

UNIVERSITY OF PENNSYLVANIA

SCHOOL OF ARTS AND SCIENCES

DEPARTMENT OF EARTH & ENVIRONMENTAL SCIENCE

COLLEGE OF LIBERAL AND PROFESSIONAL STUDIES



RESOURCE MANAGEMENT ABSTRACTS

ANALYSIS OF LAND CONSERVATION METHODS FOR ACQUISITION OF LAND INHOLDINGS IN TURRIALBA VOLCANO NATIONAL PARK, COSTA RICA

Alfonso Castro (2017)

Readers:

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The existence of land inholdings in Turrialba Volcano National Park, in Costa Rica, represent an obstacle for the implementation of a management plan. Currently, 78% of the area encompassing the national park is private land, dedicated to dairy production and agriculture. Sections of these properties have been devastated by increased emissions of ash and gas emanating from Turrialba Volcano since 2012. This situation provides a unique opportunity to acquire the land inholdings and annex them to the national park, facilitating the implementation of the management plan. A series of land conservation methods to acquire the private inholdings were evaluated, as well as on site visits and personal communications with park officials, professionals in the field of conservation, and land owners. The research shows that different land conservation methods require a high degree of coordination and diplomacy between government branches, financial institutions, conservation organizations, and international partners. The research also suggests that enactment of laws and tax regulations encouraging conservation, is less costly and benefits other national parks. Currently, this type of legislation is limited in Costa Rica. Debt for nature swaps, used twice before in Costa Rica, constitutes the most advantageous option for the acquisition of the land inholdings in Turrialba Volcano National Park.

BIOMONITORING OF THE FRESHWATER MACROINVERTEBRATE COMMUNITY IN NORTHEAST BANGLADESH AND WESTERN BHUTAN: AN INITIATIVE TO STRENGTHEN LOCAL SCIENTIFIC CAPACITY

Naimul Islam (2017)

Readers:

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With their high diversity, high abundance, and spectrum of pollution tolerances, benthic macroinvertebrates are an inexpensive yet powerful tool for biomonitoring of freshwater quality near anthropogenic impacts. Aimed at the expansion of successful scientific practice for the well-being of the resource-dependent rural communities in South Asia, this study had two main components. The first part emphasized characterizing little-known Bangladeshi and Bhutanese benthos communities using Leaf pack and Surber Sampler techniques. The second part endeavored to construe and communicate scientific information with the local communities in the respective countries. Benthic faunal data from a total of 24 sites in Bangladesh and Bhutan were collected in summer 2016 to define the taxonomic composition. Simultaneously, water chemical data was collected at each and every study site for calibration. Aquatic faunal groups, using the EPT index or Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), are described in this paper. The macrobenthos communities of upstream and downstream were identified down to the family level including taxa belonging to order Diptera (Chironomidae), Coleoptera, and EPT taxa. Leaf packs in Bangladesh have shown a higher abundance of Chironomidae family and lowered EPT richness. Whereas, dipnet sampling in both countries found higher EPT richness in protected areas (upstream), particularly Ephemeroptera in Bhutan compared to Bangladesh. Near urban or downstream sites are lower in the abundance of all species.

Empowering state citizens with affordable and accessible modern technologies to monitor their natural resources was the fundamental objective of this study. How to make scientific research outcomes comprehensible and applicable to land-use decision-making by a community and local government institution is the vital question of the second part. Both countries mandated sustainable resource management for poverty reduction and integrated economic development. Citizen participation in stream monitoring would support local and national government in the better management of water basins across the country.

RESTORING HABITAT IN DENSELY-POPULATED SUBURBS IN THE NORTHEAST: A DEMONSTRATION PROJECT

Mary A. Westervelt (2017)

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Researchers have documented the decrease in populations of native birds and other wildlife, as well as the fact that this decrease correlates with loss of natural habitat in the suburbs. Suburban sprawl has also led to increased stormwater runoff, which carries road and lawn chemicals into local streams and erodes stream banks. Suburban homeowners may be unaware of these problems or unsure of how they can remedy the situation. While model pollinator gardens and rain gardens exist, they are often in out-of-the way places such as nature centers, where the average person will not see them without special effort. Furthermore, the models often lack design appeal, appearing as a random collection of plants.

In order to provide an accessible model of appealing landscaping using native plants, a multi-year project to re-landscape the gardens was begun at Trinity Presbyterian Church, Berwyn, Pennsylvania, in 2015. Church members embraced the plan to beautify the property while improving the ecosystem function of the church's gardens and reducing stormwater runoff. The project thus had the dual purpose of improving the property's ecosystem function and appearance, and providing an example for the congregation and the local community to emulate.

A key element of the project was to get congregation members involved in the planning, funding, and actual installation of rain gardens, terraced beds, and pollinator gardens. Installation of the first rain garden provided an opportunity to also get the larger community involved: A local public garden (Jenkins Arboretum and Gardens) donated over 100 plants, and the project became the Eagle Scout project for a local Boy Scout, Connor Bryan. In the second year (2016), more plants were added and the gardens were expanded, successfully enlisting more active involvement from the congregation. The next step of the project was to create a brochure that could be shared with congregations, schools, and municipalities interested in pursuing a similar project.

FOREST OFFSET PROJECTS AND THE CALIFORNIA COMPLIANCE OFFSET PROGRAM

Agatha Leach (2016)

Readers:

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The state of California's Compliance Offset Program exists as a de facto national carbon market and supports a robust set of forest-carbon offset projects across the United States. The participation of forestland projects in the California Offset Program allows for potential market-based incentives towards improved management and increased conservation of forests. This project synthesizes available data on the magnitude and nature of forestland projects listed under the California Compliance Offset Program to better our understanding of the significance of market-based incentives offered through the program. Timber investment management organizations (TIMOs), real estate investment trusts (REITs), and carbon-project developers maintain high representation in project ownership and management. Risk of reversal and non-permanence was found to be significant and linked with geographic location. The potential for market-based incentives developed through the program to encourage forestland conservation is not strongly confirmed through the analysis. Project generated funds through offset sales and timber harvests do not seemingly compete with fair market value for timberland. However, increasing enrollment in the program by project developers suggests that qualities and experiences beyond those captured in this analysis allow for a robust, sustainable participation of forestland in the program.

PUBLIC OPINION OF THE WEST PHILADELPHIA COMMUNITY ON THE USE OF GARDEN CEMETERIES AS RECREATIONAL GREEN SPACE

Oscar Serpell (2016)

Readers:

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Daphne Churchill, The Children's Hospital of Philadelphia

Over the last decade, psychologists, medical professionals, and city planners have increasingly acknowledged the important role nature and urban green spaces play in human physical and mental health. In Philadelphia, and many other US cities, garden cemeteries represent a substantial amount of publically accessible green space. However, unlike city parks, these spaces have profound emotional and cultural significance to many people, and this significance must be taken into account when determining appropriate use of the space. Several studies from European and US cities have examined the attitudes and behavior of cemetery visitors, but none have successfully collected data from non-visiting community members. Through questionnaire data collected from 79 participating residents of West Philadelphia, this research illuminates the differing attitudes of community members towards inner-city garden cemeteries. The findings reveal that in the West Philadelphia community, there are significant variations in attitudes towards, and use of, cemeteries between different social groups. These findings should encourage privately managed cemeteries to consider the cultural and ethnic diversity of neighborhoods when developing public outreach programming.

ANALYSIS AND EXPLORATION OF NATURAL AND CULTURAL HERITAGE SITES IN GUANGXI PROVINCE, CHINA - THE APPLICATION OF AERIAL IMAGING AND MODELING WITH A DRONE

Xuantong Wang (2016)

Readers:

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Lisa Kiziuk, Willistown Conservation Trust

China has the world's most spectacular examples of humid tropical to subtropical karst landscapes. Moreover, there is also great cultural and ethnic diversity in these karst regions. The unique cultural and natural sites symbolize the combination of astonishing karst features and ancient people's creativity and wisdom. Nevertheless, many of these cultural and natural sites have not been fully studied and protected, and they remain lesser known to the general public. Inspired by the modeling of the Christ the Redeemer statue in Brazil, the first ever, accurate high-resolution, 3D reconstruction of the statue in 2015 created by the universities and technology companies, this study used drones and modeling technology to create 3D models of these sites. Drones, also known as Unmanned Aerial Vehicles (UAVs), are useful and flexible platforms for remote sensing, monitoring, and inspections. By attaching a camera, drones can help us capture accurate aerial images remotely. With either computer-based or cloud-based applications, we can convert still images into precise, georeferenced 2D maps and 3D models. In order to explore and examine how to use drones to generate 3D models, various sites in Guangxi Province of China, including the karst sinkholes, ancient painting sites, terraced rice fields, historical towns, and karst valleys were selected to test the effectiveness and efficiency of modeling and mapping. This new combination of modeling technologies can be adopted by scientists, planners, and others to study and analyze cultural and natural sites located in rural areas in order to protect the environment and manage natural resources effectively.

AN ADAPTIVE MANAGEMENT PLAN FOR THE NATURAL LANDS SECTION OF MORRIS ARBORETUM OF THE UNIVERSITY OF PENNSYLVANIA

Tracy Beerley (2015)

Readers:

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Sarah Willig, PhD., Penn Earth & Env Science

The Morris Arboretum of the University of Pennsylvania is a public garden and educational institute located in the northwest corner of Philadelphia County, Pennsylvania. This project has assembled an adaptive management plan for the Natural Lands Section of Morris Arboretum. The framework for an adaptive management plan includes the following steps: (1) assessment of the current status of the site; (2) determination of future desired conditions with measurable objectives; (3) design and implementation of ways to accomplish desired objectives; and (4) monitoring and evaluation.

Physical conditions including geology, hydrology, soils and topography were obtained to gain information about the Natural Lands Section. A botanical survey of the canopy, understory and herbaceous layers was conducted to gather baseline data on the abundance and diversity of plant species. With existing knowledge and data gained through the survey, descriptions of the desired conditions with measurable objectives were described in moderate detail. Monitoring and evaluation is a critical component of an adaptive plan, however the timeline for the task is beyond the scope of this project. The results of this project further reveal the ecological issues associated with an urban landscape disturbed by the negative impacts from overpopulation of deer and invasive plant species. Overall, this project has assembled an adaptive management plan for a variety of purposes including operational management, planning, and fundraising for future development.

SHOEMAKER GREEN MONITORING HANDBOOK

Kaylan Dorsch (2015)

Readers:

Grant Scavello, Environmental Protection Agency

Yvette Bordeaux, PhD., Penn Earth and Env Science

Shoemaker Green is a recreational greenspace located on Penn’s campus, serving as a model for green infrastructure and sustainable design in the City of Philadelphia. Recognized for its innovative features in stormwater management, ecological services, use of native plants, and incorporation of recycled materials for construction, Shoemaker Green also serves as a pilot site for the Sustainable Sites Initiative (SITES). The University of Pennsylvania’s Earth and Environmental Science Department and site designers Andropogon Associates are engaged in a 5-year monitoring plan (spanning from 2013-2017) to measure the performance of the green infrastructure and best management practices installed at the site. This project aims to create a “Shoemaker Green Monitoring Handbook” for use by students, faculty and colleagues to assist with the continued monitoring of water, soil, vegetation and other parameters for the duration of the monitoring plan.

THE PENN BIRD STRIKES PROJECT: ADDRESSING BIRD-WINDOW COLLISIONS ON PENN'S CAMPUS

Joseph R. Durrance (2015)

Readers:

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Keith Russell, PhD, Audubon PA

It has been estimated that nearly a billion birds each year are killed in the United States when they collide with windows (Klem 2014; Loss 2014). Research has shown that birds do not see windows as an obstacle and perceive them as an extension of natural surroundings either through reflection, or as a passage due to transparency (Klem 1990). Monitoring of buildings by the author since fall of 2013, as well as observations and anecdotal information from others, has revealed that bird strikes are a problem on Penn's campus, resulting in mortality of both resident and migratory species. Research has shown that birds will avoid horizontal areas 2 inches or less and vertical areas 4 inches in width (Klem 1990). The Penn Green Fund has provided funding to treat the exterior of the windows of two sites on campus recognized as bird-window collision hot spots with printed horizontal pattern spaced 2 inches horizontally, making the windows more visible to birds. The two sites, a pedestrian bridge at the School of Veterinary Medicine and the Johnson Pavilion at the Perelman School of Medicine are being monitored for bird fatalities during the spring migration, prior to the installation of the window treatment, and will continue through the fall migration, allowing for pre-and post-treatment comparison. The Penn Bird Strikes Project strives to serve as a catalyst for further exploration into possible solutions for this issue, as well as raise awareness on campus about a local and global issue. Interpretive signage at each site will introduce the issue of bird-window collisions to the public, describe the goals of the project, and encourage students, faculty and staff to report their own bird fatality observations via a web based data collection form created by the author. The project will compile these observations in order to provide a more complete campus wide overview of where bird-window collisions are taking place. This information will be provided to Penn in the Green Fund summary report, providing insight into the scale of bird strikes on campus and providing possible solutions going forward on a larger scale.

ASSESSING THE IMPACTS OF DAMMING, AGRICULTURE AND URBANIZATION ON A HEADWATER STREAM IN SOUTHEASTERN PENNSYLVANIA: THE OKEHOCKING RUN

Benjamin Ireland (2015)

Readers:

John Jackson, PhD., Stroud Water Research Center

Dr. Sarah Willig, PhD., Penn Earth & Env Science

Okehocking Run is a small headwater stream located in Chester County in southeastern Pennsylvania. It is a tributary of Ridley Creek, with waterways compromised by the cumulative effects of damming, urbanization and agriculture. The purpose of this study was to examine the extent to which those land use practices are impacting Okehocking Run. From December 18, 2013 to August 18, 2014, water temperature was monitored at six sites covering the entire length of the Okehocking. A macro-invertebrate survey was performed at those same six sites in early spring 2014. Sampling for fish species was done one time in May 2014 at three sites, roughly corresponding to the beginning, middle and end of the Okehocking study reach. Lastly, a limited chemical analysis of water from the Okehocking was performed during January, February, March and August 2014. Stream temperature was separated by month, and average daily mean, maximum and minimum temperature for each month was determined. This analysis revealed a stream sensitive to the presence and absence of riparian shading as well as significant spikes in temperature as a direct result of dams. Macro-invertebrate taxa were identified down to the family level and a statistical analysis was performed on the assembled data using SAS software. A MAIS score based on ten macro-invertebrate metrics was created for each of the six sites, and indicated a relatively impaired stream teetering between fair and poor quality conditions. Fish species in the Okehocking were typical of other streams in the region, although pollution-sensitive species such as trout were absent. For fish, diversity amongst survey sites and habitat (riffle vs. pool) was calculated using the Simpson Diversity Index. In general, the fish survey site below the dam had the highest diversity of all while throughout the stream fish species tended to prefer pools over riffles. Damming above the last survey site as well as relatively high summer temperatures throughout the stream are likely the influencing factors behind fish community distribution and the absence of sensitive species like trout, which are found in Ridley Creek. The limited chemical analysis was not especially indicative of impaired conditions. High levels of oxygenation, acceptable pH values, and relatively low TDS and conductivity values were noted in December, January and February, while a phosphate (PO_4^{3-}) analysis done in August was indicative of excessive phosphate loading; however, a more comprehensive long-term chemical monitoring program would need to be established to confirm those results.

IMPROVING THE ESTABLISHMENT OF NEW RIPARIAN FOREST BUFFERS: USE OF SHELTERS, VOLE GUARDS, AND STONE MULCHING TO IMPROVE SEEDLING GROWTH AND SURVIVAL

Robin Spurlino (2015)

Readers:

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Sarah Willig, Ph.D., Penn Earth & Env Science

Riparian forest buffers planted to improve freshwater stream ecosystem functions face numerous threats to survival during the first year. Land managers and restoration specialists invest time and materials into planting these forest buffers only to find marginal survival of tree seedlings. Successful restoration of forest buffers requires planning and implementation of best management practices along with diligent maintenance. Best management practices often entail the use of materials and devices to improve seedling survival but lack scientific information upon which to base decisions. This study examines the survival and growth of trees in a riparian buffer one year after planting and looks for evidence of vole-induced mortality. Voles may significantly decrease the survival of recently planted trees by gnawing through the roots or bark and stunting growth or causing seedling death. The riparian buffer located along a small tributary to the White Clay Creek in Chester County, Pennsylvania consists of five different species of trees, *Acer rubrum* (red maple), *Quercus bicolor* (swamp white oak), *Betula nigra* (river birch), *Liriodendron tulipifera* (tulip poplar), and *Platanus occidentalis* (American sycamore). Each tree had either a Tubex tree shelter or an Acorn tree shelter installed to protect it from deer browse and one of three treatments to be evaluated for its effectiveness in preventing vole damage: no treatment, a plastic vole guard, or a stone barrier around the base of the seedling. During four days in October, 2014 the height of each tree was measured in centimeters from its base at ground level to its uppermost tip and recorded as alive or dead. Results were analyzed to determine if survival or growth is significantly different between tree shelters and vole treatments. Trees in Tubex tree shelters had a marginally better rate of survival overall. Similarly, vole-induced tree mortality was significantly greater in Acorn shelters compared to Tubex, but not by a great margin. Differences in survival were found between vole treatments with the stone treatment having significantly greater survival over no treatment. The findings suggest that future riparian buffers should be planted with Tubex tree shelters and stone mulch wherever possible.

DETERMINING SUCCESS: HOW THE IMPLEMENTATION OF HIGHER-RANKED RECOVERY ACTIONS IMPROVES THE STATUS OF ENDANGERED SPECIES

Elizabeth Whitney Morton Webber (2015)

Readers:

Ya-Wei Li, Defenders of Wildlife

Jacob Malcom, PhD., Defenders of Wildlife

Sarah A. Willig, PhD., Penn Earth & Env Science

The Endangered Species Act (ESA) “protect(s) and recover(s) imperiled species and the ecosystems upon which they depend” (Endangered Species Act, 1973). Today, 1,569 domestic species and 629 foreign species are protected under the ESA. While the U.S. Fish & Wildlife Service (FWS), has successfully recovered 30 species and ‘downlisted’ an additional 27 from endangered to threatened, another 21 have or will be delisted because of extinction. From the time FWS issued its 2011-2012 Report to Congress through March 15, 2015, 37 species were recommended for reclassification because of recovery, uplisting, or downlisting. The question of whether FWS recovery priorities achieve the best conservation outcomes is under much debate. This study found that the more Priority 1 and 2 recovery actions completed, partially completed, or currently ongoing, and the less threats present and more abundant the species, the better the recovery outcomes. Publicly available documents were used to determine the extent to which FWS has implemented recovery actions for species that the agency has recommended for reclassification and how these actions have affected species status. Looking primarily at species’ recovery plans and five-year status reviews, this study quantifies the extent to which implementation of recovery actions correlates with recovery or decline. Changes in species status were subsequently characterized based on changes in threats and/or abundance of the species. Data was compiled for ten declining species (uplisting), twenty-seven improving species (down- or de-listing), and fifteen species without a status change (control).

In order to improve the efficiency of recovery planning, the findings from this study suggest that FWS should implement Priority 1 actions that primarily focus on threat alleviation first; that a coding system that quantifies changes in threats and abundance be reported in the Biennial Reports to Congress; and that a template for drafting and reviewing recovery plans and five-year status reviews be implemented in order to support reclassification recommendations.