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Cooperative Soil Science

2018 Highlights

NCSS National Cooperative Soil Survey

Wisconsin
Natural
Resources
Conservation
Service

wi.nrcs.usda.gov/

Helping People Help the Land

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Preface

Helping People Understand Soils

Soils play a key role in human life by providing most of the world's food. Soils also play a critical role in water quality and support an array of non-food products. There will always be a need for soil scientists to collect and improve data, provide technical soil services and educate landowners and partners on soil practices. Soil scientists must have broad knowledge of many different disciplines, such as ecology, geology, agronomy, forestry, GIS, data science, and more. Soil science has traditionally included soil formation; physical, chemical, biological, and fertility properties; and relation to landform and landscapes. As populations increase and climates change, a heavy strain is placed on agriculture. Soils are the backbone of agriculture, and soil quality is critical to our future. Soil quality, soil ecology, and the importance of organic matter management are crucial in managing fertility and lessening drought impact. Soil science needs to adapt to the changing times and expand beyond primarily survey activities. Data science, geospatial analytics, and new delivery tools will be the key to a successful soil science future.

Wisconsin soils information and technology is a joint effort of the National Cooperative Soil Survey (NCSS) and Wisconsin Cooperative Soil Survey (WCSS). Both initiatives include Federal and State agencies, universities, and professional societies to deliver the best science-based soil information to the public.

This partnership works to cooperatively investigate, inventory, document, classify, interpret, disseminate, and publish information about soils. The Cooperative Soil Science program of Wisconsin outlines the strategy for soil science progress in Wisconsin, delivery of data and products, and delivery of soils assistance. The purpose of the WCSS is to bring our cooperators and other soil science supporters up to date on soils activities in the State and to collaborate on future projects. The need to collaborate is driven by changes in science, technology, fiscal conditions, and professional culture. The Cooperative Soil Science Program acknowledges the importance and challenges of generational staffing turnover, changing societal needs, and unique ecological conditions. Team members see this strategy as a pragmatic path towards increasing the sustainability of the WCSS and the science of soils.

Demand and user volume for technical soils information is growing. WCSS looks at the agricultural community as a critical user base but also recognizes many other user groups who utilize soils information. Needs are constantly changing at the local and national scale. It is critical that national NCSS staff and WCSS staff band together and share resources and information to enable our users to have the ability to develop effective models at State, national and global scales. NCSS and WCSS strive to address State, national, and global needs of new customers. As needs change, which data we collect and how we collect it will change. The information we collected and knew 30 or 100 years ago is different than what we collect and know today. The world is not flat, and data is not static. If we saw a doctor today, we would not request treatment, prescriptions, or vaccines from 30 years ago; we would request the most modern treatment from the best science put forward. The same goes with soil information, or any other science as it continually evolves. Data is continually being improved, enhanced, and maintained.

FY 2018 Priorities

Soil Science Division

The Soil Science Division (SSD) supports the NRCS mission by delivering vital information and expertise to agency staff, partners, and the public in innovative ways. The division's priorities for FY 2018 will enable it to continue that service.

Soil and Ecological Site Inventory

Initial Soil Inventory

Accelerate the foundational (initial) soil inventory on all lands, including private, Tribal, and Federal lands

The initial soil inventory is the foundation upon which all subsequent soils products and information are developed, maintained, and interpreted. As of 2017, an initial survey had been completed on more than 80 percent of the United States, including 92 percent of non-Federal lands. Detailed soil survey maps and data are accessible through Web Soil Survey for these areas.

More than 450 million acres of soils have not yet been inventoried. Over 70 percent of this acreage, 330 million acres, is on Federal lands. The remaining 120 million acres include conservation-priority areas, such as Tribal lands in Alaska. The Soil Science Division, in collaboration with National Cooperative Soil Survey (NCSS) partners and State Conservationists, is implementing a plan to accelerate the inventory of the remaining private and Tribal lands. The plan proposes completion of the foundational soil inventory by 2026. Priority will be given to Tribal and private lands on which conservation technical assistance and farm bill program delivery are NRCS priorities.

The initial inventory is the basis for customers to ask questions, request existing data, and seek current soil interpretations. It is also the basis for development of new data and interpretations. It is needed in the development of conservation programs and provides the scientific basis to address soil health issues and other emerging land use concerns.

Ecological Sites

Provide ecological site products to broaden conservation applications and training in collaboration with national, center, and State technical staff and Federal partners

Ecological site inventory, state-and-transition models, and ecological site descriptions are critical for selecting, implementing, and assessing conservation practices; recognizing thresholds of irreversible change in managed ecosystems; and estimating potentials for soil carbon sequestration. The use of ecological site information for conservation planning is an application of existing NRCS guidelines. The first step of this use is selecting the ecological site and ecological state; the next step is defining conservation goals and objectives; the third step is selecting appropriate conservation practices; and the fourth step is monitoring the impact of the practices to adjust future management decisions. Long-range and project plans for soil survey will include protocols for the definition, inventory, and description of ecological sites. Provisional ecological sites are planned to be available for the continental United States by 2020 and for the entire country by 2025.

Dynamic Soil Properties

Accelerate the collection of dynamic soil property (DSP) data

Dynamic soil properties, which are those properties that change with land use and management, enhance soil survey products. Dynamic soil properties are used to frame, measure, and predict the response of soils to disturbances caused by human and nonhuman factors. Dynamic soil properties link soil inventories—as collected by traditional soil survey methods—to advancing areas of soil health, conservation, and management practices. Potential levels of DSPs are determined by inherent soil properties, but a range of actual observed values are possible. The range can depend on land use, land cover, management practices, and individual field conditions. Links can be made between ecological sites, interpretive soil groups (such as forage suitability groups), and DSP values in both absolute and relative terms. There is an increasing demand for dynamic soil property data to inform management activities, to better assess the impact of those activities (ecosystem services), and to provide more detailed and site-specific information for model development and for applications. Collection of DSP data will be integrated into all projects and will become a routine component of soil inventory.

VISION

A society that values soil as essential to life.

MISSION

Provide scientifically based soil and ecosystem information to manage natural resources

Major Land Resource Area Updates

Accelerate field activities of major land resource area (MLRA) updates in order to develop a seamless coverage of soils information across the Nation

Updating soil survey information by MLRA ensures that current, accurate information is available to meet the needs of the majority of users and is delivered in a timely manner. Project plans are coordinated across the existing (i.e., "traditional" or "non-MLRA") soil survey area boundaries and follow natural landforms. The MLRA process facilitates mapping, interpreting, and delivering seamless soils information across broad geographical areas that have common resource values, land uses, and management concerns. The MLRA update process is driven by the outcome of previous and ongoing Soil Data Join Recorrelation (SDJR) activities as well as by collaboration with NCSS partners. NCSS partners will be involved in all aspects of the planning and field work processes through their involvement on technical teams, management teams, and boards of advisors.

Technical Soil Services

Assist States in providing science-based technical soil services to enhance and support soil health activities, conservation planning, and program delivery and to maintain and expand our partnerships with university cooperators and external customers

The Soil Science Division (SSD) is committed to assisting the State Conservationists through State soil scientists. The SSD provides assistance to improve the quality and quantity of technical soil services that support agency priorities. The SSD, the Ecological Sciences Division, and the Soil Health Division will continue to work in partnership with States to provide science-based soil property information and applications. The SSD will continue to collaborate with State soil scientists to promote the application of soils information in resource assessment for conservation planning, onsite investigations to support conservation practice design, assessments of soil health and dynamic soil properties, identification of hydric soils for wetland determinations, and other conservation technical assistance. The SSD is also committed to assisting States as they help customers understand and properly use the soil survey, provide customers with predictions and interpretations about the behavior of soil, and offer help to traditional, nontraditional, and underserved customers through soil workshops, training sessions, and volunteer opportunities. These services will be beneficial for assisting in critical conservation areas and for broadening the conservation partnership.

National Cooperative Soil Survey

Strengthen the National Cooperative Soil Survey (NCSS) through increased transparency and collaboration with internal and external partners

The strength of the NCSS derives from collaboration between NCSS partners—Federal, State, and local government agencies, universities, and the private sector—to achieve common goals in advancing soil science. The Soil Science Division will work through State Conservationists and State soil scientists to strengthen communication lines among NCSS partners. The SSD will promote agency priorities in soil health, conservation initiatives, and conservation planning to landowners. The SSD will encourage NCSS partners to actively participate in regional and national conferences and to serve in subject matter training cadres.

What's Ahead for Soil Survey

Digital Soil Mapping

In the past, soil survey mapped by vector polygons, but now software technology and new data provide soil scientists the opportunity to map at a greater level of detail. The following four articles discuss the next generation of potential soil survey products to provide additional information to our users; for example yield monitor data used in precision agriculture.

These tools allow soil scientists to represent the distribution of soils with greater detail than traditional soil maps. Even with these new products, an onsite investigation will always be needed. However, having a soil map at a greater detail can streamline the conservation planning process. Different soils can be represented individually instead of being packaged together in a map unit. This will make working with the data much easier.

- Digital Soil Mapping
- Disaggregation "Refinement"
- Soil Properties in RASTER form in predefined depths

Digital Soil Mapping Quantifying the Soil-Landscape Paradigm

By Jay Skovlin, NRCS

Berman Hudson astutely categorized soil survey as a scientific program based on the application of the soil-landscape paradigm (Hudson, 1992). So what is the soil-landscape paradigm and how did Hudson define it?

Hudson's soil-landscape paradigm was his summary of a deterministic approach to mapping soils in which the interaction of soil-forming factors, on a given landscape, results in distinct and repeating "soil-landscape units." Underpinning the soil-landscape paradigm is an equally powerful paradigm, the theory of soil-forming factors, initially conceived by Dokuchaeiv (Glinka, 1927) and Hilgard (Jenny, 1961). The work of Hans Jenny (1941) further articulated and validated the soil-forming factors of climate, living organisms, relief, parent material, and time, expressed by the acronym CLORPT, which remains a seminal concept of pedology. Over the last century of soil survey, the soil-landscape paradigm arose as the dominant operative approach validated by decades of repeated observation of soils on the landscape. Hudson's soil-landscape paradigm has since been modified by additional process models and has evolved into the soil-geomorphic approach emphasized today within the Natural Resources Conservation Service (NRCS) and the National Cooperative Soil Survey (NCSS)(Wysocki and Schoeneberger, 2000).

Despite the benefits of operating under such a useful construct as the soil landscape paradigm, we continue to be hampered by its weaknesses. This paradigm is overly dependent on tacit knowledge rather than clearly documented and described evidence and rationale supporting the landscape models learned through experience (Ditzler, 2003). The full knowledge and understanding of the soil scientist who produces the map cannot be easily articulated and commonly cannot be adequately captured in the actual product. Furthermore, the tacit knowledge accumulated in the process of producing a soil survey is difficult to transfer even among soil scientists. Confounding the difficulty of the transfer of tacit knowledge is the fact that in the past the documentation collected during the creation of a soil survey was considered less important than the finished product and thus important reference data were often lost or destroyed. As a result, important knowledge of the spatial relationships of the soil landscape that is gained in applying the soil-landscape paradigm is not explicitly distilled and remains embedded in categorical maps which do not convey the complexity of the information in an efficient and transparent manner (Bui, 2004). As noted by Hudson (1992), the cumulative result is that the tacit knowledge gained over time, through decades of soil survey efforts, has not been explained and summarized in language so that the insights from this vast trove of knowledge can be integrated into the soil science literature.

As a field soil scientist, I see DSM playing an important role in the capture and communication of tacit knowledge. Most DSM methods aim to quantify aspects of the soil-landscape paradigm. They can be used to apply the concepts we have developed from our tacit knowledge and help us capture that information in the more specific spatial representation of spatial models and raster maps. Although DSM methods attempt to quantify soil relationships and properties using the often unfamiliar vocabulary of statistics, these methods and models generally reflect a digital version of the thought process that occurs in the mind of any soil scientist engaged in the enterprise of mapping soils. Using multiple input layers derived from digital terrain models, categorical data (such as geologic or vegetation data), remote sensing data, and direct observations, the analyst looks for spatial relationships and assesses the strength of relationships between these environmental covariates and the variable of interest. Only in the last several years has the potential in computing power combined with advances in GIS and the availability of geostatistical methods made these more computationally intensive approaches possible (McBratney et al., 2003).

In recent years, the soil survey program has made great strides in converting analog processes of product delivery to digital processes, such as the development of the Soil Data Mart and Web Soil Survey. The release of NASIS 6.0 (Soil Database) and migration to the Microsoft SQL server database platform puts the soil survey program on a solid footing for future advances. In spite of these gains, however, our product development process remains insular and focused on vector mapping products. Digitally produced soil maps appear to have a distinct advantage over traditionally produced soil survey maps with respect to the ability to apply a consistent methodology, assess the level of accuracy, and represent different kinds and amounts of detail (Hempel et al., 2008).

Another important idea comes from Hudson's use of the term "set" (Hanson, 1969), which involves the process of preparing a person to see new phenomena and to see it in a certain way. The idea is that what one can observe and learn depends largely on what one has been prepared to observe and learn. So how can we, as NCSS soil scientists, "set" ourselves to learn more about and be more receptive to applying DSM methods? I would argue that as field soil scientists, trained in seeing the world through the soil-landscape paradigm, we are already primed to understand the appropriate application of DSM methods to soil survey. We as soil scientists need to learn more about DSM methods to ensure that they are prudently applied to the soil landscape. I would challenge each one of us, whatever our experience, to see and understand our work from a new perspective. Many of the changes that have occurred in how we accomplish the work of soil survey in the last 10 years represent a positive shift in thinking and agency culture. NRCS support of such projects as the Global Soil Map Initiative (www.globalsoilmap.net) will drive the broad application of DSM methods and the development of raster products. As products from this and other initiatives become available, the global demand for raster soil survey products will increase (Cook et al., 2008). We should work to understand where we fit within the framework of these efforts and position ourselves to make more direct contributions to it. Ultimately, it will take the ability to collaborate more freely across disciplines, agencies, countries, and States and among soil survey offices to form working groups which will focus effort and provide leadership on methods and standards for raster products. Many decisions will need to be made as to how these raster products will be delivered within the context of the existing soil survey products.

Soil scientists are as different in their opinions as the soils they find on the landscape. Attitudes and opinions about DSM methods are wide ranging, but often there is a sense of negativity about modeling and computational approaches. These opinions seem to stem from our extreme reliance on our hard-earned tacit knowledge of local and regional soil landscapes and our reluctance to admit that useful knowledge of soils could be gained by investigating soils any other way. The gestalt shift (transformational shift) in thinking and observation which allows a new soil scientist to dissect the landscape, drape soil-forming factors on it, and "see" the spatial distribution of the resulting soil families is a deeply ingrained rite of passage within our profession. In reality, DSM methods do nothing to undermine or threaten these traditions. In contrast, DSM methods hold great potential as a set of additional tools which can help us further validate our tacit knowledge and capture the results in more spatially explicit products. Now more than ever, the community of NCSS soil scientists needs to take an active role in how DSM methods are applied to our soils data. We know our data and how it was developed—its strengths and limitations. If we continue to sit back, we will find ourselves in the unenviable position of reacting to methods and products that others will develop for us (Arnold and Wilding, 1991).

Options for Communicating Soils Knowledge

By Tom D'avello, David Zimmerman and Susann Kienast-Brown; and Jim Thompson Ph.D., West Virginia University

Background

During the first 75 to 100 years of the soil survey program, the vector data model was the most practical means of spatial representation. It remained so even after the initial advent of geographic information system (GIS) technologies. The earliest GIS did not support the vector data model. For these early systems, the raster data format was the sole option for representing geographic features. Although some efforts were made to produce soil maps in a raster format, they were only produced as a cartographic exercise. The potential for computer modeling of soil data had yet to be realized, and thus the raster data format did not offer an immediate advantage for use in soil survey.

As GIS software progressed to accommodate vector representation, it was readily adopted to reproduce and develop vector soil maps that previously had been inked on hard-copy media. A humorous quip used to differentiate the two dominant data types was "raster is faster, but vector is corrector." This phrase mainly referred to the fact that the vector data model could more accurately represent specific boundaries but required the increased cost of data input, management, and processing time. However, for soil maps intended to convey data that varies continuously across the landscape, the vector data model (i) has inherent cartographic limits, (ii) conveys information in a limited and commonly unrealistic manner, and (iii) demands intensive management to maintain topology in a GIS. Given the advances in geospatial technologies and the limitations of the vector data model, recent attention has been devoted to adopting ways of representing our soil knowledge using the raster data model.

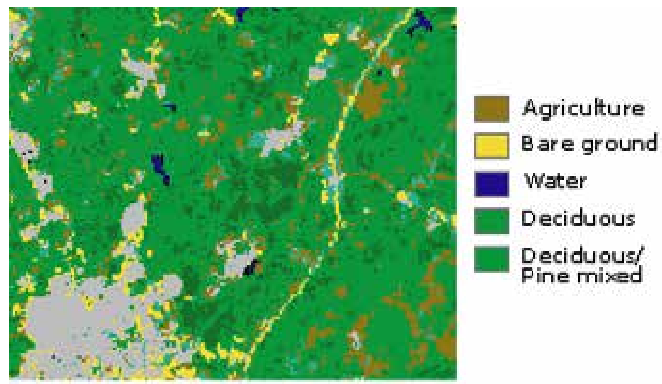
So, what does the raster data format offer us that the vector model lacks?

The Raster Format

A raster is "a spatial data model that defines space as an array of equally sized cells arranged in rows and columns and composed of single or multiple bands. Each cell contains an attribute value with geographic coordinates contained in the ordering of the matrix" (Summer and Wade, 2006) (below).

The size of the cells, known as the spatial resolution, essentially eliminates the cartographic limits of the vector model, i.e., small areas of soils can be represented if desired. Without the constraints of scale-based cartographic limits, many components and small areas of map units that are currently only listed as minor components or inclusions in the database could be identified on the landscape. Showing where these soils occur is a great enhancement to our current model, which just lists or describes where they occur.

One objection to presenting the greater spatial detail is the possibility of misunderstanding the degree of confidence in the detailed representation. All soil map unit delineations, however, are predictions. The small patches that are likely in a raster product are simply predictions that are not cartographically constrained. Raster-driven methods have an important advantage that addresses this issue: the option to calculate uncertainty and provide this information for soil classes or properties.



Graphic example of a raster.

Raster data can be stored and archived with ease. It allows model inputs and outputs to be consistently maintained during model development and accessed after project completion. If data are properly archived, model results can also be traced back to model inputs and parameters. This benefit of the raster data format adds an element of transparency into map building.

Restricting the soil survey product to one data model (vector) limits our ability to fully represent and convey our soil knowledge to users. If multiple product lines and data models are developed and provided, a wider array of users and user needs could be satisfied.

Raster Opportunities

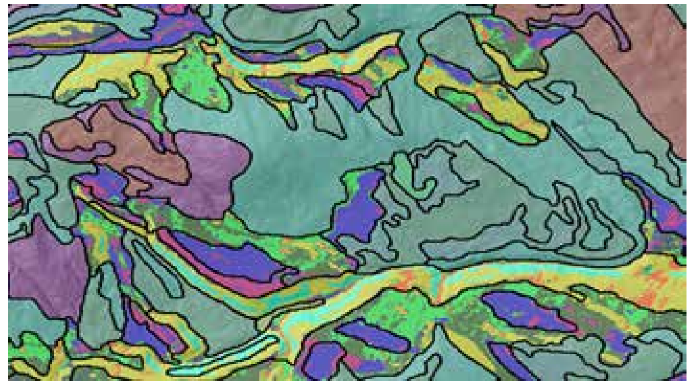
The use of geospatial techniques for mapping soils is broadly covered by the term "digital soil mapping" (DSM) (McBratney et al., 2003). Such use has progressed as soil scientists have adopted the latest tools to assist in the mapping process. The process of making an inference about a landscape segment (e.g., a soil map unit) from a few point-based observations using the operative soil-forming factors is named "modeling." Whether the soil map is produced using nothing but a bucket auger and an aerial photo or using geospatial software, the process is a modeling operation. The use of DSM methods will increase over time and will eventually cease to be considered distinct, novel techniques. A common component of DSM methods are raster data inputs referenced by various algorithms. From raster inputs come raster outputs.

gSSURGO hybrid—One option for producing a raster-based soil survey starts with enhancements to a currently delivered product: gSSURGO, which is a 10-meter resolution raster version of SSURGO. This product is essentially a vector-to-raster format conversion. The footprint of gSSURGO could serve as a template (i.e., snap raster) for raster-based data produced for initial and update soil survey projects. The final products would be directly mosaicked into the gSSURGO dataset. This work flow would require virtually no changes to our current database and delivery systems for gSSURGO. One major change, however, would be the use of the raster output as the final spatial representation rather than as an interim step in the development of a vector product.

An example of a gSSURGO hybrid is the raster survey of Essex County, Vermont, which is available from the Geospatial Data Gateway. The survey is a detailed raster product developed during an initial soil survey using readily available GIS tools. The product is inclusive of one catena formed in a common parent material and was developed using knowledge-based modeling techniques. SSURGO on the following page shows an area of the Essex County raster soil survey mosaicked into gSSURGO. Using contemporary methods, the process of updating by catena or common physiographic region would yield data similar to the Essex County raster. Any soil survey product resulting from an MLRA update or initial soil survey project could be mosaicked into gSSURGO. A "disaggregated spatial representation" may be one way to describe the resulting product for MLRA update projects (Nauman and Thompson, 2014).

A product mosaicked into gSSURGO enables the delivery of a spatially explicit representation and interpretation of individual soil components, something not possible with the vector model. The product accommodates the delivery of legacy survey data. It also allows for rapid updates that might focus on areas of less intense mapping or areas where the needs for use and management changed after initial mapping. The product, which includes data developed at multiple resolutions and from different processes, is akin to the USGS National Elevation Dataset best available data set. It is also akin to some of the national NAIP imagery that has fine resolution in urban and high-use areas and coarser resolution in more remote areas. Educational resources would need to be developed to explain the varying levels of detail and the proper interpretation and use of the data. This option would require very little adjustment to our current system because the database needs are identical and the spatial data manipulations are routine.

Inclusion of non-soil data—Currently, our database contains a multitude of non-soil data, such as climatic, terrain, and land cover variables used to generate interpretations. The

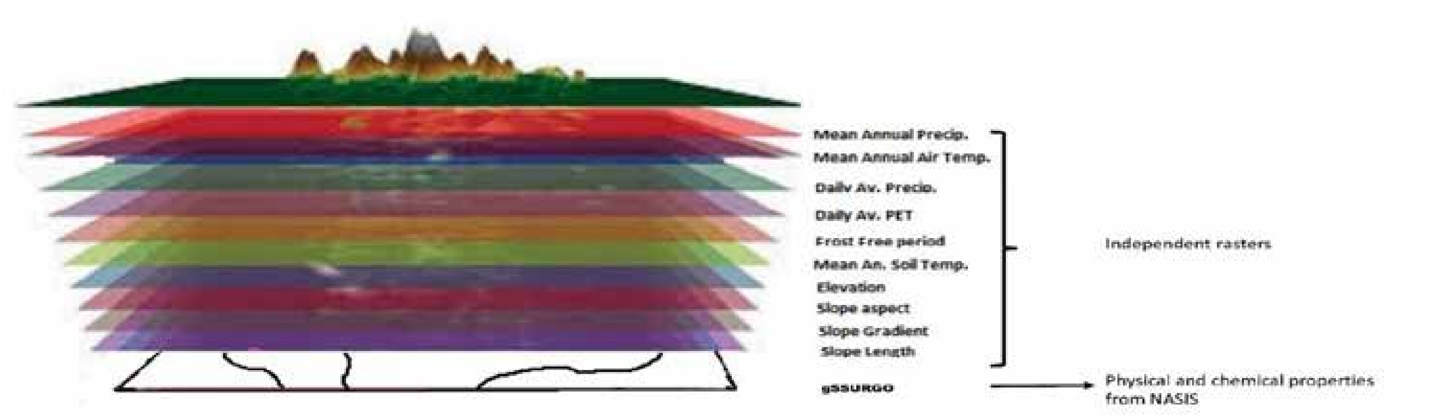


SSURGO vector lines overlaid with gSSURGO. The detailed areas represent the components of the modeled catena of Essex County, Vermont.

inclusion of these variables in a relational database associated with polygonal map units is a relic of the pre-GIS period in which the database originated. Populating this data is time consuming and prone to error. In addition, a database is inadequate for representing geographic phenomenon, such as multi-modal distributions (e.g. slope aspect), or continuous data, such as mean annual precipitation or slope gradient. The capability to utilize separate raster datasets representing pertinent non-soil variables for developing interpretations (below) would improve resulting interpretations and reduce the time and effort required to populate these non-soil data elements. Many of these non-soil environmental layers are produced and maintained by other credible agencies and organizations and could easily be adopted as part of an official raster data set.

Multidimensional soil properties—The most comprehensive option for soils raster data would be the complete raster representation of all properties used for interpretations maintained in a multidimensional dataset (Xu et al., 2016). Multidimensional data is captured at multiple times or depths and typically stored in netCDF, GRIB, or HDF format. Each file contains one or multiple variables, and each variable is a multidimensional array that represents data at a given time or a given vertical dimension. For example, a netCDF file can store temperature, humidity, and wind-speed for every month from 2010 to 2014 and at each elevation of 0, 1, and 10 meters above mean sea level (ESRI, 2017). For soil survey, this format could store soil temperature, soil moisture content, and other dynamic soil properties at multiple soil depths on daily, monthly, and annual steps.

The GlobalSoilMap project (IUSS, 2017; Hartemink et al., 2010) has specifications for a minimal dataset of physical and chemical soil properties at predefined depths. These data could be coupled with the multitude of non-soil environmental variables, including climatic, terrain, land cover, and land use treatments, to support interpretations and simulation modeling. The figure on the following page is an example of how the data might be organized and what this data type would allow. The use of multidimensional data formats would be new to the NCSS, but many organizations have been using multidimensional data in an established,



Non-soil raster layers used in concert with soils data in a raster format for the development of interpretations.

operational manner. Such organizations could serve as excellent examples and references (The HDF Group, 2006-2016).

The raster format greatly expands the capabilities of conveying our knowledge and offers the possibility of providing a relevant, effective, flexible, and interpretable product (Grunwald et al., 2011). By providing raster data as an additional soil information product, we could pursue work in a manner that is more compatible with current earth science data technologies and increase our capacity to develop and deliver significantly updated soils data. These options should be pursued and developed not as replacements to SSURGO, but as additional complementary soil information products that expand our ability to communicate our knowledge of the soil system to a variety of modern soil information users.

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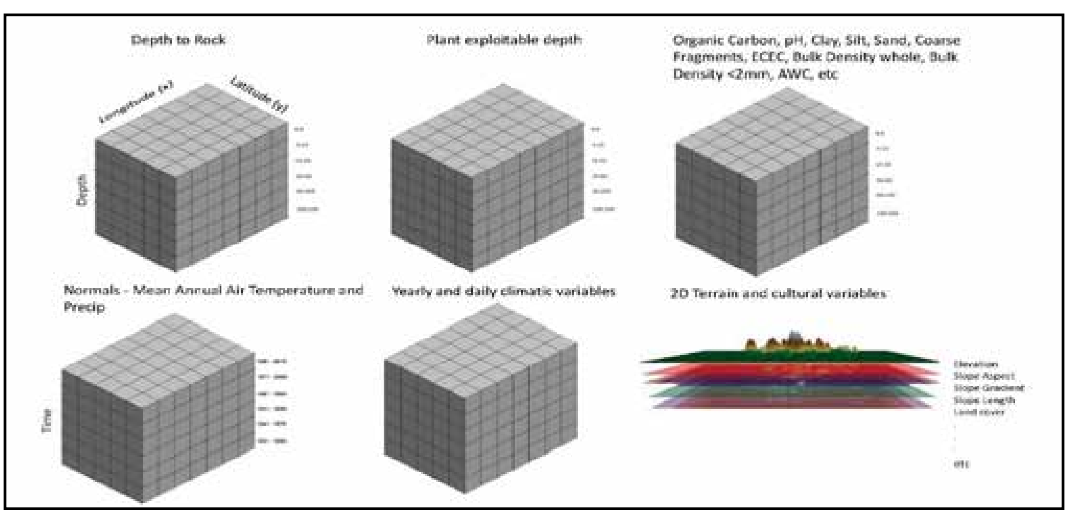


Multidimensional data: *Data over an area varying with location, time, and depth.*

Midwest Soil Survey Disaggregation "SSURGO Refinement" Investigation for Sable and Ipava Soil Map Units

By Tom D'avello, R. Tegeler, B. Teater and D. Baumgartner; NRCS

Background

Midwest Soil Survey Disaggregation "SSURGO Refinement" Investigation for Sable and Ipava Soil Map UnitsDisaggregation is a way to refine soil maps by showing the other soils that occur within soil map units.

Soil map units consist of one or more components. Consociations are named for the dominant soil comprising the map unit. Associations and complexes are map units consisting of two or more components. The components in complexes cannot be separately mapped at the scale of mapping. The components in associations can be separated at the scale of mapping, but use and management does not warrant their separation. Identification and spatial representation of major components within map units is desired for modern use and interpretation of soil maps. Disaggregation is the term that has been used to identify and delineate components within map units.

Soil map units in most of the central States are dominated by consociations. Illinois is representative of areas dominated by row-crop agriculture, with large areas of gently sloping terrain. The tools available while the modern soil survey was being completed in the USA consisted primarily of aerial photographs with stereo coverage, and topographic quadrangles. Digital elevation models were typically not used as they were unavailable or of insufficient resolution to adequately define slopes and landforms as required for the surveys.

The extent of Sable is shown in figure 1 and occurs on 900,207 acres in Illinois with a limited occurrence in Wisconsin.

Figure 1.—Extent of Sable and Ipava by MLRA.

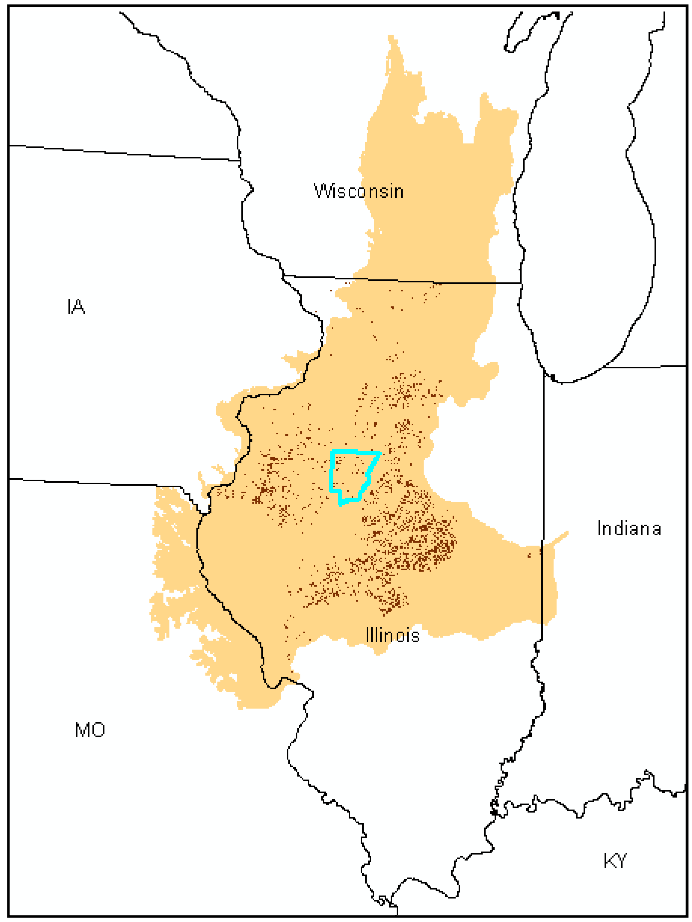


Figure 2.—Current extent of the Sable soil series shown in dark brown according to the January, 2012, SSURGO data, with corresponding MLRAs in tan and Peoria County study area shown in blue.

The availability of high resolution elevation data derived from LiDAR provides the potential for further refinement of soil maps. Peoria County, Illinois has 3m DEMs, derived from LiDAR, available through the USGS. This study will investigate the potential for identification of ponded and non-ponded components of Sable and Ipava map units using the high resolution DEMs.

Project Area

The project area is within MLRAs 95B, 108A, 108B, 108C and 115.

Peoria County, Illinois is located in the Central Feed Grains and Livestock Land Resource Region, in MLRA 108B and 115C. The project area is within MLRA 108B, Illinois and Iowa Deep Loess and Drift, East Central Part, within the headwaters of hydrologic unit 071300050602 (Fig. 2).

The project area, outlined in dark blue, is 7,105 acres in size. The area outlined in red in figure 3 identifies approximately 2,300 acres available for field investigation and verification. The soil series mapped within the watershed and their acreage for the extent of the delineations touching the watershed are listed in the table.

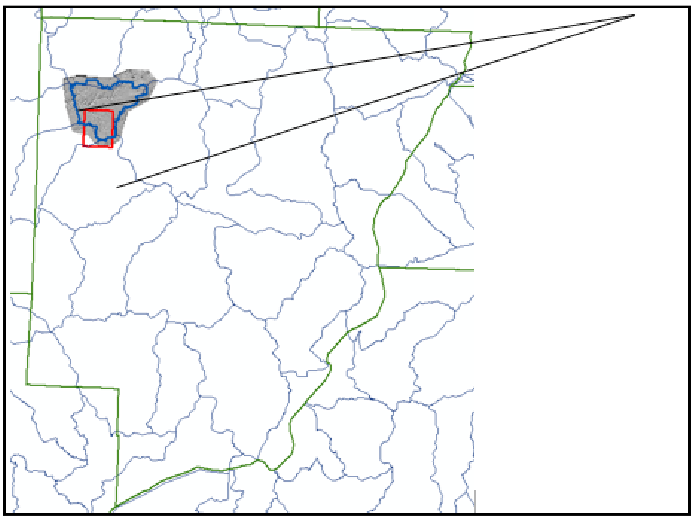


Figure 3.—Project area location in Peoria County, Illinois.

Series	Acres	Percent
Sawmill	29	0.1
Proctor	5	0.02
Assumption	52	0.2
Tama	1176	5
Ipava	17852	73
Denny	14	0.05
Lawson	141	0.6
Elkhart	1428	6
Sable	3868	16

Acreage of soil series within and touching project area.

Disaggregation Investigation for Sable Soil Map Units

Project Goals

Sable map units have traditionally been considered ponded, but recent discussions have questioned this assumption. High resolution digital elevation models may provide a tool to identify topographic features like depression or talfs, which would be likely to pond.

The goal will be to test techniques that identify ponded components in Sable delineations in the study area. GIS tools that identify sinks will be used and the features identified and described as depressions in this document are predicted to be ponded components in the map units. The results will be applied to the county, with the intention of application to the entire extent of Sable. The availability of LiDAR will hinder that effort for the short-term, but the Peoria County investigation will serve as an example for extending the concept to a broader area. A paired study will be performed using 10 meter USGS digital elevation models to compare the effects of resolution on model performance.

Soil-Landscape Relationships of Sable

Sable is a fine-silty, mixed, superactive, mesic Typic Endoaquolls that consists of very deep, poorly drained, moderately permeable soils formed in loess on nearly level broad summits of moraines and stream terraces. Slope ranges from 0 to 2 percent. Mean annual temperature ranges from 7.8 to 12.2 degrees C (46 to 54 degrees F)., mean annual precipitation ranges from 760 to 1020 mm (30 to 40 inches), frost free days range from 140 to 180 days, and elevation ranges from 104 to 311 meters (340 to 1020 feet) above mean sea level. Non-ponded components of Sable are present.

Graphical representations of the soil-landscape relationships are displayed in the figures 4, 5, and 6.

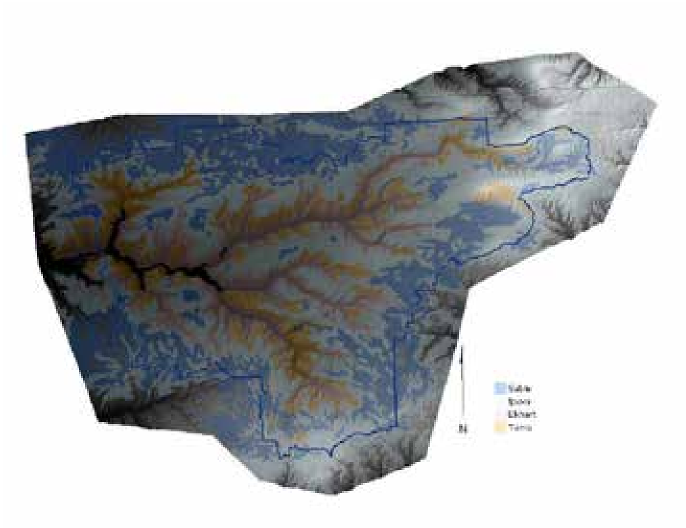


Figure 4.—Rendering of current soil landform relationships of project area.

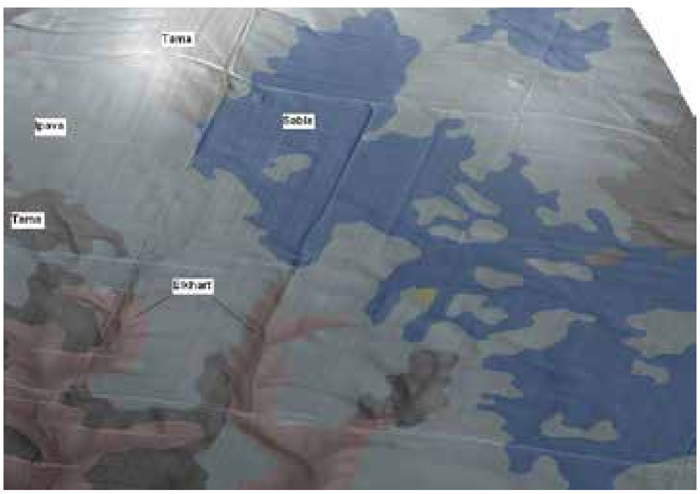


Figure 5.—Enlarged view looking east from the east-central portion of watershed.

Determination of Ponded Components

Assuming the fixed extent of existing Sable polygons will allow GIS functions to spatially depict potentially ponded and non-ponded areas and summarize them statistically. The predicted areas will be available for use by NRCS and SWCD staff to verify if ponding is present.

Two models in ArcGIS were utilized to predict ponded areas:

1) Depression depth

2) Depression cost surface

The first method identifies sinks in the DEM, and then defines the watershed of each sink, followed by zonal maximum and zonal minimum operations with the watersheds serving as the zone layer and the DEM serving as the raster value layer. Depression depth is determined by subtracting the zonal minimum from the zonal maximum. This output should be verified as some sinks identified may be anomalies in the data, rather than actual sinks.

The second model is similar, but uses the zonal fill operation to identify depressions then applies a cost distance function using slope as a cost raster. The output values increase with increasing slope and distance from depressions. The threshold value selected from the output file is dependent on the user and will need to be selected and verified with expert knowledge.

Sable units were selected from the Peoria County SSURGO dataset and saved as a separate layer. This layer was used as a mask to extract elevation data from both the 3 and 10 meter elevation data. Both models were executed using the extracted elevation data. Zonal Statistics as Table using the Sable polygons as zones was used to summarize the data for the depression depth surface.

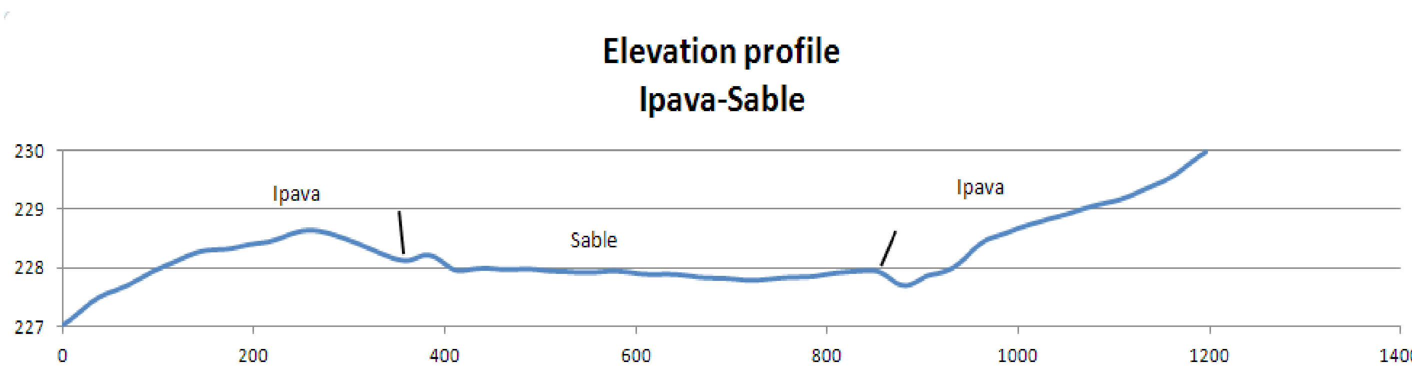


Figure 6.—Cross-section across Ipava and Sable map units.

Results

3 Meter NED

There are 15,524 acres of Sable mapped in Peoria County represented by 1009 polygons. Twenty two percent of the polygons had no identified depression surface present, while a relatively constant distribution remained as percentages of depression area increased (figure 7).

Forty one percent of the area mapped as Sable is identified as a depression based on the 3 meter DEM and the depression depth model. This is likely a liberal estimate, as some depressions are based on sinks that are data anomalies rather than actual sinks. There is no relationship between polygon size and percentage of area identified as a depression. An example of the output for depression depth is provided in the figure 8. For comparison, the depression cost surface for the same area with a Histogram Equalization stretch applied to the legend is shown in figure 9.

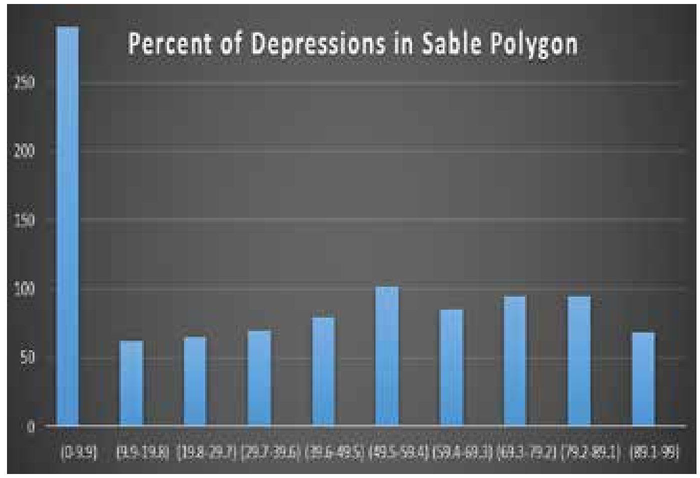


Figure 7.—Histogram of depression distribution summarized by polygon for Sable units in Peoria County, Illinois

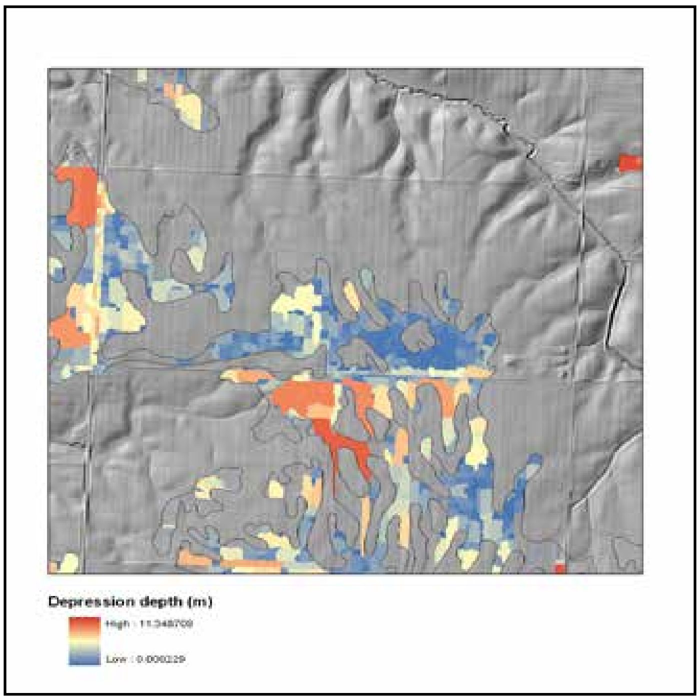


Figure 8.—Depression depth with Sable polygons draped over hillshade (5x exaggeration).

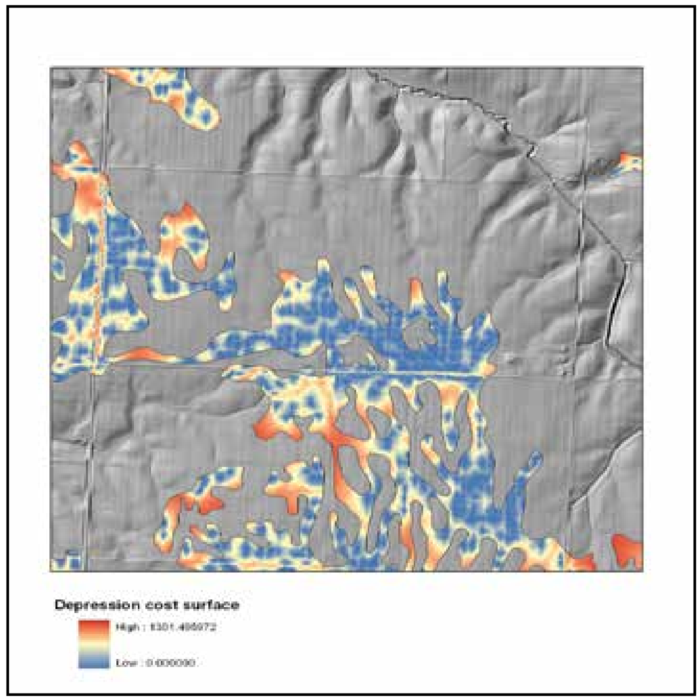


Figure 9.—Depression cost surface with Sable polygons draped over hillshade (5x exaggeration)

Both models depict similar trends in the elevation model, with the cost surface providing a more subtle gradation due to its method of derivation.

10 meter NED

An identical routine was applied to the 10 meter DEM. Results indicate 95 percent of the polygons contain no depressions compared to 22 percent for the 3 meter data. The histogram of depression composition by polygon in the figure 10 displays the similar even distribution as the 3 meter DEM.

A sample of the predicted depression depth using the 10 meter DEM is shown in figure 11.

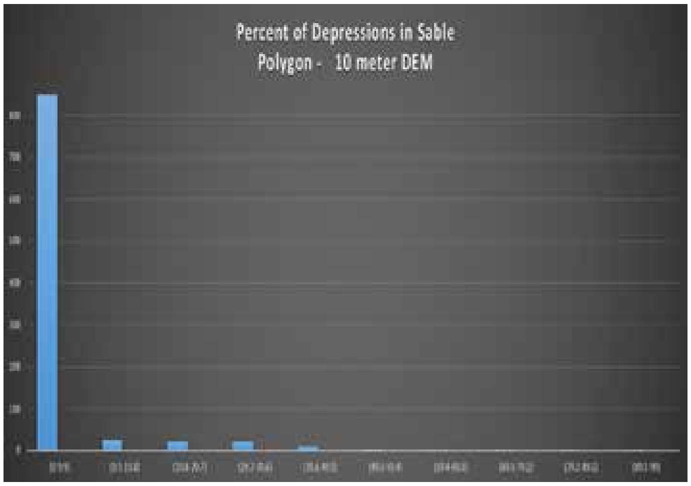


Figure 10.—Histogram of depression distribution summarized by polygon for Sable units in Peoria County, Illinois based on a 10 meter DEM.

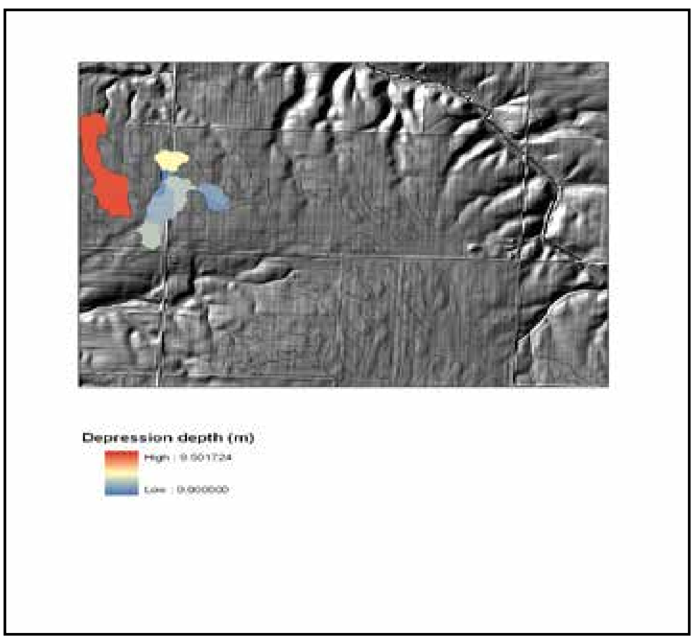


Figure 11.—Depression depth predicted using 10 meter DEMs with Sable polygons draped over hillshade (5x exaggeration)

Disaggregation Investigation for Ipava Soil Map Units (Ipava Extent)

This study will investigate the potential for identification of ponded components in Ipava map units using the high resolution DEMs.

Ipava map units are mapped in association with poorly drained Sable soils and Sable soils are a common component in Ipava map units. High resolution digital elevation models may provide a tool to identify topographic features like depression which would be likely to pond and correspond to Sable soils. The moderately well drained Buckhart soil is another common component of Ipava map units. This investigation is focused on the identification of the depressional components. GIS tools that identify sinks will be used and the features identified and described as depressions in this document are predicted to be Sable components in the Ipava map units.

Soil-Landscape Relationships of Ipava

Ipava soils are very deep, somewhat poorly drained occurring on nearly level to gently sloping broad summits on uplands. Slope gradients typically are between 1 and 3 percent and range from 0 to 5 percent. Ipava soils formed in loess. Mean annual temperature ranges from 7.8 to 13.3 degrees C (46 to 56 degrees F), mean annual precipitation ranges from 737 to 1016 mm (29 to 40 inches), frost free days range from 160 to 180 days, and elevation ranges from 107 to 396 meters (350 to 1300 feet) above sea level. The poorly drained Sable and moderately well drained Buckhart soils are common components of Ipava map units. A cross-section representations of the soil-landscape relationship is displayed in figure 12.

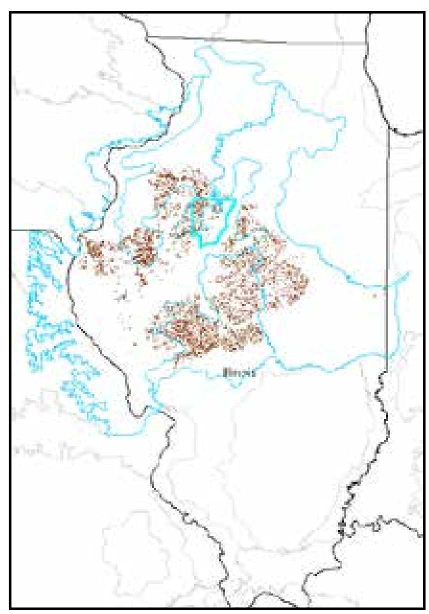


Figure 12.—Current extent of the Ipava soil series shown in dark brown according to the January, 2012, SSURGO data. Includes MLRAs 108A, 108B and 115C.

Determination of Ponded Components

Assuming the fixed extent of existing Ipava polygons will allow GIS functions to spatially depict potentially ponded areas and summarize them statistically. The predicted areas will be available for use by NRCS and SWCD staff to verify if ponding is present.

Two models in ArcGIS were utilized to predict ponded areas:

1) Depression depth

2) Depression cost surface

The first method identifies sinks in the DEM, and then defines the watershed of each sink, followed by zonal maximum and zonal minimum operations with the watersheds serving as the zone layer and the DEM serving as the raster value layer. Depression depth is determined by subtracting the zonal minimum from the zonal maximum. This output should be verified as some sinks identified may be anomalies in the data, rather than actual sinks.

The second model is similar, but uses the zonal fill operation to identify depressions then applies a cost distance function using slope as a cost raster. The output values increase with increasing slope and distance from depressions. The threshold value selected from the output file is dependent on the user and will need to be selected and verified with expert knowledge.

Ipava units and all polygons sharing borders with Ipava were selected from the Peoria County SSURGO dataset and saved as a separate layer. This layer was used as a mask to extract the 3 meter elevation data. The 10 meter DEM was not used, due to its coarse rendering of landscape features in this study with the Sable investigation. Both models were executed using the extracted elevation data. Zonal Statistics as Table using the Ipava polygons as zones was used to summarize the data for depression depth and depression cost surface. Threshold values were used for both models as a point for future testing:

Depression cost surface
0 – 0.15 m – no depression
0.15 – 1m depression
> 1 – no depression

Depression cost surface
0- 10 depression
>10 no depression

Results

There are 47,191 acres of Ipava mapped in Peoria County represented by 793 polygons. Both predictions estimated 9 percent of the area mapped as Ipava comprised of depressions. Thresholds at the lower and upper end of the depression depth distribution and upper end of the depression cost surface model were used for the Ipava estimates resulted in a more conservative estimate compared to the Sable estimates reported here, which only used a threshold for deep depressions.

An example of the output for depression depth of the Ipava units is provided in figure 13.

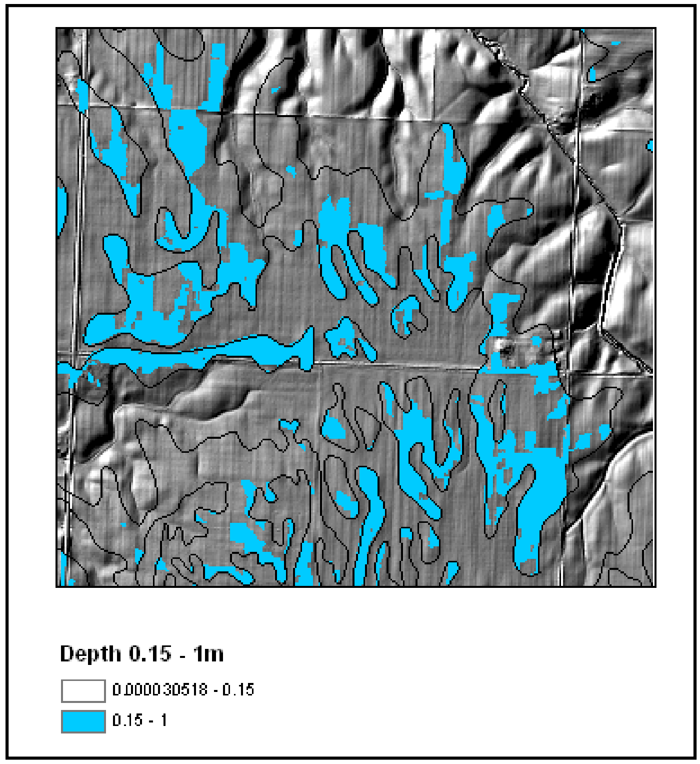


Figure 13.—Depression depth with Ipava polygons draped over hillshade (5x exaggeration)

Discussion

Sable

The depression depth model was used for identification of depressions and calculation of depression composition within Sable map units due to the objective nature of the model and the limited need for subjective interpretation of the results. High resolution elevation data derived from LiDAR will have false sinks, which results in over estimation of depression extent. Verification of the results with expert knowledge is an important step with this interpretation. A field visit to a portion of the study watershed confirmed some of the depressions identified by the model, but an exhaustive investigation should be completed to determine presence/absence of depressions. Both models are dependent on the identification of Sinks. High resolution elevation data tends to have a high number of artifacts, especially sinks. Techniques for identification of sink artifacts commonly rely on size and/or depth thresholds (Li, 2011).

The 10 meter elevation data under estimates depression extent compared to the 3 meter DEMs. This was confirmed with a field visit. The 10 meter DEMs in general have proven to be unsuitable for many soil survey applications in the gentle terrain of the Midwest.

The alternate depression cost surface should be investigated to determine how various threshold values correspond to actual depressional areas. The value of this derivative is the fine gradation of cell values compared to the broader patches defined by the depression depth model. This finer gradation may allow more accurate estimates of depression extent. Using a combination of the depression depth output with the depression cost surface may also be a possibility to explore.

This investigation used elevation data extracted from the soil polygons being investigated. This technique is expedient and repeatable. It also reduces processing time and minimizes the need for sub setting data when using larger extents. The drawback to this procedure is removing the terrain within map units from their context. In the case of depression identification, it is possible depressions from adjacent areas exist and extend into Sable units. An alternate procedure would be to select both map units of interest and adjacent map units prior to extracting the DEM. These are both alternatives to working with a seamless DEM for a large extent, which can be CPU intensive and require sub setting data and processing in piecewise fashion.

The results of this investigation indicate significant portions of Sable map units are not ponded. This is based on the assumption that identified depressions from GIS models are coincident with actual depressions. Results also indicate the usefulness of high resolution elevation data for predicting surface features like depressions compared to coarser 10 meter DEMs.

Ipava

The depression depth and depression cost surface models were used for identification of depressions and calculation of depression composition within Ipava map units. Thresholds were used for the Ipava estimates as a test and suggested technique for application of this method in the future. The use of thresholds resulted in a more conservative estimate, but it is still a liberal estimate as some depressions are based on sinks that are data artifacts rather than actual sinks. Filtering sinks based on size and depth would be a technique to apply and verify by ground truthing as suggested by Li (2011).

Review of Aerial Photography

A qualitative comparison was made between NAIP imagery and predicted depressions for the 2004-2012 growing season (2008 is unavailable). The assumption to verify was differential crop response and the correlation with predicted ponded areas. In general, no pattern or relationship was observed for any of the photography with the exception of years 2009 and 2010 and that was weak. An example from the 2009 NAIP is presented in figure 14.

Many areas are predicted as depressions that show similar crop response to areas without depressions as well as the opposite situation. The use of NAIP for evaluation purposes is due to its availability and as a quick means of gathering corroborating evidence to verify predictions. It is possible to classify NAIP imagery using image processing techniques, but the software and time required usually exceed the usefulness of the output (USFS personal communication).

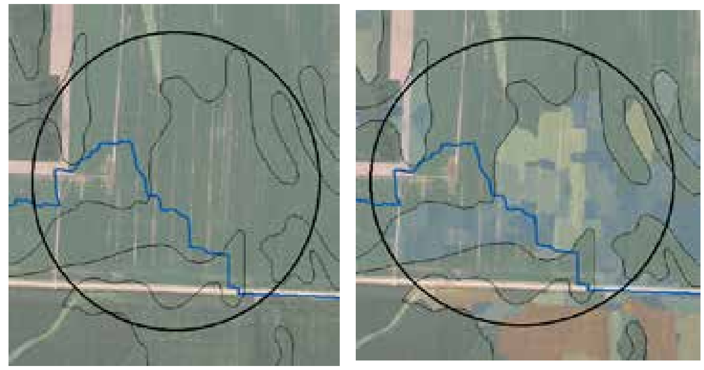


Figure 14.—Image above shows some areas of poor growth which corresponds to predicted depressions on the right.

The question becomes, what is the most reasonable way to attribute the component phases of a map unit, a global assignment or one determined from high resolution elevation data using repeatable techniques? A quote from George Box (1987) may help in the decision making process;

"Remember that all models are wrong; the practical question is how wrong they have to be to not be useful."

Contents

1. Box, G. E., & Draper, N. R. 1987. *Empirical model- building and response surfaces*. John Wiley & Sons.

2. https://soilseries.sc.egov.usda.gov/OSD_Docs/S/SABLE.html

3. https://soilseries.sc.egov.usda.gov/OSD_Docs/I/IPAVA.html

4. Li, S., MacMillan, R. A., Lobb, D. A., McConkey, B. G., Moulin, A., & Fraser, W. R. (2011). Lidar DEM error analyses and topographic depression identification in a hummocky landscape in the prairie region of Canada. *Geomorphology*, *129*(3), 263-275.

Investigation of Souris Lobe

Barnes Series - Investigation of Souris Lobe, Soil-Water Monitoring, and Map Unit Recorrelation

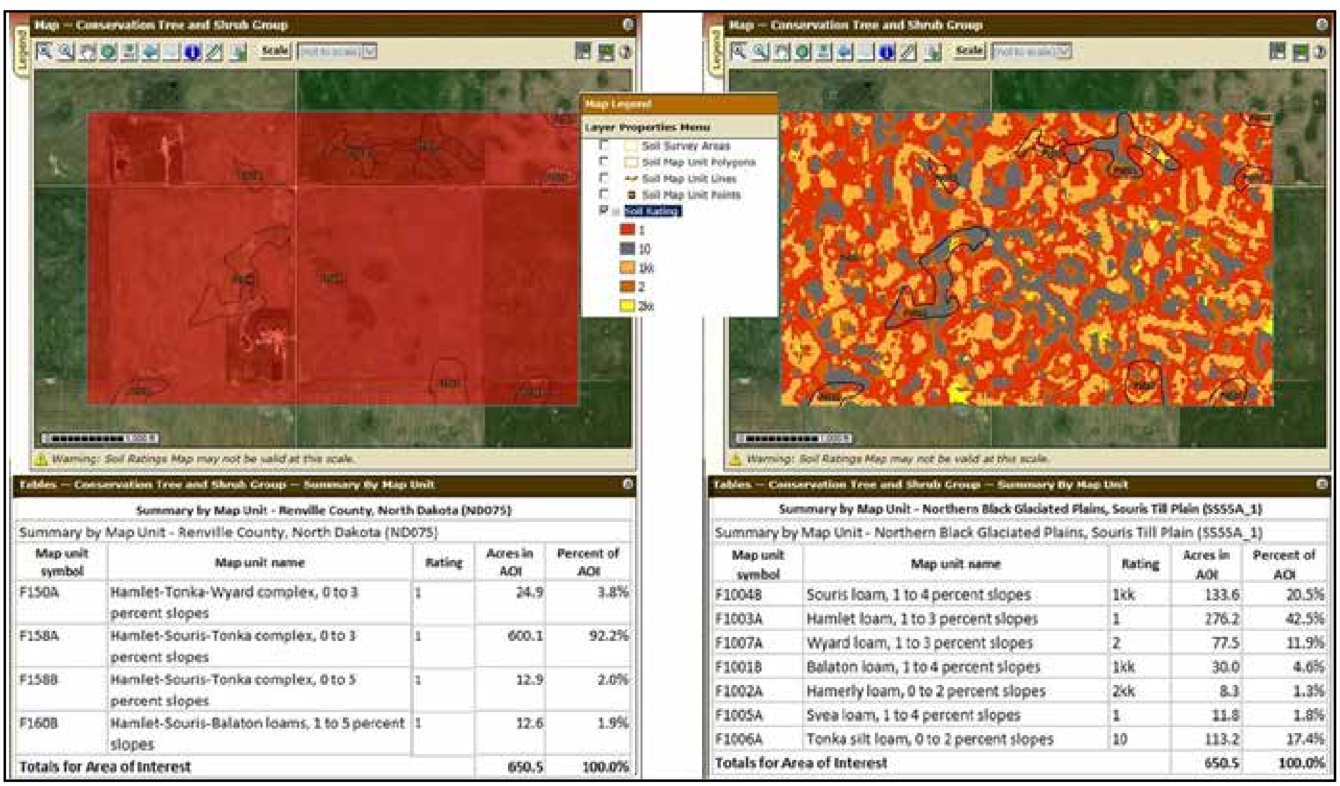
By Joe Brennan; NRCS

In 2017, MLRA staff completed an extensive soil survey update project addressing deficiencies in existing soil data across a five county area of north-central North Dakota. Project results reconciled and expanded on available soil data crossing 1.1 million acres of glaciated till plains in the heart of the Prairie Pothole Region.

In the project area, several recent wet years resulted in an extraordinary amount of prevented planting, illustrating potential shortcomings in existing soil survey (SSURGO) data. Soils with saturation at or near the surface have significant considerations for use and management. Evaluations of soil survey publications and digital data revealed that limitations from saturation were often underestimated relative to soils with better internal drainage. In addition to cropping limitations from saturation, elevated risk of salinization has been identified in some seasonally wet soils, which carry unique management considerations.

MLRA staff explored the potential of digital soil mapping (DSM) techniques to update the soil survey product extensively with limited resources. DSM allowed staff to extrapolate field investigations of soil saturation, chemistry, and development across the landscape in a quantifiable and consistent manner, thus improving understanding of soil variability. These predictive mapping products were foundational to the update of existing soil survey information by defining what was in map units and by isolating areas where minor adjustment could render an improved product for use and management. Updated soil property data were shaped by reviewing soil descriptions and laboratory analysis collected from the area.

As updates to SSURGO spatial and tabular data were applied, focus shifted to the viability of publishing predictive mapping products in a complimentary raster (gridded) soil survey product. A field based accuracy assessment reported



Summary by Map Unit - Renville County, North Dakota (ND075)

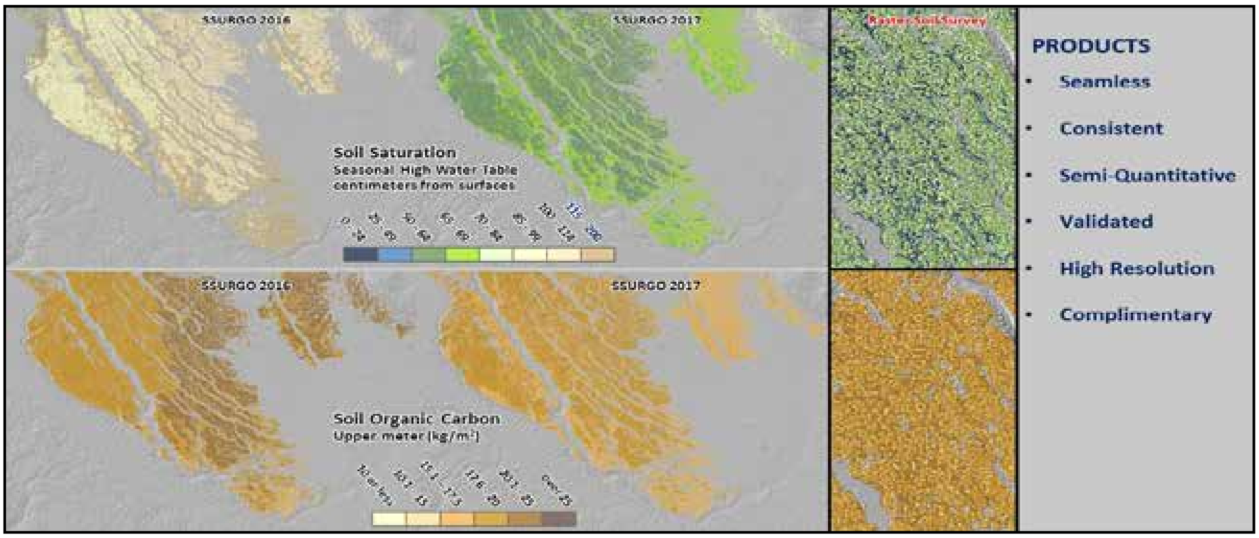
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
F150A	Hamlet-Tonka-Wyard complex, 0 to 3 percent slopes	1	24.9	3.8%
F158A	Hamlet-Souris-Tonka complex, 0 to 3 percent slopes	1	600.1	92.2%
F158B	Hamlet-Souris-Tonka complex, 0 to 5 percent slopes	1	12.9	2.0%
F160B	Hamlet-Souris-Balaton loams, 1 to 5 percent slopes	1	12.6	1.9%
Totals for Area of Interest			650.5	100.0%

Summary by Map Unit - Northern Black Glaciated Plains, Souris Till Plain (SSSSA_1)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
F1004B	Souris loam, 1 to 4 percent slopes	1kk	133.6	20.5%
F1003A	Hamlet loam, 1 to 3 percent slopes	1	276.2	42.5%
F1007A	Wyard loam, 1 to 3 percent slopes	2	77.5	11.9%
F1001B	Balaton loam, 1 to 4 percent slopes	1kk	30.0	4.6%
F1002A	Hamerly loam, 0 to 2 percent slopes	2kk	8.3	1.3%
F1005A	Svea loam, 1 to 4 percent slopes	1	11.8	1.8%
F1006A	Tonka silt loam, 0 to 2 percent slopes	10	113.2	17.4%
Totals for Area of Interest			650.5	100.0%

Web Soil Survey map displaying no variability in conservation tree and shrub groups in SSURGO (left) across a square mile area of Renville County, ND. Several SSURGO map units convey identical ratings in Web Soil Survey due to scale limitations and aggregation of dissimilar components in a map unit. In Raster Soil Survey products available from the Geospatial Data Gateway (right), greater variability in soil properties, interpretations, and ratings are available to user.

76% overall accuracy (+/-10 m) of predictive mapping, providing an objective metric in evaluating data integrity. In April 2017, the North Dakota State soil scientist certified the publishing of the first 10-m raster soil survey product developed through a soil survey update project. This data is now available for parts of Bottineau, Burke, McHenry, Renville, and Ward Counties in North Dakota. It can be accessed by all soil survey customers from the Raster Soil Survey choice on the [USDA-NRCS Geospatial Data Gateway](). A raster soil survey product improves the representation of known variability in inherent potential and in limitations of soils across the landscape. Over 250 times more detail is potentially defined. Raster soil surveys have improved applicability to precision management and have enhanced interpretive potential for field-scale conservation planning in comparison with scale-dependent data available from SSURGO.



Regional scale maps of two interpretively significant soil properties in the project area from SSURGO before (left) and after (right) the completion of this project. This MLRA field project rendered data-driven soil properties seamlessly across political boundaries.

Ecological Site Partnership University of Wisconsin-Stevens Point

By Stacey Clark; NRCS

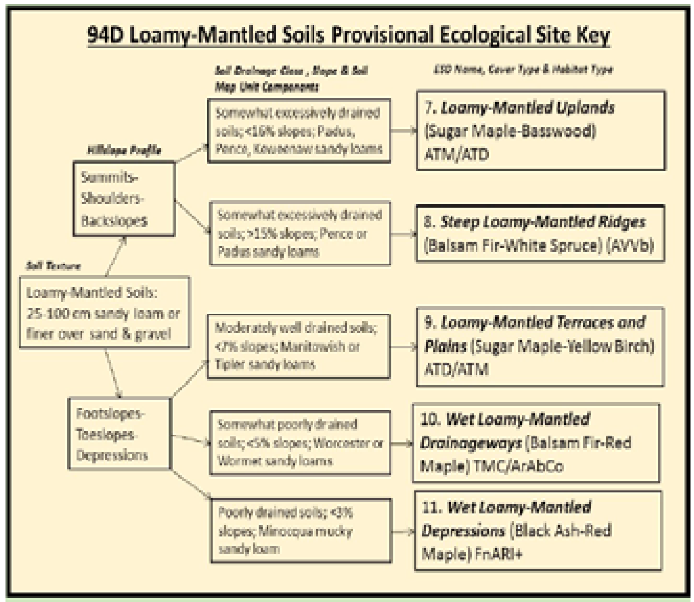
The National Ecological Site Provisional Initiative (PES NB 430-306-NI) has provided an accelerated framework for completing the beginning stages of ecological site descriptions (ESDs) across the country. In fiscal year 2017, Wisconsin NRCS partnered with the University of Wisconsin—Stevens Point to develop interim provisional ecological site (PES) products. The deliverables of the contract will provide PES keys, PES legends, and PES descriptions for over 10 Major Land Resource Areas (MLRAs) that cover the State of Wisconsin.

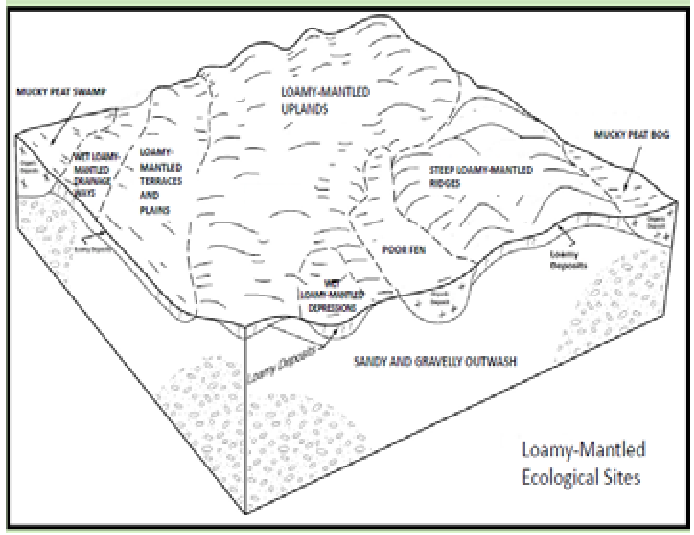
A **PES key** is a field guidance document that directs the user through multiple options of abiotic parameters associated with the landscape, soils, hydrology, climate, and other factors to determine which ecological site (ES) the user is standing on. These keys are most commonly dichotomous, but they can also take the form of flowcharts, choice lists, excel spreadsheets, and more. When the user needs to make an onsite determination of the ES, they can follow the PES key, informed by an onsite soils check and an understanding of the landscape position. The figure to the right shows an example of a portion of a PES key that was developed for MLRA 94D in Wisconsin prior to the contract for the rest of the State.

A **PES legend** is a spreadsheet that documents every component of every map unit associated with each Major Land Resource Area. For each of these soils components, the associated properties in the database (National Soils Information System) are listed, as well as the proposed ES concept to be linked with each soil map unit component. This assignment of an ES concept to a soil map unit component is referred to as "correlation" of an ecological site to a map unit component. The PES legend tracks the ES assignments proposed for correlation in the database.

A **PES description** is a document that briefly identifies the abiotic name and characteristics of the ES, provides administrative information, and includes a basic state-and-transition model (STM). These documents are currently available for MLRA 94D PESs on the Ecological Site Information System website and the Web Soil Survey. For the remaining MLRAs in Wisconsin, those products will also be made available through those websites after the contractors complete the products and the data has undergone quality control, quality assurance, and correlation.

The contract with the University of Wisconsin—Stevens Point is set to be completed in fiscal year 2021. The contract was separated into two parts: the northern portion of the State and the southern portion. The figure below illustrates the MLRAs covered in each part of the State for the contract.



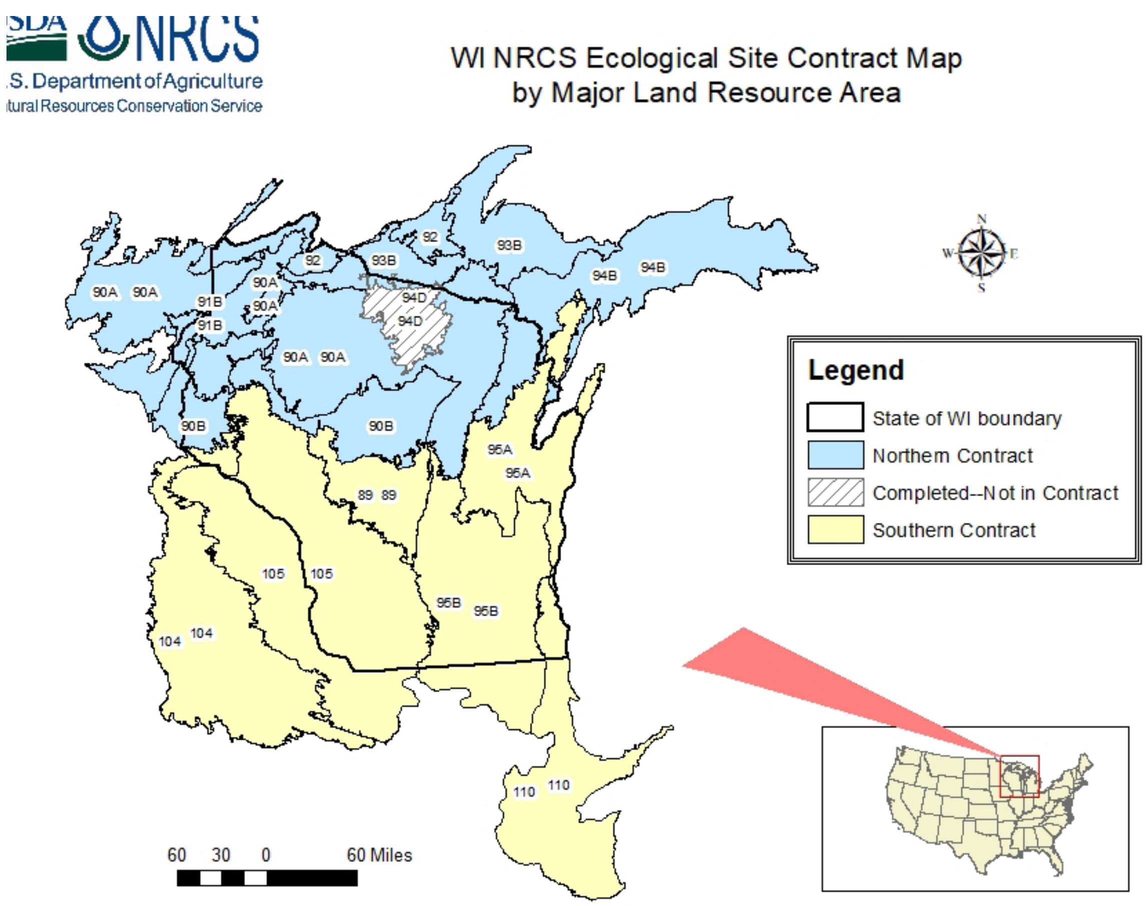


Example portion of the provisional ecological site (PES) key for MLRA 94D, which is being used as an example for completion of the rest of the ES contract work in the State of Wisconsin.

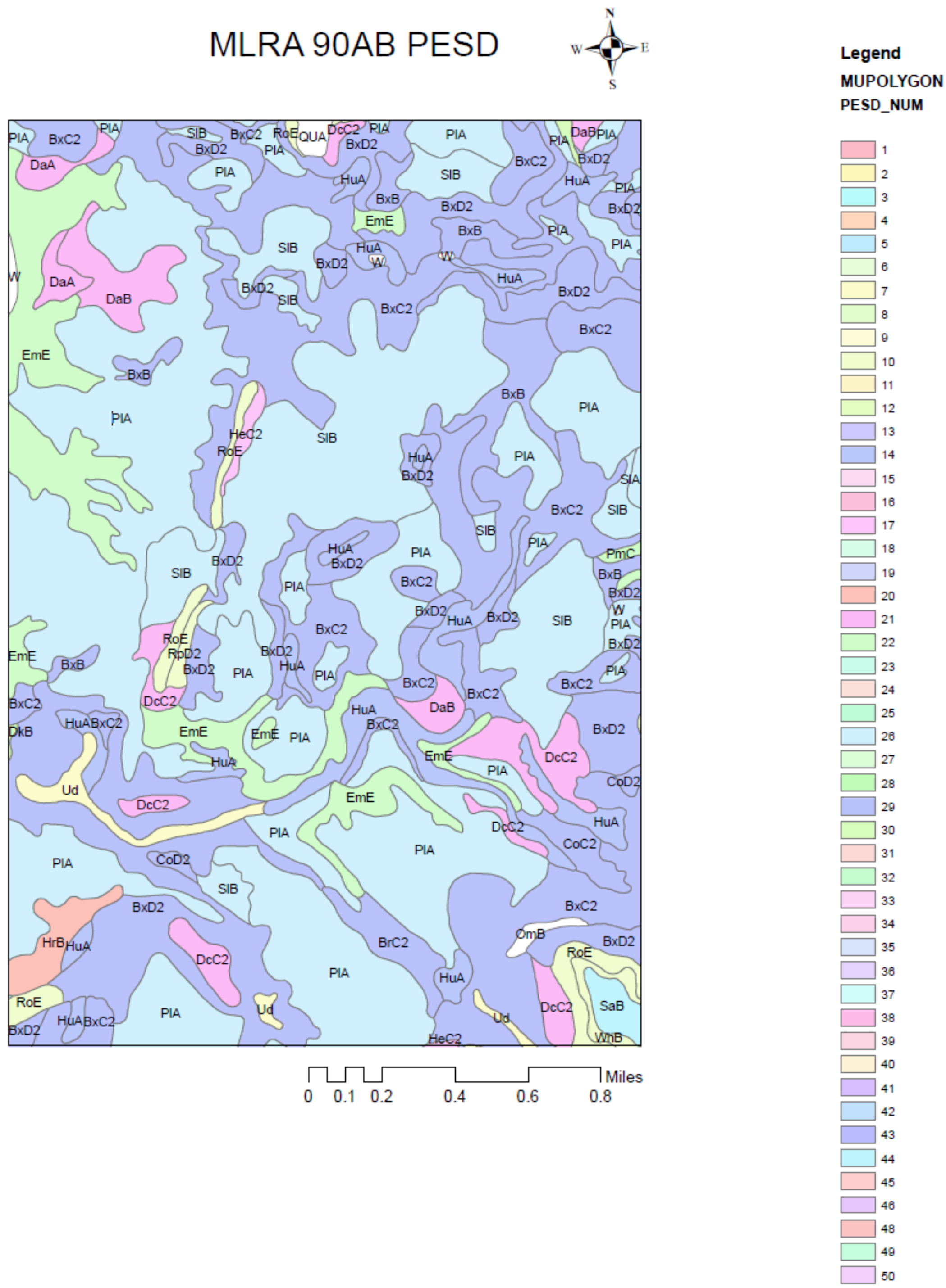
The NRCS is proud to be partnering with our Cooperative Soil Survey partners in this contract endeavor. The contractors, Dr. Jacob Prater and Dr. Bryant Scharenbroch, are both assistant professors of soil and waste resources in the College of Natural Resources at University of Wisconsin—Stevens Point. The contractors are also working with an icon in the Wisconsin world of ecology, Dr. John Kotar, and are incorporating information from his publications “Forest Communities and Habitat Types of Northern/Southern Wisconsin” by John Kotar, Joseph A. Kovach, and Timothy L. Burger. The contract is also relying on the input from local experts in soil mapping of the area, such as retired soil scientist David Hvizdak, our own area resource soil scientists and MLRA soil scientists, and outside-agency partners, including the US Forest Service and the Wisconsin Department of Natural Resources.

The contracting team started off the contract this fiscal year by hosting three separate, day-long workshops. At the workshops, they refined their skills on developing PES keys and legends and conducted the soil sorting and ecological site concept development process. The team has recently completed their first draft of a PES key and legend for MLRA 90A/B. The figure on the following page shows an excerpt of the mapping of the PES concepts identified for major components in MLRA 90A/B.

This historic contract within the National Cooperative Soil Survey program is one of the largest in geographical area covered, dollar amount, and resources dedicated to ecological site work to date. The team of experts are excited about the work, and they believe that this will bring a new tool (provisional ecological site descriptions) to the forefront of natural resource conservation. This tool will link a known source of reference material (Kotar Habitat Types) for ecology and land management in Wisconsin with the NRCS soil mapping and PESD content (state-and-transition models), providing unified and seamless landscape assessment and tools for planning.



Wisconsin NRCS Ecological Site Contract Map by MLRA, illustrating the northern and southern parts of the contract.



An excerpt of the mapping of the PES concepts identified for major components in MLRA 90A/B.

NRCS Onalaska Soil Office

Digital Soil Mapping Bluff Prairie Project

By Mike England; NRCS

Bluff Prairies are ecological sites that are unique to specific soils that have been identified in Major Land Resource Area (MLRA) 105, the "Driftless" Area. These prairies are found on steep and very steep backslopes of southwest-facing (warm) aspects of the valley sides in bedrock-controlled uplands.

The purpose for this project is to update and create a SSURGO product for these unique ecological sites using digital soil mapping (DSM) and other soil survey techniques. The ecological site information, along with an updated soil survey, will enable conservation partners to improve and protect these areas and even to restore these areas to their natural state.

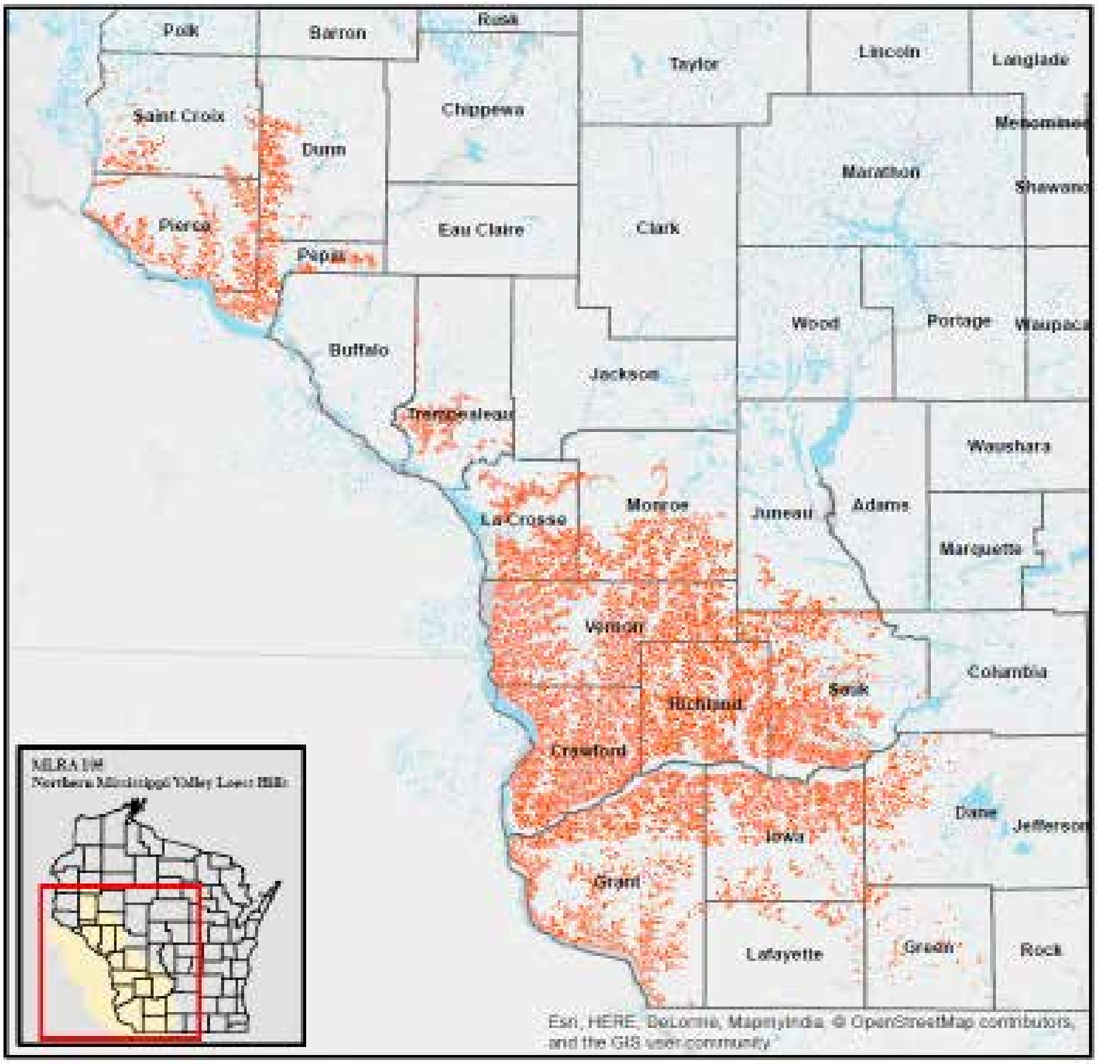
These prairie ecological niches are extremely important to threatened and endangered plant and animal ecology as well to as many partners in their conservation and restoration activities. These sites provide habitat for several threatened and endangered plants and animals in many States, including Wisconsin, Iowa, Minnesota, and Illinois along the Upper Mississippi River Watershed.

The outcome of this project will enable the soil and ecological site information to be available to interested customers; e.g., The Prairie Enthusiasts; DNR and NRCS field conservationists in Wisconsin, Minnesota, and Iowa; USDA Forest Service; National Eagle Center; and The Nature Conservancy. Along with supplying habitat for numerous species of reptiles, mammals, insects, and plants, these unique areas harbor hunting grounds for golden eagles and other birds of prey in the winter time.

Recent field work has been conducted over a 2-year period in developing the first approved ecological sites in Wisconsin with fully populated data, state-and-transition models, and modern field documentation supporting the findings in over 30 counties among 4 states. The Onalaska MLRA Soil Survey Office invested multiple efforts over a decade identifying and honing the range in characteristics for these specific series and component concepts. More than 30 counties in 4 states were visited to help predict the distribution of the Dolomite Colluvium and Sandstone Colluvium Bluff Prairies ecological site descriptions. Because of multiple pedon descriptions, observations, historical documents, and transects of vegetative data, we were able to identify the specific properties needed to consistently identify the surficial and geological influences required to incorporate the model across political boundaries.

Mike England (MLRA Soil Scientist, NRCS) at a Bluff Prairie Site on Mississippi River in Vernon County, WI, near Rush Creek WI SNA.

Typical Bluff Prairie showing both ESDs in Sauk County, Wisconsin near Spring Green in Wisconsin River Valley.



View from a top Dolomite Bluff Prairie in Vernon County, Wisconsin observing the other aspects of ESDs in the different States of Allamakee County, Iowa (left) and Houston County, Minnesota (right).

Mike England (MLRA Soil Scientist, NRCS) at a Rock outcrop inclusion of a Sandstone Bluff Prairie in Houston County, Minnesota near Mound Prairie.

NRCS Juneau Soil Office

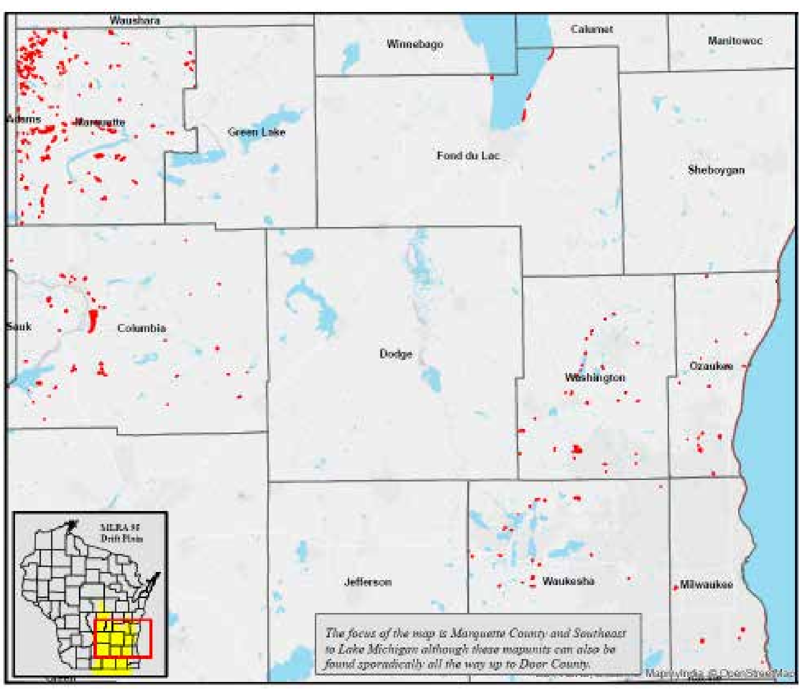
Miscellaneous Group Map Units

Miscellaneous groups were primarily used as map units in areas of soil survey where taxonomic characteristics could not be further defined. We're finding that this was not this case for a lot of the miscellaneous groups mapped in Wisconsin in the 1950s and 1960s. Currently, these map units have very few interpretations linked to them. There are over 50,000 acres of miscellaneous groups mapped in southeastern Wisconsin that have no or poor interpretations. Most of these miscellaneous groups are mapped at the interface between urban and rural areas, where a lot of growth is taking place and the need for resource information is the highest.

The Sandy Miscellaneous group is the first miscellaneous group soil map unit that we're addressing. It encompasses most of the sandy miscellaneous group map units in MLRA 95. Currently, a wide array of miscellaneous groups are mapped. These miscellaneous groups have been a source of confusion and inconsistencies for users of soil survey information for decades. The absence of interpretations has also lead to incomplete planning and information. Many of these sandy named groups are on very intensively developed land or land that is being developed now. The South East Wisconsin Planning Commission has been aware of the issues associated with these miscellaneous groups and is anxious to see them resolved.

Field procedures will center on clarifying the vast differences among these soils and quantifying their differences into soil taxa with solid interpretations.

As illustrated in the following photo, the "Sandy Land" miscellaneous group is mapped across a wide variety of landforms, landscapes, and land uses. This project will differentiate and quantify soil properties necessary for addressing resource concerns, such as erosion and water quality.



Dual Drainage Class Components

In southeastern Wisconsin, many of the historic map unit component concepts were mapped with dual drainage classes. A typical example would be St. Charles, well drained and moderately well drained. While these wide ranging depths to water table no longer fit into the range of characteristics of a given soil series, they do remain in the database of "Official Data." As land use ever intensifies in Wisconsin, the demand for accurate soils information becomes paramount. More and accurate data are the key to completing useful official data. High water-quality standards are important to Wisconsin residents. For recreation, drinking water, and all-around public safety, a more accurate picture of the water table is the first step.

We installed two Hobo WX3000 remote stations in southeastern Wisconsin. They communicate changes in ground water level in real time via a telephone line and help us accurately quantify the water table. This information will be compiled and will eventually help us characterize the water tables on a monthly basis.

Investigation of Catlin Series

By Kristine Ryan; NRCS

Catlin Series once included well and moderately well drained soils (dual drainage). It's been mapped on Wisconsin an aged and Illinoisan aged till plains. The current Catlin Series concept only includes moderately well drained soils. During the recent update activities well drained Catlin soils on the Illinoisan till plain have been re-correlated to the Parkway Series (established 2001). This project will evaluate 23,015 acres of Catlin map units in Lee and Ogle Counties mapped on the Illinoisan till plain near the edge of the Wisconsinan glacial advance to determine if they fit the Parkway Series concept. Transect data and pedon descriptions will be collected by the Aurora staff of three in FY18. Some spatial editing may be needed to change map unit symbols. The Tech Team identified this project as a priority to improve consistency in interpretations impacted by depth to water tables.

Objectives and Procedures

Catlin is a benchmark soil mapped predominantly in MLRA 108A but with some acreage occurring in MLRAs 108B, 110, and 115C. The Catlin Series occurs in loess and the underlying calcareous till and has a water table of 2 to 3.5 feet, usually occurring on the Wisconsin till plain. The series concept had been previously correlated in similar positions on the Illinois till plain, but it appeared to be better drained. At one time, the Catlin series allowed for a "dual" drainage classes. The Catlin type location actually occurs in MLRA 108B even though the distribution reflects the Wisconsin Glacial advance in MLRA 108A. The former Rock Falls MLRA office established the Parkway Series in Henry County (MLRA 108B) in 2001, reflecting a seasonal high water table at a depth of 4 to 6 feet. Parkway has a similar parent material sequence when compared to Catlin, with the difference being that it occurs on the Illinois till plain rather than the Wisconsin till plain. Soils that had been mapped as Catlin on the Illinois till plain-which should correlate strongly with MLRA 108B-have been correlated to the Parkway series as a result of soil survey update activity in northwest Illinois. In a separate project the Aurora MLRA office will relocate the Catlin OSD location from Ogle County (MLRA 108B) to McLean County (MLRA 108A). Data will be updated including new field observations and the OSD type location sampled. Some map line work could be modified and all data associated with the data map units will be updated.

This project will allow for in-depth field observations to update the present data. Descriptions need to be made on pulled pedons and soil pits (if possible). Attention will be paid to depth of carbonates (or lack of), visual evidence of root distribution in the 2C, evidence of a Sangamon paleosol, and depth to 2 chroma iron depletions. Because this series allowed for a dual drainage class, the seasonal high water table and matrix color will be documented at each observation to determine the drainage class. Previously collected and described pedons will be reviewed. A few of these pedons represent good examples of Illinoisan till. Collaboration with retired-but currently practicing-soil scientists familiar with the survey areas and soils will be accomplished through field tours and site visits.

This project was developed from previous Catlin silt loam SDJR Initiative Projects. The Catlin series consists of very deep, moderately well drained soils on till plains. These soils formed in loess or other silty material and in the underlying loamy calcareous till. The distribution of Catlin appears to reflect the front of the Wisconsin Glacial advance in MLRA 108A.

Map Units Included in Project

Data collection will be conducted in Lee and Ogle Counties in MLRA 108B on the Illinoisan till plain and compared to the data from MLRA 108A (Wisconsinan till plain)

Benefits

- Scientific: The major benefit of this project will be that it will aid in updating our current data and range in characteristics.
- External: This will result in improved soil interpretations for users of soil survey information.
- Internal: The updated attribute data will result in improved conservation planning activities by agency personnel, particularly in regard the T factor, Ksat, and potentially the HSG.
- Synergy: Data collected and the resulting decisions made will provide the necessary background information to assist with improving soil data in this soil catena.

Marshfield Catena WaterTable Study

Resource Concern

Marshfield Catena Water Table Study addresses a water quality degradation resource concern to help aid in implementing the conservation practices may have or are expected to cause an increased change from one land use to another.

Project Study

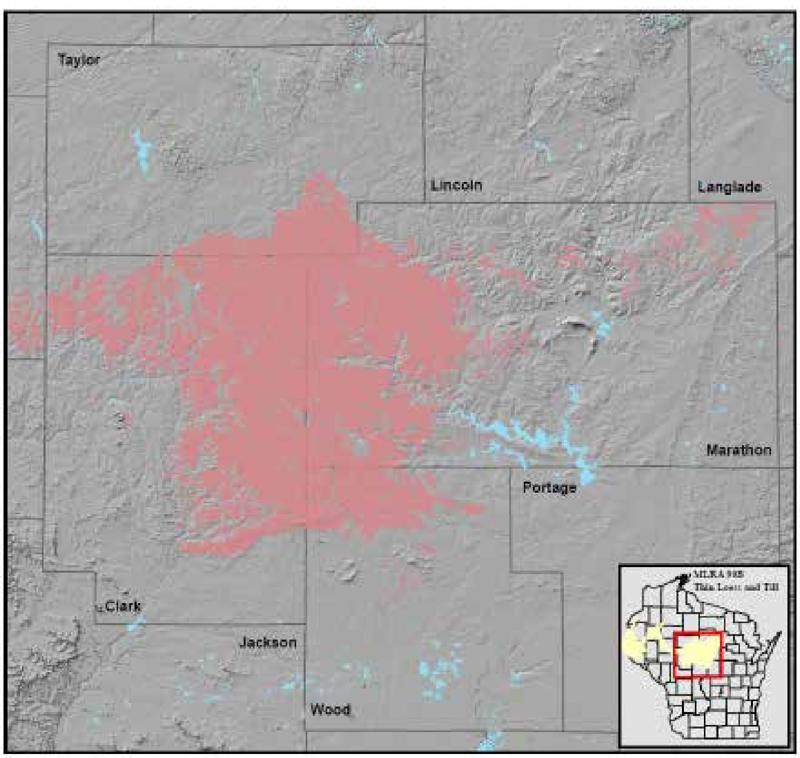
The study will be a 5 year project studying the water tables within the Marshfield silt loam, 0 to 2 percent slopes, Loyal silt loam, 1 to 6 percent slopes, Loyal silt loam 6 to 12 percent slopes, and Withee silt loam, 0 to 3 percent slopes map units. Marshfield catena water table project will inform over 650,000 acres. Marshfield soils have been described as having a perched water on top of the loamy till that remains in the upper 30cm of the profile during September through June in most years. These soils do not recognize the densic contact as is found in the better drained catena members Loyal and Withee.

Primary Goal

The primary goal of this project will be to document the seasonal fluctuations of the perched water table as well as determine if there is an apparent water table in the dryer summer months following months where it is perched. Two water table data loggers will be installed at each study site (2 sites), one just above the horizon causing the water to perch, and one below the contact to monitor infiltration and to determine if there is an apparent water table present. Ideally tubes will also be installed in adjacent Loyal and Withee delineations that will also be part of the study. Data will be collected twice per year, for a 5 years. The expected outcome of this project is an accurately populated component water table that will capture seasonal fluctuations of the perched water table, and more importantly, show how water is moving through the perching layer, and document the apparent water table if present.

Expected Outcome

The expected outcome of this project is an accurately populated component water table that will capture seasonal fluctuations of the water table, and more importantly, show if water is moving through the dense till.



NRCS Technical Soil Services

By Michael Robotham Ph.D., National Leader Technical Soil Services- NRCS

What are technical soil services?

- Technical soil services (TSS) are the professional application of soils information.
- The Technical Soil Services branch of NRCS provides free assistance to partner agencies; public and private, for-profit and non-profit organizations; and the general public.

What does TSS do for NRCS and SWCDs?

- We support conservation planning through compliance determinations and reviews (both HEL and wetlands).
- We support other agency programs and initiatives, including NRI, ecological site development, and soil health investigations.
- We conduct onsite assessments for resource inventories, practice designs, and practice implementation.
- We conduct field and area office quality assurance reviews.
- We maintain official reference documents, such as the relevant sections of the eFOTG.

What else does TSS do?

- We provide general soils-related information in person, on the phone, by social media, and by email.
- We provide soils-related training to partner agencies and organizations.
- We provide support for youth education through soil judging, land judging, conservation awareness contests, and Envirothons.
- We work with you to identify and obtain the soils information you need to address your specific concerns.
- We help you find and use NRCS tools and information resources, such as Web Soil Survey and Soil Data Access.
- We work with you on unique projects that required custom analysis of soil data and information.

How do I get help with TSS?

- Contact your State soil scientist.
- A State soil scientist is assigned to every State.
- Some States also have an assistant State soil scientist.
- Contact a resource soil scientist.
- They are located in national, regional, area, and field offices.
- Approximately 75 resource soil scientists provide full-time TSS support.
- Contact a Soil Science Division staff soil scientist.
- They are located in 12 regional offices and 124 soil survey offices nationwide.
- Approximately 350 soil scientists spend an average of 15% of their time providing TSS.

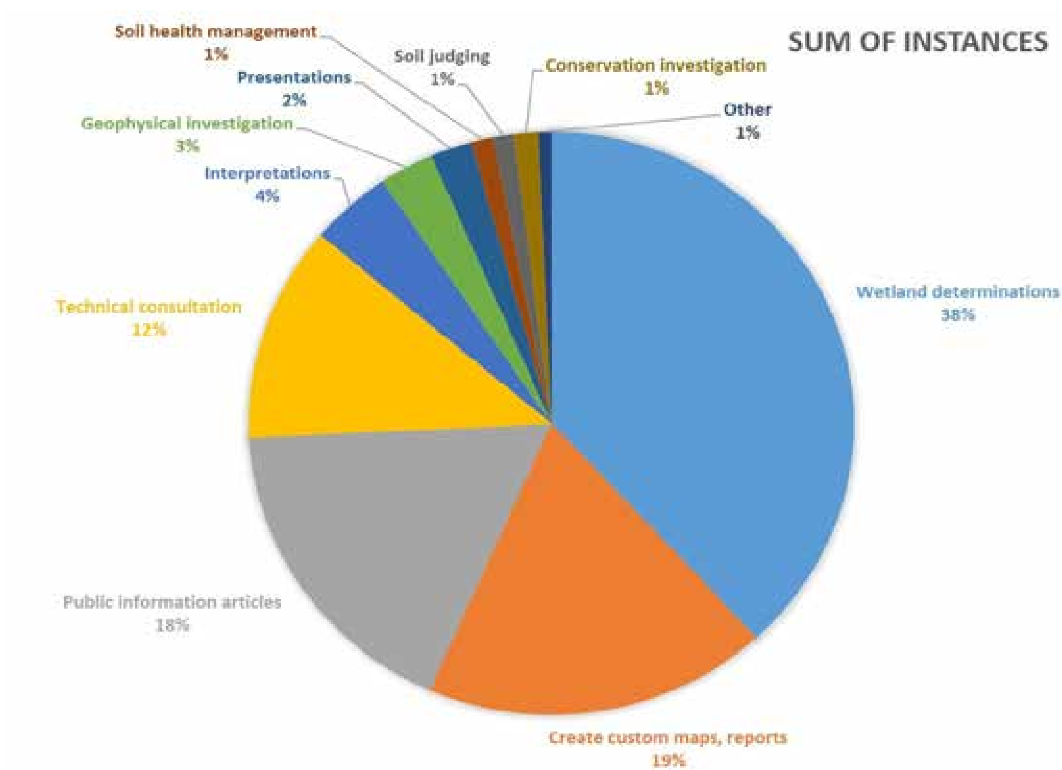
Wisconsin Technical Soil Service Priorities (Top 5)

1. Provide Soil Information to internal/external customers (need to develop measurements)
2. Site-Specific Soils Investigations (need common request protocol from NRCS-Wisconsin)
3. Site-Specific Soils Investigations for Waste Storage Facility (need defined task and request protocol from NRCS-Wisconsin)
4. Ecological Sites – Data collection and analysis; review descriptions
5. Soil Training Course for Field Offices and Partners

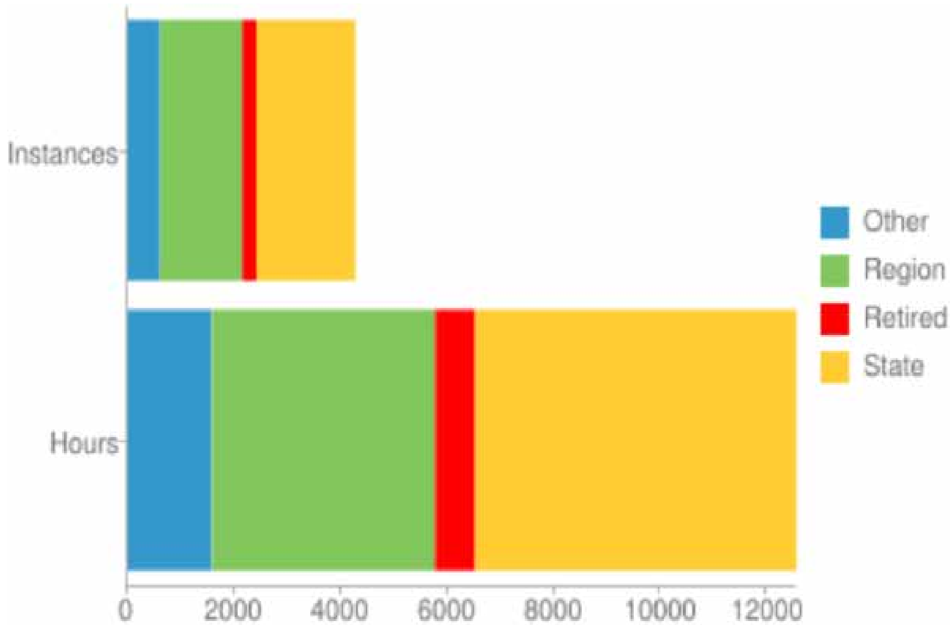
Types of Technical Soil Assistance
Area wide knowledge of Soils to assist in Easement sites
Assistance on resolving wetland issues relating to Department of Natural Resources permits for crossings and streambank
Data collection and analyses
Determining Lateral Effects for Wetlands for Engineering
Developing Soil Criteria for Conservation Planning (Resource Concern)
Developing soil criteria to use in ranking applications
Developing workload analysis and business plans
Ecological Sites – data collection and analyses; review descriptions
Farmland Policy Protection Act, LESA
GIS (creating maps, performing analyses)
GIS/GPS (creating maps, performing analyses, verifying easement boundaries)
HEL and wetland compliance
HEL/determinations/compliance/appeals
Hydric soils list
Important farmlands identification
Important Farmlands list
Liaison to other Federal, State, Local, or non-governmental agencies
Maintain eFOTG
Maintaining soil databases for Planning and Programs (RUSLE2, initiatives)
Outreach (preparing/presenting informational or technical materials, Envirothon, Land Judging)
Product publications (fact sheets, summary reports)
Program Management and Support
Program Management and Support (organizing annual work planning conference, developing business plan, reviewing/approving MLRA Soil Survey Office projects)
Program Management and Support (preparing reports, drafting bulletins, supervision, performance plans and reviews, recruiting/hiring)
Provide input for ranking
Provide input for restoration planning and design
Provide input for site eligibility
Provide training to field offices on Soil Quality Test kits
Providing soils information to internal and external customers
Quality Assurance Reviews (Area/Field Offices)
Receiving and presenting training
Resource inventories for conservation planning
Review and update soil rental rates
Reviewing conservation practice standards
Site-specific soil investigations
Site-specific soil investigations (Waste Storage Facility-313)
Soil Health Monitoring
Soil Interpretation Training Internal and External
Soil interpretations development
Soil survey – initial (mapping, database, compilation, field reviews)
Soil survey – update and maintenance (transects, database, spatial data edits, reviews)
Soil technology development/maintenance
Soil Training Course for Field Office and Partners
Special studies (carbon, soil quality, other characterization studies)
Wetland delineations/determinations/compliance/appeals
Wetland determinations for all of the above

Collaboration is the Key

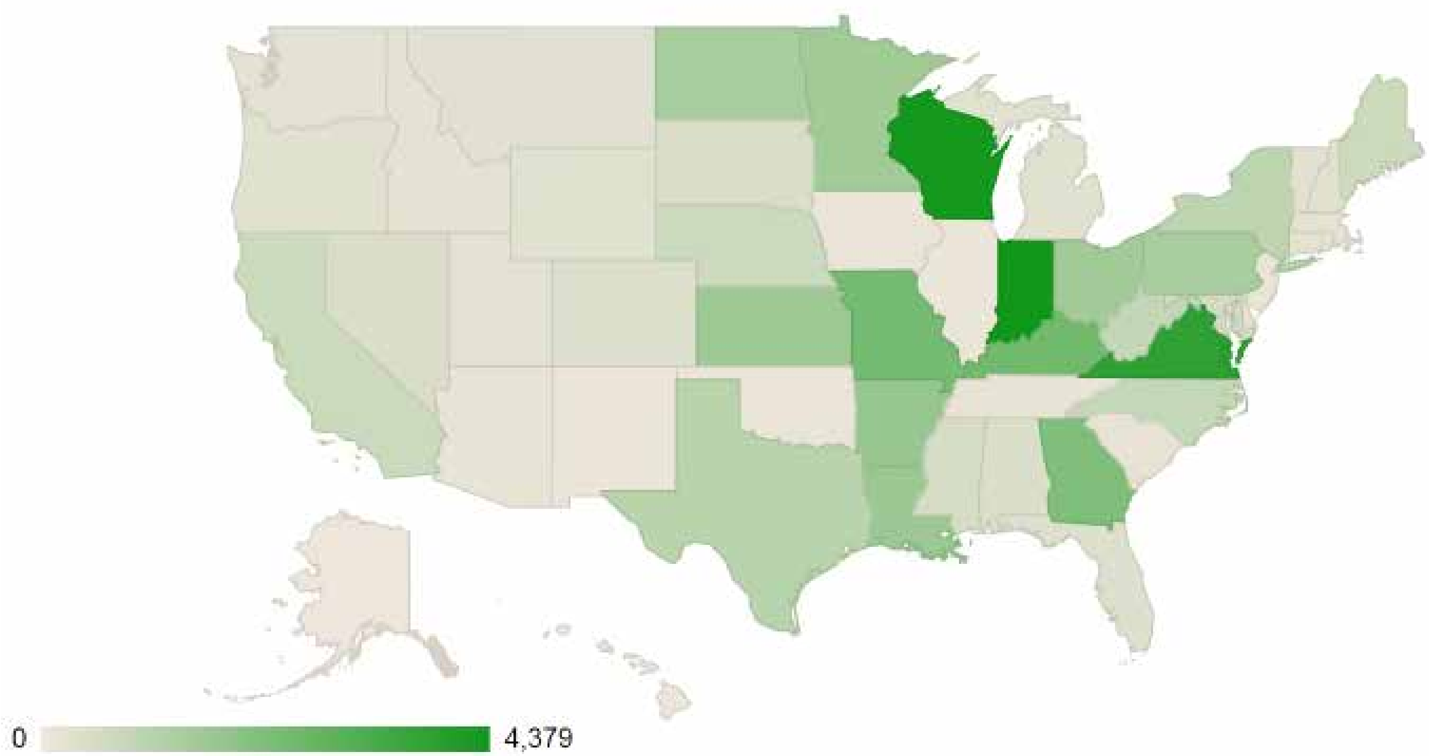
Sum of Instances



Note in Wisconsin, there is a large difference in national dominance of wetland workload, particularly for the resource soil scientist position.



- A total of 4,278 Instances of TSS activity were reported in FY 2017
- A total of about 12,500 staff hours of TSS activity were reported in FY 2017



Wisconsin is ranked second in the nation with hours and instances.

Soil Interpretations

When a Forester, Conservationist, Biologist or any other soil user goes to the field they are maybe developing an interpretation in their head as it relates to their field. For example, a forester may try to determine how to predict the most optimum location to plant certain species of trees.

Soils are complex and how we use soils data is very important in developing interpretations. This is where a soil scientist can be handy.

How users use the soils data is extremely important

- Depth
- Weighted Average
- Dominate Component
- Dominant Condition
- Minimum
- Maximum
- Thickest Layer
- Average
- Surface Horizon
- Organic Horizons
- Mineral Horizons
- Null
- No Data
- Frequency
- Restrictive Layers
- Component Percent
- Major Components
- Minor Components.
- All Components
- Depth range
- All Horizons

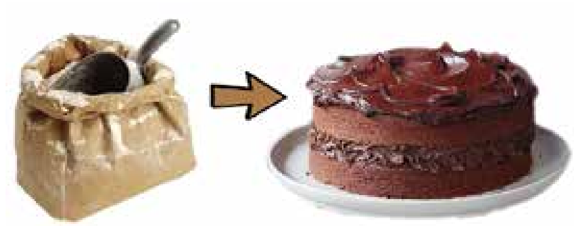
Few people, besides soil scientists, know enough about soils, and about the interactions among the many soil characteristics that define each kind of soil, to do the job by themselves. Few others have interest in all the uses and interpretations. Once a kind of soil is defined and mapped, few besides the soil scientist are concerned with all the interpretations needed, the field and horticultural crops that can be grown; the erosion hazard; the native plants and their ecological successions; how the soil will serve as subgrade for roads or foundations for buildings; and so on. Experience shows that the soil scientist must take leadership in developing the interpretations. This leadership responsibility includes getting the assistance of others, who may develop all or part of certain interpretations. Commonly, the soil scientist prepares a draft for others to react to. Responsibility to see that their work is interpreted for use is inherent in the duties of every soil scientist in the Soil Survey. –Kellogg

The soil scientist must have help and guidance from competent people in the related fields. Agronomists, horticulturists, engineers, foresters, economists, and so on can help them understand what combinations of characteristics and qualities are most important and help him assemble part of the relevant data. To work with them effectively, the soil scientist must learn something of their technical language and points of view. Then after he/she has made their interpretations in draft they can react to them, help him test them in application, and help improve them. –Kellogg

There will always be a need for soil scientists to collect and improve data, provide technical soil services, and educate landowners and partners on soil practices. Soil Science is a broad field mixing ecology; agriculture and economy to include soil formation; physical, chemical, biological, and fertility properties of soils; and these properties in relation to soil land use management. As population increases and climates change, a heavy strain will be placed on agriculture. Soils are the backbone of agriculture and a healthy soil is critical to our future. Soil quality, soil ecology, and the importance of organic matter management are crucial in managing fertility and lessening drought impact.

Understanding the Difference Between Soils Data and an Interpretation

Let's imagine you're setting up a bakery specializing in making cakes. In the figure below, the fresh flour represents official soils data (one important ingredient); the finished cakes represent soil interpretations. If the cake turns out tasting poorly, you wouldn't change the fresh flour, you'd first look at changing the overall recipe instead. The fresh flour is the raw material, or base that holds the cake together; one important ingredient of the recipe. Similarly, current official soils data is the base ingredient to making a good, solid interpretation. If you are an external user developing interpretations, one thing to keep in mind is your model might not turn out as desired the first time. You might need to modify the model several times to get desired results and calibrate it from actual data. The fresh flour (or official soils data) is all-purpose, having many uses for different interpretations and fields. Using fresh flour, or the most updated, official soils data correctly, makes a big difference in the quality of your baking creation or soils interpretation.



A practical example of flour (like official soils data), as an important ingredient to a cake (like interpretations).

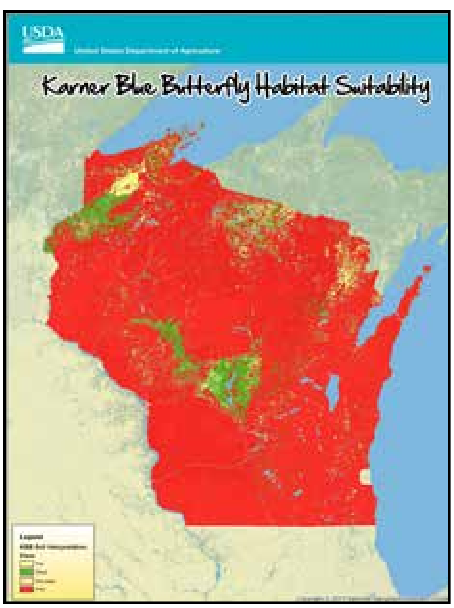
Soil Suitability for Wild Lupine and Karner Blue Butterfly

Collaborative Soil Interpretation Development to Identify Likely Endangered Species Habitat in Wisconsin: The Karner Blue Butterfly

The Karner blue butterfly (KBB) is a federally listed endangered species present in small patches across the North Central and North Eastern U.S. The KBB (pictured below) usually occupies open barrens, savannas and prairies that contain wild lupine. This plant is widespread in Wisconsin's central and northwest sands. The pale green caterpillar of the KBB feeds exclusively on the leaves of wild lupine.

USDA NRCS staff in Wisconsin were interested in finding a more efficient and consistent way to identify likely lupine habitat so that these areas could be prioritized for protection under NRCS Easements and related programs.

Because the presence of lupine is closely related to soil characteristics, staff approached Tim Miland, area resource soil scientist; Mike England, soil scientist, and Jason Nemecek, Wisconsin State soil scientist, about the possibility of developing a soil interpretation for KBB habitat suitability. A soil interpretation has been developed for the State of Wisconsin and will be available during the next soil data refresh on the web soil survey website in 2018.



Draft habitat suitability interpretation.

NRCS staff members involved include an area resource soil scientist, the State biologist, the assistant State conservationist for easements and the State resource conservationist. Other partners in the project include the U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service (USFS), and the Farm Service Agency (FSA).

The team developed a draft "Karner Blue Butterfly Habitat Suitability" interpretation (colored map picture). The next steps, now underway, are to compare the habitat suitability ratings with field data on the presence of KBB larvae as well to involve additional partners working in this area. Field and partner information will be used to refine/revise the draft interpretation as appropriate.

Jason explains, "The biggest benefit is the "ah-ha" moment when other resource management professionals realize soils can be used this way. By building the interpretation they can see it in action and realize it can be done; they can now focus and prioritize where to spend conservation funds and back it up with the science of the interpretation." This is how soils data can and should be used to help facilitate conservation planning.

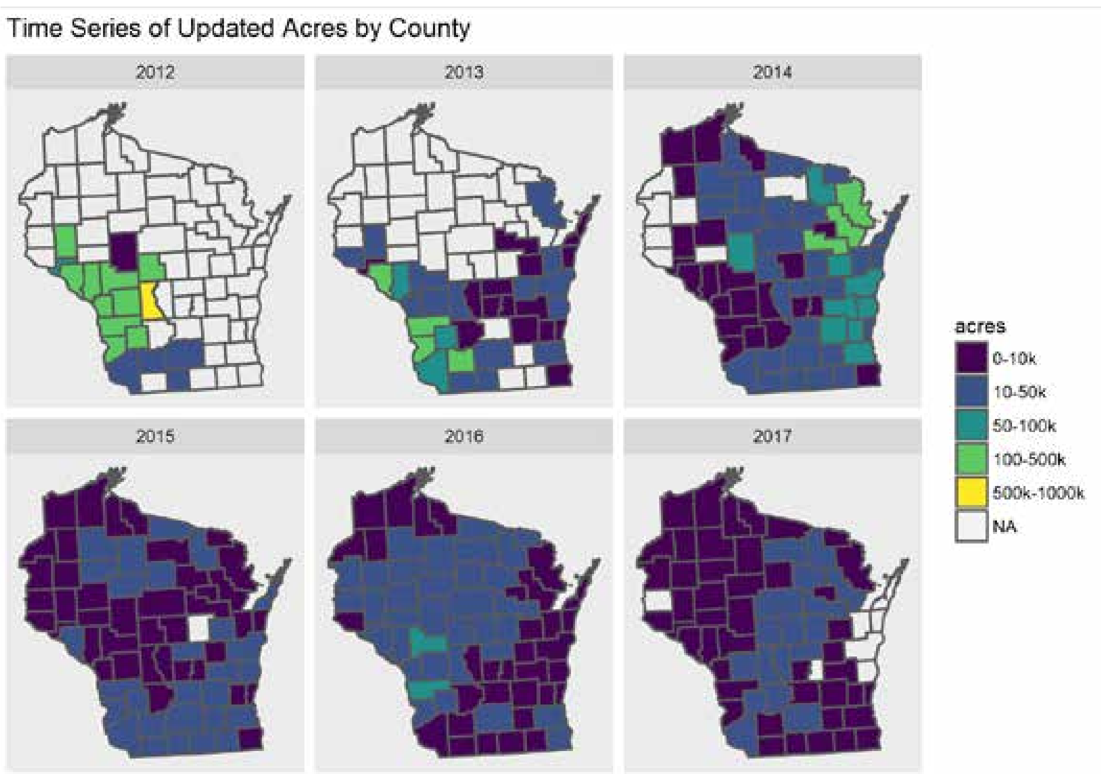
Karner Blue Butterfly

List of Soil Series Update by Year

By Stephen Roecker

For the past several years Soil Survey Offices in the East Central Glaciated Region (11) and North Central Glaciated Region (10) have focused their work on the Soil Data Join and Recorrelation (SDJR) National Initiative. The goal of this Initiative has been to increase the consistency of the Soil Survey Geographic database (SSURGO) across political boundaries. A summary of the affected areas in Wisconsin are presented below. Fiscal year (FY) 2016 will be the last official year of the SDJR Initiative. After FY2016, MLRA projects will become the main focus of Soil Survey Offices in both regions.

Fiscal Year	Updated Acres	Top 5 Soil Series Updated
2012	254,404	Emmet, Council, Water, Boone, Tarr
2013	879,593	Kewaunee, Manawa, Hochheim, Poygan, Ashkum
2014	4,439,728	Lupton, Plainfield, Newglarus, Withee, Loyal
2015	3,866,950	Magnor, Dorerton, Houghton, Newglarus, Palsgrove
2016	5,074,506	Freeon, Seaton, Rosholt, Pence, Padus
2017	1,878,454	Kennan, Valton, Friendship, Keweenaw, Meehan



Web Soil Survey Annual Refresh

The National Cooperative Soil Survey Program is an endeavor of the USDA's Natural Resources Conservation Service (NRCS) and other Federal agencies; State and local governments; and other cooperators. It provides a systematic study of the soils in a given area, including the classification, mapping, and interpretation of the soils. Soil types are classified from physical properties, drawing heavily on the principles of pedology, geology, and geomorphology. The entire Official Web Soil Survey Database (WSS) will be refreshed to ensure that updated official data is available in October of each year for use in implementing national programs affecting landowners and managers. Interpretation criteria will be updated for many national interpretations.

Below are recent Wisconsin Interpretations and Reports available on the Official Web Soil Survey:

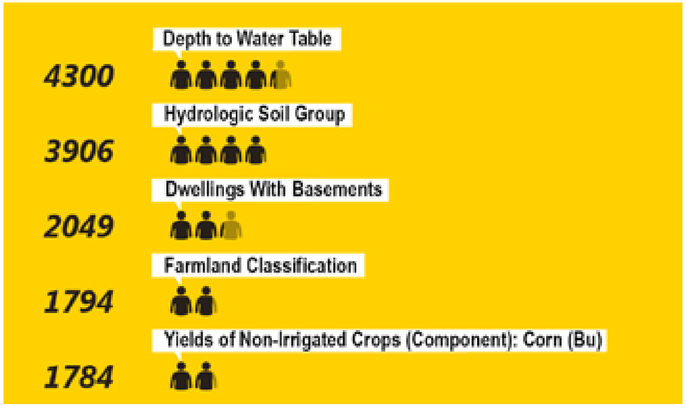
- **Commodity Crop Productivity Index for Corn (WI):** The Wisconsin Commodity Crop Productivity Index for Corn Interpretation provides soil survey users with an inherent soil property based ranking of Wisconsin soils and map units for common crop productivity. It replaces stored crop yields, produces a consistent statewide crop production index, better reflects local conditions, and improves statewide planning. Productivity indices have the advantage of being less vulnerable to changes in technology than expressions of productivity based on yield. This interpretation is currently for corn crop; separate crop interpretations may be completed in the future.
- **Hydric Rating by Map Unit (WI) Report:** Hydric Rating is under the Soil Data Explorer tab, then Soils Reports subtab, then the Land Classification folder. This new report gives the hydric soil category rating, indicating the components of map units that meet the criteria for hydric soils. Estimates are used in land use planning involving engineering, wetland considerations, and conservation planning.
- **Water Feature (WI) Report:** The report is located under the Soil Data Explorer tab, then Soils Reports sub-tab, and then the Water Features folder. This new report gives estimates of various soil water features. Estimates are used in land use planning involving engineering, wetland considerations or conservation planning. The new column, water features kind, was added to help users to determine if water table is saturated throughout or sitting on top of a restrictive root limiting pan. The report also aggregates similar months together making it simplistic and easy to read.

In fiscal year 2018, there are 4 new national interpretations:

- **Farm and Garden Composting Facility - Surface:** Composting facilities are designed to provide these six critical factors in relative proportions so that the process of biological degradation is sustained. Deficits in any of the critical factors, or imbalances among them, may result in extremely slow composting or a dormant composting system. Mixing of materials also redistributes heat, air and water and will speed the process of biological degradation. Large facilities may provide mechanical mixing of the compost materials. Smaller facilities may rely on manual turning of the materials or may add some materials that are too large to compost in order to create channels for air flow through the pile.
- **Fragile Soil Index:** Fragile soils are those that are most vulnerable to degradation. They are easily degraded (have low resistance) and are highly susceptible to erosion with low resilience. They are characterized as having low organic matter contents, low water-stable aggregates and low soil structure. Fragile soils are generally located on sloping ground, have sparse plant cover and tend to be in arid and semiarid regions. A fragile soil index interpretation was developed to rate soils based on their fragility. The index can be used in conservation and watershed planning to assist in identifying soils and areas with greater vulnerability to degradation.
- **National Commodity Crop Productivity Index (NCCPI) Ver. 3.0:** The NCCPI replaces version 2 as the National Crop Index. The NCCPI is a method of arraying the soils of the U.S. for non-irrigated commodity crop production based on their inherent soil properties. The interpretation is applicable to both heavily populated and sparsely populated areas. Ratings are for soils in their present condition. The present land use is not considered in the ratings.
- **Soil Susceptibility to Compaction:** This interpretation is designed to predict the susceptibility of soils to compaction from operation of ground-based equipment for harvesting and site preparation activities when soils are moist. Soil compaction reduces porosity and increases bulk density by reducing the interaggregate pore space. Compacted soils are less favorable for good plant growth because of high soil bulk density and hardness, reduced pore space, and poor aeration and drainage. Root penetration and growth is decreased in compacted soils because the hardness or strength of these soils prevents the expansion of roots. Supplies of air, water, and nutrients that roots need are also less favorable when compaction decreases soil porosity and drainage.

Individuals interested in knowing when surveys in a particular State are updated should visit the WSS and click on the Download Soils Data tab, then choose the State they are interested in. Customers can also visit the WSS to sign up for RSS feed notifications.

TOP 5 REQUESTED USAGE OF RATINGS



TOP 5 USAGE OF WI SOIL REPORTS

Web soil suvery website top five requested usage of ratings and usage of Wisconsin soil reports.

New NRCS Soil Website

The new site (see https://www.nrcs.usda.gov/wps/portal/nrcs/main/wi/soils/) offers tools, information and resources, bringing farmers, cooperators and other soil science supporters up to date on soils activities in the State and opportunities to collaborate in the future. The goal of the new site is to provide partners and visitors useful tools and resources 24/7 online, at their fingertips. The new Wisconsin Soils Website simplifies and improves the functionality of navigating and also provides unique, leading edge interactive tools, yet to be used anywhere else in the country. The main homepage features user friendly buttons by topic, to include soil quality, soil surveys, publications & maps, soil judging, technical soil services, tools, news & media, soil data mart, past & present, cooperative program and contact us.

Some highlights of the new website features include the following:

- The Soil Data Mart 2.0 is a real-time data mart of official soils data, providing live, interactive maps, dynamic, up-to-date reports and resources for farmers and partners across Wisconsin. The reports also provide easier and quicker access to soils datasets found on the official Web Soil Survey.
- The Soil Surveys Page houses a tool that provides live official Web Soil Survey as a one-stop shop on the Wisconsin NRCS website. It saves time and steps farmers and partners take inside the tool and provides quicker access to selected areas of interest; i.e., local farm maps.
- The Contact Us Page includes interactive story maps to pinpoint local assistance provided by resource soil scientists by county and area.

Topics on the new Wisconsin Soils website

University of Wisconsin Madison & Extension

By Francisco J Arriaga Ph.D., Assistant Professor and Extention State Specialist

The Dept. of Soil Science at the University of Wisconsin–Madison continues its tradition in providing quality education, research, outreach and extension activities in soil and environmental sciences. Our faculty, staff and students interact with multiple groups around the State, but have a special connection with NRCS.

Outreach/Extension

Often you will find NRCS and Dept. of Soil Science staff working side-by-side during field days and other outreach activities. UW–Extension State Specialist faculty based in the Dept. of Soil Science are members of several NRCS State committees, working together to improve resource conservation and management in Wisconsin. Two notable examples are collaborations in the area of crop nutrient management and soil health. These partnerships are of great benefit to the State.

Research

Research conducted in the Dept. of Soil Science is frequently done in partnership with other departments, institutes and programs within UW–Madison, as well as outside collaborators such as NRCS. Dr. Francisco Arriaga conducts research in the area of soil and water management and conservation. His research efforts in soil health, cover crop impact on soil erosion and nutrient losses, and flue-gas desulfurization gypsum application to agricultural fields has helped document the impact of various practices on soil health, crop productivity and the environment. These findings have helped guide recommendations provided by State and Federal agencies, such as NRCS. For instance, Dr. Arriaga's research team quantified reductions in total runoff volume of 24%, sediment loss of 52%, and total phosphorus loads of 42% when using cereal rye as a cover crop in corn silage production systems. Bioavailable P, which is closely linked to algae blooms in lakes and rivers, was reduced by 34% with the cover crop. Quantifying the impact of specific management practices can help guide programs and economic impacts.

Continuing Education, Outreach & E-Learning

UNIVERSITY OF WISCONSIN-MADISON

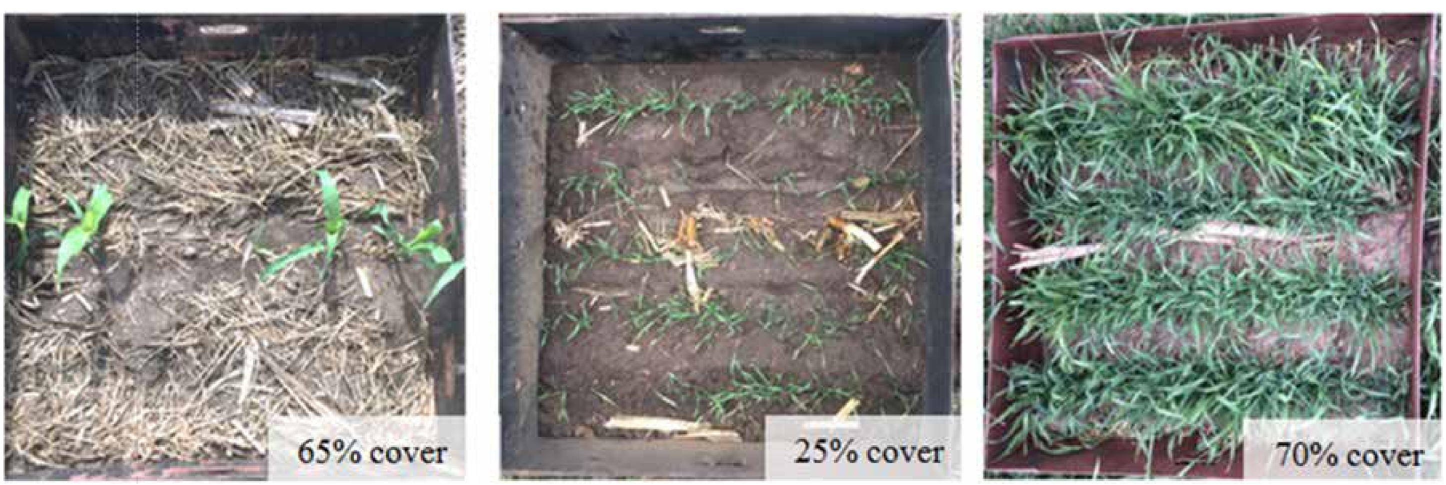


Photo courtesy of Laura Adams.

The Soils of Wisconsin

The Soils of Wisconsin was release in March 2017 from the University of Wisconsin. The authors included James Bockheim (Retired Professor UW–Madison) and Alfred Hartemink, chair and professor of Soil Science, University of Wisconsin–Madison. It provides an up-to-date and comprehensive report on the soils of Wisconsin, a State that offers a rich tapestry of soils. It discusses the relevant soil forming factors and soil processes in detail and subsequently reviews the main soil regions and dominant soil orders, including paleosols and endemic and endangered soils. Richly illustrated, the book offers both a valuable teaching resource and essential guide for policymakers, land users, and all those interested in the soils of Wisconsin.

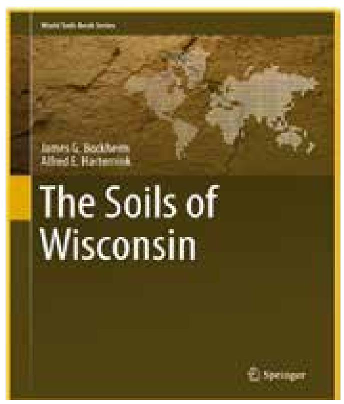
Preface

The first book solely focusing on the soils of Wisconsin was published in 1927 by A.R. Whitson—professor of soil science at the University of Wisconsin–Madison. He described the function of soils; climate, future agriculture, and forestry; and origin and classification of Wisconsin soils. He also gave detailed descriptions of 23 soil series from nine soil regions. In 1947, Dr. Charles Kellogg, who later became Director of the Soil Survey Division of the USDA Soil Conservation Service (now NRCS), published a general overview of the soils of Wisconsin as a Preliminary Study of the Profiles of the Principal Soil Types of Wisconsin. In 1976, the University of Wisconsin Press published Soils of Wisconsin that was prepared by Dr. F.D. Hole. This book contained chapters on factors of soil formation, processes of soil formation, properties of Wisconsin soils, classification of soils, soil associations within ten soil regions of the State and an appendix with soil descriptions and analytical data. This book included a soil map at a scale of 1:710,000.

This present book, in a sense, constitutes the fourth edition of the Soils of Wisconsin. The authors have benefited from several decades of new research and from the digital age in which official soil descriptions, laboratory characterizations, soil classification data and the Web Soil Survey are available. This enabled us to provide an up-to-date analysis of the soils for the State of Wisconsin. Despite the demand for soils information, only 3 (Michigan, Minnesota, and Wisconsin) of the 50 States in the USA have a general soil map published after 1999; and only 5 States (Arkansas, Florida, Louisiana, North Carolina, and Washington) have a book published after 1999 compiling soils data for the State. It is the hope that this new book will serve as a written and digital account on the soils from Wisconsin, as a reference book for soil science and related courses and as a compendium for land users, policymakers and anyone interested in our soils. On Wisconsin!

Acknowledgments

This work is based on decades of soil research and the data collected by soil scientists with the Wisconsin Geological and Natural History Survey (WGNHS) and the many surveyors and scientists from USDA Natural Resources Conservation Service (NRCS) in Madison, Wisconsin, and Lincoln, Nebraska. Without their dedicated surveying, mapping and research, this book could not have been written. WGNHS allowed use color images depicting the natural resources of Wisconsin. We are grateful to David Evans, Michael Notaro, and Yakun Zhang for producing the soil, land use and climatic maps. Unless indicated, the soil profile and landscape pictures were taken by Alfred Hartemink. Jim Bockheim acknowledges his wife, Julie, as a steady source of encouragement. We are grateful to Dr. Robert Doe, Suresh Rettagunta, and Corina van der Giessen of Springer for help in producing this book and to the chancellor of the University of Wisconsin—Madison for her support and the foreword to this book.



"We need to think about the soil as a natural resource, about which we need up-to-date and relevant data for managing and planning purposes. Farms and related agricultural business in Wisconsin generate over $80 billion per year and employ more than 400,000 people. The long-term economic and ecological sustainability of these farm operations is dependent on deep knowledge of the soil resources. We know that soil information is also essential for managing our wilder regions such as forests, marshes and grasslands. And the development of habitat around towns and cities requires soil knowledge," said Chancellor Rebecca Blank.

UW-Discovery Farms Soil Health Project

Recently there has been an increased emphasis on soil health, led by the NRCS which launched a national soil health initiative in 2012. The initiative is meant to highlight the benefits of improving and maintaining America's soil. Healthy soils are more than just fertile soils with adequate nutrient levels. They also have high soil quality, both in their physical structure and active biology. The key principles are plant diversity, minimal soil disturbance, and substantial vegetative and soil cover. Increases in soil heath have the potential to improve water quality by increasing infiltration and water holding capacity, protecting soil from erosion by providing adequate soil cover, and increasing nutrient retention and cycling. In addition to the connection of soil health to other soil properties, soil health may have an impact on nitrogen use efficiency and water quality, in particular, tile water quality.

A soil health evaluation is being conducted as a part of two other Discovery Farms projects. The Nitrogen Use Efficiency (NUE) project focuses on how and why nitrogen is supplied to corn. Project participants work with Discovery Farms to evaluate their current nitrogen management strategies in order to fine-tune cropping systems. Through field plot nitrogen trials and extensive soil testing, farmers learn how efficiently their nitrogen sources are converted into corn yield. An important aspect of fertility and crop productivity is soil health. By analyzing soil properties within NUE project field plots, a clearer understanding how soil health indicators affect nitrogen use efficiency will be identified.

Soil health is also a component of Discovery Farms tile drainage monitoring project. Nutrient loss via the tile system is a primary concern in tile drained agricultural soils. The increased nutrient retention of healthy soils may retain nitrogen and phosphorous that would otherwise travel through the tile drains. The project will determine if healthier soils results in improved tile water quality.

Discovery Farms will explore the link between nitrogen use efficiency, tile water quality and soil health using total organic carbon (TOC), particulate organic matter (POM) and active carbon (AC) as soil quality indicators. Soil samples will be collected to a 6-inch depth during each year of this work from the participating farmer's fields. Laboratory analyses will be conducted to determine TOC concentration in each sample by dry combustion. Additionally POM will be determined using a physical fractionation procedure as outlined by Cambardella and Elliot, 1992.

AC will be measured as permanganate oxidizable C (POXC) (Weil et al., 2003). These soil C fractions will provide an overall assessment of soil quality and impact of management practices. The TOC in the soil gives an overall overview of organic matter status in the soil, while POM provides insight on the stability of the soil organic matter. Conversely, AC reflects a fraction of the soil C that is sensitive to management, providing an early indication of management impacts on soil health (Culman et al., 2012). Soil C fraction information will be paired to crop productivity and tile water quality data or nitrogen use efficiency data to establish relationships. This information will also be used to demonstrate the value of soil health and soil organic matter to growers and other interested groups. At each site, samples will be sent to a lab that performs a complete chemical soil health analysis package that includes the Haney Extraction and the SolVita Respiration.

DISCOVERY FARMS WISCONSIN

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A tile monitoring site for the tile drainage project.

Discovery Farms will continue to develop a soil health database to track soil health measurements and corresponding agricultural management practices. The purpose of the database will be to assess trends and test correlations between soil health measurements, various agricultural management practices and tile water quality and/or nitrogen use efficiency.

Soil health diagnostic tools for farmers will be developed from the analysis of soil health data collected. Farmers would benefit from quantifiable expectations of baseline and future targets when pursuing soil health improvement. NRCS and other farm advisors would benefit from tools to demonstrate to farmers the reliable and quantifiable changes in soil health expected over time. A reliable metric(s) for soil health could be utilized by NRCS as part of their ranking process for selecting projects to fund.

Discovery Farms has collected one year of soil samples from the tile project and three years of NUE soil samples. The lab tests have been performed, and analysis of the data has begun. Preliminary results show that single variable analyses will be inadequate to unravel the intricate relationships between soil health, field management, and tile water quality or nitrogen use efficiency. Advanced regression analyses will likely provide greater understanding and utility of the data.

Citations

Cambardella, C. A., and E. T. Elliott. "Particulate soil organic-matter changes across a grassland cultivation sequence." Soil Science Society of America Journal 56.3 (1992): 777-783.

Culman, Steven W., et al. "Permanganate oxidizable carbon reflects a processed soil fraction that is sensitive to management." Soil Science Society of America Journal 76.2 (2012): 494-504.

Weil, Ray R., et al. "Estimating active carbon for soil quality assessment: A simplified method for laboratory and field use." American Journal of Alternative Agriculture 18.1 (2003): 3-17.

Soil sampling: pulling samples for deep soil nitrate tests for the nitrogen use efficiency project.

Grinding corn silage yield samples for the nitrogen use efficiency project.

Tile drainage is a source of nutrient loading to surface waters.

Soil Science at UW-Stevens Point

By Jacob Prater Ph.D. & Bryant Scharenbroch

Soil and Waste Resources Program

Pursue a strong education, and a bright future with Soil and Waste Resources at UW–Stevens Point. Find ways to improve the crops that feed the world. Develop better land-use plans for rural and urban areas. Enhance forests and inland waters critical to all. Manage our natural and man-made resources with efficiency. If these issues interest you, discover the Soil and Waste Resources discipline at the University of Wisconsin-Stevens Point to start building your career. As a Soil and Waste Resources student, you will choose from major options in:

- **SOIL SCIENCE**, https://www.uwsp.edu/cnr/Pages/major.aspx?name=Soil%20Science , trains you to be a soil scientist, soil conservationist or agronomist through a strong science-based curriculum. A soil science minor is also available;
- **SOIL AND LAND MANAGEMENT**, https://www.uwsp.edu/cnr/Pages/major.aspx?name=Soil%20and%20Land%20Management, provides you with skills in the techniques of tillage, nutrient management, water management and sustainable crop production while minimizing erosion and maintaining water quality; and
- **WASTE MANAGEMENT**, https://www.uwsp.edu/cnr/Pages/major.aspx?name=Waste%20Management, prepares you for jobs at landfills, wastewater treatment facilities, recycling and composting centers, and hazardous waste sites.
- A certificate in wetland science through the Society of Wetland Scientists is also available to College of Natural Resources majors who have completed a course of study that concentrates on the identification and management of wetlands.

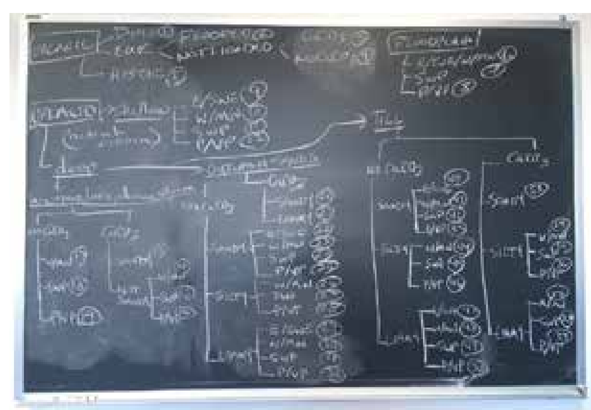
These majors provide hands-on experiences in laboratory and field courses involving biology, chemistry, math, computers and communication.

Use State-of-the-Art Facilities

Regardless of which major you choose, you will access state-of-the-art laboratories, computers and greenhouses to supplement classroom lectures and discussion. Field trips, internships and a summer field experience provide additional real-world experience. Our faculty have Ph.D.'s in soil science, waste management and engineering, and specialize in solid waste management, soil physics, hazardous waste management, microbiology, soil genesis and morphology, wastewater treatment, nutrient management, and land-use planning. Our graduates enjoy placement rates from 90 percent to 100 percent each year and work at private companies and municipal, county, State and Federal agencies.

Over the next three and half years, Jacob Prater and Bryant Scharenbroch will be working with NRCS and consultants to develop PESDs for the remaining MLRAs in Wisconsin (all but 94D). Working together with the NRCS and a couple of extremely knowledgeable consultants (John Kotar and Dave Hvizdak) it is going well so far. The approach will be to use the Forest Habitat Types as a site evaluation tool to connect with a soil sort based on abiotic factors to determine PESDs. The team will also be refining and developing soil series correlations with Kotar Forest Habitat Types (including the new ones for wetlands!).

Progress – A few months in we have gotten MLRA 90A/B soils sorted into PESD groupings and are currently analyzing the groupings spatially. Existing habitat type correlations are being digitized and will be used as an additional check for consistency on our PESDs. To the right is a snapshot of part of MLRA 90AB showing some soil groupings into PESDs.



Provisional ecological site descriptions.

Soils Education & Research at UW-Platteville

By Christopher Baxter Ph.D., Nutrient Management Specialist, UW-Extention and University of Wisconsin-Platteville

Use of Soil Survey Information in Education

Many courses at UW–Platteville utilize soil survey information. Within the School of Agriculture, these include Crop Science, Soils, Soil Morphology and Classification, Nutrient Management, Introduction to Reclamation, Environment and Conservation, GIS/GPS and Mapping and Wetlands Ecology, Restoration and Management. Additional courses in the geography and civil and environmental engineering programs also regularly use soil survey information.

Soils-Related Research and Outreach

Dr. Chris Baxter is continuing research in collaboration with colleagues at UW–Madison on soils affected by historic lead and zinc mining in Southwest Wisconsin. Current work includes laboratory incubations and greenhouse experiments to determine the effectiveness of various soil amendments at reducing zinc phytotoxicity. A trial will be established in spring 2018 to determine effectiveness of amendments at reducing zinc phytotoxicity under field conditions. Dr. Baxter is also continuing research on nutrient uptake in hops, with the intention of using this information to develop better recommendations for local hop growers, assists with regional and statewide nutrient management training programs, and develops soils-related educational programming for local educational efforts such as the Grant county “Day on the Farm”.

Dr. Yari Johnson guides undergraduate research projects on the creation of a GIS model using soils data to map potential wetland restoration sites and studying the effects of fire and other restoration practices on soil microbial activity and decomposition.

Dr. Muthu Venkateshwaran’s research focus on understanding the molecular mechanisms controlling plants’ associations with symbiotic organisms, such as rhizobia, endo- and ecto-mycorrhizal fungi. His research projects also focus on unraveling plant defense signaling pathways, specifically, investigating the role of volatile organic compounds released by plant growth promoting rhizobacteria (PGPR) as elicitors of plant defense signaling.

In addition the UW–Platteville Pioneer Farm research efforts led by Dr. Dennis Busch continue to investigate the effects of management practices on soil and agricultural runoff quality as part of the USDA ARS Long-Term Agroecosystem Research (LTAR) network.

Extra-Curricular Activities

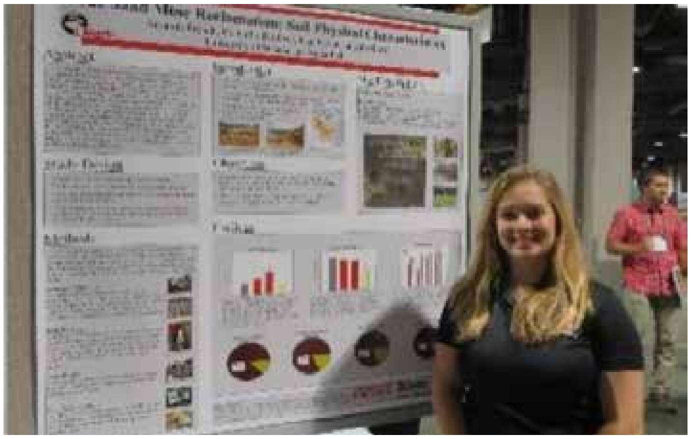
The UW–Platteville Collegiate Soils Team placed third among 24 teams that competed in the 2017 National Collegiate Soils Contest (NCSC) hosted by Northern Illinois University. Students Daniel Brumm and Lea Koning placed among the top ten individuals out of the 93 students competing. The team also competed in and placed third among eight teams competing in the National Association of College Teachers in Agriculture (NACTA) soils competition hosted by Kansas State University. In the regional competition hosted by the University of Wisconsin-Whitewater, UW–Platteville placed second and qualified for the 2018 NCSC hosted by the University of Tennessee–Martin. The team also plans to attend the NACTA competition, hosted by Northeastern Community College in Norfolk, NE.

Soil Science Program at UW–River Falls

By Holly Dolliver Ph.D.

Our Program

At UW–River Falls, we offer a degree in Crop and Soil Science with options/tracks in Crop Science, Soil Science and Sustainable Agriculture. We currently have approximately 75 undergraduate students in the major with around 20 students in the Soil Science option. Within the Soils option students can focus their coursework on either agricultural or environmental soil science. Our Introductory Soils course is a foundation course for the College of Agriculture, Food and Environmental Sciences and teaches approximately 200 students per academic year. This course has been revamped and is taught at the freshman level to introduce students to soil science early in their academic career and encourage them to take further soils coursework.



Co-Curricular Activities and Soil Judging

Students have an opportunity to participate in the Crops and Soils Club, which is one of the most active undergraduate student organizations on our campus. The club hosts social and professional activities (speakers, field tours, etc.) and is a member of the national student organization (Students of Agronomy, Soils and Environmental Sciences) affiliated with the Soil Science Society of America. Each year we sponsor 15–20 students to attend the national conference to present research, listen to presentations and participate in tours and other activities.

We have a long tradition on our campus of participation in collegiate national soil judging. The team is coached by Dr. Holly Dolliver and currently trains 10–15 students each year to participate in the North American Colleges and Teachers of Agriculture (NACTA) competition each spring.

Research Activities

The Soil Science faculty are actively involved in research projects in the region. Many of these research activities provide valuable training and career development for undergraduate students. Current research studies include manure management and the effect of soil fertility and soil health. Soil quality pre- and post-frac sand mining, soil health as it relates to short and long-term conservation practices and conservation initiatives coupled with renewable energy projects.

Soil Science at UW–Whitewater

By Peter Jacobs Ph.D., Department Chair, Professor

Soil science at UW–Whitewater is part of the Geography, Geology and Environmental Science Department. There is no full curriculum in soil science, but students from across campus are exposed to soil science principles in physical geography, which is taken general education lab science course. As part of the course, students have two labs with a soils focus. Majors and minors have the option of taking a single course titled soil science (Geography 300) that is a mix of basic soil science principles and pedology. In this course students complete a field project where they apply GPS and GIS skills from other classes to soil science to analyze the spatial variation of soil organic carbon (SOC) in the 40 acre woodlot in our campus nature preserve. Random points assigned by the GIS are navigated to by GPS, where the students collect site information, A horizon characteristics, and a sample for SOC and pH measurement in the lab. The data are entered into an attribute table that is used to produce maps and scatterplots that are the basis of their report on controls of SOC storage in the landscape.

UW–Whitewater also hosts a Collegiate Soil Team, with students who have completed the soil science course eligible to participate and travel to the Regional Collegiate Soils Competition each fall. Nearly complete turnover of the team each year means the UW–Whitewater team isn't competitive for a top placing, but the students that participate gain valuable experience in describing soils in a different soil landscape region. UW–Whitewater hosted the Regional Soils Competition in October 2017, bringing schools from the region to the carbonate-rich glacial sediments of southeast Wisconsin. For a week in October, students studied soils formed in glacial sediments including till, outwash, and lake sediment in Jefferson County, and a loess-mantled drumlin landscape in southern Dodge County. NRCS provided tremendous support through judges Karla Petges and Jeremy Ziegler, along with pit monitors.

Research projects in soil science at UW–Whitewater primarily focus on soil geomorphology and loess in Wisconsin. Active projects include: (1) weathering characteristics of a loess-paleosol sequence in the Driftless Area; (2) controls on SOC storage in uncultivated forest topsoils; and (3) Differences in A horizon clay mineralogy of native prairie and adjacent ag fields. In addition, (4) I have just begun a collaboration with NRCS soil scientists from Juneau to install automated shallow groundwater monitoring devices.

The longest known loess-paleosol sequence in the Upper Mississippi Valley is located in the Kickapoo Valley near Oil City, in southern Monroe County. The site is located on an interfluve nestled below the uplands but well above the river floodplain and contains eight lithologic units with 5 buried soils, all with normal remanent magnetism (i.e., <780 ka). The units are a mix of colluvium and loess, with loess dominating the upper part of the sequence. Previous work I did for my Master's thesis characterized the stratigraphy, pedology, micromorphology, and clay mineralogy of the section (Jacobs and Knox, 1994). In addition to good facilities for x-ray diffraction work, UW–Whitewater recently acquired a portable x-ray fluorescence (pXRF) device and I am using both tools to investigate weathering of the 8-63 µm silt fraction using x-ray diffraction (XRD) and elemental geochemistry by portable x-ray fluorescence (pXRF). The results will be published in a special issue of Quaternary Research early in 2018 (Jacobs and Davis, 2018). The issue will contain papers from the LoessFest2016 conference held in Eau Claire. With the help of an undergraduate research student, we are finishing up duplicate (XRD) and triplicate (pXRF) analyses of the samples to finish drawing our conclusions. The geochemistry supports original interpretations that the paleosols show interglacial-scale mineral weathering namely though depletion of Ca plagioclase minerals. The paleosol beneath the Sangamon Soil is formed in a loess unit with the greatest degree of weathering, which allowed a more reliable correlation with the Yarmouth Soil and the Crowley's Ridge Silt of the Middle Mississippi Valley.

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WHITEWATER

The project investigating the controls on SOC storage in uncultivated forest topsoils is a slowly-progressing project that I have worked on as sampling opportunities arise. I collect bulk density samples and am looking at correlations between SOC content and basic soil characteristics (particle size fractions, pH, clay mineralogy, base cations, and depth to free carbonates when I can determine that). From about 30 samples analyzed, the strongest predictors are pH and Ca content, which point to Ca bridging to stabilize humus compounds. Interestingly, of the particle size fractions, silt is a predictor while clay content shows no correlation with SOC.

A new project is looking at differences in the clay mineralogy of A horizons in well drained native prairie versus adjacent ag fields. I only have a few samples collected so far and have barely analyzed the differences, but I will be on sabbatical next academic year and plan to work on this project in earnest. If any collaborators reading this volume know of any potential study sites where I could gain access to sample, please contact me. The sample volume needed is small and can be done with an Oakfield probe.

Finally, UW-Whitewater has begun a collaboration with the NRCS area soil scientists in Juneau. The goal of the project is to identify duration and the depth of saturation in soils displaying SWPD morphology. We have identified two sites in Jefferson County with suitable soils that have never been cultivated. A well was installed this fall at one site and the other site will be established in the spring.

Citations

Jacobs, P.M. and Knox, J.C. 1994. Provenance and pedology of a long-term Pleistocene depositional sequence in Wisconsin's Driftless Area. Catena 22: 49-68.

Jacobs, P.M. and Davis, A.T. 2018. Mineralogical and geochemical evidence of weathering in a mid to late Pleistocene paleosol sequence in the Driftless Area of Wisconsin. Quaternary Research, in press.

Understanding Wetland Condition and Wetland Soils at a "Deeper" Level

Partner Project Allows NRCS and Wisconsin–DNR to Achieve Common Conservation Goals

By Aaron Marti, Wisconsin DNR

Very rarely does having two or more problems to overcome have a better outlook than having just one problem—but sometimes, it's the ability to make opportunity happen from such difficulties that results in creative solutions and a much better outlook than a singular solution to any of the individual problems. A previously unlikely recent partnership between the Wisconsin Department of Natural Resources, Wisconsin NRCS, and the NRCS National Soil Science Lab attempts to do just that—the old adage of "making lemonade" when life gives you lemons—or in other words, leveraging the resources, experience, and expertise of one another to creatively address ongoing issues and data gaps in natural resources conservation through rigorous science and "a few grams of grit".

After nearly two decades of work, Wisconsin will soon have a way to objectively and quantitatively measure and monitor the condition of wetlands across the State as the Wisconsin Department of Natural Resources Wetland Monitoring and Assessment team nears the final stages of completing the Wisconsin Wetland Floristic Quality Benchmarks Study. Just as water quality biologists use fish, macroinvertebrates, diatoms and/or aquatic plants to monitor the condition/biotic integrity of lakes, rivers, and streams, wetland plant communities may arguably be effective indicators of wetland ecological condition. The overall objective for the study is to create EPA Tiered Aquatic Life Use (TALU) Benchmarks for every major wetland natural community type in each of the four main EPA Omernik Level III Ecoregions of Wisconsin--the Driftless Area, the Southeast Wisconsin Till Plains, the North Central Hardwood Forests, and the Northern Lakes and Forests. From 2012-2017, over 1,000 wetlands statewide were assessed to determine plant community condition and assess potential anthropogenic disturbances using a qualitative disturbance factor checklist. For wetland natural community types which show an inverse relationship with disturbance, floristic quality benchmarks will be calculated so that the condition of wetlands can be assessed—whether comparing one wetland to other wetlands of the same natural community type within a given region, or for assessment of overall wetland condition at watershed, ecoregional, or other scales.

However, these benchmarks are underpinned by qualitative field assessments of currently observable anthropogenic disturbance. Hence, historic disturbances (e.g. prior use of wetlands for agriculture, pasturing, timber harvest, etc.) or chronic

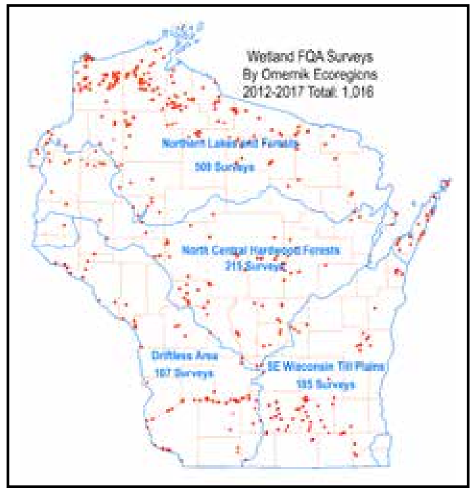
Aaron Marti (Wisconsin DNR wetland assessment research scientist-Right) and Ken Thompson (Thompson's Soil and Environmental-Left) work together to sample soils of a remote open bog wetland near White Sand Creek (near Boulder Junction, Wisconsin). Photo: Aaron Marti, Wisconsin DNR.

disturbances (e.g. nutrient or chloride loading from point/non-point sources to wetlands) which likely continue to affect wetland condition are not easily accounted for using current available approaches. Further, disturbance metrics (often Best Professional Judgement- or GIS-derived) are arguably broader proxies for changes to quantifiable in-wetland physicochemical variables from current disturbances which may directly affect wetland condition—much like changes in land use at the watershed level would be proxies to changes in the physicochemistry in a stream or lake that are causing biological impairment.

In other words, current understanding of the relationships between wetland disturbance and wetland biological integrity is still much of a "black box"—where it has been demonstrated that anthropogenic disturbance overall affects the biological integrity of wetlands, but comprehension of the effects of historic and current disturbances on actual in-wetland mechanisms that directly affect biotic communities is lacking.

A recent partnership works towards "shining light" into the "black box" of wetland condition. In early 2017, Aaron Marti (WDNR wetland assessment research scientist) and Jason Nemecek (Wisconsin NRCS State soil scientist) submitted and were approved for an NRCS State Technical Soil Services project with the NRCS National Soil Science Laboratory. The overall objective of the Wisconsin Wetland Floristic Quality Benchmarks Extension project was to collect data on wetland soil physicochemical properties across the State of Wisconsin. WDNR and Wisconsin NRCS agreed to cover all aspects of field logistics for the project and the Lab agreed to provide laboratory analytical assistance and other technical assistance as necessary. During Summer 2017, Aaron and a contractor (Ken Thompson- Thompson's Soil and Environmental: New London, Wisconsin) conducted representative soil profile descriptions and sampled surface soil physicochemistry, water chemistry (when available), and diatoms at nearly 120 sites previously surveyed as part of the Wisconsin Wetland Floristic Quality Benchmarks Study in the Northern Lakes and Forests and North Central Hardwood Forests Ecoregions. Concurrently, other members of the WDNR Wetland Monitoring and Assessment Team collected representative surface soil samples while conducting further wetland floristic quality benchmark surveys within the Driftless Area and Southeast Wisconsin Till Plains ecoregions. Twenty-four boxes carrying nearly 500 pounds of air-dried soil (literally an entire mini-van full!) from nearly 350 wetland sites across Wisconsin arrived at the NRCS National Soil Science Laboratory shortly after the New Year for a full suite physicochemical analyses.

Upon competition of lab analyses, Aaron will begin to analyze relationships among soil physicochemistry, anthropogenic disturbances, and floristic metrics by wetland natural community type and broad wetland vegetation classes at ecoregional and statewide scales. While the Wisconsin Wetland Floristic Quality Benchmarks will be calculated using percentile-driven approaches to create suggested condition tiers (a standard method employed by EPA for setting biological criteria), a second report detailing floristic benchmarks/condition tiers derived using disturbance and ecological (soil and water physicochemical) gradients rather than simple percentile based approaches is another anticipated outcome of the Extension project. Threshold Indicator Taxa Analysis (TITAN) is planned as the primary analysis to derive these gradient-based benchmarks, but the analysis will likely include other uni- and multi-variate approaches as well. Wisconsin NRCS will incorporate soil physicochemsitry data into their existing soil databases to fill in existing gaps in various wetland soil series, which have historically been undersampled not just in Wisconsin, but nationwide. In addition, NRCS will use plant data collected by WDNR to assist with Ecological Site Descriptions (ESDs).



A map of wetland sites surveyed as part of the Wisconsin Wetland Floristic Quality Benchmarks Study. Map Courtesy of Chris Noll, Wisconsin DNR.

Typical conditions for describing and sampling soils in wetlands in Wisconsin. A representative soil profile is described from a pit excavated using a sharpshooter and open-face bucket auger. Photo from a Shrub Carr on Lake Superior Red Clay Plain soils, mapped as Bergland Soil Series (near Superior, Wisconsin). Photo: Aaron Marti, Wisconsin DNR.

Disturbances to wetlands, even in remote places, take on a variety of forms. Here, an ongoing road project near the Bayfield-Douglas County line will likely change the hydrology of a once minimally-disturbed Northern Hardwood Swamp located in the floodplain headwater wetlands complex of the Poplar River. Natural disturbances, although less evident, will also likely affect the future condition of this wetland complex (dead trees in upper left are Green Ash with probable Emerald Ash Borer damage). Photo: Aaron Marti, Wisconsin DNR.

This project highlights the importance of communication and collaboration across "traditional boundaries" in order to achieve sound conservation, monitoring, and assessment of our lands, waters, and the uniquely diverse areas that form the area between them—wetlands. Together, WDNR and NRCS are working to achieve mutual conservation goals across professional/disciplinary, watershed, ecological, soil survey and political boundaries for Wisconsin in new ways, and we hope this is just the beginning.

Finding least-disturbed wetlands isn't always easy! This remote Northern Sedge Meadow, located near Moquah Lake (Ashland Co., Wisconsin) was over a mile as-a-crow-flies from the nearest paved road and required nearly three-miles of foot travel down unmaintained National Forest roads before reaching this beautiful sight on a crisp October afternoon (see insert map at bottom right). Photo: Aaron Marti, Wisconsin DNR.

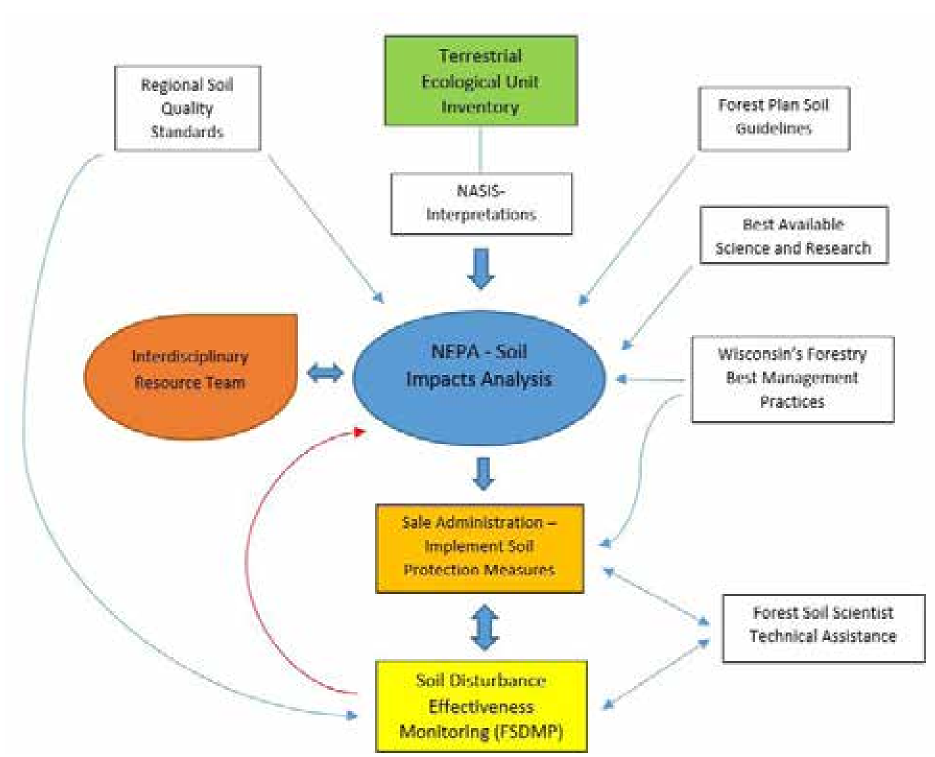
Common Goal of Timber Production and Soil Conservation

By Mark Farina, Forest Soil Scientist

Chequamegon-Nicolet National Forest and Wisconsin-DNR Partner with Common Goal of Timber Production and Soil Conservation

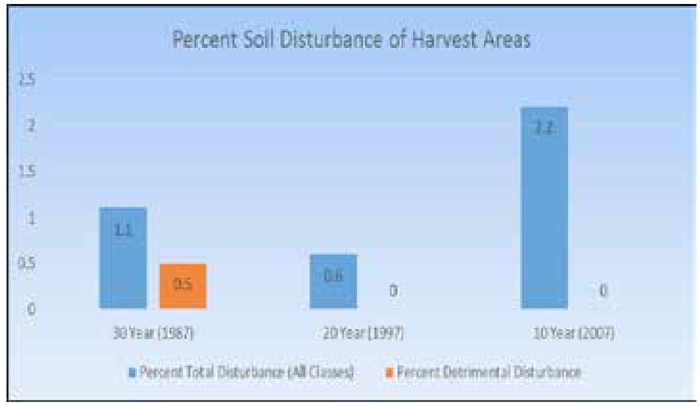
The Chequamegon-Nicolet National Forest (CNNF) has been the top timber producing forest for the past several years. Producing well over 100 million board feet of timber annually, it is home to some of the hardest working forested soils in the National Forest System. The unique combinations of parent material, drainage and seasonal weather patterns makes managing these soils especially difficult at times. The ultimate goal for soil management on the CNNF is to provide the desired physical, chemical, and biological processes and functions to maintain and improve soil productivity.

The CNNF has a long and successful history of utilizing ecologically based soils information to apply soil protection measures on the ground. The utilization of soils information on the CNNF starts with the Terrestrial Ecological Unit Inventory (TEUI), which is a hierarchical classification system. With help from the Natural Resources Conservation Service (NRCS), this system is linked to the NASIS database to create various broad-based forestry interpretations which are used in NEPA-based project planning. After the NEPA plan has been approved, a complete soil effects and management plan is implemented on each acre of managed land. After project implementation, effectiveness monitoring is then used to ensure that the project design and associated soil protection measures were successful. This is what sets Federal level forest soil management apart from others.



Soil resource flow path showing typical dissemination of soils information from the TEUI level down through the planning and implementation levels on the Chequamegon-Nicolet National Forest.

With increased timber harvest comes the potential increase of soil disturbance in the form of nutrient loss, rutting, compaction, erosion, and displacement. History has taught us that, unless carefully managed, all of these disturbances can lead to decreased soil productivity. Through several pieces of legislation, the CNNF has a legal obligation to ensure soil productivity is maintained, and we do this by implementing a comprehensive soil disturbance monitoring plan. By monitoring soil disturbance soon after harvest and decades later, we are able to show the effectiveness of current and past soil protection measures under different management and soil types.



The following graph illustrates monitoring results for a 30 year chronosequence on our rich mesic indicator soil type. The two key features of this graph show 1) positive soil amelioration through time, and 2) a relative spike (less recovery) at 30 years, which is attributable to relic disturbance from the 1986 Forest Plan that had less effective soil protection measures. These results show that current management techniques promote sustainability and that our current management plan is more effective. These results were based on a sample size of 546 locations at 75% confidence per Forest Soil Disturbance Monitoring Protocol (FSDMP).

The FSDMP developed by USDA Forest Service is a statistically accurate and rapid tool for measuring soil disturbance in the field. With years of soil monitoring data across many soil types, we have been able to develop performance based disturbance thresholds that allows us to confidently measure and report soil impacts; information that we are in-fact properly executing timber harvest activities that do not negatively impact both short and long-term soil productivity.

CNNF forest soil scientist Mark Farina monitoring post-harvest rutting depth and structural change (compaction).

Recently we have partnered with the Wisconsin Department of Natural Resources through Good Neighbor Authority to help achieve timber volume targets and better meet management objectives. Essentially the State will help administer portions of our timber sales which will allow the Forest Service to recuperate and return to the forest otherwise lost sale profits in the form of stewardship work. As mentioned previously, timber harvest operations on local, State, and private lands are not required to meet standards from the National Environmental Policy Act (NEPA)- as such, they are not upheld to the same soil quality standards as Federal lands. Early in our partnership with the State, concerns were raised that detrimental soil disturbances, typically in the form of rutting and compaction, could possibly be overlooked on these contracts resulting in negative outcomes on the overall CNNF monitoring program. In response, myself and other Federal and State resource professionals met in the field through timber harvest sale reviews, and together examined how certain soil types (properties) performed under actual management at the sale administration level. On CNNF lands it is imperative that timber sale administrators have the knowledge and skills to carry out logging operations while protecting the soil resources. Typically on the CNNF timber sale administrators work internally with forest soil scientists to do this. However, with more sales being administered under contract, there has recently been an increased need for the CNNF soils program to better define, outreach, and help guide soil quality standards at the field level. Through this partnership we were able to produce a soil quality and monitoring guidance document for the benefit of all. Although we do utilize NASIS interpretations to help base broad soil management decisions, especially at the NEPA level, successful sale administration that fully protects soil productivity is typically developed by field-gained experience and knowledge at a much larger scale. For example, only professional judgment based on experience and a good working knowledge of local soil properties can be used to estimate how much of a precipitation event would be justifiable in proactively and unilaterally shutting down a large scale operation at the operator's expense. Also, only local soil knowledge allows a sale administrator to mentally disaggregate components of a soil map unit for best skid trail designation.

Field collaboration with the State also included discussions on Wisconsin's Forestry Best Management Practices to protect soil and water resources. Lead by the State these practices have proven to be the "gold standard" in decreasing erosion and sedimentation from logging practices into streams and wetlands.

The CNNF and Wisconsin DNR have been successful at forming a mutually beneficial partnership that not only carries out an obligation to get timber to market, but also fully utilizes TEUI/soils information and a comprehensive soil disturbance monitoring program for protecting and sustaining our soil resources.

Federal and State GNA Sale Review: Left to Right: Karl Welch (CNNF Contracting Officer), Tom Piikkila(DNR Forester), Casey Krogstad (CNNF Forester), Jerod Carothers (District Silviculturist), Colleen Matula(DNR Sivilculturist), Mike Martin (District Ranger), Jeff Olsen(GNA), Nolan Kriegel (LTE), Pete Wisdom(NFL), Tim Friedrich(NFL), Dave Kafura(DNR Hydrologist), Mark Farina(CNNF soil scientist).

Mark Farina (CNNF forest soil scientist), James Kujala (Wisconsin–DNR Sale Administrator), Karl Welch (CNNF Contracting Officer) discussing skid trail layout and rutting.

FarmLab Research Will Explore Interactions of Land Cover and Management on Measures of Soil Health

By Alison Duff, Kristin McElligott, Jon Bleier and Kris Niemann, USDA Dairy Forage Research Center

The FarmLab is a new initiative of the US Dairy Forage Research Center, based at our Prairie du Sac research farm. FarmLab will serve as a farm-scale laboratory for study of the long-term economic, environmental, and social outcomes associated with land use and farming practices.

Stewardship of soil resources is critical to long-term farm sustainability. Consequently, soils research is a priority for the FarmLab team. In 2018, we will be installing a soil monitoring network at our Prairie du Sac research site that will provide a framework for periodic assessment of soil parameters and their interaction with land cover and land management practices. An early partnership with the Juneau MLRA Soil Survey Office is informing our sampling design, which includes stratification by soil series.

The initial objectives for our soils research are to estimate the baseline status of soil organic carbon and other soil health indicators, and to monitor changes in these soil indicators over time, and in response to land cover or management changes. This work will aid in national and regional long-term soil monitoring efforts, and provide a platform for soils research with collaborating partners.

FarmLab is also intended to provide opportunities for farm-scale demonstration. We look forward to future collaboration with NRCS and other partners working to provide management recommendations and resources for agricultural producers.

Agricultural Research Service

Determining Depth to Bedrock at the Wisconsin Geological and Natural History Survey

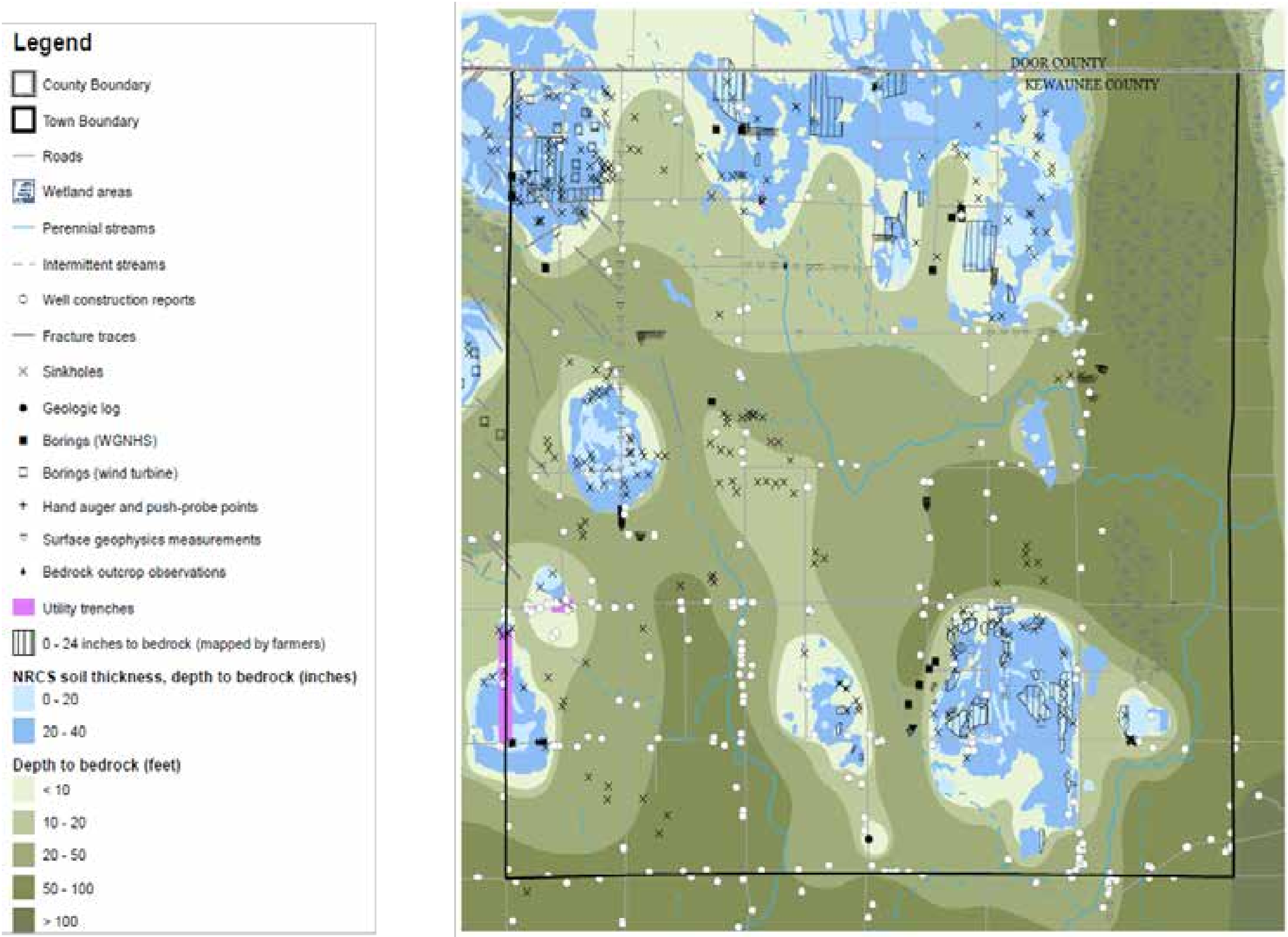
By David Hart and Michael Parson

Depth to bedrock is an important parameter for land use planning and regulation. Soils often slow and attenuate contaminants that might otherwise enter groundwater flow systems. In response to this need, the Wisconsin Geological and Natural History Survey routinely creates depth-to-bedrock maps incorporating soil thickness information from NRCS.

To create a depth-to-bedrock map, we incorporate multiple sources of information including traditional tools such as backhoes and soil augers to remote sensing and geophysics. A new map of the Town of Lincoln in Kewaunee County, Wisconsin (see http://wgnhs.uwex.edu/pubs/000952/) is an example of a WGNHS depth-to-bedrock map that used multiple data sources and methods. To construct this map, we used traditional data sources such as well construction reports and geoprobe borings to refusal, NRCS soils maps, and previously published depth-to-bedrock maps. We also incorporated construction data from wind farms and trenches used for gas piplines. We used several geophysical data sources such as electrical resistivity imaging, passive seismic and ground penetrating radar. Last, we applied remote sensing information to identify shallow bedrock in air photos and LIDAR data.

Depth-to-bedrock maps are interpretations of available data that were collected for a specific purpose. Considering that the data collection purpose is rarely to construct a regional depth-to-bedrock map, the value, limitation, and error of each data source needs to be carefully considered. For example, well construction reports provide point data of bedrock depth. They are common and easily obtained. However, their exact locations are often known only to within several hundred feet, creating error in areas with significant topography. Moreover, the exact top of bedrock can be difficult to determine especially if there is a gradual transition from soil to bedrock. NRCS soils maps are invaluable for mapping depths to bedrock but are used with some caution because they were created primarily to represent soils, not necessarily bedrock depth. Often soil augers meet refusal in lithic soils before actually encountering bedrock. That depth of refusal is perhaps relevant for describing the soils but not necessarily for other uses. Likewise, geophysics can often provide estimations of bedrock depth over a linear distance but has a much greater error in the depth estimation when compared to data from a backhoe. Finally, a trained soil or earth scientist, who applies knowledge of how soils form and bedrock erodes, is essential for synthesizing the available data into an interpretation of bedrock depth. As our knowledge of those processes grows and the tools and data needed to make the maps improve, we expect to create more accurate maps to meet societal needs.

Location map showing the mapped study area.



Town of Lincoln, Kewaunee County, Wisconsin – Depth-to-bedrock Map

Wisconsin Society of Professional Soil Scientists (WSPSS)

By Phil Meyer

The Wisconsin Society of Professional Soil Scientists (WSPSS) is a statewide non-profit organization of soil scientists involved in the fields of classifying and interpreting soils. The Society was founded in 1971. WSPSS members include people working in private consulting soil firms, academic institutions, State and Federal agencies, county land use managers, non-profit organizations and land conservation departments.

Purpose

1. Provide a statewide organization for soil scientists from various specializations.
2. Promote communication among soil scientists.
3. Provide a forum for the continuing education of soil scientists.

Benefits and Opportunities

Members attend the annual meeting held in the fall each year. The meeting consists of a business session, election of officers, lunch and an informative speaker. An educational meeting in the spring of each year. This meeting consists of an informative program on subjects relating to the field of soil classification and interpretation. A field trip is often planned. Members have opportunities to meet and interact with fellow soil scientists on a professional and social basis.

Website: www.wspss.wordpress.com

"Pedon Vault" App: Soil Profiles at Your Fingertips

Scientists, educators, farmers, anyone interested in soils, have you ever tried to learn about your local land by looking at a cross section of your soil, known as a soil profile, only to realize the sample doesn't have the layered exposure you were looking for? Soil profiles with good exposure usually show darker soil near the top of a cross section, and lighter soils below. When exposed, various soil horizons or layers of soil are seen. Each horizon holds physical, chemical, biological, and mineral differences.

Screen view of the new Pedon Vault app.

The USDA Natural Resources Conservation Service (NRCS) in Wisconsin and the NRCS National Soil Survey Center have made available a new app, Pedon Vault, the first of its kind, to offer a national database of sites to visit in the field offering good exposures of soil profiles and data. Thus, the app name, Pedon Vault, a vault of three-dimensional samples of a soil large enough to show characteristics of all its horizons.

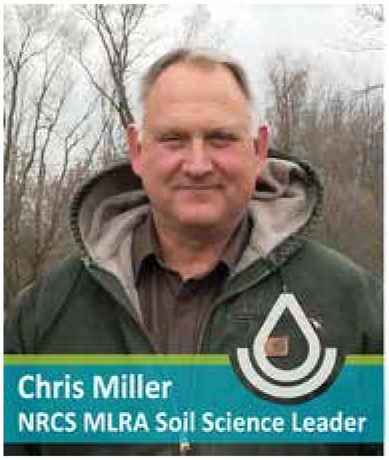
"Pedon Vault give users, nationwide, a means to share data by populating a national database of sites that can be used by educators, scientists, farmers, landowners, schools, soil judging teams, the general public, and many more," said Wisconsin State soil scientist, Jason Nemecek. The app records soil exposures across the country and populates a national database. Interested users can then visit sites in the field with good exposures of soil profiles with data available at their fingertips.

"Pedon Vault application offers valuable insight into soil profiles and is a great first step toward citizen science involvement with the national soils program," said David Hoover, NRCS Director of the National Soil Survey Center. Pedon Vault allows users to download and keep local surveys housed in the app for review and use. Users are able to record, document, and upload photos, share, and update soil profile data around the country. Users can also pinpoint locations using location panels, full screen maps, and latitude and longitude for current locations. Map and text settings are also customizable in the app.

A step-by-step user guide with application screenshots is available on the NRCS Wisconsin Soils Homepage. If you are interested in downloading the application, review specific steps in the user guide. For more information about soil tools available for use and how NRCS can assist you, visit the NRCS National Soils Homepage.

An Introduction to Soil Survey and MLRA

Growing Education Video Series



Listen to our very own NRCS Major Land Resource Area (MLRA) Soil Science Leader, Chris Miller, discuss soil survey and MLRA covering parts of Wisconsin, IL and MI. Learn about the history, current projects affecting your area, recent advancements, and more in this new video: https://www.youtube.com/watch?v=c1kVMR9Ar6I.

Please subscribe to the NRCS Wisconsin YouTube Channel for more educational videos coming soon.

For more information and local NRCS contacts, visit the NRCS-Wisconsin MLRA website: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wi/soils/surveys/?cid=nrcs142p2_020878.

Cooperative Soil Science Tools

Web Soil Survey

http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Soil Data Access

http://sdmdataaccess.nrcs.usda.gov/

Soil Data Access is the name of a suite of web services and applications whose purpose is to meet requirements for requesting and delivering soil survey spatial and tabular data that are not being met by the current Web Soil Survey and Geospatial Data Gateway websites.

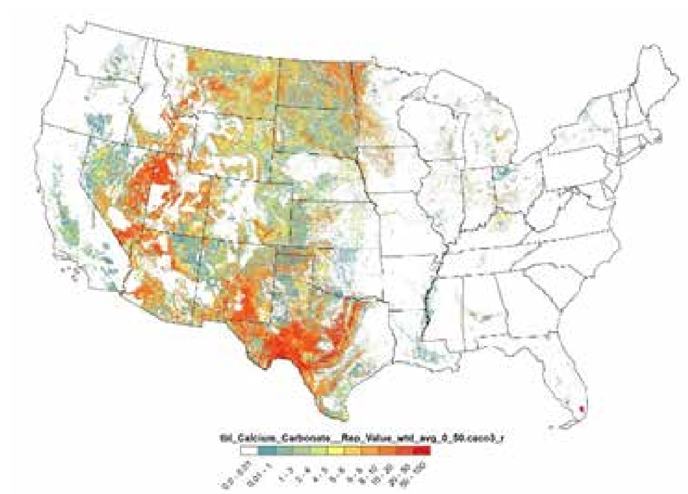
The New NRCS "Pedon Vault" App: Soil Profiles at Your Fingertips

http://www.nrcs.usda.gov/wps/portal/nrcs/main/wi/soils/

Scientists, educators, farmers, anyone interested in soils, have you ever tried to learn about your local land by looking at a cross section of your soil, known as a soil profile, only to realize the sample doesn't have the layered exposure you were looking for?

The NRCS in Wisconsin and the National Soil Survey Center have made available a new app, Pedon Vault, the first of its kind, to offer a national database of sites to visit in the field offering good exposures of soil profiles and data. Thus, the app name, Pedon Vault, a vault of three-dimensional samples of a soil large enough to show characteristics of all its horizons.

SSURGO OnDemand: NEW Soil Data Viewer Alternative!



http://www.nrcs.usda.gov/wps/portal/nrcs/main/wi/soils/

The SSURGO OnDemand Dynamic Spatial Interpretations Tool can process soils data from large geographic areas rapidly and is a one-stop shop for any number of soil survey areas at once for any and all interpretations or properties. It accesses authoritative soils data without the need for downloading external tabular data sets.

Please direct questions and comments to:

Chad Ferguson at charles.ferguson@nc.usda.gov or
Jason Nemecek at jason.nemecek@wi.usda.gov.

Soil Lab Data: Lab Data Mart

http://ncsslabdatamart.sc.egov.usda.gov/

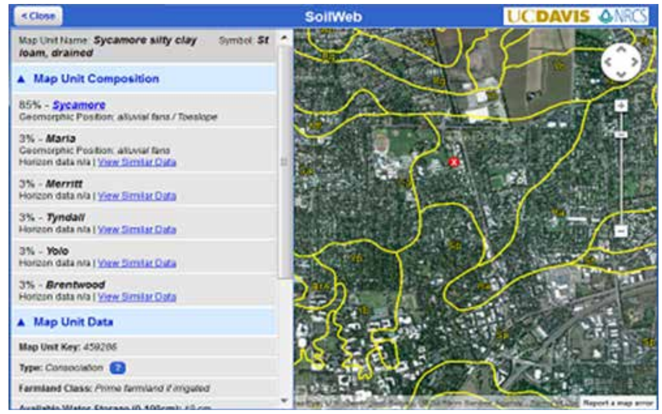
The National Cooperative Soil Survey (NCSS) Soil Characterization Database. This application allows you to generate, print, and download reports containing soil characterization data from the National Soil Survey Center (NSSC) Kellogg Soil Survey Laboratory (KSSL) and cooperating laboratories. The data are stored and maintained by the NSSC–KSSL. Data can be viewed on-screen or downloaded in comma-delimited text files for use in other applications.

SoilWeb

https://casoilresource.lawr.ucdavis.edu/gmap/

SoilWeb products can be used to access USDA NCSS detailed soil survey data (SSURGO) for most of the United States. Please choose an interface to SoilWeb:

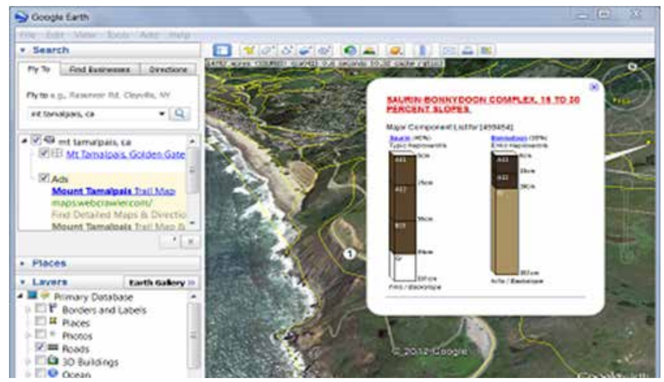
Explore soil survey areas using an interactive Google map. View detailed information about map units and their components. This app runs in your web browser and is compatible with desktop computers, tablets, and smartphones.



SoilWeb Earth

http://casoilresource.lawr.ucdavis.edu/soil_web/kml/SoilWeb.kmz

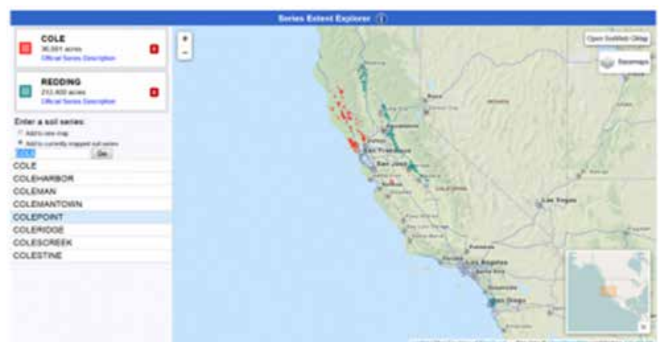
Soil survey data are delivered dynamically in a KML file, allowing you to view mapped areas in a 3-D display. You must have Google Earth or some other means of viewing KML files installed on your desktop computer, tablet, or smartphone.



SEE: Soil Series Extent Explorer

https://casoilresource.lawr.ucdavis.edu/see/

SEE allows users to explore the spatial extent of soil types nationwide.

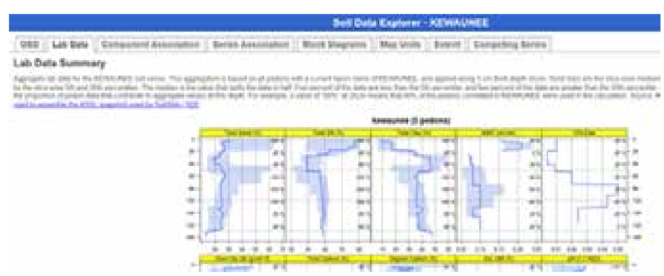


SDE: Soil Series Data Explorer (SDE)

https://casoilresource.lawr.ucdavis.edu/sde/?series=Kewaunee

https://casoilresource.lawr.ucdavis.edu/sde/?series=Manawa

This website is accessible via SEE (see above), or can be used by appending a soil series name to the end of the URL. SDE integrates KSSL, SSURGO, block diagrams, OSD, and SC databases.



SCAN/SNOTEL

http://www.wcc.nrcs.usda.gov/scan/

http://www.wcc.nrcs.usda.gov/snow/

Above and below ground sensor data. The interactive map is the simplest way to search for data.

Official Soil Series Descriptions (OSD)

https://soilseries.sc.egov.usda.gov/osdname.aspx

“Official soil series description” is a term applied to the description approved by the NRCS that defines a specific soil series in the U.S. These official soil series descriptions are descriptions of the taxa in the series category of the national system of classification. They mainly serve as specifications for identifying and classifying soils. While doing survey work, field soil scientists should have all the existing official soil series descriptions that are applicable to their soil survey areas. Other official soil series descriptions that include soils in adjacent or similar survey areas are also commonly needed.

Geospatial Data Gateway

https://gdg.sc.egov.usda.gov/

The Geospatial Data Gateway (GDG) provides access to a map library of over 100 high resolution vector and raster layers in the Geospatial Data Warehouse. It is the One Stop Source for environmental and natural resources data, at any time, from anywhere, to anyone. It allows you to choose your area of interest, browse and select data, customize the format, then download or have it shipped on media.

This service is made available through a close partnership between the three Service Center Agencies (SCA); Natural Resources Conservation Service (NRCS), Farm Service Agency (FSA) and Rural Development (RD).

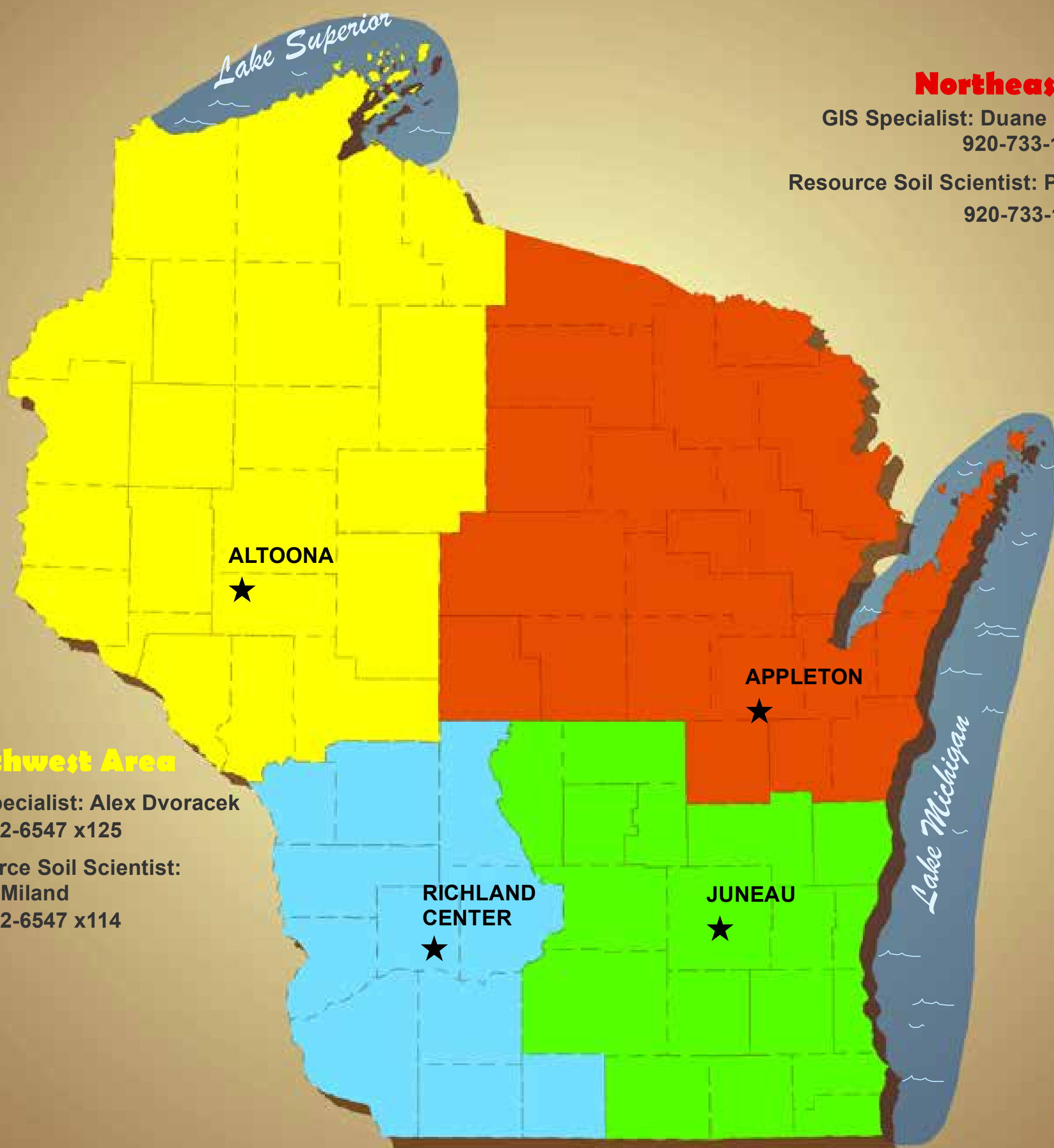
YouTube Channel National Soil Survey Center: NRCS NSSC

https://www.youtube.com/channel/UCqWbDV7-rsBe_dtwm4QqwJA

Videos and webinars for the USDA NRCS National Soil Survey Center which includes the Kellogg Soil Survey Laboratory.

WISCONSIN

Area Specialists



Northeast Area

GIS Specialist: Duane DeVerney
920-733-1575 x124

Resource Soil Scientist: Phil Meyer
920-733-1575 x118

Northwest Area

GIS Specialist: Alex Dvoracek
715-832-6547 x125

Resource Soil Scientist:
Tim Miland
715-832-6547 x114

Southwest Area

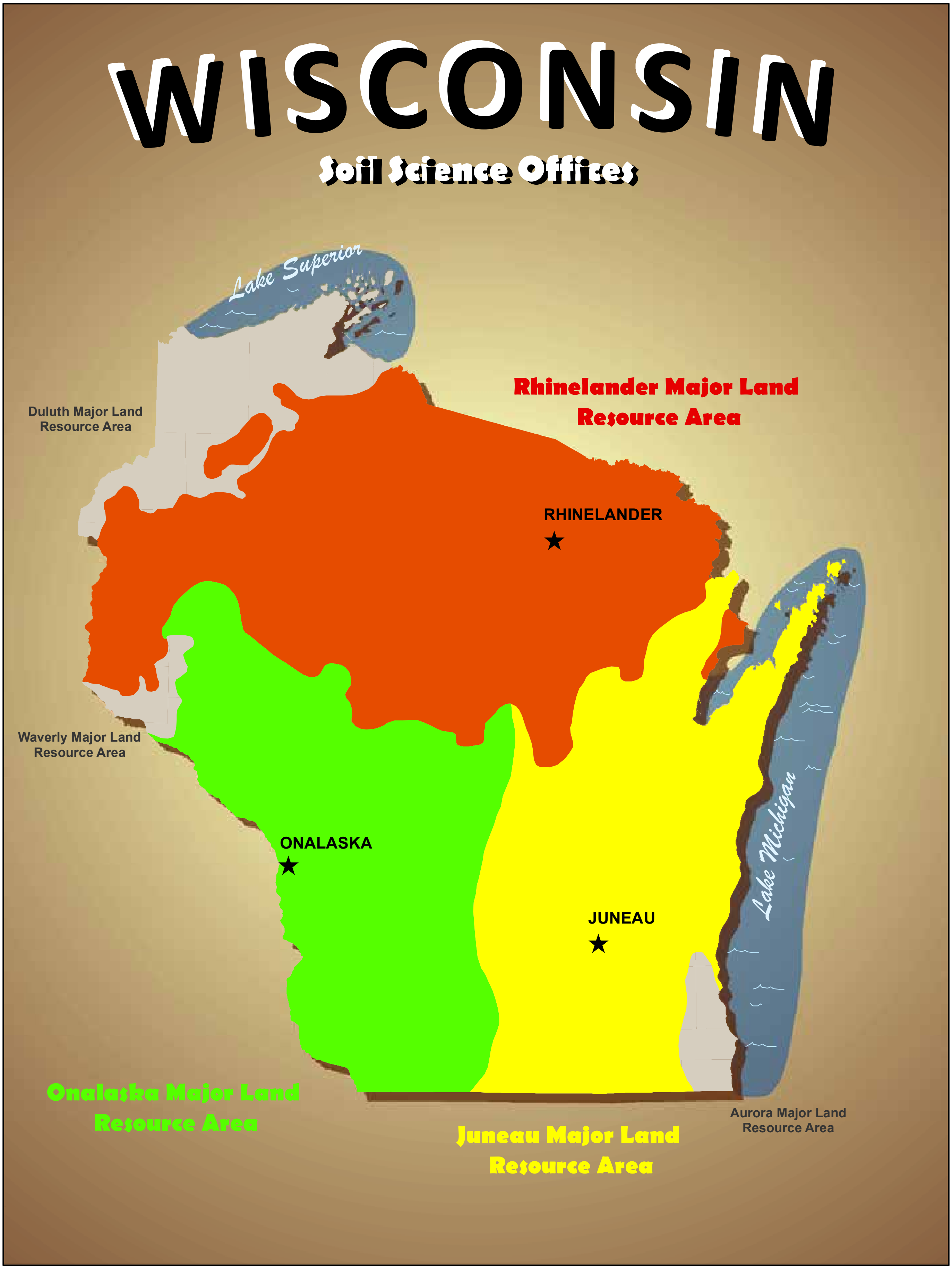
GIS Specialist: Craig Surman
608-647-8874 x131

Resource Soil Scientist:Jeff Deniger
608-647-8874 x116

Southeast Area

GIS Specialist: Vacant
920-386-9999 x109

Resource Soil Scientist:Jeremy Ziegler
920-386-9999 x122


WISCONSIN
Soil Science Offices
Lake Superior
Rhinelander Major Land Resource Area
Duluth Major Land Resource Area
RHINELANDER
Waverly Major Land Resource Area
ONALASKA
JUNEAU
Lake Michigan
Onalaska Major Land Resource Area
Juneau Major Land Resource Area
Aurora Major Land Resource Area





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