USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Twelve Tough DIGS

2023 Soils Planner

Words From the Deputy Chief

Starting with the first soil survey in 1899, the National Cooperative Soil Survey has evolved into a comprehensive partnership based on dependable science and a continuing commitment to studying, protecting, and preserving our soil and other natural resources.

Soil science is vital to human civilization and prosperity. Although this discipline has been largely unpublicized, every life is affected by discoveries related to soil. Scientists have learned about the fragility of soil ecosystems and become advocates for the wise use and conservation of natural resources. Human survival is influenced by and dependent on these functioning ecosystems.

Soil science requires more than just data collection, rigorous research, and effective model development. It requires field crews who invest blood, sweat, and tears into soil mapping. This planner acknowledges the exceptional effort of the people who dedicate themselves to sustainable land use. The stories and photographs featured in this planner are from the scientists who endured the necessary hardships to help us better understand the soil.

The first soils planner was published in 1999 to commemorate the 100th anniversary of the first soil survey. The soils planners provide more than just reminders about important conservation events and activities. They disseminate information and provide education about soil science. They stimulate interest with individuals who are not familiar with the science and generate enthusiasm for learning more.

Luis Tupas
Deputy Chief for Soil Science and Resource Assessment
USDA, Natural Resources Conservation Service

Twelve Tough DIGS

Exploring Soils in Unique and Challenging Locations

This planner recognizes unique and challenging locations that have been investigated by soil scientists. Many of the locations are spectacular but require scientists to endure extreme conditions. Some areas are desolate and have unbearable climate, such as desert heat or arctic cold. Other areas have unforgiving landscape attributes, such as isolated mountains or dense vegetation. All of the areas required the scientists to overcome unique trials.

Many of the investigations were defined by hazards and hardships. Examples include dangerous wild animals, biting insects, treacherous landscapes, rock falls, and inaccessibility. Sheer remoteness could escalate any injury into a dangerous situation, especially where the voyage was by foot or canoe. Most of the remote investigations required the adventuresome scientists to carry all their needs, such as food, water, cooking gear, and survey equipment. At times, foraging was necessary.

Unique challenges can require special equipment, such as vibracorers, fathometers, and fan boats to sample subaqueous soils along the coast and in estuaries, bays, and lakes. Less exotic equipment that isn't otherwise common during soil survey, such as watertight containers, protects supplies during boat trips. Tracked vehicles or helicopters provide transport on frozen tundra and in mountainous regions.

All the featured digs were tough, but not all were remote. Some challenges arose from restrictive or limited soil material, such as found in underwater and urban settings. Urban areas pose their own distinctive challenges, such as moving equipment through densely populated areas, avoiding utilities and other buried structures, coordinating with multiple local authorities, and studying industrial sites for possible contamination.

JANUARY

Photo by Phillip Barber, NRCS

Alaska was purchased from Russia in 1867. Since Alaska gained statehood in 1959, millions of acres of wilderness have been designated as wildlife reserves, national parks, and preserves, thereby conserving these natural treasures.

NRCS collected and described soil samples from two sites of the National Ecological Observatory Network (NEON) just north of Denali National Park and from one site near Utqiaġvik on the north coast. These research sites collect long-term ecological data related to changing ecosystems.

Hypothermia, wind, and snow blindness were safety concerns due to sub-zero temperatures. In some cases, up to 4 feet of snow was shoveled to conduct the sampling. SIPRE augers, developed by the U.S. Snow, Ice and Permafrost Research Establishment in the 1950s, were required to drill into the permanently frozen soil. Polar bears were another concern, although they were mostly out on the sea ice at the time of the project.

FEBRUARY

Photo by Steve Herriman, NRCS

The White Mountains of California are east of the Sierra Nevada. They receive little precipitation despite very high altitudes. In many places, the environment is reminiscent of a moonscape. Bighorn sheep and marmots are the only inhabitants at the higher elevations. The highest point, 14,252 feet (4,344 meters), is White Mountain Peak, an extinct volcano.

The isolation of the range makes it an ideal research location. Here, NRCS and university partners are studying factors that affect soil temperature, soil moisture, and soil climate change. This information will improve predictions of soil behavior and change over time.

Although several roads and trails provide access to the mountains, much of the landscape is steep and treacherous. Elevations are commonly around 6,500 feet, and mobility is a challenge. Most of the sampling sites are remote. Long hikes are required over rough terrain, and some climbing skills are needed.

MARCH

Photo by Bailey Parrish, North Carolina State University

Bird Island Coastal Reserve is managed by the North Carolina Department of Environmental Quality. This barrier island includes sand beaches, large dunes, and brackish marsh. Bird Island is a fish and bird oasis and a favorite nesting site of loggerhead sea turtles.

NRCS partnered with several universities to research and sample blue-carbon soils from swamps, marshes, bays, and sounds along the coasts. Blue carbon is organic material that is stored in soils throughout the world's oceans and coastal ecosystems. Understanding these "carbon sinks" will improve our understanding of the earth's carbon cycle and help combat global climate change.

Sampling soils from a boat and working underwater can be challenging. Boat safety is imperative. Other challenges of subaqueous soil sampling include moving people and equipment across the marsh and keeping the boat steady and the equipment dry.

Togiak National Wildlife Refuge consists of 4.7 million acres in southwestern Alaska near Bristol Bay. Earthquakes and volcanoes influenced the area, and the advance and retreat of glaciers further sculpted the landscape. Although the area is secluded and susceptible to treacherous weather, evidence suggests that it has been inhabited for the last 2,000 years. In fact, some remains are 4,000 to 5,000 years old.

The refuge was established to conserve fish, wildlife, and their natural habitats and to ensure continued water quality and quantity.

The refuge is roadless; access is primarily via air or water. Typically, planes drop off the scientists and gear and then return for pick up at a designated time and place. Rapidly changing weather, wind, fog, or other dangerous conditions can temporarily strand the crew. In addition, the Ahklun Mountains spread across 80 percent of the Togiak Refuge, making long treks inland challenging.

The **Boundary Waters Canoe Area Wilderness** (BWCAW) was established in 1978 in northern Minnesota and consists of about 1.1 million acres. In 2013, NRCS and the USDA Forest Service (FS) collaborated on a digital soil survey project. The BWCAW Soil Survey was a national pilot project established to test and develop standards for raster soil surveys.

The BWCAW has more than 4,000 lakes, making water quality a high priority. Wildfire prevention, forest ecosystem maintenance, endangered and invasive species management, maintenance of trails, portages, and camping sites, along with erosion control measures, are critical FS activities.

The BWCAW is extremely remote and accessible only by foot or canoe. Due to the vastness of the area, expeditions ranged from 5 to 10 days and involved camping at primitive sites. In addition to the back-breaking work of sampling rocky soils, the crew had to set up and break down a wilderness camp and carry canoes and packs weighing up to 80 pounds.

Newark is the most populous city and the second-most racially diverse in New Jersey. Known as the Garden State, New Jersey has seen a growing interest in urban agriculture.

Urban agriculture takes many forms, including backyard, roof-top, and balcony gardening; community gardening in vacant lots and parks; roadside, urban-fringe agriculture; and open-space livestock grazing. It not only provides food in highly populated areas but can also reduce transportation costs, decrease runoff associated with heavy rainfall, and improve air and water quality.

The property shown below is in Newark. A local resident acquired the property to develop it for urban agricultural production and help bring grassroots sustainability to an underserved population. NRCS assisted with soil testing using a portable X-ray fluorescence analyzer. These tests help ensure that the produce is safe from possible contaminants and provide data needed to make important decisions about soil nutrients and fertility.

APRIL

Photo by Phillip Barber, NRCS

MAY

Photo by Michael Whited, NRCS (retired)

JUNE

Photo by Lauren Finnegan, NRCS

JULY

Photo by Wilma Renken, NRCS

The **Santa Rita Experimental Range** (SRER), founded in 1903, is the oldest research area maintained by the USDA Forest Service. It has been a principal site for pioneer range research on the improvement and management of dry grasslands in the Southwest. SRER is south of Tucson at the foothills of the Santa Rita Mountains in the Sonoran Desert. It is characterized by a hot, semi-arid climate.

Data collected at SRER help scientists understand the functions of desert ecosystems. Deserts are uniquely sensitive to human disturbances.

The soils in this region are very hard to dig. Not only are they dry and rocky, but they commonly have a cemented layer, or hardpan, below the surface. Holes are excavated in shifts using a rock bar and shovel. Temperatures in the region can exceed 100 °F, so precautions are needed to protect against dehydration and the sun.

AUGUST

Photo by Jeff Rebernak, NRCS Earth Team Volunteer

Yellowstone National Park was established in 1872 and consists of 2.2 million acres. Due to volcanic activity, the park has unique hydrothermal features. Examples include Old Faithful, other active geysers, and hot springs. Other impressive geologic wonders include the Grand Canyon of Yellowstone and towering mountain ranges.

NRCS assisted with the establishment of SNOTEL stations within Yellowstone. These automated data-collection instruments were placed in remote, high-elevation locations. The stations transmit measurements of snowpack, precipitation, air temperature, and other climatic conditions. The data is used to forecast snowmelt and streamflow throughout the western United States.

Access to conduct yearly summer maintenance is either by helicopter or by horseback and pack mule. As with any trek into mountains, rockslides, exposure, falls, wildlife, avalanches, and high-altitude sickness are dangers.

SEPTEMBER

Photo by Kari Sever, NRCS

Denver, the capital of Colorado and its most populous city, has a population over 715,000, which is a 19-percent increase since 2010. Denver is nicknamed the “Mile High City” because it has an official elevation of exactly 1 mile above sea level (5,280 feet).

The Denver Soil Survey, an initial mapping project, started in 2018 and is still in progress. The soils information collected is used by local planners to address stormwater runoff, erosion, flood control, water quality, and other important urban needs.

Exceptional effort is required to obtain permissions to dig, request utility locations, adhere to local regulations, and access sites in the downtown area. In addition to logistics, digging in parks or an individual’s backyard can be challenging. All sites are hand dug, and many have human-transported material containing rock fragments or artifacts (for example, asphalt, concrete, and brick) that require a rock bar to break through.

The **Bob Marshall Wilderness Complex** (BMWC) covers over 1.5 million acres of roadless wilderness in western Montana. This remote, ruggedly mountainous area is maintained by the USDA Forest Service primarily for recreational use. It is also home to the largest population of grizzly bears anywhere in the United States outside of Alaska.

Wildlife, forestry, and ecosystem management are high priorities in the BMWC. Wildfire prevention, management for endangered and invasive species, development and maintenance of trails and camping sites, and erosion control are also important.

Trails in the BMWC are accessible only by foot or horseback. Sampling the soils required 10-day, back-country trips using draft mules to carry the bulk of the camping gear, food, and survey equipment. Field days were long, physically demanding, and exhausting but provided spectacular views.

The **Hilo Forest Reserve** is on the eastern (windward) side of Mauna Kea, which is the highest volcano on the Island of Hawaii. The reserve, which is approximately 82,000 acres, includes a Federal wildlife refuge, a State forest and nature preserves, and private holdings. The soils in the area developed from weathered volcanic ash and lava flows.

The reserve protects key forested watersheds and native species while also providing opportunities for hiking, hunting, and traditional cultural practices. Major resource concerns include invasive plants, insects, and animals, including feral ungulates and wild cattle.

This densely forested area has a steep, dissected, rugged landscape. Access is limited to hiking and hunting trails. Undulating lava flows and wetlands that remain saturated year-round make access and navigation challenging. Because of these restrictive features, helicopter drops were the only feasible way to conduct field investigations and soil survey activities.

The **Missouri Coteau** is a large plateau that stretches along the eastern side of the Missouri River. It extends south from the U.S.-Canadian border into South Dakota. The elevated rolling topography is a striking feature of the coteau, which means “little hill” in French. The closely spaced hills and knolls alternate with marshy depressions, or potholes, that dot the landscape.

NRCS investigated the wetlands in the coteau in part because of their importance to migratory birds and for water quality. The area is also referred to as the Prairie Pothole Region. It once contained about 25 million wetlands, or an average of about 83 per square mile.

Collecting soil samples in areas with permanent water cover is not easy, and the Missouri Coteau proved to be very challenging. With some ingenuity, however, the scientists found winter to be a great time to sample these places. They just added a good pair of ice cleats, warm clothes, and proper ice-cutting gear.

OCTOBER

Photo by Patrick O’Connell, NRCS

NOVEMBER

Photo by Amy Saunders Koch, NRCS

DECEMBER

Photo by Perry Sullivan, NRCS

Alaska

Above: Biologist Guy Litt (left) and Soil Scientist Dennis Mulligan (right) use a handheld, gas-powered auger to collect cores in the frozen soil.

December 2022

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
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18	19	20	21	22	23	24
25	26	27	28	29	30	31

February 2023

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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

2023 JANUARY

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 New Year's Day	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16 Martin Luther King, Jr. Day	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Did you know?

Frozen soil that remains below zero for 2 or more years is called permafrost. Permafrost limits construction because heat from a building can melt the frozen soil and destabilize the structure.

The White Mountains of California

Above: Soil Scientist Matt Cole puts the final touches on a soil climate station at 13,040 feet near Mount Barcroft.

January 2023

S	M	T	W	T	F	S
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29	30	31				

March 2023

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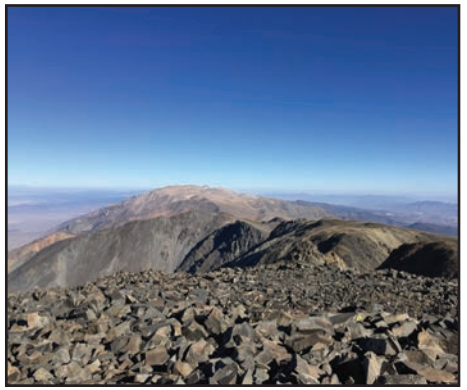
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

2023 FEBRUARY

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20 Presidents' Day	21	22	23	24	25
26	27	28				

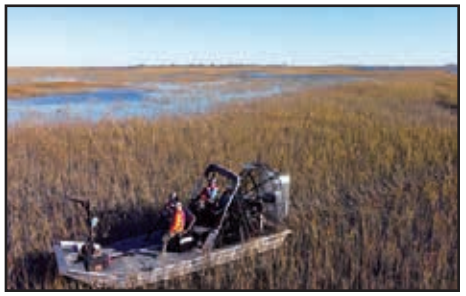


Did you know?

The White Mountains are home to groves of bristlecone pine (right). Some of these trees are estimated to be over 4,000 years old, among the oldest trees on earth.

Bird Island Coastal Reserve

Above: Soil scientists use an airboat to navigate the marsh and sample subaqueous soils.



February 2023

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19	20	21	22	23	24	25
26	27	28				

April 2023

S	M	T	W	T	F	S
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9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

2023 MARCH

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Did you know? Soils that have permanent water on the surface are called subaqueous soils.			1	2	3	4
5	6	7	8	9	10	11
12 Daylight Saving Time Begins	13	14	15	16	17	18
19	20 Vernal Equinox	21	22	23	24	25
26	27	28	29	30	31	Bird Island is a favorite nesting site of loggerhead sea turtles (right).

Togiak National Wildlife Refuge

Above: Soil Scientist Tony DeMarco explores the alpine above the Togiak River and Togiak Lake.

2023 APRIL

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Did you know? Gravel bars are ideal camp sites during boat trips but also provide bears important access to salmon runs. Brown bear tracks in the wet sand (right) remind staff to be extra vigilant around the camp.						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22 Earth Day
23	24	25	26	27	28	29
30						

March 2023

S	M	T	W	T	F	S
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5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

May 2023

S	M	T	W	T	F	S
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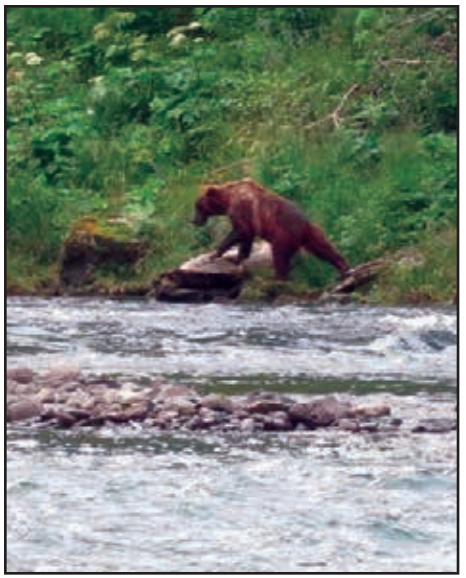
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

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Boundary Waters Canoe Area Wilderness

Above: Retired Soil Scientists Pete Weikle and Kim Steffen prepare to travel inland to the sampling point.

2023 MAY

April 2023

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
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23	24	25	26	27	28	29
30						

June 2023

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18	19	20	21	22	23	24
25	26	27	28	29	30	

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
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7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29 Memorial Day	30	31			

Did you know?

Nearly 20 percent of the total area of BWCAW is water; the rest is forested. Bedrock near the surface (right) is common in wet areas.

Newark, New Jersey

Above: Soil Scientist Edwin Muñiz measures a thick mantle of construction debris intermingled with human-transported soil materials.

May 2023

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

July 2023

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

2023 JUNE

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Did you know? Soil scientists use portable X-ray fluorescence analyzers (bottom right) for rapid onsite assessments of soil chemistry.				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19 Juneteenth	20	21 Summer Solstice	22	23	24
25	26	27	28	29	30	

Santa Rita Experimental Range

Above: Soil Scientist Samantha Carrillo (left) and Civil Engineer Trevor Towers dig a pit in the extremely dry soil of the Sonoran Desert.

2023 JULY

June 2023

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

August 2023

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Did you know? Twenty percent of the world's land surface is desert. The Sahara is the largest hot desert on earth, and Antarctica is the largest cold desert.						1
2	3	4 Independence Day	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Yellowstone National Park

Above: Soil Scientist Carla Rebernak works waist-deep in a soil pit.

2023

AUGUST

July 2023

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

September 2023

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

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Did you know? Yellowstone became the first national park in the world.		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	Packed mules carried nearly 220 pounds of equipment and 70 pounds of soil samples through 28 miles of wilderness.	

Denver, Colorado

Above: Left to right, NRCS Soil Scientists Kari Sever, Andy Steinert, Laura Craven, and Abbie Clapp sample soils in a downtown park.

August 2023

S	M	T	W	T	F	S
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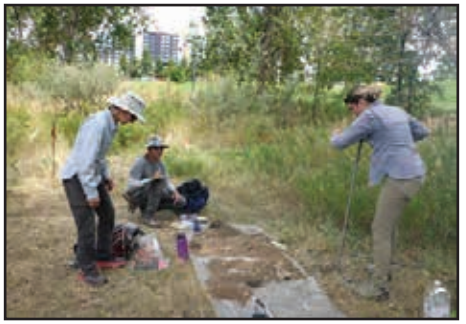
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

October 2023

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

2023 SEPTEMBER

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Did you know? The Colorado Convention Center has a large-scale, urban garden named the "Blue Bear Farm." The farm has more than 5,000 square feet of growing space and yields farm-fresh fruits, vegetables, herbs, and honey.					1	2
3	4 Labor Day	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23 Autumnal Equinox
24	25	26	27	28	29	30



Bob Marshall Wilderness Complex

Above: Mules carry camping gear and field equipment.

September 2023

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

November 2023

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

2023 OCTOBER

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7
8	9 Columbus Day	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

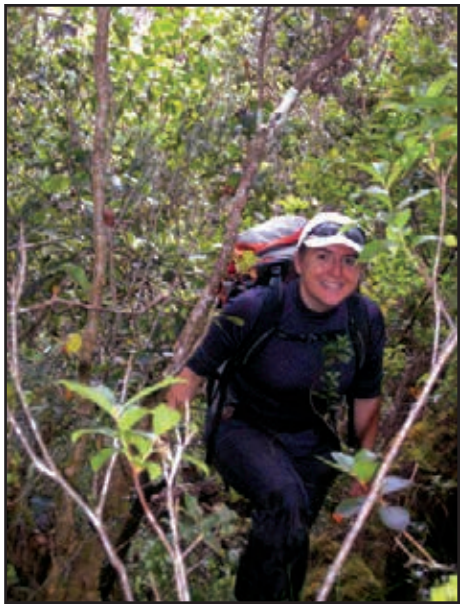
Did you know?

The Bob Marshall Wilderness Complex includes a 22-mile-long escarpment that averages 1,000 feet in height.


20
40

Hilo Forest Reserve

Above: Soil Scientist Patrick Niemeyer examines soil that developed from weathered volcanic ash and lava flows.



Mauna Kea (right) is the highest volcano on the Island of Hawaii.

October 2023

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

December 2023

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

2023 NOVEMBER

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Did you know? Molten rock is termed “magma” when underground and “lava” when exposed at the surface.			1	2	3	4
5 Daylight Saving Time Ends	6	7	8	9	10	11 Veterans Day
12	13	14	15	16	17	18
19	20	21	22	23 Thanksgiving Day	24	25
26	27	28	29	30		

Missouri Coteau

Above: Soil Scientist Brianna Wegner cuts through 2 to 4 feet of ice.

November 2023

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

January 2024

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

2023 DECEMBER

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Did you know? Wetlands only cover about 3 percent of the earth's surface but store up to a third of the world's total carbon. Wetland areas in the Coteau are important for migratory birds and water quality.					1	2
3	4	5 World Soil Day	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21 Winter Solstice	22	23
24	25 Christmas Day	26	27	28	29	30
31 New Year's Eve						

Top: Sweetwater, Wyoming.

Middle: Soil Scientists Deb Harms and Cathy Seybold in Antarctica (left); Arctic field station in Inigok, Alaska (right).

Bottom: Stockton Island in Lake Superior, Wisconsin (left); soil survey crew in Olympic National Park, Washington (right).

Front Cover: The Bob Marshall Wilderness Complex, Montana.

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Program Aid 2275; June 2022