Development of a regional, on-line soil database

Principal Investigator(s):

Scott W. Bailey, US Forest Service, Northern Research Station, swbailey@fs.fed.us

Gregory B. Lawrence, U.S. Geologic Survey, email: glawrenc@usgs.gov

Mary Martin, Complex Systems Research Center, University of New Hampshire, mary.martin@unh.edu

Collaborators:

Rock Ouimet, Québec Ministère des Resources naturelles et de la Faune, rock.ouimet@mrnf.gouv.qc.ca

Paul Hazlett, Canadian Forest Service, Great Lakes Forestry Centre, phazlett@nrcan.gc.ca

Completion date: September 30, 2012

We created an on-line, interactive database for storing and sharing soil chemistry data in ne. U.S. and e. Canada

Funding support for this project was provided by the Northeastern States Research Cooperative (NSRC), a partnership of Northern Forest states (New Hampshire, Vermont, Maine, and New York), in coordination with the USDA Forest Service. http://www.nsrcforest.org

Project Summary

- Soils, comprising only about the top 1 meter of the earth's crust are a critical resource essential for support of life on Earth.
- Although water and air quality monitoring are well accepted and widely used methods of determining environmental quality, trends, and response to disturbance, soil monitoring has received relatively little attention.
- Recent developments in field and lab methodologies and recognition of the temporal dynamics in soil quality have heightened interest in retrospective soil monitoring and change detection.
- A visible, interactive database of soil monitoring was built to further promote monitoring, collaboration, and identify future research opportunities in the Northern Forest Region.
- Formatting is consistent with other NERC databases, allowing the development of linkages.

Northeastern Soil Monitoring Cooperative

- Founded in 2007 at a meeting supported by NSRC.
- Has met annually every year since.
- The mission of the cooperative is to facilitate coordinated collection of high quality broad-based soil data to evaluate temporal dynamics, to complement meteorologic, hydrologic and biologic monitoring, and to support decision making and science education.
- http://www.uvm.edu/~nesmc/

Cooperative Objectives

1. Develop and share protocols for field and lab soil sampling and analysis
2. Identify information needs that would benefit policy and management decisions
3. Establish a rigorous multi-scale soils collection program whose continuity is maintained while responding to emerging issues.
4. Synthesize existing soil monitoring data, including a critical review of past research and analysis of time scales of various soil dynamics
5. Compile an inventory of useful historic/ongoing soil monitoring data and plots
6. Provide open access to cooperative products and promote collaboration
7. Promote opportunities at the graduate student/young investigator level.

This project specifically contributes to objectives 4-6.

Methods

- Seed data from five investigators, covering the geographic area of interest (NERC and NESMC region) were acquired and used to develop the database structure and initially populate the database.
- Differences in methodology and data reporting units were evaluated.
- A core group of soil monitoring parameters of most interest, and most commonly available were chosen to develop the database framework.
- Programs to calculate summary statistics and graphics were assembled in R.
- Mapserver programming was written to provide user registration, data selection and download, interactive query and viewing of data integrated with scalable maps, and contributions of new data to grow the database in the future.

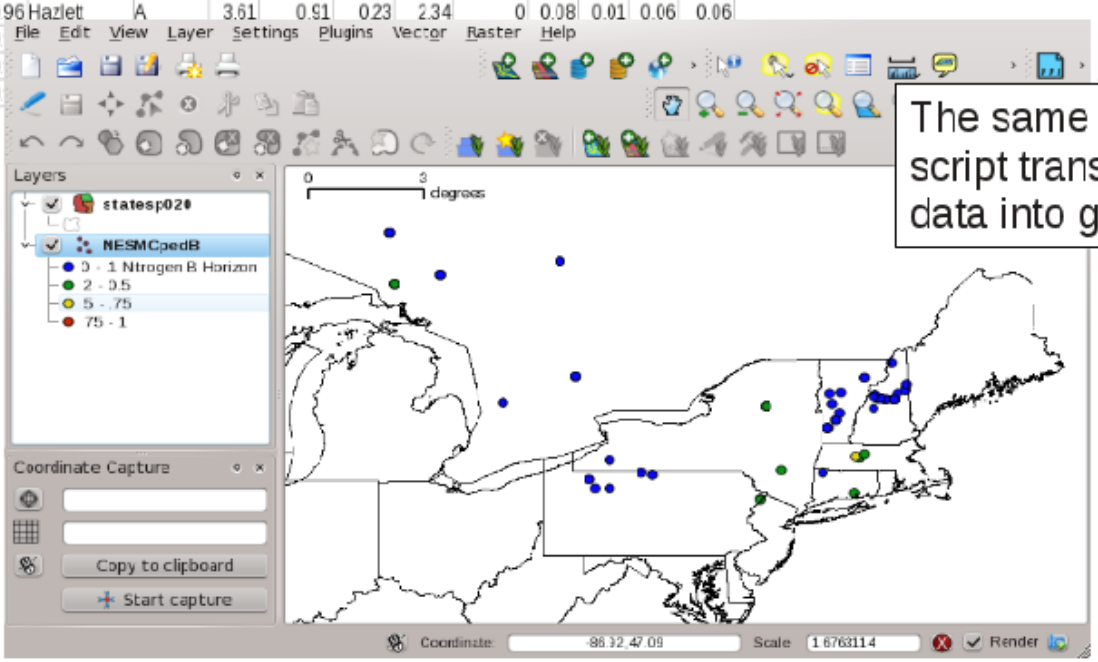
Results/Project outcomes

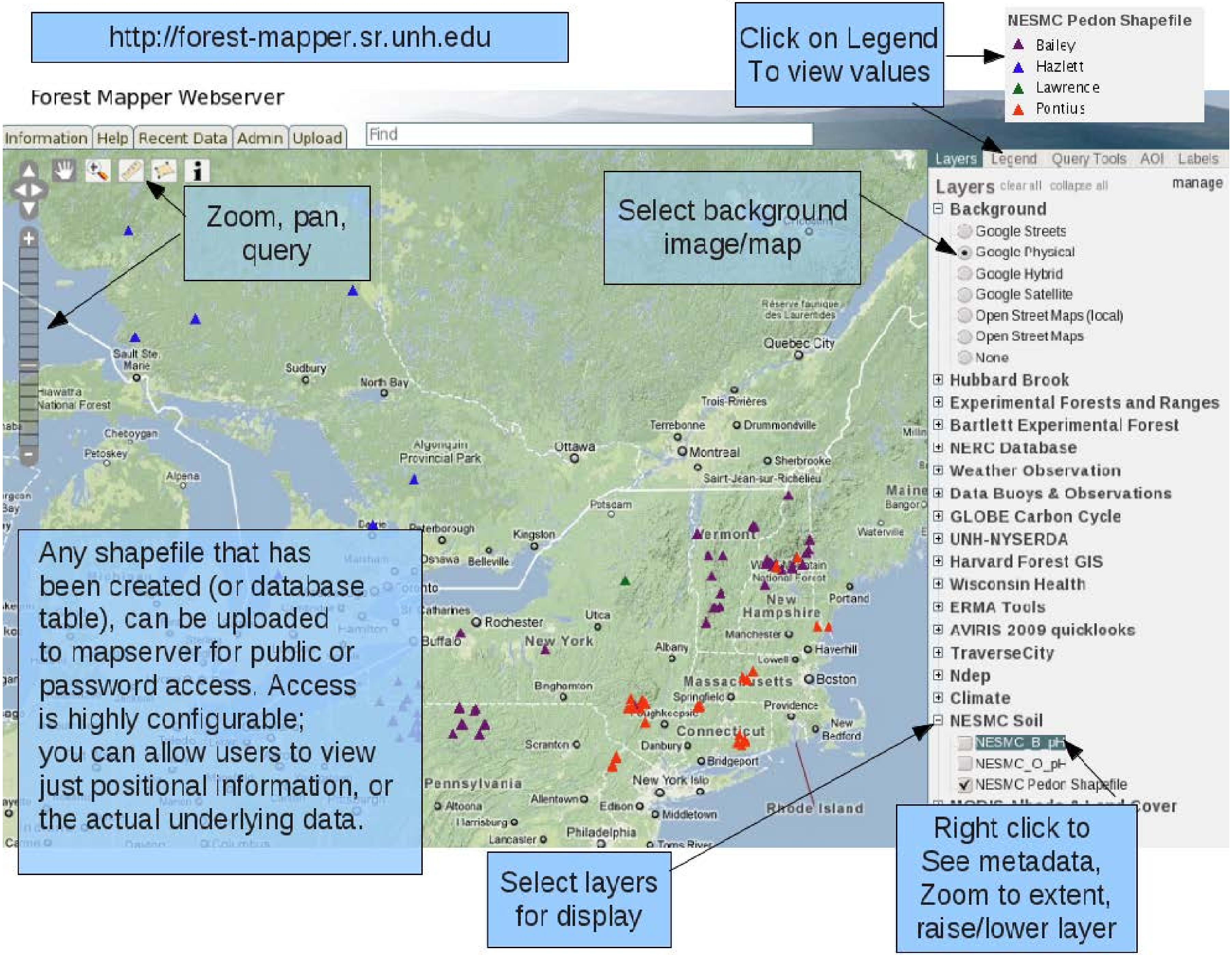
- http://forest-mapper.sr.unh.edu
- The following 3 slides illustrate database structure, and quering and mapping capabilities.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Pedon	Lon	Lat	Investigator	Horizon	pH	OrgMat	Ca	Al	Carbon	Mg	Mn	K	N
1	Pedon	Lon	Lat	Investigator	Horizon	pH	OrgMat	Ca	Al	Carbon	Mg	Mn	K	N
300	EQ03VT	-73.1	43	15	Bailey	C	5.96	1.26	0	0	0	0	0	0
301	EQ03VT	-73.1	43	15	Bailey	C	7.35	0.95	0	0	0	0	0	0
302	EQ03VT	-73.1	43	15	Bailey	C	7.45	1.08	0	0	0	0	0	0
303	EQ03VT	-73.1	43	15	Bailey	C	7.56	0.99	0	0	0	0	0	0
304	G.-BC-01-01	-74.71	43	75	Lawrence	B	2.94	8.67	0.36	4.53	5.31	0.11	0	0.11	0.53
305	G.-BC-01-01	-74.71	43	75	Lawrence	Oa	2.76	87.92	10.99	15.19	45.33	1.38	0	0.66	1.92
306	G.-BC-01-01	-74.71	43	75	Lawrence	Oe	3.06	94.68	14.24	4.72	46.85	2.29	0	1.65	2.09
307	G.-BC-01-02	-74.71	43	75	Lawrence	B	3.25	15.74	0.33	7.08	7.84	0.19	0	0.07	0.66
308	G.-BC-01-02	-74.71	43	75	Lawrence	Oa	2.5	93.17	3.35	9.92	50.39	3.83	0	0.19	1.6
561	JP-CTDH-02-01	-72.34	41	48	Pontius	Bw2	4.16	4	0.04	3.25	1.4	0.02	0.01	0.08	0.08
562	JP-CTDH-02-01	-72.34	41	48	Pontius	Bw3	4.23	1.54	0.06	1.56	0.44	0.03	0.02	0.07	0.05
563	JP-CTDH-02-01	-72.34	41	48	Pontius	A	3.25	25.24	1.87	3.7	12.6	0.5	0.04	0.4	0.59
564	JP-CTDH-02-01	-72.34	41	48	Pontius	Bw1	3.69	8.63	0.02	1.3	4.4	0.03	0	0.07	0.2
1331	PH-DR-522-2	-93.1	49	96	Hazlet	Oe	3.65	44.99	16.17	0.64	0	3.25	1.14	1.7	1.53
1332	PH-DR-522-3	-93.1	49	96	Hazlet	A	3.61	0.91	0.23	2.34	0	0.08	0.01	0.06	0.06
1333	PH-DR-522-3	-93.1	49												
1334	PH-DR-522-3	-93.1	49												
1335	PH-DR-522-4	-93.1	49												

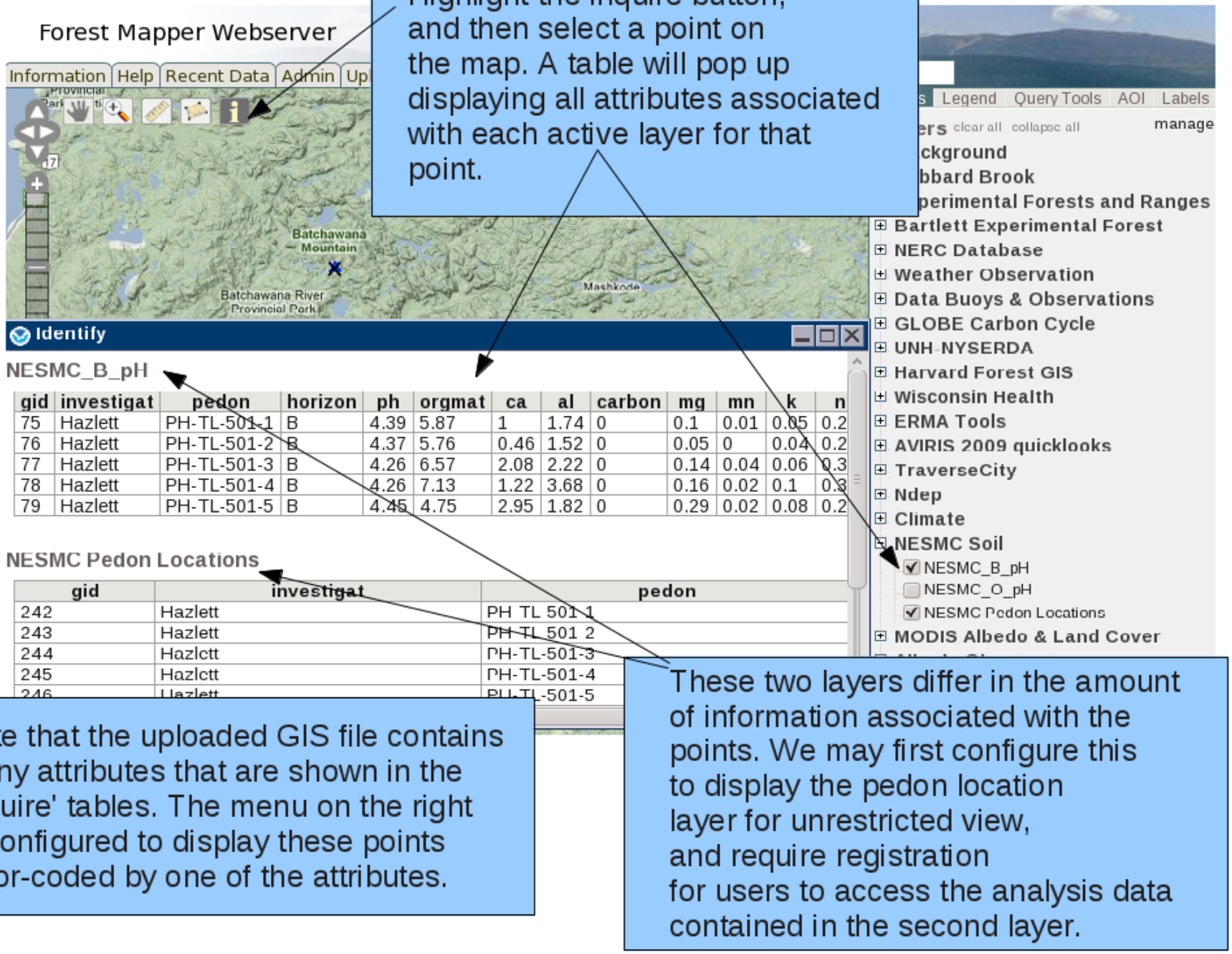
Selected variables extracted from the datasets and combined into a common format through a single workflow (using R, ShapeLib tools, and shell script commands)

The same workflow script transforms these data into gis shapefiles





http://forest-mapper.sr.unh.edu
Click on Legend To view values
NESMC Pedon Shapefile
Bailey
Hazlett
Lawrence
Pontius
Forest Mapper Webserver
Information
Help
Recent Data
Admin
Upload
Find
Layers
Legend
Query Tools
AOI
Labels
Zoom, pan, query
Select background image/map
Layers clear all collapse all manage
Background
Google Streets
Google Physical
Google Hybrid
Google Satellite
Open Street Maps (local)
Open Street Maps
None
Hubbard Brook
Experimental Forests and Ranges
Bartlett Experimental Forest
NERC Database
Weather Observation
Data Buoys & Observations
GLOBE Carbon Cycle
UNH-NYSERDA
Harvard Forest GIS
Wisconsin Health
ERMA Tools
AVIRIS 2009 quicklooks
TraverseCity
Ndep
Climate
NESMC Soil
NESMC_B_pH
NESMC_O_pH
NESMC Pedon Shapefile
Any shapefile that has been created (or database table), can be uploaded to mapserver for public or password access. Access is highly configurable; you can allow users to view just positional information, or the actual underlying data.
Select layers for display
Right click to See metadata, Zoom to extent, raise/lower layer


Forest Mapper Webserver
Information
Help
Recent Data
Admin
Up
Batchawana Mountain
Batchawana River Provincial Park
Mashkode
Identify
NESMC_B_pH
gid investigat pedon horizon ph orgmat ca al carbon mg mn k n
75 Hazlett PH-TL-501-1 B 4.39 5.87 1 1.74 0 0.1 0.01 0.05 0.2
76 Hazlett PH-TL-501-2 B 4.37 5.76 0.46 1.52 0 0.05 0 0.04 0.2
77 Hazlett PH-TL-501-3 B 4.26 6.57 2.08 2.22 0 0.14 0.04 0.06 0.3
78 Hazlett PH-TL-501-4 B 4.26 7.13 1.22 3.68 0 0.16 0.02 0.1 0.3
79 Hazlett PH-TL-501-5 B 4.45 4.75 2.95 1.82 0 0.29 0.02 0.08 0.2
NESMC Pedon Locations
gid investigat pedon
242 Hazlett PH TL 501 1
243 Hazlett PH TL 501 2
244 Hazlett PH-TL-501-3
245 Hazlett PH-TL-501-4
246 Hazlett PH-TL-501-5
Legend
Query Tools
AOI
Labels
clear all
collapse all
manage
Bartlett Experimental Forest
NERC Database
Weather Observation
Data Buoys & Observations
GLOBE Carbon Cycle
UNH-NYSERDA
Harvard Forest GIS
Wisconsin Health
ERMA Tools
AVIRIS 2009 quicklooks
TraverseCity
Ndep
Climate
NESMC Soil
NESMC_B_pH
NESMC_O_pH
NESMC Pedon Locations
MODIS Albedo & Land Cover
Highlight the inquire button, and then select a point on the map. A table will pop up displaying all attributes associated with each active layer for that point.
These two layers differ in the amount of information associated with the points. We may first configure this to display the pedon location layer for unrestricted view, and require registration for users to access the analysis data contained in the second layer.
Note that the uploaded GIS file contains many attributes that are shown in the 'inquire' tables. The menu on the right is configured to display these points color-coded by one of the attributes.

Implications and applications in the Northern Forest region

The database can be used for:

- Promotion of communication and collaboration among soils researchers in the Northern Forest region.
- Identification of data gaps and monitoring needs.
- Promotion of soil monitoring and soil re-sampling as methods of assessment of response of ecosystems to disturbance and change.

Future directions

- Database ready to grow by accepting further data contributions.
- Build metadata so the database is discoverable through search and browse functionality. (Metadata will include investigator contact information and data acccess policies).
- User registration.
- Create a NESMC URL and branding to promote project identity and ease of discovery and access.

List of products

- On-line database: http://forest-mapper.sr.unh.edu
- Peer review publication: Gregory B. Lawrence, Ivan J. Fernandez, Daniel deB. Richter, Donald S. Ross, Paul W. Hazlett, Scott W. Bailey, Rock Oiumet, Richard A.F. Warby, Arthur H. Johnson, Henry Lin, James M. Kaste, Andrei G. Lapenis, Timothy J. Sullivan. 2013. **Measuring environmental change in forest ecosystems by repeated soil sampling: a North American perspective**. Journal of Environmental Quality. *In press.*