2.5 Management Strategies and the Evaluation of Natural Systems

Adaptive Management

Actively managing disturbance-adapted ecosystems to increase their resilience to climate change is integral to their preservation and can have a positive effect on species richness. This typically involves treatments that are intended to increase biodiversity, encourage drought-tolerant species, and reduce tree density. However, while the scientific discipline of restoration ecology is emerging as a vital resource, there exists only a limited number of studies on the success of various restoration treatments, and many additional proposed protocols are novel and untested.

To address this challenge, an adaptive management framework is often utilized to implement management objectives while simultaneously developing a greater understanding of underlying ecosystem dynamics and other species interactions. The adaptive management approach, in which management strategies are informed and altered by concurrent research and data collection, is instrumental to the management of these partially understood landscapes (Williams, 2011). This framework enables managers of natural systems to identify knowledge gaps and address new problems continually as part of a cycle (Cawson & Muir, 2008). By utilizing this approach, it is possible to experimentally reduce previous management activities, test new approaches, and monitor the relative successes of these new regimes.

The Prairie-Hardwood Transition zone of southwestern Michigan has been heavily impacted by anthropogenic activity in the last 200 years. Ongoing conservation efforts to restore fragments of this previously vibrant landscape mosaic have utilized an adaptive management approach to incrementally improve species diversity and improve habitat resilience. Similarly, principles of adaptive management were utilized in this report, which includes a comprehensive plan intended to transform degraded ecosystems to high quality, resilient landscapes, increase the diversity of native biota, and provide suitable habitat for threatened wildlife species.

Reintroducing Tallgrass Prairie to Degraded Land

A byproduct of two centuries of agricultural intensification in the upper Midwest is the existence of a patchwork of scattered remnant farm fields in the region. These often occur in locations that were previously farmed at a smaller scale by European settlers but are not suitable to the industrial farm practices which currently dominate the landscape. These fields present an opportunity for restoration to a prior condition or a new stable state that will increase species richness and improve other ecological characteristics of the land.

Due to its fertility and rolling topography, land that supports prairie and savanna is frequently desired for farming, and decades of agricultural intensification have nearly extirpated these ecosystems from the Midwest. By the mid-eighteenth century most of the tallgrass prairie, a plant community that was historically present in the oak opening matrix at Baker Sanctuary, had been destroyed as land was converted to other uses. The removal of fire and other regenerative processes further degraded remaining prairie fragments and accelerated their demise (Gardner, 2011, Samson & Knopf, 1994). The loss of these open ecosystems has been devastating for the ecology of the region. Hundreds of grasses and forbs native to these ecosystems are either endangered or threatened, and grassland birds have experienced some of the largest declines of any group of species in North America (Samson & Knopf, 1994).

There is a growing recognition of the impacts of large-scale land use conversion and abuse both in academic circles and in the public, which has generated interest in the restoration of old fields to sites resembling prairies of the past. Prairie restorations increase the abundance and diversity of native pollinator communities and multiple studies show that newly restored sites are rapidly colonized with native insects. Therefore, they are becoming an integral component of conservation strategies for threatened species (Tonietto et al., 2017; Rowe & Holland, 2013). The rehabilitation of each specific site is dependent on its pre-colonial ecotype, land use history, current condition, and predicted impacts of climate change. These factors make every restoration unique and influence management decisions that dictate the cultural, mechanical, biological, and chemical alterations to the landscape.

The first step in facilitating a successful restoration is site evaluation. It is important to reveal the extent of the ecological degradation at the site and to identify targets which may need specific treatments. At Baker Sanctuary, the old fields were abandoned nearly 70 years ago, so there have been significant changes to these sites brought on by patterns of succession. Sites with more recent historical agricultural use may require mechanical treatments to remove roads, alleviate soil compaction, or to grade the landscape when it has been excavated or terraced (Pannebaker et al., 2017). After repairs to the landscape have been completed the next priority is removing the exotic and invasive grasses, forbs, and other unwanted woody vegetation. This can be accomplished through a variety of methods including but not limited to mowing grasses, brush-hogging established woody vegetation, implementing prescribed burn regimens, and the application of herbicides via foliar spray or the cut-and-pour method. The unique characteristics of each individual site dictate the order, intensity, and timing of these treatments (Pannebaker et al., 2017; Phillips-Mao, 2017).

An integral component of prairie restoration is the reintroduction and establishment of native herbaceous plant species, so the acquisition of appropriate seeds and seed mixes is crucial to the success of these projects. Attention must be given to the origin of seeds to ensure there is adequate and appropriate genetic diversity amongst the species being reintroduced. Seeds may be broadcast into bare soil following a controlled burn or injected into the soil via a seed drill if germination and establishment are determined to be challenging at a site (Pannebaker et al., 2017; Phillips-Mao, 2017). After initial reestablishment of a restored prairie, it is often necessary to continue annual treatments to remove exotic and invasive species, followed by continued efforts to improve the floral diversity of the landscape through seed dispersal. It is common for these efforts to include the harvesting of native seeds from nearby areas and the propagation of those seeds in a controlled environment. A robust monitoring program can ensure that temporary improvements to the landscape become permanent and that future problems are swiftly identified (Pannebaker et al., 2017).

The Importance of Fire to the Maintenance of Oak Communities

Oak savanna ecosystems were common throughout the Prairie-Hardwood Transition prior to European colonization and featured large oaks surrounded by herbaceous vegetation (Anderson, 1998). Much of the remaining oak savanna habitat in southeastern Michigan has been degraded by anthropogenic activity, lost to land use conversion, or diminished by succession. This has catalyzed the loss or fragmentation of numerous species populations associated with the prairie-forest border adjacent to oak forests (Reinhardt et al., 2017).

Oak savannas have historically supported diverse floral and faunal communities throughout the Midwest and were maintained with frequent fires to control the growth of woody understory species by Indigenous Peoples. Due to their importance, restoring extant fragments of oak savanna has become a top priority for conservation managers in the region. Decades of fire suppression and agricultural conversion has shifted the species composition and spatial dynamics of these ecosystems, and they require multi-year restoration regimes to create habitat favorable to the diverse wildlife that they previously supported (Dey et al., 2017).

Restoring oak savanna to ecologically appropriate sections of Baker Sanctuary is a focus of this management plan because this ecosystem is included in the Prairie Hardwood Transition that supports 30 avian species of concern. Temperate grasslands and savannas are some of the most endangered habitats in the world, with approximately only one percent of oak savannah in the US remaining (Reinhardt et al., 2017). Restoration of this land to provide quality natural communities through the control of invasive species, the protection of native species, and the renewal of annual prescribed fire and mowing regimens will improve its resilience. Furthermore, because studies have indicated that singular, low heat burns alone are not enough to permanently shift vegetative dynamics in these communities, pursuing change through an adaptive management framework will be necessary to elucidate which techniques may be combined to produce effective results (Bassett et al., 2020).

Monitoring Natural Communities

When managing a site, it is important to identify ecosystem attributes that indicate whether the site is “healthy.” This can help determine how much management is needed or when to manage a site. In the United States the USDA and the US Forest Service have a Forest Health Monitoring (FHM) and Forest Inventory Analysis (FIA) program that is designed to monitor the status and changing conditions of forests around the U.S. This program measures the crown condition, tree mortality, tree damage, soil condition, downed woody material, vegetation structure and diversity, lichen communities, and ozone injury (Tkacz et al., 2008). Detailed information regarding this protocol can be found at https://www.fia.fs.fed.us/ and also at https://www.fs.fed.us/foresthealth/protecting-forest/forest-health-monitoring/index.shtml . These methods can be time consuming and expensive to perform but can provide detailed data about forest health.

Another way to monitor the health of a site is to look for key species, whose presence or absence can be a reliable indicator of ecosystem change. Rare plants and animals require certain conditions to exist that are not present in degraded ecosystems or at sites that have lost important habitat due to anthropogenic activity (US Forest Service). The selection of key species must be site specific, reflective of its current and desired floral composition, and incorporated into a long-term restoration framework (Coulloudon et al., 1999). This requires specific knowledge of the species’ traits, to be able to identify it. These can be learned relatively easily by anyone making it a low cost, somewhat time consuming monitoring tool.

The Michigan Department of Environment, Great Lakes, and Energy has a wetland monitoring and assessment strategy for the state of Michigan that uses a three-tiered approach. This involves a landscape assessment using remote sensing, a rapid assessment using simple field indicators, and an intensive site assessment (Michigan Department of Environmental Quality (MDEQ) Water Resources Division, 2015). The United States Environmental Protection Agency (EPA) also has a monitoring and evaluation strategy for wetlands. These types of monitoring programs can provide a great deal of information about the health of an ecosystem but come at the expense of many field hours, equipment, and money. A simple monitoring

Another method used to evaluate the health of ecosystems in the Great Lakes region is the Floristic Quality Assessment (FQA), which allows for objective, quantitative judgements regarding the quality of sites through a standardized and repeatable process (Milburn, 2007). It removes subjective bias by assigning all native plant species within a region a coefficient of conservation (C) number and is designed to supplement other habitat assessment strategies. Plant communities have evolved as assemblages of species in ecosystems with varying disturbance regimes, and as a result they exhibit a diverse array of survival strategies to overcome negative impacts to their environment. Some species have evolved with characteristics that allow them to colonize low-quality environments, while others require pristine, undisturbed habitats. The C-value of each species reflects its fidelity to undisturbed natural environments as well as its tolerance to pollution and environmental degradation (Wilhelm & Masters, 1995).

The C-values assigned to each species range from zero to ten, with all non-native species automatically receiving a zero. Species that are unaffected by anthropogenic change are assigned a low C-value, from zero to four, and those with the highest fidelity towards their natural environments are rated from seven to ten. While there is inherently a level of subjectivity in any assessment of ecosystem health, the assignment of C-values to individual species and the associated Floristic Quality Index calculation utilized in thi areas. C-values are assigned collaboratively by a committee of academic professionals in each state that FQA protocols have been established, ensuring that they can be used to reliably assess the ecological condition of any site in any represented region (Herman et al., 2001). Ecologists, field botanists, and other professionals with similar backgrounds can easily use this methodology to compare sets of sites to one another and track changes to the same site over time. This can be useful when setting conservation priorities, planning restoration projects, and monitoring the health of restored sites (Milburn, 2007; Wilhelm & Masters, 1995).