OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF RECLAMATION SCIENCES

reclamation matters

Spring 2025

2025 Conference & Program

ASRS

Raccoon Creek receives Ohio Scenic River designation

Ecosystem management on reclaimed mines

Vegetation management throughout the solar energy development life cycle

SCAN HERE TO
EXPLORE THE NEW

SISEED.COM

STEVENSON
INTERMOUNTAIN SEED, INC.

WE SUPPLY OVER 450 SPECIES & VARIETIES OF SEED FOR RECLAMATION PROJECTS

REHABILITATION OF LAND DISTURBED BY:

- Mining
- Energy Production
- Wildfire
- Road Construction

LAND IMPROVEMENT PROJECTS:

- Range & Pasture
- Wetlands & Riparian
- Wildlife Habitat
- Conservation
- Watershed

SINCE
1976

CONTACT US
FOR MORE INFORMATION
ABOUT OUR

CUSTOM SEED MIXES

sales@siseed.com

435-283-6639

JUSTIN PEDERSON
Reclamation Project Sales
jpederson@millbornseeds.com
605.627.1916

JON HEALY
Reclamation Project Sales
jonh@millbornseeds.com
605.627.1917

Millborn™

Deep bench strength across the whole mine lifecycle

We Own

- Environmental and Transactional Due Diligence
- Air Permitting, Compliance, and Testing
- Environmental Permitting, Compliance, and Auditing
- Mine Expansion and Greenfield Site Design/Permitting
- Stream & Wetland Permitting and Mitigation

35+ offices nationwide

800.365.2324 | cecinc.com/mining

It.®

- Geologic Exploration and Mine Planning
- Civil Engineering and Surveying/Geospatial Services
- Wastewater Management and Treatment
- Mining Reclamation and Closure

CEC

Civil & Environmental Consultants, Inc.

ASRS IN THIS ISSUE

INDEX TO ADVERTISERS

reclamation matters

is published by
DEL Communications Inc.
www.delcommunications.com

PRESIDENT / PUBLISHER
DAVID LANGSTAFF

MANAGING EDITOR
LYNDON MCLEAN
lyndon@delcommunications.com

SALES MANAGER
DAYNA OULION

SALES REPRESENTATIVE
COLIN JAMES
colin@delcommunications.com

PRODUCTION SERVICES
S.G. Bennett Marketing Services

CREATIVE DIRECTOR / DESIGN
KATHLEEN CABLE

Publications Mail Agreement #40934510
Return undeliverable Canadian addresses to:
DEL Communications Inc.
Suite 300, 6 Roslyn Road
Winnipeg, Manitoba R3L 0G5
Email: david@delcommunications.com

DEL Communications Inc.

PRINTED IN CANADA | 03/2025

GOT DIRT?
WE FIX DIRT!

BRING YOUR DIRT BACK TO LIFE WITH OUR
NATURE BASED SOLUTIONS

Biosol, Humate, Mycorrhizae & PermaMatrix.

"ENVIRONMENTALLY FRIENDLY" PLANT BASED ORGANIC FERTILIZERS & AMENDMENTS

- Concentrated Organic Matter!
- Long Lasting, Stable Nutrients!
- Specialized for Mine Reclamation!
- Custom Solutions for Any Soil Conditions!
- **Used for Over 35 Years with Award Winning Results!**

Block P EPA Superfund Site
Before One Application of Biosol

10 Years Later Following One
Application of Biosol

Activate your dirt and soil with our high-quality products.

TURN YOUR DIRT INTO SOIL WITH Our BIOSOLution!

Rocky Mountain Bio Products
A Division of Bowman Construction Supply, Inc.

303-696-8964
www.wefixdirt.com

Hold on... here we go!

BRENDA SCHLADWEILER

Wow…it has been six months since I put together the President's Message for the Fall edition of *Reclamation Matters*. For those of us who are older, we know how fast time flies, and it seems to be gaining momentum!

At the time of this writing, winter has dug in its heels after a relatively mild fall, but spring is always around the corner somewhere. In the northern climates (in the Northern Hemisphere, that is), it's likely later than for those of you in the southern portions. And for those of you in the Southern Hemisphere, it's the opposite. Cannot even think about that sometimes as it's hard enough for me to keep U.S. time zones separate. For those of you who have scheduled Zoom calls with me, you know that is true.

Your NEC and ASRS officers have had a busy time since the fall edition of Reclamation Matters.

1. The webinar series that kicked off in October 2024 has been successful. We look forward to continuing that tradition in Fall 2025 after taking the summer off. If any of you have a message you want to share, please contact me or Kenton Sena/Jenise Bauman for the 2025-2026 series. Our email addresses are below.
2. The International Initiative under the direction of Yoginder (Paul) Chugh and Brenda Schladweiler – with help from Jeff Skousen, Lee Daniels, and Natalie Kruse Daniels – have moved into the IOC phase, which stands for International Oversight Committee. There are representatives from Australia, Canada, China, Europe, India, and South Africa for the initial portion of this phase. Later, we hope to add representation from other portions of Europe and South America, to name a couple. In line with the International Perspectives session in Knoxville, we are planning one for Butte as well. The initial goals of the IOC phase include, in part:

a. Develop a summary document of

the Initiative that can be advertised within each participating country and associated societies and industries within those countries.

b. Encourage scientific research papers and subsequent participation in international conferences and journals, including our own Journal of Reclamation Sciences.

c. Work collaboratively with each other to share education and training information within individual countries that can help each country's reclamation/restoration efforts.

3. Preparing for the 2025 annual meeting in Butte, Montana. Thank you to Dustin Wasley and Steve Dent, co-chairs on the planning committee for this event. Laramie is waiting in the wings for the 2026 annual meeting with Pittsburgh for the 2027 meeting. We are looking for someone to consider the 2028 meeting, regardless of whether you are in an eastern location or a western location. The planning for the annual meeting is a big effort by a lot of people, so often it's "who has the resources to do this"? Keep in mind, we could partner with a sister organization as we have in the past, if a related meeting occurs in a similar time frame. It's never too early to start planning. If you have any questions, please feel to contact me or any member of the NEC. Our email addresses are below.

4. Kelsea Green and Ali Meek are constantly updating our web page and social media accounts, respectively. If you have any ideas or information, please email me or any member of the NEC.

5. The NEC is also considering additional ways that members can connect and benefit from other activities during the year than just at the annual meeting. Bill Zeaman with the NEC is investigating ways to keep our retirees engaged in the Society and has come up with great ideas. We can all benefit from the institutional knowledge and family-like atmosphere that ASRS represents.

If you have any ideas on anything, please contact me or any member of the NEC. Which reminds me…. we had an election in Fall 2024 and have a full slate of new and returning committee members. What a great group of people!

CURRENT NEC

President	Brenda Schladweiler	bschladweiler@bksenvironmental.com
Past-President	Julie LaBar	jlabar@okstate.edu
President-Elect	Kennet Bertelsen	kbertelsen@haleyaldrich.com
NEC delegate, 2nd year	Seth Cude	seth@rockwellscience.com
NEC delegate, 2nd year	Kelsea Green	kelsea@biomost.com
NEC delegate, 1st year	Bill Zeaman	bill.zeaman@dnr.mo.gov
NEC delegate, 1st year	Jenise Bauman	jbauman@cityoftacoma.org
Early Career representative	Brandon Holzbauer-Schweitzer	Brandon.holzbauerschweitzer@jacobs.com
Technical Divisions representative	Kenton Sena	kenton.sena@uky.edu

INCOMING NEC JUNE 2025

President	Kennet Bertelsen	kbertelsen@haleyaldrich.com
Past-President	Brenda Schladweiler	bschladweiler@bksenvironmental.com
President-Elect	Jennifer Franklin	jafranklin@utk.edu
NEC delegate, 1st year	Kelsea Green	kelsea@biomost.com
NEC delegate, 1st year	Hannah Angel	angel@uky.edu
NEC delegate, 2nd year	Bill Zeaman	bill.zeaman@dnr.mo.gov
NEC delegate, 2nd year	Jenise Bauman	jbauman@cityoftacoma.org
Early Career representative	Brandon Holzbauer-Schweitzer	Brandon.holzbauerschweitzer@jacobs.com
Technical Divisions representative	Kenton Sena	kenton.sena@uky.edu

Consider attending the annual conference in Butte, Montana and invite a friend!

The road to Butte and beyond

MICHAEL CURRAN
ABNOVA ECOLOGICAL SOLUTIONS

As I write this in -4^{O} windy conditions from Cheyenne, I eagerly await warmer weather and getting to connect with all my ASRS colleagues at this year's annual meeting in Butte, Montana. I am very grateful to the authors for their contributions to this issue and hope the readers find the articles as interesting as I did. It is not shocking, but I am always amazed at our members who were able to get the other notes into *Reclamation Matters* with so much on their plates – so thanks Brenda, Brandon, and Gwen for putting together the President's message, the Early Career note, the Wild Women of Reclamation note. I am proud to say we have added a note specific to retirees and lifetime members, as their continued involvement with ASRS is paramount to the Society – thanks to Bill for facilitating this. As usual, the meeting planning committee has done a terrific job getting the schedule put together.

I've been very fortunate over the last year to be working on a State of Wyoming-wide reclamation and restoration document. To date, we've received nine white papers and have 16 survey respondents with a combined >400 years of experience reclaiming or restoring various types of disturbance across the Cowboy State. Several respondents are ASRS members, and it has been an excellent learning experience for me – coming from an academic background, it's fascinating to learn from those who have been running equipment and practicing reclamation for many years. One thing that stands out across reclamation practitioners is in the harsh environmental conditions of Wyoming, reclamation takes time, patience, resilience, and a willingness to understand how to get better and learn from mistakes…something we can all carry over to everyday life.

I hope this note finds everyone well and wish everyone attending the Butte meeting safe travels. As always, it is encouraged for anyone looking to tell neat stories or write articles written for the layperson to contact me at reclamationmatters@asrs.us – and for those looking to publish scientific articles to contact Natalie Kruse-Daniels, who does an amazing job editing *Reclamation Sciences*, at reclamationsciences@asrs.us – we both look forward to continuing the dissemination of knowledge and information associated with reclamation.

Looking ahead

BRANDON HOLZBAUER-SCHWEITZER
STUDENT AND EARLY CAREER PROFESSIONALS REPRESENTATIVE

First, I'd like to thank everyone for their participation and engagement with the Society and the various activities we held since the 2024 ASRS Conference. We have many more exciting items planned for 2025, and we hope to continue to see the many faces which make our Society great. We're also eager to get feedback on how we can improve our webinars, round tables, and the Annual Conference. The commitment from our members, National Executive Council, and many other councils are what make the Society great and allows us to continue to organize our Annual Conference.

I hope everyone had a wonderful holiday season and productive start to 2025. Since you've last heard from me, many new roles and responsibilities have been brought to my life. From the professional perspective, I've continued to advance with my position with Jacobs Engineering and look forward to the many opportunities and challenges to come. From a personal perspective, I became a dad this past October, and what a ride it has been! I am truly grateful for our little girl, Hadley, and that I get to share this amazing time in my life with my wife Heather.

This year is already moving fast, and it will maintain this pace as the spring/summer field season rapidly approaches. I hope you all can be safe and productive in whatever exciting opportunities you face this year. I will be running several pilot-scale studies at various active and closed mining sites. The general focus of these studies is on the treatment and management of water and treatment byproducts. The goal of these studies is to demonstrate the efficiency and benefits of hybrid treatment technologies. These testing opportunities are unique in the consulting world, and I'm eager to share the results with you all at the 2025 Annual Conference in Butte.

As I continue my term as the ECP for the NEC, I look forward to meeting new people and reinforcing relationships with old friends. We are also working on expanding what ASRS can offer the students and ECPs through our Student Engagement Committee. This cannot be done alone, so please consider this a call out to all those interested in becoming involved, learning more about the early years of your career and what opportunities are available as we grow together. Any questions, comments, or requests you may have are welcomed with open arms.

Thank you all for your continued support, engagement, and participation with ASRS.

LIFETIME AND RETIRED MEMBERS SPOTLIGHT

The American Society of Reclamation Sciences is wanting to recognize an important aspect of our reclamation community by recognizing those who have dedicated their professional working history in reclamation and are now either a Lifetime Member or retired. We are seeking out those Lifetime and retired members who want to contribute to the Society with an article recognizing what notable changes were experienced, a lesson or two learned, and how the Society has contributed to their experience since the beginning of employment to your current stage in life. The Society is also interested in how to provide Lifetime and retired members with better service.

This would involve a write up of about this same length of wording as what is in this article and a high-quality photograph of yourself. The society is seeking ways to keep in contact with American Society of Reclamation Sciences, Lifetime, and retired members. Our Lifetime and retired members possess a wealth of knowledge about different aspects of reclamation, and what better way to share this experience than with an article for the next group to learn from. Please consider providing an article for *Reclamation Matters*. A great contact to work with about this Spotlight Page is Dr. Michael Curran, who can be reached by email at reclamationmatters@asrs.us.

We hope to see you and others in Butte, Montana for the 2025 American Society of Reclamation Sciences Annual Meeting. There is some information about the Butte Annual Meeting on the web site at https://www.asrs.us/2025-conference/, and look for future updates.

Thank you for your consideration to help spread the word about your life career in the field of reclamation, because it does matter. The Society is also looking into a mentorship program; we hope that you will also consider being a mentor. More information about this subject will be forthcoming.

Sincerely,

Bill Zeaman, Member, National Executive Committee, American Society of Reclamation Sciences

Wild Women of Reclamation gathering at the 42nd Annual Meeting of ASRS

Front row (L to R): Justine McCann, Sara Klopf, Brenda Schladweiler, Kelsea Green, Marie Shepherd, Kathryn Eckhoff, Michele Coleman, Hannah Angel, and Lindsey Moffitt. Back row (L to R): Gwen Geidel, Kaela Walton-Sather, Natalie Kruse Daniels, Jenise Bauman, Rayanna Benally, and Krista Noyes.

And a few that didn't quite make the main photo shoot! L to R Cassidy Mollick, Olivia Mitchell and Lerato Ratsoenyane.

To: All women involved in reclamation are invited; feel free to bring a colleague!
What: A networking opportunity targeted towards women in reclamation
When: 7:00 – 8:15 AM, Tuesday June 3, 2025
Where: Butte, MT; Copper King Hotel and Convention Center (room TBD)

Wild Women of Reclamation (WWR) is an ASRS networking social group for women engaged in reclamation. Participants will meet on June 3rd at the conference center before the morning technical presentations. Every woman is welcome. We have a presentation, do some networking, meet new attendees, and catch up with life with a few old and new friends. Presentations in the past have dealt with choosing your own path, mentoring, starting your own business and juggling a research career with family and community obligations. The presentations had one theme in common: adaptability. Feedback from participants at the breakfast meeting and after, indicated that those participants just starting their careers appreciated the honest feedback on

"how it used to be" and, in many ways, "how it still is."

This year's presenter will be Marie Shepherd, P.E., Senior Manager for the Environmental division for Peabody's Kayenta Mine in Arizona. The Kayenta Mine Complex (KMC), which includes mines separately designated as the Kayenta Mine and Black Mesa Mine, is located on Black Mesa in Navajo County, Arizona on lands leased from the Navajo Nation and Hopi Tribe. The Black Mesa is a massive highland in Northeastern Arizona covering approximately 2.1 million acres. The Peabody lease covers 64,858 acres on the northern part of the Mesa just south of Kayenta, Arizona. Within the Kayenta Mine, there are several pit areas, one of which is J19. The J19 pit was mined from 2003 to 2016 and final reclamation was completed in 2022. Under Marie's supervision, the KMC was awarded the Distinction in Reclamation Award in 2024 by ASRS. In 2019, this reclamation area of the mine received the Excellence in Surface Coal Mining and Reclamation Director's Award from the Office of Surface Mining and Reclamation Enforcement, which recognized the importance of the Cultural Plant Habitat and domestic grazing opportunities that the mine had returned to the local indigenous people's life and culture. We look forward to hearing Marie's story on her life experiences and in her field of reclamation.

At WWR, we engage in a mentoring exercise where we match up less experienced reclamationists to women who have more experience and more contacts. This is an easy way to build up contacts, bounce off ideas and to learn about other careers. We also have a newsletter that goes out several times a year, or as often as we can get stories. The content is a way to inform and to share. Please keep those stories coming!

This will be the 11th WWR meeting at ASRS. There is no membership to Wild Women of Reclamation – just camaraderie and networking! We will have some breakfast items available so just come to the Convention Center on Tuesday, June 3 at 7 a.m. and join us! If you end up arriving late for whatever reason, still come on into the room. We will be there until 8:15 a.m. We look forward to seeing as many of you who can make it. Feel free to bring a friend or new colleague.

Contacts:
Sara Klopf, ksara1@vt.edu
Gwen Geidel, Geidel@sc.edu

Raccoon Creek, Ohio: From mining impairment to Scenic River Designation

BY NATALIE KRUSE DANIELS, AMY MACKEY, AND NORA SULLIVAN

State of Ohio Governor Mike DeWine and Ohio University employee and Raccoon Creek Watershed Coordinator Amy Mackey on the banks of Raccoon Creek after Scenic River Designation.

For generations, it was common knowledge among locals that Raccoon Creek in Southeast Ohio didn't have fish and that a swim in the acidic waters would cure your summer case of poison ivy. Fast-forward to late 2024, when Raccoon Creek became the first State of Ohio Scenic River in Southeast Ohio, where historic mining was concentrated.

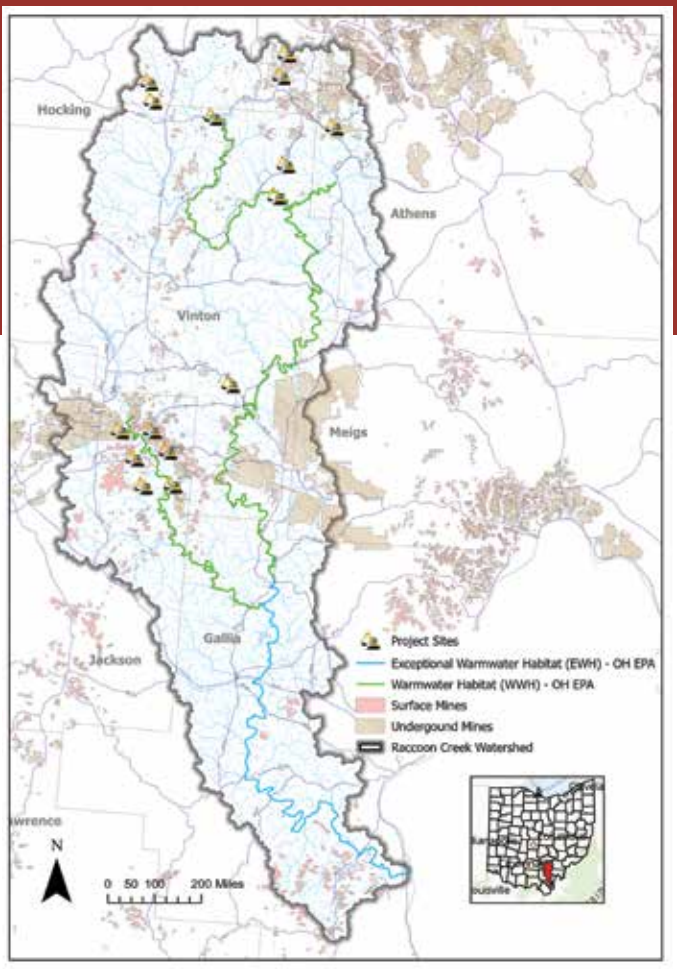
Raccoon Creek is a nearly 700-square-mile watershed in Southeast Ohio that flows directly into the Ohio River. The watershed saw approximately 50,000 acres of coal mining prior to environmental permitting and regulation, about half underground and half surface mining. The region's coal is high in sulfur and weathers to create acid mine drainage (AMD) rich in iron, aluminum, and manganese. Prior to reclamation and remediation, the Ohio Environmental Protection Agency (OEPA) designated much of the watershed, particularly in the most mining impaired portions, as Limited Resource Water, suggesting the lowest degree of biological integrity.

In 1981, when early fish surveys were conducted, only 21 species of fish were present in the whole watershed, with only one species of fish found at the mouth of Little Raccoon Creek. Spurred by pressure from local citizens about the widespread mining impairment in the watershed, partners from state agencies, Ohio Department of Natural Resources (ODNR) and OEPA, non-profit organizations, primarily Raccoon Creek Partnership, local universities, Ohio University and Hocking College, local partners, and landowners collaborated to plan and implement reclamation and remediation projects on abandoned mine lands. Since 1998, over $15 million has been invested in treatment of Raccoon Creek through various funding mechanisms, including Abandoned Mine Land (AML) funds, EPA Non-Point Source 319 Grants, and OSM Watershed Cooperative Agreement Program funds. This has facilitated 22 reclamation, treatment, and maintenance projects including land reclamation, steel slag leach beds, wetland-based systems, limestone leach beds, lime channels for conveyance, and a lime doser.

Beyond efforts to treat AMD, low-head dam removal projects are a watershed priority. In 2019, the first low-head dam removal project was completed using an OEPA Non-Point Source 319 Grant in partnership with Zaleski State Forest in Sandy Run, a tributary to Raccoon Creek. While the dam was a reasonably small structure – only three feet high and 40 feet long – it created a barrier to fish passage. Prior to removal, fish surveys showed that the stream supported 12 species downstream of the dam, while only four species were present upstream of the dam. After this successful project, the next priority for low-head dam removal is the Vinton low-head dam located alongside the village park in Vinton, Ohio, in Gallia County. The Vinton low-head dam is a larger structure and creates a significant barrier to fish passage and risk to human safety at high flow. At the time of publication, Raccoon Creek Partnership and Ohio University are in ongoing discussions with the landowner.

As AMD treatment projects have improved the water quality in the watershed, it has opened the watershed to other risks.

Above: Acid mine drainage treatment in Raccoon Creek Watershed.



Right: Raccoon Creek's recovery has resulted from strategic treatment and reclamation projects in the most impaired areas of the watershed.

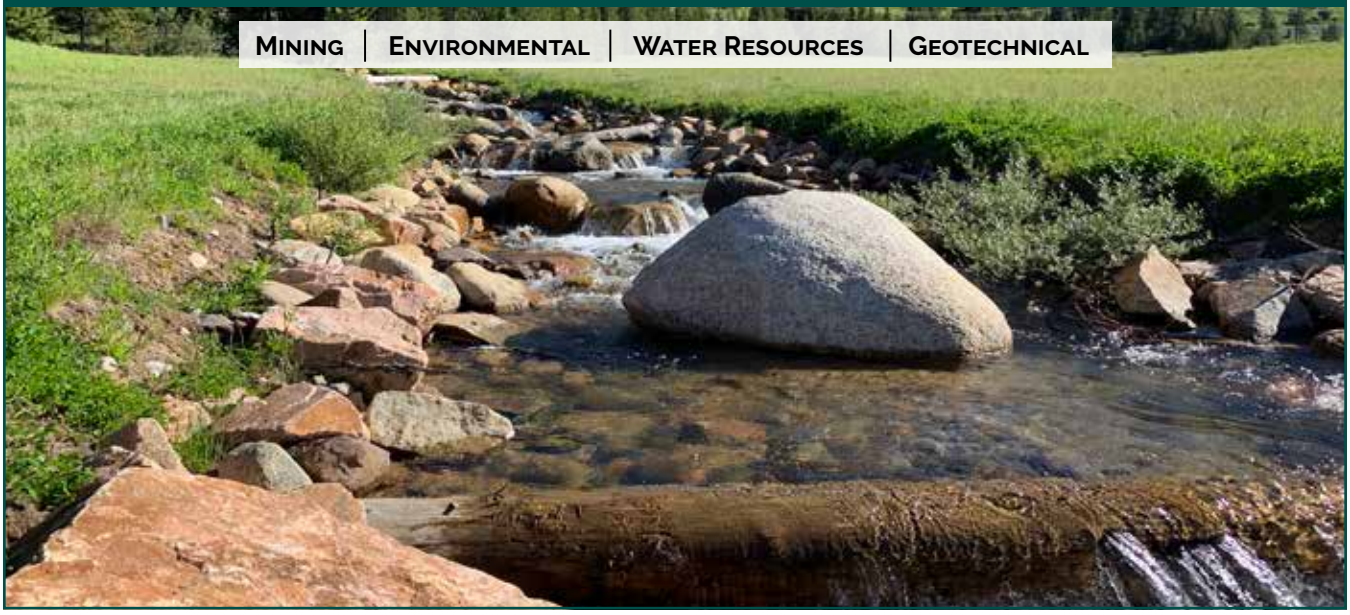
Invasive bighead carp have been found in the Ohio River, including the R.C. Byrd Pool where the confluence with Raccoon Creek is located. The U.S. Fish and Wildlife Service led an effort with ODNR, Ohio University, West Virginia University, West Virginia Department of Natural Resources, and Kentucky Fish and Wildlife to tag and remove bighead

Acid mine drainage emerging from a hillside near Hewett Fork, a tributary to Raccoon Creek in Athens County, Ohio.

carp from Raccoon Creek and the R.C. Byrd Pool of the Ohio River. This included ultrasonic tags that were surgically implanted in some individuals to detect movement, dam passage, and survival, and to understand tributary use. Gill nets were set across Raccoon Creek to capture and remove adult fish in 2016 and 2019. Despite ongoing efforts, data suggest that density of bighead carp is increasing.

In 2018, after a watershed-wide water quality study conducted by OEPA, the watershed improvement that treatment and reclamation projects created was clear. This study led to a redesignation of the Aquatic Life Uses for much of Raccoon Creek. The headwaters of Raccoon Creek, originally designated as Limited Resource Water and never expected to recover, were redesignated as Warm Water Habitat, the expected conditions for the State. Raccoon Creek is now meeting Warm Water Habitat conditions from river mile 40.3 to river mile 111, plus portions of Little Raccoon Creek and Hewett Fork tributaries. The section of Raccoon Creek from the low-head dam in Vinton at river mile 40.3 to the backwaters of the Ohio River at river mile 8.15 has been redesignated and is meeting conditions for Exceptional Warmwater Habitat, representing waters with rare and unusual species, high biodiversity, and exceptional chemical and physical water quality. This redesignation marks a historic change in the watershed.

As it became apparent to agency partners that the recovery efforts were successful, Ohio University and Raccoon Creek Partnership began to gather information and local support to designate Raccoon Creek as a State Scenic River. The Scenic



For designation, a river must not only have high-quality chemistry and aquatic biology but also have limited road crossings or roads in the riparian, limited industrial, commercial, or residential development near the river, intact riparian corridors, and be mostly free flowing.

Rivers program aims to protect the aquatic and terrestrial natural resources in high quality rivers in the state in support of the surrounding communities. Until Raccoon Creek, there were no State Scenic Rivers in Southeast Ohio and none in the coal-bearing region of the state. Given the recovery of Raccoon Creek Watershed, there was a unique opportunity for recognition of the incredible watershed recovery and to expand the State Scenic River program into an underserved part of the State.

For designation, a river must not only have high-quality chemistry and aquatic biology but also have limited road crossings or roads in the riparian, limited industrial, commercial, or residential development near the river, intact riparian corridors, and be mostly free flowing. These technical considerations must be accompanied by local support from landowners, local leaders, soil and water conservation districts, and other stakeholders. As the water quality and aquatic ecology have improved, so have recreation activities. Recovering conditions the watershed have stimulated the development of the Moonville Rail Trail, popular with hikers, bikers, and horseback riders, which crosses Raccoon Creek several times and a popular private canoe and kayak livery on the banks of Racoon Creek.

After a multi-year effort, in November 2024, the Governor of the State of Ohio, Mike DeWine, and Director of ODNR, Mary Mertz, designated Raccoon Creek as the first State Scenic River in the coal-bearing region of Southeast Ohio. From only supporting a few, mostly tolerant fish species, to a thriving river that supports outdoor recreation and has been recognized for its recovery, Raccoon Creek represents a true success story in AMD reclamation and treatment.

ASRS

Visit www.asrs.us/2025-conference/ to register today!

ASRS 2025 Preliminary Conference Program
42 Years of Reclamation – First Time in Butte!

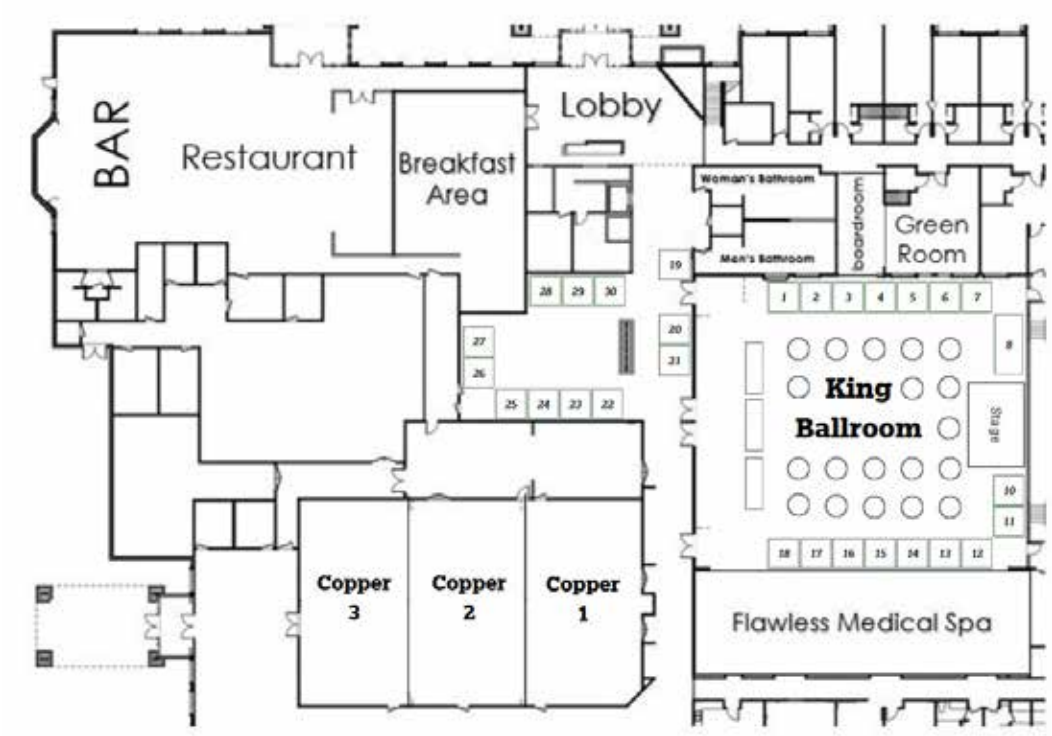
The 42nd Annual Meeting of the American Society of Reclamation Sciences (ASRS) is happening June 1st – 5th in Butte, Montana. Butte is one of the largest Superfund areas in the U.S. and has a storied history of mining and reclamation. The conference will focus on the research, technical, and regulatory issues associated with the land and water implications of anthropogenic land disturbances. It will provide a forum for the dissemination of information through presentation of research findings, field tours, workshops, and open technical discussion of public policy relating to mining, reclamation, restoration, reforestation, and land management issues. This conference will provide an amazing opportunity for your company or organization to interface with reclamation professionals and those who influence decisions about the mining and reclamation industry.

2025 Schedule Snapshot

<table>
<tr><th>SUNDAY
June 1</th><th>MONDAY
June 2</th><th>TUESDAY
June 3</th><th>WEDNESDAY
June 4</th><th>THURSDAY
June 5</th></tr>
<tr><td colspan="2" rowspan="2">Breakfast on Own
Hotel Lobby*
7:00 – 8:00 am</td><td>Haulin' ASRS
6:30 – 7:30 am</td><td>Haulin' ASRS
6:30 – 7:30 am</td><td>Haulin' ASRS
6:30 – 7:30 am</td><td rowspan="2">Breakfast on Own
Hotel Lobby*
7:00 – 8:00 am</td></tr>
<tr><td>Breakfast on Own
Hotel Lobby*
7:00 – 8:00 am</td><td>Breakfast on Own
Hotel Lobby*
7:00 – 8:00 am</td><td>Breakfast on Own
Hotel Lobby*
7:00 – 8:00 am</td></tr>
<tr><td rowspan="3">Registration &
Exhibitor Setup
10:00 – 5:00 pm
Lobby Area</td><td rowspan="2">Montana
Resources Mine
Tour**
10:00 am –
2:30 pm</td><td rowspan="2">Opening Plenary Session
9:00 – 11:30 am
King Ballroom</td><td>Wild Women of
Reclamation Breakfast
7:00 – 8:30 am
King Ballroom</td><td rowspan="2">Technical Sessions
8:00 am – 12:00 pm
Copper 1, 2, 3,
King Ballroom</td><td rowspan="2">Warm Springs Wildlife
Management Area
Birding Tour**
8:30 – 11:00 am</td></tr>
<tr><td>Technical Sessions
8:30 am – 12:00 pm
Copper 1, 2, 3,
King Ballroom</td></tr>
<tr><td rowspan="2">Headframe Spirits
Distillery Tour**
2:30 – 4:30 pm</td><td>Annual Awards &
Business Meeting
Luncheon
12:00 – 1:30 pm
King Ballroom</td><td colspan="2">Lunch on Own
12:00 – 1:00 pm</td><td>Student Awards
Luncheon
12:00 – 1:30 pm
King Ballroom</td><td>Lunch on Own</td></tr>
<tr><td colspan="2" rowspan="2">NEC Meeting
12:00 – 6:00 pm
Boardroom</td><td rowspan="2">Technical Sessions
1:30 – 5:00 pm
Copper 1, 2, 3,
King Ballroom</td><td rowspan="2">WY AML
Seeding
Certification
Class
3:00 – 5:00 pm
King Ballroom</td><td>Technical
Sessions
1:00 – 5:00 pm
Copper 1, 2, 3,
King Ballroom</td><td>Technical Sessions
1:30 – 5:00 pm
Copper 1, 2, 3,
King Ballroom</td><td rowspan="3">Anaconda Smelter
Tour**
1:00 – 3:30 pm</td></tr>
<tr><td>NEC Wrap Up Meeting
3:00 – 4:00 pm
Boardroom</td></tr>
<tr><td colspan="2">Welcome Exhibitor & Sponsor
Reception
6:00 – 8:00 pm
King Ballroom</td><td>Monday Social Event**
6:00 – 9:00 pm
The Butte Depot</td><td colspan="2">Poster Session Social
5:00 – 6:30 pm
King Ballroom</td><td>Early Career
Professionals
Social Event**
6:00 – 9:00 pm
Montana Tech Student
Success Center</td></tr>
</table>

Complimentary breakfast provided to Copper King Hotel guests
****Transportation provided***

Copper King Convention Center



Meeting Financial Sponsors and Exhibitors

PLATINUM

PIONEER TECHNICAL SERVICES

WET Water & Environmental TECHNOLOGIES

GOLD

HALEY ALDRICH

Peabody

SILVER

ENERGY LABORATORIES

DEQ MONTANA

RESPEC

Montana Resources

Meeting Financial Sponsors and Exhibitors

COPPER

Special Thanks to Our Exhibitors

2025 Conference Planning Committee

COMMITTEE CHAIRS

Dustin Wasley, PE | Haley & Aldrich

Dr. Stephen Dent | CDM Smith

PLANNING COMMITTEE

Susie Anderson | Montana Tech

Kennet Bertelsen, PE | Haley & Aldrich

Devin Clary | Washington Corporations

Jo Combo | Haley & Aldrich

John Haney, PE | Haley & Aldrich

Bill Henne | Haley & Aldrich

Kevin Houck, PE | Haley & Aldrich

Brenda Schladweiler | BKS Environmental Associates

Ed Spotts | KC Harvey

Marty Bennett | Pioneer Technical Services

Terry Biere | Pioneer Technical Services

Stephen Coe | Water & Environmental Technologies

Kelsea Green | Bio Most

Tony Wesche | Pioneer Technical Services

Andrew Hess | Olympus Technical Services

Chris Norman | Pace Analytical

Rylie Skellenger | Haley & Aldrich

Nick Tucci | Haley & Aldrich

On behalf of the 2025 ASRS National Meeting Local Planning Committee and the ASRS National Executive Committee (NEC), we want to thank our Sponsors and Exhibitors for their support, as well as our meeting attendees in Butte for their continued support of our Society.

Professional Field Tour Information

Sunday, June 1 – Montana Resources Mine Tour

Hosted by Montana Resources

10:00 am – 2:00 pm

9:45 am	**Assemble in the hotel lobby for a prompt 10:00 am departure.**
10:00 am	**Board bus and depart for the Berkeley Pit, roughly 5 miles north of the hotel. 3-hour tour of Montana Resources Mining Operations, Reclamation, and Water Treatment.**
2:30 pm	**Arrive at Headframe Distillery**

Headframe Spirits Distillery Tour

2:30 – 4:30 pm

2:30 pm	**Arrive at Headframe Distillery**
4:30 pm	**Depart Headframe Distillery for Copper King Inn**

Professional Field Tour Information

Thursday, June 5 – Warm Springs Wildlife Management Area Birding Tour

8:30 – 11:30 am

8:15 am	**Assemble in the hotel lobby for a prompt 8:30 am departure.**
8:30 am	**Board bus and depart for the Warm Springs Wildlife Management Area (WMA), roughly 27 miles northwest of the hotel.**
9:00 am	**Arrive at the WMA.**
11:30 am	**Depart WMA**
	**** More details to come**

Thursday, June 5 – Anaconda Smelter Tour

1:00 – 4:00 pm

1:00 pm	**Depart from Copper King Hotel**
1:30 pm	**Arrive in Anaconda**
3:30 pm	**Depart for Copper King Inn**
	**** More details to come**

Agenda for Sunday, June 1, 2025

10:00 am – 2:30 pm	Montana Resources Mine Tour – Meet in Hotel Lobby
2:30 – 4:30 pm	Headframe Spirits Distillery Tour
12:00 – 5:00 pm	Registration and Exhibitor Setup – King Ballroom
12:00 – 6:00 pm	National Executive Committee (NEC) Meeting – Boardroom
6:00 – 8:00 pm	Sponsor & Exhibitor Welcome Reception – King Ballroom

Agenda for Monday, June 2, 2025

6:30 – 7:30 am	Haulin' ASRS
7:00 – 8:00 am	Breakfast on your own – Hotel Lobby
8:00 am – 5:00 pm	Registration – Hotel Lobby
9:00 – 11:30 am	Opening Plenary Session – King Ballroom
12:00 – 1:30 pm	Annual Awards & Business Meeting Luncheon – King Ballroom
1:30 – 5:00 pm	Technical Sessions – Rooms Copper 1, 2, 3
6:00 – 9:00 pm	Social Event at the Butte Depot

Join us for catered appetizers and drinks at the Butte Depot at 818 South Arizona Street!

Set in the heart of Uptown Butte, the Butte Depot once served as a crucial transport hub and now hosts gatherings of all kinds and sizes for the Butte community.

Agenda for Tuesday, June 3, 2025

6:30 – 7:30 am	**Haulin' ASRS**
7:00 – 8:00 am	**Breakfast on your own – Hotel Lobby**
7:00 – 8:30 am	**Wild Women of Reclamation Breakfast – King Ballroom**
8:00 am – 5:00 pm	**Registration – Hotel Lobby**
8:00 am – 12:00 pm	**Technical Sessions – Rooms Copper 1, 2, 3, King Ballroom**
12:00 – 1:30 pm	**Lunch on your own**
1:30 – 5:00 pm	**Technical Sessions – Rooms Copper 1, 2, 3 King Ballroom**
3:00 – 5:00 pm	**Wyoming AML Seeding Certification Class – King Ballroom** The Wyoming Abandoned Mine Land (AML) Division will host a Seeding Specialist Certification Class. In this hour-and-a-half practical training, reclamation professionals will learn to develop diverse seed mixes, the nuances of ordering seeding material, equipment performance standards, proper calibration and operation techniques with seeding equipment. The class will also focus on planning, designing, construction management techniques, and tools aimed at improving vegetation establishment of diverse native plant communities.
5:00 – 6:30 pm	**Poster Session Social – King Ballroom**

Agenda for Wednesday, June 4, 2025

6:30 – 7:30 am	**Haulin' ASRS**
7:00 – 8:00 am	**Breakfast on your own – Hotel Lobby**
8:00 am – 5:00 pm	**Registration – Hotel Lobby**
8:00 am – 12:00 pm	**Technical Sessions – Rooms Copper 1, 2, 3, King Ballroom**
12:00 – 1:30 pm	**Student Awards Luncheon – King Ballroom**
1:30 – 5:00 pm	**Technical Sessions – Rooms Copper 1, 2, 3 King Ballroom**
3:00 – 4:00 pm	**National Executive Committee (NEC) Wrap Up Meeting – Boardroom**
6:00 – 9:00 pm	**Early Career Professionals (ECPs)/Student Social Event – Montana Tech Student Success Center**

Join us for catered appetizers and drinks at the Montana Tech Student Success Center!

This free event will bring together ECPs, students, and experienced professionals for valuable mentorship. This event will include food, beverages, and fun interaction. It's open to everyone!

Technical Sessions – Monday, June 2, 2025 (Afternoon)

Time	SESSION 1A GOOD SAM & RECLAMATION Room Copper 1	SESSION 1B WHERE ARE THE FISH? Room Copper 2	SESSION 1C CLIMATE & RESILIENCY Room Copper 3
1:30 - 2:00 pm	Proof of Concept: The Good Samaritan Pilot Program **Jacob Dillon, Crowley Fleck**	Where are the Fish? Evolving Metal-Related Risks in an Ecosystem Impacted by a Century of Mining **Madison Foster, USGS**	Practical Approaches to Climate resilience in Reclamation Projects **Theresa Hughes**, **KC Harvey**
2:00 - 2:30 pm	Novel Hydrologic and Geochemical Baseline Assessments for Closure Planning at Golden Sunlight Mine, Montana **Tracie Jackson, Barrick Gold Corp**	A 10-Year Review of Chinook and Sockeye Salmon Conservation Initiatives within the Skykomish Watershed in Washington State **Jenise Bauman**, **Tacoma Power**	Using Statistical Models to Identify Drivers of Change **Simone Durney, RESPEC**
2:30 - 3:00 pm	Grizzly Gulch Placer Mine Reclamation **Joel Pemble**, **RESPEC**	Where are the Fish: A Paradox of declining Fish Populations and Improving Insect Communities in a Mine-Impacted Ecosystem **Michelle Fillion**, **USGS**	Importance of Biodiversity and Restoration of Landscapes Devastated by Major Tropical Cyclones in the Partial Reserve of Lake Niassa, Mozambique **Gelito Inacio Franco Sululu**, **Commonwealth Youth Climate Change Network**
3:00 – 3:30 pm – BREAK – KING BALLROOM AND EXHIBIT AREA ***Sponsored by Abnova Ecological Solutions***			
Time	**SESSION 2A NORTH IDAHO'S NINEMILE BASIN Room Copper 1**	**SESSION 2B GOVERNMENT & TRIBAL Room Copper 2**	**SESSION 2C BIOCHAR Room Copper 3**
3:30 – 4:00 pm	15 Years of Ninemile Basin Remediation Bunker Hill Superfund Site **Calen Busch, Maul Foster & Alongi** **Tony Wesche, Pioneer Technical Services** **Tausha Miller, CDM Smith**	Abandoned Mines and the Bipartisan Infrastructure Law (BIL): How the BIL Helped Reclaim Tribal Trust Lands **Heather Brighton, NewFields**	Bioavailability-Based remediation of Pb-Contaminated Mine Land and Urban Soils using Various Biochar **Adriana Dacres*, Ohio State University**
4:00 – 4:30 pm		From Remediation to Restoration: A Tar Creek Story **Paige Ford, Quapaw Nation**	Using Wastewood Biochar as a Potential Soil Amendment: An Underground Greenhouse Study **Gavin Rahl*, Montana Tech**
4:30 – 5:00 pm		Introduction to Camp Guernsey (WY) ITAM - Rehabilitation vs. True Reclamation **Dustin J. Kafka, Wyoming Camp Guernsey Training Center**	Use of Biochar as Soil Amendment to Improve Reclamation Success and Soil Resiliency **Amir Hass, West Virginia State University**
6:00 - 9:00 pm – SOCIAL EVENT – BUTTE DEPOT			

*** Denotes Student**

Technical Sessions – Tuesday, June 3, 2025 (Morning)

Time	SESSION 3A ACID ROCK DRAINAGE Room Copper 1	SESSION 3B ALL THINGS PFAS Room Copper 2	SESSION 3C SILVER BOW CREEK Room Copper 3	SESSION 3D STREAM RESTORATION/PUBLIC ENGAGEMENT King Ballroom
8:30 - 9:00 am	Natural Acid Rock Drainage: Examples from Montana **Chris Gammons, Montana Tech**	How to Test PFAS in Complex Matrices **Sarah Choyke, Eurofins Environmental Testing**	Restoring and Revegetating a Floodplain Contaminated with Mine Waste near Butte, MT **Richard Prodgers, Bighorn Environmental Sciences**	TDS Mitigation in Mining Affected Streams Using In-Stream Reservoirs **German Banda, West Virginia State University**
9:00 - 9:30 am	Automatic Quantification of Dissolved Copper in Remote Acid Mine Drainage Sites **Dean Gouramanis, Fluid Photonics Corp**	Navigating PFAS Challenges in NPDES Permit Renewals **Rune Lassen, KC Harvey**	Silver Bow Creek Greenway **Michael Browne, Pioneer Technical Services**	Evaluating Urban Stream Restoration Success: Water Quality, Macroinvertebrate Surveys, and eDNA **Kenton L. Sena, University of Kentucky**
9:30 - 10:00 am	Recent Changes in the Berkeley Pit Water Quality **Gary Icopini, Montana Bureau of Mines & Geology**	PFAS Regulations and Methods Update for Environmental Professionals **Isaac Schmidt, Pace Analytical**	Ecosystem Service Monitoring at Silver Bow Creek Conservation Area **Molly McDermott, Ramboll Americas Engineering Solutions**	Unlocking the Power of Success Stories: the Do's and Don'ts of Communicating Reclamation Projects **Shannon Carla King, Whiskey Jack Gallery**
10:00 – 10:30 am – BREAK – KING BALLROOM AND EXHIBIT AREA				
Time	**SESSION 4A TECHNOLOGY ROUNDUP 1 Room Copper 1**	**SESSION 4B MINE CLOSURE & COVER DESIGN Room Copper 2**	**SESSION 4C BUTTE AREA RECLAMATION Room Copper 3**	
10:30 - 11:00 am	Quantifying the Number of Abandoned Mine Gestures in the United States: Progress and Complications **Jeff Mauk, USGS**	Chemical Compatibility of Lake Dredge for Abandoned Mine Land Reclamation Borrow Material **Natalie Kruse Daniels, Ohio University**	Characterization of a Mining District Superfund Site Butte West Side Soils Operable Unit Remedial Investigation **Nicholas Anton, CDM Smith**	
11:00 - 11:30 am	Developing a Mine-Focused Risk Layer for the Conterminous U.S. **Brennon Peterson, USGS**	Assessing Impacts of Engineered Soil Amendment and Erosion Control Materials on Mine Cover System Design and Implementation **Marc S. Theisen, Profile Products, LLC**	Transforming Butte: from the Parrott Tailings to a Resilience Hub **Stephen Coe, Water & Environmental Technologies**	
11:30 am - 12:00 pm	Artificial Intelligence - A Primer and Potential Applications to Land Reclamation **Y.M. Kanouff, JC2 Ventures Michael F. Curran, Abnova Ecological Solutions**	Integrating Closure Planning into the Mining Lifecycle: A Strategic Roadmap for Sustainable and Responsible Mine Closure **Andre van Coller, Digby Wells Environmental**	Coversoil Attributes and Influence on Vegetation Cover on Reclaimed Areas of the Continental Mine **John Beaver, WESTECH**	
12:00 - 1:30 pm - LUNCH ON OWN				

Technical Sessions – Tuesday, June 3, 2025 (Afternoon)

Time	SESSION 5A TECHNOLOGY ROUNDUP 2 Room Copper 1	SESSION 5B MERCURY GEOCHEMISTRY Room Copper 2	SESSION 5C RESOURCE RECOVERY Room Copper 3	SESSION 5D INNOVATIONS IN MINE RECLAMATION King Ballroom
1:30 – 2:00 pm	Understanding Seismic Imaging for Mine Reclamation: Insights and Innovations from Geophysical Investigations of Abandoned Mines **Lincoln Steele, Tetra Tech**	Evaluation of Multiple Sediment Amendments at a Mercury-Contaminated Reservoir using Bench Top Microcosm Treatability Testing **Paul Ho, CDM Smith**	Coal Mine Drainage and the Interagency Coal Mine Drainage Geochemical Database: Legacy Pollution as a Future Energy Resource **Bonnie McDevitt, USGS**	Evolving Landscapes: The Rising Importance of Land Reclamation in Response to Societal and Technological Shifts since 1975 **Tanya Richens, TCR Environmental Consulting**
2:00 – 2:30 pm	Using Geospatial and Geostatistical Models Created with Leapfrog Works to Inform Remediation Design at a Historical Smelter Site in Butte, Montana **Maria Pomeroy, Pioneer Technical Services**	Assessing Methylmercury in Sediments at Varying Depths: A Case Study in Methylation Dynamics **Steve Dent, CDM Smith**	Residuals from Passive Treatment System Process Units Close the Loop on Resource Recovery **Robert W. Nairn, University of Oklahoma**	A National Geospatial Decision Tool for Science-Based Management and Restoration of Mined Lands **Daniel Jones, USGS**
2:30 – 3:00 pm	Remote Sensing Methods to Identify Culverts Impairing Fish Passage **Natalie Kruse Daniels, Ohio University**	Evaluation of Sorbent Application Methods for Mercury Control in a Contaminated Reservoir in San Jose, California **Marc Beutel, University of California Merced**	Geotechnical and Geophysics–Is there a Connection? **David J. Barrick*, Montana Tech**	Development of a Robust Thiocyanate (SCN-) Measurement Principle for Subsequent Implementation on Industrial Scale Gold Processing Plants **Vikash Arjun, Mintek**
3:00 – 3:30 pm – BREAK – KING BALLROOM AND EXHIBIT AREA ***Sponsored by Granite Seed and Erosion Control***				
Time	**SESSION 6A FOREST RECLAMATION Room Copper 1**	**SESSION 6B GEOCHEMISTRY Room Copper 2**	**SESSION 6C TREATMENT TECHNOLOGY Room Copper 3**	**SESSION 6D SEEDING CERTIFICATION King Ballroom**
3:30 – 4:00 pm	Recovery of Vegetation After Relieving Soil Compaction on a Reclaimed Surface **Jennifer Franklin, University of Tennessee**	Field Calibration of PHREEQ-N-AMDTreat Input Parameters **D. Clayton, BioMost**	On-Site Stabilization of Elemental Mercury **Caleb Fontenot, Albemarle**	Wyoming AML Seeding Certification Class 3:00 – 5:00 pm **Josh Oakleaf, WY AML** **Seth Cude, Rockwell Science** **Randy Walsh, Tetra Tech**
4:00 – 4:30 pm	Importing the Forestry Reclamation Approach to Northern Minnesota: an ASRS Technology Transfer Success Story **Meghan Blair, Barr Engineering**	Watershed and Reservoir Geochemistry: A Case Study in the San Juan River Watershed with Applications to the Kootenai River and Clark River Watersheds **Johanna Blake, USGS**	The Use of Hydrochar as an Amendment in Bioreactors for Acid Mine Drainage **Natalie Kruse Daniels, Ohio University**	
4:30 – 5:00 pm	Possible Ecological Indicators of Ecosystem Function Around Mining Areas Using Soil, Water, and Biological Characteristics: A Case Study **Y.P. Chugh, Southern Illinois University**	Geochemical Considerations for Sulfate Seepage in Mine Closure at Jerritt Canyon Mine **Jenna Adams & Donovan Gross | Haley & Aldrich and First Majestic Silver**	The EBR: Biological Selenium Removal without Production of Troublesome Se Species and Complex Post-Treatment **Ola Opara, WesTech Engineering**	
5:00 – 6:30 pm – POSTER SESSION SOCIAL – KING BALLROOM				

*** Denotes Student**

Poster Session Social – Tuesday, June 3, 2025

5:00 – 6:30 pm – King Ballroom

1	Rodents and Cheatgrass Limit Bitterbrush Establishment in Colorado Mountain Shrublands **By: N. Nelson*, D.B. Johnston, and M. Paschke**
2	Metagenomic and Geochemical Insights into Silver Bow Creek Microbial Ecology **By: P.G. Helfrich*, J. Feldman, I. Robertson, C. Shiek, and A. Cox**
3	Recovery Rates of Native Plants around Butte, MT: Phytomining Feasibility **By: H. Cogley***
4	Edge Effects in a Mining-Fragmented Grassland Impact Plant Survival and Growth, but not Seed Production or Seeding Rates **By: T. Adrian* and R.W. Pal**
5	Restoration Technique Impacts Vegetative Cover, Species Richness, and Native Plant Growth Whereas Slope Impacts Cryptogrammic Crust Cover **By: P.G. Helfrich*, T. Adrian, C. Leitert, and R.W. Pal**
6	Selenium Removal by Fast-Pyrolysis Waste Timber Biochar and Iron Modified Biochar for Phosphate Mine Reclamation **By: M. Gavin*, D. Strawn, and D. Page-Dumroese**
7	Quantifying Long-Term Persistence of Biochar on Reclaimed Placer Tailings in the Umatilla National Forest, Oregon **By: P. Tietz*, Z. Kayler, D. Page-Dumroese, R. Heinse, and M. Coleman**
8	Characterizing Underground Coal Mine and Fire Surface hazards via Geomorphic Analysis using Remote and Ground-Based Techniques **By: J. Hiatt*, W. Zhou, and L. Wood**
9	Microbial Community Succession in Recovering Riparian Zones **By: C. Leitert* and P.G. Helfrich**
10	Microbial Zinc Metabolism in a Recovering Stream **By: M. Naim*, P.G. Helfrich, J. Feldman, I. Robertson, and A. Cox**
11	Food Web Selenium Accumulation Could Impact Fish in a Recovering Aquatic Ecosystem **By: E. Heneba*, J. Timmer, P.G. Helfrich, E. Andrade Barahona, and A. Cox**
12	Manganese Speciation in Anaerobic, Organic-Matter-Rich Wetland **By: A. Hardgrave* and J. LaBar**
13	Experimental Assessment of Three Activated-Carbon-Based Sorbents in Remediating Hg-Contaminated Reservoir Sediments in the Historic New Almaden Mining District, California **By: D. Phan* and M. Beutel**
14	Investigation of a Newly Observed Autumn Olive Pathogen on a Southwestern Virginia Coal Mine **By: J. Kanouff*, S.K. Klopf, D. Putnam, J. Barney, and P. Donovan**
15	Experimental Approaches to Assessing Methylmercury Production Potential of Mildly Hg-Contaminated Soils in a Planned Storm-Water Treatment Wetland, California **By: F.O. Onipede* and M.W. Beutel**
16	Development and Optimization of a Novel Reactor for Remediating Acid Mine Drainage Using Natural Substrates **By: D.T. Maiga, A. Tshikovhi, T.T. Phadi, L.L. Sibali, and T.A.M. Msagati**
17	Effect of Fermentation Conditions on the Performance of Microbial Cellulose Membranes for Filtration Applications **By: A. Raychaudhuri* and K. Ganesan**
18	Rare Earth Element Occurrences in Acidic Mine Drainage in Montana **By: M. Vitale* and J. Quarels**

*** Denotes Student**

Join us for the Annual Poster Session Social!

Students will present their research posters and network with other academic and business professionals! There will be food, beverages, and a full bar.

Technical Sessions – Wednesday, June 4, 2025 (Morning)

Time	SESSION 7A PASSIVE WATER TREATMENT Room Copper 1	SESSION 7B GEOMORPHIC RECLAMATION Room Copper 2	SESSION 7C MODELING Room Copper 3
8:30 - 9:00 am	Case Study: Design and Implementation of the Dream Mountain Passive Treatment System - Northern WV **Cody Neely, BioMost**	Geomorphic Reclamation of the Abandoned McIntosh Uranium Open Pit Mine **Harold Hutson, BRS**	Reducing Design Uncertainty with Comparative Numerical Groundwater Modeling at a Former Smelter Site **Ross Monasmith, Pioneer Technical Services**
9:00 - 9:30 am	Performance of a Passive Treatment System over 30 Years in Tennessee **Terry Schmidt, EARTHRES**	Sustainable Soil Erosion and Sediment Control in Surface Coal Mines, USA Semi-Arid Environment **Anna Krzyszowska, Environmental Consulting**	Predicting Settling Pond Hydrology and Chemistry from Extreme Weather and Operations using GoldSim **Kevin Wright, Trihydro**
9:30 - 10:00 am	Comparison of Pollutant Removal Rates for Three Limestone-Only Autoflushing Vertical Flow Ponds **Kelsea Green, BioMost**	North Culbertson Mine Reclamation: Historic Coal Mine Subsidence and Erosion Mitigation through Geomorphic Design, GPS Machine-Controlled Equipment, and Native Species Revegetation **Kyle L. Johnson, P.E., Herrera Environmental Consultants**	Optimizing Water Management at North Mara Gold Mine: Strategic Response to Excess Water Accumulation on the Tailings Storage Facility **Andre van Coller, Digby Wells Environmental**

10:00 - 10:30 am – BREAK – KING BALLROOM AND EXHIBIT AREA

Time	SESSION 8A AMENDMENTS & BIOSOLIDS Room Copper 1	SESSION 8B WYOMING RECLAMATION Room Copper 2	SESSION 8C WILDLIFE & WATERFOWL Room Copper 3	SESSION 8D SITE CHARACTERIZATION King Ballroom
10:30 - 11:00 am	Effect of Organic and Inorganic Soil Amendments on Zinc and Lead Availability in Soils Affected by Historic Mining Activities **Chris Baxter, University of Wisconsin-Platteville**	Mitigation of the UPCC Rock Springs Nos. 3, 4, 7, and 8 Mines Below Interstate 80 **Ryan Reed, BRS**	Waterfowl Protection at the Berkeley Pit **Stella Capoccia, Montana Tech**	Transport, Fate, and Exposure to Selenium from the Elk Valley British Columbia, Canada Coal Mines into Ecosystems of the Upper Columbia River Basin, United States **Travis Schmidt, USGS**
11:00 - 11:30 am	Testing Soil Amendments to Reduce Lead Bioaccessibility at Bench- and Field-Scale **Molly McDermott, Ramboll Americas Engineering Solutions**	Lessons Learned from over 400 Years of Practitioner Experience in Wyoming **Michael F. Curran, Abnova Ecological Solutions**	The Use of Waterfowl Nesting Structures in Remediated Areas as an Educational and Research Tool **Mark Mariano, Montana Wetlands and Waterfowl**	Post-Wildfire Site Restoration in Steep Slope Terrain **Dale Evans, IDR**
11:30 am - 12:00 pm	Mine Soil Reconstruction Protocols to Improve Internal Drainage and Plant Growth in Reclaimed Coastal Plain Mine Soils in Virginia **W. Lee Daniels, Virginia Tech**	Final Pit Backfill and Spoil Regrade using a Dragline and Dozer **Allen Wellborn, Navajo Transitional Energy Company**	Creating Reclamation and Restoration Plans with an Emphasis on Establishing Terrestrial Food Webs **Michael F. Curran, Abnova Ecological Solutions**	High Resolution Stormwater Monitoring: Study Design, Outcomes, and Lessons Learned from Contrasting Three Hydrologic Studies in the Western United States **Joseph Gilbert, CDM Smith**

12:00 – 1:30 pm – STUDENT AWARDS LUNCHEON – KING BALLROOM

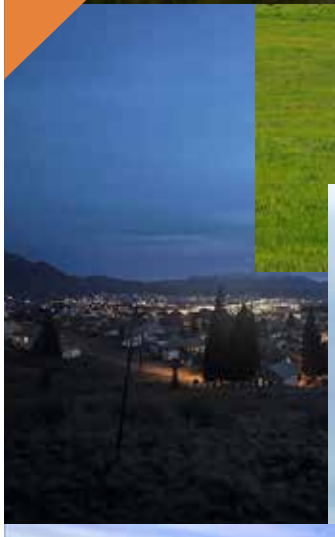
Technical Session – Wednesday, June 4, 2025 (Afternoon)

Time	SESSION 9A APPALACHIAN RECLAMATION & RESTORATION Room Copper 1	SESSION 9B REMOTE SENSING/GIS Room Copper 2	SESSION 9C WETLANDS & WILLOWS Room Copper 3
1:30 - 2:00 pm	Tetra Tech Abandoned Mine Land Reclamation Projects in the Appalachian and Mid-Continent Regions **Eric Cavazza, Tetra Tech**	Using Remotely Sensed Imagery to Characterize the Historic Bentonite Mining Area Near Belle Fourche, South Dakota, to Develop an Ecological Restoration **Patrick Kozak, South Dakota School of Mines**	Biogeochemical Evaluation of a Coal Field Natural ARD Treatment System in Central Montana **Scott Hensel, Haley & Aldrich**
2:00 - 2:30 pm	A Landscape-Scale Assessment of Mining and Restoration Activities in the Appalachian Region **Michael O'Donnell, USGS**	CDM Smith Sky Wave Remote Sensing and Machine Learning Technologies for Site Investigations and Monitoring **Devin Wilson, CDM Smith**	Hydrologic Controls on Nutrient Retention in a Restored Wetland **Emily Fox* and Dupe Oluwesesan*, Ohio University**
2:30 - 3:00 pm	Long-Term (10-Year) Effects of Mine Spoil Weathering on Leachate Quality **Sara Klopf, Virginia Tech**	Use of Digital Technologies and GIS to Improve Reclamation Monitoring and Reporting **Zach Farmer, Abnova Ecological Solutions**	Investigating the Phytoextraction Potential and Metals Uptake for Willow Species in the Rocky Mountains **Johannes Chandler*, Montana Tech**
3:00 – 3:30 pm – BREAK – KING BALLROOM AND EXHIBIT AREA ***Sponsored by O'Keefe Drilling***			
Time	**SESSION 10A INTERNATIONAL PERSPECTIVES Room Copper 1**	**SESSION 10B WATER AML ISSUES Room Copper 2**	**SESSION 10C VEGETATION Room Copper 3**
3:30 - 4:00 pm	Turning Polluting Mine Wastes into Earth Materials - A Nature-Based Approach to Achieve Sustainable Ecological Rehabilitation **Longbin Huang, University of Queensland**	Insights and Lessons Learned from Launching New Mine Land Reforestation Program **Kaela Walton-Sather, Cumberland River Compact**	Micronutrient Enabled Establishment of Native Grasses and Reduced Invasive Plant Prevalence Through Novel Fertilization Strategies Emphasizing Soil Health **Stuart Jennings, Edaphix**
4:00 - 4:30 pm	Assessment of Mining Activities Impacts on Ecosystem Services: A Case Study **Mao Zhen, School of Environment and Spatial Informatics, China University of Mining and Technology**	Status of Abandoned Mine Lands Managed by the BLM Butte Field Office, Southwest Montana **Amanda Rossi, Bureau of Land Management**	Establishment of a Native Vegetation Cover at Sweetwater Mine Site: Evaluation of Waste Byproducts and Mycorrhizal-Assisted Ecorestoration **Mariam Al Lami, Missouri University of Science and Technology**
4:30 - 5:00 pm	The Potential for Peatland Reclamation in the Smelter-Impacted Landscape of Sudbury, Ontario **Dr. Peter Beckett, Laurentian University**	Evaluation of Legacy Gold Mining in South Carolina **Dr. Gwen Geidel, School of the Earth, Ocean and Environment, University of South Carolina**	Repurposing Woody Debris via Fuel Reduction Practices to Enhance Hillside Stability and Soil Seedbank Recovery **Daniel Kelly*, Montana Tech**
6:00 – 9:00 pm – EARLY CAREER PROFESSIONALS SOCIAL – MONTANA TECH STUDENT SUCCESS CENTER			

*** Denotes Student**

ASRS


MONTANA TECH




The LINCOLN HOTEL
Butte Special BEER
Montana's FINEST BEER

GOT DIRT?
WE FIX DIRT!

BRING YOUR DIRT BACK TO LIFE WITH OUR
NATURE BASED SOLUTIONS

Biosol, Humate, Mycorrhizae & PermaMatrix.

"ENVIRONMENTALLY FRIENDLY" PLANT BASED ORGANIC FERTILIZERS & AMENDMENTS

- Concentrated Organic Matter!
- Long Lasting, Stable Nutrients!
- Specialized for Mine Reclamation!
- Custom Solutions for Any Soil Conditions!
- **Used for Over 35 Years with Award Winning Results!**

Block P EPA Superfund Site
Before One Application of Biosol

10 Years Later Following One
Application of Biosol

Activate your dirt and soil with our high-quality products.

TURN YOUR DIRT INTO SOIL WITH Our BIOSOLution!

Rocky Mountain Bio Products
A Division of Bowman Construction Supply, Inc.

303-696-8964
www.wefixdirt.com

From planning to operation:
The beneficial outcomes of vegetation management throughout the solar energy development life cycle

BY NATE WOJCIK, PRINCIPAL RESTORATION ECOLOGIST AT SWCA ENVIRONMENTAL CONSULTANTS
(WITH SUPPORT FROM MANDY BENGSTON, KELLEY HOUSE,
AND TONY ST. AUBIN, ECOLOGICAL RESTORATION EXPERTS AT SWCA)

Green grass with yellow flowers blooming under a Minnesota solar farm.

Soil, water, and vegetation – three critical ecological components of a successful utility-scale solar or distributed generation solar site. Although these elements may be an afterthought from an asset management perspective, an effective vegetation management plan plays a critical role in the long-term efficiency, safety, and sustainability of a solar energy site. It helps maximize energy production, protect infrastructure, and comply with regulatory requirements, while also contributing to community and environmental stewardship.

In its simplest form, vegetation management focuses on establishing and maintaining desired vegetation growth to avoid or mitigate undesired outcomes. Solar energy site developers, operators, and owners often view vegetation management from the asset down, with a focus on making sure vegetation does not shade the solar panels, become entangled in drivelines, or create fire hazards or other safety issues. As ecologists, my colleagues and I view vegetation management from the soil up, striving to understand the soil composition and the vegetation that would benefit the project in many ways – contributing to soil health, stabilizing the site to reduce erosion, promoting beneficial wildlife habitat, and making the visual landscape more appealing for the community.

Various flowers thriving beneath solar panels.

Yet, vegetation management is anything but simple. Inadequate vegetation planning and management can lead to timeline and cost increases that threaten a solar energy project's profitability during operation and maintenance (O&M). At SWCA, we

see various vegetation challenges across utility-scale facilities that relate to these premises: soil and vegetation are not appropriately considered during project planning, and soil and vegetation management plans are not implemented throughout the construction and operation of a solar energy site. Failure to properly address soil and vegetation resources within solar sites can lead to considerable increases in maintenance challenges and repairs; the cost of addressing these is often five to 10 times the cost of implementing proper vegetation management strategies from the beginning.

Integrating ecological vegetation management into solar energy site development phases

Each phase of solar energy site development has its own goals and objectives. From a vegetation management perspective, here is what you need to consider for each phase of the project life cycle.

- **Planning: Siting and Permitting / Design and Engineering**
  Considerations and decisions made for soil and vegetation management during the planning phase always have substantial impacts during the construction and O&M phases of solar development. First, it is necessary to understand the requirements for vegetation the development may be subject to (local permitting revegetation standards; pollinator scorecards) and create a vegetation management strategy to achieve those requirements. Second, it's just as important to recognize what elements of those requirements are practical in the successive phases. There is often a disconnect between what is agreed to during the planning and permitting phase and what is possible to implement during construction and maintain while operating. At the very least, we recommend having discussions with regulatory authorities on the practicality of such requirements. Planning is not a one-size-fits-all approach.

  During the planning phase, vegetation management specialists will want to assess the water availability and the current vegetative and soil conditions across the proposed solar energy site to create the best plan for vegetation establishment based on actual site conditions and desired conditions for operations.

SWCA stabilized large-scale erosion at the Davidson County Solar Farm in North Carolina by armoring concentrated flow areas, redirecting runoff to prevent erosion, and implementing a native plant and pollinator re-vegetation strategy for site stability. Image shows project before stabilization for erosion.

- **Construction**
  Consider how the site will need to be developed, and how construction activities and certain applications will guide the direction of vegetation establishment across a site. Generally, the engineering, procurement, and construction (EPC) contractors take on the responsibility to achieve the approved commitments and required actions that became permit conditions in the planning and permitting phase of the project. Yet, the goal of this phase – to build in the most cost-effective and efficient manner – conflicts with the time needed for successful vegetation establishment, which typically extends beyond the construction timeline (more than two years, and potentially greater than five years in arid environments).

During the construction phase, vegetation management specialists will want to carefully handle (or minimize disturbance to) the topsoil, stabilize the soil, establish cover crops and/or nurse crops, plant pioneer species in project seed mixtures, and control noxious and invasive weed species. The benefits and cost savings of this proactive approach will become evident years later during operations; therefore, it's critical to incentivize the EPC to ensure site preparation and revegetation activities are all done right the first time.

- **Operations and Maintenance (O&M)**
  The owner/operator inherits the commitments, standards, and challenges that come with vegetation management, for better or worse. Vegetation management decisions, or failure of proper implementation, that carry through the construction of solar energy sites can bear great weight on asset management, future financing, and implications for insurance. Proper vegetation maintenance ensures regulatory compliance while reducing O&M costs in the long term. Well-established native and desired vegetation will successively reduce long-term maintenance costs over the life of the project, increasing efficiency and profitability.

During the O&M phase, vegetation management specialists will want to monitor and evaluate revegetation and soil health recovery, maintain desired long-term vegetation, and incorporate additional ecological solutions to support the entire ecosystem and provide beneficial habitat. My ecological restoration colleagues and I recommend developing an aggressive adaptive management strategy before the operations phase, so that systems are in place to respond to emerging issues (e.g., weed outbreaks, soil erosion, vegetation losses) before they become expensive management problems.

Frequently asked questions regarding vegetation management

Our team of experts at SWCA consistently hear the following questions when discussing these topics with solar industry professionals (developers, builders, contractors, owners, operators, and asset managers).

What will improve long-term budgeting for vegetation management and maintenance?

Vegetation management is expensive and rarely appropriately budgeted. Poor vegetation management design or inadequate implementation in any of the project phases can escalate costs by an order of magnitude. Therefore, budgeting adequately for effective implementation and ongoing maintenance will save money and headaches. But how can this be done?

We, the solar industry, need to start

blending the phases of the development life cycle of a utility-scale or distributed generation solar site to improve long-term budgeting for vegetation management and maintenance during operation. It starts with better communication between the teams leading the various project phases. Those who manage the site need to have conversations with the developers to understand the vegetation management consensus and permit conditions. In an even more proactive approach, site managers would have a voice in the permitting agreements during the planning phase. Once a plan is ready, further conversations need to happen with the EPC contractor before construction begins.

How is soil affected during construction and O&M? And what can be done to maintain or improve soil health?

Soil is certainly affected during construction when clearing and moving soil, primarily through the improper handling of topsoil and the potential mixing with subsoil that can result.

Topsoil and subsoil have very different biological, chemical, and physical attributes, and topsoil is like an ecologist's gold with a nutrient- and mineral-rich composition. If developers take care of the topsoil and preserve the properties that impact soil health and plant growth, desired vegetation is much easier to reestablish. This also fosters a positive feedback loop, where maintaining desired, native vegetation feeds into promoting and maintaining long-term soil health. If subsoils are left at the surface or mixed with topsoil, it risks exposing salts and other soil-limiting properties that will restrict revegetation potential.

Questions to address in the vegetation management plan before construction include: What soils are the team working with? Are there any notable limitations (chemical, physical, other)? What is the team doing with the topsoil? Is the team going to salvage soil, or is leaving the topsoil in place an option? (Note, leaving topsoil intact and protected [where possible] is generally a more effective restoration strategy than salvaging and redistributing soils.) How is the team addressing the compaction of soil when heavy equipment moves across the site? And finally, how is the team redistributing the most important resource to support vegetation—

White flowers among solar panels.

the topsoil? What actions are the team taking to further promote the establishment of vegetation? In other words, how is the team preparing the site to grow the desired native vegetation?

Why is seed mixture design critical to the success of vegetation management on utility-scale solar sites?

A well-designed seed mixture accounts for the vegetation that will grow well within a site, which doesn't always align with what someone wants to grow there. A solid seed mixture should also consider the number of seeds per square foot, how different species will interact with each other, and how desired species can compete with weeds in the short and long term.

Taking time to design targeted seed mixtures across a site for different objectives will go a long way in facilitating the establishment of vegetation. Generally, my colleagues and I recommend having a buffer seed mix (for areas within the site that do not have operational infrastructure; these may include elements like access roads, retention ponds, sediment basins, or undisturbed areas), an array seed mix (for areas under operational infrastructure), and other seed mixtures that consider the hydrology and other resources within the site.

What is the benefit of a well-designed vegetation management strategy?

Consider the long-term value of well-designed vegetation management strategies and the ecological benefits that healthy native vegetation can bring to your site. Implementing these strategies can provide tangible benefits such as carbon sequestration from deep-rooted perennial plants, healthy soils, and clean water.

By incorporating high pollinator-friendly scores into vegetation management plans, you can foster positive public opinion and create opportunities for community engagement and stewardship. This approach includes educational initiatives, community involvement, and environmental awareness programs that strengthen the bond between your project and the local community. Dive deeper into this topic with our "The Perks of Pollinators: How Natural Habitat is Heating Up in the Solar Industry" article.

Tailoring strategies to meet the specific goals of individual projects, with a focus on sustainability and stewardship, helps comply with environmental permitting requirements and adheres to regulations and policies that protect and enhance the natural landscape. Aesthetically pleasing designs that integrate into the surrounding environment promote long-term ecosystem health and foster positive public perception.

As a restoration ecologist, I am passionate about how vegetation management can improve ecological ecosystems in three significant ways:

1. **Climate:** Promoting renewable energy sources and enhancing carbon sequestration directly contribute to climate change mitigation.
2. **Water:** Strategies that help retain water and protect water bodies from sedimentation ensure the health and sustainability of local water resources.
3. **Biodiversity:** Promoting biodiversity supports wildlife and attracts beneficial species, contributing to a thriving and balanced ecosystem.

Tailored vegetation management strategies with SWCA

At SWCA, we specialize in providing vegetation management strategies and detailed, actionable plans designed for long-term success and sustainability. Our expert team is dedicated to delivering innovative and practical services tailored to meet your specific needs throughout the entire life cycle of your project. Additionally, we enhance the aesthetic appeal and community acceptance of your

projects with landscape screening plans and design sets. Our stormwater integration services ensure compliance with environmental regulations while minimizing impact on local waterways.

We offer comprehensive weed management solutions through integrated vegetation management, incorporating mechanical, chemical, and biological methods to maintain optimal site conditions. Our team can define the scope of work for EPC contractors, ensuring clarity and efficiency in project execution, and help streamline your EPC contractor contracts by identifying and removing unnecessary elements, thereby reducing costs and complexities. We provide thorough performance inspections and environmental compliance monitoring to help your project meet all regulatory requirements and operate at peak efficiency.

Our adaptive management approach allows for continuous improvement and adjustment of strategies based on real-time data and changing conditions. Additionally, we offer forecasting services to predict and plan for future vegetation management and maintenance needs, ensuring your project remains sustainable and cost-effective.

We encourage the solar development community to continue discussing vegetation management across the development life cycle of utility-scale and distributed generated solar. Partner with SWCA to support the success of your solar energy projects from planning and permitting through construction and operation. Together, we can achieve beneficial ecological outcomes, strengthen community connections, and promote environmental stewardship.

Ecosystem management on reclaimed mines

BY JENNIFER FRANKLIN, UNIVERSITY OF TENNESSEE; YOGINDER CHUGH, UNIVERSITY OF SOUTHERN ILLINOIS CARBONDALE; BRENDA SCHLADWEILER, BKS ENVIRONMENTAL ASSOCIATES; GWENDELYN GEIDEL, UNIVERSITY OF SOUTH CAROLINA.

While the global mineral industry continues to grow about 1.9 percent annually since 1985, rising populations are placing greater demands on our land and water resources to provide the goods and services needed. How can we produce and utilize mineral resources more efficiently while minimizing negative and enhancing positive environmental impacts? By considering ecosystem services as part of the permitting, reclamation, and management (that includes restoration) process, we can maintain or even improve the natural capital of mined lands to support multiple land and water uses without significantly increasing the cost of reclamation.

Figure 1. Site in Tennessee where coal mining was completed in 1958, with minimal reclamation.

Ecosystem services assess the direct and indirect contributions of the ecosystem to humans and are divided into four categories. Provisioning services include resources directly gained from the land such as food crops, wood, and fresh water. Regulating services include carbon sequestration, flood control, and other functions that help to stabilize our climate and water cycle. Among the many ways we use land are for recreation, tourism, and inspiration or spiritual meaning, all considered as cultural services. Supporting services provide an indirect benefit but are necessary for other ecosystem services and include soil health, nutrient cycling, and wildlife habitat. The term "natural capital" refers to the ability of the land to provide these ecosystem services.

Natural capital can be determined through an ecosystem assessment, which is an attempt to define and evaluate the structure and function of ecosystems using data to characterize ecosystem health, impairment, integrity, and/or value. For example, the site in Figure 1, mined prior to the Surface Mining Control and Reclamation Act or SMCRA (1977), has greater natural capital than the pre-mined condition because the deep, loose soils resulted in increased water storage and faster than average forest growth, while the variations in topography and soils have led to a particularly high diversity of plants and amphibians. In contrast, many sites in the eastern US reclaimed in the 1980s and '90s (Figure 2) provide fewer ecosystem services than the pre-mined site as compacted soils reduce water infiltration and forest growth, and non-native vegetation has resulted in low biodiversity (notably, at a much higher reclamation cost!).

Although the long-term outcome on the pre-SMCRA site is excellent, in the absence of pre-mining assessment and management planning, there could have been considerable negative impacts to the local environment. An ecosystem risk assessment (an integral part of ecosystem management) is a process that evaluates the likelihood of adverse impacts on the ecological environment because of exposure to one or more natural and/or human stressors. Ecosystem assessment,

Figure 2. Former coal mine reclaimed in the 1990s with techniques common for that era. The area of former hardwood forest is now dominated by shrubs and non-native species.

undertaken pre- and post-mining, is the only way to develop strategies for ecosystem restoration and management, and assess their effectiveness. The current state and use of ecosystem assessment varies across different geographic regions and land uses.

In the Western United States, landscapes are dependent on geology and soil development, as well as prevailing weather including temperatures and precipitation. There are latitudinal changes (north to south) as well as elevational changes. Over this large area, industries and ecosystems vary considerably. A comprehensive ecosystem assessment is commonly undertaken pre- and post-mining.

Other than the extractable mineral, there are two main components of valuation: pre-disturbance functions and resources (ecosystem assessment) and cost of management (reclamation or restoration) to reestablish those functions. Within the first component, several environmental characteristics should be measured such as air quality, water quality, soils, vegetation, wildlife, etc. The overall purpose of gathering this information is to "paint the picture" of what this pre-disturbance landscape looks like from a quantified point of view. It can also identify issues that may not make this area conducive to disturbance and reclamation/restoration. Secondarily, this information is used for post-disturbance management purposes such as designing seed mixes, what type of weed management plan should be employed, and overall reclamation design.

Within the second component, what is the cost of reclamation or restoration to reestablish these landscapes? Several factors impact whether a site is too costly to reclaim, and the challenges vary widely throughout this region: a variety of landscapes and environmental factors, a variety of land uses and ecosystem services, social considerations, and values based on human perspectives. The National Environmental Policy Act or NEPA (1970) is a federal law that requires stakeholder involvement in any federal action. Various alternatives of development are evaluated. State permitting processes are in addition to NEPA and provide another level of "valuation." Bonding under the Surface Mining Control and Reclamation Act or SMCRA (1977) provides some measure of valuation both pre-disturbance and post-disturbance on coal mined lands based on bonding requirements. Bonding for all disturbances may provide some level of quantitatively evaluating the resources in an area but does not necessarily include ecosystem services directly; much of it is assumed.

In prime farmlands of the central US, crop production is the primary ecosystem service and is the main measure of assessment, both pre- and post-mining. Within coal removal areas, federal laws dictate reestablishment of same or better crop yield on reclaimed lands. Bond release may be delayed due to variations in crop yields between crops and years. A pre-mining ecosystem assessment may help to identify opportunities to increase natural capital either by reconstructing conditions that optimize crop yield or increase value at a landscape scale by incorporating complementary land uses such pollinator habitat or wetlands as a nature-based solution to improve water quality.

Forests are the dominant ecosystem in eastern US, and forestry is the primary end land use across most of the Appalachian coal region. Mining and reclamation approaches are designed to minimize off-site impacts, leave stable slopes and to promote the establishment of native forest. Post-reclamation ecosystem assessment is often limited to water quality, vegetative cover, and trees per unit area. In this highly fragmented and degraded region, a pre-mining ecosystem assessment could help identify opportunities to increase ecosystem services as part of the reclamation process.

Ecosystem assessment can be used as a comprehensive tool to document reclamation success. The Graves Mountain kyanite mine near Lincolnton, Georgia produced minerals used in primarily in refractory brick. Pyrite grains occur throughout the ore, creating the potential for acid formation once exposed to surface elements. The pH of tailings and water from tailings were in the 2 to 3 range pre-reclamation. Reclamation of the tailings ponds was dependent on a multi-component integrated technology to improve near surface water quality and lower the water table, decrease acid levels in the near surface, vegetative zone, promote vegetation establishment through addition of ridges and furrows (RAF), crushed limestone and organic matter, and monitor sequestered soil carbon, as well as differences between forested and non-forested areas. Resulting long-term reclamation in this case study indicated a lowered water table, improved surface water runoff quality, and enhanced growth of at least 10 volunteer tree species (mixed conifer and deciduous) in the RAF sites, in addition to numerous volunteer grass and herbaceous species.

Once impractical because of the expense of collecting and analyzing large amounts of environmental assessment data, emerging technologies have brought comprehensive and quantitative ecosystem assessments within reach. As these develop, we need to ensure that they are objective and uniform across environments. New data analysis tools will assist the reclamation community in designing reclamation that will optimize ecosystem services in an ever-changing environment by incorporating multiple land uses and sharing data. Finally, emerging markets such as hydrologic regulation, carbon storage, and tourism may provide new economic incentives for reclamation.

Learning to grow: Answering key questions to improve the supply of native seeds for Wyoming reclamation projects

BY MICHAELA OWENS

Direct seeding on reclamation sites is often the most cost effective and only viable option for revegetation and is therefore common practice. However, seeding failure is not uncommon. The use of locally adapted native seed has the potential to reduce these costly failures as these plant materials come from ecological communities that have adapted over long time periods to the specific conditions at a site or in a region. Not only do these locally adapted materials have the potential to establish and reproduce better, they also often provide superior habitat and forage to wildlife over nonnatives and cultivars. Moreover, the use of local seed doesn't solely lead to better reclamation outcomes for ecosystems; it can also benefit reclamation practitioners in meeting their revegetation requirements and subsequently the overall success of their projects.

Unfortunately, these sorts of plant materials are in short supply or are prohibitively expensive. Often the only seed available from native species are cultivars. When seed that is not ecologically appropriate is used in reclamation, the result is often seeding failure, low diversity of established species, reduced ecosystem function, and a failure to meet revegetation goals. Though this is a problem across the American West, it is an especially prevalent problem for reclamation projects in the sagebrush dominated ecosystems of Wyoming. To this point, very few seeds sourced from populations within Wyoming – let alone from within an appropriate seed transfer zone – are available on the open market. The dryland environment of sagebrush ecosystems within Wyoming provides a challenging setting for the establishment of plant communities, making the use of local seed even more important. The sagebrush biome is also facing unprecedented threats to its extent and function from invasive annual grasses like cheatgrass, which then contribute to bigger and more frequent wildfires. Cheatgrass, like many invasive species, thrives in disturbed soils and can quickly invade and dominate in environments with low plant cover, like freshly reclaimed mine sites. Establishing a healthy and diverse native ecosystem is the best way to create a landscape that can resist invasion. To accomplish this, the use of native and locally adapted seed is key.

To address the need for more local seed sources for reclamation projects in Wyoming, The Nature Conservancy has been working to improve the supply of native seed in a project funded by the Abandoned Mine Lands programs of both the Wyoming Department of Environmental Quality (DEQ) and the Bureau of Land Management (BLM). This work is part of the Native Plants Project led by these two agencies and was featured in an article in the Spring 2024 edition of Reclamation Matters. We have started to address the shortage of appropriate seed by addressing critical knowledge gaps in the development of new plant materials: how to get seeds from desirable species to germinate, and which species will do well on reclamation sites in Wyoming. In sagebrush ecosystems wildflower species make up a large portion of the plant diversity and are of special importance to the greater sage-grouse habitat and diet. For this reason, we are focused on working with wildflower species.

To determine which native species to focus on, we talked with partners and conducted a statewide survey of seed users to understand which species were most desired but unavailable. Once we had a list of desired species, we began to collect seed. Collecting seed from native species can be challenging, time consuming, rewarding, and fun. The first step to successful seed collection is to identify areas where target species might be and then go out and look for those species. Sometimes

The sagebrush steppe of Wyoming in spring sporting an abundance of wildflowers which provide important forage and habitat to wildlife.

Michaela Owens collecting seed for lab trials

despite good intel on the location of a species population, you will find that there are no plants there or there are multiple species that look very similar and careful identification is required. Once a population has been found, it has to be checked on throughout the growing season to keep tabs on where it is in the process of producing seeds. Sometimes we will monitor a species for an entire season only to come back later and find that all the plants have been trampled by cows, the conditions are so hot and dry that little to no seed was produced, or all the seed has already been dispersed from the plant and there's nothing left to collect. Wild plant species have adaptations that help them survive and reproduce in the wild but that can make seed collection difficult. One example of this is indeterminate seed production, which means that all the seeds on one plant mature at different times, requiring many visits to collect enough seed. It is important to make note of these sorts of traits, as seeds that are too difficult to collect efficiently or that have poor seed production may not be good candidates for large-scale seed production. Despite these challenges and setbacks to successful seed collection phase, getting out to beautiful and wild locations to look at wildflowers and collect their seeds is one of the best parts of the work.

Once we have enough seeds for each species, we put them through a series of tests in the lab to determine what treatment and environmental conditions they need to germinate. As an adaptive strategy, many dryland plant species have developed seed dormancy to ensure that the seeds germinate at the optimal time of year for survival. In the sagebrush steppe of Wyoming, this often means that the seeds need a period of cold, wet conditions (i.e., winter conditions) before they can germinate. Cold stratification is the seed treatment required to relieve this type of dormancy. Another dormancy type common to Wyoming is the presence of a hard seed coat that needs to be abraded before the seed can take up water and subsequently germinate. The treatment required to alleviate this type of dormancy is called scarification; this is done by scratching the seed coat with something abrasive like sandpaper, or it can be done by chemical means. To determine if a species has dormancy, we simulate conditions they would experience on the landscape in the lab and observe whether they take up water and germinate. Through these iterative trials, we can determine what type of dormancy a seed has, if any. With this information, we can produce protocols on how to get a seed to germinate, which are made available to anyone looking to work with these species (protocols available at npn.rngr.net). To this point, we have tested seedlots from 15 species and have characterized the germination requirements for 13 of those.

The next step in our process is to test these species in real-life scenarios. The purpose of these trials is to see if these species can grow and thrive in the harsh conditions of a post reclamation or restoration site. If a species cannot do well in these conditions, then we can recommend that it's not prioritized for commercial seed production. As part of these field experiments, we want to know whether scarifying seed with a hard seed coat in advance of seeding has an effect on their establishment. To do this, we seed both scarified and unscarified seed for those species and then observe and analyze the differences in seedling emergence. For seeds that require cold stratification, we do not treat them beforehand. We install these trials and sow the seeds in the fall to see if

Three of our target species (from left to right): Hoary Townsend daisy (Townsendia incana), lesser rushy milkvetch (Astragalus convallarius), and larch-leaf beardtongue (Penstemon laricifolius).

the winter conditions at these sites are adequate to break dormancy. So far, we've tested 12 different species in the field. Of these 12 species, five have already gone through at least one growing season and we have data on their performance. The remainder were seeded in the fall of 2024, and we will not have data on their performance until the end of the field season in 2025. We have installed these trials at two different reclaimed mine sites across multiple years and one burn scar for a total of five field trials installed to date. We want to test our species across years and in as many locations as possible because there will be variations in temperature, soil type, and precipitation across sites that may make them more or less suitable. Our hope is to identify species that are not only suitable for reclamation sites but that can be used in other restoration contexts as well.

From these experiments, we have so far identified three species that have performed well on the mine sites. Of these three, one has indeterminate seeds, which makes seed collection difficult; for this reason, we do not recommend it for large-scale seed production. The other two, rayless tansyaster (Machaeranthera gridelioides) and sand beardtongue (Penstemon arenicola) could be good candidates for seed production, but there are many other questions that remain to be answered before production can be scaled up. These include: What other types of restoration contexts could they perform well in? How many growing seasons do they take before they produce seed? When is peak seed production and when do fields need to be replanted? How much seed can a grower expect to produce in a typical year? Can they be grown without irrigation? How widely can they be used across the biome and do well? Will they be able to reproduce to do well in a warming climate that shortens the period of winter conditions needed to germinate?

The work that we've done to date to investigate germination requirements and suitability for reclamation sites is only a small part of a large effort across Wyoming by many different stakeholders to improve the supply

Seeds being tested in the lab to determine germination requirements

Three of our best performing species growing at reclaimed mine sites (from left to right): Rayless tanseyaster (Macharanthera grindelioides), lesser rushy milkvetch (Astragalus convallarius), and sand beardtongue (Penstemon arenicola).

This table lists all the species we have tested to date and what type of seed treatment they need to germinate

SPECIES	COMMON NAME	SEED TREATMENT NEEDED
Astragalus purshii	Woolypod milkvetch	1-month cold stratification + scarification
Astragalus convallarius	Rushy lesser milkvetch	Scarification
Astragalus drummondii	Drummond's milkvetch	Scarification
Erigeron caespitosus	Tufted fleabane	Inconclusive
Ipomopsis congesta	Spiked ipomopsis	2-4 months cold stratification
Ipomopsis spicata	Ballhead ipomopsis	3-4 months cold stratification
Machaeranthera canescens	Hoary tansyaster	Inconclusive
Machaeranthera canescens	Rayless tansyasterww	2-4 months cold stratification
Machaeranthera tanecetifolia	Tansey-leaf tansyaster	None required , 1-3 month cold stratification may improve germination
Packera cana	Woolly groundsel	None
Penstemon arenicola	Sand beardtongue	5+ months cold stratification
Penstemon laricifolius	Larch-leaf beardtongue	4+ months cold stratification
Townsendia incana	Hoary Townsend daisy	None required
Vicia americana	American vetch	Scarification

of native seeds for reclamation and restoration now before the need for appropriate plant materials increases drastically due to increased invasion of cheatgrass, subsequent wildfires, and the changing climate. Currently, most seeding in Wyoming is being done by private industry to reclaim areas after extractive activities. While these projects are planned in advance, it's still hard for practitioners to get the seeds they want for their projects. Substitutions in seed mixes are a common reality. In a future with more unpredictable events and unstable demand for seeds, it will be very difficult for suppliers to meet the need if we don't act now to improve the supply of seeds for Wyoming.

Beyond the need for more information on how to germinate target species and which kinds of sites they would be suitable for, seed producers face many barriers to successful production of native seed. Because of this, there are currently very few growers in Wyoming producing native wildflower seed, in particular. The chief barrier that native seed producers cite is unstable demand. Demand for a specific species may be very high one year, leading to great prices for the grower, but then the demand may tank the following year and make the production of that species unprofitable. The reclamation industry can help stabilize this demand by planning seed mixes and working to find a supply for the species they desire years in advance of projects. Additionally, being willing to engage with growers using novel contracting mechanisms that reduce the risk to growers is another way reclamation practitioners can help. If all stakeholders work together to address this shortage in the supply of locally adapted seed for reclamation and restoration projects, we can create a future where seed users can acquire the seed they need for the best outcomes of their projects, which will result in the conservation of the wild beauty that Wyoming is known for.

KC HARVEY
ENVIRONMENTAL

FROM RECLAMATION TO REALIZATION — KC HARVEY DELIVERS IT ALL.

At KC Harvey, we take an integrative partnership approach to land reclamation and ecosystem restoration.

That means we work side-by-side with you to provide the best in reclamation science and implementation. We bring reclamation science, engineering, and field service capabilities to the table, working closely with our clients to minimize costs, maximize success, and reduce liability.

Whether your project needs planning, testing, designing, implementing, monitoring, maintaining, or troubleshooting services — KC Harvey is here to make it happen.

DISCOVER HOW OUR TEAM OF PROFESSIONALS CAN DRIVE YOUR PROJECT TO SUCCESS

TRAVIS KIMSEY
Director of Professional Field Services
tkimsey@kcharvey.com
307.349.1382

DAVID STEED
Director of Mining Services
dsteed@kcharvey.com
801.231.5595

SKIP VEST
Director, Oil & Gas Regulatory Services
svest@kcharvey.com
720.644.7721