Journal of The American Society of Mining and Reclamation (JASMR)

An Official Online Publication of the American Society of Mining and Reclamation

ISSN Number 2328-8744

Volume 8, Number 1, 2019

The Journal of the Society of Mining and Reclamation will be published quarterly online on the Society's website: www.asmr.us

Page charges are $10 US/page for non-members, payable prior to placement in the web Journal.

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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 are welcome. 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

SOIL STOCKPILE SEED VIABILITY DECLINES WITH DEPTH AND IS IMPACTED BY SURFACE VEGETATION

Jennifer Buss, Bradley D. Pinno

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http://www.asmr.us/Publications/Journal/Vol 8 Issue 1/Buss-AB.pdf

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EFFECT OF TOPSOIL STOCKPILING ON SOIL PROPERTIES AND ORGANIC AMENDMENTS ON TREE GROWTH DURING GOLD MINE RECLAMATION IN GHANA

Paul Kofi Nsiah and W. Schaaf

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PHYTOREMEDIATION OF SELENIUM-IMPACTED WATER BY AQUATIC MACROPHYTES

Michael Nattrass, N. Rebecca McGrew, Jesse I. Morrison, and Brian S. Baldwin

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DOI: http://dx.doi.org/10.21000/JASMR19010069

ABSTRACTS OF PAPERS
Case Studies

ABIOTIC AND BIOTIC FACTORS IN COAL MINE SOILS INFLUENCE ECTOMYCORRHIZAL COMPOSITION AND SYMBIOSIS[1]

Jenise M. Bauman[2], Shiv Hiremath, and Amy Santas

Abstract. Surface mining for coal leads to significant changes in ectomycorrhizal (ECM) fungal community composition by removing host plants and altering the structure and chemistry of the soil environment. These changes impact ECM fungal composition and efficiency of ectomycorrhizal formation. This study investigates the influence of soil abiotic factors on ECM community composition and root colonization. Two different surface coal mine sites in Ohio, U.S.A. were used: an abandoned surface mine and a site reclaimed under the Surface Mining and Control Act of 1977. Within the abandoned site, three unique conditions were delineated: 1) remnant forest edge, 2) restoration plots consisting of *Pinus virginiana*, and 3) non-vegetated sites. American chestnut (*Castanea dentata* Marsh. Borkh) were sown as nuts for use as ECM trap trees. The presence and identity of native ECM were determined by fungal DNA sequencing of the internal transcribed spacer (ITS) region. Relationships between fungal genera and soil characteristics were determined by a non-metric multidimensional scaling (NMDS) ordination. A multiple regression was used to determine which soil variables influenced ECM root colonization. Results illustrated significant differences between the abandoned mine soils when compared to the reclaimed soils in terms of pH, phosphorus, and potassium. ECM fungal composition was dependent upon the levels of phosphorus, organic matter, and magnesium in the soil. Certain ECM genera were associated with higher phosphorus and pH, while some were linked to nutrient impoverishment. Differences existed between two ectomycorrhizal fungal species within the *Scleroderma* genera, suggesting that not all species within a genus share environmental preferences. Organic matter was a significant predictor of ECM root colonization. Knowledge of these factors will be helpful for designing suitable mine reforestation strategies such as prediction of ECM fungi, use of ECM inoculum, and soil amendments.

Additional Keywords: anthropogenic soil disturbances; abandoned coal mines; legacy mines; soil fungi; seedling establishment; mine reclamation; *Castanea dentata*

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[1] This manuscript was submitted to JASMR for consideration and was not presented at any of our meetings

[2] Jenise M. Bauman, Professor, Huxley College of the Environment, Western Washington University, Poulsbo, WA, 98370; Shiv Hiremath is a Research Scientist with USDA Forest Service, Delaware, OH 43015; and Amy Santas, Professor, Department of Biology, Muskingum University, New Concord, OH.

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DOI: http://dx.doi.org/10.21000/JASMR19010001

Research Papers

SOIL STOCKPILE SEED VIABILITY DECLINES WITH DEPTH AND IS IMPACTED BY SURFACE VEGETATION[1]

Jennifer Buss[2], Bradley D. Pinno

Abstract: Stockpiled soil will be used to operationally reclaim approximately half of the area disturbed by one oil sands mine in northern Alberta, Canada over the next few decades. However, there are concerns regarding the viability of native seeds in stockpiles relative to directly placed reclamation soil. To test the germination of seeds from a four-year-old soil stockpile, we took samples at different depths up to 90 cm from three surface vegetation communities (sweet clover, sow-thistle, and wheatgrass dominated). These samples were placed in the greenhouse on top of potting soil to allow any seeds to germinate for nine weeks. The highest species richness (42% of species) and total plant abundance (68% of all plants) were found at the surface of the stockpile (0-10 cm). Most of the species found in these soil samples were native (63%) and the most abundant species was slender wheatgrass, a native grass species. Vegetation type did not affect the species richness, but there was a higher average seedling abundance in the sow-thistle treatment. The vegetation types did impact the seed-bank community at the surface of the stockpile, with the most abundant species on the surface having the most impact on the seed bank community for each respective vegetation type. However, below the surface the most abundant species in the seed bank did not always reflect the dominant surface vegetation. Using soil stockpiles for final land reclamation in the future may be an issue because of the low number of viable seeds below the surface.

Additional Key Words: seed bank, species abundance, species richness, germination

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1. Oral paper presented at the 2018 National Meeting of the American Society of Mining and Reclamation, St. Louis, MO: The Gateway to Land Reclamation, June 2 - 7, 2018.
2. Jennifer Buss is a MSc Student, Renewable Resources Department, University of Alberta, Alberta, Canada. * Corresponding author (jbuss@ualberta.ca). Bradley D. Pinno is Assistant Professor of Silviculture, Renewable Resources Department, University of Alberta, Alberta, Canada.

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DOI: http://dx.doi.org/10.21000/JASMR19010023

EFFECT OF TOPSOIL STOCKPILING ON SOIL PROPERTIES AND ORGANIC AMENDMENTS ON TREE GROWTH DURING GOLD MINE RECLAMATION IN GHANA[1]

Paul Kofi Nsiah and W. Schaaf[2]

Abstract: Topsoil is a valuable resource and regarded as the most critical and key component in any successful revegetation following mining activities. Consequently, salvaging and stockpiling topsoil for use in future reclamation is encouraged in mine operations. Studies have, however, demonstrated topsoil stockpiling has adverse impacts on soil properties and that stockpiled topsoil would require organic amendment to promote plant growth. This study was therefore undertaken with the hypothesis that (a) topsoil stockpiling as practiced at Newmont Ghana Gold Limited has adverse impacts on soil properties and (b) amending stockpiled topsoil with organic materials, composted sewage sludge and poultry layer manure, promotes the survival and growth of planted trees. A waste rock dump measuring 36m by 45m was graded and covered with a 70 cm layer of stockpiled subsoil followed by a 30 cm layer of stockpiled topsoil. Soil samples, with three replications, were collected at random from the experimental site and from a nearby un-mined, agricultural site used as reference, for determination of pH, nutrients, organic matter, electrical conductivity, effective cation exchange capacity, base saturation, bulk density, and texture. Poultry layer manure (PLM), composted sewage sludge (CSS), and no amendment (control) were the treatments. Potted-seedlings of five forest tree species; *Terminalia superba*, *Terminalia ivorensis*, *Mansonia altissima*, *Kola gigantea,* and *Cedrela odorata;* were planted in May 2016, followed by application of 1 kg and 0.5 kg (dry weight) of the PLM and the CSS respectively, per tree. Diameter and height data of all planted trees and number of surviving trees were collected twice to determine tree growth and survival. Statistical analysis revealed that topsoil stockpiling did not have any significant adverse impact on the measured soil properties, compared with the reference plot. One-way ANOVA combined with LSD and Duncan post-hoc tests ($\alpha = 0.05$) also indicated no significant influence of organic amendments on tree growth. Competition from herbaceous plants due to ineffective weed control was observed to be the main driving factor hindering survival and growth of planted trees. Further study to compare planting the intended tree species concurrently with ground cover species in the first growing season combined with adequate weed control to influence tree growth and survival at the site, to the application of organic amendments is warranted.

Key words: topsoil, mine-reclamation, organic amendment, revegetation, soil properties, trees species

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[1] Oral paper to be presented at the 2019 National Meeting of the American Society of Mining and Reclamation, Big Sky, MT. Welcome Back to Montana: The Land of Reclamation Pioneers, June 3–7, 2019. To be published by ASMR, 1305 Weathervane Dr., Champaign, IL 61821.

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http://www.asmr.us/Publications/Journal/Vol 8 Issue 1/Nsiah-GR.pdf

DOI: http://dx.doi.org/10.21000/JASMR19010045

PHYTOREMEDIATION OF SELENIUM-IMPACTED WATER BY AQUATIC MACROPHYTES[1]

Michael Nattrass[2], N. Rebecca McGrew[3], Jesse I. Morrison[2], and Brian S. Baldwin[2]

Abstract. Stormwater runoff raises concern over potential downstream impacts of selenium (Se) on aquatic ecosystems. Constructed wetland phytoremediation is a sustainable, inexpensive, eco-friendly technology with potential to remove Se from stormwater. The objectives of this study were to: 1) evaluate the bioavailability of Se chemical form and concentration on plant uptake and 2) determine the potential of aquatic macrophytes to improve water quality in a constructed wetland[4]. The experiment was arranged as a 2 X 2 factorial nested within a split-split plot design replicated three times. Cattail (CT; *Typha angustifolia* L.), duckweed (DWD; *Lemna minor* L.), fanwort (CAB; *Cabomba caroliniana* A. Gray), soft rush (SR; *Juncus effuses* L.), muskgrass (MG; *Chara* spp.), and unplanted controls (UNP) were acclimatized 14 d in 115-L microcosms containing 0.035 m^3 of Catalpa silty clay loam with 26 L of water supplemented with 0.1 N Hoagland's solution. Selenium treatments were applied as a 4-L solution of either sodium selenite (SeO_3^{2-}) or sodium selenate (SeO_4^{2-}) to a total volume of 30 L at 0, 500, or 1000 µg Se L^{-1}. Water samples were collected daily for six days. Plant and soil samples were collected prior to Se application and at three-day intervals post Se application. Water, plant, and soil samples were analyzed for total [Se] by inductively coupled plasma-mass spectrometry. Data were analyzed with PROC GLM at α=0.05. After six days, CT and MG-planted microcosms significantly decreased aqueous [Se] by 75 and 74%, respectively, compared to 61% for UNP. The aqueous fraction of microcosms planted to CAB, DWD, and SR were similar to UNP controls. Plant tissue Se content in CT was significantly less than CAB, DWD, or MG, suggesting CT has the potential to volatilize Se. Given its abundance and efficacy, CT is likely a suitable species for Se removal in constructed wetlands supplied with either selenite or selenate-impacted waters.

Additional Key Words: cattail, duckweed, fanwort, muskgrass, phytoremediation, selenate, selenite, selenium, softrush

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[1] Oral paper presented at the 2018 national meeting of the American Society of Mining and Reclamation, St. Louis, MO ***The Gateway to Land Reclamation***, June 3 - 7, 2018. R.I. Barnhisel (Ed.) Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821.

[2] Michael Nattrass, Student, Ph.D., Jesse I. Morrison, Associate Research Professor, PhD., Brian S. Baldwin, Professor, Plant and Soil Sciences, Mississippi State University, Mississippi State, MS.

[3] N. Rebecca McGrew, Environmental Manager, North American Coal.

[4] Work reported here was conducted 33° 28' 9" N; 88° 47' W.

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http://www.asmr.us/Publications/Journal/Vol 8 Issue 1/Nattrass-MS.pdf

DOI: http://dx.doi.org/10.21000/JASMR19010069

ABOUT THE AUTHORS

Dr. Brian S. Baldwin is a Professor of Plant Sciences and Genetics was born on Long Island, New York, and left to attend Bates College (Lewiston, ME) for an undergraduate degree – B.A. Botany. Dr. Baldwin moved to New Mexico to obtain a M.S. in plant breeding working with alfalfa at New Mexico State University. After three years working as a cotton breeder for Dunn Seed Farms, Inc. in Seminole, TX, he returned to Las Cruces (NMSU) to obtain a Ph.D. in plant genetic improvement. Dr. Baldwin moved to Mississippi State University in 1990; as Assistant Dean of CALS with a teaching appointment in Agronomy (now Plant & Soil Sciences). Over a five-year period, he migrated to teaching and research in Plant & Soil Sciences. During his tenure at Mississippi State, Brian has taught seven courses ranging from Biometrical Genetics to Survey of Agriculture. His research focuses on alternative crops, specializing in native grasses for conservation, reclamation and forage.

Dr. Jenise Bauman is a professor at Western Washington University in Huxley College of the Environment. She earned her Ph.D. from Miami University, Oxford Ohio, M.S. from West Virginia University, and B.S. at Eastern Kentucky University. Dr. Bauman is initiating projects that are focused on the restoration of coal mine landscapes in the Appalachian forests, the recovery of riparian forests in the Pacific Northwest, and the reconstruction of estuaries in urban areas of the Western Washington peninsulas. Her research couples field methods with molecular techniques to better understand vegetation establishment, plant interactions, and system recovery in disturbed soils.

Ms. Jennifer Buss is a M.Sc student at the University of Alberta. Her current research involves soil stockpiling and its impacts on seed viability and vegetation communities. She received her B.Sc. degree in Environmental Conservation Sciences from the University of Alberta.

Dr. Shiv Hiremath is a research biologist with the USDA Forest Service, Northern Research Station in Delaware, Ohio. His research combines molecular and microscopic work to better understand the mycorrhizae interactions with American chestnut. He is currently planting these hybrids in reclaimed coal mine sites in the Appalachian to determine field conditions conducive for re-establishing chestnut and testing various species of mycorrhizal fungi for effectiveness.

N. Rebecca McGrew (Not available)

Dr. Jesse I. Morrison is currently an Assistant Research Professor in the Department of Plant and Soil Sciences at Mississippi State University. Originally from western North Carolina, Dr. Morrison was first introduced to post-mining reclamation research while completing his Master's degree in Crop Science at the University of Kentucky. Since joining the Forage and Biomass Breeding and Agronomics team at MSU in 2013, Jesse has worked extensively in native plant germplasm development for increased service and function in conservation, revegetation, and forage utilization systems. A devoted outdoorsman, Dr. Morrison's research program strives to conserve genetic diversity in North American native plant species while increasing the value of native plants to contemporary ecosystem designs through the use of traditional breeding methods.

Mr. Michael P. Nattrass is a doctoral student in the Department of Plant and Soil Sciences at Mississippi State University. He received a M.S. in Agronomy from MSU (2016) with research focusing on nutrient management in row crops. His research focuses on passive treatment options for improving water quality.

Mr. Paul Kofi Nsiah is currently a Ph.D. student at the Chair of Soil Protection and Recultivation (Reclamation) at the Brandenburg Technology University in Cottbus – Germany. He obtained his BSc in Natural Resources Management and MSc in Environmental Resources Management from the Kwame Nkrumah University of Science and Technology, Kumasi – Ghana. Prior to the Ph.D. study in 2015, Paul was a lecturer at the Department of Environmental Management at the University of Energy and Natural Resources, Sunyani - Ghana. Between 2010 and 2013, he was a lecturer at the Department of Land Reclamation and Rehabilitation of the Kwame Nkrumah University of Science and Technology, Kumasi - Ghana. Mr. Nsiah is a professional forester who also worked with Newmont Ghana Gold Limited Ahafo Project in Kenyase - Ghana, where he obtained much of his industrial experience in mine site reclamation. Mr. Nsiah has won awards in Land Reclamation, the most famous among which include the 2017 Environment Excellence Award from the International Erosion Control Association in Long-Beach California – USA and the Second Prize Winner of the maiden edition of the Quarry Life Award competition organized by the Heidelberg Cement Group – Germany, in 2012. His current research focuses on best practices in mine land reclamation, restoration of disturbed landscapes, the use of biological geotextiles in erosion and sediment control, substrate amendment for vegetation establishment.

Dr. Brad Pinno is an Assistant Professor – Silviculture at the University of Alberta in Edmonton. He received his BSc and MSc in Forestry from the University of Alberta and his PhD in Soil Science from the University of Saskatchewan. He has also worked as a Research Scientist with the Canadian Forest Service and as an Operations and Planning Forester. Current research focuses on oil sands mine reclamation and disturbance ecology in the boreal forest, specifically linking soil, plants and operational practices to ecosystem processes.

Dr. Amy Santas is Chair of the Biology Department and Associate Professor of Biology at Muskingum University. She earned her Ph.D. in Cell and Molecular Biology from the University of Wisconsin—Madison and a B.A. in Biology from Luther College, Decorah, IA. Dr. Santas is initiating projects that are focused on the restoration of coal mine landscapes in the Appalachian forests. Her research couples field methods with molecular techniques to better understand vegetation establishment, plant interactions, and system recovery in disturbed soils. She also is initiating projects aimed at understanding the distribution of non-native fish populations in Ohio. In addition, Dr. Santas utilizes biochemical methods to characterize the composition and function of the dystroglycan complex in epidermis.

Dr. Wolfgang Schaaf is an associate professor for soil science and deputy head of the Chair of Soil Protection and Recultivation at BTU. He studied geoecology at the University of Bayreuth/Germany and did also his PhD there. He was research assistant at the Institute of Forest Ecology Eberswalde, Germany. Since 1993 he works in Cottbus on soil chemistry, water and nutrient cycling in ecosystems, restoration of disturbed landscapes, and ecosystem development. He is head of the soil science lab at BTU and course-manager of "Land Use and Water Resource Management "(B.S. and M.S.). He is member of the German Soil Science Society and of the European Geosciences Union (EGU). He published about 50 peer-reviewed and numerous other papers.