National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Natural Resource Condition Assessment

Herbert Hoover National Historic Site

Natural Resource Report NPS/HEHO/NRR—2019/2033

ON THE COVER

Photograph across restored prairie towards the Miles Farm (inset is the Herbert Hoover birthplace cottage), Herbert Hoover National Historic Site, Iowa (CSU/DAVE JONES)

Natural Resource Condition Assessment

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Natural Resource Report NPS/HEHO/NRR—2019/2033

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

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Executive Summary

Publisher's Note: Natural Resource Condition Assessments provide a snapshot-in-time evaluation of park resource conditions. For this report, most or all of the data discovery and analyses occurred during the period of 2013 to 2016. Thus, park conditions reported in this document pertain to that time period. Due to revised publishing requirements and/or scientific delays, this report was not published until 2019.

The National Park Service (NPS) Natural Resource Condition Assessment (NRCA) Program administered by the NPS Water Resources Division evaluates current conditions for important natural resources and resource indicators using primarily existing information and data. NRCAs also report on trends in resource condition when possible, identify critical data gaps, and characterize a general level of confidence for study findings. This NRCA complements historic resource assessments, is multi-disciplinary in scope, employs a hierarchical indicator framework, identifies and develops reference conditions/values for comparison against current conditions, and emphasizes spatial evaluation of conditions and GIS (map) products where possible.

Herbert Hoover National Historic Site (HEHO) was created in 1972 to "preserve in public ownership historically significant properties associated with the life of Herbert Hoover." From a natural resources perspective, the approximately 81 acres of reconstructed tallgrass prairie are a significant and rare community within the region. The combination of historic elements and high-quality tallgrass prairie provide a rich experience for visitors and create links to history and the natural landscape. The small-town setting is well preserved within the core of the park, and many of the landscape views have high scenic quality. Because the regional landscape is dominated by private land dominated by agricultural use, the Historic Site setting provides an important place for visitors to experience the outdoors. Park managers and NPS initiatives have made great strides since the park was created and an active monitoring program supports park management.

The NRCA for HEHO began in 2012. This study employed a scoping process involving Colorado State University, Park and NPS staffs to discuss the NRCA framework, identify important park resources, and gather existing information and data. Indicators and measures for each resource were then identified and evaluated. Data and information were analyzed and synthesized to provide summaries and address condition, trend and confidence using a standardized but flexible framework.

A total of 14 focal resources were examined: six addressing landscape context – system and human dimensions, three addressing chemical and physical attributes, and five addressing biological attributes. Landscape context-system and human dimensions included land cover and land use, night sky, soundscape, scenery, climate change and fire disturbance regime. Climate change and land cover/land use were not assigned a condition or trend—they provide important context to the park and many natural resources, and can be stressors. Some of the land cover and land use-related stressors at HEHO and in the larger region are related to the development of rural agricultural land and increases in population and housing over time. The trend in land development, coupled with a lack of significantly-sized and linked protected areas in the region, presents challenges and risks to the conservation of HEHO natural resources, including dark night skies, natural sounds, scenery and air and water quality. The fire regime warranted moderate concern with an unchanging trend, and might be significantly ameliorated via planning, programmatic and budgetary measures.

The supporting chemical and physical environment at the park includes its air quality, water quality and stream hydrology/geomorphology. The condition of these resources can a affect human dimensions of the park such as visibility and scenery as well as biological components such as stream biota. Air quality, water quality and stream hydrology/geomorphology all warranted significant management concern. Stressors outside the park are significantly impacting these resources.

The floral biological components examined included prairie vegetation and invasive exotic plants. The park is an excellent example of tallgrass prairie and one of the best examples of restored tallgrass prairie in Iowa. Challenges related to invasive plant management and fire regime contribute to management concerns. Although the prairie is rated in good condition, there is some risk associated with potential expansion of nonnative invasive plants. Maintenance of a desirable fire regime can help control woody plants and promote floristic diversity, but is challenging due to the park's location within an urbanized area.

The faunal biological components examined included aquatic macroinvertebrates, birds and fish Aquatic macroinvertebrates are likely being impacted by poor water quality and altered stream flows/hydrology. The fish community was rated in good condition but the reference condition is poorly defined and stream habitat is highly altered. The bird community warrants moderate concern. Trends for faunal resources examined are unchanging or unknown. Because of the small size of the park and the predominance of developed and agricultural land uses, opportunities to support a diverse faunal assemblage at HEHO, including a variety of herpetofauna, carnivores, ungulates and other species is limited. Many animals have been lost from the landscape and are no longer present in the park. Nonetheless, the park still provides an island of restored prairie that provides habitat for native animals.

The identification of data gaps during the course of the assessment is an important outcome of the NRCA. In some cases significant data gaps contributed to low confidence in the condition or trend assigned to a resource. Primary data gaps and uncertainties encountered were lack of recent survey data; uncertainties regarding reference conditions; lack of consistent, long-term data; and incomplete understanding of the ecology of resources.

Ecosystem stressors impacting park resources and their management exist both inside and outside park boundaries. Altered disturbance regimes such as fire and flooding, conversion and fragmentation of natural habitats, spread of invasive exotic plants and animal species that threaten regional biological diversity, altered hydrology and stream channel degradation, and water pollution appear to be significant stressors of biological resources. Other resources related to human dimensions and visitation appeared to be stressed or directly affected by changes in land uses and land cover, population and housing densities, and traffic. Many resources were found to have interrelated stressors, the most common being invasive plants, damage to streams and water quality by agricultural practices and development, and degraded visitor experiences related to night skies, soundscape and scenery. Stream restoration at HEHO is highly constrained by requirements to protect historic and other structures located within the floodplain.

There are opportunities to mitigate the effects of some local stressors through planning, management and mitigation. Stressors driven by more distant factors such as light pollution generated by urban centers, and increase in regional transportation volumes affecting sights and sounds, and air quality issues in distant urban centers affecting prescribed burning are more difficult to mitigate. Collectively, this context supports resource planning and management within the park, and will help park managers to develop near-term management priorities, engage in watershed or landscape-scale collaboration and education efforts, conduct park planning, and report program performance.

The area outside the commemorative area supports many natural resource functions while providing an "accessible" and "spacious" setting within which the historic setting can be experienced and visitors can experience the outdoors. The historic context is therefore buffered to some degree and complemented by the natural areas surrounding the core visitation area. Nonetheless, the landscape immediately surrounding the park and in the broader region continues to change significantly in ways that degrade park natural resources and impact visitor experience.

Herbert Hoover National Historic Site faces challenges that are compounded by its small size and isolation with regard to other protected natural areas. Regional and park-specific mitigation and adaptation strategies are needed to maintain or improve the condition of some resources over time in response to stressors such as weeds, altered hydrology and undesirable effects of urban and exurban encroachment. Success will require acknowledging a "dynamic change context" and managing widespread and volatile problems while confronting uncertainties, managing natural and cultural resources simultaneously and interdependently, developing broad disciplinary and interdisciplinary knowledge, and establishing connectivity across broad landscapes beyond park borders.

Prologue

Publisher's Note: Changes in publishing requirements, and in some cases scientific delays, resulted in several NRCA reports not being published in a timely manner. These publications reported on studies initiated in the 2013-16 timeframe. Since Natural Resource Condition Assessments provide a snapshot-in-time evaluation of park resource conditions, it is important to note that data discovery and analyses for this study was conducted a few years prior to publication. Thus, park conditions reported in this document pertain to that time period. Please see the Publisher's Note at the beginning of the Executive Summary for dates specific to this report.

Chapter 1. NRCA Background Information

Natural Resource Condition Assessments (NRCAs) evaluate current conditions for a subset of natural resources and resource indicators in national park units, hereafter "parks." NRCAs also report on trends in resource condition (when possible), identify critical data gaps, and characterize a general level of confidence for study findings. The resources and indicators emphasized in a given project depend on the park's resource setting, status of resource stewardship planning and science in identifying high-priority indicators, and availability of data and expertise to assess current conditions for a variety of potential study resources and indicators.

NRCAs Strive to Provide…

- *Credible condition reporting for a subset of important park natural resources and indicators*
- *Useful condition summaries by broader resource categories or topics, and by park areas*

NRCAs represent a relatively new approach to assessing and reporting on park resource conditions. They are meant to complement—not replace—traditional issue-and threat-based resource assessments. As distinguishing characteristics, all NRCAs:

- Are multi-disciplinary in scope;[1]
- Employ hierarchical indicator frameworks;[2]
- Identify or develop reference conditions/values for comparison against current conditions;[3]
- Emphasize spatial evaluation of conditions and GIS (map) products;[4]
- Summarize key findings by park areas; and [5]
- Follow national NRCA guidelines and standards for study design and reporting products.

Although the primary objective of NRCAs is to report on current conditions relative to logical forms of reference conditions and values, NRCAs also report on trends, when appropriate (i.e., when the underlying data and methods support such reporting), as well as influences on resource conditions.

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[1] The breadth of natural resources and number/type of indicators evaluated will vary by park.

[2] Frameworks help guide a multi-disciplinary selection of indicators and subsequent "roll up" and reporting of data for measures ⇨ conditions for indicators ⇨ condition summaries by broader topics and park areas

[3] NRCAs must consider ecologically-based reference conditions, must also consider applicable legal and regulatory standards, and can consider other management-specified condition objectives or targets; each study indicator can be evaluated against one or more types of logical reference conditions. Reference values can be expressed in qualitative to quantitative terms, as a single value or range of values; they represent desirable resource conditions or, alternatively, condition states that we wish to avoid or that require a follow-up response (e.g., ecological thresholds or management "triggers").

[4] As possible and appropriate, NRCAs describe condition gradients or differences across a park for important natural resources and study indicators through a set of GIS coverages and map products.

[5] In addition to reporting on indicator-level conditions, investigators are asked to take a bigger picture (more holistic) view and summarize overall findings and provide suggestions to managers on an area-by-area basis: 1) by park ecosystem/habitat types or watersheds, and 2) for other park areas as requested.

These influences may include past activities or conditions that provide a helpful context for understanding current conditions, and/or present-day threats and stressors that are best interpreted at park, watershed, or landscape scales (though NRCAs do not report on condition status for land areas and natural resources beyond park boundaries). Intensive cause-and-effect analyses of threats and stressors, and development of detailed treatment options, are outside the scope of NRCAs.

Due to their modest funding, relatively quick timeframe for completion, and reliance on existing data and information, NRCAs are not intended to be exhaustive. Their methodology typically involves an informal synthesis of scientific data and information from multiple and diverse sources. Level of rigor and statistical repeatability will vary by resource or indicator, reflecting differences in existing data and knowledge bases across the varied study components.

The credibility of NRCA results is derived from the data, methods, and reference values used in the project work, which are designed to be appropriate for the stated purpose of the project, as well as adequately documented. For each study indicator for which current condition or trend is reported, we will identify critical data gaps and describe the level of confidence in at least qualitative terms. Involvement of park staff and National Park Service (NPS) subject-matter experts at critical points during the project timeline is also important. These staff will be asked to assist with the selection of study indicators; recommend data sets, methods, and reference conditions and values; and help provide a multi-disciplinary review of draft study findings and products.

NRCAs can yield new insights about current park resource conditions, but, in many cases, their greatest value may be the development of useful documentation regarding known or suspected resource conditions within parks. Reporting products can help park managers as they think about near-term workload priorities, frame data and study needs for important park resources, and communicate messages about current park resource conditions to various audiences. A successful NRCA delivers science-based information that is both credible and has practical uses for a variety of park decision making, planning, and partnership activities.

Important NRCA Success Factors

- *Obtaining good input from park staff and other NPS subject-matter experts at critical points in the project timeline*
- *Using study frameworks that accommodate meaningful condition reporting at multiple levels (measures ➩ indicators ➩ broader resource topics and park areas)*
- *Building credibility by clearly documenting the data and methods used, critical data gaps, and level of confidence for indicator-level condition findings*

However, it is important to note that NRCAs do not establish management targets for study indicators. That process must occur through park planning and management activities. What an NRCA can do is deliver science-based information that will assist park managers in their ongoing, long-term efforts to describe and quantify a park's desired resource conditions and management targets. In the near term, NRCA findings assist strategic park resource planning[6] and help parks to report on government accountability measures.[7] In addition, although in-depth analysis of the effects of climate change on park natural resources is outside the scope of NRCAs, the condition analyses and data sets developed for NRCAs will be useful for park-level climate-change studies and planning efforts.

NRCAs also provide a useful complement to rigorous NPS science support programs, such as the NPS Natural Resources Inventory & Monitoring (I&M) Program.[8] For example, NRCAs can provide current condition estimates and help establish reference conditions, or baseline values, for some of a park's vital signs monitoring indicators. They can also draw upon non-NPS data to help evaluate current conditions for those same vital signs. In some cases, I&M data sets are incorporated into NRCA analyses and reporting products.

NRCA Reporting Products…

Provide a credible, snapshot-in-time evaluation for a subset of important park natural resources and indicators, to help park managers:

- *Direct limited staff and funding resources to park areas and natural resources that represent high need and/or high opportunity situations* ***(near-term operational planning and management)***
- *Improve understanding and quantification for desired conditions for the park's "fundamental" and "other important" natural resources and values* ***(longer-term strategic planning)***
- *Communicate succinct messages regarding current resource conditions to government program managers, to Congress, and to the general public* ***("resource condition status" reporting)***

Over the next several years, the NPS plans to fund an NRCA project for each of the approximately 270 parks served by the NPS I&M Program. For more information visit the NRCA Program website.

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[6] An NRCA can be useful during the development of a park's Resource Stewardship Strategy (RSS) and can also be tailored to act as a post-RSS project.

[7] While accountability reporting measures are subject to change, the spatial and reference-based condition data provided by NRCAs will be useful for most forms of "resource condition status" reporting as may be required by the NPS, the Department of the Interior, or the Office of Management and Budget.

[8] The I&M program consists of 32 networks nationwide that are implementing "vital signs" monitoring in order to assess the condition of park ecosystems and develop a stronger scientific basis for stewardship and management of natural resources across the National Park System. "Vital signs" are a subset of physical, chemical, and biological elements and processes of park ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values.

Chapter 2. Introduction and Resource Setting

Publisher's Note: Natural Resource Condition Assessments provide a snapshot-in-time evaluation of park resource conditions. For this report, most or all of the data discovery and analyses occurred during the period of (year 2013) to (year 2016). Thus, park conditions reported in this document pertain to that time period. Due to revised publishing requirements and/or scientific delays, this report was not published until (year 2019).

2.1. Introduction

2.1.1. Enabling Legislation

Congress authorized the Historic Site on August 12, 1965, through Public Law 89-119 (79 Stat. 510). This legislation authorized the acquisition and development of lands in the City of West Branch, Iowa to "preserve in public ownership historically significant properties associated with the life of Herbert Hoover." Public Law 89-119 authorized the transfer of all federal property to the NPS with the exception of the Herbert Hoover Presidential Library (HHPL). The law also authorized the acquisition of additional property to enlarge and develop the Historic Site. The NPS established the Historic Site on August 17, 1972.

2.1.2. Geographic Setting

Herbert Hoover National Historic Site is located in Cedar County, Iowa, on the southern edge of the town West Branch (Figure 2.1-1). It is 10 mi east of Iowa City, 34 mi southeast of Cedar Rapids, and 46 mi west of Davenport.

2.1.3. Park Significance

Herbert Hoover National Historic Site preserves and provides an accessible, dignified, and spacious setting in which visitors can experience the birthplace cottage, gravesite, Presidential Library-Museum, and other resources. It commemorates and interprets the life, career, and accomplishments of Herbert Hoover in cooperation with other organizations. The *General Management Plan* (NPS 2004) describes the following significance of the National Historic Site:

- It is the birthplace and site of the formative years that set Herbert Hoover on the road to becoming the nation's 31st President and a global humanitarian.
- From his birth to age 11, Herbert Hoover's experiences and associations with his family and the community of West Branch influenced his personality, work ethic, spiritual and moral character, and ambition. These strong traits are evident throughout his public service and private endeavors.
- It memorializes Herbert Hoover by encompassing his birthplace cottage, gravesite, Presidential Library-Museum, Friends Meeting House, Blacksmith Shop, Schoolhouse, statue of Isis, tallgrass prairie, and a branch of the Wapsinonoc Creek in a dignified setting in the town of West Branch, Iowa.

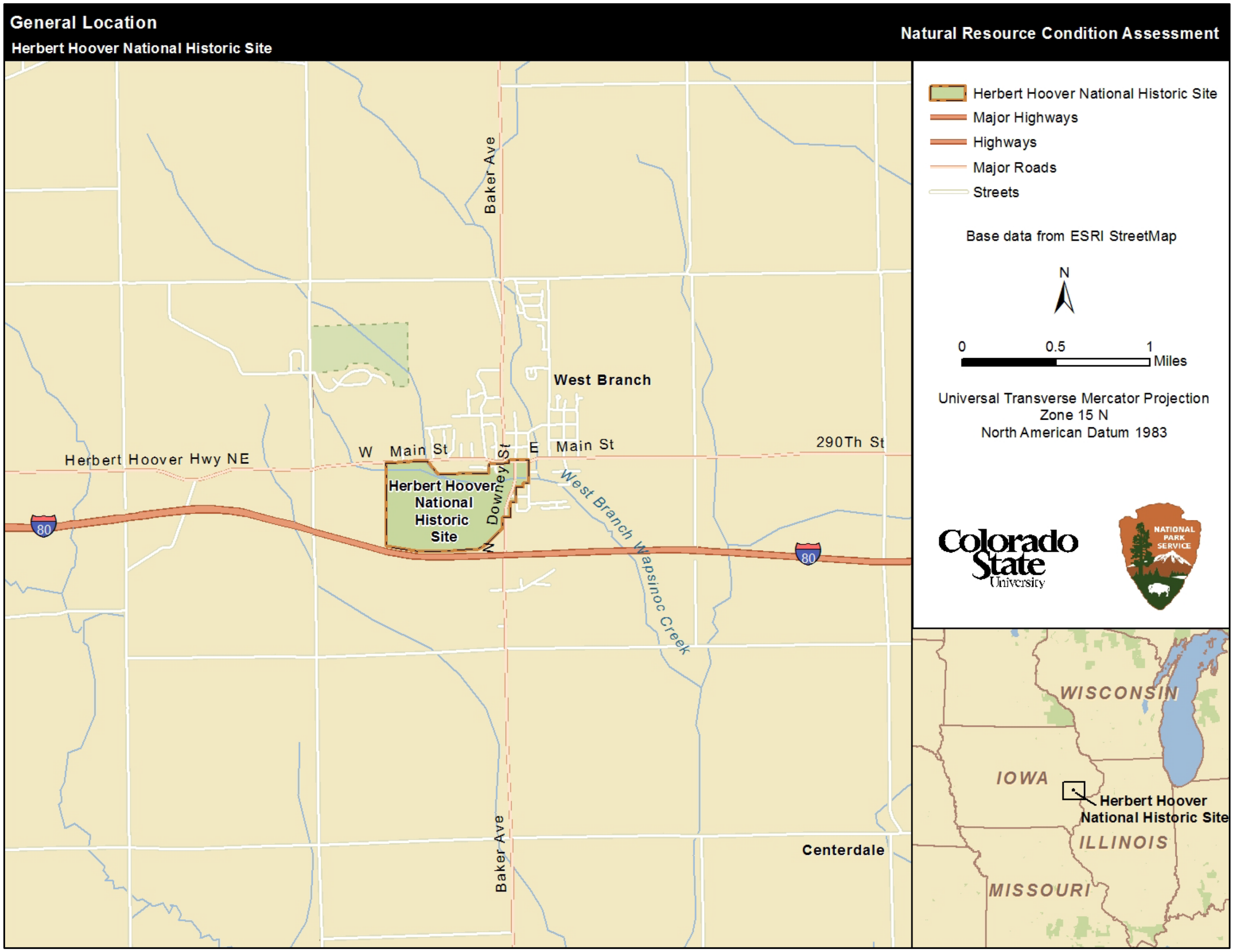

Figure 2.1-1. General location of Herbert Hoover National Historic Site.

The involvement of Herbert Hoover, Lou Henry Hoover, their family, friends, and the community was a driving force for the establishment, design, and management of Herbert Hoover National Historic Site. In this spirit of cooperation, the NPS facilitates the stewardship of this commemorative site.

The Historic Site consists of 186.80 ac that includes the birthplace of President Herbert Hoover, the Herbert Hoover Presidential Library-Museum, the Gravesite of President and Mrs. Hoover, the site of a house in which Hoover lived in West Branch from 1879 until 1884, a Friends (Quaker) Meeting House, a representation of his father's Blacksmith Shop, a Schoolhouse, and several late nineteenth-century and early twentieth century houses and outbuildings. The setting includes an unnamed branch of the Wapsinonoc Creek (also known as "Hoover Creek"), the Isaac Miles Farm, an eighty-one acre reconstructed tallgrass prairie, the Thompson Farm, a maintenance facility, visitor center, picnic area, parking areas, and open space. The Historic Site also includes Parkside Drive, which connects West Branch with Interstate 80, and the Loop Road, which connects Parkside Drive with the Presidential Library-Museum and the Gravesite.

From a natural resources perspective, the approximately 81 ac of reconstructed tallgrass prairie are a significant and rare community within the region. While approximately 85% of Iowa was occupied by tallgrass prairie prior to European settlement, less than 0.1% of those areas remain in prairie vegetation (Smith 1998). Additional resource-centric significance of the Historic Site is its mandate as an "accessible" and "spacious" setting within which the historic setting can be experienced. Because the regional landscape is dominated by private land dominated by agricultural use, the Historic Site setting provides an important place for visitors to experience the outdoors.

2.1.4. Visitation Statistics

Park visitors are a mixture of recreation and non-recreation travelers and local residents. Annual park recreation visitation appears to be generally declining since recordkeeping began in 1971 (Figure 2.1-2). A bump in visitation occurred in the early 1990s is associated with the rededication of the Presidential Library following its expansion. Mean annual visitation for the five-year period ending 2012 was 142,223 recreation visitors per year. Monthly visitation is highest in the summer (Figure 2.1-3). Available data indicate a significant decline in visitation from March through October during the 2002–2012 period compared to the 1979–1989 period. December visitation has increased significantly during the same periods. In 2012 the most popular visitor activities were Presidential Library-Museum visits and visiting Park grounds, followed by birthplace cottage and visitor center visits and special events visits. A variety of promotions, including Hooverfest, Christmas Past, and other special events and exhibits contribute significantly to visitation. Approximately 10,000 students visit the historic site each spring and fall for educational programs and tours.

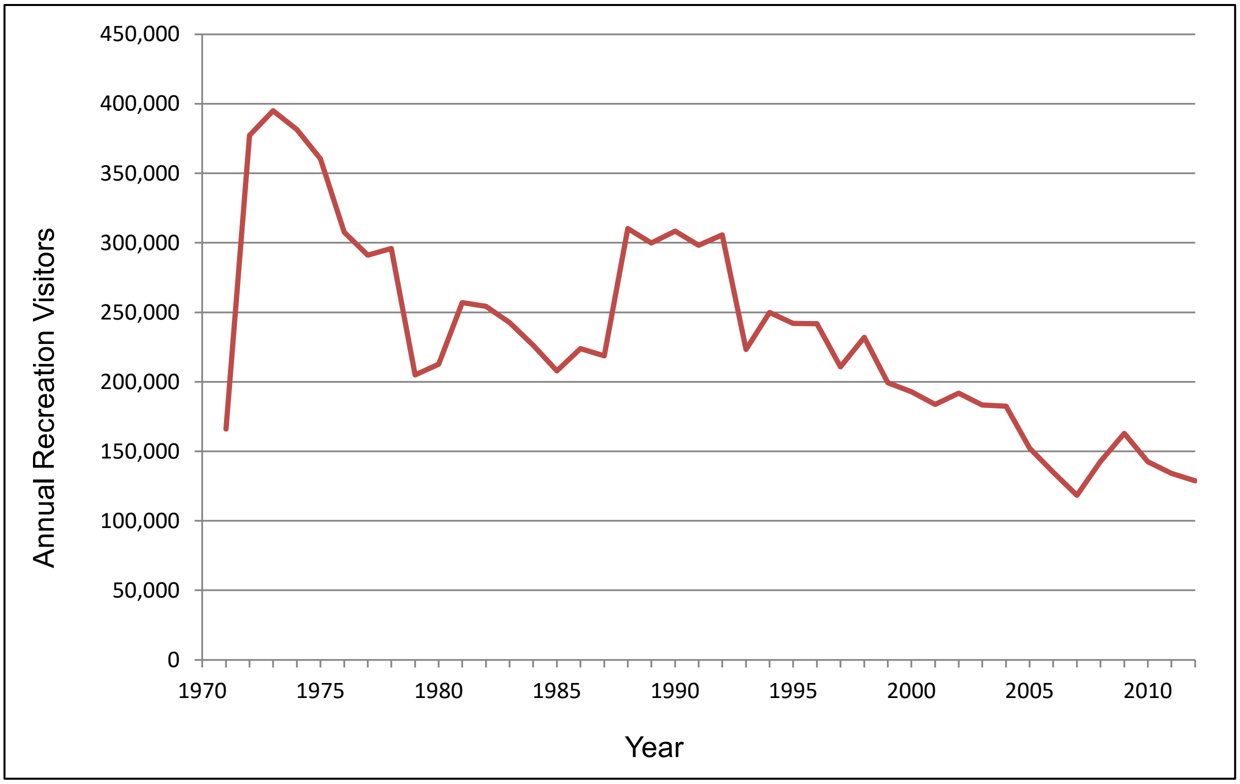

Figure 2.1-2. Annual HEHO recreation visitation for 1971–2012 (Data from NPS 2013).

The birthplace cottage is generally open from May through September. A minority of visitors use the trails traversing the prairie areas outside of the historic district, museum and Hoover gravesite areas. It is estimated that there are approximately 18,000 non-recreation visitors per year at HEHO (NPS 2013).

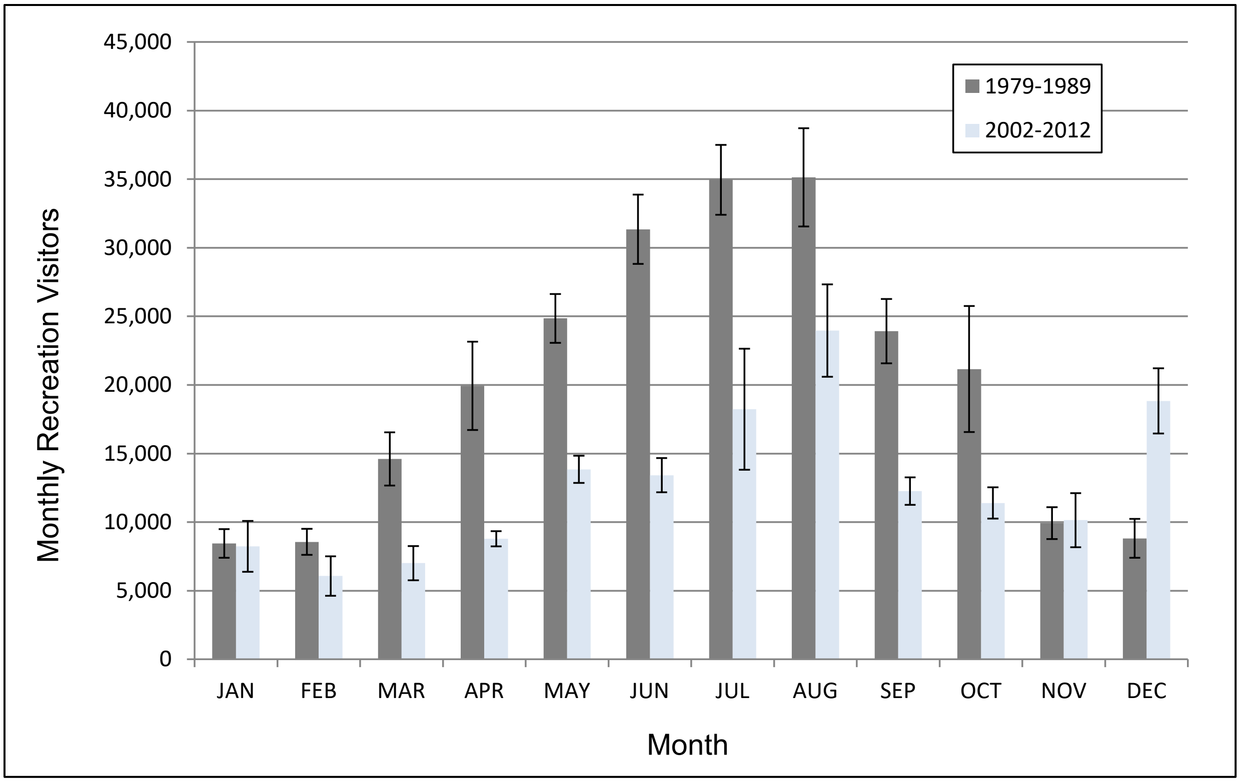

Figure 2.1-3. Mean monthly recreation visitation for HEHO for its first ten years compared to the 2002–2012 period. (Data from NPS 2013). Error bars represent 90% confidence intervals.

2.2. Natural Resources

2.2.1. Climate

The climate at HEHO is continental and characterized by cold winters and hot summers (Figure 2.2-1). Summers tend to be hot and humid; winters are cold, windy, and snowy; and spring and fall are mild with moderate temperatures (NPS 2013). The average annual temperature at HEHO is 11.0° Celsius (C) (51.8 Fahrenheit (F)). The coldest month is January, with an average temperature of -4.7° C (23.6° F). The warmest month is July, with an average temperature of 24.8° C (76.6° F). The median growing season length at HEHO is 182 days with a last spring frost occurring around April 14 and a first fall frost occurring around October 13 (MRCC 2013a). The snow season at HEHO spans October to April and averages 70.36 cm (27.7 in) of snowfall annually (MRCC 2013b).

The regional climate and projected changes to climate in the vicinity of the Historic Site are discussed in Chapter 4.

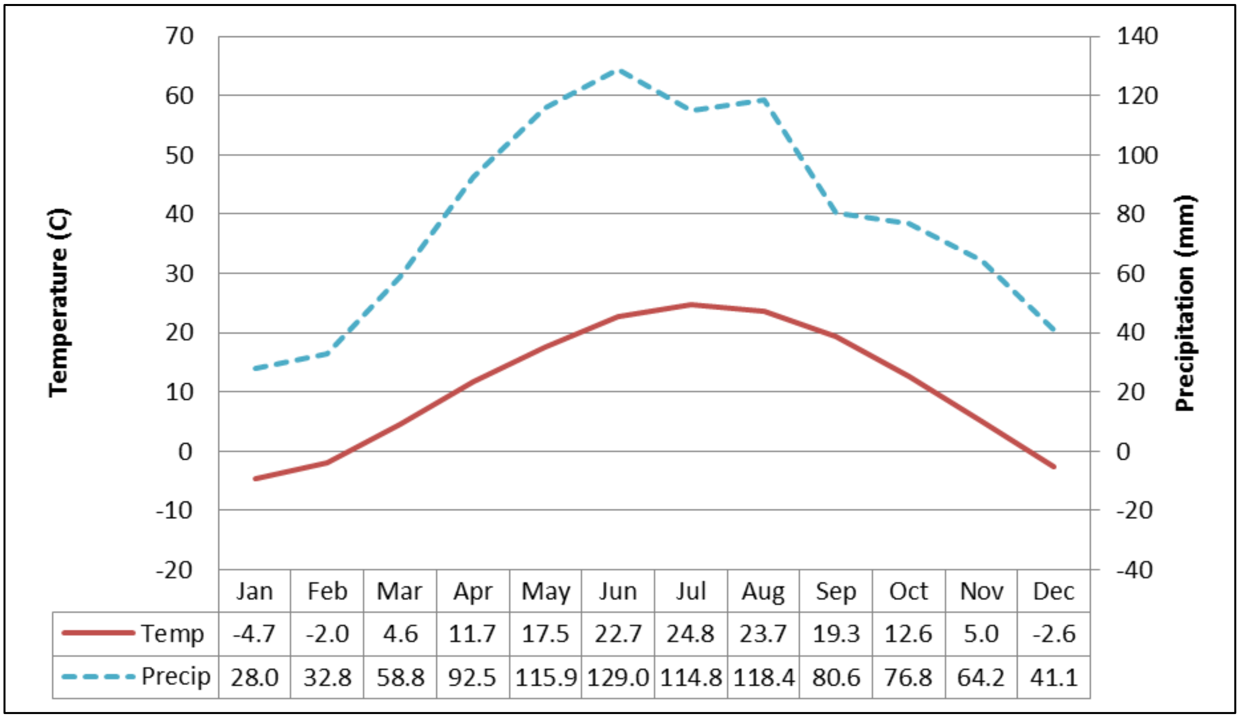

Figure 2.2-1. Walter climate diagram of Herbert Hoover National Historic Site 30-year temperature and precipitation averages (1981–2010) (data source: NCDC 2013).

2.2.2. Geology and Soils

The underlying geology of Iowa shows a general gradient in age from east to west: the geologic ages of the rock in eastern Iowa are older, from the Silurian period (over 400 million years before present) to the Precambrian period (over 600 million years before present). Going west, the geology is younger, with most rocks exhibiting characteristics of either the Cretaceous period (approximately 100 million years before present) or the Pennsylvanian period (300 million years before present). The rocks were deposited originally as loose sediments in shallow seas or along coastal or floodplain areas that hardened over time (IDNR 2014).

The soils of Iowa are, generally speaking, deep, well-drained soils that once supported the tallgrass prairie throughout this region and are productive as agricultural soils. Cedar County contains 48 soils considered “prime” (containing the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops), two of which are present within the current boundaries of HEHO (NPS 2006). The Colo-Ely complex covers the majority of the park, while the Tama Silt Loam (the state soil of Iowa) covers the area around the Thompson Farm.

2.2.3. Hydrology

The primary hydrological feature of HEHO is a tributary of the West Branch of the Wapsinonoc Creek, referred to locally as Hoover Creek. Hoover Creek, draining nearly 1,700 ac of land to the west and north, has a baseflow averaging about 3 cubic feet per second (CFS). The creek bed used to be no more than a grassy swale prior to settlement and the agricultural conversion throughout the region. Since then, the hydrological regime has changed to one susceptible to flooding and that threatens the cultural resources of HEHO. The hydrology of the creek changed in two primary stages (NPS 2006). First, early settlers to the region harvested the trees along the banks of Hoover Creek and similar waterways for timber. Later, as the owners converted the lands to agricultural fields, they installed agricultural drainage tiles to aid surface water drainage from fields. Without the streambank vegetation and under changing flow dynamics from regional agriculture, streams like Hoover Creek changed from meandering waterways to scoured, highly-incised stream beds, with unstable stream banks and migrating channels (NPS 2006).

During the 1993 flood, water nearly reached the foundation of the historic Friends Meeting house (NPS).

Increasing urbanization has also changed the hydrology of Hoover Creek. With more roads, parking lots, and other impermeable surfaces in the watershed, rainfall and snowmelt no longer seep slowly into the prairie soils but instead flow rapidly overland into creeks and streams. The problem of urbanization and its impact to surface water and flooding dynamics began in the mid-20th century, with approximately 200 ac of land urbanized between 1940 and 2003, and future projections predict another 168 ac of urban development in the near future (NPS 2006). Many of the historic resources protected by the park lie within the 50-, 25- and 15-year floodplains of Hoover Creek and the west branch of Wapsinonoc Creek. This places them in jeopardy of damage or loss during flood events. In the 11-year period from 1991 through 2003, the park experienced 18 floods that inundated park buildings or infrastructure and interrupted services to visitors (NPS 2006).

2.2.4. Air Quality

Herbert Hoover National Historic Site (HEHO), like all the other parks within the Heartland Inventory & Monitoring network, is designated as a Class II airshed by the Clean Air Act of 1997. As such, air quality within the park is protected to a less stringent degree than in other parks and protected areas around the country. Air quality at HEHO is not directly measured within the historic site but instead inferred from instrumentation located around the region.

The air quality parameters estimated for HEHO reflect regional air quality characteristics. For example, the wet and dry deposition of nitrogen and sulfur for HEHO reflects the rural and agricultural character of central Iowa (NPS 2013), while ozone concentrations generally mirror regional ones and do not indicate significant ozone concerns. These specific resource issues as well as visibility are addressed later in the document, and all have consequences for the health and condition of natural communities, human health and the quality of the visitor experience.

2.2.5. Land Use

Eastern Iowa was once unbroken tallgrass prairie, and the lands supporting this ecosystem became prime agricultural lands during westward expansion and the subsequent agricultural revolution. First settlers cleared timber that grew along streambanks and in patches within the prairie; later the lands were plowed and planted (NPS 2006). Recently, urbanization has been the driving force in land use change. While the human population within Cedar County (18,416, Census Bureau 2012) still indicates a strong rural character, the conversion of lands from agriculture to suburban lands with impervious surfaces like roofs, roads, and parking lots has affected natural resource properties. Flooding is now a significant disturbance, and the park has invested significant resources into minimizing infrastructure risk and resource degradation (NPS 2006). Furthermore, increasing human development also increases the likelihood of invading exotic plant and animal species; exotic plants require significant management attention and activity. Dominant agricultural uses include row cropping of corn and soy beans, hay and pasture.

2.2.6. Wildlife

Native tallgrass prairie, with its productivity and its natural cycles of disturbance, has frequently demonstrated significant wildlife diversity. Birds, mammals, and herpetofauna provide significant species diversity within the prairie lands. The Heartland I&M Network has inventoried many of these groups, and the results indicate significant natural resources for this national historic site.

Breeding bird surveys conducted over 5 years (2005–2010) indicate that species diversity in the grassland habitats at HEHO is greater than bird diversity in adjacent developed areas (Peitz 2010). Nearly 30 bird species were catalogued in grasslands in the last two years of those surveys. A mammal inventory found a wide range of mammals indicating the diversity of habitats within HEHO: species typical of tallgrass prairies, old farm fields, managed parklands, and riparian habitats have been documented (Robbins 2005). Only 3 snake species were found during a herpetofaunal inventory, suggesting marginal habitats for these groups (Richtsmeier 2003). Nine species of butterflies and forty-three species of insects and spiders have been observed. No federally-listed threatened or endangered plant or animal species or candidate species are known to occur in Cedar County, Iowa (NPS 2004).

2.2.7. Vegetation

Prior to settlement by European emigrants and the widespread conversion to agriculture, the lands of eastern Iowa were comprised of tallgrass prairie, a product of the fertile soils, abundant rainfall, and a disturbance regime from both grazing and fire. Over 80 ac of tallgrass prairie have been restored within the park's Natural Zone through active management and restoration efforts at HEHO. The goal of this restoration includes recreating a representation of the native tallgrass prairie that demonstrates the natural function of this once-dominant ecosystem (James 2011).

Big bluestem (*Andropogon gerardii*) dominates the tallgrass prairie at HEHO, with other grasses like Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), and little bluestem (*Schizachyrium scoparium*) contributing to the restored prairie species list (NPS 2014). In addition to the grasses of the prairie, native forbs (wildflowers) contribute a colorful component to the prairie. These forbs contribute approximately 50% of the foliar cover in recent monitoring studies, matching the foliar cover of the grasses within the restored prairie (James 2011). The prairie ecosystem was once maintained by a combination of grazing and fire, but park management now relies primarily on prescribed fire and invasive plant management to maintain the community health and vigor of the native plants while keeping exotic grasses and forbs, as well as trees, at bay. Without periodic fire, shrubs and trees would invade the prairie and outcompete native prairie vegetation.

Woodlands along Hoover Creek and throughout the eastern half of the Historic site consist of a mix of native and introduced species with a ground cover of turf grasses. The woodlands are largely managed to create an open, park-like atmosphere.

2.3. Resource Stewardship

2.3.1. Management Directives and Planning Guidance

Each unit in the National Park System is required by the National Park Service Organic Act of 1916 to "conserve the scenery and natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations." The General Authorities Act in 1970 (as amended) reiterated the provisions of the Organic Act and emphasized that "these areas, though distinct in character, are united through their inter-related purposes and resources into one national park system as cumulative expressions of a single national heritage." It also re-emphasized the importance of "unimpaired" NPS resources for future generations. The enabling legislation establishes park purposes and legislatively authorized uses within a context of cultural and natural resources. The National Park Service Management Policies (NPS 2006a) provides Service-wide guidance for Park System planning, land protection, natural and cultural resources management, wilderness preservation and management, interpretation and education, use of the parks, park facilities and commercial visitor services. All management and planning documents developed for the park must adhere to these overarching documents and other laws, Executive Orders and Director's Orders.

A number of important NPS documents guide the management of natural resources in the park. The *General Management Plan and Environmental Assessment* (NPS 2004) is the primary planning document for Herbert Hoover National Historic Site. The plan provides a broad direction for all phases and elements of HEHO management. The implemented management alternative places an emphasis on commemorating the cultural heritage and life of President Herbert Hoover while maintaining the park's natural and cultural resources. Natural and cultural resources serve as symbols of significant events and influences on his character and career, and enable visitors to make personal connections to the significance of the Hoover story and heritage of the area. Restoration of the native prairie and removal of modern facilities from the floodplain will preserve important aspects of both natural and cultural resources while providing a wide choice of activities in a protected environment. Other important documents guiding stewardship at HEHO include the *Fire Management Plan* (NPS 2001), *Prairie Management Plan* (NPS 2003), *Hoover Creek Stream Management Plan and Environmental Impact Statement* (NPS 2006b), and the *National Historic Site Long-Range Interpretive Plan* (NPS 2008).

These broad and park-specific documents and management directives provide important information for identifying and characterizing focal resources and articulating resource reference conditions in this natural resource condition assessment.

2.3.2. Management Zones

Management zones were developed to facilitate planning and management of different areas and resources within the Historic Site (Figure 2.3-1). The following management zones are described in the *General Management Plan* (NPS 2004).

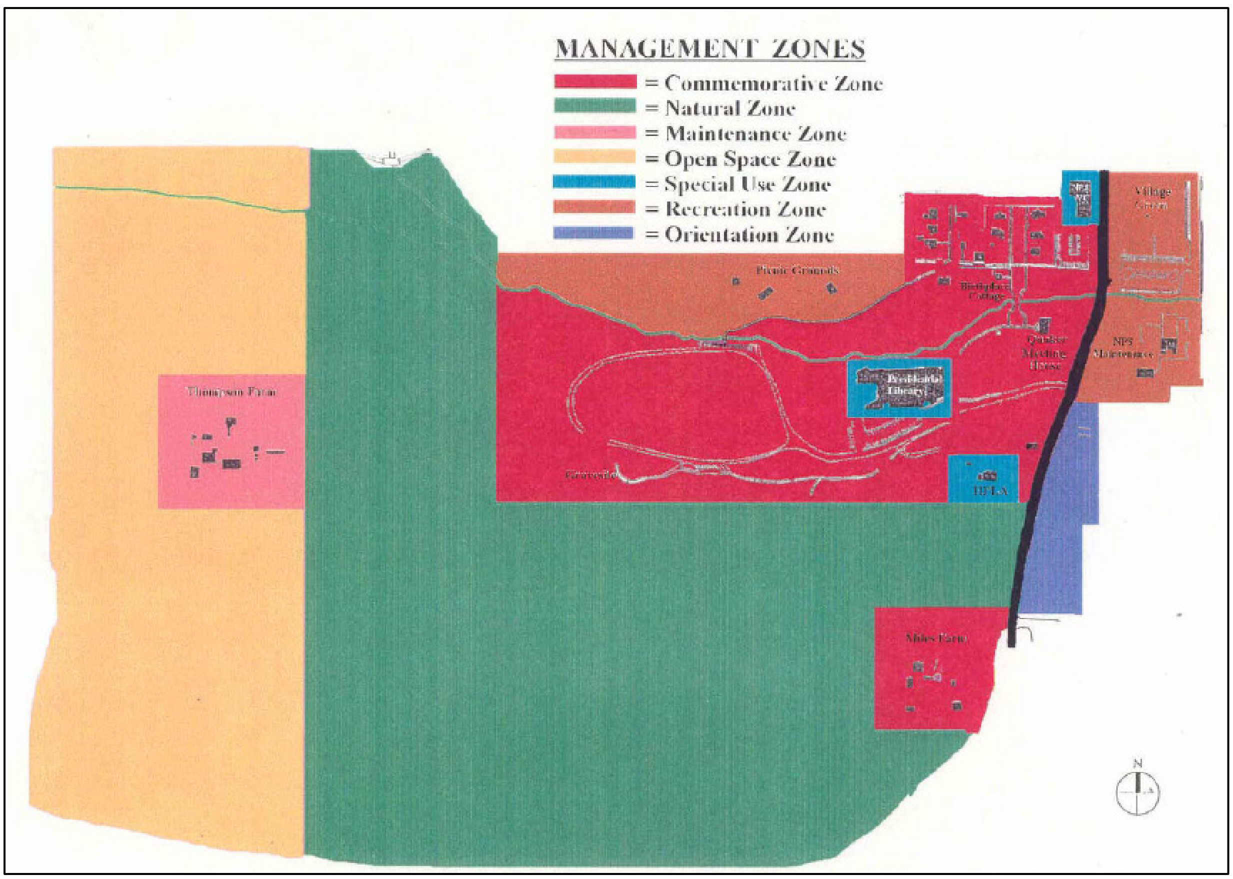

Figure 2.3-1. Schematic of management zones at Herbert Hoover National Historic Site (NPS 2004).

Commemorative Zone

This zone includes the historic neighborhood district, birthplace cottage, gravesite, Herbert Hoover Presidential Library-Museum, Miles Farm, Friends Meeting House and other historic resources. The NPS manages resources and provides visitor experiences to emphasize the commemoration of Herbert Hoover. Vegetation consists of managed turf grasses, park-like settings and woodlands. The NPS preserves, protects, and maintains cultural resources in a highly designed setting that encourages personal reflection on the meaning of Hoover's life.

Natural Zone

This zone includes approximately 76 ac of restored tallgrass prairie with some patches of scattered woodlands and shrublands. This zone provides a natural, spacious setting to support the commemoration of Herbert Hoover. The NPS manages natural resources to meet all applicable laws, policies, and management standards to preserve, but does not plan to fully restore the prairie ecosystem. Visitors have the opportunity to experience the influence of the natural world on Herbert Hoover's life through interpretation, contemplation, and recreation using the interpretive trails, and typically experience a high degree of solitude. The natural zone provides a natural boundary between the Historic Site and Interstate 80 and other development.

Maintenance Zone

This zone within the Thompson Farm parcel provides a low-profile location for maintenance operations. The design of new buildings will remain compatible with Thompson Farm buildings and the facility will harmonize with the setting of the adjacent zones. Only limited, incidental visitor access would occur in this zone with no visitor facilities, trails, services, or programs.

Orientation Zone

This zone near the park entrance provides an opportunity for visitors to orient themselves to the entire Hoover Complex. Resources in this small area would be maintained in a highly manicured manner to create a welcoming atmosphere.

Open Space Zone

This zone surrounds the Thompson Farm complex to the south, west and north, abuts the natural zone to the east and enhances the open, spacious area of the Commemoration Zone. Natural resources are in a highly manipulated condition as agricultural fields or as maintained groundcover vegetation. Only limited, incidental visitor access would occur in this zone with no visitor facilities, trails, services, or programs.

Special Use Zone

This zone includes facilities operated or controlled by other governmental agencies or private interests on lands within the boundary of the Historic Site. These currently include the HHPL, the Federal Office Building, and the Administrative Building for the Herbert Hoover Presidential Library Association, Inc.

Recreation Zone
This zone in the northeast corner and north-central areas of the Historic Site provides visitors and local residents with facilities and opportunities for safe recreational activities unrelated to the commemoration of President Hoover. Social and group activities result in a moderate degree of contact with other visitors, and visitors therefore have a low opportunity for solitude. No significant cultural resources occur in this zone. Natural resources are in a highly designed and manipulated condition.

2.3.3. Resource Issues Overview
Regional Great Plains ecosystem stressors that can impact park resources and their management include altered disturbance regimes such as fire and flooding, conversion and fragmentation of natural habitats, spread of invasive exotic plants and animal species that threaten regional biological diversity, loss of native pollinators, excess deer browsing, altered hydrology and channel degradation of streams, sedimentation and pollution of streams, and poorly-sited utility-scale wind turbines (Schneider et al. 2011).

Park management concerns highlighted in the *General Management Plan* (NPS 2004) and by Park staff during the scoping process consist of natural and cultural resource-related issues as well as stressors from outside the park. Primary resource management concerns within the park and beyond park boundaries are briefly described below.

Prairie Quality and Natural Processes
Woody plant encroachment competes with native prairie vegetation and alters the character of the natural and cultural landscape. The primary tools used to manage the prairie are active restoration, weed management and prescribed fire. Nonnative invasive plants have been introduced and have spread throughout the region via agriculture other human disturbances and practices. Invasive exotic plants are a concern because of their potentially detrimental effects on the native and restored tallgrass prairie. An aggressive program to control invasive exotic plants is in place at HEHO. Prairie conservation is challenging and in recent years some gains may be partially offset by reduced frequency of prescribed burning.

Scenic Resources
Views from the park have changed significantly since the park's creation in 1972. The views are variable, consisting of urban and commercial elements, energy and communication lines and structures, roads and highways, exurban and urban development, agriculture, and natural or natural-appearing settings. When HEHO was created, the town of West Branch and other nearby towns and cities were considerably smaller than they are today. Surrounding lands were agricultural and where the terrain allowed, there were few obstructions to views from the park all the way to the horizon. As development in the surrounding communities and the highway interchange have grown closer to the park and as inconsistent visual elements have appeared within view, the sense of open, extensive rural landscape is more difficult to experience. Much of the development surrounding the park is inconsistent with the landscape character associated with the park mission and purpose.

Other Impacts of Land Uses on Visitor/Cultural Experience

The sights, sounds and landscape associated with the park environs have changed over time as human population has increased and uses of the area have become more intensive or changed over time. Land-use changes and development outside the park impact the visitor experience with regard to altered scenery, excessive and unnatural noise, light pollution and solitude. The juxtaposition of development inside and outside the park with cultural features and landscapes degrades the visitor experience. Excessive noise from Interstate 80 is very noticeable.

Water Quality and Stream Hydrology

Hoover Creek water quality and its watershed are highly degraded due to overwhelming upstream alterations including urbanization, little buffering of riparian corridors, farming, drain tiling and ditching, and channelization of stream courses. The stream channel through the park is incised heavily with unstable stream banks. Flooding is a major concern that is being addressed through the development and implementation of a stream management plan. The section of Hoover Creek within the park is currently listed as an impaired reach for fecal coliforms.

2.3.4. Status of Supporting Science

Available data and reports varied significantly depending upon the resource topic. Much of the supporting baseline survey and monitoring data was collected through the ongoing Heartland Network of the Inventory and Monitoring (I&M) Program initiated in the early 2000s. The heartland Network also supported requests for geospatial data. Landscape context information and aspects of human dimensions were greatly supported by national program staff such as the Natural Sounds and Night Skies Division (NSNSD), the national NPS Air Quality program, and the NPScape Project within the Inventory and Monitoring Program. Additional information and data were provided by the park, published and unpublished reports and articles, and other outside experts noted in the individual resource sections.

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Chapter 3. Study Scoping and Design

3.1. Preliminary Scoping

The initial phase of the study consisted of a series of meetings, conversations and collaborations between Colorado State University and NPS staff, including the Midwest Regional NPS Office, the Heartland I&M Network, park staff, Water Resources Division (NRCA proponent), and National I&M programs. Initial scoping consisted of reviewing the Heartland Inventory and Monitoring Network and Prairie Cluster Prototype Monitoring Program Vital Signs Monitoring Plan (DeBacker et al. 2005) in order to begin to understand the management and resource context for the park. Vital signs previous identified and prioritized for the park were the basis for a preliminary list of focal resources to support initial NRCA discussions with park and other NPS staff. A site visit and initial meetings took place December 3–5, 2012 at HEHO Headquarters. The purpose of the preliminary scoping meetings was to:

- establish contact and begin dialogue with key staff members;
- identify points of contact;
- provide an overview of NRCA purpose and process (for park staff);
- provide an overview of park context, administrative history and management concerns (for cooperators);
- discuss analysis framework, reporting scales/units, and rating system;
- identify and discuss priority/focal resources in support of framework development –
- traditional natural resources (e.g., bison, water quality, rare plant),
- ecological processes or patterns (e.g., fire regime),
- specific natural or cultural/ethnographic features inextricably linked to natural resources, or
- values linked to biophysical resources and landscape context (e.g., dark night skies, soundscape, viewscape);
- discuss key NRCA concepts including indicators and measures, threats and stressors, and reference conditions;
- identify and gather available data and information;
- identify sources of expertise inside and outside the NPS;
- define project expectations, constraints, and the need to balance depth vs. breadth; and
- review the assessment timeline.

Key constraints placed on the scope of NRCA development included the following:

- the assessment will provide a snapshot of a subset of park resources, as determined through the scoping process;
- some lower priority resources or those having little supporting data may not be fully examined to allow a more comprehensive analysis of higher-priority resources;
- the assessment will use existing information/data and not modeled or projected data, although limited analysis and data development may be undertaken where feasible (e.g., data to support views/scenery analysis)—future modeled data is only used in the climate change section; and
- assignment of condition ratings may be constrained by insufficient information or inadequately defined reference conditions.

3.2. Study Design

3.2.1. Indicator Framework, Focal Resources and Indicators

The NRCA uses a framework adapted from The Heinz Center (2008) to examine condition and trends in key natural resources at the park (Table 3.2-1). The Heinz structure was identified in the NRCA guidance documents as a relevant framework that organizes indicators under each focal resource within broad groupings of ecosystem attributes related to: landscape context including system and human dimensions; chemical and physical components; biological components; and agents of change. Although threats and stressors are described for each focal resource, the *Land Cover and Land Use*, *Fire Regime* and *Climate Change* sections were added to address broad ecosystem-level processes and stressors affecting multiple resources. A small subset of the resources identified as important to the park and desirable to include in the NRCA during the scoping phase were either not included as focal resources or were addressed in a brief fashion due to lack of information or data, poor understanding of their ecological role and significance in the landscape, their absence at the park, or lack of justification to include them as a focal resource. The latter case for eliminating resources considered to have a lower priority for inclusion also reflected realities related to balancing cooperator budget, breadth of the assessment across many resources and depth of analysis. A total of 14 resources were examined and included here: six addressing system and human dimensions, three addressing chemical and physical attributes, and five addressing biological attributes.

Table 3.2-1. Herbert Hoover National Historic Site natural resource condition assessment framework.

Ecosystem Attributes	Focal Resources	Indicators and Measures of Condition
Landscape context: system and human dimensions	Land cover and land use	• Land cover/land use • Population and housing • Conservation/protection status
	Night sky	• Anthropogenic light • Anthropogenic light ratio (ALR)

Table 3.2-1 (continued). Herbert Hoover National Historic Site natural resource condition assessment framework.

Ecosystem Attributes	Focal Resources	Indicators and Measures of Condition
Landscape context: system and human dimensions (continued)	Soundscape	• Ambient noise levels • Anthropogenic sources of noise • Traffic volumes on nearby and park roads
	Views and scenery	• Integrity of landscape views from key view points • Housing densities surrounding the park • Air quality-visibility • Potential visibility of new wind energy structures
	Climate change	• Modeled temperature and precipitation vs. historic baseline Aridity – Palmer index (historic) and moisture deficit (modeled) • Plant phenology
	Fire disturbance regime	• Fire frequency (return interval) • Seasonality • Severity
Chemical and physical	Air quality	• Level of ozone • Atmospheric wet deposition of total N and total S • Visibility haze index
	Stream hydrology and geomorphology	• Proper functioning condition (PFC) rating • Channel evolution model (CEM) stage
	Water quality	• Total dissolved solids • Chloride • Sulfate • Dissolved oxygen • Coliform bacteria • Temperature
Biological: plants	Prairie vegetation	• Extent of vegetation community types • Plant richness and diversity • Vegetation structure and woody encroachment • Invasive plant abundance/index
	Invasive exotic plants	• Frequency • Abundance and distribution • Presence and abundance of state noxious plants
Biological: animals	Aquatic macroinvertebrates	• Richness and diversity metrics • Hilsenhoff Biotic Index

Table 3.2-1 (continued). Herbert Hoover National Historic Site natural resource condition assessment framework.

Ecosystem Attributes	Focal Resources	Indicators and Measures of Condition
Biological: animals (continued)	Birds	• Native species richness (S) • Bird index of biotic integrity (IBI) • Occurrence and status of bird species of conservation concern
	Fish community	• Native species richness • Fish index of biotic integrity (IBI)

3.2.2. Reporting Areas

The reporting area for all resources is generally the entire area within the park boundary. In some cases indicators were analyzed using subsets based on geographic or ecological strata within the park, e.g., grassland birds and woodland birds. The results for those subsets were then combined into single park-wide condition and trend ratings for the resource. For several resources such as those capturing landscape context (e.g., land cover and land use, dark night skies, soundscape and viewscape), the extent of the analysis varies by resource, often extends outside park boundaries in a fixed or variable way and is in some cases influenced by the locations selected for analysis (e.g., location of key view points for scenery analysis).

3.2.3. General Approach and Methods

General Approach

This study employed a scoping process involving Colorado State University, Park and NPS staff to discuss the NRCA framework, identify important Park resources, and gather existing literature and data for each of the focal resources. Indicators and measures to be used for each resource were then identified and evaluated indicators. All available data and information was analyzed and synthesized to provide summaries and address condition, trend and confidence. Condition ratings compared the current condition(s) at the park to the reference condition(s) when possible. In some cases, due to interrelationships, a focal resource was used to help determine condition and/or trend for another focal resource. For example, changes and land cover/land use and impervious surfaces within the watershed are used to support trend determination for stream hydrology.

Sources of Information and Data

Non-spatial data, published literature, unpublished reports and other grey literature related to conditions both inside and outside the park were obtained from myriad sources. The primary sources for park-specific resource data were park staff, Heartland I&M Network staff, and the public access side of the IRMA (Integrated Resource Management Applications) web portal, which is intended as a "one-stop shop" for data and information on park-related resources. Park and HTLN staff were also invaluable source of knowledge regarding resources, stressors and management history and activities. State and federal agency reports and data were downloaded using the web or obtained from the park or other agency staff. Spatial data were provided by the park, the Heartland Network, the NPS Midwest Region Office and other sources. GIS data developed to support analyses or maps were documented using NPS metadata standards. The NPS Inventory and Monitoring (I&M) program and Night Skies and Natural Sounds Division (NSNSD) provided valuable data to support the assessment. Primary data sources are described in each focal resource section. In some cases existing data were reworked in order to make them more useful for analysis. In the case of stream geomorphology and views/scenery, we collected data in the field to support those resources due to a lack of existing information and data.

Subject Matter Experts

A number of subject matter experts were consulted while developing this assessment. Expert involvement included in-person and telephone meetings, correspondence, and reviews of preliminary resource drafts. The experts consulted for each focal resource are listed in the resource sections in Chapter 4.

Data Analyses and NRCA Development

Data analysis and development of technical sections followed NRCA guidance and recommendations provided by the NPS. Data analyses were tailored to individual resources, and methods for individual analyses are described within each section of chapter four. As one of the tenets of the NRCA framework, geospatial analysis and presentation of results is used where possible throughout the assessment. Periodic contact between the authors, park and other NPS staff and subject matter experts took place as needed to obtain additional data and information or collaborate on an analysis framework or approach or on the interpretation of results.

Final Assessments

Final drafts followed a process of preliminary draft review and comment by park staff and other reviewers. Reviewer comments were incorporate and addressed to improve the analysis within the limits of the NRCA scope, schedule and budget.

Rating Condition, Trend and Confidence

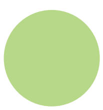
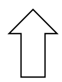
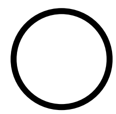
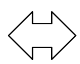
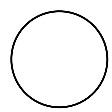
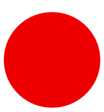
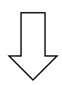
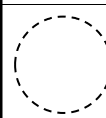
For each focal resource, a reference condition for each indicator is established and a condition rating framework presented. The condition rating framework forms the basis for assigning a current condition to each indicator. In some cases current condition and trend may be based on data or information that is several or more years old. Condition may be based on qualitative, semi-quantitative or quantitative data. Trend is assigned where data exists for at least two time periods separated by an ecologically significant span or may be based on qualitative assessments using historical information, photographs, anecdotal evidence or professional opinion. It is not uncommon for there to be some correlation among indicators for a particular focal resource. In a few cases, the trend assigned to an indicator may be influenced by the data for a correlated indicator. For example, traffic trend data may influence the trend rating for anthropogenic noise levels.

The level of confidence assigned to each indicator assessed integrates the comfort level associated with the condition and/or trend rating assigned. A lower confidence (i.e., higher uncertainty) may be assigned where modeled data has considerable uncertainty or numerous assumptions, where changes may be small and no quantitative data is available, where statistical inference is poor (e.g., as is often the case where sample sizes are inadequate), where interannual or seasonal variability is very high or unknown, where detectability is difficult when monitoring (e.g., some plants and birds), where only several closely spaced data points are available for trend determination (e.g., invasive exotic plant sampling only several years apart and only 2 periods available), or where a very small proportion of the reference frame or population of interest is sampled (in time or space), which influences influencing the representativeness of the sample (e.g., the timing and length of attended listening data for natural sounds analysis). Lack of information/data may result in an unknown condition rating, which is often associated with unknown trend and low confidence.

Symbology and Scoring[9]

This NRCA uses a standardized set of symbols to represent condition status, trend and confidence in the status and trend assessment (Table 3.2-2, Table 3.2-3). This standardized symbology provides some consistency with other NPS initiatives such as State of the Parks and Resource Stewardship Strategies.

Table 3.2-2. Standardized condition status, trend and confidence symbology used in this NRCA.

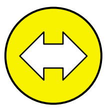
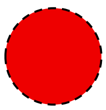
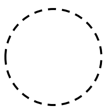
Condition Status		Trend in Condition		Confidence in Assessment	
	Resource is in Good Condition		Condition is Improving		High
	Resource warrants Moderate Concern		Condition is Unchanging		Medium
	Resource warrants Significant Concern		Condition is Deteriorating		Low
No Color	Current Condition is Unknown or Indeterminate	No Arrow	Trend in Condition is Unknown or Not Applicable	–	–

The overall assessment of the condition for a focal resource may be based on a combination of the status and trend of multiple indicators and specific measures of condition. A set of rules was developed for summarizing the overall status and trend of a particular resource when ratings are assigned for two or more indicators or measures of condition. To determine the combined condition, each red symbol is assigned zero points, each yellow symbol is assigned 50 points, and each green symbol is assigned 100 points. Open (uncolored) circles are omitted from the calculation. Average scores of 0 to 33 warrant significant concern, average scores of 34 to 66 warrant moderate concern and average scores of 67 to 100 indicate the resource is in good condition. In some cases certain

[9] Adapted from NPS-NRCA Guidance Update dated January 14, 2014.

indicators may be assigned larger weights than others when combining multiple metrics into a condition score. In those cases the authors provide an explanation for the weights applied.

Table 3.2-3. Examples of how condition symbols should be interpreted.

Symbol Example	Description of Symbol
	Resource is in good condition; its condition is improving; high confidence in the assessment.
	Condition of resource warrants moderate concern; condition is unchanging; medium confidence in the assessment.
	Condition of resource warrants significant concern; trend in condition is unknown or not applicable; low confidence in the assessment.
	Current condition is unknown or indeterminate due to inadequate data, lack of reference value(s) for comparative purposes, and/or insufficient expert knowledge to reach a more specific condition determination; trend in condition is unknown or not applicable; low confidence in the assessment.

To determine the overall trend, the total number of down arrows is subtracted from the total number of up arrows. If the result is 3 or greater, the overall trend is improving. If the result is -3 or lower, the overall trend is deteriorating. If the result is between 2 and -2, the overall trend is unchanged. Sideways trend arrows and cases where trend is unknown are omitted from this calculation.

Organization of Focal Resource Assessments

Background and Importance

This section provides information regarding the relevance of the resource to the park and the broader ecological or geographic context. This section explains the characteristics of the resource to help the reader understand subsequent sections of the document. Relevant stressors of the resource and the indicators/measures selected are listed or discussed.

Data and Methods

This section describes the source and type of data used for evaluating the indicators/measures, data management and analysis (including qualitative) methods used for processing or evaluating the data, and outputs supporting the assessment.

Reference Conditions

This section describes the reference conditions applied to each indicator and how the reference conditions are cross walked to a condition status rating for each indicator. NRCAs must use logical and clearly documented forms of reference conditions and values. Reference condition concepts and guidance is briefly described in Chapter 1. A reference condition is “a quantifiable or otherwise objective value or range of values for an indicator or specific measure of condition that is intended to provide context for comparison with the current condition values. The reference condition is intended to represent an acceptable resource condition, with appropriate information and scientific or scholarly consensus" (NPS 2014). An important characteristic of a reference condition is that it may be revisited and refined over time. The nature of the reference condition prescribed for a particular resource can vary with the status of the resource relative to historic conditions and anticipated future conditions (Figure 3.2-1).

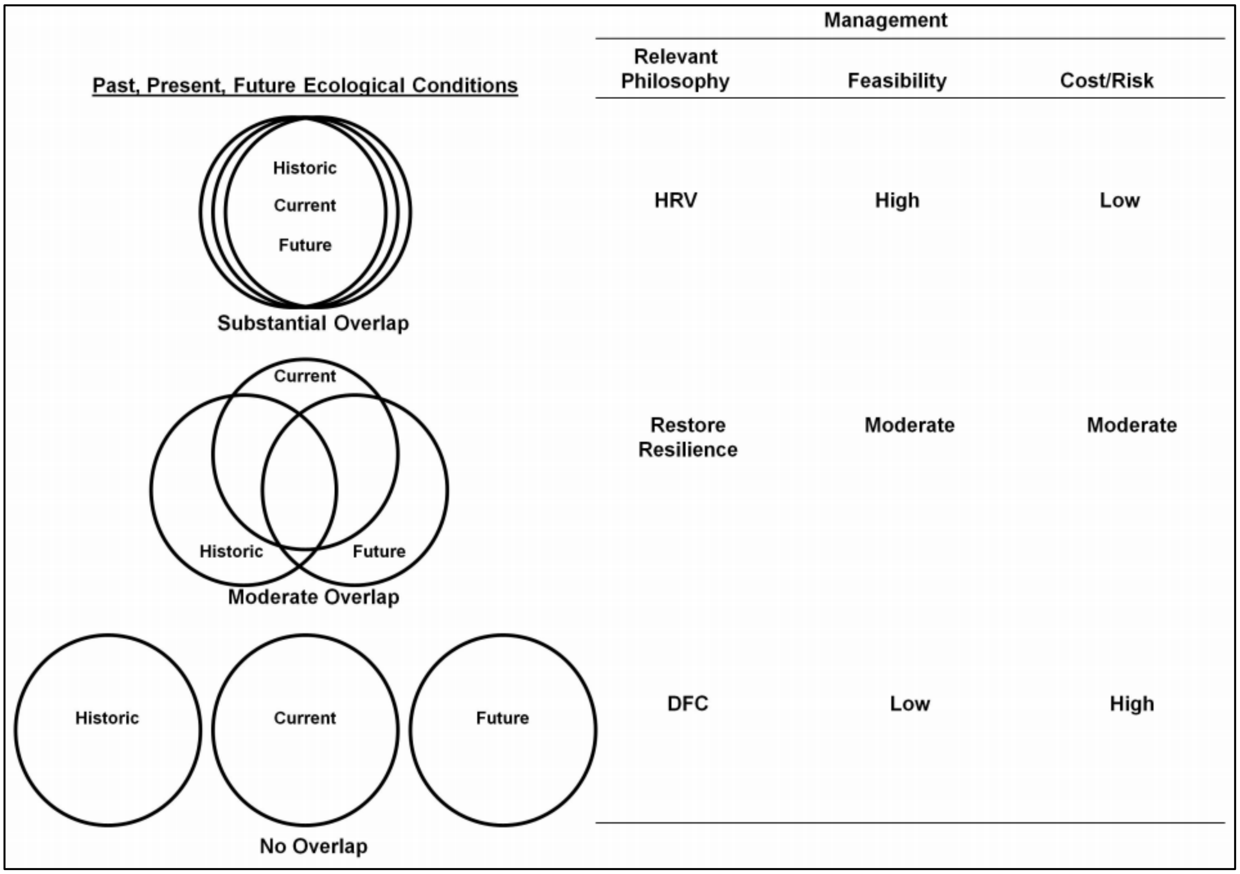


Figure 3.2-1. Illustration of three possible cases of the extent to which current ecosystem conditions in a place differ from historic conditions and from projected future conditions. Circles denote the range of variability for each time period. Also shown are the expected management criteria for each case. HRV = historic range of variability, DFC = desired future conditions (Hansen et al. 2014).

For example, substantial overlap may exist for prairie vegetation, moderate overlap may exist for birds and little or no overlap may exist for nonnative invasive plants. Reference conditions can be particularly difficult to define where presettlement conditions or range of variability are unknown, and/or where little inventory and monitoring data exist.

Condition and Trend

This section provides a summary of the condition for each indicator/measure based on available literature, data, and expert opinions. A condition status, trend and confidence designation for each indicator/measure is assigned and accompanying rationale is provided. Where multiple indicators or metrics are used, a single rating is consolidated for each resource using the condition rating scoring framework described earlier in this chapter.

Uncertainty and Data Gaps

This section briefly highlights information and data gaps and uncertainties related to assessment of the resource. Low confidence can be associated with a combination of data that is not current, insufficient data, unrepresentative data, poorly documented data, or data having poor precision and/or accuracy.

Sources of Expertise

Individuals who were consulted or provided preliminary reviews for the focal resource are listed in this section.

Literature Cited

This section lists all of the referenced sources in this section.

3.3. Literature Cited

DeBacker, M.D., C.C. Young (editor), P. Adams, L. Morrison, D. Peitz, G.A. Rowell, M. Williams, and D. Bowles. 2005. Heartland Inventory and Monitoring Network and Prairie Cluster Prototype monitoring program vital signs monitoring plan. National Park Service Heartland I&M Network and Prairie Cluster Prototype Monitoring Program, Wilson's Creek National Battlefield. Available at: http://science.nature.nps.gov/im/monitor/MonitoringPlans.cfm.

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National Park Service (NPS). 2014. Natural resource condition assessment guidance documents and useful resources. NPS Water Resources Division. Available at: http://www.nature.nps.gov/water/nrca/guidance.cfm.

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Chapter 4. Natural Resource Conditions

Table 4.0-1 provides an outline of the focal resources investigated in this chapter.

Table 4.0-1. Outline of Resource conditions in Chapter 4 of this report.

Ecosystem Attribute	Focal Resource	Section Number
Landscape Context: System and Human Dimensions	Land Cover and Land Use	4.1
	Night Sky	4.2
	Soundscape	4.3
	Scenery	4.4
	Climate Change	4.5
	Fire Disturbance Regime	4.6
Chemical and Physical	Air Quality	4.7
	Stream Hydrology and Geomorphology	4.8
	Water Quality	4.9
Biological: Plants	Prairie Vegetation	4.10
	Invasive Exotic Plants	4.11
Biological: Animals	Aquatic Macroinvertebrates	4.12
	Bird Community	4.13
	Fish Community	4.14

4.1. Land Cover and Land Use

4.1.1. Background and Importance

This section places park resources and management concerns within a local and regional context of land cover and land use and examines implications related to population and protected areas conservation. Using several metrics, it characterizes conditions and dynamics of the surrounding areas, highlights the potential effects of related landscape-scale stressors on park resources, and underscores the conservation value of the park to the surrounding region. The synthesis of national data uses a series of straightforward spatial analyses for areas within and surrounding the park. Condition and trend ratings are not assigned to these landscape context metrics. In some cases long-term data are not available and for the most part the park has little influence over activities occurring outside park boundaries. Longer-term data is available for some population and housing metrics.

Indicators of landscape context applied here include a variety of metrics for land cover and land use, population and housing, and land conservation status. Due to the relatively small size of the park, the overwhelmingly non-natural status of surrounding lands, and the lack of significant regional migration by terrestrial fauna of concern, road densities and habitat fragmentation and connectivity both within the park and outside the park are not examined.

Threats and Stressors

Land use is intensifying around many protected areas including national park units (Wittemyer et al. 2008, Wade and Theobald 2010, Davis and Hansen 2011, Hansen et al. 2014). Many parks in the region are concerned with the ecological consequences of habitat loss associated with urbanization outside park boundaries, conversion of surrounding areas to non-natural uses, as well as the effects of runoff from impermeable surfaces on hydrologic flows through the parks (Hansen and Gryskiewicz 2003). The growth of housing adjacent to protected areas can create a patchwork of land use that degrades the conservation impact of high-value protected areas on adjacent parcels and within the region (Radeloff et al. 2010). Protected areas are most effective when they conserve habitat within their boundaries and are connected with other protected areas via intact corridors (Radeloff et al. 2010). According to the Radeloff et al. study, the main threat to protected areas in the U.S. is housing density, which is highly correlated with population density. The adverse effects of development also impact the quality of the natural environment and visitor experience related to dark night skies, natural soundscapes and viewscapes/scenery.

Indicators and Measures

- Land cover and use
- Extent of Anderson Level I classes
- Extent of natural vs. converted land cover
- Extent of impervious surface area
- Human population and housing
- Housing density
- Historic population: total and density
- Population: current and projected total and density
- Conservation status
- Protected area (ownership) extent
- Biodiversity conservation status (level of protection)

4.1.2. Data and Methods

Spatial data for land cover, population, and housing used for condition and trend analysis were provided by the NPS NPScape Program and follow protocols described in Monahan et al. (2012). Sources of other data are noted below.

Defining Areas of Interest

Landscape context elements within and adjacent to the park were compared to resource conditions in the broader region surrounding the park. Landscape attributes important to park resources often vary with scale or spatial extent. Relevant scales or areas of analysis (AOAs) include the landscape within the park itself (i.e., the reporting unit used for many focal resources in this report), the “boundary” area immediately adjacent to the park (e.g., 3 km buffer), the local area surrounding a park (e.g., within 30 km of the park boundary), the watershed area(s) upstream from the park influencing park streams, nearby counties, and the broader prairie ecoregion. Areas of analysis used for the different landscape context indicators and metrics are based on recommendations from Monahan et al. (2012) (Table 4.1-1), and serve to capture a variety of scales to facilitate examination of the integrated effects of human activities. Contributing upstream watershed is included because it significantly influences water quality and watershed/hydrologic characteristics (Monahan and Gross 2012). The park is relatively small, regional topography is very gentle, and climate is fairly uniform throughout the areas of interest.

Table 4.1-1. Areas of analysis used for landscape context measures.

Landscape Metric Category	Indicators and Measures	Areas of Analysis				
		3 km Buffer around Park	**Park + 30 km Buffer**	**Contributing Upstream Watershed**	**Counties Overlapping with Park + 30 km Buffer**	**Tallgrass Prairie Region**
Land cover and use	Anderson level I	X	X	X	–	–
	Natural vs. Converted land cover	X	X	X	–	X
	Impervious surfaces	–	–	X	–	–
Human population and housing	Population total and density by census block group (historic and projected)	–	X	–	–	–
	Historic population totals by county	–	–	–	X	–
	Housing density 1970–2010	–	X	X	–	–
Conservation status	Protected areas (ownership) and biodiversity conservation status	X	X	–	–	X

Land Cover

USGS National Land Cover Dataset (NLCD) data for 2006 was used to characterize current/recent conditions. NLCD data products are derived from Landsat Thematic Mapper (TM) imagery with a 30 m pixel resolution. NLCD change detection is a very powerful tool because it follows a well-documented, consistent procedure that is highly repeatable over time. Although NLCD data date back to 1992, differences in classification and analysis methods do not favor comparison of the 1992 data with 2006 data (Monahan et al. 2012). We present the 2006 NLCD data. Procedures for the summarization of data for the following indicators are from (NPS 2014a).

Anderson land cover/land use classes

NLCD data were interpreted and classified using Anderson Level I land cover classes (Table 4.1-2) for the areas of analysis listed in Table 4.1-1. Change in natural land cover is possibly the most basic indication of habitat condition (O'Neill et al. 1997). Knowing the proportion of natural land cover to converted land area provides a general indication of overall landscape condition, offering insight into potential threats and opportunities for future conservation.

Table 4.1-2. Anderson land cover/land use classes (Anderson et al. 1976) and rules for reclassifying Anderson land cover as natural vs. converted land cover.

Anderson Level I	Anderson Level II	Natural/Converted
Open water	–	Natural
Developed	–	Converted
Barren/Quarries/Transitional	–	Natural
Forest	–	Natural
Shrub/Scrub	–	Natural
Grassland/Herbaceous	–	Natural
Agriculture	Pasture/hay vs. cultivated agriculture	Converted
Wetlands	–	Natural

Acreage of natural vs. converted land cover

The NLCD Anderson Level I "developed" and "agriculture" classes were reclassified as "converted" (Table 4.1-2) and analyzed using the areas of analysis listed in 4.1-1. Other classes were classified as "natural."

Impervious surface area

The NLCD Anderson Level I "developed" classes are reclassified as "impervious" and all other land cover classes were classified as "pervious" and analyzed using the areas of analysis listed in Table 4.1-1. Impervious surfaces include bare rock, paved roads, and areas covered with roofs and pavement. These surfaces prevent infiltration of precipitation into the ground. Reduced infiltration can cause significant hydrological effects including quicker runoff into streams and rivers resulting in flooding, more rapid rising and dropping of streamflow after precipitation events, reduced local evapotranspiration, and reduced recharge of local aquifers. Imperviousness can also increase aquatic pollution as contaminant transport is increased by water flowing directly to a stream or other water body without the opportunity for uptake or decomposition by plants and soil organisms. The effects of imperviousness on hydrology are especially pronounced in smaller watersheds, such as the contributing watershed upstream of the park's Hoover Creek (1,759 ac).

Human Population and Housing

Housing Density

Change from 1970 to 2010 and projected changes to 2050 were examined. The NPScape housing density metrics used here are based on the Spatially Explicit Regional Growth Model (SERGoM v3) (Theobald 2005). Housing density data are categorized into 11 non-uniform development classes described by Theobald (2005): rural (0–0.0618 units/ha), exurban (0.0618–1.47 units/ha), suburban (1.47–10.0 units/ha), and urban (> 10.0 units/ha). The non-uniform ranges permit a much finer delineation of areas of low-density housing than is common for non-ecological studies (Monahan et al. 2012).

Total Population and Population Density

High human population density has been shown to adversely affect the persistence of habitats and species (Kerr and Currie 1995, Woodroffe 2000, Parks and Harcourt 2002, Luck 2007). Conversion of natural landscapes to agriculture, suburban, and urban landscapes is generally permanent, and this loss of habitat is a primary cause of biodiversity declines (Wilcove et al. 1998). Human conversion of landscapes can alter ecosystems and reduce biodiversity by replacing habitat with non-habitable cover types and structures, fragmenting habitat, reducing availability of food and water, increase disturbance by people and their animals, alter vegetation communities, and increase light, noise, and pollution.

Historical data were derived from county-level population totals for all counties overlapping with the 30 km park buffer, and U.S Census Bureau block data from 1990, 2000 and 2010 for population density. Population density (number of people per square kilometer) classes follow NPScape guidance (NPS 2014b).

Conservation Status

For our region of interest, the two primary sources of protected areas data were the Protected Areas Database-US (PAD-US) Version 2 (Conservation Biology Institute 2013) and the National Conservation Easement Database (NCED). The two databases are designed to be used together to show comprehensive protection status for areas of interest while using compatible database attributes such as ownership type and agency.

Ownership

Land ownership greatly influences the level of conservation protection. The PAD-US (CBI Edition) Version 2 is a national geospatial database of protected fee lands in the United States containing valuable attribution on land ownership, management designations, and conservation status (using national GAP coding systems). The National Conservation Easement Database (NCED) Version III (July 2013) is a voluntary national geospatial database of conservation easement information that compiles records from land trusts and public agencies throughout the United States. It is a collaborative partnership by the Conservation Biology Institute, Defenders of Wildlife, Ducks

Unlimited, NatureServe, and the Trust for Public Land (NCED 2013). As of May 2013, the acreage of publicly-held easements is considered to be 90% complete for Iowa; the accounting of the acreage of NGO-held easements in Iowa is currently estimated at approximately eight percent complete. The low percentage of completeness for NGO-held easements is because: 1) they have not been digitized, 2) they were withheld from NCED, or 3) the NCED team is still working with the easement holders to collect the information (http://www.conservationeasement.us/about/completeness).

Level of Protection

The United States Geological Survey Gap Analysis Program (GAP) uses a scale of 1 to 4 to categorize the degree of biodiversity protection for each distinct land unit (Scott et al. 1993). A status of "I" denotes the highest, most permanent level of maintenance, and "IV" represents no biodiversity protection or areas of unknown status. The PAD-US (CBI Version 2) database includes the coded GAP biodiversity protection status of each parcel. The NECD database is designed to accommodate the GAP protection status field but most parcels have not been assigned a GAP conservation value. The four status categories are described below.

Status I

These areas have permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, and intensity) are allowed to proceed without interference or are mimicked through management. Most national parks, Nature Conservancy preserves, some wilderness areas, Audubon Society preserves, some USFWS National Wildlife Refuges and Research Natural Areas are included in this class.

Status II

These areas have permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use or management practices that degrade the quality of existing natural communities. Some national parks, most wilderness areas, USFWS Refuges managed for recreational uses, and BLM Areas of Critical Environmental Concern are included in this class.

Status III

These areas have permanent protection from conversion of natural land cover for the majority of the area, but may be subject to extractive uses of either a broad, low-intensity type or localized intense type. This class also confers protection to federally-listed endangered and threatened species throughout the area. Most non-designated public lands, including USFS, BLM and state park land are included in this class.

Status IV

These areas lack irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat types. This class allows for intensive use throughout the tract, and includes those tracts for which the existence of such restrictions or sufficient information to establish a higher status is unknown. Most private lands fall into this category by default.

Protected areas data from the two databases was examined by owner type and by easement protection status within a 30 km buffer of the park boundary. GAP biodiversity protection values were summarized for NCED and PAD-US parcels by ownership type within the 30 km buffer areas of interest. Protected areas data were also examined within the entire range of the tallgrass prairie ecoregion. There is some spatial overlap between the PAD-US and NCED databases due to the existence of easements on some lands owned by federal, state and local agencies. Where easements existed on these public (i.e., protected) lands, the acreages were reported by owner only to avoid double counting in the number of protected acres.

4.1.3. Condition and Trend

Land Cover and Use

Extent of Anderson Level I Classes 2006

Within 3 km of the HEHO boundary, over 70% of land acreage is used for agriculture, and nearly 17% is developed (Table 4.1-3, Figure 4.1-1, Figure 4.1-2), reflecting the proximity of the park to the town of West Branch. The area within 3 km of the park boundary is more developed compared to the surrounding 30 km area. Within the 30 km buffer, over 70% of the acreage is agricultural and 10% is developed. Land cover of the contributing upstream watershed of Hoover Creek is over 70% agriculture, partially explaining the impaired condition of water quality in Hoover Creek. The interaction between agricultural acreage and housing development, which is an important aspect of land cover and land use surrounding HEHO, is discussed in the *Population and Housing* section. The next most prevalent land cover class for all AOAs is grassland/herbaceous. These grassland areas are small and very fragmented, and likely have lost most of their ecological function (Figure 4.1-2).

Table 4.1-3. Anderson Level 1 land cover classes within 3 km and 30 km of the park boundary, and within the contributing upstream watershed of the park.

	3 km Buffer		Park + 30 km Buffer		Contributing Upstream Watershed	
Anderson Level I Classes	**Acres**	**% of Area**	**Acres**	**% of Area**	**Acres**	**% of Area**
Open water	7	0.07%	11,468	1.58%	0	0.00%
Developed	1,675	16.91%	72,110	9.94%	374	21.26%
Barren/Quarries/Transitional	0	0.00%	611	0.08%	0	0.00%
Forest	28	0.28%	56,410	7.77%	0	0.00%
Scrub/Shrub	< 1	0.01%	14	0.00%	0	0.00%
Grassland/Herbaceous	373	3.76%	45,524	6.27%	147	8.33%
Agriculture	7,798	78.70%	510,063	70.30%	1,239	70.40%
Wetlands	28	0.28%	29,377	4.05%	0	0.00%
Total	**9,908**	–	**725,577**	–	**1,759**	–

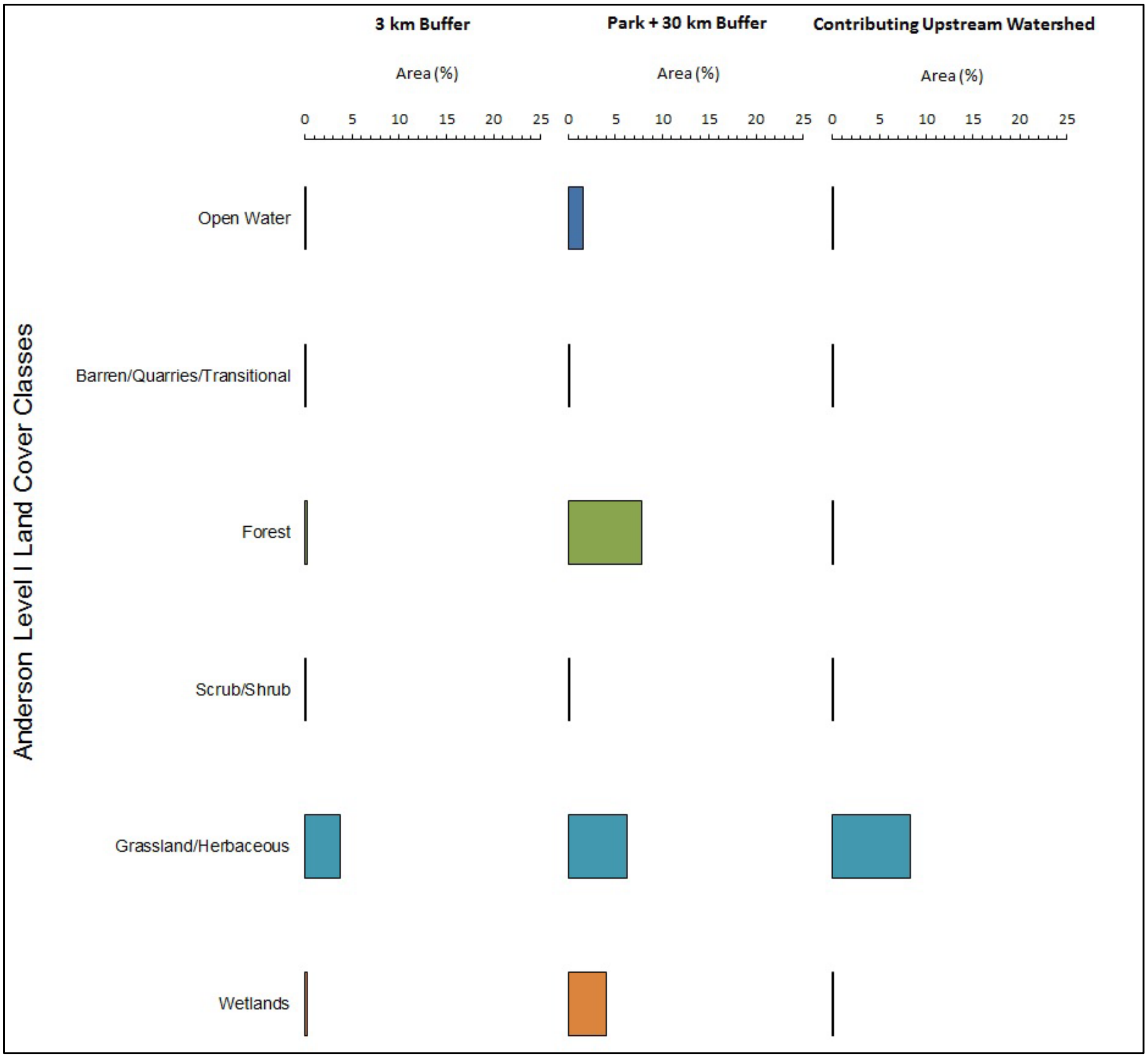

Figure 4.1-1. Anderson Level 1 land cover class proportions within 3 km and 30 km of the park boundary, and within the contributing upstream watershed of the park. Developed and agriculture land cover classes are omitted here to improve the scale of the graphic (Anderson et al. 1976).

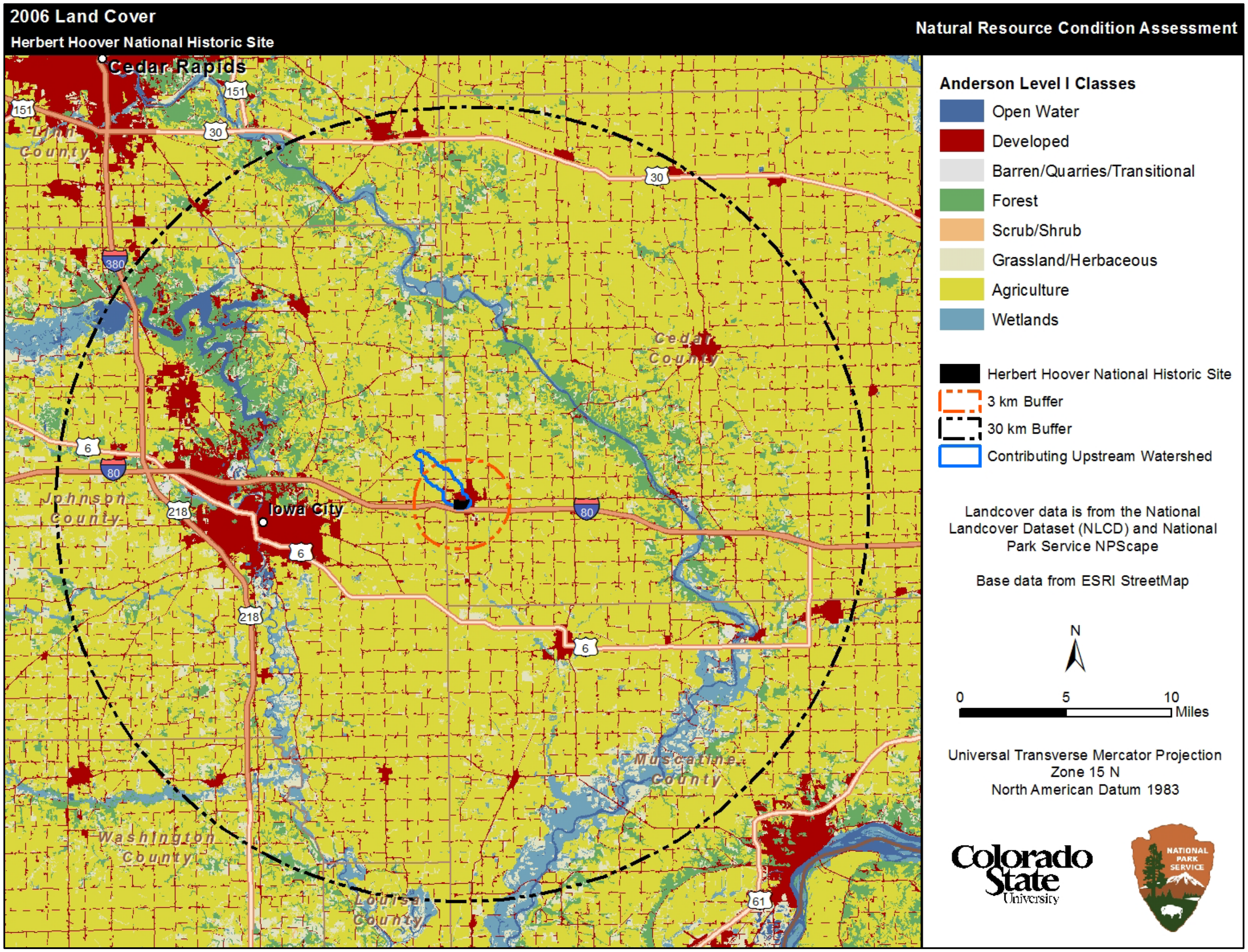

Figure 4.1-2. Anderson Level 1 land cover classes within 3 km and 30 km of the park boundary, and within the contributing upstream watershed of the park. National Land Cover Dataset data provided by NPS NPScape Program (2006).

Within the Western Corn Belt Region, which encompasses portions of Minnesota, Iowa, Nebraska, South Dakota and North Dakota an accelerated rate of conversion of grasslands (including native and anthropogenically modified grassland types) to croplands such as corn and soybeans was documented between 2006 and 2011 (Wright and Wimberly 2013). Results indicated a net decline in grass-dominated land cover totaling nearly 530,000 ha (> 1.3 million ac) over the five-year time period, with annual conversion rates varying from 1.0–5.4%. In Iowa, the net loss of grassland to corn and soybeans was estimated at 152,000 ha (376,000 ac). This trend will reduce the amount of native prairie and other pasture and hay fields, reduce connectivity among grassland patches, and reduce wildlife habitat value while further altering watershed characteristics and water quality.

Natural vs. Converted Land Cover

The proportion of converted acreage surrounding HEHO is high in relation to the Tallgrass Prairie ecoregion as a whole (Table 4.1-4). Within 30 km of the park boundary, only 19.8% of the area is classified as natural, and only 8.3% of the contributing upstream watershed is classified as natural (Figure 4.1-3). Within the 30 km neighborhood, much of the area classified as natural is located on state conservation lands. The low proportion of natural acreage is largely attributed to the heavy agricultural use of the surrounding area, both for pasture and crops (Figure 4.1-3).

Table 4.1-4. Natural vs. converted acreage within 3 km and 30 km of the park boundary, within the contributing upstream watershed of the park, and within the Tallgrass Prairie Ecoregion.

	Natural		Converted	
AOA	**Acres**	**% of Area**	**Acres**	**% of Area**
3 km	435	4.39%	9,473	95.61%
Park + 30 km buffer	143,404	19.76%	582,173	80.24%
Contributing upstream watershed	147	8.33%	1,613	91.67%
Tallgrass prairie ecoregion	63,104,955	32.73%	129,810,610	67.27%

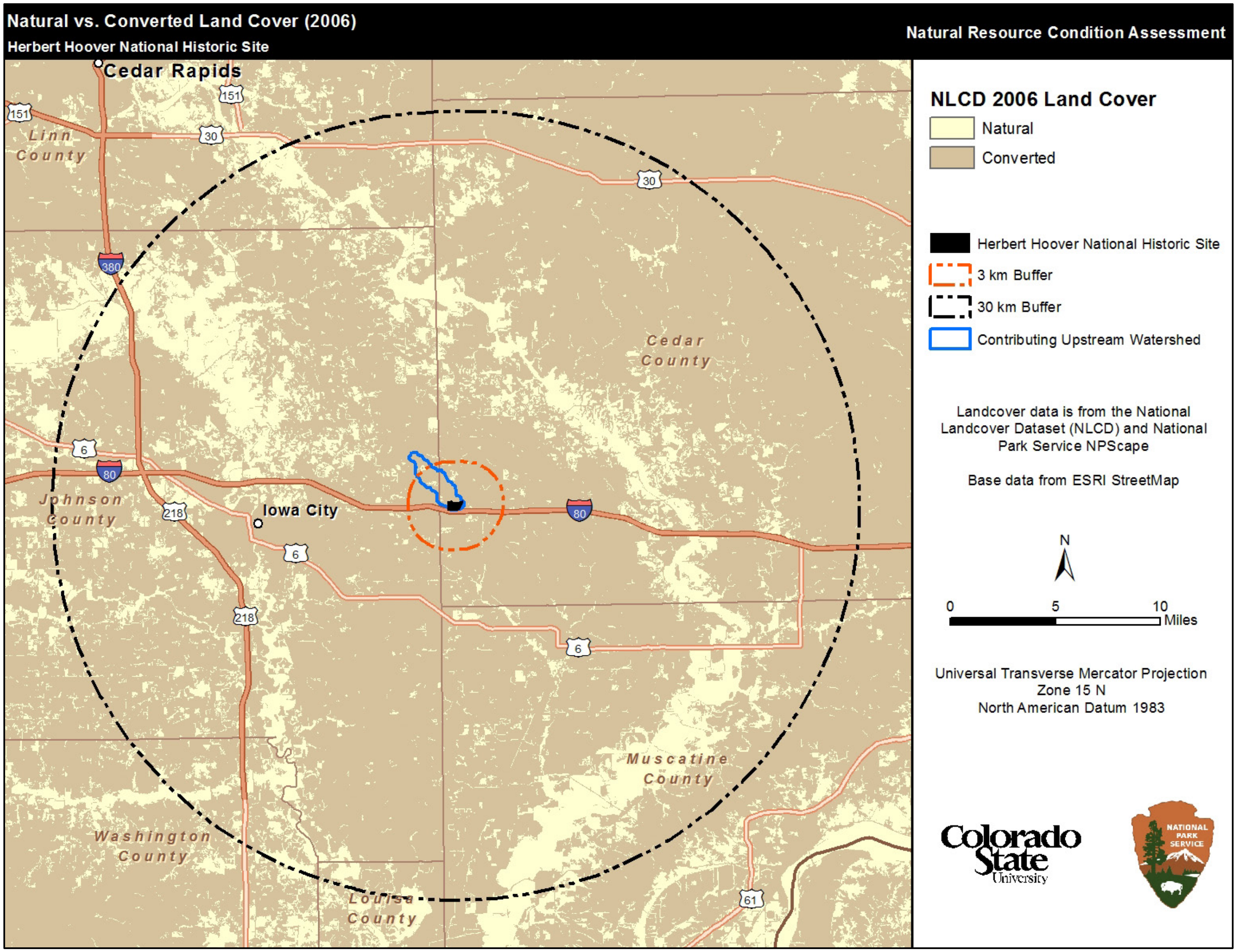

Figure 4.1-3. Natural vs. converted land cover classes within 3 km and 30 km of the park boundary, and within the contributing upstream watershed of the park. National Land Cover Dataset data provided by NPS NPScape Program (2006).

Impervious Surface Area

Most of HEHO's contributing upstream watershed is in the lowest imperviousness class (0–2% impervious surfaces) (Table 4.1-5, Figure 4.1-4). There is a moderate degree of imperviousness in relation to other parks in the region, however, the imperviousness of the area is still quite low. This is most likely attributable to the fact that although the area is highly converted, most of the converted acreage is agricultural land, which retains a significant amount of its permeability. As a benchmark for future analysis, approximately 8.4% of the contributing upstream watershed of the park was classified as having > 25% impervious surfaces (Table 4.1-5), the vast majority of which is concentrated near the town of West Branch (Figure 4.1-4).

Table 4.1-5. Percent impervious surfaces acreage based on Anderson land cover classes within the contributing upstream watershed of the park.

Percent Impervious Surface	Acres	% of Area
0%–2%	1,406	79.90%
2%–4%	27	1.50%
4%–6%	29	1.67%
6%–8%	26	1.50%
8%–10%	23	1.30%
10%–15%	43	2.44%
15%–25%	58	3.31%
25%–50%	95	5.41%
50%–100%	52	2.96%
Total	**1,759**	–

Population and Housing

Historic and Projected Population

Population density within 30 km of the park's boundary is low, with most of the area within this 30 km radius having a density of 1–20 people/km^2 (Table 4.1-6, Figure 4.1-5) and consisting of agricultural fields. Historically, population has been relatively constant with the exception of Linn and Johnson Counties (Figure 4.1-6), which contains the Cities of Cedar Rapids and Iowa City, respectively. There appears to be a trend in conversion of rural (agricultural) land to exurban housing developments. In addition, a large portion of the acreage surrounding HEHO is private agricultural land, which is more readily converted to housing than other types of land coverage (Hansen and Gryskiewicz 2003).

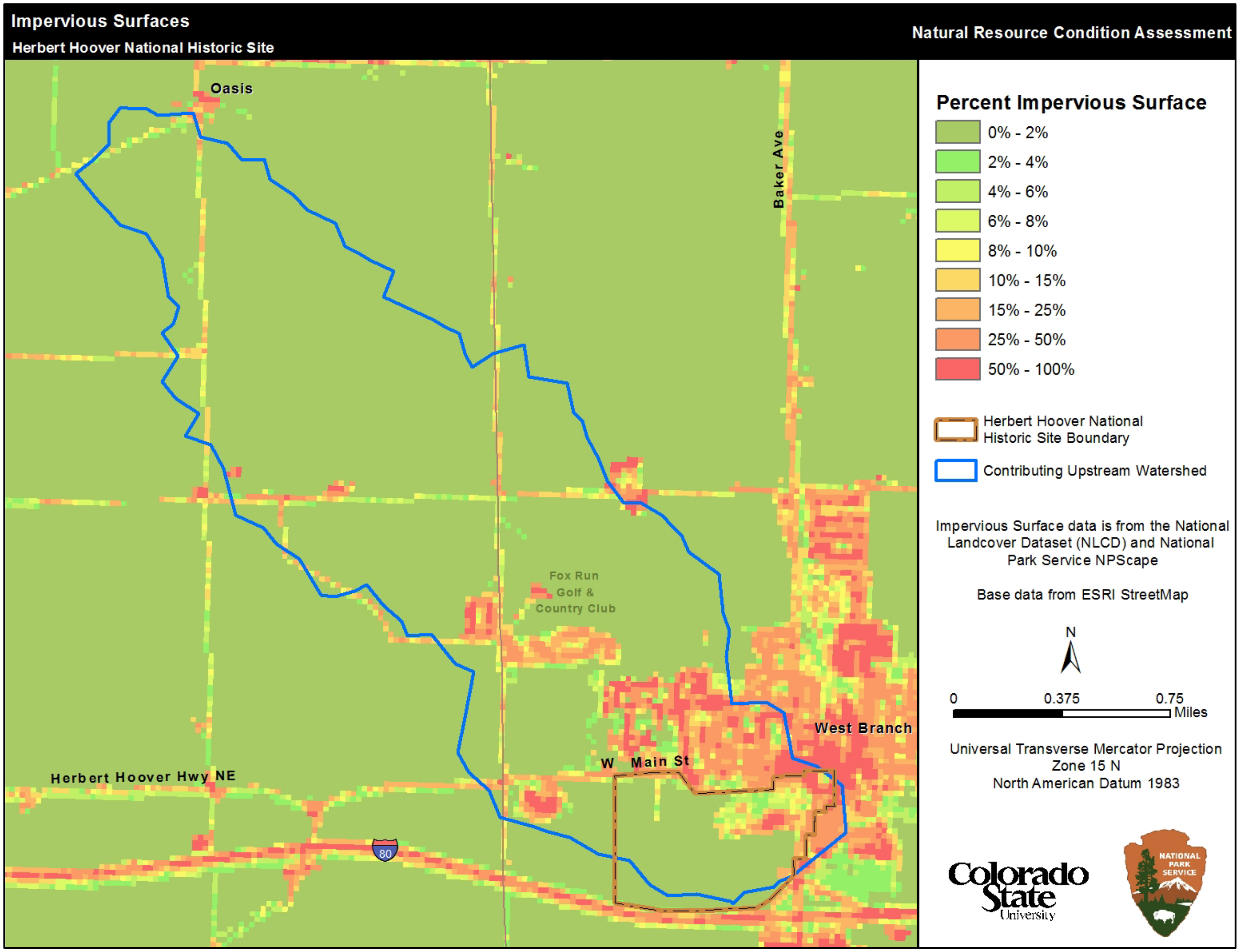

Figure 4.1-4. Percent impervious surfaces based on Anderson land cover classes within 3 km and 30 km of the park boundary, and within the contributing upstream watershed of the park. National Land Cover Dataset data provided by NPS NPScape Program (2006).

Table 4.1-6. Population density classes and acreage for 1990, 2000, and 2010 by census block group for the park and surrounding 30 km buffer.

	1990		2000		2010	
Population Density (#/km2)	**Acres**	**% of Area**	**Acres**	**% of Area**	**Acres**	**% of Area**
1–20	619,643	85.40%	577,051	79.53%	584,162	80.51%
21–75	57,103	7.87%	93,890	12.94%	78,653	10.84%
76–150	30,184	4.16%	20,752	2.86%	30,039	4.14%
151–300	10,231	1.41%	19,953	2.75%	21,405	2.95%
301–750	3,483	0.48%	6,095	0.84%	7,111	0.98%
751–1200	1,016	0.14%	2,540	0.35%	726	0.10%
1201–1500	943	0.13%	2,467	0.34%	1,161	0.16%
1501–2000	1,088	0.15%	1,233	0.17%	943	0.13%
2001–3000	943	0.13%	1,016	0.14%	798	0.11%
> 3000	943	0.13%	653	0.09%	508	0.07%

Housing Density

Housing density in the region surrounding the park shows marked patterns of change between 1970 and 2010 (Table 4.1-7, Figure 4.1-5). Areas shown in white in Figure 4.1-7 are primarily State Wildlife Management Areas and open water. Within a 30 km radius of the park, the most notable trend is an increase in exurban areas and a corresponding decrease in rural acreage. There is an increase in the acreage of suburban areas but the major change in housing density is associated with existing urban centers such as Iowa City and Cedar Rapids. However, there is also a pattern of increasing exurban housing density in unincorporated areas, including areas close to towns and major roads. Acreage for urban, commercial/industrial, and urban regional park classes for 2010 were 2,104 (0.29%), 6,820 (0.94%), and 2,830 (0.39%), respectively. These acreages are not forecasted to significantly change by 2050.

Table 4.1-7. Historic and projected housing density classes by decade for 1970–2050 for the park and surrounding 30 km buffer.

	Rural (0–0.0618 units/ha)		Exurban (0.0618–1.47 units/ha)		Suburban (1.47–10.0 units/ha)	
Census Year	**Acres**	**% of Area**	**Acres**	**% of Area**	**Acres**	**% of Area**
1970	612,605	84.43%	96,502	13.30%	6,022	0.83%
1980	568,127	78.30%	138,585	19.10%	7,981	1.10%
1990	541,498	74.63%	164,053	22.61%	8,852	1.22%
2000	480,767	66.26%	222,970	30.73%	10,593	1.46%
2010	446,593	61.55%	255,693	35.24%	11,754	1.62%
2020	428,598	59.07%	271,583	37.43%	13,641	1.88%
2030	420,762	57.99%	277,678	38.27%	15,310	2.11%

Table 4.1-7 (continued). Historic and projected housing density classes by decade for 1970–2050 for the park and surrounding 30 km buffer.

Census Year	Rural (0–0.0618 units/ha) Acres	Rural % of Area	Exurban (0.0618–1.47 units/ha) Acres	Exurban % of Area	Suburban (1.47–10.0 units/ha) Acres	Suburban % of Area
2040	415,393	57.25%	281,161	38.75%	17,124	2.36%
2050	413,506	56.99%	281,596	38.81%	18,430	2.54%

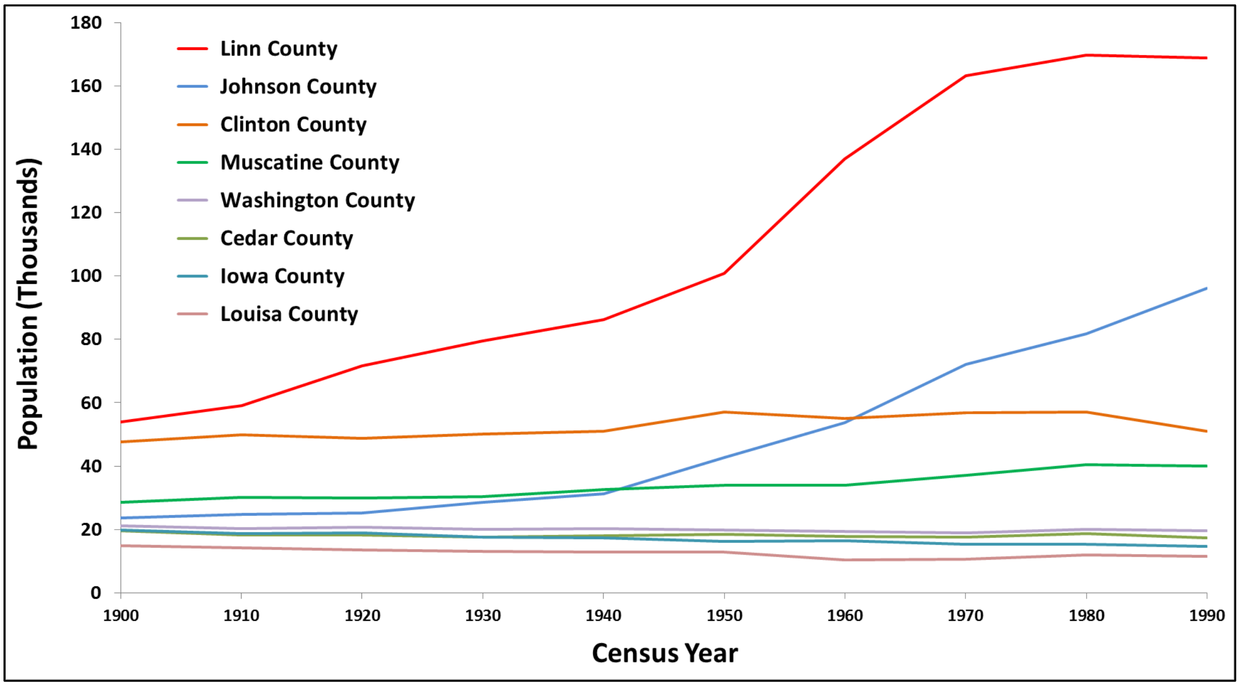

Figure 4.1-5. Historic population by census year of counties within 30 km of HEHO.

Conservation Status

Spatial data from the Protected Areas Database-US (PAD-US) Version 2 (Conservation Biology Institute 2013) and the National Conservation Easement Database (NCED) were consolidated to show comprehensive protection status for areas of interest while using compatible database attributes such as ownership type and agency (Figures 4.1-6–4.1.8). The analysis illustrates the paucity of protected areas near the park and in the larger region.

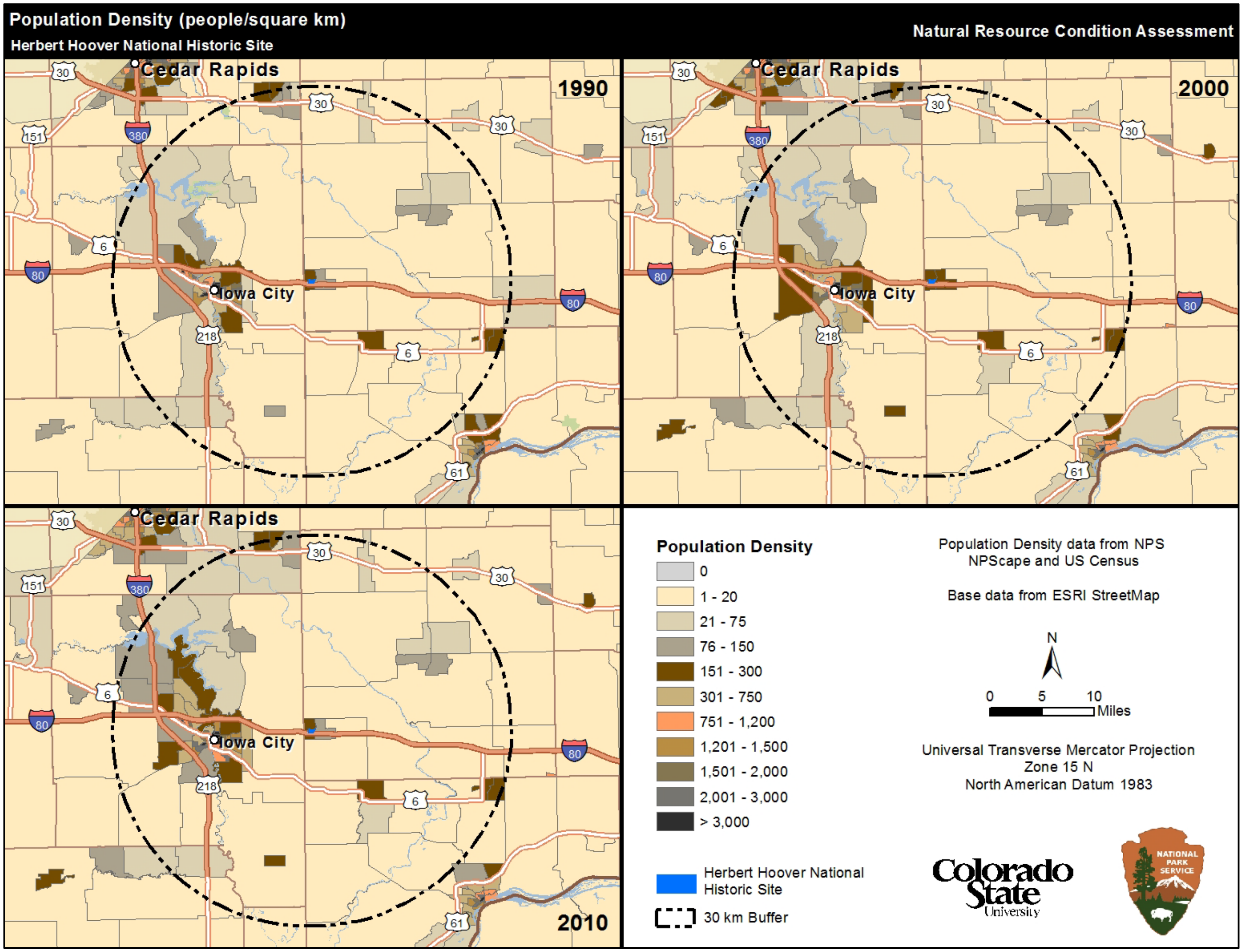

Figure 4.1-6. Population density for 1990, 2000, and 2010 by census block group for the park and surrounding 30 km buffer. U.S. Census data provided by NPS NPScape Program.

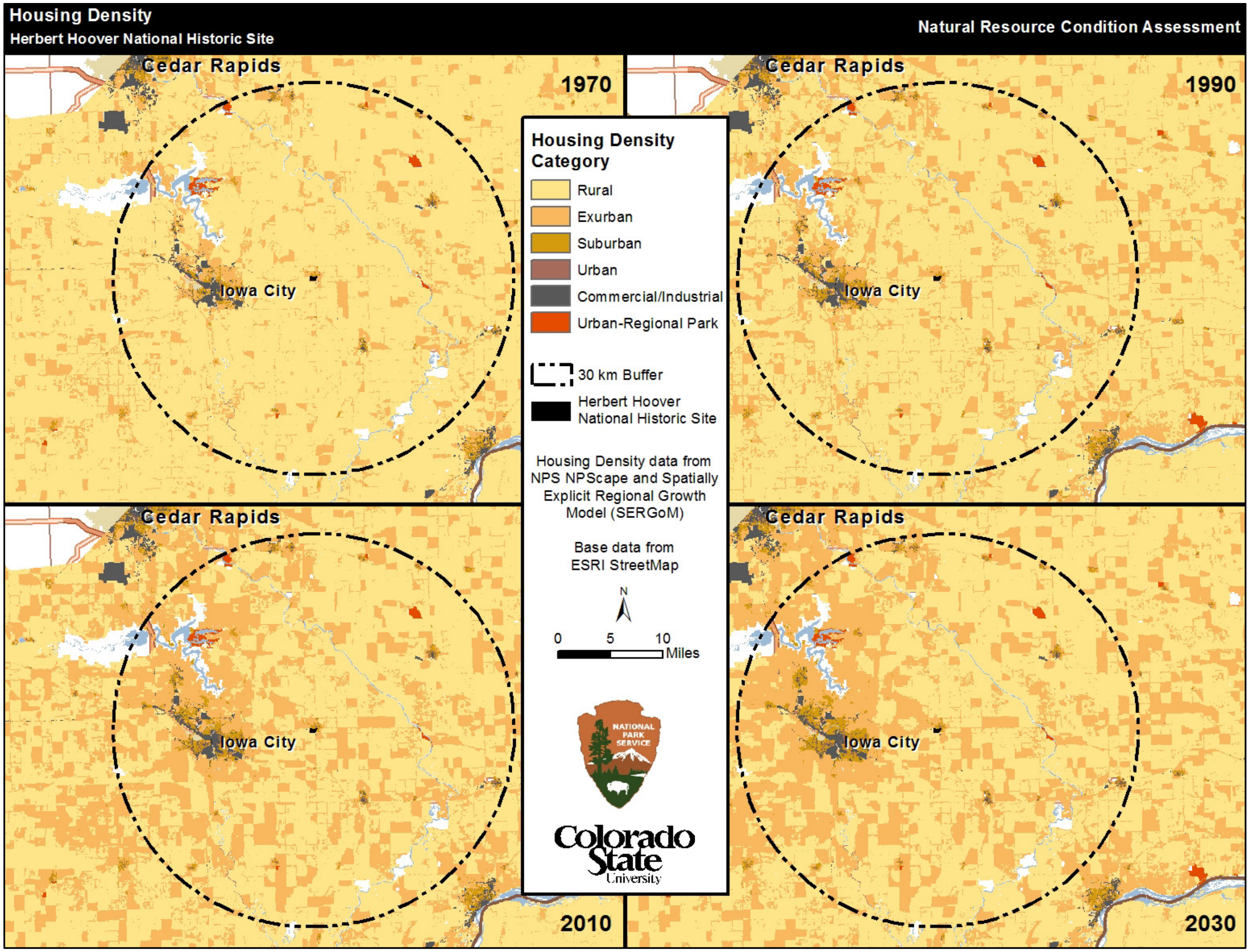

Figure 4.1-7. Historic and projected housing density for 1970, 1990, 2010 and 2030 for the park and surrounding 30 km buffer. SERGOM data provided by NPS NPScape Program.

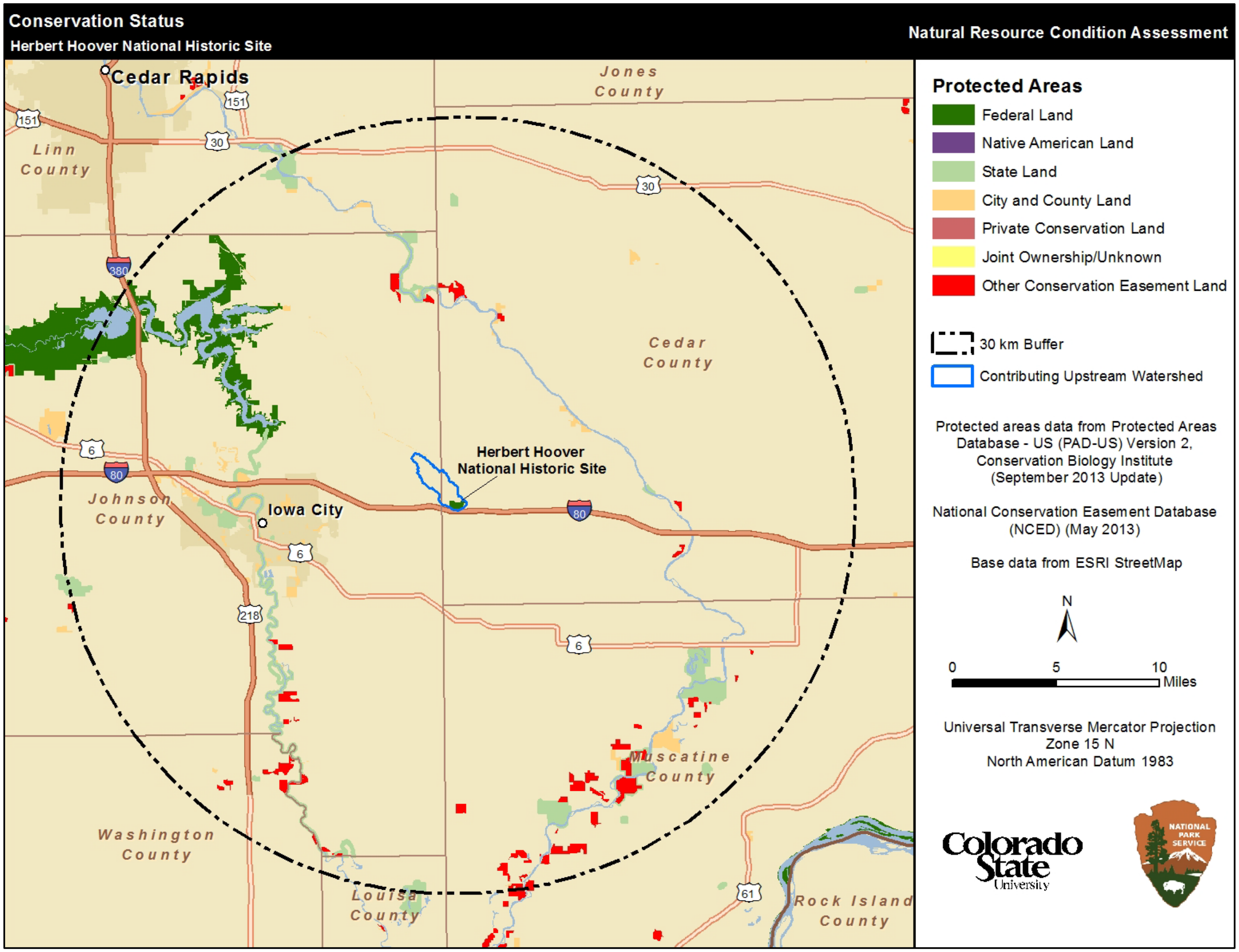

Figure 4.1-8. Conservation status of lands within 30 km of the boundary of Herbert Hoover National Historic Site. Map classes combine ownership from the NCED database and biodiversity conservation status from the PAD-US protected areas database.

Ownership

Across the tallgrass prairie region, over 95% of land is privately held and has no formal conservation protection status (Table 4.1-8). Within the 30 km park buffer and the Tallgrass Prairie ecoregion, most protected land is owned by the Federal and state governments. Within the contributing upstream watershed, HEHO is the only protected area, and thus all protected land is owned by the Federal government.

Table 4.1-8. Acreage of lands within 30 km of the boundary of Herbert Hoover National Historic Site, within the contributing upstream watershed of the park, and within the Tallgrass Prairie ecoregion having some level of conservation protection. Percentages are the proportion of the total acreage of each area of analysis.

	Park + 30 km Buffer		Contributing Upstream Watershed		Tallgrass Prairie Ecoregion	
Ownership	**Acres**	**% of Area**	**Acres**	**% of Area**	**Acres**	**% of Area**
Federal	15,431	2.31%	162	9.21%	2,697,850	1.40%
Native American	0	0.00%	0	0.00%	1,342,495	0.70%
State	8,212	1.13%	0	0.00%	2,642,484	1.37%
City and county	4,448	0.61%	0	0.00%	253,233	0.13%
Private conservation	1,302	0.18%	0	0.00%	202,828	0.11%
Joint ownership/unknown	0	0.00%	0	0.00%	148,056	0.08%
Other conservation easement	4,229	0.58%	0	0.00%	874,316	0.45%
Total	**33,621**	**4.81%**	**162**	**9.21%**	**8,161,263**	**4.23%**

<u>Level of Protection</u>

There are differences in the inferred protection status of lands within each of the AOAs. Within 30 km of the park, there is substantial land area within each biodiversity protection status level (Table 4.1-9). Approximately 1% of the land area is classified as having Status I or Status II protection. All of the protected acreage in the contributing upstream watershed is Status II. For comparison, more than half of the protected acreage in the Tallgrass Prairie ecoregion is Status IV, the default, low-level protections status for private lands or those with unknown conservation status. More than 90% of land area in each of the AOAs is not protected, which highlights the importance of HEHO and other occasional parcels that do provide biodiversity protection in the region. Moreover, in protected areas such as Herbert Hoover National Historic Site, natural processes and disturbance regimes are more likely to occur and support a greater degree of biodiversity, as well as provide critical linkages to the surrounding natural landscape.

Table 4.1-9. Biodiversity protection status of lands within 30 km of the park boundary, within the contributing upstream watershed of the park, and within the Tallgrass Prairie ecoregion (PAD-US and NCED data). Percentages are the proportion of total AOA area.

	Park + 30 km buffer		Contributing Upstream Watershed		Tallgrass Prairie Ecoregion	
Protection Level	**Acres**	**% of Area**	**Acres**	**% of Area**	**Acres**	**% of Area**
I	1,459	0.20%	0	0.00%	241,924	0.13%
II	5,979	0.82%	162	9.21%	1,069,131	0.55%
III	8,623	1.19%	0	0.00%	2,359,903	1.22%
IV	17,560	2.42%	0	0.00%	4,490,304	2.33%
Total	**33,621**	**4.81%**	**162**	**9.21%**	**8,161,263**	**4.23%**

Land Cover and Land Use Summary

Overall, the park has similar threats and stressors to other parks in the Tallgrass Prairie ecoregion (Table 4.1-10). Most of these land cover and land use-related stressors at HEHO and in the larger region are related to the development of rural agricultural land and increases in population/housing over time. Conversion of hay and pasture lands to cropland is also a concern, as the former class has much higher conservation value. The trend in land development, coupled with the lack of significantly-sized and linked protected areas, is a significant threat to the conservation of natural resources of Herbert Hoover National Historic Site to also include dark night skies, natural sounds and scenery. This summary of land cover and land use metrics provides a useful context of known stressors, supports resource planning and management within the park, and provides a foundation for collaborative conservation with other landowners in the surrounding area.

Table 4.1-10. Summary for landscape context indicators, Herbert Hoover National Historic Site.

Landscape Metric Category	Indicator	Summary notes integrating results for 3 km, contributing upstream watershed and 30 km areas of interest
Land cover	Extent of Anderson level I and II classes	Most of the acreage surrounding HEHO is agricultural land. The next most prevalent land use is developed, most of which is housing developments.
	Extent of impervious surface area	Highly impervious areas are concentrated in and around the city of West Branch, Iowa. Although the watershed is highly converted, most of the converted acreage is agricultural land, which retains a significant amount of its permeability.
	Extent of natural vs. converted land cover	The proportion of converted acreage surrounding HEHO is high in relation to the Tallgrass Prairie Ecoregion as a whole. This can be attributed to the heavy agricultural use of the surrounding area, both for pasture and crops.

Table 4.1-10 (continued). Summary for landscape context indicators, Herbert Hoover National Historic Site.

Landscape Metric Category	Indicator	Summary notes integrating results for 3 km, contributing upstream watershed and 30 km areas of interest
Population and housing	Historic and projected population total and density	Population density within 30 km of the park's boundary is low, with most of the area having a density of 1–20 people/km^2. The low population density is attributable to the prevalence of agriculture surrounding the park. Historically, county populations in the surrounding area have been relatively stable with the exception of Linn and Johnson Counties.
	Housing density	Within a 30 km radius of the park, the most notable trend is an increase in exurban areas and a corresponding decrease in rural acreage. There is an increase in the acreage of suburban areas but the major change in housing density is associated with existing urban centers such as Cedar Rapids and Iowa City.
Conservation status	Protected area extent and biodiversity protection status	Only a small portion of the acreage in the region surrounding the park is protected through ownership or conservation easements. The vast majority of land surrounding HEHO is private agricultural land, which generally has a low biodiversity protection level, limited conservation value, and is more readily developed than some other types of land. The rarity of protected lands within the region underscores the critical value of the park as a conservation island within a highly altered predominantly agricultural landscape.

4.1.4. Uncertainty and Data Gaps

There are several sources of uncertainty associated with our analysis. The first is related to the single point in time (2006) that was examined for in land cover and land use using NLCD data. The inclusion of 2011 and other data in the future will provide a more robust assessment of trends and rates of change for some land cover and land use attributes. Another source of uncertainty is associated with assumptions regarding the relationships between land ownership and conservation status. Although information about ownership and protection status can be useful, the degree to which biodiversity is represented within the existing network of protected areas is largely unknown (Pressey et al. 2002). Protection status and extent must be combined with assessments of conservation effectiveness (e.g., location, design, and progress toward conservation objectives) to achieve more meaningful results (Chape et al. 2005).

4.1.5. Sources of Expertise

- Bill Monahan, Ph.D., NPS Inventory and Monitoring Division, Fort Collins, Colorado. Dr. Monahan provided NPScape data summaries, consulted on the selection and use of various metrics, and provided helpful manuscript reviews.

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4.2. Night Sky

4.2.1. Background and Importance

National parks serve as refuges for the endangered resource of natural darkness and starry night skies. Existing studies from the NPS Midwest Region since 2000 found that dark night skies are rated as "extremely" or "very" important by 57% of visitor groups (Kulesza 2013). The National Park Service recognizes the significance of naturally dark night skies to humans and many wildlife species and aims to protect the night skies of parks just like other important natural resources. With nearly half of all species being nocturnal and requiring naturally dark habitat, the presence of excessive artificial light can cause significant impacts to these species (Rich and Longcore 2006). For humans, there is cultural, scientific, economic, and recreational value associated with high-quality night skies. *NPS Management Policies* state that the NPS "will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light" (NPS 2006). The *Management Policies* also provide specific actions that the NPS will take to prevent the loss of dark conditions and natural night skies: restricting the use of artificial lighting where safety and resource requirements allow, utilizing minimal-impact lighting techniques, and providing shielding for artificial lighting (NPS 2006).

The National Park Service defines a natural lightscape as the resources and values that exist in the absence of human-caused light at night time. Natural lightscapes are critical for night time scenery and nocturnal habitat. There are many species that depend on natural patterns of light and dark for navigation, predation and other natural processes. Light pollution is the introduction of artificial light either directly or indirectly into the natural environment. Light pollution can have a negative effect on the organisms within a park and can also reduce the enjoyment of park visitors; it degrades the view of the night sky by reducing the contrast between faint extraterrestrial objects and the background of the luminous atmosphere. An example of light pollution is sky glow, sometimes referred to as artificial sky glow, light domes or fugitive light, which is the brightening of the night sky from human-caused light scattered into the atmosphere. Another form of light pollution is glare, which is the direct shining of light. Both of these forms of light pollution impact the human perception of nighttime, natural landscapes and features of the night sky (NPS 2014).

Excessive artificial light pollution in NPS units threatens to adversely impact natural and cultural resources and the quality of visitor experiences. It is important to document with reliable data existing baseline conditions of the lightscapes in national park units so that monitoring of long-term changes can be implemented and management actions taken to restore natural conditions, where necessary (NPS undated). Poor air quality in combination with light pollution can dim the stars and other celestial objects and lead to reduced ability to see starry skies. Poor air quality also "scatters" artificial light, resulting in parks near cities and other significant light sources having a greater "sky glow" than if pollution was not present (Kulesza 2013). The NPS has clearly declared its commitment to protecting dark night skies for the benefit of natural ecosystems and the enjoyment of current and future generations of park visitors.

The park's Long-Range Interpretive Plan (NPS 2008) identifies the importance of sensory experiences in enhancing the significance of the site: "The particular features, systems, processes, experiences, scenes, sounds, smells, etc., that are key to achieving the park's purpose and maintaining its significance constitute its fundamental resources and values" (NPS 2004, p. 5). The Plan further emphasizes the importance of establishing a serene and simple setting for visitors to the site: "The park presents the opportunity for visitors to experience the serenity of the landscape and explore the simplicity of the small town rural character with all of their senses" (NPS 2004, p. 6). Visitor experience goals developed by park staff state that the public should have opportunities to experience the park by means of all of the senses, and the public should be able to find solitude and personal discovery (NPS 2004, p. 11). Moreover, the Plan identifies the need for research to better understand the effects of light pollution on the park's natural and social resources (NPS 2004, p. 67).

Threats and Stressors

Light originating from modern transportation and development within and beyond the park's boundaries and from artificial lighting in the park represents a distinct threat to the natural and historic lightscape of the park and to the quality of visitor experiences. Specific threats for this park include light from vehicles on Interstate 80, artificial light from development in and around the town of West Branch and other small urban centers, stadium lights at West Branch High School, and light pollution from Iowa City. Commercial development near the Interstate interchange represents a significant increase in local light pollution in recent years.

A comprehensive examination of landscape context related to landcover/landuse, population and housing, all of which are correlated with light pollution, was performed for the area surrounding the Site and is presented in the *Land Cover and Land Use* section within this chapter. Landscape context parameters can be highly correlated with ambient light levels. Therefore changes in these factors can have significant impacts on the night sky of the park.

Indicators and Measures

- Artificial night sky brightness

4.2.2. Data and Methods

The NPS Natural Sounds and Night Skies Division (NSNSD) developed a nation-wide model of ambient light levels and calculated anthropogenic light ratio (ALR) values spatially. Modeling was applied to all NPS units, including the entire area of Herbert Hoover National Historic Site and the surrounding region. Although model results from NSNSD were not available to include in this assessment, their analysis will permit estimation of the impact of anthropogenic light pollution on the darkness of night skies in the park. Cinzano et al. (2001) provides an alternate data source in the form of an atlas that displays artificial night sky brightness worldwide. A geospatial data layer of the Cinzano data was acquired to examine the park and surrounding region. The image was inspected for the quality of the night sky and major sources of light pollution in proximity to the park. Other indicators sometimes used to assess the quality of the night sky include the Bortle dark sky scale, the limiting magnitude scale of sky brightness and the ALR referenced above. No data is available for those indicators at this time.

4.2.3. Reference Conditions

The reference condition for the night sky in Herbert Hoover National Historic Site is one in which the intrusion of artificial light into the night scene is minimized. Natural sources of light (such as moonlight, starlight, and the Milky Way) will be more visible from the park than anthropogenic sources. As little outdoor lighting as is necessary to maintain a safe environment for park visitors and employees will be utilized. To help the park achieve its cultural mission, it is important that the night sky of the site retains its historic character. During the time of Herbert Hoover's life in West Branch, there would have been little artificial light degrading dark night skies.

4.2.4. Condition and Trend

The image from the Cinzano et al. (2001) atlas of artificial night sky brightness for North America and the region surrounding HEHO is shown in Figure 4.2-1. The region surrounding the park (Figure 4.2-1) has some pockets of darker night skies to the southwest of the park. However, there are also several nearby sources of significant light pollution, such as the cities of Cedar Rapids to the northwest, Iowa City immediately to the west, and Davenport to the east. These urban areas pose the greatest threat to the quality of the night sky in the park. Many constellations, planets and the Milky Way cannot be consistently observed at this location.

Based on these results and the trends in landscape context, the condition of dark night skies at HEHO warrants moderate concern with a deteriorating trend (Table 4.2-1). Confidence in the assessment is medium due to the lack of quantitative data and the use of only a single indicator.

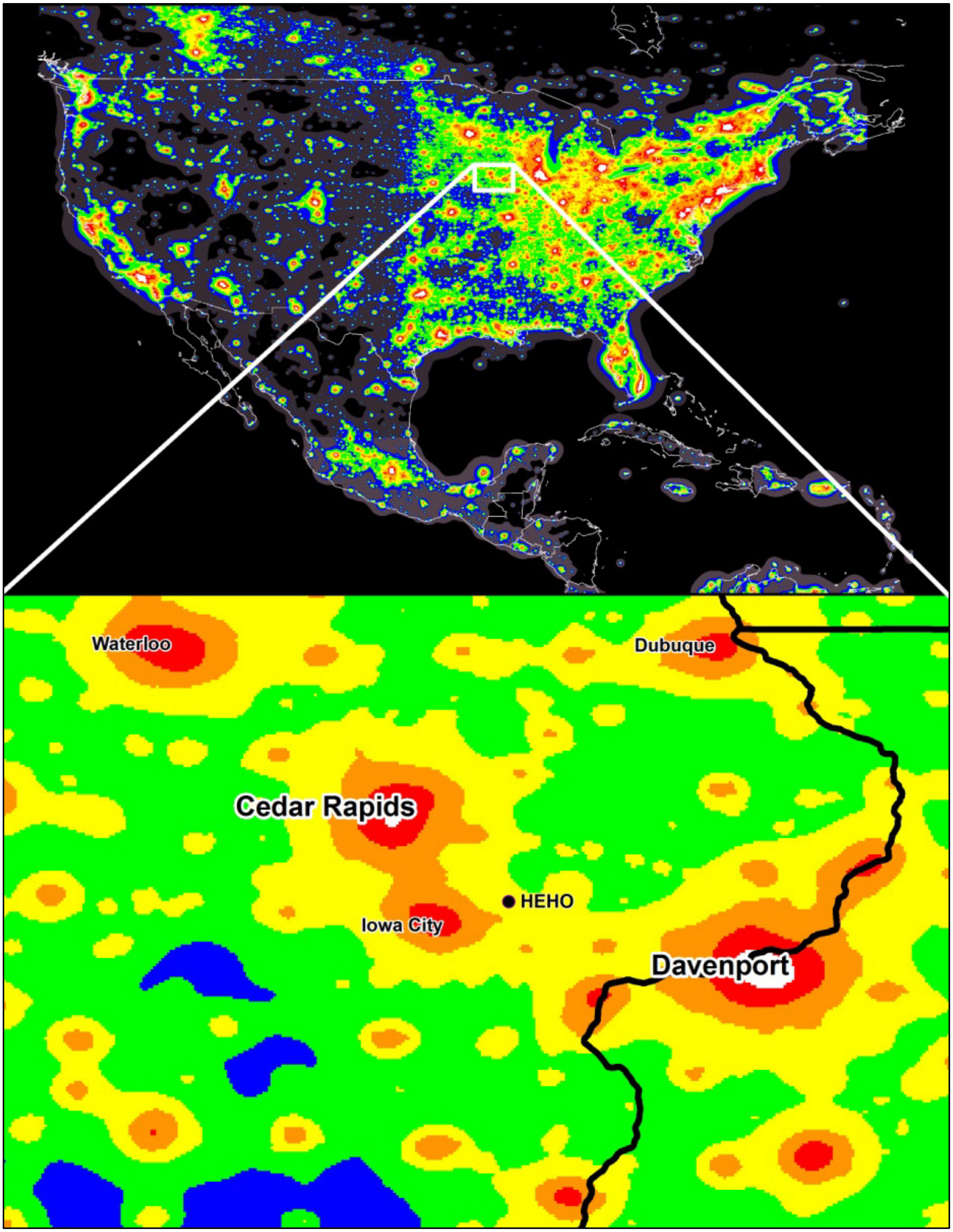
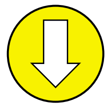
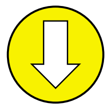


Figure 4.2-1. Artificial night sky brightness across the contiguous U.S. (top) and in the region surrounding Herbert Hoover National Historic Site (bottom) (Cinzano et al. 2001).

Table 4.2-1. Condition and trend summary for dark night skies at Herbert Hoover National Historic Site.

Indicator	Condition Status/Trend	Rationale
Artificial night sky brightness		Several nearby urban areas produce significant light pollution that degrades the quality of the park's night skies. Trends in local and regional development are expected to further degrade dark night skies.
Overall Condition Status and Trend for Dark Night Skies		**The condition of dark night skies warrants moderate concern with a deteriorating trend. Confidence in the assessment is medium.**

4.2.5. Uncertainty and Data Gaps

No night sky monitoring studies have been conducted by the NPS in Herbert Hoover National Historic Site. The inclusion of measured or modeled anthropogenic light as the data becomes available will provide a baseline for night sky condition and enable quantitative assessment of trends over time. Additional measures for night skies could include Bortle Dark Sky Scale assessments, limiting magnitude estimation, and assessment of sky brightness using a charged couple device (CCD) and Unihedron Sky Quality Meter (SQM).

4.2.6. Sources of Expertise

- Chad Moore, Night Skies Program Manager, NPS Natural Sounds and Night Skies Division

4.2.7. Literature Cited

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4.3. Soundscape

4.3.1. Background and Importance

Park natural soundscape resources encompass all the natural sounds that occur in parks, including the physical capacity for transmitting those natural sounds and the interrelationships among park natural sounds of different frequencies and volumes (NPS 2006). Visitors to national parks are often highly motivated to experience natural quiet and the sounds of nature (McDonald et al. 1995). Most visitors prefer to hear sounds that are intrinsic to the natural and cultural settings of the parks they are visiting. A growing body of research also documents the biological and behavioral impacts of unnatural and unusual noise on a variety of wildlife (Barber et al. 2010). Many species depend on natural soundscape conditions—free from anthropogenic noise intrusions—to successfully reproduce and survive (Habib et al. 2007, Rabin et al. 2006). In 2000 the NPS issued *Director's Order #47: Soundscape Preservation and Noise Management* "to articulate National Park Service operational policies that will require, to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources" (NPS 2000). The order established guidelines for monitoring and planning to preserve park soundscapes.

New NPS management policies introduced in 2006 included several directives related to soundscapes, including the affirmation that "The Service will preserve, to the greatest extent possible, the natural soundscapes of parks. The Service will restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts" (NPS 2006). Excessive anthropogenic noise in NPS units threatens to adversely impact natural and cultural resources and the quality of visitor experiences. The NPS has clearly declared its commitment to protecting intrinsic soundscapes for the enjoyment of current and future generations of park visitors.

HEHO's 2008 *Long-Range Interpretive Plan* identifies the importance of sensory experiences in enhancing the significance of the site: "The particular features, systems, processes, experiences, scenes, sounds, smells, etc., that are key to achieving the park's purpose and maintaining its significance constitute its fundamental resources and values" (NPS 2008, p. 5). The plan lists fundamental resources and values for the park, which include "opportunities to experience the quiet contemplative space and values that were important in Hoover's life" in the Quaker meetinghouse (NPS 2008, p. 5). The plan further emphasizes the importance of establishing a serene and simple setting for visitors to the site: "The park presents the opportunity for visitors to experience the serenity of the landscape and explore the simplicity of the small town rural character with all of their senses" (NPS 2008, p. 6). Visitor experience goals developed by HEHO staff state that the public should be able to find solitude and personal discovery (NPS 2008, p. 11). Moreover, the plan identifies the need for research to better understand the effects of noise pollution on the park's natural and social resources (NPS 2008, p. 67). Thus, noise originating from modern transportation (especially from the interstate highway that passes along the park's southern boundary), the neighboring town of West Branch, and mechanical maintenance activities and facilities represents a distinct threat to the natural and historic soundscape of HEHO, as well as the quality of visitor experiences (M. Wilson, personal communication, July 23, 2013).

Threats and Stressors

Primary threats to the natural soundscape include noise originating from modern transportation within and beyond the park's boundaries; from motorized park management activities; and from commercial, industrial, urban and exurban development. Traffic noise from Interstate 80 is by far the largest source of noise. Aircraft noise is typically one of the most pervasive threats to natural sounds in NPS units, and is a notable source of anthropogenic noise at HEHO. Major nearby airports include Cedar Rapids, Davenport and Iowa City, Iowa. Some of the high elevation air traffic is from trans-continental east-west routes (FlightAware 2014). Locally, there is little regional propeller airplane traffic feeding larger airport hubs (University of Nebraska Omaha 2014). Government reports indicate that air and vehicle traffic are projected to significantly increase at regional and national scales (U.S. Department of Transportation 2010, U.S. Department of Transportation 2013). While noise associated with park management activities could be minimized over time through the use of best management practices, the transportation and development noise sources are a distinct threat to the natural and historic soundscape of HEHO and the quality of visitor experiences.

A comprehensive examination of landscape context related to landcover/landuse and population and housing, all of which can degrade natural and historic soundscapes, was performed for the area surrounding the park and is presented in Section 4.1. These parameters can be highly correlated with ambient sound levels. Therefore changes in these factors can have significant impacts on the soundscape of the park.

Indicators and Measures

- Anthropogenic sources of noise – presence/absence and relative noise level
- Traffic volume on I-80 and other local roads – vehicle counts
- Percent time above specified levels – 35, 45, 52, and 60 dBA
- Exceedence levels – L_{90}, L_{50}, L_{10}
- Sounds levels by frequency
- Percent time audible natural and anthropogenic sound sources
- Anthropogenic sound level impacts (modeled) – minimum, 1st quartile, median, 3rd quartile, maximum

4.3.2. Data and Methods

The condition of the soundscape at HEHO was evaluated based on data provided by the NPS Natural Sounds and Night Skies Division (NSNSD). The NSNSD conducted acoustical monitoring at a single site in HEHO for 41 days in 2013 (NPS 2013). Various metrics of soundscape condition were collected during this monitoring period and are described below. The NSNSD provided results from nation-wide modeling of ambient sound levels (Mennitt et al. 2013). Modeling was applied to all NPS units, including the entire area of HEHO and the surrounding region. This analysis permitted estimation of the impact of anthropogenic noise on natural sound levels in the park. Traffic volume data for adjacent roads and highways are summarized in order to provide some context for the analysis of external sources of noise affecting the park. The NSNSD conducted four hours of attended listening over the course of two days at HEHO in May, 2013 to identify all sound sources that are audible from a specific site in the park during a fixed time interval (M. Nelson, personal communication, July 15, 2013). Qualitative data from HEHO staff are also presented in this assessment. Staff members were asked to identify natural and human-caused (extrinsic or intrinsic to the park's values) sounds present at HEHO. Staff members were also asked to describe the desired soundscape conditions for HEHO, including anthropogenic cultural sounds that could potentially be considered appropriate for the park's mission and purpose.

Decibel Scale

Sound pressure levels are often represented in the logarithmic decibel (dB) scale. In this scale, 0 dB is equivalent to the lower threshold of human hearing at a frequency of 1 kHz. This scale can be adjusted to account for human sensitivity to different frequencies of sound, a correction known as A-weighting. A-weighted sound pressure levels are represented in the dBA scale. Examples of common sound sources (both within and outside of park environments) and their approximate dBA values are shown in Table 4.3-1 (Lynch 2009).

Table 4.3-1. Sound pressure level examples from NPS and other settings (Lynch 2009).

Park Sound Sources	Common Sound Sources	dBA
Volcano crater (Haleakala National Park)	Human breathing at 3 m	10
Leaves rustling (Canyonlands National Park)	Whispering	20
Crickets at 5 m (Zion National Park)	Residential area at night	40
Conversation at 5 m (Whitman Mission National Historic Site)	Busy restaurant	60
Snowcoach at 30 m (Yellowstone National Park)	Curbside of busy street	80
Thunder (Arches National Park)	Jackhammer at 2 m	100
Military jet at 100 m AGL (Yukon-Charley Rivers National Preserve)	Train horn at 1 m	120

4.3.3. Reference Conditions

The reference condition for the soundscape in HEHO is one dominated by natural and cultural sounds that are intrinsic to the park. During the historic period of Herbert Hoover's boyhood (1879–1884), the setting was a small town surrounded by small farms and homesteads. Motorized transportation did not exist there at that time and farming was done by hand and through the use of oxen and horses. Natural sounds for the reference condition include birds, wind, rain, running water, and insects. Cultural sounds for the reference condition include the blacksmith shop (i.e., metal being hammered and bellows), sounds from people and small-town activities, and park interpretive programs.

Natural quiet, or the absence of sound, was identified by park managers as a desired natural soundscape condition that no longer occurs in the park (M. Wilson, personal communication, September 9, 2013). A condition rating system for the soundscape indicators is presented in Table 4.3-2.

Table 4.3-2. Reference condition rating framework for soundscape indicators at HEHO.

Indicator	Good Condition	Warrants Moderate Concern	Warrants Significant Concern
Anthropogenic sources of noise	Infrequent, low, or inaudible levels of anthropogenic noise. Annoyance level of visitors low. Recognizes historic sounds such as the blacksmith shop.	Moderately frequent and audible anthropogenic noise. Annoyance level of visitors moderate.	Frequent and highly audible anthropogenic noise. Annoyance level of visitors high.
Road traffic volume	Not exceeding current traffic volumes in town of West Branch of approximately 870 (Downey St.), 1,470 (Main St.) and 36,000 (I-80) vehicles per day; no increase in the proportion of heavy commercial trucks. Based on 2010 data.	5–10% increase in total traffic volume from 2010 baseline; higher proportion of heavy commercial trucks.	> 10% increase in total traffic volume from 2010 baseline; higher proportion of heavy commercial trucks.
Percent time above specified levels	Sound level above 52 dBA (level of speech interference for interpretive programs) less than 10% of the time	Sound level above 52 dBA (level of speech interference for interpretive programs) 10%–25% of the time	Sound level above 52 dBA (level of speech interference for interpretive programs) more than 25% of the time.
Exceedence levels	L_{50} ≤ 35 dBA (sound level exceeded 50% of the time is less than or equal to 35 dBA)	35 dBA < L_{50} < 45 dBA (sound level exceeded 50% of the time is between 35 and 45 dBA)	L_{50} ≥ 45 dBA (sound level exceeded 50% of the time is greater than or equal to 45 dBA)
Attended listening	Natural sounds heard continuously; anthropogenic (except appropriate cultural) sounds heard rarely.	Natural sounds heard some of the time; anthropogenic sounds heard frequently but not continuously.	Natural sounds heard rarely; anthropogenic sounds heard continuously.
Anthropogenic sound level impacts	• Median impact ≤ 3 dBA • Maximum impact ≤ 7.5 dBA	• 3 dBA < Median impact < 5 dBA • 7.5 dBA < Maximum impact < 10 dBA	• Median impact ≥ 5 dBA • Maximum impact ≥ 10 dBA

4.3.4. Condition and Trend

Anthropogenic Sources of Noise

The following common sources of anthropogenic noise were identified by staff members at HEHO (M. Wilson, personal communication, July 23, 2013): vehicle traffic from I-80, Parkside Drive, and Main Street; park maintenance equipment (i.e., lawn mowers, weed trimmers, leaf blowers, and utility vehicles); sirens from the adjacent fire station; aircraft from the airport in Cedar Rapids; bells/chimes from the library/museum; and sounds from the park's blacksmith shop (i.e., metal being hammered and bellows). The predominant sources of modern anthropogenic noise are different from those expected for the Herbert Hoover boyhood period. The majority of anthropogenic noise sources originate outside the park. There is nothing to indicate that these conditions will change in the near future. The condition of this indicator warrants significant concern, with an unchanging trend and a high level of confidence.

Traffic Volume: I-80 and Other Local Roads

According to the Iowa Department of Transportation's (DOT) Office of Transportation Data, the County Road X30 interchange of I-80 in the town of West Branch had an annual average daily traffic volume of 35,800 vehicles in 2012, including 11,643 trucks and buses (Iowa DOT 2012). The Iowa DOT also records trends in traffic volume on state road segments. Table 4.3-3 summarizes annual average traffic volumes near West Branch in both 1998 and 2010 (Iowa Department of Transportation 2010). There is a trend towards higher local traffic volumes close to HEHO, as well as on I-80, in 2010 compared to 1998. The condition of this indicator warrants moderate concern with a deteriorating trend and a high confidence level.

Table 4.3-3. Annual average daily traffic volumes near West Branch, IA (Iowa DOT 2010).

	Average Daily Traffic Volume (Number of Vehicles)		
Road Segment	**1998**	**2010**	**% change 1998–2010**
Downey St. (north of I-80)	950	870	-9%
Main St. (West Branch)	1,100	1,470	+37%
I-80 (west of interchange)	33,900	36,600	+8%

Percent Time Above Specified Sound levels

The NSNSD collected acoustical monitoring data for 41 days at one site (Gravesite Prairie) in 2013 (NPS 2013) (Table 4.3-4). Percent time above specific sound pressure (decibel) levels was determined for 2 frequency ranges: 20–1250 Hz (low frequency range) and 12.5–20,000 Hz (full frequency range). The low frequency range includes common transportation noise but excludes higher frequency sounds, such as those produced by birds and insects. Sound pressure levels measured in the park were compared to levels that are known to produce functional effects in humans, including blood pressure and heart rate increases in sleeping humans at 35 dBA (Haralabidis et al. 2008), the World Health Organization's recommended maximum noise level inside bedrooms at 45 dBA (Berglund et al. 1999), speech interference for interpretive programs at 52 dBA (EPA 1974), and speech interruption for normal conversation at 60 dBA (USEPA 1974).

Table 4.3-4. Percent time above various sound pressure levels and exceedance levels for various percentages of time.

Time of Day	Frequency Range (Hz)	Percent Time Above (%)				Exceedance Levels (dBA)		
		35 dBA	45 dBA	52 dBA	60 dBA	L_{90}	L_{50}	L_{10}
Day (0700–1900h)	20–1250	100.0	76.7	16.9	0.3	45.2	48.6	52.3
	12.5–20,000	100.0	91.1	27.4	0.8	47.1	50.4	53.9
Night (1900–0700h)	20–1250	99.9	83.3	38.9	1.2	46.4	50.7	54.3
	12.5–20,000	100.0	88.2	49.4	2.1	47.6	51.6	55.3

For the low frequency range during daytime hours (0700 to 1900), measured sound pressure levels were above 35 dBA 100.0% of the time, above 45 dBA 76.7% of the time, above 52 dBA 16.9% of the time, and above 60 dBA 0.3% of the time. For the full frequency range during daytime hours, measured sound pressure levels were above 35 dBA 100.0% of the time, above 45 dBA 91.1% of the time, above 52 dBA 27.4% of the time, and above 60 dBA 0.8% of the time. For the low frequency range during nighttime hours (1900 to 0700), measured sound pressure levels were above 35 dBA 99.9% of the time, above 45 dBA 83.3% of the time, above 52 dBA 38.9% of the time, and above 60 dBA 1.2% of the time. For the full frequency range during nighttime hours, measured sound pressure levels were above 35 dBA 100.0% of the time, above 45 dBA 88.2% of the time, above 52 dBA 49.4% of the time, and above 60 dBA 2.1% of the time. The condition of this indicator warrants significant concern with an unknown trend and a high confidence level.

Exceedance Levels

The NSNSD also calculated the sound pressure levels that were exceeded a certain percentage of the time during the monitoring period (i.e., L_{50} is the dBA value that is exceeded 50% of the stated time period) (NPS 2013). For the low frequency range during daytime hours, L_{90} was 45.2 dBA, L_{50} was 48.6 dBA, and L_{10} was 52.3 dBA. For the full frequency range during daytime hours, L_{90} was 47.1 dBA, L_{50} was 50.4 dBA, and L_{10} was 53.9 dBA. For the low frequency range during nighttime hours, L_{90} was 46.4 dBA, L_{50} was 50.7 dBA, and L_{10} was 54.3 dBA. For the full frequency range during nighttime hours, L_{90} was 47.6 dBA, L_{50} was 51.6 dBA, and L_{10} was 55.3 dBA. Table 4.3-4 summarizes the percent time above and exceedance level metrics. The condition of this indicator warrants significant concern with an unknown trend and a high confidence level.

Sound Levels by Frequency

The full frequency spectrum derived from acoustic monitoring can be divided into 33 smaller frequency bands (each representing a single one-third octave range). The NSNSD created plots of the daytime and nighttime sound pressure levels for each frequency band in order to demonstrate the distribution of lower- and higher-frequency sounds occurring in HEHO throughout the day (NPS 2013) (Figure 4.3-1). Although these plots can be informative when combined with other metrics, they are not useful indicators of soundscape quality on their own. Furthermore, it is challenging to select a reference condition for this indicator. Sound levels by frequency are included here for reference and may be used in future assessments; a condition rating is not assigned.

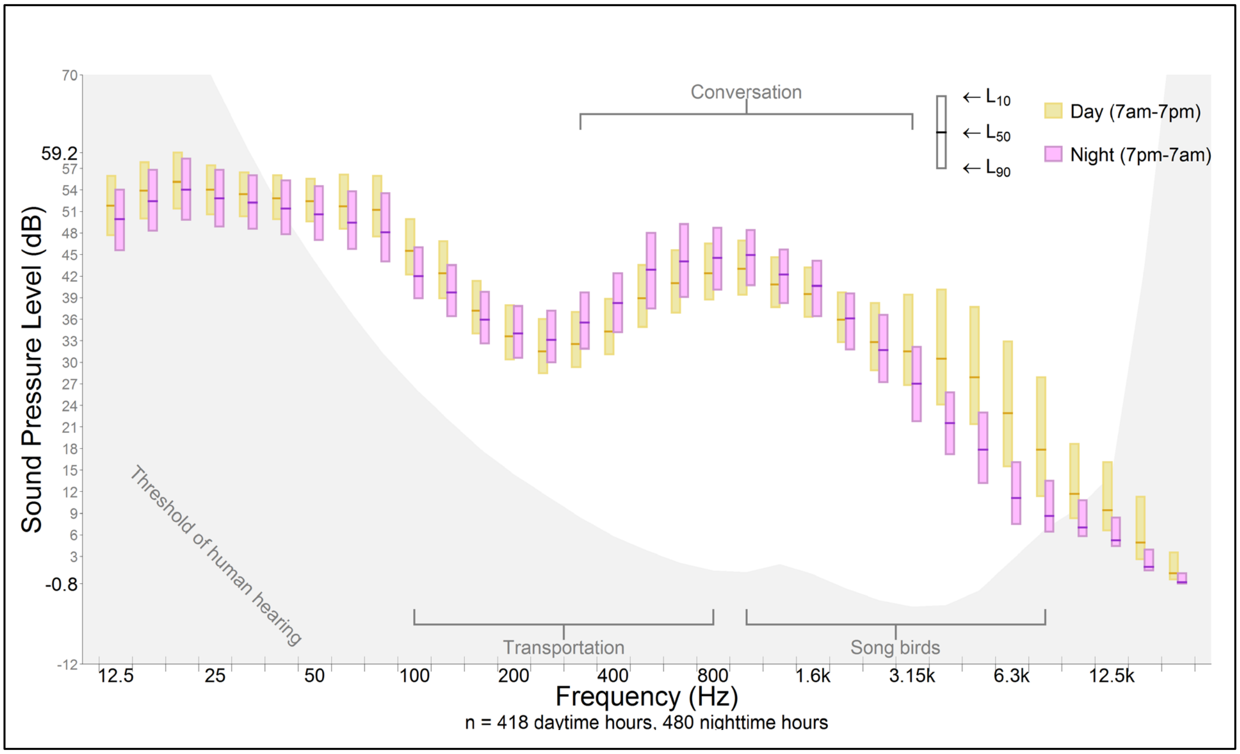


Figure 4.3-1. Daytime and nighttime sound pressure levels for 33 one-third octave frequency bands. Graphic provided by NSNSD (July 2013).

Percent Time Audible Natural and Anthropogenic Sounds (Attended Listening)

The NSNSD conducted four hours of attended listening over the course of two days at HEHO in May, 2013 (M. Nelson, personal communication, July 15, 2013). Attended listening consists of a trained observer recording all sounds—natural and anthropogenic—that are audible from a specific site during a fixed time interval. In this case, four 1-hour listening sessions were performed at the "Gravesite Prairie" site where the acoustical monitoring stations were set up. This station location is near the boundary between a landscaped area and restored prairie on the edge of the Commemorative Zone. The summarized data provide an estimate of how often different sound sources are audible in the park.

Although the individual listening sessions only represent a small snapshot in time and place, the results are potentially informative in determining the balance between natural, cultural, and other anthropogenic sounds that may typically be audible to HEHO visitors. For example, in all 4 sessions, vehicles (particularly from I-80) were audible during the entire hour of listening. Aircraft were audible 6% to 27% of the time, and people could be heard from 0% to 30% of the time. There was much variation in how often park maintenance or facilities could be heard, ranging from 1% of Session 1 and 0% of Session 2 (in the late afternoon hours of May 9) to 93% of Session 3 and 88% of

Session 4 (in the morning hours of May 10). In terms of natural sounds, birds could be heard nearly constantly during all sessions. Wind and water were also audible at times. No cultural sounds were identified by the listener. Full results are included in Table 4.3-5.

Table 4.3-5. Time audible percentages for various sound sources in HEHO from attended listening sessions (NPS 2013).

Sound Source	Time Audible (%)			
	Session 1 (2013-05-09 16:45–17:45)	Session 2 (2013-05-09 18:00–19:00)	Session 3 (2013-05-10 06:45–07:45)	Session 4 (2013-05-10 08:00–09:00)
Vehicle	100.0	100.0	100.0	100.0
Bird	99.9	99.9	99.9	99.9
People	29.6	1.9	–	18.6
Wind	22.6	2.3	–	45.4
Aircraft	15.4	26.9	5.7	21.9
Water (natural)	3.5	–	–	–
Facilities	0.8	–	93.1	84.5
Insect	0.1	–	–	–
Dog	–	1.5	1.0	0.2
Alarm	–	–	1.6	–
Bells	–	–	–	9.4
Park maintenance	–	–	–	3.4

The condition of this indicator warrants significant concern with an unknown trend and a high confidence level.

Anthropogenic Impacts on Ambient Sound Level (Modeled)

The NSNSD has used acoustic modeling to estimate the anthropogenic impact to the ambient sound level in HEHO, which is the existing sound level minus the estimated natural sound level (Mennitt et al. 2013). Mean impact thus provides a measure of how much anthropogenic noise is increasing the existing sound level above the natural sound level, on average, in the park. For reference in translating sound level impacts into functional effects (for human visitors and resident wildlife), an increase in background sound level of 3 dB produces an approximate decrease in listening area of 50%. In other words, by raising the sound level in HEHO by just 3 dB, the ability of listeners to hear the sounds around them is effectively cut in half. Furthermore, an increase of 7 dB leads to an approximate decrease in listening area of 80%, and an increase of 10 dB decreases listening area approximately 90%.

In HEHO, the mean impact was 9.2 dBA. Additional metrics describing a range of impacts across the landscape of the park were also obtained. Minimum impact (minimum sound level impact in the park) was 7.2 dBA, 1st quartile impact (25% of points in the park have this level or impact or less) was 9.0 dBA, median impact (50% of the park has this impact or less) was 9.2 dBA, 3rd quartile impact (75% of the park has this impact or less) was 9.4 dBA, and maximum impact (maximum impact value inside park boundaries) was 10.4 dBA. Modeled mean impacts in the area immediately surrounding HEHO as well as the larger region are shown in Figure 4.3-2. The area within the park with the lowest anthropogenic sound level impacts is the heart of the western prairie parcel between the Gravesite and Thompson farm. The area with the highest impacts is Parkside Drive in the northeast corner of the park. The condition of this indicator warrants significant concern with a medium confidence level. No trend data is available.

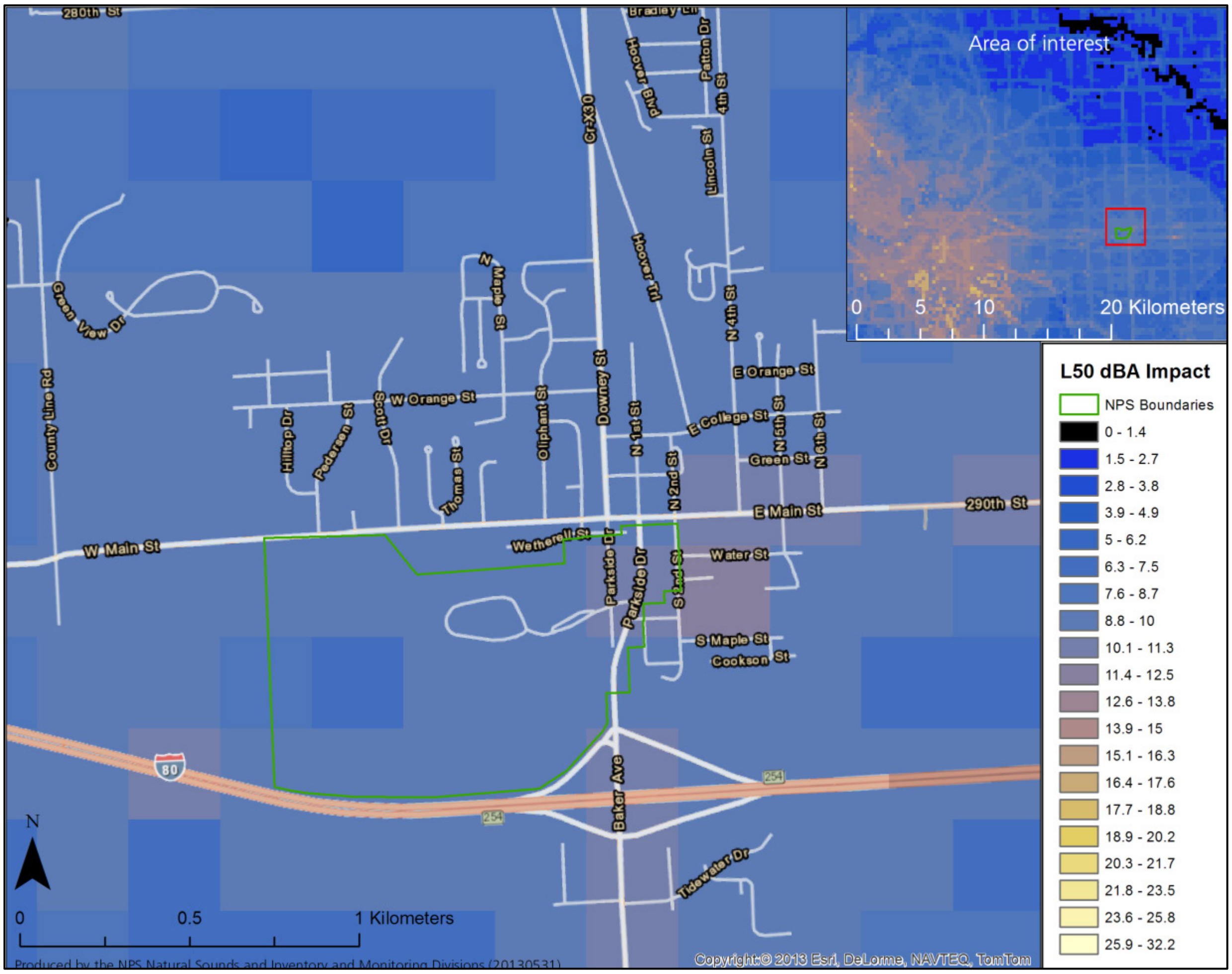
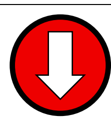
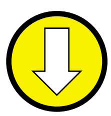
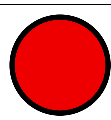
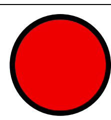
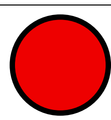
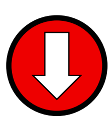
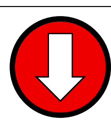


Figure 4.3-2. Modeled mean sound level impacts in the area immediately surrounding HEHO and in the larger region (inset). Graphic provided by NSNSD (May 2013).

<u>Overall Condition and Trend</u>

The data presented above suggest that the condition of the soundscape at HEHO warrants significant concern, with a deteriorating trend due to projections for increased ground and air traffic over time. A summary of soundscape indicators is shown in Table 4.3-6. The sound pressure level associated with physiological changes in humans (35 dBA) was exceeded 100% of the time in the park both day and night. Sound pressure levels exceeded 45 dBA from 77% to 91% of the time, depending on the time of day and frequency range measured. Sound pressure levels also exceeded 52 dBA (the level at which speech interference occurs for interpretive programs) as much as 49% of the time most. The mean exceedance levels in the park (L_{50} for the full frequency range) were 50.4 dBA during the day and 51.6 dBA at night, which are very high values. Additionally, the attended listening sessions found that vehicle noise was audible 100% of the time in the park. State transportation data indicate that traffic volumes on nearby roads and the interstate highway have increased in recent years. Noise from park maintenance or facilities was also audible for 93% and 88% of the time for two of the listening sessions. Nationwide modeling of anthropogenic sound level impacts indicates that modern noise intrusions are substantially increasing the existing ambient sound level above the natural ambient sound level of the park (mean impact = 9.1 dBA). As long as noise from the adjacent highway and park management activities remains pervasive in the park, the condition of the soundscape will likely continue to deteriorate. The confidence associated with these ratings is high due to the wide range of measures available including quantitative metrics.

Table 4.3-6. Condition and trend summary for the soundscape at Herbert Hoover National Historic Site.

Indicator	**Condition Status/Trend**	**Rationale**
Anthropogenic sources of noise		Noise from anthropogenic sources is pervasive. Noise from modern transportation on Interstate 80 and the town of West Branch particularly threaten the park's natural soundscape.
I-80 and local road traffic volume		There is a trend towards higher local traffic volumes close to HEHO. Average daily traffic volume increased 37% on Main St. in the town of West Branch and 8% on I-80 (near the park) between 1998 and 2010. If those trends continue, then the park's soundscape will be further negatively impacted by increasing traffic noise.
Percent time above specified sound levels		Sound pressure levels exceed 52 dBA ≥ 25% of the time during both day and night.
Exceedance levels		Measured L_{50} exceeds 45 dBA.
Attended listening		Although birds were heard continuously, vehicles were also audible for 100% of the time during all listening sessions. Aircraft were also heard as much as 27% of the time during one listening session.
Anthropogenic impacts to ambient sound level		Anthropogenic noise is significantly increasing the existing ambient sound level above the natural ambient sound level of the park (median impact > 5.0 dBA, maximum impact > 10.0 dBA). Ground and air traffic are generally projected to increase over time.
Overall Condition Status and Trend for Soundscape		**Condition warrants significant concern with a deteriorating trend. Confidence in the assessment is high.**

4.3.5. Uncertainty and Data Gaps

The NPS NSNSD has conducted acoustical monitoring studies at a single site in HEHO to measure ambient sound levels and the audibility of different intrinsic and extrinsic sound sources in the park. A full acoustical monitoring report is forthcoming. However, evaluative research has not been collected to determine the social impacts of existing soundscape conditions on visitor experiences in HEHO.

4.3.6. Sources of Expertise

- Emma Lynch, Acoustical Resource Specialist, NPS Night Skies and Natural Sounds Division
- Misty Nelson, Acoustical Technician, NPS Night Skies and Natural Sounds Division
- Mike Wilson, Chief Ranger, Herbert Hoover National Historic Site

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4.4. Scenery

4.4.1. Background and Importance

Scenery, i.e., visual resources, has important value in terms of historic and cultural context, aesthetics, and tourism and health. Scenery encompasses the visible physical features on a landscape including the land, water, vegetation, structures, animals and other features, and is linked to air quality-related values and dark night skies. The National Park Service Organic Act of 1916 specifies that the NPS shall "conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Protection and conservation of scenic resources is also required under other legislation and policies such as the National Environmental Policy Act, Federal Land Policy and Management Act, National Historic Preservation Act, the Clean Air Act and NPS guidance. Current *NPS Management Policies* (NPS 2006) do not provide guidance regarding service-wide policies or practices for scenery conservation.

View of tallgrass prairie and the Isaac Miles Farmstead, Herbert Hoover National Historic Site (CSU).

Within the NPS Midwest Region, scenic views were ranked as the 1st or 2nd most important criteria for visit quality 33% of the time, and rated *extremely* or *very important* by 89% of respondents (Kulesza et al. 2013). Park units generally address visual resource management on a case-by-case basis (Mark Meyer, personal comment August 2013), and effort is increasingly applied to conservation of visual resources as forces and development external to parks increasingly impact visual landscapes supporting natural and historic views.

The prairie ecosystem that once covered the tallgrass prairie region is one of horizontal character. Fields of grass extend outward towards the horizon, with only a few trees or other vertical features extending above prairie grasslands and the horizon. Even as settlers converted the prairie to agricultural fields, the horizontal nature of the landscape remained intact. Vertical manmade elements constitute the greatest inconsistencies in the landscape views from the park.

The enabling park legislation mandates that the park will preserve historically significant properties associated with the life of President Herbert Hoover, and that the park will provide an “accessible” and “spacious” environment within which the historic setting can be experienced within the historic West Branch setting. The National Register of Historic Places-listed site includes the birthplace cottage, the Herbert Hoover Presidential Library-Museum (HHPL), the graves of President Hoover and his wife, Lou Henry Hoover, and other historic resources. The park is a cultural landscape that also has important natural resources elements such as the reconstructed tallgrass prairie and Hoover Creek. Scenic values at HEHO complement the historical elements of the park (NPS 2008). The one scenic vista specifically mentioned during the park’s Resource Stewardship Strategy process is the view between the birthplace cottage and gravesite. Originally conceived by President Hoover, the view (from either end) illustrates that anyone can start from a simple life and achieve great things (NPS 2008).

The period of significance portrayed by the cultural landscape spans 92 years, from Hoover's birth in 1874 through his death in 1964. Two distinct sub-periods have the most direct associations with Herbert Hoover: 1874–1885, the years of Hoover's boyhood spent in West Branch; and 1935–1964, the post-presidential period when the Hoover family actively participated in site preservation and commemoration. The historic core of the Site includes a re-created village neighborhood representative of eastern Iowa in the 1880s. The neighborhood, which consists largely of residential structures, is aligned along a typical Midwest grid pattern of streets. The birthplace cottage is the primary resource associated with the period of significance. An unnamed tributary of the west branch of Wapsinonoc Creek, known locally as Hoover Creek, is the defining natural feature through the middle of the park. A loop road through a park-like setting extends west of the HHPL in the riparian area. The loop concept retains the characteristics of a nineteenth century racetrack that was part of the former Cedar County fairgrounds that was located on this site. An expansive lawn area contains picnic shelters, paved sidewalks, and an open park-like setting with scattered trees. The southwest portion of the Loop Road climbs slightly to the upland location of the Gravesite, from which there is a panoramic view of the core area below. An open vista is provided between the gravesite and birthplace cottage (NPS 2004).

The Isaac Miles Farm on the southeast corner and the Thompson Farm along the western border contribute a rural, agricultural landscape to the site. The farms represent nineteenth and early-twentieth century Iowa farmsteads, which provided the setting Hoover associated with West Branch. A portion of the historic Isaac Miles Farm south and west of the Loop Road has been restored to tallgrass prairie. During the period of significance, this area contained cultivated fields. Although the restored prairie does not have any historic Hoover association, it is in keeping with management objectives to maintain both the openness associated with the agrarian landscape and a dignified setting befitting the commemoration of President Hoover. The Thompson Farm, located in the upland area of the western portion of the Historic Site, is actively farmed under the terms of its acquisition. The HHPL and its associated entry drive and parking areas add a formal, institutional layer to the cultural landscape. The visitor center and the maintenance facility are relatively undistinguished within the business and residential setting of the town and do not contribute significantly to landscape integrity (NPS 2004).

Views from the park have changed significantly since the park's creation in 1972. The views are variable, consisting of agricultural and natural or natural-appearing settings, urban and commercial elements, energy and communication lines and structures, roads and highways, exurban and urban development, and historic/cultural settings and elements. When HEHO was created, the town of West Branch and other nearby towns and cities were considerably smaller than they are today. Surrounding lands were agricultural and where the terrain allowed, there were few obstructions to views from the park all the way to the horizon. As development in the surrounding communities and the highway interchange has grown closer to the park and as inconsistent visual elements have appeared within view, the sense of openness associated with extensive rural landscapes is more difficult to experience.

Much of the development surrounding the park is inconsistent with the landscape character associated with the park mission and purpose. Construction of the section of Interstate 80 along the southern park boundary was completed in August of 1962. The interstate followed an entirely new road alignment through agricultural lands just south of West Branch and north of Highway 6, which was previously the main road between Davenport and Des Moines (AARoads 2014). Although the Interstate 80 section was completed during the 1935–1964 post-presidential period, the highway and associated traffic do not fit well within the intended cultural landscape context of the park.

There are NPS initiatives that collectively support park scenery and viewshed conservation, including support for NPS renewable energy and visual resources staff and development of a Scenery Conservation Program within the NPS Air Resources Division. Other federal agencies such as the Bureau of Land Management, Forest Service and Fish and Wildlife Service also have established or are developing programs to promote scenery conservation. Important components of these initiatives include scenery inventory, evaluation and conservation, with consideration to renewable energy visual impacts and viewshed impacts extending beyond park boundaries.

<u>Threats and Stressors</u>

The vast majority of threats and stressors to the park viewscape are related to development and incompatible land uses outside the park boundary.

- Air pollution/haze affects visitors' ability to see features, color and detail in distant views.
- Suburban/exurban development.
- Industrial and commercial development – large/tall structures are more important than acreage occupied. Industrial development is also related to other incompatible elements such as visible smoke/steam/dust, roads, increased traffic and noise, and commercial signage.

- Other man-made structures, including farms and public buildings that have larger structures (e.g., outbuildings, silos, high school stadium) and more mechanized equipment relative to the historic reference periods.
- Roads and traffic.
- Energy development and infrastructure (e.g., power transmission structures and lines). The wind energy potential in this area is low and development of wind turbines is unlikely.
- Communications structures.
- Indicators and Measures
- Scenic quality of landscape views
- Housing densities in the surrounding 30 km area
- Air quality – visibility

4.4.2. Data and Methods

Scenery has not been previously evaluated at HEHO. Measures supporting this assessment include both quantitative and qualitative assessments. The assessment framework integrates ground-based measures of scenic quality from key viewpoints, a GIS–based analysis of housing density, and air quality visibility information. In this assessment we use the terms scenery, views, and scenic resources interchangeably. The viewshed is the total landscape that can be seen from a particular location, which could be a point, such as a scenic overlook; a line, such a travel route; or an area, such as a lake. Several factors limit the spatial extent of the viewshed from a given viewpoint either in reality or when using geospatial modeling. These factors include topography, vegetation, manmade structures, target height, viewer height, the curvature of the earth, and atmospheric refraction. The actual visibility of an object would depend on the viewer's eyesight; the object's size, shape, color, reflectivity, and orientation to the viewer; the lighting that falls on the object; the presence of haze and other factors (USDI 2013).

<u>Scenic Quality</u>

Key Viewpoints and Views

A viewpoint is the designated location from which a viewed landscape is evaluated. The viewed landscape or view is the scene the observer is looking at from the viewpoint. Some viewpoints may have several different and distinct views. In some cases a single view may encompass all directions from a viewpoint.

Important viewpoints and associated views were discussed and identified as part of the NRCA scoping process and data gathering. Four key or primary viewpoints and associated views considered important relative to the park's mission and/or having high levels of visitation, and seven secondary points/views were evaluated (Figure 4.4-1).

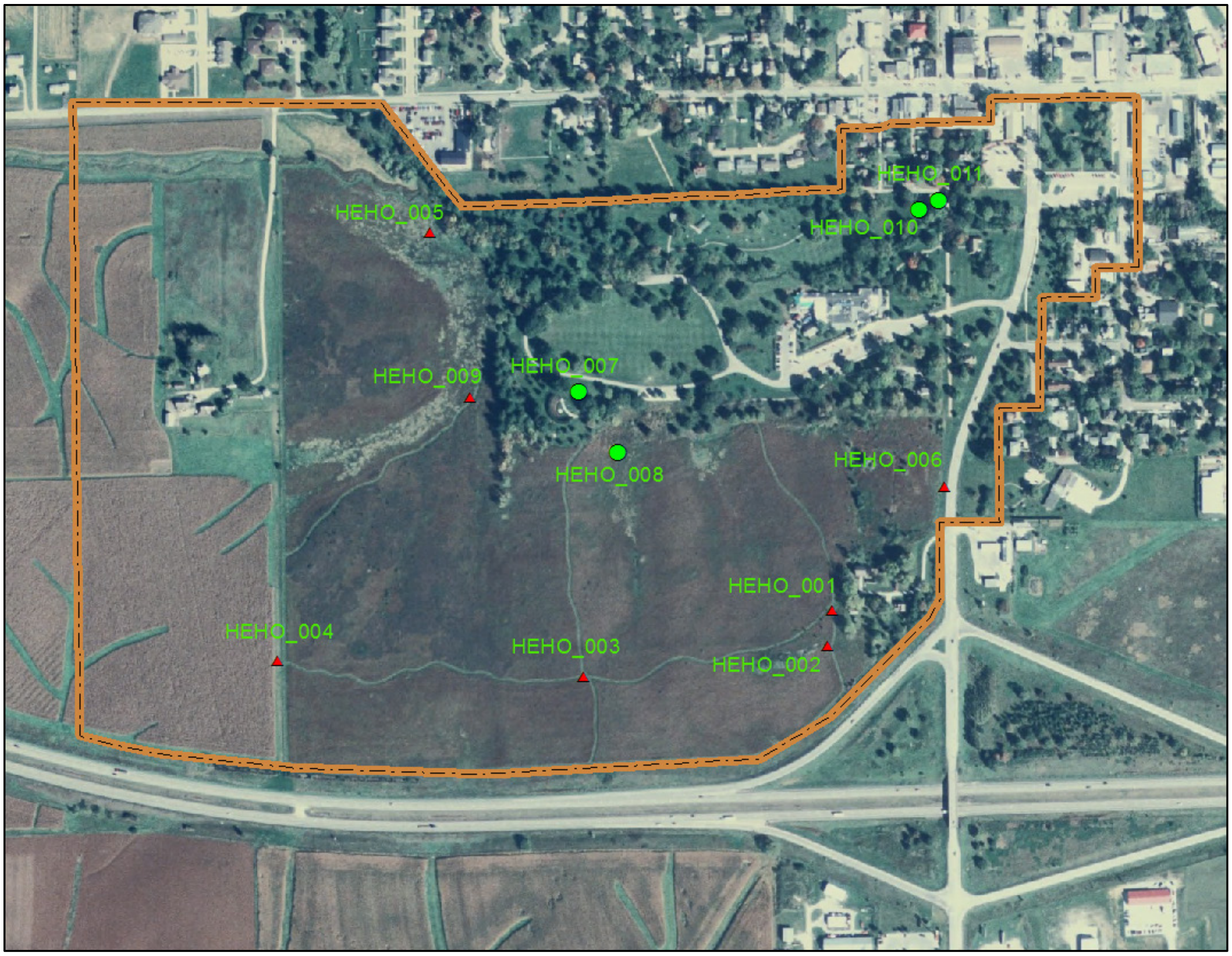


Figure 4.4-1. Location of primary viewpoints at Herbert Hoover National Historic Site. Key views are represented by green circles; secondary views are represented by red triangles. Park boundary is the orange and black dashed line (NPS MRO, CSU ArcGIS).

Panoramic photos for the primary and secondary views were taken by CSU staff in July 2013 with a Canon G10 camera using a 50 mm focal length and an image resolution of 14.6 megapixels. Each high-resolution panorama consisted of five to six overlapping photos in a single row that were combined using Gigapan Stitch software. Resulting photos had a field of view approximately 80–140 degrees wide and 20–25 degrees tall. Panoramas with a size of approximately 16,000 x 35,000 pixels were exported as .tiff graphics ranging from 60–100 megabytes in size. Original and stitched panoramic photographs and associated location data will be delivered to the park with the NRCA.

Each view was evaluated by CSU staff in August 2013 using methodology developed by the NPS Air Resources Division Scenery Conservation Program (SCP) and presented at a workshop at Homestead National Monument in August 2013. Using the SCP methodology, a landscape character type was assigned to each view (NPS Scenery Conservation Program 2014a). Possible types include natural/natural appearing, pastoral, agricultural, rural, suburban, urban and industrial. Primary landscape types present at HEHO are natural/natural-appearing, rural and agricultural landscapes.

For each view, landscape character elements were characterized and evaluated within the foreground, middle-ground and background using a streamlined version of the SCP methods (Figure 4.4-2). The distance zones are based on visibility of features rather than specific, fixed distances from the observer. For the foreground, human scale is most important and the viewer may feel that they are “part of the landscape.” Surface features are often visible, colors are distinct and details of human and wildlife activities are most easily observed. For the middle-ground, viewers may feel more like they are looking “at the landscape” rather than “being in it.” Patterns and landforms define the view, rather than individual elements. Objects such as trees, shrubs, rock outcrops and houses form a texture or pattern. Details are lost and the outlines of objects are less distinct. Colors become more muted and less distinct at the farther reaches of the middle-ground. The background is characterized by elements being very far away. Texture and patterns have largely disappeared. The horizon and landforms such as mountains dominate the backdrop. In some areas of rolling or mountainous terrain, in heavily vegetated landscapes, or urban settings the background may not be seen at all or it may not have a discernable limit (NPS Scenery Conservation Program 2013).

Figure 4.4-2. Example of approximate distance zones used in characterizing and evaluating landscape views in the Great Plains (CSU).

The scenic quality of each viewed landscape was evaluated based on the assigned landscape character and the assessment of the viewed landscape, and incorporates both natural and cultural considerations. Scenic quality scores were assigned to landscape character integrity, which is based on an evaluation of landscape elements present (landform, landcover, land use and human structures), the quality and condition of those elements, and the presence and type of inconsistent elements in the view. Dominant and secondary elements visible in each distance zone are the main drivers of the scenic quality rating. The conspicuousness of manmade features affects their impact as inconsistent elements within a view (Table 4.4-1).

Table 4.4-1. Characteristics affecting the conspicuousness of human-made features (Struthers et al. 2014).

Characteristic	Less Conspicuous	More Conspicuous
Distance	Distant from the vantage point	Close to the vantage point
Size (height, length, volume)	Small relative to the landscape	Large relative to the landscape
Color and shape	Colors and shapes that blend into the landscape	Colors and shapes that contrast with the landscape
Movement and noise	Lacking movement or noise	Exhibits obvious movement or noise

Housing Densities in the Surrounding Area

Houses and their associated utilities and roads commonly degrade the quality of landscape views comprised of natural and/or cultural elements. Housing density data derived from U.S. Census Bureau data and summarized by the NPS NPScape program were used to examine the distribution and extent of housing density classes within a 30 km area surrounding the park. A comprehensive examination of land cover, landuse, population and housing density is presented in Section 4.1 of this assessment. The results for housing densities in the region surrounding the park are used here as an indicator of condition and trend in threats to park views. The extent and percentage of housing density classes between 1970 and 2050 were examined using development classes described by Theobald (2005): rural (0–0.0618 units/ha), exurban (0.0618–1.47 units/ha), suburban (1.47–10.0 unit/ha), and urban (> 10.0 units/ha).

Air Quality – Visibility

Visibility can affect view condition by limiting the distance and clarity of the observed views. Poor visibility due to air quality degradation can reduce the quality and integrity of landscape views over time. Condition and trends in air quality attributes are examined in Section 4.7 of this report.

Visibility is measured using the Haze Index in deciviews (dv). Visibility conditions are the difference between average current visibility and estimated average natural visibility, where the average natural visibility is the mean between the 40^{th} and 60^{th} percentiles (NPS ARD 2013a). Five-year interpolated averages are used in the contiguous US.

4.4.3. Reference Conditions

Considerations for both scenic and historic integrity at the park are integrated within the scenic quality evaluation. The reference state is based on a range of natural conditions and historic/cultural elements that would have existed in the period referenced by the park's mission. The park preserves historically significant properties and memorializes Herbert Hoover. Outside of the Commemorative Zone, the Natural Zone containing the restored prairie provides a place for reflection and a buffer between the Historic Site and Interstate 80 and other development. During the Herbert Hoover boyhood period from 1874–1885, the area surrounding the park was largely agricultural and rural to the east, south and west and a small town to the north. On the edge and outside of West Branch, the landscape would have been characterized by open vistas dominated by farm fields and pastures with some remnant tallgrass prairie, occasional patches of shrubs, and woodland corridors along perennial streams. There would have been occasional farmsteads having one or more small buildings and livestock. Occasional fences, fencerows, and occasional dirt roads would have been present. By the 1930s, some electrical or communication wires may have been present

Inconsistent landscape elements within views can be inside or outside the park. Examples of inconsistent landscape elements include:

- paved roads and high density of dirt roads and/or high traffic volumes;
- urban, suburban and exurban development;
- rural homes that are not farms;
- industrial-era farm structures such as large silos;
- energy and communication infrastructure, including wind turbines, electrical and phone transmission lines, and communication towers such as cell phone towers;
- fencing;
- commercial and industrial structures;
- commercial advertisement elements such as billboards and excessive signage;
- vegetation that is inconsistent with the reference condition and landscape character type; and
- some park structures and infrastructure.

A summary of reference conditions and condition class rating for scenic quality, housing density, and visibility indicators is shown in Table 4.4-2, Table 4.4-3, and Table 4.4-4, respectively. Due to the uncertainties in viewshed modelling and the lack of previous research on the effects of wind turbine development on the perceived viewshed quality of a landscape, an objective condition rating system was not created for visibility of wind turbines.

Table 4.4-2. Condition rating framework for scenic quality at Herbert Hoover National Historic Site (modified from NPS Scenery Conservation Program 2014b).

Component	Significant Concern	Moderate Concern	Good Condition
Landscape character elements	Few important character elements are plainly visible and/or many important elements are missing.	Some important landscape features are present, but some important elements are missing.	Most or all important elements of the designated landscape character are plainly visible (e.g., natural features, land use types, structures, etc.).
Quality and condition of elements	Most elements are of poor quality and/or in poor condition. Many or most natural-appearing elements are poor examples of the idealized features. Built elements appear to be of poor quality, or are not well cared for.	Most elements are of fair quality and/or in fair condition. Some natural-appearing elements such as vegetation may not all appear to be healthy or vigorous or may be outside of the natural range of variability expected; lakes and rivers may appear polluted or littered with debris. Some built elements may be of lower quality, are of unfinished construction, or not well cared for.	Most elements are of high quality and in good condition, such as a robust, healthy forest, or a lake with clean water and a natural-looking shoreline, but natural cycles and stress agents within the natural range of variability are acceptable. Built elements use appropriate materials, designs, and finishes and appear to be well cared for.
Inconsistent elements	Many or major inconsistent elements are plainly visible and may be dominant features in the view.	Some inconsistent landscape character elements are plainly visible.	Only a few minor inconsistent landscape character elements such as industrial facilities in a natural landscape or suburban housing developments in an agricultural landscape are plainly visible.

Table 4.4-3. Condition class descriptions for housing densities (modified from Struthers et al. 2014).

Condition Class	Description
Good	Undeveloped or rural, agricultural (farm and ranch) housing dominates outside of the town of West Branch. Housing densities are primarily < 0.07 units/ha. Small concentrated areas of higher densities may exist, but usually not in proximity to the observation point and are relatively inconspicuous.
Moderate concern	Outside of downtown West Branch, housing densities are more prominent in the landscape and are generally exurban in character with densities between 0.07 and 1.5 units/ha, but the scenic and historic values are largely maintained.
Significant concern	Higher density housing generally falls within the suburban class (> 1.5 to 10 units/ha) or more dense classes, such that the scenic and historic value is either lost or close to being lost.

Table 4.4-4. Condition rating framework for visibility (NPS ARD 2013b).

Condition Class	Visibility (dv)
Good	< 2
Moderate concern	2–8
Significant concern	> 8

4.4.4. Condition and Trend

Scenery and views from the park are variable. Some views are dominated by within-park landscapes and elements, while others are influenced by midground and background elements and landscapes outside park boundaries. Outside the park, the viewed landscape character is dominated by an agricultural setting interspersed with suburban and exurban, commercial, and communications elements. View directions typically represent a field of view of about 100 degrees. For example a view to the north might include scenery from the northwest, north and northeast (i.e., 310 degrees to 50 degrees). At HEHO, because of the small park size, variable terrain and vegetation and proximity of development and extensive private lands outside the park boundary, the view quality can be very different for viewpoints relatively close to one another. There is considerable overlap in the views seen from many of the primary and secondary viewpoints discussed here. The primary views are assigned a greater weight in the scenic quality ratings compared to the secondary views.

Scenic Quality from Primary and Secondary Viewpoints

Scenic quality was evaluated for four primary and seven secondary views. Some views were classified as having more than one viewed landscape character type. Prairie views often had natural/natural appearing landscapes in the foreground and rural, agricultural, and urban/exurban character elements in the middle ground and background. A description of each view is presented below.

Primary Views

Viewpoint 10: "cabin to gravesite"

The birthplace cottage is the primary resource associated with the period of significance. Originally conceived by President Hoover, the view between the birthplace cottage and the gravesite illustrates that anyone can start from a simple life and achieve great things (NPS 2008). The significant of this view between the cottage and the gravesite is connected to the view from gravesite looking toward the cottage (Figure 4.4-3). The viewpoint is just behind the back porch of the cottage. The view of the gravesite area and flagpole to the southwest across the commemorative area is framed by trees on either side. The foreground consists of a vegetable garden, maintained lawn, several historic structures, and a park-like setting with shrubs and trees. Hoover creek is nearby on the left but is incised and not visible. The middle ground consists of mowed and maintained grassy areas with trees. Several historic homes, the HHPL and associated parking are partly visible through the vegetation. Due to the predominance of trees, most of the view does not have a background, the exception being the view to the southwest extending to gravesite.

Figure 4.4-3. Panoramic view from the back of the birthplace cottage to the Gravesite (center) to the southwest (viewpoint 10, view "cabin to gravesite") in July 2013 (CSU).

Viewpoint 7: "gravesite to cabin"

The birthplace cottage is the primary resource associated with the period of significance. Originally conceived by President Hoover, the view between the gravesite and the birthplace cottage illustrates that anyone can start from a simple life and achieve great things (NPS 2008). The significance of this view is connected to the view from the cottage looking toward the gravesite (Figure 4.4-4). The viewpoint is in front (east) of the flagpole. The view of the birthplace cottage and to the northeast across the commemorative area is framed by trees on either side. Oval Drive is in the foreground. The foreground and middle ground consist of a maintained lawn and a park-like setting with scattered trees. The middle ground consists of mowed and maintained grassy areas with trees and includes a small parking area. Restored prairie and the Isaac Miles Farmstead are visible up the slope to the east. Due to the predominance of trees, most of the view does not have a background, the exception being the view to the northeast extending to birthplace cottage. The view has an interesting combination of formal commemorative, historic and natural elements.

Figure 4.4-4. Panoramic view from the Gravesite to the birthplace cottage (center) to the northeast (viewpoint 7, view "gravesite to cabin") in July 2013 (CSU).

Viewpoint 11: "Downey and Penn St."

The view point is at the center of the intersection of South Downey Street and Penn Street. The view is in all directions. This is the heart of the historic neighborhood district within the Commemorative Zone. The landscape character is of a small town neighborhood representative of eastern Iowa in the 1880s. The mature trees lining the roads provide an inviting and park-like setting and provide shade. The homes, other structures, walkways and fences are well-maintained. The only noticeable elements inconsistent with the historic landscape character are traffic and parked vehicles north of Wetherell Street on West Main Street and North Downey Street and the road and traffic on Parkside Drive directly to the south (Figures 4.4-5 to 4.4-8).

Figure 4.4-5. Panoramic view looking north from the intersection of Downey St. and Penn St. (viewpoint 11, view “Downey and Penn St. 360 degrees”) in July 2013 (CSU).

Figure 4.4-6. Panoramic view looking east from the intersection of Downey St. and Penn St. (viewpoint 11, view “Downey and Penn St. 360 degrees”) in July 2013 (CSU).

Figure 4.4-7. Panoramic view looking south from the intersection of Downey St. and Penn St. (viewpoint 11, view “Downey and Penn St. 360 degrees”) in July 2013 (CSU).

Figure 4.4-8. Panoramic view looking west from the intersection of Downey St. and Penn St. (viewpoint 11, view “Downey and Penn St. 360 degrees”) in July 2013 (CSU).

Viewpoint 8: “Prairie lookout to southeast”

This view is from the interpretive area just to the southeast of the gravesite. The patio-like observation point is accessible and fairly close to Oval Drive and the gravesite. This is an exceptional view that includes both natural and cultural elements. The main view is of the restored tallgrass prairie to the south and southeast (Figure 4.4-9). Views to the north are of the park-like commemorative area and Oval Drive. Views to the west are largely obstructed by the terrain and trees on the west and south sides of the gravesite area. The view has a natural landscape character. The foreground is dominated by restored tallgrass prairie and is framed on the east side by deciduous and evergreen woodland. The vegetation is considered a good example of a successful native prairie restoration and contains diverse grasses and forbs/wildflowers. The middle ground is also dominated by prairie vegetation. Part of the parking area of the HHPL is visible through the trees. The background on the horizon contains the Isaac Miles Farmstead, which is the only agricultural structure in the area that survives from the time when Herbert Hoover was a young boy. The prairie meets the sky along the horizon west (right) of the farm. The roofs of several commercial buildings near the I-80 interchange and several street lamp posts are visible in the background to the left of the farm, but they are fairly inconspicuous. The farmstead promotes a rural or agricultural character. No other development is visible in this direction.

Figure 4.4-9. Panoramic view to the southeast from the prairie lookout patio toward the Isaac Miles Farm (viewpoint 8, view “prairie lookout southeast”) in July 2013 (CSU).

Secondary Views

<u>*Viewpoint 1: “Miles Farm southwest to northwest”*</u>

This viewpoint is at the intersection of several prairie trails just west of the Miles Farm parking area. The terrain and trees limit visibility of some of the development in West Branch and the surrounding area and views of the highway and traffic (Figure 4.4-10). Views to the east are obstructed by the Farmstead and dense trees. The foreground view is natural/natural-appearing with high-quality restored tallgrass prairie, the Miles Farm and an interpretive sign. Prairie paths are mowed and relatively inconspicuous. The middle ground is dominated by prairie and treed areas. Oval Drive is partly visible and the Thompson Farm is visible to the west. The McDonalds golden arches are visible above the horizon at the far left. The background includes several farms, occasional other rural homes, four communications towers, the

West Branch water tower, light structures surrounding the high school stadium, and a large conspicuous billboard (currently “IHOP”) adjacent to the stadium and facing east toward the park.

Figure 4.4-10. Panoramic view from Miles Farm to the northwest (viewpoint 1, view “Miles Farm SW to NW”) in July 2013 (CSU).

Viewpoint 2: “Miles Farm ridge to south”

The viewpoint is on the low ridge on a prairie path spur southwest of the Miles Farm. Immediate foreground is prairie vegetation and some woody plants (Figures 4.4-11 and 4.4-12). The middle ground is dominated by the highway and agricultural fields. Inconsistent elements include commercial and industrial development near the highway interchange, a communications tower, the McDonalds golden arches, wooden power poles and associated power lines, light posts associated with roads and parking lots, Interstate 80 with car and truck traffic, a municipal water tower and some farm structures. The background is forest and farm fields. This prairie area has significant woody encroachment, but the view may be improved by using vegetation to screen views to the south.

Figure 4.4-11. Panoramic view from Miles Farm ridge to the southwest (viewpoint 2, view "Miles Farm SW to NW") in July 2013 (CSU).

Figure 4.4-12. Panoramic view from the spur trail on the ridge southwest of the Miles Farm house looking south (viewpoint 2, view "Miles Farm ridge to south") in July 2013 (CSU).

Viewpoint 3: "Central prairie junction 360 degrees"

This viewpoint is in the core of the restored prairie area and provides the most expansive park views. The terrain and distant trees obscure some of the inconsistent elements within the view or make them less conspicuous. This view shares many qualities with views from the Miles Farm and the southwest trail junction viewpoint. Mowed grass trails extend from this point in the cardinal directions (Figures 4.4-12 to 4.4-16). The foreground in all directions is restored tallgrass prairie. The quality of the prairie is moderately high and there is little to no woody plant encroachment except for to the southeast. Prairie paths are mowed and relatively inconspicuous. The middle ground is dominated by prairie with some treed areas. Interstate 80 and traffic is visible to the southwest but the interstate is largely blocked by the low rise to the south. The Thompson Farm is visible to the west and the Miles Farm to the east. The background includes agricultural fields, several farms, occasional other rural homes, a number of communications towers, the several water towers, light structures surrounding the high school stadium, high school buildings and a large conspicuous billboard (currently "IHOP") adjacent to the stadium and facing east toward the park, the McDonalds golden arches, and suburban development to the northwest. Most of the inconsistent elements are strong vertical features that make them highly conspicuous. The abundance of trees in all directions exceeds what would be expected for the period of reference.

Figure 4.4-13. Panoramic photo looking northeast from the south-central prairie trail junction (viewpoint 3, view "south-central prairie junction 360 degrees") in August 2013 (CSU).

Figure 4.4-14. Panoramic photo looking southeast from the south-central prairie trail junction (viewpoint 3, view "south-central prairie junction 360 degrees") in August 2013 (CSU).

Figure 4.4-15. Panoramic photo looking southwest from the south-central prairie trail junction (viewpoint 3, view "south-central prairie junction 360 degrees") in August 2013 (CSU).

Figure 4.4-16. Panoramic photo looking northwest from the south-central prairie trail junction (viewpoint 3, view “south-central prairie junction 360 degrees”) in August 2013 (CSU).

Viewpoint 4: “Southwest trail junction to west”

This viewpoint is located at the park boundary at the western end of the prairie trail along the low rise north of Interstate 80. The assessed view is to the west and has elements of agricultural and rural landscape characters. The foreground is a hayfield. The middle ground is agricultural fields and Interstate 80. The background is dominated by agricultural fields, several farms and rural homes with trees. Inconsistent elements include the interstate and traffic, the high school, stadium and ball field light towers and adjacent IHOP billboard, and communications towers. The inconsistent elements are moderately conspicuous (Figure 4.4-17).

Figure 4.4-17. Panoramic photo looking southwest from the southwest trail junction (viewpoint 4, view "southwest trail junction west") in August 2013 (CSU).

Viewpoint 5: "Northwest trail to west"

This viewpoint is west of the northwest corner of Oval Drive, following along the south side of Hoover Creek. The view to east is largely blocked by trees. The assessed view is to the west toward the Thompson Farm. The viewed landscape character is a combination of natural/semi-natural, agricultural and urban/exurban. The foreground is restored tallgrass prairie with a mowed grass trail (Figure 4.4-18). The middle ground and background include the Thompson Farm and the field extending from it to the north, several houses, and a suburban development to the northwest. The High school stadium light towers and some low electrical/phone lines are visible to the west and northwest. Trees are associated with residences and farms.

Figure 4.4-18. Panoramic photo looking west from prairie trail from the northwest area of Oval Drive (viewpoint 5, view “northwest trail to west) in August 2013 (CSU).

Viewpoint 6: “Park approach Parkside Drive”

This view towards the north from the west road shoulder by the entrance to the Miles Farmstead is the first view of HEHO when arriving from the highway on Parkside Drive. The view draws the observer’s gaze down tree-lined historic South Downey Street, which is no longer open to car traffic. The realigned, newer section of South Downey Street (a.k.a. Parkside Drive) bends around the park and is surrounded by large trees. The rural landscape character type within the park on the west side of the road is distinctly different form the suburban character type on land east of the road (Figure 4.4-19). West of the road, high-quality natural and cultural elements are present; the foreground is dominated by a wide mowed shoulder area and restored tallgrass prairie. The wide mowed area seems inconsistent with the rest of the landscape character on the park side of the road, but may be required for management reasons. The middle ground contains a period home and mature deciduous trees. East of the road, the foreground is dominated by mowed grass and trees and a NPS park sign. The middle ground is dominated by trees and houses and signage/banners associated with the park. The middle ground contains a period home and mature deciduous trees. The background is predominantly trees along the horizon and a few small communication and industrial structures.

Figure 4.4-19. Panoramic photo looking north down historic North Downey Street (center) and Parkside Drive (right) from near the entrance to the Miles Farm on Parkside Drive (viewpoint 6, view “park approach Parkside Drive”) in August 2013 (CSU).

Viewpoint 9: “West Oval prairie trail southwest *to northwest”*

The viewpoint is to the west of the trailhead in a wooded area on the west end of Oval Drive. The view has elements of both natural/natural-appearing and rural landscape character types. The topography to the southwest rises up and largely limits the view to restored tallgrass prairie within the park boundary. Views to the west and northwest extend farther and outside the park. The foreground is dominated by restored tallgrass prairie having diverse grasses and forbs with some scattered woody shrubs and small trees (Figures 4.4-20 and 4.4-21). The middle ground consists of restored tallgrass prairie and woodlands bordering the Commemorative Area and Hoover Creek to the north. The woodlands frame the prairie. In the background, the Thompson Farm surrounded by trees is visible on a rise to the west. A suburban development outside the park is visible to the northwest. One communications tower is visible on the horizon. The suburban development is a moderately conspicuous inconsistent element.

Figure 4.4-20. Panoramic photo looking southwest from prairie trail near the west end of Oval Drive (viewpoint 9, view "west Oval prairie trail southwest-northwest") in August 2013 (CSU).

Figure 4.4-21. Panoramic photo looking southwest from prairie trail near the west end of Oval Drive (viewpoint 9, view "west Oval prairie trail southwest-northwest") in August 2013 (CSU).

Views were evaluated and assigned a scenic quality rating (Table 4.4-5) using the criteria in Table 4.4-2. All primary views received a good scenic quality rating. They are tightly linked to the park mission and purpose, and the prairie views from near the gravesite are excellent while providing the intended buffer between the commemorative zone and adjacent development. With the exception of the view of the park approach on Parkview Drive, secondary views are from the prairie trail network. The scenic quality of secondary views varied from good to moderate concern. Views extending outside to the southwest and northwest, and especially those including the I-80 interchange and the highway, had the lowest ratings due to the conspicuousness of inconsistent elements such as the highway, commercial structures, the high school stadium and adjacent billboard and suburban development. Residential, commercial and communication tower development have significantly degraded views extending outside the park, especially over the past 10 years. The overall rating for scenic quality is good with a declining trend. Confidence in the assessment is medium due to the somewhat subjective nature of the assessment.

Table 4.4-5. Summary of primary and secondary view scenic quality condition ratings at Herbert Hoover National Historic Site.

View Type	Viewpoint/View	Landscape Character Elements	Quality and Condition of Elements	Inconsistent Elements	Scenic Quality Rating
Primary views	Viewpoint 10: Cabin to gravesite	Good	Good	Good	Good
	Viewpoint 7: Gravesite to cabin	Good	Good	Good	Good
	Viewpoint 11: Downey and Penn St. 360 degrees	Good	Good	Good	Good
	Viewpoint 8: Prairie lookout to southeast	Good	Good	Good	Good
Secondary views	Viewpoint 1: Miles Farm southwest to northwest	Good	Good	Moderate concern	Good
	Viewpoint 2: Miles Farm ridge to south	Moderate concern	Moderate concern	Significant concern	Moderate concern
	Viewpoint 3: Central prairie junction 360 degrees	Good	Good	Significant concern	Moderate concern
	Viewpoint 4: Southwest trail junction to west	Moderate concern	Moderate concern	Significant concern	Moderate concern
	Viewpoint 5: Northwest trail to west	Good	Good	Moderate concern	Good
	Viewpoint 6: Park approach Parkside Drive	Good	Moderate concern	Good	Good
	Viewpoint 9: West Oval prairie trail southwest to northwest	Good	Good	Moderate concern	Good

Housing Densities

Housing density in the region surrounding the park shows marked patterns of change between 1970 and 2010. Within a 30 km radius of the park, the most notable trend is an increase in exurban areas and a corresponding decrease in rural acreage in unincorporated areas, including areas close to towns and major roads (Table 4.4-6). The extent of suburban acreage also increased steadily during this period. Acreage for urban, commercial/industrial, and urban regional park classes for 2010 were 2,104 (0.29%), 6,820 (0.94%), and 2,830 (0.39%), respectively. These acreages are not forecast to significantly change by 2050.

Table 4.4-6. Housing density classes within 30 km of Herbert Hoover National Historic Site (1970–2050) (data provided by NPS NPScape Program).

	Rural (0–0.0618 units/ha)		Exurban (0.0618–1.47 units/ha)		Suburban (1.47–10.0 units/ha)	
Census Year	**Acres**	**% of Area**	**Acres**	**% of Area**	**Acres**	**% of Area**
1970	612,605	84.43%	96,502	13.30%	6,022	0.83%
1980	568,127	78.30%	138,585	19.10%	7,981	1.10%
1990	541,498	74.63%	164,053	22.61%	8,852	1.22%
2000	480,767	66.26%	222,970	30.73%	10,593	1.46%
2010	446,593	61.55%	255,693	35.24%	11,754	1.62%
2020	428,598	59.07%	271,583	37.43%	13,641	1.88%
2030	420,762	57.99%	277,678	38.27%	15,310	2.11%
2040	415,393	57.25%	281,161	38.75%	17,124	2.36%
2050	413,506	56.99%	281,596	38.81%	18,430	2.54%

Acreages of exurban and suburban areas are forecast to continue to increase, albeit at a slower rate, between 2010 and 2050. Additional details are presented in the *Land Cover and Land Use* chapter of this assessment. Locally, there are virtually no lands protected from development by virtue of ownership. Although the housing density is predominantly rural, small concentrated areas of higher densities exist close to the park, are visible from some primary and secondary view points and are relatively conspicuous. Based on the current extent of these housing density categories and forecast change, this indicator warrants moderate concern for views, with a deteriorating trend and high level of confidence.

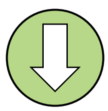
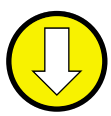
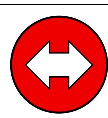
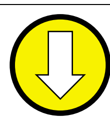
Air Quality – Visibility

The five-year averages for visibility consistently fall in the "Poor Condition" category. The visibility levels have been between 9.7 dv and 10.6 dv throughout the 2001–2010 period. The condition of this indicator warrants significant concern, with an unchanging trend and medium confidence due to the regional and modeled nature of the data. Although the gently rolling topography and lack of high vantage points at HEHO somewhat limit the observation of distant objects due to visual obstruction by trees, other objects and the curvature of the earth, the poor visibility rating is notable. Condition of this indicator warrants significant concern with an unchanging trend. Confidence in the assessment is medium.

Overall Condition and Trend

Overall condition of views warrants moderate concern with a deteriorating trend. Confidence in the assessment is medium to high. Condition of scenery is weighted most heavily toward the scenic quality ratings, which are based on actual views and human observations from defined vantage points. Less weight is given to the examination of housing densities and landcover, which illuminate larger landscape issues that may affect the park into the future and also impact secondary views in and around the park. Despite the weighting, the overall condition is considered to warrant moderate concern (Table 4.4-7). Primary views within the park are relatively well-buffered from development in the surrounding area, but views from prairie viewpoints are vulnerable to degradation over time as the rural agricultural landscape changes.

Table 4.4-7. Condition and trend summary for scenery at Herbert Hoover National Historic Site.

Indicator	Condition Status/Trend	Rationale
Scenic quality		All primary views received a good scenic quality rating. They are tightly linked to the park mission and purpose. The scenic quality of secondary views varied from good to moderate concern. Views extending outside to the southwest and northwest, and especially those including the I-80 interchange and the highway, had the lowest ratings due to the conspicuousness of inconsistent elements. Development outside the park has degraded secondary views in the recent past.
Housing densities in the surrounding 30 km area		Within a 30 km radius of the park, during 1970 to 2010 there was an increase in exurban areas and a corresponding decrease in rural acreage in unincorporated areas, including areas close to towns and major roads. The extent of suburban areas also increased steadily during this period. Acreages of exurban and suburban areas are forecast to continue to increase between 2010 and 2050. Additional details are presented in the Land Cover and Land Use chapter of this assessment.
Air quality – visibility		The five-year averages for visibility consistently fall in the NPS Air Resources Division “poor condition” category. See the Air Quality section of the NRCA for more details.
Overall Condition Status and Trend for Scenery and Views		**Condition warrants moderate concern with a deteriorating (current and anticipated) trend. Confidence in the assessment is medium.**

4.4.5. Uncertainty and Data Gaps

Further examination of key park views by local staff is recommended incorporating the scenic quality protocols being developed by the NPS Scenery Conservation Program.

4.4.6. Sources of Expertise

- Rob Bennets, Network Coordinator, Southern Plains I&M Network, NPS Inventory and Monitoring Division
- Doug Wilder and Matt Colwin, NPS Midwest Geospatial Support Center
- Mark Meyer, Renewable Energy Visual Resource Specialist, NPS Natural Resources Stewardship/Science, Air Resources Division. Mr. Meyer provided helpful manuscript reviews.
- The National Park Service's Air Resources Division oversees the national air resource management program for the NPS. Together with parks and NPS regional offices, they monitor air quality in park units, and provide air quality analysis and expertise related to all air quality topics. Note that the measures and methods used for assessing the condition of viewshed in this report predate current measures and methods recommended by the NPS. For current information and methodology, please visit the NPS Air Resources Division website at https://www.nps.gov/subjects/air/index.htm or contact the NPS at visual_resources@nps.gov.

4.4.7. Literature Cited

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4.5. Climate Change

4.5.1. Background and Importance

Climate change is increasingly recognized as a major stressor of biological taxa, communities and ecological systems. The climate suitable for Great Plains grasslands is expected to remain relatively stable with some expansion to the north in Canada, but the range of tallgrass prairie along the eastern boundary is expected to contract (Rehfeldt et al. 2012). This contraction would potentially affect tallgrass prairie primarily in Illinois, southwestern Minnesota, Iowa, northern Missouri, and the eastern portions of South Dakota, Nebraska, Kansas, Oklahoma and Texas.

Increasing CO_2 tends to increase plant growth and water use efficiency, but may be limited by water and nutrient availability. Transpiration rates usually decline as CO_2 increases, while, in many plants, photosynthesis and growth increase. Growth response to CO_2 is usually highest in rapidly-growing plants and in plants with the C3 photosynthetic pathway (most woody plants and 'cool-season' grasses) versus the C4 pathway (most 'warm-season' grasses) (Polley 1997). Changes in grassland composition due to the interaction of temperature, moisture, nutrient availability and CO_2 are very difficult to predict (Polley 1997, Morgan et al. 2008), but evidence increasingly suggests that rising CO_2 and temperature plus increased winter precipitation can favor herbaceous forbs, legumes, and woody plants in many Great Plains rangelands, with uncertain changes in the balance between cool-season and warm-season perennial grasses (Morgan et al. 2008). Changes in species composition will likely vary by region and by year and will depend on depth and timing of available soil water as well as disturbance factors such as grazing, fire, and disease, which can have strong influence on plant communities (Bagne et al. 2013). Long-term research at the Konza Prairie found that primary productivity NPP in tallgrass prairie is a product of spatial and temporal variability in light, water, and nutrients, driven by a combination of topography, fire history, and climate, and is not driven strongly by precipitation alone (Briggs and Knapp 1995). Dynamics shaping plant community composition will also be influenced by increasingly severe and frequent droughts, floods and fires (Bagne et al. 2012).

Climate change is examined here using modeled future climate scenarios, but potential resource vulnerability and management implications are based on the relative amounts and directions of changes rather than specific magnitudes or thresholds of change. Although the park can do its part to mitigate greenhouse gas emissions and optimize the efficiency of park operations vis a vis greenhouse gases, climate change and its associated effects on park resources are largely out of the control of park managers. Climate change will require an evaluation of the vulnerability of park resources. Moreover, specific and diverse adaptation measures for some park resources may be necessary to mitigate effects of climate change and transition to future climatic conditions.

Threats and Stressors

Increases in atmospheric greenhouse gases are resulting in changes in global, regional and local climates. Changes in the amounts and patterns of temperature and precipitation have numerous direct and indirect effects on environmental conditions and biota. An increase in the frequency of extreme weather is also anticipated under climate change.

Indicators and Measures

- Temperature changes from baseline – minimum, mean, and maximum temperatures (monthly)
- Precipitation changes from baseline – annual and seasonal; very heavy events
- Indices of aridity/drought – historic period of record and future vs. baseline period
- Plant phenology (baseline only) – enhanced vegetation index values for onset of spring greenup, maximum greenness (peak vegetation), onset of senescence, and onset of minimum greenness; projected changes in frost-free period.

4.5.2. Data and Methods

A variety of data and analysis approaches are used to characterize the climate during the historic period of record and examine possible changes in climate for the park. A combination of site-specific and regional results is presented. Historic climate and modeled future climate change were examined for the area extending approximately 30 km from the park boundary. Because the park is relatively small, geographic variation within the park is minimal and monthly values were averaged across the area of interest.

Two families of scenarios are generally used for future climate projections: the 2000 Special Report on Emission Scenarios (SRES) and the 2010 Representative Concentration Pathways (RCP). Results for both of these families are presented here. The SRES scenarios are named by family (A1, A2, B1, and B2) and the RCP scenarios are numbered according to the change in radiative forcing (from +2.6 to +8.5 watts per square meter) anticipated by 2100. Comparing carbon dioxide concentrations and global temperature change between the SRES and RCP scenarios, SRES A1 is similar to RCP 8.5, SRES A1B is similar to RCP 6.0 and SRES B1 is similar to RCP 4.5 (Walsh et al. 2014a).

Consolidation of future modeled climates and comparisons with historic baseline and graphic representation of results was supported by the USGS North Central Climate Science Center (NCCSC) hosted by Colorado State University (http://revampclimate.colostate.edu/). Future climate projections for the NCCSC products are presented for several scenarios of future greenhouse gas concentrations (i.e., emission scenarios); representative concentration pathway (RCP) 8.5 represents the high emissions scenario and RCP 4.5 represents a moderate emissions scenario. Examination of historic climate data used PRISM (4 km) data downloaded from http://cida.usgs.gov (PRISM Climate Group 2014). Climate projections for non-spatial graphics use CMIP5 downscaled data downloaded from the Green Data Oasis website (http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html) (CMIP5 Modeling Groups 2014). CMIP5 downscaling procedures are described in Maurer et al. (2002). Approximately 35 general circulation models (GCMs) that use quantitative methods to simulate the interactions of the atmosphere, oceans, land surface, and ice were used for the NCCSC summaries. Because the variability in results among models makes interpreting results problematic, ensemble summaries were used to combine the simulations of multiple GCMs and quantify the range of possibilities for future climates under the different emission scenarios. Using ensemble median values based on the results from many GCMs provides a more robust climate simulation versus using results of individual models (Girvetz et al. 2009). Future values were averaged over specified periods to approximate values (i.e., future modeled values for 2080 represent the mean for the 2070–1989 period). Seasonal summaries use the following groupings: winter = December, January, and February; spring = March, April, and May; summer = June, July, and August; and autumn = September, October, and November.

The Palmer Drought Severity Index (PDSI) uses temperature and precipitation data to calculate water supply and demand, incorporates soil moisture, and is considered most effective for unirrigated cropland (Palmer 1965, USDA 2014). The Palmer Index is most effective in determining long term drought (i.e., at least several months). Long-term drought is cumulative, so the intensity of drought during a point in time is dependent on the current weather patterns plus the cumulative patterns of the previous period. The Index is used widely by the U.S. Department of Agriculture and other agencies. PDSI values range between -4.00 or less (extreme drought) and +4.00 or greater (extreme moisture). The index uses a value of 0 as "normal." Monthly PDSI values were obtained from the National Climatic Data Center (NCDC 2013). Assumptions of the PDSI regarding the relationship between temperature and evaporation may give biased (i.e., overestimated evaporation) results in the context of climate change (Sheffield et al. 2012). However, examination of historic PDSI does appear to corroborate known drought periods and the PDSI approach is not used to model future drought.

Modeling into the future, moisture deficit was modeled using the web-based Climate Wizard Custom tools applying 12 km downscaled climate projections for more than 15 different GCMs (The Nature Conservancy, University of Washington and University of Southern Mississippi 2014; Maurer et al. 2007). Two greenhouse gas emissions scenarios – High (A2) and Medium (A1B) were used for the Climate Wizard results. The balance between precipitation and the amount of water that an ecosystem could potentially use though evaporation and transpiration (i.e., potential evapotranspiration or PET) is the basis for the climatic moisture deficit. PET is higher with warmer temperatures and more daylight hours. PET was calculated based on monthly temperature and monthly average number of daylight hours using a modified version of the Thornethwaite equation and procedures described by Wolock and McCabe (1999). Climatic moisture deficit quantitatively estimates moisture stress in a system; a higher moisture deficit reflects higher moisture stress. A deficit (in mm) occurs only when precipitation (i.e., supply) is less than PET (i.e., demand) in a given month. If precipitation decreases or temperature increases (increasing PET) moisture deficit increases. Deficit is calculated as monthly PET minus precipitation (in mm), and is set to zero if precipitation is greater than PET. Monthly results are summed to provide seasonal or annual values (The Nature Conservancy, University of Washington and University of Southern Mississippi 2014).

Plant phenology was examined using existing and freely available remote sensing data, specifically the NASA-funded 250 m spatial resolution land-surface phenology product for North America. This product is calculated from an annual record of vegetation health observed by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. The land surface phenology product summarizes all the observations throughout a year into a few, key, ecologically relevant biophysical parameters or metrics. MODIS land products include two Vegetation Indexes (VI) derived from the remotely sensed fraction of photosynthetically active radiation detected every one to two days by the MODIS sensors (Gao et al. 2008). Normalized difference vegetation index (NDVI) and enhanced vegetation index (EVI) datasets represent 8 day composites of MODIS data at the 250 m spatial resolution scale (Tan et al. 2009). The revisit interval for any geographic point is approximately 1–2 days. The resulting land surface phenology metrics are produced from these composites using an enhanced algorithm within the TIMESAT software program (Tan et al. 2009). Phenology data for pixels within the park boundary were gathered and summarized by Kevin James of the Heartland I&M Network using procedures and tools described in James et al. (2013). It was important to keep the pixels examined within the park, since most areas outside the park are not prairie or other forms of native vegetation.

4.5.3. Reference Conditions

For most indices, the reference condition for this assessment is an 85-year period from about 1895, when meteorological data were first collected, to 1980, when a significant change in many climate indices roughly began. Although there may be some changes occurring during this period, the long reference period avoids bias associated with wet, dry, warm and cold periods or extreme events such as prolonged or severe drought. Some analyses of historic data use a 1950–1980 baseline because of limited dates associated with downscaled CMIP5 data. For the climatic moisture deficit projections, future values were compared to a baseline period of 1961–1980. For frost-free season length, the baseline period was 1901–1960.

4.5.4. Historic Conditions, Range of Variability and Modeled Changes

<u>Temperature</u>

Historic Trends

A linear regression model was fit to average minimum and average maximum monthly temperature for 1895–1980 and 1980 to 2012 in the vicinity of the park (Figure 4.5-1). The earlier period corresponds to the period that is associated with no change in climate or a slower rate of change compared to 1980 or later. At HEHO, mean minimum monthly temperatures did not increase significantly over time during 1895–1980 ($p = 0.068$) or from 1980–2012 ($p = 0.67$). The model results for mean monthly maximum temperature over time were not statistically significant for either period, with P values of 0.63 and 0.84 for the two periods, respectively.

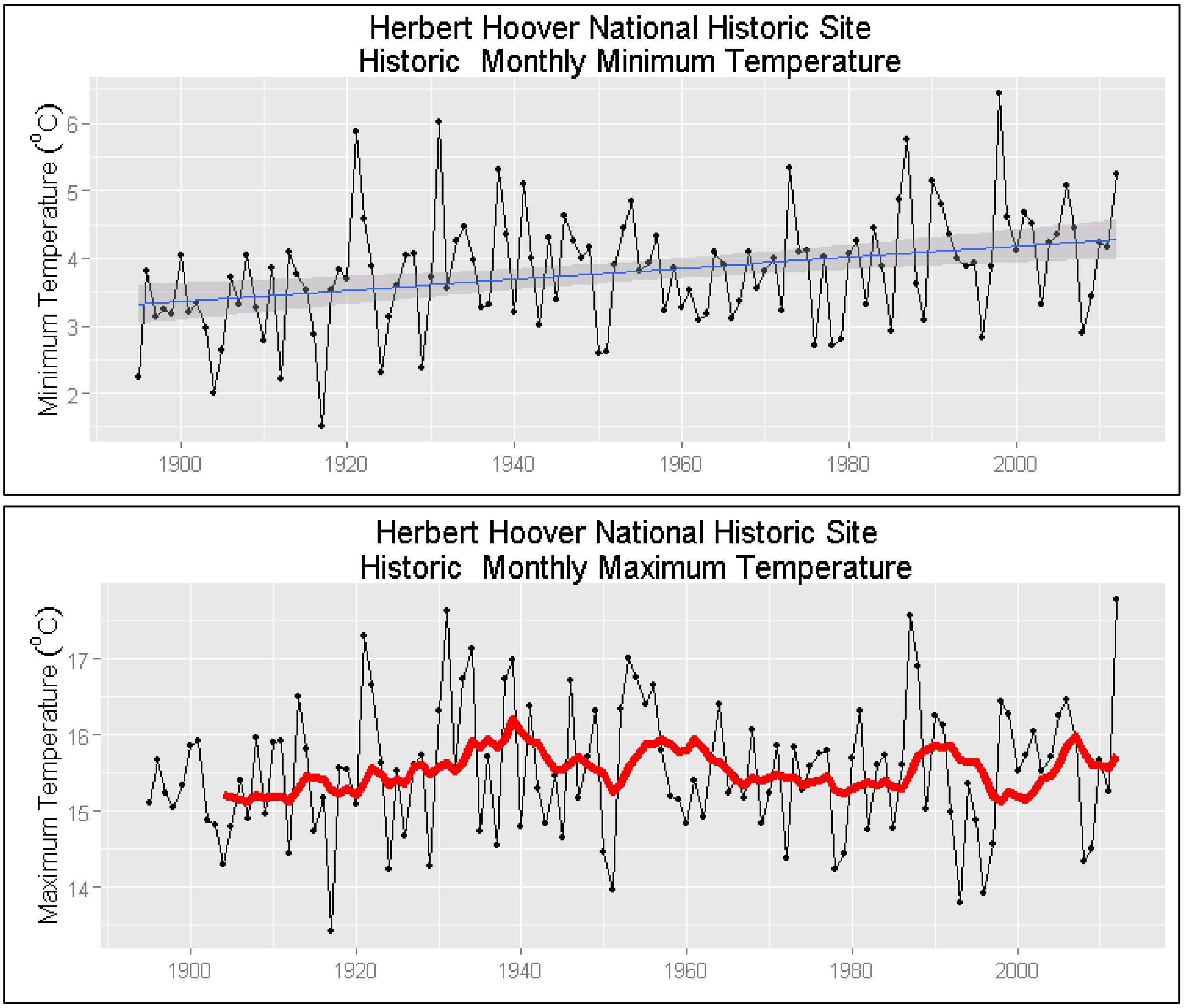

Figure 4.5-1. Historic PRISM data at Herbert Hoover National Historic Site for minimum temperature showing linear model fit (top) and maximum temperature with a five year lag running mean (bottom) (Data and graphic prepared by NCCSC).

The lack of trends in monthly minimum temperatures over time are further illustrated in a graphical representation of the data for the period of record (Figure 4.5-2), which normalizes differences between a baseline period of 1895 to 1980 with individual monthly values. High temperatures associated with severe droughts that occurred in the 1930s, late 1950s, late 1980s are evident in Figure 4.5-2. An anomaly plot showing annual minimum temperatures over time further illustrates patterns in this variable during the recent past, with above average minimum temperatures in most years since 1920 relative to the long term average (Figure 4.5-3). Monthly data were also grouped by season into model quartiles for minimum temperature (Figure 4.5-4). Seasonal data shows a distinct increase in minimum temperatures in spring and summer over the past several decades and cooler autumns during the same period.

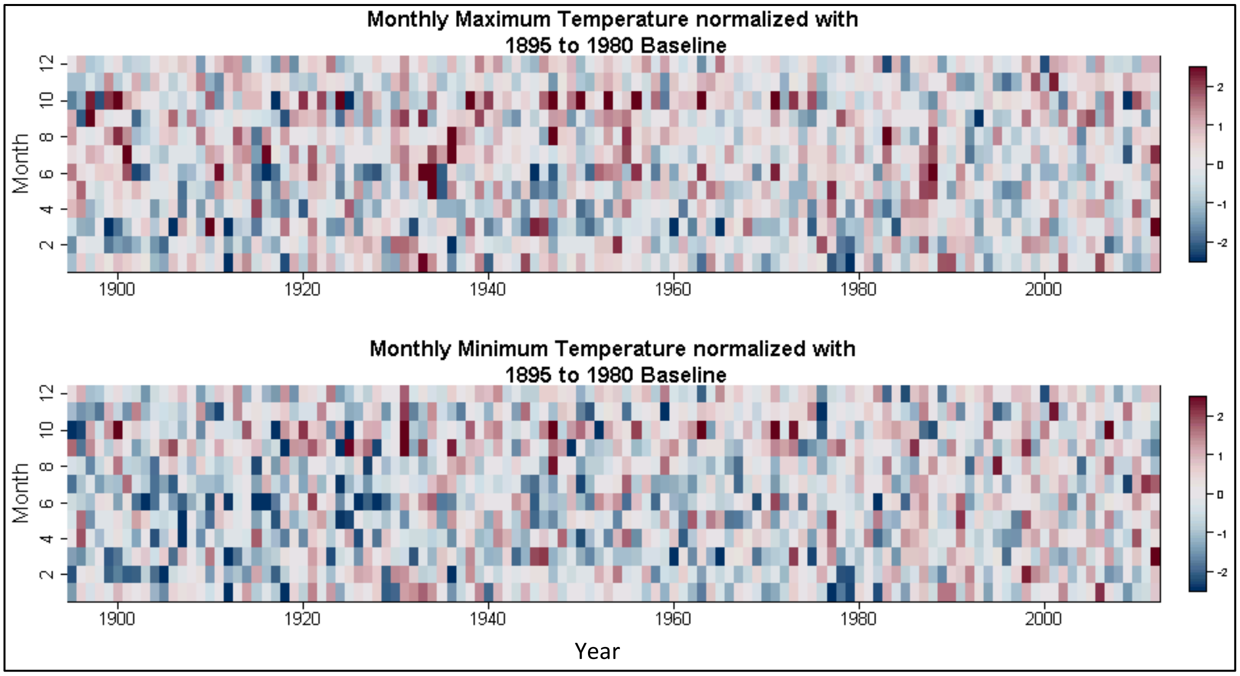

Figure 4.5-2. Mean monthly maximum temperature (top) and monthly minimum temperature (bottom) showing the normalized difference from a baseline (1895–1980) period for each month and year for Herbert Hoover National Historic Site. The baseline is calculated monthly within the specified year range. The pixels are normalized by month and colors range from +/- 2.5 standard deviations from the mean of the baseline period (Data and graphic prepared by NCCSC).

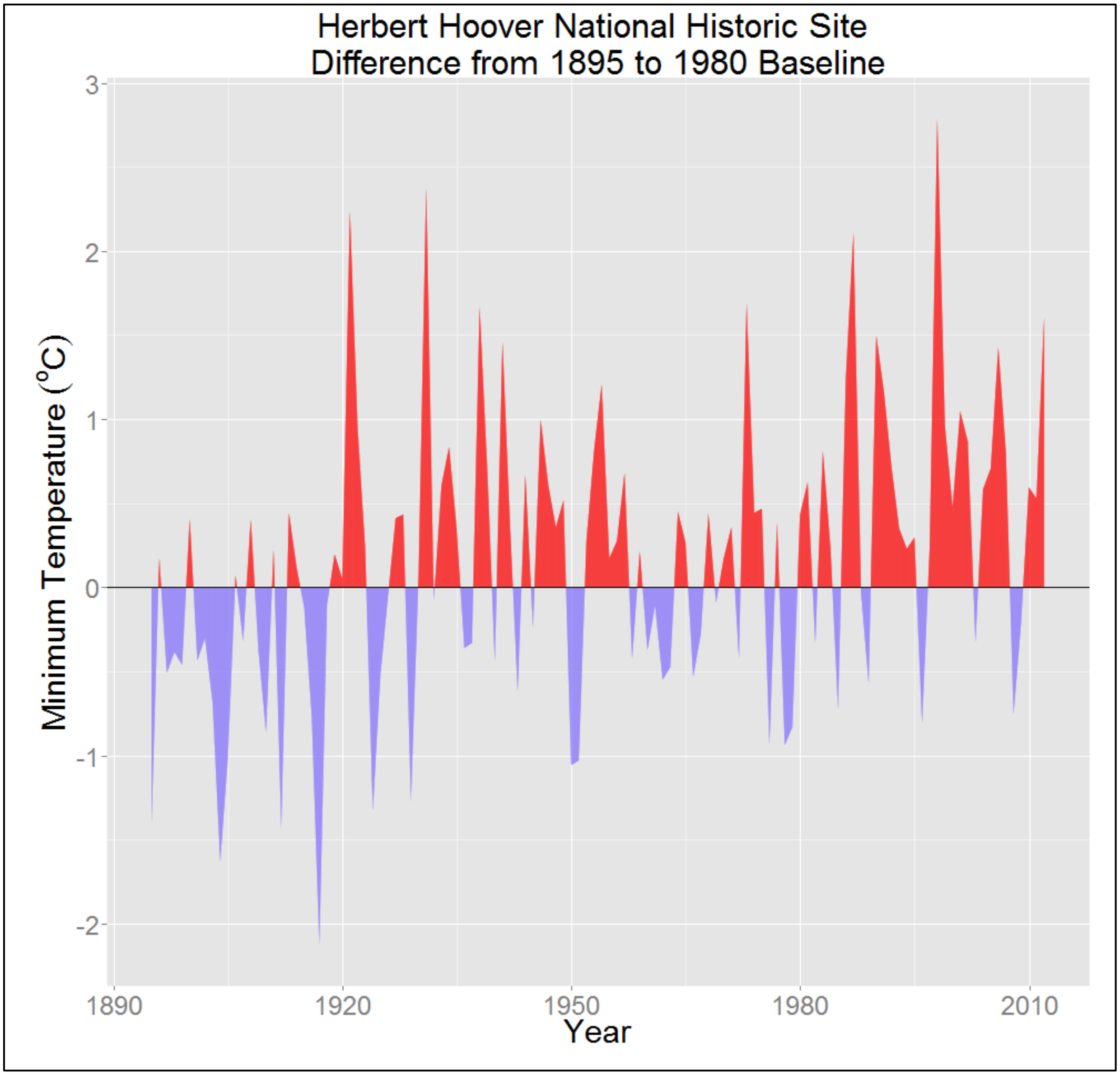

Figure 4.5-3. Anomaly plot for mean minimum temperature showing the difference between individual years from 1895 to 2012 and a baseline (1895 to 1980 average) for Herbert Hoover National Historic Site (Data and graphic prepared by NCCSC).

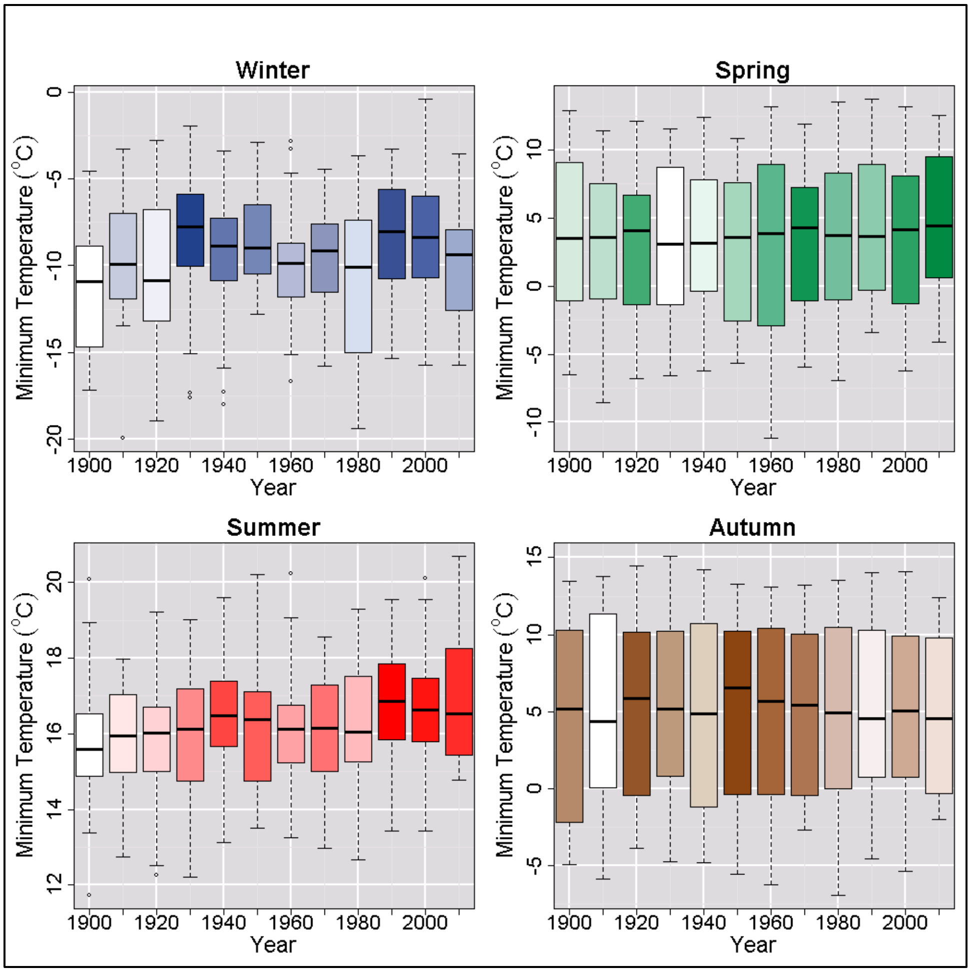

Figure 4.5-4. Seasonal historic mean minimum temperature quartiles for Herbert Hoover National Historic Site using PRISM data. Within a season, darker colors represent higher temperatures (Data and graphic prepared by NCCSC).

Modeled Future Changes

Models indicate that temperatures at the park will rise significantly under climate change (Figure 4.5-5). According to median ensemble estimates, both minimum and maximum temperature are expected to increase by approximately 1–2 °C by the 2050s, and by approximately 2–5 °C by the 2080s, depending on the scenario (Figure 4.5-5).

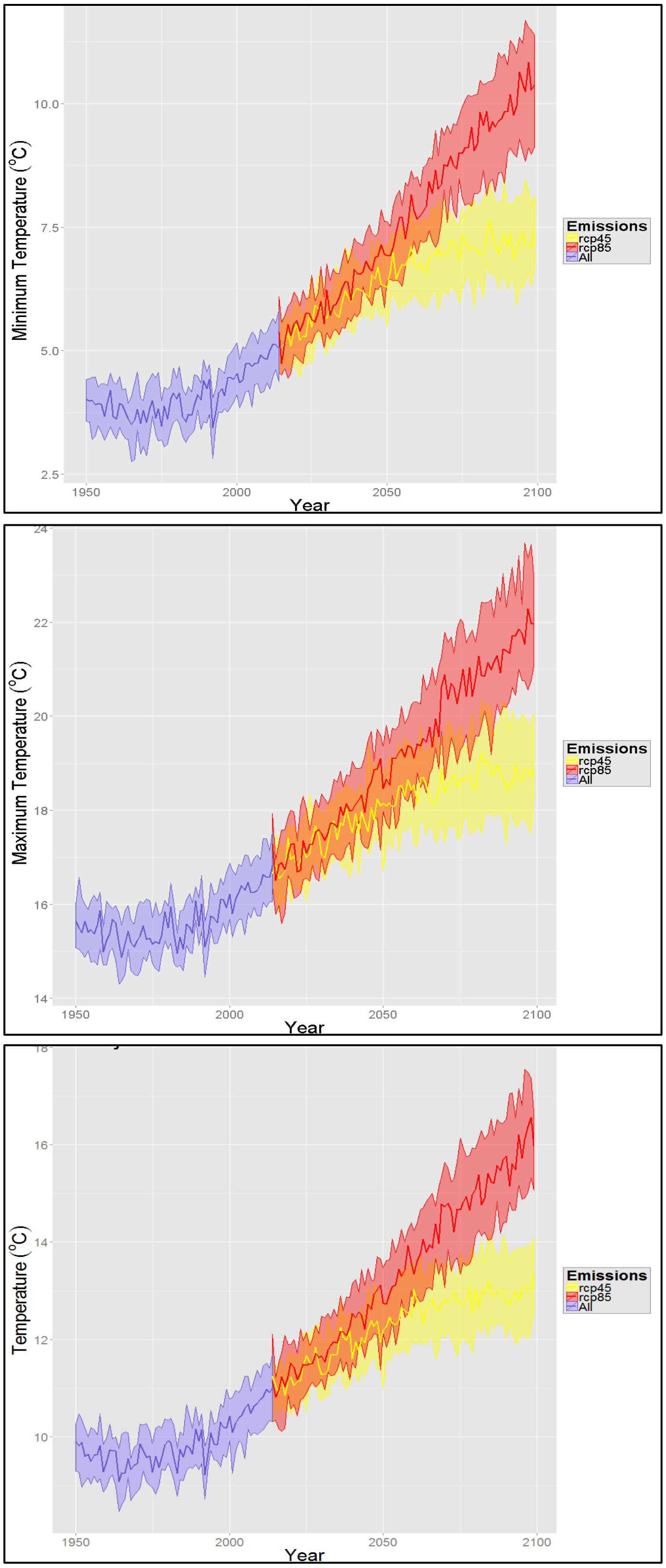

Figure 4.5-5. Projections for annual minimum, maximum and mean temperature with median, 25 and 75% quantiles grouped by emissions scenario for Herbert Hoover National Historic Site (Data and graphic prepared by NCCSC).

Precipitation

Historic Trends

Historic trends in monthly and annual precipitation for 1895–2010 were examined to understand patterns and variability. Mean monthly precipitation illustrates some wetter and drier periods but changes in amounts or seasonality over time are not clear (Figure 4.5-6). Linear regression of mean monthly precipitation with time were not significant for the 1895–1980 period ($p = 0.953$) or the 1980–2012 period ($p = 0.826$) (Figure 4.5-7). Variability in seasonal and annual precipitation is relatively high.

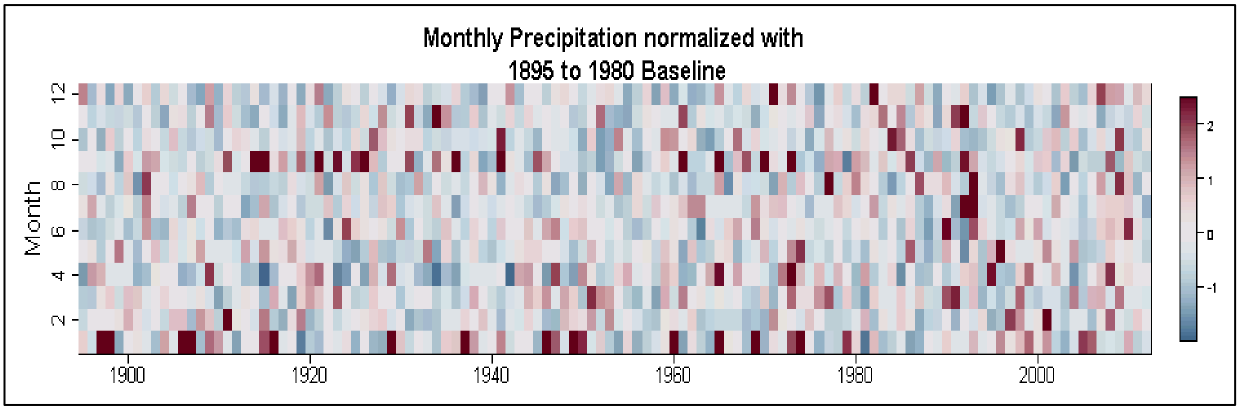

Figure 4.5-6. Mean monthly precipitation showing the normalized difference from a baseline (1895–1980) period for each month and year for Herbert Hoover National Historic Site. The baseline is calculated monthly within the specified year range. The pixels are normalized by month and colors range from +/- 2.5 standard deviations from the mean of the baseline period (Data and graphic prepared by NCCSC).

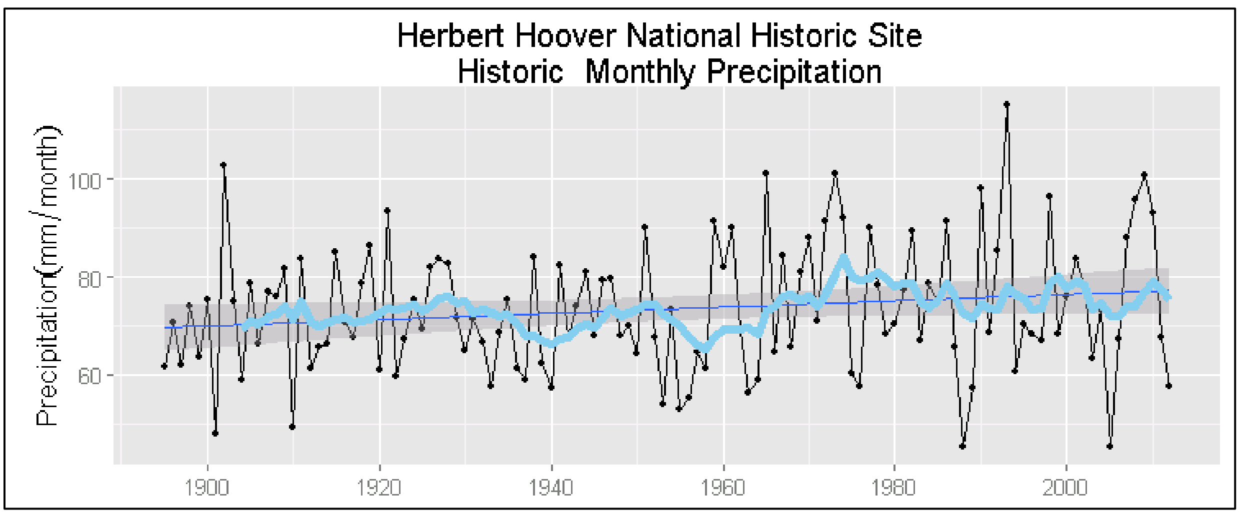

Figure 4.5-7. Historic PRISM data for precipitation at Herbert Hoover National Historic Site showing linear model fit and a five year lag running mean (Data and graphic prepared by NCCSC).

In recent decades there have been increases nationally in the annual amount of precipitation falling in very heavy events, defined as the heaviest 1% of all daily events from 1901 to 2012. The largest regional increases have been in the Northeast, Great Plains, Midwest and Southeast regions when compared to the 1901–1960 average (Walsh et al. 2014b). Regional results for the Midwest region including Herbert Hoover National Historic Site indicate 20 to 30% or more increases in the annual amount of precipitation falling in very heavy events over the past few decades (Figure 4.5-8).

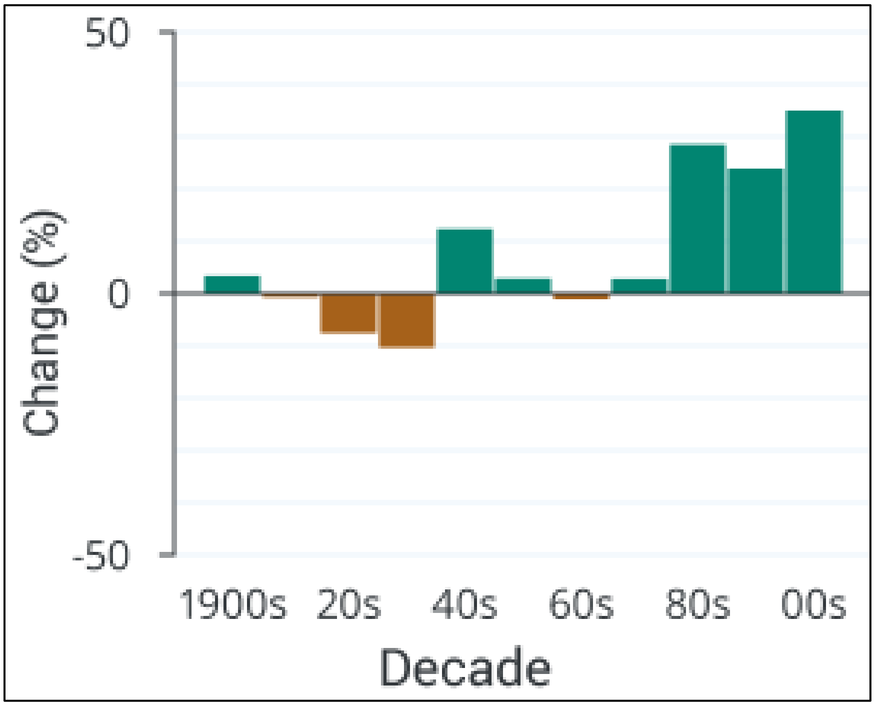

Figure 4.5-8. Percent changes in the annual amount of precipitation falling in very heavy events compared to the 1901–1960 average for the Midwest region including Iowa and Minnesota. A very heavy event is defined as the heaviest 1% of all daily events from 1901 to 2012. The far right bar is for 2001–2012 (Kunkel et al. 2013 as presented in Walsh et al. (2014b)).

Modeled Future Changes

Modeled climate through the year 2100 shows an increase in mean monthly precipitation under both moderate (RCP4.5) and high (RCP8.5) emission scenarios (Figure 4.5-9). Both the medium and high emission scenarios produce higher mean monthly precipitation compared to the baseline period, with an increase of approximately 2.6–4.3 mm (0.10–0.17 in) per month or 31.2–51.6 mm (1.23–2.03 in) per year by the 2040s, and 5.9–8.7 mm (0.23–0.34 in) per month or 71.5–104.4 mm (2.8–4.1 in) per year by the 2080s. The relationship between emissions scenario and precipitation varies with the future modeling period.

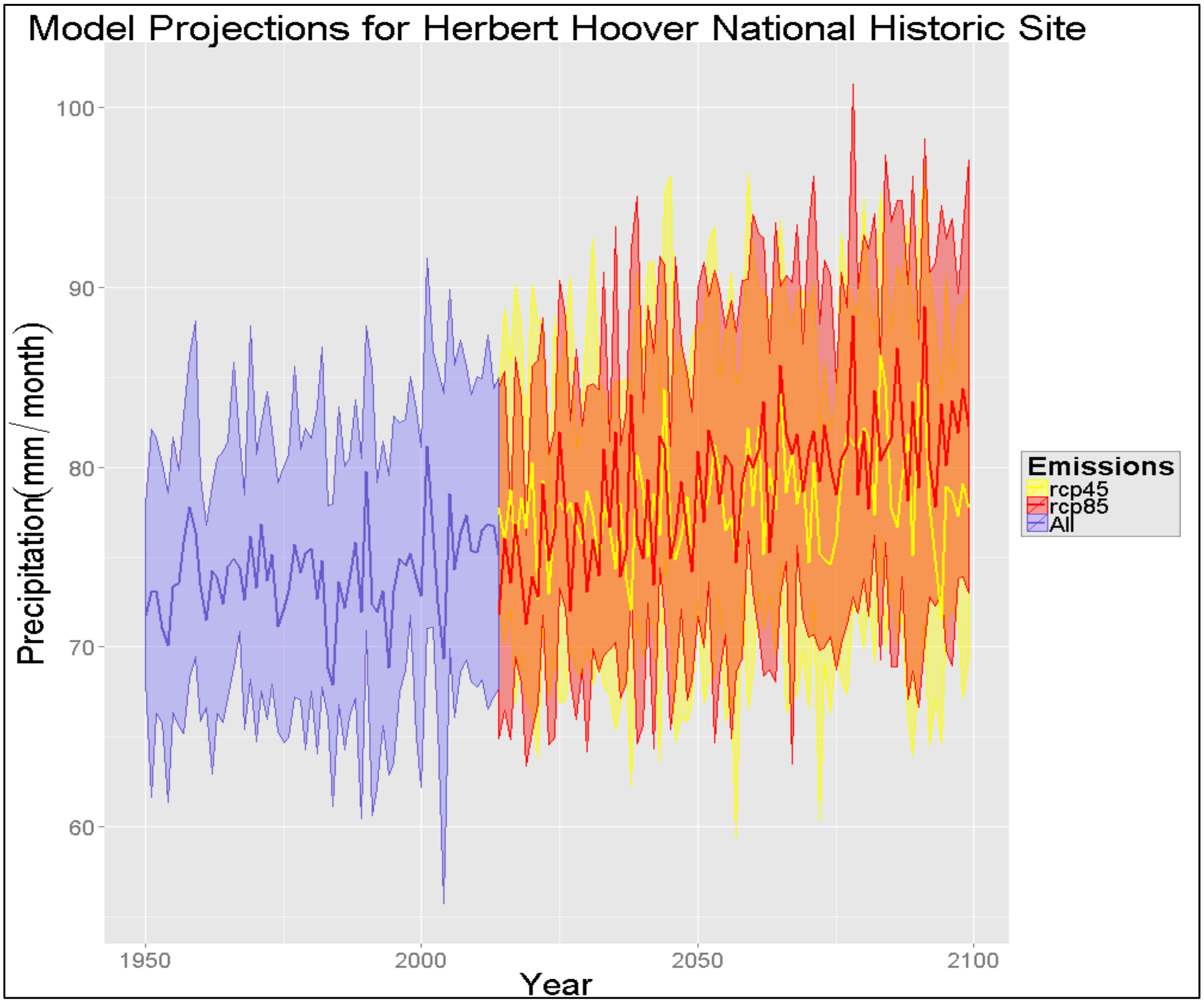

Figure 4.5-9. Projections for precipitation/month with mean, 25% and 75% quantiles grouped by emissions scenario for Herbert Hoover National Historic Site (Data and graphic prepared by NCCSC).

Aridity

Aridity and moisture availability is examined using the Palmer Drought Severity Index (Palmer 1965) for the historic 1940–2012 period. A climatic deficit index (The Nature Conservancy, University of Washington and University of Southern Mississippi 2014) is used to compare the 1961–1980 baseline with mid-century (2050) and end-century (2095) modeled values for medium (A1B) and high (A2) emission scenarios.

Historic Trends

Palmer Drought Severity Index (PDSI) values were calculated for the period from 1895 to 2012 (Figure 4.5-10). While drought is sometimes described as cyclic, the frequency and duration of cycles is highly unpredictable. For the period of record, HEHO PDSI data shows periodic moderate to severe drought lasting 2–5 years occurring once or twice per decade, including a drought in 2012. The most extreme drought events occurred in the early 1930s (the Dustbowl), the mid-1950s and the late 1980s.

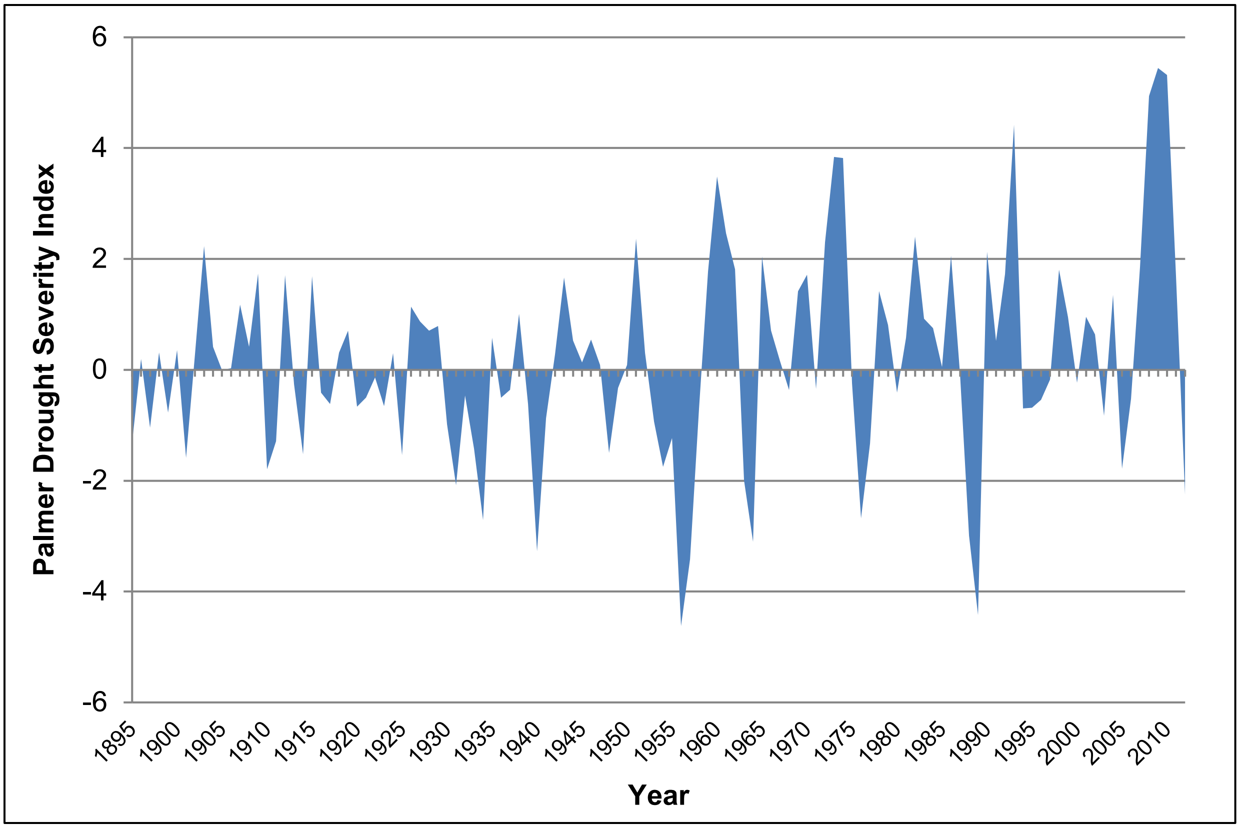

Figure 4.5-10. Palmer Drought Severity Index from 1940–2012 for Herbert Hoover National Historic Site. Negative values represent drought conditions and positive values represent moist conditions (NCDC 2013).

Modeled Future Changes

Moisture deficit results for Herbert Hoover National Historic Site were modeled using the Climate Wizard Custom Tools (http://climatewizardcustom.org/). Modeled results varied by emissions scenario and season and were highly variable across global circulation models. Under the moderate and high emissions scenarios, annual moisture deficit is projected to be approximately 67–69 mm (2.64–2.72 in) per year by 2050 and 156–195 mm (6.14–7.68 in) per year by 2095 (Figure 4.5-11). Seasonal changes were most evident for summer under both emissions scenarios. Annual summer season moisture deficits ranging from 49–59 mm (1.93–2.32 in) are forecast for medium and high-emission scenarios by 2095.

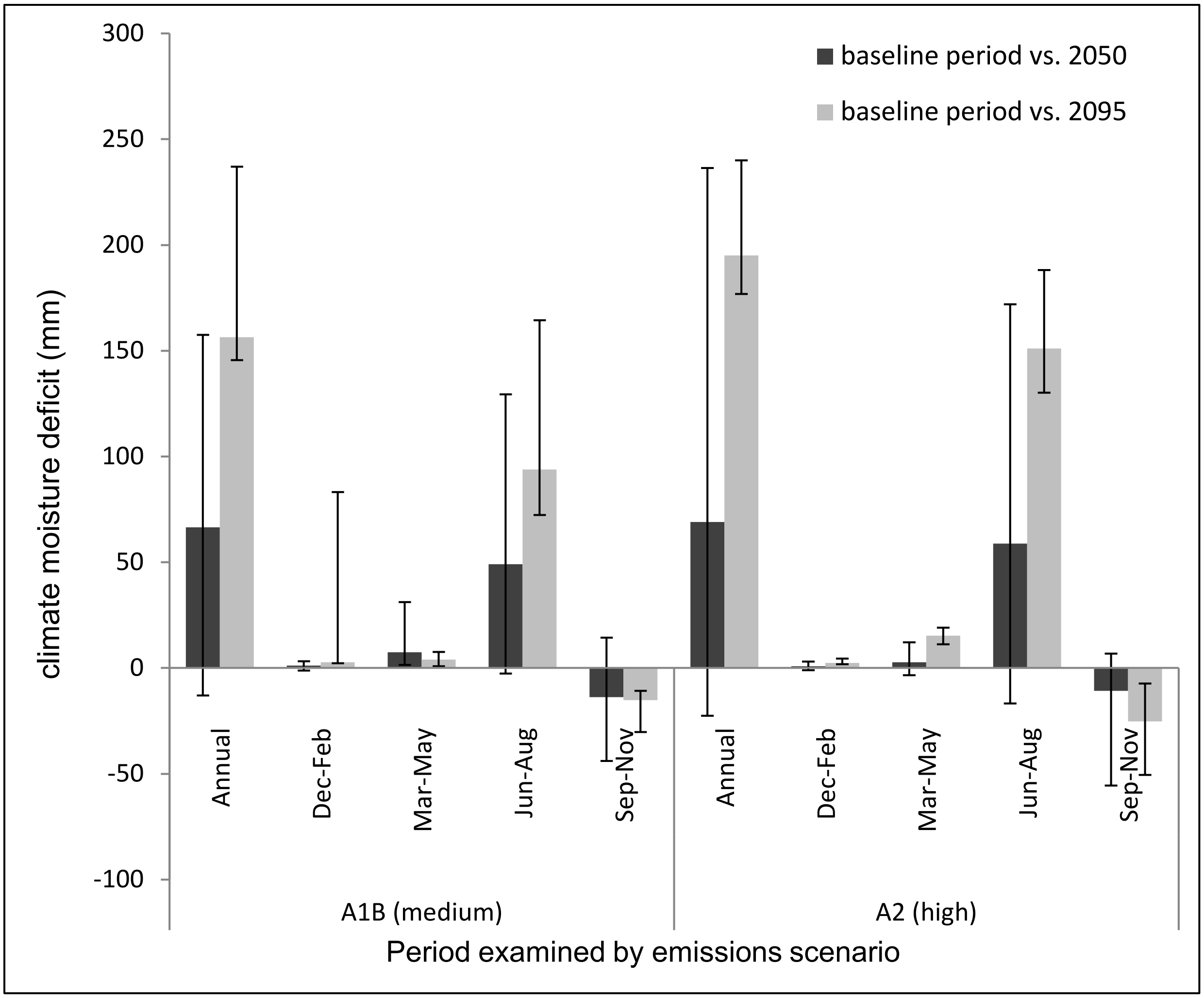

Figure 4.5-11. Annual and seasonal climatic moisture deficit for 2040–2060 and 2090–2099 compared to the baseline 1961–1980 period under two emission scenarios for a 30 X 30 km area surrounding Herbert Hoover National Historic Site. Higher positive values indicate increasing aridity. Median values with 25% and 75% quartile limits. Analysis was done using the Climate Wizard Custom tools (The Nature Conservancy, University of Washington and University of Southern Mississippi 2014). High positive values reflect drier conditions.

<u>Plant Phenology and Frost-Free Period</u>

Plant Phenology

Plant phenology serves as an excellent global warming indicator because it is one of the most readily observable ecosystem reactions to climate change (McEwan et al. 2011). Increases in temperature are responsible for plants flowering earlier in the spring and the delayed onset of dormancy in autumn. This affects not only synchrony among plants, pollinators and complex evolutionary adaptation, but can shorten (or lengthen) a plant's growing season. Phenology also plays an important role in the amount of water released to the atmosphere via evapotranspiration, sequestration of carbon in new growth, and the amount of nitrogen utilized from the soil (Ibanez et al. 2010).

Plant phenology in the park and surrounding area is primarily governed by a combination of plant genetics and the effects of weather and day length. If plant communities change due to management, disturbance, changing climate, or other drivers, then plant phenology may also change due to those compositional changes. For example, cool-season grasses such as smooth brome (*Bromus inermis*) tend to start growing earlier in the spring, reach maximum production and flower earlier compared to warm season grasses such as Indiangrass (*Sorghastrum nutans*). In a study of temperature changes and plant phenology in the northern Great Plains, Dunnell and Travers (2011) found that 5% to 17% of the species observed have significantly shifted their first flowering time either earlier or later relative to the previous century. Overall, they found that as spring temperatures in the northern Great Plains have increased and the growing season has lengthened, some spring flowering species have advanced their first flowering time, some fall species have delayed their first flowering, and some species have not changed (Dunnell and Travers 2011).

Although there is a plethora of collaborative scientific endeavors, high resolution spatial and temporal phenology data is generally unavailable for most locations. Approaches used to investigate the influence of global change on terrestrial plant and ecosystem phenology include species-level observation networks such as the USA National Phenology Network, remote sensing such as MODIS analysis used here, Eddy-covariance monitoring of carbon fluxes using recording stations, phenology modeling and plot-scale global change experiments. A review of the utility, limitations and temporal and spatial resolution of various methods is presented by Cleland et al. (2007).

Here we use a greenness index derived from MODIS imagery to characterize plant phenology. For the 11-year baseline period of record, the mean greenup date was April 4 (90% confidence interval of +/- 5.8 days), mean vegetation greenness peaked on July 21 (90% confidence interval of +/- 3.3 days) and mean onset of minimum greenness was November 19 (90% confidence interval of +/- 5.8 days) (Figure 4.5-12). The onset of greenup appears to be the most consistent among the metrics. Dates for maximum greenness were most consistent from year to year, followed by greenup dates and onset of minimum greenness. The distribution of annual values for the three metrics over the baseline period is show in Figure 4.5-13.

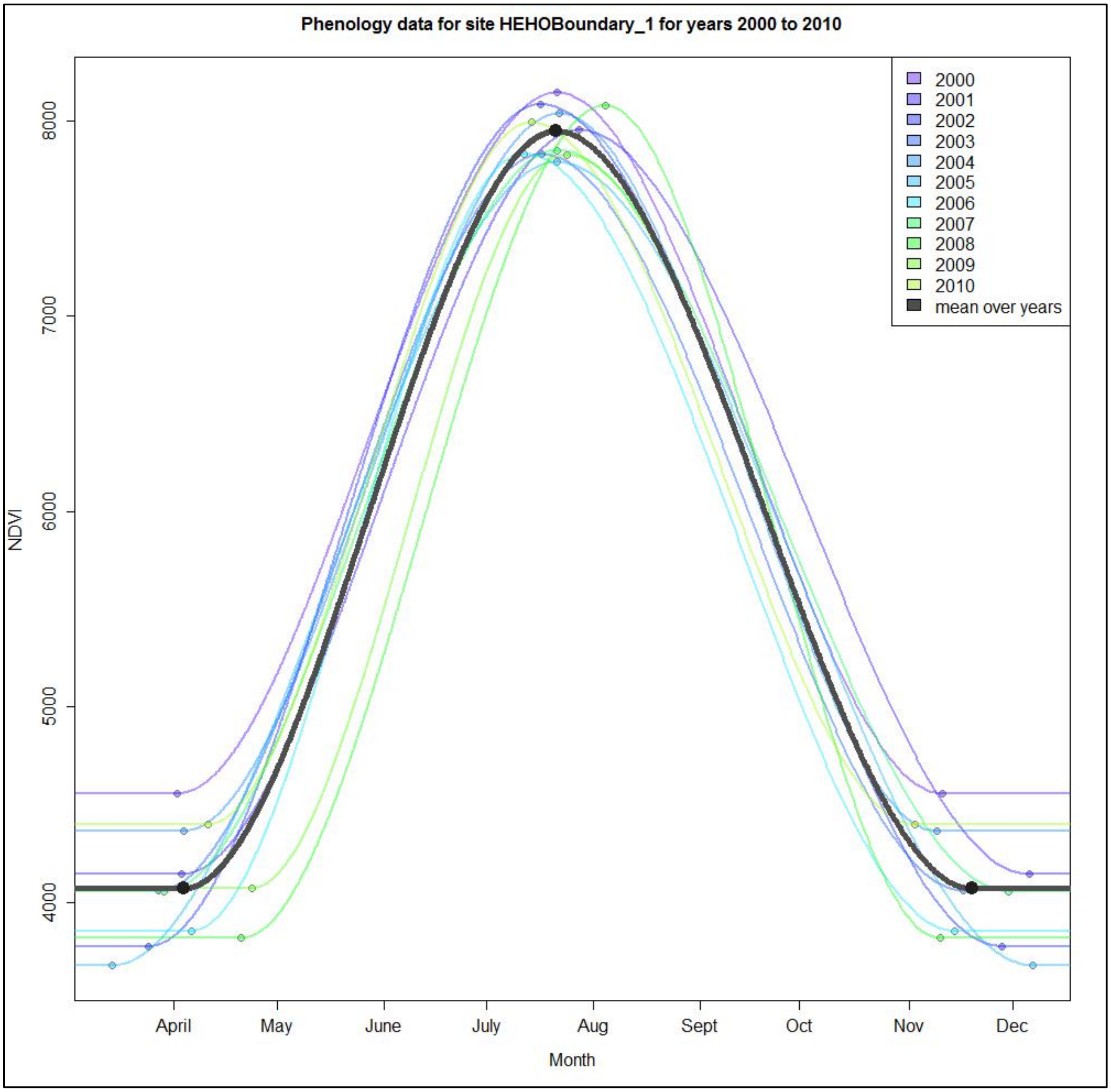

Figure 4.5-12. Phenology curves for Herbert Hoover National Historic Site based on MODIS imagery vegetation indices. The graph shows dates for greenup initiation (left), maximum greenness (center), and the end of vegetation senescence or onset of minimum greenness (browndown end) (right) for the period of record. Data visualization provided by Kevin James, Heartland I&M Network.

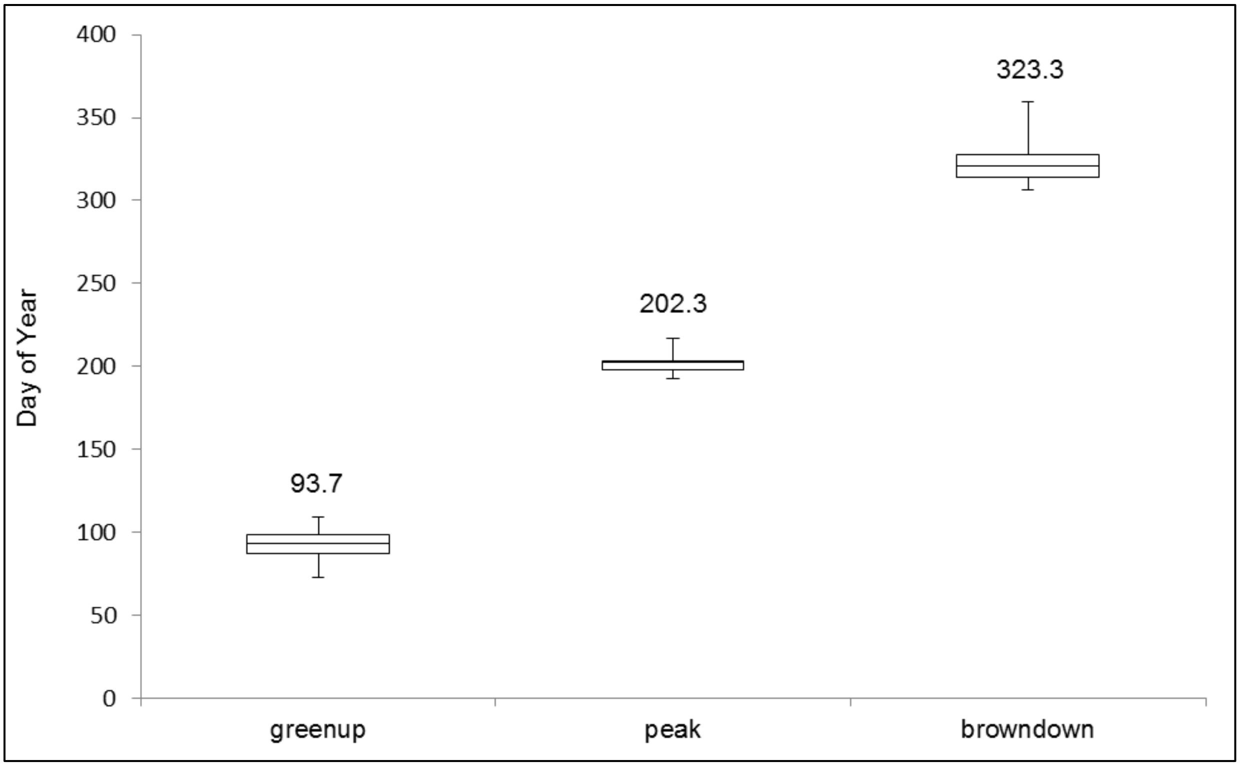

Figure 4.5-13. Box plots for the base period for dates associated with onset of vegetation greenup, maximum greenness and onset of minimum greenness, based on MODIS EVI data. Lines represent median values, boxes represent the limits of 25th and 75th percentile values and whiskers represent remaining values. Numbers above box plots are the means for each phenological period.

Frost-Free Period

The length of the frost-free season is a major determinant of the types of plants and crops that do well in a particular region. These observed climate changes are correlated with increases in satellite-derived estimates of the length of the growing season (Jeong et al. 2011). The frost-free season length, defined as the period between the last occurrence of 32°F in the spring and the first occurrence of 32°F in the fall, has been gradually increasing since the 1980s (USEPA 2013). The last frost in the spring has been occurring earlier in the year, and the first frost in the fall has been happening later. In the eastern Great Plains region, the average frost-free season for 1991–2011 was about 9–10 days longer than during 1901–1960 (Walsh et al. 2014b). A longer growing season can increase carbon sequestration in plants (Peñuelas et al. 2009) and increase the growth of both desirable and undesirable plants. In some cases where moisture is limited, greater evaporation and plant transpiration associated with the longer growing season can mean less productivity due to increased drying (Melillo et al. 2014).

By the 2070–2099 period, the frost-free season for the eastern Great Plains is projected to rise significantly as heat-trapping gas emissions continue to grow, increasing by 10–20 days under the lower emissions (B1) scenario and 30–40 days under the higher (A2) emissions scenario compared to the 1901–1906 baseline period (Melillo et al. 2014).

Overall Assessment

All indications are that the climate in this region is already becoming drier (despite increasing precipitation), hotter, and is more prone to more frequent and extreme weather events and drought. Trends in the indicators are projected to continue or accelerate by the end of the century. Because these changes in the environment are beyond the control of park managers and is not a conventional resource to be managed, climate change is not evaluated using the condition status and trend framework applied in this condition assessment. Research and monitoring related to climate change, the anticipated vulnerability of specific resources vis-a-vis climate change, and its associated effects on resources and interaction with other ecological processes can be informed by this broad overview of the magnitude of climate change in the park region.

4.5.5. Management and Ecological Implications

Changing climate is anticipated to impact Great Plains grasslands in a number of ways, and is likely to compound the effects of existing stressors to potentially increase the vulnerability of grasslands to pests, invasive species and loss of native species (NFWPCAP 2012). Species ranges and ecological dynamics are already responding to recent climate shifts, and current reserves including NPS units will be unable to support all species, communities and ecosystems (Heller and Zavaleta 2009), some of which form the core of their park mission. Some of the key anticipated ecological impacts and management implications of climate change in the tallgrass prairie region and HEHO include:

- Contraction of tallgrass prairie extent along the eastern boundary (Rehfeldt et al. 2008).
- Increased plant production in northern latitude and high altitude Great Plains rangelands and decreased plant productivity in the southern Great Plains (Morgan et al. 2008).
- Increases in invasive exotic plants (Morgan et al. 2008).
- Reduced water availability – projected annual and seasonal moisture deficits indicate that any increases in precipitation in the region are unlikely to be sufficient to offset overall decreases in soil moisture and water availability due to increase temperatures, increase water utilization and aquifer depletion (Karl et al. 2009). Water-dependent habitats are especially at risk due to increased evaporation resulting in altered aquifer and surface water dynamics (Bagne et al. 2012).
- More frequent extreme events such as heat waves, droughts and heavy rains (Karl et al. 2009), with heavier rainfall events likely in the northern and central areas (Kunkel et al. 2013) and increasing likelihood of flooding in the wetter, northern portions of the Great Plains (USEPA 2013).
- Limited ability for species and communities to adapt; the relatively flat terrain characterizing these grasslands increases vulnerability to climate change because species and habitats may be obliged to migrate long distances to compensate for temperature shifts. This challenge is exacerbated by the highly fragmented and altered agricultural landscape in the region (Bagne et al. 2013).
- A decrease in rainfall may lead to a net carbon loss in the system (IPCC 2007). Trees and shrubs show higher CO_2 responsiveness than do herbaceous plants, which may lead to increases in woody plants as atmospheric CO_2 rises (IPCC 2007).

- Climate change is likely to exacerbate existing stressors related to anthropogenic disturbances at landscape scales including energy development and agriculture that fragment the landscape and hinder species adaptation (Bagne et al. 2013, Shaeffer et al. 2014).

It is increasingly clear that given significant shifts in climatic variables, adaptation efforts will need to emphasize managing for inevitable ecological changes and concurrently adjusting some management objectives or targets (Stein et al. 2013). In a review of articles examining biodiversity conservation recommendations in response to climate change, Heller and Zavaleta (2009) synthesized conservation recommendations with regard to regional planning, site-scale management, and modification of existing conservation plans. They found that most recommendations offer general principles for climate change adaptation but lack specificity needed for implementation. Specific adaptation tools and approaches will undoubtedly help park managers with these challenges. Adaptation approaches need to be intentional, context-specific and based on a deliberative process, rather than structured around selecting from a generic menu of options (Stein et al. 2014).

While climate change cannot be controlled by the park, managers can take steps to minimize the severity of exposure to these changes and help conserve sensitive resources as the transition continues. An in-depth analysis of the effects of climate change on park natural resources goes beyond the scope of this NRCA. However, approaches for integrating climate change vulnerability into NRCAs are being examined (Jones et al. in prep.). Existing condition analyses and data sets developed by this NRCA will be useful for subsequent park-level climate change studies and planning efforts.

4.5.6. Uncertainty and Data Gaps

Climate change projections have inherently high uncertainty. Confidence is higher in modeled temperature dynamics and lower for modeled precipitation totals and seasonal patterns. The largest uncertainty in projecting climate change beyond the next few decades is the level of heat-trapping gas emissions (Walsh et al. 2014b). Information gaps to help manage resources and understand the repercussions of climate change to the park include the need for: 1) more specific, applied examples of adaptation principles that are consistent with uncertainty about the future; 2) a practical adaptation planning process to guide selection and integration of recommendations into existing policies and programs; and 3) greater integration of social science and extension of adaptation approaches beyond park boundaries (Heller and Zavaleta 2009).

4.5.7. Sources of Expertise

- Jeffrey Morisette, Director, DOI North Central Climate Science Center
- Marian Talbert, Biostatistician, DOI North Central Climate Science Center
- John Gross, Climate Change Ecologist, NPS Inventory and Monitoring Program National Office

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4.6. Fire Disturbance Regime

4.6.1. Background and Importance

According to *NPS Management Policies* (NPS 2006), natural resources in NPS units will be managed to preserve fundamental physical and biological processes, as well as individual species, features, and plant and animal communities. The 2006 *NPS Management Policies* specifically mentions the importance of restoring natural processes such as fire to areas that have been disturbed by fire suppression, as well as the importance of maintaining open areas in situations where they were formerly maintained by natural processes. Further principles and strategic guidelines governing the management of wildland fire on NPS parks are presented in *Director's Order #18: Wildland Fire Management* (NPS 2008). At Herbert Hoover National Historic Site (HEHO), fire is a critical natural process that is used in conjunction with other tools and techniques to restore the natural landscape and ethnographic character of the area, restore the tallgrass prairie ecosystem and manage introduced exotic plants and woody species.

Fire is one of the principal disturbances on the landscape at HEHO, both historically and currently, but settlement by European emigrants in the mid-1800s led to fire suppression in the region (NPS 2007). From a fire and fuels perspective, grazing by livestock and bison influenced the fire regime by reducing fuel accumulation and standing fuels. Currently there is no managed grazing at HEHO, although grazing by deer, other mammals and insects does occur. The role of fire and its importance to a healthy prairie ecosystem are well documented throughout the ecological literature (Anderson et al. 1970, Bragg and Hulbert 1976, Buell and Facey 1960, Hartnett et al. 1996, Wright and Bailey 1982). The tallgrass prairie system contains plant and animal communities that are characterized as fire-adapted or fire-dependent, requiring periodic episodes of fire to retain their ecological integrity. Under fire suppression, these communities can experience undesirable impacts such as unnatural successional trends, loss of habitat for fire-adapted plant and animal species, or vulnerability to unnaturally severe wildland fire (NPS 2006). Under the current park *Fire Management Plan* (NPS 2007) the park uses prescribed fires to favor native prairie vegetation. In conjunction with mechanical and chemical exotic vegetation control, fire helps to control the abundance of woody and invasive plants. The site is organized into eight burn units, counting Unit 5a as a separate unit (Figure 4.6-1).

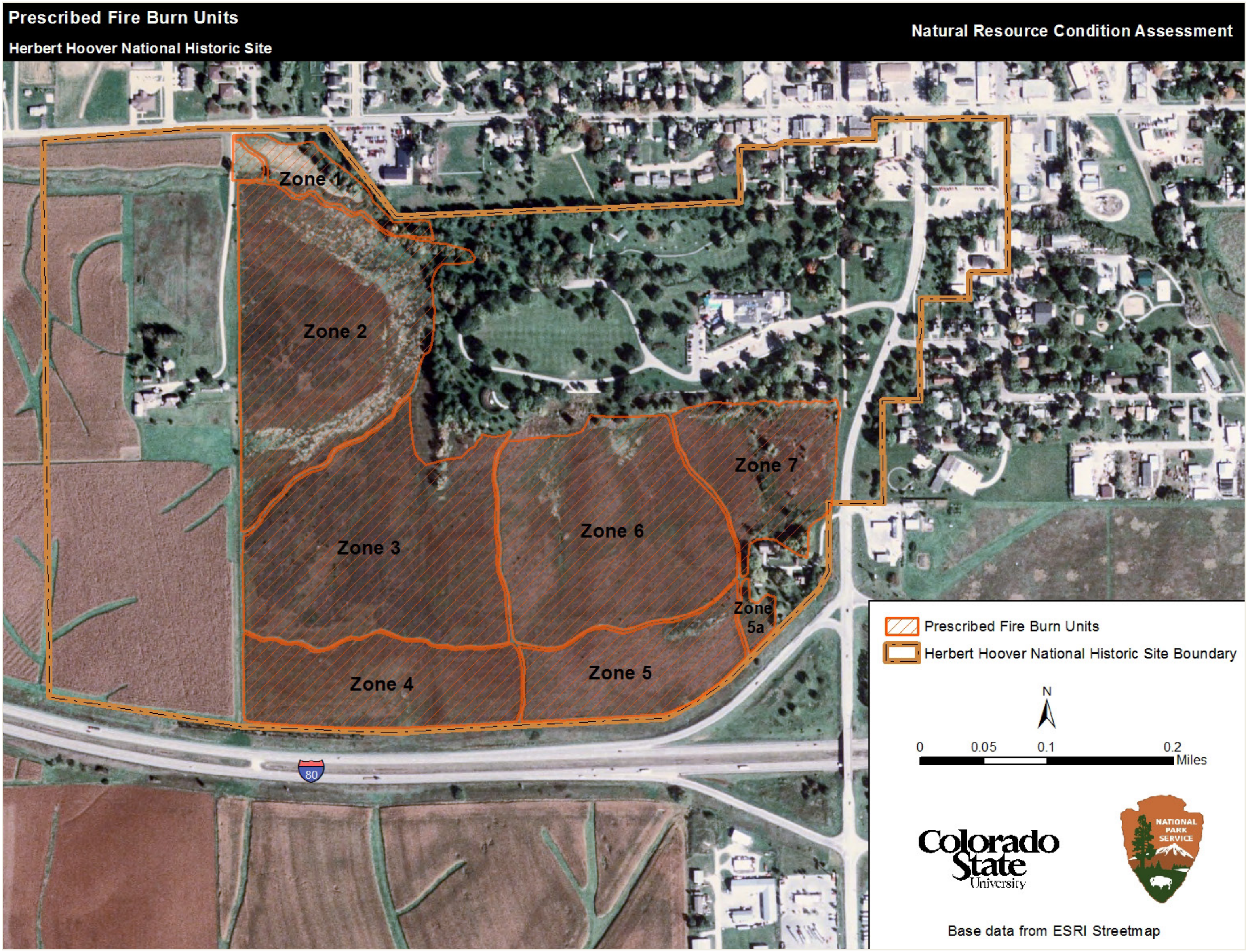


Figure 4.6-1. Herbert Hoover National Historic Site burn unit schematic (CUS, Esri Streetmap).

In recent years, scientists and land managers have recognized the importance of creating heterogeneity on the landscape to promote diversity, sustain species adapted to natural disturbance regimes, and foster a variety of faunal habitat structures (Wiens 1997, Fuhlendorf and Engle 2001, Reinking 2005). In tallgrass prairie, the primary disturbance agents of fire and grazing interact with other biotic and abiotic factors to maximize heterogeneity and species diversity on the landscape (Fuhlendorf et al. 2006, Hamilton 2007, Knapp et al. 1999). While ecosystem traits such as increased heterogeneity and mean species richness may benefit from synergistic effects of fire and grazing, even without grazing the ecosystem benefits from fire, and especially frequent fire, are clear (Hartnett et al. 1996, Bowles and Jones 2013). The strategy of creating a diverse and shifting mosaic of seral stages is healthy for the ecosystem and tends to benefit native flora and fauna (Gaetani et al. 2010).

The two fire seasons at the site are spring and fall. Although the Fire management Plan (NPS 2007) cites fall burns scheduled for the years 2007 and 2009, data were not available to confirm that fall burns took place. The burn units are typically burned on a 2–4 year rotation (dependent on the needs and condition of the burn unit) intended to include spring and fall burns. Managed fire frequency aims to be shorter than the historical average (Wright and Bailey 1982) to prevent and reduce exotic and woody vegetation during prairie restoration (NPS 2007). Mowed lines are established prior to each burn to prevent accidental ignition of non-target areas. Individual burn plans are prepared and approved for the implementation of each prescribed fire. All wildland fires are immediately suppressed.

Fire Regime Components

As a natural process and disturbance agent, fire is often used by land managers to introduce the ecological benefits of fire. Fire directly and indirectly influences a number of the focal resources addressed in this assessment, including prairie vegetation, invasive exotic plants, faunal resources, views and scenery, and cultural use and resources. As such fire is perhaps the most influential ecological driver within the park. The fire regime is characterized by fire frequency, seasonality, extent and severity.

Fire Frequency

Before the arrival of European agriculture, fires on the Great Plains often covered vast areas with much of the burned area far from the ignition source due to the long distances that a fire could burn uninterrupted through the ample and unbroken fuels. The frequency of lightning-caused fires in the region is relatively low and therefore most presettlement and post-settlement fires are thought to be of anthropogenic origin (Schroeder and Buck 1970). Historic fire frequency was high, with average return intervals estimated to be less than 10 years (Guyette et al. 2010, Wright and Bailey 1982). Landscape fragmentation resulting from modern agricultural practices and urban development have virtually eliminated landscape-level fire spread and thus vastly reduced the fire frequency on prairie remnants.

Lack of frequent fire in tallgrass prairie usually results in increased woody encroachment (Bragg and Hulbert 1976, Briggs et al. 2002, Bowles and Jones 2013). Conversely, high frequency fire with return intervals of two years or less over the course of a decade or more may decrease species richness (Davison and Kindscher 1999; Collins et al. 1995, 2002), though it should be noted that some species richness arises from undesirable species. High frequency fire may also help control some invasive species (Smith and Knapp 1999). The relationship between fire and undesirable species has led many land managers to use a fire frequency of less than 5 years in the northern Great Plains to control woodies and minimize their encroachment into the prairie.

Fire Seasonality

The timing of burns plays a role in determining vegetation responses (Towne and Owensby 1984, Engle and Bidwell 2001, Towne and Kemp 2003). The timing of the burn in relation to plant growth stage may influence the abundance or expression of plant guilds. In general, species that are actively growing, flowering, or setting seed at the time of fire tend to decline over repeated applications during this point in their phenology. Species that benefit most from fire are usually those that are just beginning to grow (Davison and Kindscher 1999). The response of woody plants to season of burning is unclear. Burning during drought or during seed set may result in slow post-fire recovery (Pyne et al. 1996). Some evidence suggests that late summer burns promote subdominant species such as some forbs without compromising the vigor of dominant warm-season grasses (Copeland et al. 2002) and may favor early flowering species that would otherwise be eliminated by competition from large, late flowering C4 grasses (Howe 1994, 1995, 2000).

Prior to European settlement, fire generally escalated during drought years (Anderson et al. 1970). The fire season covered many months (Anderson et al. 1970, Knapp and Seastedt 1998) and fires on the Great Plains were possible for much of the year due to both anthropogenic and natural causes (Bragg and Hulbert 1976, TPNPERC 2005). Large fires, which accounted for most of the acreage burned, were restricted to those periods when fuels were dry across vast acreages allowing fires to spread unimpeded (Wright and Bailey 1982).

Seasonality of prescribed burn programs is often determined by containment considerations and often differs from presettlement seasonality of burns. Spring fires are often easier to conduct successfully compared to other seasons due to high soil moisture and frequent rains. However, the traditional burn season of February to April has some of the fewest hours per day available to conduct prescribed burns (Weir Undated). Managers consider a host of factors when determining burn timing such as target plant phenology, prescription weather, local events, acceptance of fire, and availability of operational crews.

Fire Severity

Fire severity during prescribed grassland fires is usually low due to moderate weather conditions, limited fuel and the relatively short residence time of the fire as it passes over any given point on the landscape. However, energy output from a fire at the high end of this range may be as much as four times that of a fire at the low end (Engle et al. 1993, Ewing and Engle 1988). In prairie ecosystems, fire severity will increase as fuel loads increase with time since burn and where shrubs encroach.

Fire Extent

The extent of historic fires on the prairie landscape varied widely. Almost all fire regimes exhibit a power law probability distribution of fire size versus number of fires; the vast majority of fires are very small and only a handful of fires are very large (Cui and Perera 2008). However, the acreage accounted for by the few large fires accounts for the vast majority of all acres burned and therefore these few large fires are of outsized important to the overall fire regime.

Burn size is important in part because of its effect on encroachment, particularly of woody species. Prairie remnants with stands of woody species close by will experience higher rates of seeding from undesirable species. HEHO's small size allows managers to burn most of it relatively completely, reducing unburned pockets available to woody species. This helps to prevent seeding and subsequent encroachment, easing the burden of woody species control.

In terms of present day fire management, bigger fires are not always better, and fires of the extent of 200 years ago no longer occur. The park is an island of prairie surrounded for miles by agricultural land. Therefore, the needs of prairie species must be met to the greatest extent possible using habitat within the park boundaries, necessitating management of a mosaic of communities and seral/structural stages on a much smaller geographic scale than would have occurred in pre-settlement times. For these reasons, fire extent is not evaluated here as an indicator of condition.

<u>Implications of Climate Change on Fire Regime</u>

The effects of changing climate on the fire regime and fire-related ecological effects at the park have not been modeled or examined in detail. A comprehensive summary of historic climate variation and climate change projections for the park and surrounding area is presented in Section 4.5 Results for precipitation, temperature, aridity, and growing season vary by emissions scenario, future time period and sometimes by season. In general, the climate at HEHO is forecast to become hotter and wetter compared to the current climate, but increased temperatures are anticipated to more than offset the increase in precipitation. Both minimum and maximum temperatures are expected to increase by approximately 1–2 °C by 2050, and by approximately 2–5 °C by 2080, depending on the emissions scenario. Precipitation is projected to increase by approximately 2.6–4.3 mm (0.1–0.17 in) per month or 31.2–51.6 mm (1.23–2.03 in) per year by the 2040s. Very heavy rainfall events are projected to become more frequent. As an index of drought, annual summer season moisture deficits ranging from 67–69 mm (2.64–2.72 in) compared to historic baseline conditions are forecast for medium and high-emission scenarios by 2095. It is getting significantly warmer earlier in the spring and the growing season is projected to lengthen by 10–40 days per year depending on the emissions scenario.

Specific implications of climate change on the park's fire regime and fire management cannot be predicted with a high level of confidence, but some generalizations and likely scenarios merit discussion. Wildland fire in the region surrounding the park is virtually non-existent. Small-scale prescribed burning outside the park occurs occasionally on private and public lands. The fire regime at the park is highly managed and driven by prescribed fire events planned for specific dates within burn units of a defined size and location. Therefore, it seems unlikely that the fire return interval would be affected by climate change. Prescribed burns in the park are currently conducted only during fuels and weather conditions meeting a burn prescription window (i.e., acceptable range of temperature, humidity, wind and fuel conditions) to minimize the chance of fires getting out of control or producing unwanted smoke. Similar prescription windows would be applied in the future. Therefore, future fire intensity and severity would likely be similar to current fire intensity and severity. Severity of later summer burns may increase since severity is affected by soil moisture. The most significant management implication of climate change may be that prescribed burning prescription windows may become smaller and/or fewer in number as minimum and maximum temperatures rise and relative humidity declines. These changing factors would make it more difficult for the park to reach prescribed burn acreage/frequency objectives, especially when the park is scheduling burns supported by non-resident crews well ahead of the scheduled burn. Summer and late summer/fall burns may also be more difficult to schedule with smaller prescription windows, or periods meeting prescription may occur earlier or later in the year.

Threats and Stressors

- Virtual elimination of fire outside of the park reduces the possibility of fire spread into the site.
- Continued alteration of the natural fire regime within the park, which now emphasizes a moderate fire frequency and low fire severity with little temporal and spatial variation.
- Encroachment of development outside the site boundary that may place additional constraints on burning due to fire risk and smoke.

Indicators and Measures

- Fire frequency
- Fire seasonality
- Fire severity

4.6.2. Data and Methods

Fire history from park records is used to examine fire regime indicators and determine the overall fire regime within the period of record. No empirical data is available prior to the start of park records, however there are voluminous anecdotal descriptions of the pre-settlement fire regime of the Great Plains and other grassland ecosystems from historic journals, newspaper articles, and other sources that have since been compiled and corroborated by current research.

Data were obtained from the park and the Heartland I&M Network. Current fire data are limited to the year, size, and generalized season of the fire (winter, spring, summer, or fall). Thus, analysis of current fire management is limited to fire return interval (i.e., fire frequency), seasonality, and extent of burning within park boundaries and fire severity is extrapolated from these data.

4.6.3. Reference Conditions

The pre-settlement fire regime, based on published literature, is used as the reference condition for assessing condition status and trend of the fire regime. Achieving a good condition rating under present day land management pressures may not be feasible for a variety of reasons. These include conflicting management objectives, relationships with the wide variety of stakeholders involved with most National Parks, smoke management and fire containment concerns, budgetary issues, and management of rare species as well as invasive species. Nonetheless, the presettlement fire regime is documented to have been well suited to maintaining the biotic and abiotic elements of a healthy and functional prairie ecosystem and no alternative regime has been demonstrated to achieve the same benefits. The condition rating framework for fire indicators at Herbert Hoover National Historic Site is shown in Table 4.6-1.

Table 4.6-1. Condition rating framework for fire indicators at Herbert Hoover National Historic Site.

Indicator	Good Condition	Warrants Moderate Concern	Warrants Significant Concern
Fire frequency	• Mean fire return interval for all burn units ≤ 5 years • Fire return interval regularly varies within and among burn units	• Mean fire return interval for all burn units 6–10 years • Fire return interval occasionally varies within and among burn units	• Mean fire return interval for all burn units > 10 years • Little or no variation in fire frequency within and among burn units
Fire seasonality	• Season of most burns executed within historic range (March through October) • Season of burns regularly varies within and among burn units	• More than ¼ of burns executed outside of historic range • Seasonality of burns occasionally varies within and among burn units	• More than ½ of burns executed outside of historic range • Little or no variation in seasonality of burns within and among burn units
Fire severity	• Burns occasionally result in moderate to high burn severity	• Burns very rarely result in moderate to high burn severity	• No burns result in moderate to high burn severity

4.6.4. Condition and Trend

Fire Frequency

The park currently burns a portion of the site nearly every year. Within the period for which data is available, starting in 1984, the fire return interval was generally four years or less, which compares well with the reference condition (Figures 4.6-2 and 4.6-3).

Fire return interval currently varies within and among burn units (Figure 4.6-4). Unit 1 has the lowest variability while other units have moderate to high variability. Overall, there is good variability spatially, with different burn units receiving differing fire return intervals. There are notable gaps in fire application (Figure 4.6-5), and this helps to reproduce some of the variability in fire return interval that was likely present during the reference condition. In regard to temporal variability, there appears to be a tendency to burn at 1 or 2 year intervals as these two intervals account for 72% of all fire return intervals. These results indicate the resource is in good condition with an unchanging trend.

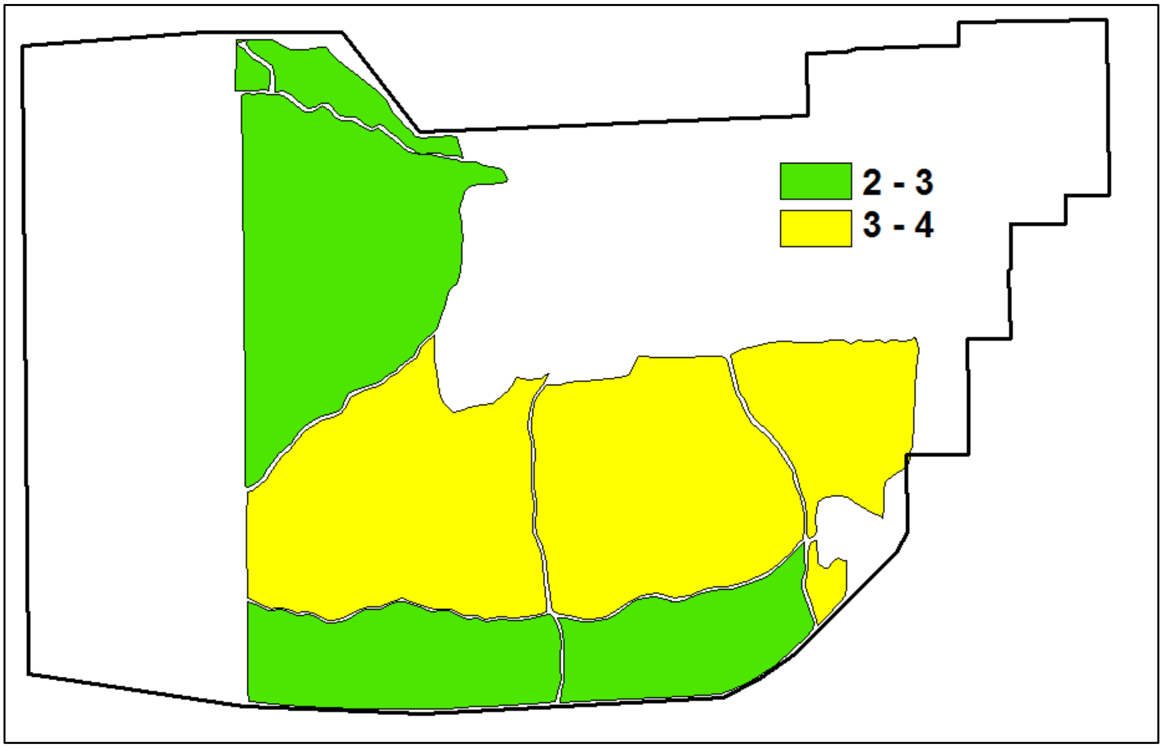


Figure 4.6-2. Average fire return interval, in years, from 1984 to 2011 (IMRO and HTLN; data calculated by CSU).

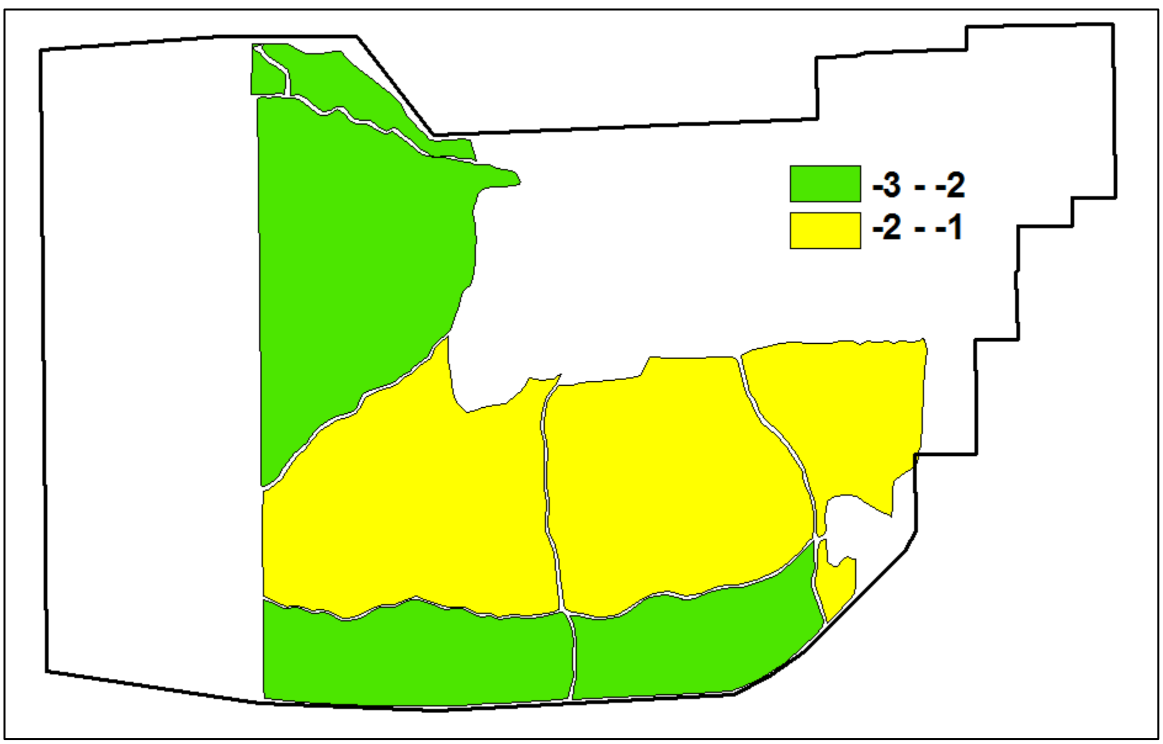


Figure 4.6-3. The reference return interval (5 years) subtracted from the average return interval (IMRO and HTLN; data calculated by CSU).

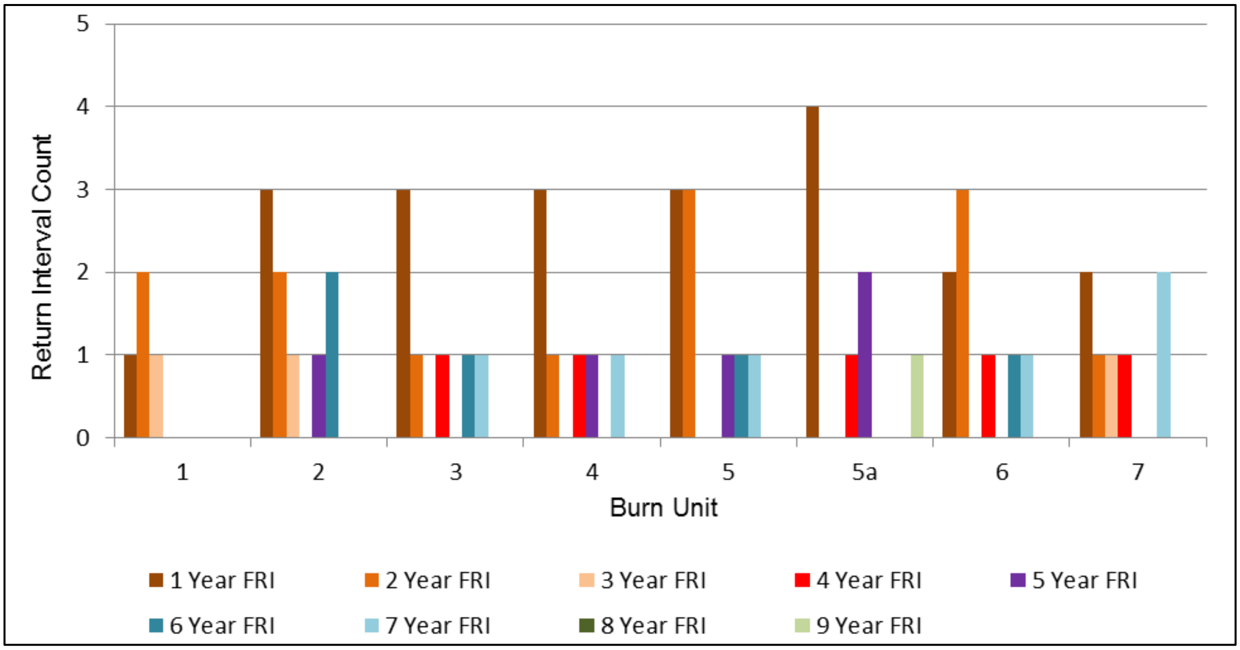


Figure 4.6-4. The count of return interval frequency in each burn unit of HEHO from 1984 to 2011. FRI = fire return interval (IMRO and HTLN; data calculated by CSU).

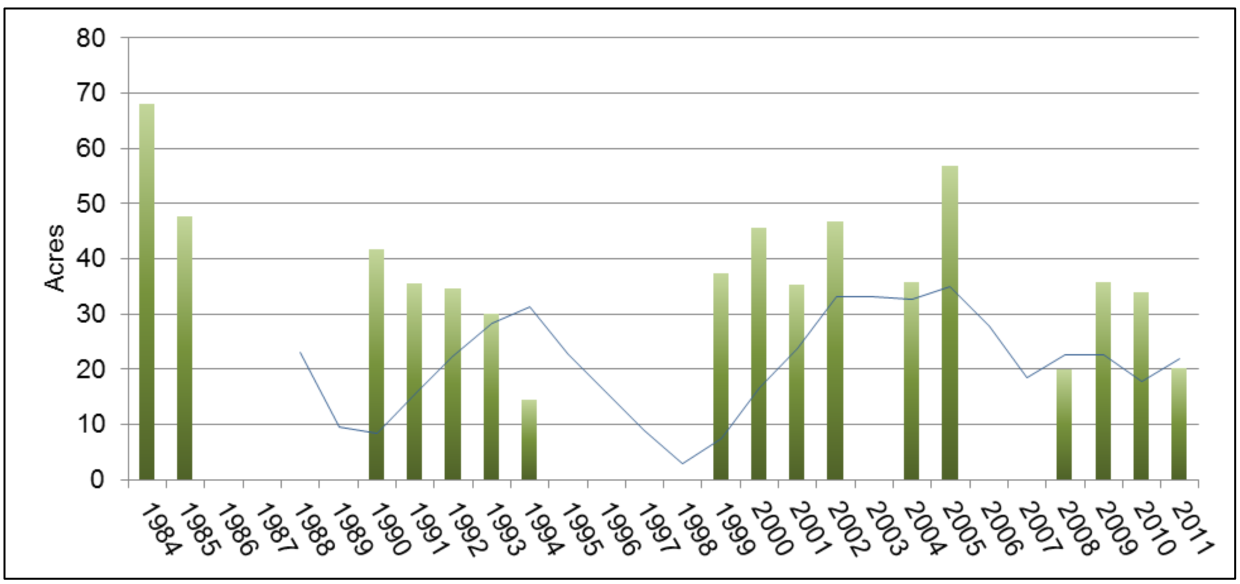


Figure 4.6-5. Average number of acres burned per year (bars) and the five year moving average (line) (IMRO and HTLN; data calculated by CSU).

<u>Fire Seasonality</u>

At HEHO, virtually all burns occur during the spring and early summer months with almost no variability in fire season. This will tend to benefit warm season grasses at the expense of cool season grasses and some forbs (Towne and Kemp 2003, Towne and Owensby 1984) and likely differs from the variability in seasonality of burn that was experienced under reference conditions. This indicator warrants moderate concern relative to the reference condition, with an unchanging trend.

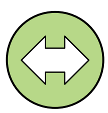
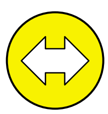
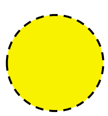
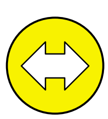
Fire Severity

There is no data with which to assess fire severity although it can be assumed that fire severity will increase with time since fire. Given that burn frequency generally falls within the range of the reference condition, it can be extrapolated that burn severity is probably consistent with the reference condition of mostly low to moderate burn severity. However, this also means that if fires were in prescription that they were planned to be of low intensity if the prescription was for low winds, moderate humidity and moderate temperature. The inferred lack of significant variability in fire severity warrants moderate concern for this indicator with an unknown trend due to lack of data.

Overall Rating

Overall, the condition of the fire regime warrants moderate concern with an unchanging trend (Table 4.6-2). Fire regime components vary in their ability to meet reference conditions for the site. Although fire frequencies generally fall within the desired range, variability in the seasonality of fire may limit the restoration benefits and reduce heterogeneity within the prairie. Administrative challenges and inconsistent funding of prescribed burn management may adversely affect the condition of this resource over time. Proximity to urban areas and Interstate 80 create public health and safety concerns related to smoke associated with burning. While fire is the preferred tool, there will continue to be limits to its use at HEHO, and continued or expanded use of techniques and tools such as haying, herbicides and manual/mechanical control of woody plants will likely be necessary.

Table 4.6-2. Condition and trend summary for fire regime at Herbert Hoover National Historic Site.

Indicator	Condition Status/Trend	Rationale
Fire frequency		Results indicate the fire return interval over the past several decades has been within the range of the reference condition. There is moderate variability in the fire frequency within and among burn units.
Fire seasonality		Data is complete but coarse. The timing within a season is important to post-fire responses. The current spring-only burning program probably conflicts with more variable burn timing in the reference condition. There is a lack of variability in the seasonality of burning.
Fire severity		Data related to fire severity does not exist. Extrapolated data suggests that fire severity falls within the range of the reference conditions. However, conservative fire prescription windows to minimize the risk of fires escaping or endangering property and health are characterized by conditions that produce low to moderate severity. Therefore, high-severity fires are likely occurring less often than under presettlement conditions. Data is not available to assess the current trend.
Overall Condition Status and Trend for Fire Regime		**The condition of the fire regime warrants moderate concern with an unchanging trend. Confidence in the assessment is medium due to missing or coarse data regarding fire seasonality and severity.**

4.6.5. Uncertainty and Data Gaps

There is no burn data after 2011. It is unknown whether burning has continued in the interim. There is no way to assess burn severity from the existing data.

4.6.6. Sources of Expertise

- Sherry Leis, Fire Science Program Leader and Heartland Inventory and Monitoring Network Cooperator, Missouri State University Biology Department, Springfield, Missouri. Ms. Leis provided helpful reviews on manuscript organization and content and reference condition concepts.

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4.7. Air Quality

4.7.1. Background and Importance

The NPS Organic Act, *Air Quality Management Policy 4.7.1*, and the Clean Air Act of 1977 and its subsequent amendments protect and regulate the air quality of the National Parks within the United States. The NPS is responsible for protecting air quality and related issues which may be impacted by air pollution. Many resources in parks can be affected by air pollution. For example, scenic vistas require good visibility and low haze. Human-made pollution can harm ecological resources, including water quality, plants and animals. Air pollution can also cause or intensify respiratory symptoms for visitors and employees at NPS areas. Because of these many links, poor and/or declining air quality can impact park visitation. A synthesis of seven visitor studies conducted in the NPS Midwest Region found that clean air was ranked as *extremely important* or *very important* by 88% of visitor groups (Kulesza et al. 2013).

National Park Service units fall under two different classifications for air quality protection. Class I airsheds are defined as national parks over 6,000 ac (2,428 ha), national wilderness areas, national memorial parks over 5,000 ac (2,023 ha), or international parks in existence as of August 7, 1977 (NPS ARD 2013b). Class II airsheds are areas of the country protected under the Clean Air Act, but identified for somewhat less stringent protection from air pollution damage than a Class I area, except in specified cases (NPS ARD 2013b). Based on this classification, HEHO falls under the Class II area of protection.

Air quality can have a significant impact on the vegetation and ecology of an area. The NPS Air Resources Division describes ground-level ozone as having a larger effect on plants than all other air pollutants combined (NPS ARD 2012a). Nitrogen (ammonia – NH_4) and sulfur (sulfate – SO_3) deposition can cause acidification of water bodies, while excess nitrate (NO_3) can lead to nutrient effects on biodiversity. Decreased visibility from haze does not affect the ecology of an area so much as it affects the human element through decreased viewing opportunities of the protected lands and surrounding areas.

As of December 2012, the HEHO area was not listed by the EPA as an area of nonattainment for any air quality indicators, although it is near Muscatine County, IA, which is listed for SO_2 nonattainment (EPA 2013). HEHO experiences “High” exposure to atmospheric Nitrogen (N) enrichment and has been described as being at moderate risk from N enrichment (Sullivan et al 2011a). HEHO also has “High” exposure to acidic deposition from Sulfur (S) and N emissions and has been described as being at moderate risk from acidic deposition (Sullivan et al 2011b).

<u>Threats/Stressors</u>

The Iowa Environmental Council (IEC) cites the following as threats to Iowa air quality: fine particulate matter, greenhouse gas emissions, ammonia, air toxics, and livestock facility emissions (IEC 2014).

<u>Indicators and Measures</u>

- Level of ozone

- Atmospheric wet deposition in total N and total S
- Visibility haze index

4.7.2. Data and Methods

The NPS Air Resources Division (ARD) has produced an interactive Air Atlas that shows the 5-year interpolated values for ozone, atmospheric deposition, and visibility at each NPS unit across the contiguous US. Interpolated values for ozone, wet deposition, and visibility were used to assess the air quality condition at HEHO. The NPS ARD Air Atlas provides the best air quality information for HEHO.

The NPS ARD (2013c) published the trends and conditions of air quality at all NPS properties using data from 2000–2009 and 2005–2009, respectively. The NPS ARD report used a non-parametric regression technique known as the Theil Method to determine ozone, deposition, and visibility trends using yearly data. Although the five-year averages may appear to have some trends, these are not always supported by the annual values. Currently, there are no monitoring stations for ozone, wet deposition, or visibility located within HEHO. Monitoring data originates from regional monitoring stations and interpolated values. The nearest ozone monitoring station is located in Cedar Rapids, Iowa, about 25 mi west of HEHO. Wet deposition is monitored at Monmouth, Illinois, 55 mi south of HEHO (NPS ARD 2001). There are no Interagency Monitoring of Protected Visual Environments (IMPROVE) visibility monitoring stations within 100 mi of HEHO (NPS ARD 2001).

4.7.3. Reference Conditions

Reference conditions are based on USEPA standards or have been recommended by NPS ARD (2013a). A summary of reference conditions and condition class ratings for air quality indicators is shown in Table 4.7-1.

Table 4.7-1. Reference condition framework for air quality indicators (NPS ARD 2012a, NPS ARD 2012b, NPS ARD 2012c).

Air Quality Indicator	Good Condition	Moderate Condition	Poor Condition
Ozone	≤ 60 ppb	61–75 ppb	≥ 76 ppb
Wet deposition (total N and total S)	<1 kg/ha/yr	1–3 kg/ha/yr	> 3 kg/ha/yr
Visibility	< 2 dv	2–8 dv	> 8 dv

Ozone

The EPA's standard benchmark for protecting human health is 75 parts per billion (ppb) of ozone, averaged over an 8-hour period. The 3 year average of the annual 4th highest daily maximum 8-hour average ozone concentration must not exceed the 75 ppb mark to meet the EPA standard. The NPS ARD utilizes the five-year averages of 4th highest daily maximum 8-hour ozone concentrations for parks within the contiguous United States (NPS ARD 2013a).

The NPS ARD ranks ozone conditions as good if levels are less than or equal to 60 ppb, moderate between 61–75 ppb, and poor if levels are greater than or equal to 76 ppb (Table 4.7-1) (NPS ARD 2013a).

Wet Deposition

The NPS ARD considers parks which receive less than 1 kg/ha/yr each of nitrogen and sulfur as being in good condition. Parks receiving between 1–3 kg/ha/yr are ranked as moderate condition. Those parks which receive greater than 3 kg/ha/yr are ranked as poor condition (Table 4.7-1) (NPS ARD 2013a).

Visibility

Visibility is measured using the Haze Index in deciviews (dv). Visibility conditions are the difference between average current visibility and estimated average natural visibility, where the average natural visibility is the mean between the 40^{th} and 60^{th} percentiles (NPS ARD 2013a). Five-year interpolated averages are used in the contiguous US. Visibility is considered to be in good condition if visibility is less than 2 dv, moderate condition if between 2–8 dv, and poor condition if greater than 8 dv (Table 4.7-1) (NPS ARD 2013a).

4.7.4. Condition and Trend

Condition status ratings for air quality indicators are summarized in Table 4.7-2.

Table 4.7-2. Condition status results for 5-year means between 2001 and 2010 for air quality indicators at HEHO (NPS ARD 2012a, NPS ARD 2012b, NPS ARD 2012c).

Averaged 5-year Period	Ozone (ppb)	Total N (kg/ha/yr)	Total S (kg/ha/yr)	Visibility (dv)
2006–2010	65.1 (moderate)	5.6 (poor)	3.4 (poor)	10.6 (poor)
2005–2009	66.5 (moderate)	5.9 (poor)	3.7 (poor)	11.5 (poor)
2004–2008	67.1 (moderate)	6.1 (poor)	3.9 (poor)	11.9 (poor)
2003–2007	68.6 (moderate)	6.3 (poor)	4.3 (poor)	11.6 (poor)
2001–2005	70.0 (moderate)	6.4 (poor)	4.3 (poor)	9.7 (poor)

Ozone

Ozone is known to impact vegetation and human health and is a concern at many NPS units. There are 9 plant species identified within HEHO that are sensitive to ozone (Table 4.7-3). Ozone is able to enter leaves through stomata and causes chlorosis and necrosis of leaves (Figure 4.7-1), among other problems. Soil moisture plays a big role in the uptake of ambient ozone. Moist soils allow plants to transpire and increase stomatal conductance which, in turn, increases ozone uptake (Panek and Ustin 2004). Ozone causes problems for humans as well, including difficulty breathing, chest pain, coughing, inflamed airways, and making lungs more susceptible to infection (EPA 2012).

Table 4.7-3. HEHO plant species sensitive to ozone (NPS ARD 2003; NPS ARD 2004).

Scientific Name	**Common Name**
Asclepias syriaca	Common milkweed
Fraxinus pennsylvanica	Green ash
Parthenocissus quinquefolia	Virginia creeper
Cercis canadensis	Redbud
Sambucus Canadensis	American elder
Platanus occidentalis	American sycamore
Robinia pseudoacacia	American elder
Prunus serotina	Black cherry
Rubus allegheniensis	Allegheny blackberry

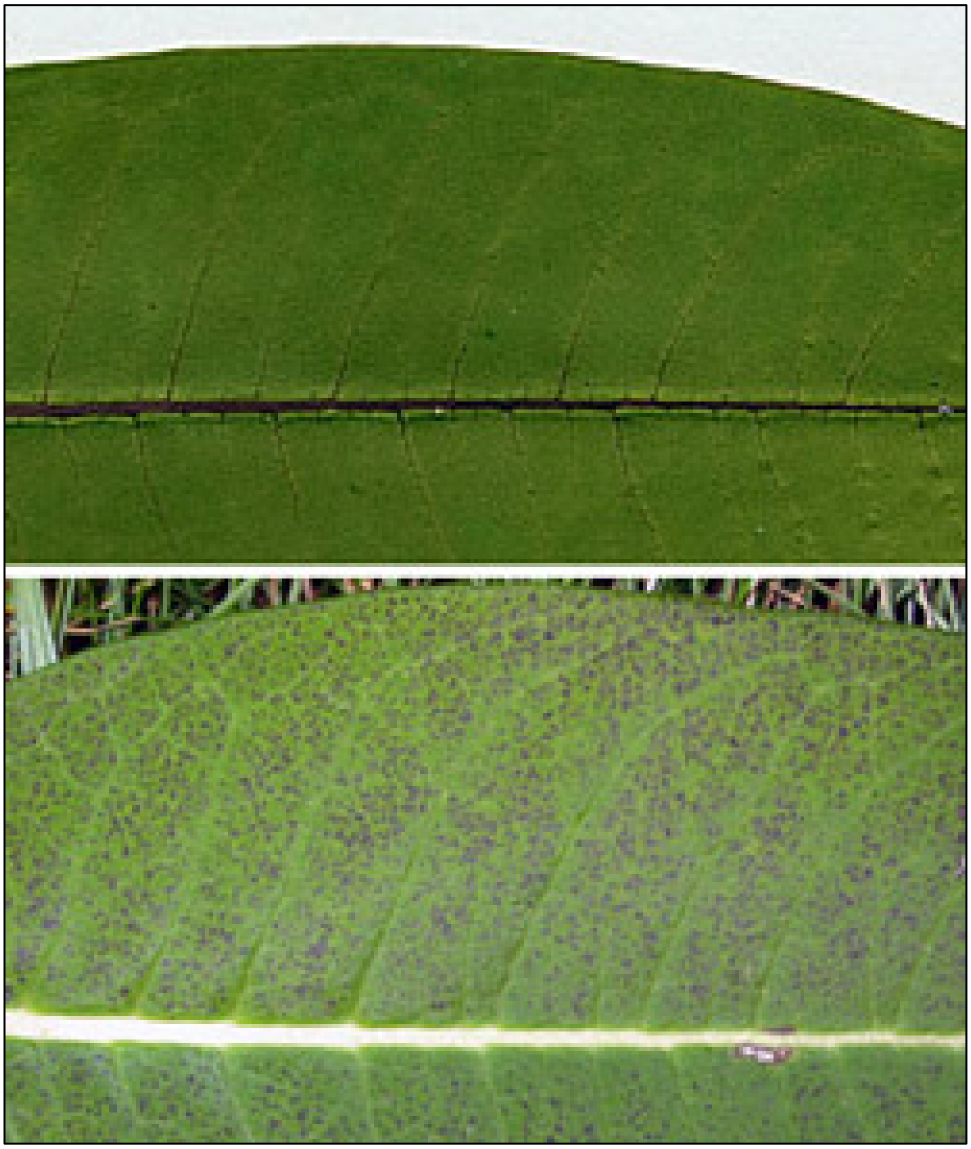


Figure 4.7-1. *Asclepias syriaca* normal leaf, top, and ozone-injured leaf, bottom (NPS ARD).

From 2006–2010 HEHO experienced a 4th highest 8-hour ozone average concentration of 65.1 parts per billion (ppb) (Table 4.7-2) (NPS 2012a). This most recent air quality data indicates moderate condition for ozone levels. Although the data suggests a slight improving trend in ozone levels, the trend is not statistically significant (NPS ARD 2013c). The condition of this indicator warrants moderate concern, with an unchanging trend and medium confidence due to the regional and modeled nature of the data.

Wet Deposition

The five-year averages for total N wet deposition between 2001 and 2010 ranged from 5.6 to 6.4 kg/ha/yr, The five-year averages for total S deposition between 2001 and 2010 ranged from 3.4 to 4.3 kg/ha/yr, These deposition values consistently fall in the poor condition category (Table 4.7-2). The deposition rates improved slightly from the 2001–2005 period to the 2006–2010 period. The NPS ARD (2013c) indicates that the trend is not statistically significant. The condition of this indicator warrants significant concern, with an unchanging trend and medium confidence due to the regional and modeled nature of the data.

Visibility

The five-year averages for visibility consistently fall in the poor condition category. Visibility levels were between 9.7 dv and 11.9 dv throughout the 2001–2010 period. The air condition trend analysis (NPS ARD 2013c) indicates no significant trend. The condition of this indicator warrants significant concern, with an unchanging trend and medium confidence due to the regional and modeled nature of the data.

Overall Condition

Based on the evaluation of air quality indicators, air quality condition warrants significant concern, with an unchanging trend (Table 4.7-4). Confidence in the assessment is medium. Impacts to air quality appear to be largely from distant sources that are affecting regional air quality. Air quality at HEHO is comparable to other parks in the Midwest Region (NPS 2010).

Table 4.7-4. Condition and trend summary for air quality at Herbert Hoover National Historic Site.

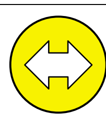
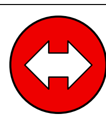
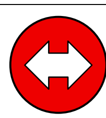
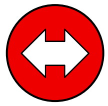
Indicator	Condition Status/Trend	Rationale
Ozone		Ozone levels are consistently within the moderate condition category during the 2001–2010 period with an unchanging trend.
Wet deposition (total N and total S)		Wet deposition measurements are consistently in poor condition for HEHO and show no trend.
Visibility		Visibility measurements are consistently in poor condition for HEHO, and show no trend.

Table 4.7-4 (continued). Condition and trend summary for air quality at Herbert Hoover National Historic Site.

Indicator	Condition Status/Trend	Rationale
Overall Condition Status and Trend for Air Quality		**The condition of air quality indicators warrants significant concern, with an unchanging trend. Confidence in the assessment is medium.**

4.7.5. Uncertainty and Data Gaps

Monitoring stations within HEHO would provide a better understanding of specific air quality conditions at the property. The Air Atlas interpolations are adequate, but can misrepresent park conditions due to modeling errors. Monitoring of air quality conditions within HEHO or nearby would reduce uncertainty from the interpolations.

4.7.6. Sources of Expertise

- The National Park Service's Air Resources Division oversees the national air resource management program for the NPS. Together with parks and NPS regional offices, they monitor air quality in park units, and provide air quality analysis and expertise related to all air quality topics. For current air quality data and information for this park, please visit the NPS Air Resources Division website at https://www.nps.gov/subjects/air/index.htm.

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4.8. Stream Hydrology and Geomorphology

4.8.1. Background and Importance

NPS Management Policies (NPS 2006a) specify that the Service will manage watersheds as complete hydrologic systems and minimize human-caused disturbance to the natural upland processes that deliver water, sediment, and woody debris to streams. These processes include runoff, erosion, and disturbance to vegetation and soil caused by fire, insects, weather events and other stressors. The Service will manage streams to protect stream processes such as flooding, stream migration, and associated erosion and deposition that create habitat features. The Service will protect watershed and stream features primarily by avoiding impacts on watershed and riparian vegetation and by allowing natural fluvial processes to proceed unimpeded (NPS 2006a). These park and national NPS goals require an integrated perspective that includes upland vegetation management, wildlife management, management of springs and impoundments, and riparian zone management, all of which affect aquatic resources and surface water quality.

At Herbert Hoover National Flooding on Hoover Creek in May 1909. View is from the vicinity of the gravesites looking east (NPS).

Historic Site (HEHO) an unnamed tributary of the West Branch of Wapsinonoc Creek, known locally as Hoover Creek, forms within the park as two small tributaries entering from the north and west. It flows to the east through the heart of the park and exits the park upstream of its confluence with the west branch of Wapsinonoc Creek (Figure 4.8-1). Hoover Creek serves as the primary drainage for portions of the city of West Branch. Changes in flow characteristics have adversely affected stream health and function. Physical changes to the stream have altered its appearance from the time of Herbert Hoover's childhood (NPS 2006b). Many of the historic resources protected by the park lie within the 50-, 25- and 15-year floodplains of Hoover Creek and the west branch of Wapsinonoc Creek. This places the resources in jeopardy of damage or loss during flood events..

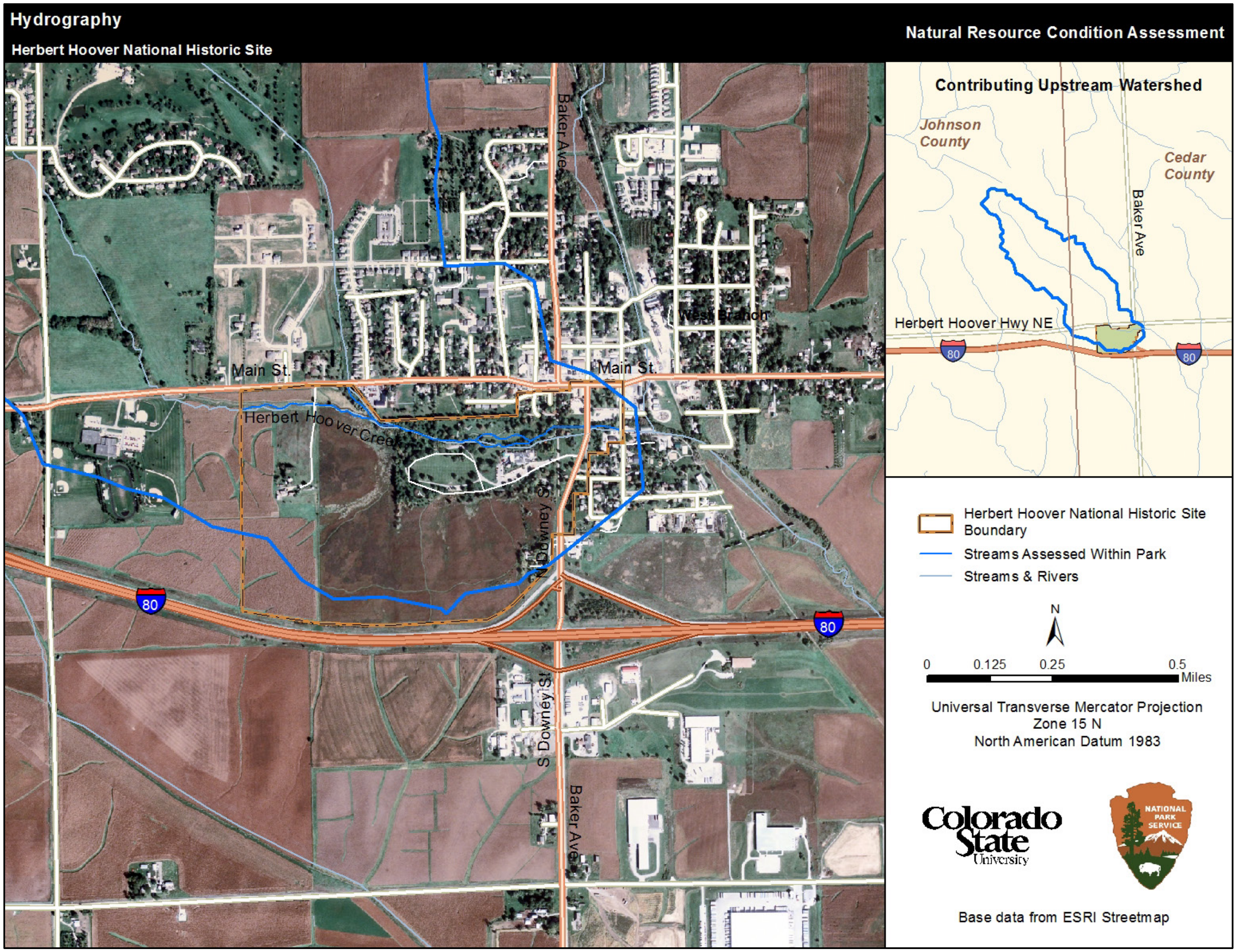


Figure 4.8-1. Streams in the vicinity of Herbert Hoover National Historic Site, Iowa (NPS).

In the 11-year period from 1991 through 2003, the park experienced 18 floods that inundated park buildings or infrastructure and interrupted services to visitors. In 1993 an event estimated to be a 35 year flood flooded much of the park and threatened several historic structures. Historic flooding of the creek is well documented, and led to the development of a stream management plan and environmental impact statement (EIS) in 2006 to address issues related to the degradation of Hoover Creek and risks posed to historic structures and resources (NPS 2006b).

The stream system was heavily altered prior to the period when Herbert Hoover lived in West Branch, and disturbances and development within the watershed continue to this day. Early settlers of the area removed most of the trees along local creek channels shortly after their arrival for use as building materials and fuel. A second wave of immigrants that arrived in the 1880s implemented extensive farming of the prairie and installed agricultural drainage tiles to increase the acreage of arable land. Over time, the altered hydrologic regime incised the natural swamps and sloughs into narrow, steep-sided channels, creating perennial streams where ephemeral drainages previously dominated (NPS 2004a, 2004b). Historic and ongoing land use changes continued to alter the hydrology from the groundwater based system to one consisting primarily of surface water morphology by reducing infiltration and increasing runoff

Stream realignment and construction in the northwest corner of the park just south of West Main Street looking southeast, 1970; the Isaac Miles Farm is visible in the distance directly over the crane operator (NPS).

Stream condition depends on interactions between inflowing supplies of water and sediment, valley setting, and external controls such as riparian vegetation. A stream is generally considered stable and in equilibrium when its sediment-transport capacity balances the sediment supply delivered from the watershed and upstream reaches such that the stream dynamically maintains its pattern, dimension, and profile over engineering time scales of about 50 years. If watershed changes alter the flow regime, sediment supply, vegetative reinforcement, or the channel directly, the stream may undergo a period of instability involving incision and/or widening in response. During this transition period, streams commonly exhibit increased erosion, bank failures, and aggradation which can negatively influence aquatic and riparian habitats which are major determinants of biotic composition.

Stream management objectives for the park were developed to guide the *Stream Management* Plan/*EIS* (NPS 2006b). They are to:

- reduce flood threat and flood damage to historic structures and other cultural resources;
- reduce the frequency at which flood events occur within the park by increasing stream flow capacity;
- stabilize banks and reduce entrenchment and lateral cutting of the stream;
- implement modern, sustainable riparian management techniques; and
- provide safe, stable stream banks from which visitors can observe the stream and riparian area.

Approximately 80% of HEHO's contributing upstream watershed is classified as having 0–2% impervious surfaces. Approximately 8.4% of the contributing upstream catchment of the park was classified as having > 25% impervious surfaces, the vast majority of which is concentrated near the town of West Branch. Land cover and land use characteristics of HEHO's contributing upstream watershed are examined in detail in Section 4.1, *Land Cover and Land Use*.

<u>Threats and Stressors</u>

- Urban and suburban development within the watershed affecting impervious surfaces, water quality, stream flows, and hydrologic response to precipitation events.
- Drain tiling of current and historic agricultural lands within the watershed.
- Vegetation management practices that do not favor streambank stability (this is potentially a stressor and management constraint).
- Historic degradation of stream stability resulting in channel incision, headcutting and slumping resulting in continued instability and accelerated erosion.
- Climate change may increase the incidence of extreme runoff events, which may impact stream recovery.

<u>Indicators and Measures</u>

- Proper functioning condition (PFC) rating
- Channel evolution model (CEM) stage

4.8.2. Data and Methods

Hoover Creek was visually assessed for Proper Functioning Condition (PFC) (BLM 1998) and Channel Evolution Model (CEM) stage (Schumm et al. 1984) along its course within the park. Field assessments by Colorado State University were conducted in June, 2013. PFC assessment consisted of evaluating seventeen hydrologic, vegetative, soil, and geomorphological parameters ultimately leading to a PFC and CEM ratings for the stream reach. PFC condition characteristics are described below. The CEM rating was used to support the PFC determination as well as indicate the trend in condition, especially where Functional at Risk conditions exist.

Functioning Condition

Proper Functioning Condition

Streams and associated riparian areas are functioning properly when adequate vegetation, landform, or large woody debris is present to:

1) Dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality;
2) Filter sediment, capture bedload, and aid floodplain development;
3) Improve floodwater retention and groundwater recharge;
4) Develop root masses that stabilize stream banks against cutting action;
5) Develop diverse ponding and channel characteristics to provide habitat and the water depths, durations, temperature regimes, and substrates necessary for fish production, waterfowl breeding, and other uses; and
6) Support greater biodiversity.

Functional – At Risk

These riparian areas are in functional condition, but an existing soil, water, vegetation, or related attribute makes them susceptible to degradation. For example, a stream reach may exhibit attributes of a properly-functioning riparian system, but it may be poised to suffer severe erosion during a large storm in the future due to likely migration of a headcut or increased runoff associated with recent urbanization in the watershed. When this rating is assigned to a stream reach, then its "trend" toward or away from PFC is assessed.

Nonfunctional

These are riparian areas that are clearly not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows, and thus are not reducing erosion, improving water quality, sustaining desirable channel and riparian habitat characteristics, and so on as described in the PFC definition. The absence of certain physical attributes such as a floodplain where one should exist is an indicator of nonfunctioning conditions.

Channel Evolution Model (CEM)

Developed by Schumm et al. (1984), the CEM is designed to determine the stage of stream evolution in incising channels. The CEM rating was used to support the PFC determination as well as indicate the trend in condition, especially where Functional at Risk conditions exist. CEM scores of I, III, and V might not indicate trends but a CEM Type II channel usually indicates a deteriorating trend. CEM Type IV channel indicates an improving trend.

Determining the CEM stage is a useful tool for managers to not only help identify the current condition of the stream but it can also indicate the possible future trend allowing for informed management decisions about stream protection and rehabilitation. There are many reasons why incision may occur within a stream, but it is generally due to a disparity between sediment-transport capacity and sediment supply (Watson et al. 2002). Incision sometimes manifests as a headcut that will progress upstream as long as the sediment-transport capacity is higher than the supply and no resistive strata are encountered. Eventually the channel will incise deep enough to where bank failures occur due to geotechnical instability. Failures are generally caused by bank heights greater than the critical bank height, which results in mass failures and widening in the channel. With the addition of new sediment to the channel from the failed banks, the ratio of sediment-transport capacity to supply may switch, resulting in aggradation and a decrease in bed slope. The decreased bed slope reduces the sediment-transport capacity of the stream eventually resulting in a new dynamic quasi-equilibrium slope and a newly-stable channel. This evolution takes place in five stages and can generally be seen in order from upstream to downstream (Figure 4.8-2).

A CEM Type I reach is located upstream of a headcut and is considered stable. A CEM Type II reach is defined as actively incising, however, bank heights are still below critical bank height so bank failures are not present. In CEM Type III, bank heights are now above critical bank height, which results in mass bank failures and channel widening. In CEM Type IV, the channel begins to tend toward a stable state due to aggradation from an influx of sediment from the eroded banks. Bank failures may still be present in this stage of evolution. Finally, CEM Type V is when the channel has recovered because a new balance between sediment-transport capacity and supply has been reached.

CEM stage was determined by walking the stream lengths in an upstream to downstream direction. The channel was visually assessed for signs of incision, bank failures, aggradation, and terracing to help determine stage. If definitive breaks in CEM score were seen along the stream, different reach scores would be assigned. CEM stage scores ranged from Stage 1 to Stage 5 in 0.5 increments.

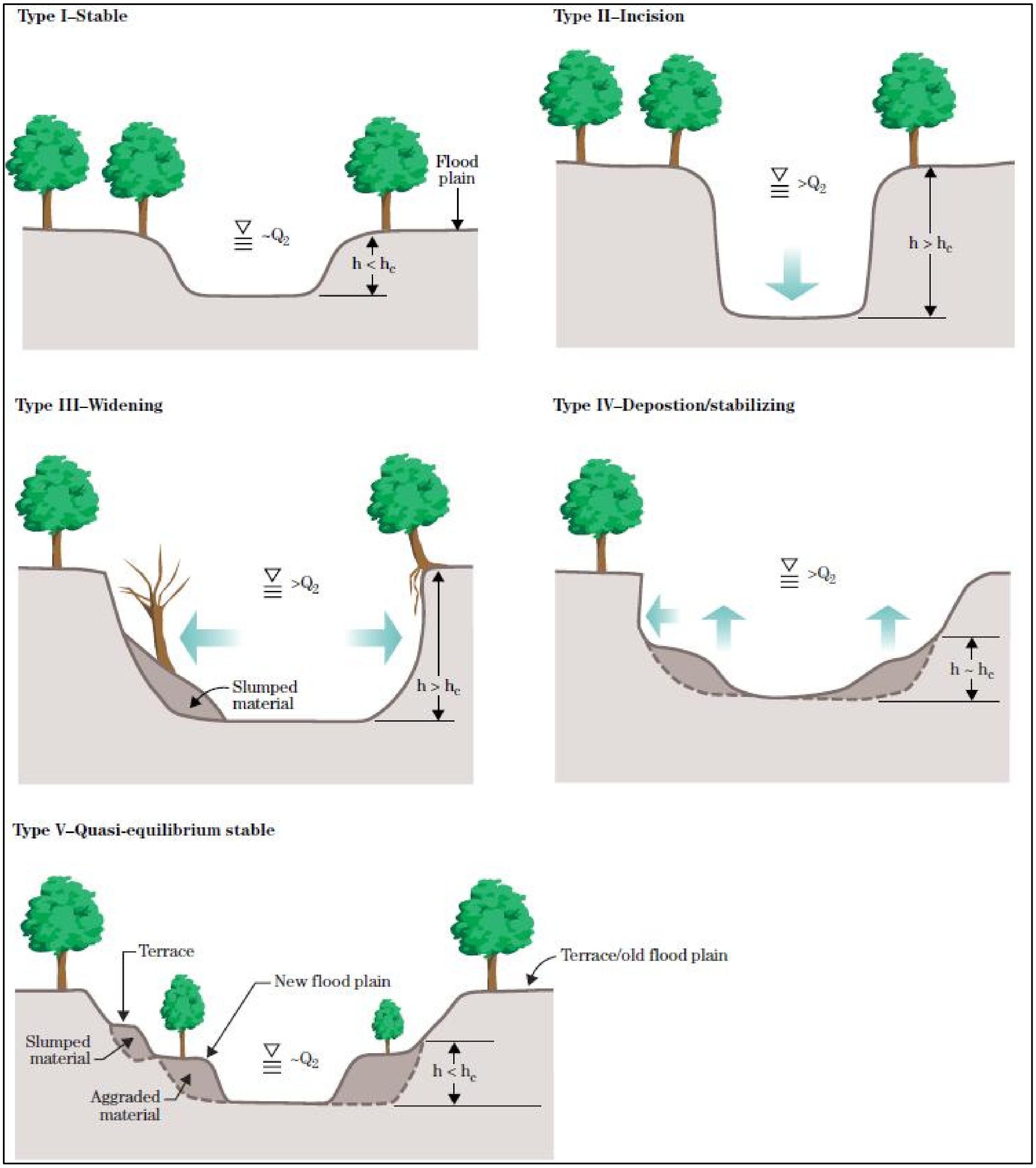


Figure 4.8-2. Cross-section view of the five types of channels in the CEM (NRCS 2007).

4.8.3. Reference Conditions

The current condition of the stream is evaluated relative to a defined reference condition. Inherent within the PFC scoring of functioning condition is the idea of potential, which is defined as the "highest ecological status an area can attain given no political, social, or economic constraints" (Schumm et al. 1984). Likewise, for CEM stage the reference condition would be a Stage 1 channel type where the sediment supply is in balance with sediment transport, creating a stable channel. It was assumed for these historically prairie ecosystems that the reference condition for the streams would be based upon a stable channel whose flow and sediment regime had not been altered in any way. The PFC and CEM framework is translated into a NRCA condition status rating as follows:

- Resource is in good condition – *Proper Functioning Condition* with CEM Type I (historic) or Type V (restored/rehabilitated) channel.
- Resource warrants moderate concern – *Functional At-Risk* often with a downward or no apparent trend CEM Type II, or with an upward or no apparent trend CEM Type IV channel.
- Resource warrants significant concern – *Nonfunctional* often with CEM Type III channel.

4.8.4. Condition and Trend

Hoover Creek was rated Nonfunctional. Sixteen criteria were rated negatively and one rated N/A for beaver presence. The channel is deeply incised down to a less erodible clay pan throughout the reach. Banks are nearly vertical and range from 5- to 10-ft high. Mass wasting is occurring in most bends and in some runs despite areas of less erodible clay pan in the toe of the banks (Figure 4.8-3). Fluvial erosion is creating undercut banks everywhere that has not already failed. Aggradation is occurring in some areas but especially at bridge culverts. Vegetation on the banks is dense in areas but some bends with failures are bare. Upland plant species are dominant along the banks but they do not have the root density or depth to prevent erosion.

Figure 4.8-3. Bank failures are prominent along most bends and some runs of Hoover Creek. Toe erosion along the banks eventually undermines the bank causing cantilever failure (CSU).

There is little to no bar formation occurring within the channel. The flashy flow regime appears to completely evacuate any failed bank material that could begin to form a new lower bank. The riparian area is mowed close to the top of the channel banks, and vegetation has been cut down along the channel banks for aesthetic reasons as recently as 2012. Some gabion structures and an old retaining wall along the creek have been undermined in isolated locations. Multiple outflow pipes drain into the channel throughout the park and are causing localized erosion. Historic land use change from prairie to agriculture caused the initial channel incision but more recent urbanization and grade-control structure construction has continued to alter the flow regime and sediment transport of Hoover Creek. The stream was scored CEM Stage 3 as the channel is actively adjusting to the land use changes and flow modification occurring within the watershed.

Suburban development across the northern border of the park within the Hoover Creek watershed. Restored prairie in foreground (CSU).

Overall, Hoover Creek has responded to historical land use changes that have altered surface water runoff within the watershed. It is thought that historically Hoover Creek was a grass swale with no defined channel. Then in the 1880s, settlers began intensively farming the land, including installing agricultural drainage tiles, which increased the quantity and delivery times of runoff to the channel causing erosion through the swale and creating the current stream channel. Moreover, approximately 425 ac (172 ha) were urbanized from 1940 to 2010, which has increased the impervious area within the Hoover Creek watershed. Urbanization has been shown to increase runoff and decrease sediment input which can result in channel incision, widening, or both (Bledsoe and Watson 2001). This more urban flow regime has led to continued incision and bank erosion in Hoover Creek. A golf course built in 1964 within the floodplain of Hoover Creek has resulted in large mowed areas and a narrow riparian buffer along the stream, which can allow for quicker runoff delivery to the channel.

View of Hoover Creek looking west from the vicinity of the Birthplace Cottage. The stream is incised and streamside vegetation is managed to maintain open views between the Cottage and Gravesite (CSU).

In December 2012, a large grade-control structure that essentially acts as a dam was built in the upper part of the watershed. The retention basin stores runoff from approximately 311 ac (126 ha) of farmland. This structure has reduced peak flows and reduced flooding in the park. However, dams trap sediment and can increase the duration of low to medium flows which can result in increased bank erosion (Williams and Wolman, 1984, Roesner et al. 2001). Within the park the channel is further degraded by the repeated cutting of vegetation along the bank. This decreases the roughness of the channel, which can keep flow depths lower to help with flooding but it also increases water velocities creating accelerated bank erosion. Flooding is a main concern within the park in order to protect the historic buildings and other structures. Plans for the construction of a large flood-retention basin on the west side of the park to address flooding concerns are still being finalized. Part of the design plans would be to modify the existing stream channel into a more meandering stream with graded banks to allow for more flow capacity through the park (NPS 2006b).

A streamflow gage was installed in 2000 on Hoover Creek by the U.S. Geological Survey (USGS gage 05464942). Hoover Creek can be characterized as having a flashy flow regime consisting of baseflow conditions with occasional high-flow events. The creek has also run dry in periods of drought such as in 2012. Precipitation data are from the Iowa City Municipal Airport (GHCND: USW00014937) located approximately 15 mi west of the Hoover Creek watershed. Since the precipitation gage is not located within the Hoover Creek watershed, some differences in rainfall amount and the observed streamflow response may occur. Monthly average streamflow is greatest in the spring and early summer months (Figures 4.8-4, 4.8-5).

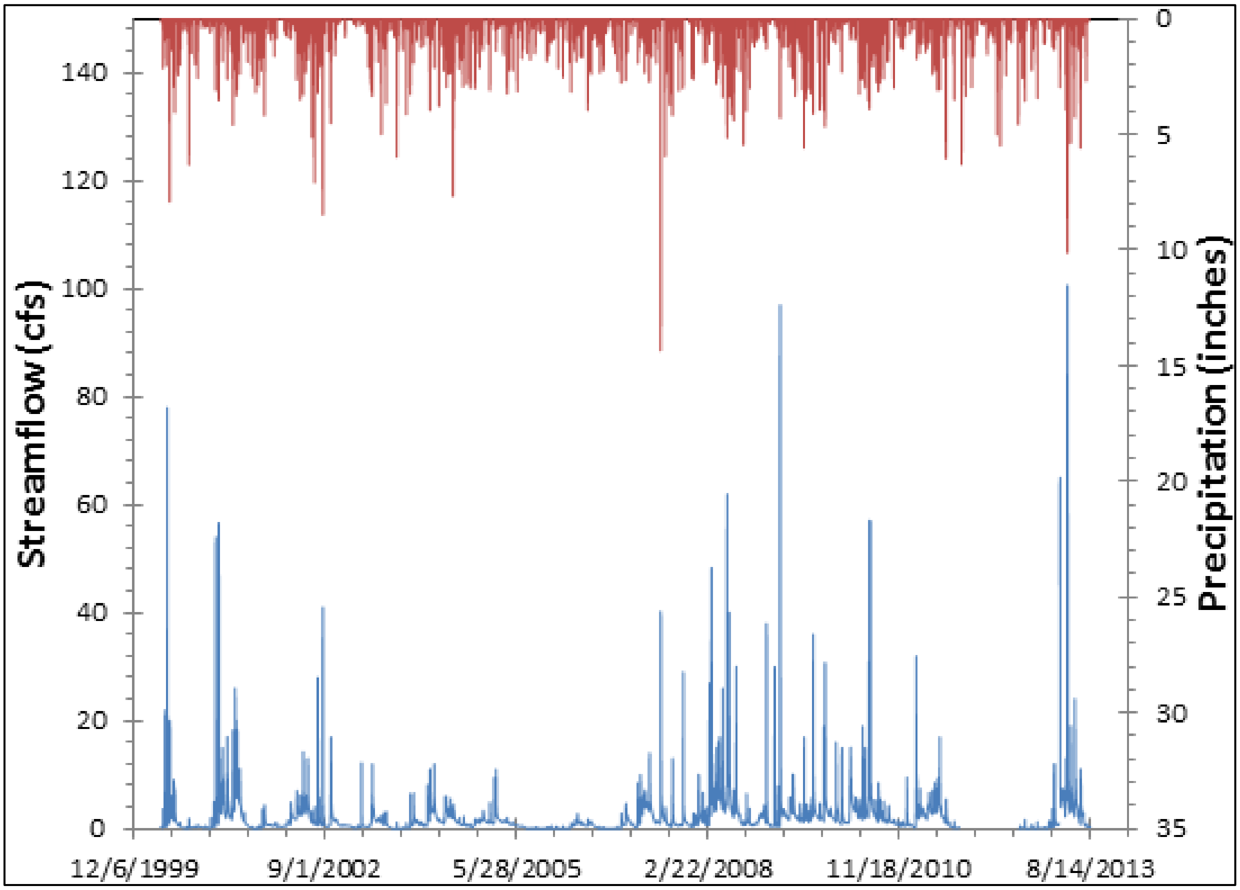


Figure 4.8-4. Hyetograph of daily streamflow values (blue lines) for Hoover Creek (USGS 05464942) and daily precipitation values (red lines) for Iowa City Municipal Airport (GHCND: USW00014937). (USGS 2015, NOAA 2015).

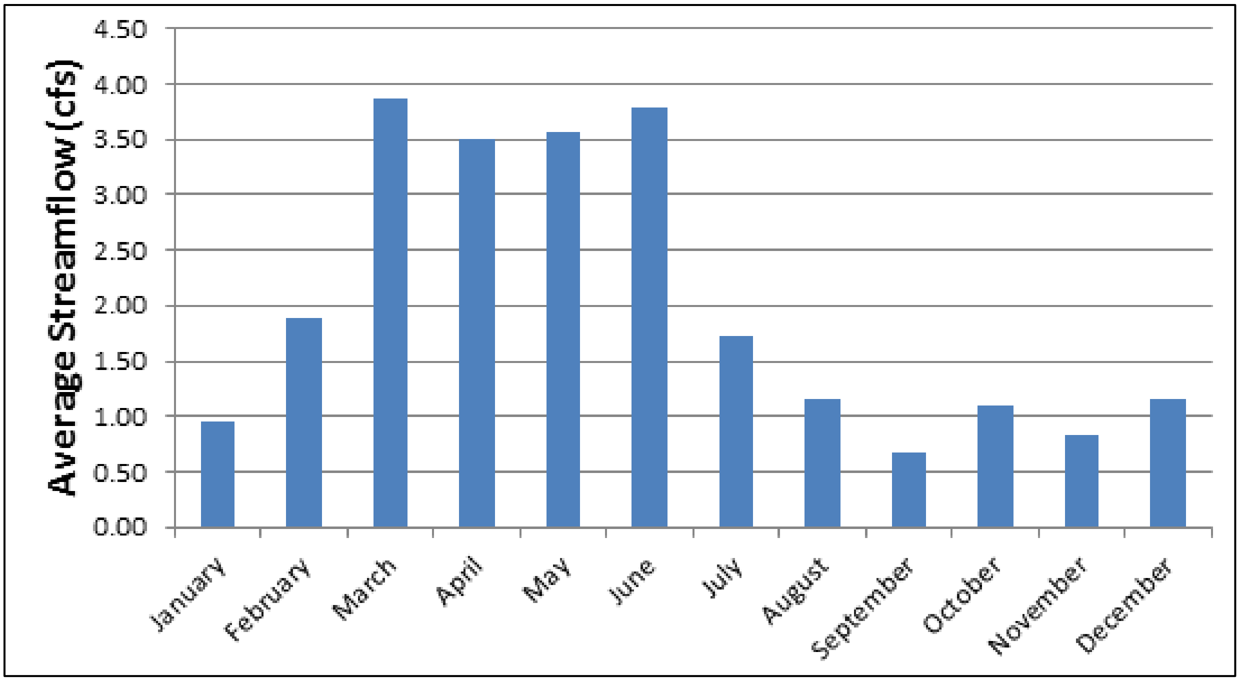


Figure 4.8-5. Average monthly streamflow for Hoover Creek for the period 2000 to 2013 (USGS 2015).

Flow characteristics before and after the grade-control structure construction were analyzed but with only 8 months of post-basin data, results are inconclusive with respect to the impact of the dam on the flow regime of Hoover Creek. A plot of cumulative precipitation vs. cumulative streamflow for the period of record (double mass curve) shows a change in slope around 2008, indicating that more streamflow is occurring in response to less precipitation (Figure 4.8-6). Historic aerial images of the watershed during this time indicate that a housing development including a retention basin for the development began construction in 2005, was mostly completed by 2008, and was finished by 2010 (Figure 4.8-7). The absence of a shift in the amount of runoff produced per unit precipitation as indicated by the slope of the double mass curve prior to 2008 is likely due to a period of very low precipitation from 2005 to 2007. However, it is readily apparent that the retention basin and increase in impervious area is directly affecting the flow regime, and by extension, the sediment regime of Hoover Creek. These upstream changes most likely are contributing to ongoing channel degradation as the stream responds to increased flow flashiness and stream power and reduced upstream sediment supply.

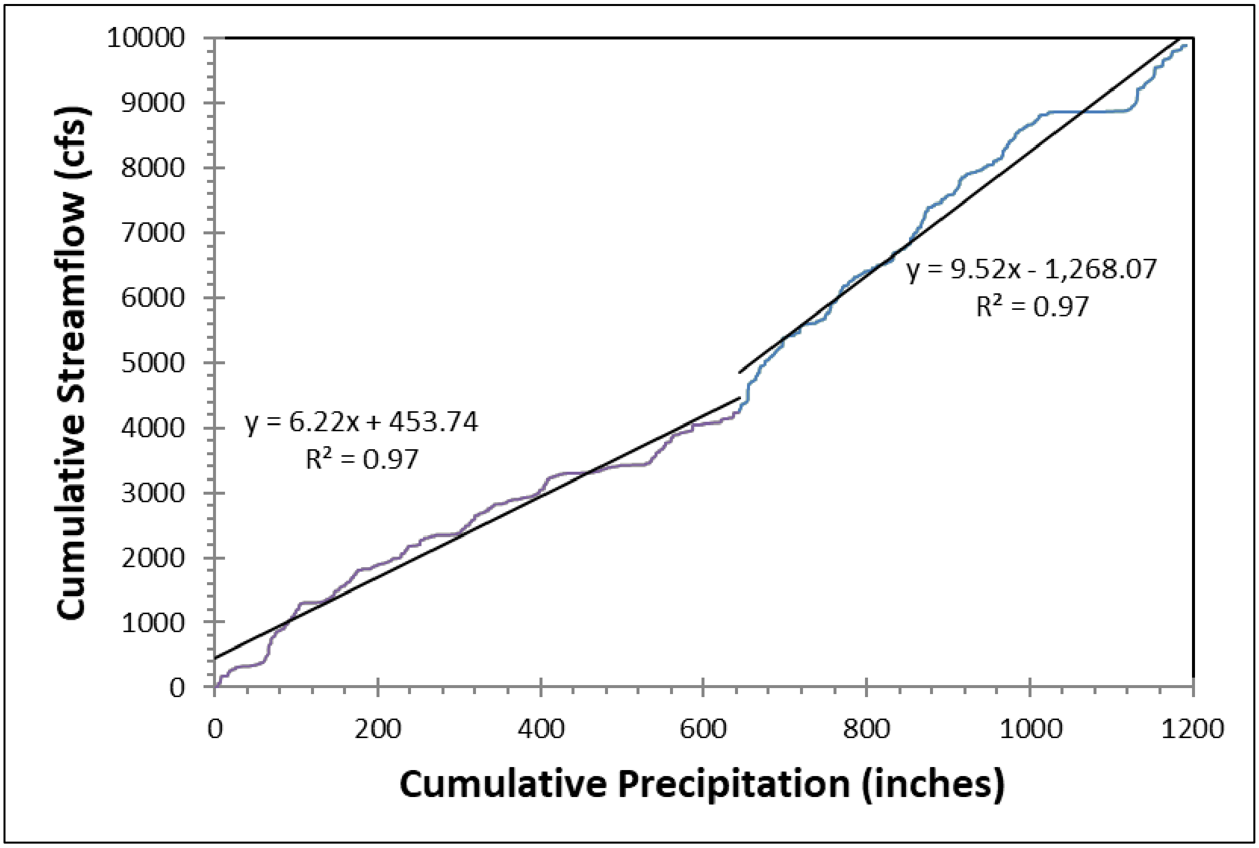
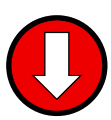
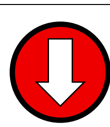


Figure 4.8-6. Cumulative streamflow vs. cumulative precipitation for the Hoover Creek area for the period 2000 to 2013. The break in data occurs at 1/1/2008 (USGS 2015).

Figure 4.8-7. Aerial photograph of new housing development being constructed in September 2010. Hoover Creek runs north to south just to the east of the development. The retention basin is identified in the photograph (imagery from ArcGIS).

Based on the PFC rating and other available information, the condition of the stream warrants significant concern, with a deteriorating trend and a high level of confidence (Table 4.8-1).

Table 4.8-1. Condition and trend summary for stream hydrology and geomorphology at Herbert Hoover National Historic Site, Iowa.

Indicator	Condition Status/Trend	Rationale
Proper functioning condition/CEM		Urbanization has altered the flow regime and caused the creek to incise beyond critical bank heights resulting in widespread bank failure. Continued urbanization and altered hydrology within the watershed will further cause the stream to degrade.
Overall Condition Status and Trend for Stream Hydrology and Geomorphology		**Condition warrants significant concern with a deteriorating trend. Confidence in the assessment is high.**

4.8.5. Uncertainty and Data Gaps

The effect of the recently-built grade-control structure on the flow regime of Hoover Creek cannot be determined at present due to the short period of post-construction streamflow data. However, in coming years continued analysis of the flow data will help determine what affect the structure may be having on the hydrology, sediment transport, and channel stability of Hoover Creek. The same is true for the possible planned retention basin and redesigned channel of Hoover Creek. It will be important to monitor the stability of the newly-designed channel and how it may adjust to continuing urbanization and associated flow and sediment modification within the watershed.

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Williams, G. P. and G. M. Wolman. 1984. Downstream effects of dams on alluvial rivers. U.S. Geological Survey Professional Paper 1286, 83 p.

4.9. Water Quality

4.9.1. Background and Importance

Surface water in Herbert Hoover National Historic Site (HEHO) consists of an unnamed tributary to the West Branch of the Wapsinonoc Creek, which is locally known as Hoover Creek. Hoover Creek drains approximately 1,700 ac of agricultural fields, residential land, and a golf course (NPS 2006). It is fed by surface runoff and groundwater flows and is subject to flooding due to altered upstream land use that causes increased runoff. The resulting floodwaters threaten the historic and other structures, artifacts, and documents of the park (NPS 2013). Hoover Creek water quality is largely influenced by the agricultural and urban land uses surrounding the creek. Hoover Creek has historically been impacted by agricultural uses but in the last 70 years approximately 250 ac of agricultural land use has been converted to an urban landscape (Foreman 2007). Foreman (2007) calculated land use cover within the Hoover Creek watershed and found 52.6% row crop, 37.5% grassland, urban 7.5%, and a small percentage as wetland, forest, or other land use. A *Stream Management Plan and Environmental Impact Statement* (NPS 2006) was completed in response to historic flooding of the park. It evaluates a range of management actions designed to increase protection of the historic and cultural resources and restore stream function in Hoover Creek. Mitigation associated with the Plan is currently in the planning phase.

Hoover Creek section within the Commemorative Zone near the Presidential Library (CSU photo).

The federal Clean Water Act (as amended 1972) requires states to adopt water quality standards to protect lakes, streams, and wetlands from pollution. The standards define how much of a pollutant can be in the water and still meet designated uses, such as drinking, fishing, and swimming. A water body is “impaired” if it fails to meet one or more water quality standards. To identify and restore impaired waters, Section 303(d) of the Clean Water Act requires states to assess all waters to determine if they meet water quality standards, list waters that do not meet standards (also known as the 303d list) and update the list every even-numbered year, and conduct total maximum daily load (TMDL) studies to establish pollutant-reduction goals needed to restore waters. Federal and state regulations and programs also require implementation of restoration measures to meet TMDLs. Delisting of impaired waters only occurs when new and reliable data indicates that the water body is no longer impaired. Hoover Creek is listed as a 303(d) impaired water body for fecal coliforms (Figure 4.9-1) (IDNR 2012a).

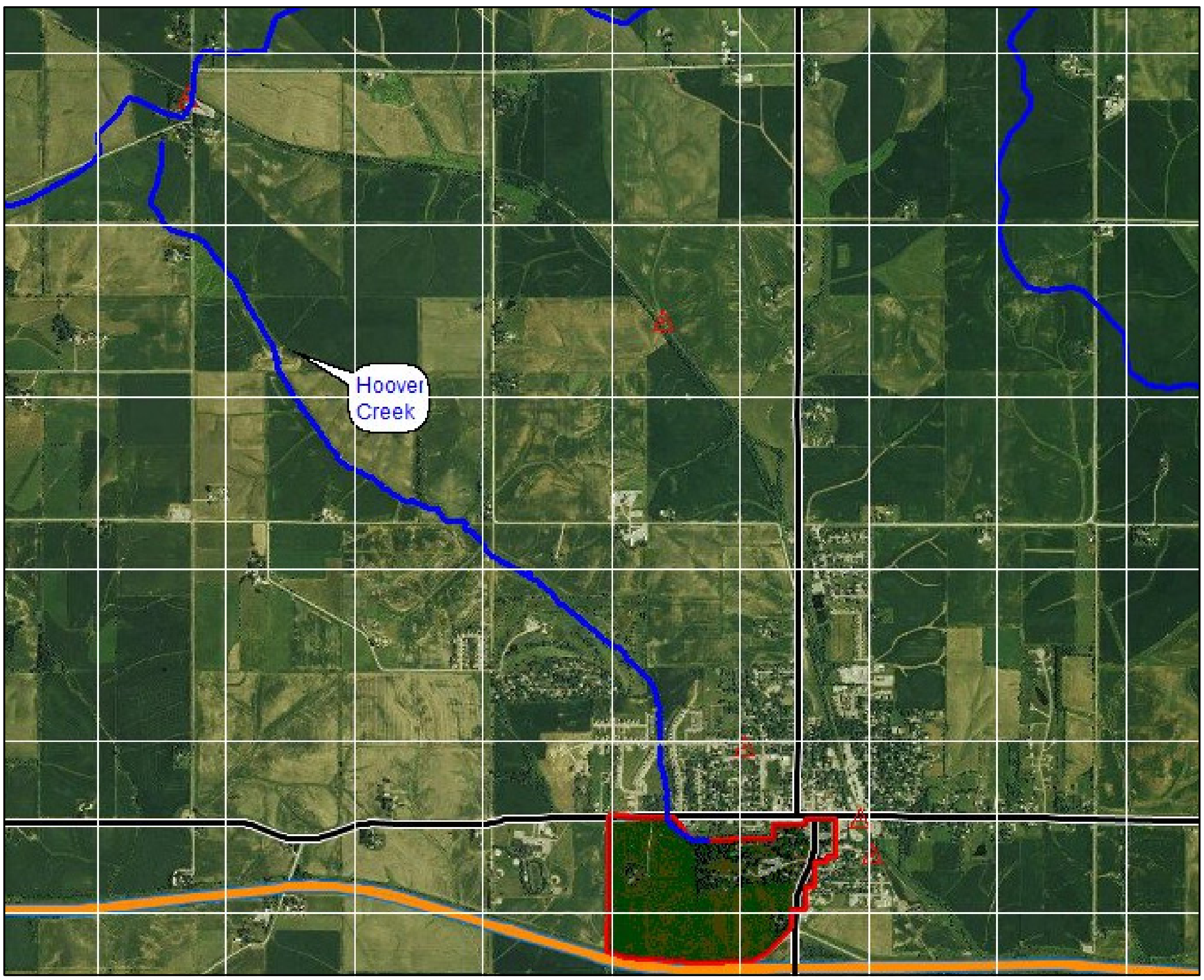


Figure 4.9-1. Impaired reach of Hoover Creek (ArcGIS, EPA 2013e).

Hoover Creek contains a variety of fish including the white sucker (*Catostomus commersoni*), blacknose dace (*Rhinichthys atratulus*), two species of minnow (*Pimephales* sp.), central stoneroller

(*Campostoma anomalum*), three species of shiner (*Notropis* sp.), creek chub (*Semotilus atromaculatus*), and Johnny darter (*Etheostoma nigrum*).

Threats and Stressors

The most immediate threat and stressor to water quality in HEHO is agricultural and urban land use upstream. The conversion of grassland to drained agricultural fields and paved urban settings has increased runoff rates and peak flows of Hoover Creek due to excess overland flow caused by land-use change. The flashy nature of the stream results in slumping stream banks, erosion, down cutting of the stream bed, and sediment impacts to the stream (NPS 2006). More details on stream hydrology are presented in Section 4.8. Water quality is also affected by the various contaminants that come from agriculture and urban sources. Climate change may be another stressor to water quality at HEHO. Drought years and high temperatures can reduce the volume of water, lower DO concentrations, and help concentrate pollutants.

Indicators and Measures

Total dissolved solids

Total dissolved solids (TDS) is a measure of the total concentration of dissolved substances in water (SDWF 2013). TDS may consist of inorganic minerals, or salts, in ionic and organic material. TDS for a sample of water is measured by passing the sample through a 0.45 micron filter to remove suspended solids, the remaining water is evaporated and the remaining residue represents the TDS concentration in milligrams per liter (mg/L) (USBR 2013). Common sources of TDS include natural sources, such as mineral springs, and urban runoff but may also come from industrial sources, sewage, fertilizers, road runoff, and soil erosion. TDS concentrations can impact the water balance of cells within aquatic organisms by causing the cells to swell when TDS is too low and to shrink when TDS is too high (EPA 2013a).

Chloride

Chloride is an inorganic salt that may be deposited into surface waters from a variety of sources such as road salting, oil and gas wells, and agricultural runoff (McDaniel 2013). High levels of chloride can be toxic to freshwater fish and macroinvertebrates. The toxicity of chloride is increased when mixed with potassium or magnesium, as it is with certain road salts (NHDES 2013). When these metals are released from chloride, the dissolved oxygen levels are reduced which causes additional stress to aquatic life (NHDES 2013). Additionally, high chloride levels can facilitate some fast growing invasive plants, such as Eurasian water milfoil, which can out-compete native fauna (Evans and Frick 2001).

Sulfate

Sulfate is a constituent of TDS and may form salts with sodium, potassium, calcium, magnesium, and other cations. Sulfate can be found naturally in surface waters but anthropogenic sources such as reverse osmosis reject water, waste from pyrite oxidation, and coal preparation waste water may lead to elevated levels of sulfate. Elevated levels of sulfate may be toxic to some macroinvertebrates while fish are more tolerant of excess sulfate (IDNR 2013a).

Dissolved oxygen

Dissolved oxygen (DO) in water bodies is critical for aquatic fauna. Oxygen enters water bodies from the atmosphere as well as ground water discharge. Photosynthesis also plays a key role in DO availability because of the effect of water clarity and duration of sunlight on water temperature (USGS 2013a). The amount of DO in a water body is related to the temperature of the water body; cold water holds more oxygen than warm water is able to (USGS 2013a). All forms of aquatic life use DO and therefore, DO is used to measure the "health" of lakes and streams. Depletion of DO from water bodies leads to eutrophication.

Coliform bacteria

Coliform bacteria are measured by total coliform through a laboratory test examining the number of bacteria colonies that grow on a prepared medium (USGS 2013b). Fecal coliforms and *E. coli* are coliform bacteria found in the intestinal tract of warm-blooded animals. Coliform bacteria can cause a variety of illnesses and have been used to establish microbial water quality criteria (USGS 2013b).

Aquatic macroinvertebrates

Macroinvertebrates are organisms that are visible by the naked eye. Aquatic macroinvertebrates live in the water for all or part of their lives and are dependent on water quality (NYNRM 2013). Aquatic macroinvertebrates are a significant part of a water body because they are an essential part of the food chain in aquatic environments. They are sensitive to chemical, physical, and biological water conditions, and are a good indicator of water quality (EPA 2013b). Some aquatic macroinvertebrates are more sensitive to water quality than others, such as stonefly nymphs. Stonefly nymphs cannot survive low DO levels and their absence may indicate the impairment of a water body (EPA 2013b). Aquatic macroinvertebrates are not addressed in this section. For a detailed description of HEHO's aquatic macroinvertebrates, refer to the *Aquatic Macroinvertebrates* assessment section in this document.

Stream Flow

The amount or volume of water that flows through a water body over a certain length of time is the flow rate. Flow rates are important to aquatic and terrestrial fauna as well as to water quality (EPA 2013c). Larger flow rates can ameliorate pollutants in a water body faster than smaller flow rates. Organisms are influenced by water body flow rates as well; some aquatic fauna require fast flowing waters while others require calm pools or springs (EPA 2013c).

4.9.2. Data and Methods

The NPS (1999) previously compiled surface-water quality data for HEHO using six of the EPA's national databases: Storage and Retrieval (STORET) water quality database management system, River Reach File (RF3), Industrial Facilities Discharge (IFD), Drink Water Supplies (DRINKS), Flow Gages (GAGES), and Water Impoundments (DAMS). The retrieval resulted in 80 observations at 4 different monitoring stations. There were 2 stations (HEHO 0002, HEHO 0003) located within the park boundary. These two stations were single-year sampling efforts by the NPS. The City of West Branch operated the remaining stations (HEHO 0001 upstream from the park, and HEHO 0004 downstream of the park), which were sampled during more than one year, but only included total ammonia as a parameter.

Foreman (2007) published the results of sampling efforts on Hoover Creek between June 2004 and October 2006 and data from this study were uploaded to the Iowa STORET website. Coliform bacteria, dissolved oxygen, and stream flow were among other parameters sampled and those results have been used here to help determine a condition status for Hoover Creek. Four locations (denoted as 1, 2, 3, and 4) were sampled monthly in the Hoover Creek watershed. The Iowa STORET data (IDNR 2013b) was used for parameter analysis.

4.9.3. Reference Conditions

The reference conditions for HEHO's water quality are the Iowa Department of Natural Resources (IDNR) water quality standards for surface waters, which provide limits for health of freshwater organisms as well as drinking water standards. The U.S. Environmental Protection Agency (USEPA) standards are also listed for reference purposes (Table 4.9-1).

Table 4.9-1. IDNR and EPA standards for surface-water quality (IDNR 2012b, USEPA 2013d).

Parameter	Iowa Standard[B]	USEPA Standard
Total dissolved solids	n/a	≤ 250 mg/L
Chloride	≤ 250 mg/L	≤ 860 mg/L[A]
Sulfate	–	≤ 250 mg/L[A]
Dissolved oxygen	≥ 5.0 mg/L	≥ 4.0 mg/L
Coliform bacteria	≤ 126 CFU/100 ml	≤ 200 CFU/100 ml

[A] standard for drinking water

[B] standard is calculated based on the hardness of the water and the chloride concentration

Indicators with values within the published standards are considered to be in good condition. Those with slight compliance problems or where a TMDL plan has been established warrant moderate concern. Those that significantly exceed compliance limits or that exceed limits but do not have a developed TMDL warrant significant concern.

4.9.4. Condition and Trend

<u>Total Dissolved Solids</u>

There are no recorded values for total dissolved solids (TDS) published for water quality monitoring stations within, upstream, or downstream of HEHO. A current condition and trend cannot be determined.

<u>Chloride</u>

There are no recorded values for chloride levels in Hoover Creek that have been published for water quality monitoring stations within, upstream, or downstream of HEHO. A current condition and trend cannot be determined.

<u>Sulfate</u>

IDNR (2012b) provides a formula to determine the acceptable level of sulfate in surface water that is dependent on the hardness of the water as well as the chloride level of the water. If the hardness of the water is less than 100 mg/L, the sulfate standard is ≤ 500 mg/L. The single sample from station

HEHO 0002 from June 1993 contained 27 mg/L of sulfate (NPS 1999) indicates that the sulfate level is within the allowable level. However, one reading is insufficient to determine a current condition or trend of sulfate levels in Hoover Creek.

Dissolved Oxygen

IDNR (2012b) standards state that the acceptable level of dissolved oxygen for surface waters is greater than or equal to 5 mg/L. This is slightly more stringent than the EPA's standard of greater than or equal to 4 mg/L. The NPS recorded two observations from one station within HEHO during the summer of 1993. The minimum recorded value and the mean were both above the IDNR and USEPA standard for dissolved oxygen. Foreman's (2007) study of Hoover Creek water quality yielded 12 observations at each of the two stations located within HEHO. The minimum dissolved oxygen reading at both stations was below the standard, but the mean of each station was well above the standard (Table 4.9-2).

Table 4.9-2. Dissolved oxygen measurements from three monitoring stations including minimum, maximum, and mean values (mg/L) (NPS 1999, IDNR 2013b).

Station	Period of Record	Observations	Minimum	Maximum	Mean
HEHO 0002	6/93–8/93	2	8.7	11.3	10.0
2	6/04–7/05	12	2.7	9.9	7.4
3	6/04–7/05	12	3.2	11.1	7.5

Based on the available data, DO is considered to be in good condition. A trend cannot be determined and there is low confidence in the assessment due to the age and disparity of the data.

Coliform Bacteria

Hoover Creek is listed as an impaired reach for fecal coliforms (USEPA 2013e), and a TMDL is still needed for Hoover Creek. The IDNR standard for fecal coliforms is less than or equal to 126 CFU/100 ml while the USEPA standard is less restrictive at 200 CFU/100 ml. The NPS recorded one observation of fecal coliforms during the summer of 1993. The singular sample of fecal coliforms measured 300 CFU/100 ml, exceeding the standards set by IDNR and the EPA. Foreman (2007) collected 14 samples from each of the two monitoring sites within HEHO. The minimum coliform readings were well below the established standards but the maximum readings were well above the standards, with a peak value of 2300 CFU/100 ml. The mean value for both monitoring stations was well above the IDNR and USEPA standards (Table 4.9-3).

Based on the available data, the condition warrants significant concern. A trend cannot be determined and there is low confidence in the assessment due to the age and disparity of the data.

Table 4.9-3. Total coliform measurements from three monitoring stations including minimum, maximum, and mean values (mg/L) (NPS1999, IDNR 2013b).

Station	Period of Record	Number of Observations	Minimum	Maximum	Mean
HEHO 0002	6/93	1	300	300	300.0
2	6/04–7/05	14	30	950	364.3
3	6/04–7/05	14	10	2300	483.9

Stream Flow

There is no established standard for flow rates for Hoover Creek. Foreman (2007) recorded stream flow rates at the gaging station in HEHO from 2004 through 2006. During that time the flow rate exceeded 10 cubic feet per second (CFS) several times. Flow rates during the 2004–2005 seasons were mostly around or above 1 CFS. The flow rates during the 2005–2006 seasons were mostly below 1 CFS and the long-term average flow may be about 2–3 CFS NPS (2006). The 1993 flood is estimated to be a 35-year flood event with flows exceeding 1,500 CFS. The flow regime is further altered because portions of the contributing watershed contain drain tiles to enable agricultural production. Because of ongoing alterations within the contributing watershed resulting in increased hydrologic response and peak flows, the flow rate is considered to warrant significant concern, with a declining trend and low confidence. The trend may be improved by planned NPS projects.

Condition Summary

The current condition of water quality in HEHO is largely undetermined due to a general lack of monitoring data (Table 4.9-4). However, water quality condition warrants significant concern due to the fact that Hoover Creek is listed as impaired by fecal coliforms, available data indicate high levels of coliforms, and stream flows are degraded. There is low confidence in this assessment due to the age and availability of data.

Table 4.9-4. Condition and trend summary for water quality for Herbert Hoover National Historic Site.

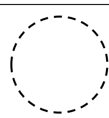
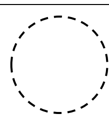
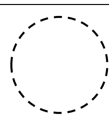
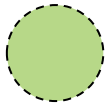
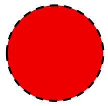
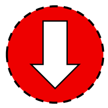
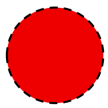
Indicator	Condition Status/Trend	Rationale
Total dissolved solids		There is no available data for TDS in HEHO.
Chloride		There is no available data for chloride in HEHO.
Sulfate		There is one available data point from 1993 for sulfate at HEHO.

Table 4.9-4 (continued). Condition and trend summary for water quality for Herbert Hoover National Historic Site.

Indicator	Condition Status/Trend	Rationale
Dissolved oxygen		There is a small amount of data available for DO at HEHO that indicate good levels of DO. However, the most recent records date back to a study completed during 2004–2005.
Total coliform		There is a small amount of data available for coliforms at HEHO. The USEPA lists Hoover Creek as impaired by fecal coliforms and the available data shows coliform levels above the established standards.
Stream flow		Historic alteration of flows by agricultural drain tiles has degraded flows. More recent development and urbanization have further altered flows and increased runoff.
Overall Condition Status and Trend for Water Quality		**Overall water quality condition warrants significant concern but the trend is unknown**

4.9.5. Uncertainty and Data Gaps

There are currently large gaps in knowledge regarding water quality within HEHO. There have been two monitoring locations established within the park but monitoring only occurred for a short period between 2004 and 2006. A prior NPS sampling effort occurred in 1993 but yielded very few observations of water quality. There has been no new monitoring since 2006 but Hoover Creek has been listed by the USEPA as an impaired stream for fecal coliforms, stating that a TMDL is needed. Currently, there is no TMDL available for Hoover Creek.

In order to understand the water quality conditions at HEHO, more frequent water quality monitoring needs to occur throughout the year. Monitoring should focus on fecal coliforms because Hoover Creek is impaired due to fecal coliforms. There should also be a focus on dissolved oxygen because of the aquatic life found in Hoover Creek. Improved monitoring of stream flows and water quality will likely accompany the stream alterations planned through the *Hoover Creek Stream Management Plan* (NPS 2006).

4.9.6. Sources of Expertise

- The NPS Water Resources Division is the primary source of expertise for water quality within HEHO. The Iowa Department of Natural Resources is the secondary source of expertise for water quality of Hoover Creek.
- Mary Skopec (mary.skopec@dnr.iowa.gov) – Stream Monitoring Coordinator, Iowa Department of Natural Resources

4.9.7. Literature Cited

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4.10. Prairie Vegetation

4.10.1. Background and Importance

Tallgrass prairie once covered some 570,00 km^2 of central North America, extending eastward from Nebraska and Kansas through the "Prairie Peninsula" of Iowa, Illinois, parts of Minnesota, Missouri, and Wisconsin, and western Indiana, and north to eastern portions of the Dakotas and southern Canada (Transeau 1935, Risser et al. 1981, Anderson 2006). Although the tallgrass prairie developed in areas where precipitation levels are favorable for the growth of trees and shrubs, in pre-settlement times, fire, drought, and ungulate grazing acted to prevent invasion by shrubs and trees, and favored warm-season grass species (Stubbendieck and Willson 1986, Sims and Risser 2000, Anderson 2006). Areas formerly dominated by tallgrass prairie are now largely converted to cultivated agriculture, and examples of this vegetation are reduced to scattered remnant unplowed tracts and small restored patches such as the prairie at Herbert Hoover National Historic Site (HEHO).

HEHO lies within the Central Tallgrass Prairie ecoregion (Figure 4.10-1), where tallgrass prairies are most mesic, with deep rich soils (Comer et al. 2003). Tallgrass prairie vegetation on the deepest soils is characterized by tall (1–2 m) grass species such as big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). Drier or shallow-soiled areas are characterized by mid- to shortgrass species, such as little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), prairie dropseed (*Sporobolus heterolepis*), and porcupinegrass (*Hesperostipa spartea*) (Sims and Risser 2000, NatureServe 2013). These tallgrass prairie communities also have a diverse forb component (TNC 2008).

The history of early prairie establishment and management at the park is described by Stubbendieck and Willson (1986). In the spring of 1971, six years after the designation of the park unit as a national historic site, 76 ac (31 ha) of cultivated land lying to the south and west of the presidential gravesite were seeded back to native prairie grasses. Recent vegetation mapping at the park by Diamond et al. (2014) classified 71.6 ac as restored tallgrass prairie (Figure 4.10-2).

The restored prairie was established both as a maintenance feature and as a possible representation of the environment characteristic of the landscape during the boyhood days of Herbert Hoover. A mixture of big bluestem, little bluestem, switchgrass, Indiangrass, and sideoats grama was seeded on approximately 65 ac (26 ha) of upland in the spring of 1971. At the same time, big bluestem, switchgrass, and Indiangrass were seeded on approximately 11 ac (5 ha) of wetter sites in the northwest portion of the restoration area. No prairie forbs were included in the original seeding mixture. Additional seed and plugs were planted in 1976, 1978, 1983, 1984, and 1990–1994 including native forbs and Canada wild rye (*Elymus canadensis*) (Williams et al. 2007).

Over time, the park has added prairie acreage through abandonment of previously mowed areas and through conversion of several acres of mowed lawn to prairie. Of the 81 ac designated as the natural zone at Herbert Hoover National Historic Site (HEHO), approximately 70 ac comprise the original reconstructed tallgrass prairie. The entire area has been under active management to achieve the goals and objectives presented in the *Prairie Management Plan* (NPS 2003) and *Draft Resource Stewardship Strategy* (NPS 2006). The vision for this area of the park is to create a system that serves as a facsimile of the tallgrass prairie that once dominated Iowa and with vegetation that largely functions as a native prairie community.

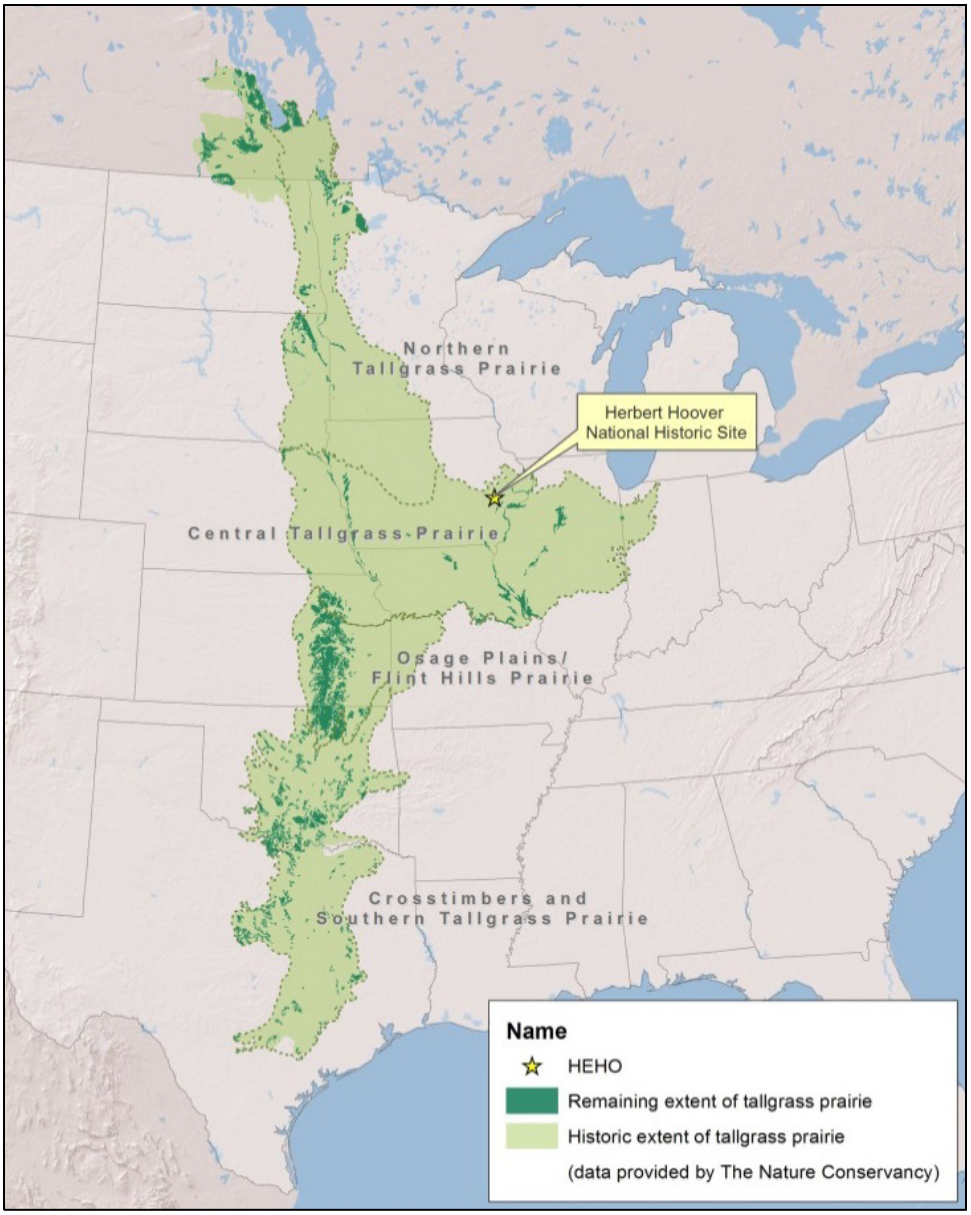


Figure 4.10-1. Location of HEHO within the tallgrass prairie region. Unpublished data provided by the Nature Conservancy.

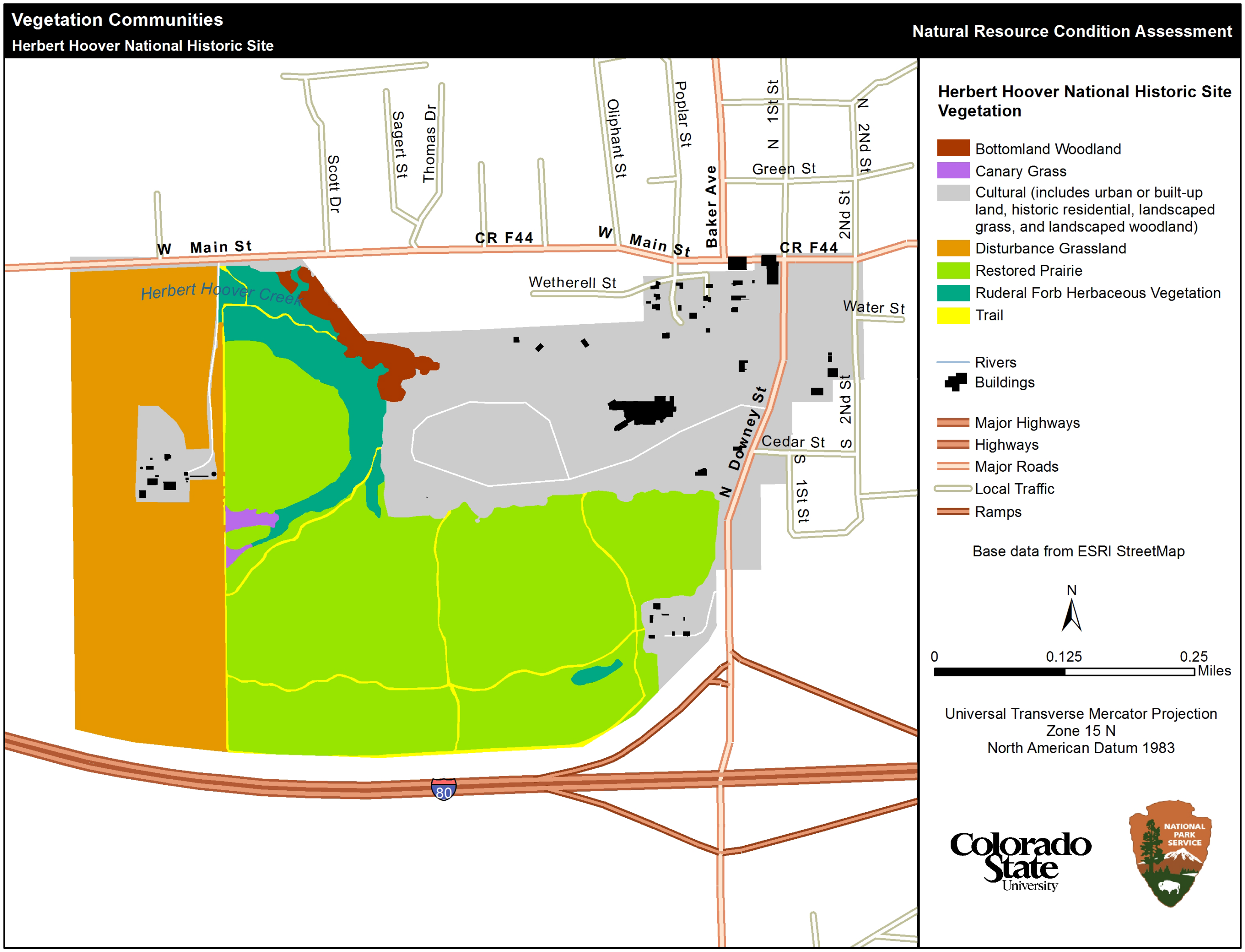


Figure 4.10-2. Vegetation communities and landcover classes at HEHO. Vegetation map data from Diamond et al. (2014).

Post-restoration observations made by Landers (1975) noted that the condition of the HEHO prairie varied from excellent to very weedy. Few woody species had invaded but herbaceous weeds were thought to be a problem. Extensive annual weed growth occurred during the first growing season. The entire area was mowed in midsummer of 1971 and burned in the spring of 1972 to stimulate the newly planted grasses and to reduce competition from weeds.

Starting in 1977 and through 1980 or 1982, approximately 20 ac (8 ha) were mowed each fall on a rotational basis. The hay was baled and hauled away to remove the excess organic matter which would be removed by fire in the natural ecosystem. Canada thistle (*Cirsium arvense*) infested portions of the area.

Attempted control measures for Canada thistle and other invasive broadleaf forbs included both mechanical removal and application of herbicides. Mowing and baling as a general management practice was stopped sometime between 1980 and 1982 (Stubbendieck and Willson 1986, Williams et al. 2007). In April 1984 approximately 40 ac were burned. Following the burn, 30 ac infested with Canada thistle were chemically treated, plowed, and reseeded to a mixture of prairie grasses and forbs. All units of the prairie were burned at least once in 1984 and 1985, but another four years passed before fire was used again. Two aggressive series of burn treatments occurred in the 1990s. Formal surveys and monitoring by Dr. Paul Christiansen took place between 1984 and 2005. A summary of those monitoring results are presented by Williams et al. (2007).

Prairie vegetation between the Herbert Hoover Gravesite and the historic Miles Farm (CSU).

Numerous native and nonnative forbs have moved into the area over time. They include Canada goldenrod (*Solidago canadensis*), asters (*Aster* spp.), giant ragweed (*Ambrosia trifida*), common ragweed (*Ambrosia artemisiifolia*), lettuces (*Lactuca* spp.), dandelion (*Taraxacum officinale)*, American burnweed (*Erechtites hieracifolia*), Platte groundsel (*Senecio plattensis*), alsike clover (*Trifolium hybridum*), white sweetclover (*Melilotus alba*), common milkweed (*Asclepias syriaca*), horsetail (*Equisetum arvense*), Pennsylvania smartweed (*Polygonum pensylvanicum*), hedge bindweed (*Convolvulus sepium*), field thistle (*Cirsium discolor*), and bull thistle (*Cirsium vulgare*). Woody plants are present, but are not dense in the area. Woody species include Siberian elm (*Ulmus pumila*), elderberry (*Sambucus canadensis*), honeysuckles (*Lonicera* spp.), multiflora rose (*Rosa multiflora*), and dogwoods (*Cornus* spp.). Five distinct vegetation types outside maintained or developed areas were described and mapped by Diamond et al. (2014). (Table 4.10-1, Figure 4.10-2).

Table 4.10-1. Summary of mapped vegetation types (Diamond et al. 2014).

Vegetation Physiognomy	Mapped Type Name	Scientific Name/Description	Number of Polygons	Acres	Hectares
Forest and woodlands	Bottomland ruderal woodland	*Fraxinus americana-Celtis occidentalis-Quercus macrocarpa*/Woodland	2	2.8	1.1
Herbaceous vegetation	Reed canarygrass western herbaceous vegetation (cegl001417)	*Phalaris arundinacea*/Western herbaceous vegetation	2	0.6	0.2
	Forb ruderal herbaceous vegetation	*Silphium perfoliatum-Monarda fistulosa-Conium maculatum*/Ruderal herbaceous vegetation	4	9.1	3.7
	Pasture and old field	*Bromus* spp.- *Elymus repens*/Pasture and old field	1	38.9	15.7
	Restored tallgrass prairie	*Andropogon gerardii-Sorghastrum nutans*/Herbaceous vegetation	9	71.6	29
Other land use/land cover classes	Developed land	Buildings, parking lots, picnic areas, roads, cemetery, garden, sewage application field	7	65	26.3
Total land use/land cover	**–**	**–**	**7**	**65**	**26.3**
Total natural vegetation	**–**	**–**	**18**	**123**	**49.8**
Totals	**–**	**–**	**25**	**188**	**76**

Management techniques used to manage the prairie towards a diverse assemblage of native species have included prescribed burning, mowing, shrub and tree cutting and herbicide application (NPS 2004). Management of woody plants and invasive and noninvasive exotic plants are ongoing challenges for the park. The prairie vegetation community monitoring at HEHO is intended to: describe the prairie species composition, structure and diversity; determine temporal changes in species composition, structure, and diversity; and determine the relationship between observed changes and environmental variables, including specific management efforts (James et al. 2009).

Threats

Primary threats to the condition of the prairie vegetation at HEHO are expansion of existing invasive exotic plant infestations and/or invasion of new exotic plant species, altered disturbance regimes due to lack of native grazers and altered fire regime, and invasion of the grassland by woody species. Over time, these stressors may lead to undesirable changes in species composition and reduced native species diversity.

Indicators and Measures

Condition of the restored prairie community at HEHO was evaluated using metrics for species composition, diversity, and vegetation structure:

- Species composition measured as proportion of native species cover by site
- Native species richness by site (S)
- Native species diversity by site (Modified Shannon, Hill's N1)
- Native species evenness by site (Hill's E5)
- Structure measured as native or non-native forb + graminoid cover, and woody cover
- Invasive exotic plants

4.10.2. Data and Methods

The Heartland Inventory and Monitoring Network (HTLN) has been monitoring vegetation at HEHO since 2004. In 2004 there were four monitoring sites in prairie vegetation; two more were added in 2006, for a current total of six (Figure 4.10-3). Data are collected on two permanent parallel transects (50 m in length and 20 m apart), with five 10 m^2 circular plots placed at 10 m intervals along each transect. Foliar cover is estimated in the 10 m^2 plot using a modified Daubenmire scale, and three nested frequency plots (1.0, 0.1, and 0.01 m^2) are read within the large plot. The 0.1 ha area between the two transects is used to collect data on woody species greater than 5.0 cm dbh in the understory and overstory canopy layers. Summary data reported for each site (transect pair) are: 1) plant species richness and diversity, 2) the ratio of exotic to native species, 3) species abundance and frequency, (4) woody species density and basal area, (5) overstory canopy cover and (6) ground cover characteristics (James et al. 2009). Additional vegetation data summaries were gleaned from Williams and Christiansen (2007), who examined changes during 21 years of monitoring between 1982 and 2005. Data from the earlier Christianson work encompassing 14 permanent plots installed in 1982 and 1994 has been organized in a database by the NPS Heartland I&M Network and has some compatibility with the protocol applied in 2004 and beyond. Invasive exotic plants data are described in that subsection within this chapter, and used as an indicator for the condition of prairie vegetation here. Although results from the Diamond et al. (2014) vegetation and classification and map are integrated where possible, plot data were not yet published during the preparation of this report.

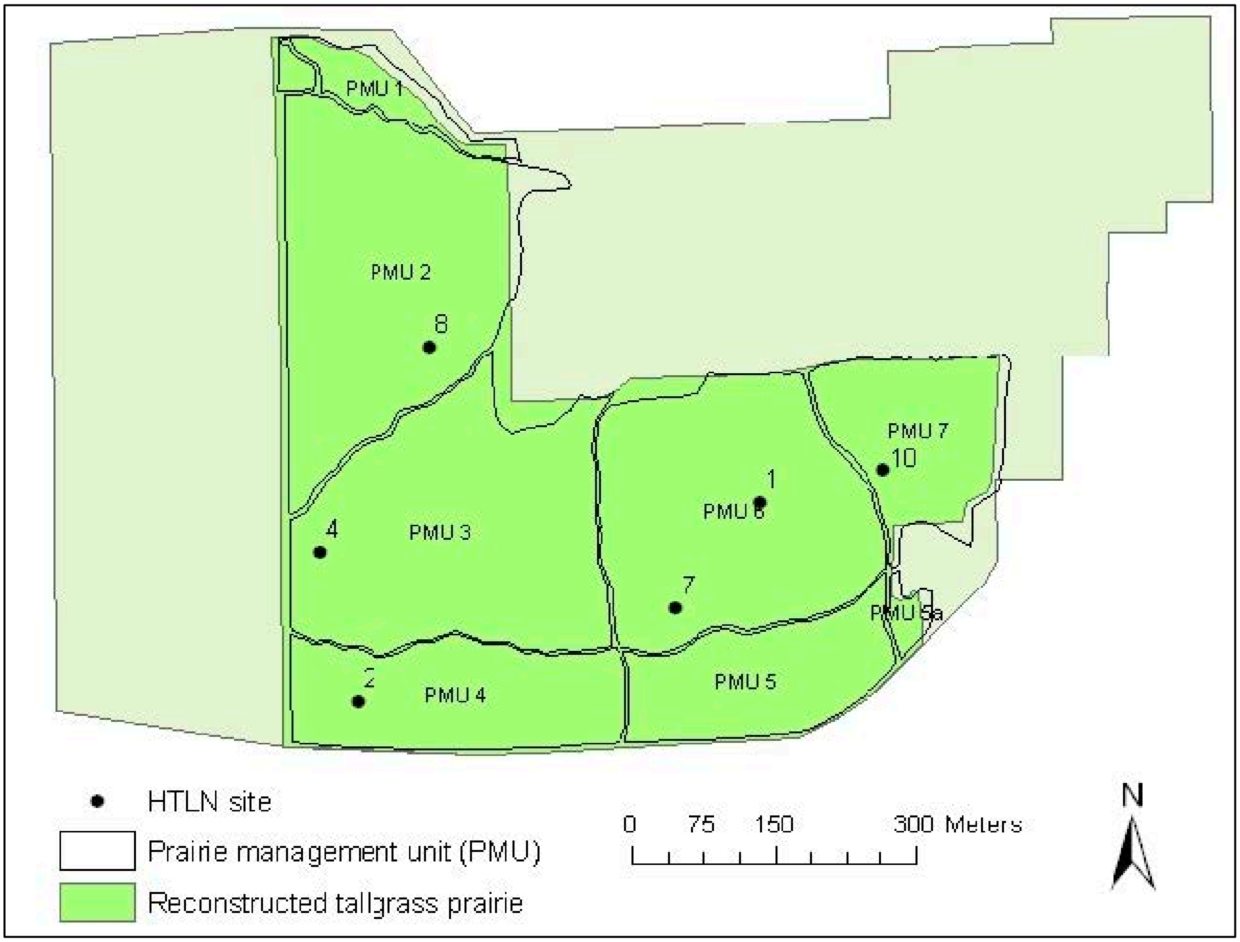


Figure 4.10-3. Prairie management units (PMUs) and vegetation plots sampled since 2006 (James 2011).

4.10.3. Reference Conditions

Because we can only indirectly assess the condition of prairie vegetation within HEHO, we used metrics derived from the HTLN vegetation monitoring data to develop preliminary reference benchmarks.

With regard to non-native vegetation, the ideal condition for HEHO would be the complete absence of non-native species, representing conditions during pre-settlement times. Because this type of reference condition is not feasible, we instead consider a baseline reference condition as a "best attainable condition" (*sensu* Stoddard et al. 2006) under which the composition, diversity, and structure of prairie vegetation at HEHO is sufficient to maintain the plant community in a stable or improving condition.

Threshold levels of non-native species cover have not been rigorously defined. Spyreas et al. (2004) found an average of 36% relative percent cover of non-native species in Illinois prairie grasslands. Miles and Knops (2009) reported that sites having > 60% relative cover of the native prairie grasses *Andropogon gerardii* and *Schizachyrium scoparium* were more likely to follow successional patterns typical of prairie communities. We used a level of 60% relative cover of native plant species as a threshold below which the prairie vegetation community is likely to face significant challenges in recovery to a desirable functioning condition. An upper threshold of 80% indicating good condition for native plant species cover is based on levels specified by NatureServe and several Natural Heritage Programs for good to excellent condition ranking in other types of remnant prairie communities (e.g., Decker 2007, WNHP 2011), and on values observed at remnant tallgrass prairie sites in the Midwest (Taft et al. 2006, Sivicek and Taft 2011).

Indices of richness and diversity are intended to estimate biological variability and quality in a way that allows comparison of different sites within a community type, or a comparison of different periods at a single site (Heip et al. 1998). Such indices are relatively easy to generate, but difficult to interpret in relation to the expected condition and trajectory of real-world species assemblages. Moreover, diversity indices summarize the structure of a community, not its functioning (Heip et al. 1998). Expected values of these indices for particular community types have not been, and probably cannot be defined (Hurlbert 1971, Ludwig and Reynolds 1988), and variation in both historical and microsite characteristics can produce significant differences in the composition and structure of two nominally identical plant communities (Sluis 2002, Hanson et al. 2008). There is, however, some evidence that plant species richness, diversity, and evenness is generally greater in remnant prairies than in restored prairies (Kindscher and Tieszen 1998, Sluis 2002, Polley et al. 2005, Taft et al. 2006), so that higher index values are broadly indicative of higher quality. In the absence of well-defined standards for such metrics, we have adopted an approach where values in the first year of vegetation monitoring with the current protocol (2004) represent a reference point or baseline for comparison with subsequent years.

A resource condition rating framework integrating the reference condition concepts discussed here is shown in Table 4.10-2.We assessed three indices of diversity and evenness for native species in HEHO prairie vegetation. The first, most straightforward measure of community richness is the number of all native species (S) in the sample, regardless of their abundances. Our second measure of diversity is Hill's N1 (a modified Shannon's index), which estimates the number of *abundant* species in the sample and downplays the contribution of rare species while giving additional insight into the relative importance of each community member. Finally, we calculated the modified Hill's ratio evenness index (E5), which approaches zero as a single species becomes more dominant.

Comparison of functional group structure between years involves a combination of quantitative and qualitative evaluation. Because no expected values for relative cover of native forbs vs. native grasses have been established, we compared the relative proportion of the two groups as a baseline, with the expectation that both groups should be well represented. In some prairie restorations, the abundance of native forbs has been relatively low compared to remnant prairies because few native forb seeds were used in the seeding mix or native forbs were sometimes historically impacted in the course of controlling broad-leaved weeds using non-selective herbicides. Woody species cover indicator levels are based on the LANDFIRE Biophysical Setting Model for Central Tallgrass Prairie (LANDFIRE 2008), where a cover of 30% woody species indicates a level considered beyond normal for this part of the tallgrass prairie region. Because woody species are being actively controlled or killed, we expect that values should remain at or below 2004 levels.

Table 4.10-2. Resource condition indicator rating framework for prairie vegetation indicators at HEHO.

Indicator	Good Condition	Warrants Moderate Concern	Warrants Significant Concern
Composition	≥ 80% cover native species	60 to < 80% cover native species	< 60% cover native species
Native species richness	> 85% of 2004 mean	70–85% of 2004 mean	< 70% of 2004 mean
Native species diversity	> 85% of 2004 mean	70–85% of 2004 mean	< 70% of 2004 mean
Native species evenness	> 85% of 2004 mean	70–85% of 2004 mean	< 70% of 2004 mean
Structure native graminoids and forbs	Relative cover of native graminoids or forbs 20–80% of combined cover for those two groups	Relative cover of native graminoids or forbs 10–20% of combined cover for those two groups	Relative cover of native graminoids or forbs < 10% of combined cover for those two groups
Woody species	Woody plant cover < 15%	Woody plant cover 15–25%	Woody plant cover > 25%

4.10.4. Condition and Trend

<u>Species Composition</u>

The proportion of native plant species present at monitoring sites has been fairly consistent (Figure 4.10-4) with a mean of 80% or greater in all monitoring years since 2004. Native vs. introduced plant cover data from Williams (2007) for the 1982–2005 period shows native plant cover comprising approximately 80% of total plant cover (Figure 4.10-5). The species composition indicates good condition with an unchanging trend and medium confidence.

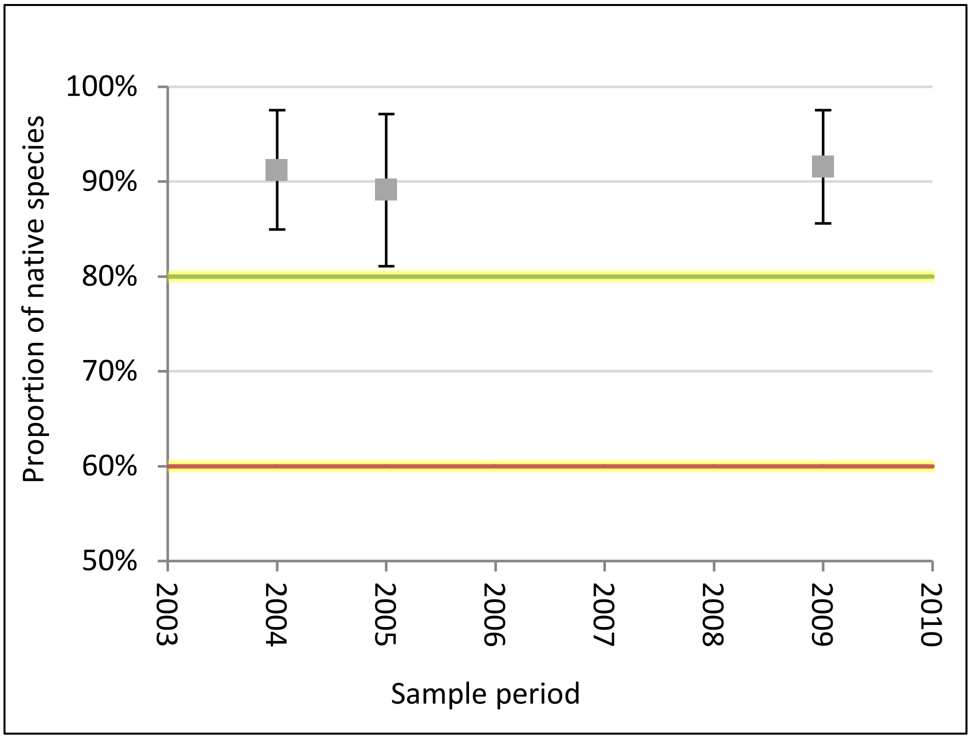


Figure 4.10-4. Mean proportion cover of native plant species by site during monitoring years 2004–2009. Error bars represent 90% confidence interval of the mean (James 2011).

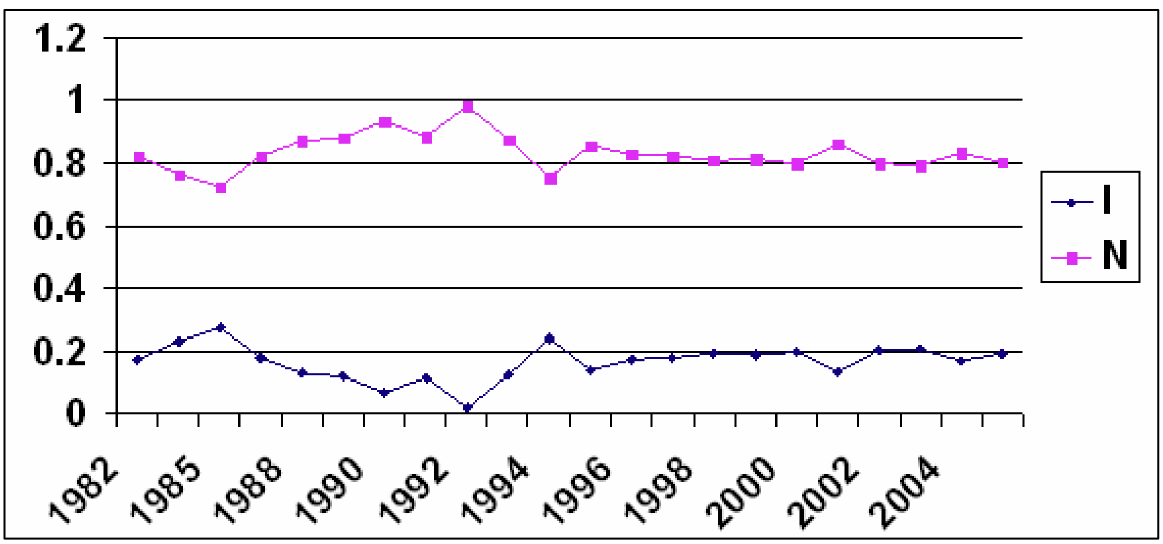


Figure 4.10-5. Mean relative cover of native (N) and introduced (I) species (1982–2005) using data from the original 15 plots installed by Dr. Christiansen (Williams 2007).

Native Species Diversity

Native species richness for prairie communities at HEHO has remained reasonably stable during the monitoring period from 2004 to 2009, averaging between 21 and 26 species per site (Figure 4.10-6a). This level is lower than that of other HTLN units with prairie vegetation, reflecting the disturbance history of the site. In 2009, mean native species richness was slightly below 85% of the 2004 reference level. However, this was still within the 90% confidence interval for 2004. These results indicate the indicator is in good condition with an unchanging trend.

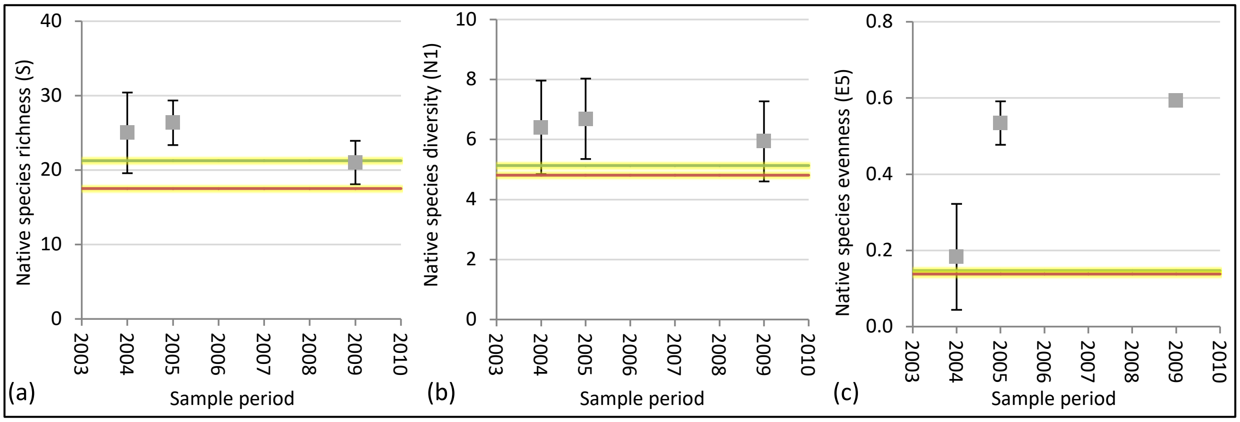


Figure 4.10-6. Estimates of native species richness (left), diversity (center), and evenness (right) for HEHO. Error bars represent 90% confidence intervals around the mean (James 2011).

A similar pattern is observed for native species diversity (measured by Hill's N1), which averaged between 5.9 and 6.7 "abundant species" (Figure 4.10-6b). In contrast, native species evenness, as measured by Hill's E5, shows an apparent increasing trend, and was highest in 2009 (Figure 4.10-6c). With the exception of 2009 S values, prairie vegetation sites have maintained a mean richness of > 85% of the 2004 reference point in all subsequent years. The overall result indicates good condition and an unchanging trend. Confidence in the assessment is medium due to the relatively short period represented by the data and uncertainties related to reference condition.

<u>Structure</u>

Historic data shows that approximately 11 years after the prairie restoration, warm-season grasses comprised approximately 85% of relative plant cover. By about 24 years after restoration (1995), relative cover of warm season grasses had declined steadily with concurrent increases in summer and fall forbs (Figure 4.10-7). Both dominant functional groups show a high level of stability since then, both averaging between 40 and 50% relative cover. Non-native forbs and graminoids and many other functional groups are generally a minor component of prairie community structure at HEHO (Figure 4.10-7).

Native graminoids typically account for about 46% of the cover values of all native non-woody plant species combined. Relative proportions are somewhat variable between years, but generally stable (Figure 4.10-8). In all years, the native graminoid/native forb split included at least 20% of each functional group, indicating good condition with an unchanging trend. The contribution of woody species to prairie structure at HEHO is less than 8% in all monitoring years (Figure 4.10-9), well below the threshold of concern. These metric indicates that vegetation structure is in good condition with an unchanging trend.

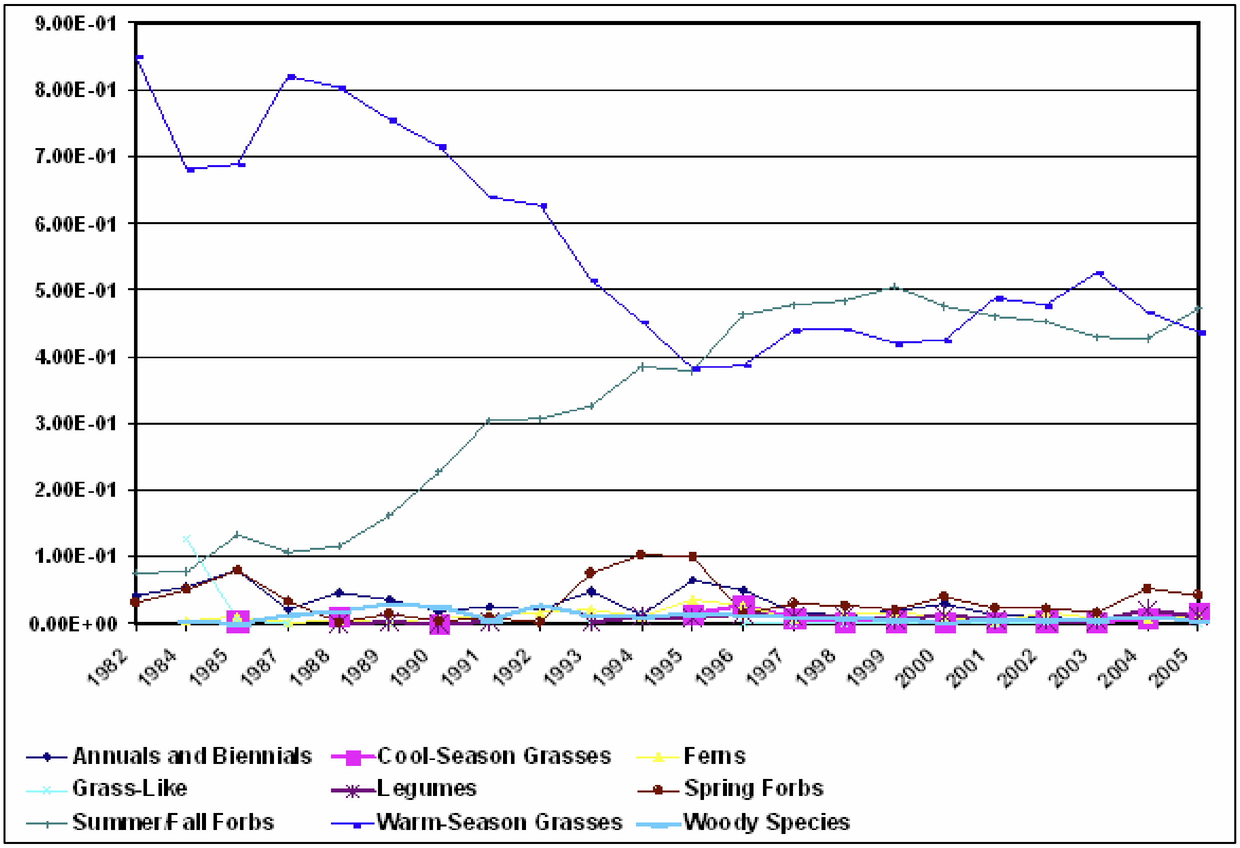


Figure 4.10-7. Mean relative cover of functional plant groups (1982–2005) using data from the original 15 plots installed by Dr. Christiansen and reported in Williams (2007). Y-axis values are labeled as exponents and range from 0–90% relative cover.

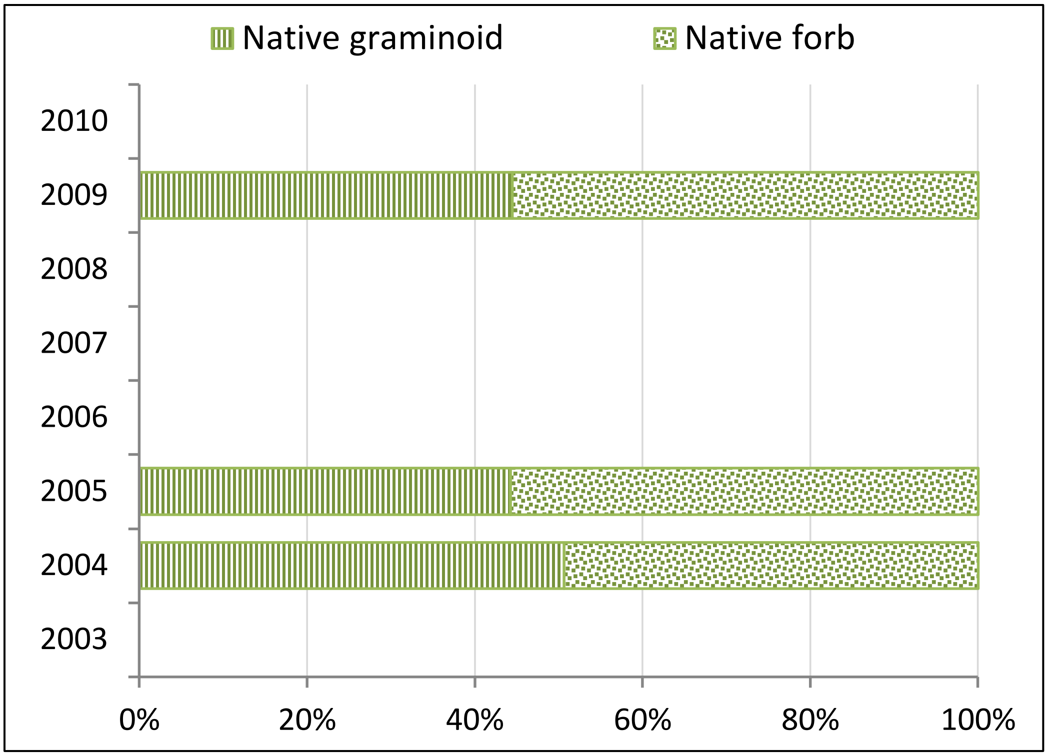


Figure 4.10-8. Percent cover of native forbs and graminoids at HEHO as a proportion of the combined total cover of the two functional groups in 2004, 2005 and 2009.

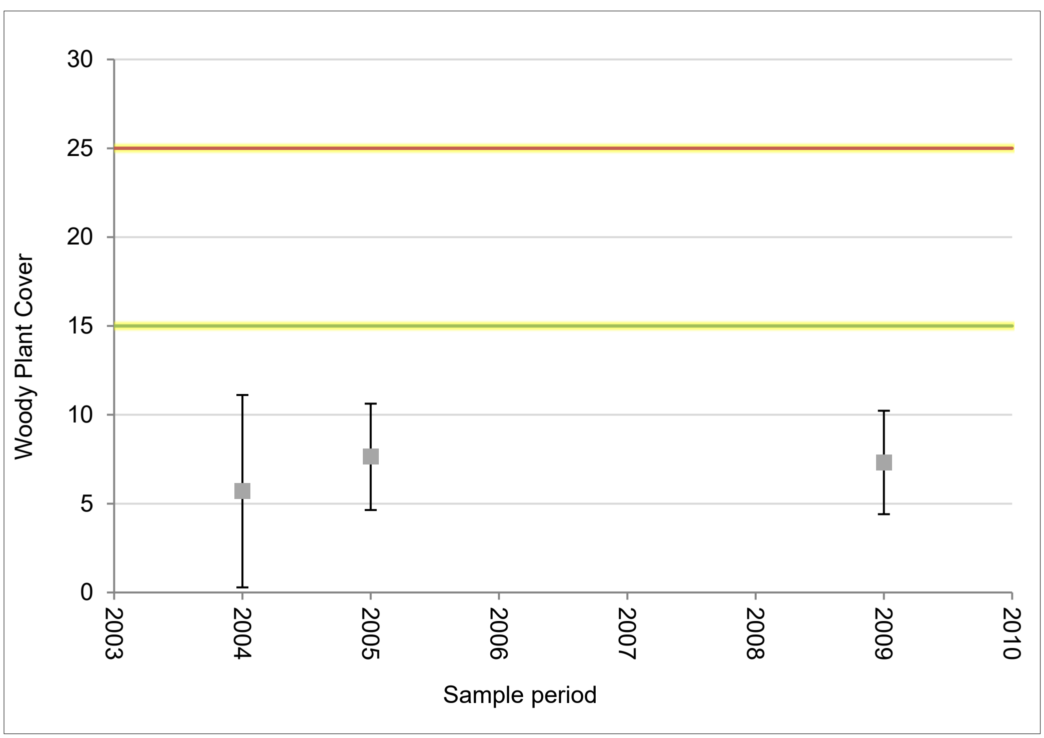


Figure 4.10-9. Mean percent woody plant cover at HEHO during monitoring years 2004–2009. Error bars represent 90% confidence intervals around the mean. Upper (red) line represents significant concern condition threshold; lower (green) line represents the upper threshold for good condition.

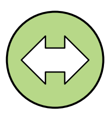
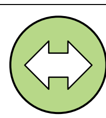
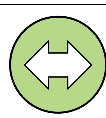
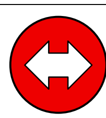
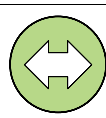
Invasive Exotic Plants

Invasive exotic plants (IEP) at HEHO are evaluated in section 4.11 of this report. Six IEP species are present with high frequency and cover. The invasive grasses reed canarygrass and smooth brome are present throughout the park and may degrade the function of native grasslands. A significant portion of search units have more than 5 IEP species present. Five Iowa state-listed noxious weeds were present in 2009 with combined coverage exceeding 1% of the park. The lack of more than two years of monitoring data, the and low confidence associated with defining reference conditions result in a medium level of confidence for the indicator. Because of the number, frequency, and abundance of IEP species at HEHO, including five state-listed noxious weeds, this indicator warranted significant concern with an unchanging trend.

Overall Condition and Trend

Values for the native species diversity measures are generally good, and appear to be unchanging. Community composition and vegetation structure metrics also indicate good condition of prairie vegetation at HEHO, with an unchanging trend. Invasive exotic plant species warrant significant concern with an unchanging trend. The overall condition of prairie vegetation at HEHO is good, and is unchanging for the time period covered by this assessment (Table 4.10-3). Although the prairie is rated in good condition, there is some risk associated with expansion of nonnative invasive plants. Confidence in the assessment is medium due to small sample sizes and uncertainties regarding the condition rating thresholds.

Table 4.10-3. Condition and trend summary for prairie vegetation at Herbert Hoover National Historic Site.

Indicator	Condition Status/Trend	Rationale
Community composition		All prairie sites have maintained a mean of at least 80% cover of native plant species.
Native species diversity		Native species richness for prairie communities at HEHO has remained reasonably stable, averaging 21–26 species per site, and about 6–7 abundant species. Species evenness may be increasing.
Vegetation structure		Native forbs and graminoids are generally well represented in prairie sites, and levels of woody vegetation cover are below 15%..
Invasive exotic plants		The number, frequency, and abundance of IEP species at HEHO, including five state-listed noxious weeds, results in a rating of significant concern.
Overall Condition and Trend for Prairie Vegetation		**The prairie vegetation condition is good with an unchanging trend. Confidence in the assessment is medium.**

4.10.5. Uncertainty and Data Gaps

Restoration and maintenance of prairie communities at HEHO is extremely challenging given the effects of nonnative invasives and altered disturbance regimes. High variability in sample data due to interannual weather differences, phenology and small sample sizes can make it difficult to interpret data and detect statistically significant changes or lack thereof over time. Modifying the sampling design to increase statistical sensitivity to changes in the resource may better help managers to adapt management approaches accordingly. Further discussion of condition thresholds for various indicators would help to refine condition rating as well as specific prairie management objectives.

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4.11. Invasive Exotic Plants

4.11.1. Background and Importance

The terms non-native, alien, and exotic are all used to describe species that have been introduced to an area. Introduced species vary widely in their potential to cause harmful changes to ecosystems; most non-native species are not invasive, although they are usually indicative of some type of disturbance. Executive Order (EO) 13112 (1999) defines an invasive species as "…an alien (or non-native) species whose introduction does, or is likely to cause economic or environmental harm or harm to human health." Under the EO, federal agencies are directed to prevent introductions, provide control and minimize the economic, ecologic and human health impacts of invasive species. Invasive species include all taxa of organisms, not just plants. These species can degrade habitat quality by displacing native species that provide important food, nesting material, or cover (e.g., Jakle and Gatz 1985, Trammel and Butler 1995). Wilcove et al. (1998) identified the spread of alien species as the second most important threat to biodiversity in the U.S. Heavy infestation of non-native species can also alter fire, soil water, and nutrient dynamics (Sheley and Petroff 1999). Finally, severe infestations can hamper recreational activities, detract from visitor experiences, and present a significant challenge to the NPS directive to maintain natural resources unimpaired for future generations (NPS 2009, 2013).

Monitoring of invasive exotic plants is a priority for parks within the Heartland Inventory and Monitoring (I&M) Network. During the vital signs selection process in 2003, invasive exotic plants were identified as the most important management issue for Herbert Hoover National Historic Site (HEHO) (Young et al. 2007). Invasive exotic plants are spread into NPS units by various pathways, including roads, trails, and riparian corridors (Young et al. 2007). The number of non-native plant species is often correlated with visitation levels and extent of backcountry trails and riparian areas (Allen et al. 2009).

Invasive exotic plants are of concern for HEHO because they are a threat to the restored prairie at the site. Highly invasive exotic plants that are well established include crownvetch (*Securigera varia*), reed canarygrass (*Phalaris arundinacea*), smooth brome (*Bromus inermis*), and sweetclover (*Melilotus officinalis*). Management plans at HEHO include objectives of controlling invasive plants and replanting native species along drainages within the restored prairie. In 2009, the park used a combination of chemical and mechanical methods (mowing and hand-pulling) to control invasive plant species (Young et al 2010). In 2011, the Heartland Network Exotic Plant Management Team supported a seasonal biotechnician and Conservation Corps of Iowa (CCI) staff to control reed canarygrass prior to planting the sites with a mixture of native warm season grasses such as big bluestem (*Andropogon gerardii*) and native forbs. The Team also supported follow-up treatments in 2012 to control re-establishing reed canarygrass (Beard and App 2012).

<u>Threats and Stressors</u>

Threats to the condition of HEHO from the presence of invasive exotic plant species include 1) the alteration of native species dominance and loss of rare species, 2) changes in nutrient cycles, soil chemistry, and water availability, and 3) overall shifts in community productivity.

Indicators and Measures

We assessed the condition of invasive exotic plants at HEHO by evaluating:

- Introduced exotic plant frequency
- Introduced exotic plant abundance
- Introduced exotic plant distribution
- State noxious weed presence/status

4.11.2. Data and Methods

The Heartland I&M Network has developed an invasive exotic plant monitoring protocol (Young et al. 2007) that uses a prioritization database for species to be monitored on network parks. High priority exotic plants are designated based on a consensus of state and regional exotic plants lists. The process helps identify those exotic plant species that are likely to be highly invasive in natural areas. HEHO has three watch lists: 1) the early detection watch list, identifying high priority species known to occur in the state but not known to occur in the park based on the NPSpecies database; 2) the park-established watch list, containing high priority species known to occur in the unit based on the NPSpecies database; and 3) the park-based watch list, which includes plants selected by park managers or network staff and that may not have been included on the other lists due to incomplete information in NPSpecies or USDA Plants databases (e.g., state distribution information was inaccurate) or due to differing opinions regarding network designation of a plant as a high priority (Table 4.11-1). Twelve of the park-listed species are considered noxious weeds by the state of Iowa: *Carduus nutans, Cirsium arvense, C. vulgare, Daucus carota, Dipsacus fullonum, D. laciniatus, Euphorbia esula, Lythrum salicaria, Plantago lanceolata, Rhamnus cathartica, Rosa multiflora,* and *Sonchus arvensis.* Of those 12 listed, six (*Cirsium arvense, Cirsium vulgare, Daucus carota, Rhamnus cathartica, Rosa multiflora,* and *Sonchus arvensis* were documented at the park in 2013. Although aquatic species are included on the watch lists, surveys have focused on terrestrial communities, only occasionally documenting aquatics.

Table 4.11-1. Watch lists for invasive exotic plants at HEHO.

Watch List	Scientific Name	Common Name
NPS early detection watch list	*Ailanthus altissima*	Tree of heaven
	Alliaria petiolata	Garlic mustard
	Alnus glutinosa	European alder
	Azolla spp.	Mosquito fern
	Berberis thunbergii	Japanese barberry
	Carduus nutans	Musk thistle
	Celastrus orbiculatus	Oriental bittersweet
	Centaurea biebersteinii	Spotted knapweed
	Centaurea solstitialis	Yellow star-thistle
	Dipsacus fullonum	Fuller's teasel

Table 4.11-1 (continued). Watch lists for invasive exotic plants at HEHO.

Watch List	Scientific Name	Common Name
NPS early detection watch list (continued)	*Dipsacus laciniatus*	Cutleaf teasel
	Euonymus alata	Burning bush
	Euphorbia esula	Leafy spurge
	Frangula alnus	Glossy buckthorn
	Holcus lanatus	Common velvetgrass
	Humulus japonicus	Japanese hop
	Hydrilla verticillata	Waterthyme
	Hyoscyamus niger	Black henbane
	Lespedeza bicolor	Shrub lespedeza
	Lespedeza cuneata	Sericea lespedeza
	Ligustrum vulgare	European privet
	Schedonorus phoenix	Tall fescue
	Schedonorus pratensis	Meadow fescue
	Lonicera maackii	Amur honeysuckle
	Lysimachia nummularia	Creeping jenny
	Lythrum salicaria	Purple loosestrife
	Myriophyllum spicatum	Eurasian watermilfoil
	Phragmites australis	Common reed
	Plantago lanceolata	Narrowleaf plantain
	Poa compressa	Canada bluegrass
	Polygonum cuspidatum	Japanese knotweed
	Populus alba	White poplar
	Potamogeton crispus	Curly pondweed
	Rhamnus cathartica	Common buckthorn
	Securigera varia	Crownvetch
	Sorghum halepense	Johnsongrass
	Torilis arvensis	Spreading hedgeparsley
	Typha angustifolia	Narrowleaf cattail
	Viburnum opulus	European cranberrybush
	Vinca minor	Common periwinkle
Park-established watch list	*Abutilon theophrasti*	Velvetleaf
	Acer platanoides	Norway maple
	Calystegia sepium	Hedge false bindweed
	Chenopodium album	Lambsquarters
	Daucus carota	Queen Anne’s lace
	Elymus repens	Quackgrass

Table 4.11-1 (continued). Watch lists for invasive exotic plants at HEHO.

Watch List	Scientific Name	Common Name
Park-established watch list (continued)	*Dactylis glomerata*	Orchardgrass
	Elaeagnus angustifolia	Russian olive
	Elaeagnus umbellata	Autumn olive
	Glechoma hederacea	Ground ivy
	Hesperis matronalis	Dames rocket
	Lonicera morrowii	Morrow's honeysuckle
	Lonicera tatarica	Tatarian honeysuckle
	Lotus corniculatus	Bird's-foot trefoil
	Melilotus officinalis	Sweetclover
	Morus alba	White mulberry
	Pastinaca sativa	Wild parsnip
	Phalaris arundinacea	Reed canarygrass
	Phleum pratense	Timothy
	Poa pratensis	Kentucky bluegrass
	Potentilla recta	Sulphur cinquefoil
	Robinia pseudoacacia	Black locust
	Rosa multiflora	Multiflora rose
	Solanum dulcamara	Climbing nightshade
	Ulmus pumila	Siberian elm
	Verbascum thapsus	Common mullein
Park-based watch list	*Abutilon theophrasti*	Velvetleaf
	Acer platanoides	Norway maple
	Calystegia sepium	Hedge false bindweed
	Chenopodium album	Lambsquarters
	Daucus carota	Queen Anne's lace
	Elymus repens	Quackgrass
	Euonymus atropurpureus	Burningbush
	Polygonum spp.	Knotweed
	Sonchus arvensis	Field sowthistle
	Trifolium hybridum	Alsike clover
	Trifolium pratense	Red clover

Sampling of invasive exotic plants at HEHO took place in 2006, 2009 and 2013. For relatively small parks such as HEHO, the HTLN protocol specified that exotic plant search units be created by dividing park management units into search units that were generally 1–3 ac (0.4–1.2 ha) in size with a target size of 2 ac. At HEHO, this resulted in 50 search units with sizes ranging between 0.372–

3.468 ac (0.15–1.4 ha) with a mean size of 1.67 ac (0.68 ha) representing 83.7 ac (33.9 ha) within the park (Figure 4.11-1).

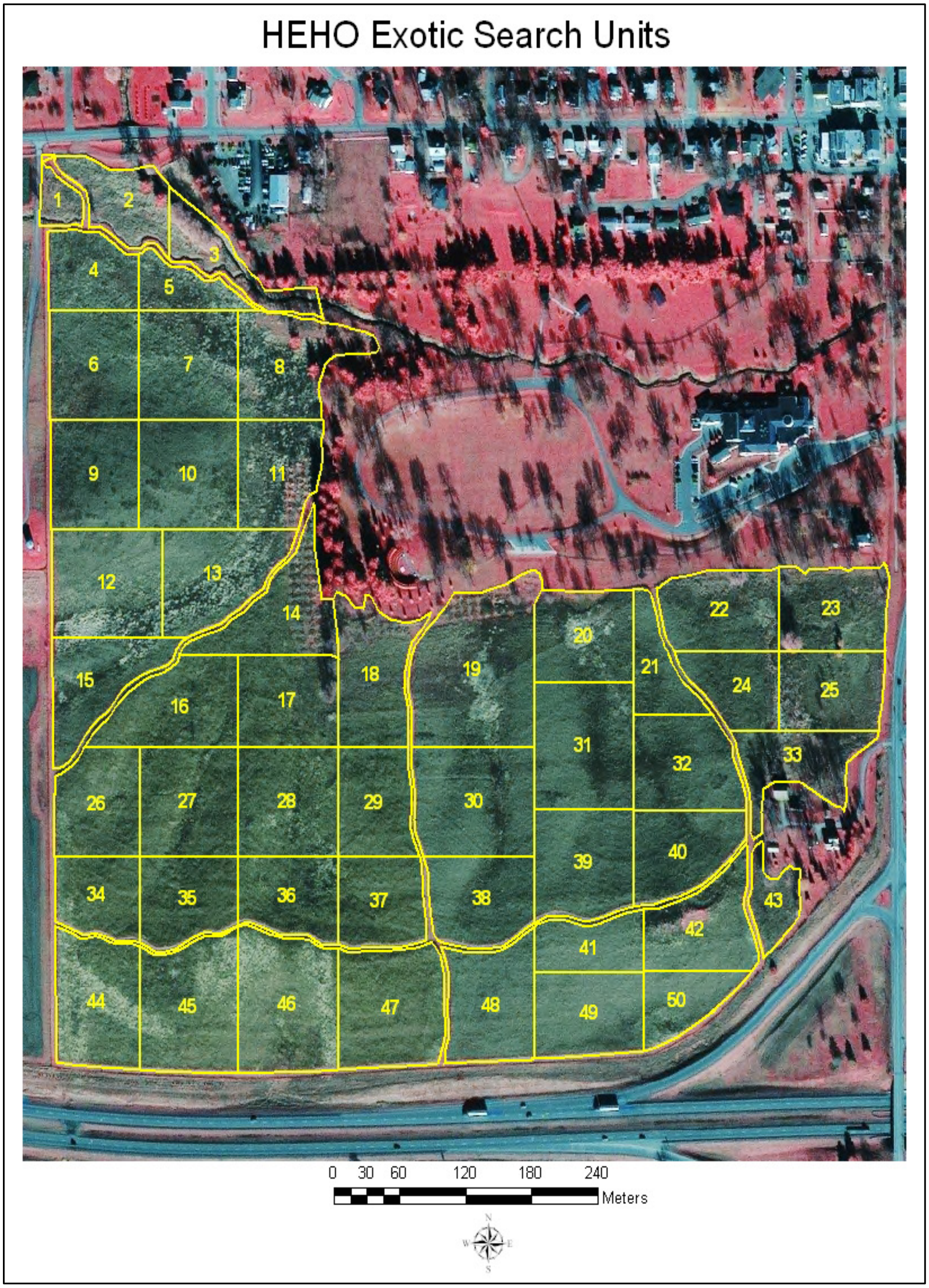


Figure 4.11-1. Exotic plant search units at HEHO (Young et al. 2007).

Within each search unit, three equally spaced east-west belt transects 3 to 12 m wide are surveyed, and canopy cover classes are estimated (Young et al. 2007). Cover classes were: 0 = 0, 1 = 0.1–0.9 m^2, 2 = 1–9.9 m^2, 3 = 10–49.9 m^2, 4 = 50–99.9 m^2, 5 = 100–499.9 m^2, 6 = 499.9–999.9 m^2, and 7 ≥ 1,000 m^2). The widest belt possible given site conditions was used. Entire polygons were not searched. A park-wide cover range was estimated using the high and low values of the cover classes for each invasive exotic plant encountered. A minimum cover estimate was calculated as the sum of lower endpoints of cover classes divided by the calculated maximum area searched (36.5 ac, 14.8 ha, or 43.7% of the Historic Site), resulting in a park-wide estimate of the lowest possible cover within the greatest possible area searched.

Likewise, the maximum cover estimate was calculated as the sum of cover class upper endpoints divided by the calculated minimum area searched (10.9% of the Historic Site), representing an estimate of the highest possible cover within the smallest area searched. These minimum and maximum cover estimates provide an estimated range of cover that accounts for the uncertainty arising from the sampling method (Young et al. 2010). Monitoring began in 2006, and was repeated in 2009 and 2013. Frequency and cover data were abstracted from Young et al. (2010) for 2006 and 2009 surveys, and from Young and Bell (2013) for 2013 data. Changes in cover by search unit were evaluated using data provided by Heartland I&M Network staff. Cover classes were converted to midpoints and summed across species for each search unit.

4.11.3. Reference Conditions

The ideal condition for HEHO would be the complete absence of non-native species, representing conditions during pre-settlement times. Because this type of reference condition is not feasible for a unit with the history of HEHO, we instead consider a baseline reference condition as conditions under which the integrity of plant communities remains essentially unimpaired and natural processes that are affected by species composition are able to operate within the natural range of variation.

We used a three-class condition scale to evaluate the condition and trend for invasive plants (Table 4.11-2 and Table 4.11-3). A good condition rating is achieved under conditions where IEP species are present but at generally low frequency and cover, and only in isolated patches. Conditions where many IEP species are present with widespread and substantial cover for some species indicate a condition warranting significant concern. Because species numbers and distribution are variable from year to year even in the absence of control efforts, we focused our trend evaluation on the largest change classes, instead of on those of a few percentage points. A combined change in cover of more than 500 percentage points for all species sampled in the polygon is used to indicate a “substantial” increase or decrease.

Table 4.11-2. Reference condition rating framework for invasive exotic plants at HEHO.

Condition	Frequency	Abundance	Distribution	State Noxious Weeds
Good	In the most recent monitoring period, no IEP species are present with > 50% frequency	In the most recent monitoring period, no IEP species are present with estimated cover range that exceeds 15% of total park acres	In the most recent monitoring period, < 10% of search units have > 5 IEP species present	No state noxious weed species are present
Moderate Concern	In the most recent monitoring period, a few IEP species (1–3) are present with > 50% frequency	In the most recent monitoring period, a few IEP species (1–3) are present with cover range that exceeds 15% of total park acres	In the most recent monitoring period, > 10% of search units have > 5 IEP species present, AND < 25% have 10 or more IEP species present	1–3 state noxious weed species are present, AND state noxious weed species acreage is < 1% of park area
Significant Concern	In the most recent monitoring period, many IEP species (> 3) are present with > 50% frequency	In the most recent monitoring period, many IEP species (> 3) are present with cover range that exceeds15%of total park acres	In the most recent monitoring period, > 25% of search units have 10 or more IEP species present	More than 3 state noxious weed species are present OR state noxious weed species acreage is > 1% of park area

Table 4.11-3. Reference trend rating framework for invasive exotic plants at HEHO.

Trend		Change in IEP Cover
Improving	⇧	25% or more of search units have a substantial decrease in IEP cover AND fewer than 15% have a substantial increase in IEP cover
Unchanging	⇔	> 75% of search units have no substantial increase or decrease in IEP cover AND < 25% of search units have a substantial decrease in IEP cover
Deteriorating	⇩	> 25% of search units have a substantial increase in IEP cover

4.11.4. Condition and Trend

Frequency

A cumulative total of 27 IEP species were detected at HEHO during the three monitoring periods. Several species previously detected (*Elymus repens, Carduus nutans, Calystegia sepium*, *Trifolium pretense*, *Chenopodium album* and *Phleum pratense*) were not found during monitoring in 2013. Two species (*Rhamnus cathartica* and *Dactylis glomerata*) not found in 2009 were documented in 2013. Seven species (*Melilotus officinalis, Poa* spp., *Lonicera* spp., *Pastinaca sativa*, *Bromus inermis*, *Daucus carota* and *Phalaris arundinacea*) were present with frequencies above 50% (Figure

4.11-2). Frequencies for 13 species increased from 2009 to 2013, while 14 decreased. Results for this indicator warrant significant concern, with an improving trend and medium confidence.

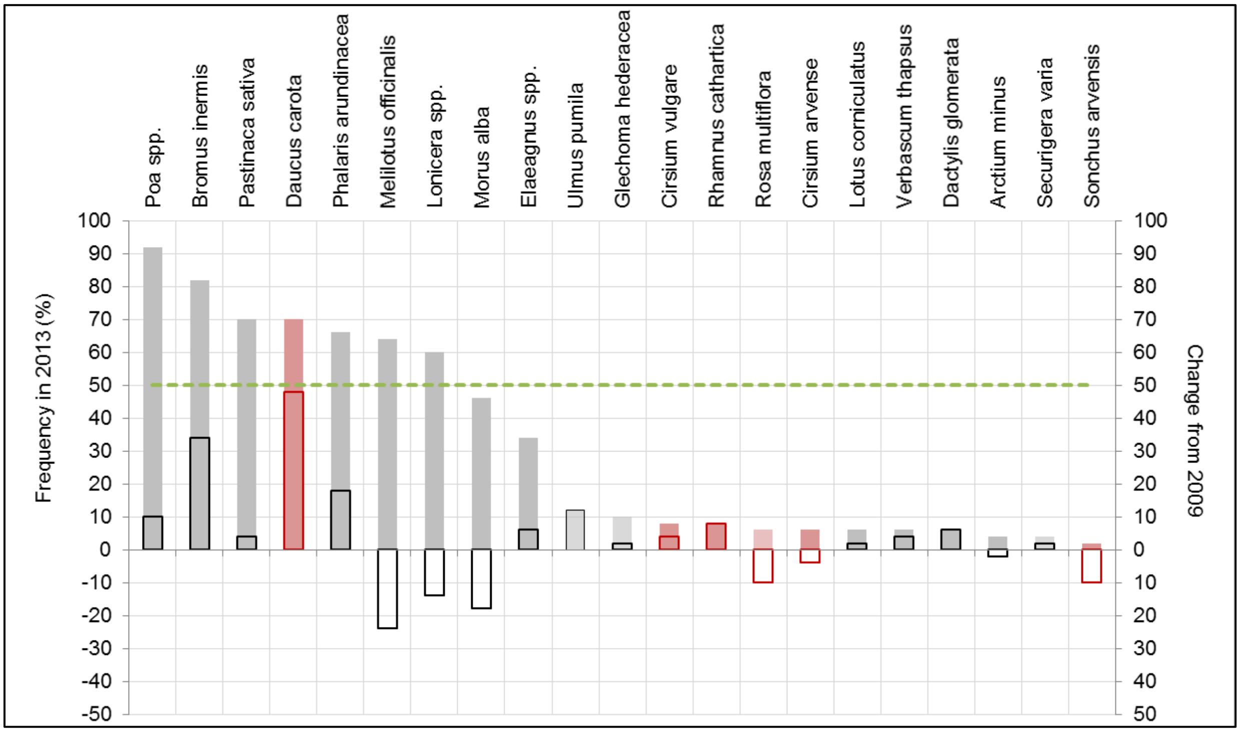


Figure 4.11-2. Frequency of IEP species at HEHO in 2013 (solid bars), and change in frequency from 2009 (open bars). Species sorted by decreasing percent frequency. The 50% frequency threshold (see text) is indicated by a dashed line. Values for Iowa state-listed noxious species are shown in red.

<u>Abundance</u>

Estimated cover ranges of IEP as reported by Young and Bell (2013) indicate that *Phalaris arundinacea* and *Bromus inermis* are the most abundant IEP species at HEHO, with cover exceeding 15% of the total undeveloped acreage of the Historic Site (Figure 4.11-3). Change in IEP cover range values was mixed, with a number of the more abundant species decreasing in cover range. Results for this indicator warrant moderate concern, with an unchanging trend and medium confidence level.

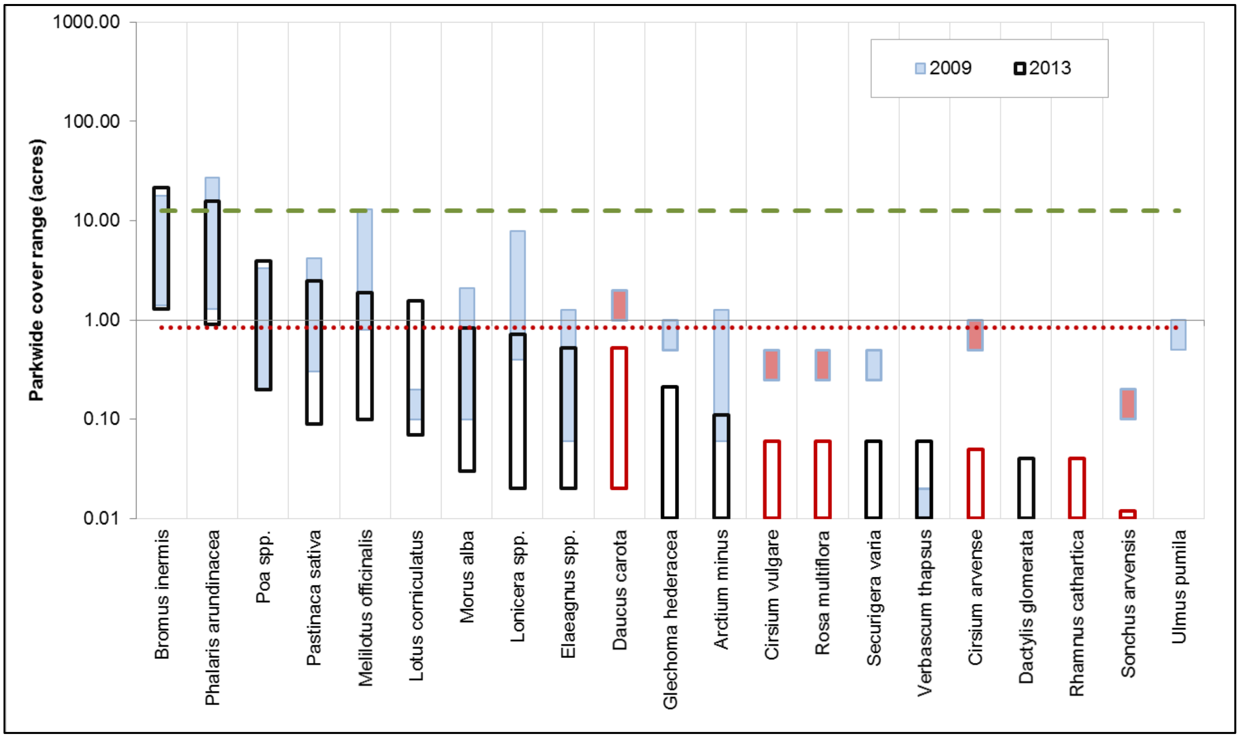


Figure 4.11-3. Cover ranges of IEP species at HEHO in 2009 and 2013. Species sorted by decreasing 2013 cover acreage (note log scale). The 15% cover threshold for all IEP species (see text) is indicated by a dashed line. Values for Iowa state-listed noxious species are shown in red and the 1% state-noxious cover threshold is shown as a dotted line.

Distribution

There are no search units at HEHO without IEP species present (Figure 4.11-4, left). Almost two thirds (62%) of all search units have 6–10 IEP species. One unit has 1–5 species, and all of the other search units (36%) have more than 10 IEP species. Five search units (10%) had a substantial increase in IEP cover (Figure 4.11-4, right), and 14 search units (28%) had a substantial decrease in IEP cover. The majority of search units (62%) were stable. Results for this indicator warrant moderate concern, with an improving trend and medium confidence level.

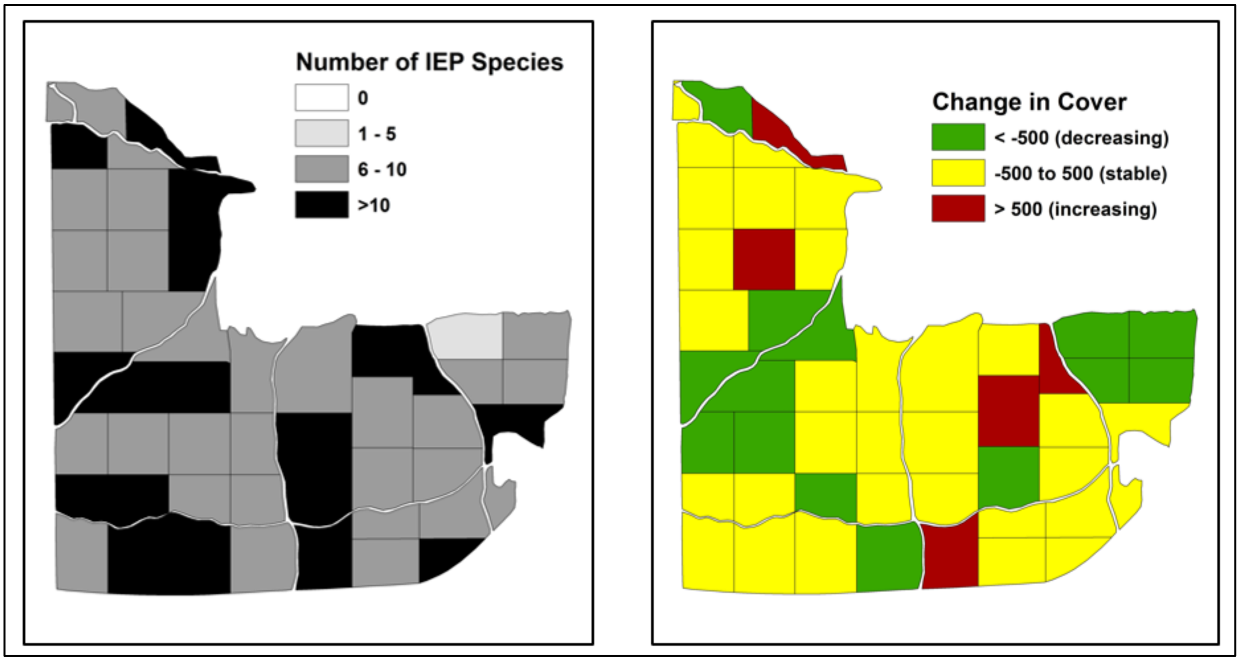


Figure 4.11-4. Number of IEP species by search unit in 2013 (left) and net change in cover class of each species (summed) between 2009 and 2013 (right) (Young and Bell 2013).

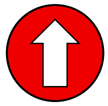
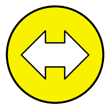
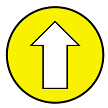
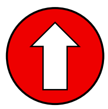
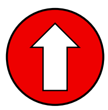
State Noxious Weeds

Six Iowa state-listed noxious weed species (*Cirsium arvense, C. vulgare, Daucus carota, Rosa multiflora, Rhamnus cathartica* and *Sonchus arvensis*) were present in 2013 (Figure 4.11-2), with a combined cover of 0.6 ac, 0.2 ha or 1.1% of the total Historic Site acreage. Cover for state-listed noxious weed species showed a decrease, while IEP frequencies (especially *Daucus carota*) generally showed an increase. *Carduus nutans* and *Rhamnus cathartica* were detected in 2006 but not in 2009; *Rhamnus cathartica* reappeared in 2013. Results for this indicator warrant significant concern, with an improving trend and medium confidence level.

Overall Condition and Trend

The IEP monitoring data is rich in spatial and non-spatial information, and presents challenges in determining an overall rating for the Historic Site. Trends in individual species are more straightforward to assess and interpret than composition changes due to multiple species and abundances. Based on the four indicators evaluated, the condition of the Historic Site warrants significant concern with an improving trend (Table 4.11-4). Six IEP species are present with high frequency and cover. Two invasives, reed canarygrass and smooth brome, are present throughout the park and may degrade the function of native grasslands. All but one search units have more than 5 IEP species present. Six Iowa state-listed noxious weeds were present in 2013 with combined coverage exceeding 1% of the park. The low confidence associated with defining reference conditions result in a medium level of confidence for the resource.

Table 4.11-4. Condition and trend summary for invasive/exotic species at Herbert Hoover National Historic Site.

Indicator	Condition Status/Trend	Rationale
Frequency		Seven IEP species are present with high frequency. The invasive grasses reed canarygrass and smooth brome are present throughout the park and may degrade the function of native grasslands.
Abundance		One IEP species (smooth brome) has an estimated cover range just under 25% of the total acreage of the Historic Site, and reed canarygrass is well over 15%. These IEP species may affect the capacity of native grasslands to recover from disturbance.
Distribution		All but one search unit has more than 5 IEP species present, indicating that IEP species are widespread within most of the park.
State noxious weeds		Six Iowa state-listed noxious weeds were present in 2013, with combined coverage exceeding 1% of the park.
Overall Condition and Trend for Introduced Exotic Species		**The overall condition warrants significant concern with an improving trend; confidence in the assessment is medium.**

4.11.5. Uncertainties and Data Gaps

The available data reflects intensive surveys covering all areas of the park and addressing park-based watch lists. Spatial and temporal resolution of the data is high.

4.11.6. Sources of Expertise

- Craig Young, Biologist and Invasive Plant Program Leader, NPS Heartland I&M Network provided helpful reviews and clarifications on HTLN methodologies and sampling designs.

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4.12. Aquatic Macroinvertebrates

4.12.1. Background and Importance

Macroinvertebrates are organisms that are visible to the naked eye. Aquatic macroinvertebrates complete all or part of their life cycle in water, and because of this are dependent on water quality (NYNRM 2013). Aquatic macroinvertebrates are an important component in the ecology of a water body because they are an essential part of the food chain in aquatic environments. Aquatic macroinvertebrates are often used as indicators of water quality and overall watershed health (EPA 2013). Some species are tolerant of pollution or poor water quality, while others are highly sensitive to it. The presence or absence of tolerant and intolerant taxa can therefore be an indication of a water body's condition and water quality (EPA 2013). Species diversity can also be an indicator of habitat health, as a diverse habitat with more ecological "niches" can generally support more species. For these reasons, aquatic macroinvertebrate indices are included in this condition assessment to indicate aquatic habitat diversity and suitability, condition of natural processes, and also as a proxy for water quality. Physical and chemical water quality attributes are examined in the Water Quality section of this report.

Stonefly nymph. Stonefly nymphs are especially sensitive to changes in water quality (NPS 2010).

An unnamed tributary of the west branch of Wapsinonoc Creek, known unofficially as Hoover Creek, runs through the Herbert Hoover National Historic Site (HEHO). Hoover Creek drains about 1,752 ac of agricultural, rural residential, and urban land. The Hoover Creek watershed has been dominated by agricultural land use since the mid-1800s. Agricultural land in the watershed is tiled (drained with perforated pipes) and development has pressed close to the stream banks during the last century. Approximately 250 m of the upstream portion of the creek flows adjacent to an 81-acre restored tallgrass prairie, but the downstream portion of the creek drains some impervious surfaces and managed lawn within the historic site. In recent years, agricultural land use has declined as the city of West Branch expands into the watershed creating a more urban landscape in the vicinity of HEHO. Such land use changes have dramatically altered the water quality and stream hydrology throughout the watershed by creating more dynamic surface water flow regimes. This encourages flashiness during peak flows and poses a threat to historic structures and many cultural resources in the flood plain. Flashy flows or a rapid stream rise following modest rainfall can have dramatic effects on channel morphology and biological integrity by increasing erosion within the stream and decreasing the stability, quality, quantity, and diversity of microhabitats. The banks of Hoover Creek in HEHO are largely eroded due to incision and the frequent floods that occur there.

The NPS Heartland Inventory and Monitoring Network (HTLN) began monitoring water quality and invertebrate community structure in Hoover Creek in 2008 (Bowles et al. 2008). The monitoring objectives of the program, as described by DeBacker et al. (2005), are to: 1) determine the status and trends of invertebrate species diversity, abundance, and community metrics; and 2) relate the invertebrate community to overall water quality through quantification of metrics related to species richness, abundance, diversity, and region-specific multi-metric indices as indicators of water quality and habitat condition. This report will summarize baseline aquatic invertebrate monitoring data collected in 2008 and subsequent data collected in 2011 using the framework of the monitoring protocol in the context of reference conditions described below.

Threats and Stressors

Hoover Creek has degraded water quality from both point and non-point pollution sources (Foreman 2007). There are several tile lines that drain into the creek within the jurisdictional boundaries of the historic site. Water quality parameters for Hoover Creek that have violated state and/or federal standards include nitrate + nitrite nitrogen, total Kjeldahl nitrogen, turbidity, dissolved oxygen, and bacteria. Periodic sampling of Hoover Creek indicates that the creek previously violated state standards for bacteria and nitrate-nitrogen with bacteria levels of 39,000 colony forming units (CFU)/100 ml and nitrate-nitrogen concentrations that exceed 20 mg/L. Foreman (2007) reported the primary source of the fecal contamination comes from leaking septic systems or gray-water lines within the Historic Site. Hoover Creek is listed as an impaired stream under Section 303(d) of the Clean Water Act (IDNR 2010).

Indicators and Measures

Richness and Diversity

- Genus Richness
- Genus Evenness
- EPT Richness
- EPT Ratio
- Shannon Index (or Shannon-Weiner Index)
- Pollution Tolerance

- Hilsenhoff Biotic Index (HBI)

4.12.2. Data and Methods

Methods and procedures used in this report follow the Monitoring Protocol for Aquatic Invertebrates of Small Streams in the Heartland Inventory & Monitoring Network (Bowles et al. 2008). Samples were collected at one reach of Hoover Creek in 2008 and 2011. Three successive riffles were sampled with three benthic invertebrate samples collected at each riffle, resulting in nine samples each year. A Surber stream bottom sampler (500 µm mesh, 0.09 m^2) was used to collect the samples. Samples were sorted in the laboratory following a subsampling routine described in Bowles et al. (2008). Taxa were identified to the lowest practical taxonomic level (usually genus) and counted. Metrics calculated for each sample included genus richness, Shannon diversity index, EPT (Ephemeroptera, Plecoptera, Trichoptera) richness, EPT ratio (EPT density/(EPT density + Chironomidae density)), genus evenness (where 0 = minimum evenness, 1 = maximum evenness), and Hilsenhoff biotic index (HBI) (Bowles et al. 2008). For details on calculating and interpreting metrics used in this report refer to Bowles et al. (2008). High values are preferred for all metrics, except for HBI, where smaller values indicate better habitat. An increase in HBI values over time is undesired, and would reflect the community's increasing tolerance to disturbance.

The intent of the HTLN monitoring program is to monitor community condition within a site over time and not make comparisons within the site (Bowles et al. 2008). Because only two years of data exists, the range of variability over time is unknown, and a statistical analysis of trends in the data is not performed.

4.12.3. Reference Conditions

Due to the lack of data prior to 2008 for Hoover Creek, comparisons will be made from the aquatic macroinvertebrate assemblages and biological condition of other small, Midwestern plains streams such as those examined by Wilton (2004), and aquatic invertebrate monitoring reports for other HTLN parks. Data for the initial sampling year of 2008 and subsequent sampling in 2011 are shown in Table 4.12-1. The framework for determining resource condition ratings is shown in Table 4.12-2. These ratings are based on reference values obtained from best available data.

Table 4.12-1. Means and ranges for invertebrate metrics collected from Hoover Creek, Herbert Hoover National Historic Site in 2008 and 2011. N = 9 (Bowles et al. 2010).

	2008		2011	
Metric	**Site Mean**	**Range**	**Site Mean**	**Range**
Genus richness	13.9	12.7–14.7	12.8	11.3–15.3
EPT richness	4.67	4.3–5.0	4.78	4.0–5.7
EPT ratio	0.40	0.1–0.6	0.6	0.3–0.8
Shannon Index	1.75	1.8–2.2	1.90	1.6–2.2
Genus evenness	0.66	0.5–0.8	0.74	0.6–0.8
Hilsenhoff Biotic Index	5.80	5.4–6.3	5.2	4.6–5.9

Table 4.12-2. Resource condition indicator rating framework for aquatic macroinvertebrate communities at Hoover Creek at HEHO.

Indicator	Good Condition	Warrants Moderate Concern	Warrants Significant Concern
Genus richness[A]	> 15	7–15	< 7
EPT richness[B]	> 14	8–14	< 8
EPT ratio[C]	> 0.75	0.25–0.75	< 0.25
Shannon index[D]	> 2.5	1–2.5	< 1
Genus evenness	Unknown	Unknown	Unknown
Hilsenhoff Biotic Index[E]	0.00–4.25	4.26–6.50	6.51–10.00

[1] Bowles 2009: values for these metrics were obtained by combining the author's valuation of Pipestone Creek (used as a proxy for Hoover Creek) as "mildly impaired" with values of these metrics from 1989–2007.

[2] Bukantis 1998

[3] State of Vermont 2008: values from this report are from a small, high gradient stream and are used here as an estimate for HEHO aquatic communities. Confidence in these reference values are low.

[4] Wilhm 1970

[5] Hilsenhoff 1988

4.12.4. Condition and Trend

The framework for determining resource condition ratings is shown in Table 4.12-2. Ratings are based on reference values obtained from best available data.

Taxa and EPT richness values for Hoover Creek in 2011 were again roughly one-third those expected for regional reference streams (Wilton 2004). Mean taxa richness across riffles was 12.8 (range 11.3–15.3) while mean EPT richness was 4.78 (range 4.0–5.7). Mean HBI was moderately high at 5.2 (range 4.6–5.9). Mean Shannon diversity index was 1.90 (range 1.6–2.2), and mean taxa evenness was 0.74 (range 0.6–0.8). Mean EPT ratio was 0.6 (range 0.3–0.8) (Bowles 2014).

The dominant EPT taxa in samples included moderately intolerant taxa, such as the caddisfly (Trichoptera) genus *Hydroptila* (Hydroptilidae) (tolerance value 6.0), and the mayfly family Baetidae (tolerance value 4.0). Only the genera *Ceratopsyche* (Trichoptera: Hydropsychidae) and *Optioservus* (Coleoptera: Elmidae) had tolerance values less than four. In contrast to samples collected in 2008, *Ceratopsyche* was more abundant in the 2011. The dominant taxa across samples included tolerant Oligochaeta, the dipterans Chironomidae and *Simulium* (Simuliide), and *Ceratopsyche*. The tolerant isopod genus *Lirceus* and the riffle beetle Stenelmis (Elmidae), and the dipteran Hemerodromia were secondarily dominant (Bowles 2014).

<u>Overall Condition and Trend</u>

Foreman (2007) conducted the only other study of aquatic invertebrates in Hoover Creek using a multihabitat approach described in the IOWATER Advanced Benthic Macroinvertebrate Indexing Methods, a qualitative approach that used only family-level invertebrate identifications (Wilton 2004). The findings of that study showed the invertebrate community in Hoover Creek was dominated by organisms that were largely tolerant of pollution and habitat deterioration. Foreman

(2007) also reported that while overall taxa richness ranged from 10–14 taxa, over 75% of the total benthic density typically was dominated by only 3 taxa. Also, the % EPT among samples was low with a maximum of only 3.9% (Foreman 2007). Although the methods used by Foreman (2007) are not directly comparable to those used in this study, the findings are similar. Benthic metrics, particularly taxa richness and EPT richness for Hoover Creek were roughly one-third those expected for regional reference streams (Wilton 2004). The dominant EPT taxa represented in Hoover Creek were the caddisfly genera *Cheumatopsyche* and *Hydroptila*, and the mayfly family Baetidae all of which are moderately intolerant of disturbance. Moreover, no stoneflies (Plecoptera) were collected, and other sensitive EPT taxa were rare in samples. The available evidence from these datasets and that of Foreman (2007) strongly suggests Hoover Creek is impaired (Table 4.12-3). The condition of aquatic macroinvertebrates has not changed appreciably since 2008 (Bowles 2014).

Table 4.12-3. Condition assessment interpretation for aquatic macroinvertebrate community at HEHO.

Indicator	**Condition Status/Trend**	**Rationale**
Taxa/Genus richness		Genus richness values indicate moderate concern for this metric. Confidence level is low.
EPT richness		EPT richness was in poor condition in Hoover and warrants significant concern. Confidence level is low.
EPT ratio		EPT ratio values moderate concern for this metric. Confidence level is low.
Shannon Index		Shannon Index values indicate significant concern for this metric. Confidence level is low.
Genus evenness		Current condition is unknown due to lack of availability of reference values for the Genus Evenness metric.
Hilsenhoff Biotic Index (HBI)		HBI values indicate moderate concern for this metric. Confidence level is low.
Overall Condition Status for Aquatic Macroinvertebrate Community		**Condition of the resource warrants significant concern with an unknown trend. Confidence in the assessment is low.**

Based on the evaluation of aquatic macroinvertebrate metrics and comparisons with similar streams, condition of the resource warrants significant concern. Due to the low confidence in the assessment, trends are undetermined. Confidence in the assessment is low due to lack of data history and the need for several degrees of estimation for each metric. Impacts to aquatic macroinvertebrate communities appear to be largely from upstream sources that are out of NPS control.

4.12.5. Uncertainty and Data Gaps

Condition and trends were not able to be determined with any level of confidence due to lack of baseline data for Hoover Creek.

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4.13. Bird Community

4.13.1. Background and Importance

Grassland and woodland birds are conspicuous components of those parks residing within prairie ecotones and are an important natural resource within grassland parks of the Heartland Inventory and Monitoring Network (HTLN). Grassland birds have been in consistent decline since the 1970s (Sauer et al. 2000). In 2005, NPS formally recognized this decline and began taking actions to combat the loss of grassland birds (Peterjohn 2006). The NPS recommends a species-specific approach to park management that focuses on obligate grassland species. An obligate grassland bird is defined as "any species that has become adapted to and reliant on some variety of grassland habitats for part or all of its life" (Vickery et al. 1999).

Grassland bird populations are excellent indicators of environmental condition because individual species assemblages associate with specific grassland types, they occur across a continuum of anthropogenic disturbances, species assemblages are predictive of these disturbance levels, and birds are relatively easily detected and well researched (Bibby et al. 2000, Canterbury et al. 2000, Browder et al. 2002, Bryce et al. 2002, NABCI 2009). In addition, birds are well-liked by the public, the public can relate to concerns about bird communities, birding is a popular activity at most parks, and bird songs contribute to the natural soundscape.

The upland grassland and bottomland riparian forest found at HEHO support wintering, feeding, and breeding populations of both resident and migrating avian species. Because of the rarity of non-agricultural lands in the region, HEHO is especially valuable by providing relatively unfragmented (albeit small) patches of native prairie that serve as a refuge within a highly altered agricultural landscape. Changes in avian community composition and abundance in these habitats often indicates environmental change, either locally or at broader ecosystem scales. Habitat fragmentation and conversion of native vegetation to agricultural and urban landscapes occurring outside the park negatively impacts populations of some resident bird species at HEHO, particularly specialist species that have evolved within stable environments (Devictor et al. 2008, La Sorte 2006). Avian community composition and diversity would be expected to improve with the restoration of native prairie and woodland plant communities at HEHO and in the surrounding landscape (Johnson 2006, Boren et al. 1999).

<u>Threats and Stressors</u>

Avian declines have been caused by multiple factors including the conversion of grassland to other land cover types, habitat fragmentation, and mowing regimes (Lookingbill et al. 2012). Current threats to the bird community at HEHO include the conversion of habitats to agricultural and urban uses including cultivation and residential, commercial, and industrial development locally, regionally and within the extent of migratory patterns (Hansen and Gryskiewicz 2003). Regional changes in land cover and human population are further described in *Section 4.1*. Conversion of lands from natural land cover types result in habitat loss, habitat fragmentation, water pollution and the disruption of hydrologic flow regimes. In turn, these modifications disrupt ecological functions important to ecosystem integrity and important to maintaining the community and composition of species at HEHO comparable to that of the natural habitat of the region (Jorgensen and Müller 2000).

Consequently, the ecological functioning of HEHO depends upon maintaining the natural systems outside park boundaries. These changes in land use are linked to ecological function by five disturbance mechanisms (Hansen and Gryskiewicz 2003):

1) land use activities reduces the functional size of a reserve, eliminating important ecosystem components lying outside the historic sites boundary;
2) land use activities alter the flow of energy or materials across the landscape irrespective of the historic sites political boundary, disrupting the ecological processes dependent upon those flows both outside and inside the historic site and across its boundaries;
3) habitat conversion outside the reserve may eliminate unique habitats, such as seasonal habitats and migration corridors;
4) the negative influences of land use activities may extend into the reserve and create edge effects; and
5) increased population density may directly impact parks through increased recreation and human disturbance.

Indicators and Measures

- Native species richness (S)
- Bird index of biotic integrity (IBI)
- Occurrence and status of bird species of conservation concern

4.13.2. Data and Methods

The HTLN has implemented long-term monitoring of birds at parks within network parks including HEHO. The purpose of this monitoring is to track changes in bird community composition and abundance and to monitor bird response to changes in habitat structure and other habitat variables related to management activities (Peitz et al. 2008). In 2005, the HTLN began systematic surveys of breeding birds and their habitat at grassland sites at HEHO. Monitoring was conducted every year at grassland sites, except for 2007, at a subsample of 28 permanent sites arranged in a systematic 200 X 200 m grid rotated 45 degrees from north to minimize the coincidence of survey points and roads, fences and other structures (Peitz 2010) (Figure 4.13-1). In 2008, 10 more permanent woodland sample sites were added to the sampling grid with annual sampling from 2008 through 2012 (Peitz 2010).

Data supporting this assessment is primarily from the 28 grassland sample sites, sampled annually from 2005 through 2012 except for in 2007, and from 10 woodland sites, sampled annually from 2008 through 2012. Data from 2008 to 2012 were not included in any published reports and were obtained directly from HEHO staff. The number of sites sampled per year at the grassland sample sites ranged from 9 to 30 while all 10 woodland sites were sampled each year of monitoring. Variable circular plot methodology was used, wherein all birds seen or heard at plots during 3 to 5-min sampling periods were recorded along with their corresponding distance from the observer (Peitz et al. 2008). The mean value per sample site for each indicator was used to assess condition and trend in the bird community.

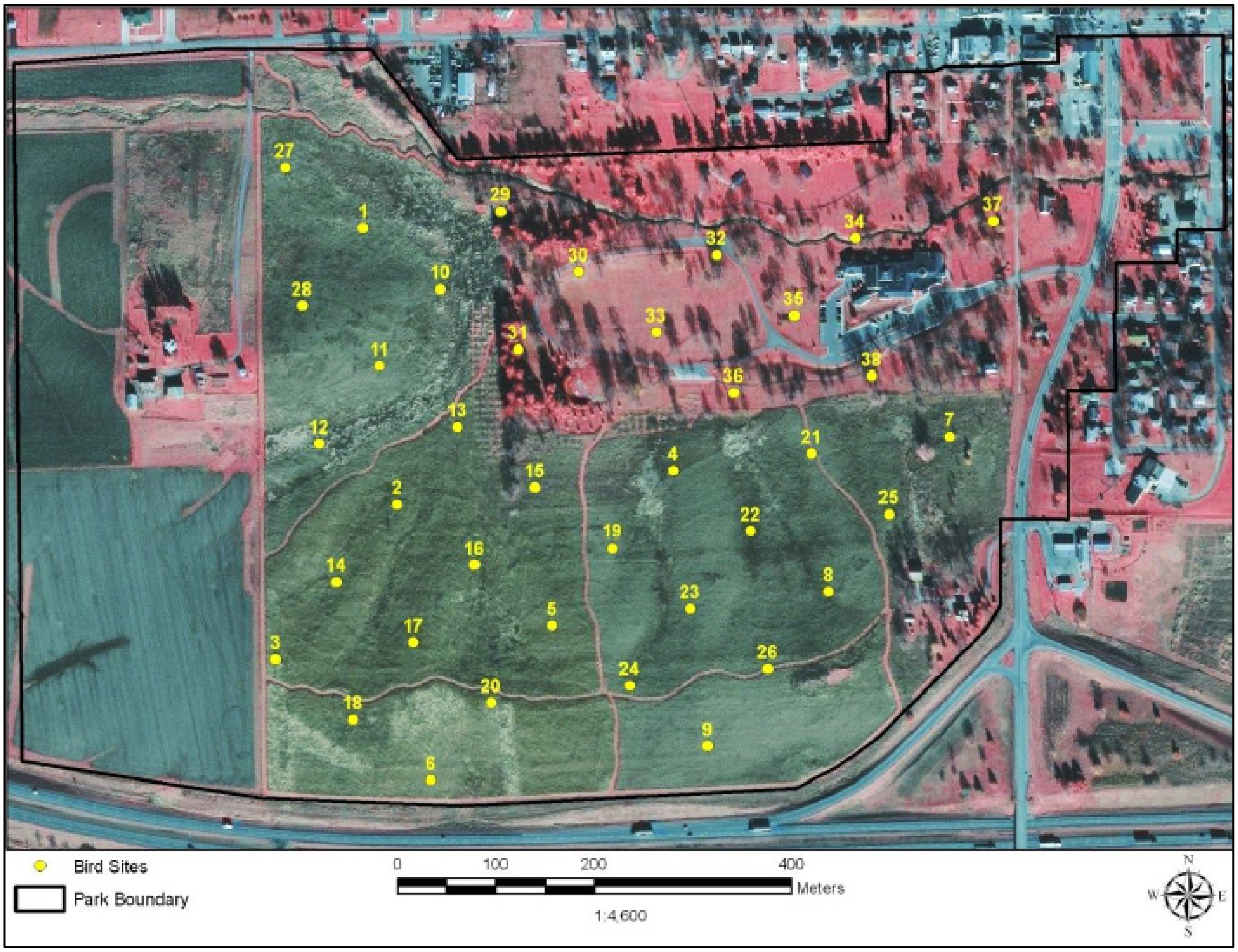


Figure 4.13-1. Bird monitoring plot locations on Herbert Hoover National Historic Site, Iowa (Peitz 2010).

To evaluate trend over time, we compared the occurrence of species detected during the initial survey conducted at HEHO in 2006 for grassland sites and 2008 for woodland sites, to species detected during the 2012 surveys. Only native species were included in calculations of species richness. Bird Index of Biotic Integrity (IBI) values were calculated separately for the grassland and woodland samples, and included a guild for exotic/non-natives. The bird IBI is based on the methodology developed for bird communities of the mid-Atlantic Highlands (O'Connell et al. 1998a). The bird IBI was modified from O'Connell et al. (1998a) to reflect the land-use and land-cover types of the HTLN (e.g., grassland for the grassland IBI and riparian woodland for the woodland IBI and pasture and row crop, urban and suburban area for both IBIs). Specialist guilds included in the IBI tend to be associated with either extensive grassland cover or extensive woodland cover. Therefore, higher IBI scores reflect bird communities associated with aspects of more mature ecosystem structure, function, and composition. For example, sites with higher grassland bird IBI scores consist of a bird community with more grassland-dependent species, ground cleaners, and single-brooded or open ground nesters (i.e., specialists) but with fewer omnivores, exotic/non-natives, nest predators/brood parasites and residents (i.e., generalists). A discussion of guild selection and use is found in Marshall et al. (Undated).

To calculate the IBI score, species are first assigned to guilds (some species may be assigned to more than one guild, depending on their life history traits). The proportional species richness of each guild is then calculated by dividing the number of species detected within a specific guild by the total number of species detected. Each category of proportional species richness is then ranked for each guild on a scale of 5 (high integrity) to 0 (low integrity) (O'Connell et al. 1998a, 1998b, 2000). For specialist guilds, the highest-occurrence category is ranked a "5," the next highest a "4," etc. For generalist guilds, the ranking is reversed; a "5" is assigned to the lowest-occurrence category. Therefore, a site can receive a rank of "5" for a guild if the site supports the highest category of proportional species richness for a specialist guild or the lowest category of proportional species richness for a generalist guild. The final bird IBI score is then calculated by summing the rank for each guild's proportional species richness across all guilds.

The biotic or ecological "condition" described by the bird IBI, then moves along a disturbance gradient from relatively intact, extensive, mature grassland or woodland with high IBI scores to more disturbed, developed or urban grassland or woodland with low IBI scores. Some woodland forest birds were recorded at the grassland sample sites. However, forest guilds (i.e., bark prober, upper-canopy forager, lower-canopy forager, aerial screener, aerial sallier, canopy nester, forest-ground nester, forest generalist, interior forest obligate, and riparian dependent guilds) were not used to calculate the grassland bird IBI score. The reverse was true of the woodland sites; grassland guilds (i.e., grassland ground cleaner, grassland ground nester, and grassland dependent) were not used to calculate the woodland bird IBI. The response guilds incorporated into the grassland and woodland bird IBIs are listed in Table 4.13-1.

<u>The Occurrence and Status of Species of Conservation Concern</u>

Our intent for this indicator was to identify species at HEHO that are considered species of concern at either a national or local scale and to assess the current status (occurrence) of those species at the park. This analysis was restricted to those species that either breed at the park or that are residents. Those species occurring at the park during migration only and incidental occurrences of species outside of their normal range were excluded from the analysis.

To identify priority conservation species we used lists developed by Partners in Flight (PIF), a cooperative effort among federal, state and local government agencies that identifies and assesses species of conservation concern based on biological criteria including population size, breeding distribution, non-breeding distribution, threats to breeding, threats to non-breeding, and population trend (Panjabi et al. 2005). PIF assessments are conducted at both national and regional scales. At the national scale, the PIF North American Landbird Conservation Plan identifies what are considered "Continental Watch List Species" and "Continental Stewardship Species" (Rich et al. 2004).

Table 4.13-1. Bird species guilds used to calculate the IBI score at Herbert Hoover National Historic Site.

Bird Index of Biotic Integrity (IBI)	Biotic Integrity Element	Guild Category	Response Guild	Guild Classification	Number of Species in Guild
Grassland IBI	Functional	Trophic	Omnivore	Generalist	24
	Functional	Insectivore foraging behavior	Grassland ground gleaner	Specialist	5
	Compositional	Origin	Exotic/non-native	Generalist	3
	Compositional	Migration status	Resident	Generalist	20
	Compositional	Migration status	Temperate migrant	Generalist	17
	Compositional	Number of broods	Single-brooded	Specialist	26
	Compositional	Population limiting	Nest predator/brood parasite	Generalist	3
	Structural	Nest placement	Grassland ground nester	Specialist	3
	Structural	Nest placement	Shrub nester	Generalist	12
	Structural	Primary habitat	Grassland dependent	Specialist	2
Woodland IBI	Functional	Trophic	Omnivore	Generalist	22
	Functional	Insectivore foraging behavior	Bark prober	Specialist	6
	Functional	Insectivore foraging behavior	Upper canopy forager	Specialist	4
	Functional	Insectivore foraging behavior	Lower canopy forager	Specialist	7
	Functional	Insectivore foraging behavior	Aerial sallier	Specialist	4
	Functional	Insectivore foraging behavior	Aerial screener	Specialist	2
	Compositional	Origin	Exotic/non-native	Generalist	1
	Compositional	Migration status	Resident	Generalist	20
	Compositional	Migration status	Temperate migrant	Generalist	19
	Compositional	Number of broods	Single-brooded	Specialist	31
	Compositional	Population limiting	Nest predator/brood parasite	Generalist	5
	Structural	Nest placement	Canopy nester	Specialist	16
	Structural	Nest placement	Forest ground nester	Specialist	1
	Structural	Nest placement	Shrub nester	Generalist	13

Table 4.13-1 (continued). Bird species guilds used to calculate the IBI score at Herbert Hoover National Historic Site.

Bird Index of Biotic Integrity (IBI)	Biotic Integrity Element	Guild Category	Response Guild	Guild Classification	Number of Species in Guild
Woodland IBI (continued)	Structural	Primary habitat	Forest generalist	Generalist	19
	Structural	Primary habitat	Interior forest obligate	Specialist	7
	Structural	Primary habitat	Riparian dependent	Specialist	2

Conservation Watch List Species are considered by PIF as those with the greatest need for conservation due to a combination of small and declining populations, limited distributions, and significant threats throughout their ranges (Panjabi et al. 2005). Continental Stewardship species are defined as those species that have a significant percentage of their world breeding and/or nonbreeding population (i.e., breeding population for migratory birds) confined to a specific avifaunal biome. Avifaunal biomes are adjoining areas in North America that share similar avifaunas as identified through cluster analysis (Rich at al. 2004). We consulted the PIF Conservation Watch List and Stewardship species list to identify birds at HEHO that are of national conservation priority.

PIF has also adopted Bird Conservation Regions (BCRs), after the North American Bird Conservation Initiative. BCRs are ecologically distinct regions in North America with similar bird communities, habitats and resource management issues. Regional bird conservation plans are developed by PIF using the BCRs as the unit of planning and the same principles of concern (Watch List and Continental Stewardship species) are applied at the scale of the BCR. This approach recognizes that some species may be declining dramatically at the local scale, even though they are not of high concern nationally. HEHO is within the Dissected Till Plains physiographic area. The conservation plan for this area was also consulted to identify those bird species that are a conservation priority within the local area but may not be of national concern (Fitzgerald and Pashley 2000).

4.13.3. Reference Conditions

Little historic bird survey data exist for Herbert Hoover National Historic Site. Bird surveys using the point count method at nine grassland sample points were conducted at HEHO in 2005 and 2006 (Peitz 2007). A more comprehensive and statistically rigorous sample using methods described in Peitz et al. (2008) was first implemented in 2008 at both grassland and woodland sites. Bird reference condition for the grassland bird community is based on the initial survey conducted in 2005. Condition for the woodland bird community is based on the initial HTLN 2008 bird survey results. Maintaining or exceeding the level of biodiversity as defined by initial calculation of native species richness and the initial quality of bird community composition as defined by the initial IBI score are considered good condition. A rating system for departure from good condition is shown in Table 4.13-2.

A community at the theoretical maximum high IBI score, or highest integrity, consists of a bird community with only specialist guilds and without any generalist guilds. The integrity represented by a particular IBI score is based upon a theoretical maximum community at HEHO receiving a grassland bird IBI score of 44 and the theoretical minimum community, a score of 10, which corresponds to either only species from “specialist guilds” being detected or only “generalist guilds” being detected, respectively. Similarly calculated, the theoretical maximum and minimum woodland bird IBI scores at HEHO are 86 and 23.5, respectively. As with the grassland bird community, a woodland bird community with a high IBI score will contain more specialist guild members and fewer generalist guild members.

Table 4.13-2. Resource condition rating framework for birds at Herbert Hoover National Historic Site.

		Community		
Community	**Indicator**	**Resource is in Good Condition**	**Resource Warrants Moderate Concern**	**Resource Warrants Significant Concern**
Grassland Birds	Native species richness (S)	85–100+ % of 2009 value	70–85% of 2009 value	< 70% of 2009 value
	Index of biotic integrity	29.1–44.0	22.1–29.0	10.0–22.0
	Bird species of conservation concern	85–100+ % of 2009 value	70–85% of 2009 value	< 70% of 2009 value
Woodland Birds	Native species richness (S)	85–100+ % of 2009 value	70–85% of 2009 value	< 70% of 2009 value
	Index of biotic integrity	58.1–86	45.1–58.0	23.5–45.0
	Bird species of conservation concern	85–100+ % of 2009 value	70–85% of 2009 value	< 70% of 2009 value

Threshold levels for bird IBI scores have not been rigorously defined, but O'Connell et al. (2000) established thresholds that include four categories of condition corresponding to the proportional species richness of each specialist guild and generalist guild. For the grassland bird IBI score at HEHO these thresholds include the following categories: 1) excellent (highest-integrity) – score of 34.1–44.0; 2) good (high-integrity) – score of 29.1–34.0; 3) fair (medium integrity) – score of 22.1–29.0; and 4) poor (low-integrity rural and low-integrity urban) – score of 10.0–22.0. The woodland bird IBI values and ranges for these corresponding four categories were: 1) 67.1–86.0; 2) 58.1–67.0; 3) 45.1–58.0; and 4) 23.5–45.0. The condition classes were modified to determine the resource condition indicator scoring for the HEHO bird IBI (Table 4.13-2) using a three-tiered rating system.

We also compared the candidate list of species of concern to the list of species observed at HEHO during the 2012 survey. We used the number of species of concern recorded in the initial survey year of 2005 for the grassland or 2008 for the woodland as the reference condition for comparison. The condition of the resource is considered higher if more species of concern are observed. This implies that the populations of those species are increasing and/or they are using the park more.

4.13.4. Condition and Trend

Grassland Birds

Species Richness

A total of 17 native species and 18 total species were recorded at grassland sampling stations in 2012. The most common species was the red-winged blackbird (*Agelaius phoeniceus*). The eastern meadowlark (*Sturnella magna*), American goldfinch (*Carduelis tristis*), dickcissel (*Spiza americana*), and American robin (*Turdus migratorius*) were also moderately common (Table 4.13-3). The 17 native species observed in 2012 exceeds the 13 native species recorded during the 2008 bird survey at HEHO (Table 4.13-3).

Table 4.13-3. Grassland bird species recorded in 2012 and 2005 at prairie survey stations on Herbert Hoover National Historic Site.

Common Name	Species Name	AOU Code	Number Observed 2005	Number Observed 2012
American goldfinch	*Carduelis tristis*	AMGO	111	14
American robin	*Turdus migratorius*	AMRO	93	19
Barn swallow	*Hirundo rustica*	BARS	59	4
Barred owl	*Strix varia*	BOOW	1	0
Blue jay	*Cyanocitta cristata*	–	0	3
Brown thrasher(Accent[A,B]	***Toxostoma rufum***	**BRTH**	**7**	**0**
Brown-headed cowbird	*Molothrus ater*	BHCO	0	10
Cedar waxwing	*Bombycilla cedrorum*	CEDW	4	0

[A] Bolded names are Partners in Flight species of continental importance.

[B] Highlighted names are Partners in Flight priority species for Physiographic Area 32: The Dissected Till Plains.

Table 4.13-3 (continued). Grassland bird species recorded in 2012 and 2005 at prairie survey stations on Herbert Hoover National Historic Site.

Common Name	Species Name	AOU Code	Number Observed 2005	Number Observed 2012
Chimney swift	*Certhia americana*	CHSW	30	0
Common grackle	*Picoides pubescens*	COGR	76	12
Common yellowthroat	*Geothlypis trichas*	COYE	91	26
Dickcissel[A,B]	***Spiza americana***	**DICK**	**94**	**9**
Eastern kingbird[B]	*Tyrannus tyrannus*	EAKI	0	2
Eastern meadowlark	*Sturnella magna*	EAME	119	2
European starling	*Sturnus vulgaris*	EUST	28	3
Indigo bunting[A,B]	***Passerina cyanea***	**INBU**	**4**	**0**
Mourning dove	*Zenaida macroura*	MODO	71	4
Northern cardinal	*Parus bicolor*	NOCA	7	0
Red-winged blackbird	*Agelaius phoeniceus*	RWBL	257	82
Ring-necked pheasant	*Phasianus colchicus*	RPHE	2	13
Song sparrow	*Melospiza melodia*	SOSP	12	0

[A] Bolded names are Partners in Flight species of continental importance.

[B] Highlighted names are Partners in Flight priority species for Physiographic Area 32: The Dissected Till Plains.

The slope of the linear regression line for mean native grassland bird species richness per sample site was positive and statistically significant at $\alpha = 0.10$ ($r^2 = 0.03$, $p = 0.7$), suggesting an increasing trend in the richness of the grassland bird community during the monitoring period (Figure 4.13-2). In 2012, there was an average of 5.3 native grassland bird species per sample site recorded at HEHO, greater than the management target of 85 percent of 4.0, the number recorded in 2005 when monitoring was initiated at HEHO. These results indicate that the resource is in good condition with an improving trend.

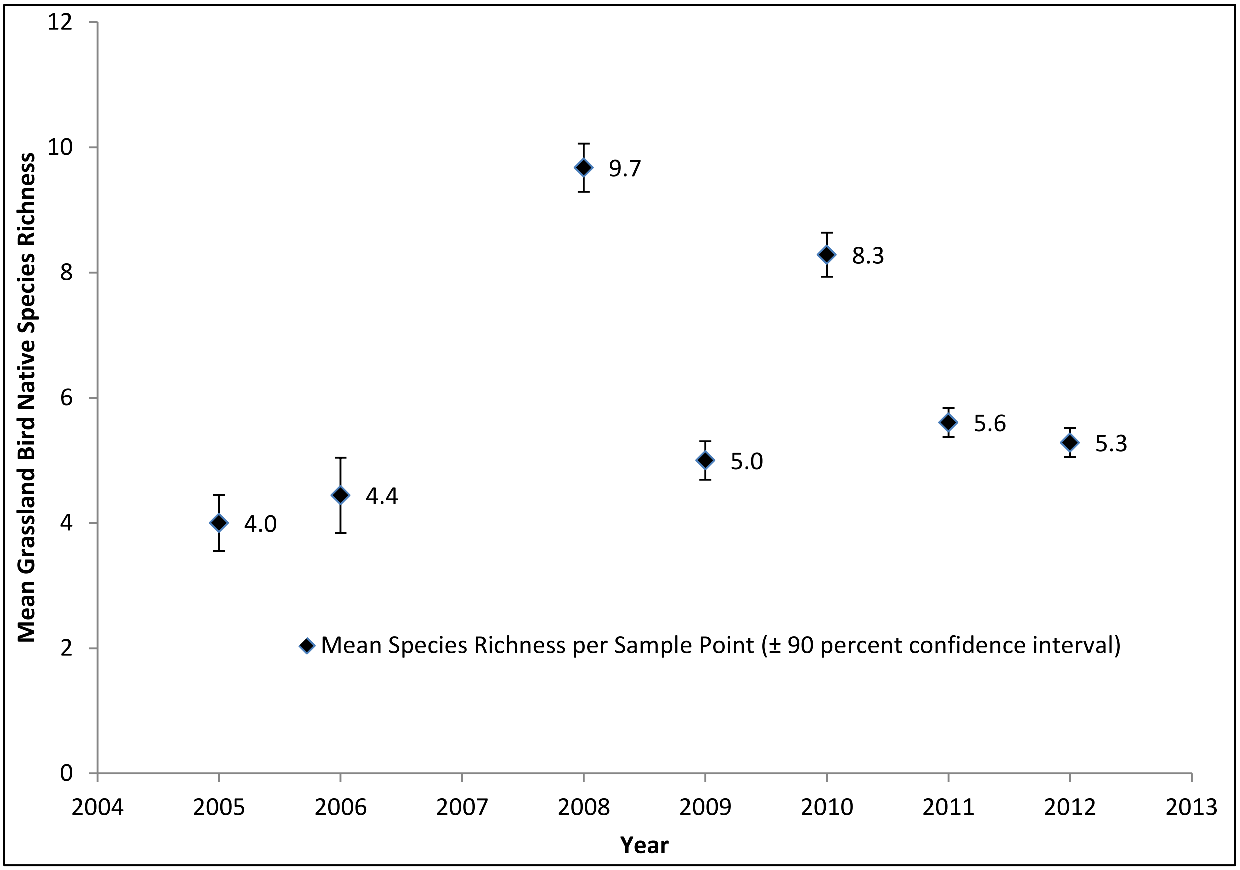


Figure 4.13-2. Means and 90 percent confidence intervals for native grassland bird species richness at Herbert Hoover National Historic Site from 2005 to 2012.

Index of Biotic Integrity

The mean grassland bird IBI score per sample site in 2012 was 27, indicating that composition of the grassland bird community at HEHO has moderate integrity (Table 4.13-2). The slope of the linear regression line for the mean grassland bird IBI scores per sample site was positive and statistically significant ($r^2 = 0.77$, $p = 0.009$) indicating an increase in the biotic integrity of the bird community between 2005 and 2012. The 90 percent confidence intervals for the scores overlap moderately but variance in the sample data is relatively low (Figure 4.13-3). Mean 2012 IBI scores warrant moderate concern (Table 4.13-2) with an improving trend.

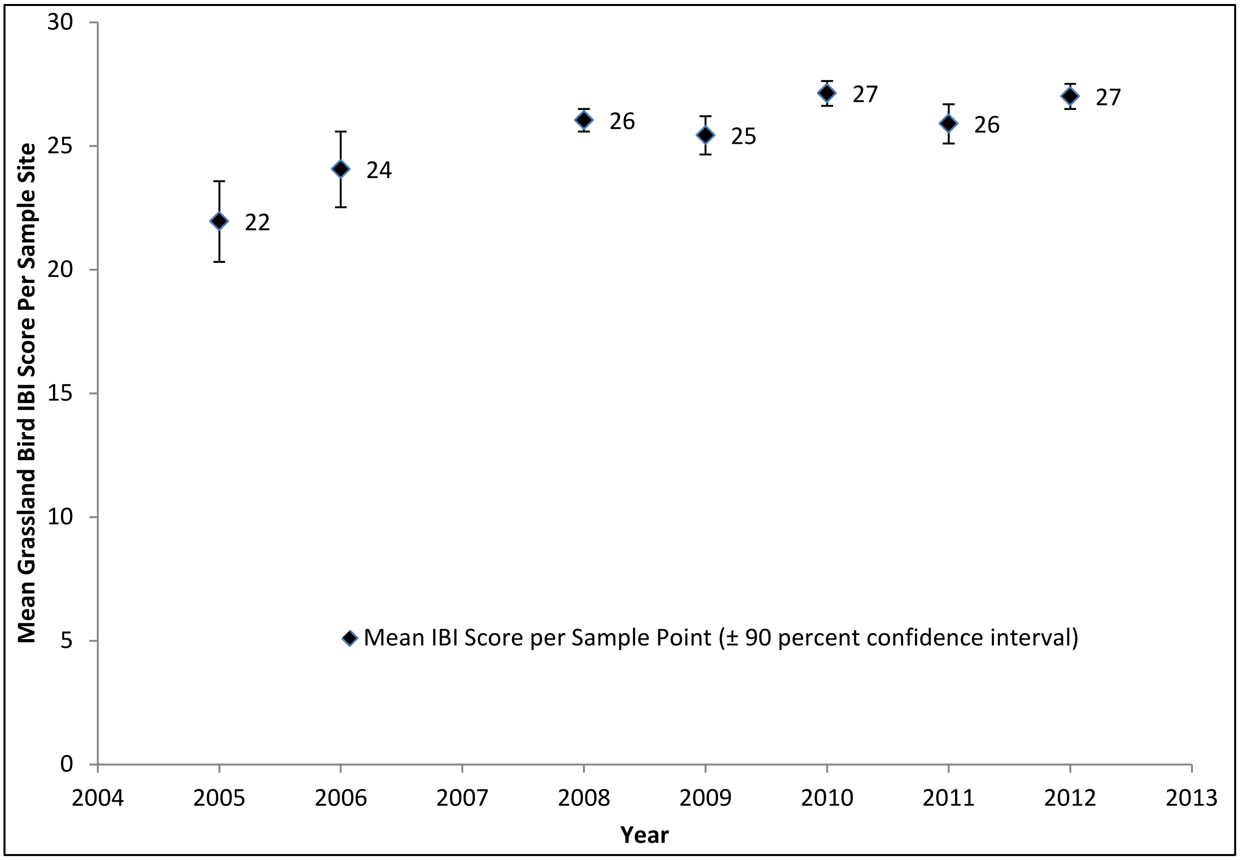


Figure 4.13-3. Means and 90 percent confidence intervals for grassland bird species IBI score at Herbert Hoover National Historic Site from 2005 to 2012.

Species of Concern

Three species recorded during the 2012 grassland bird survey are listed as Partner in Flight birds of concern (Rich et al. 2004, Fitzgerald and Pashley 2000), which is more than the single species of concern reported in 2005 (Table 4.13-3). The dickcissel (*Spiza americana*) was the only grassland obligate species recorded at HEHO in both 2012 and 2005. The only species of concern recorded at HEHO in 2012 were the dickcissel (tallgrass prairie or weedy fields), brown thrasher (*Toxostoma rufum*) (grasslands with scattered shrubs and trees) and indigo bunting (*Passerina cyanea*) (edges of woods and fields with shrubby thickets).

The slope of the linear regression line for the mean number of grassland bird species of concern per sample site was positive but not statistically significant ($r^2 = 0.09$, $p = 0.5$), suggesting an unchanging trend in the number of bird species of concern present (Figure 4.13-4). In 2012, the mean number of bird species of concern per sample site was 0.8, greater than the management target of 85 percent of the 2005 mean (0.6 species). These results indicate that the resource is in good condition with an unchanging trend.

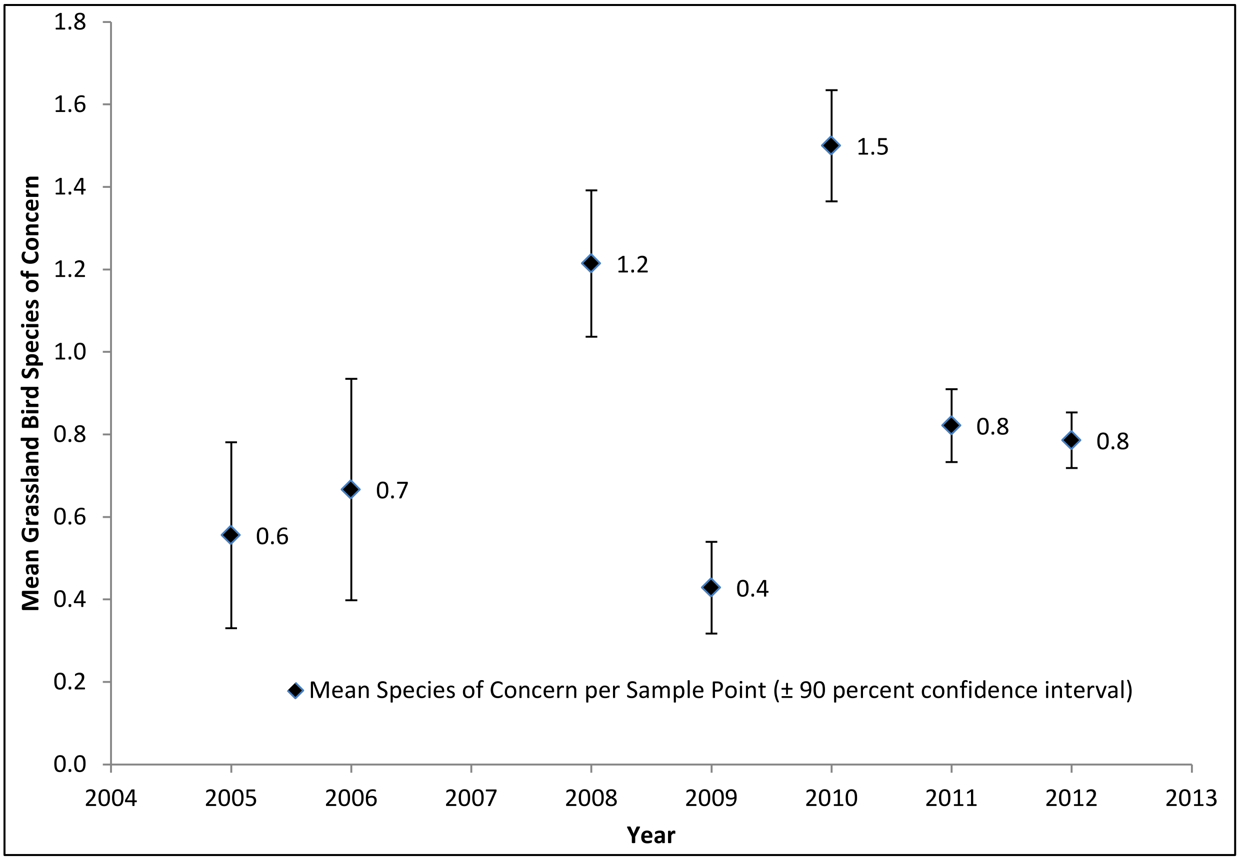


Figure 4.13-4. Means and 90 percent confidence intervals for grassland bird species of concern at Herbert Hoover National Historic Site from 2005 to 2012.

<u>Woodland Birds</u>

Species Richness

There were 22 native species out of 24 species in total recorded at woodland sampling stations in 2012. The most common species was the American robin (*Turdus migratorius*). The barn swallow (*Hirundo rustica*) and mourning dove (*Zenaida macroura*) were moderately common (Table 4.13-4). The 22 native species observed in 2012 is less than the 29 native species recorded during the 2008 bird survey (Table 4.13-4).

The slope of the linear regression line for mean native woodland bird species richness per sample site was negative and not statistically significant ($r^2 = 0.25$, $p = 0.4$), suggesting an unchanging trend in the richness of the woodland bird community (Figure 4.13-5). The 5.9 mean native woodland bird species per sample site recorded in 2012 warrants significant concern (Table 4.13-2) with an unchanging trend.

Table 4.13-4. Bird species recorded in 2012 and 2008 at woodland survey stations on Herbert Hoover National Historic Site.

Common Name	Species Name	AOU Code	Number Observed	
			2012	2008
American goldfinch	*Carduelis tristis*	AMGO	22	11
American redstart	*Setophaga ruticilla*	AMRO	0	3
American robin	*Turdus migratorius*	AMRO	75	154
Barn swallow	*Hirundo rustica*	BARS	42	71
Blue jay	*Cyanocitta cristata*	BLJA	18	86
Brown thrasher[A,B]	***Toxostoma rufum***	**BRTH**	**16**	**41**
Brown-headed cowbird	*Molothrus ater*	BHCO	11	15
Cedar waxwing	*Bombycilla cedrorum*	CEDW	0	16
Chimney swift	*Certhia americana*	CHSW	9	6
Chipping sparrow	*Spizella passerina*	CHSP	0	18
Common grackle	*Picoides pubescens*	COGR	26	124
Common nighthawk	*Chordeiles minor*	CONI	6	7
Common yellowthroat	*Geothlypis trichas*	COYE	0	65
Dickcissel[A,B]	***Spiza americana***	**DICK**	**13**	**19**
Eastern kingbird[B]	*Tyrannus tyrannus*	EAKI	0	13
Eastern meadowlark	*Sturnella magna*	EAME	0	69
Eastern phoebe[A,B]	***Sayornis phoebe***	**EAPH**	**12**	**0**
Eastern wood-pewee	*Contopus virens*	EAWP	5	27
European starling	*Sturnus vulgaris*	EUST	18	74
Gray catbird	*Dumetella carolinensis*	GRCA	23	58
House finch	*Haemorhous mexicanus*	HOFI	1	0
House sparrow	*Passer domesticus*	HOSP	7	29
House wren	*Troglodytes aedon*	HOWR	14	14
Indigo bunting	***Passerina cyanea***	**INBU**	**15**	**6**
Mourning dove	*Zenaida macroura*	MODO	45	110
Northern (Baltimore) oriole[B]	*Icterus galbula*	BAOR	0	64
Northern (Yellow-shafted) flicker	*Colaptes auratus*	YSFL	0	3
Northern cardinal	*Parus bicolor*	NOCA	29	76
Red-winged blackbird	*Agelaius phoeniceus*	RWBL	19	78
Rose-breasted grosbeak	*Pheucticus ludovicianus*	RBGR	23	32
Ruby-throated hummingbird	*Archilochus colubris*	RTHU	4	0
Song sparrow	*Melospiza melodia*	SOSP	6	65

[A] Bolded names are Partners in Flight species of continental importance.

[B] Highlighted names are Partners in Flight priority species for Physiographic Area 32: The Dissected Till Plains.

Table 4.13-4 (continued). Bird species recorded in 2012 and 2008 at woodland survey stations on Herbert Hoover National Historic Site.

Common Name	Species Name	AOU Code	Number Observed	
			2012	2008
Turkey vulture	*Thryothorus ludovicianus*	TUVU	0	9
Warbling vireo	*Vireo gilvus*	WAVI	0	38

[A] Bolded names are Partners in Flight species of continental importance.

[B] Highlighted names are Partners in Flight priority species for Physiographic Area 32: The Dissected Till Plains.

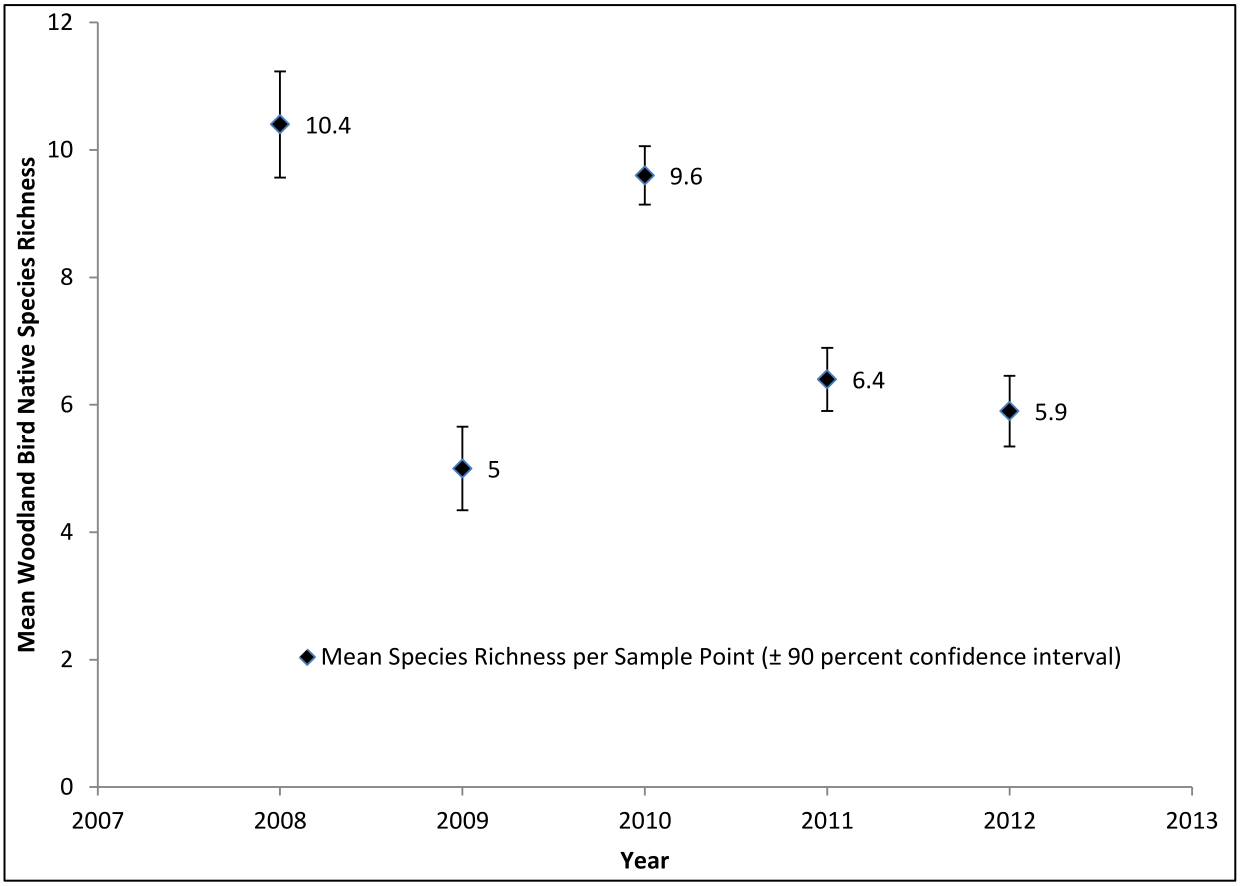


Figure 4.13-5. Means and 90 percent confidence intervals for woodland bird species richness at Herbert Hoover National Historic Site from 2008 to 2012.

Index of Biotic Integrity

The mean woodland bird IBI score of 41.2 in 2012 is greater than the 2008 score of 39.8, indicating the composition of the riparian woodland bird community is of low integrity (Table 4.13-2). The slope of the linear regression line for the woodland bird IBI scores is positive and not statistically significant ($r^2 = 0.12$, $p = 0.6$) suggesting an unchanging trend in the IBI scores. The 90 percent confidence intervals for the mean scores per sample site also suggest an unchanging trend since 2008 (Figure 4.13-6). In 2012, the mean woodland IBI score at HEHO was 41.2, a score that warrants significant concern (Table 4.13-2).

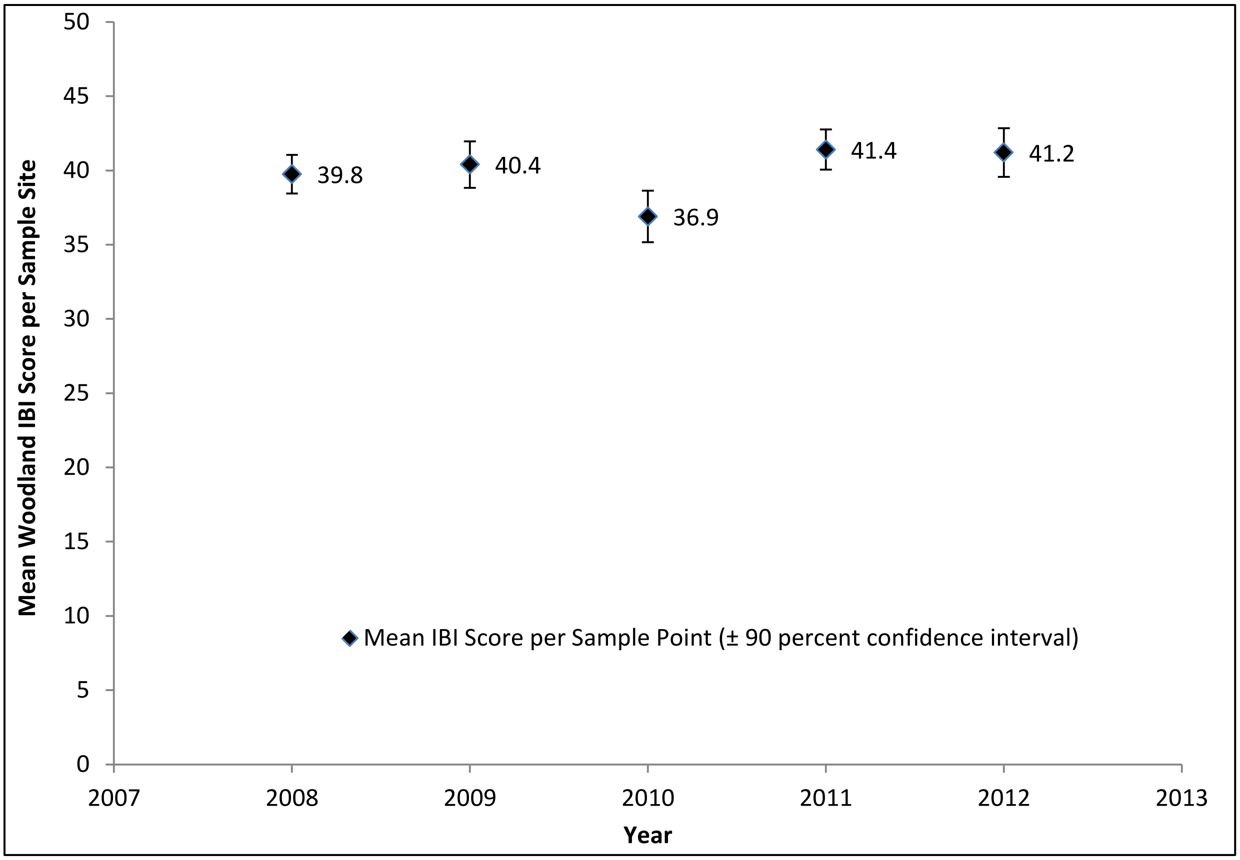


Figure 4.13-6. Means and 90 percent confidence intervals for woodland bird species IBI score at Herbert Hoover National Historic Site from 2008 to 2012.

Species of Concern

Four species found at HEHO during the 2012 woodland bird survey are listed as PIF birds of concern compared to five species of concern recorded in 2008 (Table 4.13-4). One riparian obligate species, the red-winged blackbird (*Agelaius phoeniceus*), was recorded in 2012. This species was also the only riparian obligate species observed in 2008. The most common species of concern recorded at woodland sites and their habitats in 2012 were the brown thrasher (*Toxostoma rufum*) (grasslands with scattered shrubs and trees) and indigo bunting (*Passerina cyanea*) (edges of woods and fields with shrubby thickets). Other PIF species of concern present in 2012 included the dickcissel (*Spiza americana*) (tallgrass prairie or weedy fields) and eastern phoebe (*Sayornis phoebe*) (Table 4.13-4).

The slope of the linear regression line for the mean woodland bird species of concern per sample site was negative but not statistically significant ($r^2 = 0.24$, $p = 0.4$), suggesting an unchanging trend in the number of woodland bird species of concern. The 90 percent confidence intervals for the mean number of species of concern per sample also suggest an unchanging trend since 2008 (Figure 4.13-7). In 2012, there were 0.8 mean woodland bird species of concern per sample site, less than the management target of 85 percent of 1.1, the mean number recorded in 2008 when monitoring was initiated. The mean number of species of concern per sample site in 2012 warrants moderate concern (Table 4.13-2).

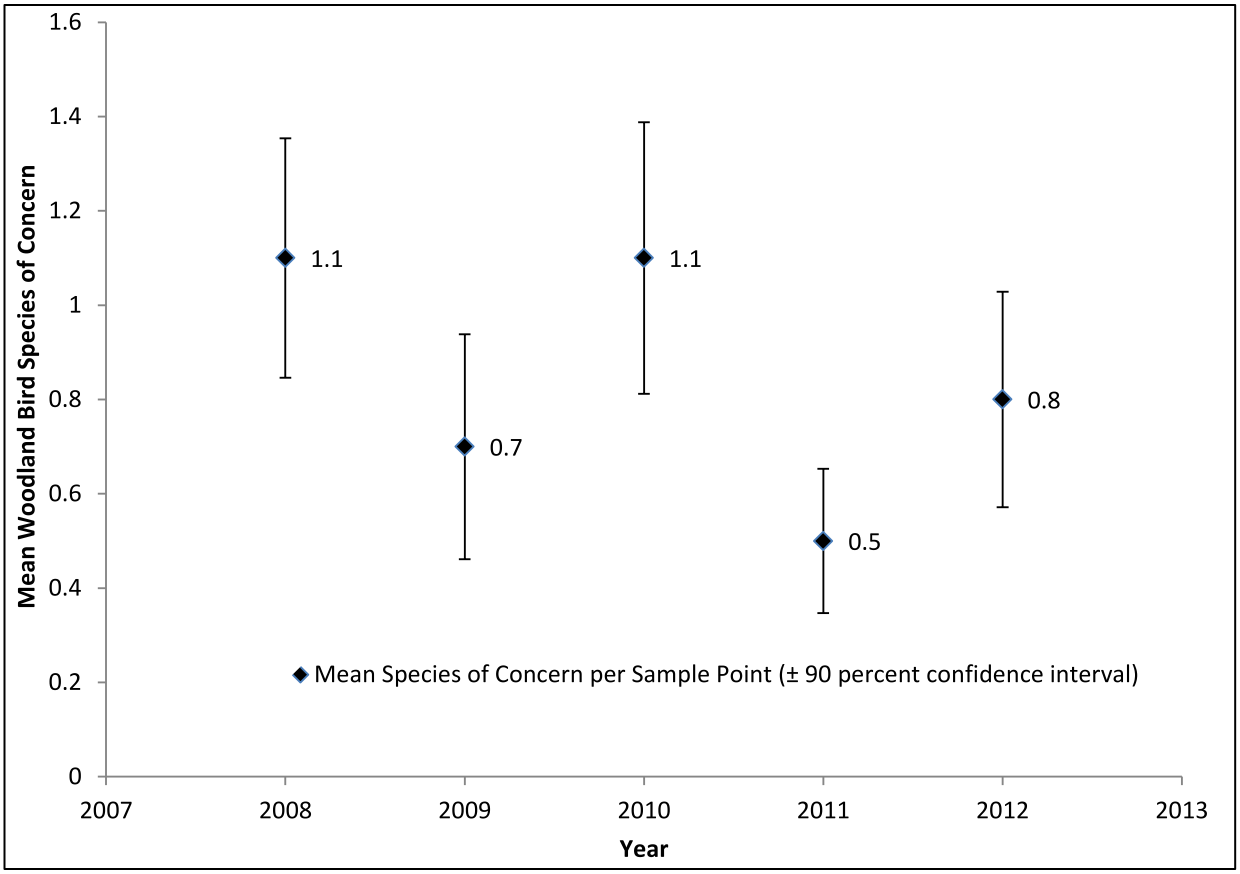
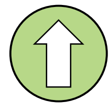
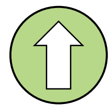
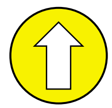
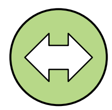
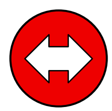
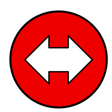
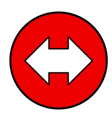
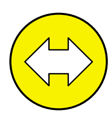
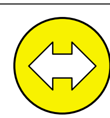


Figure 4.13-7. Mean number of woodland bird species of concern per sample location at Herbert Hoover National Historic Site from 2008 to 2012 with 90 percent confidence intervals.

<u>Overall Condition and Trend</u>

The values for the metrics of native species richness, the bird IBI, and the number of species of concern present in 2012 indicate that the condition of the bird community warrants moderate concern with an unchanging to improving trend. Grassland birds were in good condition with an improving trend while woodland birds associated with riparian and bur oak woodlands warranted significant concern. There are a number of obligate grassland birds and the community structure is representative of a moderately disturbed landscape (Table 4.13-5).

Table 4.13-5. Condition and trend summary for birds at Herbert Hoover National Historic Site.

Community	**Indicator**	**Condition Status/Trend**	**Rationale**
Grassland Birds	Grassland birds overall		–
	Native species richness (s)		Mean native grassland bird species richness fluctuated between 4.0 and 9.7 species per sample site between 2005 and 2012 with mean richness equaling 5.3 in 2012. Results indicate an improving trend in species richness from 2005 to 2012.
	Bird index of biotic integrity		In 2012, the grassland bird IBI score was 27, which was below the target baseline value. There was a positive trend in the bird community integrity between 2006 and 2012
	Species of conservation concern		The mean number of bird species of concern fluctuated between 0.4 and 1.5 species per sample site from 2005 to 2012, with 0.8 species of concern per sample site present in 2012.
Woodland Birds	Woodland birds overall		–
	Native species richness (s)		Mean native woodland bird species richness fluctuated between 5.0 and 10.4 species per sample site from 2008 to 2012 with mean richness equaling 5.9 in 2012; 57 percent of the 2008 total of 10.4, warranting significant concern.
	Bird Index of Biotic Integrity		In 2012, the woodland bird IBI score was 41.2.
	Species of conservation concern		The mean number of woodland bird species of concern fluctuated between 0.5 and 1.1 species per sample site from 2008 to 2012 with 0.8 species of concern per sample site present in 2012.
Overall Condition Status and Trend for Birds			**Condition warrants moderate concern with an unchanging to improving trend. Confidence in the assessment is medium.**

4.13.5. Uncertainty and Data Gaps

Confidence in this assessment was medium and confidence in the trend assigned is low to medium. The key uncertainty related to the assessment of the bird community at HEHO is the relatively short time period upon which the assessment is based. A factor potentially affecting the quality of the data is the probability that a bird that is present during the time the point count is occurring is detected. The protocols used for monitoring birds in the HTLN rely on a 5-minute count interval. Extending the interval to 10 minutes would likely increase the probability of detecting a species. Nonetheless, because points are surveyed only once per year, there is always the chance that rare or less vocal species will go undetected. This can be a problem when calculating the index of biotic integrity, which is calculated based on the number of species within different guilds.

4.13.6. Sources of Expertise

- David Peitz, a wildlife biologist at the Heartland I&M Network is responsible for collecting the monitoring data at HEHO upon which this assessment is based and also for leading the design of the protocol used to monitor birds at parks of the HTLN.

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4.14. Fish Community

4.14.1. Background and Importance

The National Park Service *protects, preserves, and manages biological resources and related ecosystem processes in the national park system including aquatic resources. Prairie stream fish are components of these aquatic systems and are important components of grassland parks of the Heartland Inventory and Monitoring Network (HTLN). North American freshwater fish, including prairie stream fish, have been in decline since the early 20th century (Hoagstrom et al. 2006, Jelks et al. 2008, Barrineau et al. 2010). This decline has been caused by multiple factors including conversion of uplands to cropland and livestock pasture* (beginning in the 1880s) (Knopf and Samson 1996), habitat fragmentation caused by reservoir construction (beginning in the 1950s), reduced discharge caused by groundwater withdrawal (beginning in the 1960s), and invasion by non-native fishes (Gido et al. 2010). *In 2001, the NPS formally recognized the decline of the Topeka shiner (*Notropis topeka*) at HTLN Parks. In 2008 this concern was extended to all native fish and actions were initiated to combat the loss of prairie stream fish (Potter Thomas et al. 2001, Dodd et al. 2008). The NPS recommends an approach to managing this critical resource that focuses on monitoring the prairie stream fish community to understand community condition and trend and how they correlate with management actions.*

*Prairie stream fish populations hold an intrinsic value as environmental indicators because they are important components of prairie aquatic ecosystems. Specific species are intolerant of chemical pollutants or habitat changes, making their assemblages indicative of water and habitat quality (*Pflieger 1997, Barbour et al. 1999, Schrank et al. 2001). Therefore, *fish community composition offers an indication of stream environmental health. The native fish populations of prairie streams have undergone profound changes with many species either declining in number or being extirpated. Alterations to the landscape caused by changes in land use, land cover and hydrology have contributed to habitat degradation (Knopf and Samson 1996).* Long-term monitoring *of abundance and diversity of native fish species at parks of the Heartland I&M Network supports evaluations of stream biotic integrity and the quality of fish habitat, providing park managers with the science-based understanding needed to make informed decisions regarding the management of aquatic ecosystems.*

NPS lands provide some of the least impacted stream habitat remaining in the Midwest. Because of the rarity of non-agricultural lands in the region, HEHO is especially valuable by providing some protected patches of stream habitat critical for sustaining native prairie fishes within a highly altered agricultural landscape (Dodd et al. 2008). Habitat fragmentation and conversion of native vegetation to agricultural and urban landscapes occurring outside the park will negatively impact populations of some fish species resident to HEHO, particularly intolerant species that have evolved within stable environments *(Knopf and Samson 1996, Gido et al. 2010)*. Fish community composition and diversity should improve with native prairie restoration, water treatment, flow management, dam removal, or cessation of groundwater pumping both within HEHO and in the surrounding landscape (Gido et al. 2010).

Threats and Stressors

Native aquatic communities are well adapted to withstanding periods of drought, but biological diversity is threatened as streams are further stressed by flow alterations and excessive water appropriations. Diversion of water from streams and rivers during drought can reduce the amount of deep-water refugia available to fish and raises water temperatures that can result in fish and invertebrate mortality. Pumping of groundwater for irrigation, municipal and other uses lowers water table levels that would otherwise supplement stream flows through hot and dry periods. Dams and other barriers on rivers and streams restrict fish and wildlife movements, leaving large expanses of potential habitat uninhabited and/or suppressing gene flow among populations (Schneider et al. 2011). In conjunction with these stressors, urban and suburban development and conversion of prairies to agriculture (nonnative pasture and crop lands) have degraded Herbert Hoover Creek through sedimentation, nutrient loading, chemical pollution, altered stream flows, stream channelization and habitat fragmentation.

The aquatic resources at HEHO have been affected by habitat destruction, degradation, modification, and fragmentation (NPS 2006). Agriculture and development in the surrounding landscape have resulted in siltation, reduced water quality, tributary impoundment, stream channelization, and changes in stream hydrology (NPS 2006). Dams and other barriers on rivers and streams restrict fish and wildlife movements, leaving large expanses of potential habitat uninhabited and/or suppressing gene flow among populations (Schneider et al. 2011).The combined and interacting effects of these influences have resulted in population declines and range reduction of freshwater fish not only at HEHO, but also in the region surrounding the park.

Protection of freshwater biodiversity is difficult because it is influenced by the upstream drainage network, the surrounding land, and activity in the riparian zone (Dudgeon et al. 2006). The modifications to the surrounding landscape disrupt ecological functions important to ecosystem integrity and important to maintaining the community and composition of species at HEHO comparable to that of the natural habitat of the region (Jorgensen and Müller 2000). Consequently, the ecological functioning of HEHO depends upon maintaining the natural systems outside the park boundaries. These changes in land use are linked to ecological function at HEHO by five mechanisms (Hansen and Gryskiewicz 2003):

1) land use activities reduce the functional size of a reserve, eliminating important ecosystem components lying outside the park boundary;
2) land use activities alter the flow of energy or materials across the landscape irrespective of the park’s political boundary, disrupting the ecological processes dependent upon those flows both outside and inside the park and across its boundaries;
3) habitat conversion outside the reserve may eliminate unique habitats, such as seasonal habitats and migration corridors;
4) the negative influences of land use activities may extend into the reserve and create edge effects; and
5) increased population density may directly impact parks through increased recreation and human disturbance.

Indicators and Measures

- Native species richness (S)
- Fish index of biotic integrity (IBI)
- Occurrence and status of fish species of conservation concern

4.14.2. Data and Methods

The HTLN has implemented long-term monitoring of fish at parks within network parks including HEHO (Dodd et al. 2008). The purpose of the monitoring is to determine the status and long-term trends in fish community composition and abundance, and to correlate this community data to water quality and habitat conditions. This allows for monitoring fish responses to changes in habitat variables related to land use changes and management activities (Dodd et al. 2008). In 2008, the HTLN began systematic surveys of fish and their habitat in Hoover Creek at HEHO (Dodd and Keefe 2013). One stream reach within Hoover Creek was sampled in July 2008 and 2011 using a single pass with a pulsed DC backpack electrofishing unit throughout the stream sampling reach (Figure 4.14-1). All fish were counted and identified to species, 30 individuals per species were measured and weighed, and any anomalies (e.g., deformities, eroded fins, lesions, tumors, and blackspot parasite) were recorded. Data from this single sample reach was used to determine the condition of the fish community at HEHO. Because only one stream reach was sampled it is not possible to estimate the precision or variability associated with the value of the condition indicators being used to assess the fish population.

To evaluate trends over time, we compared the occurrence of species detected during the initial survey conducted at HEHO in 2008 to species detected during the 2011 survey. Only native species were included in calculations of species richness, as the inclusion of exotic/non-native species would make interpretation of richness results problematic from a biotic integrity standpoint.

Fish Index of Biotic Integrity (IBI) values were calculated and compared between 2008 and 2011. The fish IBI is based on methodology developed for fish communities of the Ozark Highland streams (Dauwalter et al. 2003). It is important to note that the fish IBI was modified from Dauwalter et al. (2003) to reflect the prairie stream fish species that are present at HEHO. Specialist guilds included in the IBI tend to be associated with more pristine and less degraded freshwater habitats. Therefore, higher IBI scores reflect fish communities associated with habitats where water quality is high and with fewer land-use changes in the upland affecting instream conditions. For example, sites with higher fish IBI scores consist of a fish community with more insectivores, carnivores, darters, sculpins, madtom species, and lithophilic spawners (i.e., specialist guilds), but with fewer algivorous/herbivorous, invertivorous and piscivorous species, green sunfish, bluegill, yellow bullhead and channel catfish (i.e., generalist guilds). Communities with higher IBI scores tend to have lower occurrences of black spot or other anomalies compared to more degraded communities. A discussion of guild considerations is found in Dauwalter et al. (2003).

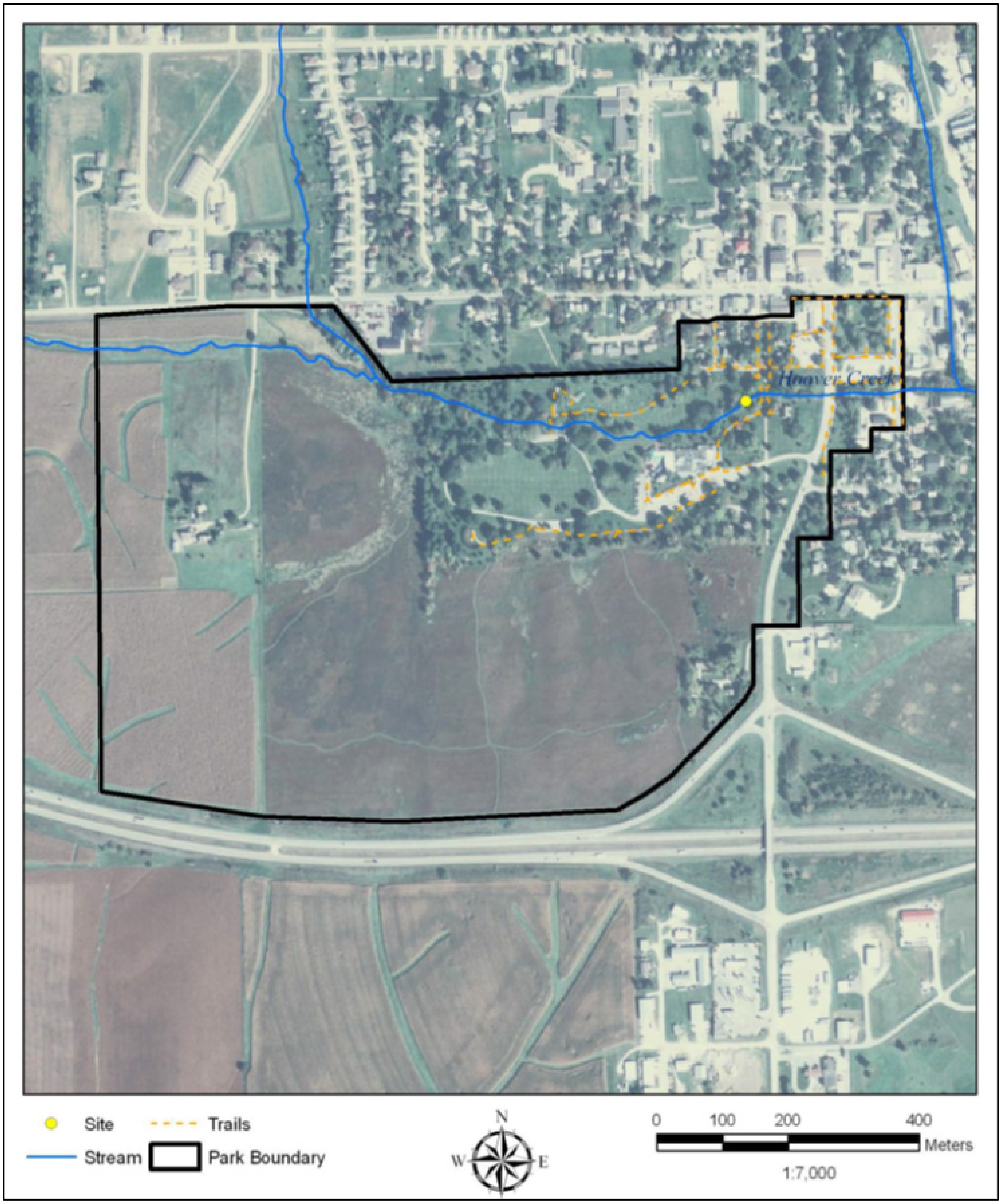

Figure 4.14-1. Location of the stream reach sampled annually in 2008 and 2011 at Herbert Hoover National Historic Site (Dodd et al. 2008).

The biotic or ecological "condition" described by the fish IBI, then moves along a disturbance gradient from a relatively intact, pristine, high water quality stream with high IBI scores to a more disturbed, developed or urban landscape with lower water quality and with low IBI scores. Classification of the fish species observed at HEHO into trophic and reproductive behavior guilds followed the classifications of Smogor and Angermeier (1999) as reported in Dauwalter et al. (2003). The response guilds incorporated into the fish IBIs are listed in Table 4.14-1.

Table 4.14-1. Fish species guilds used to calculate the IBI score.

Biotic Integrity Element	Guild Category	Response Guild	Relationship to IBI Score	Number of Species in Guild
Functional	Trophic composition	Percent algivorous/herbivorous, invertivorous and piscivorous	Negative	0
		Percent invertivorous	Positive	4
		Percent carnivorous	Positive	0
Tolerance/ intolerance	Tolerant species	Percent green sunfish, bluegill, yellow bullhead and channel catfish	Negative	0
	Intolerant species	Number of darter, sculpin, and madtom species	Positive	1
Physical condition	Fish health	Percent with black spot or an anomaly	Negative	3
Structural	Reproductive behavior	Number of lithophilic spawning species	Positive	7

A broader fish conservation context was evaluated by examining the native fish community to determine which species that occur at HEHO are considered species of conservation concern either nationally or in Nebraska and examining the occurrence of those species at the park. *To identify fish species that are of conservation priority we used species listed as either endangered or threatened by the U. S. Fish and Wildlife Service (USFWS) under the Endangered Species Act; U. S. Forest Service (USFS) and Bureau of Land Management (BLM) sensitive species lists; NatureServe G1 to G3 and S1 ranked species; and State lists of endangered, threatened and special concern species.* Including fish listed by Iowa's Threatened and Endangered Species Program recognizes that some species may be declining dramatically at the state scale, even though they are not declining nationally.

4.14.3. Reference Conditions

Little historic survey data exist for Herbert Hoover National Historic Site. One stream reach within Hoover Creek was sampled in July 2008 and 2011 using a single pass with a pulsed DC backpack electrofishing unit throughout the stream sampling reach (Figure 4.14-1) (Dodd and Keefe 2013). Fish reference condition for the sampled stream reach is based on the initial HTLN 2008 fish survey results. Maintaining or exceeding the level of biodiversity as defined by initial calculation of native species richness (as an index of diversity) and the initial quality of fish community composition as defined by the initial IBI score are considered good condition. A rating system for departure from good condition is shown in Table 4.14-2.

Table 4.14-2. Resource condition rating framework for fish at Herbert Hoover National Historic Site, Iowa.

Indicator	Condition Status Resource is in Good Condition	 Warrants Moderate Concern	 Warrants Significant Concern
Native species richness (s)	> 85–100+ % of 2008 value	70–85% of 2008 value	< 70% of 2008 value
Index of Biotic Integrity	60.1–100	40.1–60.0	0–40.0
Fish species of conservation concern	> 85–100+ % of 2008 value	70–85% of 2008 value	< 70% of 2008 value

The fish IBI score reflects a disturbance gradient from relatively intact and high quality stream ecosystem with high IBI scores to more disturbed, developed or urban stream ecosystem with low IBI scores. To calculate the IBI score, species are first assigned to guilds based on taxonomic composition, trophic composition, reproductive composition and fish condition (some species may be assigned to more than one guild, depending on their life history traits). The proportional richness of each guild is then calculated by dividing the number of individuals or species detected within a specific guild by the total number of individuals or species detected.

The next step in the fish IBI is to standardized metrics to score from 0 to 10 by developing threshold limits and linear equations after Dauwalter (2003). Threshold limits were minimum, 50th, and 95th percentile values for individual sample reaches of parks within the HTLN. After determining threshold limits, we adjusted each metric to score from 0 (very poor condition) to 10 (good condition) by using the equation:

$$MS = A + B \times (MR)$$

where MS = metric score, MR = raw metric value calculated from the sample reach data, A = the y-intercept in the regression of MS versus MR, and B = the slope in the regression of MS versus MR. Regressions were computed from the points for the upper and lower thresholds, which were assigned scores of 0 or 10 depending on a metric's relationship with stream site quality. Finally, IBI scores were standardized to score from 0 to 100. The final fish IBI score was calculated as follows:

$$IBI = \frac{(\sum_{i=1}^{N} MS_i) \times 10}{N}$$

where IBI = IBI score, MS = metric score of the i^{th} metric, and N = the number of metrics.

A community at the theoretical maximum high IBI score, or highest integrity, consists of a fish community with only specialist guilds and without any generalist guilds.

Threshold levels for fish IBI scores have not been rigorously defined, but Dauwalter et al. (2003) established thresholds that include four categories of condition corresponding to the standardized fish IBI score. For the fish IBI score at HEHO these thresholds include the following categories: 1) excellent (highest-integrity) – score of 80.1–100.0; 2) good (high-integrity) – score of 60.1–80.0; 3) fair (medium integrity) – score of 40.1–60.0; 4) poor (low-integrity rural and low-integrity urban) – score of 20.1–40.0; and 5) poorest (lowest integrity) – score of 0–20.0. To accommodate the three tiered nature of the assessment framework the two highest condition categories were combined into a single "high integrity" category, the middle class was considered a "fair integrity" category, and the two lowest condition categories were combined into a single "low integrity" category for the fish community at HEHO (Table 4.14-2).

We also compared the candidate list of species of concern to the actual list of species observed at HEHO during the 2011 survey. We used the number of species of concern recorded in the initial survey year of 2008 as the reference condition for comparison. The condition of the resource is considered higher if more species of concern are observed. This implies that the populations of those species are increasing and/or they are using the park more. A rating condition framework integrating reference condition concepts for native fish is shown in Table 4.14-2.

4.14.4. Condition and Trend

<u>Species Richness</u>

A total of 8 species were recorded at the stream sampling station in 2011, equivalent to the 8 species observed during the initial survey in 2008. The most common species was the Johnny darter (*Etheostoma nigrum*). The creek chub (*Semotilus atromaculatus*) and blacknose dace (*Campostoma anomalum*) were moderately common (Table 4.14-3). Compared to 2008, all species recorded at HEHO had increased counts in 2011 with the total individuals counted for all species increasing by 680 percent, while the count for the most common species, the Johnny darter, increased by 1,325 percent (Table 4.14-3). In 2011, there were 8 native fish species recorded at the single stream reach, greater than the management target of 85% of 8, the value in 2008 when sampling was initiated at HEHO. The native fish species richness recorded in 2011, when compared to the 2008 value, indicates the resource is in good condition (Table 4.14-2). It was not possible to determine the trend in species richness because the sample variability for each time point is unknown. The lack of multiple samples from numerous stream reaches on Hoover Creek makes it impossible to assess precision in the calculated values for species richness at HEHO.

Table 4.14-3. Fish species recorded in 2011 and 2008 at fish survey stations on Herbert Hoover National Historic Site.

Common Name	Species Name	Number Observed 2011	Number Observed 2008	USFS and Federal ESA List Status[A]	Nature - Serve Global Rank	State List Status[B]
Bigmouth shiner	*Notropis dorsalis*	25	2	none	G5	none
Blacknose dace	*Rhinichthys atratulus*	77	1	none	G5	none
Bluntnose minnow	*Pimephales notatus*	6	2	none	G5	none
Central stoneroller	*Campostoma anomalum*	17	3	none	G5	none
Common shiner	*Luxilus cornutus*	27	4	none	G5	none
Creek chub	*Semotilus atromaculatus*	80	19	none	G5	none
Johnny darter	*Etheostoma nigrum*	114	8	none	G5	none
White sucker	*Catostomus commersoni*	13	7	none	G5	none

[A] Federal status – LE = listed endangered, LT = listed threatened, P = proposed, C = candidate.

[B] State status – SE = state endangered, ST = state threatened, SC = state special concern.

Index of Biotic Integrity

The fish IBI score in 2011 was 81.2 compared to the 2008 score of 85.7. This IBI score indicates that composition of the fish community at HEHO in 2011 was in good condition (Table 4.14-2). It was not possible to determine the trend in the biotic integrity of the fish community because only two years of sample data were available for analysis. The lack of multiple samples from numerous stream reaches on Hoover Creek makes it impossible to assess precision in the calculated values of the fish IBI at HEHO.

Species of Concern

No at-risk species were recorded at HEHO either during the 2008 survey or the 2011 survey. This lack of data made it impossible to assess trends in the number of species of concern present. The lack of multiple samples from numerous stream reaches on Hoover Creek makes it impossible to assess precision in the calculated values for the number of species of concern at HEHO.

Overall Condition and Trend

The values for the metrics of native species richness, the fish IBI, and the number of species of concern present in 2011, indicate that HEHO fish community is in good condition, with a community structure that is representative of a landscape in good condition (Table 4.14-4). An analysis of the trend in the condition indicators was not possible because of the single sample in each time period. Confidence in the assessment is low.

Table 4.14-4. Condition and trend summary for fish at Herbert Hoover National Historic Site, Iowa.

Indicator	Condition Status/Trend	Rationale
Native species richness (s)	Good condition (green), dashed outline	Native fish species richness remained the same from 2008 to 2010 (good condition) with 8 species recorded in each year, greater than the management target of 85 percent of 8. Analysis of the fish monitoring data for trend in native species richness was not possible because only two years of sampling are were available for analysis.
Fish Index of Biotic Integrity	Good condition (green), dashed outline	In 2010, the fish IBI score was 81.2 (good condition). Analysis of the mean fish IBI scores for the trend in the biotic integrity of the fish community was not possible because only two years of sample data were available for analysis.
Species of conservation concern	Unknown (unfilled), dashed outline	No fish species of special concern were documented at the one stream sample reach surveyed in both 2008 and 2010.
Overall Condition Status for Fish	Good condition (green), dashed outline	**Condition is good with an unknown trend. Confidence in the assessment is low.**

4.14.5. Uncertainty and Data Gaps

Confidence in this assessment was low and trend analyses were not possible. The key uncertainty related to the assessment of the fish community at HEHO is in the limited years of data upon which the assessment is based and the lack of multiple independent samples from numerous stream reaches of Hoover Creek. Assessments of ecological change should use long-term data spanning decades rather than the 2 years of monitoring data available for this assessment (Holmes 2010 and Magurran et al. 2010).

4.14.6. Sources of Expertise

- Hope Dodd, a Fisheries Biologist, Heartland I&M Network and Prairie Cluster Prototype Programs. Hope is responsible for collecting the monitoring data at HEHO upon which this assessment is based and also for leading the design of the protocol used to monitor fishes at parks of the HTLN (Dodd et al 2008). Her research interests focus on anthropogenic disturbances in lotic systems and assessment of these long-term effects on water quality, habitat, and biota.

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5. Summary and Discussion

This section summarizes condition and trend results by focal resource, highlights management implications and interrelationships among resources, reinforces relationships between resource condition and landscape context elements, and consolidates data gaps.

5.1. Condition Summary and Management Implications

A total of 14 focal resources were examined: six address landscape context-system and human dimensions, three address chemical and physical attributes, and five address biological attributes. Status and trend assigned to each focal resource and a synopsis of supporting rationale are presented in Table 5.1-1.

Table 5.1-1. Summary of focal resource condition and trend for Herbert Hoover National Historic Site.

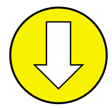
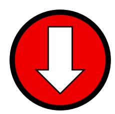
Ecosystem Attribute	Resource	Condition Status/Trend	Rationale for Overall Condition/Trend Rating
Landscape context – system and human dimensions	Land cover and land use	Condition and trend not assigned	Overall, the park has threats and stressors that are similar to other parks in the Tallgrass Prairie ecoregion. Most land cover and land use-related stressors at HEHO and in the larger region are related to development of rural agricultural land and increases in population and housing. Conversion of hay and pasture lands to cropland is also a concern. Trends in development and conversion, coupled with the lack of significantly-sized and linked protected areas, significantly impacts conservation of natural resources of the park as well as dark night skies, natural sounds and scenery. The summary of land cover and land use metrics provides a useful context of stressors, supports resource planning and management within the park, and provides a foundation for collaborative conservation with landowners in the surrounding area.
	Night sky		The nearby cities of Cedar Rapids, Iowa City, and Davenport contribute to anthropogenic light near HEHO. The condition of dark night skies at HEHO warrants moderate concern with a deteriorating trend. Confidence in the assessment is medium due to the lack of quantitative data and the use of only a single indicator.
	Soundscape		Noise from anthropogenic sources is pervasive. Noise from modern transportation on Interstate 80 and the town of West Branch particularly threaten the park's natural soundscape, but noise from park maintenance and aircraft are also prominent. The sound pressure level associated with physiological changes in humans (35 dBA) was exceeded 100% of the time in the park both day and night. Vehicle noise was audible 100% of the time in the park during attended listening data collection. Nationwide modeling of anthropogenic sound level impacts indicates that modern noise intrusions are substantially increasing the ambient sound level above the natural ambient sound level of the park. Ground and air traffic are anticipated to continue to increase over time, contributing to a deteriorating trend in condition. Confidence is very high due to the numerous quantitative and qualitative metrics.

Table 5.1-1 (continued). Summary of focal resource condition and trend for Herbert Hoover National Historic Site.

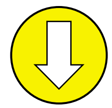
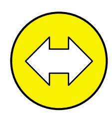
Ecosystem Attribute	Resource	Condition Status/Trend	Rationale for Overall Condition/Trend Rating
	Scenery and views		All primary views received a good scenic quality rating. The scenic quality of secondary views varied from good to moderate concern. Views extending outside the park to the southwest and northwest, and especially those including the I-80 interchange and the highway had the lowest ratings due to the conspicuousness of inconsistent elements. Development outside the park has degraded secondary views in the recent past. Within a 30 km radius of the park, during 1970 to 2010 there has been an increase in exurban areas and a corresponding decrease in rural acreage in unincorporated areas, including areas close to towns and major roads. The five-year averages for visibility consistently fall in the NPS Air Resources Division “poor condition” category.
Landscape context – system and human dimensions (continued)	Climate change	Condition and trend not assigned	The park climate is becoming drier (despite increasing precipitation), hotter, and is potentially more prone to more frequent and extreme weather events. Trends are projected to continue or accelerate by the end of the century. Research and monitoring related to climate change, the anticipated vulnerability of specific resources vis-a-vis climate change, and its associated effects on resources and interaction with other ecological processes such as plant composition and fire can be informed by this broad overview of the magnitude of climate change. It also supports ongoing, anticipatory and adaptive management. More specific climate change adaptation tools and techniques appear to be needed at the park scale.
	Fire disturbance regime		Fire regime components vary in their ability to meet reference conditions for the site. Although fire frequencies generally fall within the desired range, variability in the seasonality of fire may limit the restoration benefits and reduce heterogeneity within the prairie. Fire severity is estimated to be below desired levels. Administrative uncertainties and inconsistent funding of prescribed burn management may adversely affect the condition of this resource over time. Proximity to urban areas and Interstate 80 create public health and safety concerns related to smoke associated with burning. While fire is the preferred tool, there will continue to be limits to its use at HEHO, and continued or expanded use of techniques and tools such as haying, herbicides and manual/mechanical control of woody plants will likely be necessary.

Table 5.1-1 (continued). Summary of focal resource condition and trend for Herbert Hoover National Historic Site.

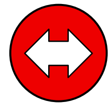
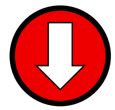
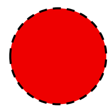
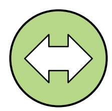
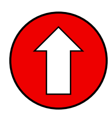
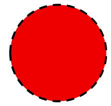
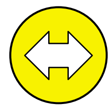
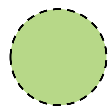
Ecosystem Attribute	Resource	Condition Status/Trend	Rationale for Overall Condition/Trend Rating
Chemical and physical environment	Air quality		Based on the evaluation of ozone, nitrogen and sulfur wet deposition, and visibility, air quality condition warrants significant concern with an unchanging trend. Impacts to air quality are largely from distant sources that are affecting regional air quality.
	Stream hydrology and geomorphology		Applying the Proper Functioning Condition and Channel Evolution Model framework, the portion of Hoover Creek flowing through the park warranted significant concern. Urbanization has altered the flow regime and caused the creek to incise beyond critical bank heights resulting in widespread bank failure. Continued urbanization and altered hydrology within the watershed will likely further degrade the stream. Although stream restoration may be constrained by the presence of historic and other structures within the floodplain, stream and floodwater management plans are in progress.
	Water quality		The current condition of water quality in HEHO is largely undetermined due to a general lack of monitoring data. However, water quality condition warrants significant concern due to the fact that Hoover Creek is listed as impaired by fecal coliforms and available data indicate high levels of coliforms. Confidence in the assessment is low due to the age and availability of data.
Biological – plants	Prairie vegetation		The overall condition of prairie vegetation is good and conditions were relatively unchanging during 2004–2009. Prairie sites have maintained a mean of at least 80% cover of native plant species. Native species richness for prairie communities at HEHO has remained reasonably stable, averaging 21–26 species per site, with about 6–7 abundant species. Species evenness may be increasing. Native forbs and graminoids are generally well represented and levels of woody vegetation cover are below 15%. There is moderate concern regarding the number, frequency, and abundance of invasive exotic plant species, including five state-listed noxious weeds.
	Invasive exotic plants (IEPs)		Seven IEP species are present with high frequency and cover. The invasive grasses reed canarygrass and smooth brome are present throughout the park and may degrade the function of native grasslands. All but one search unit have more than 5 IEP species present. Six Iowa state-listed noxious weeds were present in 2013 with combined coverage exceeding 1% of the park. The low confidence associated with defining reference conditions results in a medium level of confidence for the indicator.

Table 5.1-1 (continued). Summary of focal resource condition and trend for Herbert Hoover National Historic Site.

Ecosystem Attribute	Resource	Condition Status/Trend	Rationale for Overall Condition/Trend Rating
Biological – animals	Aquatic macroinverte-Brates		Based on the evaluation of aquatic macroinvertebrate metrics and comparisons with similar streams, condition of the resource warrants significant concern. Due to the lack of multiple samples, trends were not determined. Confidence in the assessment is low due to lack of data history and unknown precision for metrics.
	Bird community		Native species richness, the bird index of biologic integrity, and the number of species of concern present in 2012 indicate that the condition of the bird community warrants moderate concern with an unchanging to improving trend. Grassland birds were in good condition with an improving trend while woodland birds associated with riparian and bur oak woodlands warranted significant concern with an unchanging trend. Some obligate grassland birds were present and the community structure is representative of a moderately disturbed landscape.
	Fish community		Native species richness, fish index of biotic integrity (IBI), and number of species of concern present indicate that HEHO is in good condition, with a community structure that is representative of a landscape in good condition. An analysis of the trend in the condition indicators assessed was not possible because only two years of sample data were available for analysis and the precision of single sample sizes is unknown. Confidence in the assessment is low.

5.1.1. Landscape Context –System and Human Dimensions

Landscape context – system and human dimensions included land cover and land use, night sky, soundscape, scenery, climate change and fire disturbance regime (Table 5.1-1). Climate change and land cover/land use were not assigned a condition or trend—they provide important context to the park and many natural resources, and can be stressors. Some of the land cover and land use-related stressors at HEHO and in the larger region are related to the development of rural agricultural land and increases in population/housing over time. The trend in land development, coupled with the lack of significantly-sized and linked protected areas, presents significant challenges to the conservation of natural resources of HEHO to also include dark night skies, natural sounds and scenery. Climate change is happening and is affecting resources, but is not considered *good* or *bad* per se. The information synthesized in that section is useful in examining potential trends in the vulnerability of sensitive biological resources. The fire regime is included here because in this region fire is a key natural process under which many biological components have evolved. Therefore, it is deemed a critical component of the long-term persistence of prairie species and the ecological integrity of the system. The fire regime warranted moderate concern with an unchanging trend, and might be significantly ameliorated via planning, programmatic and budgetary measures. Nonetheless, the use of fire with its associated smoke is constrained by the proximity to urban areas and Interstate 80.

There are opportunities to mitigate the effects of local landscape context stressors through planning, management and mitigation. Stressors driven by more distant factors such as light pollution generated by urban centers and increase in regional transportation volumes affecting sights and sounds are more difficult to mitigate. Collectively, this context supports resource planning and management within the park, and provides a foundation for collaborative conservation with other landowners in the surrounding area.

5.1.2. Chemical and Physical Environment

The supporting chemical and physical environment at the park includes its air quality, water quality and stream hydrology/geomorphology (Table 5.1-1). The condition of these resources can a affect human dimensions of the park such as visibility and scenery as well as biological components such as vegetation health and stream biota. Air quality, water quality and stream hydrology/ geomorphology all warranted significant management concern. Stressors outside the park are significantly impacting these resources, but riparian vegetation and stream channel management for cultural purposes may be exacerbating stream hydrology issues. Conditions were estimated to be unchanging for air quality, deteriorating for stream hydrology and the trend in water quality is unknown.

5.1.3. Biological Component – Plants

The floral biological components examined included prairie vegetation and invasive exotic plants (Table 5.1-1). The park is a rare example of tallgrass prairie restoration in the region and one of the few in the area. Challenges related to invasive plant management and fire regime contribute to management concerns. Although the prairie is rated in good condition, there is some risk associated with potential expansion of nonnative invasive plants. Maintenance of a desirable fire regime can help control woody plants and promote floristic diversity, but is challenging due to the park's location within an urbanized area.

5.1.4. Biological Component – Animals

The faunal biological components examined included aquatic macroinvertebrates, birds and fish (Table 5.1-1). Aquatic macroinvertebrates are likely being impacted by poor water quality and altered stream flows/hydrology. The fish community was rated in good condition but the reference condition is poorly defined and stream habitat is highly altered. The bird community warrants moderate concern. Trends for faunal resources examined are unchanging or unknown. Because of the small size of the park and the predominance of developed and agricultural land uses, opportunities to support a diverse faunal assemblage at HEHO, including a variety of herpetofauna, carnivores, ungulates and other species is limited. Many animals have been lost from the landscape and are no longer present in the park. Nonetheless, the park still provides an island of restored prairie that provides habitat for native animals.

5.2. Data Gaps and Uncertainties

The identification of data gaps during the course of the assessment is an important outcome of the NRCA (Table 5.2-1). In some cases significant data gaps contributed to low confidence in the condition or trend assigned to a resource. Primary data gaps and uncertainties encountered were lack of recent survey data; uncertainties regarding reference conditions; weak sampling designs; and lack of consistent, long-term data.

Table 5.2-1. Data gaps identified for focal resources examined at Herbert Hoover National Historic Site.

Ecosystem Attribute	Resource	Data Gaps
Landscape context–system and human dimensions	Land cover and land use	Single point in time (2006) used. Degree of protection on private lands uncertain.
	Night sky	Lack of quantitative data and the use of a single indicator reduce confidence in the assessment.
	Soundscape	The impacts of existing soundscape conditions on visitor experiences are unknown.
	Views and scenery	Further examination of key park views by park staff is recommended incorporating scenic quality protocols being developed by the NPS Scenery Conservation Program.
	Climate change	Climate change projections are complex with inherently high uncertainty. More specific guidance for park adaptation is needed.
	Fire disturbance regime	Burn severity data.
Chemical and physical environment	Air quality	Local air monitoring stations vs. interpolated regional data would provide more accurate data.
	Stream hydrology and geomorphology	The effects of upstream and instream development and remediation projects are not well documented.
	Water quality	There have been two monitoring locations established within the park but monitoring only occurred for a short period between 2004 and 2006.Currently, there is no TMDL available for Hoover Creek.

Table 5.2-1 (continued). Data gaps identified for focal resources examined at Herbert Hoover National Historic Site.

Ecosystem Attribute	Resource	Data Gaps
Biological – plants	Prairie vegetation	High variability in sample data due to interannual weather differences, phenology and small sample sizes can make it difficult to interpret data and detect statistically significant changes over time. Reference conditions are poorly defined for the region.
	Invasive exotic plants	No gaps were identified. The available data reflects intensive surveys covering all areas of the park and addressing park-based watch lists. Spatial resolution of the data is high.
Biological – animals	Aquatic macroinvertebrates	Reference conditions are poorly defined in this region. Only one year of data available.
	Bird community	No significant gaps were identified.
	Fish community	Only two years of sampling data are inadequate to properly assess condition and trend; few sampling sites; reference conditions are poorly defined/characterized.

5.3. Conclusions

In recent years, scientists and land managers have recognized the importance of creating heterogeneity on the landscape to promote diversity, sustain species adapted to natural disturbance regimes, and foster a variety of faunal habitat structures (Wiens 1997, Fuhlendorf and Engle 2001, Reinking 2005). In tallgrass prairie, the primary disturbance agents of fire and grazing interact with other biotic and abiotic factors to maximize heterogeneity and species diversity on the landscape (Fuhlendorf et al. 2006, Hamilton 2007, Knapp et al. 1999). Despite the absence of significant numbers of native grazers, a high-quality prairie has been created and maintained through judicious use of fire, weed management, and restoration activities. The area outside the commemorative area supports many natural resource functions while providing an "accessible" and "spacious" setting within which the historic setting can be experienced.

Because the regional landscape is dominated by private land and agricultural land uses, the Historic Site setting provides an important place for visitors to experience the outdoors. The historic context is therefore buffered to some degree and complemented by the natural areas surrounding the core visitation area. Nonetheless, the landscape immediately surrounding the park and in the broader region continues to change significantly in ways that degrade park natural resources and impact visitor experience. The changes occurring outside the park boundary adversely impact a number of resources including natural sounds, night skies and air and water quality. Fragmentation of surrounding lands and the paucity of protected areas in the region also present challenges to maintaining diverse animal and plant communities and natural processes.

Management success will require acknowledging a "dynamic change context" that manages widespread and volatile problems while confronting uncertainties, managing natural and cultural resources simultaneously and interdependently, developing broad disciplinary and interdisciplinary knowledge, and establishing connectivity across broad landscapes beyond park borders (National Park Service Advisory Board Science Committee 2012). Herbert Hoover National Historic Site faces challenges that are compounded by its small size and isolation with regard to other protected natural areas. Regional and park-specific mitigation and adaptation strategies are needed to maintain or improve the condition of some resources over time in response to stressors such as weeds, altered hydrology and undesirable effects of urban and exurban encroachment.

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