A REVIEW OF URBAN RESTORATION GOALS AND IMPACTS

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Introduction

Humans have been changing their environment for centuries. Unfortunately, many of these changes have generated adverse effects on the environment including the decrease in biodiversity due to species extinction (Tillman 2000), simplification of complex ecosystems, the spread of invasive species, inhibition of native species success (Lindig-Cisneros and Zedler 2002) and a decrease in both air and water quality. The decrease in air and water quality when combined, result in a changing climate (Bernhardt and Palmer 2006). Thus the need to restore environments to their 'natural' state due both to ecological and human concerns has become more prevalent. The act of environmental restoration is frequently thought of as a large–scale activity (Miller and Hobbs 2002) that most often occurs in a remote location such as a national park. However, restoration can also take place in urban areas on a smaller scale.

Restoration is defined as activities performed with the intent of returning an ecosystem to its condition prior to human influence (Harris 2010). A restoration effort should restore ecosystem function (Lindig-Cisneros and Zedler 2000) as well as species biodiversity (Pavo-Zuckerman 2008) not just for the present, but to establish the ability to continue to support these outcomes within an ecosystem over time. Urban restoration is unique (Pavao-Zuckerman 2008) in that land area is typically small and isolated from other undeveloped areas. Urban soils and plant life may be significantly altered in conjunction with urban development (Pavao-Zuckerman 2008) relative to other types of restoration. Therefore, even restored urban areas may not be able to support native species (Pavao-Zuckerman 2008). Restored urban areas can be fundamental to the continuation of some species (Rudd et al 2002) and their fragmentation can be beneficial by creating meta-populations which may foster species survival (Rudd et al 2002).

Historically, planning for urban restoration was limited with human efficiency and convenience at the forefront of the effort. Little consideration was given to the existing habitat during the restoration process and therefore a completely new schema was placed on top of an area that may or may not have been compatible. This left most cities with little vegetation and an abundance of impervious surface which can directly affect runoff rates impacting rivers and wetlands (Bernhardt and Palmer 2007). Limited vegetation also influences the ability of most organisms to survive leaving only those organisms which are most capable of adapting to human conditions (Ingram 2008). While fragmented habitat can still be beneficial, an absence of any habitat supports nothing. Today with both greater availability of research and support from the scientific community, those who implement restoration efforts, whether individuals or agencies, work toward creating the best habitat they can for both humans and wildlife.

Restoration of urban areas is not only about preserving natural ecosystems, there are also related human benefits which are often overlooked. In our modern society people are too often only distantly associated with natural areas (Miller and Hobbs 2002). Restored urban areas can provide opportunity for a greater connection between humans and natural areas. As the majority of the general public is unfamiliar with the restoration process (Miller and Hobbs 2002) the benefits of restoration are not often recognized by individuals or the community. It is important that people have access to natural areas to foster the understanding that nature is intimately linked to humans (Andersson 2006). Promoting this understanding can help people be more involved and understand their responsibility for maintaining the environment (Andersson 2006). Thus, restoration can provide humans with both a deeper connection to nature as well as a sense of community responsibility which may lead to increased support for future endeavors (Newman 2008). Using current restoration knowledge and techniques, it is possible to plan an urban area that maintains green space while simultaneously being adapted so that it can be enjoyed by humans without being harmed.

Problems arise in all types of restoration, even those which have clearly defined goals. Money, time, and man power are just a few of the issues which can discourage a successful restoration effort (Geist and Galatowitsch 1999). While modern city planning has increased the amount of natural areas included in new city development, as well as restoration of urban waste areas which are already present and not being used (Ingram 2008), this may not be enough. To maximize the utility of these efforts and the potential benefit to the ecosystem and humans the restoration effort should be carefully assessed. As there are no overarching guidelines for assessment of urban restoration the maximum capacity for success has likely not yet been reached (Palmer et al 2005). Although there is currently no protocol to ensure success, it is possible to assemble a partial list of components that should be given careful consideration when embarking on a restoration endeavor. These components will be referred to as 'restoration endpoints'.

Restoration Endpoints

Biodiversity

A common restoration endpoint is maintenance of biodiversity. Biodiversity is the difference between all living organisms which allows for complex but stable systems which house any number of given organisms (Convention on Biological Diversity 2006). Biodiversity controls ecosystem stability as well as the long-term success or failure of a restoration effort. Biodiversity promotes competition between species which reduces stress on the ecosystem as a whole should one species be significantly affected by a disturbance (Tilman 2000). Effective biodiversity can be difficult to achieve as it requires a long-term progression of growth which may not be measureable in months or even years. Further, biodiversity must be assessed with an understanding of historical diversity as well as modern changes to a species composition.

Natural Areas

Most urban areas now contain some form of green space in the form of parks, courtyard plantings and roadway medians which can be considered as natural areas within an urban habitat. 'Green space' is the encompassing term for any space containing plants within a city such as parks, gardens, or even unattended open areas which are growing any kind of vegetation (EPA 2000). Simple green spaces are easy to create and sometimes included as part of the planning for cities in the form of parks and gardens (Newman 2008). Green spaces support biodiversity within urban areas and help foster the benefits that humans receive from the natural world around us such as water filtration, oxygenation of the atmosphere, and soil management (Tilman 2000). In most urban areas patches of green space are limited in size (Andersson 2006) and surrounded by development which can impair the natural flow of organisms and restrict their movement to corridors (Rudd et al 2002). This is not to say that green spaces must be large in order to be effective. Having multiple green spaces in close proximity can be equally effective in fostering organism success relative to one larger green space (Andersson 2006). More research is necessary to fully understand how these 'patches' successfully relate to each other or to the greater urban area including suburbs or rural areas (Andersson 2006).

Control of Invasive Species

As opposed to restoring with regard to biodiversity or total natural area, restoration can aim to reduce invasive species. Invasive species by definition are non-native species, not historically present in an area, which can threaten biodiversity through adverse effects on native organisms. The most common problem with invasive species is their creation of monocultures, and their ability to drive out native species through competition. This is especially prevalent in disturbed areas such as newly planted sites within a city (Hobbs et al 2006). The presence of invasive species can influence biological communities and the success of other restoration endpoints (i.e., biodiversity, native communities) (Antonio and Meyerson 2002).

Many restoration projects focus on restoring small patches of land within a city and these patches are at high risk for the occurrence of invasive species (Vidra and Shear 2008). Thus the project may benefit from focusing on minimizing the potential for invasive species. Unlike other aspects of restoration much research has been done on invasive species and the consequences of their incursion. For example, Vidra and Shear (2008) conducted an experiment to determine where and how easily invasive species took over an area near an urban stream. They found that larger patches of land were not exempt from invasion and that these places may be more likely to be invaded in their understory. They further determined that land use may play the most important role in the establishment of invasive species. This conclusion was established because most invasive species were discovered in residential gardens near or surrounding the stream. From this they concluded that areas adjacent to streams near residences or large landscaped areas, such as shopping malls, may be the most vulnerable to exotic species invasion (Vidra and Shear 2008). Because of their many and far-reaching ill effects invasive species should be monitored and discouraged to the fullest extent possible.

Soil Quality

Soil is often overlooked as a potential endpoint for restoration but can significantly influence restoration success. Soil quality is defined by the Natural Resources and Conservation Service (2012) as ‘the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation’. Soil composition may also have significant influence on the success or failure of a restoration effort. For example, the prior treatment of soils can limit plant growth eliminating the detritus chain and leaving plants with shallow root systems which make them less functional in the ecosystem and easily killed (Schaefer 2009). Urbanization frequently alters soil quality negatively influencing seedling establishment and subsequently species diversity (Pavao-Zuckerman 2008). Thus restoration is the primary way to remediate the soil.

Restoration of soil can be costly as it can require many additives or in extreme cases bringing in new top soil. An alternative to addictives and replacement would be the inoculation of native mychorrizae to foster soil restoration (Kleczewski et al 2008). However this can also be expensive and does not guarantee a positive outcome. The fungi used in the inoculation may not be accepted by the target plant(s) and the soil itself may not support the fungi before it has time to properly bond to the plant roots (Kleczewski et al 2008). Thus, preliminary studies are necessary for soil restoration endeavors to select a restoration process that would ensure the highest probability of success.

Flow Regime

The restoration of streams and rivers to their previous meandering state with associated wetlands, or flow regime, has become a prominent venture. The returning flow regimes to their previous state can decrease flooding in areas and increase the water quality through better filtration in wetlands and ground water (Bernhardt and Palmer 2007). Flow regime restoration can include channel manipulations, introduction of wetlands and vegetation, or development of new flow paths (Bernhardt and Palmer 2007). However the success of efforts to restore flow regimes is often dependent on long-term channel stability. Recent efforts to restore flow regimes have incorporated the use of boulders or concrete to maintain stream banks and prevent erosion (Bernhardt and Palmer 2007). These efforts are not necessarily considered restoration and are more often associated with alleviating short-term problems.

Palmer et al. (2005) highlight that all restoration should not be considered ecological because there are no standards at present for what a restoration project should achieve. Due to the lack of specific standards they set up five criteria that define stream restoration specifically (Palmer et al 2005). In short, Palmer et al. (2005) argued that to be considered an ecological restoration the undertaking must restore the 'natural river processes'. However Bernhardt and Palmer (2007) note that this may be a difficult goal to achieve as streams in urban areas have often already been forced into unnatural settings and may not ever be able to return to previous conditions especially after considering time and money constraints. Waterway restoration can also be more costly and less effective in urban areas compared to rural areas due to the piecing of land resulting from multiple property ownership (Bernhardt and Palmer 2007). Therefore, further actions must be taken to help ensure, at the very least, healthy living systems both up and down stream.

Case Studies

While scientists bring concern about their particular focus to the forefront of their experiments in restoration, they are not generally the individuals in charge of the day-to-day restoration that takes place by businesses or interest groups. Contractors, landscape architects, and even government employees are those who, hopefully, are implementing what scientists have identified as important restoration endpoints. To support these professionals in their work, scientists need to both expand their research and their audience when reporting results. Reporting should highlight the most important aspects of restoration and clarify those which are more supporting rather than compulsory. Some professionals have already found ways in which to enact what they have learned, both on their own, and in conjunction with scientists yielding successful restoration efforts.

Revival Field – Mel Chin

In a collaborative effort to restore a landfill in St. Paul, Minnesota, a scientist, Rufus Cheney, and artist, Mel Chin, worked together to create 'Revival Field' (Felson and Pickett 2005). This project was started in 1990 and has been ongoing (Youngs 2000). The project used plants which were predisposed to removing toxins, especially heavy metals, from the soil. The intention of this endeavor was to support phytoremediation (Felson and Pickett 2005). The ultimate goal of the project was to remove heavy metals and other toxins from the soil, harvest the plants which subsequently contained these toxins, and then burn the plants to ash, so that the metals (like zinc and cadmium) can be extracted and reused (Youngs 2000). Eventually this project would become self sustaining so that the cost of future efforts would be minimal and future use of the 'toxic' space would be more appealing (Youngs 2000). Because of both its artistic as well as scientific aspects, Revival Field is no longer just one field. Other fields created to mimic its intentions have been set up to both remediate the soil as well as be an example the public can understand and appreciate. Through the use of plants, Revival Field helps to highlight soil restoration in an urban ecosystem by both removing toxic metals as well as adding detritus to the soil. While this project hopes to be self sustaining it is also creating a new and fertile soil which one day would be able to support other less specialized species of plants.

Green Streets – New York

New York City has permitted a program called 'Green Streets' to be implemented by the Department of Parks and Recreation (Felson and Pickett 2005). 'Green Streets' builds planters in medians, along sidewalks, and in other open unused spaces in New York City (Felson and Pickett 2005). According to plaNYC (2011) 312 sites have been planted since 1996 and they will be receiving additional funding for another 480 new sites by 2017. PlaNYC (2011) notes that these 'mini parks' create safer environments for pedestrians crossing streets, calm busy traffic, and catch storm water thereby decreasing runoff. Green Streets is an excellent example of creating green space within cities, and especially to help link larger spaces, such as parks, together so that organisms may move freely between them and increase biodiversity.

Montrose Point

Montrose Point is a part of Lincoln Park in Chicago that in 1929 started to work on creating both a park and natural space by mowing certain portions for activities while leaving other space less managed (Gobster 2001). During World War II Montrose Point was used as an Army base and eventually a missile base truncating any plans that had been in place to create a more natural green space (Gobster 2001). At this time, the US Army put a fence covered in honeysuckle between Lincoln Park and Montrose Point (Gobster 2001). After the Army left and Montrose Point was given back to Lincoln Park, it sat dormant for 20 years before a plan was created for the space (Gobster 2001). During this time it became a haven for birds and since then has been expanded through the growth of shrubs and other vegetation making it more habitable and safe for many different bird species (Gobster 2001). These additions were made at the insistence of birders who urged the space be used for this purpose (Gobster 2001). Montrose Point is an excellent example of enhancing a natural space which started as an unwanted area and was subsequently augmented to create an ideal habitat which supports a large population of organisms. By supporting the already present plant and bird community both biodiversity and soil quality were improved by this project. More plants, brought to the site in the form of seeds by birds, will slowly be able to impact the site through successional means; slowly adding both stability with root systems and detritus from dead leaves and annuals.

Assessment of Restoration

A common problem with restoration is how to measure its success (Palmer et al 2005). The assessment of a restored site is typically not compulsory. Further, there are no clearly defined measures of restoration and most restoration efforts are not accompanied by required assessments after the restoration activities are completed (Palmer et al 2005). The only goals that are created for restoration efforts are those which are set out by the decision makers at the onset of the project. Those people or entities developing the goals are not required to have an in-depth knowledge of restoration and likely have limited understanding of the biological and ecological processes governing ecosystem dynamics. If assessment does take place it is customarily done after the project completion and only requires the site to have met all the short-term goals listed at project inception (Palmer et al. 2005). Thus, long-term community or ecosystem assessments are typically not incorporated into the process though they are essential to understanding effects of restoration efforts (Atkinson 1994).

Assessment of restoration efforts would best be determined by an independent third party, with no direct affiliation with the project. If further action is advised as a result of the assessment the government would most likely become the arbiter of the efficacy of the restoration efforts. This determination would also need to become a long term process rather than merely a check that the initial project was completed. Palmer et al. (2005) suggests that the time taken to continue assessment of an area should be linked to both its size and importance. At least ten years seems to be a reasonable and realistic length of time to complete a comprehensive assessment based on period of organismal and ecosystem activities. There are some ensuing complications to extended assessment. Companies which started the project may no longer be in the area, or even in business, when the final assessment is completed. In cases of success this would not be a problem, however if failure was determined, there would not be an entity avaliable to be held accountable for correcting the problems or redoing the work. Unless the company or entity restoring an area is still present well after initial restoration, modifications may not be possible.

Suggestions for Successful Restoration

While most restoration efforts are still vague in their goals, some scientists offer suggestions on how to define 'success' and increase the likelihood of a efficacious restoration. A majority of these suggestions have been made specifically for freshwater ecosystems. Vanderbosch and Galatowitsch (2010) set guidelines for successful lakeshore restoration, but many of these guidelines can be extrapolated to restoration of other ecosystems. Their suggestion of proper seed mixes, using plants and seeds which are known to be dependable, and recreating an understory, are all suitable steps to create a base of prospering plants from which to foster organismal success (Vanderbosch and Galatowitsch 2010). Fencing off areas is also a strategy that can be used for all types of restoration as it keeps newly disturbed areas safe from any further human interference until seedlings can take root and sustain themselves (Vanderbosch and Galatowitsch 2010). Bernhardt and Palmer (2007) suggest stream restoration should create variable habitats (e.g., pool, riffle, woody debris) to foster long-term restoration success. This type of variation within a system is also key to the detritus cycle in terrestrial restoration which helps fuel the restoration of soil, and in turn the success of vegetation. While most propositions that author's offer are ecosystem specific that does not impede the suggestions importance to the success of not only the target system being restored, but also all systems which benefit through any further study of restoration.

Societal Concerns

While ecosystem and organismal interactions are essential to the success of any restoration effort, in urban systems humans play a pivotal role in the potential success of restoration. The people who help plant, maintain, or even just pass through these green spaces will impact their growth in myriad ways. Even the first step of getting people to take part in community gatherings to vote on whether a park, garden, or other green space will be added to an urban area is not always an easy task (Newman 2008). While people from many demographics may be interested in helping with a restoration or taking part in education about the efforts, some may lose interest if there is no encouragement for their participation (Newman 2008). Further, citizens vary in the resources they may be able to contribute (e.g., time, abilities, money). Because of variable resources among citizens, restoration projects can sometimes be concentrated in areas that are populated by individuals in more affluent economic groups which may not be the most advantageous or beneficial for the ecosystem (Newman 2008).

Community gardens can be an easy way to involve people in building green space around their community before attempting a restoration project. It will show the community the beauty and benefits that nature can provide. These types of projects have been shown to enhance both the environment and neighborhood (Beilin and Hunter 2011). Larger sections of land which are provided by community gardens, whether growing food or flowers, can be invaluable to sustaining organisms, but small individual gardens can also take part in this effort (Goddard et al 2009). By initiating community gardens individuals may be more motivated to create their own gardens. Goddard et al (2009) discusses 'wildlife friendly' gardens which not only contain vegetables and other human oriented plants but also those which will help support insects and birds. Those families who use gardens as a means to subsidize their food sources most likely cannot afford to plant any extraneous species within their gardens (Goddard et al 2009). However, diversifying and connecting both regular gardens and 'wild life friendly' gardens can help support even such an extensive goal as biodiversity (Goddard et al 2009). If community gardens spurred many individuals in the community to plant their own gardens, it may be possible to use a large portion of the community garden as a ‘wildlife friendly’ garden as it would not be necessary for food production, helping to sustain the movement of organisms all around the city.

Conclusions

There are no easy answers for questions regarding restoration and its various techniques to ensure success. However, restoring systems with careful consideration of habitat, native status, and ultimate goals certainly improves the overall outcome and the potential long-term success of all efforts. The goals and assessments of restoration should include identification of the endpoints desired, as well as potential uses for a given area. Stated standards and well-defined regulation would greatly benefit all restoration efforts. Further, restoration planning in an urban area should not discount or ignore the human populations surrounding them. People from all backgrounds can become enthused at the prospect of green space around them, even without an understanding of how it will benefit them. Helping those who live in cities to become closer to nature and to understand how they can interact with it may be the best step to moving forward to a sustainable future.

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