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Journal of the American Society of Mining and Reclamation

The Journal of the American Society of Mining and Reclamation **(JASMR)** promotes the exchange of basic and applied solutions for the reclamation, restoration, and revitalization of landscapes impacted by the extraction of natural resources—including, but not limited to coal, minerals, gas, and oil. Contributions reporting original research, case studies, field demonstrations, or policy dealing with some aspect of ecosystem reclamation are accepted from all disciplines for consideration by the editorial board.

Contributions to JASMR

The Journal of the American Society of Mining and Reclamation publishes contributions under the headings Research Papers, Case Studies, Demonstrations, Policy Papers and Review articles. All papers are peer reviewed. Manuscripts may be volunteered, invited, or coordinated as a symposium.

Research Papers: Emphasis is given to the understanding of underlying processes rather than to monitoring. Applying these principals to specific, replicated laboratory, glasshouse, and field problems dealing with reclamation are encouraged. These reports are grouped into the following ASMR defined groups: ecology, forestry and wildlife, geotechnical engineering, land use planning and design, international tailings reclamation, soils and overburden, and water management.

Case Studies: Papers in this category report on reclamation activities over spatial or temporal scales. Monitoring of the response of ecosystem components (water, soil, and vegetation) to innovative practices are the basis for these case study reports.

Demonstration Studies: Papers in this category report on reclamation activities that do not necessarily include projects where significant amounts of data are collected. These may consist of largely photographic evidence of before and after some reclamation technique is applied. These may be observations that practicing reclamationists have observed that have changed how they continued to enhance the process of returning disturbed landscapes to a more desirable condition.

Policy or Review Papers: Submission of papers dealing with regulatory and procedural issues is welcomed. These papers emphasize changing approaches to the science and technology of landscape revitalization. We strive to have them reviewed within 6 weeks.

Other: Letters to the Editor are accepted, and Book Reviews may be invited by the Editor-in Chief.

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RESEARCH PAPERS

CASE STUDY: SOME LESSONS FROM THE EARLY DEVELOPMENT OF NATIVE FOREST REHABILITATION AT THREE SURFACE MINE COMPLEXES IN AUSTRALIA[1]

R.N. Humphries[2]

Abstract: The rehabilitation of forest and other woody vegetation ecosystems on mineral extraction sites is common place and a major post-mining land use throughout Australia. Owing to the need for government certification (under Australian Government and State legislation) for mine closure, monitoring of the establishing forests or other woody ecosystems is typically undertaken using agreed completion criteria which are predictive of rehabilitation future achievement.

The collation and review of the monitoring results for the early development of the rehabilitated forests at three surface mines provide an opportunity to identify key processes and practices that might be used to enhance the achievements in Australia and elsewhere. The monitoring results for two rehabilitation schemes in sub-tropical Queensland (mineral sand and coal) and one in Western Australia (bauxite) were examined.

Whilst it is evident that woody vegetation comprising several native tree and shrub species can be readily established, the resulting vegetation communities in the early development of the forest vegetation can be notably different in their composition and structure to the target and/or locally occurring native types.

It is concluded that forest structural formation in combination with species composition, are of importance in establishing the predicted trajectory of the developing forest type, ecosystem, functioning, and sustainability. Species composition is likely to influence initial forest structure and the need for intervention practices, such as thinning, that may be required to achieve the necessary structural formation and ultimately the targeted native forest types. The principles established are likely to universally apply irrespective of the mineral and climatic types examined.

Additional Key words: plant community composition, vegetation structure, bauxite, coal, mineral sand

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[1] Oral paper presented at the 2015 National Meeting of the American Society of Mining and Reclamation, Lexington, KY ***Reclamation Opportunities for a Sustainable Future*** June 6-11, 2015. R.I. Barnhisel (Ed.) Published by ASMR, 1305 Weathervane Dr., Champaign, IL 61821.

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ISLANDS – SOIL PATCHES AND PLANT COMMUNITY DYNAMICS ON A NEW OIL SANDS RECLAMATION DESIGN[1]

Bradley D. Pinno[2], Ira Sherr, Ruth C. Errington, and Krista Shea

Abstract: The goal of land reclamation after oil sands mining in the boreal forest of northern Alberta, Canada is to re-establish functioning forest ecosystems, including the development of a natural plant community. Reclamation practices include the use of operational reclamation soils derived from upland forest soils (referred to as forest floor-mineral mix (FFMM)), which has higher plant diversity, and lowland based peat-mineral mix (PMM), which has greater tree regeneration. Building from experience in forest harvesting practices and natural landscape patterns, the "Islands" reclamation concept was put into practice in a new reclamation area established in 2015 with patches or islands of differing sizes and shapes of FFMM placed within a matrix of the more abundant PMM. These islands of FFMM are intended to serve as lifeboats and colonization centres for native biota. Initial studies are focusing on determining the optimal size and spacing of the FFMM patches. Plant species area curves were developed and show that patch sizes of at least 671 – 960 m^2 are recommended to allow initial establishment of native plant species, and in particular woody species, with smaller patch sizes favouring non-native weedy species. Initial spatial patterns indicate no relationship between plant species richness and distance to FFMM – PMM soil boundary with the rate and distance of spread of native plants from the FFMM patches being an important monitoring consideration in future years. This work on the Islands approach will help in the development of more efficient and effective reclamation practices which take advantage of the ecological differences in available reclamation soils.

Keywords – forest floor-mineral mix, peat-mineral mix, plant community, reclamation soils, mineable oil sands, Alberta

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[1] Oral paper to be presented at the 2016 National Meeting of the American Society of Mining and Reclamation, Spokane, WA, ***Reclaiming the West***, June 4-9, 2016. R.I. Barnhisel (Ed) Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821.

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VALIDATION OF A STREAM AND RIPARIAN HABITAT ASSESSMENT PROTOCOL USING STREAM SALAMANDERS IN THE SOUTHWEST VIRGINIA COALFIELDS[1]

Sara E. Sweeten[2] and W. Mark Ford

Abstract: Within the central Appalachia Coalfields, the aquatic impacts of large-scale land uses, such as surface mining, are of particular ecological concern. Identification and quantification of land use impacts to aquatic ecosystems are a necessary first step to aid in mitigation of negative consequences to biota. However, quantifying physical environmental quality such as stream and riparian habitat often can be quite difficult, particularly when there is time or fiscal limitations. As such, standard protocols such as the U.S. EPA's Stream Habitat Rapid Bioassessment Protocol have been established to be cost- and time-effective. This protocol estimates ten different stream and riparian conditions on a scale of 0 to 20. Unfortunately, using estimations can be problematic because of large potential variation in the scoring depending on differences in training, experience, and opinion of the personnel doing the estimations. In order to help negate these biases and provide a simplified process, the U.S. Army Corps of Engineers (USACE) developed a functional assessment for streams that measures 11 stream and riparian variables along with watershed land use to calculate three different scores, a hydrology score, biogeochemical score, and habitat score. In our study, we examined the correlation of stream salamander presence and abundance to the three USACE scores. In the summer of 2013, we visited 70 sites in the southwest Virginia Coalfields multiple times to collect salamanders and quantify stream and riparian microhabitat parameters. Using occupancy and abundance analyses, we found strong relationships among three *Desmognathus spp.* and the USACE Habitat FCI score. Accordingly, the Habitat FCI score provides a reasonable assessment of physical instream and riparian conditions that may serve as a surrogate for understanding the community composition and integrity of aquatic salamander in the region.

Additional Key Words: Central Appalachia; headwater streams; rapid assessment; coal mining

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[1] Oral paper presented at the 2015 National Meeting of the American Society of Mining and Reclamation, Lexington, KY ***Reclamation Opportunities for a Sustainable Future*** June 6-11, 2015.

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Case Studies

CASE STUDY: 20 YEARS OF ACID ROCK DRAINAGE CHEMISTRY IMPROVEMENTS AFTER A BACTERICIDE APPLICATION[1]

James J. Gusek[2] and Van G. Plocus

Abstract. The Fisher site is a backfilled and reclaimed (in 1984) surface coal mine in western Pennsylvania, USA. A post-closure toe seep at the site discharged acid rock drainage generated in pyritic rock zones that were identified using geophysical techniques. In 1995, sodium hydroxide and bactericide solutions were injected through cased boreholes into the pyritic zones in a two-step process: sodium hydroxide followed by bactericide. Prior to the event, the toe seepage had been treated with the addition of sodium hydroxide followed by a series of settling ponds and wetland zones. Post-injection, the seepage exhibited net-alkaline chemistry and the sodium hydroxide amendment was discontinued. Based on the prevailing wisdom at the time, the effects of the injection event were expected to be temporary. Two decades later, the beneficial effects of the two-step injection event appear to persist and bond release for the site is pending. The seep chemistry has been monitored for over 25 years and the data trends suggest that the steady-state condition of net alkalinity in the seep water entering the ponds and wetland may be permanent. One current view is that the initial suppression of *Acidithiobacillus ferrooxidans* bacterial community with the sodium hydroxide and bactericide has been maintained by the seasonal infusion of anti-bactericidal organic acids derived from the robust vegetative cover. The situation appears to be self-sustaining. Others may view the data skeptically; that is, the cause and effect of bactericide application and the sustained benefits of the vegetative cover are not proven conclusively. Certainly, the observations suggest that additional focused study is warranted.

Additional Key Words: sustainability, surfactant, coal, ARD, probiotics

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[1] Paper presented at the 2015 National Meeting of the American Society of Mining and Reclamation, Lexington, KY *Reclamation Opportunities for a Sustainable Future* June 7 - 11, 2015. R.I. Barnhisel (Ed.) Published by ASMR, 1305 Weathervane Drive, Champaign, IL 61821.

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TOTAL DISSOLVED SOLIDS IN AN OHIO MINED AREA[1]

Jonathan Peterson[2]

Abstract: At a mined area in northeastern Ohio, Total Dissolved Solids (TDS) concentrations within a large creek and its tributary sometimes exceeded the local regulatory limit. The TDS stemmed from active and inactive coal mines and their settling ponds, from which dissolved loads were carried to the creek and tributary via outfalls. The existing compliance strategy was to control the timing of problematic outfalls, reducing flows when exceedance was imminent; however, because of the variability of weather and mining activities, identifying the problematic outfalls would require more frequent measurements than could be performed manually.

Data logging stations were deployed on the creek and the tributary between each mining outfall, and specific conductivity (for TDS) and pressure (for flow) were recorded at 10-minute intervals. Field testing resulted in an innovative design for the data logger housing. A telemetry station was installed to provide real-time warnings should TDS-thresholds be exceeded downstream of the coal mine. Data analysis included calculations of mass loading and the annual TDS delivered by each outfall. Results indicated four outfalls whose mass loads were particularly problematic, and that TDS was occasionally resultant from an unknown source located upstream of the coal mines. Recommendations are included regarding the designs of systems.

Additional Key Words:

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[1] Oral paper presented at the 2016 National Meeting of the American Society of Mining and Reclamation, Spokane, WA, ***Reclaiming the West***, June 4-9, 2016. R.I. Barnhisel (Ed) Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821.

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REVEGETATION TRENDS AND LESSONS AT TWO MONTANA COAL MINES BASED ON 20 YEARS OF MONITORING[1]

R. A. Prodgers[2]

Abstract: Bighorn Environmental Sciences monitored revegetation at Spring Creek Coal Mine (SCCM) and Decker Coal Mine (DCM) in semiarid southcentral Montana for 20 years using consistent transect locations and methods. Measurements include canopy coverage, air-dried peak standing crop (PSC), and shrub density. About 30 SCCM fields were old enough to evaluate temporal trends. Findings include:

- Ten years after seeding, post-mine perennial productivity and canopy coverage were trending upward and exceeded both performance standards and pre-mine vegetation.
- Shrub density declined in about 4/5s of fields. Meeting the shrub density standard of 5,740/ha for wildlife habitat, the primary post-mine land use, is a major revegetation challenge.
- *Rosana* western wheatgrass tripled in relative cover by the conclusion of monitoring. It combines environmental suitability and vigorous rhizomatous spread. Introduced sheep fescue spread even more abundantly, quadrupling relative cover from the early years to one decade or more later, also spreading to adjacent fields.
- Cheatgrass, which replaces annual forb weeds in unsatisfactory seedings, showed no net temporal trend.
- The explosion of the first-year kochia impairs seeding success through interference competition. Prevention requires mine-wide effort. Seeding into annual weeds or litter has not worked, requiring chemical weed control and litter removal before interseeding. The first seeding opportunity is the best.
- Shrub seedings are far more successful on suitable spoil than on topsoil. However, some spoil meeting the chemical-physical suitability criteria does not support satisfactory revegetation. Scoria can be a fine shrub and diversity substrate or disappointing.
- Heavy-seeded Chenopod shrubs can be established through drill seeding even among vigorous, competitive grasses.
- Light-seeded sagebrush establishes best when seeded apart from the heavy-seeded plants.
- The most prevalent contribution of direct-haul coversoil to revegetation is weeds, not native perennials.

Additional Key Words: performance standards, bond release, seeding shrubs, revegetation substrates, plant litter, seeding techniques, interseeding, pre-emergent herbicides.

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[1] Oral paper presented at the 2016 National Meeting of the American Society of Mining and Reclamation, Spokane, WA ***Reclaiming the West*** June 4-9, 2016. Published by ASMR, 1305 Weathervane Dr., Champaign, IL 61821.

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THE SPENCEVILLE COPPER MINE CLOSURE[1]

William J. Walker[2], Dan Wanket and Alberto Pujol

Abstract: Spenceville Mine is an abandoned copper mine located in the Sierra Nevada foothills of California. The mine was operated intermittently from the 1880's until 1918. The site was covered with mine tailings and overburden materials. In addition, the central portion of the site was occupied by a flooded open pit, which contained approximately 6 million gallons of acidic water with a pH averaging 2.5. The U.S Army owned the site from 1941 to 1962, at which time it was transferred to the California Department of Fish and Game (DFG) with the creation of the Spenceville Wildlife Refuge.

The closure plan was approved by the regulatory agencies in early 2001, and mine closure activities began in April 2001. In subsequent months a water treatment plant was constructed and used to treat the pit water. The treated water was then applied to land in the vicinity of the site. The mine waste was excavated, treated with lime, and placed in the dewatered pit. A two foot layer of local soil was placed as cover over the entire site, and a mine-impacted stream was restored to its original channel. In addition to these tasks, closure activities had to address the potential for unexploded ordnances, reclamation of shafts and tunnels in the dewatered pit, and documentation of cultural resources.

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[1] Oral paper to be presented at the 2016 National Meeting of the American Society of Mining and Reclamation, Spokane, WA, ***Reclaiming the West***, June 4-9, 2016. R.I. Barnhisel (Ed) Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821.

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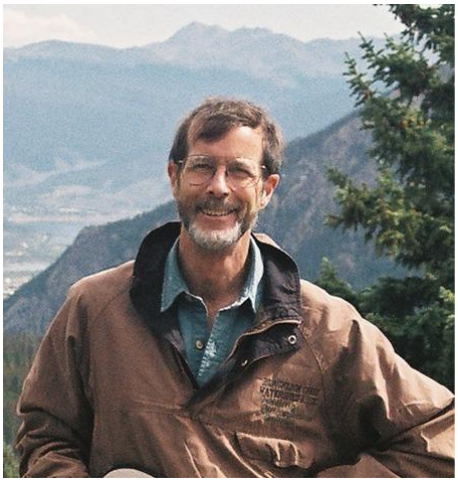
W. Mark Ford is the unit leader of the U.S. Geological Survey Virginia Cooperative Fish and Wildlife Research Unit and associate professor in the Department of Fisheries and Wildlife Conservation, Virginia Tech. His primary research interests are wildlife habitat associations and management in the Appalachians and Mid-Atlantic, particularly bats and other threatened, endangered and sensitive species in a dynamic lands context, i.e., forestry, mining, and urbanization. He earned a Ph.D. in Forest Resources at the University of Georgia, a M.S. in Wildlife Ecology at Mississippi State University and a B.S. in Wildlife and Fisheries Science at the University of Tennessee. Prior to coming to U.S. Geological Survey and Virginia Tech, he had experience with the U.S. Army Engineer Research Development Center and the U.S. Forest Service Northern Research Station as a research wildlife biologist and the Westvaco Corporation as a research forest project manager



Mr. James J. Gusek, PE is a senior engineer with Sovereign Consulting Inc. and is based in Lakewood, Colorado. He graduated from the Colorado School of Mines in 1973 with a B.Sc. in Mining Engineering. He specializes in the design of passive treatment systems for mine influenced water. Since 1987, his work with acid rock drainage prevention and passive water treatment systems has included about 75 projects throughout the U.S. and internationally. He is on the steering and mitigation committees of the Acid Drainage Technology Initiative - Metal Mining Sector (ADTI-MMS).
He is honored to have been recognized as the ASMR Reclamationist of the Year in 2008 and the ASMR Researcher of the Year in 2014. He is a founding member and former president of the Denver Professional Chapter of Engineers Without Borders.

Dr. R. Neil Humphries is currently the Environmental Co-Coordinator for Celtic Energy's coal mining operations in the UK, whilst still practicing as an independent consultant for other mineral resource companies. He is a chartered biologist and soil scientist who specializes in the reconstruction of ecosystems and the development of reclamation practices, a Fellow of the Institute of Quarrying and holds a Visiting Professorship at Cranfiled University's National Soil Research Institute. His 40 years of practical and research achievements was recently recognized by his receipt of ASMR's William T Plass Award 2013.

Mr. Jonathan Peterson is a Project Geologist with over 8 years of consulting experience at railway, mining, military, and aircraft-manufacturing sites. He has a B.S. in Earth and Space Sciences from the University of Washington and an M.S. in Geology from Western Washington University. His thesis involved a mineralogical source investigation linking Glacier Peak to Whidbey Island and this fueled his interest in fate and transport. His subsequent consulting work has included characterizing contaminated groundwater and stormwater, and troubleshooting remediation systems and field equipment. On his projects, the main pollutants have been metals, petroleum, chlorinated solvents, and/or acidity. Since 2013, he has helped Sovereign Consulting characterize and treat mining-influenced waters, and this emphasis has meant an enjoyable combination of fieldwork, data evaluation, and product testing in an intellectually challenging field.

Dr. Bradley D. Pinno is a research scientist with the Canadian Forest Service based in Edmonton, Alberta. He received his BSc Forestry and MSc from the University of Alberta and his PhD in Soil Science from the University of Saskatchewan. Current research focuses on mine reclamation and disturbance ecology, specifically linking below and above-ground ecosystem processes across a range of spatial and temporal scales.

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Dr. William Walker is a Senior Geochemist with Sovereign Consulting Inc. in Seattle, WA. He completed a BS and MS in Chemistry and a PhD in Geochemistry/Water Chemistry from the University of California-Davis. Over the past 25 years he has completed numerous water quality studies and mining/smelter related projects as part of environmental forensic and remediation projects. He specializes in analysis of reactions pertinent to water quality and acid mine drainage and on methods of water quality improvement to mine related effluents.