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Soil and Plant Science Division

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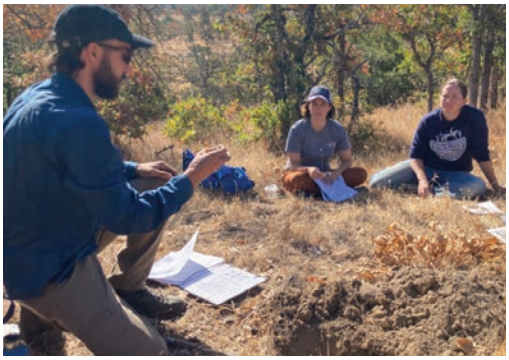
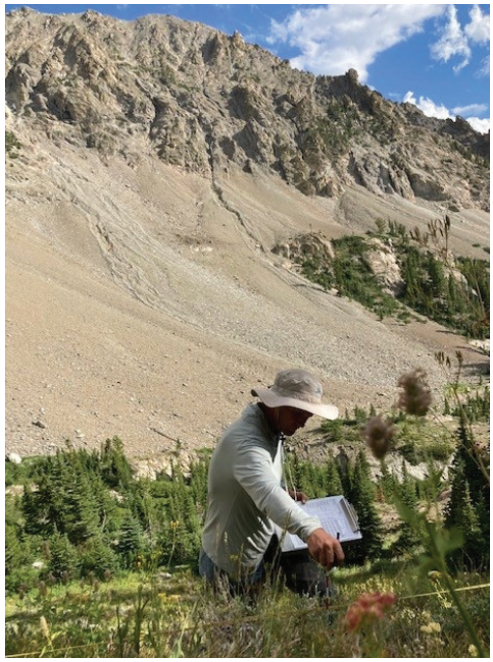


"... I cannot conceive of the time when knowledge of soils will be complete. Our expectation is that our successors will build on what has been done, as we are building on the work of our predecessors."

— R.S. Smith, Director of the Illinois Soil Survey, 1928



Introduction

The Soil and Plant Science Division (SPSD) operates under the USDA NRCS Deputy Chief for Soil Science and Resource Assessment. The SPSD leads the National Cooperative Soil Survey (NCSS) and manages the Soil Survey Program. The NCSS is a nationwide partnership of federal, State, and local agencies, universities, conservation districts, and private-sector organizations. The strength of the NCSS originates from the collaboration of activities at national, regional, State, and local levels to achieve common goals in advancing soil and ecological science across the United States and its trust territories. Activities include investigating, inventorying, documenting, classifying, interpreting, promoting, disseminating, and maintaining soil and ecological site information of the United States and its trust territories. Other joint activities of the NCSS are training, conducting research, administering the PLANTS (Plant List of Attributes, Names, Taxonomy, and Symbols) database, providing technical soil and ecological site services, and supporting USDA Farm Bill programs.

Link to Conservation

The Soil and Plant Science Division (SPSD) coordinates with NRCS State offices to deliver soil, plant, and ecological site information that supports conservation planning, soil health activities, urban sustainability, climate smart efforts, and equitable program and service delivery. The Division is committed to assisting State conservationists by providing soil data to use in the Conservation Assessment Ranking Tool and the Conservation Desktop, the PLANTS (Plant List of Attributes, Names, Taxonomy, and Symbols) database, Food Security Act wetland determinations, and technical soil and ecological site services for a variety of conservation planning efforts.

Conservation Assessment Ranking Tool and Conservation Desktop

The Soil and Plant Science Division (SPSD) has automated conservation data systems and developed soil data automation services for the NRCS conservation planning applications. The development of the Conservation Assessment Ranking Tool (CART), which pairs a vast amount of soil-based decision-support with new technology, is a major data innovation in the Agency. Through the development of CART, the SPSD rapidly accelerated soil data delivery into the conservation planning and ranking process. Many soil interpretations and the methods used to create them fit well with the concepts of resource concerns on a field and the limitations or assumptions that CART uses.

In fiscal year 2023, Soil Data Access (SDA) received 120 million queries (3.8 queries per second) with 5 million of those queries coming from CART. SDA is a suite of web services and applications used to meet requirements for requesting and delivering soil survey spatial and tabular data not met by the Web Soil Survey and Geospatial Data Gateway.

In Conservation Desktop (CD), conservationists use a module in the preplanning process to work with producers on their land. Conservationists can run scenarios and help scope the conservation plan and the options for the producers based on their soil and land capabilities and limitations. Another CD tool that the SPSD developed for the conservation planners is the Nutrient Sensitive Areas Analysis – Soil Sensitivity (nutrient runoff) preplanning tool. Conservationists use this preplanning tool and map to help clients when planning to reduce nutrient runoff from their operations. Conservation planners can select practices and fields to run the sensitivity analysis to help with planning alternatives. The results of the sensitivity analysis from the assessment and ranking process can be stored in CART for future use.

Web Soil Survey Metrics

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey (NCSS). It provides access to the largest natural resource information system in the world, with soil maps and data available online for more than 95 percent of the Nation's counties. The site is updated and maintained online as the single authoritative source of NCSS program information.

In fiscal year 2023, about 3.4 million customers created an area of interest, 1.9 million reviewed a soil rating, and 1 million printed a soil report in WSS.

The top five national WSS ratings viewed by customers:

1. Hydrologic Soil Group
2. Farmland Classification
3. Hydric Rating by Map Unit
4. Depth to Water Table
5. Nonirrigated Capability Class

The top five national WSS reports viewed by customers:

1. Engineering Properties
2. Physical Soil Properties
3. Map Unit Description
4. Soil Features
5. Hydric Soil List – All Components

The top five areas of interests viewed by customers:

1. State of Connecticut
2. Lee County, Florida
3. Harris County, Texas
4. Bexar County, Texas
5. Travis County, Texas

2023 Annual Soils Refresh

On October 1, 2023, USDA NRCS State and Soil and Plant Science Division (SPSD) staff completed the Annual Soils Refresh (ASR) of the soil survey database to provide new soil data, updates to existing soil data, and new soil interpretations. SPSD staff coordinate the ASR to ensure all official soil data adhere to the National Cooperative Soil Survey standards and are available to NRCS and the public through Web Soil Survey (WSS) and Soil Data Access (SDA).

Major additions to the official soil survey database include:

- 56 million acres of new soil data added
- 3,377 soil survey areas published
- Tabular data refreshed for all soil survey areas
- Spatial data refreshed for 700 soil survey areas
- 117 national soil interpretations published
- 36,000 new soil polygons added
- 2,000 new map units added
- 16,000 new soil components added

The following states had soil survey areas with new data added in 2023: Alaska, Arkansas, California, Colorado, Connecticut, Florida, Idaho, Minnesota, Montana, Oregon, Tennessee, Utah, and Wyoming. The 2023 ASR contained 56 million acres of new soil data that will be reflected in the fiscal year 2024 Soil Data Mart that feeds into WSS and SDA to support NRCS programs and conservation planning.

PLANTS Database

Established in 1990, the PLANTS (Plant List of Attributes, Names, Taxonomy, and Symbols) database is an international scientific standard for plant information. Accessed through the PLANTS website, the database provides basic scientific information for over 35,000 species of plants growing in the United States, as well as Canada, Greenland, and the Territorial Collectivity of Saint Pierre and Miquelon. PLANTS is one of USDA's most visited websites, annually averaging 2.5 million users and 3.5 million sessions with over 12.6 million page views. PLANTS is critical to the mission of NRCS, touching on all aspects of conservation planning that involve the need for basic plant information for cover crops, culturally significant plants, pollinators, wetlands, invasive and noxious weeds, and endangered, threatened, and rare plants.

Technical Soil and Ecological Site Services

In fiscal year 2023, Soil and Plant Science Division (SPSD) staff provided 29 percent of the NRCS' total technical soil and ecological site services. These services helped external and internal partners, such as NRCS conservation planners, rangeland specialists, engineers, and resource soil scientists, understand and properly use soil, plant, and ecological site information.

The top 12 technical services completed by SPSD staff in fiscal year 2023 were:

- Technical consultations
- Soil judging contests, Envirothons, etc.
- Education through lectures, presentations, displays, and posters
- NRCS and partner training
- Onsite soil investigation – soil health management
- Onsite soil investigation – conservation practice design or installation
- National Resources Inventory
- Custom maps, reports, and data files creation
- Onsite soil investigation – other (non-soil survey)
- Public information articles, pamphlets, booklets, etc.
- Onsite soil investigation – wetland determination or delineation
- Interpretation development or validation

For NRCS conservation planning efforts, technical services include items such as:

- Measuring infiltration rates for irrigation and pond designs
- Collecting data to prepare restoration plans for Emergency Watershed Protection Program – Floodplain Easements
- Assessing soil-based resource concerns
- Conducting onsite soil investigations for Emergency Watershed Protection Program – Recovery damage survey reports
- Determining hydric soils for Food Security Act wetland conservation compliance
- Conducting ground penetrating radar investigations for the placement of waste storage facilities
- Recommending conservation practices to improve degraded soil properties
- Assessing soils for the Agricultural Conservation Easement Program – Agricultural Land Easements
- Conducting in-field soil health assessments
- Interpreting soil productivity for groups of crops or soil suitability for wildlife

Conservation Innovations

Raster Soil Property Data

Soil and Plant Science Division (SPSD) staff, New Mexico State University, and West Virginia University created Soil Landscapes of the United States (SOLUS) for the contiguous United States. SOLUS is a collection of 532 100m soil property rasters for 19 soil properties at 7 depths with uncertainty estimates. With soil property rasters, conservation planners will be able to integrate custom interpretations based on specific properties found in a selected area. Soil property rasters incorporate more remote sensed data and create a faster, more efficient database than what is currently used.

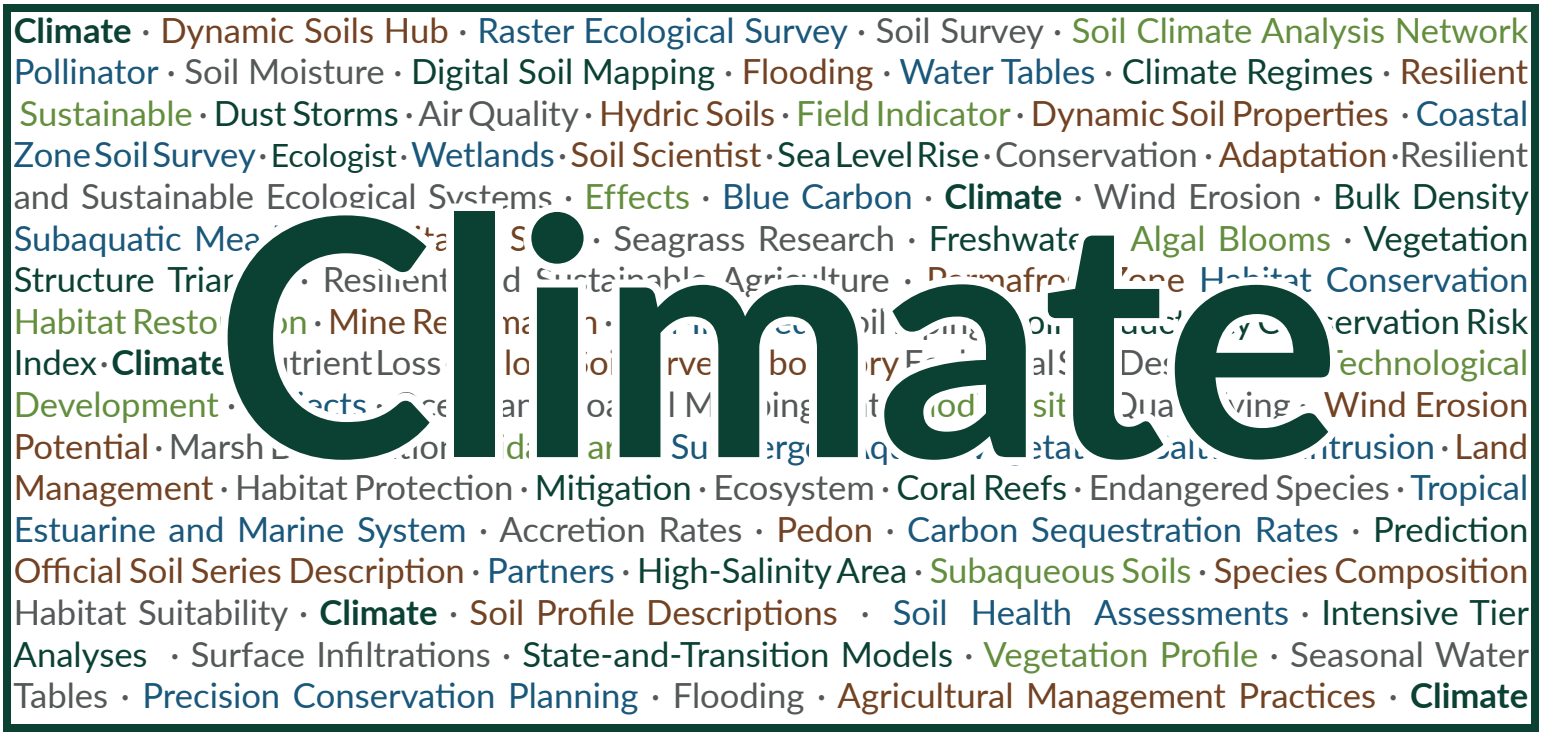
Dynamic Soils Hub

The Dynamic Soils Hub, initiated in 2023, is an innovative, high-end, geospatial data user interface that builds new data products from a wide variety of existing data sets to support the Conservation Innovation Grants, the Conservation Stewardship Program, the Environmental Quality Incentives Program, and Soil Health programs. It was developed to rapidly respond to customer requests for science-based soil property data at the Deputy Chief, Chief, and Under Secretary levels.

The Dynamic Soils Hub is an innovation that expands USDA's capacity to model and report on soil properties that change with conservation management on a human time scale. It will empower the collection, storage, and delivery of data related to dynamic soil properties and conservation management. The Dynamic Soils Hub will link soil and conservation databases, providing the ability to assess outcomes in conservation programs by accessing otherwise siloed data and models across Agency divisions.

Connections to Agency and Department Priorities – Highlights

The Soil and Plant Science Division (SPSD) provides a unique source of comprehensive, up-to-date, science-based data and information concerning all aspects of soil, plant, and ecological sites across the United States and its trust territories. While completing this work, the Division is fully engaged and connected to Agency and Department priorities of climate, diversity, and urban activities. The following sections provide short descriptions of various SPSD activities that highlight the Division's support of these three key priorities.



Preliminary Results Show Extremely Slow Changes in Dynamic Soil Properties in the High Plains

The Soil and Plant Science Division (SPSD) in the South Central Soil Survey Region completed dynamic soil property (DSP) sampling on a project studying potential changes in soils and ecological sites converted from cropland to grassland. The study compared seven treatments with unique temporal variations in management schemes of improved pasture or native rangeland. Data collection included soil profile descriptions, soil health assessments, DSP intensive tier analyses, and surface infiltrations. In addition, SPSD staff collected vegetative ecological site data to better understand the Loamy Upland ecological site.

Preliminary results comparing all 7 treatments show that changes in DSPs are very slow and require more than 70 years for a measurable change in properties. Sites replanted back to native grass species in the 1950s have evidence of a dense plow pan identical to sites that have been in grass for less than 20 years. With respect to the definition of dynamic change, meaning measurable change within a human lifespan, the soils of the high plains do not exhibit dynamic change under normal conditions. This lack of change may be due to the dry aridic ustic climate. Results from this project prove that soil degradation through management or disturbance will leave a long-lasting negative impact on soil resources on the high plains with more than 100 years required for any measurable changes in soil properties. Investigations of ecological site parameters have shown that degraded soil properties influence species composition and cause decreased productivity.

Kellogg Soil Survey Laboratory Provides Essential Data to NRCS Programs

Kellogg Soil Survey Laboratory (KSSL) staff analyzed quantitative soil data essential for National Cooperative Soil Survey (NCSS) and NRCS programs, such as Conservation Technical Assistance and Farm Bill Programs. The NCSS data supports the soil survey for classification, interpretations, and dynamic soil property inventory; land management decisions and soil health assessment and monitoring; and measured values that help determine the effectiveness of conservation practices and programs including the Conservation Effects Assessment Project, the Environmental Policy Integrated Climate model, and the Revised Universal Soil Loss Equation.

Pollinator Data Field to Support Conservation Planning

The USDA Office of the Chief Scientist and the Xerces Society are working with the Soil and Plant Science Division (SPSD) to obtain high-quality, vetted data to populate the pollinator data field in the PLANTS (Plant List of Attributes, Names, Taxonomy, and Symbols) database. In fiscal year 2023, several meetings were held with Agricultural Research Service, Animal and Plant Health Inspection Service, U.S. Environmental Protection Agency, U.S. Geological Survey, and NRCS staff and University of Sussex (United Kingdom) researchers regarding pollinator data sharing with PLANTS. The goal is to perform a large data update in PLANTS that will populate the pollinator data field to support ongoing conservation efforts for pollinators that are vulnerable to climate changes.

Mid-Infrared Technology Used for Mine Reclamation and Soil Piping

In the Northeast Soil Survey Region, Soil and Plant Science Division (SPSD) staff have been using mid-infrared (MIR) spectrometry to help Kentucky and Illinois NRCS staff model coal mine carbon and other data related to mine reclamation. SPSD staff are also using MIR technology in a collaborative effort with the University of Kentucky and the Kentucky Geological Survey to determine soil properties where soil piping occurs. Soil piping is the development of large, air-filled voids in the subsurface that appear suddenly after strong rains and are associated with landslides and subsidence. The models developed for Kentucky include portions of Illinois, Indiana, Missouri, Ohio, and Tennessee.

North Copper River Soil Survey in Alaska Provides Information to Help People Understand Climate Change

In 2023, Soil and Plant Science Division (SPSD) staff continued the soil and plant inventory for 7.86 million acres of initial mapping called the North Copper River Soil Survey (fig. 1). Four, 12-day, field campaigns resulted in a total of 351 pedon, site, and vegetation descriptions collected along with over 1,200 physical soil samples. Staff completed fieldwork on land owned by the Bureau of Land Management, the State of Alaska, Alaska Native corporations, and private individuals. Input from local Alaskan Native communities continues to be a priority when designating areas of interest where soil maps will be useful to local communities. As climate change is most accelerated and apparent at northern latitudes, SPSD investigations of the landscapes contained within this soil survey support our Agency's understanding of the current climate conditions and accelerated climate changes.

Figure 1.—The Copper River Basin.

Coastal Zone Soil Survey of West Galveston Bay in Galveston, Texas, to Assist with Habitat Conservation, Restoration, and Protection Efforts

West Galveston Bay is the largest estuary in Texas and the second most productive estuary in the United States after the Chesapeake Bay. Between 1950 and today, the area has experienced enormous wetland, seagrass, and habitat losses. To help conserve, restore, and protect this area, the Soil and Plant Science Division (SPSD) initiated a coastal zone soil survey (CZSS) of West Galveston Bay.

SPSD staff used a stratified random sampling technique called conditioned Latin hypercube sampling to select soil sample locations in the bay, marsh, and surrounding water bodies. After describing soil profiles and collecting the soil samples, analyses were completed at the local SPSD laboratory and Texas A&M University's Soil Characterization Laboratory. From this sampling technique, eight new subaqueous soil series were proposed. In 2023, staff used this collection of soil information to fill in data gaps, like the presence of sulfidic materials. In 2024, staff will post the CZSS on Web Soil Survey to help improve the long-term health and productivity of West Galveston Bay.

Soil and Plant Science Division Helps the Resource Assessment Branch Identify Fields at Risk of Nutrient Loss

The Resource Assessment Branch and Soil and Plant Science Division staff developed the Soil Productivity Conservation Risk Index. The newly developed index will use both the Conservation Effects Assessment Project's Conservation Benefits Index and the National Commodity Crop Productivity Index to identify fields at risk of nutrient loss due to extreme variation in the soils.

Technology Development for Ecological Site Descriptions

A Soil and Plant Science Division (SPSD) ecologist authored an R software package "vegnasis" to facilitate the summary and visualization of vegetation field data for ecological site descriptions. The goal is to provide tools akin to the algorithms for the quantitative pedology ("aqp") package developed by SPSD soil scientists. Currently, graphical outputs are vegetation structure triangles and vegetation profile graphs (figs. 2 and 3).

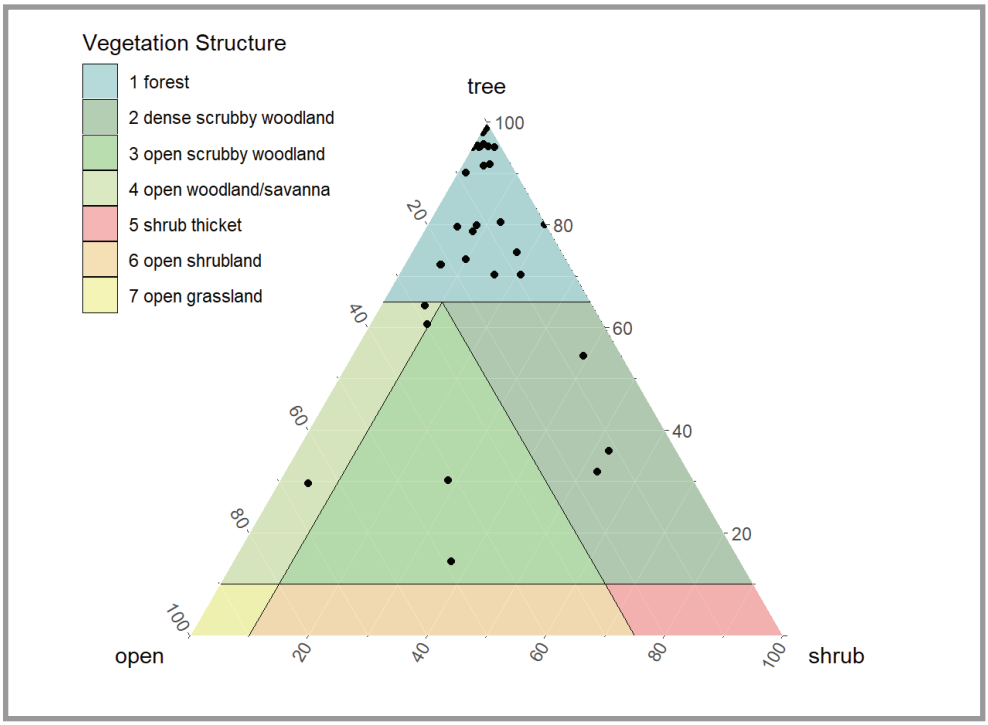


Figure 2.—Vegetation structure triangle.

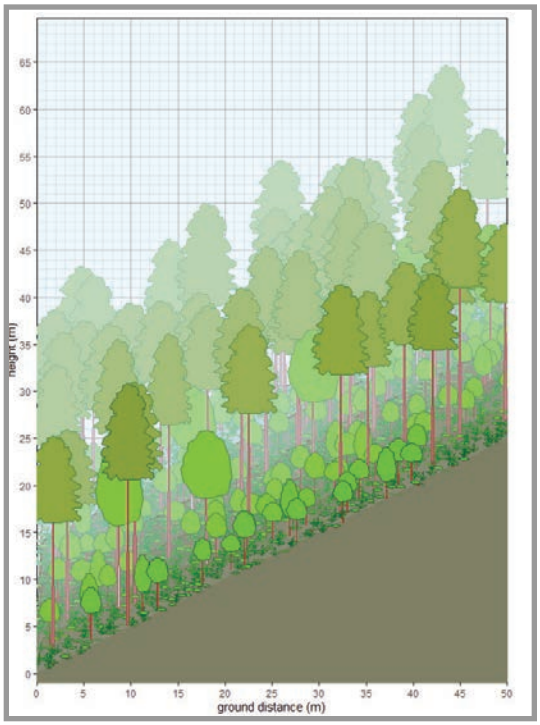


Figure 3.—Vegetation profile.

National Cooperative Soil Survey Provides Data on the Continuous Permafrost Zone in the Alaskan Arctic

In 2023, Soil and Plant Science Division (SPSD) staff from 4 different offices across the United States (California, Utah, Arkansas, and North Dakota) traveled to a remote Inigok Field Station situated roughly 40 miles southwest of Nuiqsut, Alaska. The station is managed by the Bureau of Land Management. It has very little infrastructure and requires personnel to be self-reliant for shelter, food, and water purification. Inigok is in an area dominated by continuous permafrost and served as a central point for SPSD staff during field investigations related to permafrost extraction and characterizations.

SPSD staff used specialized, gas-powered, hand-operated augers to extract 70 permafrost cores and collected over 200 individual unique grab samples (figs. 4, 5, and 6). The data collected provides more information to the scientific community about the continuous permafrost zone in the Alaskan Arctic. Ice structure in permafrost can inform our understanding of what processes formed the permafrost initially and can give us clues as to how certain soils may react to permafrost degradation in the future.

Figure 4.—Soil and Plant Science Division staff operate a permafrost auger.

Figure 5.—A Soil and Plant Science Division staff member kneels beside a permafrost core.

Figure 6.—A set of cores show permafrost variability on a 10 m transect.

National Funding Opportunity Recipients Research Soil Moisture and Biology

In fiscal year 2023, the Soil and Plant Science Division (SPSD) funded collaborative research agreements with Texas A&M AgriLife Research, Oklahoma State University, and the University of Texas at San Antonio.

Texas A&M AgriLife Research and NRCS entered into an agreement to determine the effects of agricultural management practices on soil properties and moisture dynamics and to quantify spatial and temporal differences in soil moisture and hydrologic parameters between croplands and undisturbed areas. Researchers will facilitate the use of MIR technology, compare measured properties with soil survey data, and produce a database containing information regarding temporal changes in soil physical properties and moisture in croplands and adjacent undisturbed areas at three locations across Texas: College Station, Stephenville, and Lubbock.

Oklahoma State University and the NRCS entered into an agreement to use soil survey data and soil climate monitoring systems to address National Cooperative Soil Survey research priorities. The objectives are to evaluate and improve soil moisture prediction algorithms and to develop applications of soil climate measurements and soil moisture predictions in forecasting streamflow and water table depth.

The Department of Integrative Biology at the University of Texas at San Antonio and the NRCS will explore novel methods for collecting soil biology information using the Foldscope. Foldscopes are ultra-low-cost origami-based microscopes capable of imaging in brightfield, darkfield, and fluorescence modes. This pilot project is designed to provide proof of concept for using Foldscopes to identify fungal hyphae in soils.

Figure 7.—An ecologist collects vegetation to measure biomass production.

Figure 8.—A soil scientist in a grassy area sets up a Saturo unit to measure hydraulic conductivity.

Dynamic Soil Property Project Examines the Historic Grand Kankakee Marsh

The Indiana Department of Natural Resources, the Pokagon Band of Potawatomi Indians, the Illinois Nature Preserves Commission, the Illinois Chapter of the Nature Conservancy, and Soil and Plant Science Division staff conducted a dynamic soil property project in Indiana and Illinois covering the historical extent of the Grand Kankakee Marsh (figs. 7, 8, and 9). The project in Major Land Resource Area 98 (Southern Michigan and Northern Indiana Drift Plains) compared the Maumee and Granby soil series across two different phases of a cultivated land management state, conventional tillage and conservation tillage, in addition to a reference state of wet prairie.

Prior to the dredging of the Kankakee River in Indiana, the Grand Kankakee Marsh was the largest wetland in North America earning it the name of the "Everglades of the North." Historically, the marsh stretched across more than 500,000 acres in 7 counties in Indiana and a single county in Illinois. Upon dredging and channelizing the Kankakee River in the late 1880s for agricultural purposes, the river was reduced from 250 meandering miles to 90 straight miles. Today, the Grand Kankakee Marsh has been reduced to less than 5 percent of its historic extent though some restoration efforts are currently underway.

Figure 9.—Soil and Plant Science Division staff sample dynamic soil property sites in Indiana and Illinois.

National Technical Committee for Hydric Soils Develops New Field Indicator

In fiscal year 2023, the National Technical Committee for Hydric Soils (NTCHS) developed a new field indicator to help identify extremely high pH hydric soils. These soils meet the definition of a hydric soil but previously lacked a field indicator to help in their identification.

The NTCHS is a committee of NRCS soil scientists and soil and wetland scientists from other federal agencies interested in the identification of wetlands as well as university and other scientists selected for their expertise in the science of hydric soils. The committee reviews and acts on recommendations concerning the identification of hydric soils. These recommendations are used by many State and local agencies, the U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency for Clean Water Act policy.

National Cooperative Soil Survey Data Used to Identify Wind Erosion Potential

Soil and Plant Science Division (SPSD) staff from the Northwest Soil Survey Region provided spatial and tabular data to field offices and partners to support a targeted implementation plan for the Environmental Quality Incentive Program in eastern Montana. SPSD staff provided National Cooperative Soil Survey maps and tabular data on wind erodibility to enable NRCS field staff to identify areas of high wind erosion potential and prioritize conservation planning efforts.

Catastrophic Flooding on the Missouri River Leads to Digital Soil Mapping Project

In fiscal year 2023, local soil and water conservation districts, Iowa State University, county assessors, and Soil and Plant Science Division (SPSD) staff developed a project to update the soil survey maps along the Missouri River because of the catastrophic flooding in areas that border Nebraska and Iowa. Due to this extreme disturbance and manipulation, existing soil survey maps and interpretations no longer reflected the current conditions. SPSD staff evaluated the use of digital soil mapping technologies in combination with light detection and ranging technology to capture changes in soils along the Missouri River flood plain (fig. 10). These changes resulted from flooding events in 2011 and 2019 that were so catastrophic they required farmers to bulldoze and regrade portions of their fields to make them passable for farm equipment.

Figure 10.—Flooding deposits covered areas with light-colored sand.

National Cooperative Soil Survey Data Used to Expand National Priority Areas Eligible for Inflation Reduction Act Funding

The Soil and Plant Science Division (SPSD) helped determine the national priority areas eligible for Inflation Reduction Act funding for Agricultural Conservation Easement Program (ACEP) easements. At the request of the NRCS national conservation easement specialist, the SPSD delivered National Cooperative Soil Survey spatial data for layers of wet, high organic matter content soils. For the ACEP-Wetland Reserve Easement, the NRCS prioritizes land with soils high in organic carbon that have a high potential for carbon sequestration.

Soil and Plant Science Division Develops Tool to Support NRCS SMART (Source, Method, Assessment, Rate, and Timing) Nutrient Management Planning

In support of the NRCS SMART Nutrient Management Plan, the Soil and Plant Science Division developed a soil sensitivity index to rate soils based on their sensitivity to nutrient runoff. In conservation planning, the index can be used to help identify soils and areas with greater vulnerability to nutrient runoff. The most sensitive soils are those that are most vulnerable or highly susceptible to nutrient runoff.

The NRCS is providing a public version of the nutrient management soil threshold results used in Conservation Assessment Ranking Tool for technical service providers (TSPs). TSPs can use the available results to support the Nutrient Loss Action Plan, TSP Nutrient Management Planning, and expansion of the TSP program prioritized by the NRCS Chief and Congress.

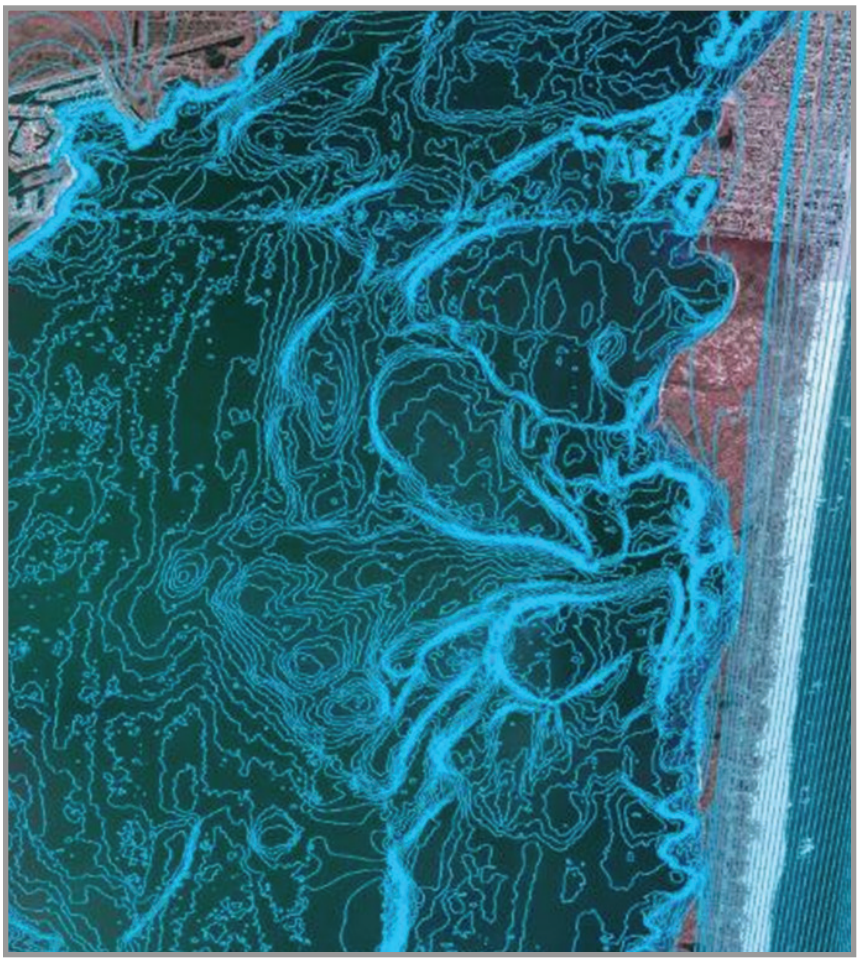


Figure 11.—Contours created by topobathymetric light detection and ranging technology are used for mapping subaqueous and coastal soils.

National Oceanic and Atmospheric Administration and NRCS to Acquire Ocean and Coastal Mapping Data

Today, 52 percent of the U.S. Exclusive Economic Zone, including our oceans, coasts, and Great Lakes, remain unmapped to modern standards and have no topobathymetric light detection and ranging (LiDAR) technology available (fig. 11). To rectify this lack of data, the National Oceanic and Atmospheric Administration and the NRCS signed a memorandum of agreement to acquire topobathymetric LiDAR technology along the coast of Long Island Sound in 2023 to be used as a base map for coastal zone soil survey mapping. The use of topobathymetric LiDAR technology, measuring and recording land, water, and submerged land using airborne laser-based sensors, is a critical component for mapping coastal zone soils. Other important applications include assessing and preparing for potential impacts of threats such as sea level rise, flooding, and storm surge to coastal communities.

Partnership Conducts Submerged Aquatic Vegetation Monitoring in the Albemarle-Pamlico Estuary in North Carolina

Each year in spring and autumn, the Albemarle-Pamlico National Estuary Partnership (APNEP) conducts tier-1 and tier-2 monitoring of submerged aquatic vegetation (SAV) in high-salinity areas of the Albemarle-Pamlico Estuary System. Tier-1 monitoring consists of collecting and reviewing imagery, and tier-2 monitoring consists of in-the-water confirmation of remotely sensed seagrass meadows as well as species composition and benthic cover classification.

To complete the tier-2 monitoring, partners inventory at least 150 locations each cycle with the same points being sampled twice, once in spring and once in autumn (fig. 12). Partners divided the inventory work and shared the data across the partnership. The Soil and Plant Science Division (SPSD) has been a member of the APNEP SAV Team since 2006 and has participated in tier-2 monitoring since it began in the spring of 2021. In 2022, SPSD staff participated in collecting tier-2 field data during both the spring (38 points) and autumn (83 points) inventory cycles.

This SAV monitoring data will help the SPSD with ecological site concept development, including identification of the landforms, soils, and aquatic edaphic environments where SAV meadows can or cannot be found. It will contribute to the development and description of state-and-transition models for subaqueous soils including species composition, stocking, and related ecological dynamics within and between states and communities. The SAV monitoring data could also help develop habitat suitability interpretations.

Figure 12.—Scientists conduct submerged aquatic vegetation monitoring in the Albemarle-Pamlico Estuary.

Coastal Zone Soil Survey of Indian River Lagoon in Florida Helps Address Local Concerns

The St. Johns River Water Management District researchers, the University of Florida's Whitney Laboratory for Marine Bioscience leaders, and Soil and Plant Science Division (SPSD) staff initiated the first coastal zone soil survey (CZSS) project for the Indian River Lagoon (IRL) as a first line of defense to address local resource concerns (fig. 13). Since 2011, algal blooms have dramatically increased, devastating the local economy, ecology, and culture. In 2011, an unprecedented number of manatees in the IRL died due to starvation.

Figure 13.—A Soil and Plant Science Division soil scientist views an open subaqueous soil core.

Known for its biodiversity, the IRL supports more than 4,300 species of plants and animals, making it one of the top fishing destinations in the world for spotted seatrout and red drum. With the constant increase of freshwater discharges into the IRL, shellfish habitat has depleted and carried soils and pollutants into the lagoon, fostering harmful algal blooms and promoting seagrass destruction. Over the years, these factors have destroyed the fishery balance and diversity, reducing and eliminating the lagoon's natural capacity for restoration.

This multiyear CZSS cooperative effort involves various partner agencies, including the Florida Department of Environmental Protection, NASA, the U.S. Air Force, the U.S. Fish and Wildlife Service, and the Florida NRCS. The final product will be the first CZSS in Florida published to the Web Soil Survey and will provide soil data and interpretations needed to address the local natural resource concerns.

Quantifying Blue Carbon Stocks in the Chesapeake Bay Watershed

As part of a cooperative research project, the Virginia Institute of Marine Sciences and the Soil and Plant Science Division (SPSD) sampled 73 soils on a variety of coastal ecosystems in the lower Chesapeake Bay watershed to estimate carbon stocks in subaerial marsh and subaqueous soils (figs. 14 and 15). Then, through a working agreement, SPSD staff sent the samples to North Carolina State University to complete laboratory analyses on 20 subaqueous and 53 subaerial pedons. With this information, SPSD staff are quantifying carbon stocks for each pedon, developing new mineral and organic soil series, establishing a baseline of soil data to update the soil survey, and entering data into the National Soil Information System to complete the project in 2024.

Figure 14.—A Soil and Plant Science Division boat is used to sample soils in the Chesapeake Bay watershed.

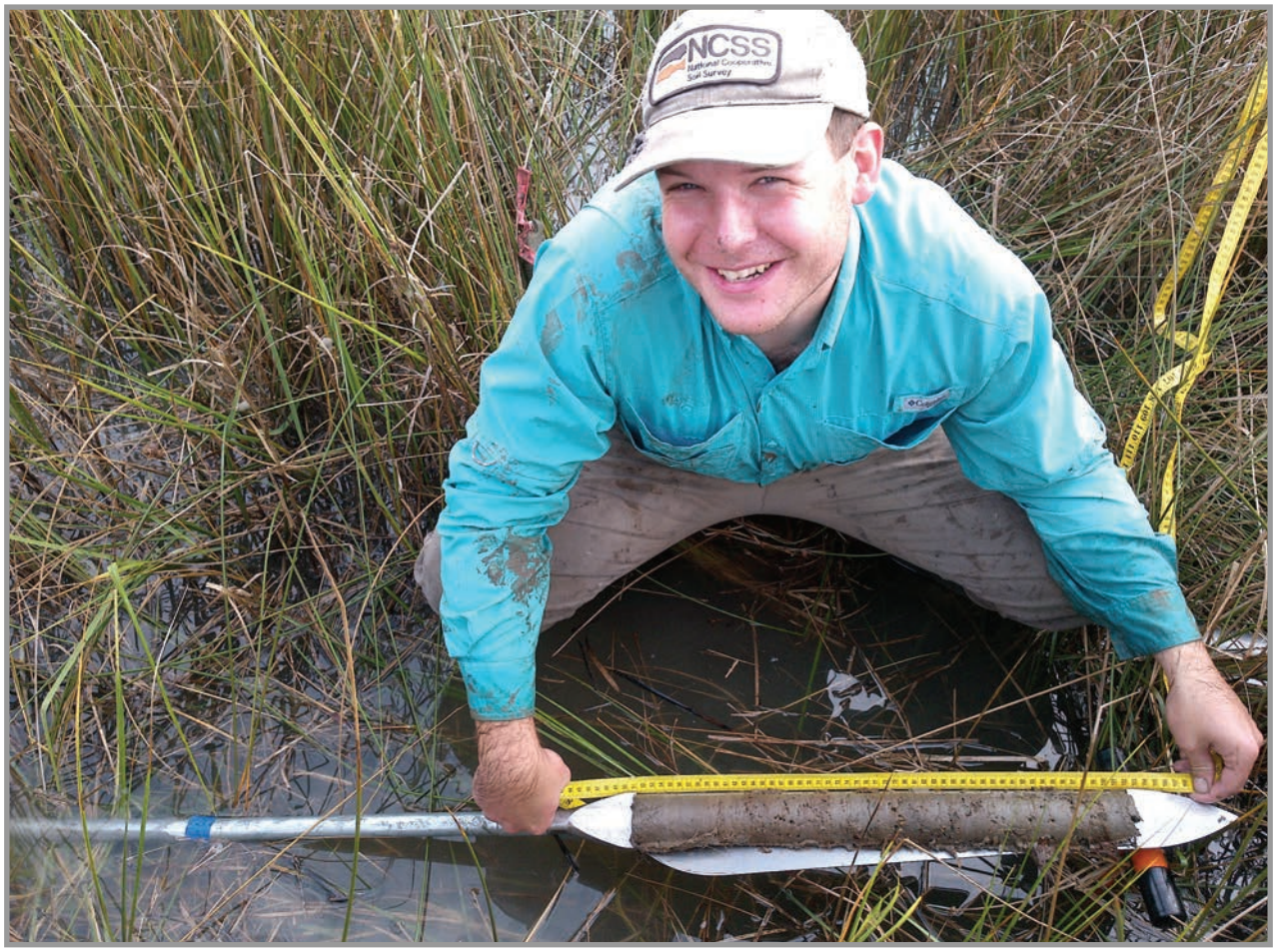


Figure 15.—A Soil and Plant Science Division soil scientist describes a tidal marsh soil using a Macauley peat sampler.

Soil and Plant Science Division Investigates Seasonal Water Tables and Soil Climate Regimes

The Soil and Plant Science Division (SPSD) in the South Central Soil Survey Region is engaged in long-term investigations of seasonal water tables and mean annual soil temperatures (MAST). The SPSD installs and maintains a network of soil monitoring equipment that supports the long-term investigation of seasonal water tables and soil climate regimes in Major Land Resource Area (MLRA) 84B (West Cross Timbers). The project will improve soil interpretations associated with the presence or absence of a seasonal water table, our understanding of differences in organic carbon and soil classification due to temporal and spatial variability in precipitation and management, and our knowledge of soil-water relationships related to ecological change.

The SPSD also monitors MAST to improve understanding of the extent and spatial distribution of different soil temperature regimes in the Southern Great Plains. The areas comprising MLRAs 77A (Southern High Plains, Northern Part) and 77E (Southern High Plains, Breaks) are near the intersection of two soil temperature regimes, mesic and thermic. Current data supporting these regimes is extrapolated from mean annual air temperature (MAAT) data from weather stations scattered throughout the area, which approximates MAST by adding 1 °C (1.8 °F) to MAAT. Research has shown that MAAT can be either cooler or warmer than MAST, depending on slope and aspect. Some research has suggested that MAST should be the same as MAAT at the adequate depth of equilibrium. Preliminary results from soil temperature monitoring from the past 7 years have indicated a warming trend across the northern areas of the study area. The SPSD plans further data collection for this project in the next 3 years to provide measured soil temperature data across MLRA 77E for use in soil data interpretations and ecological site descriptions.

Soil and Plant Science Division Staff Identify Suitable Soils for Emergency Animal Mortality Burial Due to Pathogenic Avian Influenza Outbreak

The Soil and Plant Science Division (SPSD) was contacted to conduct an emergency onsite soil investigation to identify two sites as suitable burial locations for the disposal of a large number of animals in a pit or trench. A large poultry operation with approximately two million chickens in northeastern Colorado had an outbreak of Highly Pathogenic Avian Influenza A (H5N1), creating an immediate need for disposal of carcasses and eggs at the facility. Prompt and accurate soil survey technical assistance provided by Northwest Soil Survey Region SPSD staff allowed the poultry operation to dispose of the carcasses and eggs efficiently and effectively, in agreement with all governing regulatory agencies.

Dust Storms and Air Quality Issues Around the Salton Sea Near Riverside, California, Fosters Collection of Soil Data

The Bureau of Land Management, Formation Environmental, and the Soil and Plant Science Division (SPSD) are completing a soil survey on the exposed playas along the margin of the Salton Sea shoreline near Riverside, California, to understand how to reduce wind erosion (fig. 16). The Salton Sea's water level dropped, reaching a new elevation of equilibrium following reallocation of surface water from Imperial Valley to nearby cities, which exposed a vast amount of sea floor. With this large amount of exposed sea floor, wind erosion of the soil is creating dust storms and air quality issues. The exposed sea floor of this shallow, saline lake (with salt levels double that of the Pacific Ocean) created a soil data gap between the old and new shorelines of the Salton Sea. A private company that had also collected soil cores from the area provided soil data and laboratory analyses to help fill in the missing soil survey information and support the expansion of soil survey mapping. This soil survey project is scheduled to be completed in 2026.

Figure 16.—Exposed playas along the margin of the Salton Sea shoreline near Riverside, California.

Lake Mattamuskeet National Wildlife Refuge in North Carolina to Reestablish Subaquatic Meadows Using Coastal Zone Soil Survey

At the request of the Lake Mattamuskeet National Wildlife Refuge and the North Carolina Wildlife Resources Commission, the Soil and Plant Science Division (SPSD) initiated the Lake Mattamuskeet coastal zone soil survey (CZSS) to guide efforts on reducing lake turbidity and reestablishing its once extensive subaquatic meadows (fig. 17). The refuge features the largest freshwater lake in North Carolina and a historic abundance of submerged aquatic vegetation, making it a vital stop on the Atlantic Flyway for migratory waterfowl. It is a popular destination for fishing and birdwatching. SPSD Special Projects Region staff completed data and laboratory analyses for the Lake Mattamuskeet CZSS in 2023, putting it on track to be the first subaqueous soil survey in North Carolina publicly available in Web Soil Survey.

Figure 17.—Soil and Plant Science Division soil scientists view an open subaqueous soil core.

Soil Climate Analysis Network and Tribal Soil Climate Analysis Network

Soil and Plant Science Division staff support the physical infrastructure and data quality of 213 Soil Climate Analysis Network sites and 22 Tribal Soil Climate Analysis Network sites located in 45 states and trust territories, including Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands (fig. 18). All sites collect and record atmospheric data (air temperature, relative humidity, precipitation, wind, and solar) and in situ soil data (volumetric water content and temperature). Data are collected hourly and available in many forms on the web and through multiple web services. Useful information for conservation and farm management derived from this data are also available through a third-party website that the NRCS supports.

Figure 18.—As part of an agreement with the Bureau of Land Management, a crew installed three new Soil Climate Analysis Network sites near Mono Lake, California.

Dynamic Soil Property Projects Across the United States Support Conservation

The Soil and Plant Science Division (SPSD) Dynamic Soil Property (DSP) Focus Team consists of over 170 members from the USDA and NRCS who collaborate to deliver scientifically defensible soil information to support conservation management for healthy soils and sustainable ecosystems. DSPs are soil properties that change in response to land use, management, and natural disturbance. DSPs include soil organic carbon, infiltration, and structure and drivers of soil functions. They can indicate past management as well as predict responses and guide decisions made by land managers. Currently, the SPSD has about 330 DSP projects planned across the United States with the goal of developing decision support tools.

Coastal Zone Soil Survey of Jobos Bay, Puerto Rico, Assists with Conservation Management Planning

The Puerto Rico Natural Environmental Resources Department, Sea Grant, and the Soil and Plant Science Division organized a coastal zone soil survey of Jobos Bay in Puerto Rico and collected 20 subaqueous soil cores based on benthic communities and maps (fig. 19). Jobos Bay contains mangrove islands and coral reefs within the boundaries of the Jobos Bay National Estuarine Research Reserve along with mangrove forests, lagoons, salt flats, dry forests, and seagrass beds. These ecosystems provide habitat for a great diversity of flora and fauna, including several rare and endangered species as well as a variety of species of tropical fish. Jobos Bay is a tropical estuarine and marine system, which makes it an ideal location for research, teaching, and the development and implementation of sound conservation management planning.

Figure 19.—An open subaqueous soil core from the coastal zone soil survey of Jobos Bay.

Coastal Zone Soil Survey Data from Currituck Sound, North Carolina, Helps Others Mitigate and Adapt to the Effects of Climate Change

Beginning this year, the Albemarle-Pamlico National Estuary Partnership, the National Audubon Society, the North Carolina Coastal Reserve and the National Estuarine Research Reserve, the East Carolina University, the Virginia Department of Wildlife Resources, the U.S. Fish and Wildlife Service, and Soil and Plant Science Division (SPSD) Special Projects Region staff will conduct a coastal zone soil survey (CZSS) and a submerged aquatic vegetation (SAV) inventory of the Currituck Sound, located in northeastern North Carolina and southeastern Virginia (fig. 20). SPSD staff have started the CZSS by preparing a soil sampling design and delineating subaqueous landforms using bathymetry.

The CZSS project will study marsh migration, saltwater intrusion, and SAV decline to better prepare land managers to mitigate and adapt to the effects of climate change. The aim of analyzing and mapping SAV, along with its associated decline, is to protect and revitalize aquatic plant communities and the associated fisheries in the economically valuable and unique area. The SAV inventory and the CZSS are scheduled to be completed by 2025.

Estimating Blue Carbon and Investigating Marsh Degradation in Ocean County, New Jersey

The Barnegat Bay Partnership, the U.S. Environmental Protection Agency (USEPA), and the Soil and Plant Science Division collected 25 tidal marsh pedons for full laboratory characterization for an USEPA Regionally Applied Research Effort grant project (fig. 21). The project focuses on the effects of excess nutrients on marsh degradation and erosion in the Barnegat and Little Egg Harbor estuaries in Ocean County, New Jersey. SPSD staff will use the laboratory and field data to update the tidal marsh soil survey, which includes bulk density and total carbon data, to improve estimates of blue carbon stocks. Ongoing marsh restoration efforts, such as living shorelines, thin layer deposition, beneficial reuse of dredge materials, and marsh enhancement, will also benefit from the CZSS information.

Figure 20.—The coastal zone soil survey data will help mitigate and adapt to the effects of climate change in Currituck Sound.

Figure 21.—Soil and Plant Science Division soil scientists collect a subaqueous soil core.

Effects of Sea Level Rise in North Carolina Revealed by Coastal Zone Soil Survey

North Carolina State University (NCSU) and the Soil and Plant Science Division (SPSD) are investigating soil blue carbon stocks and the effects of saltwater intrusion in North Carolina's Albemarle Sound and Pamlico Sound. The project proposed by NCSU focuses on collecting soil data along salinity gradients to quantify the impacts of saltwater intrusion, accretion rates, and blue carbon stocks in soils (fig. 22). It is the first coastal zone soil survey project to quantify soil organic carbon stocks to a consistent depth of two meters and quantify the effects of sea level rise on soil salinization.

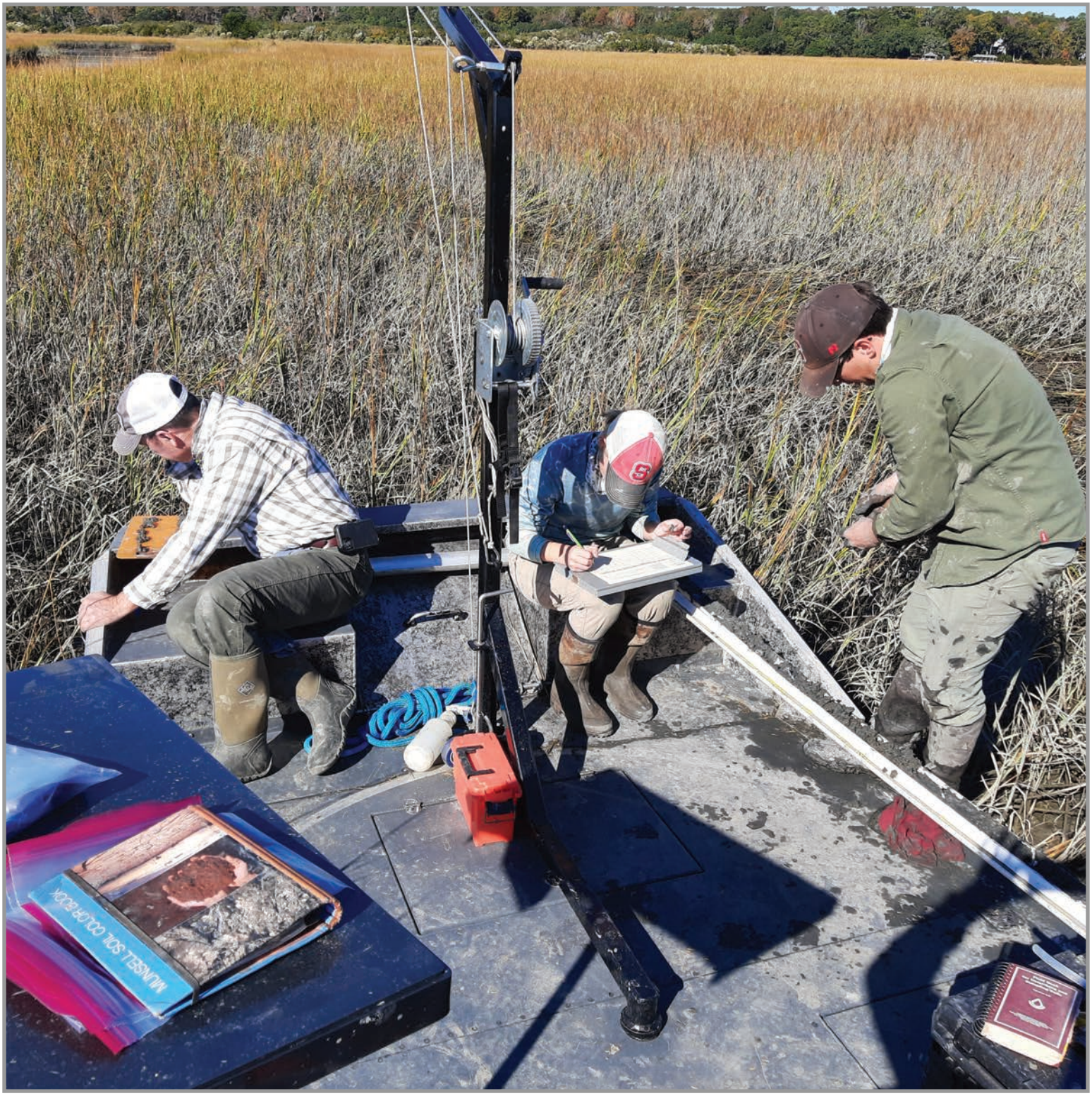


Figure 22.—Soil and Plant Science Division scientists collect soils and plant data to estimate soil blue carbon stocks and quantify the effects of sea level rise on saltwater intrusion.

This project will generate regional maps displaying the extent of saltwater intrusion into previously freshwater areas. NCSU will also use the data to define linkages among saltwater intrusion, soil accretion, and carbon sequestration rates to predict ecological changes from the transition of forested freshwater systems to ghost forests and salt-marsh systems.

In 2023, the SPSD used the data to update three official soil series descriptions, which can be found in Web Soil Survey, along the Albemarle Sound and Pamlico Sound coastlines. In 2024, the data will guide further sampling and mapping efforts in the sounds.

Bridging Soil Data, a Foundation to Meet Emerging Needs Due to Climate Change

Soil and Plant Science Division staff integrated dynamic soil properties for soil health, or DSP4SH, cooperator data, U.S. Forest Service pedon data, and scanned historical data by evaluating existing data and developing a crosswalk and entity relationship diagram. Scripts were built to transform the data into an SQLite database. A mechanism for data import to the National Soil Information System via SQLite is in development in fiscal year 2024. Integrating this data is part of the crucial foundation required for enhancing and delivering new soil survey products, meeting emerging needs due to climate change, and maintaining relevance to natural resources conservation planning.

Dynamic Soils Hub Water Quality Models

The Dynamic Soils Hub Water Quality Models contain soil map unit ratings for nutrient leaching and soil runoff potential and Conservation Assessment Ranking Tool (CART) threshold values for nonpoint nitrogen surface loss, nonpoint phosphorus surface loss, sediment transport, nonpoint nitrogen leaching loss, and nonpoint phosphorus leaching loss. Ratings and threshold values are provided for undrained and drained conditions to accommodate soils assigned dual hydrologic soil groups. Technical service providers and conservation planners will be able to view these ratings in CART to identify vulnerable areas and address resource concerns (fig. 23).

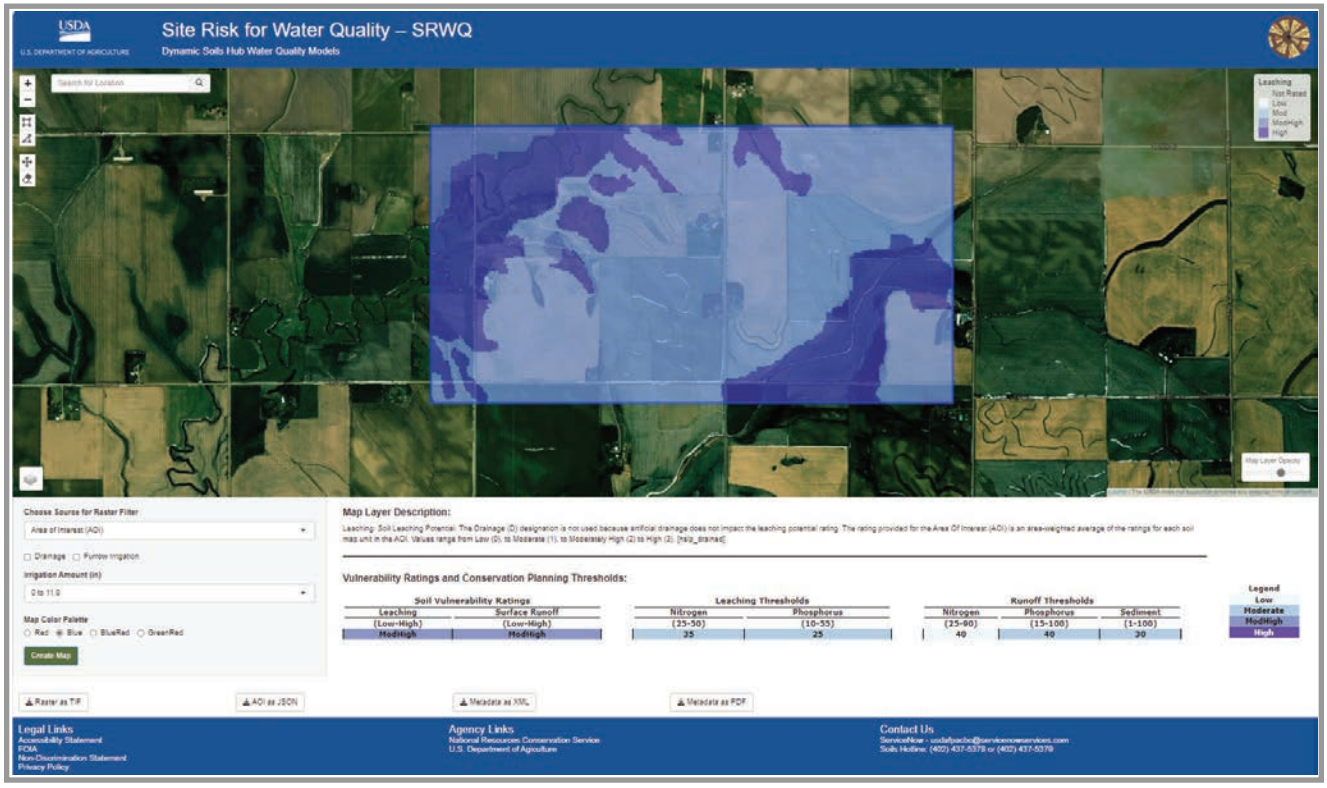


Figure 23.—Dynamic Soils Hub Water Quality Models web page showing maps and data.

Soil Moisture and Temperature Sensors Installed at the Fernow and Hubbard Brook Experimental Forests

In the Northeast Soil Survey Region, the Soil and Plant Science Division is collaborating with the U.S. Forest Service on soil survey projects in the Hubbard Brook Experimental Forest (Thornton, New Hampshire) and Fernow Experimental Forest (Parsons, West Virginia). These experimental forests have long-term watershed data, along with experimental manipulations. The multidisciplinary team installed soil moisture and temperature sensors in the Fernow Experimental Forest and Hubbard Brook Experimental Forest. Being able to monitor the soil moisture in these watersheds will help provide a clearer picture of water movement.

Upper Missouri River Basin Monitoring Network Established in Response to Historic Flooding

After the historic 2011 flood, the U.S. Army Corps of Engineers and various agencies developed a framework for the establishment of an Upper Missouri River Basin (UMRB) Soil Moisture and Plains Snow and Soil Moisture Monitoring Network (UMRB Monitoring Network). The UMRB Monitoring Network involves the establishment of a network of stations to monitor snowpack and soil moisture throughout the plains area of the UMRB (fig. 24) These stations will improve current soil moisture data and monitoring procedures as well as enhance how federal, State, and local agencies use existing and new technologies.

In fiscal year 2023, the Soil and Plant Science Division (SPSD) sampled 61 soil pits in the UMRB in 5 states: Montana, Nebraska, North Dakota, South Dakota, and Wyoming. To date, 166 soil characterization sites have been sampled for the project. When the project completes its 10-year life span, the SPSD will have sampled over 550 soil characterization pits for the UMRB Monitoring Network.

Figure 24.—Installation of an Upper Missouri River Basin Monitoring Network station to monitor snowpack and soil moisture.

Upper Missouri River Watershed Project to Help Build Resilient and Sustainable Agriculture and Ecological Systems

Figure 25.—A Upper Missouri River Watershed Project (Mesonet) site in Crook County, Wyoming.

The Upper Missouri River Watershed Project (Mesonet) is a cooperative project between the NRCS, the U.S. Army Corps of Engineers, and the University of Montana. In fiscal year 2023, Montana NRCS, Bureau of Land Management (BLM), and Soil and Plant Science Division staff collected soil samples at 31 sites in Montana and 11 sites in Wyoming (fig. 25). Mesonet is a partner-driven system of networked climate observation stations that monitor weather, soil moisture, and vegetation response. Cellular signals transmit near real-time data to be viewed online through the Montana Climate Office. Mesonet supports adaptive management of farms, rangeland, water resources, and natural ecosystems, with the aim of building resilient and sustainable agricultural, economic, and ecological systems.

A diverse and large array of customers use this weather and soil climate information, from non-professionals with an interest in current weather conditions to researchers validating satellite data. Some of the customers are Native American Tribes, the U.S. Forest Service, National Oceanic and Atmospheric Administration, NASA, BLM, university cooperators and researchers, drought assessment professionals, farmers, and anyone with a general interest in weather and soil climate conditions.

Raster Ecological Survey Products Support Conservation Planning

The Digital Soil Mapping Focus Team initiated the development of raster ecological survey products (fig. 26). Raster ecological surveys in combination with raster soil surveys and Soil Landscapes of the United States maps will provide a foundation for interactive state-and-transition models (STMs) and enhanced interpretations. Together, the soil survey products can be used to support precision conservation planning, development of ecological site descriptions, STMs, and decision support tools.

Figure 26.—Example of a raster ecological survey created with a digital soil mapping framework for Glacier National Park in Montana.

Soil and Plant Science Division Exhibits Reach Customers Across the United States

Soil and Plant Science Division staff shared soil and plant science information with approximately 60,000 people by hosting a variety of in-person exhibits at the American Geophysical Union Fall Meeting (over 20,000 attendees), National Science Teaching Association Meeting (10,000 attendees), American Planning Association Meeting (over 4,000 attendees), American Society of Agronomy – Crop Science Society America – Soil Science Society America Annual Meeting (over 4,000 attendees), National 4-H Conference Youth Career Fair (hundreds of students from various states), Ecological Society of America (over 4,000 attendees), American Planning Association Conference (over 4,000 attendees), and the National Science Teaching Association Meeting (over 10,000 attendees).

Helping Develop the Natural Rubber Industry in the United States

Almost all natural rubber, a critical component of aircraft tires, comes from the rubber tree that grows in the tropical areas of southeast Asia. Due to such factors as plant disease, supply chain disruptions, and climate change, the USDA has started building a public and private partnership to develop a natural rubber industry in the United States. To assist with this effort, the Soil and Plant Science Division developed interpretations to indicate the best-suited soils for production of the desert shrub guayule (*Parthenium argentatum*) and Russian dandelion (*Taraxacum kok-saghyz*), also known as TKS.

Soil and Plant Science Division Expands PLANTS Invasive and Noxious Weeds Information in the Caribbean Area

The Soil and Plant Science Division (SPSD) is working on a cooperative agreement with Effective Environmental Restoration (EER), a non-governmental organization located in Cabo Rojo, Puerto Rico. The goal of the agreement is for EER to work with the Centre for Agriculture and Bioscience International (CABI) in London to modernize and expand the information in PLANTS (Plant List of Attributes, Names, Taxonomy, and Symbols) database regarding invasive and noxious weeds, especially in the Caribbean area, an underserved region. To date, EER and CABI have prepared 19 invasive species fact sheets and a list of over 5,000 species of invasive or potentially invasive plants in the Caribbean.

Collaboration to Compare Agricultural Conditions Across Counties

Soil and Plant Science Division interpretations staff and Economic Research Service (ERS) staff are collaborating to adapt Pedro Sanchez's Fertility Capability Classification to worldwide use employing the Harmonized World Soil Database. This will allow the ERS to make valid comparisons of agricultural conditions across countries.

Soils Presentation at Tuskegee University

Soil and Plant Science Division (SPSD) staff met with a diverse group of students participating in the Forestry and Natural Resources – Tuskegee Research Enrichment Kamp, or TREK, Summer Program hosted by Tuskegee University (fig. 27). The presentation focused on the role of a soil scientist, the importance of soil health and management, how to access and use soil survey information, and methods of soil sampling and analysis. In addition to these concepts, SPSD staff introduced students to geographic information system software and conservation planning.

National Cooperative Soil Survey Project of the Salton Sea, California, to Help Mitigate Hazardous Dust Emissions

The Soil and Plant Science Division is working on an interagency agreement with the Bureau of Reclamation and the Bureau of Land Management to complete soil survey mapping in recently exposed playas around the Salton Sea perimeter and shallow water areas expected to be exposed in the future. In 1905, overflow of the Colorado River during the construction of a large irrigation canal created the Salton Sea in a portion of the lakebed of what was once the ancient Lake Cahuilla. More recently, prolonged drought and reallocation of Colorado River water for the regional urban water supply (fig. 28) have impacted water levels in the Salton Sea.

National Cooperative Soil Survey information and interpretations are needed to support planning and implementation of science-based conservation practices that will mitigate hazardous dust emissions, caused by a receding lake level, to improve air quality in nearby socioeconomically vulnerable communities located downwind in the Imperial Valley of southern California.

Figure 27.—Students who attended the soils presentation at Tuskegee University gather in front of the soil tunnel.

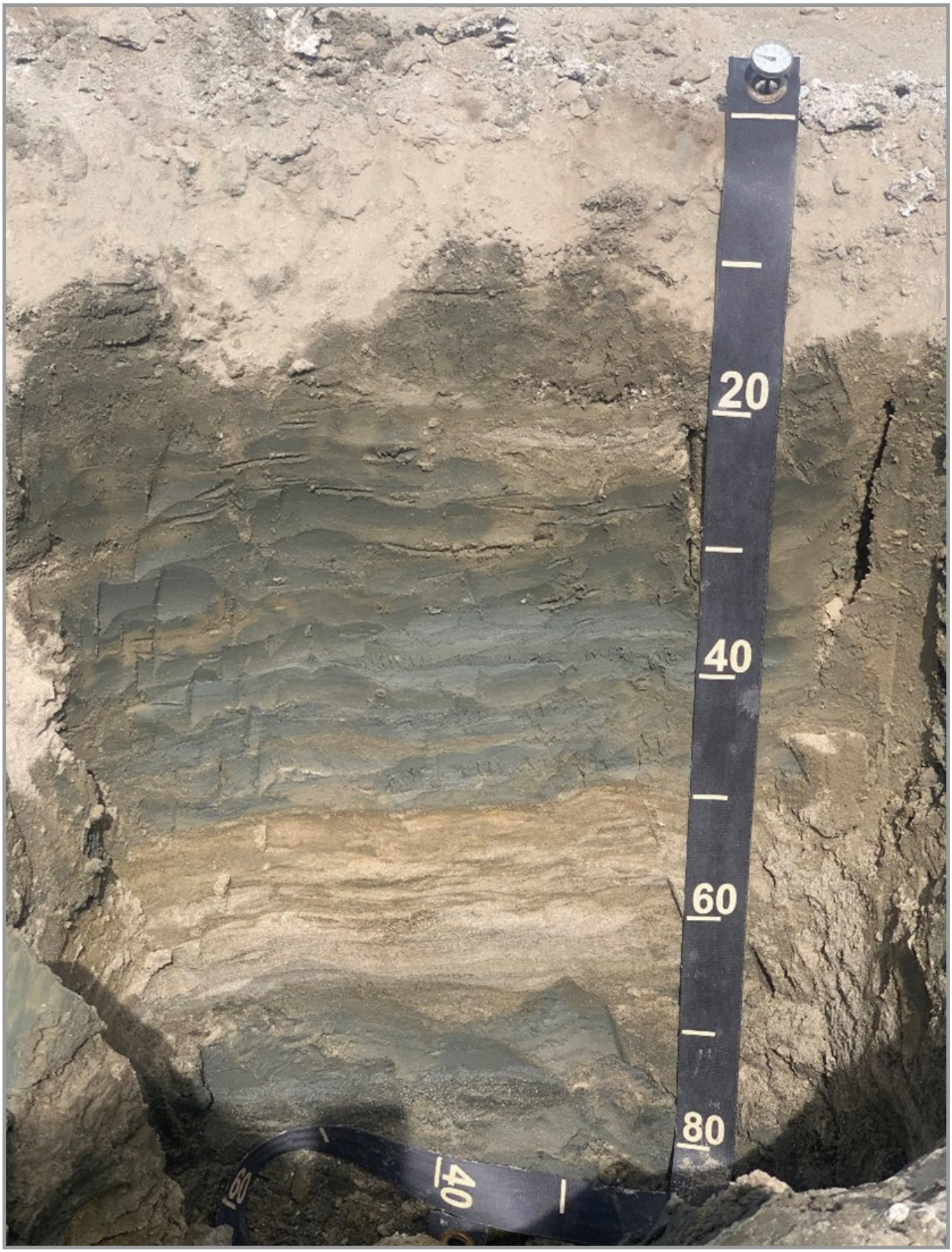


Figure 28.—A soil profile in a recently exposed playa previously covered by the Salton Sea. Alternating layers of alluvial deposits are visible from geologic periods of being covered by water by the Salton Sea (surface deposits), Colorado River overflow (yellow soil colors below 50 cm), and ancient Lake Cahuilla deposits (alternating gray colors).

Soil and Plant Science Division Assists with Fertilizer Production Expansion Program

In fiscal year 2023, the Biden Administration announced that $500 million in grants would be offered through the Fertilizer Production Expansion Program to increase American-made fertilizer production, spur competition, and combat price hikes on U.S. farmers caused by the war in Ukraine. Soil and Plant Science Division staff participated in the rigorous evaluation and review of some of the over 300 proposals for the Fertilizer Production Expansion Program applications to improve access to fertilizers or fertilizer alternatives.

Technical Soil Services Help Aquaculture Producer Experiencing Major Decline in Productivity in New Jersey

The National Oceanic and Atmospheric Administration (NOAA) and the New Jersey Department of Environmental Protection (NJDEP) requested technical soil services from the Soil and Plant Science Division (SPSD) to obtain subaqueous soil data in a set of aquaculture leases in Barnegat Bay, New Jersey. A large-scale aquaculture grower was experiencing a dramatic decrease in clam survivorship and growth over the last 3 to 5 years (fig. 29). To determine the cause of the decrease in aquaculture productivity, NOAA shellfish biologists were interested in gathering soil and water quality data.

The SPSD collected subaqueous soil samples and provided data on soil pH, texture, and the presence of sulfidic materials, specifically monosulfides, within the lease areas. The data showed normal soil pH levels, monosulfides present in all but one location, and very dark soil colors in areas where clam growth and survivorship had declined the most. Water quality and more in-depth studies are being performed by the NOAA and the NJDEP to further assist the aquaculture producer.

Figure 29.—A Soil and Plant Science Division scientist holds clams from Barnegat Bay, New Jersey.

Cacao for Peace

From February 27 through March 4, 2023, Soil and Plant Science Division (SPSD) staff and partners attended planning meetings for the Cacao for Peace Workshop in Palmira, Colombia. SPSD scientists traveled to Colombia for the Project Planning Workshop to develop a work plan for Cacao for Peace, which supports the development of a self-reliant and thriving Colombian cacao industry. The work plan will guide project partners to improve cacao productivity and quality by defining the roles and responsibilities of various subject matter experts cooperating in various tasks to deliver defined outputs and deliverables for soil mapping in Cordoba, Columbia.

Coastal Zone Soil Survey of Great Bay and Mullica River, New Jersey, Highlighted in The Sandpaper

The coastal zone soil survey (CZSS) project in Great Bay and Mullica River, New Jersey, was highlighted in The Sandpaper, a newspaper for Long Beach Island and Southern Ocean County, New Jersey. The project is a partnership of State and local government agencies, aquaculture producers, local universities, private nonprofit groups, and the Soil and Plant Science Division to help promote aquatic habitat on shellfish leases and enhance water quality throughout the Barnegat and Great Bay Region of New Jersey. Stockton University and the New Jersey Bay Islands Initiative are also interested in the CZSS for eelgrass and marsh restoration.

The CZSS in this area will support the New Jersey Conservation Opportunities Advancing Sustainable Technologies for Aquaculture Leases Aquaculture Project and a Regional Conservation Partnership Program (RCPP) project awarded to the Ocean County Soil Conservation District. The RCPP project will use the CZSS to identify additional shellfish leases, pinpoint ideal shellfish reef restoration areas, and provide soil information to the conservation planners and estuarine restoration managers (fig. 30). The RCPP project seeks to implement new conservation practice scenarios by connecting local farmers with NRCS and Farm Bill conservation programs.

Figure 30.—One of the Soil and Plant Science Division coring vessels used to collect subaqueous soil samples during the coastal zone soil survey of Great Bay and Mullica River, New Jersey.

Soil and Plant Science Division Assembles Geographically and Taxonomically Diverse Mid-Infrared Spectral Library

Kellogg Soil Survey Laboratory (KSSL) staff continue to assemble a mid-infrared (MIR) spectral library, like international efforts using soil spectrometry, as a low-cost tool for the rapid prediction of soil carbon and other properties. The KSSL MIR spectral library represents almost 90,000 legacy samples from the KSSL soil archive, the largest public collection in the United States with over 400,000 specimens.

Geographically and taxonomically diverse calibration models are under development for use by soil survey field offices for the rapid prediction of soil properties, such as soil organic carbon from MIR spectra, with attractively low errors. MIR spectrometry allows rapid data collection while assuring data quality and consistency using a tool that any NRCS field soil scientist can use for soil survey and technical soil services, including soil health investigations.

Technical Soil and Ecological Site Services Assist Tribes

Soil and Plant Science Division (SPSD) staff in the Southwest Soil Survey Region provided training activities and technical soil and ecological site services to five different Tribes: the White Mountain and San Carlos Apache, Miwuk, Hopi, and Navajo. SPSD staff assisted the Hopi Tribe with regenerative grazing and the Miwuk Tribe with a dynamic soil properties investigation. These SPSD activities reach underserved populations and improve climate resilient conservation planning.

Soil and Plant Science Division Ensures Documents Are Section 508 Compliant

Working together, Soil and Plant Science Division (SPSD) staff and the Farm Production and Conservation digital accessibility program manager (Section 508) provide staff with information and instruction for meeting Section 508 requirements. Section 508 of the Rehabilitation Act requires all electronic documents created by government employees to be accessible to people with disabilities. SPSD staff have created Section 508 compliant templates for employees, hosted live and virtual Section 508 compliance training attended by staff from multiple USDA agencies, and posted guidance and training resources on the Section 508 page of the SPSD SharePoint (fig. 31).

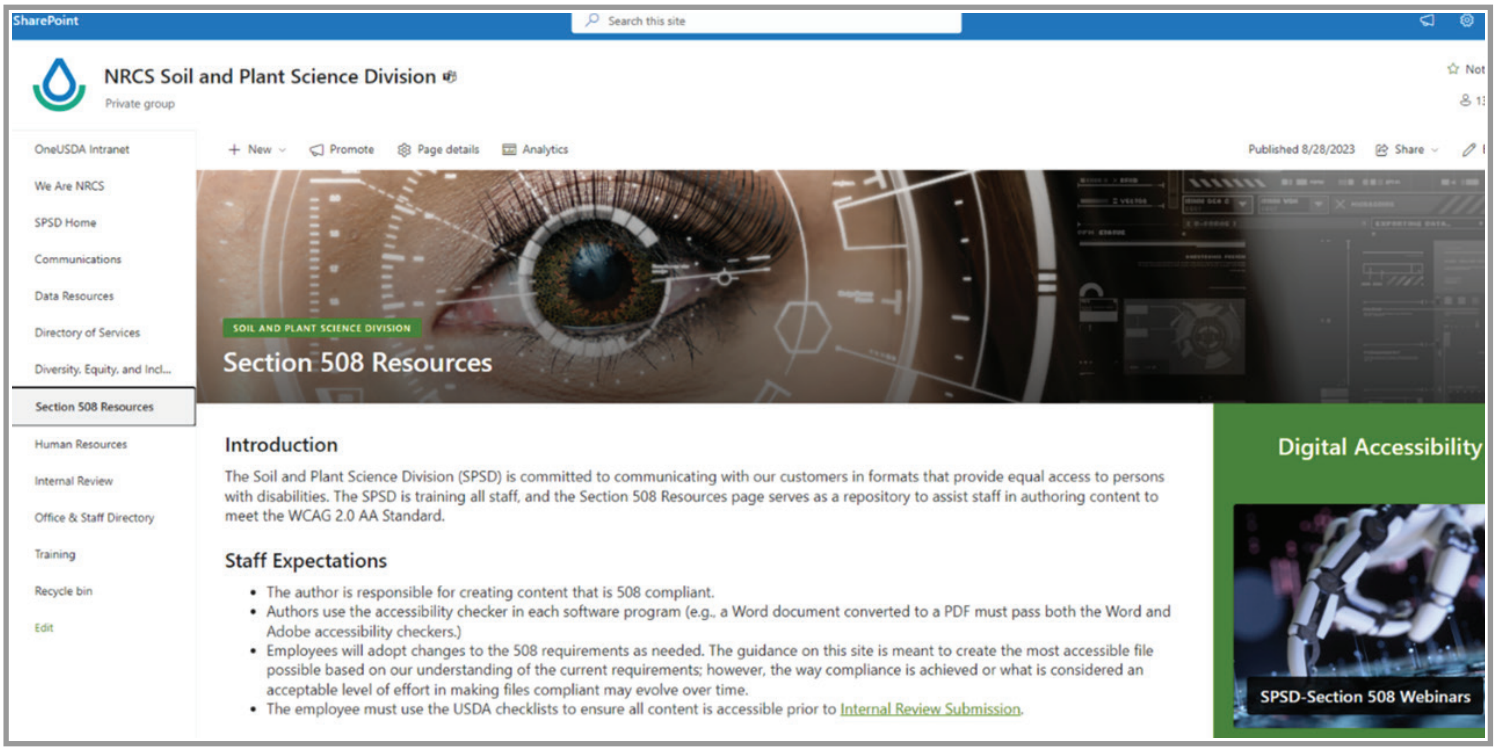


Figure 31.—The Section 508 page of the Soil and Plant Science Division SharePoint site.

Predicting the Movement of Per- and Polyfluoroalkyl Substances in Soils

The Soil and Plant Science Division is developing soil interpretations to predict where and how fast per- and polyfluoroalkyl substances (PFAS) might move through soils into ground and surface waters. PFAS are a group of chemicals that have been manufactured and used in a wide variety of applications, such as firefighting and waterproofing, since the 1950s. These compounds resist degradation and can be mobile in soils. The primary means of exposure for humans and animals is contaminated water supplies, although these substances are also taken up by plants, which are then eaten by humans and animals. These chemicals are a concern in urban and rural environments because they do not break down, can move through soils and contaminate drinking water sources, and build up in fish and wildlife.

Soil and Plant Science Division Attends Our Lands to Your Hands Expo and the National Western Stock Show Ag Adventures

At the Our Lands to Your Hands Expo event in Longmont, Colorado, Soil and Plant Science Division (SPSD) staff provided children with information on soil and soil health through demonstrations and hands-on activities. Using plenty of props and imagination, students enjoyed activities inside and outside the soil tunnel (fig. 32).

SPSD Northwest Soil Survey Region soil scientists provided hands-on demonstrations and activities at Ag Adventures during the National Western Stock Show event in Denver, Colorado. Students learned about soil texture and compaction through a hands-on infiltration activity, about cover crops with sprouting pea shoots, and about how small and precious our agricultural land is in comparison to the vast oceans through an action-packed land verses water activity demonstration. The NRCS soil pedon mascot Sammie Soil was on hand to welcome the young agricultural enthusiasts and invite them to hang out for photos and "high-fives."

Figure 32.—A Soil and Plant Science Division staff member uses the NRCS soil tunnel to demonstrate what soil is made of at the Our Lands to Your Hands Expo.

Soil Property Maps for the Contiguous United States Promotes Equity

In fiscal year 2023, the Digital Soil Mapping Focus Team completed the Soil Landscapes of the United States (SOLUS) and SOLUS100. SOLUS property maps provide a complete, consistent, and current inventory of soil resources for the United States and are updated annually to include improvements in data availability and modeling methods. SOLUS100 is a set of 19 continuous soil property maps predicted at 7 depths with uncertainty and accuracy estimates (fig. 33) for the contiguous United States.

Complete coverage of the United States means the same quality of data is available to users for every acre of ground. Nationwide, high-resolution continuous soil property maps, such as SOLUS, provide a foundation for modeling ecological sites and understanding how different landscapes and environments will respond to changes in land management or use, conservation practices, and climate. These types of soil map products serve all communities equally in the ability to generate interpretations for management and use, support conservation programs and planning, and respond to environmental changes.

Kellogg Soil Survey Laboratory Delivers National Cooperative Soil Survey Characterization Database

Kellogg Soil Survey Laboratory (KSSL) staff maintain and deliver the National Cooperative Soil Survey Characterization Database, a comprehensive soil laboratory dataset of chemical, physical, and mineralogical properties from over 75,000 sample sites, which are the result of 120 years of inventorying soils of the United States and trust territories. A wide range of customers, including farmers, ranchers, internal USDA staff, other federal agencies, nonprofit organizations, local governments, and university partners, use the database.

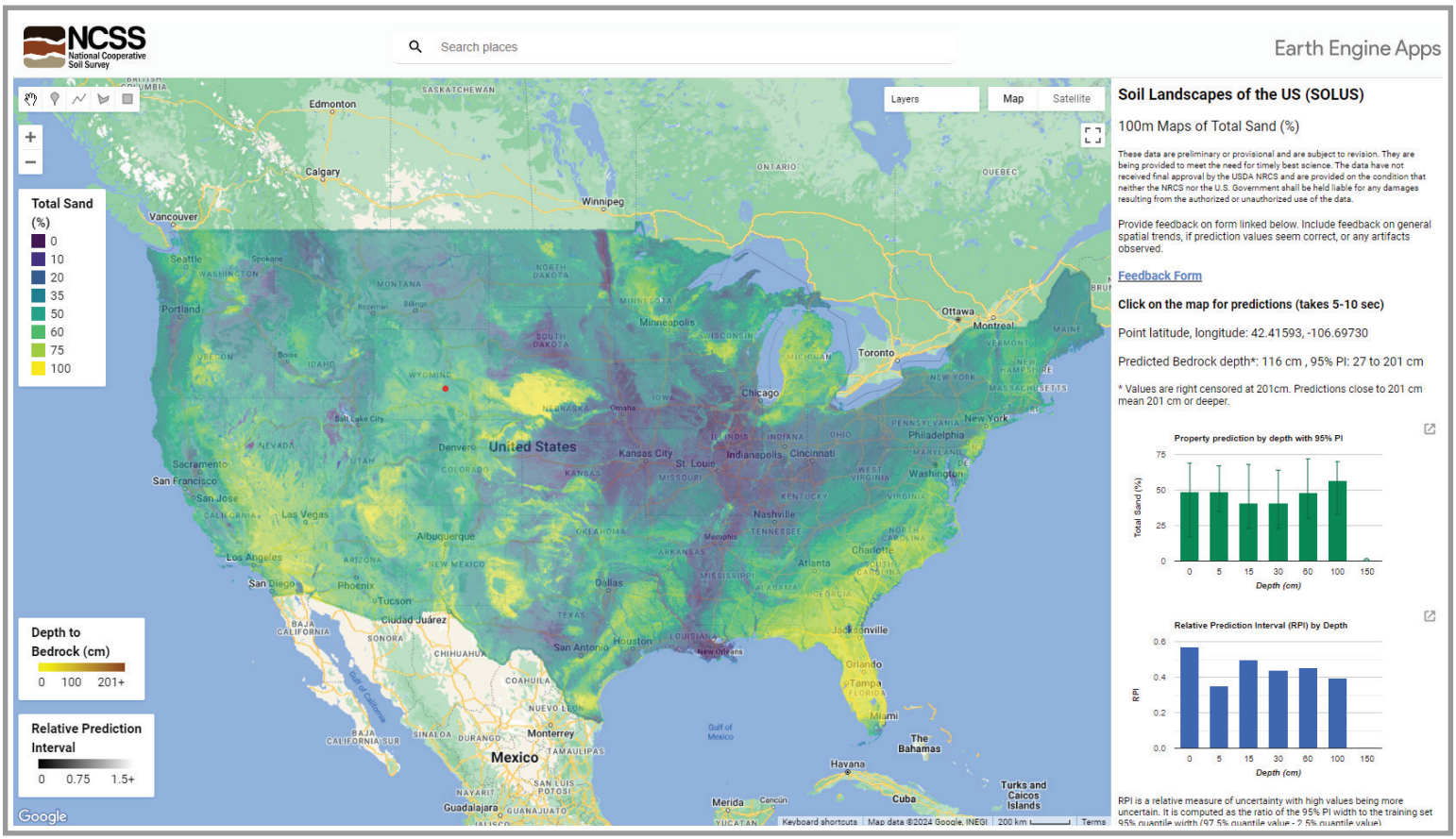


Figure 33.—SOLUS100 review app for total sand (0 cm depth shown) built in Google Earth Engine and Google Cloud Platform to facilitate review and comment period.

The KSSL participates in the United Nations Food and Agriculture Organization, Global Soil Partnership, and Global Soil Laboratory Network. In addition, the KSSL facilitates harmonization of methods of analysis and standards for laboratory quality control and improves capacities of laboratories worldwide to perform soil analysis.

Soil and Plant Science Division Establishes Soils 101 Training for Oregon NRCS

With a new generation of NRCS employees coming into the Agency, Oregon NRCS saw the need for training to elevate knowledge of local soils among NRCS interns and staff. In August 2023, Soil and Plant Science Division staff hosted a two-day training for Pathways interns and new soil conservation planners for Oregon NRCS (fig. 34). Designed for new employees who had completed basic soils college coursework, the training provided participants with more specialized soil knowledge needed to excel in their careers.

Figure 34.—Oregon NRCS Pathways interns and new soil conservation planners examine a soil profile of the Amity series in Willamette Valley.

In-Person Hydric Soil Courses in High Demand by NRCS

During fiscal year 2023, after 3 years of limited in-person training, the Soil and Plant Science Division hosted in-person Hydric Soils for Wetland Delineation, which is a NRCS requirement for staff who conduct Food Security Act wetland conservation compliance determinations, and Advanced Hydric Soils for Soil and Wetland Scientists training courses. Local NRCS staff ensured the success of each course by helping to identify field sites and providing supporting information.

The Central National Technical Service Center, Kansas NRCS, Wisconsin NRCS, Iowa NRCS, and the SPSD revised the content of the Hydric Soils for Wetland Delineation course by developing a comprehensive Microsoft Teams channel to provide course materials and adding user notes to presentations, references, websites, and a glossary of terms. Local NRCS State office and SPSD staff helped by identifying sites for field exercises, providing off-site information, and assisting with field day activities during the course. A total of 62 students from 22 states participated in the training.

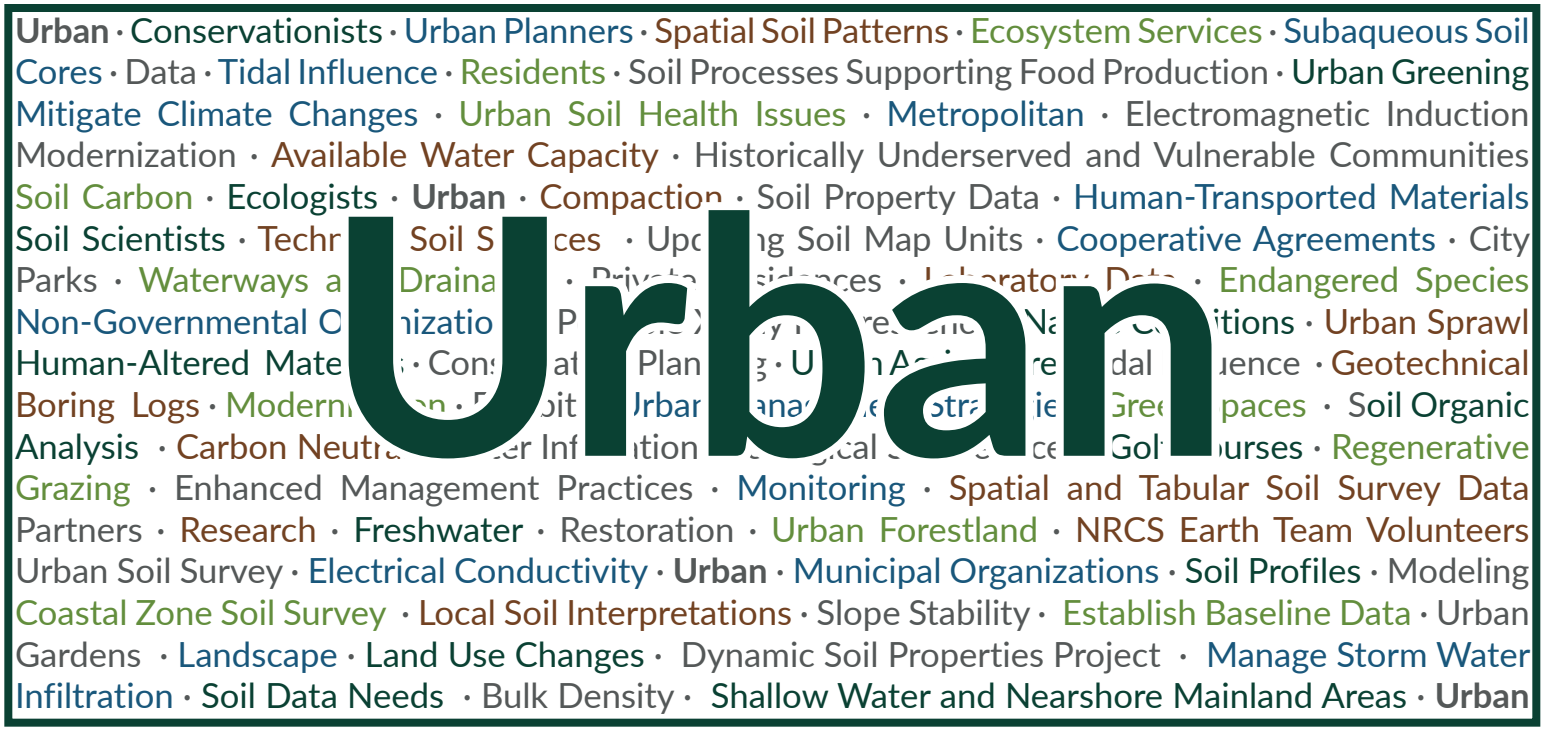
North Carolina State University and SPSD staff taught the Advanced Hydric Soils for Soil and Wetland Scientists course in Meridian, Mississippi. The course focuses on the science behind the Field Indicators of Hydric Soils in the United States and other tools used for the identification of hydric soils. Local NRCS State staff assisted with obtaining permission to use field sites and by providing local background information in the field. A total of 21 students from 18 states participated in the class.

Expansive Kellogg Soil Survey Laboratory Clientele

In 2023, Kellogg Soil Survey Laboratory (KSSL) staff conducted analyses and validation on 25,469 soil samples collected from individual soil horizons that represent 153 soil projects. The soil samples analyzed in 2023 came from the NRCS and other agency clientele that include major land resource area soil survey offices, State soil scientists, resource soil scientists, university cooperators, USDA NRCS Plant Materials Centers, National Resources Inventory, National Soil Climate Network, Tribal Soil Climate Analysis Network, the National Ecological Observatory Network, National Wetland Condition, Assessment, and outreach activities, such as collegiate soil judging and the United Nations Food and Agriculture Organization. The KSSL recorded 98,642 analytical results on chemical, physical, mineralogical, and biological soil properties by more than 50 different analytical methods.

National Cooperative Soil Survey Updates Support Underserved Communities

Soil and Plant Science Division (SPSD) staff updated soil map units previously classified as miscellaneous land categories in playas to provide valuable National Cooperative Soil Survey information to the Bureau of Land Management. Playas are a significant hydrological component in these landscapes, as was noted in this year's rainfall events at Black Rock playa, Nevada, which is the site of the Burning Man Festival. Updating these miscellaneous land types to soil data map units that have parameterized data supports modeling efforts for future climate change impacts and provides more information to help underserved communities that often have landholdings in these areas.



National Cooperative Soil Survey Projects Benefit Historically Underserved and Vulnerable Urban Communities

Soil and Plant Science Division (SPSD) staff are conducting National Cooperative Soil Survey (NCSS) projects in Camden, New Jersey; Denver, Colorado; Hartford, Connecticut; Ithaca, New York; Milwaukee, Wisconsin; St. Louis, Missouri; Salton Sea, California; San Antonio, Texas; metropolitan Philadelphia, Pennsylvania; and Raleigh, North Carolina. SPSD staff are planning to initiate NCSS projects in Lexington, Kentucky; Los Angeles, California; Niagara, New York; and Pittsburgh, Pennsylvania.

The projects will provide data to meet the diverse needs of conservationists, urban planners, and residents who want to understand the soil processes that support food production, improve soil conditions for urban greening to combat climate changes, address food scarcity, mitigate climate changes, and address urban soil health issues. This work aligns with the NRCS Climate Adaption Plan and USDA Strategic Plan by helping combat climate changes in historically underserved and vulnerable urban communities.

National Cooperative Soil Survey in Raleigh, North Carolina, Aids Urban Agriculture

The City of Raleigh, North Carolina the NRCS, and Soil and Plant Science Division staff initiated a National Cooperative Soil Survey (NCSS) project in Raleigh, located in Wake County. The first soil survey of Raleigh was completed in the 1960s, and the city has since experienced significant growth and alteration to the landscape and hydrology. The NCSS project will support urban conservation planning and urban agriculture, and it will modernize soil survey information in the area.

Soil and Plant Science Division Staff Contribute to the Deeply Rooted: How Soil Connects Us Exhibit

Soil and Plant Science Division staff in the Southwest Soil Survey Region contributed extensively to the Deeply Rooted: How Soil Connects Us exhibit at the Valene Smith Museum of Archaeology at Chico State University in California. The exhibit, which was viewed by about 2,000 people, emphasized the connection with local resources used by native populations in the area.

Congressionally Directed Spending Provides a Coastal Zone Soil Survey of Long Island Sound

On Friday, March 11, 2022, President Biden signed a bill into law authorizing Congressionally directed spending for the USDA NRCS to collaborate with partners to conduct and publish a coastal zone soil survey for the shallow water and nearshore mainland areas of the Long Island Sound Estuary System in Connecticut and New York. Managed by the Soil and Plant Science Division (SPSD), this National Cooperative Soil Survey project will provide crucial information to help manage, restore, and protect the Long Island Sound and its coastal areas.

In April 2022, SPSD soil scientists began collecting subaqueous soil cores from diverse landforms around Stonington Harbor in New London County, Connecticut (fig. 35). Working from east to west across the Connecticut portion of Long Island Sound, the fieldwork progressed throughout the year and ended by winter in Southport Harbor in Fairfield, Connecticut. Under the guidance of the SPSD Special Projects Region, 40 SPSD soil scientists and ecologists from across the country shared equipment, expertise, and knowledge to collect over 350 subaqueous cores.

Figure 35.—Soil and Plant Science Division soil scientists cap a subaqueous soil core collected as part of the coastal zone soil survey of Long Island Sound.

National Cooperative Soil Survey in the City of Denver, Colorado

Colorado State University, the City and County of Denver, Colorado NRCS, and the Soil and Plant Science Division (SPSD) are working together on the soil survey of Denver County, Colorado, which includes the city of Denver. In 2019, the City and County of Denver granted the SPSD access to city and county lands to complete soil survey data collection. In 2020 and 2021, SPSD soil scientists completed collecting soil survey data from golf courses, cemeteries, city parks and recreation areas, waterways and drainages, urban gardens, and private residences to document the degree and extent of intact soils formed under native conditions and soils formed in human-altered or human-transported materials. In 2024, SPSD staff will post the soil survey to Web Soil Survey.

Partnerships Help Analyze the Coastal and Subaqueous Soils of the Urban Sea

National Cooperative Soil Survey partners, the University of Connecticut, and the University of Rhode Island worked with the Soil and Plant Science Division (SPSD) Special Projects Region and Coastal Zone Soil Survey (CZSS) Focus Team to develop two cooperative agreements. As part of the agreements, university laboratories will complete time-sensitive and project-specific soil sample analyses for the CZSS of Long Island Sound. The data from these analyses include soil organic carbon (total and organic carbon), incubated or oxidized pH, routine pH for mineral or organic soil materials, bulk density, electrical conductivity (1:5 EC and EC for halinity classes), calcium carbonate, and particle size. Data from these analyses aid in mapping soils of coastal and subaqueous areas of Long Island Sound, also called the "Urban Sea" because it supports a large amount of people living in the watershed (fig. 36).

Figure 36.—Soil and Plant Science Division soil scientists describe a subaqueous soil core collected as part of the coastal zone soil survey of Long Island Sound.

National Cooperative Soil Survey Supports Conservation Planning in the City of Milwaukee, Wisconsin

Soil and Plant Science Division (SPSD) staff are working with the City of Milwaukee to complete an urban soil survey of Milwaukee County, Wisconsin. SPSD soil scientists are conducting fieldwork by accessing city parks, vacant lots, cemeteries, and urban agriculture sites (figs. 37 and 38). Where access is limited, staff are using geotechnical boring logs. When complete, this urban soil survey project will provide new soil survey maps and data to support conservation planning and other urban management strategies for approximately 54,000 acres.

Dynamic Soil Property Project at the White Memorial Conservation Center in Litchfield, Connecticut

The Connecticut Agriculture Experiment Station and Soil and Plant Science Division staff are conducting a dynamic soil property (DSP) project evaluating DSPs and soil health indicators of two soil series to look at the effects of six different forest management treatments: diameter limit, shelterwood, silviculture clear cut, commercial clear cut, coppice with standard, and an uncut control plot. The project is located at the White Memorial Conservation Center, which is dedicated to protecting the forest while also providing year-round natural history education and research programs to the public.

National Cooperative Soil Survey (NCSS) data from forestland DSP projects provide landowners and foresters with valuable information on forest management activities as it relates to forest soil health and management. NCSS data can also be used to improve upon the current ecological site descriptions and for future conservation planning.

Figure 37.—An hand-dug soil profile (photo tape depths in inches) from the Milwaukee area.

Figure 38.—Mitchell Park Horticultural Conservatory domes shrouded in wildfire smoke in Milwaukee County, Wisconsin.

Geophysical Tools Improve National Cooperative Soil Survey Data in the City of Ithaca, New York

Local stakeholders from municipalities, Cornell University and its satellite locations, and non-governmental organizations along with New York NRCS and Soil and Plant Science Division (SPSD) staff are collaborating to produce a soil survey that meets local needs for soil information to improve conservation planning efforts. For this soil survey project, SPSD staff are using the latest technologies, such as ground penetrating radar, electromagnetic induction, and portable x-ray fluorescence (figs. 39, 40, 41, and 42), to improve the accuracy of soil maps.

Soil and Plant Science Division Helps the City of San Antonio Commit to Being Carbon Neutral by 2050

During the week of November 14–18, 2022, Soil and Plant Science Division (SPSD) staff from the South Central Soil Survey Region traveled to San Antonio to conduct the third installment of a carbon sampling for the San Antonio Carbon Project. The Greater Edwards Aquifer Alliance and the City of San Antonio contacted the NRCS to measure soil carbon within the city limits to begin efforts to combat climate change. The carbon sampling project aims to quantify the amount of carbon across varying green spaces, including parks, schools, and natural areas. The city hopes to gain a deeper understanding of where carbon is stored to aid in land management decision making, given the city's commitment to being carbon neutral by 2050.

National Cooperative Soil Survey information will help the San Antonio Parks and Recreation Department select best management practices to improve soil carbon storage, increase available water capacity, increase water infiltration, and decrease water runoff to lessen water quantity leaving the city and improve the water quality through natural rivers and creeks. The SPSD hopes the San Antonio Carbon Project will be a blueprint for the other urban areas within Texas, as well as nationwide, to learn about urban soils and help cities combat climate change.

Figure 39.—Soil and Plant Science Division soil scientists use electromagnetic induction equipment to document the thickness of dredge spoil at the southern margin of Lake Cayuga in a filled marshland.

Figure 40.—Soil and Plant Science Division soil scientists use ground penetrating radar to document the thickness of dredge spoil at the southern margin of Lake Cayuga in a filled marshland.

Figure 41.—A soil formed in coal ash (photo tape depths in centimeters) in Ithaca, New York, capped with clean fill materials.

Figure 42.—Buried human artifacts from the excavation at a municipal golf course.

National Cooperative Soil Survey Project Supports Interest in Soil Information for Urban Agriculture in Camden County, New Jersey

Soil and Plant Science Division (SPSD) staff are completing a National Cooperative Soil Survey project in Camden County, New Jersey, originally published in 1964, in response to increased interests for urban agriculture and demand for technical soil services. SPSD staff will review portions of the city of Camden and the western portion of the county currently mapped as urban land that have limited or no soil information for conservationists, city planners, and residents. The project will fill in soil survey gaps, update soil survey mapping, and investigate the soils formed in human-transported parent materials along the rivers and creeks within the urban core. SPSD staff plan to deliver spatial and tabular soil survey data to be included when the next annual Web Soil Survey refresh occurs in 2024.

Cities of Hartford and Windsor, Connecticut, Request Soil Data to Support Forest Management Plan and Rare Insects

The City of Hartford, the Connecticut Department of Energy and Environmental Protection, NRCS Earth Team volunteers, Connecticut NRCS and Soil and Plant Science Division staff completed an urban soil survey covering 132 acres of urban forestland in Keney Park (Hartford, Connecticut) and 270 acres in the Matianuck Sand Dunes Natural Area Preserve (Windsor, Connecticut) (figs. 43 and 44). The area was altered by human activities, such as the creation of small pools, ponds, and channels and the building of a zoo and mass plantings. It also experienced natural disturbances from the hurricane of 1938.

Figure 43.—A soil profile at the Matianuck Sand Dune Natural Area Preserve (photo tape depths in centimeters).

Figure 44.—A Soil and Plant Science Division staff member observes the landscape.

The National Cooperative Soil Survey information improves the accuracy of the soil survey maps and provides laboratory data, such as soil pH, texture, and total carbon, to help municipal, State, and non-government organizations develop a forest management plan for the area. The information will also enhance management practices to support insects such as the federally threatened and State endangered big sand beetles and the rare and endangered ghost dune tiger beetles.

Investigating Dynamic Soil Properties at the Pamet River Marsh Restoration Site in Truro, Massachusetts

The National Park Service and Soil and Plant Science Division staff are conducting the first dynamic soil property (DSP) project to document changes in soil properties with the restoration of the Pamet River marsh system in Truro, Massachusetts. The NRCS Watershed Protection and Flood Prevention Program along with the Cape Cod Water Resources Restoration Project will fund the development of a restoration plan to reestablish tidal and saltwater flow.

The Pamet River is an estuarine system that cuts across lower Cape Cod starting from Cape Cod Bay and extending almost all the way to the Atlantic Ocean. Over 150 years ago, a dike was installed that restricts tidal flow to nearly half of the system. With this restriction, areas that were once salt marsh converted to a freshwater marsh system. Recent overwash events during storms have caused saltwater from the Atlantic Ocean to enter the system and inundate this freshwater system, causing temporarily elevated salinity levels and impacting freshwater marsh vegetation and drinking water wells.

The DSP project will compare soil properties in an unrestricted estuarine salt marsh to those properties of a marsh that has experienced limited tidal influence for over 150 years. The project will provide insight into changes in DSPs, including bulk density, conductivity, and organic carbon content, that influence important parameters, such as carbon stocks and habitat resiliency, with sea level rise. The project will also provide baseline data to monitor changes over time after the restoration of tidal influence to the upper Pamet River and possibly show that restoring and preserving degraded salt marshes can increase carbon sequestration.

National Cooperative Soil Survey in Greater Philadelphia, Pennsylvania, Supports Urban Agricultural Conservation Planning

Delaware County Conservation District, Pennsylvania State Parks, Pennsylvania NRCS, and Soil and Plant Science Division staff completed a National Cooperative Soil Survey project in Delaware County, Pennsylvania, a part of the greater Philadelphia area (figs. 45 and 46). The first soil survey in this area was completed in the 1960s, and land use changes, such as urban sprawl, have dramatically altered the landscape prompting updates to the soil survey. The team worked together to provide soil survey data for science-based conservation planning and developed local soil interpretations. Enhanced soil interpretations included saturated hydraulic conductivity, runoff, compaction, and metrics supporting urban agriculture conservation planning.

Figure 45.—A Soil and Plant Science Division soil scientist documents the description of a soil profile in a residential backyard near Philadelphia, Pennsylvania.

Figure 46.—A Folcroft soil profile, a new soil series formed in human-transported materials with a high content of human artifacts and rock fragments on raised human-created landforms.

City of St. Louis, Missouri, Looks to the National Cooperative Soil Survey to Help Manage Stormwater

Soil and Plant Science Division (SPSD) staff have started a National Cooperative Soil Survey (NCSS) project for the City of St. Louis, Missouri. SPSD soil scientists began collecting soil descriptions at sites throughout the city and plan to continue through 2024 (fig. 47). The NCSS project will provide updated mapping, soil property data, and ecological site information to meet the increased need and demand for soil information to better manage stormwater infiltration and runoff.

Figure 47.—A Harvester soil profile showing human-altered and human-manufactured material.

Allegheny County Conservation District Hosts National Cooperative Soil Survey Meeting in Pittsburgh, Pennsylvania

In August 2023, the Allegheny County Conservation District hosted a two-day meeting that included presentations and field visits to discuss a potential soil survey update for the Pittsburgh, Pennsylvania, area. Representatives from the Pennsylvania NRCS, the University of Pittsburgh, the City of Pittsburgh, Allegheny County, the Allegheny County Sanitary Authority, the U.S. Army Corps of Engineers, Upstream Pittsburgh, and the Soil and Plant Science Division attended. Partners identified important soil data and interpretation needs related to urban agriculture and food production, climate resiliency and soil carbon, soil hydrology, dynamic soil properties, spatial soil patterns, slope stability, and other ecosystem services (fig. 48).

Figure 48.—National Cooperative Soil Survey partners and Soil and Plant Science Division soil scientists discuss urban soil properties and classification at an urban farm in Pittsburgh, Pennsylvania. The site is in a former public housing area that has since been demolished and converted to an urban farm to support the local community (photo used with permission from Jonathan Burgess, University of Pittsburgh).

“Be it deep or shallow, red or black, sand or clay, the soil is the link between the rock core of the earth and the living things on its surface. It is the foothold for the plants we grow. Therein lies the main reason for our interest in soils.”

— Roy W. Simonson, USDA Yearbook of Agriculture, 1957