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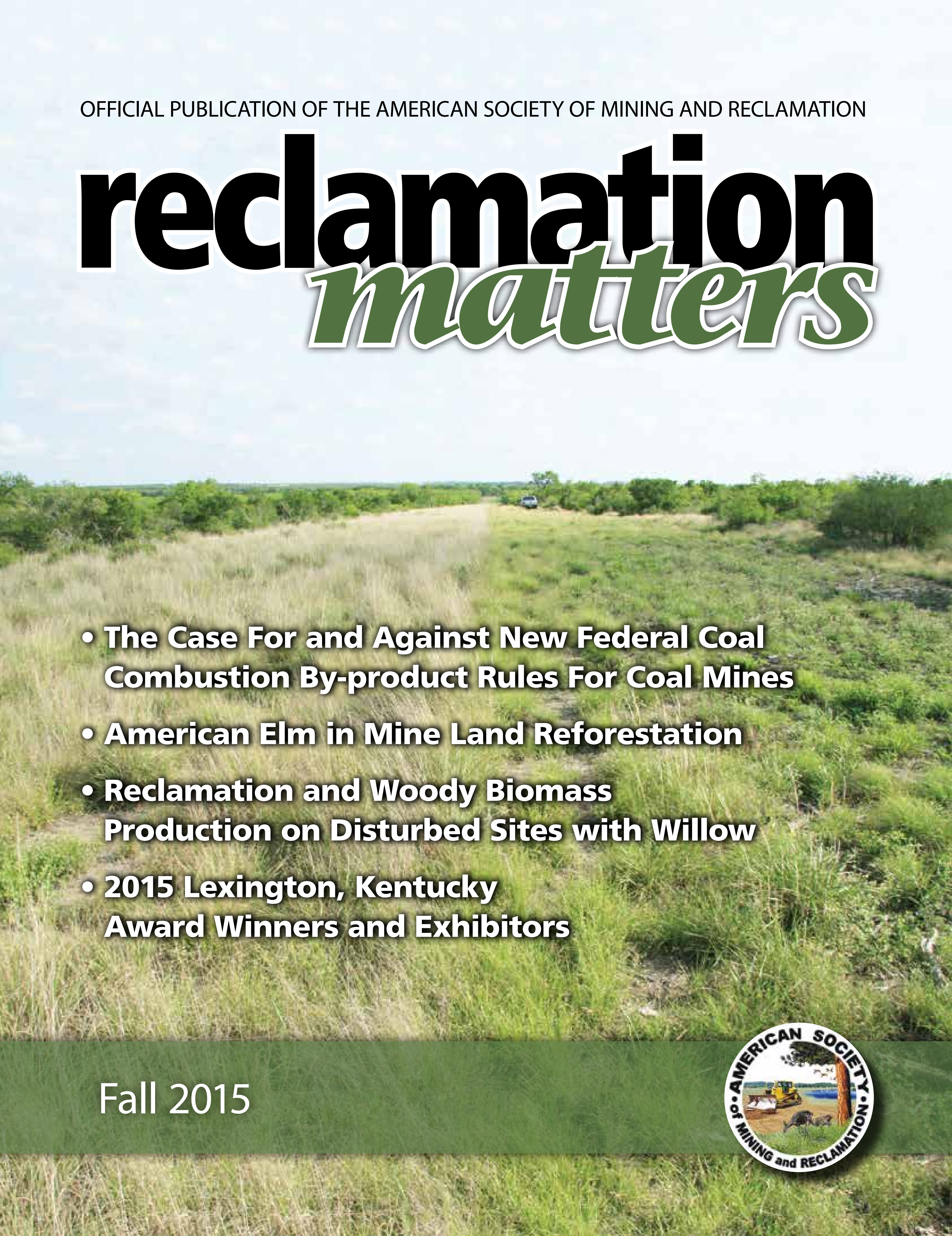

- **The Case For and Against New Federal Coal Combustion By-product Rules For Coal Mines**
- **American Elm in Mine Land Reforestation**
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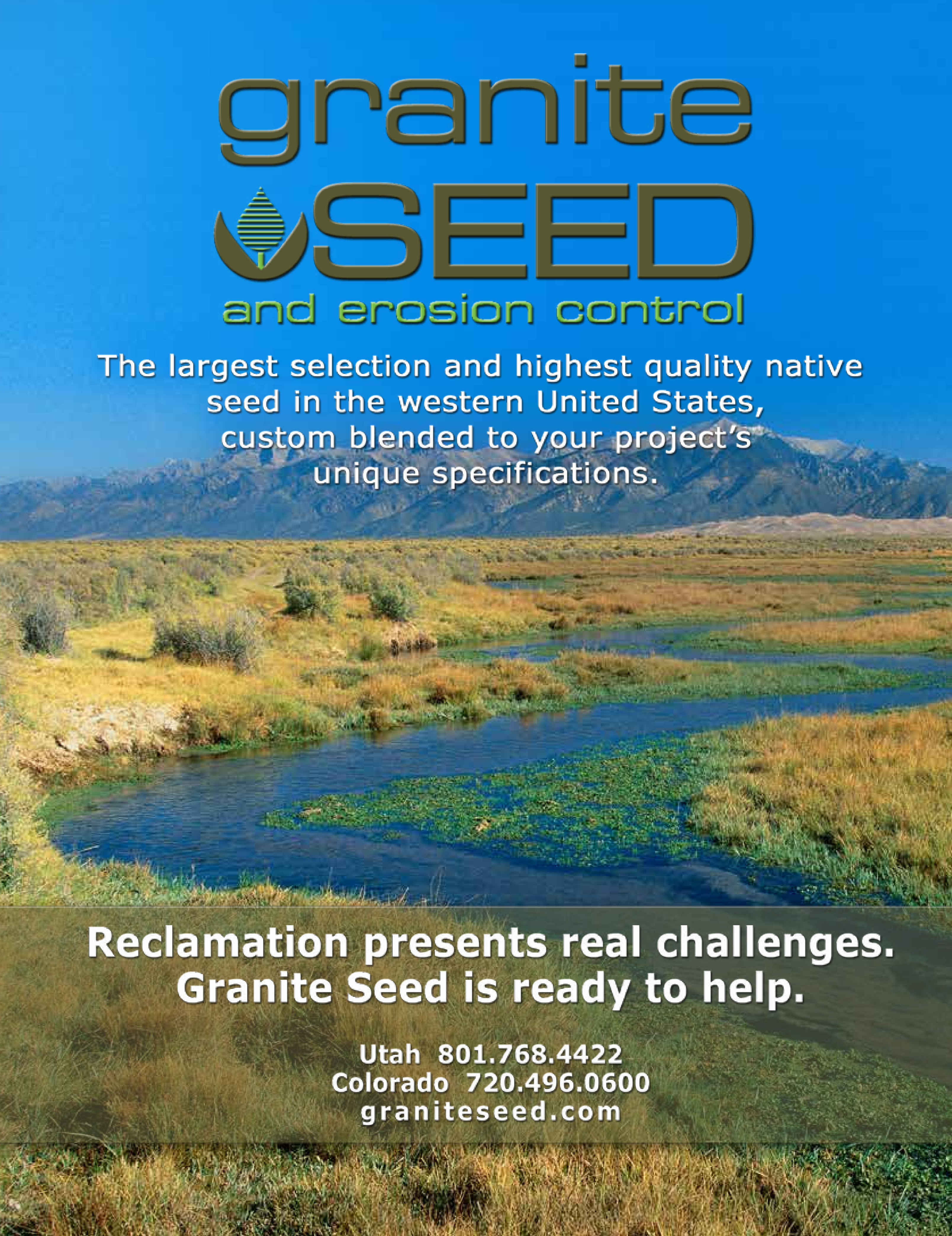
- **2015 Lexington, Kentucky Award Winners and Exhibitors**

Fall 2015

AMERICAN SOCIETY of MINING and RECLAMATION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reclamation matters

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Looking Forward

By Brenda Schladweiler, ASMR President

June 21, 2015. On this summer solstice day, it seems fitting to talk about how your current president feels with the recent "changing of the guard" in Lexington. First, let me take this opportunity to thank the following people:

1) Dick Barnhisel and his planning committee, including Lela and granddaughter for organizing and implementing the Lexington meeting. I have a new appreciation for the horse country surrounding Lexington, as well as a renewed interest in the differences between eastern and western reclamation. I am glad that the meeting locale switches each year, as it allows all of us to walk in each other's shoes.
2) Joe Friedlander, past ASMR President, for completion of duties this past year and laying the groundwork on the remaining challenges we face as a society.
3) Bob Darmody, Executive Secretary, who will be working side-by-side with me and the NEC as we focus on Spokane, as well as larger global issues related to ASMR.
4) All those past presidents who offered a helping hand to me during the Lexington meetings. That institutional knowledge is invaluable. Despite NEC experience and this past year as "incoming president," the shoes to be filled as president can be daunting, especially for someone who wears a size 6 women's shoe.
5) Finally, all those people who bent my ear during the meeting and provided great ideas as we move forward as a society. You were heard.

The next year's agenda is full for the ASMR administrative team. We are all looking forward to the next meeting in Spokane and appreciate the planning of Dustin and his crew to provide us with great sessions, tours and workshops. I hope all of you are planning to attend.

As the NEC, we are trying to compile written policies for the society as much of the institutional knowledge is passing. I encourage you to write your knowledge down now, rather than regret later and wonder how and why we did certain things. Financially, we are a healthy society and are trying to organize those assets so we can be transparent to our members. The Financial Advisory Committee, under the direction of Lee Daniels, Michele Coleman and Tim Danehy, provides a great service to the NEC in financial oversight and recommendations.

We have a variety of members, both nationally and internationally. Our strength is in our varied occupations, ages and gender, as well as our personal interests. Our annual meeting provides opportunities for Wild Women of Reclamation, Young Professionals, energetic people who like to run in the morning, golfers, and the participants of technical tours and social tours who give us access to the local area. We appreciate the continued involvement of retirees who can offer so much in terms of knowledge and history of this society.

I love the students who attend our meetings. Those eager minds, freshly equipped by their professors and mentors, may just change this world.

We owe a deep gratitude to our vendors and sponsors, some of whom have been with us a very long time and continue to show that support. You provide an opportunity to learn during the annual meeting, as well as giving us an excuse to provide food and beverage on Sunday nights! We appreciate you very much.

We are a unique organization. We bring together industry, academia and practitioners to learn from each other. We all have a part and a responsibility to make this the best society ever. The challenge can often be what is most important in this day and time… the details can vary from year to year but the underlying deep values never change. Those are:

- We love what we do… we love making things grow and serving our industries.
- We value what we can learn from each other.
- We make a difference in what happens in this world, our countries of origin, and where we call "home."

Have a great year and buckle your seat belts. ■

Going Down the Road

By Jeff Skousen,
West Virginia University

Years ago, when our kids were little, our family would take an annual two-week vacation across the country, packing our children in the minivan and driving from Morgantown, West Virginia, to Salt Lake City, Utah, where many of our extended family lived. The trip was 30 hours one-way, and I was one of those types who divided the drive into two, grueling 15-hour days and the kids had to "hold it" until we stopped briefly for gas every four or five hours. I tried to prepare the car with all the routine maintenance so it could bear the stress of the trip before starting out – and my wife attempted to prepare our four kids.

One memorable year, the first 15-hour day passed with little concern: we drove through Wheeling, Columbus, Indianapolis, and Des Moines on our way to Omaha, Nebraska; the kids fighting and whining all the way (no electronic gadgets in those days). The next day was a Saturday. We left Omaha, but as we passed Lincoln, the car suddenly quit and I coasted to the side of the freeway. I looked at the engine and found nothing obviously wrong and, after about 15 minutes, the car started again. Off we went until Grand Island, where the car died again. As before, we waited 15 minutes and it started again. I thought this is going to be a long trip: two hours of driving with 15-minute breakdowns! At North Platte the car died again, so after the required 15-minute wait, I spotted a car dealership near the freeway exit. The last mechanic was closing up at 12 noon on Saturday. I explained the problem, and he said it was a failing fuel pump, but all the workers were gone and no one would be back until Monday to fix it. Surprisingly, he looked at us with compassion and said, "Well, wait a minute, let me see if we have the pump in the back." A minute later, he walked out holding the pump and said, "I can have this repaired in about 45 minutes." He changed the fuel pump while we watched, and we drove out of the shop about 1:30 p.m., grateful for the kindness of the last mechanic on duty. I paid him and gave him a big tip in cash.

Several lessons can be gleaned from this experience. First, no matter how a person prepares, unexpected events occur that can derail plans and detour you from the intended path. These unexpected delays and diversions occur to all of us at various times in our professional and personal lives. Some of the unanticipated events can be prevented with forward thinking, but others are complete surprises and come with no warning. A second lesson can be learned from my response when the problem arose. I could have ignored the warning and continued my drive/stall strategy with eventual dreadful consequences. When confronted with an unexpected problem, it is best to address it immediately because avoiding or postponing a response will often cause a small problem to magnify into a larger issue, resulting in more delays, effort and expense. And third, the assistance of another was required to get us back on track. Many times, the messes we encounter are beyond our ability to fix, and we must accept help from others. Asking for help is not a sign of weakness. Learning to ask and accept assistance (*and to give*) when needed is often rewarded. We are grateful for the kindness of that mechanic who recognized our need and responded.

> *Learning to ask and accept assistance (and to give) when needed is often rewarded. Asking for help is not a sign of weakness.*

Thoughtful preparation and planning for contingencies are our best defenses against uncertainties and unexpected events. We will receive warning signs every now and then, and it is up to us to heed the signs, identify the problems, act quickly to fix or control the problem, and obtain help as needed.

(Thanks to Norm Cantrell and Jim Thompson for insights to this article). ■

Getting the Most Out of Your Plant Materials

By Cally Driessen

I recently switched careers from environmental consulting to growing native plants in a nursery. Trained as a soil scientist and specializing in reclamation, I realized I knew very little about establishing plants. I knew soil properties desired by plants and methods to improve the soil, but I knew very little about the growth stages of plants and how to care for them throughout their lifecycle. I've learned a lot in the last months and hope to pass along some of this information to those of you who feel like I did.

As reclamation specialists, we aim to leave the landscape equal to or better than the pre-disturbance condition. A critical step in this process is establishing a diverse plant community capable of sustaining itself. Often we worry so much about providing a suitable medium for plants to establish, we may overlook providing the necessary care for plant materials.

Selecting viable and appropriate plant materials is an important first step to establishing a healthy plant community. Seed is more affordable than containerized or bare root plants. Slow growing plants such as trees and shrubs typically do better as planted one- or two-year-old seedlings than seeds. Species such as willow and cottonwood establish well from cuttings of live plants.

Seed should be stored in a cool, dark, and dry place until it is ready for use. Heat, light, and moisture stimulate germination and increase pathogens. The storage area should be no warmer than 70 degrees Fahrenheit. Many seeds require scarification and/or a cold stratification to germinate. This should be evaluated on a species-by-species basis. Seeding in the fall typically enables cold stratification by taking advantage of winter temperatures prior to germination in the spring. Seed germination decreases overtime and seeding should occur as soon as conditions allow.

Live plant stock such as containerized plants, bare root plants, or cuttings requires more attention than seeds during storage. It is best to wait to collect live plant stock from nurseries until the site is ready to plant. Nurseries have better facilities for watering and caring for plants than are normally available at the planting site and large roots are often severed to move the plants. If storage at the site is necessary, the plants must be watered to insure the roots do not dry. Cuttings should be stored in well-aerated water until ready for planting. Hormones may be added to stimulate root growth.

Competition with other species; predation, grazing, and browsing; and unfavorable environmental conditions limit the success of plant establishment. Weeds should be mowed or treated with herbicide prior to seeding or transplanting. Reducing weedy cover can also eliminate habitat for birds and rodents that eat seeds. Fencing may be required to prevent grazing and browsing of the establishing plants. Seeding and transplanting must take place under favorable environmental conditions.

The Rocky Mountain Research Station lists moisture, temperature, gas exchange, light, after-ripening, and dormancy as the conditions required for seed germination (Monsen et al., 2004). These should be reviewed for each species to insure the conditions are appropriate for germination. Monsen et al. (2004) describe the rules of transplanting which include: (1) never allow roots or stem ends to dry, (2) keep plants cool – do not allow them to overheat prior to planting, (3) plant during cool periods with adequate moisture, (4) compact soil around the roots at planting time, and (5) eliminate plant competition around the transplant. Dig holes large enough for transplants so that the roots do not crush or bend and are completely below the soil surface. Place the plant so its base is level with the soil surface and partially backfill the hole. Water the plant to remove any air pockets, then fill the rest of the hole with soil and water again. Many native plants are prone to shock so it is very important to gently handle the roots and to keep the area around the transplant moist. Water is vitally important for growing seedlings and new transplants, if there is insufficient precipitation, plan for supplemental irrigation.

Successful revegetation is the most visually striking way to display reclamation success. Take some extra time to properly handle and care for your plant materials.

Monsen, S., Stevens, R., and Shaw, N. 2004. *Restoring western ranges and wildlands*. Gen. Tech. Rep. RMRS-GTR-136-vol-3. Fort Collins, Co: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. ■

Wild Women OF RECLAMATION

Back row: **Jennifer Keese (Alaska Department of Natural Resources), Cindy Adams (BKS Environmental), Zenah Orndorff (Virginia Tech), Alison Keller (WV Department of Environmental Protection), Kara Dallaire (West Virginia University Graduate Student), Steffany Scagline (West Virginia University Graduate Student), Lindsay Wilson-Kokes (Civil & Environmental Consultants, Inc.), Margaret Dunn (Stream Restoration Inc.), Gwen Geidel (University of South Carolina), Jane Thomas (Wyoming Analytical Labs).**

Front Row: **Jennifer Franklin (University of Tennesee), Hannah Angel (Stephen F. Austin State University Graduate Student), Michele Coleman (NB Power), Renee Romsland (Alaska Department of Natural Resources), Brenda Schladweiler (BKS Environmental).**

Missing from photo but participated in 2015 meeting - Amy Gondran, Virginia Tech; Crystal Cook Marshall, ARIES-VT; Jessica (Odenheimer) Joyce, Moody & Associates, Inc.; KeriAnne Pritchett, Cascade Earth Sciences; Megan Malony, Oak Ridge National Laboratory; Zanna Brinkman, ND PSC

The third gathering of Wild Women of Reclamation (WWR) occurred in Lexington, Kentucky at the 2015 Joint Conference ASMR and ARRI (32nd Annual American Society for Mining and Reclamation/ 9th Annual Meeting of the Appalachian Regional Reforestation Initiative) on June 8, 2015. Women in all stages of their careers gathered to have breakfast, enjoy a presentation by Margaret Dunn, network, create mentoring opportunities, discuss experiences and most importantly, share some laughs. The goal of the gathering is comradery and to have a discussion of common experiences, unique as women, in the pursuit of better reclamation. This affiliation is also another tool we can use to empower women to have confidence in our abilities to advance in our careers, mentor the future generation of professionals and to improve the lives of everyone through our interactions.

Margaret Dunn was the invited guest speaker for WWR 2015. Margaret Hensley Dunn, PG, CPG (Professional Geologist, Certified Professional Geologist), is the President of Stream Restoration Inc., a non-profit that focuses on developing public-private partnerships with stakeholders to implement sustainable solutions to mine drainage issues. Margaret is also President of BioMost, Inc., and as a co-inventor, has four U.S. patents relating to passive mine drainage treatment technology.

Margaret is a well-known, respected and well-honored practitioner who has mentored many young people over the past several decades. Many of us know Margaret as the consultant who has travelled to many ASMR meetings with a van of young employees. In her humbling demeanor, Margaret spoke of the skills and qualities of some of the many young people she has employed and mentored over the years. She spoke with pride about the growth, both technically and in personal interactions, which her staff has developed through – and what she didn't say – her mentoring, by allowing them the freedom to challenge their talents, learn new skills and work through all facets of a problem to determine the best approach. She encouraged and supported her employees to extend their skills through public outreach, presentations at conferences, and interactions with a wide range of people – school children, academia, and contractors. Her advice was to provide support and to empower people who show initiative, creativity and responsibility to meet challenges encountered on real-life projects. Although Margaret's office mantra is "work hard and try to do more," her employees always seemed to be thoroughly enjoying their work because she enables them to expand. Margaret feels that "we all have interests and talents that can be used to help others to develop their gifts."

During the discussion that followed, there were several humorous anecdotal stories about working as a woman in reclamation, presented by members of all ages. It is that interaction that members found most useful.

To keep the networking going throughout the coming year, the group was divided into "more experienced" individuals (greater than five years in a working career) versus "less experienced" (less than five years). Persons from each group were paired and asked to keep in touch with each other throughout the coming year.

As with any organization, communication and perceived benefits are key to staying involved. Original discussions during the development of WWR had been to establish a LinkedIn account for sharing ideas, stories and networking, derive a plan to increase public awareness of reclamation issue and dispel myths on energy related issues. After three annual meetings, the general consensus was to keep the gatherings simple for now as we all have busy lives, but that just meeting people on a more personal level enhanced the benefits of participating in the ASMR conference. The highlight and most engaging activity was determined to be the breakfast, which will continue to have a presentation and an open discussion. Throughout the year, we will continue to work on mentoring relationships, invite members to join the LinkedIn group for sharing information and continue with quarterly reminders on mentoring, updates on any group relevant information or ideas and notices about the planning for the annual breakfast.

Wild Women of Reclamation was initiated by Dr. Brenda Schladweiler in 2013 as a tool to provide mentorship and professional support for women in reclamation. Wild Women of Reclamation (WWR) is open to any female who works in the field of reclamation, whether a practitioner, academic, consultant, service provider, in the natural resource industry or other. There are no fees, no forms and no formalities to join. Current contacts are co-chairs Michele Coleman (MColeman@nbpower.com) and Cindy Adams (cadams@bksenvironmental.com).

So, fellow Wild Women of Reclamation, please join the WWR LinkedIn account by contacting Cindy and continue to share your stores of "worst days of work" and" lovely wildflowers." If you have suggestions about improving networking and communications, please don't hesitate to contact either Michele or Cindy directly. We look forward to seeing many of you and any new invitees in Spokane in 2016! ■

Jeffrey G. Skousen

2015 William T. Plass Lifetime Achievement Award

Our recipient of the William T. Plass Award has worked in the field of mined land reclamation for over 30 years. He has taught, mentored students, carried out research and outreach efforts at West Virginia University since 1985. He is recognized for his research and outreach efforts in acid mine drainage, reforestation, and post-mining land use development. His peers noted that one of his most important contributions is the training of the next generation of reclamation scientists and practitioners. Jeff has advised 36 graduate students (with three current MS students) and served on graduate committees of 65 other students. He has received numerous awards including Outstanding Teacher, Outstanding Researcher, and Outstanding Service in his Division and College, and has twice received the WVU's prestigious Heebink Award for Distinguished Service to the State for land reclamation and water quality research. He was the Reclamation Researcher of the Year for ASMR in 1999.

Over his 30-year career in land reclamation Jeff has written and co-authored some 237 publications and articles. The publications comprise 171 book chapters, journal articles, and conference proceedings. He is principal author of 86 of these publications and 66 are extension/outreach publications. He is editor of two periodic publications: ASMR's *Reclamation Matters* magazine and the annual West Virginia Mine Drainage Task Force Symposium proceedings. Jeff served as President of ASMR in 1991 and 2004 and organized ASMR conferences in 1990 and 2004. He has also served as an associate editor for the *Journal of Environmental Quality*. His long career in teaching, mentoring, research and outreach at the local, national and international level make Jeff Skousen an outstanding recipient of the William T. Plass Award, our society's most prestigious award.

He was nominated by Neil Humphries, Manager of Natural Resources and Visiting Professor Celtic Energy Ltd., Caerphilly, United Kingdom. ■

Brenda Schladweiler

2015 Reclamationist of the Year Award

This year's recipient of the Reclamationist of the Year Award has been involved in multiple endeavors of reclamation for 36 years. She started her career as an Environmental Technician, Range Scientist, Associate Environmental Coordinator, and Project Coordinator within the mining industry. Then, in 1982, she established her own company and since then has carried out pre-mining environmental assessments and reclamation planning in the mining industry and more recently in the oil and gas industry. She has been active in numerous professional organizations including the Soil and Water Conservation Society, Soil Science Society of America, Society for Range Management, and the American Society of Mining and Reclamation. She has also been deeply involved with local and regional governments, such as conservation districts, outdoor classroom committees, and has served as a liaison for the Wyoming Reclamation and Restoration Center. She has served ASMR over many years, was involved in the planning of three national conferences, has served on the NEC, and will be serving as our 2015-2016 President. The Society's 2015 Reclamationist of the Year Award is presented to Brenda Schladweiler.

She was nominated by Pete Stahl, Director of the Wyoming Reclamation and Restoration Center, University of Wyoming. ■

Christopher Barton

2015 Richard L. and Lela M. Barnhisel Reclamation Researcher of the Year Award

This year's recipient of the Richard L. and Lela M. Barnhisel Reclamation Researcher of the Year Award has been involved environmental and mined land reclamation research for 25 years. During his career, he has worked with the U.S. Forest Service, South Carolina University, University of Louisville, and the University of Kentucky. He is very active in teaching and advising of students at the University of Kentucky. He has supported and advised 19 graduate students and is presently advising five additional students in their current M.S. or Ph.D. degree programs. His research in mined land reclamation, aquatic ecosystem processes, and water resource impacts have been funded by over $8.6 million dollars of grants in recent years. His research has resulted in over 50 peer-reviewed journal articles and 10 book chapters. He organized and is President of Green Forests Work (a 501c 3) organization that works to re-establish healthy and productive forests on mined lands in Appalachia. This program has resulted in more than 1.2 million trees being planted by thousands of volunteers and over 912 different partners. He is an active member of ASMR and on the planning committee of the 2015 ASMR conference. We are proud to present Christopher Barton with the 2015 Richard L. and Lela M. Barnhisel Researcher of the Year Award.

He was nominated by Richard Barnhisel, past Executive Secretary, ASMR. ■

Coteau Properties Company

Distinction in Reclamation

Joe Friedlander (ASMR President) presents award to William Kirk (Coteau Properties).

This award recognizes excellence in reclamation design, implementation, and overall success. The Coteau Properties Company Freedom Mine is being recognized for the design and development of the Harmony Lake Wildlife Management Area near Beulah, ND. This project uniquely demonstrates superior reclamation: it is the first public fishery specifically planned, designed, and constructed on reclaimed land at an active mining operation in the semiarid West. Development of the Harmony Lake Wildlife Management Area involved the cooperation of the North Dakota Game and Fish Department, North Dakota Public Service Commission, and Coteau Properties Company Freedom Mine. It is recognized as a major local recreational asset for pheasant hunting, duck hunting, Canada goose hunting, and fishing for many species that were not previously available to the public. ■

ARRI Reforestation Award

The ARRI Excellence in Reforestation Awards is presented to White Oak Surface Mine, a 649- acre surface and underground mining operation permitted by DRC Coal, LLC. The permitted land was historically used extensively by the mining and logging industries. These industries left degraded land that had orphan highwalls, numerous open pits, non-native grasses, and barren soil. The Forestry Reclamation Approach was used extensively throughout this operation and DRC Coal, LLC has repeatedly gone above and beyond what the permit calls for in order to help promote and implement the FRA. The land use of the site has been improved, native species are invading, and wildlife habitat has been established. ■

Dave Hartos (left, Deputy Regional Director, OSMRE) presents Dean Chambers (middle, Reclamation Supervisor, DRC Coal, LLC) and Phil Boggs (right, engineering consultant, Mark V Mining and Engineering, Inc.) the Regional ARRI – Excellence in Reforestation Award.

American Society of Mining and Reclamation Awards Program

The awards program of the American Society of Mining and Reclamation provides an opportunity to honor members of our society for their outstanding and exemplary efforts in mined land reclamation, research and long-term efforts and accomplishments in this area. Our awards committee is made up of representatives of the mining industry, academia, and government agencies. This year's committee included Eddie Beardon, Lee Daniels, Scott Belden, Stephen Schroeder, George Vance and Jerry Schuman (committee chair). We encourage all members to give serious consideration to nominating one of many worthy members for these awards for 2016. Information is on the ASMR website and the nomination procedure is quite simple and straightforward. ■

AMERICAN SOCIETY of MINING and RECLAMATION

Student Awards

Oral Presentation 1st place - Anthony Timpano (VT)
Oral Presentation 2nd place - Stephany Scagline (WVU)
Oral Presentation 3rd place - Sarah Smith (SIU)

PhD Scholarship - Abhishek Roy Chowdhury

MS Scholarship - Bryan Page (University of Oklahoma)

Poster Presentation 1st place - David Balthrup
Poster Presentation 2nd place - Kristen Dieterman (Winona State)
Poster Presentation 3rd place - Daniel Johnson (Virginia Tech)

Poster 2nd Place - Kristen Dieterman (Winona State)

Oral 2nd Place - Steffany Scagline (West Virginia University)

Poster 3rd Place - Daniel Johnson (Virginia Tech)

Skelly and Loy - Terry Schmidt

JRW Bioremediation

Trihydro and Herrera - Amy Blyth

Carus Corp.

Virginia Center for Coal and Energy

Sovereign Consulting

ARRI

Biomost

Ranier Seeds - Kevin Miller

Exhibitors

Truax - Michael Hall

NASLR - Janet Yates and Jennifer Keese

Hy-Tech Mushroom Compost - Lisa Van Houten

Office of Surface Mining -
Jeff Trump and LaVon Edwards

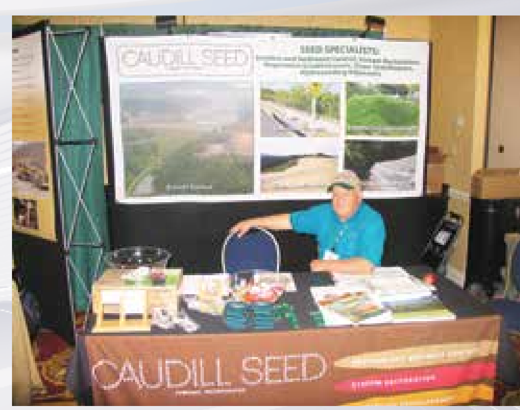
Pacific Inter-Mountain Distribution -
Bill and Erik Krippaehne

Arbogen

Voss Signs

RESPEC - James Brown and Garrie Krueger

Copperhead Environmental Consulting - Josh Adams



Caudill Seed - Kevin Howard

American Society of Mining and Reclamation

33rd National Meeting

June 4 – 10, 2016, Spokane, Washington

rdarmody@illinois.edu

West Virginia Mine Drainage Task Force Symposium

37th Annual Meeting

March 29-30, 2016, Morgantown, WV

jskousen@wvu.edu

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In Defense of SMCRA:

The Case For and Against New Federal Coal Combustion By-product Rules For Coal Mines

By Kimery C. Vories

E-Ternion: Energy, Environment & Economy, Wentzville, MO USA

CCB Placement as a seal to prevent acid mine drainage.

Introduction

The beneficial placement of Coal Combustion By-Products (CCBs) (i.e. fly ash, bottom ash, flue gas desulfurization material, and fluidized bed combustion material) in coal mines permitted under the Surface Coal Mining and Reclamation Act (SMCRA) has be ongoing since the passage of the Act in 1977. CCBs have been placed at SMCRA permitted mines for the purposes of: (1) a seal to contain acid forming materials and prevent the formation of acid mine drainage (Picture 1); (2) an agricultural supplement to create productive artificial soils on abandoned mine lands where native soils are not available (Picture 2); (3) a flowable fill that seals and stabilizes abandoned underground mines to prevent subsidence and the production of acid mine drainage; (4) a construction material for dams, roads, or other earth-like materials where such materials are needed as a compact and durable base (Picture 4); (5) an alkaline additive used to physically and chemically stabilize coal refuse during disposal (Picture 5); and (6) a non-toxic, earth-like fill material used to achieve approximate original contour for final pits and spoil areas (Picture 6) (Vories, 2007).

Technical Investigations by Interior

In May of 1994, the Office of Surface Mining Reclamation and Enforcement (OSMRE) identified CCBs as a priority topic for technical studies and applied research topics from the States, industry, and public interest groups. The OSMRE organized a multi-interest group steering committee to plan and implement a wide range of technology development, transfer events, and products to advance the application of good science wherever CCB placement was planned in surface coal mines. The steering committee was composed of recognized experts related to all aspects of CCBs from universities, the appropriate State and Federal agencies, the coal industry, electric utilities, and the CCBs recycling industry. The OSMRE conducted and published the proceedings of six national technical forums (Chugh et al. 1996, Vories et al. 2000, Vories et al. 2002, Vories et al. 2004, Vories et al. 2005, and Vories et al. 2006) on all aspects of CCB placement at SMCRA coal mines between 1996 and 2006. Subject matter experts presented 144 technical papers over all major topic areas related to CCB placement at coal mines. Based on the findings presented in these forums it was concluded that "Beneficial uses of CCBs at SMCRA coal mines have been researched and documented over the 30-year history of SMCRA. Extensive regulatory authority water quality monitoring data and university research data indicate that the placement of these materials under the permitting and performance standard requirements at a mine regulated under SMCRA usually results in a positive impact to human health and the environment when it is used to mitigate other existing potential mining hazards (Vories 2007).

Existing SMCRA Regulatory Requirements for CCB Placement

The following table provides a brief category summary of applicable SMCRA regulations that covers CCB placement. The complete table of requirements can be found in Appendix E of the Final Report by the National Academy of Science "Managing CCRs in Mines" (NRC 2006).

Ground Water Monitoring	***SMCRA References: 30 CFR*** *Part 777.15 – Completeness Of Application • Parts 779.11, 783.11 – Environmental Resources • Parts 779.18, 783.18 – Climatological Information • Parts 779.21(a), 783.21(a) – Soil Resources • Parts 779.24, 783.24 – General Features • Parts 779.24(g), 786.24(g) – Surface Water Movement • Parts 779.25(a)(6), 783.25(a)(6) – Ground Water • Parts 779.25(a)(7), 783.25(a)(7) – Surface Water Bodies And Structures • Parts 779.25(a)(9), 783.25(a)(9) – Identification Of Placement Areas • Parts 780.21, 784.14 – Hydrologic Information • Parts 780.22, 784.22 – Geologic Information • Parts 780.21(f) & 784.14(e) – Probable Hydrologic Consequences • Parts 780.21(g) & 784.14(f) – Cumulative Hydrologic Impact Assessment*
Well Design & Deployment	***SMCRA References: 30 CFR*** *Part 780.21 Hydrologic Information • Parts 780.21(i), 784.14(h) – Ground Water Monitoring Plan • Parts 816.41(c), 817.41(a) – Ground Water Monitoring • Parts 780.23(b), 784.15(b) – Post-Mining Land Use*
Water Quality Parameters	***SMCRA References: 30 CFR*** *Parts 780.21(i), 784.14(h) – Ground Water Monitoring Plan • Parts 816.41(c), 817.41(a) – Ground Water Monitoring • Part 780.21 – Hydrologic Information • Parts 780.23(b), 784.15(b) – Post-Mining Land Use*
Water Monitoring Frequency	***SMCRA References: 30 CFR*** *Parts 780.21(i), 784.14(h) – Ground Water Monitoring Plan • Parts 816.41(c), 817.41(a) – Ground Water Monitoring*
Water Monitoring Duration	***SMCRA References: 30 CFR*** *Part 800.13 – Period Of Liability • Parts 816.131(2)(i) & (3)(i) – Bonding Period And Annual Precipitation • Parts 816.41(a),(b) & (h) – Hydrologic-Balance Protection • Part 816.42 – Water Quality Standards And Effluent Limitations*
Performance Standards	***SMCRA References: 30 CFR*** *Part 701.11(d) – Application Of Standards • Parts 816.41 – Hydrologic-Balance Protection • Parts 816.41(h), 817.41(j) – Water Rights And Replacement • Part 816.42 – Water Quality Standards And Effluent Limitations • Parts 816.95 – Stabilization Of Surface Area • Part 780.18(b)(9) – Description Of Pollution Control • Part 780.15 – Fugitive Dust Control Practices*
Maximum Contaminant Levels	***SMCRA References: 30 CFR*** *Part 780.21(i) – Ground-Water Monitoring Plan • Part 816.41 – Hydrologic-Balance Protection • Part 816.42 –*
Prohibitions to Protect Health & Environment	***SMCRA References: 30 CFR*** *Part 773.15 – Written Findings For Permit Application Approval.*
Unacceptable Ash Characteristics	***SMCRA References: 30 CFR*** *Part 816.41(f) – Toxic-Forming Materials • Parts 816.102(f), 817.102(f) – Encapsulation • Parts 780.21, 784.14 – Hydrologic Information • Parts 780.22, 784.22 – Geologic Information • Parts 780.21(f) & 784.14(e) – Probable Hydrologic Consequences • Parts 780.21(g) & 784.14(f) – Cumulative Hydrologic Impact Assessment • Part 816.41 – Hydrologic-Balance Protection • Part 816.42 – Water Quality Standards And Effluent Limitations*
Location Restrictions & Baseline Monitoring	*General Environmental Resources Information including the cultural, historic, and archeological resources, 30 CFR §779.12. • Climatic Information, 30 CFR §779.18. • Vegetation Information, 30 CFR §779.19. • Soils Resource Information, 30 CFR §779.21. • Maps: General Requirements, 30 CFR §779.24. • Cross sections, maps and plans, 30 CFR §779.25. • Fish and Wildlife Resources, 30 CFR §779.16. Hydrologic Information, 30 CFR §780.21 • Geologic Information, 30 CFR §780.22*
Permitting & Planning	***SMCRA References:*** ***PL 95-87*** *• Section 102* ***30 CFR*** *Part 701.11(d) – Application Of Standards • Part 773 – Permits And Permit Processing Requirements • Part 777.15 – Completeness Of Application • Part 778.17 – Permit Term • Part 779.11 – Characterization Of Environmental Resources • Part 779.1, 780.1, 783.1, 784.1 – Scope Of Requirements For Permit Application. • Parts 779.2, 780.2, 783.2, 784.2 – Objectives Of Informational requirements For Permitting.*
Acid/Base Accounting	***SMCRA References: 30 CFR*** *Part 816.41 – Hydrologic-Balance Protection • Part 816.42 – Water Quality Standards And Effluent Limitations • Parts 780.21(h), 784.14(g) – Hydrologic Reclamation Plan • Parts 816.102, 817.102 – Backfilling And Grading: General Requirements • Parts 780.21(f), 784.14(e) – Probable Hydrologic Consequences Determination*

Deed Recording	***SMCRA References: 30 CFR*** *Parts 780.14, 784.23 – Map Requirements • Part 773.6 – Public Participation In Permit Processing • Parts 773.6, 840.14, 842.16 – Availability of Records • Parts 780.23, 784.15 – Reclamation Plan: Post-mining Land Use • Parts 816.133, 817.133 – Post-mining Land Use*
Fugitive Dust Control	***SMCRA References: 30 CFR*** *Part 780.15 – Air Pollution Control Plan • Part 816.95 – Stabilization Of Surface Areas (Fugitive Dust Control)*
Public Participation	***SMCRA References: 30 CFR*** *Part 773.6 – Public Participation In Permit Processing • Part 773.6(a)(1) – Public Advertisement Of Permits • Part 773.6, 773.9, 774.15 – Notification Requirements • Parts 773.6, 840.14, 842.16 – Availability Of Records • Part 773.6(d) – Public Availability Of Permit Applications • Parts 840.15, 840.16, 842.11 – Public Participation In Enforcement • Part 842.12 – Requests For Federal Inspections • Part 842.14 – Review Of Adequacy And Completeness Of Inspections* SMCRA provides for citizen lawsuits and judicial review of decisions. ***SMCRA References: 30 CFR*** *Part 775 – Administrative And Judicial Review Of Decisions • Part 842.12 – Requests For Federal Inspections • Part 842.15 – Review Of Decision Not To Inspect Or Enforce* ***43 CFR Subtitle A, Part 4, Subpart L –*** *Special Rules* ***Applicable to Surface Coal Mining*** *Hearings And Appeals*
Enforcement and Corrective Action	***SMCRA References: 30 CFR*** *Part 840 – State Regulatory Authority: Inspection And Enforcement • Part 842 – Federal Inspections And Monitoring • Part 843 – Federal Enforcement • Part 845 – Civil Penalties • Part 846 – Individual Civil Penalties*
Post Reclamation Care	***SMCRA References: 30 CFR*** *Ch. VII, subchapter J – Bonding And Insurance Requirements For Surface Coal Mining And Reclamation Operations. • Part 800.13 – Period Of Liability • Parts 816.41, 817.41 – Hydrologic-Balance Protection • Parts 816.42, 817.42 – Water Quality Standards And Effluent Limitations • Parts 816.111, 817.111 – Revegetation: General Requirements • Parts 816.116, 817.116 – Revegetation: Standards For Success • Parts 816.132, 817.132 – Cessation Of Operations: Permanent • Parts 816.133, 817.133 – Post-mining Land Use • Parts 780.23(b), 784.15(b) – Reclamation Plan: Land Use Information, Following Reclamation*

Regulatory Challenge by the USEPA

In May of 2000, the USEPA announced that regulation of SMCRA-permitted mines under the Resource Conservation and Recovery Act (RCRA) may be necessary since they found a small number (less than 12 from about 1,000 monitoring wells at CCB disposal sites nationwide) of unlined solid waste disposal facilities at electric utilities where leachates from the facilities have contained trace elements at levels of toxicity detrimental to public health and/or the environment (Kim et al. 2001). Although the USEPA had not found any such examples at SMCRA mines, they thought that the similarities between utility disposal sites and mine sites where CCBs are placed as fill warrant similar regulation under subtitle D of RCRA. In addition, the USEPA believed that ground water monitoring at SMCRA mine sites may be inadequately designed to detect toxicity; and bonding of SMCRA mine sites (a minimum of 5/10 years after reclamation and revegetation has been completed) may be of insufficient duration to detect toxicity (USEPA 2000).

CCB placement to supplement soils.

CCBs to make flowable fill with concrete for underground mine plugging.

CCBs can be added to stabilize and treat coal refuse.


CCBs for construction of roads and foundations.


CCBs to add to spoil to achieve approximate original contour requirements.

USEPA-Funded Investigation by the National Academy of Science

In 2003, Congress directed the EPA to commission an independent study of the health, safety, and environmental risks associated with the placement of CCBs in active and abandoned coal mines in all major U.S. coal basins. As a result, in September 2004, the National Research Council (NRC) established the Committee on Mine Placement of Coal Combustion Residues and charged it with conducting the study. In March 2006, the committee published its findings in a report titled "Managing Coal Combustion Residues in Mines" (http://newton.nap.edu/openbook/0309100496/html/index.html). The NRC committee concluded that placing CCBs "in coal mines as part of the reclamation process is a viable management option as long as: (1) CCB placement is properly planned and carried out in a manner that avoids significant adverse environmental and health impacts; and (2) the regulatory process for issuing permits includes clear provisions for public involvement." The NRC committee further recommended that "enforceable Federal standards be established for the disposal of CCBs in mine fills" (NRC 2006).

Substantive Issues and Evidence	Number
Number of Documented EPA Damage Cases at SMCRA Permits	0
Number of SMCRA Damage Cases identified in NAS Study	0
Number of SMCRA Documented Damage Cases in the last 38 years	0
Number of cases identified by Interior where fully implemented SCMRA programs have failed to protect the public and environment	0
Number of Interior Oversight Investigations into the Adequacy of State Programs to adequately implement existing SMCRA requirements for CCB placement. Interior must determine through oversight investigations under Reg. 8 that the existing SMCRA requirements are or are not being fully implemented for CCB placement in order to determine if there is a factual need for additional rules.	0
Number of peer reviewed scientific publications that document where fully implemented SCMRA programs have failed to protect the public & environment related to CCB placement	0
Number of technical and scientific papers that have documented that CCB placement at coal mines have shown no adverse impact to public or the environment	144+
Percent of SMCRA that applies to CCB placement without mention of specific CCB terminology.	100
Percent of SMCRA requirements that are Federally Enforceable	100

Interior Department Rulemaking

On March 14, 2007, the OSMRE published an advance notice of proposed rulemaking in response to the NRC report (72 FR 12026-12030). The OSMRE requested comments on how it should implement the recommendations in the NRC report. Specifically the OSMRE requested comments on how the regulations implementing Titles IV (abandoned mines) and V (active mines) of SMCRA to regulate the placement of CCBs should be revised. The OSMRE received a wide variety of information and opinions from interested parties in response to this request.

The Case For or Against New Federal CCB rules under SMCRA

The following Chart documents substantive issues and evidence that must be weighed in consideration of new Federal rulemaking under SMCRA.

Conclusion

CCB placement has been permitted at SMCRA mines since 1977. After extensive investigations by the OSMRE, the USEPA, and the National Academy of Science, there has been no documented scientific evidence produced to conclusively demonstrate a single instance where SMCRA permits have failed to protect the public or environment. Logic and the rule of law would dictate that prior to attempting additional Federal rulemaking concerning CCB placement at SMCRA mines, it must first be determined whether or not SMCRA is being fully implemented for this practice in all States where it occurs. After such an investigation is completed, then any States not fully implementing SMCRA for such placement must be required to do so. With the current situation where SMCRA is fully implemented and no documented scientific evidence exists for protection of the environment, no additional Federal rulemaking should be proposed.

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Reclamation and Woody Biomass Production on Disturbed Sites with Willow (*Salix interior*)

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Picture 1. A two-year-old *Salix interior* planting established on coal mine overburden using dormant stem cuttings with an abundance of flower catkins capable of releasing thousands of seeds per catkin annually. Several adjacent root shoots can be seen developing from the spreading network of rhizomes (shallow roots).

Introduction

Reclaiming disturbed sites, such as the oil sands region of Alberta and coal mining areas in eastern Canada, may also facilitate establishment of short-rotation woody biomass plantations aimed at emerging bioenergy, chemicals, and materials industries. A fast-growing species is needed that is easily and cost-effectively established on nutrient-poor tailings and that is well-adapted for good growth on such low fertility sites. *Salix interior* (INT) is a willow native to North America and is one of the few willow species that forms multi-stemmed vegetative colonies similar to colony formation in aspen (*Populus tremuloides*). This species is found throughout northern Alberta and the valley of the Athabasca River, which flows through the oil sands. Furthermore, it can readily be found invading and colonizing

Fig. 2. A one-year-old *Salix eriocephala* plant established during the previous growing season on coal mine overburden using dormant stem cuttings. Two-year-old coppice plants of this species can release millions of seeds annually.

Fig. 3. Small patches of *Salix interior* established on coarse gravel erosion sediments on coal mine overburden in eastern Canada.

oil sands mine tailings, demonstrating its adaptability to such harsh, infertile sites. This species is easy to establish using dormant, rootless stem cuttings. Rooting success is over 95 percent in some INT clones. Plantation establishment represents a major cost in short-rotation biomass feedstock production, and any reduction in this cost can significantly affect the economic viability of biomass production.

Of approximately 350 willow species worldwide, only a small group of six or seven North American willows in the taxonomic section *Longifoliae* (Argus, 2010) have the ability to spread from an extensive network of shallow, horizontal roots. Section *Longifoliae* includes *Salix interior* Rowlee (sandbar willow) and the closely related, *S. exigua* Nuttall (sandbar or coyote willow). These are riparian willows that occur naturally from Mexico to Alaska and across much of the interior of North America east of the Rocky Mountains.

Our goals were two-fold. First, we set out to characterize clones of INT that would be useful for both land reclamation and woody biomass production on infertile disturbed sites subject to wind and water erosion. Second, we wanted to raise awareness of the potential economic advantages of vegetative reproduction and colony formation via root stem (RS) production as a way of reducing plantation establishment costs, thereby increasing the commercial viability of short-rotation woody biomass plantations. To do this, we quantified survival, height growth, biomass production, and colony spread via RS formation among eight INT clones that had been previously selected for their survival and growth performance. We determined the differences in colony spread rates via RS as related to site or soil conditions. And we identified superior performing clones for distribution to land managers interested in site reclamation and commercial biomass production.

Site Characteristics and Methods

Our field test site was a narrow, shallow

Table 1. Soil properties for the two site types, rock overburden and loose gravel, at the Salmon Harbour (SH) mine site. Sites with different letters are significantly different using ANOVA test, α = 0.05.

Site	Organic matter (%)	Carbon (%)	Nitrogen (%)	Potassium meq 100 g^{-1}	Calcium meq 100 g^{-1}	Magnesium meq 100 g^{-1}	Phosphorus (ppm)
Shale rock overburden	3.5 a	0.3 a	0.07 a	0.2 a	8.5 a	1.1 a	4.3 a
Coarse gravel outwash	5.3 a	0.2 b	0.05 b	0.2 a	7.2 a	1.0 a	2.0 b

Site	Sand (%)	Silt (%)	Clay (%)	pH	C:N ratio	Sulfur (%)	Rock (%)*
Shale rock overburden	28 b	57 a	14 a	5.9 a	4.0 a	0.02 a	30 a
Coarse gravel outwash	72 a	23 b	5 b	6.4 a	3.1 a	0.02 a	32 a

***Note: Rock percentage is taken before the sand, silt and clay percentage, which are equal to 100%.**

valley that had been landscaped to minimize erosion after mining operations at the Salmon Harbour coal mine operated by NB Power (a public utility), near Fredericton, New Brunswick (NB), Canada (Lat. 46°07' N; Long. 66°05' W). The valley bottomland consisted of two distinct soil types: areas characterized by the exposed broken shale rock overburden that dominates the mine site and areas covered to varying depths by sand and gravel deposits formed from erosion sediments. The depth of these gravel deposits ranged from 16 centimeters to 117 centimeters, with an overall average depth of 53 centimeters. Soil texture properties showed significant differences between site types: sand content was 28 and 72 percent, silt content was 58 and 23 percent and clay content was 14 and 5 percent for the shale rock overburden and gravel erosion sediments, respectively (Table 1). Soil nutrient properties were generally similar between the two site types, and soil nitrogen was very low for both site types, with 0.07 percent and 0.05 percent for the shale rock overburden and gravel sediments, respectively. Soil depth was the most distinguishing feature of the two site types.

Stem cuttings, approximately 20 centimeters in length were collected from eight selected clones of INT from one- and two-year-old stems from an established common-garden field test. Stem sections were stored over the winter months in a freezer at -5°C at the Atlantic Forestry Centre of the Canadian Forest Service in Fredericton, NB. Prior to field test establishment, stem cuttings were moved from frozen storage to a refrigerator held at 3oC for several days of thawing, followed by 48 hours of soaking in water immediately prior to planting at the mine site.

Rootless stem cuttings from these eight INT clones were established at 2 m by 2 m spacing within linear clonal row plots aligned perpendicular to the axis of the valley bottomland. These linear clonal row plots were arranged in 10 blocks that ran up both sides of the valley. Survival counts were made in August 2012, approximately four months after stem cuttings had been established, and again in June 2014 during the third growing season following establishment. After plants had completed three years of growth, the three tallest plants from the valley bottom of each clonal row plot were selected for height measurements. The aboveground biomass from the largest plant per clonal plot was harvested at ground level, and the fresh weight was measured to the nearest 0.01 kg using an electronic infant weigh scale (Electronic Infant Scale, model ACS-20A-YE). Stem colony spread was measured by counting the number of RS arising within a 2 m x 2 m square plot around each of the three plants (ramets) selected for height measurement from each clonal plot. The three sampled plants per plot served as the plot centers of the 2 m x 2 m plot used to count the number of RS arising within each plot. Statistical analyses are detailed in Mosseler and Major (2015).

Results

Eight INT clones showed high variability in survival rates and significant differences in survival among clones (Fig. 1). There was also a large decline in survival over the three growing seasons from an overall average survival of 73 percent during the year of establishment to an overall survival of just 42 percent by the third growing season. Both height and aboveground biomass production at age three were highly variable, and there were significant differences in height growth among the eight clones (Fig. 2). Overall, there were no significant differences in height or biomass production between site types, but certain clones (i.e., LAF-I2, LIM-I3, LON-I2, and PEM-I4) showed

Table 2. Origins of *Salix interior* genotypes (clones) used for biomass production trait assessments made in a common-garden study at the Salmon Harbour mine site near Minto, NB, Canada.

Origin	Latitude; Longitude	Clone	Crown form description
Ottawa, ON	45°42'N; 75°69'W	LAF-I2f	bushy, upright stems; medium
		LAF-I5f	few, tall, upright stems; sparsely-branched
Roebuck, ON	44°80'N; 75°61'W	LIM-I3m	compact, rotund bush; medium
		LIM-I6f	few, upright stems; medium density branching
Long Sault, ON	45°03'N; 74°89'W	LON-I2m	rotund bush, medium density
		LON-I3m	few, upright stems; sparse to medium density branching
		LON-I4f	few, upright stems; sparse to medium density branching
Pembroke, ON	45°50'N; 77°07'W	PEM-I4f	many short upright stems; rotund bush; densely branched

Note: m=male, f-female

significant differences in their growth performance across the different site types (Fig. 2). The latter two clones grew better on the loose, coarse gravel deposits, whereas the former two clones performed better on the rock overburden. By age three, there was a modest statistical difference among clones in the number of RS arising within the 2 m x 2 m plots around each mother plant (ortet), but there were both a significant and a large difference among site types for this trait (Fig. 3). The number of RS was much greater on sites containing the sand and gravel outwash deposits. In addition, there was also a significant clone by site interaction, with clone PEM-I4 showing a dramatically greater capacity in spreading of RS on the erosion sediments than all other clones.

Despite variable moisture conditions along the linear clonal plots that transected this narrow, shallow valley, survival over the year of establishment was surprisingly high (Picture 1). However, by the

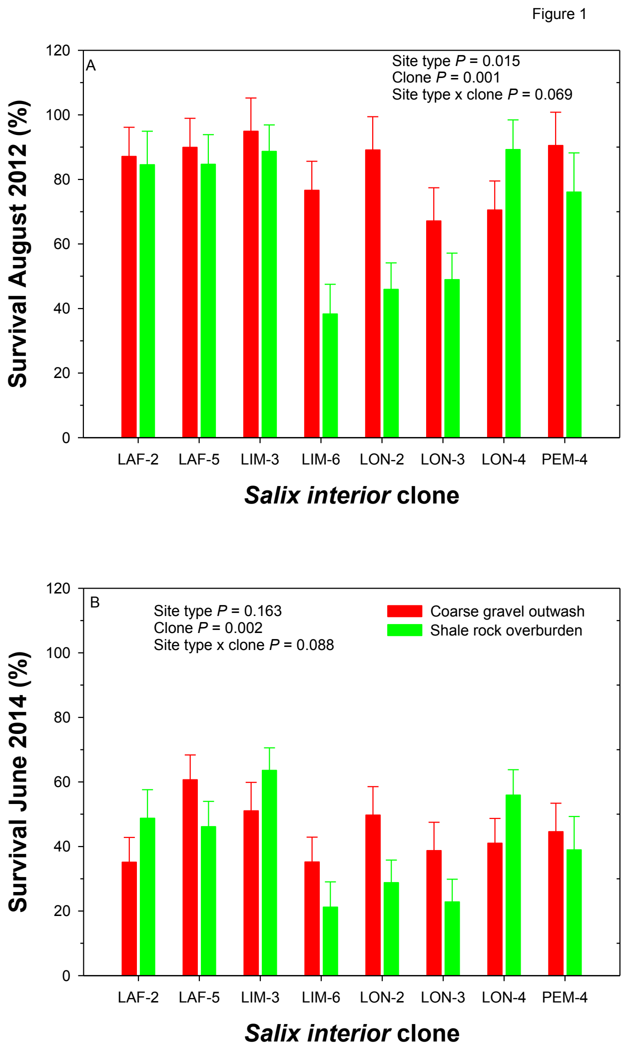

Fig. 1. Percent survival of eight clones of *Salix interior*, established as stem cuttings, on two different site types (coarse gravel outwash versus shale rock overburden) during the year of establishment (A) and during the third growing season (B) on a former coal mine site. Clonal origin codes are defined in Table 2.

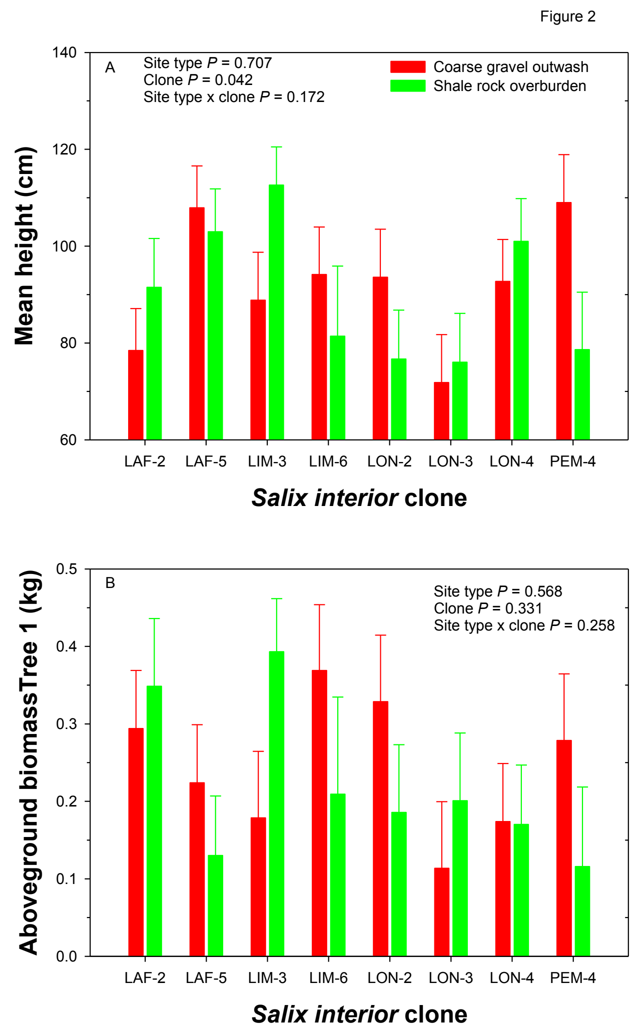

Fig. 2. Mean height growth (cm) and aboveground fresh biomass production (g) of eight clones of *Salix interior* on two different site types (coarse gravel outwash versus shale rock overburden) at age three from establishment as rootless stem cuttings. Clonal origin codes are defined in Table 2.

third year after establishment, survival had declined dramatically, and growth was very poor along the drier sides of the valley. Differences in growth and survival were probably primarily related to differences in moisture availability that were evident along the entire sides of the valley. Only those plants located in the moist center of the valley bottom of each clonal plot grew "normally" (Picture 2). Poor growth in areas outside the moist valley bottom demonstrated that riparian species, such as INT, require abundant available moisture throughout the growing season for sustained growth.

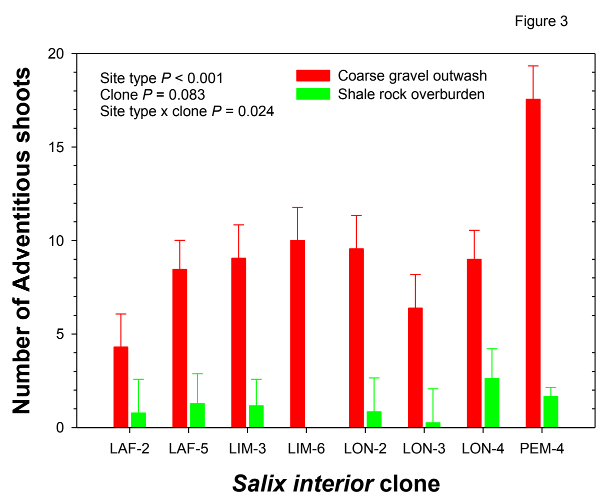

Fig. 3. The number of root stems produced in a 2 m x 2 m plot around ortets of eight clones of *Salix interior* on two different site types (coarse gravel outwash versus shale rock overburden) at age three from establishment as rootless stem cuttings. Clonal origin codes are defined in Table 2.

In other restoration plantings across this coal mine site, INT appeared to survive and thrive best when associated with active erosion stream channels that provided a source of water during the growing season. Nevertheless, over a number of years, root suckering will allow INT to colonize adjacent drier sites in much the same way that balsam poplar (*Populus balsamifera*) and aspens use RS formation exclusively for colonizing sites too dry for seed germination. Although establishment of INT via rootless stem cuttings on sites with high seasonal variation in moisture availability was not always successful along the dry sides of the valley in this study, we have observed five- and six-year-old INT colonies spreading up the sides of dry embankments at various other locations on the Salmon Harbour mine site, indicating that INT can eventually invade drier sites, but that this process requires more time for plants to develop a deep root system capable of reaching the water table. Therefore, this ability to invade drier soils over time via colony formation may be an important characteristic for biomass production plantations on sites with variable seasonal moisture availability.

The strong clonal response in terms of genotype by environment interactions for survival (Fig. 1), height growth, and biomass yield (Fig. 2), and colony spread (Fig. 3) indicates potential opportunities for clonal selection for different growth forms and traits and seed formation (Pictures 2 and 3). For instance, if the rate of clonal spread by RS is the most important growth trait for stream bank stabilization and erosion control, clones such as PEM-I4 may be a preferred growth form. If biomass production for bioenergy purposes is of primary interest, then higher-yielding clones such as LAF-I2, LIM-I6, or LON-I2 might be best.

The best growth of INT colonies in this study was found on sites with loose sand and gravel outwash sediments as opposed to the shale rock overburden. After one season of growth, some plants had already reached heights of one meter on these gravel outwash deposits, had started to spread by RS, and had begun to flower and release viable seeds. This habit of early flowering and prolific seed production suggests that small patches of INT planted across the tailings landscape could promote rapid revegetation of tailings and possibly slow the invasion and colonization of grasses and ericaceous shrubs that can hinder restoration of forest cover on these tailings sites.

Summary

Salix interior provides one of the most promising species for colonizing coal mining areas in eastern Canada and Alberta's oil sands based on its mode of clonal spread by RS. This species shows good survival and growth on these reclaimed sites and could play an important role in the future as woody biomass feedstocks. Clonal differences in INT are apparent, which provides selection for varieties with good survival and growth rates. Establishment with cuttings and spread may represent a major cost advantage in plantation establishment, maintenance, and management. Yields from INT clones are comparable to other willows being field tested for biomass production.

Acknowledgments

We are indebted to George Argus for helpful input and comments over many years in our willow studies. We also thank Setsu Mosseler and Don Ostaff for assistance in field-test establishment and data collection, Michel Labrecque and the Montreal Botanical Gardens for hosting the willow common-garden tests that provided plant material, the Canadian Forest Service for providing operating funds and facilities, Michele Coleman and NB Power for supporting our mine reclamation studies, and Jim Estey of the Laboratory for Forest Soils and Environmental Quality at the University of New Brunswick for conducting soil analyses.

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Influence of Seeding Method and Seed Mix Diversity on Native Plant Restoration Success Following Oil and Gas Pipeline Installation in South Texas

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Oil and gas production activities are often met with mixed emotions by private landowners in southern Texas. There is the obvious financial benefit to the landowner, but there is also the associated loss of wildlife habitat. Seeding method and seed mixture diversity are two key considerations for successful native plant reseeding to mitigate wildlife habitat loss. *South Texas Natives* (STN) has done considerable research to provide answers to frequent questions about these topics in relation to oil and gas production in southern Texas.

South Texas Natives is a project of the Caesar Kleberg Wildlife Research Institute at Texas A&M University-Kingsville. STN's mission is to develop and promote native plants for the restoration and reclamation of habitats on private and public lands. In order to achieve this mission, STN develops ecotypic native seed germplasms for use in southern Texas, works with commercial seedsmen to ensure that adequate supplies are produced for restoration projects, and researches effective planting techniques using the released seed sources. To date, STN and its collaborators have released 25 ecotypic native seed germplasms for use in southern Texas, which have resulted in commercial seed for restoration plantings on 20,000-50,000 acres annually. Prior to the first releases made by STN, there was little to no native plant material available that was adapted to southern Texas for use in restoration and reclamation projects.

The need for STN was created by a paradigm shift that has occurred over the last 20 years in southern Texas where many landowners shifted primary land use from livestock production to recreation including fee- or lease-hunting of wildlife. This land use shift influenced a gradual change away from planting non-native forage species for restoration to the current use of "wildlife habitat friendly" native species. Coupled with the discovery and exploration of the Eagle Ford Shale oil and gas play necessitating

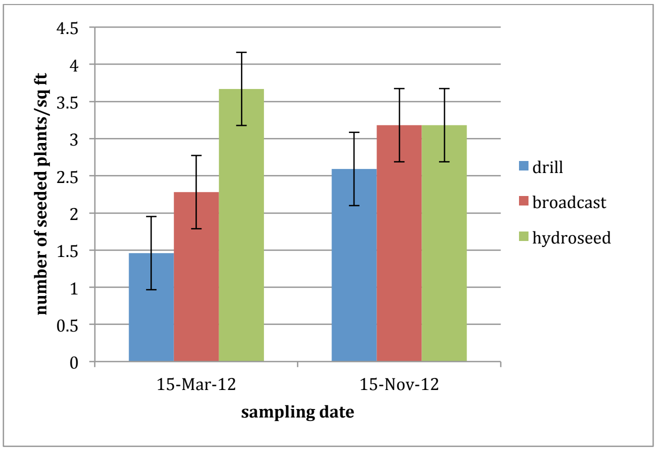

Figure 1. Seeded plant density of the three different planting techniques 3 and 9 months post planting.

Figure 2. Pipeline ROW planted with a diverse ecotyipc seed mix on the right side of the post and unseeded areas left of the post.

large amounts of land reclamation activity, land use changes have resulted in an immediate need for ecotypic native seed, effective seeding technologies, and educational efforts to inform land owners and managers of new products and technologies.

In order to meet these goals, STN in collaboration with Texas A&M Agrilife Extension, Texas Parks and Wildlife Department, and the United States Department of Agriculture-Natural Resources Conservation Service (USDA NRCS), conducted two separate plantings on newly constructed pipeline rights-of-ways (ROWs) in the Eagle Ford Shale region of southern Texas. We evaluated

Figure 3. Pipeline ROW in Wilson County following planting.

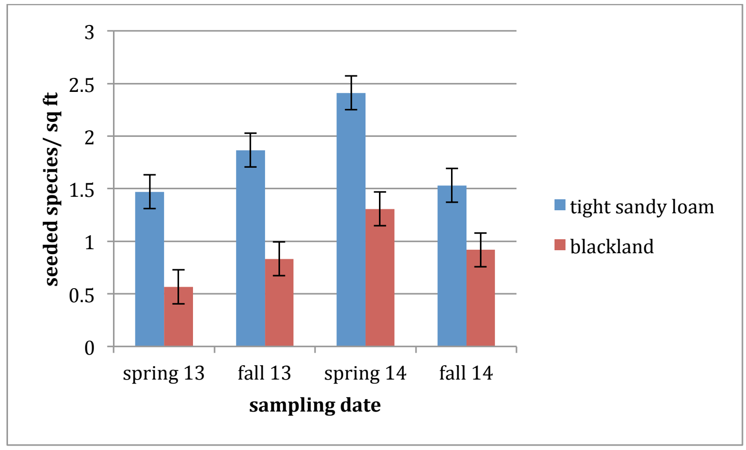

Figure 4. Seeded plant density of both seed mixes at all sampling dates.

four different seeding techniques and three different seed mixes on two different private ranches affected by newly constructed ROWs. These plantings were installed with the purpose of testing the ability of native plants to be used in restoration necessitated by oil and gas activities.

Live Oak County, Texas Pipeline ROW Restoration Project

The first planting was conducted approximately 10 miles north of Three Rivers, TX, in Live Oak County. This planting was designed to compare broadcast seeding, drill seeding, and hydroseeding on three different soil types. Plantings were completed on February 27, 2012 and were seeded using the same seed mix containing 23 species of native grasses, forbs, and legumes. The seed mix for this project consisted of 75 percent early and mid-successional plants in the hopes of quickly establishing cover. The remaining 25 percent of the seed mix was split evenly between late successional grasses, forbs, and legumes. All seed sources included in the seed mix were developed by STN, and all are currently produced by commercial seedsmen. Three days prior to planting, the nine 0.18-ac plots were laid out and sprayed with a mixture of glyphosate and 2,4-D amine herbicides at a rate of 22 oz/acre and 6 oz/acre, respectively. Seeding was conducted in three ways. Broadcast seeding was done with a seeder mounted on a tractor. Drill seeding was done with a Truax Flex II no-till drill. Hydroseeding was conducted with a Finn T120 hydroseeder with a 70/30 wood fiber/cellulose hydromulch blend produced by Second Nature® applied at a rate of 2,500 lbs/acre (Pawelek et al. in press).

Each planting technique was replicated on three different soil types. Site one was a Pavelek clay loam, which is classified as shallow ridge ecological site and is characterized by a gravelly loam surface texture over hard caliche. The second site was a Choke silty clay loam, a deep calcareous fine sandy loam or sandy clay loam characterized as a gray sandy loam ecological site. The third site was a Rosenbrock clay, which is a deep fertile clay in the rolling Blackland ecological site (Soil Survey Staff 2014).

Figure 5. Restored pipeline ROW in Wilson County 1 year post planting.

Figure 6. Diverse plant community established on a restored pipeline ROW in South Texas.

Data were collected bi-annually in spring and fall beginning in spring 2012. Vegetation sampling was done using a five-square-foot frame to count plant density at 25 random locations in each treatment plot. All plant species rooted within the frame were identified and counted.

Rainfall at this site was favorable for plant establishment with the site receiving 7 in. of rain in the first three months post seeding. All planting methods were successful in terms of acceptable establishment of seeded species within three months post planting according to the USDA NRCS range planting practice standards (USDA NRCS 2014), which was used as our criteria for evaluation. NRCS rates a planting successful when it has at least 0.5 seeded plants per square foot by one year after seeding. At the first sampling date (May 15th 2012), there were no differences in plant density of seeded plants among the three soil types. Differences were found for the density of seeded plants among the three different seeding methods at the first sampling date. Hydroseeding averaged 3.67 seeded plants/ ft^2, which provided 60 percent more seeded species than drill seeding (1.46 seeded plants/ft^2) (Figure 1). Broadcast seeding was not different than the other two seeding treatments averaging 2.28 seeded plants/ft^2. By the second sampling date (nine months after seeding), there were only small differences among techniques having only 0.5 plants/ ft^2 difference among all three treatments (Figure 1). Although we found no differences in the number of seeded species per square foot, there were differences in species composition documented among the soil types.

Overall results from this study site showed that successful establishment of ecotypic native species can be accomplished with all three seeding techniques on Eagle Ford Shale ROWs. The effects of seeding technique on establishment are similar to those seen by other researchers throughout the U.S., who have reported that given adequate moisture, a variety of seeding techniques can be successful (Hardegree et al. 2011). Observationally, areas seeded with the diverse mix of ecotypic native seed out performed unseeded areas adjacent to our research plots in terms of vegetation coverage (Figure 2).

Wilson County, Texas Pipeline ROW Restoration Project

The second pipeline reseeding project was conducted approximately 20 miles east of Floresville, TX, in Wilson County. This project was a factorial experiment designed to examine the differences in establishment between two different seed mixes on two different ecological sites using two different planting techniques. We planted both seed mixes with both seeding methods in two plots at each site. The first mix was a "high diversity mix" (HDM) and was made up of 31 native grasses and forbs. The second mix was a "grass only mix" (GOM), which would be considered a standard ecotypic native seed mix used presently on many ROWs. This mix was made up of 10 of the most common native grasses that are medium to short in stature.

The two seeding techniques used in the project were drill seeding using a Truax Flex II® native seed drill and broadcasting using a Trillion® broadcast seeder. The two ecological sites included in this project were a tight sandy loam and a Blackland. The Blackland site has soils that are deep, dark-colored calcareous clays with large water holding capacity and high shrink-swell properties. The tight sandy loam site has very deep, well-drained sandy clay soils (Soil Survey Staff 2014). Similarly to the project in Live Oak County, this ROW was sprayed with a mixture of glyphosate and 2,4-D prior to planting to control emergent weedy vegetation prior to planting. At this location herbicide was applied on February 26, 2013, and seeding was conducted on March 6 (Figure 3).

Data were collected in the same manner as the Live Oak county project beginning June 2013, approximately three months post-seeding. At three months post-seeding, all treatment combinations had successful (≥0.5 seeded plants/square foot) establishment as per NRCS standards. Unlike the Live Oak project, here we saw no seeding treatment effect at any sampling date. Thus, for the purpose of comparing seed mixes and ecological sites, data collected from planting methods were combined. There also was no difference in density of seeded species between the two seed mixes throughout the length of the study. Although there were no differences in plant density between the two seed mixes, with the HDM mix averaging 1.4 seeded plants/ft^2 and the GOM averaging 1.2 seeded plants/ft^2, there was a significant difference in the number of seeded species that established, with the HDM averaging 10 seeded species/plot, almost twice as many species as the GOM which averaged 6 seeded species/plot.

We found a difference in seeded species density between the two ecological sites at each sampling date. The Blackland site had plant densities that ranged from 0.57 to 1.3 seeded plants/ft^2, while on the tight sandy loam site plant densities ranged from 1.4 to 2.4 seeded plants/ft^2 (Figure 4). A difference in seeded species establishment was also observed between the two sites with the tight sandy loam site averaging 9 species while the Blackland site averaged 6 species.

Results from this study reaffirm the ability of ecotypic native seed material to be used successfully in the revegetation of oil and gas pipelines. It is also interesting to note that even though the less diverse seed mix was successful at establishing vegetation, fewer seeded species established. This result is similar to those found by Piper (2014) who found that there was little increase in seeded species cover between a 12- and 20-species seed mix, but there were more species observed in the higher diversity mix. The higher number of seeded species could result in more wildlife use or ability to withstand invasion by exotic grasses (Falk et al. 2013). It is also of note that although there were three times as many species in the HDM there were on average less than twice as many species that established. Although the higher number of seeded species in the HDM would seem inherently true, Grman and Brudvig (2014) found that only at large spatial scales and in favorable growing conditions did increased seed mix diversity increase beta diversity. This site also showed a large difference between restoration results between the two adjacent ecological sites. We suggest these differences show the need for diverse seed

mixes to maximize performance across variable soil types that might occur along the length of a linear reclamation site such as a pipeline ROW (Figures 5 and 6).

These two projects provide practical guidance to reclamation practitioners in several regards. First, ecotypic native seed sources are capable of meeting revegetation needs on new oil and gas pipeline ROWs in southern Texas in as little as three months post-planting given adequate moisture. Secondly, multiple planting techniques can be used successfully to establish native seeds in oil and gas pipeline ROWS. Third, the higher seed mix diversity, the better the chance that a single seed mix will provide adequate cover across multiple soil types or ecological sites. This should help enhance success and provide more diversity on the landscape.

Caesar Kleberg Wildlife Research Institute manuscript number 15-111.

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American Elm in Mine Land Reforestation

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Figure 1. American elm trees in a natural setting show the typical urn-shaped form (credit: www.treeinabox.com)

Introduction

Reforestation of mined land in the Appalachians realizes many important benefits and provides important ecosystem services. Because much of the reclaimed mine lands in Appalachia were previously in forest, reclaiming these drastically disturbed areas to forests is desirable, feasible and cost-effective. The Forestry Reclamation Approach (FRA) provides a five-step procedure to achieve successful mine land reforestation (Burger et al. 2005, Zipper et al. 2011).

Because high tree species diversity is a hallmark of the Appalachian forest, one of the steps of the FRA is to reforest the site with a variety of native tree species so that the resulting stand is diverse and sustainable. Our research has demonstrated that a variety of Appalachian hardwood species do well on reclaimed mine sites, but some species do not survive well, or do not tolerate the extreme conditions on newly reclaimed mine sites. Also, the practical use and availability of species may change over time. For example, eastern ash species (*Fraxinus*) have historically been good reclamation species and widely planted (Rathfon and others 2004). However, an invasive insect, Emerald ash borer, is threatening to extirpate ash trees, so ash is no longer recommended for planting. Thus, it is necessary to continue to refine the recommended planting mix and expand the possibilities.

We can also use the planting mixtures on reclaimed lands as a means to provide important ecosystem functions or services. For example, recent work with American chestnut (*Castanea dentata*) suggests that it may be a good candidate for mine land reforestation. Planting blight-resistant American chestnut on mined lands may serve the added benefit of re-introducing American chestnut to the landscape (McCarthy et al. 2010).

American elm (*Ulmus americana*) was a small component in the eastern USA forest, but more importantly as an urban shade tree. It has desirable silvicultural characteristics, historically had a very wide distribution, and occurred in a variety of sites naturally (Figure 1). It seeds prolifically, and these seeds can be carried long distances by the wind and animals, and the seed germinates very quickly. Elm leaf litter is high in nutrients and decomposes quickly, making those nutrients quickly available to the trees and other organisms and improves the soil in the vicinity of the tree.

Dutch elm disease (DED) is caused by a sac fungi (*Ophiostoma novo-ulmi*) that is spread by the elm bark beetle. The fungi was originally native to Asia and accidently introduced into America and Europe in 1920. The name "Dutch" elm disease refers to its discovery and identification by Dutch tree pathologists. Since its introduction, DED has swept through urban areas, and has altered the role of elm in forest ecosystems. Elm trees often survive to seed producing age, but later die from clogging of water-con-

Figure 2. American elm foliage showing symptoms of Dutch elm disease. Typical symptoms include discoloration and wilting of foliage, followed by branch dieback, and eventually tree death.

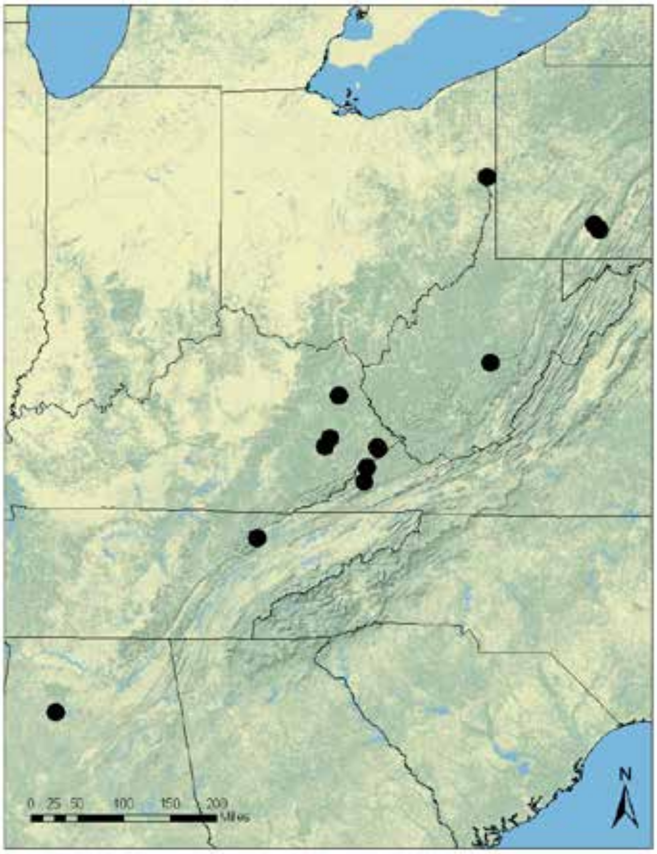

Figure 3. Reclaimed mine sites where DED-tolerant American elms have been planted.

ducting tissues (Figure 2). While DED has not eliminated elms from the landscape, the elms die before becoming large trees. Dutch elm disease tolerance has been noted in some elm trees and breeding programs have resulted in DED-tolerant American elms (Slavicek and Knight 2012) that may be planted into the landscape.

We propose that planting DED-tolerant American elm may be a good means to increase tree species diversity on reclaimed mine lands and to help spread DED-tolerant elm individuals in the coal mining region of the eastern USA. Planting DED-tolerant elm seedlings may help restore some ecosystem functions.

Methods

In 2013 and 2014, initial selections of reputed DED-tolerant American elm seedlings were planted at 14 sites in the Appalachian coal fields from Alabama to Pennsylvania (Figure 3). Elevations ranged from 220 meters to more than 900 meters, and sites included FRA sites, legacy sites (sites that had previously been reclaimed under SMCRA 1992-2005), and AML (abandoned mine land) and bond forfeiture lands. Seed was produced at a USDA Forest Service seed orchard in Delaware, OH. Known DED-tolerant cultivars were used in controlled breeding efforts to create trees with increased tolerance (Slavicek and Knight 2012). Crosses performed for this effort include the R18-2 female X Valley Forge male, and R18-2 male X Valley Forge female. Seedlings were grown at the West Virginia State Tree Nursery at Clements,

Site	State	Elev (m)	Date Planted	Site History	Site Prep	Mine Soil
Pike Co. A	KY	510	3/7/2013	Legacy mine site, reclaimed ~1998	ripped to 36 inches	mine spoil
Pike Co. B	KY	500	3/13/2013	Legacy mine site, reclaimed ~ 2000	ripped to 36 inches	mine spoil
Breathitt Co.	KY	420	3/24/2013	AML site	ripped to 36 inches	1/3 soil, 2/3 mine spoil
Lawrence Co	KY	460	3/28/2013	Bond forfeiture mine land, reclaimed 2012	ripped to 36 inches	mine spoil
Wise Co.	VA	556	3/27/2013	Legacy mine site, reclaimed about 1995	ripped to 36 inches	mine spoil
Campbell Co	TN	915	4/4/2013	Legacy mine site; reclaimed about 1992	ripped to 36 inches	mine spoil
Walker Co	AL	220	2/16/2013	Legacy mine site, reclaimed ~1998	ripped to 12 inches (lightly)	sandy soil

Table 1. Characteristics of sites where Dutch elm disease tolerant elms were planted on mined sites in the eastern USA coal region.

WV. Fifty elm seedlings (1-0) were planted per site in a circular plot 15.24 m in radius.

Survival, diameter and height were measured on seven of these sites (Table 1) over the first two years following establishment. Seedlings were assessed for vigor class and browsing, using scales shown in Table 2. Elm performance was compared with yellow-poplar (*Liriodendron tulipifer*a) seedlings planted on the same sites at the same time.

Results and Discussion

These American elm seedlings performed well when out-planted on reclaimed mined lands. The average first year survival by the planted seedlings was 80 percent, and percent survival after two growing seasons exceeded 75 percent on all of the sites, except for the site in Breathitt County, KY, where survival was only 65 percent (Table 3). The lower two-year survival on the Breathitt County site is attributed to browsing of 26 to 50 percent of the stems by deer and elk. The second-year average height was significantly lower on this site (34.6 centimeters) but the vigor class indicated that the seedlings were under relatively little stress, despite moderate browsing.

After two growing seasons, American elms averaged 62 centimeters in height, ranging from approximately 35 to 70 centimeters across the seven sites. When compared to yellow-poplar, the American elm average height after two years was similar (Figure 4) across all sites where both species were planted. The average vigor class was slightly greater for American elm, and the average browse index was slightly less for American elm relative to yellow-poplar (Figure 5), suggesting that browsing may have been slightly less, or have had a smaller effect.

The results of this trial suggest there may be utility in planting American elm on reclaimed mined lands throughout the Appalachians (Figure 6). There is an obvious need to monitor these trees into the future to see whether these positive results continue and whether the relative success at this early stage translates into successful reproduction. Also, it will be important to know whether these trees tolerate DED. An important hurdle to overcome before widespread planting of DED-tolerant American elms is finding sufficient seedlings of sufficient genetic diversity and provenance. These early results suggest such an effort may be worthwhile. As

Rating	Vigor Class	Browse Class
0	Dead	No impact/no browse
1	Nearly dead	Light (1-25% of stems are browsed)
2	Stressed	Moderate (26-50% of stems are browsed, seedlings not hedged)
3	Little Stress	Heavy >50% of stems are browsed, seedling hedge (top greatly missing)
4	No Stress	Severe >50% of stems are browsed, seeding hedged < 6 inches tall

Table 2. Vigor and browse classifications used for seedlings.

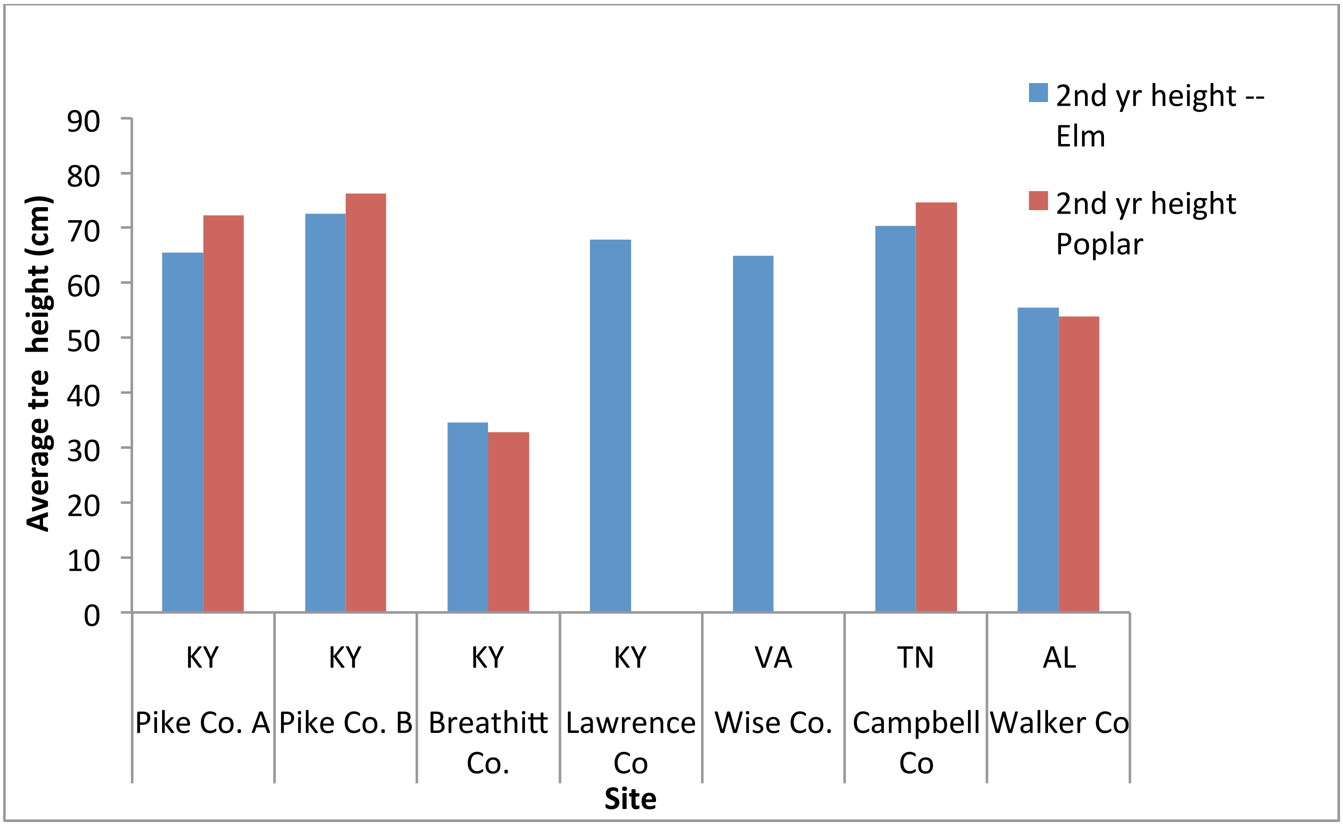

Figure 4. Second-year height of American elm and yellow-poplar.

the number of tree species available for reforestation of disturbed lands decreases, continued development of novel seed sources should occur so that new trees or disease-resistant trees can be introduced without loss of forest diversity.

Conclusions

The DED-tolerant American elm seedlings performed well during the first two years of a field trial across the Appalachians. Survival was high, exceeding 75 percent in most cases, but browsing may be a problem in some areas. There is considerable promise in out-planting these seedlings. The tolerance of these trees to DED and other stressors will be determined with time on these sites and will help managers know whether American Elms can be re-planted into the forest.

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Site Location	State	Survival (%)	Height (cm)	Vigor Class (0-4)	Browsing (0-4)
Pike Co. A	KY	78	66	3.7	0.3
Pike Co. B	KY	82	73	3.0	0.5
Breathitt Co.	KY	65	35	3.0	2.2
Lawrence Co.	KY	75	68	3.9	1.3
Wise Co.	VA	80	65	3.6	0.2
Campbell Co.	TN	80	70	3.9	0.2
Walker Co.	AL	78	56	3.7	1.0
Average		77	62	3.5	0.8

Table 3. Average survival, height, vigor and browsing of Dutch elm disease tolerant American elm seedlings grown on surface mines in the eastern USA coal mining region.

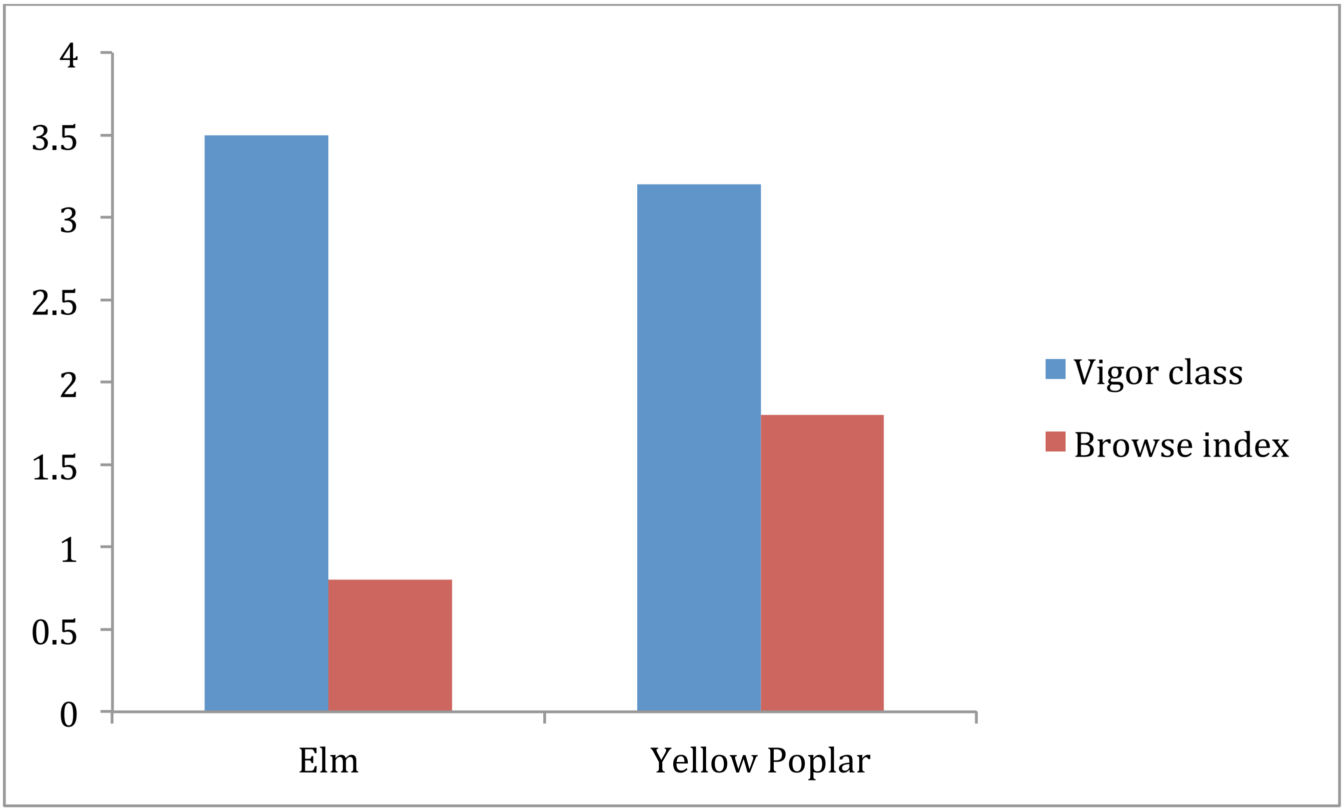

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Figure 6. American Elm seedling planted on reclaimed mine land, after one growing season.

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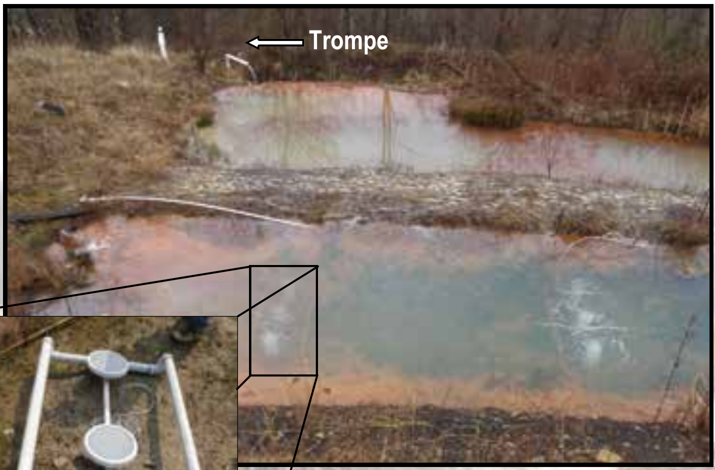

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