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 7, Number 1, 2018

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.

All manuscripts are peer reviewed. Authors will be kept anonymous from the reviewers.

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.

Printed copies: Although this Journal is an online Journal, copies are available at the cost of printing with an ink-jet or color laser printer. Contact asmr@twc.com for cost of current and back issues.

Cover photo is curtesy of Dr. Amanda Schoonmaker with the Northern Alberta Institute of Technology showing the effect of cluster treatments with significantly greater aspen cover

Manuscripts are submitted electronically to Dr. Richard Barnhisel at asmrjournal@twc.com or r.barnhisel@twc.com

Style Guide for Authors: Manuscript preparation guide is available at:
http://www.asmr.us/Publications/Journal/Manuscript%20Guidelines%20Journal.pdf
Which is preferred or
https://www.soils.org/files/publications/style/chapter-01.pdf

Table of Contents

Research Papers

To open the papers, click on the pdf file below the author's name.

Case Studies

Demonstration Paper

DEVELOPING DIVERSE, EFFECTIVE, AND PERMANENT PLANT COMMUNITIES ON RECLAIMED SURFACE COAL MINES: RESTORING ECOSYSTEM FUNCTION

Edward A. Vasquez[2] and Roger L. Sheley pp 77-109

Click below for full paper.

http://www.asmr.us/Publications/Journal/Vol 7 Issue 1/Vasquez-CO.pdf

DOI: http://doi.org/10.21000/JASMR18010077

ABSTRACTS OF PAPERS
RESEARCH PAPERS

VALUING THE ENVIRONMENTAL BENEFITS FROM REFORESTATION ON RECLAIMED SURFACE MINES IN APPALACHIA[1]

Xiaoshu Li[2], Andrew Stainback, Chris Barton, and Jian Yang

Abstract. Surface mining has impacted large portions of eastern Kentucky's forestland and many of these areas are currently unmanaged. The Appalachian Regional Reforestation Initiative (ARRI) was launched in 2004 as a means to promote forest reclamation. This study evaluated four ecosystem services provided by reforestation on legacy reclaimed mine sites: carbon sequestration, water quantity and quality, wildlife biodiversity, and aesthetic and recreational value. Spatial analysis and benefit transfer methods were employed to evaluate the non-market value from reforestation. We classified the legacy lands in eastern Kentucky as barren, grassland, or shrub(scrub) land use and calculated the ecosystem benefits for each landscape type. Compared with the reclamation cost, we find that under a 7% discount rate only land in riparian zones provided net benefits from reforestation. The total ecosystem benefits provided by reforestation in these landscape positions were $1,449,690. However, under a 3% discount rate with all the land reclaimed as forest in the study area, the total value of ecosystem services generated from these lands were $456,428,682. The ecosystem service benefits from reforestation on reclaimed legacy lands depends on landscape type, the specific dynamics of ecosystem recovery, and demographics of populations nearby. The results demonstrate the importance of synthesizing essential ecological and economic concepts in mining land reclamation planning.

Additional Key Words: forest reclamation; ecosystem services; benefit transfer

---

[1] Paper submitted to JASMR for publication.

[2] Xiaoshu Li is Research Associate, University of Kentucky, Lexington, KY, 40546; Andrew Stainback is Ecological Economist, Everglades Foundation, Palmetto Bay, FL, 33157; Chris Barton is Professor, Department of Forestry and Natural Resources, University of Kentucky, Lexington, KY, 40546; and Jian Yang is an Assistant Professor, Department of Forestry and Natural Resources, University of Kentucky, Lexington, KY, 40546.

Click below for full paper or on the DOI

http://www.asmr.us/Publications/Journal/Vol 7 Issue 1/Li-KY.pdf

DOI: http://doi.org/10.21000/JASMR18010001 pages 1-29

EFFECTS OF ALDERS (ALNUS SP.) USED FOR RECLAMATION OF LIGNITE COMBUSTION WASTES[1]

Marcin Pietrzykowski[2], Bartłomiej Woś, Marcin Chodak, Katarzyna Sroka, Marek Pająk, Tomasz Wanic and Wojciech Krzaklewski

Abstract. Combustion waste and fly ash disposal sites have unfavourable properties for revegetation. Owing to its phytoameliorative ability different alder species have long been used in the reclamation of degraded sites, as N-fixing species and forecrop for introducing more demanding tree species in reforestation. We present the growth parameters and effects of black alder (*Alnus glutinosa*), grey alder (*A. incana*), and green alder (*A. viridis*) on the physicochemical and biological properties of the technosols developed from the lignite combustion wastes disposal site in central Poland after 10 years of plant growth. The study plots were randomly arranged (72 m^2 of each plot, four replications for variant) at 3 species × 2 different soil treatments: CCW+L (combustion waste with lignite amendment in planting hole) and CCW (pure combustion waste). The obtained results indicate that soil treatment did not significantly influence the studied physicochemical soil parameters (pH, CEC, RESP, SOC, N_{tot} and macronutrients content) either in O horizon or in the mineral soil. The effect of species on pH, N_{tot} and macronutrients content was evident in the O horizon but not in the mineral soil. The better growth parameters were found for black alder than for grey alder. The mean height was 3.9 and 6.3 m for grey and black alder, respectively. Accumulation of litter layer (O_l) ranged from 2.9 to 3.6 Mg ha^{-1} (mega gram per hectare), and grey alder litter was characterized by the highest content of nutrients (N-P-K). Organic C content in the 0-5 cm mineral layer (A) increased to 38.06 and 47.80 g kg^{-1} (gram per kilogram dry soil), respectively for green and black alder. The highest N content in A layer was measured under black alder. Microbial respiration and biomass were significantly lower in the O_l layer under green alder than under two other alder species. However, in the mineral soil all three alder species stimulated microbialbiomass and activity similarly. Because of the highest growth parameters of black alder and the highest litter production under canopy and N content in the soil we recommend this species for revegetation of combustion waste disposal site.

Additional Key Words: Fly ash, revegetation, N-fixing, soil respiration

---

[1] 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. Published by ASMR; 1305 Weathervane Dr., Champaign, IL61821.

[2] Marcin Pietrzykowski, Professor, Department of Forest Ecology and Reclamation, Institute of Ecology and Silviculture, Faculty of Forestry, University of Agriculture in Krakow, Al. 29 Listopada 46, 31–425 Krakow, Poland.

Click below for full paper or the DOI.

http://www.asmr.us/Publications/Journal/Vol 7 Issue 1/Pietrzykowski-Poland.pdf

DOI: http://doi.org/10.21000/JASMR18010030 pages 30-55

Case Studies

SPECIFIC CONDUCTANCE REDUCTION IN VALLEY FILL RUNOFF USING THE COST-EFFECTIVE SULFATE REMOVAL PROCESS[1]

Catherine V. Grey[2], Gregory D. Boardman, Jeffrey Parks, Zachary Kemak, and Kristin Gunther

Abstract: In recent years, the specific conductance (SC) of Appalachian coal mining runoff waters has become a parameter of concern with the EPA due to its negative effect on aquatic life and water quality. In order to comply with the EPA guidance suggesting an effluent SC of 500 µS/cm, the Appalachian Research Initiative for Environmental Science (ARIES) Center at Virginia Tech requested that testing be conducted to determine the most effective technologies for reduction of SC. Runoff water was collected from two sites in southwestern Virginia and characterized to determine the source of SC. The primary contributing ions were determined to be Na^{+}, Mg^{2+}, Ca^{2+}, and SO_4^{2-}. Once characterized, the sample water was treated using a two-step precipitation method called the Cost-Effective Sulfate Removal (CESR) process. Study results indicate that source water with an SC of 1,500-2,500 µS/cm could be successfully reduced below the proposed EPA limit of 500 µS/cm when the second step of the CESR process lasted 18 hours and the reagent dose was 1.25x the source water sulfate concentration. The success of this process was due to its ability to remove more than 85% of the Ca, Mg, and SO_4^{2-} from the water, which together accounted for more than 90% of ions in the source water.

Additional Key Words: Electrical Conductivity, Appalachia, CESR

---

[1] Paper submitted to JASMR for publication.

[2] Catherine Grey is a master's degree recipient, Gregory D. Boardman is a Professor Emeritus, Jeffrey Parks is a Research Scientist, Zachary E. Kemak is a master's degree recipient, and Kristin Gunther is a bachelor's degree recipient, Civil and Environmental Engineering Department, Virginia Tech, Blacksburg, VA 24061.

Click below for full paper or the DOI.

http://www.asmr.us/Publications/Journal/Vol 7 Issue 1/Grey-VA.pdf

DOI: http://doi.org/10.21000/JASMR18010056 Pages 56-76

Demonstration Paper

DEVELOPING DIVERSE, EFFECTIVE, AND PERMANENT PLANT COMMUNITIES ON RECLAIMED SURFACE COAL MINES: RESTORING ECOSYSTEM FUNCTION[1]

Edward A. Vasquez[2] and Roger L. Sheley

Abstract. Surface coal mine disturbances affect vegetation, soil chemical/physical properties, bedrock, and landforms. The scope of this article focuses on lands to be reclaimed back to rangelands (post-mine land use) similar to the pre-mine ecosystem in terms of plant composition/diversity, structure, and ecosystem function. Reclamation programs that solely emphasize plant community composition and structure rather than effectively repairing disturbed or altered ecological processes ignores the foundation upon which the sustainability of reconstructed plant communities depends. Reclamation success may be improved by addressing primary ecological processes driving ecosystem function as part of the reclamation process. Altered primary processes require repair of the physical system in conjunction with adding seeds or plants. Land-form design strategies, which are designed to capture, store, and release water effectively into re-constructed watersheds is the foundation of successfully reclaimed ecosystems. Because plant functional groups can differ in their spatial and temporal acquisition of resources, improving functional diversity may be a method to more fully utilize soil nutrients in reclaimed soils and improve resilience to weed invasion. Strategically combining species with different seed/seedling traits in seed mixtures can increase chances of achieving adequate plant establishment during revegetation. Monitoring program design should be an integral part of the reclamation planning process, and indicators reflecting landscape-scale processes can be adapted to monitor reclamation project success. Effective reclamation plans are process-oriented, seek to initiate self-repair, and address landscape interactions. The probability of achieving successful reclamation is enhanced by pursuing a broader goal of improving ecosystem vigor, organization and resilience utilizing novel assemblages of species that perform desired functions and produce a range of ecosystem goods and services. Reclaiming mined land requires realistic objectives that consider the ecological potential of the site, land-use goals, and socioeconomic constraints.

Additional Key words: Restoration, Revegetation, Biodiversity, Plant Functional Groups, Geomorphic Reclamation

---

[1] 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, Champaign, IL 61821.

[2] Edward A. Vasquez, Ecologist, USDI – Office of Surface Mining Reclamation and Enforcement, 1999 Broadway, Denver, CO 80202; and Roger L. Sheley, Ecologist, USDA-Agricultural Research Service, 67826-A Highway 205, Burns, OR 97720

Click below for full paper or the DOI.

http://www.asmr.us/Publications/Journal/Vol 7 Issue 1/Vasquez-CO.pdf

DOI: http://doi.org/10.21000/JASMR18010077 Pages 77-109

ABOUT THE AUTHORS

Dr. Christopher D. Barton, is the Director of the University of Kentucky's Appalachian Center and Professor of Forest Hydrology and Watershed Management in the Department of Forestry and Natural Resources. Dr. Barton is currently working in the areas of ecosystem restoration, reforestation and remediation primarily in stream and wetland habitats and mined lands. In addition, improved methods for preventing water quality degradation from logging and mining activities are currently being examined. Dr. Barton is an Associate Editor for the International Journal of Phytoremediation and the International Journal of Mining, Reclamation and Environment. Dr. Barton is also currently serving as the co-Team Leader of the Appalachian Regional Reforestation Initiative's Science Team and founder of the Green Forests Work program. Dr. Barton was the recipient of several National awards including the American Society of Mining and Reclamation's 2015 Richard and Lela Barnhisel Researcher of the Year Award. For more information visit: www.greenforestswork.org and www.facebook.com/Greenforestswork

Dr. Gregory Boardman is a Professor Emeritus of Civil and Environmental Engineering at Virginia Tech. He is a Fellow of the American Society of Civil Engineers(F.ASCE), licensed as a professional engineer (P.E.) in Virginia, a Diplomate of Environmental Engineering (DEE), and a Diplomate of Water Resources Engineering (D.WRE). During his 40 years on the faculty at Virginia Tech, Dr. Boardman performed research and taught courses in the areas of environmental engineering principles, water and wastewater treatment processes, industrial and hazardous waste management, and environmental toxicology. He served as an engineering consultant to more than 50 agencies and companies, was the principal or co-principal investigator for more than 150 funded research projects and published more than 240 papers and reports in the environmental area.

Marcin Chodak PhD., D.Sc. is an Associate Professor at AGH University of Science and Technology in Kraków, Poland. He received his M.S. degree in Environmental Engineering from AGH University of Science and Technology and Ph.D. in Forestry from Georg-August University in Göttingen, Germany. His research interests include reclamation of post-mining barrens, soil pollution effects, microbiological properties of soils and interactions between plants and soil microorganisms.

Ms. Catherine Grey is a civil engineer with NAVFAC Atlantic. She received her M.S. in environmental engineering (2017) and B.S. in civil engineering (2015) from Virginia Tech, where she focused on drinking water, municipal and industrial wastewater treatment. Current areas of interest include emerging contaminants, such as per- and polyfluoroalkyl substances.

Kristin Gunther

Mr. Zachary Kemak is a civil engineer with Black & Veatch. He received his MS in environmental engineering from Virginia Tech (2016) and BS in civil engineering from NC State University (2014). Current work focuses include water treatment, wastewater treatment, and sustainable infrastructure.

Wojciech Krzaklewski Ph.D., D.Sc., currently is emeritus professor in Department of Forest Ecology and Reclamation, Agricultural University of Krakow. His main field of interest are direction of succession, phytosociology and reclamation methods. He initiated and continues pioneer research in Poland on the application of green alder (Alnus viridis) in forest reclamation and practical using of succession communities in reclamation process. He is the author and co-author of over 170 studies devoted to reclamation and environmental engineering. He was supervisor of six doctoral thesis, and over forty master and bachelor degree students. He is co-inventor of 3 patents on reclamation and bio-stabilization methods, and an author of conceptual studies and projects for forest reclamation of the largest post-mine dumping grounds in Poland, including in lignite mining (Bełchatów, Turów, Adamów), sulfur mining (Machów and Osiek) and sand filing mining excavations (Szczakowa, Kuźnica Warężyńska, Kotlarnia) with pioneer projects of using succession in reclamation.

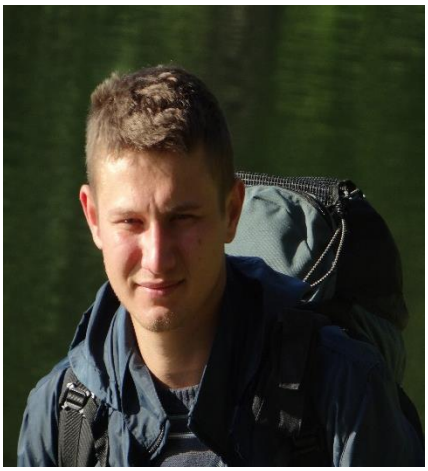
Marek Pająk Ph.D. is a researcher in Department of Forest Ecology and Reclamation, Agricultural University in Krakow. He focused on reclamation and biomonitoring. He received his PhD in 2003 in forestry at the University of Agriculture in Kraków. He gives lectures on forest reclamation at the Faculty of Forestry, University of Agriculture in Krakow.

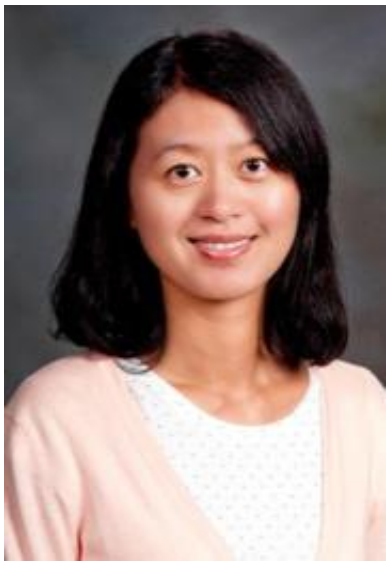
Jeffrey Parks

Katarzyna Sroka M.Sc. Katarzyna Sroka is a laboratory researcher at the AGH University of Science and Technology in Kraków, Poland. She received her M.Sc. in Chemistry at the Jagiellonian University in Kraków, Poland. Currently she works on her Ph.D. in Environmental Engineering at the AGH University of Science and Technology. Her research interests focus on chemical and microbiological properties of mine soils.

Tomasz Wanic Ph.D. is a Quality Manager in the Laboratory of Geochemistry of Forest Environment and Areas Designated for Reclamation at the Faculty of Forestry, University of Agriculture in Krakow. He received his PhD in 2001 in forestry at the University of Agriculture in Kraków. He focuses on the study of the impact of alder species on natural and post-agricultural and post-industrial soils.

Bartłomiej Woś, Ph.D. is a researcher at the University of Agriculture in Krakow, Poland. He received his PhD in 2015 in Forestry, Forest Ecology and Reclamation, Faculty of Forestry at the University of Agriculture in Krakow. His research interests include reclamation of disturbed lands, tree species adaptation to disturbed habitats, mine soils – vegetation relationships, tree species effects on soil properties, pedogenesis and forest ecosystem development on post-mining sites.





Dr. Xiaoshu Li, graduated with a Ph.D. in Economics and a MS in Statistics from Virginia Tech University. Currently, she is a research associate at the University of Kentucky. Xiaoshu's areas of research include environmental economics, applied econometrics, cost-benefit analysis and spatial statistics. Xiaoshu's research interests focus on non-market evaluation methods and its application to forest ecosystem services. She has worked on research projects using the contingent value evaluation method to investigate the public's preferences toward different alternatives of forest harvesting practices. She has also employed hedonic models to investigate the economic damages from forest pest infestation of hemlock wooly adelgid in northeastern US.

Marcin Pietrzykowski Ph.D., D.Sc., completed his doctoral degree in 2005 and habilitation in 2011 in Reclamation of Degraded Land and Forest Ecology at Agricultural University in Krakow, Poland. Currently he is a full professor in Forestry, Forest Ecology and Reclamation at Department of Forest Ecology and Reclamation, Faculty of Forestry, ACU in Krakow. Doctor Pietrzykowski has been involved with the reclamation and redevelopment of post-industrial sites and mined lands. His principal focus rested on the restoration ecology, environmental specifics, soil-plant relationships and overall dynamics of new forest ecosystems, and also on the specific methods of bio-stabilization and remediation of the most heavily contaminated sites. In 2013 he has taken Fulbright scholarship and developed his research in Department of Crop and Soil Environmental Science at Virginia Tech, Blacksburg VA. He is Laureate of Cultura Prize 2015 by Alfred Toepfer Foundation for his significant input to comprehensive studies on reclamation of mine site restoration in Europe. He is an author and co-author of over 100 scientific papers and co-inventor of patents of bio-stabilization and reclamation methods.

Dr. G. Andrew Stainback is an Economist for the Everglades Foundation. Originally from Virginia, he received his B.S. and M.S. degrees from Virginia Tech and the University of Montana respectively. After completing his Ph.D. in natural resource economics at the University of Florida, he received his J.D. from Florida State University. He has expertise in economics, social science and environmental policy. Over the past fifteen years, he has conducted research on the economics of ecosystem services, the human dimensions of natural resource management, and sustainable development in both domestic and international contexts.

Dr. Edward Vasquez received his B.S. and Ph.D. from the University of Arizona. He majored in Rangeland Ecology/Management and Soil Science. Following his graduate work, Dr. Vasquez completed a post-doc with the Agricultural Research Service focusing on rangeland weed management, particularly with respect to exotic annual grasses. Following his post-doc, Dr. Vasquez was a visiting faculty member at Humboldt State University, Department of Forestry and Wildland Resources. Dr. Vasquez currently works as an ecologist for the Office of Surface Mining Reclamation and Enforcement, Western Region Program Support Division.

Dr. Jian Yang is an Assistant Professor of Forest Landscape Ecology at the University of Kentucky. His research mainly focuses on the causes and consequences of natural and anthropogenic disturbances (e.g., wildfire, timber harvest, mining) on forest composition and structure, ecosystem processes and landscape dynamics. He has been developing new methods and applications of remote sensing, geographic information system, and ecological modeling to address complex interactions of forest, climate, and disturbance. He is also working on the integration of ecosystem service assessment and landscape ecology to provide new insights to complex issues in environmental management under the context of global change. Dr. Yang obtained his PhD in Forestry from the University of Missouri.