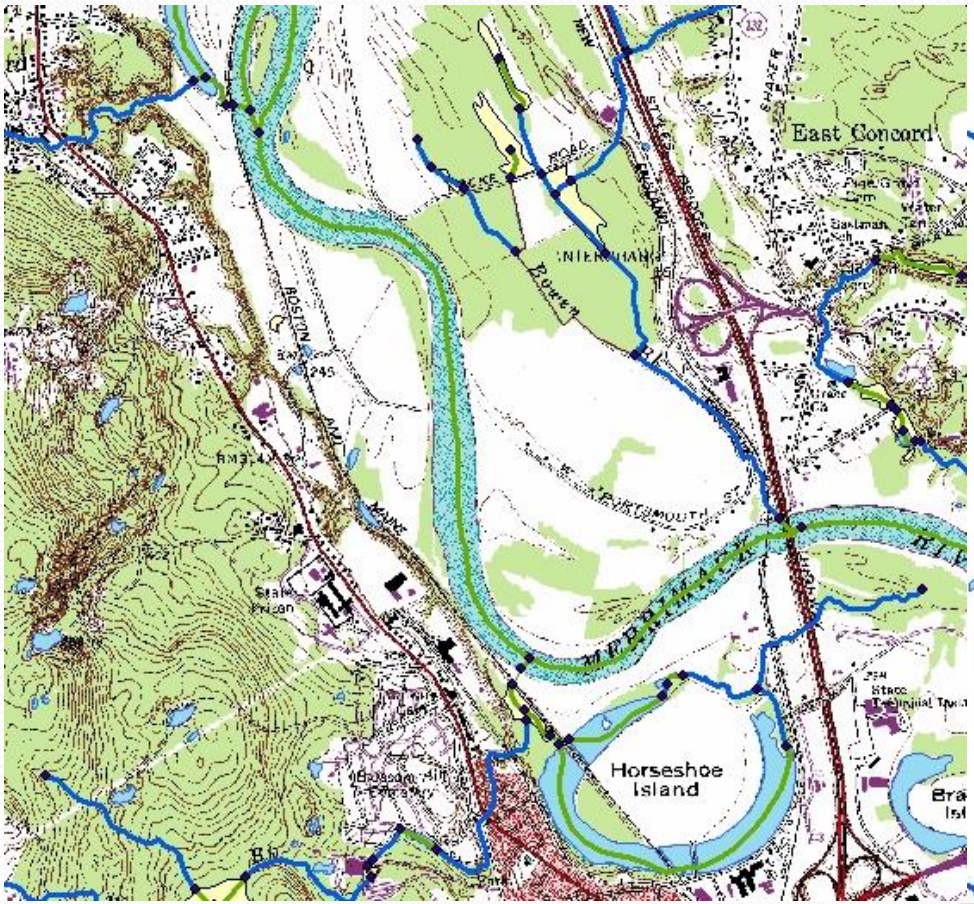
- Surficial and bedrock geologic mapping as part of the cooperative STATEMAP program
- Stewardship of the National Hydrography Dataset (NHD) and Watershed Boundary Dataset (WBD)
- Geologic hazard assessment
  - Hydrologic Modeling of Culverts
- Monitor statewide groundwater levels
- Maintain the NH Water Well Inventory



National Hydrography Dataset (NHD) and Watershed Boundary Dataset (WBD)



NHD Data: Every water feature on 24K-scale USGS topo maps

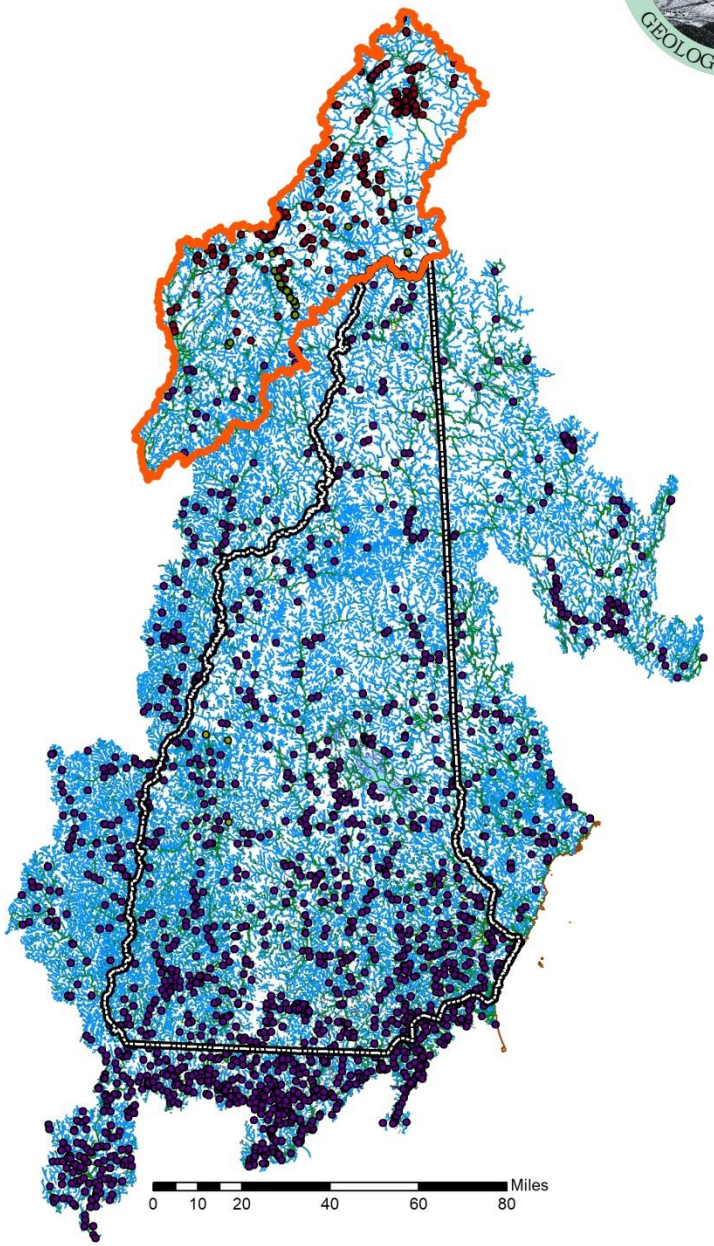


NHD on Topo base

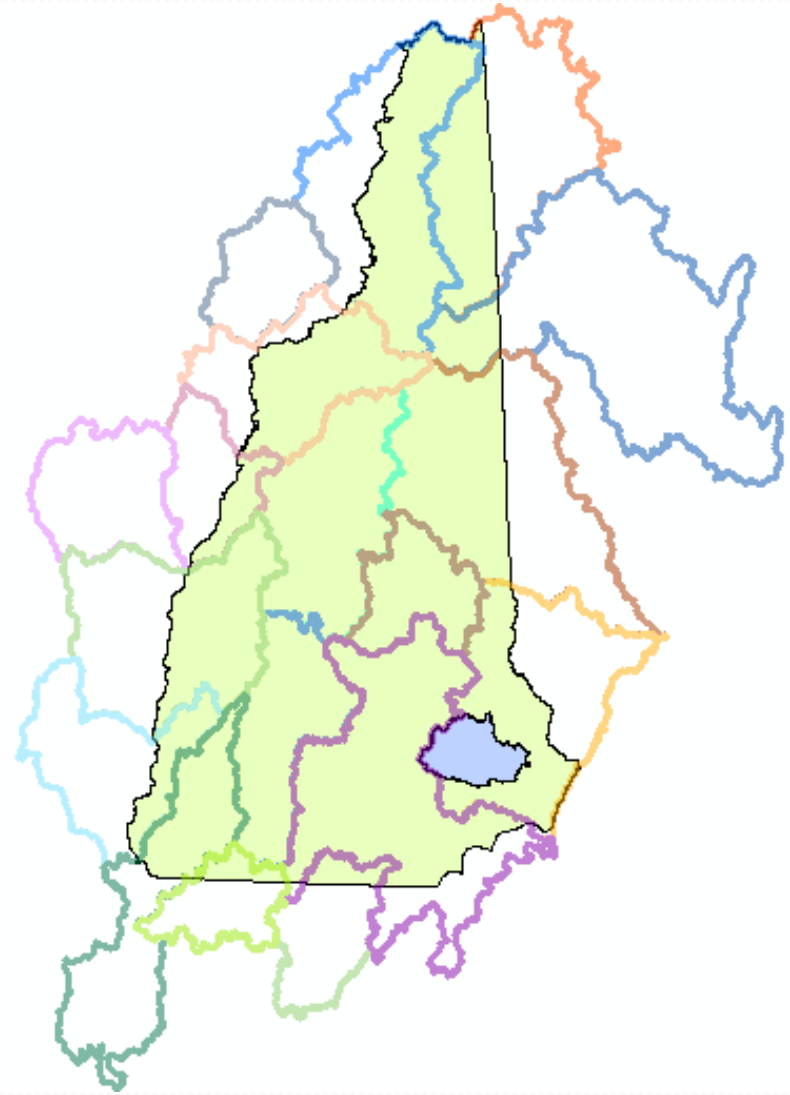
NHD vector data

NHHD, a subset of NHD

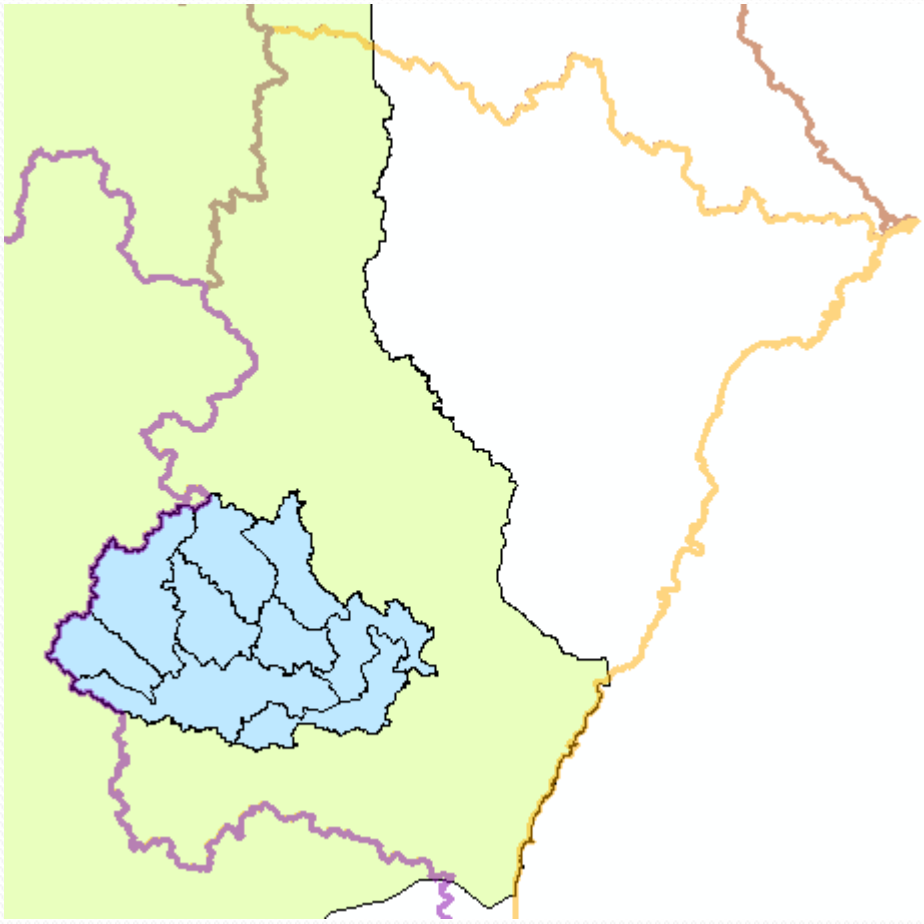
- Inventory of New Hampshire surface waters (streams, lakes, wetlands etc.) at 1:24000 scale
  - 145,000 streams
  - 54,000 waterbodies
  - 3,450 points/events
  - Is not comprehensive of every feature!



WBD: Nested hierarchy of drainage areas

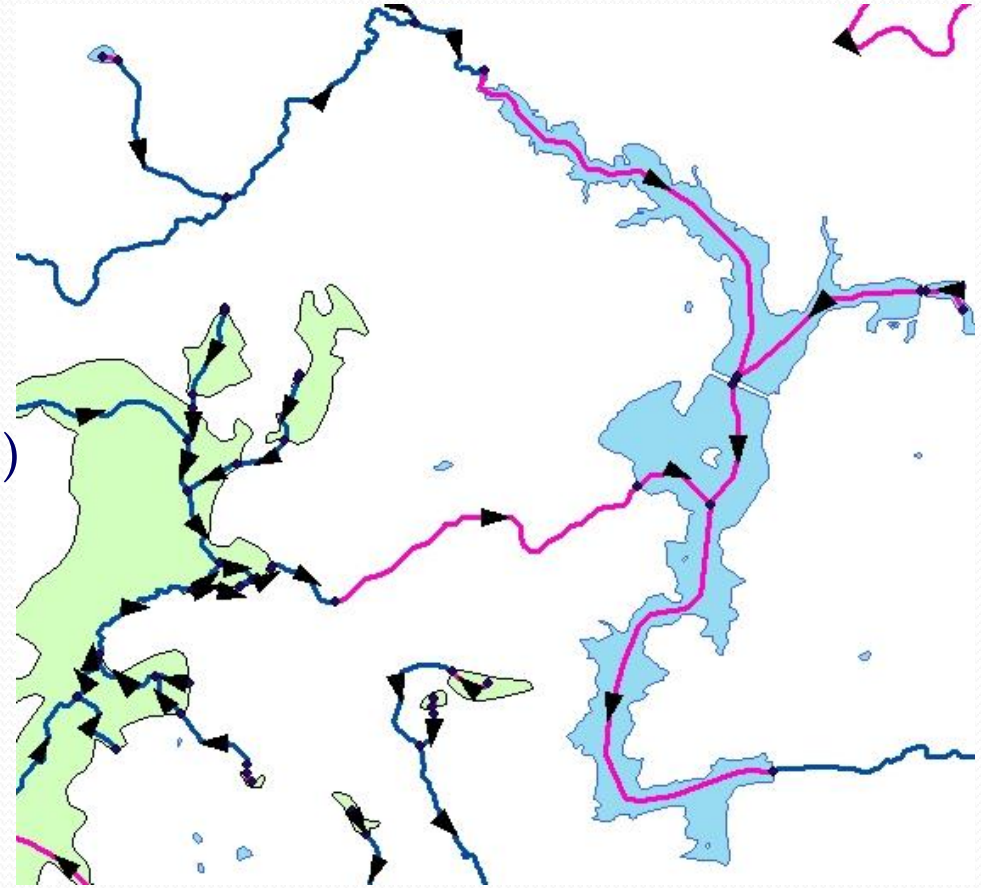


Scaling down from HUC8 to HUC10 to HUC12



Data Structure

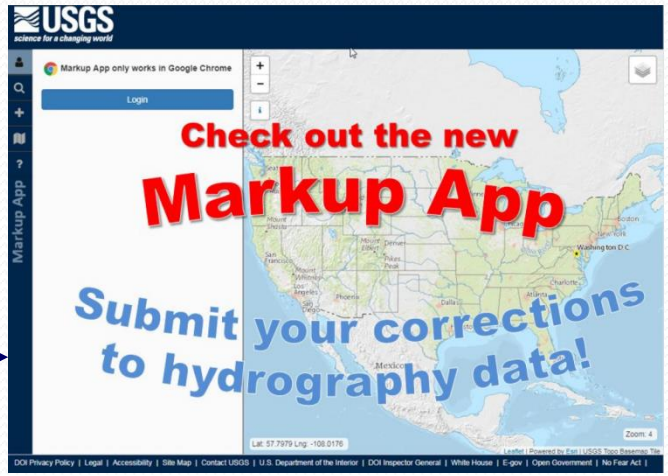
- Today – 24K scale State-wide
- Geodatabase
  - WBD feature dataset
    - Polygons (HUCs)
  - NHD feature dataset
    - Points (dams, gages etc.)
    - Lines (streams, pipelines etc.)
    - Polygons (lakes, dams etc.)
- Directional Network
  - The streams know where they're going (as long as ***we*** do!)



Network Attributes

- Feature-level metadata – what got changed, when and why
- GNIS Naming – USGS "Naming" Database
- Basic geometries (length/area)
- Tabular relations between features
- New NHDPlus High Resolution offers NHD+WBD+NED:
  - Thematic Elevation plots (streams, headwaters, confluences)
  - Basin characteristics (annual mean precipitation, temperature, runoff, and mean latitude)
  - Stream characteristics (discharge, velocity, elevation, slope, etc.)

NHD Maintenance



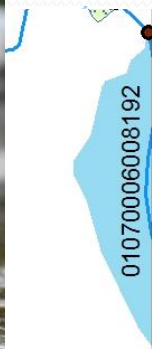
- …By NHGS
  - Reviews and edits NHD per suggestions
    - from public
    - and agency employees
  - Working with WMNF to map headwaters
  - "Event" creation (dams, h20 quality stations, etc.)
- …By USGS
  - Periodic "refresh" of NHDPlus HR (currently ongoing)
  - Adds new stream gages, synchronization
  - General management

Ongoing Event Creation (points, lines and areas)

- Stream Gages
- Dams
- Stream Crossings
- Stream Cross Sections
- Water Quality Monitoring Stations
- Water Withdrawals/Returns
- Designated Rivers of NH (line events)

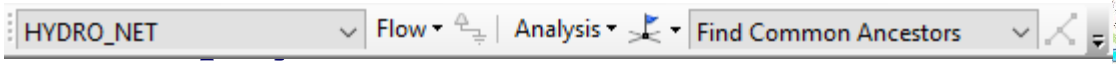
Point and Linear Events:

Every event has an address

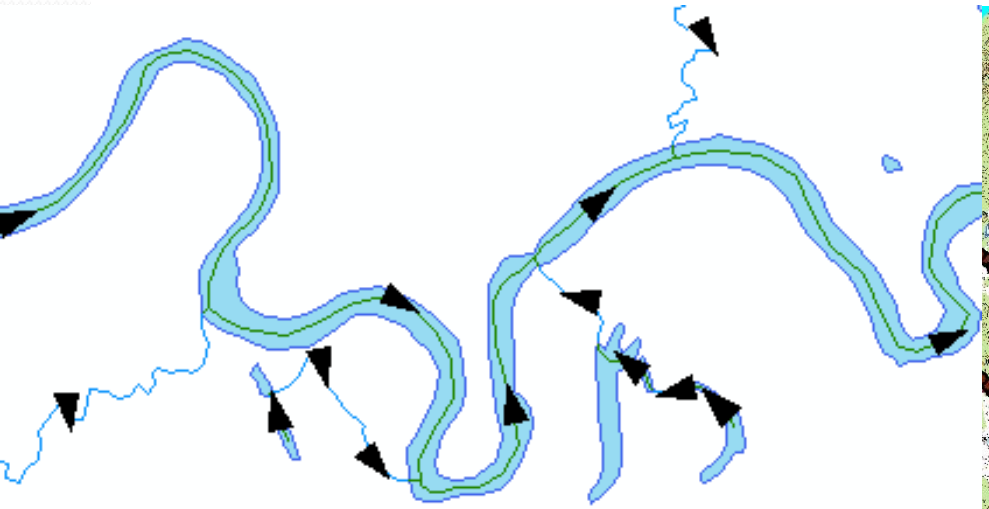


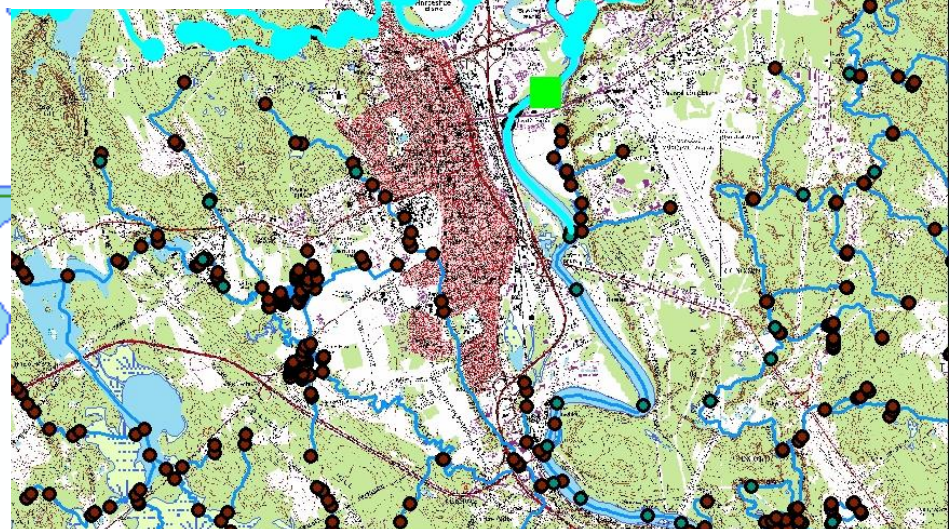
Serving data to the public

- Web-based applications allow for data discovery through NHD network tracing. Find information like dams, water quality stations, etc.
  - ESRI Utility Network Analyst toolbar



  - Up and Down Stream Tracing
  - Upstream Accumulation





Aqua Incognita: The Unknown Headwaters

Bishop et al. (2008)

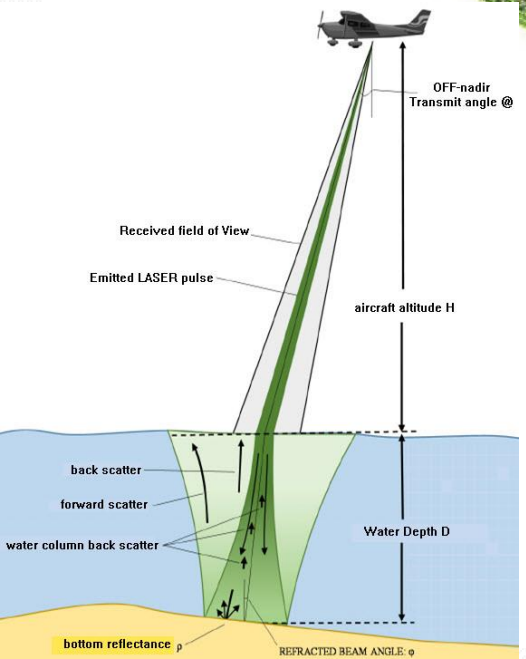
Why study headwater streams and their catchments?

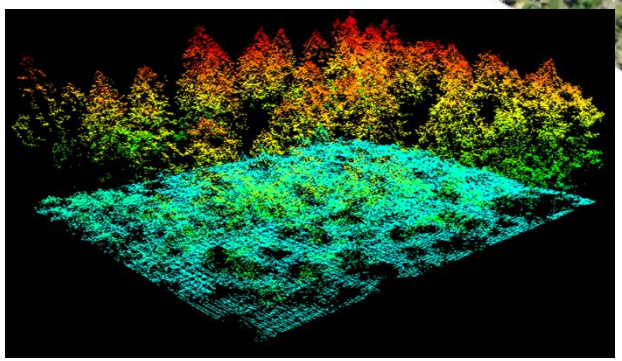
- **Compose 60% to 80% of a catchment** (MacDonald and Coe, 2007)
- **Comprise 50% of the stream length**
- Higher in elevation, receive more rain and **generate most of the total streamflow** (MacDonald and Coe, 2007)
- **Water Quality** in headwaters affect whole basin: land owners of headwater streams are less likely to manage water quality (Armstrong et al., 2012)
- Hydrogeologists: Important to model **storm hydrology, at** stream crossings: **stream length → travel time → timing of peak flow** (culverts need to be adequately sized or they fail and threaten infrastructure)

Biological Importance of headwater streams

- **Nutrient cycling** in headwater catchments → downstream ecosystems
- Small streams differ widely in physical, chemical, and biotic attributes providing habitats for a diverse range of species (Meyer et al., 2007)
- Scott Bailey @ Hubbard Brook: Seasonally flowing streams…
  - Were found to control variation in dissolved organic carbon concentrations (Gannon et al. 2015)
  - regulate surface water quality
  - are underrepresented on maps

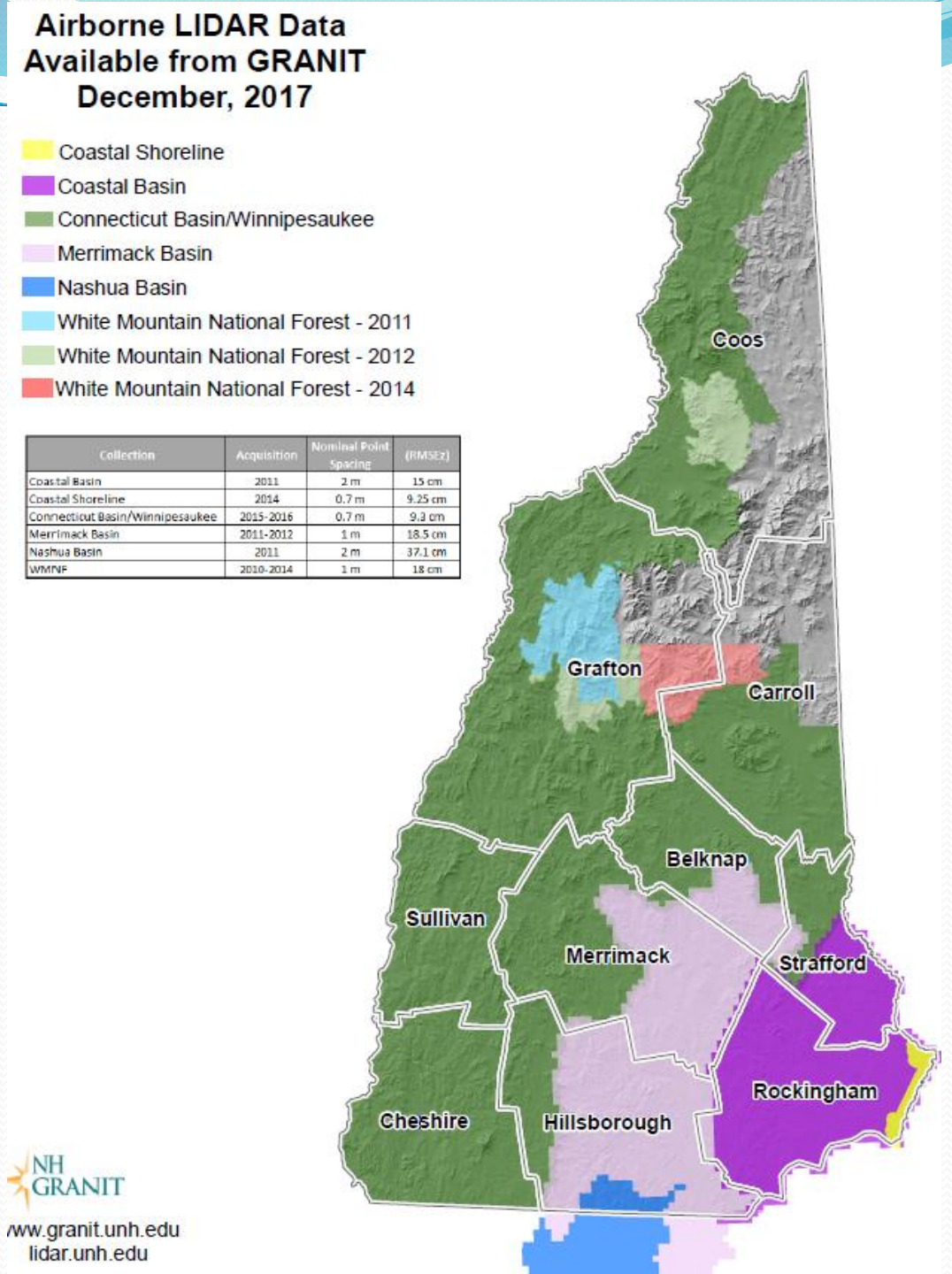
LiDAR


OFF-nadir
Transmit angle @
Received field of View
Emitted LASER pulse
aircraft altitude H
back scatter
forward scatter
water column back scatter
Water Depth D
bottom reflectance ρ
REFRACTED BEAM ANGLE: φ



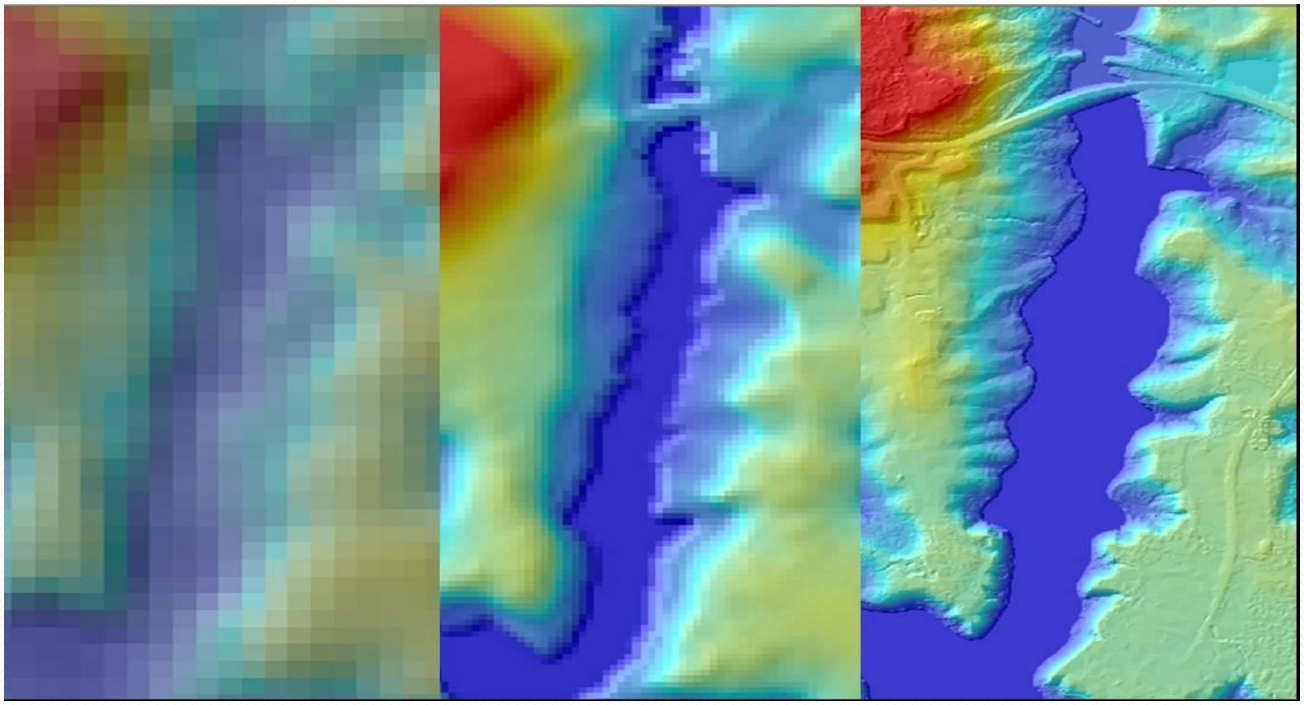
LiDAR: Light Detection and Ranging

- Almost complete statewide coverage!
- Umbagog region currently being QC'd
- Download tiles from GRANIT (UNH)
- Need GIS software to process (open source options)



The Emerging LiDAR Landscape

Comparison of terrain models for Fresh Creek, Strafford County, NH: NED 30-meter and 10-meter DEMs versus 1-meter LiDAR



30-meter DEM	10-meter DEM	1-meter DEM

Thornton

Meander Scar

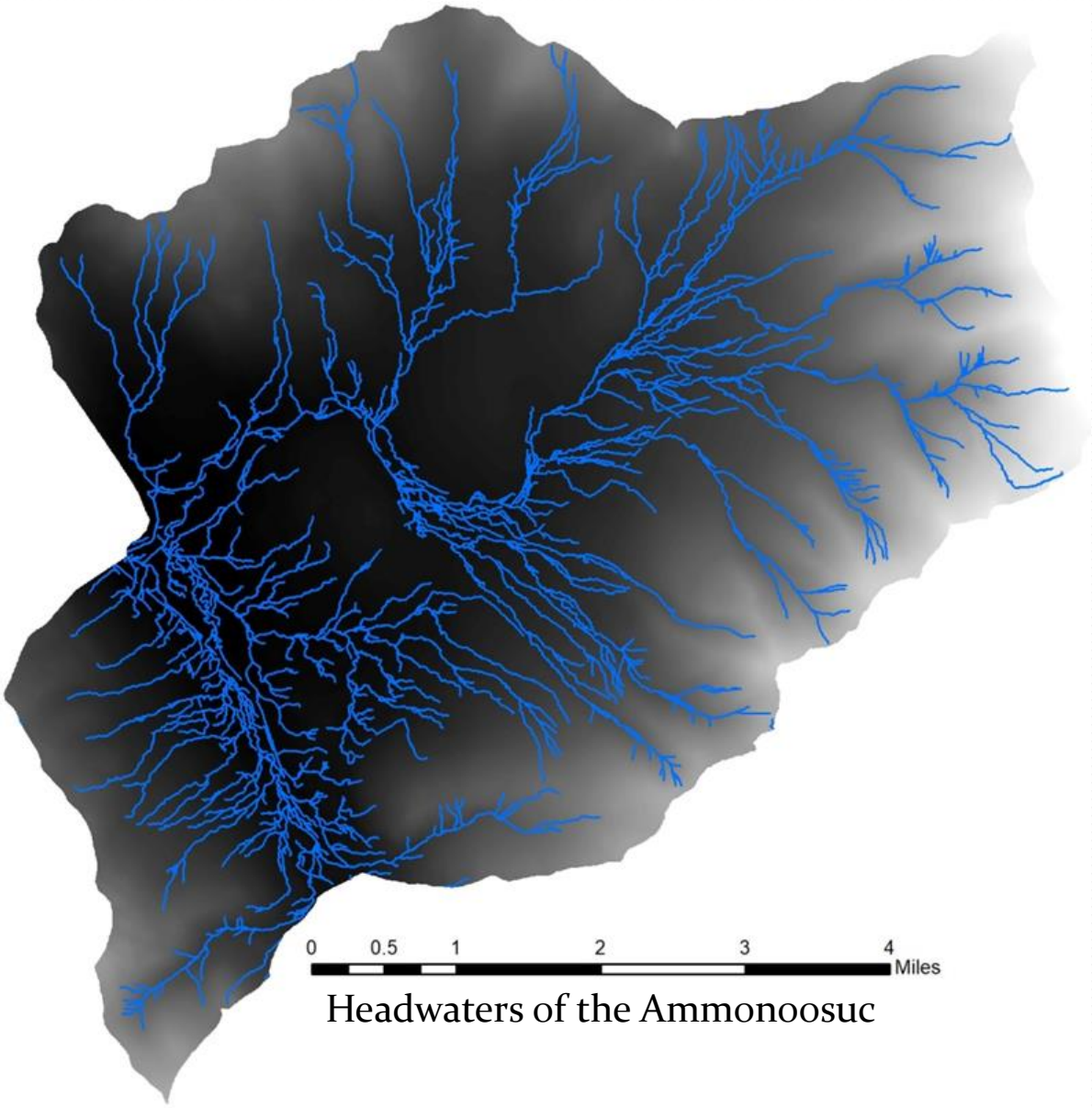
Meltwater Channels

Fluted till surface

Till (?) Slump

Esker ridge

Stream extraction from Lidar



Headwaters of the Ammonoosuc

Network Extraction Methods

- Find areas where water would accumulate (morphological filters)
  - Find valley areas (large depressions)
  - Find channelized areas (small depressions)
- Find connected areas where water would flow
  - Find areas common to small and large depressions
  - Clean up (2 standard deviation, 500 cell threshold)
- Use these as seed points to run D8 flow algorithm
- Convert accumulation grid to lines

Morphological Filters on LiDAR DEMs

From Cho et al 2010 and Rodriguez 2007

7	6	5	6	7
6	5	4	5	6
5	4	3	4	5
4	3	2	3	4
3	2	1	2	3

Original DEM

Dilation (maximum)

7	7	6	7	7
7	7	6	7	7
6	6	5	6	6
5	5	4	5	5
4	4	3	4	4

Closing(min(max))

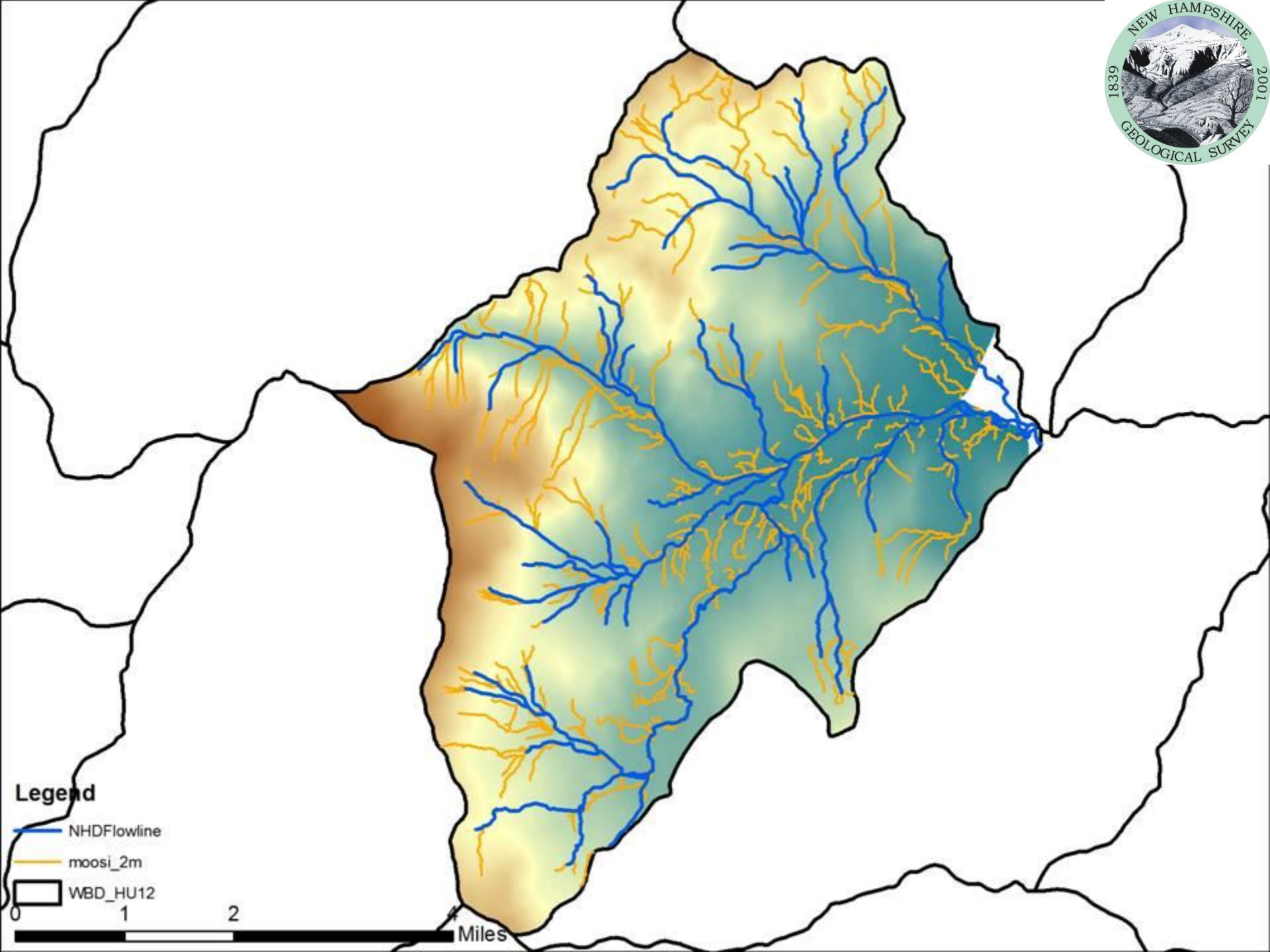
7	6	6	6	7
6	5	5	5	6
5	4	4	4	5
4	3	3	3	4
4	3	3	3	4

BotHat (closing-DEM)

0	0	1	0	0
0	0	1	0	0
0	0	1	0	0
0	0	1	0	0
1	1	2	1	1

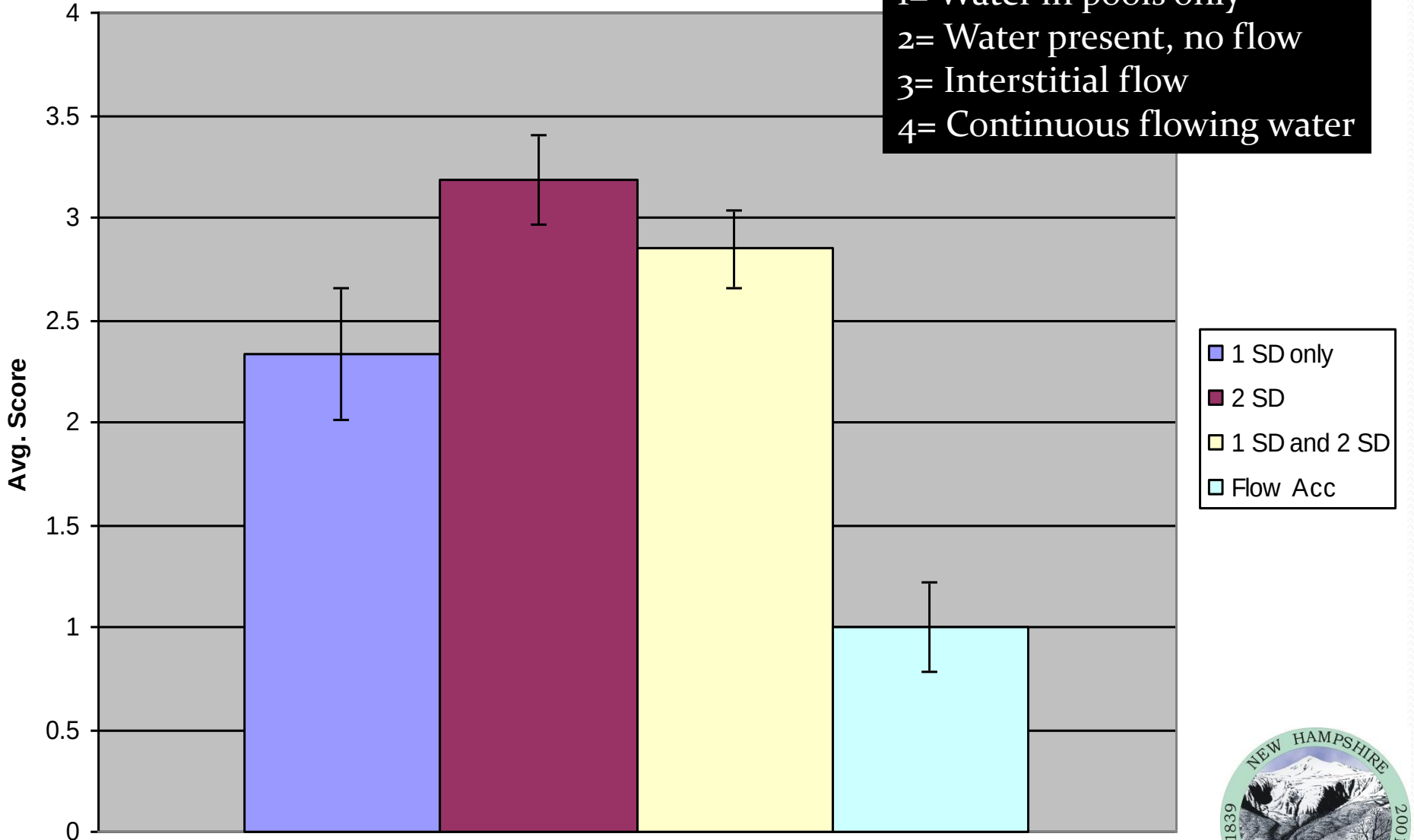
Moosilauke Brook

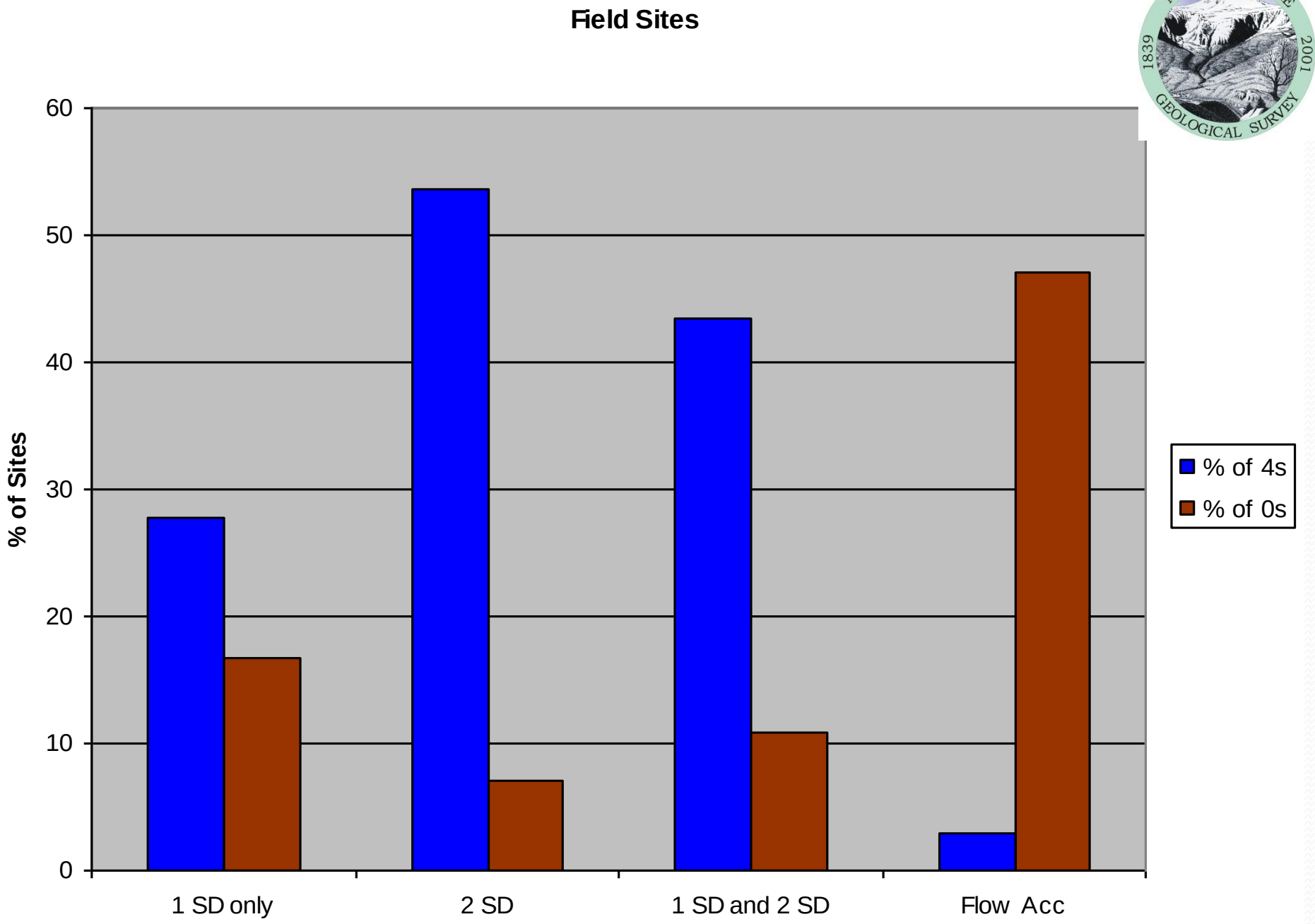
0 0.75 1.5 3 Miles


NEW HAMPSHIRE
1839
2001
GEOLOGICAL SURVEY
Legend
NHDFlowline
moosi_2m
WBD_HU12
0
1
2
Miles

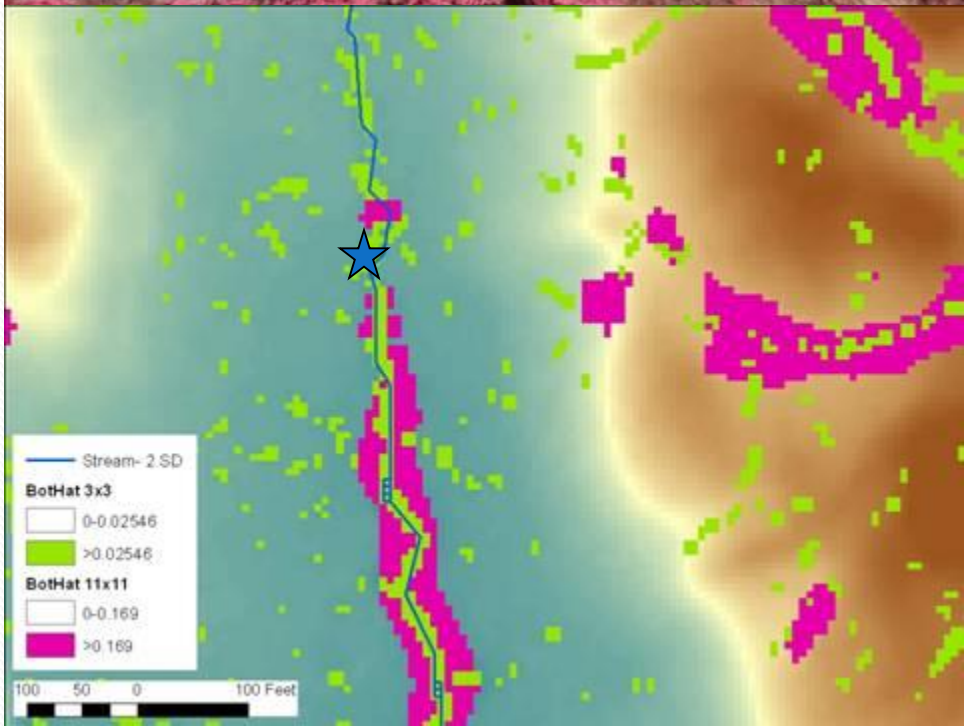
Field Site Scores

0= No water
1= Water in pools only
2= Water present, no flow
3= Interstitial flow
4= Continuous flowing water



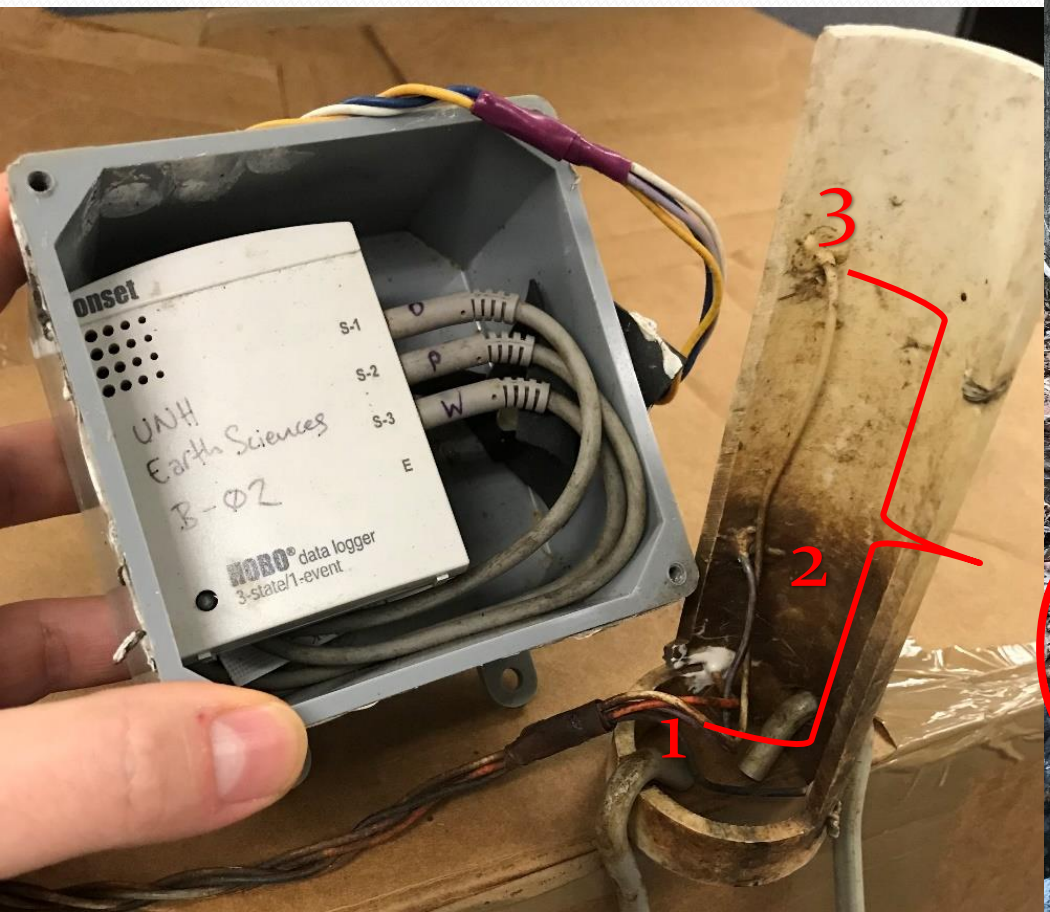

Field Sites
% of Sites
60
50
40
30
20
10
0
1 SD only
2 SD
1 SD and 2 SD
Flow Acc
% of 4s
% of 0s

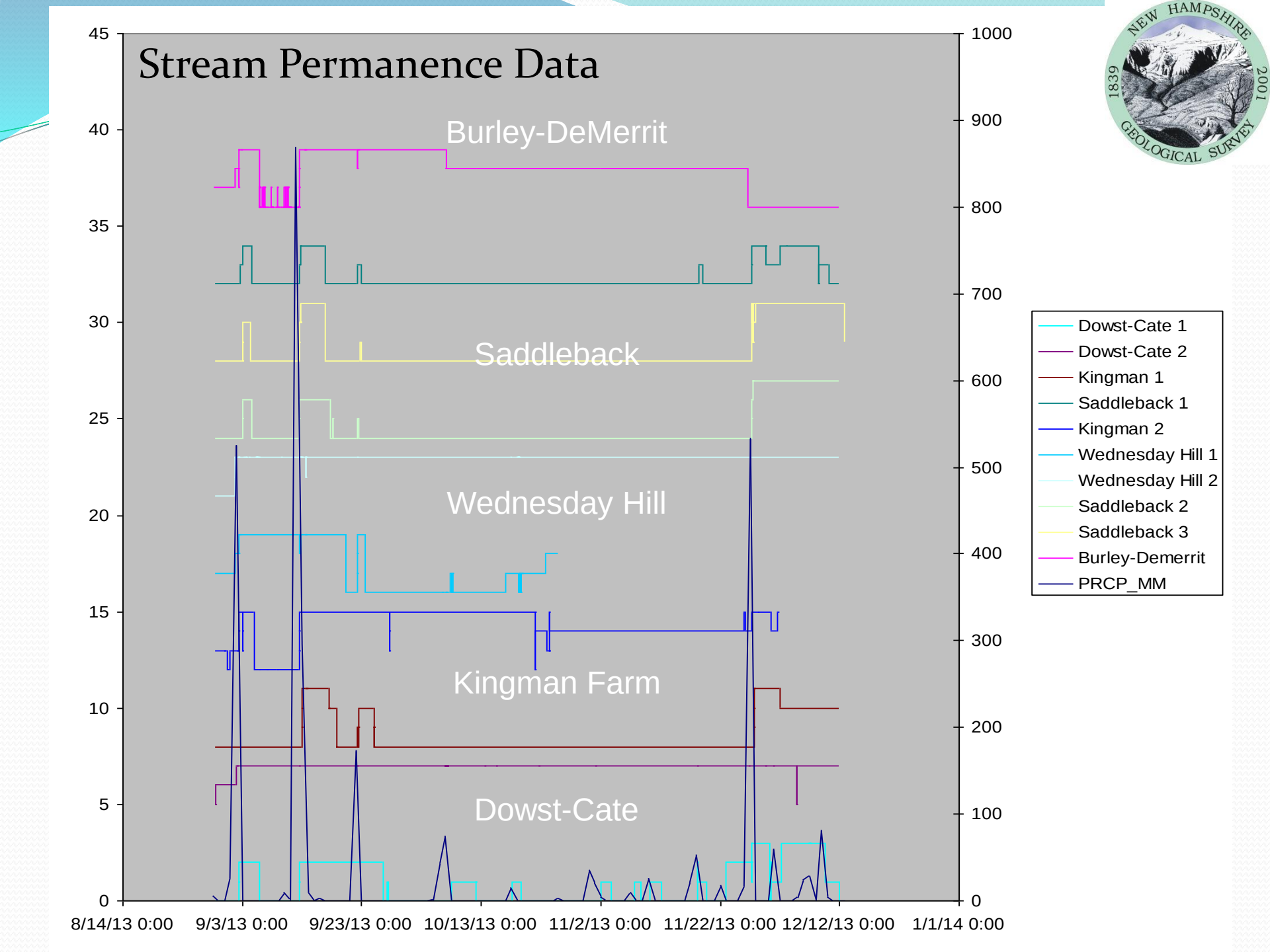

100 50 0 100 Feet


Stream- 2 SD
BotHat 3x3
0-0.02546
>0.02546
BotHat 11x11
0-0.169
>0.169
100 50 0 100 Feet

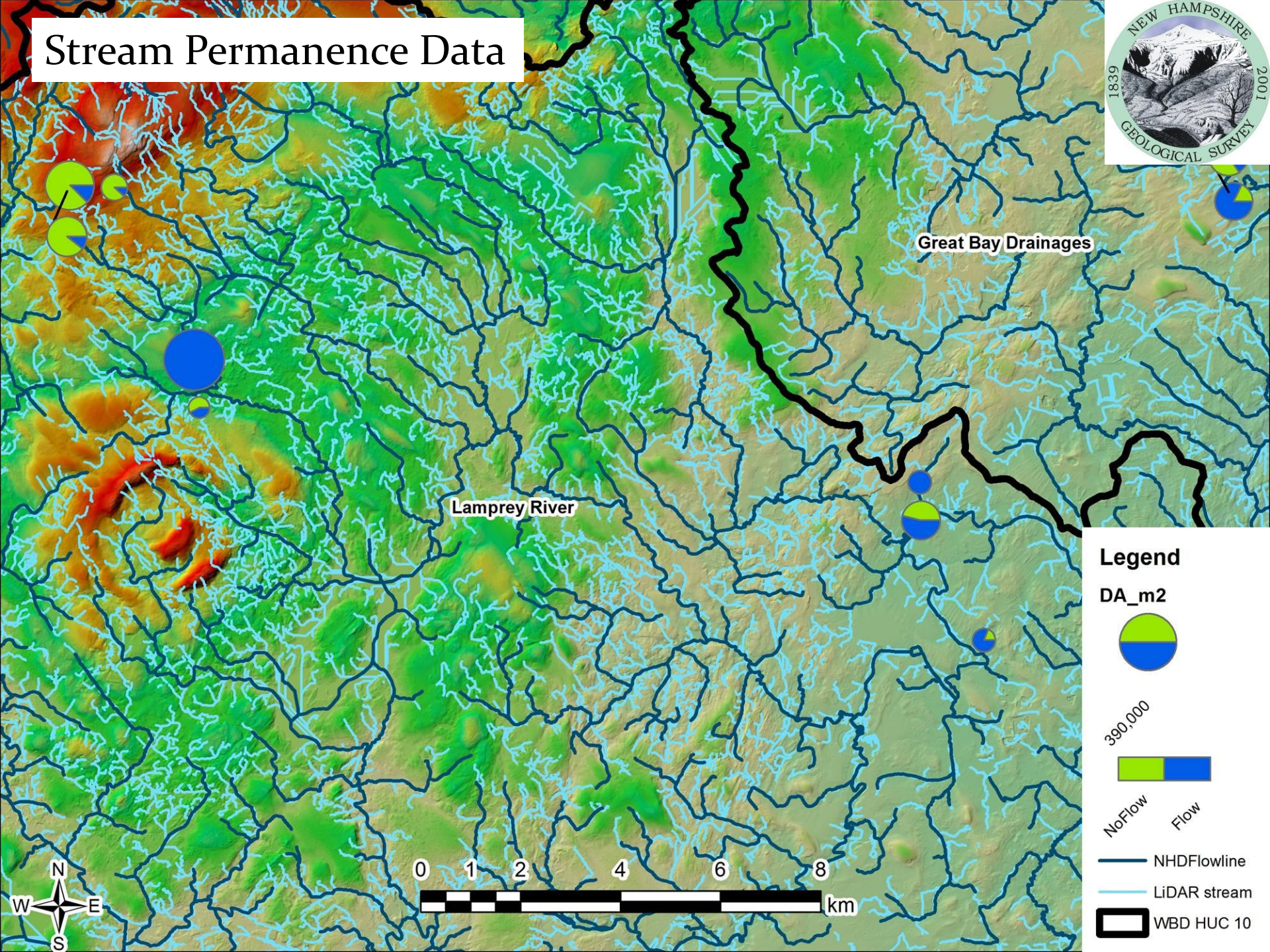
Stream Permanence Sensors

- Simple-state sensors record up to 3 relative levels in channel (per Bhamjee and Lindsay, 2011)




Stream Permanence Data
Burley-DeMerrit
Saddleback
Wednesday Hill
Kingman Farm
Dowst-Cate
45
40
35
30
25
20
15
10
5
0
1000
900
800
700
600
500
400
300
200
100
0
8/14/13 0:00
9/3/13 0:00
9/23/13 0:00
10/13/13 0:00
11/2/13 0:00
11/22/13 0:00
12/12/13 0:00
1/1/14 0:00
Dowst-Cate 1
Dowst-Cate 2
Kingman 1
Saddleback 1
Kingman 2
Wednesday Hill 1
Wednesday Hill 2
Saddleback 2
Saddleback 3
Burley-Demerrit
PRCP_MM

Stream Permanence Data



Thank you NHWWC!

Any Questions?

Please contact NHGS:

Joshua.Keeley@des.nh.gov
Frederick.Chormann@des.nh.gov

PS. Check out the NHD viewer

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