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Spring 2023

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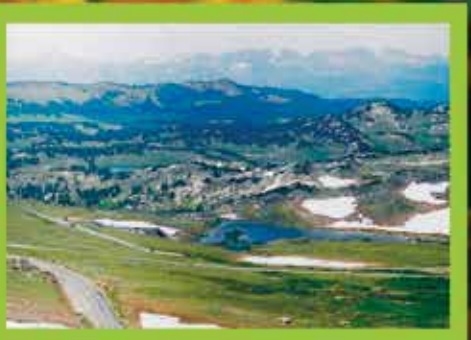

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Reclamationists: Why our AWEsome work can make us happy

MICHELE COLEMAN

It has been an interesting term as President. I can sum up the year as one where I experienced many situations of gratitude and awe. Both are critical components for happiness, so I am very happy as I write this editorial. For awe, it was looking for experiences in our daily lives that made us think, took our breathe away, gave us goosebumps or knowing that what we do as reclamationists will inspire awe in others. Here are some of my experiences this past year.

As seems to be common when one takes over as President, my term was not what I had envisioned. Our long-time Executive Director (Robert Darmody) stepped down and ASRS transitioned to hiring a management group (FASS) for our back-office affairs. For a bit of history, the Executive Director provided the consistency that made the annual transition with incoming presidents, NEC delegates, and new conference organizers relatively seamless. ASRS has had only three Executive Directors/Executive Secretaries (ED/ES) since its inception in 1984. Their efforts were responsible for the consistency we have in quality conferences and organization management. As we worked through transitioning, the NEC got to witness firsthand how many facets of managing our organization "just happened" because of the hard-working Executive Director. I was in awe of the workload.

I am grateful to Dr. Robert Darmody, Dr. Richard Barnhisel (and his wife Lela), and Dr. Bill Plass for the years of dedication they devoted to managing the ASRS operation as EDs/ESs. These were members who never rested on their laurels but strived to continue to expand the base of knowledge of their members by supporting the NEC and conference chair organizers.

But ASRS is not just the ED and the NEC; it is also supported by many members who have been on the NEC or who have managed other facets of the organization. I want to thank a long-time member and huge contributor to ASRS over the past four decades, Dr. Jeff Skousen. Dr. Skousen has been on the NEC, has been President of ASRS twice (1990-1991, 2003-2004) and has been the chair of three conferences (1990, 2004, 2017). But his most lasting contribution was as the initiator and Editor of *Reclamation Matters* for 18 years (36 issues). Jeff's final column was in the Fall 2022 edition. As usual, Jeff's commentary was a keeper, an article that generated awe and was worth ripping out of the magazine and posting on my wall to read again and again. I am grateful for the many years of great *Reclamation Matters* and ASRS commitments that Jeff has provided. Jeff's editor articles were thoughtful, inspirational, and practical. He was a genius at wordsmithing, turning a thought to have a deep meaning with lots of consideration going into each word but phrased to be lighthearted. He made his message look easy and practical. I am not envious, I am awed.

But isn't that how we approach our reclamation – we want our resulting research or landscapes to leave a legacy of awe? We do a lot of research, put in a lot of thought, design, work and the outcome to the non-expert viewer is usually "hey, this looks good!". Here are two examples where reclamation techniques I had learned at ASRS had produced awe at reclaimed mine sites.

I was surprised last May when my brother asked for a tour of one of my reclaimed mine sites. He wanted to see what I had spent 30 years doing. We walked for several hours across a variety of seven to 15-year-old recontoured landscapes, observing ducks, geese and muskrats, beaver trails, and having my grandson stand on a beaver house (maybe not my smartest idea on second thought, as the beavers may have had young babies inside the house). We looked at deer scat in the meadows and old bear scat in the raspberry thickets, shrubby areas with songbirds perched on branches or pecking on old seed clusters and young Acadian forest with

a new season of leaves and growing dense enough to provide cover and shelter for deer and ruffed grouse during the hunting season. As he stood on a high point surveying the reclaimed mine, my brother said, "Wow, if I didn't know I was on a mine site, I would have assumed we were just out on a nice hike. This was incredible." Our team had done work that inspired awe! Reclamation success!

On a practical note, I was recently talking to a member of that same reclamation team, and he said that a few local hunters, trappers and nature lovers had been out at the same site and had reportedly a) shot a nice buck b) trapped plenty of rabbits for Christmas dinners, c) shot a few geese, and d) enjoyed many lovely nature walks. They were all awed by the positive legacy of mining that we had created for the local community.

Michele Coleman's brother (Ed Duell) and grandson (Kyle Leitch).

I knew then that our work as reclamationists was inspiring awe in those that were viewing our work (and putting food on people's tables!). Much like me reading Jeff's columns, many of those that viewed our work didn't understand the complexity of what we had crafted, they were awed by the

outcome. We created something that gave them that feeling that can take the breath away or a provide a sense of treasure or amazement. We created something that made people stop to take it all in. We created an outcome that was not anticipated by others.

How lucky are we to be part of this work that helps to create more experiences of awe in the world? Very lucky and we should feel much gratitude for the opportunity.

For me personally, I have much gratitude for the support of the NEC this year. To past president Tim Danehy and incoming president Julie LaBar, thanks for your patience with the many email and phone discussions. To NEC Delegates Kenton Sena, Kennet Bertelsen, Sara Klopf, and Paul Griswold, and Early Career Representative Allen Wellborn: thanks for all the committee and subcommittee work, zoom meetings, and commentary on emails. We asked a lot of you. Paul also did double duty as the Awards Subcommittee Chair. Barry Stewart was Student Scholarship Subcommittee Chair. I am in awe of the amount of work that did get done by people with careers, families, and lives, and for Kenton and Sara, very young children to add into the mix. I think we do our jobs to create awe so that when these children are older, we can proudly show them what we have done, and they too can experience awe.

These past few years of the pandemic have hopefully taught us to be more comfortable expressing our gratefulness and to appreciate the situations where we experience awe, both of which leads to higher levels of happiness I hope that when you think about the impact of the work that you do, that you feel the gratitude to those who assist you, that your outcomes let you and others experience awe, and that the combination makes you happy.

Currently, I am looking forward to what Michael Curran, the new editor for *Reclamation Matters*, and Natalie Kruse, editor of the journal *Reclamation Sciences*, have planned. I am also looking forward to seeing many of you at the 40th Anniversary of ASRS (formerly ASMR and ASSMR) meeting in Boise, Idaho June 4-7, 2023. I can't wait to see what Dustin Wasley and his conference organizing team have in store for us!

As I hand over the gavel to Julie LaBar this June, it will be with much gratitude...

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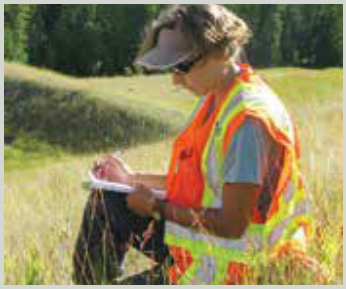

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Big shoes to fill

MICHAEL CURRAN,
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In July 2022, I received the archives of ASMR and ASRS Conference Proceedings and hardcopies of past *Reclamation Matters* editions. Sorting through them, I found myself looking back fondly of memories from previous conferences, interactions with ASRS members, and recalling talks and articles that have helped shape my view of reclamation as a science, practice, discipline, and ultimately collaborative effort among people with different backgrounds, skillsets, and job titles. It's hard to believe the first conference I attended was in Bismarck, North Dakota in 2011, as a fledgling master's student at University of Wyoming. Perhaps it is harder for me to believe that I've gotten lucky enough to learn about wide range of reclamation projects across the country since then by attending conferences and reading *Reclamation Matters* twice a year.

While digging through these boxes, I came across the Fall 2014 issue, where I contributed my first piece to *Reclamation Matters* titled "Bridging the gaps among science, policy, and practice". I remember walking into a class the first semester of my PhD program and being told by a professor, "Nice article, but you're wasting your time in academia if you're writing articles for magazines rather than peer-reviewed journals." Little did he know, at the time, I was working on obtaining data from many oil and gas operating companies and government agencies across Wyoming. In my travels around the state, meeting with reclamation professionals from various companies and agencies, one thing I noticed as I was sitting in lobbies or peeking around the reading material on the coffee tables was almost none of them had copies of Science, Nature, International Soil and Water Conservation Research or any other peer-reviewed academic journals readily available. Almost all of them had copies of *Reclamation Matters*. As an outsider with a New Jersey area code, being greeted by folks from Wyoming with "Oh, yeah, I know you… you're the guy who wrote that article suggesting academia help industry practitioners," certainly seemed to help initiate conversations about data sharing. Within a year, with help from industry and government, we had the largest oil and gas reclamation database in the world, and its contributions were recognized by the US Fish and Wildlife Service prior to the 2015 non-listing decision of the Greater Sage-grouse under the Endangered Species Act. For that, I'm forever grateful to *Reclamation Matters*.

After I got through *Reclamation Matters* issues from 2011-2022, I started looking at older issues, conference proceedings, membership lists, and some other documents in these boxes. Aside from being impressed by the meticulous records kept (presumably by Dick Barnhisel, Bob Darmody, and others), I started thinking about what has kept me a member of this society for over a decade. In my time as a graduate student and post-doc, and more recently as a consultant, I got to attend a lot of conferences held by other societies and organizations. One thing that has always stuck out to me about ASRS is the mix of involved people. I can't think of another society which has such a blend of industry, government, consultants, engineering firms, academics, and others so closely intertwined. Not only does this society have a diverse mix of fields represented, but there's a strong push to include students and early career professionals in the society and plenty of members in later career stages willing to help mentor them. Not only do I love that aspect of ASRS, but I enjoy that there is a vessel to connect the society outside of conferences – at least, that's something I consider *Reclamation Matters* to be.

Of course, I read through a lot of previous Editor's Messages written by Jeff Skousen, the mastermind behind

Reclamation Matters. In 2021, when Jeff told members of the National Executive Committee he'd be retiring and wanting to step away from *Reclamation Matters*, the fate of the magazine was up in the air. Michele Coleman was instrumental in getting the ball rolling, knowing what Jeff has built for this society is too important to let go. After much discussion and deliberation, I think all on the NEC were in agreement that *Reclamation Matters* is a big part of ASRS' identity. With the approval of Michele, Julie Labar, Tim Danehy, Natalie Kruse Daniels, Paul Griswold, Sara Klopf, Kenton Sena, Gwen Giedel, Allen Wellborn, Bob Darmody, and Jeff, it was agreed that I'll try to fill Jeff's shoes as the new editor of *Reclamation Matters*.

I know these are very big shoes to fill and I'm not entirely sure I'm the best person to fill them. That said, I promise I'll try my best. Thankfully, although I'll assume the title of Editor, I have a team behind me to help fill Jeff's shoes. The support I've received from Michele, Jeff and other NEC members has been outstanding, and I cannot thank the authors of this edition's articles enough (nor can I express how grateful I am that the first article comes from Dr. Skousen himself).

Maybe because the last in-depth conversation I had with Jeff was at the Red Head Mountain Bike Trails during the Duluth conference, I keep thinking of this as being like learning to ride a bicycle. I got to watch an expert for the 12 years from afar. Jeff was kind enough to let me learn a lot more, keeping me in the loop on every interaction with the Spring 2022 issue. Then, Jeff put me on training wheels and allowed me to work alongside him with the Fall 2022 issue. While the training wheels are off now, I'm glad to know Jeff's a phone call away if I need him and that I have plenty of support from Michele and others. I look forward to serving ASRS in this role, and the greatest support I could receive from ASRS members would be to have those interested in writing articles for *Reclamation Matters* contact me to help keep the ball rolling. Thank you, Jeff, for all of your work over the past two decades to make *Reclamation Matters* something myself and others love about this society. I hope to make you proud and hope to see you and many other ASRS members at the 2023 Conference in Boise.

The role of an Early Career Professional (ECP)

BY ALLEN WELLBORN, ENVIRONMENTAL ENGINEER, SR., SPRING CREEK MINE,
NAVAJO TRANSITIONAL ENERGY COMPANY, ASRS EARLY CAREER PROFESSIONAL REPRESENTATIVE

Congratulations, you just got your first full-time job after graduating with your degree – now what?

Perhaps you interned for a company over your last summer and were hired full-time, or you just got your first full-time job after working as a seasonal technician for a few years. What does that mean for you as you transition into a contributing member of your new company? Quite often, you'll find yourself overwhelmed with safety trainings and learning new company policies while trying to understand all the nuances of your employer. However, the knowledge, new ideas, and expertise that you bring can be extremely beneficial to your employer and your field. In recent times, more and more companies are finding themselves with an aging work force and are starting to lose knowledge that is not passed on. By starting your career, you are bringing in new technology, new ways of thinking, and new ideas to help keep companies improving and building for the future.

Many companies will put a new employee on a "probationary period" to allow them to assimilate to their position while learning all the aspects of their position. This is your time to get familiar with your new role and learn all the protocols, programs, tasks, and responsibilities required to be a contributing member of the team. These probation periods typically last for a few months, after which, you'll typically see a change in work schedule, you may receive a pay increase, and other responsibilities will become placed upon you. Your first couple of years are spent mastering the new skills you learned and practicing the basics of what you were taught in college. As you get experience under your belt, and your comfort level increases, opportunities exist for you to begin expanding within your company. Some may move laterally within their place of employment, and others may switch companies entirely for a magnitude of reasons. These first few years of your career are all about building your professional résumé through training and self-taught practices. Attending conferences, company sponsored trainings, and learning software are all key to building your knowledge bank as a foundation for the rest of your career.

As you advance through these first few years, your role is to learn and personally grow, while providing your resources and skills to the company. A great way to help you advance through your years as an ECP is to maintain a membership with a professional society, such as the American Society of Reclamation Sciences. Many societies and organizations have an ECP chapter

ASRS members enjoying the Early Career Professional networking event at the 2022 conference in Duluth.

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comprised of young professionals and students as a way for you to network, connect, and learn skills and trades. Now is the time to also become active within those societies and groups as a contributing member, whether it's part of a technical division, giving talks at annual meetings, writing articles for the society newsletter, or participating in webinars. Staying active within your field is a surefire way to help accelerate your career and get you to the next level.

I recently had the opportunity to ask a young engineer within my company what being an ECP meant to them. I've included their responses below:

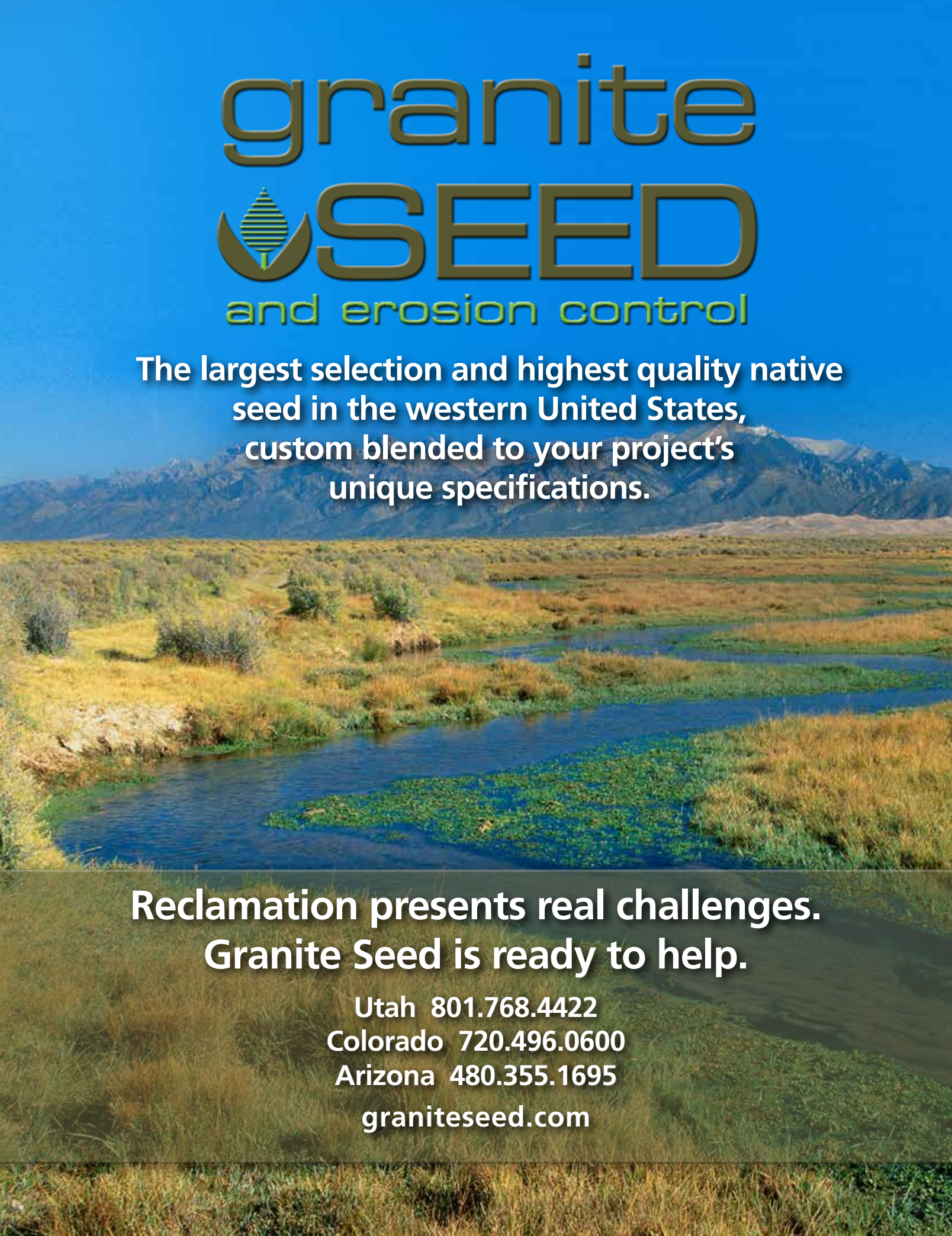
"Being an early career professional means, to me, that it's my time to grow, learn, gain experience, and explore new things.

Often times when new graduates start their new jobs, we end making a big move to do so, whether it be across the country or just to a new living environment in town. There's a lot that comes with starting you first job out of school outside of your work life. You have to be patient with yourself while you figure out your life outside of work.

This is your time to make mistakes. Your coworkers want you to succeed and more often than not would love to help you learn from mistakes that not only you make, but that they have made in their careers. Ask lots of questions and have them look at your work. They will be able to point out any mistakes or ways to better optimize what you're working on.

You won't use nearly as much of your schooling as you think you will -- you don't need to keep all your notebooks. A lot of what you learn in school is becoming familiar with the industry and to train your mind to think like an engineer. You'll learn so much more in your first year of working than you did in school."

As you progress through your first 10 years within the workforce, the skills and knowledge you learn will be some of the most valuable information you can retain. I encourage you to ask questions, take lots of notes, remain active, and don't be afraid to step out of your comfort zone. Whether you are a student who's about to transition to the workforce or an ECP who is getting your foot in the door in the industry, feel free to reach out to any one of the ASRS NEC members, including myself, with questions. If we don't have an answer, we will find it for you and help you along in your journey!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Wild Women of Reclamation

at the 40th Annual Meeting of ASRS

Wild Women of Reclamation, 2022 ASRS meeting, Duluth, MN (left to right). Top row: Jenifer Engstrom, Rachel Lange, Kahindree Ositimehin, Keana Trudel, Ally Kramer, Beverly Alvarez Torres, Annalie Peterson, Katie Larson, Sara Post, Jennifer Franklin, Abbey Wick, Rachel Wagner. 2nd row: McKenzie Dorman, Melissa Bantz, Chantel Mertiz, Ashlyn Campagne, Gwen Geidel, Jenise Bauman, Marsha Patelke, Joy Jenkins, Justine McCann. Bottom row: Annica Brown, Michele Coleman, Apsana Kafle, Mehgan Blair, Natalie Kruse-Daniels and Lena, Summer King, Susan Darmody.

To: All women involved in reclamation are invited – feel free to bring a colleague!
What: A networking opportunity targeted toward women in reclamation
When: 7:00- 8:15 a.m., Tuesday June 6, 2023
Where: Boise Center (conference venue)

The Boise, Idaho conference will be the eight annual Wild Women of Reclamation meeting at a ASRS conference. WWR originated in Laramie in 2013 as an idea of Brenda Schladweiler. WWR became an integral part of the agenda at the 2014 national meeting of the former American Society of Mining and Reclamation, now rebranded as the American Society of Reclamation Sciences. Participants meet at a kickoff breakfast before morning technical sessions at the beginning of the conference. Every woman is welcome. We have a presentation, do some networking, get to meet new attendees, and catch up with life with old friends. Presentations in the past have covered choosing your own path, mentoring, starting your own business, and juggling a research career with family and community obligations. The presentations have one theme

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Shown-above: Hanna, Wyoming, Elementary School Subsidence Mitigation Project for Wyoming Abandoned Mine Lands Office. The project was awarded OSMRE's Western States and Tribes Region Reclamation Award for 2022.

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Those mentors and "mentorees" are then given the assignment to keep in touch with each other throughout the coming year. This is an easy way to build up contacts, bounce off ideas, and to learn about other careers.

in common: adaptability. We are invigorated by the successes of our colleagues. 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 "how it still is" but also in what we can accomplish.

To keep the energy going throughout the year, we divide the group into "more experienced" individuals (i.e., greater than five years in your career) and "less experienced" (i.e., less than five years). One person from each group is paired with one from the other group. Those mentors and "mentorees" are then given the assignment to keep in touch with each other throughout the coming year. This is an easy way to build up contacts, bounce off ideas, and to learn about other careers. We also have a newsletter that, pre-pandemic, went out several times a year, or as often as we got stories. The content is a way to inform and to share. After the first newsletter went out, we had many requests from women not yet members of ASMR to be added to the circulation list. Please keep those stories coming!

There is no membership to Wild Women of Reclamation – just camaraderie and networking! There will be a light breakfast of coffee/tea/muffins, so just come on over to the Boise Center on Tuesday, June 6 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 that can make it. Feel free to bring a friend or new colleague.

Contacts: Michele Coleman | michele.m.coleman@gmail.com

Gwen Geidel | gwengeidel@gmail.com

Rachel Hohn | rachelhohn@gmail.com

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40TH ANNUAL MEETING

American Society of Reclamation Sciences

Boise Centre | 850 W Front Street

ASRS

ASRS 2023 Preliminary Conference Program
40 Years of Reclamation

The 40th Annual Meeting of the American Society of Reclamation Sciences (ASRS) will be held at the Boise Centre in downtown Boise, Idaho from June 4 - 7, 2023. This conference will focus on the research, technical, and regulatory issues associated with the land and water reclamation across the U.S. and abroad, with focused sessions on the projects and successes across Idaho. It will provide a forum for the dissemination of information through presentation of research findings, case studies, field tours, and open discussion of public policy relating to the applied science of reclamation, rehabilitation, remediation, and restoration. Focus will be on areas disturbed by mining, oil and gas, conventional and alternative energy production, contaminated sites, agriculture, railroad/road construction, large-scale commercial development, and other disturbances to land and water resources.

2023 Schedule Snapshot

<table>
<tr><th colspan="2">SUNDAY
6/4/23</th><th>MONDAY
6/5/23</th><th>TUESDAY
6/6/23</th><th>WEDNESDAY
6/7/23</th></tr>
<tr><td rowspan="4">Registration
Exhibitor Setup

9:00 am – 5:00 pm

SW Foyer</td><td>ASRS Office/HQ
Room 440</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></tr>
<tr><td>Breakfast on own</td><td>Breakfast on own</td><td>Wild Women of Reclamation
7:00 – 8:15 am
Room 430</td><td>Breakfast on own</td></tr>
<tr><td>DeLamar Mine
Field Tour

9:00 am – 4:00 pm

Hosted By:
Integra Resources</td><td>Opening Plenary
9:00 am – 12:00 pm
Room 400</td><td>Technical Sessions
8:30 am – 12:00 pm
Rooms 410 A/B/C</td><td>Technical Sessions
8:30 am – 12:00 pm
Rooms 410 A/B/C</td></tr>
<tr><td>Lunch on own</td><td>Awards Lunch and ASRS
Business Meeting
12:00 – 2:00 pm
Room 400</td><td>Lunch on own</td><td>Lunch/Student Awards
12:00 – 2:00 pm
Room 400</td></tr>
<tr><td colspan="2">NEC Meeting
4:00 – 6:00 pm
Room 430</td><td>Technical Sessions
2:30 – 5:30 pm
Rooms 410A/B/C</td><td>Technical Sessions
2:30 – 5:30 pm
Rooms 410A/B/C</td><td>Technical Sessions
2:30 – 3:30 pm
Rooms 410A/B/C</td></tr>
<tr><td colspan="2">Welcome Exhibitor/Sponsor
Reception
6:00 – 8:00 pm
Room 420</td><td>Dinner/Social Event
6:00 – 8:00 pm
Beside Bardenay</td><td>ECP/Student Social and
Poster Session
6:00 – 7:30 pm
Room 420</td><td>NEC Meeting
4:00 – 6:00 pm
Room 430</td></tr>
</table>

Boise Centre East Convention Centre – 4th Floor

Meeting Financial Sponsors / Exhibitors (So Far – More Room!)

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2023 Conference Planning Committee

Dustin Wasley, ASRS Annual Meeting Chair, Haley & Aldrich

- John Haney, Haley & Aldrich
- Kevin Houck, Haley & Aldrich
- Jason Poulsen, Haley & Aldrich
- Nick Tucci, Haley & Aldrich
- Jo Combo, Haley & Aldrich
- Todd Glindeman, Brown and Caldwell
- Doug Stiles, Hecla Mining
- Ben Davenport, Idaho Mining Association
- Tricia LaRue, Integra Resources
- Rob Mullener, Integra Resources
- Rio Franzman, KC Harvey
- Kennet Bertelsen, Morrison-Maierle
- Devin Clary, Montana Rail Link
- Chris Norman, Pace Analytical
- Dale Kerner, Perpetua Resources
- Hayley Rambur, Perpetua Resources
- Rachel Roskelley, JR Simplot
- Rob Orr, Teck Resources

On behalf of the ASRS Boise 2023 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 Boise for their continued support of our Society.

Professional Field Tour Information

Sunday, June 4 – DeLamar Mine Field Tour (Hosted By Integra Resources)

8:00 a.m. - 4:30 p.m.

7:45 a.m. **Assemble in The Grove parking lot for 8:00 am prompt departure.**

8:00 a.m. **Board bus and depart for the DeLamar Mine roughly 115 miles south southwest of Boise.**

10:15 a.m. **Arrive at Stop 1 - Water Treatment Plant, Historic Tailings Facility and DeLamar Pit.**

11:15 a.m. **Depart Stop 1 for Stop 2.**

11:30 a.m. **Arrive at Stop 2 - Overlook of Sullivan Gulch Waste Rock Dump #1 and Sullivan Gulch Water Treatment Facility.**

12:15 p.m. **Lunch (Box lunch and water provided).**

12:45 p.m. **Depart Stop 2 for Stop 3.**

1:00 p.m. **Arrive Stop 3 - Historic Florida Mountain Pit and Exploration Drilling Historic Disturbance Overlook.**

2:00 p.m. **Depart for Boise.**

4:30 p.m. **Arrive in Boise.**

Agenda for Sunday, June 4, 2023

All Day	**ASRS Office/Headquarters – Room 440**
9:00 a.m. - 5:00 p.m.	**Exhibitor Setup – Exhibit Hall Room 400**
9:00 a.m. - 5:00 p.m.	**Registration – SW Foyer**
9:00 a.m. - 4:00 p.m.	**Integra DeLamar Mine Tour**
4:00 p.m. - 6:00 p.m.	**NEC Meeting – Room 430**
6:00 p.m. - 8:00 p.m.	**“Ice Breaker” Welcome Reception – Room 420**

Agenda for Monday, June 5, 2023

6:30 a.m. - 7:30 a.m.	**Haulin’ ASRS – Meet at Grove Hotel Lobby**
	The ASRS Running group meets every morning.
7:30 a.m. - 5:00 p.m.	**Registration – SW Foyer**
9:00 a.m. - 5:30 p.m.	**Exhibitor Displays – Exhibit Hall Room 400**
9:00 a.m. - 12:00 p.m.	**Plenary Session / Keynote Speakers – Room 400**
	Dustin Wasley – Conference Chair – Welcome
	Michele Coleman – ASRS President – President’s Welcome
	Brad Little – Idaho Governor (Tentative)
	Ben Davenport – Executive Director, Idaho Mining Association – Mining Across Idaho
	Dan Silver – CDA Trust, An Idaho Reclamation Success Story
12:00 p.m. - 2:00 p.m.	**Awards Luncheon (Catered)/ ASRS Annual Business Meeting – Exhibit Hall Room 400**
2:00 p.m. - 5:30 p.m.	**Technical Sessions – Rooms 410 A/B/C**
6:00 p.m. - 8:00 p.m.	**Social Dinner at Beside Bardenay**

Join us for a catered appetizers and drinks at Beside Bardenay at 600 West Grove Street. Set in the heart of Boise’s famous Basque Block, Beside Bardenay is in walking distance from the Boise Centre and downtown’s vibrant nightlife.

Agenda for Tuesday, June 6, 2023

6:30 a.m. - 7:30 a.m.	**Haulin' ASRS – Meet in Grove Hotel Lobby**
7:00 a.m. - 8:15 a.m.	**Wild Women of Reclamation – Room 430** Every woman is welcome. Previous topics: Choosing your own path, mentoring, starting a business, and juggling a career with family and community obligations. Coffee, tea, and pastries will be provided.
7:30 a.m. - 5:00 p.m.	**Registration – SW Foyer**
9:00 a.m. - 5:30 p.m.	**Exhibitor Displays – Exhibit Hall Room 400**
8:30 a.m. - 12:00 p.m.	**Technical Sessions – Rooms 410 A/B/C**
12:00 p.m. - 2:00 p.m.	**Lunch on your own**
2:30 p.m. - 5:30 p.m.	**Technical Sessions – Rooms 410 A/B/C**
6:00 p.m. - 7:30 p.m.	**ECP/Student Social and Poster Presentations Session – Room 420**

6:00 p.m. - 7:30 p.m.
Early Career Professional/Student Event
Room 420

This event will bring together Early Career Professionals/Students and experienced professionals for valuable mentorship. The event will include food, beverages, and fun ways for Early Career Professionals/Students and mentors to interact.

Agenda for Wednesday, June 7, 2023

6:30 a.m. - 7:30 a.m.	**Haulin' ASRS - Meet in Grove Hotel Lobby**
7:30 a.m. - 5:00 p.m.	**Registration – SW Foyer**
9:00 a.m. - 5:30 p.m.	**Exhibitor Displays – Exhibit Hall Room 400**
8:30 a.m. - 12:00 p.m.	**Technical Sessions – Rooms 410 A/B/C**
12:00 p.m. - 2:00 p.m.	**Lunch/Student Awards (Catered) and Guest Speaker – Exhibit Hall Room 400**
2:30 p.m. - 3:30 p.m.	**Technical Sessions – Rooms 410 A/B/C**
4:00 p.m. - 6:00 p.m.	**NEC Meeting – Room 430**

Technical Sessions – Monday, June 5, 2023

Time	BIOCHAR AND AML RECLAMATION SESSION 1A Room 410A Moderator – Debbie Page-Dumroese	WATERSHED AML AND AMD/ARD SESSION 1B Room 410B Moderator – TBD	WATER TREATMENT SESSION 1C Room 410C Moderator – Kennet Bertelsen
2:00 p.m. - 2:30 p.m.	Opportunities for Biochar to Remediate Forest Soils at Abandoned Mine Lands **By Derek Pierson**	Beyond reclamation and remediation, next steps in a recovered watershed **By Amy Mackey**	Tioga River Restoration: A Tale of Active Mine Drainage Treatment and Consumptive Use Mitigation **By Thomas Clark**
2:30 p.m. - 3:00 p.m.	Limiting Factors to Restore Abandoned Mine Lands with Biochar **By Carlos Rodriquez-Franco**	Watershed-Based Strategy for Treating ARD/AMD **By P. Ziemkiewicz**	Treatment of Coal Mine Drainage with Hybrid Vertical Flow Ponds in the Midwest **By Paul Behum**
3:00 p.m. - 3:30 p.m.	Using Organic Amendments to Restore Abandoned Mine Lands in Northeastern Oregon **By Debbie Page-Dumroese**	The Role of Retention Basins in Alleviating Post-Mining Streams TDS Levels **By Amir Hass**	Genomics Application for Optimization of Constructed Wetland Treatment Systems for Oil Sands Process Water **By Kaitlyn Trepanier**
3:30 P.M. - 4:00 p.m. – BREAK – EXHIBIT HALL			
Time	**BIOCHAR AND AML RECLAMATION (CONT) SESSION 2A Room 410A Moderator – Debbie Page-Dumroese**	**WETLAND RESTORATION / WATER MANAGEMENT SESSION 2B Room 410B Moderator – Allen Wellborn**	**SAGEBRUSH/SAGE GROUSE DISCUSSIONS SESSION 2C Room 410C Moderator – TBD**
4:00 p.m. - 4:30 p.m.	Hydraulic Mines and Process-Based Restoration: Pilot Project at Grizzly Creek Diggins, Sierra County, CA **By Nick Graham**	Early Water Quality changes from stream and Wetland Restoration in Former Agriculture Land **By Sebastian Teas**	Wyoming Sage Grouse Discussion **By Josh Oakleaf**
4:30 p.m. - 5:00 p.m.	Influence of Native Fungi Inoculation and Co-Application of Biochar/Biosolids of tailings **By M. Al-Lami**	Native Wetland Restoration Projects in the Tongue River Valley of the Powder River Basin **By Allen Wellborn**	The Effects of Root Enhancement Seed Technologies and Timing of Seeding on Wyoming Big Sagebrush Establishment **By Michaela Owens**
5:00 p.m. - 5:30 p.m.	Water Technical Division Meeting	Observe, Orient, Decide, Act: Using the OODA Loop in Long-Term Water Management During Mine Closure and Reclamation **By T. Hughes**	Technology Technical Division Meeting
6:00 p.m. - 8:00 p.m. - Social Event at Beside Bardenay			

Technical Sessions – Tuesday, June 6, 2023 (morning)

Time	THE IMPORTANCE OF GEOCHEMISTRY SESSION 3A Room 410A Moderator – Nick Tucci	CLIMATE, MICROBS, AND CARBON DIOXIDE SESSION 3B Room 410B Moderator – TBD	PLANTS, PHYTOREMEDIATION, AND REVEGETATION SESSION 3C Room 410C Moderator – TBD
8:30 a.m. - 9:00 a.m.	Anthropogenic Versus Geogenic Source Determination of Heavy Metals in Residential Soils **By Jenna Adams**	Carbon Dioxide Mine Gas Investigation and Remediation **By Omar Beckford**	Australian Native Plants Phytoremediation **By Farida Abubakari**
9:00 a.m. - 9:30 a.m.	Geochemical Fingerprinting of Legacy Mining Activities at the Historic Jordan Creek Mining District **By Nick Tucci, Rob Mullener**	Microbes In Mine Reclamation: Bioecology, Biofertilizers, Bioeconomy **By Andrew Harley**	Revegetation on the Flat Creek Iron Mountain Mine Superfund Site **By Damon Sump**
9:30 a.m. - 10:00 a.m.	Engineering and Construction Technical Division Meeting	Innovations And Advancements to Enhanced Weathering **By A. Adesipo**	Progress Toward Restoring Native Vegetation in Northwest Montana and Central Wyoming **By Mark Gentry, Taylor Cross**
10:00 - 10:30 a.m. – BREAK – EXHIBIT HALL			
Time	**RECLAMATION ACROSS IDAHO – SILVER VALLEY SESSION 4A Room 410A Moderator – Tony Wesche**	**MAMMAL AND INSECT IMPACTS FROM RECLAMATION SESSION 4B Room 410B Moderator – TBD**	**GIS/MAPPING/DATA SESSION 4C Room 410C Moderator – TBD**
10:30 a.m. - 11:00 a.m.	Bunker Hill Complex, Ninemile Basin Remediation Progress Update **By Tony Wesche**	Risks of Biointrusion: Small Mammal and Insect Implications on Isolated Waste Cover Systems **By M. Barney**	Missouri's Land Reclamation Information System (LRIS) Success **By Bill Zeaman**
11:00 a.m. - 11:30 a.m.	Remedial Action Effectiveness at the Bunker Hill Superfund Site **By Christina Johnson**	Ecological Restoration for Insect Conservation within Natural Gas Fields **By Mike Curran**	Abandoned Mine Site Characterization using Electronic Field Tools **By Nick Anton**
11:30 a.m. - 12:00 p.m.	Ninemile Waste Consolidation Area **By Cody Lechleitner**	Concurrent Vegetation and Wildlife Mapping Assists Reclaimed Desired Plant Community Planning **By P. Hunter**	Listening to the Noise: What's in your Data Besides Data? **By Paul Krogstad**
12:00 - 2:00 p.m. - LUNCH ON OWN			

Technical Sessions – Tuesday, June 6, 2023 (afternoon)

Time	RECLAMATION ACROSS IDAHO – HISTORIC DISTRICTS SESSION 5A Room 410A Moderator – Dale Kerner	ARD/AMD DISCUSSIONS SESSION 5B Room 410B Moderator – Kennet Bertelsen	WYOMING AML SEEDING CERTIFICATION CLASS SESSION 5C Room 430
2:00 p.m. - 2:30 p.m.	Perpetua Stibnite Project Presentation **By Dale Kerner**	Efficacy of activated MgO on the treatment of AMD: A comparative study **By Matome Lucky Mothetha**	
2:30 p.m. - 3:00 p.m.	Integra Project Presentation **By Rob Mullener**	A hybrid and stepwise approach using a series of planted constructed wetland for the treatment of AMD **By Beauclair Nguegang**	
3:00 p.m. - 3:30 p.m.	Vegetation Technical Division Meeting	Management of acid producing materials for the Route 220 Project in Virginia **By Lee Daniels**	
3:30 - 4:00 p.m. – Break – EXHIBIT HALL			
Time	**PASSIVE TREATMENT** **SESSION 6A** **Room 410A** **Moderator –** **TBD**	**TAR CREEK SUPERFUND SITE DISCUSSION** **SESSION 6B** **Room 410B** **Moderator –** **TBD**	**WYOMING AML SEEDING CERTIFICATION CLASS (Continued)** **SESSION 6C** **Room 430**
4:00 p.m. - 4:30 p.m.	Passive Treatment Systems on Life Support – Pulling the Plug & Rebuilding **By Buck Neely**	Superfund Case Study, Tar Creek, Quapaw, OK **By Summer King**	
4:30 p.m. - 5:00 p.m.	Passive Treatment System Monitoring Utilizing Solar Powered Telemetry, A Case Study **By Dan Guy**	Nature-Based Solutions Linking Reclamation to Remediation and Restoration on Derelict Mining Sites **By Robert Narin**	
5:00 p.m. - 5:30 p.m.	Sulfate Reduction in Bench and Pilot-Scale Passive Treatment Systems **By Guadalupe Fattore**	Effect of Water Chemistry and Time on the Sustainable Reuse of Recovered Iron Oxides as Phosphate Sorbents **By Dayton Dorman**	
5:30 - 7:30 p.m. – Student – Early Career Professional / Poster Session – Room 420			

Poster Session and Networking Event– Tuesday, June 6, 2023

5:30- 7:30 p.m. – Room 420

1	Assessing Indicators of Ecosystem Recovery on Reclaimed Minesites in Eastern Hardwood Forests **By: I. Kennedy, J. Franklin, D. Buckley, and K. Sena**
2	Combined Stream and Wetland Restoration on Agricultural Ground: Bloody Run, Ohio **By: E. Pokuah, N. Kruse Daniels, K. Ositimehin, and Z. Rundell**
3	Do Beaver Dam Analogs (BDAs) Reproduce the Biodiversity and Water Filtration Ecosystem Services Provided By Beavers? **By: A. Baldwin, C. Larson, and M. Murphy**
4	Engineering with Nature to Develop Socially Sustainable Nature-Based Solutions: Natural Infrastructure to Address Complex Environmental Challenges **By: H.N. Seago, R.W. Nairn, D.M. Dorman, J.I. McCann, C.M. Morgan, L.H. Olson, O.C. Overton, A.M. Meek, J.M. Queen, S.A Dahle, S.N. Taylor, A.E. Richardson, N.L. Shepherd, and R.C. Knox**
5	Evaluating Technologies for Mining-Influenced Water (MIW) Treatment: Information and Data Needs **By: B.A. Butler and M.K. Mahoney**
6	Evaluation of the Use of Manure-Based Biochar for Zinc Retention at the Tar Creek Superfund Site **By: J.I. McCann, R.W. Nairn, and S. King**
7	Hydrology and Biogeochemistry of Legacy Sediment Riparian Ecosystems **By: C. Morgan and R.W. Nairn**
8	Impact of Riverbank Lupine (*Lupinus rivularis*) on Grand Fir (*Abies grandis*) Ectomycorrhizal Symbioses **By: A.B. Labay, R.A. Bunn, K.L. Poppe, and J.M. Bauman**
9	New Tools for Making Science-Based Decisions for Oil and Gas Reclamation **By: R. Mann, R. Lupardus, and M. Duniway**
10	Physical Classification of Iron Oxyhydroxide Treatment Residuals for Reuse in Stormwater Treatment **By: S.N. Taylor and R.W. Nairn**
11	Restoring Riparian Forests Using Assisted Migration as a Climate Change Adaption Strategy **By: C.A. Harris, A.P. Lawrence, and J.M. Bauman**
	* Denotes Student

Technical Sessions – Wednesday, June 7, 2023 (morning)

Time	REVEGETATION AND REFORESTATION SESSION 7A Room 410A Moderator – TBD	STREAM/FLOODPLAIN RESTORATION SESSION 7B Room 410B Moderator – Jason Poulsen	URBAN RECLAMATION SESSION 7C Room 410C Moderator – Kenton Sena
8:30 a.m. - 9:00 a.m.	Screening Native Species for Tolerance to Pb/Zn/Cu Tailings and Using Image-Based Analysis as a New Assessment Approach **By M. Al-Lami**	Rio Fish Passage, Stibnite – **By Jeff F.**	Reclaiming the WVU Farm Woodlot for Economic Development **By Jeff Skousen**
9:00 a.m. - 9:30 a.m.	Competitive Interactions Of American Chestnut During Mine Reclamation **By J. Bauman**	Floodplain Reconnection Stream Restoration Increases Water and Nutrient Retention **By Natalie Kruse-Daniels**	Urban Reforestation As Reclamation: Exploring Opportunities For Reclamation In An Urban Context **By Kenton Sena**
9:30 a.m. - 10:00 a.m.	Open	Gills Creek, Columbia, Sc, Reclamation Enhancement Project Following 1000-Year Flood Event Impacts **By Gwen Geidel**	Making The Case For Urban Stream Restoration And Urban Stream Channel Management **By Natalie Kruse-Daniels**
10:00 - 10:30 a.m. – Break – Exhibit Hall			
Time	**COVER SYSTEMS AND LANDFORM RECLAMATION SESSION 8A Room 410A Moderator – Kevin Houck**	**SEEDING AND REVEGETATION SESSION 8B Room 410B Moderator – Seth Cude**	**RENEWABLES AND RECLAMATION SESSION 8C Room 410C Moderator – TBD**
10:30 a.m.- 11:00 a.m.	Landform Design in Mine Reclamation: Is this the Future? **By Peter Werner**	Mulching and Soil Depressions for Revegetation of Oil and Gas Wells in Arid Ecosystems **By R. Mann**	Soil/Site Disturbance and Challenges for Utility Scale Solar facilities in Virginia **By Lee Daniels**
11:00 a.m.- 11:30 a.m.	Innovative Cover Methods/Approaches in the Phosphate Patch **By Chris Guedes**	Seed Mix Design and Implementation – A Practitioner's Guide for Successful Reclamation **By Seth Cude**	Native grassland revegetation on a utility scale solar development in South Texas **By Micayla Pearson**
11:30 a.m.- 12:00 p.m.	Wildlife Technical Division Meeting	Loblolly Pine Survival and Growth on a Mineral Sands Mine **By Sara Klopf**	Application of Geomatics for Assessment of Reclamation of a Large Mechanized Open Pit Mine: A Case Study **By Pradeep Kumar**
12:00-2:00 p.m. - Lunch and Student Presentation Awards and Guest Speaker – Room 400			

Technical Sessions – Wednesday, June 7, 2023 (afternoon)

Time	TEACHING AND LEARNING IN RECLAMATION SESSION 9A Room 410A Moderator – Kenton Sena	REVEGETATION MONITORING AND REPORTING SESSION 9B Room 410B Moderator – Mike Curran	MERCURY IN THE ENVIRONMENT SESSION 9C Room 410C Moderator – Steve Dent
2:00 p.m. - 2:30 p.m.	Engineering the Nature of Change: A Presidential Dream Course on Nature-Based Solutions **By Robert Narin**	A Practitioners Perspective: Integrated AML Reclamation Monitoring Program **By J. Schroeder**	Mercury Contamination in Peru: Community Engagement to Assessment and Remediation **By Bryn Thoms**
2:30 p.m. - 3:00 p.m.	Campus as a Reclamation Classroom: A Case Study in Urban Reclamation from Lexington **By Kenton Sena**	Monitoring Strategies for Reclamation Programs Involving Multiple Sites **By Mike Curran**	Assessing health risks at a Soviet-era mercury mine: validation of XRF for humanitarian intervention in Kyrgyz Republic **By S.L. Spearman**
3:00 p.m. - 3:30 p.m.	Appalachian STEM Enrichment Academy Online and In Person K-12 Curriculum **By Jen Bowman**	Reclamation Monitoring and Management: Metrics, Key Performance Indicators, and Dashboards for Projects Across their Life Spans **By Mike Curran**	Remediation of Calcines and Site Closure of a Remote Mercury Mine **By Gregory Reller**
NEC WRAP UP MEETING 4:00 – 5:00 p.m. Room 430			

Switchgrass and miscanthus as bioenergy crops on reclaimed surface mines

BY JEFF SKOUSEN, WEST VIRGINIA UNIVERSITY

Biomass crops can provide feedstock for co-firing in power plants and conversion to transportation fuels. These bio-feedstocks should be grown on marginal lands rather than prime agricultural land, and Appalachia provides an abundance of reclaimed mine lands that could be used to produce bioenergy crops.

Introduction

Climate change awareness has prompted research into alternative energy sources. In 2008, the USA Congress passed the Renewable Fuel Standard which mandates targets for producing alternative transportation fuels using bioenergy crops to lessen our dependence on oil and other fossil fuels. Moreover, expansion of bioenergy crop growth would stimulate rural/agricultural economies, reduce the need for food crops for biofuel, provide "green jobs," and reduce climate change by CO_2 plant uptake. While fossil fuels and renewables like solar and wind will continue to serve the world's energy needs, biomass will help in a carbon-constrained environment by producing energy from sunlight and atmospheric carbon dioxide while sequestering additional carbon belowground and improving soil quality.

The Appalachian Region of the USA has hundreds of thousands of acres of marginally productive, reclaimed coal mined lands. While these areas were successfully reclaimed to the standards of the day, the existing cover of cool-season grasses and legumes does not realize the productive potential for sustainable energy production. Mined lands offer a unique opportunity for bioenergy crop development because many of these lands are currently unmanaged and can sequester large amounts of carbon in their mine soils. The use of reclaimed mined lands provides the land base that could promote an energy-based economy utilizing agricultural products.

Most ethanol currently produced for fuel in the USA is made from corn grain. Rather than using corn or other food crops that require prime agricultural lands and high inputs, bioenergy crops can be grown on reclaimed lands in Appalachia because large contiguous reclaimed areas exist, the climate is suitable, they don't require annual fertilizer inputs, and the crops can be transported to a large portion of the USA energy market.

Switchgrass

Switchgrass was designated in the late 1980s as a "model" bioenergy crop because of its biomass production capacity in many different soil types and climates. It is a warm-season bunchgrass species, but it has short rhizomes that allow it to form a sod over time and can grow up to six feet in height. Its ability to grow without fertilizers and pesticides means it requires lower inputs than other bioenergy feedstocks and it can be harvested using standard agricultural hay equipment. The other advantages of switchgrass, and other warm-season (C4) plants in general, are that they can grow at higher temperatures, use less water, and translocate nutrients in their leaves back to the roots upon dormancy, thereby conserving nutrients in soils. Relocating nutrients into the soil helps to maintain switchgrass stands for 15 to 20 years with few or no fertilizer inputs. Numerous cultivars are available for seed purchase, which allows the buyer to select the cultivated variety of switchgrass most suited to the region being planted.

In agricultural settings, most switchgrass varieties achieve dry matter (DM) yields of three tons per acre by the second season of growth. Switchgrass requires at least three years to establish a complete vigorous stand. By the fifth year, switchgrass can achieve five to seven DM tons per acre. Yields can be higher in humid climates of Appalachia. Ethanol production averages 80 gallons per ton of material (Table 1).

Growing switchgrass on reclaimed surface mines in Appalachia could potentially be an alternative to growing bio-feedstocks on agricultural lands. Surface mining for coal is estimated to affect approximately 12 million acres of land in West Virginia, Pennsylvania, Kentucky, and a few counties in Virginia, Tennessee, and Ohio. Only during the last 10 years have studies been conducted on switchgrass growth on mined lands and preliminary studies on mined lands have shown switchgrass yields ranging from two tons per acre on poor sites (those without much of a soil resource) to as high as seven tons per acre on sites with 12 inches of topsoil.

Miscanthus

A similar opportunity exists for miscanthus, another very productive

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- Load/Haul/Dump
- Slope Reduction
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- Armoring
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bioenergy crop. Miscanthus is a genus comprised of about 15 species and is a warm-season perennial grass native to Asia and Africa. Some species were originally used for forage and thatching, but also as ornamental plants with aesthetic value. Giant Miscanthus *(Miscanthus x giganteus)* is the most common miscanthus species for biomass production. It is a sterile hybrid between *M. sinensis* and *M. sacchariflorus*. Plants grow from rhizomes, can reach heights of 10 feet, and stands have a useful life of 15 to 20 years. Giant Miscanthus is best suited for areas with at least 35 inches of rainfall per year, with better results as rainfall increases.

In agricultural soils, miscanthus DM yields ranged from four to 15 tons per acre at 16 locations throughout 10 European countries and yields in Appalachia are similar at seven to 10 tons per acre and ethanol production is about 80 gallons per ton. To sustain low maintenance costs, harvesting should be done after frost to allow nutrients to return to the soil, thereby minimizing fertilizer inputs. Pesticides are not normally needed for insect pests nor are herbicides necessary to control competition from weeds if fallen leaf material is left to provide a mulch layer that helps suppress weeds. The fallen leaf material also recycles nutrients and returns organic matter to the soil for carbon sequestration. Few studies have been conducted with miscanthus on reclaimed mined lands. This article describes biomass production on three reclaimed lands in West Virginia and Ohio.

Sites of Switchgrass and Miscanthus Trials

The **Hampshire** site was surface mined for coal and reclaimed in 1998 with 12 inches of topsoil placed over re-graded overburden (Table 2). In 1998, 2003, and 2008, lime-treated sludge from a nearby wastewater treatment plant was applied at a rate of 100 dry tons per acre.

Table 1. Typical biomass production and potential ethanol production for different bioenergy systems in farmland agricultural operations in Appalachia.

Feedstock	Harvestable Biomass[a] (Tons DM per acre)	Biomass to Ethanol Conversion (Gallons per ton)	Ethanol (Gallons per acre)
Corn grain	4.1b	90	369
Corn stover	2.5	80	200
Corn grain+stover	6.6	85	569
Switchgrass	5.0	80	400
Miscanthus	7.5	80	600

[a]Based on DM yield in Appalachia (corn grain biomass is based on 120 bushels of corn per acre).
[b]Assuming 1 ton of corn grain is equivalent to 29 bushels.

In 2010, the existing thick vegetation of cool-season grasses (tall fescue and orchard grass primarily) was killed with glyphosate herbicide (Roundup®) prior to seeding. Cave-in-Rock switchgrass was broadcast seeded into three one-acre plots at a rate of 11 pounds per acre. Biomass sampling was done by clipping at a height of four inches at the end of the growing season after dormancy (October) each year. Yield (DM) was determined after oven drying the biomass at 60°C and weighing.

The **Alton** site was reclaimed in 1985, had six inches of topsoil replaced (Table 2), and was revegetated with cool-season grass and legume species (ryegrass, orchard grass, tall fescue, white clover and birdsfoot trefoil). During the ensuing 25-year period, this unmanaged herbaceous ground cover produced roots and organic material that enriched the soil with plant nutrients. A test area of about 30 acres was selected and sprayed with glyphosate herbicide at recommended rates the previous fall and again in the spring before planting. Switchgrass (variety Kanlow) and miscanthus (private variety) were planted in separate 1-acre plots five times. Before seeding or rhizome planting, soil temperatures were greater than 60 degrees F, which generally occurs in the latter part of May and early June in northern Appalachia. Switchgrass was drilled into the killed sod with an agricultural sod-seeding drill at the rate of eight pounds per acre. Miscanthus sprigs were planted at a rate of 5,000 plugs per acre (roughly three-foot spacing). No fertilizer or amendments were applied at planting nor during the ensuing 10 years. Biomass yields were calculated from clippings as described above.

The **Wilds** is a conservation and research center located on nearly 10,000 acres of reclaimed surface-mined land in eastern Ohio. The Wilds is composed of a wildlife preserve, which imports animals from all over the world, including threatened and endangered species. It also is comprised of reclamation plantings including hardwood trees and native grass prairies, including grasses for bioenergy production. A 25-acre area, reclaimed in 1982, was selected for biomass plantings (Table 2). Soils were composed of overburden material with no topsoil, but the reclaimed soils had established organic matter pools and nutrient cycles due to additions of organic matter from vegetation over 30 years. The existing vegetation was killed with glyphosate herbicide at recommended rates and switchgrass (variety Cave-in-Rock) was drilled into the killed sod in June at a rate of eight pounds per acre.

Table 2. Site characteristics for the three reclaimed mine land sites where switchgrass and miscanthus were planted as bioenergy crops.

Site	Location	Year Reclaimed	Year Planted	Species	Site Preparation
Hampshire	Hampshire Co., WV	998	2008	Cave-in-Rock Switchgrass	12 in. Topsoil Herbicide Biosolids
Alton	Upshur Co., WV	1985	2010	Kanlow Switchgrass Miscanthus	6 in. Topsoil Herbicide
The Wilds	Muskingum Co., OH	1982	2013	Cave-in-Rock Switchgrass Miscanthus	No Topsoil Herbicide

Miscanthus rhizomes (obtained from Alloterra) were planted on three-foot centers. Aboveground biomass was taken as described above in October, dried, and weighed for DM yields.

Biomass Results on Reclaimed Land

Hampshire

Switchgrass growth was tremendous on this site due to the high fertility from applied wastewater treatment biosolids. After the third year, a complete and heavy stand of switchgrass was attained that amounted to 4.1 tons per acre (Table 3), much higher than the production that would normally occur on agricultural sites with little or no fertilization after three years. After the fifth year, the biomass was so thick that it was difficult to traverse, and the production was greater than eight tons per acre (Figure 1). Yields were slightly lower at about six tons per acre after the eighth year and by the 10th year yields had stabilized at about seven tons per acre.

Alton

Switchgrass and miscanthus stands were well established by the end of the second growing season, increasing to a consistent stand by the third growing season. Switchgrass averaged 2.2 tons per acre after the third year and increased to almost four times that by the 10th year (Table 3), clearly good growth and productivity on surface mines in this area (Figure 2).

Miscanthus DM yields were nearly five tons per acre after the third year and increased to more than 16 tons per acre by the 10th year (Figure 3). This yield of 16.6 tons per acre is more than double the 7.5 tons per acre on good agricultural soils in Table 1. These high yields show that marginal lands, like these reclaimed surface mined lands, can attain large quantities of biomass for bioenergy.

The Wilds

Switchgrass was similar in DM yields as the Alton site at around two tons per acre (without fertilization) the third year and by the fifth year achieved about four tons per acre (Table 3). Miscanthus growth at The Wilds was astonishing by the eighth year at more than 13 feet high and producing 19 tons per acre (Figure 4). Such productivity made walking through the towering thick biomass growth difficult.

Scaling Up to a Bioenergy Economy

Over the past 15 years, we've clearly demonstrated on a variety of reclaimed mine sites in Appalachia that switchgrass and miscanthus bioenergy crops can attain biomass production numbers from five to 10 tons per acre. Miscanthus generally produces 50 to 100 percent more biomass than switchgrass and in shorter time frames, but extra costs are required to

Figure 1. Cave-in-Rock switchgrass growing at the Hampshire site that had been amended with biosolids at heavy rates. After the third year, about 4 tons per acre of biomass was produced (left) and after the fifth year biomass production was more than 8 tons per acre (right).

Figure 2. Growth of Kanlow switchgrass after the third growing season (left) and after the 10th year (right) at Alton, WV. Yields averaged 2.2 tons per acre (third year) to 7.9 tons per acre (10th year).

Figure 3. Biomass production of miscanthus after the third growing season (4.9 tons per acre) and after the 10th year (16.6 tons per acre) at Alton, WV.

establish miscanthus by purchasing and manually planting the rhizomes. Both crops appear to maintain their biomass production without additional inputs up to 10 years after establishment, but production on reclaimed lands has not been determined past 10 years. In addition, studies have shown that theoretical ethanol production from these two crops is similar at about 80 gallons per ton of material (Table 1).

Several companies and investment groups are looking to capitalize on the opportunities afforded by climate change strategies to increase renewable energy sources such as bioenergy crops. Oil companies are primed to invest in green energy programs including ethanol for transportation fuels, C sequestration credits and offsets, and biomass for co-firing power plants, pellets for household fuels, and agricultural feed and bedding.

Certain questions are still unanswered concerning the scalability of bioenergy crop systems on reclaimed lands. For scaling models, some investors estimate that a profitable bioenergy venture tied to appropriate and maintainable markets would require between 20,000 and 50,000 acres of reclaimed land and entail harvestable production values of five tons per acre for switchgrass and eight tons per acre for miscanthus. One company is considering a ratio of 60 percent of the acres to miscanthus and 40 percent to switchgrass to limit reliance and liability on only one crop. This scale of land and biomass production is calculated to adequately supply the demands of a developing and moneymaking bioenergy market.

Obviously, sufficient acreages of reclaimed land exist in the Appalachian Region to support such a bioenergy agricultural economy, but not all reclaimed land is suitable due to constraints such as land slope (<10 percent) for planting/harvest equipment, existing vegetation

Table 3. Average DM yields for switchgrass and miscanthus at three reclaimed surface mines at various times after planting.

Site and Plant Species	Years after Seeding			
	3rd Year	5th Year	8th Year	10th Year
	---------- Tons per acre ----------			
Hampshire				
Switchgrass	4.1	8.5	5.9	6.8
Alton				
Switchgrass	2.2	5.2	5.3	7.9
Miscanthus	4.9	6.2	9.0	16.6
The Wilds				
Switchgrass	2.0	3.8	4.4	--[a]
Miscanthus	3.8	11.6	19.1	--[a]

[a]Insufficient time has passed.

complications (clearing and killing woody and invasive vegetation), and limits on mine soil quality and fertility and rock fragment contents on the surface.

Additional concerns are a critical mass of acreage to justify the costs of equipment mobilization and accessibility to transportation networks to haul biomass to central locations to convert biomass to biocrude or sustainable aviation fuels, or the availability of rail load-out for feedstock transport. Companies willing to undertake such a plan must have initial capital for establishing fields, a lag time of approximately three years for biomass crop production, landowners who are willing to lease long-term or sell large tracts of lands, biomass consolidators or processors who are willing and ready to market the biomass supply, infrastructure for harvesting and transportation, expected shifts and changes in the biomass supply chain, and the ability to seek and develop new value-added products from biomass.

Overcoming these hurdles will require broad thinking and flexibility, and a patient long-term commitment and vision to promote and finance such a large program. A minimum of 10 years is estimated to invest in the people, land, communities, and companies, which will determine whether the program can be sustainable and profitable.

Figure 4. Biomass production of switchgrass and miscanthus at The Wilds. After the eighth year, switchgrass biomass was 5.4 tons per acre (left), while miscanthus biomass was a whopping 19.1 tons per acre and was over 13 feet high (right).

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It comes home to you... Extending reclamation to our urban spaces

BY KENTON SENA, LEWIS HONORS COLLEGE, UNIVERSITY OF KENTUCKY

A patch of barren soil eroding prior to a student reclamation effort at University of Kentucky.

Ever since the American Society of Mining and Reclamation became the American Society of Reclamation Sciences, I've been thinking about the implications and opportunities of the name change for our vision as a society. We're about reclamation, but not just about reclaiming mines anymore... So, what else?

As an urban-dweller, I see degraded urban spaces on my daily bike commute, and I imagine possibilities for reclamation in an urban context. Urbanization feels less extreme than mining, but it can cause its own set of significant, persistent ecological issues. Urban soils can be highly compacted from construction and traffic; urban air, soil, and water can be polluted; and urban streams tend to be flashy and species-poor. Maybe these degraded urban sites could benefit from our experience in reclamation of other sorts of sites?

As a lecturer in the Lewis Honors College, my primary responsibility is teaching honors students at the University of Kentucky. And, as the only natural scientist on the faculty at present, I focus on developing interdisciplinary classes in the natural sciences (with an emphasis in ecology and the environment). When I first started in this role, I saw reclaimed mine sites as my best opportunity to teach students about the ecology of reclaimed spaces. But our nearest reclaimed mine sites were in eastern Kentucky – a solid two-hour drive one way from our Lexington campus. Over the past few years, I've increasingly situated our experiential learning spaces closer to home – starting with urban forest patches around Lexington. In the fall semester of 2022, I brought it even closer to home, by launching a class project to address a runoff and erosion problem on campus.





Students from Professor Sena's Restoration Ecology course at University of Kentucky work on reclaiming a portion of campus.

Our project site is just outside Lewis Hall, where my office is located and many of our classes are taught. This is a fairly central part of campus, so it gets good visibility (for good or ill!). Mature cherrybark oaks line both sides of the street along this stretch, in a landscape area between the sidewalk and the street – but the ground underneath is bare. No vegetation, no litter, just bare soil. On my daily bike commute, I began to notice signs of significant erosion, particularly after intense rain events. In some places, erosion channels had developed, shunting runoff from the sidewalk straight to the street. It seemed like a good site for reclamation!

In old site photos, it was clear that these sites were once vegetated with turfgrass and regularly mowed – so what prompted the loss of vegetation and rampant erosion? My suspicion is that construction of taller buildings closer to the sidewalk over the past decade increased ground-level shade in the site, making conditions less favorable for mostly sun-loving turfgrass and driving loss of vegetation over the past few years. Furthermore, alongside new construction, the sidewalks along this site were expanded, which I expect has significantly increased runoff generation. Taken together, I think the loss of vegetative cover and increased runoff caused the erosion.

I made this the class project for my Restoration Ecology class, a 100-level course in the Honors College taken primarily by non-science majors. This semester, I implemented a service-learning requirement in the course, and the class project counted toward required service hours. Working in teams, students collected data from the site: infiltration measurements using a double-ring infiltrometer, compaction measurements using a penetrometer, and soil chemistry data. Then, our partners at UK Grounds used a pneumatic tillage system to mitigate soil compaction in the site, we incorporated biochar (donated by Green Carbon Solutions—thank you!), and we planted shade-tolerant native sedges according to a plan developed by our partners at Campus Planning. All in all, between students in my class and additional volunteer participants, over 46 volunteers contributed over 100 service hours to plant over 2,000 sedges in our project site. Pending decent

All in all, between students in my class and additional volunteer participants, over 46 volunteers contributed over 100 service hours to plant over 2,000 sedges in our project site.

survival, I think that the combination of reduced compaction and planting of native shade-tolerant plants will improve infiltration and eliminate the runoff problem. With help from summer students and future classes, I'm going to monitor site conditions over the next several years – fingers crossed!

Which brings me back to the point: that for many of us, there may be a need for reclamation closer to home. In Tolkien's *The Lord of the Rings*, the hobbits come home to find a very different Shire than the one they left – their snug hobbit holes had been replaced with ugly brick buildings, their beloved urban trees had been cut down all over the Shire, Bilbo's old home was now the site of a quarry, and the new mill was pumping out air and water pollution. At the sight of the decapitated Party Tree and disemboweled hobbit holes that had once been his home, Sam sobs: "This is worse than Mordor! … Much worse in a way. It comes home to you, as they say; because it is home, and you remember it before it was all ruined." The desolation they had experienced in Mordor – a war-torn, post-industrialist wasteland – had beaten them home.

For some of us, too, it has come home to us – we find ourselves in a post-industrialist wasteland of our own making. It might be de-vegetated landscape strips dumping sediment into the storm sewer, invasive species extirpating native herbs from the understories of remnant urban forests, or permanently contaminated industrial sites like brownfields or superfund sites. What better places to apply our reclamation expertise than in our backyards, on our campuses, or on the other side of town? Like Sam, we can give ourselves to the work of reversing ecological degradation where we live, and, like Sam, we can hope for a fruitful summer.

Indigenous-led monitoring, Guardian programs, and opportunities for reclamation monitoring partnerships

BY ALEXANDRA DAVIES POST[1], RYAN GRANDJAMBE[2], JEAN L'HOMMECOURT[2], CHRISTINE A DALY[3], GILLIAN DONALD[4], BORI ARROBO[2], AND DAN MCCARTHY[1]

AFFILIATIONS: UNIVERSITY OF WATERLOO[1], FORT MCKAY FIRST NATION[2], UNIVERSITY OF CALGARY[3], DONALD FUNCTIONAL & APPLIED ECOLOGY INC.[4]

Introduction

The sustainability of a landscape and its interconnected community post-mining depends on effective reclamation monitoring programs and monitoring culturally relevant metrics of success. But who is the land being reclaimed for? Who should be involved in reclamation monitoring? And what opportunities exist for monitoring partnerships between affected Indigenous communities and mine operators? This article presents a summary of the current state of knowledge on Indigenous-led environmental monitoring in Canada, a case study overview of Fort McKay First Nation's Environmental Guardian Program, and opportunities for the inclusion of affected Indigenous communities in mine reclamation monitoring.

The physical and technical aspects of mine closure and reclamation are important, but mines around the world are increasingly anticipating the social demands upon mine closure and reclamation to support positive legacies of mining, including sustainable social, economic, and cultural closure outcomes. Consequently, reclamation and closure principles, best practice (ICMM 2019, 2020; MAC 2008, 2021; Maloney 2019), and human rights instruments are increasingly recognizing that local communities have a right to be a part of the decision-making processes that affect them. For instance, Indigenous Peoples' socio-cultural relationship to and dependence on their traditional territories and traditional land use practices are recognized internationally, through the United Nation Declaration of the Rights of Indigenous Peoples Act (UN 2007), Article 8(j) of the United Nation (UN) Convention on Biological Diversity (CBD) (UN 1992), and most recently through the COP15 and the Kunming-Montreal Global Biodiversity Framework (UNEP 2022). In Canada, Indigenous Peoples have constitutionally affirmed and legally protected rights to maintain their identity and participate where those rights may be infringed upon (Constitution Act s35 1982). Careful and effective mine closure and reclamation planning and monitoring that includes participatory and inclusive processes has the potential to support the renewal of cultural landscapes and to re-establish traditional land

INDIGENOUS GUARDIAN LEADERSHIP ON THE GLOBAL STAGE –

The United Nations Convention on Biological Diversity adopted the Kunming-Montreal Global Biodiversity Framework (GBF) and its associated 2030 biodiversity goals and targets at the United Nations Biodiversity Conference (COP15) in Montreal, Canada in December 2022 (UNEP 2022). Signed by almost 200 countries, including Canada, this landmark agreement includes recognizing and respecting the rights of Indigenous communities including over their traditional territories and tapping into their unique indigenous knowledge to protect nature. In fact, Indigenous Guardians were a focus of COP15 with funding announcements made jointly by Canada's federal government and a first of its kind National First Nation Guardian Network.

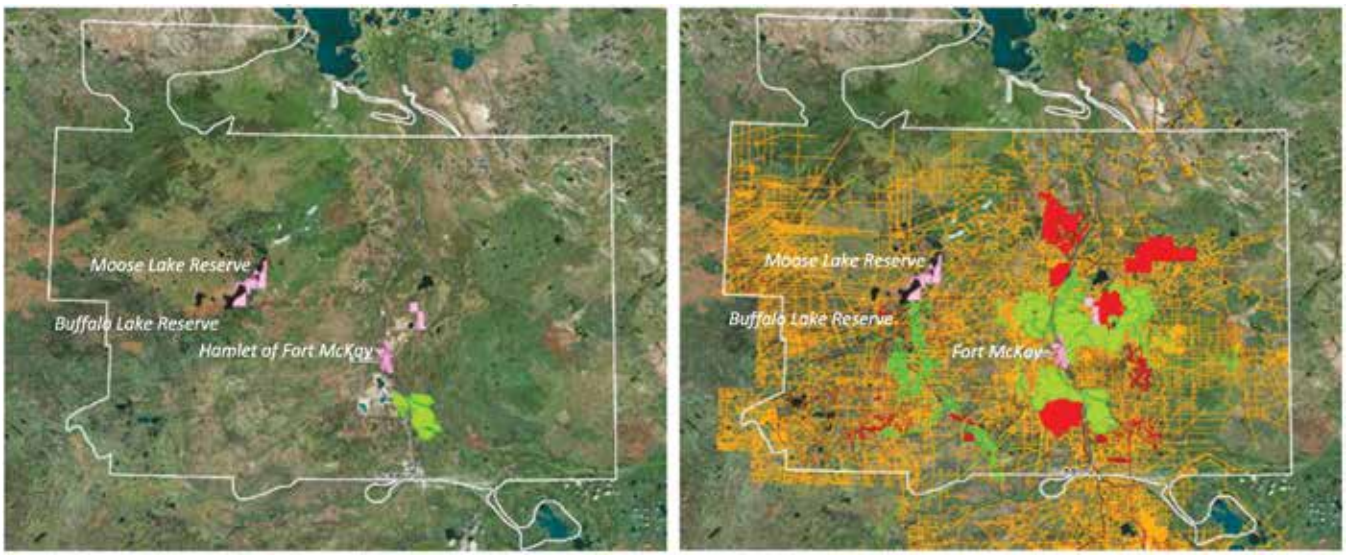

Figure 1 – (Left) A birds-eye view of the oil sands industrial footprint within the Fort McKay Traditional Territory (white line) in 1967, the year oil sands activities started, and (right) present day. Pink are Fort McKay First Nation reserve lands, green are active oil sands projects, red are proposed or approved but not yet operating projects and orange is primarily oil and gas exploration footprint. (MAP CREDIT: FORT MCKAY FIRST NATION).

use capability on reclaimed lands for affected Indigenous communities, like Fort McKay First Nation, to exercise Indigenous and Treaty Rights within their traditional territories.

The authors of this paper include First Nation (Cree and Dënesuliné [herein Dene]) knowledge holders, land users, and representatives from Fort McKay First Nation, and University of Calgary and Waterloo academic researchers of mixed European heritage. Fort McKay First Nation has nearly 900 band members of which about 500 live in the Hamlet of Fort McKay on its Traditional Territory (Figure 1) on the shores of the Athabasca River in Northeast Alberta, Canada which is also known as Treaty 8 Territory. Historically and today, Fort McKay First Nation (herein Fort McKay) practice traditional activities, including hunting of large and small game, fishing, trapping furbearers, harvesting waterfowl eggs, plants and medicines, ceremonies and keeping their spiritual connection to their traditional territory (Figure 2). As such, the sustainability of their culture is rooted in their traditional lands and waters. While Fort McKay's relationship to their homelands and traditional practices are protected in Canada, Cree and Dene band and community members are faced with ongoing industrial impacts, both positive and negative, from oil sands activities which began in the mid-1960s (Figure 1). They have a long-established record of working collaboratively with the many oil sands companies in their traditional territory, such as through joint ventures and research and environmental projects, with the intention to build a strong community that embraces change while keeping their rich history and cultural traditions (Fort McKay First Nation 2022). Building on their past contributions to reclamation advancements (e.g., BTKRG 2009; Buffalo et al. 2011; Garibaldi Heritage and Environmental Consulting 2006; Two Roads Research Team 2011, 2012), Fort McKay partnered with the Universities of Calgary and Waterloo

Figure 2 – Co-Researchers experiencing traditional land uses, such as berry picking (left) and fishing (centre) at Moose Lake. A Fort McKay community member gathers traditional plants from the boreal forest (Right).

PHOTO CREDITS: CHRISTINE DALY, ALEX DAVIES POST AND FORT MCKAY FIRST NATION.

and an oil sands company to continue their quest for their unique Cree and Dene perspectives and knowledges to be represented in the reclamation of their homelands and waters. Together, they created the Co-Reclamation Project. This article is based on Masters research conducted by Alexandra Davies Post and Fort McKay co-researchers as part of the Co-Reclamation Project, where one aim is to identify community-led monitoring best practices to support the design of an environmental guardian program to evaluate the re-establishment of traditional land use capability on reclaimed oil sands mine and in situ footprints located within the Fort McKay Traditional Territory (Figure 1).

An Introduction to Guardian Work and Indigenous-led Monitoring

Citizen science can be described as "the process whereby citizens are involved in science as researchers" (Kruger and Shannon 2000). Under the umbrella of citizen science, many terms have been used to describe the efforts of various stakeholders and their initiatives. While increasingly, Indigenous peoples are being included in citizen science initiatives, this involvement often reduces Indigenous peoples as "stakeholders", as opposed to the rights holders that they are, that "bring a wider range of knowledge to understand ecosystem change" (Berkes et al. 2007:145, Reed et al., 2020). Increasingly, we see a divergence from community-based monitoring (CBM) models when describing monitoring programs that are led by Indigenous groups and instead refer to these programs as Indigenous-led monitoring programs (Wiseman and Bardsley, 2016 and Natcher and Brunet, 2020). Canada has seen an increase in the uptake and study of Indigenous-led monitoring over the past three decades (Thompson et al., 2020). This uptake is often attributed to re-establishment of rights to self-government, increased pressure on settler governments to include Indigenous knowledge in planning processes, more collaborative governance arrangements between Indigenous and settler governments and increased concern of impacts of development and extractive industry (Berkes et al., 2007 and Johnson et. al, 2016). Other models that incorporate examples of Indigenous led monitoring include Indigenous Guardians, Watchman, Rangers, or Stewards which often imply a focus on stewardship or management of Indigenous Traditional Territories (Reed et al., 2020). Distinct from CBM programs, Indigenous Guardians hold Indigenous Knowledge unique to their homelands in which they exercise their Indigenous rights and Indigenous Guardian programs are designed and deployed based on this Indigenous Knowledge. Based on this Indigenous Guardians are:

- Rights holders, not stakeholders (Reed et al., 2020);
- Integrated into the governance and planning mechanisms of the Nation or community they serve (Wilson et al. 2018);
- Are highly skilled and possess professional expertise; and
- Exercises a level of "enforcement" unlike community-based monitors.

While each Indigenous Guardian programs is unique, Indigenous Guardians embody their nation's culture, ethics, and responsibilities through active stewardship and physical presence on the land, water, and ice in their traditional territory. Indigenous Guardians are highly skilled, technically trained, and professional stewards for their community. Their roles are expertly tailored to the geography, culture, and needs of the communities in which they are based in. Indigenous Guardians' responsibilities vary with, and within, each program but can include monitoring and research of environmental conditions (Popp et el., 2020); patrolling and demonstrating a presence on lands, waters, and ice; facilitating and promoting cultural resurgence and continuity in their communities (Peachey 2015); and

Figure 3 – Moose Lake, Fort McKay Traditional Territory.

supporting Indigenous governance frameworks and plans (Reed et al., 2020).

The Fort McKay First Nation Environmental Guardian Program

In January 2019, Fort McKay started its Environmental Guardian (EG) Program as a community driven initiative to monitor and track wildlife populations on their reserve land and traditional territory. The program focuses on areas that Fort McKay wants to protect and is working to establish a baseline before industry develops closer. Pairing quantitative measures with traditional knowledge of the landscape, the program has been a success through building capacity in the community and establishing relationships with research partners.

Figure 4 – Examples of wildlife and wildlife activity captured by wildlife camera monitoring in and around Moose Lake in Northeast Alberta, Canada which is also known as Treaty 8. Wildlife includes (above from the left) wolverine, black bear, lynx, and wolf. PHOTO CREDIT: FORT MCKAY FIRST NATION.HOTO CREDIT: FORT MCKAY FIRST NATION.

building and training. Ryan Abel, Fort McKay EG program manager, stated the program provides "opportunities for Fort McKay First Nation members to obtain training and develop skills and leadership in the environmental sciences, while also monitoring the environment and responding to community member concerns within Fort McKay First Nation's Traditional Territory."

Fort McKay's EG Program has grown to monitor water quality, air quality and wildlife. Working with local trappers and community land users, Fort McKay's EG, Ryan Grandjambe, deployed over 60 wildlife cameras across Moose Lake (Davidson and Spink, 2018, Köster et. al, 2018, and Neilson et al., 2022) (Figures 3 and 4). The results are providing exciting and useful insights. One example was wildlife cameras capturing wolves returning to the Narrows and fishing during spawning season (see Figure 4). Fort McKay also conducts water quality and quantity monitoring and operates five hydrometric stations in the Moose Lake area that measure water temperature and water depth, providing real-time data to Fort McKay community members and decision makers. Moose Lake, under special protection plan, is considered a home and refuge by community members where they can go to remember what it was once like in Fort McKay. The monitoring there is integral to the management and protections of Fort McKay's community identity and way of life (L'Hommecourt et al. 2022). Fort McKay is also monitoring air quality via the Namur Lake Air Monitoring Station (AMS), which is the world's first successful off-grid, continuous, air monitoring station (Fort McKay, 2023).

The data and results that Fort McKay's EG collect are then shared back to the community. As a Fort McKay community member himself, Grandjambe finds creative, engaging, and reciprocal ways of sharing these results through social media, focus groups, workshops, and word of mouth. Community engagement has been high and has guided the program to where it is today, focusing on what and where community members have concerns and curiosities about, which includes inquiries about the health of their traditional lands, air, and waters and the sustainability of their interconnected culture. Beyond data collection and monitoring, Fort McKay's EG program creates lasting benefits in the community, especially around capacity building and training. Ryan Abel, Fort McKay EG program manager, stated the program provides "opportunities for Fort McKay First Nation members to obtain training and develop skills and leadership in the environmental sciences, while also monitoring the environment and responding to community member concerns within Fort McKay First Nation's Traditional Territory."

Indigenous Guardian Programs Across Canada

Across Canada, Indigenous Guardian programs benefit their community in a number of ways. Indigenous Guardians engage youth and provide opportunities to transmit their knowledge, culture, and language between generations, ensuring the next generation of land users have the skills they need to be on the land. Indigenous Guardian programs are also protecting the community members on the land, filling the gaps in services from federal and provincial agencies, including search and rescue and emergency first response (CFN, 2023). Beyond the benefits felt by community members, Guardian programs represent a cultural resurgence and renewed presence on the land. These programs are one way that Nations can facilitate a strengthening of culture within their communities and return to the land the was occupied since time immemorial.

The strength of Indigenous Guardian programs lies within the capacity they build within their nations and communities; however, these programs require staff that are committed, well trained, and supplied with the necessary equipment. Consistently throughout Canada, we see programs struggle

to adequality staff and manage the immense workload and responsibilities that Indigenous Guardians hold. This is largely due to the lack of long-term continuous funding and ability of programs to pay industry competitive wages, access education and training, and manage burnout that Indigenous Guardians and managers might experience.

When surveyed, Guardians and managers noted that funding is the key limiting factor for Guardian programs to operationalize their Nation's goals and vision for on the land stewardship. Despite increases in the number of funding opportunities (Environment and Climate Change Canada, 2022), the current design of programmatic funding places constraints on the planning and activities of Guardians and their teams. Much of the available funding for Guardians is limited to one- to two-year funding opportunities that must be reapplied for each year. This style of funding is not conducive to long-term strategic planning that would enable sustained monitoring and data collection that can the inform decision-making.

Beyond funding, Indigenous Guardians face barriers around data mobilization and decision-making. The data collected by Indigenous Guardians is often designed to influence decision makers and support Indigenous governance arrangements. However, Indigenous nations experience challenges when using data and observations in collaborative decision-making processes, especially with crown governments and industry. While the legal obligation to consult Indigenous peoples in Canada rests with the Crown, often it is Indigenous Nations who work to establish opportunities to share data, information, concerns, and results collected by Indigenous Guardians through consultation forums. Notably, these forums, when they even exist, highlight the deep power inequities between Indigenous nations and non-Indigenous organizations. In addition, the bureaucratic structure of these consultations often challenges the ability of Indigenous Guardians to act on time-sensitive and crucial issues that are impacting their traditional territory.

Building strategic partnerships with other Indigenous nations,

research institutions, environmental organizations, and industry is a way Indigenous Guardians have overcome some of these constraints. We should ask how reclamation planning can benefit by the collaboration and participation of Indigenous Guardians in monitoring of reclaimed lands within their traditional territories.

Implications for Reclamation Planning

Monitoring the success of reclamation planning is key to adaptive management and allows for continuous improvement. The best way to ensure that the monitoring regime captures the perspectives of Indigenous land users, rights holders, and stewards is to ensure they're able to monitor the lands that they traditionally occupy. One interview participant put it clearly: "understanding that hiring and employing Guardians and building them in as a fundamental component of any of your environmental social governance frameworks is going to result in the successful reclamation outcomes. You need to understand that that's part of your workforce, and your very sustainability and economic profitability, if that's what's driving you, its fundamentally dependent upon having that level of expertise, informing your operations and your mitigations and your reclamation outcomes." Supporting Indigenous Guardian programs can support sustained relationships between operators and the communities they interact with. Lessons learned about traditional use monitoring needs, indicators, and measures from local community knowledge holders can also be applied towards future iterations of mine closure and reclamation plans. Such anticipatory- and rightsholder-focused planning has the potential to support the renewal of cultural landscapes and to re-establish traditional land use capability on reclaimed lands. While these relationships can sometimes be challenging and require innovative models of collaboration and potentially training, they also can create governance arrangements that can lead to better reclamation outcomes that have mutual benefits for both the operator and local community.

For Fort McKay, the EG program provides a lasting foundational capacity for the nation that is resilient and culturally grounded. Discussing the impacts of the oil sands industry Ryan Abel noted, "It's not a sustainable industry; it will go away at some point, whether it's because the resource has been fully extracted and it's not there anymore, or, you know, new technologies come along and we don't need it anymore.... Part of my long-term thinking is, how do we spend the resources that we have now to set the community up to have that training to have that capacity so that if the music stops, you've got a highly trained, highly educated group of members that are practicing their culture still."

Ultimately, Indigenous Guardian programs are expressions of nationhood and represent a return to an Indigenous-led stewardship of lands, waters, fish, wildlife, and ice. In the context of reclamation planning, Indigenous Guardians and Indigenous-led monitoring programs are in the best position to evaluate the success of a reclamation and closure plan to meet their long-term needs as traditional land users. By establishing well-funded, adequately staffed, empowered Indigenous stewards, mine operators and their reclamation planners can partner with local Indigenous communities to monitor the success of

reclamation activities while taking steps forward on a path to reconciliation.

Acknowledgements

We wish to acknowledge the dedicated, patient, and resilient Fort McKay First Nation Elders, land users, knowledge holders and youth who have contributed to our learning journey. We gratefully acknowledge the ACA Research Grant (supported by the Alberta Conservation Association), Mitacs Accelerate, an oil sands company, and University of Calgary scholarships for funding this study.

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Soil conservation in Puerto Rico: An island experience

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Introduction

If you like the *Piña Colada* drink, you must know Puerto Rico, the smallest island of the Greater Antilles, a group of islands in the Caribbean. Since 1898, Puerto Rico has been a territory of the United States of America. The island is actually under a commonwealth agreement, which refers to an association as territory rather than as a state. Because of this, surveys and conservation of the natural resources of the island are managed by local and federal agencies, such as those under the United States Department of Agriculture (USDA) like the Natural Resources Conservation Service (NRCS), Animal and Plant Health Inspection Service (APHIS), and Forest Service (FS).

Naturally, Puerto Rico is rich in soil types, fresh water, humid and dry forests, caves, tropical biodiversity, and bioluminescent bays, but also in natural disasters caused by hurricanes, tropical storms, and earthquakes. Natural disasters have hindered the agricultural development of Puerto Rico, forcing residents to find sustainable ways to manage the agricultural lands and conserve the soil. The purpose of this article is to describe how the island and its communities are dealing with and managing soil conservation challenges.

Soils of Puerto Rico

With just 3,420 square miles, Puerto Rico has 10 of the 12 soil orders recognized by USDA-NRCS: Aridisols, Alfisols, Entisols, Histosols, Inceptisols, Mollisols, Oxisols, Spodosols, Ultisols, and Vertisols (Muñoz et al., 2017) (Figure 1). To give you an idea of how rich soil diversity can be found, you will see soils with little or weak development derived from alluvial deposits such as Entisols in the rivers, organic-matter rich, dark-colored and shrink-swell soils as Mollisols and Vertisols, reddish soils as Oxisols, and other soils derived mainly from organic materials as Histosols, just during a visit to the west half of the island. Because the average number of daylight hours on the island is 12 hours, you will be able to complete the soil tour in just two days.

Geologic materials, topography, and climate greatly influence the genesis and distribution of soils on the island. In Puerto Rico, geologic materials differ in composition, formation

Figure 1. USDA-NRCS recognizes 10 of the 12 soil orders in Puerto Rico. The different soil orders are characterized by distinctive characteristics, such as the presence of spodic and albic horizons on Spodosols (left), soil cracks caused by the expansion and contraction of clay particles on Vertisols (center), and the reddish color of oxides on Oxisols (right). (Image source: Photographs taken by graduate students of soil sciences at the University of Puerto Rico).

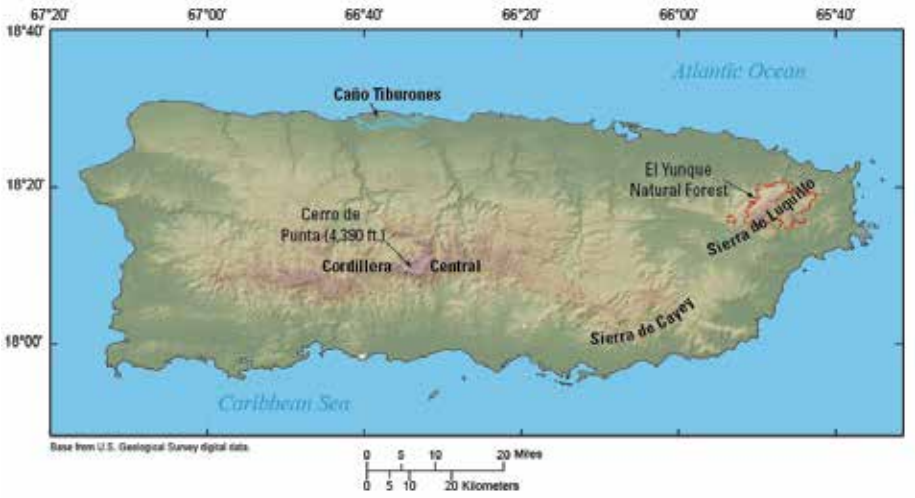

Figure 2. A map of Puerto Rico's landscape, showing green the lowest elevation and red the highest elevation. (Image source: U.S. Geological Service).

Figure 3. Several natural disasters have affected Puerto Rico recently, including pandemics, earthquakes, and hurricanes. Natural tourist attractions like Punta Ventana were destroyed by the earthquakes (top left and right, after and before the earthquakes), as well as houses in coastal communities (bottom left and right).

process, and age. The mountainous interiors are composed of Cretaceous volcanic and plutonic rocks, the north and south of the central uplands are Tertiary limestones, and the coasts are Quaternary and Recent unconsolidated sediments. The topography is dominated by the Cordillera Central, a mountain range that crosses the middle of the island west-east, and other mountains covering one third of the island with slopes higher than 16 percent. The highest peak is Cerro Punta, Ponce, at 4,389 feet, followed by Sierra de Luquillo, Fajardo, at 3,493 feet. When the mountains allow, the predominant landforms are alluvial plains, marine terraces, lagoons, marshes, karst, peneplains, and lowlands. The climate is variable and is related to the position of the mountains in the landscape. In the north part of the Cordillera Central, the moisture-laden easterly trade winds load up to 200 inches of rainfall, while in the south part, the rainfall could be less than 40 inches, because of changes in the wind's direction and the blockages by the mountains (Figure 2). This change in natural conditions is known as the "rain shadow effect".

Facing Island Disturbances

The geographical position of Puerto Rico in the Caribbean increases its susceptibility to natural phenomena such as earthquakes and hurricanes. The most recent hurricane was María in September 2017, a Category 5 hurricane that caused around 3,000 direct and indirect deaths and more than $90 billion (2017 USD) in total monetary losses. Maria had four major consequences: (i) interruptions in electrical service, (ii) food insecurity, (iii) a lack of safe housing, and (iv)

high unemployment. The COVID-19 pandemic and the 2020 earthquakes in the southwest made these consequences more severe (Figure 3). Although these other situations were devastating to the island and its people, hurricane Maria can be considered the most impactful.

To provide context, a Category 5 hurricane is the highest category with winds greater than 155 mph (249 km/h) and María had winds of 175 mph (280 km/h), enough to tear off roofs, destroy buildings, and greatly impact electrical infrastructure. For Puerto Rico, the entire electrical grid collapsed. Many islanders did not have power in their homes and businesses for months, depending on the damage level in the area. A lack of basic services, unemployment and an economic crisis led to more Puerto Ricans leaving the island, which decreased agricultural production, food security, and crop revenues. Several communities, including farmers, have begun reclaiming the lands damaged by floods, landslides, and deforestation, but there is still a lot of work to be done.

In contrast to other places, such as the Northern Great Plains, where the mechanization and industrialization of agriculture is favored by the landscape, Puerto Rico is looking to adapt agricultural models to the changing topography. This is something to think about considering that more than 80 percent of the food consumed on the island is imported and that due to commercial laws applied to the island, farm materials used to cultivate (i.e. machinery, seeds, fertilizers) must first pass through the United States, which thus increases costs for Puerto Rican farmers and investors.

Resilience as Soil Conservation Tool

"La Isla del Encanto" (the Island of Enchantment) describes Puerto Rico's natural beauty, but Puerto Ricans are known as resilient people for their ability to bounce back quickly when facing challenges. A resilient attitude on the island has led to a new cultural identity, one in which sustainability, self-sufficiency, and collaborative action are integral to day-to-day life. A number of professionals and community leaders are promoting soil health and conservation to mitigate the effects of natural disturbances on the islands. In soil conservation, protective strategies are used to prevent soil erosion or depletion by water and wind (Merriam-Webster Dictionary, 2022). Soil health refers to its continuing ability to function as a vital living ecosystem that sustains plants, animals, and humans (USDA-NRCS, 2022). To maintain soil health, soil conservation is essential.

Local farming communities, for example, are interested in learning how to increase production and supply chains sustainably. Many islanders rely on agriculture as a means of increasing resilience and decreasing vulnerability during and after disasters. Several land management and conservation practices have been implemented to improve the productivity of agricultural land, including a variety of crops, seed banking, and soil erosion control (Marrero et al., 2022). Numerous factors influence how these practices are adopted and supported by the community. According to Gladkikh et al. (2020), income, size, and current farm practices influence participation in management and conservation programs, which are supported financially by government agencies, as well as a lack of information and distrust in governments (Gladkikh et al., 2020). Considering that 94 percent of the farmers taking part in the survey made more than $10,000 from these financial incentives, these results are interesting.

Among soil conservation practices are no-tillage, conservation tillage, cover crops, and crop diversification. The use of no-tillage reduces machinery dependency and strengthens natural mechanisms such as the growth of roots and the movement of soil by insects (Figure 4). Conservation tillage reduces the impact of tilling machinery on the soil. As a result, the soil aggregates remain in shape and have enough pores to allow water and air to exchange during rainfall events. Using these practices, soil structure and pores are preserved, which increase drainage capacity and prevent flooding.

Diversifying crops is another practice used to increase a farm's resilience after natural disasters. In the rural areas of the island, crop diversity is exemplified by farms producing plátano (plantain), guineos (banana), ñame (i.e., a yam root), malanga (i.e., a species of taro root), apio (i.e., a species similar to celery root), ají (pepper), parcha (passion fruit), and lechosa (papaya). As a result of this practice, farmers are able to produce crops that can survive different weather conditions and seasons, as well as natural disasters. "La cajita" is an example of a successful local food delivery initiative, where one or multiple farms prepare a box full of local products and deliver them to consumers weekly or monthly. Agricultorapr.com is a website run by a female farmer, Stephanie Rodriguez

Above: Figure 4. Typical soil aggregates of Vertisols in the Lajas Valley, southwest of the island, in a no-tilled field.

Right: Figure 5. Through a subscription program, Stephanie Rodriguez is delivering local products from agro-ecological farms to customers.

(www.agricultorapr.com), who develops agro-ecological products based on local products cultivated on her farm (Figure 5). According to social media reviews, products from these programs have longer shelf lives and have a better flavor than the imported versions found in supermarkets. In addition, they can also impart knowledge and empowerment to others in the community who wish to contribute to the development of agriculture on the island.

When it comes to soil, crop diversity promotes soil health and soil structure. Sunn hemp (Crotalaria juncea), jack bean (Canavalia ensiformis), and sorghum (Sorghum bicolor) are used as cover crops on plantain and banana farms. Their constantly deepening roots act as augers to combat soil compaction and build soil pores. The roots of cover crops build a kind of mesh within the soil that increases the soil's stability and prevents landslides on slopes. As the roots decompose, organic matter and nutrients are added to the soil. Additionally, organic matter releases natural cohesive materials that bind soil particles, reducing soil erosion and loss of applied fertilizers or any other agricultural product.

Local organizations and communities value soil conservation both on and off the farm. Conserving mangrove forests is another way of making the island more resilient to natural disasters. Mangrove is a salt-tolerant plant that grows in areas with low oxygen levels and waterlogged soil, like coastal swamps. When hurricanes, tsunamis, and sea level rise occur, these tree-like plants protect the coast from erosion and marine life. Mangrove forests are also helpful for soil conservation and soil health in coastal areas because they store carbon in the soil (Griffith et al., 2021). Carbon (C) is a chemical element commonly known as carbon dioxide (CO_2) in the context of global warming. During photosynthesis, mangroves trap carbon gas from the atmosphere and convert it to solid carbon. Organic materials derived from mangrove tissues (e.g., leaves, roots) and animals that feed on them (e.g., corals, shells) constitute solid forms of carbon. As these tissues are buried in the soil, adapted microorganisms convert them into soil organic carbon (materials like soil organic matter and microbial biomass) and soil inorganic carbon (such as carbonates). For an island, ecosystems such as mangrove forests serve as defense and reliance against natural disasters. Therefore, initiatives related to soil conservation and soil health are key to ensuring these ecosystems are protected and managed properly.

Conclusion

The islands are critical for the conservation of biodiversity, the study of geography, and climate change research because of their diverse ecosystems. The sustainable recommendations mentioned above for soil conservation on the island are just some examples of practices that promote the four principles to improve soil health: (i) minimize soil disturbance, (ii) maximize soil cover, (iii) maximize soil biodiversity, and (iv) maximize the presence of living roots. Since Puerto Rico is an island, it has the special task of planning how to manage natural resources before, during, and after natural disasters. In addition, community initiatives are essential to the success of the management plans. To help Puerto Rico be more resilient during your visit, enjoy the natural resources respectfully and learn about local initiatives from local organizations. Here are some of them:

- Casa Pueblo (https://casapueblo.org/) - a community self-management project that is committed to appreciating and protecting natural, cultural, and human resources.
- Plenitud PR (https://www.plenitudpr.org/) - a non-profit educational farm and community dedicated to service and sustainability providing people with sustainability skills and knowledge needed to encourage inner growth and to live in harmony with themselves, each other, and the natural world.
- Para La Naturaleza (https://www.paralanaturaleza.org/) – an organization that facilitates transformative experiences in nature, conserves land of high ecological value, and encourages taking responsibility for the natural resources and promote public policy for their protection.
- Colegio de Agrónomos de Puerto Rico (http://www.colegiodeagronomospr.com/) – an organization of agronomy professionals dedicated to guaranteeing their technical-professional improvement, the development and implementation of agro-industrial policies and the protection of agricultural land.
- VisitRico (https://www.visitrico.org/) - a non-profit organization dedicated to the development of the agriculture and agricultural economy through education, health, food security, and sustainable agrotourism.
- Foundation for Puerto Rico (https://foundationforpuertorico.org/en/) - a nonprofit organization that seeks to unleash Puerto Rico's potential in the global economy with resilience programs working hand in hand with community partners, providing resources, training, funding, and networks that improve the local economy from within.
- PRxPR (https://www.prxpr.org/) - an organization that invests 100 percent of donations amongst the most critically affected communities

in aiding in short and long-term humanitarian needs focused on food/agriculture, clean water, and fuel/renewable energy initiatives.

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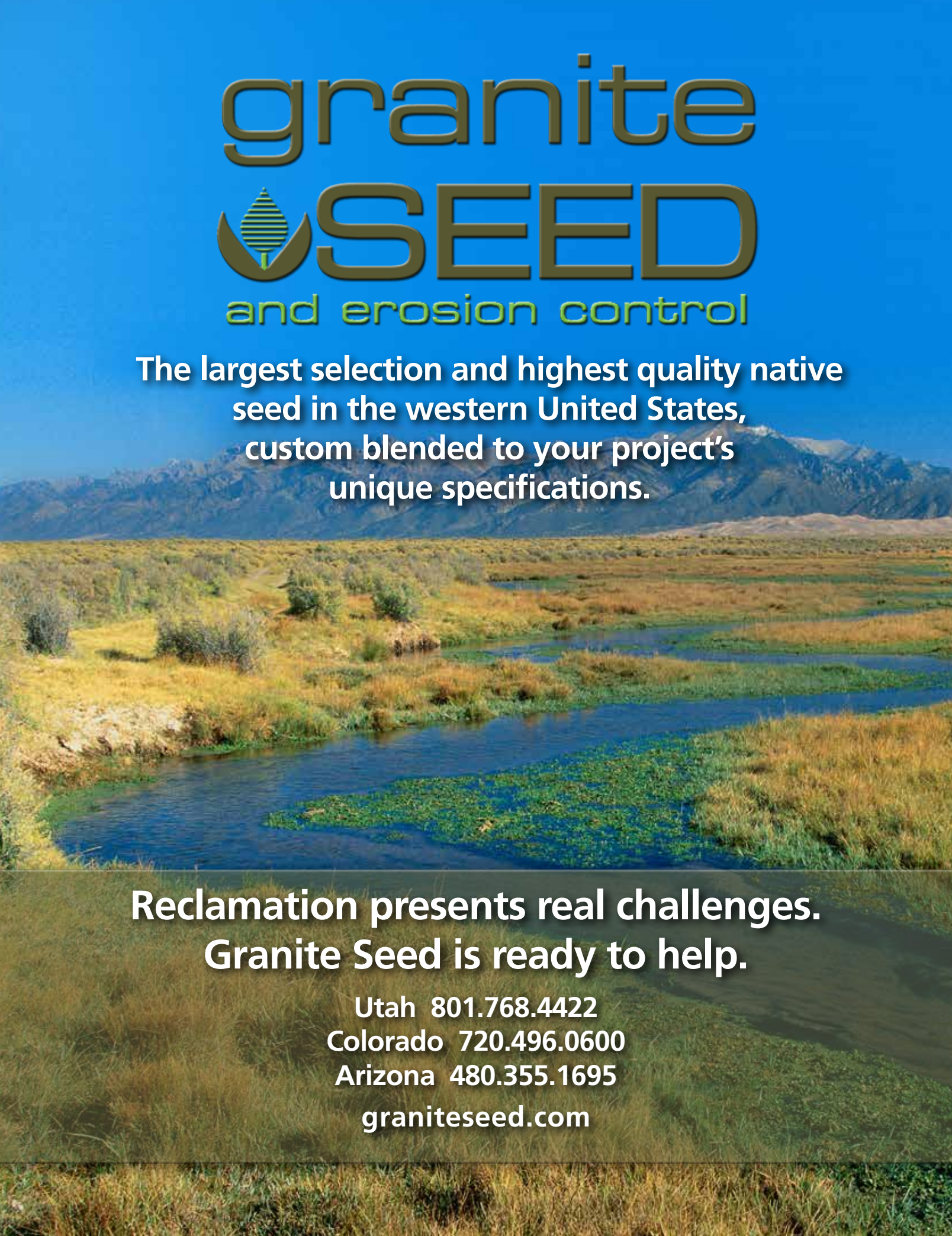
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MINE CLOSURE: RECLAMATION FOR FUTURE GENERATIONS

Our approach to mine closure is simple – we partner with clients to develop and implement tailored solutions that streamline reclamation and meet project objectives – all while considering stakeholder needs. Stantec is a world leader in the closure of operating, inactive, historic, and abandoned mines.

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