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Review of the Restoration of Abandoned Residential Sites in the Indiana Dunes National Lakeshore

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Introduction

Extensive dunes along the southern shores of Lake Michigan historically have had both high importance for human use and conservation. The 24 km of sandy lakeshore ridges between Gary and Michigan City, Indiana, form a series of dunes, which are inhabited by over 1000 native plant species, including more than 100 endangered and threatened plant taxa (Bowles 1985 in Bowles 1990). Located within the dune's ridges and swales are four major steel mills, one electric utility company, and nearly eight million people (Choi 1998). Residential development and subsequent abandonment has disturbed 35 of 81 Indiana native endangered and threatened plant species (Bowles 1990). Human activity such as residential development, pollution from heavy industry, draining of wetlands, suppression of natural fires, introduction of exotic species, shoreline development and erosion have destroyed or highly modified the original landscape. In 1966, the Indiana Dunes National Lakeshore was established to protect the remaining patchworks of dunes.

To augment the preservation of remnant, intact dunes, Indiana Dunes National Lakeshore (IDNL) park resource management teams have been working together for the last fourteen years to reverse the effects of human impact on low-density residential land use. Research studies, strategic management plans, and specific recommendations have been used by the IDNL to deal with restoring the residential sites to conditions similar to surrounding native vegetation. Indiana Dunes National Lakeshore's vision for the residential sites within the national lakeshore is to influence vegetation change so that in thirty years, species composition, species richness, and community structure are indistinguishable from that of the surrounding native vegetation.

Indiana Dunes Landscape

The original landscape that existed in the area prior to settlement has been highly modified and fragmented by human activity. Nearshore dunes that start at the edge of the shoreline have been affected by seasonal beach dwellers. The uniqueness of this area includes beaches, foredunes, sand blowouts, and sand forests. The inland dunes, located 1.2 km from the shoreline, have been impacted by residential, and industrial development. The inland dune complex is a high conservation area for its sand savannas, and wetlands, including forested and graminoid fens. Located within this area is the Northern Indiana Public Utility Company, residential development, electrical wires and towers, a railway and bicycle trail. Over 750 residential sites existing as patches within the inland dunes are being restored to resemble surrounding native vegetation.

Early Restoration Attempts (pre- 1989)

Since the establishment of the IDNL in 1966, there has been continuous focus by park managers to conserver, restore, and preserve the native landscape. Numerous ecological studies have been conducted at IDNL to understand dune and soil formation, and what role fire, water, and soil play in dune ecosystem development and change. In 1987, the park began developing a comprehensive plan to facilitate restoration of abandoned residential sites to natural conditions. Initial methods for restoring the home sites prior to 1989 only consisted of razing 400 of the 750 existing home sites (Hiebert 1990). Since a large number of residences were still occupied under a "reservation of use" purchase agreement, restorations of residential sites were projected to last until 2010.

To evaluate these initial restoration attempts research was conducted to study the role of past land use on plant succession of the abandoned residential sites to achieve a predictive understanding of vegetation change and to improve restoration decision making. In 1987, Hiebert and Pavlovic documented early plant succession in thirty abandoned residential sites in order to identify environmental factors that correlated with vegetation patterns in the IDNL. The study concluded that residential land use significantly affected likely succession rates and could potentially affect species composition of a site for at least a century. Thirty study sites were selected based on similarity in site preparation, presence of at least three of the past land uses (building site, drive, lawn, and

garden), and date of razing. Based on large-scale aerial photos taken prior to the sites being razed and ground surveillance, all sites were mapped as to past land use and year of razing. Method of collecting data included, mapping all woody vegetation using a grid system, describing all surrounding habitat, and collecting soil samples from each site and within surrounding woods.

The results of the study identified various environmental factors that potentially affect the establishment of vegetation. Major physical changes to the soil structure from residential use were increased compaction and reduced organic matter. Soil compaction was the highest in gravel drives, followed by gardens, lawns and old home sites; loss of organic matter was most severe on old home sites. Both increased compaction and decreased organic matter resulted in significant losses in soil water holding capacity, which increases plant water stress. Soil chemistry such as pH, cation exchange, and nutrient availability also differed considerably between former residential sites and native soils in surrounding woods. Garden soils enriched with fertilizers and organic matter only supported monocultures of *Solidago*spp with little species turnover after abandonment (Hiebert 1990).

Along with physical and chemical alterations to the soil, initial floristic composition also influenced the establishment of plant species after residential abandonment (Hiebert 1987). The initial floristic composition of the abandoned sites generally resulted in high percent cover of competitive exotic species. The high percent cover reduced the availability of open sites for surrounding vegetation to colonize. For example, non-native grasses, which permitted relatively little colonization of the desired native species from the surrounding vegetation generally dominated lawns. The lack of open sites for colonization by the surrounding native vegetation on the abandoned sites reduced quantity of native seed source in the soil. Availability of open sites was one of the factors that affected species composition of newly created openings proximate to seed sources from surrounding dune ecosystem vegetation.

Resulting Management Prescriptions

Results of the study yielded management prescriptions for future planning efforts intended to encourage succession towards the vegetation of the surrounding community (Hiebert 1987). The first part of the prescription breaks down the exotic species found in the residential sites and what their predicted long-term effect will have on the succession process. The first set of exotic species that were classified were taxa that are persistent, but do not reproduce and have little effect on succession (daffodils, irises, and day lilies). Removal of these species would depend if the goal of restoration was to eliminated reminders of past land use. The next set of exotic species classified were long-lived, and non-reproducing species that retard succession during life span, but only in limited area they occupy (*Picea* spp., *Pinus* spp., and fruit trees). Removal of these species was recommended if the goal of restoration was to eliminate long-lived (often exotic) species which are evidence of past land use. The last set of exotic species classified were long-lived taxa that reproduce, spread, and/or retard succession (*Ailanthus altissima, Alnus glutinosa, Lonicera japonica, Poa pratensis, Robinia psuedo-acacia,* and *Rosa mutliflora).* These species must be removed or controlled if razed sites are to succeed rapidly towards species composition of surrounding vegetation.

Other management prescriptions associated with succession of abandoned sites were also advised for gravel drives, gardens, old home sites and lawns. Management recommendations for gravel drives were to raze the affected surface area, remove drive surface to about 30 cm, and add weed-free topsoil. For garden sites, developed management prescriptions were to raze the affected surface area, remove 20 cm of topsoil, and return to natural contour. For future planning, advised management prescriptions for old home sites were to remove all buried concrete and return the sites to natural contours. Lastly, advised management prescriptions for lawns were to remove sod and soil layer, or treat with roundup in spring, followed by an autumn burn. Park resource managers used the management prescriptions advised by the researchers to evaluate the critical areas for restoration and construct future plans for those areas.

Management Plan (1990)
The results from this and other studies (Kjellmark 1982, 1983) conducted in the IDNL indicated to park resource managers that active restoration efforts were needed to improve the success of restoration efforts. Based on the research data collected prior to 1990, park resource management generated objectives in their 1990 Plan for Restoration, to return the home sites to self-sustaining native vegetation similar in species composition, community structure, and wildlife habitat of the surrounding landscape (McEachern 1990). To meet the 2010 deadline, six long-term specific goals were required to guide future work. The specific goals were (1) maintain a restoration database to track the status of each site, (2) eliminate buildings and utilities, and grade each site to blend with the surrounding topography, (3) accelerate plant succession towards the species composition and community structure of the surrounding area, (4) utilize restoration results from early years to guide work in the future, (5) use the residential sites as outdoor laboratories for future research, and (6) develop interpretive programs on human impacts to natural ecosystems and their restorations.

To accomplish each of these goals by 2010, several project tasks were developed in order to guide the work. As restorations proceeded project tasks became more complex and required more detailed tasks to accomplish the work. Many detailed tasks were developed into several different "Scope of Work's" to be used for different restoration jobs (McEachern 1990). One specific goal generated a Scope of Work that involved developing methodology to restore the native vegetation to the razed residential sites.

Lawn Experiments
Since there had not been any studies or management work that focused on exotic removal in sandy dune ecosystems, a research project was developed to find the best methods for removing exotic species from the IDNL. In May 1993, Choi and Pavlovic compared the effects of prescribed fire, herbicide treatment, sod removal and a control group on non-native grasses to develop recommendations to eradicate exotics and restore native species. The study site consisted of twenty-four experimental restoration plots in three razed residential sites within the boundaries of the national park. Fire plots were burned from temperatures of 120 degrees C to 315 degrees C, herbicide plots were treated with 1.6 L of 24 % Roundup, and sod removal excavated between 10 cm to 80 cm depth of soil and sod (Choi 1994).

Both herbicide and sod removal were recommended as the best method to eradicate exotic species. Herbicide treatment effectively eradicated exotic grasses and was able to increase planted native species cover up to 49%(*Sorghastrum nutans, Monarda punctata, Rudbeckia serotina,* and *Elymus canadensis*). Mechanical removal of sod and topsoil also effectively eradicated exotic grasses, while benefiting planted native species by creating a natural substrate of sandy, infertile soil, which also limited potential exotic species invasions (Choi 1995). Prescribed fire was not advised based on lack of success in eradicating exotic species (*Poa pratensis,* and *Agropyron repen*), and increasing cover of voluntary native species (*Paspalum stramineum,* and*Cyperus*) (Choi 1994).

Current Methods
IDNL park resource managers have discovered and refined many of their restoration techniques over the past fourteen years. Prior to 1989, restoration techniques only involved razing of abandoned sites. It wasn't until 1990 when planning objectives and techniques were defined that actual restoration of the abandoned sites began.

Park resource managers use the 1990 plan as a guiding tool to direct the restoration goals of each site. Current restoration practices involve a number of direct assessments followed by site-specific restoration prescriptions and procedure, assessments of success of the restoration, monitoring, and reapplication when necessary.

One of the first tasks park resource managers complete before any restoration begins involves a direct assessments of site. This entails sketching a rough draft of the site, estimating vegetation cover, and

identifying the locations of where surrounding vegetative species, and non-native species exist. The information gathered from the site is then stored in the Indiana Dunes geopgraphic information system to maintain and track restoration status of each site. Other information that is stored in the database include a map of all home sites, expiration date of reservation of use, size of individual sites, site status, surrounding vegetation, exotic species problem, list of undesirable species, and treatment prescriptions for each sites. As a residence is vacated, demolition of buildings and utilities from each site begins, followed by grading sites to blend in with the surrounding landscape. Because residential sites to restore become available through the year 2010, these tasks are repeated at the beginning of abandonment.

Other data that is helpful to park managers in determining site specific prescriptions, procedures, and assessment types include site and research data collected prior to 1988, lawn experiment results, digitized GIS maps, and site photographs. Permanent photo stands are set-up on restoration sites to take a series of pictures to compare vegetation growth before, during, and after restoration work. Pictures are then used to monitor and track progress while visually logging the restoration work that is in progress at the IDNL (Kwilosz 2001, personal communication).

After specific prescriptions are determined for a site, the first procedure involves removing non-native species and remaining landscaping. Woody vegetation is cut and stumps are treated with herbicide to minimize re-sprouting from the roots. Lawn grasses are either removed during demolition process, pulled, or a herbicide is used. Typically what fallows than is planting a mix of locally collected native seeds or plugs grown from locally collected seed. The mix of seeds that is generally planted consists of native grasses (*Schizachyrium scoparium, Elymus canadensis, Sorghastrum nutans, Panicum virgatum, Koeleria cristata, Stipa spartea*) and forbs (*Rudbeckia hirta, Monarda punctata,* and *Oenothera biennis*)(Choi 1998). Successfully establishing native vegetation cover is essential in reducing reinvasion of exotic species (Kwilosz 2001, personal communication).

Assessments are made the following growing season to determine if the planting of native species and exotic species removal were successful. If exotic species are still prevalent reapplication of herbicides are necessary to reduce competition and allow native species to become established (Kwilosz 2001, personal communication). Depending on the estimated exotic species cover and what future plans are for the site, specific prescriptions and procedures for treatment will vary between sites.

Conclusions

The IDNL is a traditional park that is fragmented inside an urban setting (Reshkin 1990). The resource management plan for the national lakeshore reflects this areas unique situation and suggests the types of plans other urban parks will be creating in the future. Since urban growth is inevitable, parks must be prepared to continuously change resource management plans to meet environmental impacts from increased visitor use.

The development of the IDNL resource management plan is an example of how a park was able to blend varying degrees of natural and human impacted areas together (Reshkin 1990). Because of research studies, strategic planning, and specific recommendations, park managers have been able to restore approximately 100 of the 750 abandoned sites to conditions similar to surrounding native vegetation (Kwilosz 2001). The main objectives that guided this work combined research results with planning initiatives. One other objective that aided restoration results was the maintained restoration database system. Combining these three components – research, planning, and comprehensive data management, allowed park resource managers to analysis and adjust restoration techniques as new problems developed.

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