Will Missouri's Natural Areas Endure Landscape Transformation?

By Paul W. Nelson

"The genetic memory of complex ecosystems that has evolved over millennia does not adapt well to changing management styles, varied objectives, nor different organizational philosophies." Adopted from Dr. Gerould Wilhelm, Conservation Design Forum

Introduction

For the past 100 years, Missouri state parks have provided a permanent refuge for high quality natural communities. For this reason, over 40 years ago, I chose to study the flora of Johnson's Shut-Ins State Park for my master's thesis. In 1978, girded with my passion for natural history, I became the first Natural Areas Coordinator for the Missouri Department of Natural Resources, and subsequently served on the Natural Areas Committee (MoNAC) for 33 years. In the 2016 issue of the *Missouri Natural Areas Newsletter*, MoNAC announced that 2017 represents the 40th anniversary of the founding of the Missouri Natural Areas Committee. At the time of publication, MoNAC had collectively designated 185 natural areas totaling over 87,700 acres. The newsletter further mentions that natural area managers and owners continue to face problems associated with an increasing human population.

This article assumes that newsletter readers understand and accept that natural areas are defined as "biological communities or geologic sites that preserve and are managed to perpetuate the natural character, diversity, and ecological processes of Missouri's native landscapes." For managers and natural area owners, a specified range of relevant ecological management prescriptions commensurate with certain natural community types is required to retain their healthy, vibrant qualities. However, the constant pressing forces of homogenization challenge us to assure the retention of these qualities and characteristic biodiversity. More troubling are the myths and misconceptions surrounding the ability of ecosystems to adapt, adjust and resist these changes. Fickleness of bias, philosophy, multiple and conflicting management objectives, indifference, personal aspirations, budgetary problems and other exigencies all compound the need for a one-science approach to applying the best range of management prescriptions that preserve natural area qualities.

We live in the Homogecene Era

Our world is immersed in an irreversible period of mass species extinction. The Millennium Ecosystem Assessment (www.millenniumassessment.org) findings reveal that, since the creation of the Missouri Natural Areas Program, we have lost more biodiversity worldwide than in all previous human history. Numerous scientific studies show that many plant and animal species are declining because of human activities, and are being replaced by a much smaller number of expanding species that thrive in human-altered environments. The result is a homogenized biosphere with lower diversity at regional and global scales. A quick literature review for the topic "Biotic Homogenization" reveals over 100,000 article links. Forty years ago, natural area managers and professionals had not learned of this term. Biotic homogenization occurs when native, localized ecosystems are diluted by widespread exotic or weedy native species. This results in vegetation composed of a few dominant exotic or weedy native species that displace the natural vegetation that once defined a stable natural community. Vegetative distinctiveness gradually dissolves, giving way to biological species flatness.

A few examples

Park-like savannas once covered six million acres in Missouri. Now reduced to a few thousand acres, our remaining natural savannas cannot exist without deliberate management. Tall fescue, smooth brome, a host of native weedy plant species and relict non-regenerating post, bur and white oak trees sparsely occupy former savanna grasslands. Abandoned, there's virtually no place, no classic example of any location in Missouri where a former savanna coalesces the diverse plant species that characterized this once widespread natural community. The best remaining example of true savanna in Missouri exists at Spring Creek Ranch Natural Area, a sweeping landscape actively managed with regular fire, exotic species control, and woody species removal. Active management is integral to maintaining this landscape. If abandoned, or left unmanaged, no predictable 'successional' order of plant species exists. The biodiversity trajectory, determined by variations in the savanna's history of grazing, haying, cropland and other uses, does not readily accrue species richness once damaged. For example, one scenario includes the presence of cool season exotics on now-depleted and eroded soil followed by the invasion of Eastern red cedar, black locust, persimmon, autumn olive, Bradford pear, Siberian elm and white poplar.

A similar scenario exists in our woodland and forest natural communities, where the threat of a new suite of exotic species is particularly high. Especially in increasingly urbanizing areas, the spread of bush honeysuckle is insidious and rapid. The plant's allelopathic toxicity is laying waste to a once diverse assemblage of woodland/forest wildflowers, while also inhibiting tree regeneration. The savanna equivalents of tolerant plant species that gradually spread into these urban, fire-deprived bush honeysuckle woodlands include English ivy, periwinkle, wintercreeper, burning bush and multiflora rose. Certain well-managed natural areas continue to prove somewhat resilient

Bush honeysuckle *(Lonicera maackii)* is spreading rapidly throughout urban areas, roadsides, and towns and into adjacent forests and woodlands causing severe ecological damage, altering community structure, and reducing the presence of conservative plant species. As shown in this photo, its widespread telltale green understory presence is revealed during autumn leaf off.

Photo by Pual W. Nelson

to these effects, largely due to their remoteness, lack of urbanization, lack of invasive species, and continuation of the fire regime. The 2,995-acre Ha Ha Tonka Oak Woodland Natural Area remains a premier landscape showcasing over 30 years of prescribed fire. However, even places like this are under threat of development sprawl, deer overpopulation, and interruption of natural processes.

The transformation of what remains of native vegetation continues

Landscape transformation is the near complete replacement and/or dismantling of the ancient plant and animal associations we describe as natural communities. Remnant high quality areas remain, but most are far removed from their historical character. This transformation is an inevitable, insidious force that, without a constant deliberate commitment to management, will cause the last remaining areas of temperate native vegetation to lose species and genetic diversity. The effects will be delayed in the Ozarks, but no remnant natural landscape is immune from the consequences of the ever-pressing forces of homogenization.

The following are the primary drivers of homogenization; this list is by no means all-inclusive. Many permutations of these damaging causal agents have negative domino effects on natural communities.

Resource Exploitation Upon Settlement

Early settlers built their small towns and homes in locations where they could extract wood, grow crops and livestock, mine minerals and make a living. Timber became the raw material for buildings, homes, barns, fueling steamboats and trains, furniture and firewood. In the late 1700's, the first lumber merchant Ebenezer Mudgett sparked the American Revolution over the King of England's timber laws, which initiated the Great Cut that swept across North America. Only a few small areas of Missouri contain fragments of virgin trees following the logging era.

At the same time, huge numbers of Eurasian livestock roamed and multiplied freely. Open rangelands devoid of fences allowed livestock to severely overgraze nearly all accessible natural communities. Missouri's vast natural landscape suffered decades of soil erosion as rains eroded vast quantities of gravel, sand and silt into streams and rivers. Poor farming practices added to the soil erosion problem. Even as late as the 1980's, Missouri was ranked 3RD in the U.S. for soil erosion and loss.

The fur trade opened the North American wilderness. Hunters and ranchers nearly eliminated large predators and herbivores from the top of the food chain. The passenger pigeon and Carolina parakeet are forever exterminated. Invented in 1713, Flamsteed's star chart opened the world to safer trade and commerce by sea, which opened the door to the transport of exotic plants and wildlife.

The Industrial Revolution

Beginning with the invention of the cotton gin in 1794, machines increasingly replaced human muscle in an explosion of factories worldwide, and steam engines drove rapid transport of commodities. In 1852, the train transformed a nation where people traveled further in a day than previously in a lifetime; the railroad opened wilderness to the most rapid expansion the world had ever seen. Undeveloped land rapidly divides into homes, roads, cropland, pasture, factories, mines, reservoirs, hospitals, stores, fuel stations and much more. Fragmented lands augment and facilitate the forces of homogenization.

Urbanization

Dr. Volker Radeloff and colleagues (2009) compiled spatially-detailed housing growth data from 1940 to 2000, and quantified growth for each wilderness area, national park, and national forest in the conterminous United States. Their findings show that housing development may severely limit the ability of protected areas to function as a modern "Noah's Ark." Between 1940 and 2000, 28 million housing units were built within 50 km of protected areas. Housing growth rates during the 1990s within 1 km of protected areas (20% per decade) outpaced the national average (13%). The Missouri Resources Assessment Partnership has used Landsat imagery from 1972 through 2000 to quantify the amount of urban change that has occurred in several metropolitan areas (figure 1).

Invasive species

Virtually every residence, workplace, city roadside, public building, park visitor center and more, are subject to the old-world culture of designing and manicuring matrices of lawn carpets and gardens. Humans chose from hundreds of cultivars from catalogues or plant nurseries to plant. Today's population densities and work locations force modern homes into subdivisions and high-rise apartments. Global transport brings an unlimited supply of exotic plant species used to beautify housing developments. These plants, coupled with many other non-native plant species used for agriculture, wildlife and other purposes, are the foundation of a grim landscape experiment. People across the globe transport thousands of exotic species, exposing them to the now-degraded ecosystems of North America. Having adapted and evolved in the presence of old world cultures, many plant (and animal) species out-compete native species, thereby replacing them in vast uncontrollable numbers.

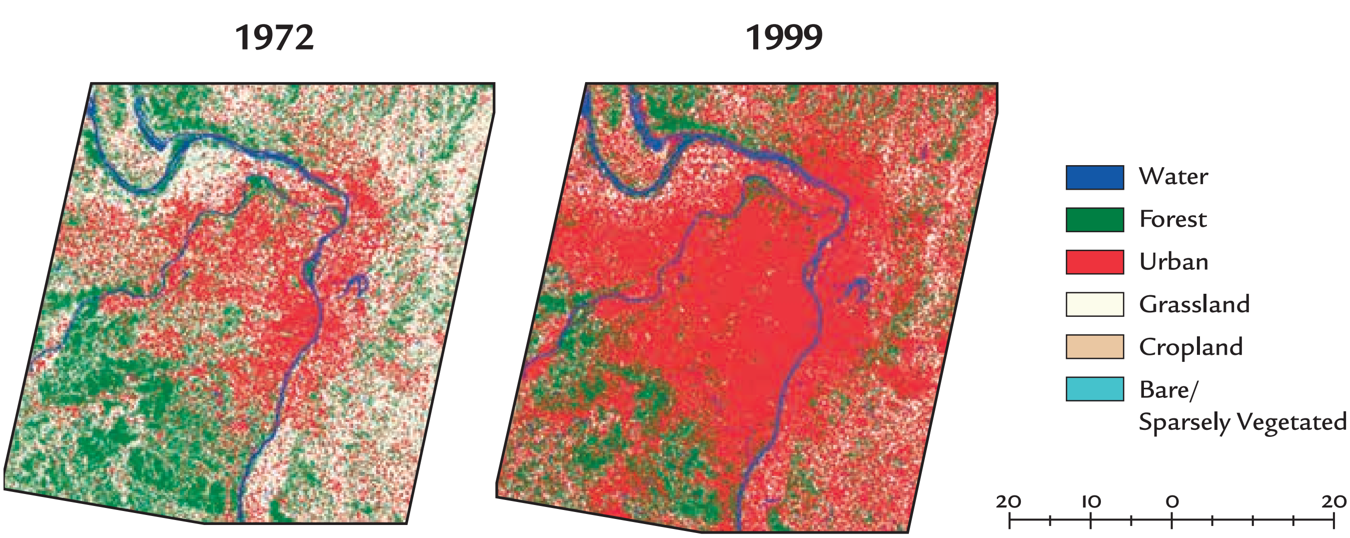
In September, 2017, I reviewed a list of 140 invasive plant species that threaten Missouri's ecosystems and biodiversity. This timely review is part of the Missouri Invasive Plant Species Task Force. In 1963, Dr. Julian Steyermark in his landmark *Flora of Missouri* recorded over 500 non-native plant species known to multiply and spread in Missouri. This number increased to over 900 with the revision of *Steyermark's Flora of Missouri* by George Yatskievych in 2013. The list of invasive plant species continues to grow.

Steyermark (1963) recorded bush honeysuckle in but a few Missouri counties in the 1950s. Today, society recognizes its menacing prevalence in virtually every county. This insidious shrub, killer of forest diversity, dominates cities and small towns. Spreading like mold on a petri dish, it is joined by autumn olive, oriental bittersweet, Japanese honeysuckle, rose of Sharon, Japanese privet and English ivy. Is this the ultimate transformed future urban forest?

The Trophic Cascade Effect

Missouri's historic native ecosystems evolved in response to an unbroken vegetated landscape of elk, bison and deer, preyed upon by wolves, mountain lions, and black bears. Today, elk and bison are confined to a few small refuges in Missouri, while only a scattering of mountain lions and bears occur. This disruption of a trophic level in the predator-prey food chain is known to cause cascade effects that ripple through the food chain. Trophic cascade describes the indirect control that a top predator exerts on species at lower, nonadjacent trophic levels. In a trophic cascade, ecological processes and consequences initiated by a change at the top of the food chain work their way down to lower trophic levels and eventually rebalance the ecological relationships of numerous species. A notable example of this top-down ecological interaction was observed in Yellowstone National Park. In the 1920s, the local extinction of the park's population of gray wolves (*Canis lupus*) through

Figure 1. Urban change in St. Louis from 1972 to 1999 using Landsat imagery (Lancos 2003)



hunting caused an increase in the elk population. This lead to a drastic drop in the abundance of numerous plants eaten by the elk with many species reduced to negligible numbers. In 1995, the reintroduction of the wolves dramatically reversed this trend, slashing the number of elk and increasing plant diversity.

Likewise, studies of the trophic cascade effect of wolf populations on white-tailed deer directly correlate areas high in wolf numbers to increased healthy populations of sensitive plant species (Callan, *et al.* 2013). Fifty years ago, seeing a white-tailed deer may have been a rare sight in Missouri. Bringing back white-tailed deer is certainly a great conservation success story, but the numbers of deer in eastern North America have surpassed a critical tipping point. Negative impacts caused by deer overbrowsing are widely published throughout North America, beginning with the works of Aldo Leopold. Roger Anderson (1997) concludes that removal of predator control from white-tailed deer populations invites ecological disasters by permitting excessive resource consumption to the detriment of whole communities of organisms. Thomas R. Rooney and colleagues (2004) correlate the loss of plant species richness in 62 upland Wisconsin forests with excessive deer browse. In Missouri, the Department of Natural Resources monitors the effects of deer browse using exclosures and winter twig browse surveys. The constant press of deer over browsing is steadily reducing populations of conservative plant species to the point of elimination. The Missouri Extension Service information on Missouri deer population dynamics discusses the effects that too many deer have on the biological carrying capacity of deer. Their data show that the historic number of white-tailed deer was estimated at 700,000. Today that estimate is 1.4 million.

Loss of historical processes, especially landscape fire and natural water flow

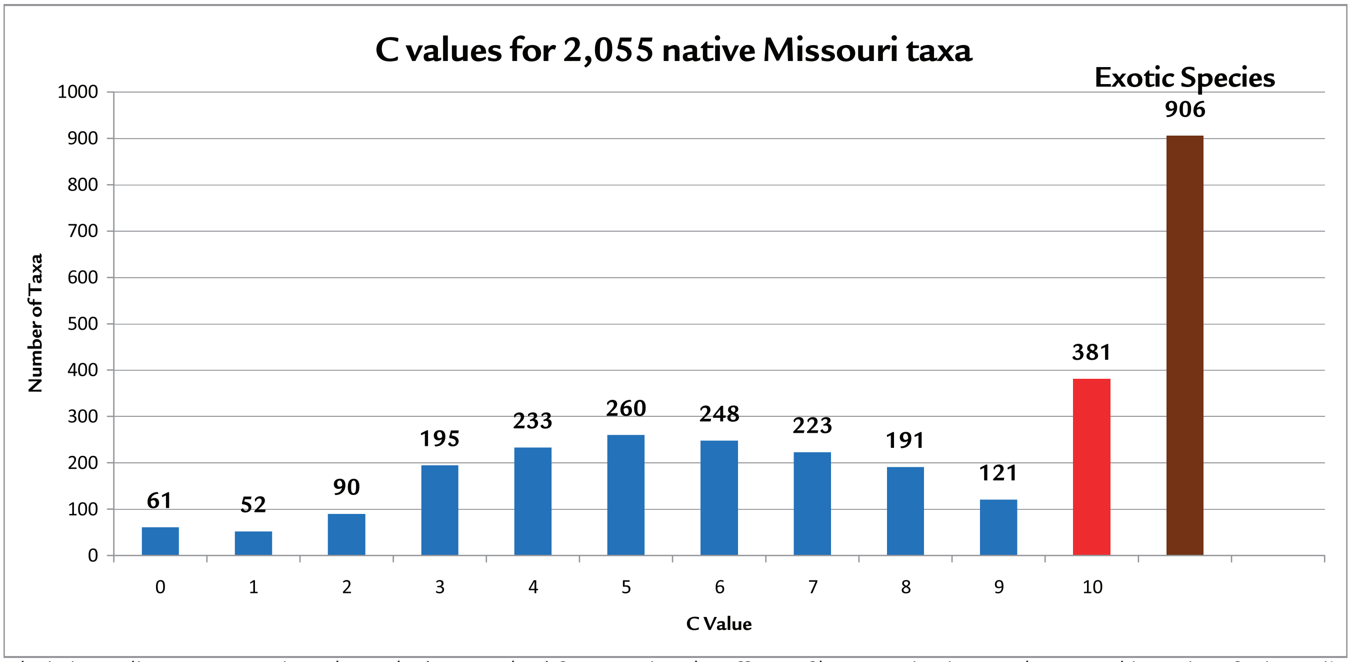
An estimated 80% of Missouri's historic vegetation was fire-mediated. Visits to Prairie State Park, Helton Prairie, Glade Top Trail in the Ava Glades Natural Area, Taum Sauk Mountain State Park, Grasshopper Hollow Natural Area and other fire-managed landscapes clearly point to the significant role that fire plays in restoring and maintaining viable conservative or habitat-specialist plant species, and the associated diverse array of wildlife, particularly invertebrate species. But the cessation of fire across the entire landscape, compounded with deer overbrowsing, accelerates the environmental impacts of homogenization.

Advancing urban sprawl makes it increasingly difficult to emulate historic fire regimes. Weakened by decades of open range overgrazing and fire suppression, what remains of fire-adapted sensitive plant species (royal catchfly, Mead's milkweed, prairie white-fringed and grass pink orchids to name a few) continue to decline, and in some instances barely holding on in small, protected refugia.

Historically major rivers such as the Missouri provided annual cycles of flooding across a wide floodplain that sustained riverine wetlands. A shifting mosaic of newly created marshes and bottomland prairies varied with others shifting towards more mesic conditions with slow sediment accrual over time. Today nearly all of our major riverine floodplains suffer from a wide variety of hydrological alterations such that current wetland hydrology has deviated significantly from historic conditions that had unique cycles of flooding and soil saturation that developed over millenia. These hydrological alterations including channelization, levees and drainage ditches in concert with watershed issues leading to increased sedimentation in places have stressed some natural areas beyond repair. For example, Cordgrass Prairie Natural Area was removed from the natural areas system because of irreversible hydrologic problems that shifted a diverse bottomland prairie to a sediment laden willow thicket.

How do we monitor and measure this transformation?

To find and designate high quality natural areas, field ecologists use a quality ranking system to locate the best examples of various natural communities. As defined in Nelson (2010), those qualities included high numbers of conservative plant species widely dispersed throughout the community. Scientists must base a sound natural areas program on the best available science with the protection of ecosystem biodiversity as its



Floristic quality assessment is perhaps the best method for assessing the effects of homogenization on the natural integrity of Missouri's native vegetation. The system relies on conservative rankings of 0 to 10 assigned to each native species. Species having a ranking of 7-10 are considered conservative with a high fidelity to intact natural areas. Likewise these species can be indicators of the negative effects of homogenization factors. Roughly one half of Missouri's 2000 native plant species are conservative elements.

primary driver. Ladd and Thomas (2015) capture the essence of the value for the Floristic Quality Assessment (FQA) for purposes of determining the degree to which the health of natural communities (and systems) maintain themselves under appropriate management practices. The utility of FQA in natural areas work is over 40 years in the making, and is employed by at least 25 other states. The assignment of Coefficients of Conservatism values to plant species is an excellent approach to assessing trends in how species that are least capable of maintaining viability are doing, and in explaining why certain high C-value plants decrease across the land.

Over 900 native plant species have conservatism values greater than 6; this is nearly 50% of all the known native plant species in Missouri. Homogenization disturbance factors further reduce and transform our native remnant landscapes to simplified dominance by a few generalist species. Fully transformed vegetation does not readily accrue conservative plant species, and any trained botanist can see this while driving from St. Louis to Kansas City where roadside vegetation is dominated by weedy generalists and exotic species.

Myths and Misconceptions of Natural Community Management

Natural plant succession, migration, realignment, recovery and resilience—all are erroneous ecological assumptions that threaten the fundamental character of high quality natural communities. Historically, these ecological behaviors operated to change ecological patterns over long periods of space and time. However, our contemporary landscape is now dominated by the causal factors of homogenization.

Some ecologists believe that ecosystems will migrate in response to climate change. Faced with the consequences of climate change, prairies and grasslands will migrate toward the East coast (National Geographic, 2008); post oak and shortleaf pine will migrate north; glades and savannas will do the same, and new orders of plant assemblages will follow. Homogenization barriers prevent these historic changes from happening in the Midwest. Nowhere on the landscape will one witness conservative (as well as many generalist) plant species migrating or coalescing anywhere removed from where they presently occur. And these conservative plants represent nearly 50% of our native flora.

Old school concepts of ecology taught us that damaged or destroyed ecosystems will recover or 'succeed' to some approximation of their former condition. For example, Dr. Julian Steyermark's *Natural Plant Associations and Succession in the Ozarks of Missouri* (1940) postulated that open woodlands dominated by our Ozark woodland flora were succeeding to "true forest" due to a wetter, more humid climate. Fire studies later taught us that historical fires maintained our woodlands' open, grass-dominated character and diversity. Rather than 'succeeding' to forest, these once open and diverse woodlands and glades abruptly degraded to lands with a depauperate understory and out-of-context tree canopy following early settlement resource exploitation. Others proclaimed that, by leaving nature to its own devices, vegetation and wildlife would recover from the consequences of the Great Cut, 100 years of open range grazing, mining, and cropland abandonment. The US Forest Service management philosophy adopted the approach that future ecological conditions across National Forests should integrate modern human values and that "adaptive management" would result in new, resilient assemblages of vegetation.

When left untouched, no aspect of our contemporary altered landscape will recover the diverse assemblage of native plants and animals uniquely associated with historical, self-replicating natural communities. Transformation effects continue to press all remaining areas of natural vegetation, thus reducing their quality. Long-term vegetation monitoring, floristic quality indexing, ecosystem assessments, natural features inventories, and threats studies are revealing something entirely different. This profound difference must reshape our thinking about the future of restorable, but diminishing, ecosystems. There is no scientific basis for supporting the idea that varying management practices and fire suppression will result in the coalescing of new plant associations that will assure plant and animal species viability. It is also a myth to assume that we can assert experimental management practices on what little remains of highly diverse assemblages of conservative plant species. Closely allied to this myth is the notion that two landowners can manage equally similar fire-adapted natural communities—one with and one without the use of fire. Some believe, without proof of data, that the consequences of such out-of-character management will contribute its own unique biodiversity.

Which plant species occupy and colonize abandoned landscapes are determined by the land's use and condition at abandonment. What happens after, in the absence of native plant propagules and the pressures of homogenization, is subject to multiple pathways—all almost always a mix of weedy exotic species winners. The more than half of all Missouri native plant species with a conservative value of 6 or more almost never colonize such areas.

Our monitoring should be directed at measuring trends in conservative species with emphasis in tracking whether management actions favor agreed-on desired conditions.

Management contributions to homogenization

Forty years of natural areas management is sufficient time to look back and assess whether our actions were beneficial or detrimental to maintaining the viability of plant and animal species found within natural areas. We are left with impressions of success, and failure. I mention impressions because not all natural areas are subject to the rigors of ecological science. Not all owners have the resources necessary to engage in the types of appropriate research from which to understand, predict and then achieve the right set of desired ecological conditions. When we do, respective agency ecologists sometimes disagree on the management issues and thus the right course of action.

Unfortunately, strong disagreements on the methods by which we should monitor, research and evaluate whether certain management actions improve or damage the attributes of healthy ecosystems can divide otherwise unified efforts to do what is best for biodiversity. We often disagree on what the desired condition or management objectives should be. Ecologists often fail to adequately test theories or use the most relevant methodologies and analysis. Instead, land managing agencies are attracted to new approaches, only to abandon them in timelines that hinder comparison of long-term data (Belovsky et al. 2004). We are reminded that these differences often lead to management actions that do not favor adaptations of ancient genetic diversity.

Disagreement on management questions can translate into management practices or styles to which ancient genetic memory of ecosystems do not adapt well. Ever-changing staff aspire to make a difference in the world. Those aspirations depend on one's history, education, experiences, work ethic, political preference, beliefs, the environment in which they live, hobbies, and biases. We all wonder what the management style of the next new natural area manager might be, whether in a state park, conservation area, Nature Conservancy area, federal property or the new owner of private lands. The wonderment arises simply because as natural area specialists we have experienced changes in management style. Agency decentralization and reorganization requires effective advocacy skills on the behalf of Missouri Natural Areas. Fortunately, we can influence the selection in the hiring process. The manager that has great passion for ecological management, coupled with the ability and desire to carry out the best prescriptions, often translates into vibrant, high quality natural landscapes.

Conclusion

Human actions are fundamentally—and to a significant extent, irreversibly—altering the diversity of life on Earth, and most of these changes represent a loss of biodiversity. The factors of homogenization changing and threatening natural areas and other lands containing remnant biodiversity will continue to grow. Society can do little to alter continuing growth trends and their development patterns. Conservation leaders must plan for the consequences of homogenization. Biodiversity must be a high priority on their list among conservation, preservation, recreation or other multiple use purposes.

Keeping in mind the huge list of management styles, human resistance factors, lack of resources and shifting priorities, an irrefutable precept is that the trajectory of change for natural area biodiversity can follow many different and undesirable pathways. Nature does not adapt well, nor is resilient to, missing critical management prescriptions. Homogenization can quickly drive damaged natural communities to turnstile tipping points of no return. We are finding that the genetic diversity of ancient ecosystems truly does not adapt well when their boundaries are surrounded in a dystopian sea of transforming landscapes. With this transformation comes a management dilemma.

To maintain natural biodiversity and species viability, management appropriate to the natural community in question must be deliberate, precise, and based on sound ecological science. Missouri's natural diversity is best assured only through the continued dedicated commitment of resources to care for natural areas and other places of ecological importance. Managers must unify to identify the management and science issues, and to reach consensus on solutions. Given 40 years of tested natural areas management, managers and administrators need to convene workshops and conferences to identify pressing issues, share management successes and failures, and seek information to quickly predict present and future ecological conditions.

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