

The Newsletter of the Maine Association of Professional Soil Scientists

Volume 26, Issue #1

www.mapss.org

Winter 2023 Edition

2022-2023 Executive Committee

President Rodney Kelshaw

Vice President Roger St. Armand

Past President Christopher Dorion

Treasurer Gary Fullerton

Secretary Eric Whitney

Director Natalie Marceau

2022-2023 Committee Chairs

Technical Chair Tony Jenkins

Webmaster Matt Dorman/Chris Dorion

Newsletter Christopher Dorion

Education Michael Jakubowski

State of Maine Liaison OPEN

University of Maine Liaison Ivan Fernandez (Orono)

USDA NRCS Liaison Lindsay Hodgman

| IN THIS ISSUE | |
|--|---------|
| President's Message - Rodney Kelshaw | Page 1 |
| Recap of Joint MAPSS – MAWS Wolfe's Neck Woods Farm & Center and | |
| Wolfe's Neck Woods State Park field conference, September 7th, 2022 | Page 3 |
| Updating <i>MAPSS Guidelines</i> | Page 8 |
| Reorganized MAPSS Website SOIL and WETLAND SCIENCE Links | Page 8 |
| Check your MAPSS website Member Directory Information | Page 8 |
| Treasurer's Report - Gary Fullerton | Page 9 |
| Preliminary agenda March 21, 2023 Joint MAPSS – MAWS Winter Conference | Page 10 |
| What role do soil and sediment play in damping or enhancing eutrophication? ¹ | |
| – Stephen A. Norton and Tristan G.S. Taber | Page 11 |
| Observations on Soil Drainage Class and Hydric Soil Determinations | |
| – David Marceau | Page 18 |
| March 15, 2022 MAPSS Annual Business Meeting Minutes: <i>To be approved at</i> | |
| the March 21, 2023 MAPSS Annual Business Meeting – Eric Whitney | Page 20 |
| Matthew Boucher – new State of Maine Soil Scientist– Bureau of Agriculture, Food and Ru | ral |
| Resources Director Nancy McBrady | Page 21 |
| | |

PRESIDENT'S MESSAGE

Rodney Kelshaw, Maine LSS #522

A MESSAGE FROM THE PRESIDENT: RODNEY KELSHAW

Hello MAPSS Membership. I want to start by saying thank you once again for the opportunity to be a contributing member to our association and to continue in the role of President. It was difficult to find a topic for this year's message; most if it felt as if it were done before: *the last few years have been strange, it is nice to be out in person, never been busier with work...* But then, two recent exchanges reminded me **Why We Do This.**

The other night a coworker brought in his daughter to meet our staff and discuss ecology. She is in college and thinking about changing majors to environmental sciences. It was fun to talk about what we do day to day, but that led to a deeper discussion. I dare say most of us really like what we do and are so interested

that, outside of work, we can't stop ourselves from annoying our friends and family by pointing out birds,

The Maine Association of Professional Soil Scientists (MAPSS) was formed in 1975. The Mission of MAPSS is to promote soil science through the exchange of technical, political, and regulatory information that influence and guide the profession of soil science. MAPSS members have interdisciplinary professional backgrounds in both the private and public sector, including soil consultants, wetland scientists, site evaluators, state and federal government scientists and regulators, students, and others with an interest in the natural sciences. The organization's goal is to ensure the success and promote the advancement of the soil science profession. MAPSS strives to provide guidance, education, and training to its members and the public on soil science issues of interest and concern.



Winter 2023 Edition

interesting vegetation, annoyance with invasive species, and apparent soil transitions, to name a few. We also use our experience to join municipal boards, committees, and professional associations. We will spend time at state legislative committee meetings, as well as weekends looking for workshop sites. We enjoy getting together with our peers outside of work and invariably the discussion is overtaken by environmental sciences topics and general "shop talk". The discussion with this student helped me reaffirm to myself why I enjoy what I do.

This summer I was fortunate to be involved in a wedding between two old friends (one of which is an environmental scientist). The morning of the wedding the groom and I went for a run, he had to go back to do groom duties, but I went a little longer and I ran by a pit. I turned back because I saw what I thought was an interesting soil boundary; I ran up into the pit, checked it out and snapped a few photos.



Upper and lower photos by Rodney Kelshaw.

A very cobbly Colton soil is seen in the upper photo.

The lower photo shows the transition from (left to right in the photo) of Colton soils to a likely Adams soil.

In these glaciofluvial deposits, the "topsoil", or solum, has typically been removed, which appears likely here as evidenced by the absence of spodic horizons and the presence of pioneering shrub vegetation.

Oftentimes we can see the transition from glaciofluvial parent material to marine sediments or glaciolacustrine sediments at the toe slopes of these eskers and deltas.

These glaciofluvial landforms are invariably zoned by towns as "Aquifer Protection Overlay Districts" and provide high quality, sustainable drinking water to Mainers.



I then went back to the streamside cabin where I was staying with my family and the first thing I did was pull up the NRCS map on my phone to see what soils were mapped in the area and where the boundaries were located. As you would expect, the NRCS nailed it.



Volume 26, Issue #1

In these times there are so many unknowns; whether you are a consultant, in academia, a regulatory staffer, or an NGO, your daily work is affected by new discoveries in soil chemistry, soil contamination issues, strategies to affect climate change, changes in legislation, and the economy. Despite all the unknowns, we can all rely on the fact that we do this because we enjoy it, and it is fulfilling outside of work. We stay interested, engaged, and, through MAPSS, we continue to further soil knowledge outside of our organization.

Recap of Joint MAPSS – MAWS Wolfe's Neck Woods Farm & Center and Wolfe's Neck Woods State Park, September 7th, 2022

Rodney Kelshaw, Maine LSS #522 and Christopher Dorion, LSS #454

On September 7, 2022 MAPSS and MAWS held their joint annual field day workshop in Freeport. We were fortunate to once again have access to The Wolfe's Neck Center for Agriculture & the Environment (TWNC) and The Wolfe's Neck Woods State Park along with The Freeport Conservation Trust Rachel's Cove conservation area.

"Wolfe's Neck Woods State Park is a five-minute drive from the center of Freeport's bustling shopping district, and as visitors approach the park, marshes and open fields provide a tranquil transformation back to nature. In 1969, this area of more than 200 acres was given to the State by Mr. and Mrs. Lawrence M.C. Smith of Freeport. The park contains varied ecosystems, including climax white pine and hemlock forests, a salt marsh estuary, and the rocky shorelines on Casco Bays and the Harraseeket River."





MAPSS – MAWS 2022 Field Conference. Conference attendees at soil Test Pit-3, a Scantic silt loam. TP-5 is visible in background at the edge of unmowed wetland (PEM1), and TPs-6 and -7 are beyond this PEM1. Special thanks to site monitors Tony Jenkins, Rod Kelshaw, Roger St. Amand, Greg Granger, Nick Butler, Chris Coppi, and Chris Dorion.

"Wolfe's Neck Center for Agriculture & the Environment's mission is to transform our relationship with farming and food for a healthier planet. Situated on over 600 acres of preserved coastal landscape in Freeport, Maine, they use their diverse landscapes to connect people of all ages to the food they eat and where it comes from. Encompassing a demonstration farm, oceanfront campground, wooded trails, and historic buildings, the campus serves as a unique hub for education and exploration. As a nonprofit, Wolfe's Neck Center draws upon a rich history of innovation and experimentation to continue the legacy of this place today. Through regenerative farming, innovative soil health research, and visitor interactions, the land is used as an educational resource to create a healthier planet for all. They hope to inspire active participation in a healthier food system and build a community of people who care deeply about the future of food."

The workshop's goal was to train environmental scientists and the regulating communities in how to identify natural resources and discuss permitting scenarios. Many thanks to all the volunteers that spent countless hours selecting the sites, coordinating with partner organizations, describing soil pits, and ALL the other behind-the-scenes tasks that make a successful workshop happen.

Wolfe's Neck Center Field: Site 1 (thanks again to NRCS for providing the excavator & digging the pits). Site 1 Pit 1 Items to Review:

- Soil Parent Material & Soil Series
- NRCS Mapped Farmland of Statewide Importance
- Suitable as a stormwater BMP vegetated buffer
- Hydrologic Soil Group
- Site Evaluation Profile and Soil Condition

Site 1 Pit 2 Items to Review:

- Soil Parent Material & Soil Series
- NRCS Mapped Farmland of Statewide Importance



Volume 26, Issue #1

- Suitable as a stormwater BMP vegetated buffer
- Hydrologic Soil Group
- Site Evaluation Profile and Soil Condition

Site 1 Pit 3 Items to Review:

- Soil Parent Material & Soil Series
- NRCS Mapped Farmland of Statewide Importance
- Suitable as a stormwater BMP vegetated buffer
- Hydrologic Soil Group
- Wetland and if yes where is the boundary
- Site Evaluation Profile and Soil Condition

Site 1 Pit 4 Items to Review:

- Soil Parent Material & Soil Series
- NRCS Mapped Farmland of Statewide Importance
- Suitable as a stormwater BMP vegetated buffer
- Hydrologic Soil Group
- Site Evaluation Profile and Soil Condition

Site 1 Pit 5 Items to Review:

- Soil Parent Material & Soil Series
- NRCS Mapped Farmland of Statewide Importance
- Suitable as a stormwater BMP vegetated buffer
- Hydrologic Soil Group
- Wetland and if yes where is the boundary
- Site Evaluation Profile and Soil Condition

Site 1 Pit 6 Items to Review:

- Soil Parent Material & Soil Series
- NRCS Mapped Farmland of Statewide Importance
- Suitable as a stormwater BMP vegetated buffer
- Hydrologic Soil Group
- Wetland and if yes where is the boundary
- Site Evaluation Profile and Soil Condition

Site 1 Pit 7 Items to Review:

- Soil Parent Material & Soil Series
- NRCS Mapped Farmland of Statewide Importance
- Suitable as a stormwater BMP vegetated buffer
- Hydrologic Soil Group
- Wetland and if yes where is the boundary
- Site Evaluation Profile and Soil Condition

Site 2: Rachel's Cove Trail (Freeport Conservation Trust)

- Stream or Not a Stream? Shoreland Tributary?
- Site Evaluation Profile and Condition
- Site Evaluation suitable to design a system? Meets setbacks?

Site 3: Wolfe's Neck State Park



- Stream or Not a Stream? Does the stream continue in the roadside ditch? Are there segments that meet NRPA stream definition? How do culverts connect wetlands?
- Site Evaluation Profile and Condition
- Site Evaluation suitable to design a system? Meets setbacks?

- Overall review the pits as an undisturbed site
- Is this a PVP? Due diligence and planning within the 250' of Critical Terrestrial Habitat?
- Determine drainage class wetland.

These were challenging sites and the post lunch discussion was lively and provided some controversial findings, as always. Experts as well as State and Federal Regulators were present to answer questions and provide valuable guidance for dealing with these difficult sites and soil conditions. One of the most significant findings was that the New England Hydric Soil Indicators for Identifying Hydric Soils allows for soft masses and pore linings as an indication of wetness, however, the National List states that nodules and concretions are not considered to be redox concentrations. So, there is a discrepancy that the MAPSS Technical Committee will research over the coming year. The MDEP also provided important information on requirements for collecting soil data for stormwater BMP's. I can't stress enough the benefit of attending these annual workshops.

As with past field conferences over the last 30 years, the objective was to provide a professional level of training to natural resource professionals, ranging from soil scientists, site evaluators, wetland scientists, code enforcement officers, regulatory staffs, educators, and any interested individual from the general public. Preconference planning identified 3 sites with a variety of parent materials and soil series. Soil pits were dug with a small excavator provided by NRCS and operated by Tony Jenkins and Greg Granger. Wolfe's Neck Woods Center & Farm, as well as Wolfe's Neck Woods State Park, provided staff during the field planning phase and the day of the conference, as well as landowner permission, access, and Dig Safe location of utilities.

Before discussing the soil test pits at Site 1, Sites 2 and 3 provided challenging NRPA stream and "Potential Vernal Pool" determinations during the "dry season" (non-amphibian breeding season). In addition, Shoreland Zoning issues were challenging, because the potential stream at Rachel's Cove lay within the S.Z., which Chapter 1000 provides a different definition for a stream relative to the NRPA. Site Evaluators were challenged with determining the Profile and Condition at both Sites 2 & 3.

Site 3 contained 2 hand-dug soil test pits; one in a hydric soil (PD or VPD?) and one in a shallow Lyman soil. Both TPs were in natural, undisturbed forest settings. The Lyman soil keyed out easily to the Lyman soil series.

The hydric soil TP, utilizing the MAPSS drainage key, keyed out to VPD (3) "*Has organic soil material that extends from the ground surface to a depth of 10 to 20 cm (4 to 8 in.)* and is directly underlain by a horizon that has a depleted or gleyed matrix". The crux of this determination is two-fold: 1) The combined Oi, Oe, and Oahorizons were <u>7 inches</u> thick (therefore not a histic epipedon, so NO to indicators A1 and A2), and, the horizon directly underlying the O-horizons was determined to be an Eg-horizon. 2) Was this 2 inch thick Eg-horizon the result of saturation, or simply eluviation? Delving into the latest edition of V. 4: "(NOTE: June 2020 version has a minor change in NE-A2 indicator changing thickness of muck or mucky peat/peat to 10 cm, this change is not in the companion guide)".

"NE-A2. – Dark Muck or Mucky Peat

Technical Description: A layer of muck or mucky peat, at least 10 cm (4") but less than 20 cm



(8 in) thick, that starts within 15 cm (6 in) of the soil surface; has a value of 3 or less, and chroma of 2 or less; and is underlain by mineral soil material with a chroma of 2 or less. "Therefore, under this revised indicator, the hydric soil at Site 3 would meet Indicator **NE-A2**, as well as MAPSS Drainage Key under VPD, providing that the Eg-horizon was the result of saturation.

To keep the discussion going, the particle size control section was dominantly loamy sand, so Indicator S3: 2 inches Mucky Peat (hemic) or Peat (fibric) was also met.

In summary, this typical hydric soil situation provided a thorough review of the 3 reference guides that soil and wetland scientists utilize:

- 1. New England Hydric Soils Technical Committee. 2020 (June) Version 4, Field Indicators for Identifying Hydric Soils in New England. New England Interstate Water Pollution Control Commission, Lowell, MA.
- 2. Field Indicators of Hydric Soils in the United States -A Guide for Identifying and Delineating Hydric Soils, Version 8.2, 2018
- 3. Maine Association of Professional Soil Scientists KEY FOR THE IDENTIFICATION OF SOIL DRAINAGE CLASS (1/22/2013 rev.)

Site 1 was located in hayland on Wolfe's Neck Farm, near the Mallett Barn, and lying on the western side of the access road. There were 7 excavator dug soil test pits (TPs) in the ~ 5.5 acre field. Following are several photos and brief caption descriptions. It was notable that parent material ranged from marine sediments to lodgement till with several bedrock depth classes. The surface topography did not immediately yield insights into this variety of parent materials and bedrock depth classes.



MAPSS – **MAWS 2022 Field Conference.** *Left photo is Soil Pit TP-2, classifying closest to a Ragmuff (MWD, Mod. Deep). It contained gravelly sandy loam in the solum and coarsening to very cobbly loamy sand in the densic horizons below 25 inches. Right*



photo is Soil Pit TP-5, classifying as a Scantic silt loam. This Poorly Drained marine sediment fined to silty clay loam at 4 inches and silty clay below 24 inches.

In summary, there were variations in the other 5 TPs: TP1, Buxton; TP 3 Scantic; TP 4 Lamoine; TP 6 Peru; and TP 7 Scantic.

Conference attendees enjoyed sunny and seasonable weather during the morning site visits and afternoon. Lunch was at the Mallett barn and a lively afternoon panel discussion with regulatory staff provided a review of how statutes and rules are interpreted in the natural world.

Updating 2009 MAPSS Guidelines:

There have been several important updates, additions, and deletions over the last 13 years. We need to incorporate these changes and move to an all digital document. There are currently scanned portions of the Guidelines which are large files and cumbersome to download and edit. Please step forward if you have an interest in working on the committee to update the Guidelines.

Website:

The website link "REGULATORY/SOIL links" in the left navigation pane on the MAPSS website was reorganized in January, 2022. The purpose was to place the most commonly accessed links in a descending cascade. For example, the first link is Web Soil Survey, followed by the new HSG assessment method and the new Form E and F, and cascading down to OSDs and field manuals. Several of the HSG links were scattered about the website and challenging to find. On the following pages are screen shots of the new organization. If anyone finds dead links or similar problems, please contact web master Chris Dorion or Matt Dorman.

The on-line directory of members (<u>http://www.mapss.org/directoryinfo.htm</u>) was updated in early February, 2022. Please review your specific contact information and send any edits to: <u>dorionchristopher61@gmail.com</u>

VERIFY YOUR LICENSE INFORMATION AND STATUS:

Go to:

https://www.maine.gov/pfr/professionallicensing/professions/board-licensure-geologists-soil-scientists

Link to the menu options in the right navigation pane to maintain the accuracy of your license contact information.

License renewals are due by December 31 each year. Failure to pay the renewal fee may result in the loss of your license and you will be required to reapply and retake all exams.



| MAPSS 2022 Treasury Report | | | | |
|---|--------------------|--------------------------------------|--|--|
| MAPSS Checking Account as of 12/31/22 | | \$14,272.23 | | |
| 2022 Income | | | | |
| 2022 Income: 2022 Dues (full membership) | \$825.00 | 33 full members at \$25.00 each | | |
| 2022 Dues (num memoership) | \$823.00 | 10 associate members at \$15.00 each | | |
| 2022 Dues (associate membership) | \$130.00 | 10 associate members at \$15.00 each | | |
| 2022 Dues (student membership) | \$0.00 \$0.00 | 0 student members at \$0.00 each | | |
| 2022 Dues (nonorary membership) | \$0.00 \$075.00 | 0 nonorary members at \$0.00 each | | |
| | \$975.00 | | | |
| Annual Meeting Registration | \$0.00 | 0 registrants at \$45.00 each | | |
| | \$0.00 | 0 registrants at \$50.00 each | | |
| | \$0.00 | 0 students at \$15.00 each | | |
| - | \$0.00 | | | |
| 2022 Workshop | \$810.00 | 18 registrants at \$45.00 each | | |
| * | \$450.00 | 9 registrants at \$50.00 each | | |
| - | \$1,260.00 | 5 | | |
| 2021 Dues | \$65.00 | | | |
| 2021 Workshop | \$525.00 | | | |
| 2023 Dues | \$25.00 | | | |
| MAWS 2022 Workshop | \$755.00 | | | |
| Janet Cormier Scholarship (2023) | \$25.00 | | | |
| TOTAL INCOME | \$3,630.00 | | | |
| 2022 Expenses: | | | | |
| Envirothon (Maine Association of Conservation Districts) Annual Meeting Facility | \$1,000.00 | | | |
| Janet Cormier Scholarship (2021) | \$1,080.00 | | | |
| Janet Cormier Scholarship (2022) | \$1,000.00 | | | |
| Workshop | | | | |
| Website Host (DiscountASP.net) | \$120.00 | | | |
| Domain Registration (Speedsoft) | \$18.95 | | | |
| TOTAL EXPENSES | \$3,218.95 | | | |
| MAPSS Checking Account as of 12/31/22 | | \$14,683.28 | | |



The Lay of the LandVolume 26, Issue #1W

Winter 2023 Edition

MAINE ASSOCIATION OF PROFESSIONAL SOIL SCIENTISTS



2023 Annual Meetings & Joint Winter Conference

Meeting Theme: *4*ENERGY 4

Tuesday, March 21st -- UMaine Augusta (directions on next page)

| | 8:00 - 8:45 | Registration & Coffee/Snacks | |
|--------|--|--|--|
| | 8:45 – 9:30 | Welcome from MAWS & MAPSS Presidents <u>Featuring a lively discussion entitled "What wetlands people should know about</u> <u>soils"</u> Lee Burman & Rod Kelshaw | |
| | 9:30 – 12:00 | 2023 Regulatory Updates | |
| | 9:30 – 9:50 | Maine Land Use Planning Commission Stacy Benjamin – Acting Chief Planner Audie Arbo – Permitting and Compliance Manager | |
| | 9:50 — 10:10 | Maine Department of Inland Fisheries and Wildlife Bob Stratton, Environmental Program Manager | |
| | 10:10 — 10:30 | US Fish & Wildlife Service Patrick Dockens, Wildlife Biologist II | |
| A (| 10:30 — 10:50 | Maine Department of Environmental Protection – Stormwater/Soils Dave Waddell &/or Cody Obropta, Engineers - Bureau of Water Quality | |
| L Z | 10:50 — 11:10 | Maine Department of Environmental Protection Dawn Hallowell, Licensing Director | |
| ш | 11:10 – 11:30 | US Army Corps of Engineers, New England District Colin Greenan, Maine Project Office | |
| C | 11:30 – 12:00 | Q&A – Roundtable (all updaters) | |
| 4 | 12:00 – 1:30 Lunch + Email and Networking Time MAPSS Business Meeting Attendees Eat First | | |
| | 12:00 – 1:30 | MAPSS Business Meeting in a Break-Out Room (agenda and call-in info will be posted on MAPSS.org) | |
| | 1:30 – 2:30 | Construction Panel: Energy, Wetlands, Soils, and Stormwater MDEP Stormwater/Enforcement – Kerem Gungor and Cameron Dufour Third Party Inspectors – Jared Boyle, Tim Hodgins, Dave Moyse | |
| | 2:30 – 3:00 | 2022 Norman C. Famous Wetland Research Stipend Winner Elizabeth Gorrill Developing a New Vegetation Metric to Identify Response to Sea Level Rise in Maine Salt Marshes | |
| | 3:00 – 3:10 | Break & Refreshments | |
| | 3:10 – 4:30 | MANRS Updates and Discussion followed by MAWS Annual Business Meeting (agenda and call-in info will be posted on MAWS.me) | |



Page 11

Volume 26, Issue #1



Forward by Christopher Dorion.

I first met Dr. Norton in 1988 when I took his "Low Temperature and Pressure Aqueous Terrestrial Geochemistry" course at UMaine in Orono. As the name suggests, it was a most challenging course. By the end of the semester, I, and the other grad students in the course, came away with a comprehensive understanding of water and its major constituents as it constantly cycles through the atmosphere, surface sources, soil, and deeper groundwater.

The following article is especially relevant for soil scientists in furthering their understanding of eluviation and illuviation processes, which produce our ubiquitous northern New England spodosols.

The article is of importance to wetland scientists, who study and record the degree of oxidation - reduction of Fe and Mn as indicators of soil saturation (and hence hydric soils, one component of wetland determination).

The article provides both a technical and global synthesis of waterbody processes for natural resource professionals in these fields.

We, as natural resource professionals, can use the findings and recommendations in this article to further the maintaining of Maine's near universal exceptional water body quality. When phosphorus loading in a water body exceeds the natural maintenance capacity, this article provides treatment measures that have proven successful.

Maine contains over 5,000 lakes. They are exemplary of Maine's natural beauty. They provide drinking water, recreational opportunities, exceptional settings for seasonal and permanent camps and homes, as well as critical functions in the biogeochemical cycles supporting fauna and flora.

We heartily thank Stephen A. Norton and Tristan G.S. Taber for providing this timely paper.

Volume 26, Issue #1

What role do soil and sediment play in damping or enhancing eutrophication?¹

Stephen A. Norton Professor Emeritus, School of Earth and Climate Sciences University of Maine and Tristan G.S. Taber Water Quality Program Director Lake Stewards of Maine

¹Reprinted by permission from the Lake Stewards of Maine, January 2023

Over the years, we have given talks to LSM (and its predecessor), lake associations, the Lakes Division of the Department of Environmental Protection, and professional meetings. Some questions consistently are asked or implied by interactions with the audience: Why do we care about erosion in the watershed of a lake? Why do some lakes deteriorate in water quality, while others are quite resilient? Why must some lakes get treated with "alum" when they experience increasingly problematic algal blooms? What in the world is "alum"? What role do soil and sediment play in the answers to these questions?

The answers are not easy. To understand the mechanisms of how soil, sediment, aluminum (Al), iron (Fe), and phosphorus (P) influence eutrophication (or prevent it), we need to dig deeper. What goes on among solid inorganic matter (minerals and non-minerals), organic matter, and water in the soil, streams, lakes, and lake sediment? We use abbreviations for elements (there are more than 100). A surprising concept for some of you is that the element oxygen (O) is 93.7% by volume of Earth's crust! We can walk on, tunnel through, drill, quarry, and move the Earth's crust with explosions. And yet we breathe the gaseous form of oxygen, O₂ (two joined atoms), which only comprises 20% of our atmosphere! Dissolved O₂ in surface water may range from about 16 mg/L, depending on the temperature, to virtually 0 mg/L in sediment. Every element occurs in water; most occur as more than one chemical species (e.g., four for Al in Table 1). Some elements occur in different states of oxidation: Iron (Fe) occurs as ferrous [II] and ferric [III]), having different charges because of the different number of electrons in the atom; higher charge for the atom dissolved in water (Fe⁺³) is more oxidized. The oxidation state of Fe is designated by [brackets]. Superscript numbers are the charge of the various species dissolved in water. Subscript numbers represent the number of atoms or atom pairs in species. If we add dissolved organic carbon (DOC), the dissolved organic matter that colors lake and stream water various shades of yellow to deep brown, fluorine (F), and carbon (C), the table expands dramatically in the number of species. Elements in solutions like to associate with elements with the opposite charge! Let's examine the behavior of Al, Fe, and P.

Aluminum (Al) is the most abundant metal in Earth's crust (8.1% by weight). Most Al is in relatively insoluble silicate minerals, e.g., KAlSi₃O₈ feldspar (potassium aluminum silicate) is common in granite. When Al dissolves from minerals, it occurs as one or more of the species in Table 1. The pH of the water determines which specie(s) will be present and dominant, and how much Al could dissolve. The solubility of Al(OH)₃ is lowest at about pH = 6-6.5 (a few μ g/L), increasing dramatically below pH = 5, and less dramatically above pH = 6.5. Just below the



Page 13

Volume 26, Issue #1

Winter 2023 Edition

forest floor organic-rich layer, the pH of soil water is commonly between 4 and 5, promoting the dissolving of Al. Abundant DOC produced in this layer also increases the solubility of Albearing minerals, by combining with the Al as the uncharged molecule Al-DOC. As soil water moves downward, pH rises slowly from weathering (leaching), and as acidic DOC is consumed by microbes; consequently, Al is precipitated as Al(OH)₃ (Figure 1). That Al(OH)₃ adsorbs PO₄. The negative surface on the soil particle attracts Al⁺³ and H⁺¹, which then attract negative species from the soil water, thereby retaining PO₄. Al-DOC drains to streams and then to lakes. The Al-DOC remaining in surface water becomes photo-oxidized by sunlight, releasing the Al from DOC. Because the pH of many streams and most lakes in Maine is between 6 and 8, precipitation of small amounts of Al(OH)₃ and adsorption of P occurs, producing sediment.

Aluminum in white, Iron in red-brown



Figure 1: "A" horizon soil is a low pH layer with abundant organic matter producing abundant DOC, which slowly dissolves Al and Fe from any admixed mineral matter, transporting the Al and Fe downward in the soil profile. Al and Fe are more abundant in the less weathered B horizon. Downward weathering of the "B" soil and consumption of DOC consume oxygen and raise the pH. Fe is preferentially precipitated as Fe(OH)₃ in the upper B while Al is precipitated as Al(OH)₃ throughout "B" and into "C". The area of white and red-brown is representative of the amount of precipitated Al and Fe. Image provided by Randy Schaetzl has been modified.

Iron (Fe) is more complicated. In nature, Fe commonly occurs as either ferrous [II] iron or ferric Fe[III], depending on the availability of oxygen when the minerals formed within Earth's crust. In normal aerated water, Fe^{+3} is virtually zero and all Fe^{+2} becomes oxidized and precipitated as light to dark brown $Fe_{[III]}(OH)_3$. Iron-bearing minerals literally rust in place! If P species are present in the solution, they will be adsorbed on the Fe(OH)₃, as for Al(OH)₃. Forest soils retain their P for recycling in these two secondary products, and in organic matter. DOC also enhances the solubility of Fe-bearing minerals, forming the neutral molecule Fe-DOC. Unlike the Al story, as soon as the water reaches the water table in forest soils it typically has been



Winter 2023 Edition

depleted of O₂ because of use of O₂ by microorganisms for respiration. Dissolved O₂ in soil water starts out at 10 to 16 mg/L and ends up at close to 0 mg/L. Consequently, any remaining Fe⁺² and Fe-DOC will continue moving with the groundwater; thereafter, more Fe⁺² may be leached from the soil and bedrock. As groundwater emerges in a spring into a stream or lake, any Fe⁺² will oxidize and precipitate. Most Fe-DOC becomes photo-oxidized by sunlight. Freshly precipitated Fe(OH)₃ adsorbs small amounts of P from the water column, and the sediment gains more P-laden

| Element symbols | Majors species in water | Charge on the species |
|-----------------|--|---|
| Al = aluminum | Al ⁺³ , Al(OH) ⁺² , Al(OH) $_{2}^{+1}$ Al(OH) $_{4}^{-1}$ | +3, +2, +1, and -1, respectively |
| O = oxygen | O_2 , mostly H_2O , $(OH)^{-1}$ | O_2 is 0 in the atmosphere. |
| H = hydrogen | H^{+1} , mostly H_2O , $(OH)^{-1}$ | H is $+1$ in H ₂ O, O is -2 ; therefore, |
| | Low pH corresponds to high H ⁺¹ | H ₂ O has no overall charge. |
| Fe = iron | mostly Fe[II] ⁺² , very little Fe[III] ⁺³ | +2 (ferrous [II] and +3 (ferric [III], respectively |
| P = phosphorus | mostly H ₂ PO ₄ ⁻¹ and HPO ₄ ⁻² | The charge of P in the species is $+5$. |
| K = potassium | K ⁺¹ | +1 |

Table 1: Some chemical symbols and species used in the text. Everything is soluble, to some extent, in water and most elements in water occur as several species.

precipitate. If dissolved O_2 in the lower hypolimnion during thermal stratification drops below about 2-3 mg/L (especially in the sediment), the sediment Fe(OH)₃ dissolves, releasing its Fe as Fe⁺² and the adsorbed PO₄. This recycling of P is called "the ferrous wheel". Recycling of P is most common in shallow mesotrophic or eutrophic lakes. (This discussion explains the occurrence of the ring-around-the-collar and ring-around-the-bowl phenomenon in homes with drilled wells in Maine. Fe and manganese behave similarly so your rings can range from orange-brown to black). Dissolved Al enters a lake aided by low pH runoff (the acid rain days) and high DOC from wetlands. The Al is retained in the lake because of photo-oxidation of Al-DOC and higher pH which causes Al(OH)₃ precipitation in the water column, PO₄ adsorption from the water column, and accumulation as sediment. Most dissolved Fe in surface water reaches the lake in the form of Fe-DOC molecules (and some in groundwater), that are photo-oxidized to Fe⁺², which promptly precipitates as Fe(OH)₃, adsorbs minor PO₄ from the water column, and becomes sediment. Retention of dissolved Al and Fe in streams entering Maine lakes typically exceeds 90% in the lake. *Erosion of soil transports solid Al(OH)*₃ and Fe(OH)₃, with substantial adsorbed PO₄, from the acidic soil environment to the higher pH environment of the lake. P is desorbed to the lake water in this transition (Figure 2). That is why preventing erosion is important to lakes.

The stage is set. Lakes get out of whack because of too much P. The cause can be lake susceptibility, climate change, or human activity of many kinds. The excess P causing algal blooms is from the atmosphere (which you can do almost nothing about), the watershed (which you can do something about), and from recycling from the sediment (which you can reduce with alum treatment). Years of declining Secchi disk transparency during summer stratification, and declining pleasure and real estate values get people's attention. People prefer to swim in clear water, rather than looking at swirly pea soup. So, landowners and associations call DEP and are told that alum treatment may help. Here is what alum does in the lake.



Figure 2: Schematic of the ions adsorbed on a negatively charged soil particle at low soil pH (4-5, left) versus the same particle at higher surface water pH (7-8, right). A soil particle going from low pH to higher pH, either in soil water or open water will desorb P ($H_2PO_4^{-1} = all$ species of ionic P), SO_4^{-2} , Al^{+3} , and H^{+1} , and adsorb Ca^{+2} , Mg^{+2} , Na^{+1} , K^{+1} , (OH)⁻¹, and HCO₃⁻¹. This process is called ion exchange.

Alum is solid crystals of KAl(SO₄)₂ (potassium aluminum sulfate), but you may read that it is also KAl(SO₄)₂·12H₂O. It is expensive and the cost of application is even more expensive. Alum is very soluble so there is little difficulty getting it to dissolve as shown in Equation (1). The presence of water is implied by the charges of the ionic species.

$$\mathrm{KAl}(\mathrm{SO}_4)_2 \longrightarrow \mathrm{K}^{+1} + \mathrm{Al}^{+3} + 2\mathrm{SO}_4^{-2}$$

(1)

(2)

 $Al(OH)_3$ starts to precipitate rapidly (Equation 2) because the pH of a typical lake in Maine (6.5 to 7.5) is near the minimum solubility of $Al(OH)_3$.

$$\mathrm{Al^{+3} + 3H_2O \rightarrow Al(OH)_3 + 3H^{+1}}$$







Figure 3: Alum treatment on Long Pond, in Parsonsfield, ME. White aluminum hydroxide ($Al(OH)_3$) flocculant can be seen beneath the surface as alum is applied by the barge positioned towards the top of the image.

One solid is yielding dissolved Al while the other is precipitating Al! Reaction (2) produces acid (H⁺¹), lowering the pH. The release of H⁺¹ may be compensated for by adding an acid neutralizing agent which must be carefully combined with the alum. You may have seen photos or videos of an alum treatment, such as the one on Lake Auburn in Auburn, or Long Pond in Parsonsfield, ME (Figure 3). The white plume behind the boat is precipitating Al(OH)₃ in very tiny fluffy particles. The small particles have a high surface area to volume relationship. Al(OH)₃ surface area increases as the diameter of the particle decreases due to this size change for the same mass. Thus, adsorption of PO₄ increases as particle size decreases. The Al(OH)₃ slowly sinks down through the water because it is denser than water and eventually becomes sediment. On the way to the bottom, it adsorbs substantial amounts of PO₄ from the water column via adsorption. Al(OH)₃'s solubility is not affected by oxidation (high dissolved O₂) or reduction (low dissolved O₂). So, if the upper sediment or bottom water goes anoxic (less than about 2 mg O₂/L), only the Fe(OH)₃ will dissolve and yield its adsorbed PO₄. But the sediment is now "chemically capped" with a very thin layer of Al(OH)₃ that will adsorb any released PO₄ from the dissolving Fe(OH)₃. The million dollar question is how much alum should we add so that the sediment has a barrier to releasing PO₄ during anoxic periods. We need to know two things.



Winter 2023 Edition



Figure 4: Wet sediment from the top of a lake sediment core is subjected to five successive extractions with the same sediment sample, using dissolved chemical reagents labeled (1)...(5). After each reagent is added to 0.500-1.000 g of sediment, with specified contact time between sediment and reagent, the solution-sample is centrifuged, solution decanted with a pipette, sample washed with the same reagent, thoroughly mixed, centrifuged, decanted, filtered, combined with the first filtered supernatant, and chemically analyzed for Al, Fe, P, and Ca. The procedure is from Psenner et al. (1988), modified by using Tessier et al. (1979) for extraction (1) and Hieltjes and Lijklema (1980) for extraction (3). Most data from Maine lakes have been obtained using this procedure.

- 1. What are the unmodified proportions of Al(OH)₃, Fe(OH)₃, and P in the top 3-5 cm of sediment?
- 2. How much Al(OH)₃ must be added to the sediment to prevent recycling of P during anoxic (0 to 2 mg O_2/L) conditions.

The top 5+ cm (2+ inches) of sediment are most interactive with the lake water. Professor Jiří Kopáček (from the Czech Republic) answered the questions, in part with samples from Maine lakes. In their laboratory, uppermost sediment from cores (0-1 or 0-5 cm) was subjected to five successive increasingly rigorous chemical extractions and the resulting solutions (sol.) were analyzed for Al, Fe, P, and Ca: (sol. 1) distilled water to remove loosely bound ions; (sol. 2) a strong reducing agent (which mimics 0 mg dissolved O_2/L) that dissolves most Fe(OH)₃ and any PO₄ adsorbed to it; (sol. 3) a strong basic solution (NaOH) that dissolves most Al(OH)₃ and PO₄ adsorbed to it; (sol. 3) a strong basic solution (Figure 4). The conclusion of these experiment was: "*negligible amounts of PO₄ (are) released from lake sediments during hypolimnetic anoxia if either the molar ratio Al(sol. 3):Fe(sol. 2) is > 3, or the molar ratio Al(sol. 3):P(sol.1+sol.2) is >25" (Kopáček et al., 2005). These analyses have been conducted on over 150 Maine lake cores; the rules are almost universally correct! These measurements enable us to calculate how much Al(OH)₃ from alum must reach the sediment to prevent release of P during anoxic periods for a calculated rate of Fe dissolution. Even as Fe(OH)₃*



Volume 26, Issue #1

Winter 2023 Edition

dissolves and releases its adsorbed PO₄, <u>the Al(OH)₃ from alum treatment can adsorb it "immediately".</u> Many processes control the length of the effectiveness of the treatment, including rate of sediment accumulation and flux of P from the watershed and atmospheric inputs, but the sediments are no longer a significant source of recycled P. A treatment may last about 8-10 years or more. Shallow lakes with developed shorelines (agriculture and housing) in certain geologic settings are most vulnerable to eutrophication. Deep lakes are generally less vulnerable (Amirbahman et al., 2022; Deeds et al., 2020, 2021).

Acknowledgments

We are very grateful to our colleagues: LSM staff, LSM's former Executive Director Scott Williams and the 1,000+ LSM volunteers, DEP Lakes Division leader Linda Bacon who helps train the volunteers and assures reliable data is made available to the scientific community, Aria Amirbahman at Santa Clara University, CA, Jeremy Deeds of DEP, Colin Holme, Director of LEA, and Jiří Kopáček. They have been generous with assistance, data, and wisdom for 40 years.

References

Amirbahman, A., Fitzgibbon, K., Norton, S., Bacon, L., and Birkel, S. D., 2022, Controls on the epilimnetic phosphorus concentration in small temperate lakes: Environ. Sci.: Processes and Impacts. 24, 89-101.

Deeds, J., Amirbahman, A., Norton, S. A., and Bacon, L. C., 2020, A Hydrogeomorphic and Condition Classification for Maine, USA, Lakes. Lake Reserv. Manag. DOI: 10.1080/10402381.2020.1728597, 36, 2, 122-138.

Deeds, J., Amirbahman, A., Norton, S. A., and Bacon, L., 2021 Predicting anoxia in low nutrient lakes. Ecol. Applic. 31, 6, DOI: 10.1002/eap.2361.

Hieltjes, A.H.M. and Lijklema, L., 1980, Fractionation of inorganic phosphates in calcareous sediments. J. Environ. Qual. 9, 405-407.

Kopáček, J., Borovec, J., Hejzlar, J., Ulrich, K-U., Norton, S. A., and Amirbahman, A., 2005, Aluminum control of phosphorus sorption by lake sediments: Environ. Sci. Tech. 39, 8784-8789.

Psenner, R., Boström, B., Dinka, M., Petterson, K., Pucsko, R., and Sager, M., 1988, Fractionation of phosphorus in suspended matter and sediment. Arch. Hydrobiol. Ergebnisse Limnol. 30, 98-103.

Tessier, A., Campbell, P. G. C., and Bisson, M., 1979, Sequential extraction procedure for the speciation of particulate trace-metals. Anal. Chem. 51, 844-851.

Observations on Soil Drainage Class and Hydric Soil Determinations

David L. Marceau, Maine Licensed Soil Scientist # 182, Maine Licensed Site Evaluator # 246, Wetland Scientist

Over the past several years, I have noticed a discrepancy between NRCS depth to seasonal high water table calls (and associated drainage class calls) and other Maine soil scientists and site evaluators' seasonal high water table calls. Some of the variabilities are inevitable, because each person has a varying amount of



experience/training in different regions, and also may even see colors differently. However, generally, these are not the variabilities which concern me. The variability I am referring to is redox features, which NRCS soil scientists do not identify as evidence of wetness (i.e., seasonal high water table) while other soils scientists and site evaluators do. This article attempts to explore the reasons for these discrepancies.

Firstly, the concept of redox features evolved from the term "mottling". Mottling is a variation in color in comparison to the soil profile color. Mottling, as it relates to soils in Maine, is interpreted as evidence of wetness. Redox features are a more encompassing term for soil features that are evidence of wetness. Two examples of redox features which are not considered mottles are oxidized rhizospheres and organic staining. A seasonal high water table in many cases is identified by redox features. However, in some cases, such as wet soils with high organic matter, soils with gray parent material, or soils with well-developed spodic horizons, dominant soil profile colors may be used to determine evidence of wetness due to redox features being masked. In essence, the gray colors you are looking for, or the reddish colors you are looking for, are masked by the dominant gray and reddish colors of the soil profile. Also, in the case of soils with high amounts of organic matter, there is so much black organic matter that little, if any, redox features can be found.

Secondly, there is the issue of the amount/percentage of redox features, and whether they are high or low chroma colors. It appears to me that in some cases, NRCS differentiates between a 1% versus 2% quantity of redox features, and only call a seasonal high water table when redox features are gray or "low chroma". While other soil scientists are calling a seasonal high water table with <u>high OR low chroma</u> redox features. Some soil scientists that I know do not describe redox features that are less than 2% quantity, because the difference between 1% and 2% is very difficult to estimate, and causes too much confusion on the part of regulators interpreting the data. Thus, redox features that are less than 2% are generally ignored for purposes of calling a seasonal high water table.

To further complicate the issue, once a professional has identified a seasonal high water table, additional morphological characteristics must be synthesized to determine a soil drainage class. A soil drainage class is not merely determined by the depth to seasonal high water table. It also takes into account not only the depth of the water table but the duration as well. For example, determining that a seasonal high water table is at the surface does not tell one whether a soil is poorly drained or very poorly drained. The amount and quality of organic matter found at the surface is also interpreted to make this call.

The concept of drainage classes varies from State to State, or, at least region to region because the soils, climate, and agricultural practices differ. With this in mind, has the consolidation of NRCS offices and the reduction in soil scientists at the federal level made a difference in the way drainage classes are assigned? Past experience tells me that each State has differed in its ideas about limits to drainage classes. Some of this might have to do with the money that is allocated to farmers, in certain categories, for a variety of farm practices. What about the differences that occur between soil scientists, site evaluators and others who are trying to determine drainage classes?

Have we in the private sector failed to keep up with standards that have been adopted in our region? I have noted that the NRCS has chosen to identify variations in potential hydric soils to be identified as "layers" and not horizons. The Maine Association of Professional Soil Scientists (MAPSS) has its drainage class key which was adopted by its association in 1989 and has been updated most recently in 2013. This key apparently disagrees with the NRCS concept of drainage classes. I say this because during our most recent field review last September, soil scientists (I was one of them) identified a seasonal high water table within a gray parent



material soil profile at 8 inches depth while NRCS soil scientists identified a seasonal high water table at more than 17 inches depth. This disparity is dramatic given that my call was very close to being poorly drained (7 inches) while the NRCS call was clearly moderately well drained.

This discussion leads us to another potential pit fall: what drainage class key is being used to make drainage class determinations? The NRCS has no published drainage class key for Maine or the land resource region that I am aware of. Thus, does it refer to the MAPSS drainage class key when making drainage class determinations in Maine? Or, is there another key they use which I am unaware of?

I present this discussion not to cause friction between the members of NRCS or any other soil scientists within our organization, but to assist soil scientists and others in understanding the way in which we interpret soils. It does not bold well for our profession if we cannot come to some type of consensus in identifying seasonal high water tables and drainage classes.

Maine Association of Professional Soil Scientists March 15, 2022 Annual Business Meeting Minutes (to be approved / amended at the March 21, 2023 Annual Business Meeting) 3:00 pm to 4:30 pm Via Zoom

Maine Association of Professional Soil Scientists March 15th, 2022, Annual Business Meeting Minutes (to be approved/amended) 11:00 AM to 12:30 PM via Zoom

The meeting was called to order at 11:00 AM by Maine Associated of Professional Soil Scientist (MAPSS) President Chris Dorion

Election of Officers

A motion was made and passed for the following slate of officers for 2022:

- President: Rodney Kelshaw
- Vice President: Roger St. Amand
- Treasurer: Gary Fullerton
- Secretary: Eric Whitney
- Past President: Chris Dorion
- Director: Natalie Marceau

Proposed slate was approved. Chris Dorion will continue to work on "*The Lay of the Land*" newsletter for the short term but is looking for a replacement.

Treasurer's Report

Gary Fullerton reported on MAPSS finances for 2021. \$920 was collected from membership dues, \$1,285 was collected from the annual workshop. \$1,000 dollars was donated to the Envirothon. A motion was made and passed to approve the Treasurer's report. Envirothon

Envirothon plans to hold an in-person event for 2022. Last year, \$1,000 was donated to



Envirothon. A motion was made and passed to donate \$1,000 to the 2022 Envirothon. Janet Cormier Scholarship

Mike Jakubowski reported on the Janet Cormier Scholarship. Two individuals applied for the scholarship in 2021, Jasmine Gregory and Angy Consella(sp?). Mike stated that the scholarship would be more helpful if awarded in the Fall semester rather than the Spring. Mike believes that the Fall would allow for more applicants due to better timing with student's academic year. Concerns were raised regarding the logistics of "doubling up" on scholarships for one year. A motion was made to open the scholarship in Fall of 2022, the motion was passed.

Membership Updates

There are currently 18 full members. No new members in 2021. Congratulations were made to recently licensed members, Mike Jakubowski, Chris Coppi, Anne Biddle, and Eric Whitney.

Natural Resource Conservation Service Updates

Tony Jenkins and Nicholas Butler gave updates on the NRCS. The service has been making a push to hire additional staff. Last year, five new hires were made including Jasmine Gregory from the Janet Cormier Scholarship. Efforts are being made to map the White Mountains and Lake Champlain area, no recent mapping in Maine. Soil Forest Productivity data sets are being updated in Maine.

Natural Resource Field Workshop - Wolfe's Neck Farm

The 2021 Natural Resource Field Workshop was held at Wolfe's Neck Farm in Freeport, Maine. The successful field day has resulted in renewed interest in reusing Wolfe's Neck as a venue. New stations will be investigated to ensure variety.

University of Maine - Loss of Soil Science Curriculum

Ivan Fernandez has stated that the University of Maine would be cutting Soil Science credits from their program. Ivan has reached out to MAPSS to assist with promoting the field of Soil Science with the hopes of adding credits to the program once again.

In August 2022 the Bureau of Agriculture, Food and Rural Resources Director Nancy McBrady Announced Critical Staff Hires: One of Which was Matthew Boucher - Soil Scientist

Matthew Boucher has joined the Department of Agriculture, Conservation and Forestry as its new Soil Scientist, where he will develop, manage, and direct the Department's new Healthy Soils Program. The Healthy Soils Program, which promotes and supports the adoption of sustainable soil management practices through partnerships with leading agricultural organizations and unique financial and technical initiatives. The State Soil Scientist position is a key resource for leading climate-smart agricultural practice education, training, and information exchange to staff, relevant state agencies, resource partners, and constituents ranging from agricultural producers to the general public. As the state soil scientist, he also provides technical assistance to stakeholders and programmatic support to various state partners including soil and water conservation districts, UMaine extension, and MOFGA.

Matt is a graduate of UMass-Amherst with a B.S. in Biology and Anthropology. He has a Ph.D. in entomology from Cornell University and was a postdoctoral scholar at Penn State before becoming the Maine soil scientist in July 2022. Matt brings nearly a decade of experience researching and developing practical solutions to agricultural problems, contributing to projects that include designing sustainable pest and disease management



Winter 2023 Edition

programs, and refining cover crop management to maximize ecosystem services. His previous work includes research and education in tree fruit, small fruit, grapes, honeybees, and field crops/forages across the Northeast. Matt is from Western Massachusetts and is now a Westbrook resident, Matt describes himself as an avid hiker, cyclist, and gardener.