Grand Canyon National Park
Arizona

U.S. Department of the Interior
National Park Service

Initial Bison Herd Reduction

ENVIRONMENTAL ASSESSMENT

May 2017

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR

Grand Canyon National Park
Arizona

Initial Bison Herd Reduction Environmental Assessment

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CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

INTRODUCTION

This environmental assessment (EA) has been prepared to evaluate actions to quickly reduce the bison (*Bison bison*) population on the North Rim of Grand Canyon National Park (the park) (figure 1). In the 1990s, the House Rock bison herd, which the Arizona Game and Fish Department (AGFD) has managed at House Rock Wildlife Area (HRWA) since 1929, began spending more time off of House Rock Wildlife Area and venturing on to the North Rim of the park. Most of the House Rock bison herd now spend a majority of their time inside the park, and the population, which is steadily increasing, is expected to reach nearly 800 animals in the next 3 years (and as large as 1,200 to 1,500 animals within 10 years) (Sturm and Holm 2015). Under these circumstances, the National Park Service (NPS) is concerned about the potential for increasing impacts from the House Rock bison herd on park resources and values. Furthermore, other agencies involved with bison management on the Kaibab Plateau (see figure 1)—the US Forest Service (USFS), the Arizona Game and Fish Department, and the Bureau of Land Management (BLM)—are also concerned about resource damage from an over-abundant bison population and that they cannot meet their bison management goals if the population continues to grow (see "Cooperative Management of the House Rock Bison Herd" section later in this chapter).

PURPOSE OF AND NEED FOR ACTION

The purpose of taking action is to (1) quickly reduce bison population density in collaboration with other agencies with jurisdiction for bison management on the Kaibab Plateau, and (2) protect park resources and values from the impacts of a steadily growing bison population. Action is needed now because:

- Most of the House Rock bison herd now spends a majority of its time inside the park.
- Biologists estimate that since the early 1990s, despite a state-managed hunt outside the park, the House Rock bison herd grew from approximately 100 bison to between 400 and 600 bison that currently roam the Kaibab Plateau.
- The House Rock bison herd is expected to grow to nearly 800 bison in the next 3 years and as large as 1,200 to 1,500 animals within 10 years (Sturm and Holm 2015).
- Given current bison distribution, abundance, and density and the expected growth of the House Rock bison herd, the National Park Service is concerned about any current and potential increased impacts on park resources, such as water, vegetation, soils, and archeological sites; and on values such as visitor experience and wilderness character.

As a result, the National Park Service is proposing to develop a plan to reduce the House Rock bison herd to fewer than 200 animals, in collaboration with the Arizona Game and Fish Department, the US Forest Service, and the InterTribal Buffalo Council. Given current bison population estimates, reducing the House Rock bison herd to fewer than 200 animals is achievable over a period of 3 to 5 years (Sturm and Holm 2015) and is consistent with recommendations for a free-ranging bison herd on the Kaibab Plateau (see "Cooperative Management of House Rock Bison Herd" section later in this chapter).

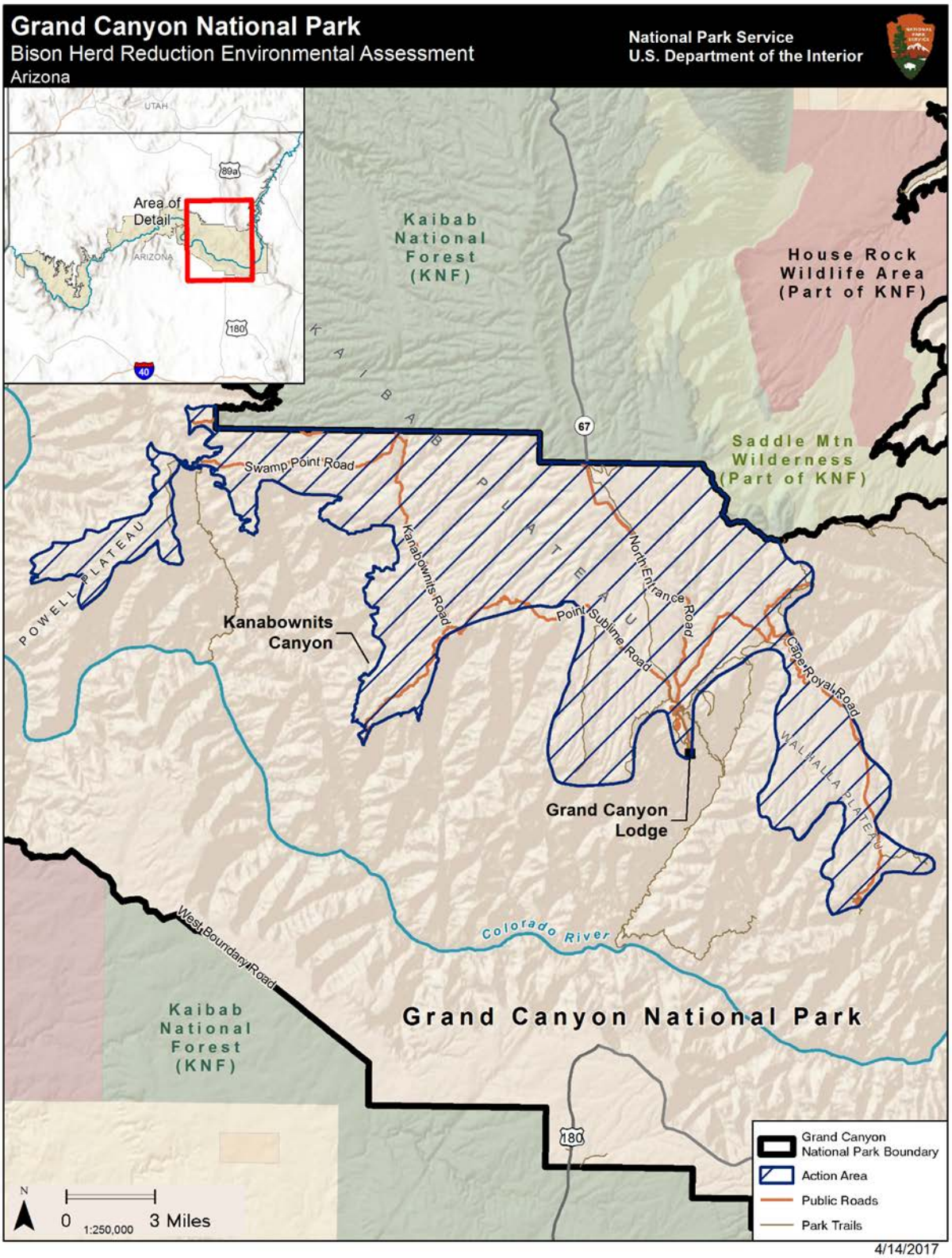

FIGURE 1. MAP OF ACTION AREA FOR THE ENVIRONMENTAL ASSESSMENT

While the proposed action, if implemented, would result in fewer than 200 bison in the park, for the purpose of this environmental assessment regarding short-term management options, the National Park Service has dismissed an alternative that eliminates bison from the park (see "Alternatives Considered But Dismissed from Detailed Analysis" in chapter 2). The Arizona Game and Fish Department manages bison in this area as a free-ranging herd through an agreement with the US Forest Service. The National Park Service would continue to work with the Arizona Game and Fish Department, US Forest Service, and Bureau of Land Management to meet each agency's long-term goals for management of the House Rock bison herd on the Kaibab Plateau (for additional discussion, see the "Background" and "Cooperative Management of the House Rock Bison Herd" sections later in this chapter).

The reduction of the House Rock bison herd would be accomplished using a suite of management tools (both non-lethal and lethal) on the North Rim of the park (see figure 1) that would be implemented in collaboration with state, tribal, and federal partners. By quickly reducing the bison population to this level and using other tools to protect park resources (e.g., localized fencing), the potential for increased impacts on park resources and values could be minimized. While the tools considered in this environmental assessment might be the same as tools used by the park for any potential future management, the National Park Service would complete, as appropriate, any additional National Environmental Policy Act (NEPA) reviews that may be needed to support future management actions.

As part of the proposed action, the park would monitor reduction tool effectiveness, bison population response, and park resource condition monitoring and may adapt approaches to bison reduction in collaboration with federal and state partners. This monitoring would establish understanding of resource impacts, response, and recovery with fewer than 200 bison on the landscape and could help inform any potential future discussions about the House Rock bison herd. A more detailed description of the NPS proposed action can be found in chapter 2 under "Alternative 2: Proposed Action (Preferred Alternative)."

The National Park Service has prepared this environmental assessment in cooperation with the US Forest Service, the Arizona Game and Fish Department, the Bureau of Land Management, and the InterTribal Buffalo Council because of their special expertise in managing bison and bison habitat. As formal cooperating agencies, they have informed the development of the proposed action, the no-action alternative, and the impacts analysis.

BACKGROUND

The House Rock bison herd descended from animals brought to northern Arizona in 1906 to the Grand Canyon Game Preserve, much of which is now Grand Canyon National Park. Beginning in 1929, the Arizona Game and Fish Department began managing this bison population in what is now known as the House Rock Wildlife Area on Kaibab National Forest (see figure 1) through an interagency agreement signed in 1950, between the US Forest Service, the Bureau of Land Management, affected cattle ranchers, and the Arizona Game and Fish Department. The *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) states that "the bison herd has been present on the North Kaibab Ranger District for more than 100 years and was specifically mentioned in legislation leading to the Grand Canyon Game Preserve."

By the late 1990s, the House Rock bison herd was spending most of its time off of the House Rock Wildlife Area and had migrated on to the North Rim of the park. The most recent year that bison returned to House Rock Wildlife Area was 2009, and now many bison do not leave the park at all (AGFD, Lutch, pers. comm. 2015a) or remain close to the park on adjacent USFS lands. Given reproduction rates and lack of predators, the House Rock bison herd has grown from an estimated 100 bison in the late 1990s to between 400 and 600 in 2014 (Plumb et al. 2016).

In response, a Tri-Agency Work Group of staff from the park, Arizona Game and Fish Department, and the US Forest Service began addressing research needs and administrative and operational challenges of long-term, cooperative management of the House Rock bison herd. These agencies were, and continue to be, concerned about the growing size of the bison population, movement of bison to areas outside House Rock Wildlife Area, and challenges associated with managing bison on the Kaibab Plateau under their current distribution. The Grand Canyon National Park report entitled *Bison Management Activities within Grand Canyon National Park* (NPS 2015a) was prepared to add to the knowledge base for addressing concerns and taking action to resolve issues related to the House Rock bison herd. The report summarizes several studies that examine potential impacts of bison on natural and cultural resources at the park. These studies contribute to a better understanding of the current situation in the park. Other projects in recent years examine how the presence of the House Rock bison herd and their behavior (e.g., wallowing) affects seeps, springs, and associated vegetation; vegetation within meadows; soils; and archeological resources.

More recently, Sturm and Holm (2015) modeled projected growth of the House Rock bison herd in the absence of NPS management, and as noted previously, the herd could grow to nearly 800 animals over the next 3 years (and to as large as 1,200 to 1,500 animals within 10 years). In addition to reproductive rates and lack of predators, the substantial decrease in availability of the House Rock bison herd for hunting outside the park, which is one of the management tools that the Arizona Game and Fish Department uses to control wildlife populations, also contributes to the projected growth of this bison population. This model, which is not prescriptive or intended to be a guide for implementation, also provided assumptions for the analysis in this environmental assessment regarding the number of bison that may be removed if the National Park Service and its partners use the various tools proposed simultaneously and complement them with hunting outside the park (see ‘Bison Removal Modeling’ section of chapter 2).

NPS AUTHORITY TO MANAGE WILDLIFE

All units of the national park system share a common mission of stewardship of the national heritage. The National Park Service has authority to manage wildlife populations and habitats on lands under its jurisdiction under the NPS Organic Act and other authorities (54 USC 100101 et seq.). The Secretary of the Interior maintains discretion to “provide for the destruction of such animals and plant life as may be detrimental to the use of any System unit” (54 USC 100752). The wildlife management authorities and policies of the National Park Service are found in section 4.4 and other provisions of NPS *Management Policies 2006* (NPS 2006a). In addition, the National Park Service is guided by the resource stewardship policies set out in Director’s Order 100 (NPS 2016a). Within these overarching authorities and policies, some inherent variability in stewardship exists in an agency that administers more than 400 individual units that span a large geography—from the South Pacific to the Arctic—and are situated in varied cultural, social, and political settings. Each unit has a variety of park-specific management directives. Indeed, management of large mammals at national parks inevitably requires consideration of both the larger natural and human-built landscapes in which a park is embedded. Additional laws, regulations, and policies applicable to specific resource topics are discussed below in the identification of issue and impact topics and in chapters 3 and 4, as appropriate.

COOPERATIVE MANAGEMENT OF THE HOUSE ROCK BISON HERD

As cooperating agencies, the Arizona Game and Fish Department and the US Forest Service have shared their goals for management of the House Rock bison herd outside of the park at various stages of this environmental assessment process. As noted above, Arizona Game and Fish Department manages the House Rock bison herd as a free-ranging wild bison through an agreement with the US Forest Service on

USFS-managed lands adjacent to the park. Arizona statute guides bison management as wildlife on USFS lands adjacent to the park. In addition, the National Park Service recognizes the non-game values (e.g., bison viewing opportunities) that the Arizona Game and Fish Department places on bison.

The National Park Service also recognizes that management actions on Grand Canyon can affect the ability of the Arizona Game and Fish Department, the US Forest Service, and the Bureau of Land Management to meet their management goals related to bison. On non-NPS lands, the Arizona Game and Fish Commission has primary statewide responsibility for wildlife management, including the House Rock bison herd. The Arizona Game and Fish Department acts under the authority of the Commission, including on land administered by the US Forest Service on the Kaibab National Forest. On the Kaibab National Forest, a common goal regarding bison for both the US Forest Service and the state is to maintain bison populations at levels that provide maximum and diverse recreational opportunities, while avoiding adverse impacts on ecosystems. To achieve this, the Arizona Game and Fish Department plans to restart a subpopulation of bison with site fidelity to the House Rock Wildlife Area and to use adaptive management strategies, including habitat management and a revised bison hunt structure outside the park to maintain most of the House Rock bison herd on USFS lands year-round. Over the last 7 years, the Arizona Game and Fish Department has used adaptive management in an attempt to maximize the number of bison harvested each year through hunt recommendations twice a year, which can be found in the Spring and General Hunting Regulations each year. Consistent with the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014), the Arizona Game and Fish Department, in coordination with the US Forest Service, would work to manage the House Rock bison herd in a manner that develops site fidelity to House Rock Wildlife Area, in balance with ecological conditions and with the potential for some seasonal use of other USFS Kaibab Plateau lands. The US Forest Service's *Kaibab National Forest Land and Resource Management Plan* assumes that the Arizona Game and Fish Department will use adaptive management tools, including hunting, trapping, fencing, and herding to minimize impacts from the House Rock bison herd on other USFS resources (USFS 2014).

Bison do not currently occur on the Arizona Strip lands managed by the Bureau of Land Management, and the BLM's resource management plan does not include desired outcomes or actions to manage the area for bison. The Arizona Game and Fish Department has no plans to include the management of bison on these lands. If bison migrate to these lands over time or as a result of actions taken under this environmental assessment, the Arizona Game and Fish Department would work with the Bureau of Land Management to manage bison within social and ecological limitations.

This environmental assessment focuses on reducing the House Rock bison herd to a level that would protect park resources and values while still allowing for a viable bison population on the Kaibab Plateau. Long-term bison management, which would consider the possible historic role of bison in this setting, is outside the scope of this environmental assessment. Understanding of this possible role of bison in the area is evolving, informed by a growing body of science and scholarly work, bison management goals of other agencies, and the Department of the *Interior's Bison Conservation Initiative* (DOI 2008). Continued dialogue is also needed with American Indian tribes and other federal and state agencies to assess any appropriate long-term, landscape-scale, ecological and cultural roles of bison across the multijurisdictional Kaibab Plateau.

The Department of the Interior's *Bison Conservation Initiative* seeks to improve bison management among its various bureaus, including the National Park Service (DOI 2008). This initiative provides an important national context and would be a key reference for potential future interagency discussions of appropriate bison management on the Kaibab Plateau. The *Bison Conservation Initiative* recognizes a national priority for developing partnership arrangements to improve management of bison populations in biologically suitable areas (DOI 2008). It also provides a foundation to strengthen existing partnerships

and develop new ones with states, American Indian tribes, landowners, agricultural interests, conservationists, and others interested in bison.

The goals outlined in the *Bison Conservation Initiative* were reinforced in 2014, when the Department of Interior issued the *DOI Bison Report: Looking Forward*, which emphasizes collaboration among federal, state, local, and tribal partners and identifies the interagency effort to address bison at Grand Canyon National Park and adjacent USFS lands as an important case study to measure success in developing these types of innovative partnerships (DOI 2014).

In addition to the Tri-Agency Working Group and working together on this environmental assessment, past examples of this collaboration include a 2014 experiment conducted by the National Park Service and Arizona Game and Fish Department that involved the capture, transport, and release of bison back to the House Rock Wildlife Area, where the current bison herd originated. Attempts have also been made to estimate and count the number of bison in the park (NPS 2015a). Results are discussed in the appropriate sections of chapters 3 and 4 of this environmental assessment.

More recently, staff from the park, the NPS Intermountain Regional Office, NPS Washington Support Offices, the Arizona Game and Fish Department, and the US Forest Service collaborated on a report (Plumb et al. 2016) to help inform the management of the House Rock bison herd. This report identifies a potential large landscape of about 215,000 acres on the Kaibab Plateau for possible future management of the herd. The report suggests a target population range of 80–200 bison on this landscape, based on a number of interagency resource management (including bison) considerations, including reducing the density of the House Rock bison herd to avoid impacts on park resources and to support partner goals for a free-ranging bison population that allows for public bison hunting and viewing opportunities on the Kaibab National Forest.

The proposed action analyzed in this environmental assessment provides an opportunity to continue to engage with American Indian tribes and other federal and state agencies regarding bison on the Kaibab Plateau. Furthermore, engaging these partners now could help lay the foundation for any future discussions about any appropriate long-term, landscape-scale, ecological and cultural role of bison across the multijurisdictional Kaibab Plateau. Although decisions about long-term bison management are outside the scope of this environmental assessment, the National Park Service is committed to working collaboratively with its cooperators regarding the long-term management of the House Rock bison herd, consistent with the direction included in Executive Order 13352, "Facilitation of Cooperative Conservation;" Department of the Interior Fish and Wildlife Policy: State-Federal Relationships (43 CFR Part 24); the *Bison Conservation Initiative* (DOI 2008); and other DOI and NPS policies regarding consultation and cooperation. These policies call on the National Park Service to consult with state agencies on certain fish and wildlife management actions and encourage the execution of memoranda of understanding, as appropriate, to ensure the conduct of programs that meet mutual objectives, as long as they do not conflict with federal law or regulation. In furtherance of the commitment to collaboration and these policies, the National Park Service is exploring entering into a formal memorandum of understanding with its partners regarding long-term management of the House Rock bison herd. Discussions regarding this memorandum of understanding are ongoing.

ISSUES AND IMPACT TOPICS

When determining whether to retain an issue for more detailed analysis in this environmental assessment, considerations included, among other things, whether or not:

- the environmental impacts associated with the issue are central to the proposed action or of critical importance;

- a detailed analysis of environmental impacts related to the issue is necessary to make a reasoned choice between alternatives;
- the environmental impacts associated with the issue are a big point of contention among the public or other agencies; or
- there are potentially significant impacts on resources associated with the issue.

Ultimately, decision makers and the public need to understand the impacts that each of the alternatives under consideration would have on specific resources. Therefore, this environmental assessment uses "impact topics" as headings to indicate which resources would be affected by each issue and to organize the discussions of the affected environment (chapter 3) and environmental consequences (chapter 4).

ISSUES AND IMPACT TOPICS CARRIED FORWARD FOR ADDITIONAL ANALYSIS

House Rock Bison Herd

In general, bison can exhibit local and regional movements that include seasonal migration and pioneering dispersal movements in response to seasonal food availability, habitat values, and increasing population abundance and density (Plumb et al. 2009). Proposed actions to reduce the House Rock bison herd, including nonlethal culling using capture and removal and lethal culling primarily using skilled volunteers and tribal personnel, would cause bison to change habitat use patterns that could alter bison population abundance and distribution inside and outside the park. Changes in demographics could also occur through the disproportionate removal of cows compared to bulls or adults compared to subadults.

Water Resources in the Karst Landscape

A reduction in density and abundance of the House Rock bison herd, as well as localized fencing of springs, seeps, lakes, ponds, and sinkholes that act as seasonal groundwater recharge points, could reduce potential impacts on these and other ephemeral sources of water found on the North Rim of the park and in adjacent areas of Kaibab National Forest. This would also reduce soil disturbance and compaction associated with the large concentrations of bison currently found near these water sources on the North Rim. This reduction would help alleviate potential concerns about changes to local hydrology that could result if such disturbances were to decrease the ability of the soil to absorb water. The reduction would also help alleviate concerns that such alterations to local hydrology may affect the recharge and drainage through the karst landscape on the Kaibab Plateau, which could affect the amount of available water and water quality throughout the karst landscape. In addition, reducing the presence of the House Rock bison herd in and adjacent to water sources could potentially improve water quality by decreasing nutrients, fecal bacteria, and disturbed soils entering the water sources. Reduction activities would be carried out in a manner that avoids direct impacts on water resources to the extent possible. However, lethal culling and associated carcass handling could occur in the vicinity of water sources, and hazing and herding could bring bison close to water sources, all of which could result in impacts on water quality from soil disturbance and compaction, as well as vegetation disturbance.

Bison-Affected Vegetation

Vegetation of concern that may be affected by bison on the North Rim include grasslands, meadows, and shrublands seasonally through foraging and consumption. In addition, high bison numbers can affect wetland-associated vegetation as bison seek water. Actions considered in this environmental assessment are intended to reduce the density and abundance of the House Rock bison herd. These actions would reduce concerns related to the loss of and changes to diversity of vegetation in vegetation communities used by bison that could result from overgrazing, trampling the vegetation itself, or compacting soils that

support vegetation. This would include reducing the levels of disturbance that the currently high concentrations of bison cause to native vegetation and soils. The actions would also reduce concerns that an expanding House Rock bison herd would begin to forage increasingly in shrublands and adversely affect this vegetation over the long term.

Reducing levels of disturbance associated with high concentrations of any wildlife species would also reduce opportunities for exotic plants to become established in disturbed areas, and reduced bison numbers would decrease opportunities for bison to introduce (through their hair and dung) propagules of exotic and invasive species of vegetation. Most notably, reducing the population is expected to benefit vegetation associated with and adjacent to seeps and springs (referred to as wetland-associated vegetation in this environmental assessment) or in meadow and grassland areas of the North Rim of the park where large concentrations of the House Rock bison herd may occur. Additionally, research in other areas where bison are managed at densities and abundance compatible with their local ecological environment have shown that bison can have some potential positive effects on native plant communities (e.g., increased overall plant community diversity through physical effects and increased overall plant productivity through compensatory plant response to herbivory) (Schoenecker 2012).

The proposed actions for reducing the House Rock bison herd may also have some adverse effects on vegetation, especially meadows and grasslands. For example, nonlethal culling operations would result in congregations of bison in meadows or other areas that could cause the loss or disturbance of vegetation. Similarly, reduction activities that congregate bison could result in new occurrences in exotic species, although efforts at revegetation and invasive plant control following reduction actions would limit this occurrence. Some indirect impacts on vegetation on the adjacent Kaibab National Forest could occur as a result of bison moving into different areas in response to reduction activities.

Soils

A reduction in the density and abundance of the House Rock bison herd could reduce erosion potential and the acceleration of erosion processes, lessen soil compaction, and limit the alteration of soil structure and soil characteristics, particularly within those habitats that bison prefer, such as in meadows and around seeps, springs, lakes, and ponds. The likelihood of trampling and compaction of fragile biological soil crusts, in areas bison may pass through on their way to more preferred habitats, could also be reduced. Reducing the density and abundance of the House Rock bison herd could also alleviate the potential for exposure and compaction of soils found on the North Rim of the park from the impacts of foraging and wallowing behavior at current bison density and abundance.

The proposed actions for reducing the House Rock bison herd may also have some adverse effects on soils. For example, nonlethal culling operations could result in short-term congregations of bison in corrals and other areas that could affect soils through soil exposure and compaction. Some indirect impacts on soils on the adjacent Kaibab National Forest could occur as a result of bison moving into different areas in response to reduction activities.

Wildlife (Other than Bison) and Wildlife Habitat

Under the proposed action, direct competition for food and water resources, browsing, trampling, and bark stripping would all be reduced as a result of a smaller House Rock bison herd. A smaller bison population would improve habitat for other wildlife species that occupy meadows, springs, seeps, lakes, ponds, ephemeral waters, and the associated wetland vegetation, such as the Northern leopard frog (*Lithobates pipiens*), nesting birds, and other browsing ungulates (e.g., mule deer [*Odocoileus hemionus*]). The reduction of the House Rock bison herd would also result in more grass and forbs available in the meadows, which would be beneficial to wildlife, including bird species.

The proposed actions for reducing the House Rock bison herd, such as the use of vehicles, firearms, or helicopters, could temporarily affect wildlife behavior as a result of associated noise. The use of vehicles also could result in direct mortality of less mobile wildlife. The corrals could affect wildlife species through small-scale habitat alteration and destruction. Some indirect impacts on wildlife on the adjacent Kaibab National Forest could occur as a result of bison moving into different areas in response to reduction activities.

Special-Status Wildlife Species

A number of special-status species occur on the North Rim of the park and in adjacent areas of Kaibab National Forest. Special-status species include plants and animals designated under the Endangered Species Act of 1973 (16 USC 1531 et seq.), species listed by the Navajo Nation, state-listed species, and USFS sensitive species. Special-status species that may benefit from a reduction in the House Rock bison herd on the North Rim of the park or may be affected by bison reduction actions are identified below; others that would not be affected were not retained for detailed analysis. Appendix A provides a list of species and the reasons for considering or dismissing them. For the purposes of this environmental assessment, only special-status wildlife species are included for further analysis because they are the most likely to be affected.

Special-status wildlife species that are addressed in the analysis include Mexican spotted owl (*Strix occidentalis lucida)* and its designated critical habitat, California condor (*Gymnogyps californianus*), northern goshawk (*Accipter gentilis*), and northern leopard frog. A reduction in the density and abundance of the House Rock bison herd could benefit these species and their habitats by reducing trampling, direct herbivory, competition for resources, and disturbance of aquatic habitats. A reduction in bison could negatively affect California condors by reducing carrion availability on the landscape; carrion is a primary food source for condors.

Proposed actions for reducing the House Rock bison herd, including the use of vehicles, firearms, helicopters, or other human activity in the area during implementation and the redistribution of bison, may also temporarily disturb special-status wildlife species within the action area and on the adjacent Kaibab National Forest.

Wilderness Character

A reduction in the density and abundance of the House Rock bison herd and its influence on other natural resources would be more reflective of the natural condition expected on the Kaibab Plateau because the bison population is currently much higher than a reasonable reference condition, such as the herd in the Henry Mountains in Utah (Plumb et al 2016). Additionally, by reducing bison densities and abundance, bison presence and herbivory could have positive effects on other natural resources that contribute to the natural character of wilderness, including soils, vegetation, and wildlife habitat.

However, reduction of the House Rock bison herd would require action in recommended wilderness areas on the North Rim. Noise, visual intrusions (e.g., from the presence of people and vehicles and use of fencing around water sources), and disturbances to natural resources (e.g., localized vegetation and soil disturbance in corrals) would affect the untrammeled, undeveloped, and natural conditions of wilderness. In addition, opportunities for solitude and primitive or unconfined recreation could be affected if parts of the North Rim are closed to visitors during bison reduction activities or if proposed activities affect the primitive or unconfined character of the wilderness. All actions in recommended wilderness must be consistent with the Wilderness Act of 1964 (16 USC 1131 et seq.) and NPS wilderness policy requirements, per NPS *Management Policies 2006* (NPS 2006a). As a result, the National Park Service is preparing a Minimum Requirements Analysis for proposed actions that involve prohibited uses in the

park's recommended wilderness areas and will complete the analysis prior to any action being taken. In addition, proposed reduction activities could also indirectly affect wilderness character in adjacent wilderness areas of Kaibab National Forest.

Cultural and Tribal Resources

Cultural and tribal resources within the park reflect the region's long history of human presence and reveal the changing human relationship with the landscape. This history is represented by many resources. Of interest in this environmental assessment are archeological sites and prehistoric structures, ethnographic resources, historic structures, and cultural landscapes (NPS 2012a) that are present on the North Rim of the park and adjacent lands.

Archeological Resources and Prehistoric and Historic Structures. As the House Rock bison herd has grown in recent years, bison have increased their range and, in winter, seek the warmth of the cliff faces on the rim of the canyon, where prehistoric structures are located. A reduction in the density and abundance of the House Rock bison herd would reduce the number of bison around prehistoric structures and decrease potential damage caused by leaning on and bumping into structures as bison negotiate the narrow cliff ledges. Some historic structures (as opposed to historic buildings), such as stock tanks and other historic ranching features, may also be affected by trampling, kicking, or horning behavior. Reduction activities would also decrease the potential for bison behavior that disturbs the ground (e.g., digging, rooting, wallowing, and trailing) to affect artifacts on the surface or in areas where high concentrations of bison occur today. Fencing around water resources could also pose a potential issue, although careful assessment prior to installation of any fencing would likely limit impacts on archeological resources. Fencing would not affect prehistoric and historic structures.

North Rim Entrance Road Corridor Cultural Landscape. Cultural landscapes are settings created by humans in the natural world, expressions of human manipulation, and adaptations of the land (NPS 2012a). The House Rock bison herd congregates in high concentrations in the meadow along the entrance road to the North Rim. This road corridor is listed on the National Register of Historic Places (national register) as a historic district, with an associated component cultural landscape. The configuration and alignment of the road, the meadows through which it traverses, and its adjoining natural features, such as Little Park Lake, are contributing features to the component cultural landscape that is part of the historic district. A reduction in the density and abundance of the House Rock bison herd could alleviate the potential for impacts on the visual and physical characteristics that contribute to the integrity of this cultural landscape. For example, a smaller herd would reduce the amount of grazing, defecation, vegetation trampling, and soil disturbance in contrast with how current bison population density and abundance affect the character of the meadow and riparian areas of Little Park Lake. The potential use of fencing around Little Park Lake could alter the visual character of the cultural landscape, resulting in adverse effects. Other designated cultural landscapes on the North Rim are in more developed areas of the park that bison avoid and would not be affected by either a growing bison herd or proposed reduction actions.

Traditional Cultural Properties and Ethnographic Tribal Resources. A traditional cultural property can be defined generally as an ethnographic resource eligible for or listed on the national register that is significant because of its association with the cultural practices or beliefs of a living community that are rooted in that community's history and are important to maintaining the continuing cultural identity of the community (NPS 2015b). Ethnographic resources include landscapes, objects, plants and animals, or sites and structures that are important to a people's sense of purpose or way of life. Ethnographic resources are both natural and cultural resources that have a special importance for specific peoples or groups different from that enjoyed by the general public (NPS 2015c). Several American Indian tribes in the region have expressed or claimed traditional cultural associations with the Grand Canyon and surrounding area,

including the Havasupai, Hopi, Hualapai, Navajo, Kaibab Band of Paiute Indians, Paiute Indian Tribe of Utah (representing the Shivwits Paiute), Las Vegas Paiute, Moapa Band of Paiute Indians, San Juan Southern Paiute, Yavapai-Apache, and the Pueblo of Zuni (NPS 2012a). The Grand Canyon Traditional Cultural Property is composed of the cultural resources (including archeological sites), sacred sites, natural features, and native plants and animals in the Grand Canyon area, including the North Rim, that make the area unique.

Similarly, tribal and ethnographic resources are the cultural and natural resources, including plants and wildlife and the associated landscapes that are important to the tribes. Areas of current or past use, which could include archeological sites, can also be considered traditional cultural properties or ethnographic resources. As noted previously for vegetation, wildlife, archeological, and historic and prehistoric structures, a reduction in the density and abundance of the House Rock bison herd would reduce the potential for overgrazing or trampling vegetation, introducing exotic species, or the likelihood of new impacts on structures and surface artifacts that may be considered ethnographic resources. Of primary concern is fencing of water resources, which could affect the appearance of ethnographically important landscapes and access to these water sources. Bison are not prominent in the culture of the tribes near the Grand Canyon, although most of the tribes do have oral histories relating to bison. However, the oral histories describe bison near the traditional homelands of the tribes, not in areas near the North Rim of the Grand Canyon. Bison and bison parts figure in modern tribal social and ceremonial activities. For Navajo, place names are also associated with bison (Hopi, Kuwanwisiwma, pers. comm. 2015; Kaibab Paiute Tribe, Homer, pers. comm. 2015; Navajo Nation, Begay and Tom, pers. comm. 2017). During the consultation process for this environmental assessment, several tribes have expressed interest in participating in the reduction activities, receiving meat, and using bison parts for ceremonies and education.

Visitor Use and Experience

Visitors have become accustomed to seeing the House Rock bison herd on the North Rim in recent years, and many enjoy seeing bison, which can often be found in the meadows at the entrance to the North Rim. Therefore, any actions that result in a reduction of the herd or that limit access to bison viewing have the potential to affect the experience of these visitors. However, reducing the abundance and density of the House Rock bison herd is expected to improve the ability of the National Park Service to protect park resources and values, which some visitors would perceive as a benefit.

Additionally, bison can be unpredictable if feeling threatened or harassed. In these situations, visitors in too close proximity may be at risk of injury. Reducing the House Rock bison herd density and abundance could potentially increase visitor safety by decreasing incidents of bison-vehicle collisions; decreasing the potential for visitors slowing and/or stopping along the roadside to view bison resulting in potential vehicle-vehicle collisions; and reducing potential for human-bison interactions when people exit their cars to view the bison. This reduction could also improve visitor experience and safety at established campsites, such as the one at Swamp Point, by reducing bison dung found throughout the campsite and reducing human-bison interactions in campgrounds.

Implementation of bison reduction activities could also affect visitor use and experience. Temporary closures in parts of the North Rim, if needed, could cause some visitors to be turned away from intended destinations for a period of time. Reduction actions resulting in noise, such as the use of helicopters or firearms, also could affect visitor use and experience for those visitors looking for solitude (see discussion of wilderness character above).

ISSUES AND IMPACT TOPICS NOT RETAINED FOR ADDITIONAL ANALYSIS

Several potential issues and impact topics were raised during internal and public scoping but were not retained for additional analysis. Using the same considerations noted previously, the interdisciplinary team analyzed these issues and determined they did not warrant more detailed discussion in this environmental assessment.

House Rock Bison Herd Disease

The House Rock bison herd has been tested for disease, and none of the primary diseases that bison can carry have been detected (AGFD, Lutch, pers. comm. 2015b). As a result, disease in the House Rock bison herd is not carried forward for further analysis.

House Rock Bison Herd Genetics

Issues associated with bison genetics vary from cattle introgression in the current herd to the loss of genetic diversity associated with reducing the herd to key numerical thresholds needed for conservation of both existing genetic diversity and continued long-term evolutionary potential. For the reasons explained below, these issues have been dismissed from further consideration. While such issues are important to the long-term management of bison populations, they are not relevant to the short time frame of the House Rock bison herd reduction proposed here.

Because cross-breeding bison and cattle occurred extensively in the late 1800s and early 1900s, some evidence of mitochondrial or nuclear domestic cattle gene introgression has been identified in over half of all US and Canadian public bison populations (Ward et al. 1999; Halbert et al. 2005; Halbert and Derr 2007). Recent genetic information from the House Rock bison herd that currently occur in and around the park, Kaibab National Forest, and House Rock Wildlife Area confirms evidence of cattle mitochondrial DNA, but low levels of cattle chromosomal DNA (Wakeling 2006), which is the source of the vast majority of heritable traits for bison. In other words, the House Rock bison herd exhibits few, if any, recognizable traits of cattle (pelage, body conformation); they look and behave like bison, and they produce viable male and female offspring indicating essential chromosomal DNA functionality. Not unlike other public bison conservation herds, these animals were and remain bison, with some cattle genetics lingering on after a century. In a recent report (Plumb et al. 2016), the National Park Service, Arizona Game and Fish Department, and US Forest service note that the genetics of the current herd can be improved and are not in conflict with missions and policies of the respective agencies.

Under the no-action alternative, the House Rock bison herd could reach 1,200 to 1,500 animals in 10 years, which is sufficient to buffer against inbreeding depression over the next several decades and would satisfy key numerical thresholds for conservation of both existing genetic diversity and continued long-term evolutionary potential (see Dratch and Gogan 2010; Eizaguirre and Baltazar-Soares 2013; Frankham, Bradshaw, and Brook 2014).

Under the proposed action, the reduction of the House Rock bison herd has the potential to affect demography that could influence genetics and result in a bison population size with the potential to suffer greater genetic decline and which may be more vulnerable to ecological disturbances than larger populations (Plumb et al. 2016). To minimize the potential loss of genetic diversity associated with changes in demography, the National Park Service would follow, to the extent practical, the International Union for the Conservation of Nature's conservation guidelines for reduction actions that are described in chapter 2. However, any potential impacts from the loss of genetic diversity would not be realized for decades after the initial population goal is reached. If necessary there are a number of effective ways to avoid these impacts (e.g., augmenting the population with additional bison from other herds, maintaining

a stable population size and avoiding wide swings in abundance, maintaining adult breeding males at a 1:1 sex ratio and, as needed, removing younger animals rather than prime-aged adults). As discussed above, the National Park Service would continue to work with the Arizona Game and Fish Department, US Forest Service, and Bureau of Land Management to meet long-term goals for management of the House Rock herd and would complete any additional necessary NEPA reviews to support future management actions, including potential long-term mitigation of impacts to genetics, as appropriate.

Other Vegetation

The North Rim of the park contains a wide variety of vegetation, including alpine meadows, spruce-fir, pinyon-juniper and mixed conifer woodlands, montane shrublands, interior chaparral desert scrub, and wetland-associated vegetation around seeps and springs. However, vegetation that is not associated with springs and seeps, alpine meadows, or montane shrublands is generally not of concern in this environmental assessment because the House Rock bison herd typically moves through these vegetation types as they travel between preferred habitats, do not spend an extended amount of time in these vegetation types, and do not noticeably affect this vegetation. In addition, any reduction in the abundance and density of the House Rock bison herd would reduce the amount of trailing and the associated potential for trampling of vegetation, inadvertent transportation of invasive plant seeds, or grazing in these other vegetation types. Additionally, reduction actions would use existing access trails and roads only, avoiding impacts on vegetation, and fencing construction would have very limited effects (see chapter 4) with offsetting benefits. Therefore, vegetation other than wetland-associated vegetation, meadows, grasslands, and shrublands is not carried forward for further analysis.

Other Special-Status Species

Special-status species that are present in the action area but would not be affected by any alternative are not addressed in this environmental assessment. Appendix A lists all special-status species that were considered for analysis and provides information as to why certain species were not included. One special-status plant species that occurs in the action area is sentry milk-vetch (*Astragalus cremnophylax* var. *cremnophylax*) (USFWS 2014, NPS, Palarino, pers. comm. 2015b). Sentry milk-vetch is only found in remote locations of the action area on the Walhalla Plateau. Although bison have recently been documented occurring on the plateau, no actions are proposed for areas containing milk-vetch, and it is unlikely bison would use milk-vetch habitat; therefore, it was not carried forward for further analysis.

The Kaibab squirrel is a subspecies of the Abert's squirrel (*Sciurus aberti*). It exclusively inhabits ponderosa pine forests of the Kaibab plateau, including the action area. While the Kaibab squirrel is not a listed species, the North Rim of the park has been designated as a National Natural Landmark for this species (NPS, Palarino, pers. comm. 2015b). Given the life-history and behavior of these squirrels, neither bison nor any of the proposed actions are likely to affect them; therefore, Kaibab squirrels were dismissed from further analysis.

Environmental Justice

Environmental justice is associated with Executive Order 12898, which was published on February 11, 1994. This executive order requires all federal agencies to incorporate environmental justice into their mission by "identifying and addressing … disproportionately high and adverse human health or environmental effects of [their] programs, policies and activities on minority and low-income populations in the United States" (Executive Order 12898, 59 *Federal Register* 7629 [1994]).

The US Environmental Protection Agency (USEPA) defines a community with potential environmental justice populations as one that has a greater percentage of minority or low-income populations than does an identified reference community. Minority populations are those populations having (1) 50% minority population in the affected area (USEPA 1998); or (2) a significantly greater minority population than the reference area. No specific thresholds are provided for low-income or poverty populations. For the purposes of this environmental assessment, if the percentage of minority and/or poverty status populations in the study area is greater than 10% of the minority and/or poverty status populations of the reference area, there is likely an environmental justice population of concern.

Concentrations of minority or low-income populations of concern are present on private and tribal lands surrounding the action area (US Census Bureau 2015). However, the proposed actions to reduce the House Rock bison herd analyzed in this environmental assessment would not cause any adverse human health effects and would therefore not cause any disproportionate effects on low-income or minority populations. Furthermore, reduction actions may indirectly result in beneficial impacts on environmental justice populations if bison meat is donated to minorities or disadvantaged populations and through capture and donation of live animals to American Indian tribes. The donation of bison heads and hides could also have some beneficial effect on these populations. Therefore, this impact topic is not carried forward for further analysis.

Air Quality and Greenhouse Gas Emissions and Effects of Climate Change on Resources and Values

The area surrounding the park is in attainment with all six USEPA criteria pollutants. Potential sources of air quality and greenhouse gas emissions from the implementation of proposed actions to reduce the House Rock bison herd include the periodic use of vehicles and helicopters to carry out the prescribed activities. Any reduction in regional air quality or increase in greenhouse gas emissions from these proposed actions would be limited to periods of operation and relatively minimal and would cease within 3 to 5 years.

Changes in climate could result in shifts in weather patterns and precipitation and changes in water availability and temperature. These could in turn affect resources impacted by a growing bison herd, such as water quality and quantity, vegetation, soils, and wildlife and wildlife habitat. Over time, beyond the 3- to 5-year implementation horizon for this action, climate change is projected to alter water resources and vegetation and potentially affect soil resources in the southwest United States. Future climate change projected impacts in the southwest include increased temperatures (hotter), drought (drier), flooding, and intense precipitation events (Garfin et al. 2014). By 2070–2099, climate models show increases in regional annual average temperatures of 5.5 degrees Fahrenheit (°F) to 9.5°F under a continuation of the current global emission scenario, and 3.5°F to 5.5°F under a substantially reduced emission scenario (Garfin et al. 2014). Without reductions in the current rising global emissions trends, precipitation is expected to decrease in parts of the southwest, especially in the winter and spring seasons by 2100; however, very heavy precipitation events are expected to increase (Garfin et al. 2014). Drought conditions in the Colorado River Basin are expected to be more frequent, intense, and longer lasting compared to historical conditions (Garfin et al. 2014). Evapotranspiration is affected by many factors, including soil moisture, which is expected to decrease as temperatures increase (Georgakakos et al. 2014). The potential for greater evapotranspiration is predicted, although the exact impacts for the action area would depend on regional conditions and responses (Georgakakos et al. 2014).

Although evidence supports that the climate is changing in northern Arizona, given the short time frame anticipated for proposed bison reduction, there are not likely to be noticeable adverse effects on resources associated with climate and exacerbated by proposed reduction actions. Because adverse impacts on park

resources are not expected to be exacerbated by climate change during the 3 to 5 years of bison reduction, this issue was not carried forward for additional detailed analysis.

Soundscapes/Acoustic Environment

Elements of proposed actions to reduce the House Rock bison herd include the use of vehicles, helicopters, and firearms. The effects of noise on visitors and wildlife are discussed in "Wildlife," "Visitor Use and Experience," and "Wilderness Character" sections of chapter 4. In addition, noise resulting from reduction activities could affect the acoustic environment of the North Rim of the park (see chapter 2 for more details on estimated times for various actions). The disturbance from reduction actions would be limited to certain sections of the North Rim at any given time and limited in duration to several hours or days, vehicle usage would be confined to certain areas, and the sound of gunfire would be temporary. In addition, these effects would cease after 3 to 5 years. Therefore, effects on the acoustic environment would not be substantial or result in impacts that are much different from current sources of noise on the North Rim.

Other Historic Districts, Buildings, Structures, and Cultural Landscapes

There are several historic districts, buildings, structures, and cultural landscapes within the developed area on the North Rim of the park, including the proposed Bright Angel Peninsula Developed Area Cultural Landscape Historic District and the Grand Canyon Lodge and surrounding buildings. These resources are concentrated in areas of high visitor use or park administrative activities that the House Rock bison herd avoids and where bison reduction actions would not occur. No other historic buildings are outside of that area on the North Rim of the park. Similarly, neither the growing House Rock bison herd nor the bison reduction activities would affect the integrity of other contributing structures within the North Rim Entrance Road Corridor cultural landscape, such as the entrance cabin and the road itself. Therefore, these historic districts, buildings, structures, and cultural landscapes are not carried forward for additional analysis.

Indian Trust Resources

Secretarial Order 3175 requires that any anticipated impacts on Indian trust resources from a proposed project or action by DOI agencies be explicitly addressed in environmental documents. The federal Indian trust responsibility is an obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal law with respect to American Indian and Alaska Native tribes.

No Indian trust resources are located on the North Rim of Grand Canyon National Park. The lands in the action area are not held in trust by the Secretary of the Interior for the benefit of Indians due to their status as Indians. As a result, the issue of Indian trust resources was dismissed.

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CHAPTER 2: ALTERNATIVES

INTRODUCTION

The National Environmental Policy Act requires federal agencies to explore a range of alternatives and analyze impacts that any reasonable alternatives could have on the human environment. "Chapter 4: Environmental Consequences" presents the results of the analyses. The alternatives under consideration must include a "no-action" alternative as prescribed by 40 CFR 1502.14. The analysis of the no-action alternative "provides a benchmark for a decision maker to compare what would happen to the environment if current management were to continue, versus what would happen to the environment if one of the action alternatives were selected for implementation (NPS 2015d)." Alternative 1 in this environmental assessment is considered the "no-action" alternative.

In addition to the no-action alternative, an interdisciplinary NPS team, including cooperators from other federal and state agencies, evaluated various approaches to address NPS and cooperating agencies' interest in reducing the House Rock bison herd as quickly as possible. The team ultimately identified a single action alternative that consists of a suite of tools to reduce the density and abundance of the House Rock bison herd (alternative 2). This chapter describes the no-action alternative and the proposed action, as well as alternatives that were considered but not carried forward for detailed analysis.

ALTERNATIVE 1: NO ACTION

Under the no-action alternative, the National Park Service would not take action to reduce the House Rock bison herd. Instead, the House Rock bison herd would continue to grow and could become as large as 1,200 to 1,500 animals within 10 years, based on NPS predictions (Sturm and Holm 2015). The park would continue to communicate with staff from the Arizona Game and Fish Department and US Forest Service as part of the Tri-Agency Work Group, and within the park, the National Park Service could conduct research on bison management tools and the presence of bison on the landscape on an *ad hoc* basis. For example, the park cooperated with the Arizona Game and Fish Department on an experiment in 2014 using corralling and baiting to capture, transport, and release bison captured in the park to the House Rock Wildlife Area on USFS lands outside the park. Currently, the National Park Service has no plans for such experiments, and if/when pursued, any future research opportunities may be subject to additional planning and compliance.

The park would monitor movement of the House Rock bison herd possibly tracking GPS collared bison or using aerial surveys and ground observations (in the summer). The National Park Service would also monitor vegetation and other sensitive resources (e.g., seeps, springs, and archeological sites) in areas where bison are present. The park would use exclosure fencing at seeps and springs on an *ad hoc* basis, primarily as a control for monitoring the effects on these resources. It would also continue to provide interpretive information on the North Rim and occasionally on the South Rim of the park about the history of the House Rock bison herd, along with many other topics, as time and staffing allow.

ALTERNATIVE 2: PROPOSED ACTION (PREFERRED ALTERNATIVE)

OVERVIEW

Under alternative 2, the National Park Service, in collaboration with state, tribal, and federal partners, would use a suite of tools to reduce the abundance of the House Rock bison herd to fewer than 200 animals as quickly as possible. National Park Service reduction actions would occur within the action area on the North Rim of the park (see figure 1 in chapter 1), which comprises approximately 97,200 acres.

The National Park Service has identified the proposed action as the preferred alternative because it best meets the purpose of and need for action. While the National Park Service, in conjunction with state, tribal, and federal partners, would work to address the management of bison across the multi-jurisdictional Kaibab Plateau landscape in the future, potential future management decisions and actions beyond this initial reduction are outside the scope of this environmental assessment. The preferred alternative is only intended to address the immediate concerns about potential impacts caused by bison on park resources and values. Furthermore, while the tools considered in this environmental assessment might be the same as tools used by the park for any potential future management, the National Park Service would complete, as appropriate, any additional NEPA reviews that may be needed to support future management actions.

The preferred alternative includes nonlethal culling using capture of bison in corrals and removal in trailers, and lethal culling using primarily skilled volunteers and tribal personnel. The National Park Service would use both nonlethal and lethal culling concurrently, where appropriate, to reduce the abundance of the House Rock bison herd. These activities would be coordinated by season and geography to maximize effectiveness of both tools. The National Park Service would coordinate culling activities occurring inside the park with AGFD management actions (e.g., hunting on National Forest System Lands) outside the park in an attempt to support each other's goals, including hunting and viewing opportunities outside the park.

Implementation of alternative 2 would also include using (1) attractants to draw bison into areas where they can be captured in corrals, (2) targeted exclusion fencing in very sensitive areas, and (3) hazing/herding. The National Park Service would collaborate with its partners to develop monitoring protocols for the House Rock bison herd (including movement, distribution, and density) and park resources to adapt bison reduction actions; and to inform any decisions about future bison reduction and planning and compliance actions once reduction under the proposed action is complete (see the "Monitoring" section in this chapter).

All actions in recommended wilderness must be consistent with the Wilderness Act of 1964 (16 USC 1131 et seq.) and NPS wilderness policy requirements, per NPS *Management Policies 2006* (NPS 2006a). As a result, the National Park Service is preparing a Minimum Requirements Analysis for proposed actions that involve prohibited uses in the park's recommended wilderness areas. The analysis will be completed prior to any action being taken. In addition, all actions would be required to follow the standard operating procedures described below to reduce potential impacts.

- Grand Canyon National Park Wildlife Program staff would inform staff and volunteers implementing bison reduction actions of California condor and Mexican spotted owl identification, presence, and potential risks/impacts.
- Condors that arrive at any area of human activity associated with proposed actions to reduce the House Rock bison herd abundance would be avoided. Staff and volunteers would notify the park's Wildlife Program Manager or Park Dispatch if condors arrive or are present in an area where proposed actions are to be implemented. Bison reduction activities would cease until condors leave the area on their own accord or qualified personnel are available to haze them from the area. Only qualified personnel are permitted to haze condors.
- Bison reduction activities would not occur within 0.5 mile of active condor nesting sites.
- Staff and volunteers would be instructed to inform the park's Wildlife Program Manager if a Mexican spotted owl is encountered at any time during the implementation of bison reduction activities. If a Mexican spotted owl is identified in the action area, activities within 0.5 mile of the owl's initial location would cease until additional discussion

between Grand Canyon Wildlife Program staff and the US Fish and Wildlife Service (USFWS) occur.

- Bison reduction activities would not occur within 0.5 mile of known Mexican spotted owl nest/roost locations during their breeding season (March 1–August 30).
- Cultural resources staff would be on site during any activities requiring ground disturbance to help identify and avoid areas that may have high potential for the presence of sensitive archeological resources and to provide expertise if any previously unknown cultural resources are discovered.
- Prior to installing corrals or implementing lethal culling, staff and volunteers would confirm that corral sites and lethal culling areas are not near or over known archeological sites.
- Temporary flags would be placed in areas that must be avoided to protect cultural resources.
- Work would stop immediately if previously unknown cultural resources are discovered until the resources are evaluated and a mitigation strategy is developed.

BISON REMOVAL MODELING

The National Park Service and its partners collaborated to develop a population model for the House Rock bison herd (Sturm and Holm 2015) that has been used to inform the EA process. Although not prescriptive or intended to be a guide for implementation, the model provides assumptions for the analysis in this environmental assessment regarding the number of bison that may be removed if the National Park Service and its partners use the various tools proposed simultaneously and complement them with hunting outside the park. The outcomes from this model inform additional assumptions that provide the reader and the decision maker insight into the relative frequency and duration of bison reduction actions, and how long it might take to reduce the House Rock bison herd to the desired density/abundance range. The Arizona Game and Fish Department has contracted for state of the art population modeling using Bayesian statistics, and that data may contribute to modeling the population as reduction actions take place.

It is important to note that several factors could influence the actual numbers of bison to be removed, and therefore, the corresponding frequency/intensity of reduction actions and the number of years to reach the density range. As a result, the National Park Service would work with its partners to develop a mutually agreed upon annual operations plan that outlines the sequencing of tools and identifies the actual number of animals the agencies would seek to remove each year.

The model outputs used for the purposes of the analysis in this environmental assessment, the assumptions used in developing the model, and the factors that could affect actual implementation and cause deviations from what has been assumed for this analysis are summarized below.

- The model is based on an initial House Rock bison herd size of 600 animals at the time of implementation and assumptions regarding (1) an overall population growth rate that accounts for calving, natural mortality, and hunting success rate outside the park; (2) the number of bison that may be removed using each tool, taking into account potential timing and locations for removing bison, and (3) the likelihood bison would become acclimatized to the tools over time and would become more difficult to find or remove.
- Outputs from the model indicate that at a starting population of 600 animals, using multiple approaches simultaneously and accounting for hunter harvest outside the park it could take the agencies approximately 3 years to reduce the House Rock bison herd to about 140 animals (which falls in the desired range of fewer than 200 bison) before calving. Taking into

account annual population growth, the model estimates this would result in the removal of approximately 560 bison over those 3 years, about 275 would be captured live, 140 would be removed lethally within the park, and approximately 140 would be removed through hunting outside the park (Sturm and Holm 2015).

- A number of factors would influence the numbers of bison to actually be culled. For example, if the initial survey detects more than 600 bison (the starting population size estimated for the purposes of modeling), the number of bison that need to be culled and the number of actions and time needed to reach less than 200 bison could increase. If the initial bison population survey detects fewer than 600 animals, fewer bison would be culled, which is expected to decrease the number of actions and time needed to reach less than 200 bison. In addition, through the development of the annual interagency operations plan, the National Park Service and its partners would identify the actual mix of tools to be used, sequencing, and timing of reduction actions. If one tool is used more frequently than another, the number of bison that may be removed by each tool and the overall number of bison to be removed could change. Additionally, periodic aerial surveys would provide updated information on density/abundance of the House Rock bison herd on the landscape for the annual interagency operations plan. Similarly, existing reproduction and mortality rates might differ from the estimate used in the model. If reproduction rates are higher and mortality lower than estimated, the growth of the House Rock bison herd would be greater and more bison may need to be removed, potentially increasing the number of actions and time needed to reach less than 200 bison. The converse would also be true if reproduction rates were lower and mortality rates higher than estimated.

HERD REDUCTION TOOLS

Nonlethal Culling

Nonlethal culling would involve capturing bison in corrals and removing them from the park in trailers. Nonlethal culling would occur at the Little Park corral site in the park (figure 2) during two periods: June to early July and then again from mid-to-late August to September, to avoid the rainy season and associated concerns with possible impacts on other resources. Bison would be drawn to the corral site with attractants, and the gates would remain open for several days, while bison become accustomed to the structure. After this time period, the gates would be closed, and the bison would be sorted into chutes in the corral to send them back to the herd, on to a trailer, or to await a later trailer. Nonlethal culling activities would continue annually until bison become more wary of the corrals, the approach becomes more difficult and less effective, or the initial bison population objective is achieved. Once corralled, bison would be transferred to a variety of willing recipients, such as tribes, the state of Arizona (to help support its goals for bison management on the Kaibab National Forest described in chapter 1), other federal agencies, and non-governmental organizations. Bison captured and transferred to Arizona Game and Fish Department would most likely be released at House Rock Wildlife Area. More animals could be moved there subsequently, although consistent with the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014), the overall herd size should be balanced with ecological conditions at House Rock Wildlife Area. Based on discussions with AGFD and USFS staff, any bison relocated to House Rock Wildlife Area would be managed to develop site fidelity to that area (see chapter 4 discussion of cumulative actions for more information). Any transportation of bison to out-of-state destinations would comply with state requirements for the transport of animals across state lines. Table 1 provides more information on the details of implementation of nonlethal culling.

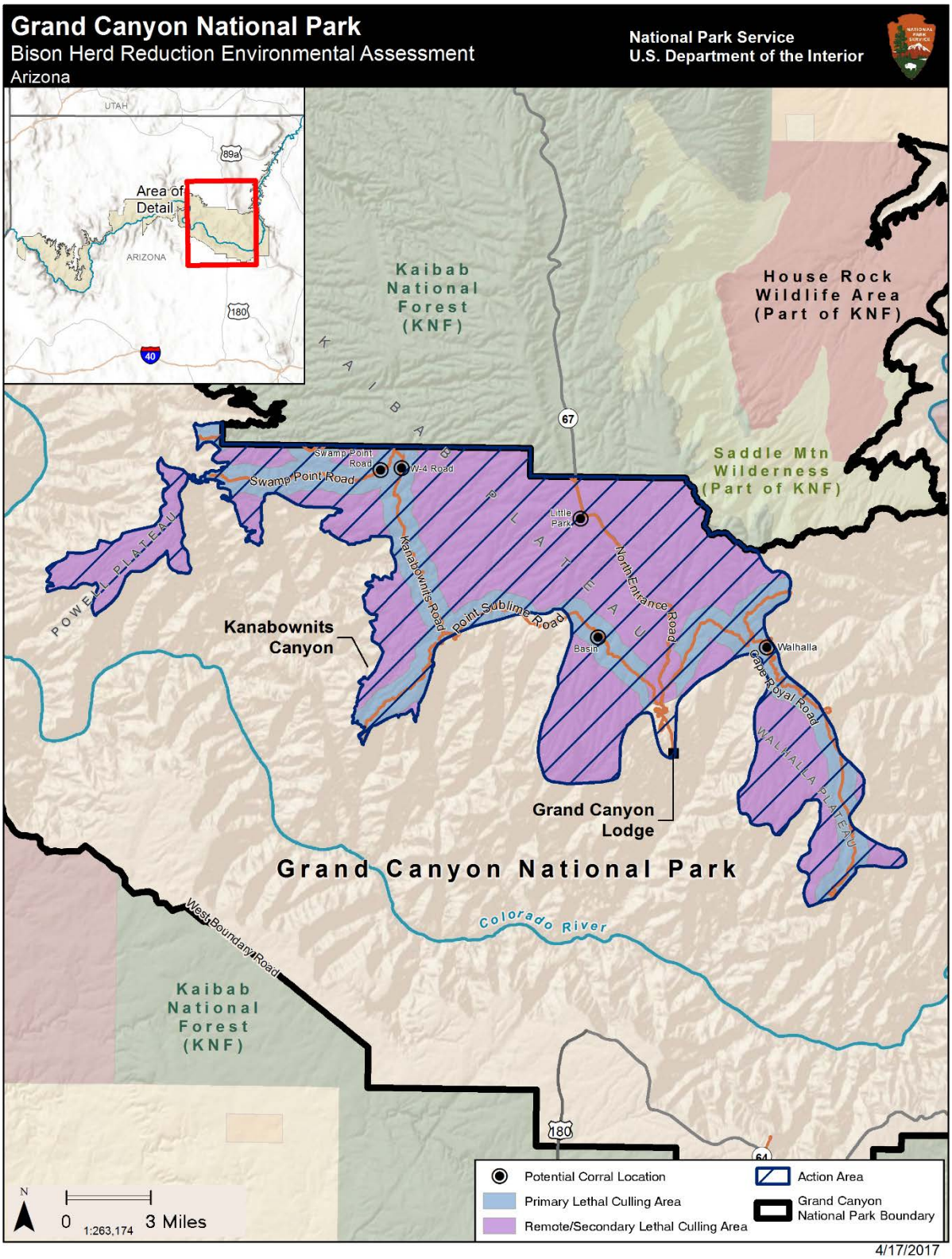

FIGURE 2. POTENTIAL CORRAL SITES AND PRIMARY LETHAL CULLING AREAS

TABLE 1. NONLETHAL CULLING DETAILS

Timing of Nonlethal Culling	Primary Corral Site	Secondary Corral Sites	Area of Corral and Corral Site Access	Duration of Construction/ Removal	Types of Vehicle Use	Estimated Number of Trailer Trips to Remove 275 Bison
June-July August–September	Little Park	Swamp Point Road W4 Road Basin Walhalla	2 acres/corral Up to 10 acres for all sites	1 to 2 days per corral per event	Tractor and backhoes Trucks Stock trailers	30 trips over 3 years

The Little Park site would be used as the primary corral site, and additional sites could be added if bison are congregating in other areas accessible to these previously identified sites (see figure 2). To the extent possible, nonlethal culling would occur outside recommended wilderness and near roads in nonwilderness corridors. Capture operations would occur at these secondary sites in the same time frames as at the Little Park site. Any bison injured during nonlethal culling efforts would be immobilized, using trained staff certified to use NPS-approved immobilization techniques or agents, and released if possible, or humanely dispatched.

Installation of the Corrals. The National Park Service would install corrals at capture locations (see figure 2). Corrals would be circular and are expected to be approximately 120 feet in diameter (figure 3). The corrals would be constructed over the course of 1 to 2 days with 7-foot-high metal panel fencing and anchored with large concrete blocks. The corrals would be constructed to be free-standing if possible; however, it may become necessary to place anchors in the ground at corral sites. The fences and anchors would be temporary and would not affect known archeological resources. In addition, tarps or billboard screens would be attached to the panels to block the ability of the bison to see out of the corrals, reducing the stress on the animals being corralled. Corrals would be configured to allow for sorting and processing of bison, as appropriate. Tractors, backhoes, or trucks would be used to move corral construction materials. Some off-road travel would be required for the vehicles transporting materials to access the corral sites and help place the anchor blocks. This travel would typically be less than a quarter mile from an existing roadway. Off-road travel would be restricted to a designated corridor to limit impacts to the smallest possible area. If any unknown archeological resources were encountered, work would be halted until the resources are evaluated and a mitigation strategy is developed. The corral and access area is expected to affect about 1 to 2 acres for each corral site. For the purposes of analysis, corral activities are expected to affect 2 acres.

Removal of Captured Bison. Once corralled (see the "Additional Bison Reduction Tools" section later in this chapter for details on how bison are drawn into the corrals), staff would move the bison into trailers through chutes and transport them by truck to their ultimate destination. Stock trailers typically hold 8 to 10 bison. Based on estimates from the Sturm and Holm (2015) population model, the analysis in this environmental assessment assumes that approximately 30 trips would be required to and from corral sites with the truck and trailer to move approximately 275 bison over the course of 3 years. Some off-road travel would be required for the trucks to access the corral sites. Off-road travel would be restricted to a designated corridor to minimize impacts. Travel corridors and the corral site would be revegetated or reseeded with native species once corral infrastructure is removed from the area. Soils in these areas may also be aerated by discing or using hand tools.

Source: National Park Service
Note that this photo does not show the anchor blocks or panel screens.

FIGURE 3. CORRAL USED AT LITTLE PARK CORRAL SITE IN 2014

Corral Storage. Most corrals would be temporary and would be disassembled after each nonlethal culling season and stored at the designated corral site(s) until capture is deemed ineffective or when initial bison population objectives are met. At that point, corral material would be removed from the corral site until it is needed again. No corral storage would occur in recommended wilderness.

Lethal Culling

Team Composition. The National Park Service would manage overall lethal culling activities; this includes coordinating with AGFD on the activities below, as well as leading teams consisting primarily of skilled volunteers and tribal personnel to shoot bison.

NPS staff would directly supervise teams in the field during any bison reduction activities, including directing team members on which bison to shoot. Each lethal culling team would consist of a qualified NPS employee as a team lead and up to four other team members (e.g., skilled volunteers, tribal personnel); teams using horses or oversnow travel could be smaller (e.g., an NPS lead and two others). In addition, up to five additional people would accompany non-NPS team members (i.e., up to 20 additional people) to assist with carcass processing and removal. Other agency personnel and contractors could also be used to cull bison in limited circumstances. Each lethal culling period would last for 5 days, with one day of orientation and training, and a four-day field period. Table 2 at the end of this section provides the details of the lethal culling activities.

Proficiency, Planning, and Preparation. Before assisting with lethal culling actions, all team members would need to meet a number of predetermined requirements, including a demonstrated level of firearm proficiency and knowledge of public safety and protection policies established by the park in collaboration with the Arizona Game and Fish Department (see the "Human Safety" section, below). Team leaders would meet the same qualifications as the skilled volunteers conducting the shooting. Lethal culling would be accomplished using centerfire rifles, consistent with the description of bison hunting firearms allowed outside of the park under current AGFD regulations. Lead-free bullets would be required. Lethal culling team members would consider the caliber of ammunition, shot placement, and other factors to ensure the humaneness of the action. Team members could also be involved with other activities such as locating groups of bison to facilitate reduction, field dressing bison, and handling carcasses. Each member's role would be identified during the pre-reduction training and could include any of the actions noted above. This pre-reduction training would also be used to prepare staff and volunteers to avoid archeological resources and disturbances to cultural landscapes during the performance of their duties and to brief participants on identification of sensitive resources and the significance of the cultural landscape in the field and actions to take to avoid disturbing archeological sites and the cultural landscape, and it would include a discussion of the consequences and penalties associated with disturbing cultural resources within the park. Because of the sensitivity of water resources and associated vegetation to impacts caused by lethal bison culling, teams would be instructed to wait for bison to move away from water sources that are not protected by local exclusion fencing before shooting if at all possible, or baiting could be used in some circumstances to attract bison away from sensitive resources (e.g., archeological sites, seeps and springs).

Teams would discuss current knowledge of bison locations and where they would focus lethal culling efforts during morning and evening briefings on each subsequent day after the initial training (days two through five). GPS data from collars on bison, ground observations, and aerial reconnaissance using fixed-wing aircraft could be used to identify areas that the House Rock bison herd uses and improve the effectiveness of lethal culling events. Hazing and baiting, as described later in this chapter under "Additional Bison Reduction Tools," could also be used if needed to congregate bison and facilitate lethal culling.

Some areas on the North Rim of the park may experience limited closures during lethal culling events to ensure visitor safety. While lethal culling could occur year round, it would primarily be used from October 15 to May 14, after the snow falls and access roads to the North Rim of the park are closed to the public. When North Rim access roads are open (i.e., from May 15 until they are closed because of snowfall), lethal culling would occur in more remote areas to avoid potential corral sites for nonlethal culling, such as the site at Little Park.

Primary lethal culling areas would most likely include areas within a short distance of public access roads within the known range of the House Rock bison herd on the North Rim (see figure 2). Lethal culling would not occur along the North Rim Entrance Road when the park's access roads are open and when nonlethal culling events are planned at Little Park, but could occur there once these roads are closed. However, other more remote areas within the range of the House Rock bison herd on the North Rim (see figure 2) could be included in lethal culling depending on the presence of bison and avoidance of corral sites or other constraints. The number of lethal culling teams present may be adjusted based on accessibility and movement of bison (see "Timing of Lethal Culling Efforts" below). When more than one lethal culling team is present, teams would work simultaneously in different areas of the park for safety considerations. Reduction actions would be coordinated with the Arizona Game and Fish Department and US Forest Service in areas near the national forest boundary to increase opportunities for hunter harvest outside of the park. For example, the National Park Service would work with the Arizona Game and Fish Department so that bison that disperse to adjacent US Forest Service lands in response to lethal culling could be hunted outside the park and would not immediately return to the North Rim.

Timing of Lethal Culling Efforts. For the purpose of analysis, several assumptions were made about the timing of the lethal culling efforts. The number of lethal culling teams could increase or decrease, as appropriate, given weather and availability of team members.

- January through March—one to two teams per week may be used because of the limited opportunities for lethal culling operations as a result of snow conditions and the remoteness of the North Rim areas where the House Rock bison herd over-winters.
- April through May 14—lethal culling operations would increase to two to three teams per week focused on bison leaving wintering areas, depending on road conditions and access to groups of House Rock bison.
- May 15 through October 14—lethal culling would consist of no more than one team per week depending on whether bison can be located in their winter range in the more remote parts of the park (bison tend to spend time in smaller groups in the winter and congregate centrally in other seasons).
- October 15 through December—two to three lethal culling teams per week would be used until road conditions and access to groups of House Rock bison are compromised by snow conditions.

Team leaders would make all removal decisions regarding location and age/sex of individual bison to be removed during each lethal culling period. Lethal culling efforts would concentrate on removing yearlings, although some other animals may be selected, as appropriate, for tribal use. Removal of cows and other segments of the population would consider the breeding cycle. For example, the House Rock bison generally calve from late March through May; therefore, the most appropriate time to lethally remove adult cows would be mid-July through the end of December to avoid reducing late gestation cows and cows with dependent calves for animal welfare reasons.

Once a team ceases shooting each day, team members, including the carcass removal team, would begin field dressing and preparing for the removal of the bison parts, either by foot, using stock packers, or sling loaded via helicopter as described in the "Access to Sites and Reconnaissance" section, depending on the removal option chosen by the team leaders and the results of the Minimum Requirements Analysis, which would be completed before taking any action.

Carcass Handling and Disposition. Members of the lethal culling and carcass removal teams (as described above) would be the primary field dressers for bison carcasses. Volunteer packer teams would be assembled from designees of lethal culling team members, with up to five carcass handlers per non-NPS team member. The National Park Service would make every reasonable effort to remove salvageable meat from the field for beneficial human use and would donate it, as appropriate, to the teams of volunteers who participated in lethal culling and removing carcasses from the field, food banks, and designated tribal members. Other bison parts (e.g., hides, heads, horns) would be either donated to tribal partners or federal or state agencies or cooperators for non-monetary uses (e.g., tribal ceremonial uses, public or educational display, research), or they would be left in the field. Organ and gut piles may be left in the field for scavengers such as the California condor.

While every effort would be made to remove salvageable meat, hides, and heads of bison during lethal culling operations, even in very remote locations, the team leader would have the discretion to determine when it is appropriate to leave any of these items in the field. The decision would be based on a hierarchy of human and pack animal safety and logistics for accessing a remote site, environmental conditions, and the availability and cost of the park helicopter to assist under the constraints for helicopter

use outlined below under the "Access to Sites and Reconnaissance" section and the Wilderness Minimum Requirements Analysis, which will be completed prior to any action takes place.

To enhance the efficiency of reduction operations, up to 20 experienced contractors or volunteers familiar with processing, preparing, and packing out game in rough terrain using pack horses/mules could accompany teams during lethal culling. This would allow lethal culling teams to focus on locating and shooting bison as opposed to transporting meat; packing out the carcasses would be the preferred method of carcass removal. Helicopters could be used only under certain situations to prevent wasting meat when other primary carcass removal techniques (contract packers, foot removal) are not practical or timely, and when determined to be the minimum tool available. The National Park Service would provide meat packing bags that would be labelled and, once removed from the field, transported to a centralized cold storage site or facility. The park would consult with the NPS Public Health Program, as well as Arizona Game and Fish Department, to ensure meat is handled and stored properly for consumption.

Access to Sites and Reconnaissance. Lethal culling and carcass processing teams could use several methods to reach areas where reduction activities would occur. Where bison are within a few miles of open public or administrative use roads, lethal culling teams would gain access using standard trucks, sport utility vehicles, utility task vehicles (e.g., a small 2- to 6-person four-wheel drive off-road vehicle), or snow machines on existing roads and then walk into the areas where bison are located. For more remote areas, stock (e.g., mules, horses) could be used to transport personnel. Ultimately the exact mode of access would be determined by the Minimum Requirements Analysis, which will be completed prior to taking any action.

Assumptions concerning the number of vehicles or other means of accessing the sites are based on the model predicting how many bison would be removed annually and on weather conditions and are used for the purpose of analysis. Actual numbers of vehicles may vary based on conditions in the field. Overnight camps on the North Rim are not anticipated. However, if an overnight camp within the park is determined to be necessary during field operations for both lethal and nonlethal culling, the camp would be located at a previously designated or established location whenever possible. In the unlikely event that backcountry camping is necessary at a non-designated site, crews would use "leave no trace" protocols to avoid impacts and, if necessary, restoration would be undertaken at the site.

Vehicles. Four-wheel-drive trucks and sport utility vehicles would be allowed on any roads open to the public and on roads used for administrative purposes. No new roads would be constructed, nor would any abandoned roadbeds be reopened (e.g., to access Kanabownits by vehicle). Utility task vehicles could be allowed on roads when not open to and used by public vehicles; no off-road, all-terrain vehicle or utility task vehicle use would be permitted off established roads.

The use of vehicles for bison reduction activities would be restricted by seasonal snowfall and snowpack, which likely would limit most vehicle use to May through November. Based on the bison population model (Sturm and Holm 2015), the analysis in this environmental assessment assumes that each team would require up to four vehicles. For periods where up to 3 teams are conducting reduction activities, up to 12 vehicles could be using the road system for each 4-day field period.

The larger number of teams would be limited to the 7-month primary lethal culling period (i.e., mid-October through mid-May; approximately 1,440 vehicle days assuming 30 weeks of operations). During each 5-month secondary lethal culling period (mid-May through mid-October), a maximum of 4 vehicles would be used because only one team would be operating (approximately 352 vehicle days assuming 22 weeks of operations).

Stock Animals (Mules or Horses). Stock animals could be used to access bison reduction areas and remove carcasses and are a preferred method of removing the carcasses. The lethal culling team could use stock animals for access to bison reduction areas during each four-day field period. Depending on conditions and bison distribution, the team leader could also reduce the number of team members (e.g., two) or consider two smaller teams (e.g., one leader, two team members per team) for logistical and safety considerations. Use of stock animals for both access and carcass removal would likely occur in conjunction with vehicle use (trailering) as the starting or entry point for stock from a roadway. Depending on the size and number of carcasses to be removed, for the purpose of analysis, three to four stock animals would be needed per bison removed. Stock use would likely be limited to the same time frame as vehicle use (e.g., snow free access) but would occur during both the primary and secondary removal periods. During each 4-day field period, 12 to 16 stock animals could be on the North Rim for bison reduction access and carcass removal. Hay brought in to feed the stock animals while in the field would comply with the park's weed-free hay policy to minimize risk that seeds for exotic and invasive plants are brought into the park.

Snow Machines. Consistent with park policy, snow machines used by lethal culling teams would be restricted to use on established roads open to the public and roads used for administrative purposes on the North Rim by NPS staff. The same restrictions described above for vehicles would apply, e.g., off-road/over snow travel via snow machines would not be permitted. Snow machines would likely be used from December to April, assuming adequate snowpack. For safety reasons, only one lethal culling team would be operating via snow machine during each four-day field period. Each team member would operate a snow machine. Depending on conditions and bison distribution, the team leader could also reduce the number of individuals operating snow machines (e.g., two) or consider two teams, each with fewer team members, due to logistical and safety considerations of winter over-snow travel. Snow machines with attached sleds could be used to remove dressed carcasses that have been brought to a roadway on which snow machines are allowed to operate.

Helicopters and Fixed-Wing Aircraft. Helicopters could occasionally be used to allow for strategic removal of carcasses in extremely remote areas. Such areas could include Powell Plateau or other remote areas above and below the rim. Based on helicopter load restrictions and assumptions about the number of carcasses and the weight of a carcass, for the purpose of analysis, up to six helicopter trips for retrieving carcasses per year could occur, with each trip lasting approximately 1 to 2 hours of total flight time.

Helicopters would be operated in accordance with all relevant regulations, policies, and plans; be consistent with the interagency helicopter operations guide; and would not land to retrieve carcasses, but rather carcasses would be sling-loaded. Only team leaders who have been trained and qualified to safely work with sling loading would participate in helicopter operations. In the unlikely event that bison are shot below the rim (see "Additional Bison Reduction Tools, Hazing and Herding") and individuals on foot or horseback cannot easily remove the carcasses, helicopters could be used, but only if restrictions concerning the Mexican spotted owl, Northern Goshawk, and California condor for all air flights are followed.

Fixed-wing aircraft may be also used for aerial reconnaissance to locate bison to focus lethal culling activities and conduct monitoring. Flights would be similar to those that currently occur to locate and count bison on the North Rim of the park. A maximum 52 fixed-wing flights related to bison reconnaissance would occur per year; this number would likely be less because of weather restrictions and the number of sharpshooters on the ground. Requirements for aircraft use in support of any bison reduction efforts would include:

- Ensure helibase staff and pilots are informed of condor identification, presence, and potential risks.
- Contact the Grand Canyon National Park Wildlife Program Manager a minimum of two weeks prior to project commencement concerning the presence/absence of threatened or endangered species utilizing nearby cliffs/canyons.
- Minimize aircraft use along the rim and cliffs to the greatest extent possible.
- Stay at least 1 mile away from active condor nest locations and vicinities except when human safety would be compromised (note: the active condor nesting season is February 1–September 30, although these dates may be modified based on the most current information regarding condor nesting activities and coordination with the park's Wildlife Program Manager, Endangered Species Act Section 7 Coordinator, and the US Fish and Wildlife Service).
- Stay at least 1,200 feet away from condors in the air or on the ground/cliffs unless safety concerns override this restriction.
- Give up airspace to the extent possible if airborne condors approach aircraft, as long as this action does not jeopardize safety.
- Remain at least 1,200 feet from the boundary of any designated Mexican spotted owl protected activity center.
- Stay at least 500 feet away from known nesting trees for the Northern Goshawk.

TABLE 2. LETHAL CULLING DETAILS

Removal Period Timing	Approx. Days of Active Lethal Culling Activities/ Period	No. of Teams/ Week	No. of Skilled Volunteers/ Week	No. of Vehicles/ Week	Access to Areas	Bison Carcass Removal Method	No. of Carcass Removal Handlers/ Week	No. of Stock Animals/ Week	Bison Monitoring and Reconnaissance Approx. No. of Fixed-Wing Flights / Period
October 15–December	60	2–3	8–12	8–12	4 wheel drive/stock animals or snow machines	Stock animals	40–60	12-16	12
January–March	72	1–2	4–8	4–8	4 wheel drive or snow machines	Helicopter (up to 6 trips)/ stock animals/ snow machines	20–40	12-16	13
April–May 14	40	2–3	8–12	8–12	4 wheel drive/ stock animals	Stock animals	40–60	12-16	5
May 15–October 14	120	1	4	4	4 wheel drive/ stock animals	Stock animals	20	12-16	22

OTHER CONSIDERATIONS FOR HERD REDUCTION

Herd Composition

The park would identify the desired population composition (age classes and sex ratio) prior to the initial population reduction action and then would monitor the population to maintain that composition as the reduction activities take place. The results of this monitoring would also be used to help inform future management of the House Rock bison herd inside and outside of the park. The initial sex ratio goal is to maintain breeding age adults at a 1:1 sex ratio using a combination of available herd reduction tools, each of which may focus on a different segment of the population.

Genetic Considerations

The International Union for the Conservation of Nature's American Bison Specialist group published a status survey and conservation guidelines (2010) that provides recommendations for preserving important population characteristics of a herd. This report includes recommendations for reducing bison populations, and to the extent practicable, the park would follow these recommendations.

Although removals would focus on yearlings and younger male bison within the park (because they are not the focus of hunters outside of the park and are easier to process and transport), where possible, implementation of the proposed action would seek to remove animals from across all subpopulations and a range of age classes. Therefore, to the extent possible, proposed actions to reduce the House Rock bison herd would be distributed across all areas where bison occur and would not overburden a particular subpopulation. For example, it would be desirable to remove bison from Little Park and Powell Plateau in even proportions because different subpopulations are likely to spend the majority of their time in those two places.

In addition, to the greatest extent possible, preferential removal of related individuals would be avoided because it can lead to losses in genetic diversity and effective population size (IUCN 2010), concerns which could become relevant later as next steps to management of bison on the Kaibab Plateau are considered. Therefore, during population reduction actions, purposeful release of select live-captured individuals or passing on the lethal removal of select individuals that are otherwise available for removal from the population may occur. Such choices would be informed by subject matter experts or by a decision tree formulated by such experts.

ADDITIONAL BISON REDUCTION TOOLS

Hazing and Herding

Hazing and herding by people on foot and horseback, using soft-handling methods and actions (e.g., loud noises) that startle bison to encourage the animals to move toward or away from a location would be used to prompt bison movement. In addition, up to 6 helicopter flights could be used from October16 through May 14 for hazing bison away from rim edges and off of Powell Plateau (resulting in a total of no more than 12 helicopter flights per year for all bison-related actions). However, based on previous experiences indicating that herding and hazing is not always effective, the park is unlikely to implement this technique on a regular basis (e.g., like lethal culling). Hazing would be avoided at the end of that period unless absolutely necessary to avoid stress on late gestation cows and young calves that could lead to increased calf mortality and failed pregnancies. Flights would last from 1 to 2 hours each. These practices may be used as a stand-alone tool to disperse bison as appropriate or in combination with other tools to increase their effectiveness. For example, herding techniques could be used to help guide bison into the corrals. Bison movement data could be used to track groups of animals to be herded. Hazing would not be used

during calving season and while the calves are still very young to avoid the potential for increased cow and calf mortality. Although action below the rim is not expected, if the park is unsuccessful in preventing the bison from staying above the rim, it could use hazing and herding to move bison back above the rim and could use firearms as part of the hazing process or default to lethal culling. Animals fatally shot below the rim would be removed if possible or left in the field for scavengers if they cannot be accessed.

Use of Attractants

Attractants involve using food, water in the form of temporary portable water tanks, or mineral licks to draw bison to desired areas. Bait stations and other attractants could be used in combination with hazing and herding to compel bison to move in a desired direction for capture, lethal culling, or to move bison away from areas where they may be damaging resources.

Local Exclusion Fencing

The National Park Service may place exclusion fences at local water sources in the park (figure 4) and at other areas where park resources are at risk of experiencing increased impacts as a result of the steady growth of the House Rock bison herd that is expected to reach approximately 800 animals in the next 3 years (and as many as 1,200 to 1,500 animals within 10 years) (Sturm and Holm 2015). Fenced areas would be small (e.g., 2 acres or less) and would be typically constructed for the protection of highly sensitive resources (e.g., springs and seeps or archeological sites). Other fencing could be used in areas with evidence of high bison use of the area (e.g., archeological sites). Fencing would be configured with steel or wood posts and wiring spaced to let wildlife other than bison through to protect species that live in the wetland-associated vegetation and allow wildlife access to drinking water. Fencing would likely be strung using high tensile smooth wire at the top and bottom strands, spaced at appropriate heights, with possible use of barbed wire in the middle strands. Several configurations are possible, but they would all allow for safe wildlife passage for species smaller than bison while excluding bison (Gates 2006; AGFD 2011). Fence posts and postholes would be 10 to 12 inches in diameter, and placed 16 to 20 feet apart. Fencing would be necessary primarily while the reduction of the House Rock bison herd is taking place but may be left in place to help redistribute bison that remain in the park. Monitoring would occur to assess the effectiveness of using fencing to protect other natural and cultural resources.

HUMAN SAFETY

The proposed action would ensure a safety program is in place to minimize risk from lethal or nonlethal culling activities or other actions. In coordination with agency cooperators, park staff would develop an annual operations plan to identify the sequencing of tools and how many animals would be removed each year and to ensure proper training, certification, and safety of personnel. Training would occur for lethal culling teams and for safe nonlethal culling techniques. Standard NPS practices would be followed to ensure the safety of all involved with bison reduction actions. Leaders of the lethal culling and carcass removal teams would be NPS employees who meet the same qualifications as team members conducting the lethal removal activities. Team members conducting the nonlethal culling activities would have experience with the capture of large mammals and know how to conduct themselves safely. Portions of the park in which lethal culling or corralling take place would be closed to visitors to ensure their safety. Details regarding these closures, such as announcing closures, mechanics of closures, and staffing, would be determined in the annual operations plan.

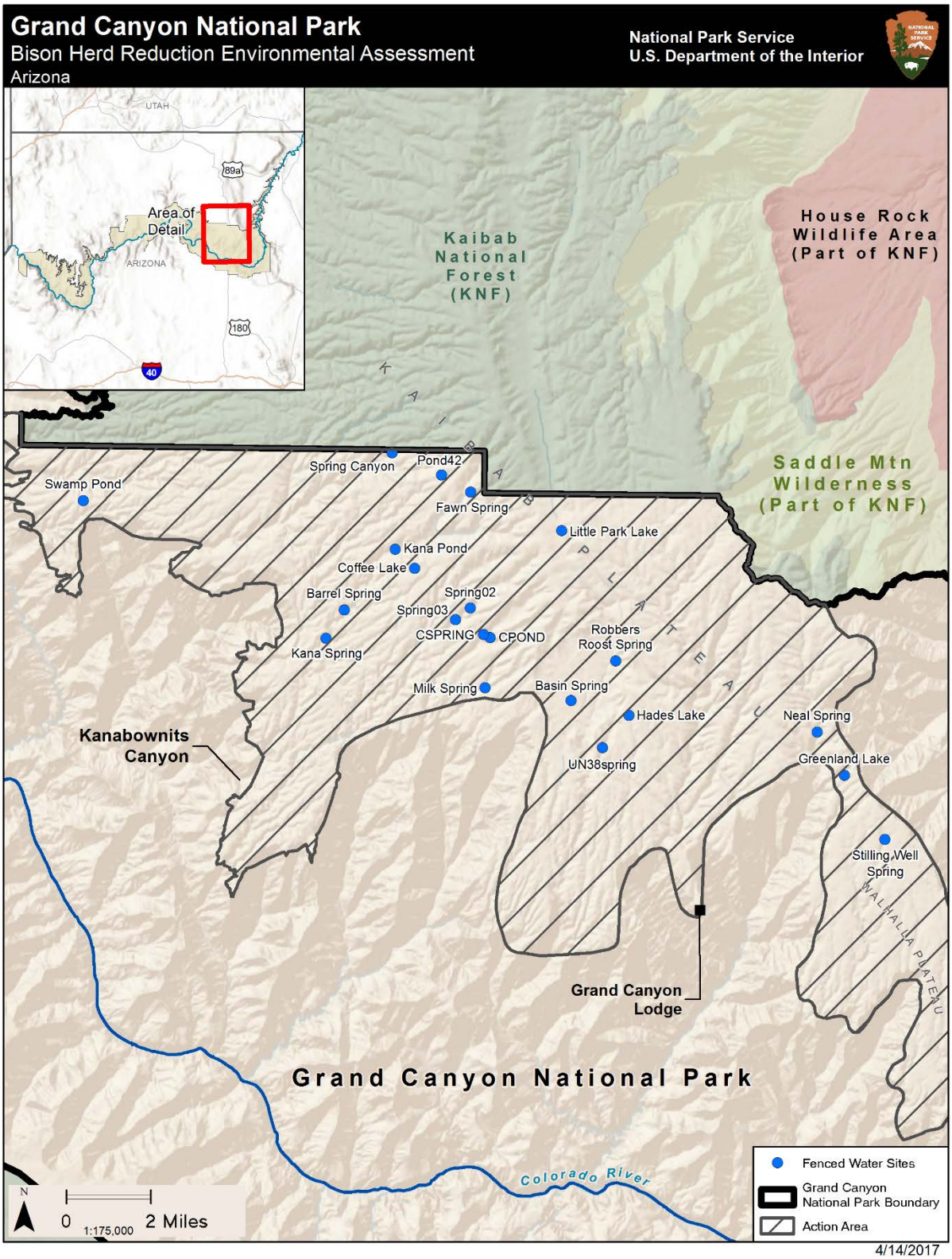

FIGURE 4. POTENTIAL WATER RESOURCES TO BE FENCED

PUBLIC OUTREACH AND EDUCATION

The National Park Service would educate visitors about the House Rock bison herd and the population reduction efforts, including informing them of any closures needed during reduction actions.

MONITORING

Three types of monitoring are associated with the proposed action: reduction tool effectiveness, bison response, and other resource response.

Reduction Tool Effectiveness

At some point, bison would likely become wary of corralling activities and become more difficult to capture. How quickly this process would occur is unknown. Similarly, lethal reduction actions would also trigger responses from the bison, but it is not clear what those responses would be. Bison have demonstrated awareness of hunting actions outside the park, which is one reason they spend time in the park. For example, closure of a portion of the Kaibab National Forest adjacent to the northeast part of the park to hunting in 2016 resulted in bison remaining outside the park for prolonged periods. Prior to this closure to hunting, bison spent little time in that part of the forest (AGFD, Lutch, pers. comm. 2017a). Park staff and cooperators would need to monitor the outcome and effectiveness of the reduction actions and assess the situation annually to update the implementation strategy for the following year.

Bison Response (Behavior and Population)

Implementation of lethal culling using firearms would likely redistribute the House Rock bison herd and move bison either out of the park or into other areas of the park. With continued hunting pressure outside of the park, bison may move back to the park or move to other places outside of the park, including the House Rock Wildlife Area. The park and its cooperators would monitor movement and behavior of the House Rock bison herd once the initial bison reduction is complete, so that the need for future actions can be determined. At a minimum, distribution and movement monitoring would be accomplished primarily using several radio collars on bison and periodic fixed-wing overflights. Fixed-wing flights would also inform population estimates. These activities would be coordinated between the National Park Service, Arizona Game and Fish Department, and Kaibab National Forest.

Other Resources

As part of the proposed action, the National Park Service would implement a monitoring program to evaluate how resources are responding to bison reduction actions. The National Park Service would work with its partners to identify desired conditions for the resources and would use the monitoring information to determine whether additional bison management actions should be taken in the future. The monitoring information would further inform future decisions concerning additional bison management actions.

The National Park Service has identified a number of potential resources and indicators that could be monitored in the future. These resources and indicators are described in table 3.

TABLE 3. POTENTIAL RESOURCES, INDICATORS, AND METHODS AND APPROACHES TO MONITORING

Resource	Potential Indicator	Potential Monitoring Methods and Approaches
Vegetation (meadows; forest, shrubland, and scrub systems)	Percent cover and height of native grasses, forbs, woody vegetation and bare soil; interplant distance; presence of invasive and exotic plants	Monitor areas currently occupied by bison that are sensitive to potential effects of bison to understand effects attributable to concentrations of bison. Allow for consideration of other factors such as drought that could affect plant health and abundance.
Cultural resources	Artifact breakage, artifact context disturbance, architectural disturbance, erosion around sites	Monitor known sites for resulting effects on resources.
Water resources (springs, seeps, localized lakes/ponds, wetlands)	Vegetation conditions, turbidity, bacteria, nutrients, hydrology	Use vegetation surveys as described above; conduct water quality surveys in areas where bison congregate versus those with light use to compare effects. Consider other factors such as drought.
Soils and biological soil crusts	Annual N fixation, C fixation, surface roughening, soil stability	Conduct soil surveys in areas where bison congregate versus those with light use to compare effects attributable to bison.
Bison	Abundance, spatial/temporal occupancy, genetics	Conduct aerial population surveys, monitor bison tracking data, and assess herd genetics.

MITIGATION MEASURES

The park would implement additional mitigation measures during the proposed bison reduction actions under alternative 2; measures are organized by the resource or values that would be protected.

WATER RESOURCES

- Monitor seasonal water quality, soil quality, soil bulk density, and water quantity samples at bison water attraction sites and nearby caves; actively remediate sites that exceed a threshold value using best management practices related to the adversely impacted environment.
- Conduct post-corral restoration activities (or at other times), such as soil aeration and erosion control structures (if needed) to reverse effects of compaction.

BISON-AFFECTED VEGETATION

- Revegetate the corral sites or site of other actions with native species, if needed.
- Implement exotic invasive plant management measures, including manual removal with hand tools and application of herbicides in a localized and targeted fashion using backpack sprayers, depending on the plant, if needed (NPS 2006a, 2009).

SOILS

- Conduct post-corral restoration activities (or at other times), such as soil aeration and restoration and erosion control structures (if needed) to reverse effects of compaction and reduce erosion potential.

ALTERNATIVES CONSIDERED BUT DISMISSED FROM FURTHER DETAILED ANALYSIS

The following alternative actions were considered but dismissed from further detailed analysis for reasons explained below.

COMPLETE ELIMINATION OF BISON FROM GRAND CANYON NATIONAL PARK

The purpose of taking action is to quickly reduce the density of the House Rock bison herd in collaboration with other agencies involved in bison management on the Kaibab Plateau. Modeling (see "Bison Removal Modeling" section of this chapter) indicates that at current population levels it is only possible to reduce the size of the House Rock bison herd to about 140 animals (which falls in the desired range of fewer than 200 bison) in the next 3 years, which is the target timeline for reduction of the herd (Sturm and Holm 2015). This environmental assessment is also focused on short-term management actions to reduce the House Rock bison herd. Completely eliminating bison would represent a decision about long-term management that is outside the scope of this environmental assessment. Therefore, this alternative has been dismissed from detailed analysis.

MANAGED HUNT/PUBLIC HUNTING

During public scoping, some commenters advocated the use of hunting in the park to manage the House Rock bison herd. Public hunting would be inconsistent with existing laws, policies, and regulations for the park and all other units of the national park system where hunting is not authorized. As a result, hunting was dismissed from further consideration.

Public hunting is prohibited in national park areas except where "specifically mandated by Federal statutory law" (36 CFR 2.2). No such mandate for hunting exists for Grand Canyon National Park. The National Park Service has consistently reaffirmed this approach in its policies, most recently in the NPS *Management Policies 2006* (NPS 2006a).

Although public hunting and lethal culling can both be used as conservation tools in ungulate management, the differences between hunting and lethal culling must be clarified. Hunting is an activity administered by state wildlife agencies through licenses and involves fair chase and the recreational pursuit of game for meat and sport, with incidental management effects on game populations by the individual hunter. Lethal culling, on the other hand, is a non-recreational conservation tool used to reduce and control wildlife populations that have exceeded management objectives and have detrimental impacts on park resources. It is a very controlled and structured activity used to meet specific resource management objectives (e.g., wildlife population density / abundance goals, vegetation conditions) and is not implemented as a type of recreation.

FERTILITY CONTROL

The purpose of taking action is to quickly reduce the density of the House Rock bison herd, in collaboration with other agencies with jurisdiction for bison management on the Kaibab Plateau, to protect park resources and values from the impacts of the steadily growing herd. In 2015, experts reviewed ungulate fertility control experiences in 10 NPS units. The review concluded where fertility control was successful for population management, target animals must be relatively easily accessible, reside within functionally closed populations (which do not migrate), and managers should have estimates of population vital rates (Powers and Moresco 2015). Not all of these factors are true with respect to House Rock bison herd. Fertility control techniques often have proved uneconomical or infeasible for

practical implementation even in small, localized populations (Fagerstone 2002). Fertility control can take a long time and require repeated applications to achieve population reduction consistent with objectives. Even if NPS managers had sufficient understanding of the behavior and distribution of the House Rock bison herd and effective access to implement fertility control measures without significantly affecting park resources and values, fertility control measures would not quickly reduce the population to low levels and density. For example, Powers and Moresco (2015) state that if the timeline for wildlife population reduction is short (<5 years), fertility control alone is not likely to be a successful reduction strategy. Meanwhile, the potential for increased effects from the House Rock bison herd on park resources and values would continue. Therefore, a fertility control alternative does not meet the purpose and need for the proposed action and was dismissed from further consideration.

PARK BORDER FENCE

A fence is in place along some parts of the park border but has fallen down in several places. The existing fence is only designed to exclude cattle and other livestock from the park, not bison, which require more robust fencing. However, other issues related to wilderness and other wildlife movement would have too great an environmental impact that can be avoided with other alternatives. In addition, construction of a fence would not accomplish the objective to quickly reduce the House Rock bison herd to a lower level and density. As a result, this alternative was dismissed from further analysis.

GRAY OR MEXICAN WOLF REINTRODUCTION

It has been suggested that reintroduction of wolf populations to the area could help control the House Rock bison herd. The gray wolf (*Canis lupus*) is federally listed as endangered under the Endangered Species Act in northern Arizona. A single gray wolf observed in 2014 at Grand Canyon was the first documented occurrence of this species in this area since the 1940s. The action area is outside the experimental population boundary area for the Mexican gray wolf (*Canis lupus baileyi*). While wolves are important components of management of healthy ecosystems where they currently occur in units of the national park system, reintroduction of either species for the purpose of reducing the House Rock bison herd was dismissed. Reintroducing wolves would not be a predictable population reduction tool and would not reduce the House Rock bison herd quickly, or possibly at all, and would not meet the purpose for taking action; therefore, this alternative was dismissed from further analysis.

USE OF DOGS TO HAZE OR HERD THE BISON

The National Park Service considered the use of herding dogs to haze or herd bison into areas where they could be corralled or lethally removed or to move the bison off the park. Discussions with experts during internal scoping indicated that although dogs have been effectively used with other ungulates (Walter et al. 2010; Woodruff and Green 1995), anecdotal evidence and an experiment at Yellowstone National Park indicate that dogs are not effective with bison. Bison tend to either ignore or injure dogs (NPS 2014a; Hartnagle-Taylor 2009); therefore, use of this tool was dismissed from further analysis.

STAND-ALONE TOOLS FOR REDUCTION (NONLETHAL AND LETHAL CULLING)

The National Park Service considered using each of the principal population reduction tools (lethal culling and capture and removal) as stand-alone alternatives but determined that they would take too long or be too difficult to implement in a timely fashion and would therefore not meet the purpose and need. As a result, these options were dismissed from further consideration as stand-alone tools.

Assuming an initial post-calving population of 600 bison and an initial pre-management population growth rate of 15%, Sturm and Holm (2015) estimated that it could take approximately 10 years to reduce

the House Rock bison herd through lethal culling alone to approximately 150 animals pre-calving. Using similar assumptions about the initial size and growth rate of the bison population pre-management, Sturm and Holm (2015) estimated that it could take approximately 8 years to reach 200 bison using nonlethalculling as a stand-alone tool. However, they go on to predict that bison population growth, distribution, and increased wariness of the corral sites would make it difficult to reduce the House Rock bison herd below that number, and the herd would begin to grow again, so that at 15 years, the population would be back up to more than 400 bison post-calving. Bison could also become wary of the corral sites well before 8 years (Sturm and Holm 2015). Because the use of these tools would take so much time if used individually, they would not meet the purpose and need of the proposed action; therefore, this alternative was dismissed from further consideration.

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CHAPTER 3: AFFECTED ENVIRONMENT

HOUSE ROCK BISON HERD

The American bison (*Bison bison*, Linnaeus 1758) had the largest historical range and broadest array of ecological settings of all North American native ungulates—across boreal, coniferous and deciduous forests, Holarctic settings, local riparian to major river deltas, desert and montane grasslands, great and high plains, inter-mountain basins, and from coastal plains upwards towards 10,000 feet elevation.

The general ecology of bison has been well described in many individual scientific articles that have been synthesized and comprehensively reviewed, including most recently by Gates et al. (2010) and Plumb, White, and Aune (2014) as presented below. Bison are highly mobile and can traverse large expanses of land in relatively brief intervals of time. For example, wild free-ranging Yellowstone bison can travel more than 30 kilometers in a single day, and have a home range of approximately 10,000 square kilometers. Factors influencing movements within a home range include seasonal vegetation changes, interspersion and size or quality of foraging sites, the rut, presence of biting insects, snow accumulation, the need to conserve or gain energy, and the availability of water. The size of bison home ranges tends to increase with bison density and in areas of poorer habitat quality or lower forage availability. Also, population substructure has been observed, with different segments of the population using different portions of the landscape.

Current abundance of the House Rock bison herd on the North Rim and in Kaibab National Forest lands is estimated at 400 to 600 (Plumb et al. 2016). Plumb et al. (2016) found that the current abundance and density is much higher than herds in similarly arid environments, such as the herd in the Henry Mountains of Utah, and that under current bison management, the House Rock bison herd is expected to exceed 800 animals within 3 years (2020) and 1,200 to 1,500 in 10 years (2027). The distribution and prevalence of water (and snow) on the North Rim has a strong influence on current distribution and movement patterns of the House Rock bison herd, and also allows for their continued presence within the park. Any water sources that bison are not currently using will likely be exploited as their population and density increases. The House Rock bison herd at the park has spent most of its time in recent years on the North Rim, occasionally moving on to the forest or moving in seasonal patterns described previously in the "General Ecology" section (figure 5). After the July 2016 Fuller Fire on the North Rim, which occurred east of this range in the east-northeast corner of the North Rim near Point Imperial, data from radio-collared cows indicated the House Rock bison herd is now expanding eastward, exploring new vegetation on the burned lands (NPS, Holm, pers. comm. 2016b).

Bison are considered primarily diurnal (active during the day), yet may also be somewhat active at night, including foraging and group movement. The majority of bison activity is focused on foraging and ruminating (digestion), depending on season and forage quality. Bison diets consist primarily of grasses and sedges, but they will also exhibit some preferential seasonal selection of forbs and small shrub vegetation. Bison satisfy water needs by drinking free water, generally once daily, or periodic snow consumption. Adults require about 10 to 15 gallons of water per day, but this can vary between seasons. Sometimes, an emphasis on group cohesion can result in reduced water intake for the individual if the group moves away from a water source too soon.

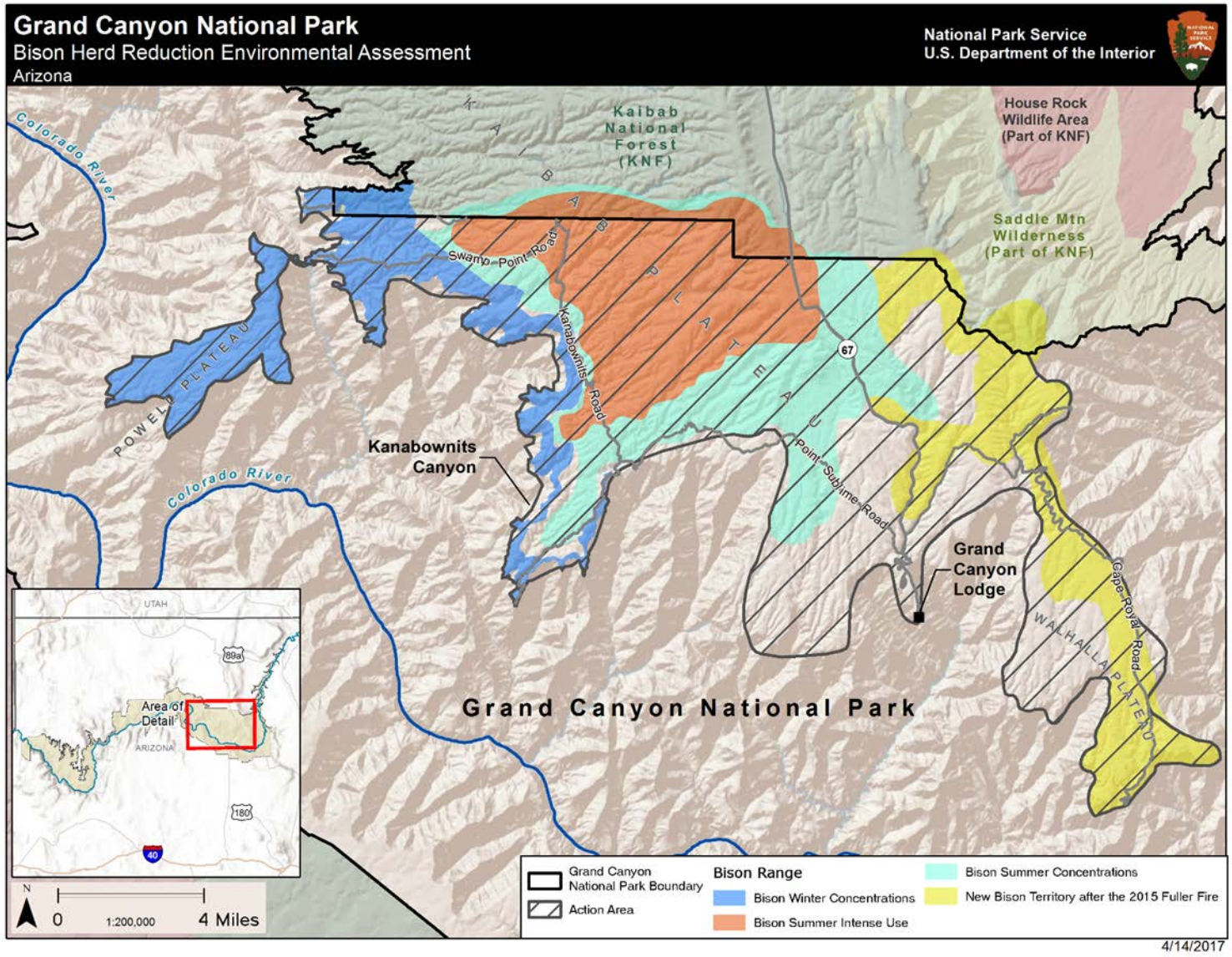

FIGURE 5. CURRENT RANGE AND SEASONAL DISTRIBUTION OF THE HOUSE ROCK BISON HERD ON THE NORTH RIM OF GRAND CANYON NATIONAL PARK

Group size and composition can vary seasonally based on forage availability and reproductive activity. In general, bison gather in larger groups throughout the summer, especially when males and females come together for breeding during the "rut." Often, group sizes will be reduced during the winter. For much of the year, mature bulls remain solitary or in small groups, only joining cows during breeding season between July and September. The House Rock bison herd appears to exhibit normal bison group size and movement, congregating mostly in the meadows in the summer (see the intense use areas in figure 5). The herd also moves around the periphery of these meadows (summer use areas in figure 5) and in smaller groups in the forest and out on the remote western plateaus to the canyon rim during the winter (figures 5 and 6). After the 2015 Fuller Fire, this pattern shifted somewhat, and a group of bison moved to the burned area to take advantage of emerging vegetation, then began to explore the Walhalla Plateau east of their summer use areas.

FIGURE 6. MIXED AGE AND SEX GROUP OF HOUSE ROCK BISON HERD IN THE MEADOW BY THE NORTH RIM ENTRANCE ROAD

Bison engage in an activity known as "wallowing" or "dust-bathing," which serves multiple purposes, including shedding winter coat and relief from insect irritation. This activity results in the creation of roughly circular, semi-permanent bare soil depressions in the landscape. Wallows can vary in size and duration, from small temporary spots, to areas many feet across that persist (figure 7).

FIGURE 7. BISON WALLOW AREA ADJACENT TO WATER ON THE NORTH RIM

WATER RESOURCES IN THE KARST LANDSCAPE

The karst landscape of the area influences both water quality and water quantity on the North Rim and below in the canyon. Karst landscape is characterized by soluble substrates such as limestone, salt, and gypsum that are easily dissolved through water movement, resulting in the formation of underground drainage systems, sinkholes, depressions, and caves (Harris and Pearthree 2002). Springs and seeps provide most of the surface water in the action area. These resources provide baseflow for the Colorado River and its perennial tributaries, support associated wetland vegetation, and are used as a source of water for wildlife and park visitors. Spring flow varies throughout the year depending on the precipitation, although the highest flows are usually associated with spring snowmelt (Rice 2008). The area is relatively arid; many months average only 1 inch of rain, and the Kaibab Plateau receives average annual precipitation of approximately 25.8 inches (NPS 2014b), so water availability can be very limited. Most springs on the North Rim are ephemeral, including Crystal Spring, Timp Spring, Kanabownits Spring, and Tipover Spring (USFS 2008; USGS 2015). Robbers Roost Spring is the only perennial spring in the action area, although the discharge is low enough that it freezes during the winter. Most of the springs are low flow and only flow for a short distance (up to 25 meters or about 80 feet) before they sink back into the ground (NPS, Tobin, pers. comm. 2016c).

Approximately 17 perennial and 7 intermittent lakes/ponds and 14 springs/seeps are on the North Rim portion of the action area (USGS 2013). Ponds on the North Rim include Coffee Lake, Little Park Lake, Castle Lake, Hades Lake, Greenland Lake, and Swamp Lake. Figure 8 depicts the locations of springs, seeps, lakes, and ponds in the action area.

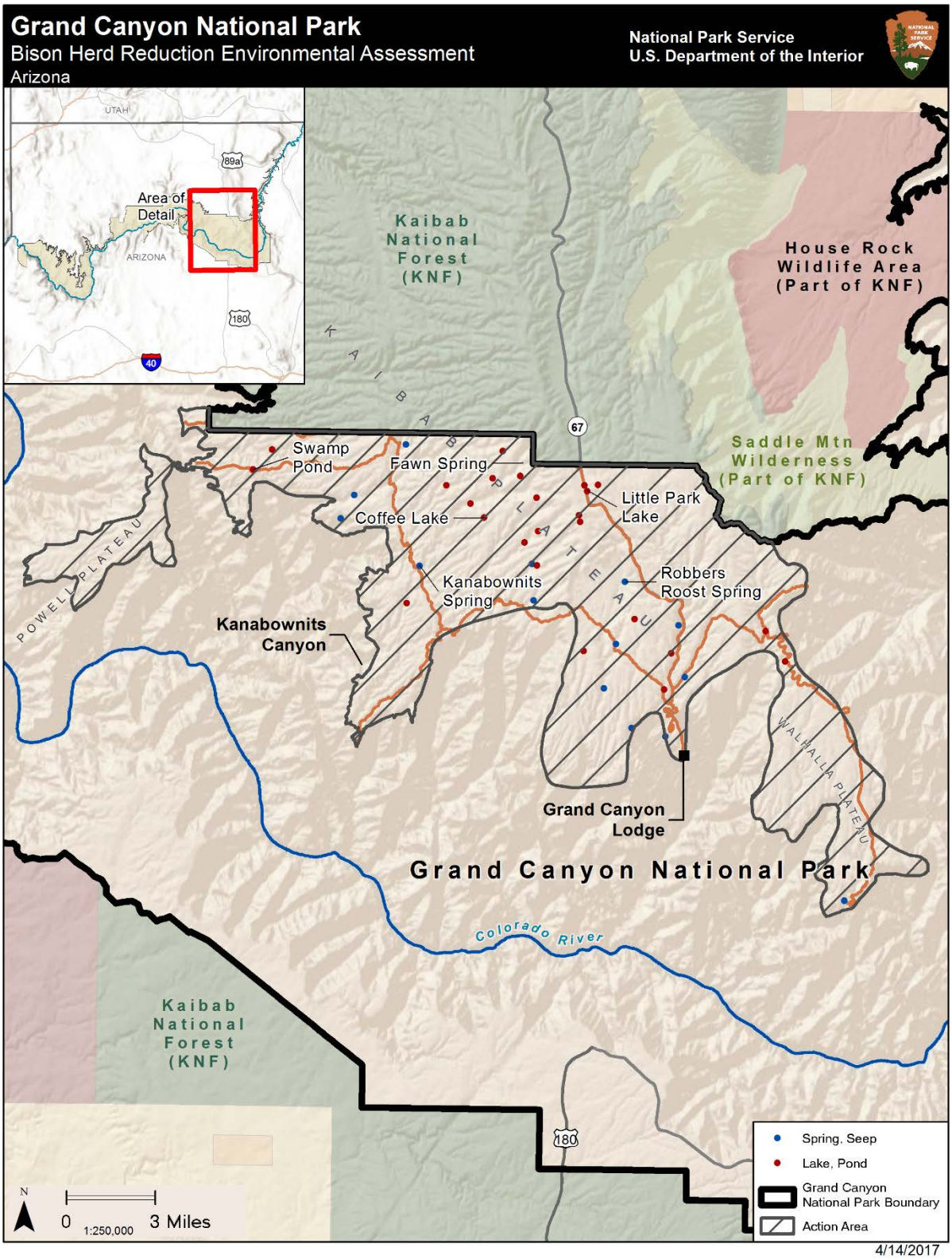

FIGURE 8. SEEPS, SPRINGS, LAKES, AND PONDS IN THE ACTION AREA

Hydrology associated with karst landforms allows surface water pollutants to enter the underground hydrological system without filtration through soil, thereby contaminating aquifers and the water supply (Harris and Pearthree 2002). Two aquifers underlay the North Rim—the Coconino aquifer and the Redwall-Muav aquifer. The predominant aquifer in the area is the Redwall-Muav aquifer (Hill and Polyak 2010) because of the thinning of Coconino sandstone below the North Rim. Within the Kaibab Plateau recharge areas, where surface water flows into the ground to the aquifers below, water infiltrates the surface through sinkholes and moves through an underground system of fractures, faults, and joints and typically discharges from springs and seeps along the south edge of the North Rim (Hill and Polyak 2010). The North Rim action area is home to more than 2,200 sinks, and soil disturbance around the sinkholes or high amounts of fecal matter from congregation of a large number of bison can cause or exacerbate water quality issues for waters in the karst landscape. Within the area where the House Rock bison herd has spent time in recent years, summer use areas contain 1,368 sinkholes, with more than 600 of them in the intense summer use areas and 134 sinks in the winter use areas. Other sinkholes are located in the eastern part of the action area, outside documented areas used by the House Rock bison herd (figure 9). Compaction and fine sediments transported by runoff can reduce infiltration in sinkholes within the karst landscape, resulting in the formation of ponds and lakes (Huntoon 1974). The sinks are also conduits for groundwater contamination from runoff, transporting nutrients and bacteria from nearby sources, including large amounts of dung.

The water quality of the North Rim surface water has not been formally investigated, except for a preliminary investigation in 2015 that examined a number of parameters at lakes and ponds on the North Rim with low, medium, and high levels of bison use (Coraci et al. 2015). Water sampling at these sites showed that *Escherichia coli (E. coli)* bacteria is present in springs in areas of medium to high bison use but is not present in springs with low bison use. The study did not provide additional analyses concerning the presence of *E. coli* or establish its source.

Since 2010, the park has monitored springs and seeps on the North Rim. The intent of the monitoring is to document the intensity of bison use and demonstrate how continued bison presence in large concentrations has affected the springs and seeps over time (NPS 2015a). Most of the monitoring has focused on effects on vegetation and soils (see discussion included under “Bison-Affected Vegetation” below). Reimondo (2012) reported that exposed and disturbed soils around springs and ponds were associated with bison use and that soil bulk density tended to increase as bison use increased. Soils with higher bulk density can restrict root growth, and bulk density increases with compaction, similar to what might occur as a result of high bison use. These disturbances and changes to the soil can occasionally lead to increased runoff, erosion and compaction of soil, and potential sedimentation of surrounding water resources (Fleischner 1994; Jones 2000), which could contribute to obstruction of the natural karst drainage points and block the natural underground transport of surface water, although this has not been studied to date. In addition, areas with concentrations of livestock in karst regions have also been linked to issues with bacterial contamination in groundwater from springs, wells, and cave streams (Kelly et al. 2009). Although bison are not livestock, their herding behaviors are similar; therefore, the study is analogous. The disturbance to springs and other surface waters and associated vegetation degrades the stability of the site, alters the hydrology, and increases the turbidity of the water body (figure 10). Numerous bison wallow areas, located along known bison travel routes in which the soil becomes compacted, have disturbed the localized water resources and associated vegetation (Reimondo 2012).

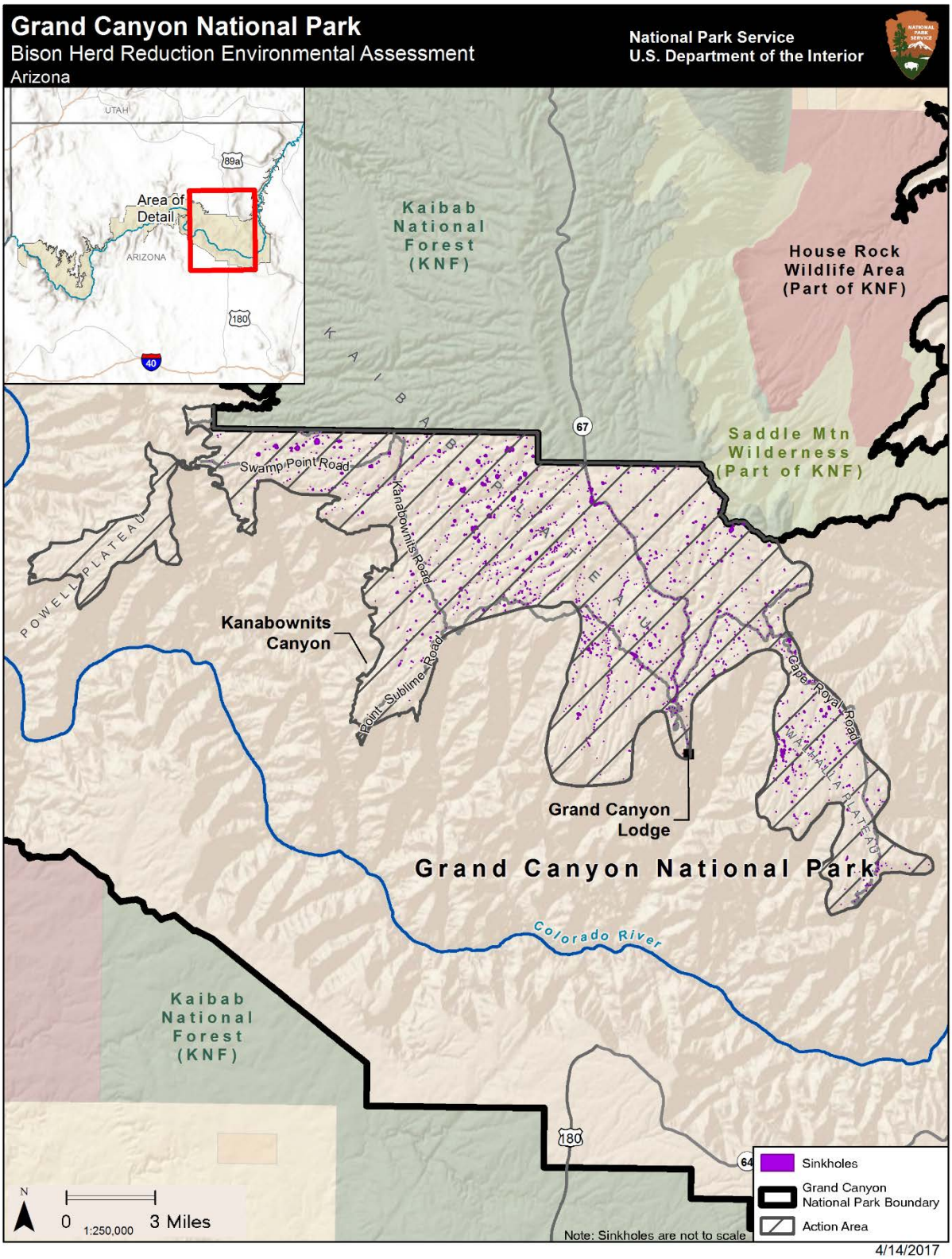

FIGURE 9. SINKHOLES IN THE ACTION AREA

Source: Louis Berger

FIGURE 10. LITTLE PARK LAKE ALONG THE NORTH RIM ENTRANCE ROAD WHERE THE HOUSE ROCK BISON HERD GATHERS IN THE MEADOW

BISON-AFFECTED VEGETATION

Vegetation that could be affected by the House Rock bison herd or bison reduction activities includes meadows, grasslands, and shrublands in the action area frequented by large concentrations of bison and the wetland vegetation associated with the seeps, springs, ponds, or lakes in those areas. The areas on the North Rim and the adjacent plateau where bison are found have high bio-richness, with a high diversity of plant species (Stortz et al. 2016).

Herbaceous plants, forbs, and grasses dominate montane meadows and subalpine grassland communities. The greater Grand Canyon landscape contains approximately 3,000 to 5,000 acres of grasslands and meadows—montane grasslands and meadows—within a 5 million-acre area (Stortz et al. 2016). The action area itself contains approximately 2,800 acres of grasslands and meadows or 56%–93% of the grassland/meadow habitat in the North Rim landscape. Figure 11 is an aerial photo base map of the action area with grasslands identified in the park's vegetation database highlighted. As the photo indicates, most of the North Rim is heavily forested, consisting mainly of fir, spruce, and pine woodlands and associated shrublands. Grasslands and meadows that are of most concern to this proposed action constitute a very small percentage of the area (roughly 3%) and often occur in scattered openings and along access roads.

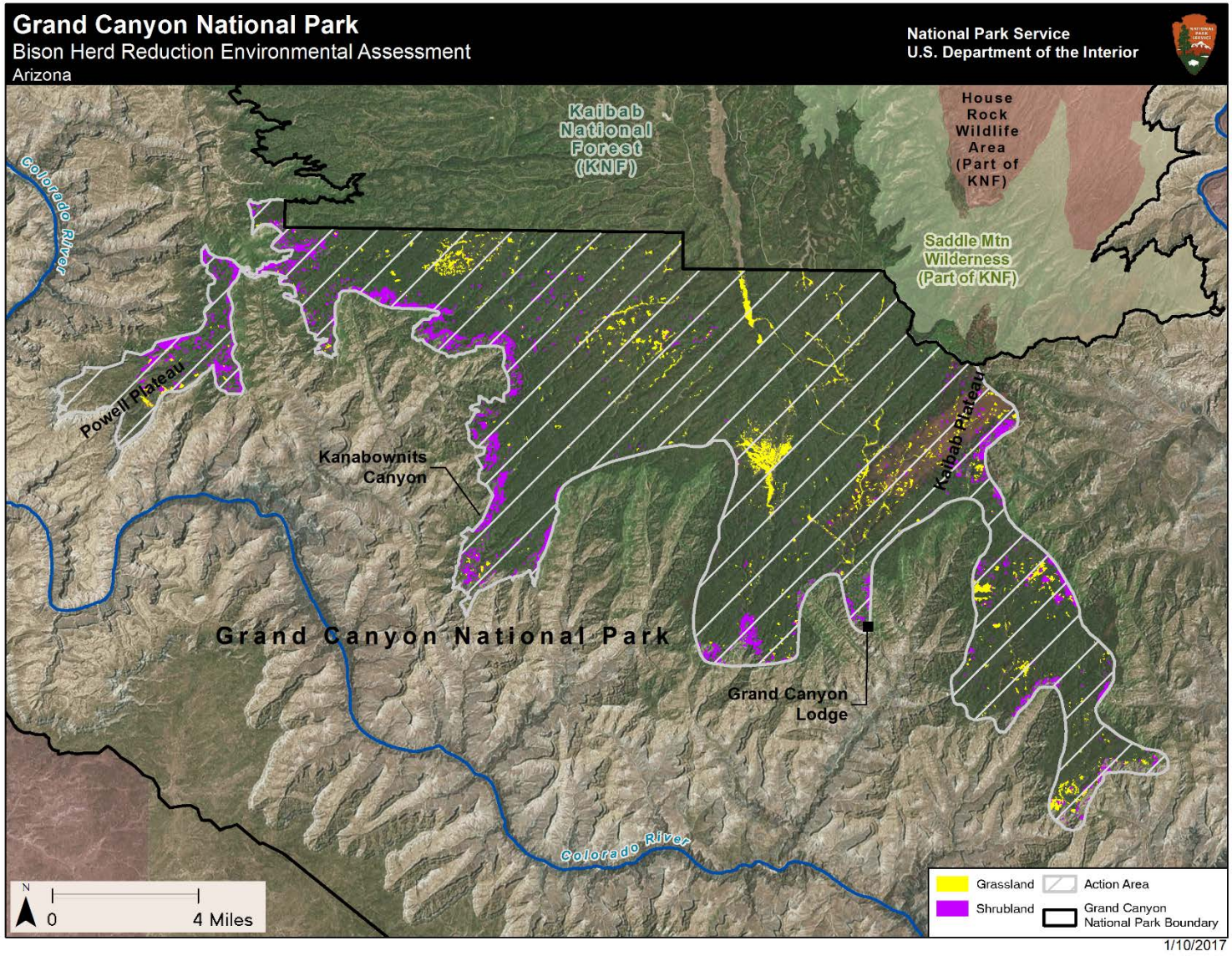

FIGURE 11. GRASSLAND AND SHRUBLAND VEGETATION IN THE ACTION AREA OF THE NORTH RIM OF THE PARK

Cool temperatures and high soil moisture exclude woody species from these small areas. According to the Greater Grand Canyon Landscape Assessment, grassland/meadow species present in the park are a rare vegetation type in the southwestern United States, and Grand Canyon meadows have state and regional significance beyond the areas that have suffered from increasingly intense bison grazing (Stortz et al. 2016). The meadow communities are typified by numerous grass species, including blue and black grama (*Bouteloua gracilis* and *Bouteloua eriopoda*), big galleta (*Pleuraphis rigida*), needle and thread grass (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), and purple threeawn (*Aristida purpurea*). The wettest areas support sedges and forbs (NPS 2015e). Figure 12 shows a relatively undisturbed alpine meadow on the North Rim. Figure 13 shows the meadow at Little Park Lake that has been heavily grazed by bison; this meadow has fewer plants (less cover) because they have been grazed close to the ground. In addition, specimens of the exotic plant, mullein (*Verbascum thapsus*), are present.

Source: Louis Berger

FIGURE 12. LIGHTLY GRAZED MEADOW ON THE NORTH RIM

Source: Louis Berger

FIGURE 13. HEAVILY GRAZED MEADOW ADJACENT TO LITTLE PARK LAKE

Montane shrubland and interior chaparral is a primary vegetation type in the greater Grand Canyon landscape, occupying nearly 25% of the park's area (Stortz et al. 2016). The action area contains about 4,957 acres of this vegetation type or roughly 5% of the action area. Montane shrubland and interior chaparral are dominated by scrub oak (*Quercus turbinella*) and manzanita (*Arctostaphylos pungens*) in warmer regions and Gamble oak (*Quercus gambelii*), three-leaf sumac (*Rhus trilobata*), snowberry (*Symphoricarpos oreophilus*), and mountain mahogany (*Cercocarpus ledifolius*) in cooler areas (Stortz et al. 2016). Bison have been observed using these shrublands, especially during the winter months.

The amount of wetland-associated vegetation on the North Rim is unknown; however, this vegetation type is associated with the 24 ponds and lakes and 14 seeps and springs that have been identified in the action area. Areas of wetland-associated vegetation are too small to show on figure 10 but occur around the springs, seeps, and ponds that are shown in figure 8.

Where water is present in seeps and springs, important and sensitive wetland-associated vegetation develops. Wetland vegetation habitats rank among the most productive and biologically diverse park terrestrial ecosystems (Crumbo and George 2005). They create isolated habitat islands that support many relict and endemic species such as the Kaibab suncup (*Chylismia confertiflora,* syn. *Camissonia confertiflora*). Seep and spring habitats are particularly vulnerable to irreversible damage given their small size, dependence on a rare and variable resource (the water in the seeps and springs), and isolation (NPS 2015e).

Researchers monitored 17 wetlands on the North Rim since 2010 for changes resulting from increases in bison use. Results of the most recent data collected in July 2014 indicate that at sites experiencing high bison use, vegetative cover is declining, bare soil is increasing, the vegetative height of wetland plants is declining and a positive correlation exists between bison use and exposed soil, and a significant negative correlation exists between bison use and vegetative cover (NPS 2015a; 2015f). These changes, which are attributable to the large number of bison that congregate at these sites, appear to be increasing in scale and intensity over the years (NPS 2015a). Figure 14 from the 2014 annual report addendum shows the current condition of Crystal Pond in 2010 (no bison use) and 2014 (high bison use).

FIGURE 14. CRYSTAL POND IN 2010 ON THE LEFT (NO BISON USE) AND IN 2014 ON THE RIGHT (HIGH BISON USE)

Exotic plant species become established in areas where native plants or soils have been disturbed. For the purposes of this analysis, the term "exotic species" refers to those species that are both nonnative or alien and invasive. Exotic plants can be aggressive and displace native vegetation by robbing moisture, nutrients, and sunlight from surrounding native plants, resulting in altered (and frequently degraded) habitats and communities. The spread of exotic plants can often occur as a result of disturbances like fire, wind storms, development, and overgrazing (such as is associated with areas of high bison use); disturbance from the growing House Rock bison herd occurs in this context. Research on exotic plant occurrence on the North Rim of the park (Crawford and Straka 2004) found significant changes in plant composition, cover, and diversity (including the introduction of exotic species) occurred as a result of the 2000 Outlet Fire on the North Rim that burned 465 acres near Bright Angel Drainage. Of the eight exotic species found in the action area, the following four species were considered to be a high priority for management, but with low feasibility of control: smooth broom (*Bromus inermis*), drooping broom (*Bromus tectorum*), Kentucky bluegrass (*Poa pratensis*), and garden sorrel (*Rumex acetosella*). The park has documented several other potential invasive plant species, including common mullein (*Verbascum thapsus*) (NPS 2016d). The park also documented evidence of exotic plant presence while mapping bison wallows and other high bison use areas in the park (NPS 2015a). Vegetation communities can benefit from bison wallowing in areas closer to the heart of their historical range (Rickel 2005; Shaw 1996), by increasing plant species richness and site diversity (Rickel 2005). On the North Rim, the soil disturbance caused by the wallows appears to have facilitated the reemergence or new establishment of mullein and has affected the native grasses and forbs in the meadows by suppressing their growth (NPS 2015a). Shaw (1996) notes a higher occurrence of exotic plant species and fewer native grasses in the wallows studied.

SOILS

The majority of the park is undeveloped, and current soil conditions are at or close to their natural state because logging, grazing, and farming have not occurred in the park for at least 75 years (NPS 2012b). The US Department of Agriculture, Natural Resources Conservation Service, has identified several soil-family complexes on the North Rim of the park. The soils in the action area range from shallow and weakly developed to deep and productive. Most soils on the Kaibab Plateau have a 2-foot-thick loamy surface with many rock fragments, making them resistant to rutting and compaction (USDA, NRCS 2002), although they are still susceptible to compaction and erosion, especially the topmost layers, if the level of disturbance is high. Wind and water erosion are major concerns on the North Rim and can damage trails and areas where the grass cover is lost from both animal and human use. The large number of bison on the North Rim has led to overgrazing, which has reduced vegetative cover and increased the amount of exposed soil in areas of high bison use (NPS 2015a)—all of which can increase erosion potential. Bison also wallow and trample on soils, which changes soil properties, leading to compaction and an increase in percolation times (figure 15) (Coraci et al. 2015). Defecation of a large number of bison can also change the nutrient composition of the soils.

Biological crusts, a protective soil layer formed by living organisms and their by-products, are found in the park's semi-arid areas on the North Rim. The extent of biological soil crusts has not been mapped, but they have been found in the western portion of the North Rim, mostly in pinyon-juniper and desert scrub xeric communities (NPS, 2012b). Although the House Rock bison herd does not spend the majority of its time in these areas, they may pass through on their way to other areas. On the southern Colorado Plateau, crusts are primarily composed of cyanobacteria, with lichens and mosses occurring in specific habitats. These crusts bind together particles in the top 0.2 inch (5 millimeters) of soil, stabilizing it, and preventing erosion. Surface roughness of particularly well-developed crusts further protects soil from water and wind erosion. Crusts' water- and nutrient-holding capacity can increase vascular plant germination and growth and has been connected to increased vigor in otherwise marginal habitats (NPS 2015e). For full development, soil crusts require long periods without compressional disturbance (trampling).

Source: Coraci et al. (2015)

FIGURE 15. BISON WALLOW AT GRAND CANYON

WILDLIFE (OTHER THAN BISON) AND WILDLIFE HABITAT

Wildlife, including mammals, birds, reptiles, and amphibians, that are of particular interest with regard to House Rock bison herd reduction activities include those species found in grasslands, meadows, shrublands, and wetland-associated vegetation that bison or bison reduction activities could directly or indirectly affect. In addition, forest species are also described to the extent that bison reduction activities could affect them. No data are available regarding the abundance or habitat conditions for any small mammal species on the North Rim (NPS 2016e). With the exception of the birds listed in the special-status species section, no data are available regarding the abundance or habitat condition for these more common wildlife species on the North Rim (NPS 2016e).

MAMMALS

Small Mammals

Several small mammals on the North Rim are habitat generalists that use ecosystems, including desert-scrub, coniferous forests, and wetland vegetation areas. Deer mice (*Peromyscus maniculatus*) and western harvest mice (*Reithrodontomys megalotis*) are common on the North Rim and serve as important prey species for many predators. The brush mouse (*Peromyscus boylii*) uses a variety of North Rim habitats, including areas adjacent to seeps, springs, lakes, and ponds. The Uinta chipmunk (*Tamias umbrinus)*, least chipmunk (*Tamias minimus*), golden-mantled ground squirrel (*Spermophilus lateralis*), and Nuttall's cottontail (*Sylvilagus nuttallii*) are found on the North Rim of the park and use primarily forest and meadow habitat. Shrews and voles occur in most habitats on the plateau, ranging from rocky slopes to grassy meadows (NPS 2015e). Several bat species on the North Rim rely on the seeps and

springs as a water source and for hunting insects, including the big brown bat (*Eptesicus fuscus*), the canyon bat (*Parastrellus hesperus),* Townsend's big-eared bat (*Corynorhinus townsendii),* and the pallid bat (*Antrozous pallidus*) (NPS, Holm, pers. comm. 2016g).

Carnivores

Most predators on the North Rim are highly mobile, hunting throughout the various habitat types. Ten terrestrial mammalian carnivore species occur on the North Rim and surrounding land, including mountain lion (*Puma concolor*), black bear (*Ursus americanus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), badger (*Taxidae taxus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), spotted skunk (*Spilogale gracilis*), and long-tailed weasel (*Mustela frenata).* Mountain lions occur throughout Arizona and can be found in any habitat. Black bears are thought to exist in very low densities throughout the park. Skunks are present on the North Rim, and coyotes are common throughout the area. The striped skunk is most often found next to water, but it can be found in any habitat. The spotted skunk prefers rocky, mountainous areas (AGFD 2016). Bobcats are commonly found on the North Rim in open and wooded areas, especially along the pinyon-juniper belt, but they use many other areas, including meadows, where they hunt rodents. Badgers uncommonly occur in grasslands, pinyon-juniper, and ponderosa pine forests. Long-tailed weasels also occur on the Kaibab Plateau, including the North Rim, although they are more broadly distributed throughout Arizona. Long-tailed weasels are active year-round and are primarily nocturnal (NPS 2015e). They can be found in grasslands and forests near water.

Ungulates

The other large ungulate currently in the action area is the mule deer. Mule deer occupy different areas depending on the season. They use pinyon-juniper, ponderosa pine, and mixed conifer forests for food and shelter and occupy a variety of habitats seasonally. They tend to avoid large openings except when foraging in meadows (NPS 2016e), which is the area where they likely compete with the House Rock bison herd for grasses and forbs. Mule deer are found in areas where teams conducting bison reduction activities would pass. On the North Rim, mule deer depend on the pinyon-juniper zone for essential winter forage and move into ponderosa pine, mixed-conifer, and spruce-fir habitats during late spring, summer, and early fall. Deer begin migrating into mixed-conifer forest in early May and remain there and in spruce-fir until late September (NPS 2015e). Although they have been documented on the Kaibab Plateau, Rocky mountain elk (*Cervus elaphus nelsoni*) are not native to the area, and there is only one reliable report of elk with in the North Rim to date. (NPS, Holm, pers. comm. 2017a).

BIRDS

Bird species of particular interest with regard to House Rock bison herd reduction activities include those species found in grasslands, meadows, shrublands, and wetland-associated vegetation that bison or bison reduction activities could directly or indirectly affect. Forest-species are also briefly discussed because reduction activities could affect them when these species occur in or traverse forest habitat.

In plateau areas on the North Rim, several bird species are generalists and occupy a variety of habitats, including the meadows and areas next to the seeps, springs, and ponds. These species include dark-eyed junco (*Junco hyemalis*), species of sparrows, western bluebird *(Sialia mexicana),* finches, and swallow species, such as the violet-green swallow *(Tachycineta thalassina)*. Forest generalists such as the broad-tailed hummingbird (*Selasphorus platycerus),* plumbeous vireo (*Vireo plumbeus*), brown creeper (*Certhia americana*), and evening grosbeak (*Coccothraustes vespertinus*) have been found in all forest types from ponderosa pine to spruce-fir. Breeding warbler diversity in ponderosa pine is second only to the Colorado River corridor, which has four breeding species. Secondary cavity nesters (e.g., pygmy

nuthatch [*Sitta pygmaea*] and western bluebird) are also an important component of the ponderosa pine forest bird community. Blue grouse *(Dendragapus obscurus*) occur on the North Rim in mixed-conifer forest (NPS 2015e).

Several raptors are closely associated with ponderosa pine, including the red-tailed hawk (*Buteo jamaicensis*), Cooper's hawk (*Accipiter cooperii*), great horned owl (*Bubo virginianus*), northern pygmy owl (*Glaucidium californicum*), and northern goshawk (*Accipiter gentilis*) (described under "Special-Status Species"). The northern pygmy owl also occurs in ponderosa pine and hunts during the day or at dusk. Flammulated owls (*Otus flammeolus*) are migratory and occur in dry, montane coniferous forests (NPS 2015e).

REPTILES AND AMPHIBIANS

Reptiles and amphibians of particular interest with regard to House Rock bison herd reduction activities include those species found in grasslands, meadows, shrublands, and wetland-associated vegetation that bison or bison reduction activities could directly or indirectly affect. Habitats for reptile and amphibians, particularly wetland communities, are extremely sensitive to ecosystem change, and local extinctions have been observed even in areas with only light grazing (Coraci et al. 2015).

Common lizard species found on the plateau include greater short-horned lizard (*Phrynosoma hernandesi*), northern plateau lizard (*Sceloporus undulatus elongatus*), and northern sagebrush lizard (*Sceloporus graciosus graciosus*). The western skink (*Eumeces skiltonianus*) is rare in habitats from grasslands to forests and is usually associated with rocky areas. The Great Basin gopher snake (*Pituophis catenifer deserticola)* is common in ponderosa pine forests, pinyon-juniper vegetation, and desert scrub. The Great Basin rattlesnake (*Crotalus viridis lutosus*) is uncommon and prefers thinly forested rocky areas in ponderosa pine forests, pinyon-juniper vegetation, or desert grasslands. The wandering garter snake (*Thamnophis elegans vagrans*), although uncommon, is found in moist habitats of the North Rim (NPS 2015a).

Amphibians are not well represented on the North Rim of the park generally because of arid conditions and lack of surface water; few amphibians inhabit plateaus. Tiger salamanders (*Ambystoma tigrinum*) inhabit areas around pools and water tanks in meadows and in North Rim ponderosa pine to spruce-fir forests. Great Plains toad (*Bufo cognatus*) and Great Basin spadefoot toad (*Spea intermontana*) can be found in areas of wetland-associated vegetation or in ponderosa pine forests throughout the North Rim (NPS 2015a).

SPECIAL-STATUS WILDLIFE SPECIES

The Endangered Species Act of 1973 requires that impacts on all federally listed threatened or endangered species be examined. NPS *Management Policies 2006* repeats this requirement and adds that the National Park Service will inventory, monitor, and manage state and locally listed species in a manner similar to its treatment of federally listed species to the greatest extent possible (NPS 2006a). The Navajo Nation and the state of Arizona also maintain lists of sensitive species. The following section focuses on special-status species likely to occur on the North Rim of the park based on discussions with tribes and cooperators, including the state, and consultation with the US Fish and Wildlife Service. As noted in chapter 1, no special-status plant species that would be at risk of being affected by bison reduction actions or by the no-action alternative were identified, so only wildlife species are discussed in this section (see appendix A for more information). The special-status species described in this section include species found in the vegetation habitats frequented by large concentrations of bison previously described (meadows, grasslands, wetlands near springs and seeps, shrublands) and species found in other habitats that could be indirectly affected by bison reduction actions.

A full list of potential special-status species (both plant and animal) on the North Rim of the park was developed using the USFWS Information for Planning and Conservation (or IPaC) planning tool (USFWS 2016a), input provided directly by USFWS staff during project scoping (USFWS 2014, 2016a) and reconfirmed with USFWS staff as consultation continued prior to publication of the environmental assessment. The complete list is included in appendix A. This list was reviewed to identify those species known to occur in the action area that bison or bison reduction actions could potentially affect, using information obtained from park staff in coordination with USFS input (NPS, Palarino, pers. comm. 2015b) and by reviewing species profiles for habitat requirements. Those species identified in appendix A that are retained for detailed analysis are described below. Other species that were either not found in the action area or that bison or bison reduction activities would not affect are addressed in appendix A but are not carried through for detailed analysis.

MEXICAN SPOTTED OWL (*STRIX OCCIDENTALIS LUCIDA*)

Source: USFWS (2012)

MEXICAN SPOTTED OWL

The Mexican spotted owl is a federally listed threatened species and is a species of concern in the state of Arizona. It typically lays its eggs in March and April with hatching occurring in early to mid-May. Young leave the nest in June and are independent by early fall. Reproduction starts at 2 to 3 years, and reproductive success generally results in one fledged offspring. Nesting and roosting occur in both forested and rocky-canyon habitats. Diet varies with location, but often includes small- and medium-sized rodents, bats, birds, reptiles, and arthropods. This species generally hunts from a perch and may cache prey. The Mexican spotted owl forages in a variety of habitats, including areas adjacent to water bodies (USFWS 2012, 2016b; NatureServe 2015).

Mexican spotted owls have been documented as breeding in the park, nesting below the rim and in multiple side canyons, and foraging on the North Rim plateau close to the canyon rim. Identified critical habitat (see figure 16) for this species in the action area includes the North Rim of the park. Furthermore, critical habitat is located on adjoining USFS- and BLM-administered lands (NPS, Palarino, pers. comm. 2015b; NPS 2016e). When the US Fish and Wildlife Service designated critical habitat for the Mexican spotted owl, it did so specific to two different habitat types: canyon and forested areas. Primary constituent elements of Mexican spotted owl critical habitat that are relevant to bison reduction activities are related to maintenance of adequate habitat for prey species and presence of water in canyon areas (USFWS 2012). The forested habitat of the North Rim considered to be owl habitat includes approximately 18,400 acres of mixed conifer forest (see figure 16). Mexican spotted owls have been documented using portions of these forested areas associated with the rim, although they primarily hunt below the rim in pinyon-juniper habitat (Bowden 2006).While primary threats to this species result from even-aged timber management practices, particularly in areas with the potential for catastrophic fires, grazing by ungulates may also pose a threat to the Mexican spotted owl if grazing has affected prey species habitat through reduction of herbaceous ground cover or by limiting regeneration of important tree species (USFWS 2016b; NatureServe 2015). In consultation with the US Fish and Wildlife Service, the park has designated a portion of Mexican spotted owl critical habitat on the North Rim as important potential nesting and roosting habitat. In addition, the park's *Fire Management Plan* includes measures to limit the amount of Mexican spotted owl habitat that is affected by high intensity fire (NPS 2012b).

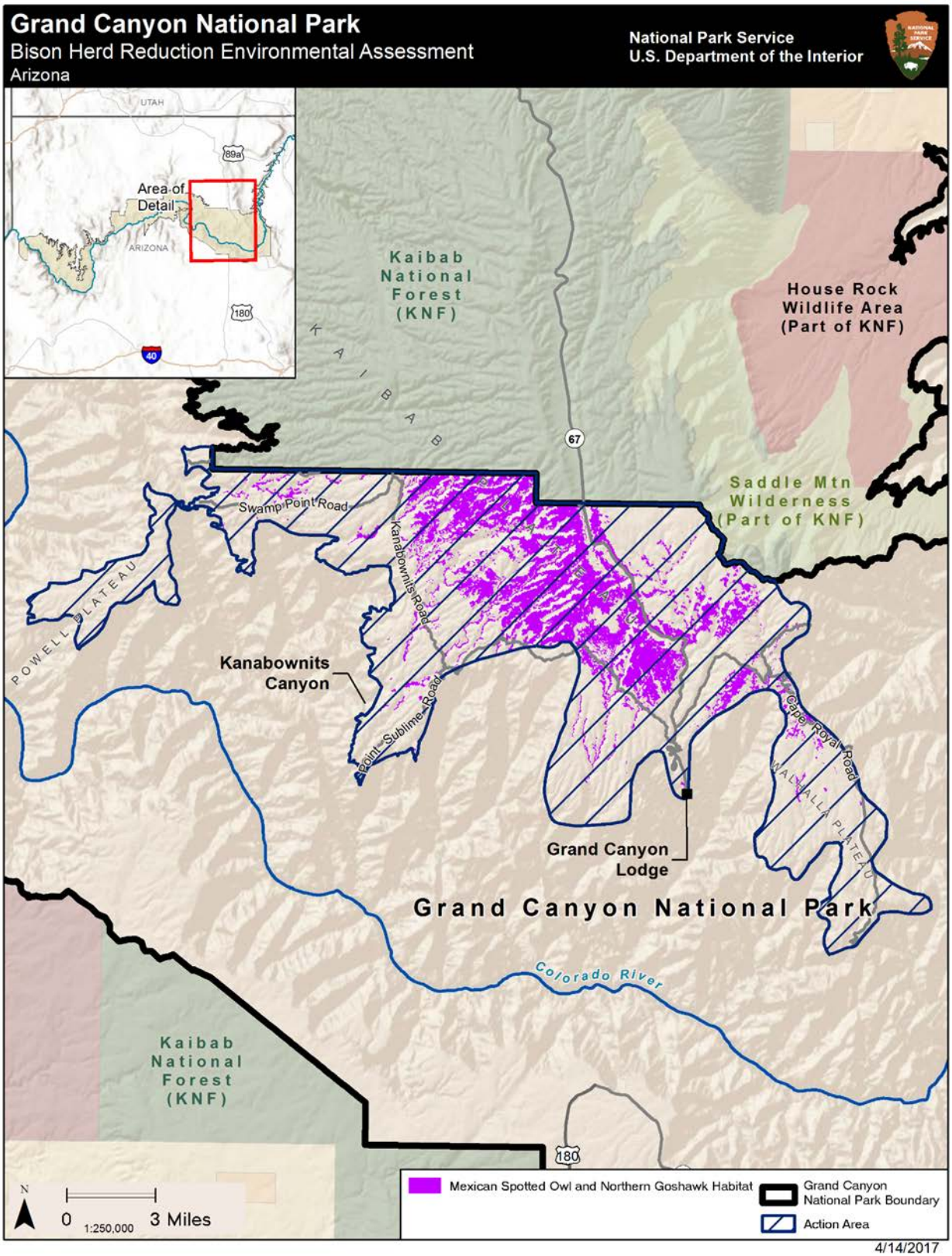

FIGURE 16. MEXICAN SPOTTED OWL CRITICAL HABITAT AND NORTHERN GOSHAWK HABITAT

CALIFORNIA CONDOR (*GYMNOGYPS CALIFORNIANUS*)

Source: USFWS (2013)
CALIFORNIA CONDOR

The California condor is a large scavenger that lays eggs from February to March with incubation lasting approximately eight weeks. Clutch size is typically one egg every other year. Young fly at about 5 to 6 months and may partially depend on parents for up to a year. California condors reach maturity at 5 to 7 years and may live for up to 45 years. Typical habitat consists of mountainous country at low and moderate elevations, especially rocky and brushy areas with cliffs available for nest sites and foraging habitat encompassing grasslands, oak savannas, mountain plateaus, ridges, and canyons. This species feeds primarily on a variety of mammal carcasses and prefer fresh meat located in relatively open terrain. Food presence is often identified by the presence of eagles and ravens (USFWS 2016b; NatureServe 2015).

Historical threats to the California condor include lead poisoning from ingestion of bullets/pellets in hunter-killed carcasses; shooting; and the removal of eggs, young, and adults from the wild for captive breeding. Other threats include collision with power lines and ingestion of toxins and trash (USFWS 2016b; NatureServe 2015). Lead poisoning from ingestion of bullets/pellets in hunter-killed carcasses is still the leading cause of death for California condors (NPS 2016e).

California condors in Arizona are an experimental population. Therefore, while this species is considered a federally endangered species, it is protected as a threatened species on park lands and as a proposed species on neighboring USFS-administered lands. No designated critical habitat for this species is present in the action area (NPS, Palarino, pers. comm. 2015b).

NORTHERN GOSHAWK (*ACCIPITER GENTILIS*)

Source: USFWS (2016c)
NORTHERN GOSHAWK

This fairly large hawk breeds in high, forested mountains and plateaus across Arizona (usually higher than 6,000 feet); primary potential northern goshawk habitat in the park is on the North Rim in mixed conifer and ponderosa pine habitats. While mating behavior starts in February, one clutch, typically with two eggs, is produced each year from late April to early May. Young typically become independent in approximately 70 days. Maturity is reached at 2 to 3 years. Breeding adults may maintain up to eight alternate nest sites. Breeding habitat typically includes large tracts of old-growth forests for nesting. Foraging habitat includes a mixture of heavily forested habitats with small openings. The forested habitat of the North Rim considered to be goshawk habitat includes approximately 18,400 acres of mixed conifer forest (see figure 16). The northern goshawk is typically a permanent resident with short-distance movements based on prey availability. This species is an opportunistic hunter, preying on a variety of small mammals and birds, though usually only a couple of prey species make up the majority of the goshawks food (Salafsky et al. 2006). On the North Rim, those species include red squirrels, ground squirrels, rabbits, northern flickers, and Steller's jays. Goshawks hunt almost exclusively in forest habitat with sufficient tree canopy for tree squirrel species and small openings and understory habitat for ground squirrels and rabbits (Reynolds, Graham, and Boyce 2007). Goshawk reproduction has been tied to prey species abundance (Salafsky et al. 2006). The primary threat to the northern goshawk is habitat alteration, especially as a result of past and current logging practices and wildfire (USFWS 2016b; NatureServe 2015; NPS 2016e). As of 2007, 18 northern goshawk territories were identified in North Rim forests (NPS 2015f). The northern goshawk

is a wildlife species of concern for the state of Arizona and for the National Park Service and is considered a USFS sensitive species.

NORTHERN LEOPARD FROG (*LITHOBATES PIPIENS*)

Source: NPS (2010a)
NORTHERN LEOPARD FROG

The northern leopard frog is a medium-sized spotted frog whose peak breeding season is in spring when temperatures reach about 50°F. Aquatic larvae metamorphose into small frogs in early to late summer, a few months after egg deposition. Females reach sexual maturity in 2 to 3 years. This species lives in the vicinity of springs, slow streams, marshes, bogs, ponds, canals, floodplains, reservoirs, and lakes. Typically, they are found in or near permanent water with rooted aquatic vegetation. In summer, they inhabit wet meadows and fields. When inactive, they typically take cover underwater, in damp niches, or caves. Wintering typically occurs underwater or underground. Larvae eat algae, plant tissue, organic debris, and some small invertebrates. Metamorphosed frogs eat various small invertebrates obtained along the water's edge or in nearby meadows or fields. Primary threats to the northern leopard frog are habitat loss and degradation, overexploitation, and interactions with exotic species (USFWS 2016b; NatureServe 2015).

This species is a wildlife species of concern in the state of Arizona. The northern leopard frog was found on the North Rim of the park in 2014. (NPS 2016e).

CULTURAL AND TRIBAL RESOURCES

The National Historic Preservation Act of 1966, as amended, is the principal legislative authority for managing cultural resources associated with NPS projects. Generally, section 106 of the National Historic Preservation Act requires all federal agencies to consider the effects of their actions on cultural resources listed in or determined eligible for listing in the National Register of Historic Places, as further described in the cultural resources section of chapter 4 in this environmental assessment. The National Historic Preservation Act, section 106 process is occurring separately but parallel to the NEPA process. In addition, the National Park Service has a unique stewardship role in the management of its cultural properties, reflected in its own regulations and policies. The following section addresses the current status of cultural resources that bison or bison reduction actions could affect, including archeological resources and prehistoric and historic structures, cultural landscapes, and traditional cultural properties and ethnographic resources.

ARCHEOLOGICAL RESOURCES (INCLUDING PREHISTORIC AND HISTORIC STRUCTURES)

A wide variety of archeological sites are located on the North Rim, including pueblos, small habitation structures, storage features, rockshelters, thermal features and roasters, artifact scatters and caches, water control features, trails, pictographs/petroglyphs, mining adits, roads, telephone and telegraph lines, historic dumps, and tree towers. Archeological resources can include features that are structures, such as prehistoric pueblos that served as housing, storage, or other purposes, or historic sites that can include corrals, fences, and/or other buildings that are no longer in use. These features are considered archeological because they are ruins and/or are no longer in use for their intended purpose. Many of these resources are considered structures and not buildings because they were not constructed to house human activities (e.g., fences and corrals).

Of the approximately 97,200 acres in the action area in the park, about 15% (14,650 acres) has been surveyed for archeological sites, resulting in the documentation of 307 archeological sites located in areas that the House Rock bison herd have used in the past. Table 4 details the types of archeological sites found in these areas, and table 5 provides an overview of the number of archeological sites on the North

Rim in areas that the House Rock bison herd uses. Some of the archeological sites are located in multiple bison use areas (e.g., summer and winter grounds); therefore, they are counted for each area, giving the impression of more sites in the total action area. Archeological sites are located in many areas that bison frequent, including meadows, near water sources, and along cliff faces were the bison may seek protection from the elements.

The most current information regarding the condition of archeological sites in the action area is from a 2014 monitoring project to determine whether bison were affecting archeological sites on the North Rim and to identify the types of impacts occurring (NPS 2014c). A total of 24 archeological sites were randomly selected for inclusion in the study. Fifteen of these sites showed evidence of the presence of bison, including tracks, bison dung, and other signs, and two of the sites were considered adversely affected, with enough damage to archeological resources or prehistoric structures (NPS 2014c) to constitute an adverse effect under the National Historic Preservation Act. Bison were noted in the vicinity of two additional sites (NPS 2014c). Examples of adverse effects noted in the report include artifact concealment, displacement or breakage of artifacts, and damage to prehistoric structures, often in combination, as a result of trampling, wallowing, and other bison behavior (NPS 2014c). Based on this information, more than 50% of sites in the study are considered at risk from adverse impacts by bison activities. The report notes that these activities have not yet affected the integrity of these resources to the extent that they are no longer eligible for the national register (NPS 2014c). Based on the results of this study, the National Park Service reviewed its archeological sites and determined that the potential exists for bison to affect approximately one-third of the archeological sites to the extent that data recovery may become necessary through archeological investigations (NPS 2016e).

TABLE 4. SITE TYPES FOUND ON THE NORTH RIM IN AREAS USED BY THE HOUSE ROCK BISON HERD

Site Type	Site Count	Description
Agricultural/ranching	4	Rock alignments, rock terraces, check dams
Roads	1	
Extractive sites	1	Mining activities, historic borrow locations, lithic quarries
Artifact scatters	84	Historic and prehistoric materials, ceramic scatters, lithic scatters, and multi-artifact type concentrations
Habitation without structures	34	No structures noted
Habitation with structures	137	Prehistoric or historic habitation sites with one or more structures noted
Protected habitation	2	Rockshelter
Culturally modified trees	21	Dendroglyphs, tree towers
Special use sites	3	Corrals and fencelines, rock features
Special use structures	19	Windbreaks, corrals, kivas, enclosures and structures associated with other features (e.g., tree towers)
Thermal features	1	Includes “hunting/fishing/gathering features” (this category was used in the past to indicate roasting features)

TABLE 5. SITES ON THE NORTH RIM IN AREAS USED BY THE HOUSE ROCK BISON HERD

Bison Use Area	Total Site Count	Sites with Associated Structures[1]
Intense summer concentrations	28	7
Summer concentrations	70	16
Winter concentrations	215	171

[1] Includes habitations with structures and special use structures

THE NORTH RIM ENTRANCE ROAD CORRIDOR CULTURAL LANDSCAPE

The National Park Service defines a cultural landscape as "a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values" (Birnbaum 1994). Bison could affect only one cultural landscape located on the North Rim—the North Rim Entrance Road Corridor cultural landscape—through changes in the appearance of important characteristics of the cultural landscape from impacts on vegetation and visual components. The North Rim Entrance Road Corridor cultural landscape is a principal component of the North Rim Entrance Road Corridor Historic District (NPS 2011a). The configuration and alignment of the road, the meadows through which it traverses, and its adjoining natural features, such as Little Park Lake, are contributing features to the component cultural landscape.

A cultural landscape is defined by its relationships between the natural and built environment. The North Rim Entrance Road is a scenic, gently curving road that begins at Arizona Highway 67 and runs south for 10 miles where it ends at CC Hill (NPS 2006b). Like other NPS roads from this era, the road follows an undulating and curvilinear route, with smooth grades that run through open meadows and undeveloped forests and around hills. The North Rim Entrance Road is an example of the NPS planning principles and design aesthetics developed during the 1920s and 1930s. Formal and informal overlooks and viewpoints are located along the route, overlooking the meadows and woodlands (NPS 2006b). The North Rim Entrance Road was constructed between 1930 and 1931; however, the period of significance extends from 1928 to 1931, to capture the construction of the entrance station. The North Rim Entrance Road is significant under criteria A and C for important events and design and craftsmanship efforts in the areas of landscape architecture, conservation, recreation, and politics/government (NPS 2006b). Characteristics of the cultural landscape include buildings and structures, circulation, land use, natural systems and features, small-scale features, spatial organization, vegetation, and views and vistas (NPS 2006b). The majority of these characteristics have been only minimally altered since its initial construction. Natural systems and features have remained essentially unchanged from the period of significance (NPS 2006b), although the meadows show signs of grazing, with reduced vegetation cover and bare patches. Little Park Lake also shows signs of reduced vegetation and soil disturbance (figure 18), even though a temporary bison exclusion fence is in place around it (figure 10). The Determination of Eligibility form for the North Rim Entrance Road notes the landscape is in "good," condition, and both it and the *North Entrance Road Cultural Landscape Inventory* note that it retains the "highest levels of integrity" and that "the appearance and character of the scenic entrance road" that most visitors have since come to associate, almost unconsciously, with their experience of park scenery, wildlife, and wilderness remains intact from the North Rim Entrance Road's period of significance (1928–1931) (NPS 2006b, 2011a) (figures 17 and 18).

Natural systems and features in the North Rim Entrance Road Corridor Historic District are associated with those typical of the Kaibab Plateau and larger North Rim region. Meadows and forested areas are dominant features along the road corridor. The meadows are composed of open, very gently rolling land that is covered in grasses and forbs. Major meadow areas in the North Rim Entrance Road Corridor Historic District include DeMotte Park, Little Park Meadow, and Harvey Meadow, all of which contribute to the district. In addition to the larger meadows of the North Rim, the corridor also encompasses numerous small, unnamed meadows along its length (NPS 2011a). Today, bison congregate in these meadows, particularly in Little Park Meadow, and they have reduced vegetation cover and created bare

patches (see figures 13 and 15), which could affect the integrity of this resource for listing on the national register. Bison were not present at the Grand Canyon during the period of significance for the cultural landscape; therefore, they are not considered contributing to the cultural landscape.

FIGURE 17. VIEW OF MEADOW LANDSCAPE ALONG THE NORTH RIM ROAD

FIGURE 18. VIEW OF MEADOW LANDSCAPE ALONG THE NORTH RIM ROAD

TRADITIONAL CULTURAL PROPERTIES AND ETHNOGRAPHIC RESOURCES

American Indian groups in the region recognize certain tangible and intangible properties as important in their tribal histories. These properties, which may or may not include archeological sites and other historic properties (i.e., any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the national register), as well as other natural or cultural features, are referred to as ethnographic resources or sometimes traditional cultural properties. The National Park Service defines ethnographic resources as any "site, structure, object, landscape, or natural resource feature assigned traditional, legendary, religious, subsistence or other significance in the cultural system of a group traditionally associated with it" (NPS 1998). A traditional cultural property is "defined generally as an ethnographic resource that is eligible for inclusion in the national register because of its association with cultural practices and beliefs of a living community that (a) are rooted in that community's history and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1990). Tribal ethnographic resources and the Grand Canyon traditional cultural property are present on the North Rim of the park, and high concentrations of bison could affect these resources.

Regional American Indian tribes that are traditionally associated with the park include the Hualapai, Havasupai, Southern Paiute, Navajo, Hopi, Zuni, and Yavapai-Apache, who continue to use the Grand Canyon and associated lands for specific traditional and cultural purposes. Five distinct Southern Paiute tribes have traditional association to the park: the Kaibab Band of Paiute Indians, Las Vegas Paiute Tribe, Moapa Band of Paiute Indians, Paiute Indian Tribe of Utah (representing the five distinct bands, the Shivwits Band maintaining the closest connections to Grand Canyon National Park), and the San Juan Southern Paiute Tribe (NPS 2016e). The National Park Service and traditionally associated tribes consider and treat the canyon itself as a traditional cultural property (NPS 2015a). The canyon's importance in cultural and traditional practices and in tribal identities speaks to the tribes' enduring canyon connections.

Although identification and documentation of ethnographic resources and traditional cultural properties are ongoing and generally not georeferenced (NPS, Brennan, pers. comm. 2016g), previous studies have identified ethnographic resources within existing areas used by the House Rock bison herd and the action area on the North Rim. These areas include landscapes, natural resources, places, and other items, as detailed in table 6 (Hedquist and Ferguson 2012). The tribes commonly consider archeological resources as traditional cultural properties; therefore, impacts on those resources also constitute impacts on traditional cultural properties. The list in table 6 does not encompass all of the ethnographic resources identified by the tribes, and the total number may never be known because of the sensitivity of this information. The tribes engaging in consultation have expressed general concerns about the impacts bison may be having on vegetation, water sources, and archeological resources.

TABLE 6. ETHNOGRAPHIC RESOURCES IN THE PARK

Ethnographic Resource	Count	Description
Landscapes	25	
Natural resources	367	Includes plants, animals, insects, and birds
Places	68	Includes archeological sites and specific locations on the landscape
Other items	7	

Not all of the traditionally associated tribes have a connection to the North Rim, and minimal information exists in the ethnographic literature regarding the connection that tribes have to bison. Although the tribes were unlikely to have had frequent or regular encounters with bison, tribes used bison obtained through hunting or trade for food and bison parts (especially the hide, hooves, and horns) for cultural or religious ceremonial purposes (Fowler and Fowler n.d.; NPS 2016h). Bison are part of the Hualapai and Navajo oral histories (NPS 2016h); play a role in the Hopi migration story (Hopi Tribe, Kuwanwisiwma, pers. comm. 2015), and have connections with the Kaibab Paiute (Kaibab Paiute Tribe, Homer, pers. comm. 2015). Appendix B presents additional information on the relationship between bison and specific tribes.

WILDERNESS CHARACTER

The official wilderness recommendation for the park was updated in 2010 (NPS 2010b), and a total of 1,143,918 acres or 94% of the park's total area was recommended for wilderness designation. NPS Wilderness Management policies require that Grand Canyon's recommended wilderness be managed the same as designated wilderness. All management actions affecting wilderness will apply the minimum requirements concept for the administration of the area. The minimum requirements concept is used to determine if management actions are necessary for the administration of wilderness, and if so, how to minimize the impacts on wilderness character (NPS 2006a).

Nearly all of the North Rim is included as recommended wilderness and is referred to throughout this environmental assessment as "wilderness." The nonwilderness developed areas on the North Rim include the paved roads and scenic overlooks, campgrounds, tourist lodging and services, nonwilderness corridors around roads, and administrative facilities. Figure 19 shows that portion of the Grand Canyon Wilderness that is located within the action area for this environmental assessment.

Wilderness on the North Rim includes expansive forests and meadows. Access to the interior of this wilderness is primarily by foot. Primitive, nonwilderness road corridors provide access to scenic overlooks, car camping, and trailheads at Swamp and Fire Points and Point Sublime. This area is bounded by USFS-administered lands, including Saddle Mountain Wilderness Area (NPS 2015g).

The relatively cool and wet North Rim offers a wilderness where the solitude of the forests can be enjoyed, complementing wilderness in the desert areas surrounding the plateau. The North Rim of the

Grand Canyon represents the last wilderness remnant (approximately 20%) of the original ponderosa-mixed conifer ecosystem found on the Kaibab Plateau (NPS 2010b).

Wilderness areas are to be preserved for their "wilderness character." Wilderness character, as described in *Keeping it Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System*, is "a holistic concept based on the interaction of (1) biophysical environments primarily free from modern human manipulation and impact, (2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society, and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature" (Landres et al. 2015). This description of wilderness character is linked to five "qualities" that are derived from the statutory language of the Wilderness Act. The following section describes the qualities of wilderness character on the North Rim in wilderness areas:

- **Untrammeled**—An untrammeled wilderness is one in which ecological systems and their biological and physical components are autonomous and free from human intervention. This quality is influenced by any activity or action that intentionally controls or manipulates the components or processes of ecological systems inside wilderness. It is supported or preserved when such management actions are not taken. It is degraded when such management actions are taken even if those actions, such as collaring wildlife or reducing fuel accumulation from decades of fire exclusion, are intended to protect resources. The forces of nature have primarily affected the North Rim wilderness, with a few exceptions related to fire suppression activities and collaring of mountain lions, big horn sheep, and bison.
- **Natural**—A natural wilderness quality shows minimal effects of modern civilization on the ecological systems and their biological and physical components. The natural quality is preserved or improved, for example, by controlling or removing exotic species or restoring ecological processes. This quality is degraded by the loss of native species, the presence of exotic species, and alteration of ecological processes such as water flow and fire regimes and the effects of climate change over time. One of the largest degradations to the natural quality of Grand Canyon's North Rim wilderness is the presence, abundance, and distribution of exotic plant species in wilderness areas. Overall, the natural quality of the wilderness is in fair to good condition despite the past and continuing alterations to the native plants and animals within the wilderness and visitor-caused impacts. The presence of, and growing House Rock bison herd on the North Rim has affected natural populations of plants in wetlands, high elevation meadows, pinyon-juniper and oak woodlands, and rim chaparral communities. The presence of bison also affects water sources, including springs, ponds and lakes. Descriptions of these features are found in other sections of this chapter.
- **Undeveloped**—The undeveloped quality of wilderness refers to retaining its primeval character and influence, without permanent improvements or human habitation, and with the imprint of modern man's work substantially unnoticeable. The presence of structures and installations and the use of motor vehicles or motorized equipment degrades the undeveloped quality of wilderness. The recommended wilderness areas of the North Rim are substantially undeveloped with some authorized non-recreational installations and/or developments. Bison exclosures include fencing around several springs and seeps. Other scientific equipment, including rebar and other markers are used for research and monitoring. Installations related to fire management activities include helispots and temporary air quality monitoring devices and radio repeaters used during active fires. The historic Kanabownits fire tower and Muav Saddle cabin pre-date the park's wilderness study. Motorized tools such as chainsaws are authorized for fire crew safety and the rare emergency landing of aircraft during emergency or search and rescue operations (typically fewer than two times per year). Motorized vehicle use is limited to the nonwilderness road corridors. Unauthorized uses of motor vehicles, motorized equipment, or mechanical transport (off-highway vehicle, motorcycle, or mountain biking use) are documented but rare.

FIGURE 19. WILDERNESS IN AND ADJACENT TO THE ACTION AREA IN THE GRAND CANYON NATIONAL PARK

- **Opportunities for solitude or primitive and unconfined recreation**—Opportunities for solitude or primitive and unconfined recreation provide visitors a chance to connect with the natural world, practice traditional skills, and have transformative personal experiences. This quality is preserved or improved by management actions that reduce visitor encounters, signs of modern civilization inside wilderness, and agency-provided recreation facilities. Management restrictions on visitor behavior can also preserve or improve this quality. The unique and special qualities of solitude or a primitive and unconfined type of recreation in the North Rim wilderness areas include listening to the sounds of nature and the opportunity to explore wilderness without observing large numbers of other visitors, structures, and installations. The North Rim wilderness areas receive little overnight use (approximately 1,000 user nights in 2015) compared to other wilderness in the park, such as Cottonwood and Bright Angel leading into the Canyon (approximately 40,000 user nights in 2015) (NPS 2016i). For approximately 4 months per year, heavy day use occurs in the Uncle Jim and Widforss use areas on the North Rim, which are adjacent to developed areas where sights and sounds of human activities are noticeable. Uncle Jim point is outside the action area, and Widforss is partially within the action area. A composting toilet and hitching rail are located at Uncle Jim Point. Scenic air tours pass over parts of the North Rim wilderness on a daily basis, and administrative activities conducted with the aid of helicopters also affect opportunities for solitude in the wilderness. Recreational activities in wilderness include hiking, and camping. Cross-country foot travel is allowed, and permits are required for overnight use. Nonwilderness road corridors provide access to trailheads for Inner Canyon trails and rim camping; the Point Sublime overlook and camp area is outside of wilderness. Campfires are not allowed.
- **Other Features of Value**—Wilderness may contain other features of value, including historic and cultural resources, paleontological resources, or extensive geologic exposures. This quality directly relates to "personal experiences in natural environments relatively free from the encumbrances of modern society" and "symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature." This quality is degraded when these resources are impaired in ways that reduce these personal experiences.

VISITOR USE AND EXPERIENCE

According to park visitors, the following elements are considered to be extremely important to experiencing the park: viewing the canyon from park overlooks, knowing that park resources and values are being protected, and experiencing natural quiet (NPS 1995).

The North Rim of the park provides a relatively remote visitor experience compared to the South Rim of the park and receives substantially less visitation, providing visitors with more opportunities for solitude. The estimated number of recreational visitors to the North Rim in 2014, based on vehicle counts, was approximately 289,357 (NPS 2015g). The North Rim is closed to vehicle traffic in the winter. In contrast, the total number of park visitors (North and South Rim) in 2014 was 4,756,771 (NPS 2015g).

Visitor facilities at the North Rim include a ranger station, picnic areas, and a visitor center and bookstore. The Grand Canyon Lodge provides the only available lodging inside the park on the North Rim. The North Rim Campground, with 87 campsites, offers tent and recreational vehicle camping from May through October. During the winter months (between November 1 and May 15), backpackers, snowshoers, and cross-country skiers are permitted to use the North Rim Campground, provided they obtain a backcountry use permit in advance (NPS 2015h). The North Rim is popular in the fall after visitor services have closed and before the North Rim Entrance Road closes due to weather (NPS, Jalbert, pers. comm. 2016j). Common recreational activities on the North Rim include day hiking, trail running,

backcountry camping, stock use (including mule rides), bicycling, driving for pleasure, and car camping (NPS 2015g). Numerous trails originate at the North Rim, including the North Kaibab Trail, which provides the only maintained route extending from the North Rim to the Colorado River (NPS 2015i). Visitor use on the North Kaibab Trail is not monitored for the first 5 miles of the trail; however, a 2006 report on backcountry day hikers at the park estimated that "daily averages range from 146 to 208 day hikers for the North Kaibab Trail" (Backlund et al. 2006). The park maintains a trail counter at the 5-mile mark, which is used to determine use by longer-distance backcountry hikers. Trail counts from this site range between 100 and 700 hikers per day, with peak days in mid-May and mid-October (NPS, Jalbert, pers. comm. 2016j).

Bison often congregate in Little Park Meadow by the North Rim Entrance Road, and viewing them is often part of the visitor experience on the North Rim. Visitor safety related to viewing the bison has been identified as an issue on the North Rim in the park. Bison can cause traffic backups and visitors may stop unexpectedly, causing traffic safety concerns. Vehicular collisions involving bison are also a concern, as are bison-human interactions associated with people getting out of their cars to view bison. In the 2014 report on bison management activities, the park noted seven bison were killed by motor vehicle collisions on the North Rim Entrance Road in 2014 (NPS 2015a). Most vehicles involved in bison collisions have sustained measurable damage, although these collisions have required no more than first aid with no serious injuries (NPS, Archard, pers. comm. 2016k). Bison also congregate in some popular backcountry destination areas, including designated camping areas at Point Sublime and Swamp Point, where the trailhead for the North Bass Trail is located. Bison gathering, wallowing, and moving through these areas have degraded vegetation and trail conditions, and bison also deposit large amounts of dung on trails and in designated camping areas (NPS, Jalbert, pers. comm. 2016l).

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CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This "Environmental Consequences" chapter analyzes beneficial and adverse impacts that would result from implementing either of the alternatives considered in this environmental assessment. The resource topics presented in this chapter and the organization of the topics correspond to the resource discussions in "Chapter 3: Affected Environment."

GENERAL ANALYSIS METHODOLOGY AND ASSUMPTIONS

The impact analysis for each potentially affected resource is focused on the environmental issues described in chapter 1. A description of the direct and indirect impacts provides the reader with an understanding of how the current condition of a resource (as described in chapter 3) would change as a result of implementing either of the alternatives. For alternative B, this includes changes that would result from the bison reduction actions themselves and/or as a result of reducing the abundance of the House Rock bison herd to fewer than 200 animals. The analysis of potential cumulative impacts describes the incremental effect contributed by the direct and indirect impacts of the NPS actions considered in this environmental assessment when compared to the total combined effects of other, unrelated actions. The analysis considers the potential for both adverse and beneficial effects and the context of the resource (e.g., how the current condition of a resource might change relative to the state of the resource at differing scales) when assessing the severity or magnitude of an impact.

When assessing potential impacts of implementing bison reduction action and/or the effects of the fewer than 200 bison on the landscape, the National Park Service used a combination of park-specific observations, documentation gathered by NPS personnel, and a body of scientific literature and studies applicable to bison, the North Rim of the park, and the resources being evaluated. When available, resource-specific data, observations, studies, or other evidence used is noted in the methodology section for each impact topic.

ASSUMPTIONS

Several guiding assumptions were used to provide context for this analysis.

Analysis Period

This environmental assessment evaluates the effects of actions needed to reduce the House Rock bison herd on the North Rim of the park. The majority of the initial management actions are expected to occur within 3 to 5 years of implementation. The environmental assessment also considers the resulting effects anticipated within approximately 5 years following the House Rock bison herd reduction to account for the effects that extend beyond the implementation period. Each analysis includes a description of the expected time frame over which impacts are expected to occur, which could be days, months, or years.

Area of Analysis

The geographic study area, or the action area, is described generally in chapter 1 and includes the North Rim of the park (see Figure 1). Impacts are considered either localized (i.e., occurring in limited areas) or widespread (i.e., occurring over the entire area of analysis). In addition, the continued increase in the bison population under alternative 1 and management actions proposed under alternative 2 could cause more bison (compared to current conditions) to move on to USFS lands adjacent to the park. Therefore,

when relevant, the impact analysis conclusions address the potential for indirect impacts on adjacent areas of the Kaibab National Forest.

Additional assumptions for the action alternative related to population levels, timing, duration, and frequency of actions are described in chapter 2.

CUMULATIVE IMPACTS ANALYSIS METHOD

Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, or reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). The temporal scale for the cumulative impacts analysis includes past actions since the late 1990s, when the House Rock bison herd started moving on to the North Rim of the park, through reasonably foreseeable future actions. The geographic scale considered for cumulative impacts is the action area, plus lands on the North Kaibab Ranger District, which includes the House Rock Wildlife Area.

Cumulative impacts are determined for each impact topic by combining the impacts of the alternative being analyzed and other past, present, and reasonably foreseeable actions that also would result in beneficial or adverse impacts. Because some of these actions are in the early planning stages, the evaluation of cumulative impacts is based on a general description of the projects. Other past, present, and reasonably foreseeable actions to be included in the cumulative impacts analysis were identified through the internal and external scoping processes and are summarized below.

Cumulative impacts are considered for both alternatives, including the no-action alternative. Following Council on Environmental Quality guidance, past actions were included, "to the extent that they are relevant and useful in analyzing whether the reasonably foreseeable effects of the agency proposal for the actions and its alternatives may have a continuing, additive, and significant relationship to those effects" (CEQ 2005).

CUMULATIVE IMPACT SCENARIO

The projects, plans, or actions described below were identified for the purpose of conducting the cumulative effects analysis. Table 7 indicates which resources or values would be affected by the cumulative actions identified.

Past, Present, and Reasonably Foreseeable Actions in Grand Canyon National Park

- **Fire management activities.** Per the park's *Fire Management Plan*, fire management activities include prescribed burns for fuels reduction to create canopy openings and restore habitat; other fuel management and reduction activities near wildland/urban interface areas, including near the North Rim Entrance Road; using a number of mechanical and manual techniques; and suppression of unplanned wildland fires in all parts of the park (NPS 2012b), including in the action area. Suppression of unplanned wildland fires is often orchestrated from established roads for safety reasons. Methods to fight fires include use of hand tools and chain saws to cut fuel breaks, and occasional use of helicopters to drop water when it will make a difference (NPS, Hiatt, pers. comm. 2017b).

TABLE 7. CUMULATIVE ACTIONS AND POTENTIAL IMPACTS ON RESOURCES AND VALUES DISCUSSED IN THIS ENVIRONMENTAL ASSESSMENT

Cumulative Action	Impact Topics										
	House Rock Bison Herd	Water Resources in the Karst Landscape	Bison-Affected Vegetation	Soils	Wildlife (Other than Bison) and Wildlife Habitat	Special-Status Species	Archeological Resources (Including Prehistoric and Historic Structures)	Cultural Landscapes	Traditional Properties and Ethnographic Resources	Wilderness Character	Visitor Use and Experience
Actions in Grand Canyon National Park											
Fire management activities	X	X		X	X	X	X	X	X	X	X
Vegetation/habitat restoration and exotic plant management	X		X		X	X	X	X	X	X	
North Rim Entrance Road maintenance and improvements				X		X	X	X	X		X
Vandalism							X		X	X	X
Wildlife studies and research	X				X					X	
Flights over the park	X				X	X			X	X	X
Actions in North Kaibab Ranger District and House Rock Wildlife Area											
Prescribed fire at Tipover	X	X	X		X	X	X		X	X	
Plateau facilities fire protection project	X	X	X		X	X	X		X	X	
Prescribed fire at Tater Vegetation Management	X	X	X		X	X			X	X	
Deer and bison hunting outside the park	X				X						
HRWA North Fence and Holding Pasture projects	X				X						
Bison trailing with feed experiment	X			X	X						
Habitat improvement-burning	X				X	X	X		X		X

- **Vegetation/habitat restoration and exotic plant management.** The park actively manages exotic and invasive plants in the park, including on the North Rim, and engages in vegetation and habitat restoration activities. The park is restoring vegetation around the cabins in the developed area on the North Rim over a 5-year period. This restoration includes planting native plants propagated from seed and cuttings on the North Rim and cultivated at the park. This planting is primarily accomplished using hand tools, although mechanical tools include a pump to distribute water from a trailer and a jackhammer-like tool are used occasionally to break up the ground (NPS, Boughter, pers. comm. 2017c). Examples of exotic plant management include removal of plants with hand tools and selective and targeted application of herbicides from backpack sprayers.
- **North Rim road maintenance and improvements.** The park regularly maintains the entrance road on the North Rim of the park, which is used year-round and is cleared of snow with heavy equipment in March and April. Maintenance includes pavement repair and patching approximately 4 days a year and repaving on an as-needed basis (usually every several years) to maintain drivability and safety (NPS, Spencer, pers. comm. 2017d).
- **Vandalism.** The park's *Backcountry Management Plan* (NPS 2015e) notes that one threat to the integrity of the wilderness and to natural and cultural resources is vandalism. Vandalism includes a wide range of activities, including graffiti on archeological objects, especially rock writings (e.g., petroglyphs or pictographs), collection piles of artifacts, removing archeological context information, camping and campfires within archeological site boundaries, disturbing archeological features, introducing carbon into site areas (from fire), denuding vegetation from foot traffic and sleeping areas, physical damage to architectural features by removing or adding stones/logs from walls and similar activities. Vandalism to any archeological site that has not been previously excavated and stabilized to withstand regular visitation is of greatest concern, because non-stabilized sites (only four on the North Rim that regularly receive such treatment) are fragile and non-renewable. Many sites have yet to be adequately documented and intentional and unintentional human disturbance easily diminish their scientific values and national register integrity.
- **Wildlife studies and research.** Wildlife studies on the North Rim include research on a variety of species, including surveys for the Mexican spotted owl, goshawks, and bat species. Studies of the Mexican spotted owl include nighttime surveys for fire project clearance over 10–12 weeks a year, involving hiking or driving and calling for the owls. For goshawks, researchers check existing nests to determine occupancy and reproductive success. Bat surveys involve mist netting for one night, three times a year at two sites. The sites are at water resources where the House Rock bison herd are known to congregate.
- **Flights over the park.** Flights over the park, include commercial air tour, transportation flights, and flights by other agencies, tribes, and landowners. Several commercial enterprises provide air tours of the canyon. These flights initiate out of the airport at Tusayan on the South Rim of the park. Commercial air tours fly two routes over the action area: the fixed-wing Black Route 1 and the helicopter Green Route 1. Both routes pass from just south of Point Imperial (northeast of the Walhalla Plateau) westward to the base of the Dragon (a land formation between Bright Angel Point and Point Sublime, see figure 19 in chapter 3), and then exit the action area to the southwest along the Dragon. In 2012, the most recent year for which data are available, 50,527 tours were flown on these routes—the highest daily total was 313, the median was 138, and 90% of days had at least 39 flights (NPS 2011b).

The National Park Service, other agencies, tribes, and nearby landowners fly the over the area on the North Rim for a variety of reasons, including wildlife counts and reconnaissance of other natural resources.

Past, Present, and Reasonably Foreseeable Actions in Kaibab National Forest and House Rock Wildlife Area

- **Prescribed fire at Tipover.** This prescribed fire includes mechanical treatment and prescribed fire on approximately 9,000 acres of lands in the North Kaibab Ranger District of the Kaibab National Forest and on North Rim lands.
- **Plateau facilities fire protection project.** This project includes mechanical treatment and prescribed fire on approximately 1,739 acres of land in the North Kaibab Ranger District of the Kaibab National Forest.
- **Prescribed fire for Tater Vegetation Management.** This project includes mechanical treatment and prescribed fire on land in the North Kaibab Ranger District of the Kaibab National Forest.
- **Public hunting.** Public hunting, managed by the state, occurs on the Kaibab Plateau outside the North Rim and serves as the main population control strategy for both bison and deer. Bison hunting currently occurs on Kaibab National Forest land and could possibly occur on BLM-administered lands if the House Rock bison herd moves unexpectedly on to these lands. The state wants to maximize bison harvest without affecting the time the bison spend on the Kaibab National Forest, which makes more bison available for harvest and reduces the impacts the bison could have on the park when they remain there. Permit levels vary annually based on past hunt results and objectives of the other agencies. Permit levels for bison are expected to increase during the implementation of bison reduction actions inside the park. The Arizona Game and Fish Commission adjusts the hunts annually to allow for changes in bison behavior and to moderate hunt pressure by changing the number of weeks hunting is allowed and adjusting whether bulls or cows should be taken, (AGFD, Lutch, pers. comm. 2017b).
- **North fence and holding pasture projects at House Rock Wildlife Area.** Fence and holding pasture projects are planned to occur on an ongoing basis. Arizona Game and Fish Department plans to rebuild and update the north fence at House Rock Wildlife Area per a memorandum of understanding with the Kaibab National Forest. In addition, Arizona Game and Fish Department plans to construct a new 4,000-acre holding pasture at House Rock Wildlife Area to meet new bison fence standards to create a functional holding pasture to acclimatize bison brought back to House Rock Wildlife Area and to keep them from wandering on to lands north of the wildlife area.
- **Bison trailing with feed experiments.** Arizona Game and Fish Department has conducted bison trailing experiments to assess the feasibility of leading the bison from the Kaibab Plateau, down South Canyon Trail to the House Rock Wildlife Area, which would draw the bison from the park. Additionally, Arizona Game and Fish Department may attempt to corral bison in the southeast corner of the Kaibab National Forest and move them to the House Rock Wildlife Area. Future projects may occur based on outcomes.
- **Improving Site Fidelity at House Rock Wildlife Areas.** A project for habitat improvement, using prescribed fires is planned for House Rock Wildlife Area, This project is still in the planning stages and is likely to occur in 1 to 2 years. The US Forest Service will institute rotational burning on House Rock Wildlife Area to stimulate new forage production and promote site fidelity of bison. Other AGFD management approaches to increase site fidelity would include keeping the bison in the 4,000-acre holding pasture described above through a complete breeding and calving season, introducing bulls from other locations, and removing older animals after the breeding and calving season has passed, so the remaining population in the pasture has no knowledge of the North Rim.

HOUSE ROCK BISON HERD

METHODS AND ASSUMPTIONS

The impact analysis for the House Rock bison herd focuses on potential changes to key aspects of bison ecology as a result of expected changes in bison density and population size associated with each alternative. A ranging species, bison occur within the action area and in portions of the adjacent Kaibab National Forest, and impacts on the population and on specific resources would be similar regardless of land management boundaries. Potential impacts on bison were evaluated based on resource expert knowledge and professional judgment, review of available bison science and stewardship references, consultation and communication with park and cooperating agency staff, and anticipated locations for reduction activities. Additional assumptions are presented under each alternative as appropriate.

IMPACTS OF ALTERNATIVE 1 (NO ACTION) ON THE HOUSE ROCK BISON HERD

Under alternative 1, impacts on basic bison ecology would result from anticipated growth in the House Rock bison herd from the current abundance of 400 to 600 to approximately 1,200 to 1,500 animals over the next 10 years (Sturm and Holm 2015). Impacts are likely to include changes in forage and water use and changes in seasonal behavior, movement, and group dynamics.

Forage and Water Use

On average, across age and sex classes, individual bison consume approximately 2%–3% of their body weight in forage per day (Richmond, Hudson, and Christopherson 1977). Within 10 years, the expected increase in the House Rock bison herd from approximately 400 to 600 to 1,200 to 1,500 would increase total annual forage consumption by approximately 250% over the current baseline level of annual forage consumption. Annual forage consumed includes new growth forage during growing seasons and consumption of residual forage during the non-growing seasons. Bison consume primarily grasses and sedges throughout the year but also balance their diet through seasonal preferences for forbs and half-shrubs. Continuing population growth toward 1,200 to 1,500 animals would likely result in increased competition among the bison for forage—most likely between prime-aged females during late-gestation and lactation. Increased competition among bison could lead individual bison to forage more in a short amount of time and result in increased impacts on the most common forage species of grasses, sedges, forbs, and half-shrubs. Over the long term, this preferential forage selection could potentially lead to reduced vitality of plant species that are favored by bison, decreased overall plant diversity, and a reduction in the number and distribution of plant species (Plumb and Dodd 1993). Reduced diversity could result in greater susceptibility to invasive or exotic species with the potential for further preferential forage selection and reductions in the preferred forage available for bison over the long term. This increase in competition for resources and reductions in preferred forage could lead to increases in bison movement across a larger landscape and physiological stress that may have impacts on the health of an increasing percentage of the House Rock bison herd.

Individual bison water consumption varies by season and age and sex classes. When free water is available, adult prime-aged bison will consume between 10 to 15 gallons per day; bison will consume less when new growth forage with higher water content is available for consumption and sometimes more when only very dry forage is available (Reynolds, Gates, and Glaholt 2003). When free water is not available, bison will sometimes consume snow or lick ice, creating scalloped surfaces wherein small amounts of free water may accumulate through surficial thawing that the bison can consume. Within this overall variability, projected growth of the House Rock bison herd from approximately 400 to 600 to approximately 1,200 to 1,500 in 10 years, is expected to lead to increases in daily, seasonal, and annual rates of individual and whole herd water consumption. Furthermore, increases in water consumption by

the growing House Rock bison herd could contribute to reductions in water recharge at key water sources (see "Water Resources in the Karst Landscape," below), which could reduce overall water availability for the bison. As the availability of water decreases, the result may be increased competition among bison for limited water and forage resources. This may change behavior or group dynamics and lead some animals to break away from their group to satisfy water needs, or they may remain with their group and risk reduced water intake if the group moves away from a water source before younger age classes can satisfy their water needs. Therefore, reductions in water availability with a growing House Rock bison herd could cause increases in physiological stress that may have impacts on the health of a growing percentage of the population. If water sources run dry as a result of overuse combined with seasonal or long-term drought, bison may be forced to move across larger landscapes in search of water.

Seasonal Behavior, Movement, and Group Dynamics

Bison exhibit substantial variability in behavior, movement, and group dynamics that underpin key aspects of their seasonal survival and mortality dynamics, such as the summer rut and spring birth synchrony when the herd tends to congregate in larger groups (Plumb, White, and Aune 2014). The approximately 250% growth of the House Rock bison herd over the next 10 years would increase the total number of bison groups across all seasons, with smaller groups likely becoming more common across the full extent of available habitat as a result of more competition for resources. Multiple smaller groups would likely gather into one or more larger herds during mid-summer for the annual breeding "rut." During fall and winter, prime-age bull bison would likely follow normal group dynamics and begin to disperse from female groups, segregating and living alone or in small groups. As herd size increases, the total number of bachelor bulls and small groups would increase, as would the movement of these smaller groups across the landscape. Competitive and violent interactions between prime-age bulls would increase during the rut as well. Following the rut, smaller groups of female, sub-prime, and juvenile animals are expected to form, although these groups could be expected to increase in total size toward multiple hundreds and increase their total movement. Changes in seasonal behavior, movement, and group dynamics could, but are not likely to, influence survival or mortality of the bison themselves.

Cumulative Impacts

Fire and vegetation (habitat) management inside and outside the park may result in reduced forage availability for a relatively short period after actions are taken, but as the area recovers, total herbaceous forage availability and quality may increase. In general, bison are highly responsive to fire events, often exhibiting preferential habitat selection for recently burned areas that include grass and sedge habitats. Outside of the park, Arizona Game and Fish Department regulate bison distribution and hunting, have conducted or plan to conduct bison trailing and feed experiments, and improve holding pasture and other fencing at House Rock Wildlife Area to acclimatize bison brought back to the area and to prevent movement of these animals to the north. While hunting outside the park removes individual bison and affects bison movement and distribution, one of the state's goals for the hunt is to help ensure the House Rock bison herd abundance is consistent with the forage available in the area. The improvements at House Rock Wildlife Area are intended to eventually support and maintain most of the House Rock bison herd on USFS lands year round, in balance with ecological conditions, and with the potential for some seasonal use of USFS Kaibab Plateau lands. This would also help ensure adequate forage for bison, which would have beneficial effects by decreasing competition and associated physiological stress. In addition, park staff conduct limited wildlife surveys and research on the North Rim—mostly periodic assessments of special-status species and bison. These studies would have little or no effect on the House Rock bison herd themselves, other than the indirect benefits of increasing the park's understanding of the bison herd's role in the ecology of the North Rim or on bison genetic composition. Flights over the North Rim of the park have low potential to disturb bison that travel or reside near the designated flight paths because most of the flights occur infrequently (i.e., a few times a year), are not low enough to disturb them, and move

through the area quickly, so the noise lasts only seconds to minutes. The House Rock bison herd is habituated to occasional fixed-wing surveys conducted to estimate bison population abundance. These flights circle briefly above the animals so that they can be counted, and bison do not tend to startle or move while this is happening. Trailing and feeding experiments would potentially draw bison out of the park toward House Rock Wildlife Area, at least temporarily and demonstrate the viability of the use of attractants to move the House Rock bison herd in desired directions. The experiment could indirectly affect bison movement and distribution.

As described above, although disturbances and changes in behavior patterns associated with cumulative actions, such as response to fire events and changes to hunt structure and to trailing and feeding experiments, would be temporary and small, other past, present, and reasonably foreseeable actions would have primarily beneficial impacts on the House Rock bison herd by improving habitat and minimizing competition for resources. Alternative 1 would have adverse impacts as a result of a growing House Rock bison herd and its increasing demands on forage and water resources, as well as physiological stress and changes in behavior, movement, and group dynamics as a result of increased competition, although those changes may, but are unlikely to, influence survival or mortality. Therefore, the overall cumulative effect on the House Rock bison herd would be adverse. The incremental effect of alternative 1 when added to these other past, present, and reasonably foreseeable impacts would be considerable.

Conclusion

Alternative 1 is expected to substantially increase bison forage and water use, leading to some competition within the species that could increase physiological stress and yield detectible changes in patterns of behavior, movement, and group dynamics, but is unlikely to noticeably influence survival or mortality of the House Rock bison herd. While cumulative actions such as habitat management, hunting, and improvements at House Rock Wildlife Area are likely to have beneficial effects, when combined with the adverse impacts of alternative 1, the overall cumulative impact on the House Rock bison herd is expected to be adverse due to shifts in bison forage and water use, behavior, and dynamics.

Although the direct and indirect impacts of alternative 1 would contribute substantially to the overall adverse cumulative impact, these changes would reflect the variability in behavior, movement, and group dynamics that bison typically exhibit (see Plumb, White, and Aune 2014; Reynolds, Gates, and Glaholt 2003) and is not likely to influence survival or mortality of the House Rock bison herd at a population level.

IMPACTS OF ALTERNATIVE 2 ON THE HOUSE ROCK BISON HERD

Resulting Bison Population

Use and Competition for Forage and Water. Within 5 years, the expected decrease in the House Rock bison herd from approximately 600 to fewer than 200 would reduce total annual forage consumption by approximately threefold below the current baseline level of annual forage consumption for 600 to 800 bison. A reduced population of 200 or fewer would likely result in substantially decreased competition within the species for forage, resulting in reduced overall herbivory at the landscape scale, decreased herbivory impacts on both common and uncommon grass/sedge and forb/half-shrub forage at the landscape scale (see Plumb and Dodd 1993), and potentially increased overall floristic diversity at the community and ecosystem levels compared to current conditions, which would improve bison forage over time. Within the overall basic variability in water consumption described for alternative 1 above, the projected population reduction (e.g., 400–600 to fewer than 200) is expected to lead to decreases in daily, seasonal, and annual rates of individual and whole herd water consumption because bison could partially increase their water intake from vegetatio

n and fewer bison would be on the landscape. Decreased competition within the species would likely ensu re that all animals are able to satisfy forage and water needs, which would reduce competition and associa ted physiological stress for the House Rock bison herd and could lead to increased survival rates.

Seasonal Behavior, Movement and Group Dynamics. A population decrease of approximately threefold from 400–600 to fewer than 200 would decrease the total number of bison groups across all seasons, with smaller gr oups likely becoming more common with reduced distribution across the full extent of available habitat. T he gathering of fewer, smaller groups into one larger herd during mid-summer for the annual breeding "rut" would likely continue. During fall and winter, prime-age bull bison would likely continue to follow normal group dynamics and disperse from female groups, s egregating and living alone or in a fewer number of small groups. Following the rut, small groups of fema le, sub-prime, and juvenile animals are expected to form, although these groups could be expected to decrease in total size (e.g., toward 10 to 30) and decrease their total movement because fewer individuals would be on the lands cape, and the need to search for forage or water would be reduced. Because such behaviors, movement, a nd group dynamics are reflective of the substantial variability that bison exhibit (see Plumb, White, and Aune 2014; Reynolds, Gates, and Glaholt 2003), these changes in behavior would be unlikely to influence survival or mortality of the House Rock bison herd at a population level.

Nonlethal Culling

Capturing bison would involve the construction of up to five corrals in different parts of the park (see figure 2 in chapter 1), each up to 2 acres in size. While the corral construction would not take more than a day or two, capture and corralling of the bison, which would attract large numbers of bison into meadows associated with corral sites, could last days to weeks. In addition, up to 10 truck/trailer trips would be needed to remove captured bison each year.

The noise associated with vehicles and equipment (e.g., backhoes) used to construct the corrals and vehicles/stock trailers to remove bison from the corrals would exceed natural sound conditions (i.e., 80 A-weighted decibels [dBA] for a backhoe compared to 0 dBA–40 dBA background/natural noise level); however, the increased noise would likely dissipate within a mile of the activity depending on the area's topography and tree cover. For a discussion of typical sound sources and levels see the "Methods and Assumptions" section of "Wildlife (Other than Bison) and Wildlife Habitat". The loudest noises would be associated with the construction of the corrals and use of heavy equipment. Once completed, the only other noise would be associated with trucks and trailers and would be similar to noise levels associated with park roads. The noise and disturbance associated with the construction of corrals and the capture and removal of live bison may cause uncaptured bison within 0.5 to 1 mile of the corral site(s) to spend less time foraging and at water sources and could affect group dynamics, such as herd movements and group size and stability, on a day-to-day basis during nonlethal culling operations. Nonlethal culling operations would be conducted in June–July and August–September, which is within the bison breeding season (generally considered July–September) and could result in some physiological stress as a result of these disturbances and changes in opportunities for foraging and water use. However, because these effects would only last days to several weeks each year with most impacts occurring during construction of the corrals, adverse impacts would be limited. Increases in bison stress associated with disturbances as a result of nonlethal culling would occur areas near the corrals, although there would be only five corral locations (see figure 2). As a result, no discernible effects on breeding success for individual bison within 0.5 to 1 mile of capture sites is expected, and the breeding success of the House Rock bison herd as a whole would not be affected.

Lethal Culling

Under alternative 2, 1 to 3 lethal culling teams (made up of 5 people each) would access bison areas by foot, truck, and/or snow machines on existing park roads, resulting in approximately 1,440 vehicle days over the course of the approximately 30 weeks each year during each primary lethal culling period (mid-October through mid-May), and approximately 352 vehicle days during the 22 weeks of operations during each 5-month secondary lethal culling period (mid-May through mid-October). In addition, a maximum of 52 fixed-wing aircraft flights (approximately 1 flight per week) might also be needed to locate bison to focus lethal culling efforts and monitor bison. Lethal culling of individual bison would lethally remove a segment of the population, resulting in the loss of individual bison. For the bison that remain, the noise associated with the presence of people; the use of vehicles, snow machines, and aircraft (60 dBA–80 dBA); and the discharging of firearms (140 dBA–175 dBA) would exceed the natural sound conditions (0 dBA–40 dBA) for limited periods of time during each 16 hour lethal culling day for approximately 4 days per week over the lethal culling periods. Noise impacts on bison would be limited because teams need to approach bison quietly in order to remove them. Excess noise would frustrate lethal culling opportunities by causing bison to disperse. Bison may disperse as a result of the discharge of firearms, although the noise-related disturbance would be instantaneous. Bison would be more apt to disperse from areas when teams move in for carcass processing. The use of helicopters to retrieve bison carcasses from remote areas would also cause some exceedances of natural sound conditions (i.e., approximately 70 dBA–90 dBA compared to the background 0 dBA–40 dBA), but the impacts are expected to be limited to 6 times per year for 1 to 2 hours at a time. In addition, lethal culling teams and carcass processors would also access areas on foot with up to 12 to 16 stock animals per week. The disturbances from the noise and presence of people associated with carcass processing would be much less (less than 60 dBA) than that of vehicles, helicopters/aircraft, and the discharge of firearms and would add a relatively small contribution to the impacts noted above because it would be more reflective of noise levels generated by visitors in the park.

For bison that remain, the noise and presence of people associated with these activities would very likely disrupt patterns of forage and water use, behavior, and group dynamics within 0.5 to-1 mile of these areas. Because lethal culling could occur year-round, this would result in daily to monthly disruptions to the House Rock bison herd. However, most lethal culling activity is expected during April to mid-May and mid-October to December when the highest concentration of lethal culling teams would be present (two to three). The April to mid-May removal period would occur during calving season (late March through May), and the noise and disturbance associated with lethal culling may cause physiological stress to late gestational animals or animals with dependent calves within 0.5 to 1 mile of the lethal culling area, which would change as teams move around. However, this stress is not expected to reduce survival and/or reproduction. Lethal culling would also occur during bison breeding season (July to September), which could cause disruptions and increase physiological stress during an important part of the bison's life cycle. However, only one team would be working in the park during this time, which would minimize the disruption to those breeding bison within 0.5 to 1 mile of the shooting locations and would minimize any potential reduction in breeding success at a population level. With the exception of noise related to the discharge of firearms, large portions of the action area would still maintain background noise levels during lethal culling activities. Ultimately, after lethal culling has ceased after 3 years, these disruptions would be eliminated, and bison forage and water use, behavior, and dynamics would stabilize.

Hazing and Herding

By its very intention, periodic hazing and herding of bison would disrupt forage and water use, individual and group behavior and dynamics, and potentially increase physiological stress. However, localized hazing and herding is not expected to disrupt bison activities beyond a few days. Longer distance hazing and herding would disrupt bison activities for several days until bison settle down in a new area or return to the area from which they were moved. The use of helicopters for hazing away from the rim could occur

up to six times a year. The noise and presence of the helicopter would be intended to move bison. Bison would be hazed or herded to areas where they could be removed or away from sensitive resource areas. Ultimately, once hazing and herding has ceased, these disruptions would be eliminated, and bison forage and water use, behavior, and dynamics would stabilize.

Management Cycle

To fully understand the impacts associated with the implementation of alternative 2, the order of actions and their potential for interaction should be considered. As described in chapter 2, bison reduction activities would likely start with nonlethal culling activities in the grasslands and meadows during early summer. These activities could coincide with a lethal culling event in other areas, likely in the shrublands of the action area. In addition, the park could also implement hazing and herding actions to move bison toward corral facilities from other areas of the action area, such as shrublands and forests. Although lethal and nonlethal culling and hazing and herding are only expected to affect targeted bison, implementing such actions repeatedly over 3 to 5 years, sometimes during important periods in the bison life cycle (e.g., calving and breeding seasons), could influence movement and distribution of the bison population, affect reproductive success that could slow population growth, and result in physiological stress that is more widespread across the herd. Ultimately, once the reduction actions are complete, these disruptions would be eliminated, and bison foraging, water use, behavior, and dynamics would stabilize.

Cumulative Impacts

Past, present, or reasonably foreseeable actions and their impacts on the House Rock bison herd would be the same as those discussed under alternative 1. Although temporary disturbances and small changes in behavior patterns associated with these other cumulative actions would occur, impacts on the House Rock bison herd would be primarily beneficial by improving habitat and minimizing competition for resources. Alternative 2 would contribute to disturbances and changes in behavior during the 3 to 5 years when reduction activities are occurring. The remaining bison could experience beneficial effects as a result of a noticeably smaller House Rock bison herd if currently stressed from density-dependent pressure; decreasing demands on forage and water resources; and the resulting changes in behavior, movement, and group dynamics that would be more consistent with a population in balance with the system. Therefore, when combined, alternative 2 and other cumulative actions would have some adverse cumulative impacts on the targeted portion of the population while reduction actions are taking place but would have beneficial impacts on remaining bison once reduction is complete. Alternative 2 would have a noticeable contribution to the adverse effects and substantial contributions to the beneficial effects.

Conclusion

As noted under alternative 1, reducing the House Rock bison herd to fewer than 200 animals under this alternative would still result in having bison on the landscape furthering DOI initiatives; however, this density and abundance would be better balanced with available resources on the North Rim. In addition, once fewer than 200 bison
remain, decreased competition within the species would likely ensure that all animals are able to satisfy fo rage and water needs, which would reduce competition and associated physiological stress for the House Rock bison herd and could lead to increased survival rates. Behaviors, movement, and group dynamics an ticipated under alternative 2 would be reflective of the substantial variability that bison exhibit (see Plumb, White, and Aune 2014; Reynolds, Gates, and Glaholt 2003), and would not necessarily influe nce survival or mortality of the House Rock bison herd at a population level.

During implementation of alternative 2, nonlethal culling, lethal culling, and hazing and herding are all expected to disrupt some bison activities and cause physiological stress to animals. These reduction

activities would create noise in excess of natural sound conditions as a result of additional vehicle trips on park roads during the primary bison removal season, the presence of teams for lethal culling and carcass handling, up to 6 helicopter and 52 fixed-wing flights, and the construction of corrals. In addition, the presence of processing teams, the forced movement of bison, and the congregation of bison near corrals would also create stressors along travel corridors, at lethal culling sites, and in/adjacent to corral sites. Although lethal and nonlethal culling are only expected to affect bison within 0.5 to 1 mile of the areas where actions are taken place and hazing and herding would only be used periodically, using these actions repeatedly over 3 to 5 years, sometimes during important periods in the bison life cycle (e.g., calving and breeding seasons) could influence movement and distribution of the House Rock bison herd, affect reproductive success that could slow population growth, and result in physiological stress that is more widespread across the herd. Ultimately, once the reduction actions are complete, these disruptions would be eliminated, and bison foraging, water use, behavior, and dynamics would stabilize.

When combined, the impacts of alternative 2 and other cumulative actions such as habitat management and hunting would have some adverse cumulative impacts while reduction actions are occurring. These impacts would result from disruptions to bison foraging, water use, behavior, and dynamics. Alternative 2 would have a noticeable contribution to the adverse effects for the duration of the 3- to 5-year reduction period. However, alternative 2 and these cumulative actions, including improvements at House Rock Wildlife Area, would also have beneficial impacts as a result improved habitat conditions that would ensure sufficient resources (forage and water) are available for bison and minimize competition and associated physiological stress. The reduction of the House Rock bison herd to fewer than 200 animals would have substantial contributions to these cumulative beneficial effects.

WATER RESOURCES IN THE KARST LANDSCAPE

METHODS AND ASSUMPTIONS

The impact analysis for the springs, seeps, lakes, ponds, and sinkholes in the karst landscape focuses on potential effects on hydrology (i.e., local recharge and drainage) and water quality (i.e., nutrients, levels of fecal bacteria, and turbidity) of the springs, seeps, lakes, ponds, and sinkholes where the House Rock bison herd congregates. While the effects of bison reduction on these resources are also addressed briefly, issues associated with localized fencing for resource protection are dismissed in chapter 1. Potential impacts on springs, seeps, lakes, ponds, and sinkholes found on the North Rim were evaluated based on resource expert knowledge of water resources and karst features on the North Rim, professional judgment, review of available research and literature, understanding of how and where bison congregate and use water sources, and anticipated locations for reduction and related activities. Clean Water Act requirements inform this analysis. Additional assumptions are presented under each alternative.

IMPACTS OF ALTERNATIVE 1 (NO ACTION) ON WATER RESOURCES IN THE KARST LANDSCAPE

Under alternative 1, the House Rock bison herd is expected to increase from about 400 to 600 to about 1,200 to 1,500 over 10 years (Sturm and Holm 2015). Existing bison impacts on hydrologic features, could include the presence of *E.coli* in standing water, heightened turbidity, and increased effluent (nutrients), as shown in Kelly et al. 2009 and Coraci et al. 2015. These impacts would be exacerbated by the population increase and the related increase in soil disturbance and fecal loading at these water sites. It should be noted, however, that Coraci et al. (2015) did not confirm the source of the E. coli in the high bison use areas, and it could be from other wildlife. The seeps, springs, lakes, and ponds that the bison use would show the most intense adverse impact under this alternative because an increase in population would increase (1) water demand pressure, (2) soil and vegetation disturbance, and (3) fecal loading in these localized highly biodiverse sites. As preferential water sites become fully utilized, and bison expand their use of other water sources, sites that are only occasionally used now would be used more, resulting

in impacts such as increased *E.coli* concentrations, turbidity, soil compaction, and nutrient enhancement through fecal loading.

The risk of water quality degradation, especially bacterial (*E. coli*) contamination, of North Rim springs and streams fed by the Kaibab and Powell Plateaus and the sinkholes that recharge the system would increase because of increased bison activity in these areas. A study of groundwater residence times (i.e., the amount of time a drop of water spends in the groundwater portion of the hydrologic cycle) observed a water response time in the order of days to Roaring Springs (Schindel 2015). With such a short residence time, surface contaminants could still be present in spring water, even springs many horizontal miles and several thousand vertical feet separating them from recharge areas. Under alternative 1, the karst topography of the Kaibab Plateau creates the potential for springs to be contaminated, despite over 1,000 feet of difference in elevation, as demonstrated in Harris and Pearthree (2002).

Alternative 1 would likely reduce water recharge, both through soil compaction at sinkholes, lakes, and ponds and by the increased water consumption by the larger House Rock bison herd. A decrease in recharge could reduce the amount of available water in the system, an amount that would vary with the number of bison and with changes in water consumption. Recent modelling efforts show perennial springs (of which only one is in the action area) are likely to be the most affected by reduced water supply (Godsey, Kirchner, and Tague 2014; Garcia and Tague 2015). Ephemeral springs, such as Crystal, Timp, Kanabownits, and Tipover may also be affected by a reduction in recharge because they are already marginal and could become completely dry for more prolonged periods than usual (USFS 2008, USGS 2015). Soil compaction would be more difficult to remediate; it usually requires direct geotechnical intervention (e.g., soil aeration through mechanical discing) (Urich 2002). Compaction impacts would be indefinite without active remediation, which is not under consideration in the no-action alternative, and would likely provide only short-term improvements, because the bison would likely return and the impacts would continue. The exact severity of the impacts is unknown because of a lack of data and accurate predictions of future bison activity at site-specific springs and sinkholes.

Alternative 1 may adversely affect karst features associated with springs, seeps, lakes, ponds, and streams. Sinkholes, underground conduits, and caves could receive increased sedimentation from surface soil, vegetation, and water disturbance that results from a larger House Rock bison herd, which could affect recharge and water quality (as explained for livestock agriculture in Urich [2002]; although bison are not livestock, their herding behaviors are similar; therefore, the study is analogous). Increased sedimentation could reduce water recharge to and through caves and the aquifer, alter water quality in the form of increased nutrients and fecal bacteria in the water, and change water recharge timing, potentially slowing the process. Increases in nutrients can decrease dissolved oxygen in water bodies and increase the risk of algal blooms. Compaction and fine sediments transported by runoff can reduce infiltration in sinkholes within the karst landscape, resulting in the formation of ponds and lakes (Huntoon 1974). Impacts could eventually include contamination of both the Coconino and Redwall-Muav aquifers, both of which are unique and vulnerable water-bearing geologic units within the karst landscape that are important for human and ecological use.

Cumulative Impacts

The cumulative impacts analysis considers impacts on the sinks, seeps, springs, lakes, ponds, and sinkholes throughout the action area and on adjacent lands underlain by the Coconino and Redwall-Muav aquifers. Given the sensitivity of karst landscape to changes to surface water resources, small impacts could have amplified effects throughout the system. The past, present, or reasonably foreseeable future action that has and would continue to affect water resources on the North Rim is fire management throughout the North Rim of the park and on adjacent lands because of the extent of the underlying aquifers and the interconnected nature of the karst landscape. Using prescribed fire in the landscape

mitigates the risk of large-stand replacement fires. Large-stand replacement fires, which burn hotter than periodic burns and most prescribed fires, often damage the organic soil layer, increasing turbidity to water sources, and adding larger than normal loads of nutrients to water. Although wildland fires would still occur on the landscape, the risk that they would be large-stand replacement fires drops noticeably, so these unplanned wildland fires would have more balanced effects on the landscape, including on water resources.

The adverse impacts of alternative 1, when added to the generally beneficial impacts of the fire management activities would still result in a decrease in hydrologic resource conditions and an overall adverse impact on water resources in the karst landscape. The impacts of alternative 1 would likely have more of an impact on water resources in the karst landscape than existing fire management activities. Because of the scarcity of water resources on the North Rim and the sensitivity of water resources in a karst system to surface influences, the incremental contribution of adverse impacts from alternative 1 would be substantial.

Conclusion

Water is a relatively scarce and fundamental resource in the park (NPS 2010c), and its existence in a karst landscape makes water resources throughout the canyon susceptible to impacts from actions on the rim. Under alternative 1, the House Rock bison herd would have an increasingly adverse impact on the springs, seeps, sinkholes, lakes, ponds, and sinkholes found in the karst landscape of the North Rim as the herd size increases and the animals spend time in and adjacent to these features, compacting soils, stirring sediments, consuming water, and defecating near water sources. Impacts would include increased nutrient loads and decreases in dissolved oxygen, bacterial contamination, increased turbidity, decreased groundwater recharge, potential blockage of karst groundwater pathways, potential contamination of the Coconino and Redwall-Muav aquifers, and decreased water quantity as a result of bison uptake. Bacterial contamination would increase because of an increased flux of fecal material to springs, seeps, lakes, ponds, and sinkholes from the increase in the House Rock bison herd. Turbidity would also increase as more bison visit watering areas, trampling the vegetation and soil and entraining sediment into the water. Groundwater recharge could decrease as the bison compact the soil in sinkholes, lakes, and ponds that recharge the aquifer. Similarly, karst pathways may become blocked by surficial compaction and increased sedimentation in the subsurface from higher turbidity. Water quantity would likely decrease overall as the increase in the House Rock bison herd numbers increase the need for water. The National Park Service has a commitment under the Federal Cave Protection Act (1988) to protect, monitor, and preserve cave and karst features in its jurisdictional limits, and such protective actions could mitigate adverse impacts on water resources more generally, but none are currently planned. The adverse impacts on water resources under this action, in relation to the beneficial cumulative impacts of prescribed fire would be greater than the benefits from prescribed fire and result in an overall adverse cumulative impact on the condition of water resources in the action area, with alternative 1 contributing a substantial increment.

Impacts on Water Resources on Adjacent Lands. The increase in the bison population under alternative 1 could cause more bison (compared to current conditions) to move on to USFS lands adjacent to the park as a result of density-dependent pioneering behavior. Although the number of bison that may disperse and their movements as the population grows would be unpredictable under alternative 1, pioneering bison are expected to seek sources of water similar to those preferred in the action area. This could result in impacts on lands outside the park similar to those described in the action area, although based on current bison behavior (i.e., the fact bison spend the majority of their time in the park) more bison are expected to remain inside the park than outside. Therefore, impacts outside the park would be of a much lower magnitude than those inside the park. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop

site fidelity of the House Rock bison herd to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan* management of bison in adherence to the plan's guidelines is anticipated to keep bison numbers at a level that would minimize their potential damage to sensitive habitats (USFS 2014).

IMPACTS OF ALTERNATIVE 2 ON WATER RESOURCES IN THE KARST LANDSCAPE

Resulting Bison Population

Under alternative 2, the expected decrease in the House Rock bison herd from 600 bison to fewer than 200 would reduce total intake of water by bison and the number of bison congregating around water resources and sinkholes. Population reduction would also reduce the number of water resources affected and the frequency with which they are affected. Fewer bison would be visiting and spending less time at the springs, ponds and other water resources throughout the North Rim that are not near bison gathering areas. At the water sites in areas where bison do congregate, frequent visitation would continue, but the number of congregating bison would be reduced. Therefore, the potential for impacts described for alternative 1 would continue, but the impacts would be much less severe, and over time, water quality and other conditions around these sites would improve. Some sites where bison are likely to continue to congregate, such as Little Park Lake, would continue to experience adverse impacts similar to but less intense than those described for alternative 1, and these impacts could affect seeps and springs below the rim and elsewhere. By reducing the House Rock bison herd to 200 animals or fewer, issues of bacterial contamination, turbidity, groundwater recharge, potential blockage of karst groundwater pathways, and water quantity would all substantially diminish in areas of current bison use, and water quality is expected to improve and water quantity expected to increase. Specifically, as the House Rock bison herd decreases and reaches the smaller herd numbers, more water would be available, water quality would improve, and more natural drainage patterns would occur throughout the North Rim and at associated spring sites below the North Rim. However, Urich (2002) notes that soil compaction in karst landscapes is difficult to reverse without manual intervention with discing or other soil aeration techniques, so impacts from compaction could continue for years unless the park intervenes after the herd size decreases.

Nonlethal Culling

Corral sites would located at least 200 feet from water sources and sinkholes to minimize the potential for vegetation disturbance, soil compaction, erosion, and concentrated defecation that could affect water quality and karst function during nonlethal culling. Any impacts that do occur would be localized (i.e., would only have the potential to impact water sources in the vicinity of one of the corral sites) and would most likely last a year to a few years because vegetation would reestablish itself, or post-corral restoration activities, such as soil aeration and revegetation, would take place as needed, depending on the amount of compaction and disturbed vegetation.

Lethal Culling

The use of stock animals and people gathering in larger numbers, possibly near water resources where bison tend to congregate, for lethal culling activities or processing carcasses could lead to compaction of or disturbance to soil and vegetation. Impacts would be limited to disturbance of any soil or water in the immediate vicinity of where lethal culling or carcass handling occurs; and would not last more than a few days because lethal culling is likely to occur in one spot then move to another site as the bison move. These impacts are more of a concern near unfenced sinkholes, springs, seeps, ponds, and lakes as bison would be more likely to be using such areas when sharpshooters approach. Areas that are fenced would be

protected; however, some impacts could occur near ponds or seeps because bison tend to congregate near water sources. If lethal culling does occur near water sources, sharpshooters would be directed not to shoot bison that are in the immediate vicinity of the water, if possible, to protect water sources and associated resources (NPS 2010c). The limited disturbance would not be noticeable within a year because of natural regrowth. In rare instances, if a site is used often for lethal culling, soil aeration and/or revegetation may be needed after the reduction activity to mitigate adverse impacts and ensure they would be reversible and with limited opportunity to affect water quality or hydrology in a meaningful way.

Hazing and Herding

Hazing and herding are not likely to often occur in the same place, and impacts on water and the karst system would likely be minimal if this tool is not used at or near sinkholes or springs. However, as these are areas where bison tend to congregate, it is possible that potentially large numbers of bison may be moved through an area and may disturb soil and vegetation near water sites and sinkholes. This is more of a concern for unfenced water sources, and as described for alternative 1, this can cause localized compaction and vegetation disturbance that can affect water recharge and water quality from reduced percolation times and increased erosion potential. The exact severity of the impacts would depend on the location and size of the bison group that is hazed or herded, and whether or not a group is driven through a water resource. Disturbances to water and the karst system from hazing and herding are expected to last a year to a few years because the disturbance is not expected to be widespread and natural revegetation or soil biological activity would occur.

Exclusion Fencing

The proposed action would use exclusion fences around the perimeter of water sources on the North Rim where resources are at risk of experiencing adverse and potentially permanent impacts from high concentrations of the House Rock bison herd. This fencing would be configured differently from the corral fencing and is described in chapter 2. Areas for fencing would be limited to the periphery of springs and seeps**.** Soil disturbance would be limited to the footprint of the posts, deadmen, and anchor wires, as described in chapter 2, so that impacts on springs and seeps would be minimal. Postholes would be small, no more than 10–12 inches in diameter, and placed 16 to 20 feet apart. Any adverse effects, such as sedimentation that could result from movement of disturbed soils into the water bodies during fence construction or maintenance, would be very limited because of the small footprint of the post holes and the ability to use silt control devices as needed. These springs and seeps would benefit, as described above for the resulting bison population, from reduced herbivory, trampling, and wallowing.

Management Cycle

Additive or synergistic effects could occur from the cycle of management and combination of reduction actions over the 3- to 5-year period. While bison tend to congregate at seeps and springs, and therefore reduction actions may occur in the vicinity of these resources, it is unlikely that additive or synergistic effects from the reduction actions would occur during implementation. As noted previously, reduction actions would have limited potential for water quality and quantity impacts due to the transient nature of the activities, and measures to mitigate potential impacts such as placing corrals at least 200 feet from water sources and directing lethal reduction team members to pass on shooting bison that are in the immediate vicinity of the water, if possible. In addition, many water sources would be fenced off and not accessible to bison or reduction teams. Although the same water sources could be affected more than once during reduction actions, impacts would be limited to disturbance of any vegetation, soil or water in the immediate vicinity of an action, impacts would not last more than a few days at any one site, and sites are expected to recover naturally within a few years or less if active revegetation occurs.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions that would affect springs, seeps, lakes, ponds, and sinkholes would be the same as those described for alternative 1—namely, prescribed fire. Prescribed fire would be beneficial because it would avert the risk of large-stand replacement fires that could cause noticeable adverse impacts on water quality and hydrologic processes in the karst landscape. When combined with alternative 2, which would have mostly beneficial effects after the reduction actions are complete, with some minimal, adverse impacts during reduction (limited to times and areas of bison reduction activities), when added to other past, present, and reasonably foreseeable future actions, the overall condition of water resources would improve by removing the disturbance and nutrient inputs that the House Rock bison herd currently puts on the system. The incremental contribution of the benefits from alternative 2 would be substantial.

Conclusion

As noted in the conclusion discussion for alternative 1, water resources are relatively scarce and are fundamental to the North Rim (NPS 2010c). Water resources, including springs, seeps, lakes, ponds, and sinkholes, would generally improve under alternative 2 because soils, riparian vegetation, and standing water resources would return to a nearly undisturbed state from bison over time as the bison population is reduced. The resulting House Rock bison herd would be small enough to have little impact on most of the hydrologic resources of the area except localized impacts where the herd may congregate for extended periods. Impacts on hydrologic processes and water quality in the karst environment as a result of the impacts on surface waters from the House Rock bison herd, as described for alternative 1 would lessen over time. Transient adverse impacts from lethal and nonlethal culling and carcass processing and removal, herding and hazing activities (likely seen for up to a few years as natural processes and park management restore resources) would include localized soil, vegetation, and water disturbance. The condition of resources would improve as a result of the reduction in the House Rock bison herd. This action would provide a net beneficial impact on hydrological resources in combination with cumulative actions occurring on the landscape, specifically prescribed fire. The incremental contribution of the benefits from alternative 2 would be substantial.

Impacts on Water Resources on Adjacent Lands. Hazing, herding, or lethal culling is expected to cause an increase in bison movement, including on to adjacent USFS lands. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, dispersing bison are expected to seek water sources outside the park similar to those preferred in the action area. The types of impacts dispersing bison would cause outside the park would be similar to the impacts described for the action area under the no-action alternative. These impacts could persist beyond the initial reduction phase if bison begin to spend more time outside of the park.

However, because fewer bison would move outside the park (compared to the resulting bison population under alternative 1), the impacts would be of a much lower magnitude. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, management of bison in adherence to the plan guidelines is anticipated keep bison numbers at a level that would minimize their potential damage on sensitive habitats (USFS 2014).

BISON-AFFECTED VEGETATION

METHODS AND ASSUMPTIONS

The impact analysis for vegetation focuses on potential changes to the diversity of grasslands, meadows, shrublands, and wetland-associated vegetation that could result from the density and abundance of the House Rock bison herd anticipated under implementation of the two alternatives considered. This analysis focuses on the potential for alternatives to change native vegetation in terms of plant cover and native plant diversity and the potential for the increase/decrease in spread of exotic plants. Potential impacts on vegetation were evaluated based on resource expert knowledge, professional judgment, communications with park staff, review of available data, and conclusions reached in the Greater Grand Canyon Landscape Assessment, currently in draft (Stortz et al. 2016). Additional assumptions are presented under each alternative as appropriate.

IMPACTS OF ALTERNATIVE 1 (NO ACTION) ON BISON-AFFECTED VEGETATION

Under the no-action alternative, high concentrations and an increasing House Rock bison herd on the landscape would affect a large portion of the 2,800 acres of the montane-subalpine grasslands ecosystem and smaller areas of the 4,957 acres of montane-shrub and interior chaparral habitat as a result of increased grazing, trampling, wallowing, and disturbances that could allow for the spread of exotic species (Stortz et al. 2016; NPS 2015e; Miller et al. 2014; Reimondo 2012; Seastedt and Pyšek 2011; Allred, Fuhlendorf, and Hamilton; Knapp et al. 1999).

As noted above in the "House Rock Bison Herd" section, bison primarily consume grasses and sedges, and the expected increase in the bison population from approximately 400 to 600 to 1,200 to 1,500 would increase total annual forage consumption by approximately 250% over the current level of annual forage consumption. Bison also balance their diet by consuming wetland-associated vegetation. Reimondo, Sisk, and Theimer (2015) found that as bison use of springs and seeps increased, wetland-associated vegetative cover decreased by 70% to 90%, vegetative height across functional groups decreased to 25% of that in low or nonuse sites, and bare soil increased to 40% to 50%. Increased intra-specific competition could lead individual bison to maximize forage intake in reduced time, which could further increase consumption of common species, including wetland-associated vegetation (Plumb and Dodd 1993).

Depending on the season, bison display a selective preference for forbs and shrubs. Shrubs such as willows (*Salix* spp.) and saltbush (*Atriplex* spp.) can be a dietary component for some populations of bison, including those in the park's scrubland. (Rotenberry 1998; Coppedge and Shaw 1997). Competition within the species could cause a shift in forage selection, resulting in grazing on shrubs and other woody vegetation. This shift could cause concentrated damage in areas on the periphery of grassland and meadow habitat.

This increase in grazing and trampling associated with 1,200 to 1,500 bison on the landscape have the potential to change plant communities over time. The vitality of species that are more susceptible to herbivory and trampling, such as those found in montane grasslands, could be reduced, leading to the loss of native species and diminished plant diversity at the community and ecosystem levels (Reimondo 2012). Furthermore, a bison population of 1,200 to 1,500 animals would cause more trampling as they move about the landscape and an increase in bison wallows (i.e., bare depressions created by rolling on the ground) and the associated removal of all localized plant biomass. Wallows have the ability to retain rainwater in the spring season and create habitat suitable for wetland species, which could have seasonal beneficial impacts on vegetation types that cover less than 1% of the action area. However, these wallow-created ephemeral pools would then be subject to subsequent damage from bison grazing, trampling, and water consumption (Stortz et al. 2016; Knapp et al. 1999) and would be prone to the establishment of

exotic plants that display a high tolerance for disturbance and drought as they evaporate in the summer (NPS 2015a; Miller et al. 2014). Increased grazing and trampling associated with a larger House Rock bison herd size could also facilitate the spread of exotic plants (NPS 2012b). Exotic plants can be aggressive and displace native vegetation by robbing moisture, nutrients, and sunlight from surrounding native plants resulting in altered (and frequently degraded) plant communities with reduced native species cover and diversity.

In many cases, bison can have a beneficial role in the maintenance of vegetation communities through foraging and nutrient cycling (Bakker et al. 2006; Rickel 2005; Knapp et al. 1999). For example, in other locations where bison are managed at densities consistent with where they are in the historical range of the species and bison are present at sustainable levels, bison foraging can increase plant species richness (Schoenecker 2012; Towne, Hartnett, and Cochran 2005). However, under the no-action alternative, the House Rock herd is expected to grow to approximately 800 animals in 3 years, and as large as 1,200 to 1,500 animals within 10 years (Sturm and Holm 2015), and these benefits would not likely be realized.

Cumulative Impacts

Several actions have the potential to combine with the effects of alternative 1 to produce cumulative impacts on grasslands, meadows, shrublands, and wetland-associated vegetation. Specifically, current and future prescribed fires and vegetation restoration activities could affect vegetation. The use of prescribed fire on the landscape has beneficial impacts on vegetation by mitigating the risk of high-intensity wildfires (Finney, McHugh, and Grenfell 2005; Agee and Skinner 2005). High-intensity wildfires pose a threat to the long-term stability of plant communities in the western United States (Keeley 2006). Furthermore, prescribed fires do not release as much nitrogen as high-intensity wildfires, allowing some vegetation to retain vital nutrients in an arid ecosystem (Wiedinmyer and Hurteau 2010).

The park actively manages exotic plants, including on the North Rim, and engages in vegetation and habitat restoration activities. These activities would have beneficial impacts on vegetation by limiting the ability of exotic plants to become established and reduce the abundance and diversity of native plants, diminish the viability of soil microbes, and disturb hydrological and nutrient cycling processes (Reid et al. 2009).

Overall benefits would be realized from the use of prescribed fire, habitat restoration, and managing the spread of exotic plants to maintain the health of native species, soil microbes, and nutrient cycling processes. However, alternative 1 would add a disproportionate adverse effect because of the overgrazing, trampling, and wallowing from the number of bison anticipated under this alternative (predicted to reach 1,500 animals over time). Some small benefits associated with the maintenance of vegetation communities through foraging and nutrient cycling could accrue; however, the adverse impacts of over-utilization of grassland and meadow habitat and wetland-associated vegetation near water sources would make these unlikely. Therefore, when the adverse impacts from alternative 1 are combined with the effects of other cumulative actions, an overall adverse cumulative impact is expected. Alternative 1 would contribute a substantial adverse increment to the overall cumulative impact.

Conclusion

The increasing House Rock bison herd under alternative 1 has the potential to affect approximately 2,800 acres of grasslands and meadows. Grasslands and meadows are not only rare in the action area, where they cover approximately 3% of the area, they are also rare within the southwestern United States and the greater Grand Canyon landscape, as evidenced by the fact that only 3,000 to 5,000 acres of these vegetation types exist in a 5-million acre area that encompasses the North Rim of the Grand Canyon (Stortz et al. 2016; NPS 2015e). As a result, the 2,800 acres of grassland and meadow vegetation in the

action area, which have state and regional importance (NPS 2015e), represent approximately 56% to 93% of all the grasslands on this broader landscape. Similarly, although the amount of acreage is unknown, the wetlands-associated vegetation is also very rare, likely limited to areas around the approximately 24 ponds and lakes and 14 seeps and springs in the action area. Montane shrubland and interior chaparral is a primary vegetation type in the greater Grand Canyon landscape, occupying nearly 25% of the park's area (Stortz et al. 2016), though it represents only 5% of the vegetation in the action area. These diverse vegetation communities are fundamental park resources because they serve as largely undisturbed remnant plant communities and ecosystems (NPS 2010c).

While bison could have a beneficial role in the maintenance of vegetation, specifically grasslands and meadows, through improved nutrient cycling, potential benefits of bison foraging on vegetation are not likely to be realized under the no-action alternative. Rather, the increasing House Rock bison herd and concentrations of bison are expected to result in overgrazing, trampling, wallowing, and associated disturbances and cause increased adverse impacts across a portion of the 2,800 acres of montane-subalpine grasslands, meadows, and wetland-associated vegetation surrounding the 38 water sources. The increased disturbance (i.e., an increase in the direct loss of vegetation and a potential increase in the spread of exotic species) expected with a House Rock bison herd size of approximately 1,200 to 1,500 animals is expected to diminish the existing native species cover and diversity of rare, regionally important meadows, and grasslands found on the North Rim. Wetland-associated vegetation, which ranks among the most productive and biologically diverse terrestrial ecosystems in the park and supports relict and endemic species, could also be lost or degraded. The potential loss of vegetation under alternative 1 could change the overall character of the plant communities, degrading already rare vegetation types. Bison would also likely increase their consumption of woody vegetation as a result of increased intra-specific competition, which could result in a shift in native shrub species abundance and diversity. These shrub habitats would face increased forage pressure during winter months as larger concentrations of bison move toward the rim of the canyon seeking lower snow levels and warmer temperatures. However, given how widely distributed shrub habitat is on the North Rim, these effects would likely be localized to areas adjacent to higher quality forage.

Although cumulative actions, such as the use of prescribed fire and exotic plant management to maintain the health of vegetative communities, would have limited beneficial effects on these vegetation types, increased grazing, trampling, and wallowing from the large number of bison anticipated under this alternative would contribute considerably to an overall adverse cumulative impact on these rare, important vegetation types.

Impacts on Vegetation on Adjacent Lands. The increase in the bison population under alternative 1 could cause more bison (compared to current conditions) to move on to USFS lands adjacent to the park as a result of density-dependent pioneering behavior. Although the number of bison that may disperse and their movements as the population grows would be unpredictable under alternative 1, pioneering bison are expected to seek foraging habitat similar to preferred habitat in the action area (i.e., grassland, meadow, shrubland, and wetland-associated vegetation). This could result in impacts on lands outside the park similar to those described in the action area, although based on current bison behavior (i.e., the fact bison spend the majority of their time in the park), more bison are expected to remain inside the park than outside. Therefore impacts outside the park would be of a much lower magnitude than those inside. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity of the House Rock bison herd to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to the plan's guidelines is anticipated to keep bison numbers at a level that would

minimize potential damage to sensitive plant species and habitats and decrease the spread of nonnative invasive species (USFS 2014).

IMPACTS OF ALTERNATIVE 2 ON BISON-AFFECTED VEGETATION

Resulting Bison Population

Under alternative 2, the expected decrease in the House Rock bison herd from approximately 600 to fewer than 200 (67% or more of the population) would reduce total annual forage consumption by approximately threefold below the current baseline level (see discussion in the "House Rock bison herd" section of this chapter, above). The reduced population would result in decreased intra-specific competition for grasslands, meadows, shrublands, and wetland-associated vegetation as food sources. Reduced herbivory is expected to improve the vitality of native plants and maintain plant diversity at the community and ecosystem levels. The reduced size of the House Rock bison herd on the landscape would also reduce the amount of vegetation lost by trampling and wallowing. A reduction in grazing, trampling, and wallowing could also reduce the potential for conditions that facilitate the spread of exotic species, decreasing competition with native species and the degradation of native plant communities. In addition, by managing the House Herd at these lower numbers, , the potential for bison foraging to have beneficial effects on vegetation, as described for alternative 1 related to nutrient cycling and the potential increase of plant species richness, is greater. However, adverse impacts (also as described the affected environment) could continue in areas currently used by bison or where they congregate in the future, although the level of impact would be less than observed under current conditions because there would be fewer than 200 bison on the landscape.

Nonlethal Culling

Adverse impacts on grasslands, meadows, shrublands, and wetland-associated vegetation from nonlethal culling activities would occur from capturing and corralling bison on small pastures (Stortz et al. 2016; Reimondo 2012). Up to five corrals, approximately 120 feet in diameter, would be used during the June–July and August–September nonlethal culling efforts (see figure 2). Each corral would likely require an access corridor no more than approximately 0.25-mile long. In total, approximately 2 acres of grassland and meadow vegetation would be disturbed from accessing each site, installing, and using each corral (for a total disturbance of approximately 10 acres). The areas inside the corrals would experience the most impacts because bison would heavily forage, trample, and wallow in the enclosed areas, resulting in a change in native plant cover and diversity within the corrals. As park staff access the site, vehicles would crush grassland and meadow vegetation, potentially resulting in a decrease in cover. These disturbances could also lead to the spread of exotic plant seeds and the associated displacement of native vegetation and indirectly modify the soil (e.g., compaction) so that plant damage is extended beyond the area of direct impact (Pickering et al. 2010; Wilshire, Shipley, and Nakata 1978).

Similar impacts on vegetation within the meadows and grasslands outside the corral would also occur as additional bison congregate in those areas either from being attracted to the bait or as bison groups are separated. However, the level of impact from grazing, trampling, and wallowing in these adjacent areas would unlikely exceed those occurring in the corrals because bison would not be confined.

The loss of vegetation, and the potential spread of exotic species from the use of corrals and their access corridors would only last a few months each summer at each site; vegetation would be restored along travel corridors and at the corral site once corral infrastructure is removed from the area.

Lethal Culling and Carcass Removal

Personnel entering areas on foot and by stock animal for lethal culling activities or to remove carcasses could crush plants and disperse seeds of exotic species, which could result in the limited displacement of native species. To mitigate the potential for introduction of exotic species, hay for stock animals would be required to adhere to the park's weed-free policy. While vehicle access to lethal culling areas has potential for similar impacts, all vehicle use would be restricted to existing roads and therefore is not expected to affect vegetation beyond the edges of any roads. For actions taking place in winter, the potential for snow machines to crush plants along roadsides would be minimal (albeit contingent on the level of snowpack) because most travel would occur over snow and the use of snow machines would be confined to approved roads and limited to one or two teams from December to April. Therefore, as a result of these mitigations and restrictions on vehicle (including snow machine use), lethal culling actions would likely affect individual plants in very limited areas that would recover through natural growth over time and would not result in noticeable impacts at the plant community level.

Hazing and Herding

Impacts from personnel entering areas on foot or by stock animal for hazing and herding techniques to direct bison to other areas of the North Rim would be similar to those described for accessing sites for lethal culling efforts. Depending on the frequency, timing (e.g., summer vs. winter), and efficacy of this management tool, adverse impacts on grasslands, meadows, shrublands, and wetland-associated vegetation from foraging, trampling, and wallowing in areas currently affected by high bison concentrations would likely decrease because the animals would be moved out of these areas. Fewer bison in these areas would potentially improve the vitality of native plants and maintain native plant diversity at the community level in these areas, as described below under the "Resulting Bison Population" section. However, as bison trail each other when they are guided to other areas, trampling and grazing of vegetation in bison travel corridors could potentially increase. Additional impacts, such as loss of native plant cover and diversity could occur from concentrated trampling of vegetation, overgrazing, and the removal of vegetation through wallowing, which would likely occur in destination areas once herding and hazing efforts cease. However, this tool would only be used to help facilitate bison removal or for the protection of sensitive resources. Associated impacts on vegetation would not occur frequently and are expected to be temporary as vegetation is expected to recover either naturally during the next growing season or through active revegetation once the hazing or herding is complete. Bison would be unlikely to remain in the destination areas in concentrated numbers because additional reduction tools would be used to remove them.

Exclusion Fencing

Alternative 2 would use exclusion fencing around the perimeter of wetland-associated vegetation surrounding springs and seeps on the North Rim. This fencing, described in chapter 2, would be configured differently from the corral fencing and would avoid highly vegetated areas. Soil disturbance would be limited to the footprint of the posts, deadmen, and anchor wires, as described in chapter 2, so that impacts on wetland-associated vegetation would be minimal. Postholes would be small, no more than 10–12 inches in diameter, and placed 16 to 20 feet apart. Any adverse effects such as trampling associated with fence installation would be limited because of the small footprint of enclosures. Wetland-associated vegetation would benefit, as described above for the resulting bison population, from reduced herbivory, trampling, and wallowing.

Management Cycle

To fully understand the impacts associated with the implementation of alternative 2, the order of actions taken and their potential for interaction should be considered. As described in chapter 2, bison reduction

activities would likely start with capture and removal activities in the grasslands and meadows during early summer. These activities could coincide with a lethal culling event in other areas, likely in the shrublands of the action area. In addition, the park could also implement hazing and herding actions to move bison toward capture facilities from other areas of the action area, such as shrublands and forests. Given the different vegetation types, the seasonality of activities (i.e., nonlethal culling in the summer, lethal culling primarily October–May), and the vegetation type-specific nature of certain reduction tools, it is unlikely that the collective use of these tools would have a synergistic impact on vegetation that would result in greater impacts than previously described.

Cumulative Impacts

Impacts from other actions considered in the cumulative impacts analysis would be the same as those described for alternative 1 and would be largely beneficial as a result of prescribed fire, habitat restoration, and exotic plant management. Alternative 2 would result in limited adverse impacts in small localized areas affected by reduction actions; the primary disturbance could be from each corral that would be approximately 2 acres (or up to 10 acres total) of grassland habitat, and these areas would be revegetated once reduction activities cease. More importantly, these same areas, other wetland-associated vegetation, and shrubs would experience benefits as a result of the decrease in disturbance and loss of vegetation from grazing, wallowing, and trampling associated with reducing the House Rock bison herd. Therefore, despite some limited and temporary adverse impacts, the beneficial impacts of a reduced bison herd as a result of alternative 2, when combined with the effects of other cumulative actions, would result in an overall beneficial cumulative impact. Alternative 2 would contribute a substantial increment to the overall beneficial cumulative impact.

Conclusion

As described for alternative 1, montane shrubland and interior chaparral is a primary vegetation type in the greater Grand Canyon landscape, whereas grasslands and meadows are not only rare in the action area (i.e., approximately 3% of the area), they are also rare within the greater Grand Canyon landscape and the southwestern United States (Stortz et al. 2016; NPS 2015e). Similarly, given the scarcity of water, wetland-associated vegetation is also extremely rare. These are all fundamental resources of the park (NPS 2010c); therefore, the overall reduction of the House Rock bison herd to fewer than 200 and the corresponding reduction in the overall pressure on these vegetation types from overgrazing and other disturbances would have important beneficial effects. Compared to current conditions, alternative 2 is expected to improve the vitality of native plants; increase cover of native plants; reduce the potential for conditions that facilitate the spread of exotic species; and maintain plant diversity at the community and ecosystem levels for grassland, meadow, shrublands, and wetland-associated vegetation. Compared to alternative 1, the reduction in the size of the House Rock bison herd under alternative 2 would greatly improve vegetation conditions in terms of species cover and diversity over time and help to improve the conditions of the resource by reducing adverse impacts associated with an expanded House Rock bison herd. The condition of these vegetation types would be more reflective of a condition prior to high concentrations of bison.

The bison management actions needed to achieve the desired bison density would contribute some small-scale adverse impacts on vegetation, primarily as a result of corralling live bison for removal. However, such actions are expected to only result in the temporary loss of 0.07% of grassland habitat per corral, and that habitat would be restored once the initial reduction of the House Rock bison herd is complete. Any potential for the spread of exotic plants would be addressed through revegetation and invasive plant treatment efforts. The effects of this and other management actions (e.g., crushing plants and spreading exotic plant seeds during access for lethal culling, carcass removal, hazing, and herding) are expected to be minimal with the implementation of mitigation measures and the timing of actions

described previously, and would be similar to the effects of any park management action that requires deploying staff to the field. Although alternative 2 would contribute minimal cumulative adverse impacts from the management actions taken, it would add important cumulative beneficial effects because of the reduction in impacts from bison grazing, trampling, and wallowing as a result of the reduced number of bison on the landscape. An overall beneficial cumulative impact is expected, and alternative 2 would contribute substantially to this overall cumulative impact.

Impacts on Vegetation on Adjacent Lands. Hazing, herding, or lethal culling pressure is expected to cause an increase in bison movement, including on to adjacent USFS lands. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, dispersing bison are expected to seek habitat outside the park that is similar to preferred habitat in the action area (i.e., grasslands, meadows, shrublands, and wetland-associated vegetation). The types of impacts dispersing bison would cause outside the park would be similar to the impacts described for the action area under the no-action alternative. These impacts could persist beyond the initial reduction phase if bison begin to spend more time outside of the park.

However, because fewer bison would disperse outside the park (compared to the resulting bison population under alternative 1), the impacts would be of a much lower magnitude. In addition, the *Kaibab National Forest Land and Resource Management Plan* (NPS 2014) notes that the goal of the US Forest Service is to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to plan's guidelines is expected to keep bison numbers at a level that would minimize their potential damage to sensitive plant species and habitats and decrease the potential spread of nonnative invasive species (USFS 2014).

SOILS

METHODS AND ASSUMPTIONS

The impact analysis for soils focuses on potential changes to erosion, compaction, and soil structure in areas where bison congregate as a result of the expected size of the House Rock bison herd associated with implementation of each alternative. This analysis centers on preferred habitats such as meadows and areas associated with seeps, springs, lakes, and ponds. While the issues of localized fencing for resource protection were dismissed in chapter 1, this analysis also briefly touches on the potential for management actions such as corralling to affect soils. Potential impacts on soils were evaluated based on resource expert knowledge, review of available research, professional judgment, anticipated locations for management activities, and the resource-specific issues identified in chapter 1. Additional assumptions are presented under each alternative as appropriate.

IMPACTS OF ALTERNATIVE 1 (NO ACTION) ON SOILS

The effects of the House Rock bison herd that have created the current conditions on the North Rim would continue and increase under this alternative. Qualitative observations of current soil conditions (Coraci et al. 2015; NPS, Tobin, pers. comm. 2016c) indicate that if the bison population increases by 250% (Plumb et al. 2016), increased wallowing and preferential use of springs, seeps, lakes, and ponds would lead to further trampling and compaction of soils (Urich 2002) which can increase soil percolation times (Coraci et al. 2015). In addition, trampling and compaction may lead to a loss of riparian vegetation cover and diversity that could further promote erosion and soil instability. In addition to increasing impacts in areas already experiencing high levels of bison use, the geographic extent of these impacts would likely increase as the herd size increases and bison pioneer to new parts of the park and affect

previously unaffected soil resources. As the bison herd grows, it is likely that the herd's movement and distribution would increase. Therefore, the likelihood that bison could cross through areas with biological soil crusts on their way to other places would remain low, but would increase. Damage from trampling breaks up the sheaths and filaments that hold soils with biological crusts together. With physical damage comes a loss of function; an area that loses as little as 10% of crust cover can increase soil losses by a factor of six in the following year. Any subsequent impacts on vegetation, via reductions in soil moisture and fertility, would take longer to manifest (NPS 2015a).

Cumulative Impacts

Fire management, road maintenance, bison trailing experiments, and vegetation management (restoration and exotic vegetation removal) in the park would all affect soil resources on the North Rim. Using prescribed fire in the landscape could have lasting beneficial impacts on soils by mitigating the risk of large-stand replacement fires that can damage the organic soil layer, increasing turbidity in water sources, and adding nutrients to water. Even with best management practices, road maintenance would result in the localized, linear (generally not more than 10 feet on either side of the road), compaction of soil, disturbance of soil through maintenance of the road shoulder, and potential contamination from oil and chemical leaks from equipment. The bison trailing experiments have localized, adverse impacts on soil conditions by increasing soil compaction and disturbance along the trailing route. This impact would last no more than a few days to a couple of months and could be mitigated by aerating the soil after the experiment, if needed. Revegetation and removal of exotic vegetation would have localized, soil disturbances that could lead to increased erosion for several weeks to months while crews are working in the field. However, natural revegetation would occur and increases in native plant cover would be expected result in the return of soils to a more natural biologic and nutrient condition because nutrient uptake by exotic vegetation would decrease.

While some past present, and reasonably foreseeable future actions (e.g., road maintenance, bison trailing experiments, and vegetation management) would lead to some short-lived (days to months) compaction and disturbance of soils, overall the cumulative actions would benefit soils by minimizing large-stand replacement fires that can damage the organic soil layer, increasing turbidity in water sources, and adding nutrients to water; and by increasing in native plant cover that would be expected to result in the return of soils to a more natural biologic and nutrient condition. However, when the adverse impacts of alternative 1 are combined with the impacts of these other past, present, and reasonably foreseeable future actions, an overall adverse impact is expected because soil conditions would worsen in areas affected by congregation of the increased herd and by wallowing, trailing, and other soil-disturbing behavior. Therefore, the resulting bison population under alternative 1 would be the primary driver for this overall adverse cumulative impact.

Conclusion

Under alternative 1, the growing House Rock bison herd would increase adverse impacts on soils on the North Rim, which are a fundamental resource to the park because of their role in shaping how landscape looks, the habitats that are present, the health of vegetation, and the quality of water and groundwater (NPS 2010c). Increased wallowing and larger congregations of bison that preferentially use springs, seeps, lakes, and ponds would lead to further trampling and compaction of soils (Urich 2002), which can increase soil percolation times (Coraci et al. 2015); and increased loss of wetland-associated vegetation cover and diversity that could further promote erosion and soil instability. As bison pioneer into new territories as a result of a growing House Rock bison herd size, these impacts would expand to new, previously undisturbed areas leading to more localized compaction and widespread soil disturbance and erosion that would vary in intensity based on spatial bison use patterns and concentrations. The shallow and poorly developed character of soils on the North Rim makes them more susceptible to these impacts

which may not be easily reversed without intervention. The impacts of other past, present, and reasonably foreseeable future actions (i.e., fire management, road maintenance, the bison trailing experiment, and vegetation management [restoration and exotic vegetation removal]) would result in overall beneficial impacts; however, when combined with alternative 1, overall cumulative impacts would be adverse, with alternative 1 contributing a substantial adverse increment.

Impacts on Soils on Adjacent Lands. The increase in the bison population under alternative 1 could cause bison (compared to current conditions) to move on to USFS lands adjacent to the park as a result of density-dependent pioneering behavior. Although the number of bison that may disperse and their movements as the populations grows would be unpredictable under alternative 1, pioneering bison are expected to seek habitat that is similar to preferred in the action area (i.e., grassland, meadow, shrubland, wetland-associated vegetation, and water sources). This could result in impacts on soils similar to those described in the action area, although based on current bison behavior (i.e., the fact bison spend the majority of their time in the park) more bison are expected to remain inside the park than outside. Therefore, impacts outside the park would be of a much lower magnitude than those inside the park. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity of the House Rock bison herd to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to plan's guidelines is anticipated to keep bison numbers at a level that would minimize potential damage to sensitive habitats (USFS 2014).

IMPACTS OF ALTERNATIVE 2 ON SOILS

Resulting Bison Population

Under this alternative, although the resulting House Rock bison herd would be fewer than 200 animals, bison would most likely continue to use many of the same sites they use currently. And while soil compaction, erosion, and degradation could continue in these localized areas, the severity and spatial extent of disturbance and compaction would be reduced as the number of animals that congregate in the meadows and near water sites are reduced. And, although soils are shallow, poorly developed, and susceptible to impacts, as the intensity and frequency of disturbance decreases, there would be less erosion, compaction, and as a result soils, including percolation times, should improve. Soil aeration in heavily compacted areas in meadows and near water sources could speed soil recovery. In addition, the decrease in the House Rock bison herd size would limit potential pioneering behavior to new parts of the North Rim, meaning soils currently unaffected by bison would likely remain that way. As the bison herd grows smaller, it is likely that the herd's movement and distribution would decrease, as would the likelihood that bison could cross through areas with biological soil crusts on their way to other places. However, should bison trample these soil crusts, damage to them could be take years or decades to recover.

Nonlethal Culling

Under alternative 2, the National Park Service may use up to five corrals to capture live bison (see figure 2). Corral installation would require the use of heavy blocks that anchor the corral fences and some off-road vehicle access that could result in localized (at the site of the anchors and where vehicles have been driven) soil compaction and increase potential for erosion each time a corral is installed/removed over the 3 to 5 years of implementation. Each corral would likely require an access corridor no more than approximately 0.25-mile long, and it is expected up to 100 trips would be needed during implementation to construct/remove corrals and remove captured bison. In total, it is expected approximately 2 acres of

soils would be disturbed at any one corral site (and a total of approximately 10 acres) from accessing the site, installing, and using each corral.

Bison would remain within the corrals for short amounts of time (likely not more than a few days) before they are loaded on to trailers. Depending on the number of bison in the corrals and surrounding areas and how long they remain in the corrals, the severity of the compaction would vary. The areas inside the corrals would experience the most impacts because bison would heavily forage, trample, and wallow in the enclosed areas, resulting in a change in native plant cover, compaction, and increased potential for erosion within the corrals. Similar impacts on soils outside the corral would also occur as additional bison congregate in those areas either from being attracted to the bait or as bison groups are separated. However, the level of impact from grazing, trampling, and wallowing in these adjacent areas would unlikely exceed those occurring in the corrals because bison would not be confined. During operations, impacts would be minimized by corral design and removal speed (both of corralled bison and of the corral structures), because the extent of possible disturbances to soil resources is related to the amount of time that the structures remain in the area and the bison remain in the structures. Post-action soil aeration and revegetation would assist with soil recovery once corralling operations are completed.

Lethal Culling

Lethal culling teams and stock animals congregating in small areas during lethal culling and carcass removal events would cause relatively localized and minimal soil disturbance and compaction. Although lethal culling could occur throughout the North Rim (see figure 2) activities are unlikely to occur in the same area over an extended period of time as lethal culling teams would follow bison as they move in response to management actions. Vehicles and snow machines could affect soils through compaction and disturbances, but would be restricted to established roads to access lethal culling areas. Therefore, impacts on soils from vehicles and snow machines would occur in small areas adjacent to roads, and, in winter, impacts would depend on the amount of snow cover (i.e., more snow would protect soils). The movement across soils and congregation of lethal culling and removal teams, including stock and carcass removal activities, could adversely impact soils through disturbance and compaction. Limiting access options and methods for the lethal culling and carcass removal teams would minimize potential soil disturbance.

Hazing and Herding

Impacts from personnel entering areas on foot or by stock animal for hazing and herding techniques to direct bison to other areas of the North Rim would be similar to those described for accessing sites for lethal culling efforts. Depending on the frequency, timing (e.g., summer vs. winter), and efficacy of this management tool, adverse impacts on soils from compaction, trailing, and wallowing in areas currently affected by high bison concentrations would likely decrease because the animals would be moved out of these areas. However, as bison trail each other when they are guided to other areas, trampling and grazing of vegetation in bison travel corridors could potentially increase, resulting in a change in native plant cover, compaction, and increased potential for erosion along the corrals. Additional impacts, such as soil compaction and increased erosion potential would likely occur in destination areas once hazing and herding ceases, as a result of the concentrated trampling and wallowing of the bison. However, this tool would only be used to help facilitate bison removal or for the protection of sensitive resources. Associated impacts on soil would not occur frequently and are expected to be temporary as recovery, either naturally during the next growing season or with active restoration once the hazing or herding is complete. Bison would be unlikely to remain in the destination areas in concentrated numbers because additional reduction tools would be used to remove them.

Exclusion Fencing

Alternative 2 would use exclusion fencing around the perimeter of water sources on the North Rim where resources are at risk of experiencing adverse and potentially permanent impacts from high concentrations of the House Rock bison herd. This fencing, described in chapter 2, would be configured differently from the corral fencing. Areas for fencing would be limited to the periphery of springs and seeps. Soil disturbance would be limited to the footprint of the posts, deadmen, and anchor wires, as described in chapter 2, so that impacts would be minimal. Postholes would be small, no more than 10–12 inches in diameter, and placed 16 to 20 feet apart. Any adverse effects during fence construction or maintenance would be limited because of the small footprint of the post holes. Soils would benefit, as described above for the resulting bison population, from reduced trampling, and wallowing.

Management Cycle

The impacts on soils over the 3- to 5-year management cycle, including from lethal and nonlethal culling and hazing and herding, are not expected to have synergistic or additive effects that would result in greater impacts than previously described. Impacts on soils associated with nonlethal culling activities would be localized and limited to the corral sites only, and revegetation at the corral sites would limit the scope of the effects on soils over time. Effects on soils associated with lethal culling would generally be limited and would be spread out geographically, such that it is unlikely that impacts would occur in the same locations over the 3- to 5-year cycle. Impacts on soils from hazing and herding would be minimal because this action would only be used periodically over the management cycle.

Cumulative Impacts

Impacts from other past, present, and reasonably foreseeable future actions would be the same as those described for alternative 1 and would be mainly beneficial from the use of prescribed fire and vegetation management on the landscape. Alternative 2 would result in localized soil disturbance that could lead to erosion and compaction from reduction activities that congregate bison and add people and equipment to the landscape. These adverse impacts could be mitigated with soil aeration and other soil conservation measures, so they would be short-lived if mitigation occurs soon after the actions take place. More importantly, alternative 2 would result in long-term benefits to soils because trampling, wallowing, and compaction would diminish as the House Rock bison herd is reduced in the park. Under alternative 2, soil resources could recover over time once the House Rock bison herd size and associated soil-disturbing behaviors decrease. The reduction actions themselves would contribute relatively small, adverse impacts. Although there would be some limited adverse impacts associated with the cumulative actions and alternative 2, when the beneficial impacts on soils from the reduction of the House Rock bison herd under alternative 2 are realized and combined with the effects of other past, present, and reasonably foreseeable future actions, the overall cumulative impact on soils would be beneficial. The contributing increment of alternative 2 to this overall beneficial impact would be substantial.

Conclusion

As noted in the conclusion discussion for alternative 1, soils in the park are fundamental to the ecological health of the park (NPS 2010c) and are also relatively sensitive to impacts because they tend to be shallow and poorly developed. Under this alternative, soil resources on the North Rim would improve over time as the House Rock bison herd decreases and the concentration and frequency of impacts from soil-disturbing bison behavior decreases. The resulting House Rock bison herd should be small enough to have little effect on most of the soil resources of the area except for extremely localized impacts where the herd may congregate and remain for extended periods. Indirect impacts from this alternative would include increased soil function over time after the House Rock bison herd is reduced. Compared to

alternative 1, the reduction in the size of the House Rock bison herd under alternative 2 would help to improve the conditions of the resource by reducing adverse impacts associated with an expanded bison population. The condition of soils on the North Rim would be more reflective of a condition prior to high concentrations of bison.

Management actions themselves would have limited impacts, with localized soil compaction, disturbance, and erosion most apparent to the approximately 10 acres of soils that would be disturbed for corralling operations. Lethal culling and hazing and herding activities would have some potential to cause similar impacts, but they would be limited to small areas where lethal culling would occur or along trailing routes, spread out geographically, and unlikely to occur in the same locations over the 3- to 5-year cycle. In addition, hazing and herding would only be used periodically over the management cycle. Mitigation actions, such as aeration and revegetation after these activities cease would also minimize the severity and duration of these adverse impacts.

Although some limited adverse impacts would be associated with cumulative actions and the implementat ion of management actions under alternative 2, when the beneficial impacts on soils from the reduction of the House Rock bison herd under alternative 2 are realized and combined with the effects of other past, p resent, and reasonably foreseeable future actions, the overall cumulative impact on soils would be benefic ial. The contributing increment of alternative 2 to this overall beneficial impact would be substantial.

Impacts on Soils on Adjacent Lands. Hazing, herding, or lethal culling pressure is expected to cause an increase in bison movement, including on to adjacent USFS lands. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, dispersing bison are expected to seek habitat outside the park that is similar to preferred habitat in the action area (i.e., grasslands, meadows, shrublands, wetland-associated vegetation, and water sources). The types of impacts dispersing bison would cause to soils outside the park would be similar to the impacts described for the action area under the no-action alternative. These impacts could persist beyond the initial reduction phase if bison begin to spend more time outside of the park.

However, because fewer bison would move outside the park (compared to the resulting bison population under alternative 1), the impacts would be of a much lower magnitude. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to the plan's guidelines is anticipated to keep bison numbers at a level that would minimize potential damage to sensitive habitats (USFS 2014).

WILDLIFE (OTHER THAN BISON) AND WILDLIFE HABITAT

METHODS AND ASSUMPTIONS

The impact analysis for wildlife and wildlife habitat focuses on potential changes to the presence and distribution of wildlife species (excluding bison) and quality of their habitat as a result of the expected size of the House Rock bison herd associated with implementation of each alternative. This analysis addresses the resource-specific issues as identified in chapter 1 and assesses the potential for reduction actions to disturb wildlife or affect wildlife habitat. Specifically, the analysis focuses on disturbance from human presence and the level, duration, and extent of noise disturbance during sensitive periods (for alternative 2).

Wildlife have varying sensitivities to noise levels. Mammals, as the most sensitive species, express sensitivities from -20 decibels (dBA), birds from 0 dBA to10 dBA, reptiles from 40 dBA to 50 dBA, and amphibians from 10 dBA to 60 dBA (FHWA 2004). The reaction to noise is variable and studies suggest they can be related to the experiences of the individual and groups of wildlife affected (Frazier 1972 as cited in Manci et al. 1988); environmental conditions; age class and gender; season; type and distance (e.g., elevation of aircraft) of noise sources; and even the activity the wildlife is participating in prior to the disturbance all may influence the reaction (NPS 1994; Ellis, Ellis, and Mindell 1991). Furthermore, several studies (NPS 1994; Carrier and Melquist 1976; Kushlan 1979) conclude that minimal use of aircraft, such as limited-season aerial surveys proposed in this EA, are not likely to cause harm or have long-term effects on mammal or bird species; however, no long-term studies have been conducted to confirm this conclusion.

In assessing the potential effects of noise, NPS considered the following sample noise levels of background natural noise levels compared to artificial noise levels each measured in A-weighted decibels. Table 8 compares the noise levels experienced in different national park units compared to more ordinary noises the public may be readily exposed to, as well as noise levels associated with vehicles or tools being proposed.

TABLE 8. COMPARISON OF BACKGROUND NOISE LEVELS AND COMMON SOUND SOURCES

Sound Sources Measured at Parks[1]	Other Common Sound Sources	Approximate dBA (A-weighted decibel)
Volcano Crater, Haleakala National Park	Human breathing at 9 feet[2]	10
Leaves Rustling, Canyonlands National Park	Whispering[2]	20
Crickets at 15 feet, Zion National Park	Residential area at night[2]	40
Conversation at 15 feet, Whitman Missions National Historic Site	Busy restaurant[3]; Cessna fixed-wing aircraft on approach[4]	60-62
	Pickup truck[5]	75
Snowcoach at 90 feet, Yellowstone National Park	Curbside of busy street[6]; Excavator[5]	80
	Hughes 500 helicopter[7]	71–90
Thunder, Arches National Park	Jackhammer at 6 feet[8]	100
Military Jet 300 feet AGL, Yukon-Charley Rivers National Preserve	Automobile horn at 3 feet[2]	120
	.22 Caliber rifle[9]	140
	Large-bore rifles and pistols[9]	>175

Notes:
1 NPS 2011b
2 Berger and Kladden 2005
3 The Engineering ToolBox n.d.
4 Federal Aviation Administration 1996
5 FHWA 2015
6 American Speech-Language Hearing Association 2017a
7 Federal Aviation Administration 1977
8 Purdue University 2015
9 American Speech-Language Hearing Association 2017b

The analysis also considers habitat alteration from management actions (e.g., corralling) and bison associated behaviors (e.g., wallowing, foraging), and competition for resources (e.g., water, forage) with

other wildlife based on the remnant size of the House Rock bison herd (for alternative 2). Potential impacts on wildlife and wildlife habitat were evaluated based on resource expert knowledge and professional judgment, review of available published and unpublished research, consultation and communication with park and cooperating agency staff, and anticipated locations and timing of reduction activities. Additional assumptions are presented under each alternative as appropriate.

IMPACTS OF ALTERNATIVE 1 (NO ACTION) ON WILDLIFE (OTHER THAN BISON)

Under alternative 1, impacts on wildlife and wildlife habitat would result from increasing competition for resources with bison (e.g., forage, water), changes to the landscape as a result of bison behavior (e.g., wallowing, travelling), and disturbance or displacement of wildlife. Since the establishment of the park in 1919, the North Rim landscape has been devoid of large ungulates (specifically bison) until only the last several decades. Therefore potential impacts on the associated ecological communities and wildlife of the North Rim are only beginning to be understood. At the current estimated population level of approximately 600 animals, the House Rock bison herd are already potentially affecting other wildlife species; with an increasing population that may reach 1,200 to 1,500 animals over the next 10 years (Sturm and Holm 2015), such impacts are likely to become more pronounced. Given this context, impacts on specific groups of wildlife and their associated habitat are discussed briefly below.

Mammals

Small Mammals. The increase in the House Rock bison herd could affect ground-dwelling small mammals through the potential for disturbance from bison travelling across the landscape and possibly direct mortality from trampling. Although bison travel through all habitat types on the North Rim, their preference for grazing and wallowing in the open meadows could result in greater impacts on small mammals and habitat within these areas. The physical presence of bison in open meadows could temporarily and directly disturb small mammals. Indirect small mammal mortality could occur from the impacts of bison on vegetation and other habitat components in these intensively used areas, if such impacts removed vegetative cover that small mammals rely on to hide in or escape from predators (as described in chapter 3). Grazing bison would also be removing potential forage for meadow-associated small mammals (e.g., seed heads). In particular, several studies indicate potentially negative impacts on rodents that occupy meadow habitat where grazing occurs (Heske and Campbell 1991; Rosenstock 1996). Other studies indicate that some meadow-associated rodent species could increase in abundance over the short term (Jones and Longland 1999); however, the long-term degradation of meadows and conversion of small portions of meadow habitat into bare ground (e.g., through wallowing) have unsustainable long-term, negative impacts at the population level. Bison use and depletion of water sources could potentially affect small mammals, particularly bats, which rely on the water sources for drinking and for foraging on the insects that are drawn to the water and wetland associated plants. A potential increase in predators due to the increase in the House Rock bison herd also could have negative impacts on small mammal populations (see "Carnivores and Mammalian Scavengers" below). As a result of all these factors in combination, the number of certain small mammal populations (e.g., ground squirrels, voles, shrews, and mice) could decrease in conjunction with a growing House Rock bison herd.

Carnivores and Mammalian Scavengers. The increase in the House Rock bison herd could have positive impacts on carnivores and mammalian scavengers because bison would provide an additional source of potential prey and biomass for carnivores and mammalian scavengers. Although little direct evidence of bison predation on the North Rim currently exists, the opportunity and availability of bison for predation from coyotes, bears, and possibly cougars could increase as the House Rock bison herd size rises. Bison calves would likely be the most vulnerable component of the House Rock bison herd to predators that inhabit the North Rim. In addition, the number of natural and other mortalities (e.g., road kills) would likely increase, thereby providing food for mammalian scavengers, such as raccoon and

skunks. As a result, the population of carnivores and scavengers could increase in conjunction with a growing House Rock bison herd, although scavengers consuming road kills are vulnerable to mortality from vehicles as well.

Ungulates. The increase in the House Rock bison herd could directly affect mule deer through competition for vegetation (forage) and water and displacement of mule deer from preferred habitats and disturbance. The Kaibab Plateau, which includes the action area, has long been recognized as an important mule deer summer range (AGFD 1999). Mule deer migrate up in elevation on to the Kaibab Plateau in May and give birth to fawns. They stay and forage and raise the fawns on the Kaibab Plateau through early fall, when they begin to migrate to lower elevation for the winter. Mule deer prefer to forage in meadows but will also browse on shrubs and other vegetation. The presence of 1,200 to 1,500 bison within the meadow habitats of the park would likely eliminate the forage that would have been available for deer. In addition, bison and mule deer would be competing for water, with bison consuming up to 10 gallons of water per animal per day. These actions could potentially reduce the fitness of individual deer. Severe reductions in fitness to many deer (particularly females) could have population-level effects on deer abundance. Because predators such as coyotes, bears, and cougars within the current range of the bison opportunistically kill other ungulates, namely deer, a potential increase in predators, could also lead to a decrease in the size of the deer population.

Birds

The increase in the House Rock bison herd could indirectly affect birds through habitat degradation and directly affect any ground-nesting birds through trampling of nest sites (e.g., dark-eyed junco, spotted towhee). To a lesser degree, competition for water and some types of vegetation could increase, and birds could be temporarily displaced from preferred foraging spots and watering sites. This would lead to reduced nesting success and increased physiological stress that could result in a decline in population numbers for these birds. In addition, an increase in the House Rock bison herd size could also lead to an increase in brown-headed cowbirds, which are known to be associated with large grazing ungulates (e.g., cattle, bison). While beneficial for cowbirds, this could also increase songbird (e.g., sparrow, finch, swallow) nest parasitism. Nest parasitism occurs when cowbirds lay their eggs in the nests of other unrelated birds that then provide incubation and all parental care needed until the young are fledged (Parrish, Howe, and Norvell 2002). This could result in decreased nesting success for these songbirds and a decrease in their population numbers.

However, some species of insectivorous birds (e.g., mountain bluebird) and generalists (e.g., ravens) could see an increase in both small and large insects that are attracted to bison dung and would provide more forage for these birds. Increased availability of bison carcasses associated with a larger herd could also provide more forage for scavenging birds, such as turkey vultures and ravens. This additional forage could lead to increases in insectivorous birds in the park. The North Rim is also occupied seasonally by a variety of migratory birds for nesting and chick rearing (Gatlin 2013). The presence of 1,200 to 1,500 bison could reduce their productivity and preclude some meadow-associated and ground-nesting birds from important breeding habitats.

Reptiles and Amphibians

Bison use and depletion of water sources could directly affect reptiles and amphibians because many species (e.g., tiger salamander and spadefoot toad) depend on water and living in or near water for portions of their life cycles. Portions of amphibian life cycles that would be particularly vulnerable to disturbance and trampling include breeding sites, where many individuals gather for reproduction, underwater egg laying pools, and tadpole and larval rearing sites. The increase in the House Rock bison herd could degrade habitat for reptiles and amphibians by increasing feces deposition in the water,

increasing turbidity (from bison walking into water sources), and decreasing water quality. Beever and Brussard (2004) also found greater reptile species richness and a tendency for greater reptile abundance when large grazers (horses) were removed from a study site. Bison travelling across the landscape could disturb or temporarily displace reptiles and amphibians that could possibly experience direct mortality as a result of trampling or stampeding. All of these impacts could lead to decreased numbers of reptiles and amphibians in areas of the North Rim used by the House Rock bison herd.

Cumulative Impacts

Fire and vegetation (habitat) management activities would have similar impacts on other wildlife (e.g., the removal of substantial amounts of wildlife habitat in the short term and the early successional stages of vegetation regrowth, which benefit many wildlife species), as described for alternative 1 for the House Rock bison herd. In addition, prescribed fire on the landscape could have beneficial impacts on wildlife habitat by mitigating the risk of high-intensity wildfires (Finney, McHugh, and Grenfell 2005; Agee and Skinner 2005), which pose a threat to the long-term stability of wildlife habitat (Keeley 2006). The timing (e.g., inside or outside of wildlife breeding periods) of fires and vegetation management would also be important in determining potential impacts on wildlife and wildlife habitat; actions during breeding and young rearing periods have the potential for the most impacts.

Outside of the park, some wildlife is managed by hunting under AGFD regulations, which is targeted at identified game species, including bison, deer, turkeys, squirrels, and predators. Hunting wildlife outside the park could reduce the numbers of these wildlife within the park because the wildlife killed by hunting within proximity to the park are often associated with park wildlife populations. However, hunting could also improve habitat condition by keeping game animal populations in balance with available resources. Other AGFD actions outside of the park involve management specific to bison (besides hunting) and other wildlife monitoring and water and habitat improvement projects. These action s would directly and indirectly benefit other wildlife by providing higher quality habitat, more forage, and more water for wildlife populations that are found in the area.

The park performs limited wildlife surveys and research within the action area, mostly with special-status species and bison. These studies would have little or no effect on wildlife themselves, other than the indirect benefits of increasing the park's understanding of the status of these species on the North Rim. Sightseeing tours in fixed-wing aircraft and helicopters and park management flights over the North Rim of the park and within the action area also have the potential to disturb wildlife that travel or reside near the designated flight paths, which could cause transient increases in movement and physiological stress that would go away once airc raft has passed.

As described above, although temporary disturbances and changes in the abundance of other wildlife associated with cumulative actions would occur, other past, present, and reasonably foreseeable actions would have primarily beneficial impacts on other wildlife by improving habitat and minimizing competition for resources. When combined with alternative 1, , the overall cumulative impact would be adverse because the large size of the House Rock bison herd that would be present within the park under this alternative (approximately 1,200 to 1,500) would result in habitat degradation, competition, and displacement of other wildlife. The incremental effect of alternative 1 when added to these other past, present, and reasonably foreseeable impacts would be considerable.

Conclusion

The Kaibab Plateau, including the portion within the boundaries of the park, encompasses several unique vegetative communities, such as high elevation mixed conifer forest and open grassy meadows that are

not found in any other portions of the park. These habitats in turn serve as important and unique refugia for many wildlife species that are not always found within other areas of the park. Various wildlife species use these habitats on a year-round or seasonal basis to provide basic food, shelter, and water for themselves and their offspring. Under alternative 1, while a larger House Rock bison herd would provide more food for some wildlife (e.g., carnivores, scavengers, and insectivorous birds), adverse impacts on wildlife habitat on the North Rim would increase, especially those impacts related to increased overgrazing, trampling, and wallowing by the large size of the House Rock bison herd (approximately 1,200 to 1,500 in 10 years). Impacts would be most apparent and detrimental to other wildlife within vegetation associated with meadows and around water sources, although impacts would also occur as a result of bison trailing though the forest and using recently burned areas. Water is a limited resource in Arizona, including on the North Rim where no free flowing year-round water exists. All wildlife species on the North Rim depend on existing seasonal water sources, many of which are currently adversely affected by the House Rock bison herd. Competition for water would increase and spread as the House Rock bison herd increases and spreads, likely resulting in early depletion of some seasonal water sources compared to current conditions, and drastically different than conditions before bison moved into the park from House Rock Wildlife Area. Under this alternative, all wildlife species could be disturbed or displaced by an ever-growing bison population, and all wildlife species would face increased competition with bison for forage and space. When combined with alternative 1, which would lead to increased forage for some wildlife (e.g., carnivores, scavengers, and insectivorous birds) and habitat degradation and decreased population numbers for other wildlife (e.g., small mammals, ungulates, ground-nesting birds, songbirds, reptiles, and amphibians), the overall cumulative impact would be adverse because of habitat degradation, competition, and displacement of other wildlife expected as a result of the large size of the House Rock bison herd that would be present within the park under this alternative (approximately 1,200 to 1,500). The incremental effect of alternative 1 when added to these other past, present, and reasonably foreseeable impacts would be considerable.

Impacts on Wildlife on Adjacent Lands. The increase in the bison population under alternative 1 could cause more bison (compared to current conditions) to move on to USFS lands adjacent to the park as a result of density-dependent pioneering behavior. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, pioneering bison are expected to seek habitat similar to that preferred in the action area (i.e., grassland, meadow, shrubland, wetland-associated vegetation, and water sources). This could result in similar impacts on those less mobile species, such as small mammals or species that rely on these habitat types for a portion of their life-history (e.g., grassland birds or reptiles and amphibians). However, more bison are expected to remain inside the park than outside based on current bison behavior (i.e., the fact bison spend the majority of their time in the park); therefore, impacts on specific species of wildlife outside the park would be of a much lower magnitude. The effects on species that are mobile or wide-ranging are unlikely to be different from those in the action area. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to the plan's guidelines would keep bison numbers at a level that would minimize potential damage to sensitive habitats (USFS 2014).

IMPACTS OF ALTERNATIVE 2 ON WILDLIFE (OTHER THAN BISON)

Under alternative 2, the impacts on wildlife from competition with the House Rock bison herd for resources and from changes to the ecological landscape would be reduced substantially. However, the actions to reduce bison numbers would have some local and temporary impacts on other wildlife. Most impacts on other wildlife would likely stem from increased noise as a result of reduction actions.

Locations throughout the North Rim of the park experience the natural quiet of the designated wilderness areas affected only by vehicles along the designated roads, the presence of visitors, maintenance activities, and sporadic aircraft overflights. Natural condition range from 0 dBA to 40 dBA (the sound of rain). General noise levels from temporary activities associated with alternative 2 would include the discharge of firearms (140 dBA–175 dBA), truck/trailer use (75 dBA), fixed-wing aircraft (60 dBA–62 dBA) and helicopter use (approximately 90 dBA). Impacts on three ecologically similar wildlife groups are discussed below for each relevant element of alternative 2.

Remnant Bison Population

Mammals. Reduction of the House Rock bison herd could affect mammal species in the action area in a number of ways.

Small Mammals—Reducing the House Rock bison herd to fewer than 200 animals would increase, compared to the current condition, plant cover, forage, and seed production. Effects related to increasing food and cover would be beneficial and could improve survivorship and reproductive rates for small mammals, and potentially result in larger populations. While the potential impacts of bison on small mammals described for alternative 1 (which are a result of bison disturbance, trampling, grazing, wallowing, and competition for water and forage) would still be present with the smaller House Rock bison herd size, these impacts would occur at a much lesser degree.

Carnivores and Mammalian Scavengers—The remnant House Rock bison herd of fewer than 200 animals would provide less prey and carrion for carnivores and mammalian scavengers compared to what is available at the current population size (approximately 400–600 bison). However, these species were present in the action area prior to the bison's arrival, indicating an ability to survive using other prey populations. Other prey include small mammals and ungulates, and any potential increase in these populations could somewhat offset the loss of bison.

Ungulates—The remnant House Rock bison herd would result in less competition with mule deer for preferred foraging habitats (i.e., meadows) and water. In addition, fewer bison on the landscape is expected to result in increases in available forage as a result of improvements in vitality of native plants and plant diversity at the community and ecosystem levels, improved water quality, and increased water quantity in localized seeps and springs on the North Rim. Reduced competition coupled with these habitat improvements would have beneficial effects because it would mean less physiological stress, increased food, and more available water, especially during the summer months when mule deer use the North Rim as summer range. This could improve survivorship and reproductive rates for ungulates and potentially result in larger populations.

Birds. Fewer bison in the park would allow for more grass and forbs to be available in meadows, helping to provide more cover and forage for meadow-associated bird species (e.g., mountain bluebirds). Ground-nesting bird species (e.g., dark-eyed juncos) would also be less likely to be disturbed or have nests trampled. This would have beneficial effects by increasing food and cover and reducing loss of nests, which could improve survivorship and reproductive rates for meadow-associated and ground-nesting birds and potentially result in larger populations. The reduction in brown-headed cowbirds and associated nest parasitism from a reduction in the House Rock bison herd is also expected to result in beneficial impacts for songbirds (e.g., sparrows, finches, swallows) as a result of improved nesting success and potentially increased population sizes. While some birds may benefit from this reduction, the remnant House Rock bison herd size of fewer than 200 animals would provide less carrion for scavenging birds (e.g., ravens and vultures) compared to what is available at the current population size. However, as noted for mammalian scavengers, these species were present in the action area prior to the bison's arrival, indicating an ability to survive with less bison carrion. Although the remnant House Rock bison herd

could still indirectly affect birds through direct disturbance and displacement within some habitats preferred by bison (e.g., meadows), as described for alternative 1, these would occur at a lesser degree.

Reptiles and Amphibians. Alternative 2 would result in habitat improvements for reptiles and amphibians compared to current condition because water quality is expected to improve with reduced bison defecation and reduced turbidity as fewer bison use and walk through water sources. Fencing some water sources would eliminate bison use of those areas and would improve habitat conditions. These improvements, coupled with lower bison densities, could result in less competition with reptiles and amphibians for scarce water resources across the North Rim. Less habitat surrounding water sources would be trampled, which should result in increases in vegetation and invertebrate prey population. Improved habitat conditions, less physiological stress associated with reduced competition, and increased prey populations could improve survivorship and reproductive rates for reptiles and amphibians and potentially result in larger populations at local water sources. However, the potential impacts discussed under alternative 1 (water utilization, degradation and depletion of water, and direct mortality due to trampling and disturbance) would still be present at some water sources used by the remnant House Rock bison herd, but these impacts would likely occur to a lesser degree as a result of lower bison densities.

Nonlethal Culling

Capturing bison would involve the construction of up to five corrals in different parts of the park (see figure 2 in chapter 1), each up to 2 acres in size. While the corral construction would not take more than a day or two, corralling operations, which would attract large numbers of bison into meadows associated with corral sites, could last days to weeks. In addition, up to 10 truck/trailer trips would be needed to remove captured bison each year.

The noise associated with vehicles and equipment (e.g., backhoes with noise levels of approximately 80 dBA) used to construct the corrals and vehicles/stock trailers (approximately 75 dBA each) to remove bison from the corrals would exceed natural sound conditions and thresholds for disturbances to wildlife as noted previously. Similar to the use of trucks, the use of the construction equipment would substantially increase the ambient noise level compared to natural conditions. However, each event would be limited in duration to several hours during construction and bison removal events. This disturbance would occur at/adjacent to corral sites and along roads that vehicles must travel on to get to the sites. Because nonlethal culling operations would generally be conducted from June–September, this could disturb mammal, reptile, and amphibian birthing/rearing of young as well as bird nesting and rearing of chicks. When coupled with the large concentrations of bison that are expected in the area (because of the presence of bait and water), this could result in displacement and disruptions that cause increased physiological stress during important parts of wildlife life cycles. For example, mule deer use these meadows as summer range for fawning and foraging, so disruptions could result in decreased fitness of individual mule deer that rely on these areas. It could also lead to nest abandonment or destruction (as a result of trampling by vehicles and/or large numbers of bison) and loss of chicks in these locations. Trampling would be less of a concern for reptiles and amphibians because corrals and access routes would be placed to avoid sensitive water resources that provide habitat for these animals. The increased activity could also result in smaller animals being trampled or struck by vehicles.

If all corrals are used in a given year, approximately 10 acres of vegetation within the immediate footprint of the corrals would be trampled and/or removed in addition to vegetation along any off-road access needed to remove bison from the corrals. Wildlife would likely avoid these localized areas and be displaced into adjacent habitat until the areas are revegetated after infrastructure is removed. This could result in some increased competition for the days/weeks that the corrals are in use.

These disruptions, mortality of individual wildlife, and habitat degradation would have adverse effects

that could lead to reduced wildlife population numbers in the vicinity of corral sites on the North Rim. However, these disturbances are expected to be limited to the corral sites, adjacent habitat, and along roads needed to access the sites and disruptions and habitat degradation would only last days to weeks. Therefore, any displaced/disturbed animals are expected to return/recover when corralling ceases in an area. This would also limit the extent of the area and the time during which wildlife may be trampled and killed during such activities.

While some carnivores and scavenging mammals/birds may avoid the area, some could benefit from the congregation of large numbers of bison attracted into meadows associated with corral sites because more potential prey may be present. Wildlife that use the water and bait at the corral sites (e.g., mule deer, birds) might also benefit from improvements in fitness during the days/weeks that the corrals are in use. Some wildlife (e.g., mule deer, birds) that use the bait and water associated with corralling would receive a high quality food supplement and have access to water, which is often a limited resource on the North Rim, possibly improving their fitness during the days/weeks corrals are in use. However, these benefits are not expected to result in noticeable increases in survivability or populations of animals because the additional food/water sources would be temporary.

Lethal Culling

Under alternative 2, lethal culling and carcass removal teams of up to 25 people would access areas where bison are located by foot, truck, and/or snow machines on existing park roads, resulting in approximately 1,440 vehicle days over the course of the approximately 30 weeks of each primary lethal culling period, and 352 vehicle days during the approximately 22 weeks of the secondary lethal culling period. In addition, a maximum of 52 fixed-wing aircraft flights (approximately 1 to 2 flights per week) could also be needed to locate bison (to focus lethal culling efforts) or to monitor bison. The noise associated with the presence of people; the use of vehicles (approximately 75 dBA per vehicle), snow machines (approximately 80 dBA per vehicle), and aircraft (approximately 60 dBA–62 dBA); and discharging of firearms (approximately 140 dBA–175 dBA) would exceed the natural sound conditions and thresholds for disturbance to/displacement of wildlife noted previously for up to 16 hours per day for approximately 4 days per week over 30 weeks. However, the noise generated by reduction actions would be intermittent in nature, and periods of natural quiet would return throughout the 16-hour work day. Noise disturbance associated with vehicles would last the longest; however, the disturbance would move with the vehicle. The use of firearms would have the loudest but shortest disturbance because noise generated from the discharge of firearms would be instantaneous.

These noise exceedances would occur in and around active lethal culling areas (i.e., where bison occur), and while they could occur year-round, most activity is expected during the April to mid-May and mid-October to December lethal culling periods when two to three lethal culling teams would be present. The April to mid-May removal period coincides with the period when small mammals could be rearing young, birds could be nesting or rearing chicks, and reptiles and amphibians may be reproducing. This could result in displacement and disruptions that cause increased physiological stress during important parts of wildlife life cycles. Two to three lethal culling teams would also be present in the park during the mid-October to December lethal culling period. However, some species of wildlife migrate away from the North Rim during the fall/winter (e.g., mule deer), become less active, or hibernate (e.g., reptiles and amphibians), which would limit the number of animals affected. Lethal culling could also occur from July to September, but only be one team would be working in the park during this time, and this would limit the disruptions during a time of year when small mammals/birds may be giving birth, nesting, or rearing young/chicks.

The use of helicopters to retrieve bison carcasses from remote areas would also cause some exceedances of natural sound conditions and thresholds for disturbance to/displacement of wildlife, but the impacts are

expected to be limited to 6 times per year for 1 to 2 hours at a time. These noise increases would be substantial when compared to natural conditions. In addition, carcass processors would also access areas on foot with up to 12 to 16 stock animals per week. Disturbance from the noise and the presence of people associated with carcass processing would be much less than that of vehicles, helicopters/aircraft, and the discharge of firearms and would add a relatively small contribution to the impacts noted above.

1,440 vehicle days over the course of the approximately 30 weeks of each primary lethal culling period, and 352 vehicle days during the approximately 22 weeks of the secondary lethal culling period, the presence of teams of up to 25 people, and the use of 12 to 16 stock animals could also cause an increase in the trampling of small mammals, birds, reptiles, and amphibians, which would result in mortality of individual wildlife. Trampling would be less of a concern for reptiles and amphibians because lethal culling teams would be trained to avoid crossing sensitive water resources that provide habitat for these animals. Additionally, accidental shootings could occur and could also result in the mortality of individual wildlife.

Disruptions to and mortality of individual wildlife would have adverse effects that could lead to reduced wildlife population numbers in areas where lethal culling would occur on the North Rim. However, these disturbances are expected to be limited to active lethal culling areas and adjacent habitat, and displaced/disturbed animals are expected to return/recover when lethal culling ceases in an area. This would also limit the extent of the area where wildlife may be trampled and killed during such activities.

Additionally, the presence of gut piles and other unretrieved bison carcass parts could provide additional forage for some carnivores and mammalian scavengers (e.g., coyotes, raccoons) and scavenging species of birds (e.g., ravens, vultures). However, the amount of additional forage would decrease over time because fewer bison would be lethally removed as the park approaches less than 200 bison (see Sturm and Holm 2015). As a result, this additional forage is not expected to cause noticeable changes in survivability or population numbers of these wildlife.

Hazing and Herding

Herding and hazing to move bison away from the rim areas could occur at any time of the year but would likely be most common from fall through spring. It could potentially be associated with summer nonlethal culling operations. When used, hazing and herding would likely result in the displacement of mammals, birds, reptiles, and amphibians from forced movement of bison, the presence and travel of people (vehicle, foot travel, and stock), and the potential use of noise devices and aircraft that would exceed natural sound conditions and noise thresholds for wildlife described previously. The use of helicopters for hazing and herding would result in similar impacts related to noise disturbance as described above for helicopter-assisted carcass removal. The use of helicopters for hazing and herding would also be limited to six times per year, lasting only 1 to 2 hours per event. If herding and hazing occurs during spring and summer, it could disturb mammal, reptile, and amphibian birthing/rearing of young and bird nesting and rearing of chicks. In addition, small mammals and birds could be trampled during the forced movement of bison and by vehicles and foot travel, which could result in mortality of individuals.

However, based on previous experiences indicating that herding and hazing is not always effective, the park is unlikely to implement this technique on a regular basis (e.g., like lethal culling). In addition, the disturbances associated with the presence and travel of people, as well as any noise-making devices, are expected to occur in the travel corridors that people/bison follow and would last less than a day. It is expected that any displaced/disturbed animals would return/recover when people, vehicles/aircraft, and bison move out of an area. This would also limit the number of animals that could be trampled and killed.

Exclusion Fencing

The proposed action would use exclusion fences. The construction of fences would result in noise and dist urbance from the crews while they use hand tools to install the posts and fencing—from a couple of hours to a few days, depending on the size of the feature being fenced. These disturbances are not expected to cause more than temporary displacement of wildlife away from the construction area to surrounding habitat, and once construction is complete, species are expected to resume using the habitat in and adjacent to the area. The fences would be configured to allow other animals, including large mammals like deer and larger species of carnivores, to access the fenced areas (Gates 2006). Fencing of the size and extent contemplated would not obstruct bats from using water sources because they could negotiate, with little trouble, the gaps to avoid fence wires and access the water. Monitoring effectiveness and removing fences when they are no longer needed would also minimize impacts on wildlife.

Management Cycle

As described in chapter 2, activities to reduce the House Rock bison herd would likely start with nonlethal culling in the grasslands and meadows during early summer. These activities could coincide with a lethal culling event in other areas, likely in the shrublands of the action area. In addition, the park could also implement hazing and herding actions to move bison toward corral facilities from other areas of the action area, such as shrublands and forests. Although nonlethal and lethal culling could occur at the same time, there would be purposeful efforts to ensure the actions are separated geographically. However, there could be combined impacts on more mobile species, such as medium to large mammals and birds that are more likely to be disturbed by management actions and expend additional energy resources, exacerbating potential increases in physiological stress and adverse impacts on reproduction, rearing, and overall population numbers. Less mobile species like small mammals, reptiles, and amphibians are less likely to be affected from combined activities given the small size of their home range and their winter behavior (i.e., underground, hibernation, and estivation).

Cumulative Impacts

The impacts from other actions considered in the cumulative impacts analysis are described for alternative 1 and would include temporary disturbances and changes in the abundance of other wildlife associated with cumulative actions but an overall, primarily beneficial impact on other wildlife by improving habitat and minimizing competition for resources. While alternative 2 would also cause disruptions, mortality of individual wildlife, and habitat degradation that could lead to reduced wildlife population numbers on the North Rim for 3 to 5 years while the House Rock bison herd is being reduced, it could also have limited benefits during the reduction period for certain species (e.g., ungulates and birds, as a result of the availability of bait and water at corral sites, and carnivores and scavenging mammals/birds, as a result of increased prey/biomass for when bison congregate at corral sites or gut piles/unretrieved bison carcass parts are left in the field). Ultimately, after bison reduction efforts cease, wildlife and wildlife habitat would experience substantial benefits because bison grazing, trampling, and wallowing in meadows and around water sources would decrease as a result of the smaller number of bison anticipated under this alternative (fewer than 200). This would result in more forage, more cover, and improved water quality that would benefit wildlife. In addition, with the smaller number of bison anticipated, the potential for all wildlife species to be disturbed or displaced would decrease, and all wildlife species would face decreased competition with the House Rock bison herd for limited water supplies, forage, and space. This could improve survivorship and reproductive rates for the more common mammals, birds, reptiles, and amphibians, and potentially result in larger wildlife populations on the North Rim.

Therefore, when the limited adverse impacts as a result of implementing alternative 2 are combined with the overall beneficial impacts of other cumulative actions and considered in the context of the beneficial

impacts of reducing the House Rock bison herd to 200 or fewer animals, an overall beneficial cumulative impact is expected for other wildlife. Alternative 2 would contribute a substantial beneficial increment because of the reduction in impacts associated with a smaller bison population.

Conclusion

Under alternative 2, bison grazing, trampling, and wallowing in meadows and around water sources would decrease as a result of the smaller number of bison anticipated under this alternative (fewer than 200), which would result in more forage, more cover, and improved water quality that would benefit small mammals, ungulates, birds, reptiles, and amphibians. In addition, with fewer bison anticipated, the potential for all wildlife species to be disturbed or displaced would decrease, and all wildlife species would face decreased competition with bison for limited water supplies, forage, and space. The potential impacts on the various wildlife guilds mentioned in the conclusion for alternative 1 would either be greatly reduced in magnitude (i.e., likely 10 to 15 times less) or would be eliminated altogether. This could improve survivorship and reproductive rates for the more common mammals, birds, reptiles, and amphibians, and potentially result in larger wildlife populations on the North Rim.

A smaller House Rock bison herd would also mean less prey and biomass for carnivores and scavenging mammals/birds compared to what is available at the current population size (approximately 400–600 bison). However, these species were present in the action area prior to the bison's arrival, indicating an ability to survive using other prey populations. These other prey include small mammals and ungulates, and any potential increase in these populations could somewhat offset the loss of bison. As a result, it is not anticipated that the loss of prey and biomass for carnivores and scavengers would have impacts on the status or stability of the North Rim populations of these animals.

As noted previously, the implementation of nonlethal and lethal culling and hazing/herding of bison would create noise in excess of natural sound conditions during short periods in specific locations. Common wildlife species that occur on the North Rim in close proximity to reduction activities are likely to be temporarily affected as a result of an additional 1,440 vehicle days over the course of the approximately 30 weeks of each primary lethal culling period, and 352 vehicle days during the approximately 22 weeks of the secondary lethal culling period, the presence of teams of up to 25 people discharging firearms, up to 6 helicopter and 52 fixed-wing flights, and the construction of corrals. In addition, the presence of processing teams with up to 12 to 16 stock animals, the forced movement of bison, and the congregation of bison near corrals would also displace wildlife along travel corridors, at lethal culling sites, and in/adjacent to corral sites. In some cases, these management actions would occur during spring/summer, which are important times of year for birthing/rearing young mammals, nesting birds/rearing chicks, and reproducing reptiles and amphibians. Some impacts could also occur during the fall and winter from lethal culling and limited hazing/herding. While these actions in the winter would have similar impacts as noted above, some species of wildlife migrate away from the North Rim during the these times (e.g., mule deer, birds), become less active, or hibernate (e.g., reptiles and amphibians), which would limit the number of animals affected during this time. Reduction activities could also cause an increase in the trampling of small mammals, birds, reptiles, and amphibians, as well as accidental shootings of wildlife, which would result in mortality of individual wildlife. Trampling would be less of a concern for reptiles and amphibians because the individuals involved with carrying out the management activities would be trained to avoid sensitive water resources that provide habitat for these animals. Additionally, if all corrals are used in a given year, approximately 10 acres of meadow vegetation within the immediate footprint of the corrals would be trampled and/or removed, including vegetation along any off-road access needed to remove bison from the corrals. Wildlife would likely avoid these areas and use adjacent habitat until nonlethal culling operations are complete and revegetation occurs.

These disruptions, mortality of individual wildlife, and habitat degradation would have adverse effects that could lead to reduced wildlife population numbers on the North Rim during the 3 to 5 years of implementation of alternative 2. Disturbances would generally last less than 1 day (e.g., from hazing and herding) to several days to weeks (e.g. lethal and nonlethal culling). However, lethal and nonlethal culling and hazing and herding could all occur each year, for 3 to 5 years until fewer than 200 bison remain. Although lethal and nonlethal culling could occur at the same time, there would be purposeful efforts to ensure the actions are separated geographically. However, there could be combined impacts on more mobile species, such as medium to large mammal and birds that are more likely to be disturbed by management actions and expend additional energy resources, exacerbating potential increases in physiological stress and adverse impacts on reproduction, rearing, and overall population numbers.

While alternative 2 could result in a reduction in wildlife population numbers during implementation, the affected wildlife would be common species found in the area, and disturbances are expected to be limited to locations on the North Rim where reduction activities occur, adjacent habitat, and along roads needed to access the sites. This would also limit the extent of the area where/time during which wildlife may be trampled and killed during such activities. The direct loss of habitat would be limited to less than 5% of the meadows found in the action area, and while the repeated use of the reduction tools could exacerbate impacts, any displaced/disturbed animals are expected to return/recover when bison reduction activities are complete. As a result, adverse impacts under alternative 2 would not affect the overall status or stability of the North Rim wildlife populations. When the limited adverse impacts as a result of implementing alternative 2 are combined with the overall beneficial impacts of other cumulative actions and considered in the context of the beneficial impacts of reducing the House Rock bison herd to 200 or fewer animals, an overall beneficial cumulative impact is expected for other wildlife. Alternative 2 would contribute substantially to these benefits because of the reduction in impacts associated with a smaller House Rock bison herd.

Impacts on Wildlife on Adjacent Lands. Hazing, herding, or lethal culling pressure is expected to cause an increase in bison movement, including on to adjacent USFS lands. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, dispersing bison are expected to seek habitat outside the park that is similar to preferred habitat in the action area (i.e., grasslands, meadows, shrublands, wetland-associated vegetation, and water sources). As described above, an increased number of bison could affect less mobile species or those that rely on these habitat types. However, the types of impacts dispersing bison would cause outside the park would be similar to the impacts described for the action area under the no-action alternative. These impacts could persist beyond the initial reduction phase if bison begin to spend more time outside of the park.

However, because fewer bison would move outside the park (compared to the resulting bison population under alternative 1), the impacts would be of a much lower magnitude. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to the plan's guidelines would keep bison numbers at a level that would minimize potential damage to sensitive habitats (USFS 2014).

SPECIAL-STATUS WILDLIFE SPECIES

METHODS AND ASSUMPTIONS

The impact analysis for special-status species focuses on potential changes to the presence and distribution of special-status wildlife species and the quality of habitat as a result of the expected House

Rock bison herd size associated with implementation of each alternative. This analysis also assesses the potential for reduction actions to disturb special-status species or affect their habitat. The following were considered in assessing impacts on special-status species: potential for direct mortality and change in habitat from the resulting House Rock bison herd size and associated behaviors (e.g., wallowing and foraging); change in habitat from reduction actions (e.g., corrals); and level, duration, and extent of noise disturbance from reduction actions (i.e., presence of humans or equipment) during sensitive periods. Adherence to the Endangered Species Act, Migratory Bird Treaty Act, and other federal wildlife laws informs this analysis. Additional assumptions are presented under each alternative, as appropriate. Potential impacts on special-status species were evaluated based on resource expert knowledge and professional judgment, review of available literature and research, anticipated locations for reduction activities, consultation and communication with park and cooperating agency staff, and the resource-specific issues identified in chapter 1.

IMPACTS OF ALTERNATIVE 1 (NO ACTION) ON SPECIAL-STATUS WILDLIFE SPECIES

Mexican Spotted Owl

It is unlikely that an increased House Rock bison herd size would directly affect Mexican spotted owls through owl mortality, injury, or disturbance. The nearest documented active Mexican spotted owl nesting habitat to the action area lies below the rim of the canyon at elevations ranging from approximately 4,200 to 6,700 feet above sea level (NPS, Holm, pers. comm. 2016m; NPS, Palarino, pers. comm. 2015b; USFWS 2016b; NatureServe 2015). Comparatively, bison use areas on the plateaus of the North Rim are at approximate elevations of 8,000 feet above sea level. However, the forested habitat of the North Rim is considered to be owl habitat, including approximately 18,400 acres of mixed conifer forest. Although Mexican spotted owls primarily hunt below the rim in pinyon-juniper habitat, they have been documented using portions of the forested areas associated with the rim, (Bowden 2006). An increased House Rock bison herd size could result in shifts in Mexican spotted owl use of the action area because trampling and grazing would modify vegetative cover that could degrade habitat and cause reductions in prey.

As described in chapter 3, primary constituent elements of Mexican spotted owl critical habitat relevant to bison reduction activities are related to maintenance of adequate prey species in foraging habitat and presence of water (USFWS 2012), specifically in canyon habitat. The species shows a preference for forested mountains and canyonlands and older, uneven-aged forests (USFWS 2013). An increase in the size of the House Rock bison herd population would likely cause some level of incidental impact on forest habitat, specifically ground cover species, as bison move between feeding areas, forage and consume water, or rest in forested areas. Grazing in forest habitat could result in reduced availability of grass cover for prey species such as mice and other rodents (USFWS 2013). Any change in prey base would reduce the amount of available foraging habitat for owls. Similarly, if high concentrations of bison eliminate, reduce, or foul important water sources associated with canyon habitat, this could also affect vegetation and thus potential owl prey distribution. Owls have not been documented drinking from water sources, but use the habitats created by them for hunting prey (USFWS 2013).

Even with the projected increase in the size of the House Rock bison herd under alternative 1, bison are not expected to be present in documented nesting habitat or primary owl hunting areas below the rim. In addition, because of the amount of forested habitat in the action area and considering habitat areas outside bison use areas, the increased House Rock bison herd is not expected to measurably affect prey species through habitat modification (NPS, Holm, pers. comm. 2016f). The level to which bison would affect forest habitat or water resources associated with canyons is currently unclear. However, the potential for these types of impacts exists, given the expected growth of the House Rock bison herd and areas of use. Therefore, the increased size of the herd could result in impacts on Mexican spotted owls, but they would be unlikely to affect the species' overall conservation and survival in the area.

California Condor

Similar to the Mexican spotted owl, California condors typically nest below the rim of the canyon in areas inaccessible to the House Rock bison herd. Higher bison concentrations would not affect breeding and nesting behavior of condors and would not likely result in condor mortality, injury, or disturbance.

As previously stated, condors feed primarily on a variety of mammal carcasses and prefer fresh meat located in relatively open terrain. As the House Rock bison herd increases in size from 400 to 600 to 1,200 to 1,500 the level of mortality associated with sick or injured bison, calves, or road kills would provide additional carrion food source and could provide benefits, such as increased survival and fitness, to condors that feed in the area, which may result in corresponding condor population increases (USFWS 1980). These benefits would be similar to those described for scavenging birds described in "Wildlife (Other than Bison) and Wildlife Habitat." Overall, alternative 1 could provide benefits to California condors in terms of additional food sources that would promote increased survival and population growth.

Northern Goshawk

An increase in the size of the House Rock bison herd from 400 to 600 to 1,200 to 1,500 is unlikely to directly affect northern goshawks through mortality, injury, or disturbance. As discussed in chapter 3, the North Rim currently includes 18 northern goshawk territories. Goshawks nest and hunt in forest habitat characterized by fairly closed canopies and small forest openings (Salafsky et al. 2006). Goshawk reproduction has been strongly correlated with prey species abundance; therefore, actions that could affect goshawk habitat or that of its prey could result in reduced reproductive success (Salafsky et al. 2006).

The increase in the House Rock bison herd would not result in any change to forest structure in terms of mature forest stands and canopy closure. Therefore, the increased herd size and impacts of bison behavior are unlikely to affect those prey species that are more arboreal in nature such as red squirrels and certain birds. However, bison impacts on understory plant species as a result of trailing, trampling, and foraging could indirectly affect the northern goshawk. For example, the House Rock bison herd could limit understory grasses, forbs, and shrub species in conifer forests. This loss of cover and habitat would affect northern goshawk prey species like ground squirrels and rabbits, in a similar manner as described for the Mexican spotted owl. If these prey species make up a large portion of a goshawk's diet, impacts on reproductive success could occur. However, the area of forest that supports northern goshawk habitat in the North Rim of the park includes approximately 18,400 acres, with additional forested habitat available on adjacent lands. Given the species versatility in prey selection, the level of potential impacts on certain prey species could affect individual birds, but is unlikely to affect the local population. As a result of the potential for reduced ground prey from increasing bison numbers, goshawks would likely shift to hunting more canopy-dependent mammal species and birds. Given the small effect that could occur to ground species in forested areas as a result of a growth in the House Rock bison herd and their versatility in prey sources, the herd would be unlikely to affect these territories or result in the reduction of goshawks in the action area.

Northern Leopard Frog

The population size of the northern leopard frog in the action area is unknown. However in 2014, a northern leopard frog was documented in a water source on the North Rim of the park within the action area. Evidence of bison using this water source was also documented at that time. No additional documented sightings of northern leopard frogs on the North Rim have occurred (NPS, Holm, pers. comm. 2016m). Because the northern leopard frog depends on permanent water with rooted vegetation throughout the year and because they inhabit wet meadows and fields during summer months (USFWS 2016b; NatureServe 2015), the increased concentration of bison under alternative 1 could result in both

direct (through trampling) and indirect (through depletion of water sources and degradation of habitat) adverse impacts on this species through direct mortality, injury, disruption of life cycle requirements (i.e., egg laying, larval development), or disturbance. Habitat trampling around water sources and a decrease in insect prey that use these habitats could all affect the northern leopard frog. Given the limited documented occurrence of the species, if a population were to exist in or around water sources affected by the growing House Rock bison herd, the local frog population could experience mortality that would affect the population's overall fitness and survival.

Cumulative Impacts

In examining the potential cumulative impacts on special-status wildlife species, this analysis considers actions that could occur in areas adjacent to the action area, as well as the Kaibab National Forest, including the House Rock Wildlife Area, to examine the larger distribution of species.

Park maintenance activities (e.g., presence of vehicles and maintenance crews) and flights over the park, including commercial air tours and administrative helicopter use, are sources of noise in the area. These sounds can disturb Mexican spotted owls, condors, and northern goshawks. In addition to noise disturbance, aircraft presence can result in species like condors shifting behavior to avoid aircraft use areas or colliding with aircraft. Impacts associated with aircraft could range from behavioral disturbance and flushing to area avoidance and even injury or mortality from collision. However, the park restricts air travel within certain proximity to owl and condor nests, birds in flight, or along certain corridors. In addition, goshawks have shown little response to noise disturbance in the area (Grubb et al. 2013). Prescribed fires could affect owls and goshawks by reducing understory prey species cover habitat, although owl and goshawk territories would be avoided to the extent they are known.

When these minimal impacts are combined with the impacts from the growing House Rock bison herd under alternative 1, condors would likely benefit from increased sources of food as the herd increases, whereas owls and goshawks could be affected by reduced levels of forest prey species. Overall, the cumulative adverse impacts would be of little consequence to owls and goshawks given the amount of canyon and forest habitat and associated prey levels available. The contribution of impacts from alternative 1 to the overall cumulative scenario would be basically doubled from what is currently occurring because of increased impacts from up to 1,200 to 1,500 bison on the landscape; however, the impacts are unlikely to cause changes in owl, condor, or goshawk populations or survival that would limit their overall conservation because of the amount of available nesting and foraging habitat.

The northern leopard frog would be affected by any action that alters the quantity or quality of surface water resources. See the cumulative impacts analysis under "Water Resources in the Karst Landscape." The potential habitat benefits to the frog provided by fire management and prescribed burning would likely be offset by the adverse effects of the growing House Rock bison herd. When combined with alternative 1, adverse impacts would get worse as more bison compete for water resources and associated habitat degradation occurs. Because frogs have limited mobility, these impacts would result in a certain level of mortality. Alternative 1 would contribute a substantial adverse increment to the overall cumulative impact based on the potential for the House Rock bison herd to limit the species distribution in the area if it grows to 1,200 to 1,500 animals.

Conclusion

A number of special-status species that are considered fundamental park resources occur in the Action Area (NPS 2010c). Special-status species include those designated under the Endangered Species Act of 1973 (16 USC 1531 et seq.), species listed by the Navajo Nation, state-listed species, and USFS sensitive species. Given their low populations, reduced distributions, and reduced overall survival, impacts on special-status wildlife species would be disproportionate compared to other wildlife species. Of the

special-status species potentially present, alternative 1 would be most likely to affect four species—Mexican spotted owl, California condor, northern goshawk, and northern leopard frog.

The analysis suggests that alternative 1 could provide benefits to the California condor because the increased size of the House Rock bison herd would likely result in an increase in carrion and associated forage for condors, which could positively affect their survival and reproductive success. Given the very limited distribution of condors and ongoing reintroduction programs, any increase in available food could provide benefits to the species and its overall conservation.

The action area includes approximately 18,400 acres of forested habitat that could support northern goshawk and Mexican spotted owl populations above the rim. These species depend on the availability of prey and suitable nesting habitat. It is unlikely that the House Rock bison herd would affect the overstory of the forests; however, they could reduce plant cover in the understory through grazing, trampling, and other behavior. For example, the loss of grass species in small forest openings could reduce local small mammal populations or result in their redistribution. This could result in reduced foraging habitat and hunting success for the Mexican spotted owl and northern goshawk. However, given the amount of foraging habitat above and below the rim for Mexican spotted owls and the versatility in goshawk diets, while the size of the House Rock bison herd would affect these species, it would not likely result in changes to species conservation or survival.

In contrast, the northern leopard frog relies on wet grassland/meadow habitat and the limited water resources found throughout the action area. Effects from the larger House Rock bison herd expected under this alternative could eliminate northern leopard frog populations through trampling, water use, and habitat destruction, which could jeopardize the persistence of the species in the area.

Impacts on Special Status Wildlife Species on Adjacent Lands. Although they may vary in prevalence and additional species may also be present, similar special-status species occur on USFS lands adjacent to the action area. For example, there are 165 additional goshawk territories on the Kaibab National Forest and likely higher numbers of leopard frogs because they were reintroduced to the forest. Similarly, Mexican spotted owl critical habitat has also been designated on the Kaibab National Forest. The Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan* includes a complete list of species present on the Kaibab National Forest (USFS 2014). Appendix A provides a list of special-status species that could occur on lands adjacent to the action area.

The increase in the bison population under alternative 1 could cause more bison (compared to current conditions) to move on to USFS lands adjacent to the park as a result of density-dependent pioneering behavior. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, pioneering bison are expected to seek habitat similar to preferred habitat in the action area (i.e., grassland, meadow, shrubland, wetland-associated vegetation, and water sources). This could result in similar impacts on those species that rely on these habitat types for a portion of their life-history (e.g., the northern leopard frog). Other special-status species considered are primarily forest species (except the condor) that would be unlikely to be affected by bison. However, because more bison are expected to remain inside the park than outside, impacts specific to special-status species outside the park would be of a much lower magnitude. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to the plan's guidelines is expected to keep bison numbers at a level that would minimize potential damage to sensitive habitats (USFS 2014).

IMPACTS OF ALTERNATIVE 2 ON SPECIAL-STATUS WILDLIFE SPECIES

Impacts on special-status wildlife under alternative 2 would occur primarily as a result of increased noise levels associated with the use of helicopters and firearms, the increased presence of humans (including vehicles and aircraft), and redistribution of the House Rock bison herd from reduction actions. For a discussion of noise impact metrics, see the discussion in the "Impacts of Alternative 2 on Wildlife (Other than Bison)" section. The potential impacts of the House Rock bison herd on special-status wildlife described for alternative 1 (as a result of bison disturbance, trampling, grazing, wallowing, and competition for water and forage) would still be present with the remnant bison population; however, these impacts would occur to a much lesser degree.

Mexican Spotted Owl

Resulting Bison
Population. As described above in alternative 1, the potential impacts of bison on Mexican spotted owl p rey and habitat would still be present with the remnant House Rock bison herd of fewer than 200 animals; however, these impacts would occur at a much lesser degree. The smaller herd on the landscape would li kely result in improved habitat for Mexican spotted owl and their prey because areas affected by the curre nt high bison population would be restored over time through natural processes or NPS management. This could improve prey habitat and result in corresponding benefits for Mexican spotted owl, though the amo unt of benefit would be difficult to measure because it would be based on the associated increase in prey a vailability.

Lethal and Nonlethal Culling, Hazing and Herding, Local Exclusion
Fencing. Nonlethal culling efforts proposed under this alternative would have no impact on Mexican spot ted owls or their habitat because the activities would occur in meadows outside of owl habitat (see figure 20 showing potential corral locations in meadow areas).

Because the majority of active breeding, nesting, and fledging habitat for the Mexican spotted owl is locat ed outside of the action area below the canyon's rim, and likely a good distance from these areas, reductio n actions such as lethal culling, hazing, herding, and the presence of crews to conduct these actions would not result in attributabl e disturbance-related impacts on the majority of Mexican spotted owl breeding or nesting (NPS, Holm, pers. comm. 2016m).

The action area contains approximately 18,400 acres of forested habitat above the rim that is potential owl nesting and foraging habitat, and owl presence, although limited, has been documented there (NPS, Holm, pers. comm. 2016m). Helicopter and fixed-wing aircraft flights supporting lethal culling efforts and hazing may cause noise and presence-related disturbances to owls in the area because noise levels in culling areas would substantially exceed background noise levels (see table 8). Fixed-wing flights would be completed on a weekly basis to determine bison locations. Comparatively, helicopter flights in support of lethal culling would only occur up to 6 times to assist in the removal of bison carcasses from remote locations. In addition, a maximum of 6 flights could occur near the rim to haze bison away from the canyon edge.

Lethal culling efforts would likely result in limited noise disturbance to nesting Mexican spotted owls, if present above the rim, as a result of the aircraft use (as described above). The presence of helicopters, used for carcass removal, and associated noise could flush adults from nests, increasing the risk of nest abandonment or injury or mortality of young. However, spotted owls typically do not flush during the pre-fledging stage (Delaney et al. 1999). Delaney et al. found that Mexican spotted owls did not flush when helicopter noise levels were around 102 decibels (dB) (1999). They also found that short-duration,

single-pass, single-aircraft overflights had little effect on owls and that the distance to the nest was more of an indicator of impact than noise levels, where the flush response occurred within 315 feet, as noise generated by helicopters varied based on operation. Owls also displayed higher disturbance rates from ground-based activities like the use of chainsaws compared to helicopter overflights (Delaney et al. 1999). Overall, Delaney et. al, concluded that the flush response did not differ between the nesting and non-nesting seasons and found no evidence that helicopter overflights detrimentally affected owl survival or reproduction (Delaney et al. 1999). Up to 12 helicopter flights would be needed each year—limited to 6 flights for carcass removal and 6 flights for hazing and herding efforts; each flight would last approximately 1 to 2 hours. To ensure that alternative 2 would not result in impacts on nesting owls, helicopters would not approach within 1,200 feet of any known Mexican spotted owl protected activity center.

Nesting owls could be temporarily disturbed by the noise associated with the sound from discharging a firearm; however, this noise, though loud (i.e. up to 175 dBA), would be instantaneous. Though birds may become more alert, they are unlikely to flush (Delaney et al. 1999); therefore, the sound of firearms is unlikely to disrupt owl nesting behavior such that effects on reproduction or fledgling success occur. The presence of field crews could also result in owls flushing from nests if individuals approach too close to the nest. However, Delaney et al. also found that researchers monitoring nesting owls cause little disturbance as birds became accustomed to researchers within 10–15 minutes (Delaney et al. 1999). Based on this research, the presence of field crews could cause disturbances to nesting owls as crews move through the area, though the effects are not expected to last more than a few minutes.

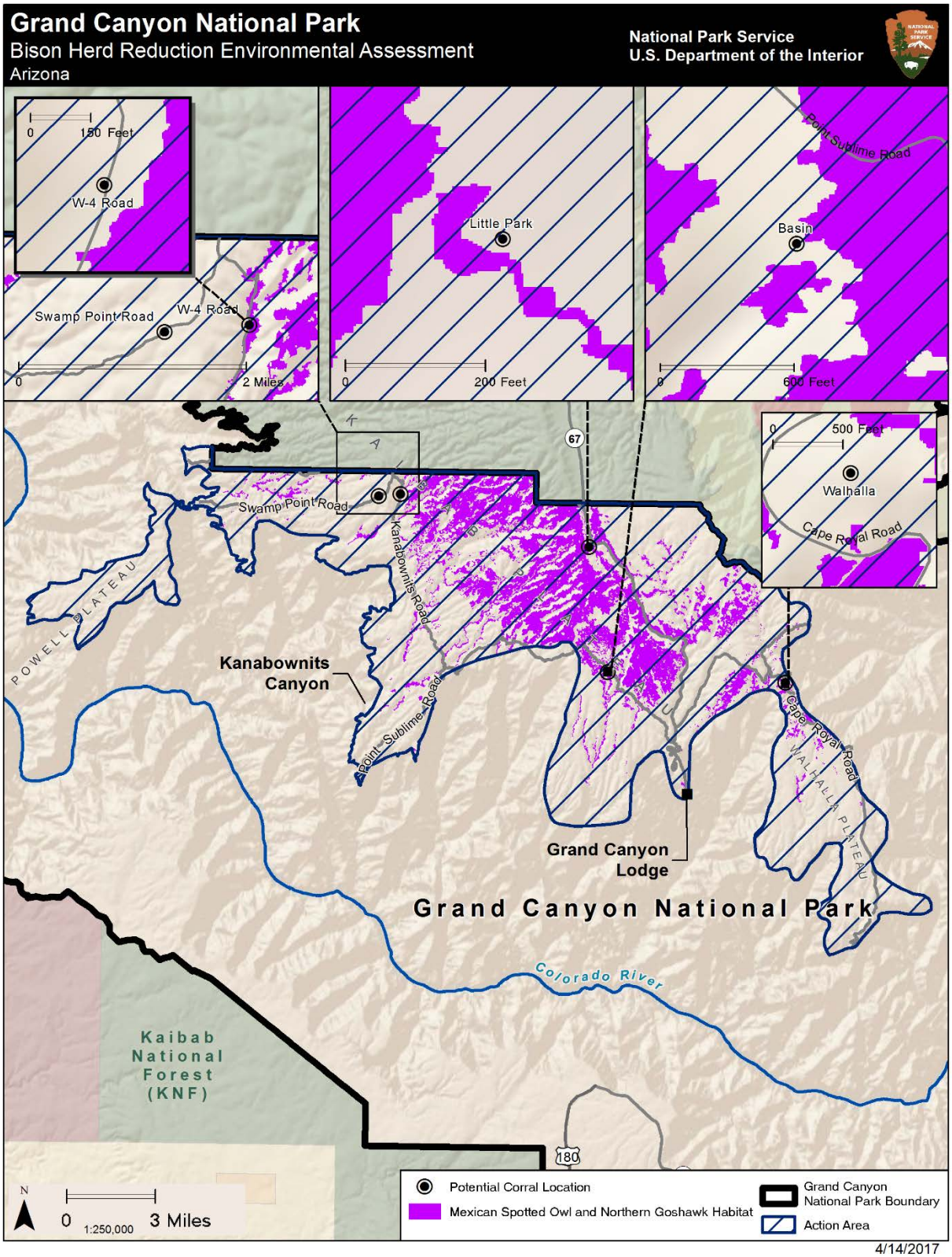

FIGURE 20. POTENTIAL CORRAL LOCATIONS IN RELATIONSHIP TO POTENTIAL MEXICAN SPOTTED OWL AND NORTHERN GOSHAWK HABITAT

Disturbances to foraging Mexican spotted owls within forest foraging habitat in or adjacent to the action area could occur if reduction activities take place in the area. However, disturbances would be limited to pre-dawn and post-dusk periods because Mexican spotted owls are nocturnal hunters. While noise-causing activities such as firearms, aircraft use, and the presence of field crews could temporarily disturb the Mexican spotted owl, as described above, this disturbance would be limited. As stated in the wildlife analysis, birds are sensitive to sound levels from 0–10 dB; therefore, they would respond to noises generated by reduction activities, which would be well above natural background noise levels. However, the noise associated with firearms would be instantaneous in nature and unlikely to cause prolonged disturbances. Impacts from helicopter and fixed-wing aircraft use would be similar to those described above. The presence of field crews could cause owls to avoid areas where reduction activities are occurring. Sufficient adjacent foraging habitat is available for owls to disperse to, and they would likely return to disturbed foraging habitat once reduction activities cease (NPS, Holm, pers. comm. 2016m). Therefore impacts on Mexican spotted owl in foraging habitat would be relatively inconsequential. Activities associated with hazing and herding bison to other areas could occur in Mexican spotted owl habitat above the rim; however, the impacts would be similar in nature to those described for lethal culling—related to the presence of field crews and associated temporary disturbance.

Local exclusion fencing activities proposed under this alternative could have impacts on Mexican spotted owls if owls were to occur in the area proposed for fencing. Owls could be temporarily disturbed during installation, resulting in them flushing or avoiding the area until activity has ceased. The fencing of water sources could benefit owls because it could improve water quality and availability in the canyon habitat. The presence of fencing could cause changes in habitat use to avoid fences; however, both the disturbance and fenced area would be small.

No adverse impacts on designated critical habitat are expected from the implementation of alternative 2 because proposed actions to reduce the House Rock bison herd size would likely improve understory foraging habitat and canyon water quality as a result of fewer bison on the landscape and the fencing of upland water sources.

Management Cycle. When considered in terms of when actions would occur over the course of a year, it is important to understand if there could be synergistic impacts based on timing and duration of reduction activities. The breeding season for the Mexican spotted owl extends from mating in January to young leaving the nest in early June. During this same period, lethal culling efforts would occur at different intensities from January through June and helicopters could be used for hazing and herding efforts near the rim from January through mid-May. Increased helicopter use for both activities could cause increased occurrence of impacts, though helicopters would be restricted from documented Mexican spotted owl nest locations. Although owls could be disturbed by activities, impacts are unlikely to affect reproduction and survival. It is unlikely that individual owls would be disturbed in subsequent years because reduction activities would likely be distributed throughout the action area.

California Condor

Resulting Bison Population. Under alternative 2, the expected decrease in the size of the House Rock bison herd from approximately 600 to fewer than 200 would reduce the potential availability of food sources for condors from bison. However, the bison that remain would still provide some level of carrion and there would still be sufficient sources of food available (e.g., deer) that condors can rely on such that the reduction of bison on the landscape would not affect overall condor survival or reproduction.

Lethal and Nonlethal Culling, Hazing and Herding, Local Exclusion Fencing. Capture and removal of bison in meadow habitat could adversely affect foraging condors because their foraging habitat encompasses grasslands, oak savannas, mountain plateaus, ridges, and canyons. Condors would likely

avoid areas of active reduction efforts and forage in other areas, although they could be attracted to water if used in corrals. A soaring bird, condors are often above tree-level as they search for food. Typically condors forage over a large home range of approximately 123,500 acres (Rivers et al. 2014), which is an area roughly 20% larger than the action area; therefore, adequate foraging areas would be available.

Lethal culling actions could cause limited disturbance (4 days in a row of activity depending on the season) to California condor from noise associated with shooting, fixed-wing aircraft flights, helicopter use, and the presence of field crews. Impacts associated with condor breeding and nesting would be similar in nature to those described above for the Mexican spotted owl because condors only nest below the rim within the park—the nearest nest is approximately 5 miles away from the boundary of the action area. Aircraft associated with this project would stay at least 1 mile away from active condor nest locations and vicinities except when human safety would be compromised. The active nesting season extends from February 1 through September 30.

The use of fixed-wing aircraft for monitoring and helicopters for carcass removal or hazing and herding in condor forage areas could displace condors to other areas or, less likely, result in collision with soaring birds. Displacement would require birds to expend additional energy; although given their general home range size, avoidance of helicopters would likely not affect foraging success or survival. Helicopters would be restricted from approaching within 1,200 feet of condors in the air and, if condors approach the aircraft, the aircraft would move away limiting any potential disturbance to minutes (Rivers et al. 2014). Although the chance of an aircraft strike exists, the likelihood would be very low.

Additionally, under alternative 2, it is possible that there would be short-term, beneficial impacts because lethal culling activities would result in an increased incidence of gut piles and other sources of carrion left from bison carcasses for the duration of active reduction (NPS, Holm, pers. comm. 2016m). Only non-lead bullets would be used, eliminating lead poisoning concerns. The extra source of food could have positive impacts on condor survival and reproduction.

Local exclusion fencing activities proposed under this alternative could affect condors if they attempted to access the water. Condors could be temporarily disturbed during installation, resulting in them avoiding the area until activity has ceased. They could also collide with fencing as they approach the water resource causing the potential for injury or mortality, although the likelihood would be rare.

Management Cycle. The breeding season for California condors extends from February through September (USFWS 2016b). During this period, lethal culling and hazing and herding efforts would be taking place in close proximity to the rim of the canyon; however, actions would be restricted from occurring within 0.5 mile of an active nest. The increased use of helicopters and noise disturbance could cause impacts during an important life cycle period. However, based on the proposed flight buffers, it is unlikely that reproduction would be disrupted. These activities would continue to occur over 3 to 5 years. If recurring impacts affected breeding and nesting success over several seasons, reduction actions could lead to reduced reproductive success and no population recruitment. Given the large area of nesting habitat throughout the Greater Grand Canyon area and the low intensity of reduction actions, the potential for these actions to be done repeatedly in the same area would be slight, and population level impacts would therefore be very low. In addition, as described above, condors would benefit from increased carcasses being available during the breeding season. It is unlikely that individual condors would be disturbed in subsequent years because reduction activities would likely be distributed throughout the action area; however, they would benefit from annual increases in available forage during active reduction efforts.

Northern Goshawk

Resulting Bison Population. Under alternative 2, reducing the House Rock bison herd to fewer than 200 animals is expected to result in increases of forest understory plant cover in small openings in the forest floor that provide food and cover for goshawk prey species like ground squirrels and rabbits. Since northern goshawk reproductive success and survival are linked to prey abundance (Salafsky et al. 2006), and improved understory conditions could increase prey abundance, alternative 2 could lead to an increase in goshawk population numbers on the North Rim, if they are currently prey limited.

Lethal and Nonlethal Culling, Hazing and Herding, Local Exclusion Fencing. Nonlethal culling actions would occur outside of goshawk habitat and would not result in any impacts on goshawks (see figure 20). Sound disturbances from aircraft, firearms, hazing, and the presence of management crews could temporarily affect breeding, nesting, and foraging habitats (which include old growth forests for nesting and a mixture of heavily forested habitat interspersed with small openings) for the northern goshawk (NPS, Holm, pers. comm. 2016m; USFWS 2016b; NatureServe 2015; NPS 2016a). Noise-related impacts would be similar to those described for Mexican spotted owl. Researchers recently examined the response of nesting and non-nesting goshawks to noise associated with logging trucks and light fixed-wing aircraft (at unknown known altitudes but assumed over 900 feet above ground level and closer and louder than commercial overflights) (Grubb et al. 2013). None of the exposure events resulted in goshawks flushing. Rather, in 60 logging truck events, goshawks displayed no response 27% of the time and only an alert (looking toward the source of noise) 73% of the time (Grubb et al. 2013). In terms of 30 passing aircraft events, goshawks displayed no response 90% of the time and only an alert response 10% of the time.

Alternative 2 would result in an increase in truck use along the roads within the action area—amounting to 1,440 additional vehicle days during the primary lethal culling period and 352 vehicle days during the secondary period. The use of vehicles for bison reduction activities would be restricted by season, which likely would limit most vehicle use to May through November. During lethal culling efforts, each team would require up to 4 vehicles. For periods where up to 3 teams are conducting reduction activities, up to 12 vehicles could be using the road system for each 4-day field period. However those vehicles would be distributed among different areas where bison are present and are similar to those used for administrative purposes. Given the lack of documented adverse response to logging trucks, the research suggests that the use of smaller pick-up trucks for hauling captured bison or bison carcasses (on roads) and aircraft for hazing, herding, or spotting/monitoring bison (above tree level) would be unlikely to have an adverse effect on goshawks in nesting areas. In addition, researchers suggested that goshawks, like eagles, may be more acclimated to aircraft; whereas ground-based noise could be associated with other disturbances (Grubb et al. 2013).

Alternative 2 calls for the use of fixed-wing aircraft for locating bison during lethal culling events. Flights would be similar to those currently performed to survey the House Rock bison herd; however, flights would occur more than four times more often. Given the likely acclimation of northern goshawks to small fixed-wing aircraft overflights, it is unlikely that they would be affected by the increase in overflights. In addition, known goshawk nesting areas would be avoided to reduce potential risks during breeding and nesting. Similarly, helicopter use associated with hazing and herding would be conducted outside of forested areas along the rim and Powell Plateau, limiting the chance of disturbing goshawks. However, the limited use of helicopters to sling bison carcasses from remote areas could affect goshawks because flights would traverse forested areas at lower altitudes than fixed-wing aircraft reconnaissance flights. These types of helicopter trips would be limited in number to approximately six trips per year lasting 1 to 2 hours per trip. Similar to other overflights, helicopters would attempt to avoid known nesting areas to reduce potential impacts. Any helicopter-generated goshawk response would be more critical during late-April through early July when eggs and young are in the nest because nest abandonment or nest

predation could occur. Overall, aircraft use could result in some rare instances of goshawks flushing from their nests—the likelihood of this occurring would be based on their tolerance of aircraft noise and potential aircraft avoidance of goshawk territories. These disturbances would likely be inconsequential, lasting only minutes.

The presence of team members could result in the flushing of goshawks if inadvertently approached. If flushing were to occur during the breeding cycle, this could result in aggressive behavior, including local vocalizations, fly-bys, and aerial attacks (Speiser and Bosakowski 1991). Birds would temporarily leave nests or otherwise expend energy reserves. Although unlikely, this could result in short periods of time when eggs and chicks could be subject to increased predation. Overall survival and fitness of adult goshawks would likely be unaffected by any expenditure of energy as a result of disturbance, and the birds would likely return to the nest once intruders left the area. The discharge of firearms could also cause temporary disturbances to goshawks similar to those described for the Mexican spotted owl (i.e., increased alertness) as well as, agitated behavior and flushing. However, based on their variation in prey and lack of flushing response to disturbances, lethal culling activities are unlikely to affect goshawk prey species abundance or limit goshawk population fitness or survival because ample prey species would continue to be available and goshawks are not likely to flush.

Local exclusion fencing activities proposed under this alternative could have impacts on goshawks if they were to occur in the area proposed for fencing. Goshawks could be temporarily disturbed during installation, resulting in them flushing or avoiding the area until activity has ceased.

Management Cycle. As described above, the northern goshawk mates in February, laying eggs in late-April to early May, and chicks fledge by early July. During this period, park staff could be conducting lethal culling and using helicopters and other tools to haze and herd bison from the rim and plateaus, increasing the number of vehicles using park roads. These activities would be discrete events but could result in more prolonged impacts (i.e., several days in a row of helicopter use or ground noise disturbance). The increased activity during the breeding season could result in goshawk disturbances or the disturbance of their prey (as discussed under wildlife, above), causing goshawks to expend additional energy reserves during winter. If these disturbances are prolonged it could cause reduced fitness and potentially affect reproductive success. However, given the relatively short duration of activities and their distribution, it is unlikely that individual goshawks would be disturbed to the point of affecting their behavior or fitness. These activities would continue to occur over 3 to 5 years. If recurring impacts affected breeding and nesting success over several seasons, reduction actions could lead to reduced reproductive success and no population recruitment. However, it is unlikely that reduction activities would occur repeatedly in exactly the same locations to the point where a decrease in goshawk reproduction or survival would occur.

Northern Leopard Frog

Resulting Bison Population. Because the density and abundance of the House Rock Herd would decrease under alternative 2, it would have fewer impacts compared to current conditions. Although the continued occurrence of the House Rock bison herd on the North Rim under alternative 2 could result in both direct (mortality or injury through trampling) and indirect (through depletion of water sources and degradation of habitat) and impacts on to the northern leopard frog, reducing the density and abundance of the House Rock Herd would decrease the impacts described under alternative 1. The level of impact would also depend on the location of any northern leopard frogs in relation to bison use areas. Because the northern leopard frog depends on permanent water with rooted vegetation throughout the year and because they inhabit wet meadows and fields during summer months (USFWS 2016b, NatureServe 2015) they could be affected by the House Rock bison herd because water would attract the remaining bison to

the same habitat types. However, local exclusion fencing could provide the necessary refugia for any small population of northern leopard frog that inhabits the North Rim of the park.

Lethal and Nonlethal Culling, Hazing and Herding, Local Exclusion Fencing. Because the northern leopard frog depends on permanent water with rooted vegetation throughout the year and because they inhabit wet meadows and fields during summer months (USFWS 2016b, NatureServe 2015), reduction activities could provide both adverse impacts and benefits to northern leopard frogs in the area. General adverse impacts, such as energy expenditures from increased flight response, would occur from noise generated from reduction activities, although amphibians have a higher noise tolerance than mammals and birds (FHWA 2004). These disturbances could affect normal behavior patterns but would not likely result in overall reduced fitness or survival of individuals. Similar impacts could occur from the presence of team members if such presence causes a flight behavior. However, reduction activities in water sources, including the immediate adjacent wetland vegetation, would be avoided to the extent possible (NPS, Holm, pers. comm. 2016m) by waiting for the bison to move away from water sources before discharging firearms. Northern leopard frogs could benefit from the installation of exclusion fencing if water sources were fenced from bison use as it would provide a refugia for the frog. Overall, reduction activities are unlikely to result in adverse impacts on northern leopard frogs that would affect it survival if present in the action area, but rather could enhance the expansion of the species locally through habitat protection from fencing.

Management Cycle. Local exclusion fences would be erected around certain water bodies that could support northern leopard frogs. If present in protected water resources, the timing and effects of other reduction activities, mainly nonlethal culling or hazing and herding, would not be realized. Frogs would not be affected during winter activities as they would be in a state of hibernation/estivation.

Cumulative Impacts

Impacts from other actions considered in the cumulative impacts analysis would be the same as those described for alternative 1, above. Noise disturbances to Mexican spotted owls, condors, and northern goshawks would occur from a variety of sources and could result in behavior changes. Aircraft presence could result in species like condors shifting behavior to avoid aircraft use areas or colliding with aircraft. Impacts associated with aircraft could range from behavioral disturbance and flushing to area avoidance and even injury or mortality from collision. However, the park restricts air travel within certain proximity to owl and condor nests, birds in flight, or along certain corridors. Prescribed fires could affect owls and goshawks by reducing understory prey species cover habitat, although owl and goshawk territories would be avoided to the extent they are known.

Impacts on the Mexican spotted owl from other actions, such as wildlife monitoring and overflights, could result in disturbance impacts similar to those described for alternative 1. Alternative 2 would likely cause some intermittent disturbance to Mexican spotted owl individuals when foraging in the action area or during active nesting. These disturbances would be unlikely to affect reproduction or survival. When combined with alternative 2, some cumulative adverse impacts on nesting or breeding associated with other actions and some additional disturbance to foraging owls could occur. However, the overall long-term, cumulative impact on owls would be unlikely to reduce reproductive success or survival, and alternative 2 would contribute a small and intermittent increment to cumulative impacts on owls.

California condors would also experience similar impacts from other cumulative actions described for alternative 1. Adverse impacts could result from overflights, although NPS flights include a protective buffer distance to minimize impacts on condors. When combined with alternative 2, adverse impacts from disturbance would be minimized, and benefits are expected because condors would have increased forage from bison carcasses during reduction actions. This could have positive impacts on condor survival and

reproduction in the area. However, this benefit would be reduced over time as the House Rock bison herd is reduced to fewer than 200 bison. Over the long term, any adverse cumulative impacts on condors are likely to be low given that actions to decrease the House Rock bison herd would eventually be reduced. Alternative 2 would contribute a small and intermittent increment to cumulative impacts from noise and the reduction of bison.

Impacts on northern goshawks from other cumulative actions would be the same as those described for alternative 1. These minimal impacts will result from park maintenance activities (e.g., presence of vehicles and maintenance crews), commercial air tours, and administrative helicopter and prescribed fires. Under alternative 2, goshawks could experience short-term disturbances associated with lethal and nonlethal culling efforts. However, this species could benefit from increased forest prey populations once the size of the House Rock bison herd is reduced and any forest vegetative ground cover impacts are reduced. Overall, adverse cumulative impacts on goshawks would be unlikely to affect reproductive success or overall survival, and alternative 2 would contribute some habitat-based benefits and small, intermittent, adverse effects related to potential disturbance.

Impacts on northern leopard frogs from other cumulative actions would be the same as those described for alternative 1. Alternative 2 would provide long-term benefits to the northern leopard frog by reducing the size of the House Rock bison herd and protecting water sources and associated vegetation. Cumulative impacts would be long term and adverse because bison would remain on the landscape and would affect water sources and adjacent habitat. Remaining bison would be attracted to surface water and could continue to affect leopard frog habitat if not fenced. However, these impacts would be greatly reduced compared to alternative 1, with alternative 2 contributing a substantial beneficial increment through habitat protection.

Conclusion

As described for alternative 1, a number of special-status species that are considered fundamental park resources occur in the action area (NPS 2010c). Special-status species include those designated under the Endangered Species Act of 1973 (16 USC 1531 et seq.), species listed by the Navajo Nation, state-listed species, and USFS sensitive species. Given their low populations, reduced distributions, and reduced overall survival, impacts on special-status species would be disproportionate compared to other wildlife species, of which alternative 2 would most likely affect four—Mexican spotted owl, California condor, northern goshawk, and northern leopard frog.

Under alternative 2, bison grazing, trampling, and wallowing in meadows and around water sources would decrease as a result of the smaller number of bison anticipated under this alternative (fewer than 200). This would result in more forage, more cover, and improved water quality that would benefit special-status species such as the northern leopard frog and Mexican spotted owl and northern goshawk prey species. The analysis suggests that alternative 2 could provide benefits to the California condor in terms of a short-term increase in forage associated with lethal culling of the bison, which could positively affect condor survival and reproductive success.

Minimal, adverse impacts could occur as a result of noise disturbance or the presence of helicopters and fixed wing airplanes; however, measures such as distance buffers would be used to minimize any impact on condors and Mexican spotted owls. Similar disturbance-related impacts could occur to the northern goshawk from the use of helicopters or presence of team members. However, it is unlikely that these impacts would affect important breeding, nesting, or foraging behaviors in a meaningful way.

Special-status species that rely on grassland and meadow habitat or water resources and wetland-associated vegetation could experience long-term, beneficial impacts. The northern leopard frog, which rely on grassland/meadow habitat and the limited water resources found throughout the action area, would

also benefit in the long term from the reduced size of the House Rock bison herd, increasing species prevalence in the area. Short-term impacts from reduction actions could be adverse in terms of congregating bison on grassland/meadow habitat and in areas with water sources. However, measures would be implemented to minimize impacts on these special-status species. None of the actions are likely to reduce the reproductive success or survival of any of the special-status species analyzed and could result in overall improved conditions.

Impacts on Special-status Wildlife Species on Adjacent Lands. Hazing, herding, or lethal culling pressure is expected to cause an increase in bison movement, including on to adjacent USFS lands. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, dispersing bison are expected to seek habitat outside the park that is similar to preferred habitat in the action area (i.e., grasslands, meadows, shrublands, wetland-associated vegetation, and water sources). As described above, only those special-status species that rely on these habitat types could be affected by increased numbers of bison (e.g., the northern leopard frog). However, the types of impacts dispersing bison would cause on adjacent lands would be similar to the impacts described for the action area under the no-action. These impacts could persist beyond the initial reduction phase if bison begin to spend more time outside of the park.

However, because fewer bison would move outside the park (compared to the resulting bison population under alternative 1), the impacts on special-status species would be of a much lower magnitude. In addition, as described above, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to the plan's guidelines would keep bison numbers at a level that would minimize potential damage to sensitive habitats (USFS 2014).

CULTURAL AND TRIBAL RESOURCES

METHODS AND ASSUMPTIONS

Cultural resources analyzed in this environmental assessment include archeological resources and historic and prehistoric structures, cultural landscapes, and traditional cultural properties and ethnographic resources. The analysis for each of the cultural resource categories considers the effects associated with the implementation of each alternative and is focused for archeological resources, prehistoric and historic structures, and cultural landscapes on potential changes to the character-defining features of these sites or districts that make them eligible for listing in the national register. The analysis of the North Rim Entrance Road Corridor cultural landscape considers effects associated with activities adding constructed features or altering the intended land-use patterns of the landscape. The analysis of ethnographic resources and traditional cultural properties focuses both on physical effects to such resources that could diminish national register eligibility and intangible qualities that the resources have for traditionally associated tribes.

Geospatial data for specific traditional cultural properties and ethnographic resources are not available for the North Rim of the Grand Canyon at this time. While the exact locations of specific ethnographic resources, traditional cultural properties, or other important places are unknown, the Grand Canyon from rim to rim is considered a traditional cultural property to the park's traditionally associated tribes as described in chapter 3. Intact natural systems, healthy populations of native plants, naturally flowing springs and seeps, and native animal populations are important to preserving the qualities of the canyon as a traditional cultural property that make it eligible for listing in the national register. Archeological sites

in general are known to be significant to the traditionally associated tribes and are thus considered traditional cultural properties for the purposes of this environmental assessment. The impact analysis for traditional cultural properties would be similar to that of archeological sites and would include identifying disturbances that would diminish qualities that make the resource eligible for the national register. Effects could also include more esoteric and intangible qualities that American Indian people ascribe to individual traditional cultural properties. Similarly, some of the effects on traditional cultural properties and ethnographic resources would be elicited under impact topics related to natural resources (vegetation, seeps and springs, and wildlife for example). Adverse effects on such natural resources would be viewed as issues of concern to the traditionally associated tribes.

The National Historic Preservation Act of 1966 (as amended) and other cultural resource laws inform this analysis. Potential effects on cultural resources were evaluated based on the knowledge of cultural resource specialists through review of available literature, including a 2014 monitoring project of a limited number of archeological resources in bison use areas on the North Rim of the park (NPS 2014c), examination of GIS data noting specific sites types where the House Rock bison herd are known to occur or could occur in the future, knowledge of expected locations for bison reduction activities, consultation and continuing communications with tribes and cooperating agency staff, and references to resource-specific issues identified in chapter 1.

Potential impacts on cultural resources were based on consideration of the following:

- soil compaction that leads to surface erosion in site areas and potentially destabilizes architectural foundations and affects national register integrity
- trailing that results in displacement and disturbance of artifact distributions and built features and diminishes national register integrity and tribal values
- wallows that result in significant disruption of artifact distributions and obscure artifact distributions through direct burial of artifacts and diminish national register integrity
- wallowing that results in loss of vegetation, larger and more numerous barren areas, diminishing populations of native plant communities and plant diversity, and an increase in exotic plant populations, all of which diminish tribal values and national register integrity
- trampling that results in breakage of surface artifacts and diminishes national register integrity
- foraging and water source use, resulting in diminished water quality, damage to sensitive riparian plants, and damage to historic water features such as water troughs, which diminishes tribal values and national register integrity
- subsurface ground disturbance during temporary fence and corral construction, which includes access via off-road vehicle corridors, resulting in the destruction of archeological deposits
- addition of constructed features or alterations along the road alignment and associated meadow, resulting in a disruption of the visual characteristics of the North Rim Entrance Road Corridor cultural landscape

ARCHEOLOGICAL RESOURCES AND HISTORIC AND PREHISTORIC STRUCTURES

Archeological sites and historic and prehistoric structures are described in chapter 3 and are only briefly summarized here. Archeological resources (sites) are “the location of a significant event, prehistoric or historic occupation or activity, or building or structure (whether standing, ruined, or vanished) where the location itself possesses historic, cultural, or archeological value” (NPS 1997). Site types present in the

bison use area include pueblos, small habitation structures, storage features, rockshelters, thermal features and roasters, artifact scatters and caches, water control features, trails, rock writing, mining adits, roads, telephone and telegraph lines, historic dumps, and tree towers. Archeological sites are located in many areas frequented by the House Rock bison herd, such as meadows, near water sources, and along cliff faces where the bison may seek protection from the elements. At present, based on 14,650 acres of archeological survey conducted in bison use areas within the park (55,000 acres at present) 307 archeological sites have been documented. Of these 307 sites, 84 are artifact scatters, a site type that is particularly at risk from disturbances from bison as a result of trailing, wallowing, and trampling (NPS 2014c). Many of these artifacts scatters represent the lifeways of ancient hunter-gatherers, known to archeologists as the Paleoindian and Archaic peoples. These two cultural groups are understudied in the park yet they lived in the canyon for thousands of years and represent the longest continuous occupations by humans in all of Grand Canyon prehistory. Gaining a clear understanding of the movements of these ancestral people is important to understanding the human history of the Grand Canyon and the part ancient hunter-gatherers played in that history. That story can only be told by studying the dispersed artifact scatters these hunter gatherers left behind.

Impacts of Alternative 1 (No Action) on Archeological Resources and Historic and Prehistoric Structures

Under the no-action alternative, the impacts of the House Rock bison herd would continue and are expected to increase on the North Rim as a result of the expected increase in the herd to 1,200 to 1,500 bison over 10 years. These effects are likely to extend into new areas, such as the Walhalla Plateau, as the growing House Rock bison herd seeks new sources of water and forage. Current telemetry evidence indicates bison have now moved on to the Walhalla Plateau after the seeking forage in the area of the Fuller Fire just north of the Walhalla Plateau in 2015 (NPS, Holton, pers. comm. 2017e) where water and forage are available. Effects from this unchecked population growth are expected to be adverse, resulting in loss of individual site integrity and substantial change to character-defining elements and features of archeological sites to the extent that many would no longer be eligible for the national register. Effects could include, among other things, destabilization of historic and prehistoric structures, destruction of fragile wooden spring features, artifact assemblage depletion, and artifact context loss.

Bison trail development, trampling, bedding, and wallowing would continue to expose, damage, and destroy *in situ* archeological resources throughout the range and have the potential to damage and destabilize built features such as walls and artifact distributions and contexts. These effects are expected to be particularly damaging to artifact scatters, which have been shown (NPS 2014c) to be very sensitive to bison wallowing and trampling. An examination of GIS data (Grand Canyon wildlife and archeological site GIS files) currently shows eight archeological sites (6 artifact scatters, 1 historic structure, and 1 dendroglyph site) that have wallows present within the site boundaries. One of these sites, B:12:0021, which is an artifact scatter and has not yet been monitored for bison effects, has 32 wallows of various sizes within the site boundary. It is very likely these wallows have resulted in adverse effects on the national register integrity for the site of materials, location, and setting. If diagnostic tools (those that can provide dating information or cultural affiliation associations) are present in the artifact scatter, the elements workmanship and association may also be diminished at the site. Other sites with wallows have, or would, suffer adverse effects from bison wallowing and trampling activities.

Numerous other archeological sites are within proximity to wallows. These archeological sites are currently displayed as points in GIS data rather than as polygons that illustrate the actual size of a given site area. It is likely that some wallows actually fall within these archeological site areas and are causing adverse effects to the sites by disturbing the ground surface, burying and breaking or displacing artifacts, destroying the surface soil and vegetation that protects artifacts and features, and disturbing the subsurface where important cultural matrices have lain undisturbed for millennia.

Bison have been observed in places below the rim of the canyon where fragile architecture features of prehistoric age are located. Site B:16:0059 is one example where monitoring documented the presence of bison in an alcove containing granaries. Trailing, wallows, and dung were reported to have disturbed artifact distributions at the site (GRCA site file record 2012). In a subsequent visit to the site, archeologists noted bison were bedding down within one portion of the site, trampling the stones associated with the walls of the structure (GRCA site file records 2014). Increased numbers of bison using these areas would result in destabilization of the walls of such structures as bison seek shelter in the shaded alcoves where the features are constructed and as bison press against the stone masonry and mud mortar buildings. Bison are expected to damage historic-age spring features such as water troughs and spring works in their attempts to gain access to water. Some of these spring features consist of wooden parts that have been exposed to the elements for 100 years, making the wood quite brittle. Bison use of such features could cause the wood to deteriorate further leading to their destruction.

Cumulative Impacts. Some past and future actions have the potential to combine with the effects of the no-action alternative to produce cumulative impacts on archeological resources and historic and prehistoric structures on the North Rim. Cultural resources have and could be affected by prescribed and wildland fire activities, vegetation/habitat restoration and exotic plant management, North Rim roads maintenance and improvements, and vandalism. Prescribed fire has beneficial effects on some archeological site types by removing excess fuels from site areas that are sensitive to fire, such a wooden buildings and rock writing (rock art) sites, and preventing higher temperature wildfires. Fire activities can also adversely affect certain types of archeological sites and historic and prehistoric structures by burning wooden items, causing glass artifacts to melt or shatter, and by causing rock writing to exfoliate from rock faces or to be covered with soot and obscuring the rock writing elements (NPS 2011a).

The park actively manages exotic plants, including on the North Rim, and engages in vegetation and habitat restoration activities. These activities would generally have beneficial effects on archeological sites by helping keep native plants established and increasing opportunities for cryptobiotic soils to establish themselves. Cryptobiotic soils stabilize soil matrices and deter erosion.

Road maintenance activities could result in adverse effects on archeological and prehistoric structures. Grading historic roads, building drainage swales, and placing culverts has resulted in subsurface disturbance in the form of damage to the distribution of artifacts by burying or dispersing them, artifact assemblage depletion, and destabilization of prehistoric stone structure foundations. Road maintenance could also result in some beneficial effects through maintaining historic road alignments and constructed road features.

Vandalism at archeological sites, such as stealing artifacts, modifying structures, putting graffiti on rock writing panels, and piling artifacts into collections, is an adverse effect on archeological sites and historic and prehistoric structures.

When the effects of the no-action alternative are added to the effects of these cumulative actions, adverse, on-site, and permanent cumulative effects on archeological resources and historic and prehistoric structures in the bison use range could occur. Although some beneficial effects would occur from current and future actions, the expected increase in the size of the House Rock bison herd under the no-action alternative would add a considerable adverse increment to the cumulative effects, given the trailing, trampling, and wallowing within archeological sites from the large number of bison that are anticipated under this alternative, resulting in overall adverse cumulative impacts.

Conclusion. The increasing size of the House Rock bison herd anticipated under the no-action alternative is expected to result in trailing, trampling, and wallowing that would cause increased adverse effects on archeological sites and historic and prehistoric structures throughout the North Rim where bison

congregate. Artifact scatters appear to be most at risk from impacts of the House Rock bison herd. Some of these scatters are the remnants of the earliest peoples to live in the Grand Canyon area. Such sites are understudied and the histories of the ancient hunter-gatherer peoples remains elusive. Historic and prehistoric structures on the rim and in protected alcoves below the rim, as well as spring features, could also be damaged by an increasing House Rock bison herd. Currently, bison appear to be expanding into new areas near the Walhalla Plateau, in search of forage and water. This expansion would result in a greater number of archeological sites receiving adverse effects such as artifact context disturbances and artifact breakage, which would diminish their eligibility for the national register. Damage to historic and prehistoric structures and features at springs and seeps would continue or expand under this alternative and diminish their national register integrity. The protection of cultural resources found on the North Rim in the bison use range (as well as other park areas) is founded in the enabling legislation for the park and as outlined in law (the National Historic Preservation Act of 1966 as amended for example) and NPS management policies (2006). Archeological sites and prehistoric and historic structures, in particular, are non-renewable and reflect not only the lifeways and histories of past peoples, but provide connections between ancestral communities and their modern tribal descendants. Within Grand Canyon's archeological history resides 12,000 years of human achievement and survival, the story of which is still being revealed and understood through study of small artifact scatters, historic and prehistoric structures and traditional cultural places.

Although there would be various beneficial cumulative effects on the cultural resources examined in this section from some fire and vegetation-related activities, increasing size of the House Rock bison herd would result in larger areas of disturbance and more adverse effects on cultural resources from trailing, trampling, and wallowing. Although some beneficial effects would occur from current and future actions, the incremental effect of the resulting size of the House Rock bison herd under the no-action alternative would be considerable based, and overall cumulative impacts would be adverse.

Impacts on Archeological Resources on Adjacent Lands. The increase in the bison population under alternative 1 could cause more bison (compared to current conditions) to move on to USFS lands adjacent to the park as a result of density-dependent pioneering behavior. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, pioneering bison are expected to seek habitats similar to preferred habitats in the action area. Bison trailing, trampling, and wallowing that would cause increased adverse effects on archeological sites and historic and prehistoric structures where bison congregate could occur on adjacent USFS lands. This could result in similar impacts on archeological resources and historic and prehistoric structures, if present, as described in the action area, although more bison are expected to remain inside the park than outside. Therefore the probability of impacts outside the park would be much lower. In addition according to the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014), the US Forest Service would attempt develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. Also according to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management is expected to ensure that cultural resources would be preserved, protected, or restored (USFS 2014).

Impacts of Alternative 2 on Archeological Resources and Historic and Prehistoric Structures

Resulting Bison Population.

Under alternative 2, the House Rock bison herd is expected to be reduced from approximately 600 to no more than 200 animals. As a result of this reduction, the potential for overall future adverse impacts on archeological resources and historic and prehistoric structures would be reduced, which would improve the resource conditions for these resources compared to current conditions and therefore provide a

beneficial impact. Benefits would include a reduction in: trampling activities, the number and extent of wallows, the number of animals congregating at archeological or structure sites, and the loss of vegetation, which protects archeological deposits.

Although impacts would be reduced, they would not be entirely eliminated because some archeological sites have already been adversely affected by bison activities, and these impacts cannot be reversed once they occur. The House Rock herd is currently habituated to specific locations where these resources are known to occur, and herd movements similar to those seen at present are expected to continue. Bison activities such as trailing and wallowing would continue. Water sources co-located with archeological resources and historic and prehistoric structures would continue to be impacted; however, the intensity of impacts under alternative is expected to be reduced compared to current conditions. As discussed in chapter 2, uncertainties associated with alternative 2 actions may result in redistribution of animals into areas where bison and bison use disturbances are not currently present. Nonetheless, under alternative 2, impacts would be less severe than under current conditions.

Nonlethal Culling. Adverse effects on archeological resources, in particular artifact scatters and historic and prehistoric habitation locations, could occur from nonlethal culling activities. Corrals would be set up annually to coincide with nonlethal culling activities in June–July and August–September. Corrals would require access via off road vehicle corridors to transport materials, equipment, and trailers large enough to transport bison. Temporary access corridors could disturb archeological resources located near these activities as a result of ground disturbance and compaction. Corrals are proposed to be constructed as free-standing structures with cement block bases, but if any post holes must be dug, there could be ground disturbance that could affect buried cultural deposits. Having an archeologist on site to document the cultural deposits provides park managers and tribes with important cultural resource information, but might not mitigate the impact of post-hole construction if previously unknown archeological deposits are uncovered during fence post installation.

Trailing would develop as animals are encouraged to travel to corral locations through the placement of water and associated bait stations. The concentration of bison within a small, confined space would denude soils of vegetation and increase water and wind erosion, potentially exposing previously unidentified buried archeological resources.

Disturbances can be reduced by working with cultural resource staff to identify specific locations for the 120-foot diameter corrals and the temporary road access to the corral sites in advance of implementation. Material storage and crew staging (for both materials and contractor housing or work camps) could also result in ground disturbance and have the potential to disturb archeological resources. Rehabilitation of trailing and associated ground disturbance at corral locations, storage, and staging areas following project completion, such as vegetation planting to restore the surface structure, would be an important step toward restoring cultural areas to pre-project conditions.

Lethal Culling. Members of the lethal culling teams and their associated support teams would be traveling via foot off established trails in large groups of up to 20 team members with associated stock animals. Although this activity would crush vegetation and create trailing, such impacts may not be evident after a subsequent season of natural vegetation growth. Additional activities associated with lethal culling that may result in localized congregations of team members over a period of several hours, such as staging and camping, if necessary may result in surface and archeological resource trampling, causing areas to become barren of vegetation, erosion as vegetation is disturbed, and artifact displacement. However, overnight camps outside of designated and established locations are not anticipated for all trips expected. If camping is necessary outside of these locations for some reason, crews would use “leave no trace” protocols to avoid impacts. As lethal culling teams track bison across the landscape, it is likely they would be accessing parts of the canyon where there has been no archeological survey conducted,

potentially disturbing undocumented archeological resources and historic and prehistoric structures. Vegetation loss could result in exposure of additional archeological features or artifacts. Activities associated with lethal culling may diminish national register integrity of archeological resources by burying artifacts altering the archeological context of site artifacts and features that are used to interpret and understand such resources. Artifact scatters tend to occur along the edges of meadows and seasonal water sources and travel corridors, locations similar to those used by bison in the park.

Shooting, processing, field dressing, and removal of bison carcasses would disturb archeological resources and historic and prehistoric structures if these activities take place within the boundaries of archeological sites. Animals downed within site boundaries would require processing on site. Deposition of gut piles into archeological site context and ground disturbances associated with removal activities would also disturb surface artifacts and structures. These disturbances would be more pronounced at prehistoric structures in places such as Powell Plateau where this site type is prevalent and bison are known to congregate during certain parts of the year. As with other ground-disturbing activities, trailing, vegetation loss, archeological site exposure and damage, and artifact displacement would occur as a result of downing, processing, and removal of bison within archeological site boundaries. Some effects would last until the next monsoon season enable native vegetation to reestablish in disturbed areas.

As discussed in chapter 2, lethal culling and other teams would attend pre-project training to help prepare them to avoid archeological resources during the performance of their duties. Participants would be briefed on identification of sensitive resources in the field and actions to take to avoid disturbing archeological sites. The cultural resource briefing would include discussion of the consequences and penalties associated with disturbing archeological resources within the park.

Hazing and Herding. Because of the number of participants and the potential to employ the use of stock animals to haze and herd bison, disturbances to archeological resources and historic and prehistoric structures from hazing and herding activities would be similar to those associated with lethal and nonlethal culling. Although teams would be trained to look for the potential presence of archeological sites, as discussed in chapter 2, congregation of people and animals in areas where archeological resources and historic and prehistoric structures occur would result in ground trampling, vegetation loss, archeological site exposure, artifact displacement, the potential for wall and mortar disturbances, and erosion, leading to a loss in national register site integrity.

The placement of water and bait stations would attract large numbers of bison to specific locations resulting in trampling and trailing by animals with disturbances similar to those described for activities associated with lethal and nonlethal culling. How bison react to water and bait locations and the presence of humans cannot be determined ahead of time. Adverse effects on archeological resources and historic and prehistoric structures from hazing and herding would result in direct, site specific, and impacts that could be permanent.

Management Cycle. In order to fully understand the impacts associated with the implementation of alternative 2, the order of actions taken and their potential for interaction should be considered. As described in chapter 2, initiation of bison reduction activities would likely include nonlethal culling activities occurring in the grasslands and meadows during early summer. This could coincide with a lethal culling event in other areas, likely shrublands, of the action area. In addition, the park could also implement hazing and herding actions to move bison toward the corral sites from other areas of the action area, such as shrublands and forests. Given the types of effects on archeological resources, and the mitigation that would be followed to avoid or minimize impacts on these resources, it is unlikely that the collective use of these tools would have a synergistic impact on archeological resources that would result in greater impacts than previously described.

Local Exclusion Fencing. Placement of exclusion fences at local water sources and other areas could have adverse effects on unknown archeological resources. However, prior to any fence construction, sites would be surveyed for the presence of archeological resources, and those areas would be avoided. If any archeological resources were inadvertently discovered during fence installation, all work would be halted until the resources could be evaluated and an appropriate mitigation strategy developed to preserve the information and artifacts to the fullest extent. These fences would also reduce the potential for the effects from bison remaining on the North Rim.

Cumulative Impacts. Impacts from other actions considered in the cumulative impact analysis would be the same as those described for alternative 1 above and would have both adverse and beneficial effects as a result of prescribed and wildland fire activities, vegetation/habitat restoration and exotic plant management, North Rim roads maintenance and improvements, and vandalism.

Alternative 2 could result in increased ground disturbance further exposing cultural resources, resulting in damage or destruction and diminishing or eliminating the national register eligibility of such resources located within the range of the House Rock bison herd; however, with mitigation, adverse effects should be minimal. Also, after the reduction of bison is complete, there would be beneficial effects on archeological resources and historic and prehistoric structures throughout the range of the House Rock herd, because impacts on fragile artifact scatters and structures would be reduced in scope. Therefore, when the benefits of alternative 2 are combined with the adverse and beneficial effects of the other cumulative actions, an overall beneficial cumulative impact is expected. Alternative 2 would contribute a noticeable beneficial increment to this overall cumulative effect.

Conclusion. Under alternative 2, although adverse effects would still occur, the smaller House Rock bison herd compared to current conditions would result in beneficial impacts based on the reduced amount of intense wallowing, trailing, and associated impacts on archeological resources and historic and prehistoric structures. The intensity of current impacts may be reduced, but would not be eliminated. Adverse effects from bison reduction activities required to decrease the current population (lethal and nonlethal culling and hazing and herding) would be limited to areas that are subject to ground disturbance and would be mitigated by undertaking appropriate avoidance and restoration activities. However, these actions could lead to some impacts that diminish or lead to the loss of national register integrity of localized archeological resources and/or historic and prehistoric structures. Compared to alternative 1, the reduction in the House Rock bison herd size under alternative 2 would greatly improve conditions by reducing the potential for disturbance of archeological resources associated with an expanded bison population.

Although alternative 2 would contribute minimal cumulative adverse effects from the reduction actions taken, it would add important benefits because of the reduction of impacts from bison wallowing, trailing, and trampling. When the benefits of alternative 2 are combined with the adverse and beneficial effects of the other cumulative actions, an overall beneficial cumulative impact is expected. Alternative 2 would contribute a noticeable beneficial increment to this overall cumulative effect.

Impacts on Archeological Resources on Adjacent Lands. As previously described, reduction actions are expected to cause an increase in bison movement, including on to adjacent USFS lands. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, some bison are expected to seek habitat outside the park that is similar to preferred habitat in the action area (i.e., grasslands, meadows, shrublands, wetland-associated vegetation, and water sources). The types of impacts dispersing bison would cause outside would be similar to the impacts described for the action area under the no-action alternative. These impacts could persist beyond the initial reduction phase if bison begin to spend more time outside of the park. However, because fewer bison would move outside the park (compared to the resulting bison population under alternative 1), the

probability of impacts would be much lower. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management is expected to ensure that cultural resources would be preserved, protected, or restored (USFS 2014).

THE NORTH RIM ENTRANCE ROAD CORRIDOR CULTURAL LANDSCAPE

The North Rim Entrance Road Corridor cultural landscape is the only cultural landscape in the current range of the House Rock bison herd. Visual characteristics of the North Rim Entrance Road cultural landscape are of primary importance for consideration here. Views along the North Rim Entrance Road corridor have changed very little since construction of the road in 1931. NPS engineers and landscape architects designed the road as a scenic drive through open meadows fringed by mixed conifer forests and aspen groves. The alignment allows for expansive vistas with very few human-made intrusions. The road complements the landscape by using few constructed features, which when present, were built using locally quarried stone elements that help blend in with the surrounding environment.

Impacts of Alternative 1 (No Action) on the North Rim Entrance Road Corridor Cultural Landscape

Under the no-action alternative, bison effects would continue and are expected to increase along the North Rim Entrance Road Corridor cultural landscape. The House Rock bison herd is habituated to specific locations such as the Little Park Meadow in the cultural landscape. Bison effects include trailing into meadows and to water sources, over-grazing of native vegetation, trampling, bedding, and wallowing, which result in denuded areas, mud pits in areas where vegetation has been stripped, and overall vegetation species composition changes within the Little Park Meadow area. These effects are similar to those described for the no-action alternative for soils and vegetation. Bison effects in the cultural landscape would continue to degrade meadow areas, a character-defining feature of the landscape, through loss of vegetation, increased barren soil areas, erosion, and accumulation of bison waste. Effects are expected to be concentrated in Little Park Lake near the North Rim Entrance Station.

Congregations of large numbers of bison along the North Rim entrance road would continue to change the visual characteristic and native plant communities of the landscape. The meadows along the entrance road have been adversely affected through heavy bison use, resulting in removal of native vegetation and an increase of bald patches where native vegetation and the subsurface seedbed have been destroyed. It is likely that greater size of the House Rock bison herd would also increase vehicle congestion and visitor foot traffic. Bison congregations change the way park visitors experience and use the landscape. People more frequently congregate along the road to observe the bison and pull their vehicle along the shoulder of the road and meadow perimeter. This can further damage roadside vegetation and diminish the undeveloped quality of the landscape corridor.

Cumulative Impacts. Some past and future NPS actions have the potential to combine with the effects of the no-action alternative to produce cumulative impacts on the North Rim Entrance Road Corridor cultural landscape within the action area. The cultural landscape has and would continue to be affected by prescribed and wildland fire activities, vegetation/habitat restoration and exotic plant management, and the North Rim roads maintenance and improvements.

Prescribed fire could have beneficial effects on aspects of the cultural landscape by removing excess fuels from the meadow perimeter, stopping the creep of forest materials into the historic meadow, and reducing

the likelihood of fire entering the landscape. Fire activities could also adversely affect forest composition and vegetation communities through introduction of invasive plant species.

The park actively manages exotic plants and engages in vegetation and habitat restoration activities to keep native plants established and improve conditions for cryptobiotic soil development, which can stabilize soils and deter erosion. These activities would generally have beneficial effects on cultural landscape resources by helping to prevent erosion because native vegetation and root structure helps promote infiltration of water rather than runoff. The viewshed across the meadow is intended to be a continuous expanse of native vegetation; managing exotics would contribute to the overall integrity of the cultural landscape.

Road maintenance activities could result in adverse effects on the North Rim Entrance Road Corridor cultural landscape. Grading and paving roads, building drainage swales, and placing culverts has altered the cultural landscape. Road maintenance could also result in some beneficial effects by maintaining historic road alignments and constructed road features.

When the adverse effects of the no-action alterative are added to those of reasonably foreseeable current and future actions, these could result in increased damage or destruction and diminish or eliminate the significant features of the cultural landscape, altering national register eligibility within the range of the House Rock bison herd, and result in overall adverse cumulative impacts. Alternative 1 would add a considerable adverse increment to the overall cumulative impact.

Conclusion. Under the no-action alternative, bison effects would continue and increase over time as the House Rock bison herd grows. These effects would result in ground disturbance that could expose, damage, or destroy vegetation on the North Rim Entrance Road Corridor cultural landscape. This rare Grand Canyon vegetation community (see the “Bison-Affected Vegetation” sections) is of state and regional importance (NPS 2015e) for their ecological values and are a critically important character-defining feature of the North Rim Entrance Road Corridor Cultural Landscape. The National Register nomination for the North Rim Entrance Road Corridor Cultural Landscape was written specifically for the cultural landscape of the area. Vegetation, including the meadows adjacent to the roadway, are contributing features of the property. It is considered eligible at the state level of significance. Loss of meadow vegetation and development of wallows from bison overuse of the area has, and could continue to diminish the integrity of the property with the potential to affect its National Register significance. It is likely that greater numbers of bison would increase vehicle congestion and visitor foot traffic, further damaging roadside vegetation and diminishing the undeveloped quality of the landscape corridor.

The no-action alternative would add a considerable adverse increment to the impacts of other reasonably foreseeable current and future actions, resulting in increased damage or destruction and diminishment or elimination of the significant features of the cultural landscape. The national register eligibility of resources within the range of the House Rock bison herd would be altered, resulting in overall adverse cumulative impacts.

Impacts of Alternative 2 on the North Rim Entrance Road Corridor Cultural Landscape

Resulting Bison Population. Under alternative 2, the House Rock bison herd is expected to be reduced from approximately 600 to fewer than 200 total animals. The House Rock bison herd is habituated to specific locations such as the Little Park Meadow in the cultural landscape, and disturbances would continue, although they would be reduced in scope and intensity compared to the no-action alternative because of the reduced size of the House Rock bison herd on the landscape. There would therefore be beneficial effects on the North Rim Entrance Road Corridor cultural landscape as a result of reduction in bison numbers throughout the district.

Trails and wallowing in particular are expected to continue in areas where this behavior has already been established. Under alternative 2 the size of the House Rock bison herd would be reduced, resulting in a reduction in future impacts on the cultural landscape. The intensity of current impacts may be reduced but would not be totally eliminated without active mitigations. However, vegetative resources would have a better opportunity to recover with a reduced number of bison present on the landscape, resulting in improvement in range conditions over time. Water sources in the cultural landscape would also continue to be affected. However, the intensity of impacts under alternative 2 are expected to be reduced in scope.

Nonlethal Culling. The Little Park Meadow has been chosen as the primary corral site with the option to use others that are outside of the North Rim Entrance Road Corridor cultural landscape if bison congregate in areas accessible to nonlethal culling operations. The proposed corral size is 120 feet in diameter, up to 2 acres total. The corral at Little Park would be set up annually to coincide with nonlethal culling activities scheduled between June–July and August–September. Corral construction would require access corridors to transport materials, equipment, and trailers large enough to transport bison. The placement of the corrals at Little Park would diminish national register integrity of setting, design, and feeling in the cultural landscape. Although the corral would be temporary, during use it would add human-made intrusions to the cultural landscape; the corral itself would not be visible from the Entrance Road, but the access to it would be. Impacts would remain evident until at least the following monsoon season when native vegetation is reestablished. Staging of materials and construction of a temporary access road to facilitate capture would change the intended land-use pattern and result in increased traffic, noise, dust, and visual intrusion by backhoes, trucks, and trailers, which would change the way park visitors experience and use the landscape, and vegetation disturbance in Little Park Lake, which would degrade the landscape. The placement of water and bait stations would attract large numbers of bison to the corral, resulting in trampling and trailing by animals in areas around the corral.

Rehabilitation of trailing and associated ground disturbance at corral locations, storage, and staging areas following project completion, such as vegetation planting to restore the surface structure, would be an important step toward restoring the cultural landscape to pre-project conditions. Careful planning would be necessary to ensure that adverse effects are mitigated prior to implementation of the proposed reduction actions. Potential mitigations include having cultural resource staff on-site during ground disturbance, temporary flagging to avoid areas, and training contractors on cultural resource significance.

Lethal Culling. Lethal culling and associated activities would likely have few effects on the overall landscape character of the North Rim Entrance Road Corridor cultural landscape because lethal culling in this high visitor use area would be avoided, and bison reduction would occur in the more remote parts of the park to avoid potential corral sites and visitors. Lethal culling could occur in the meadows along the entrance road only in the winter when the park road is closed, and only if bison are present. The House Rock bison herd has dispersed into smaller groups and spread out through the park in the winter in the past, and have not spent much time in the entrance road meadows.

Shooting, processing, field dressing, and removal of bison carcasses is not expected to occur within the boundaries of cultural landscape or be visible from the entrance road during periods of high visitor use. However, animals shot within the cultural landscape would require processing on site. Deposition of gut piles and ground disturbances associated with removal activities would also create disturbances to soils and vegetation, and these impacts would be adverse and detectable on site. Impacts would be site specific and short term.

As discussed in chapter 2, lethal culling and other teams would attend pre-project training to help prepare them to avoid disturbance within the cultural landscape during the performance of their duties. Participants would be briefed on the significance of the area and actions to take to avoid disturbing the

landscape. The cultural resource briefing would include discussion of the consequences and penalties associated with disturbing cultural resources within the park.

Hazing and Herding. Because of the number of participants and the potential to employ the use of stock animals, disturbances to the North Rim Entrance Road Corridor cultural landscape from hazing and herding activities would be similar to those associated with nonlethal culling activities. Congregation of people and animals in the cultural landscape could result in ground trampling, vegetation loss, erosion, and soil loss, further diminishing the visual quality of meadow areas. Herding into the established corral would result in impacts on vegetation in the areas immediately associated with foot traffic from lethal culling teams and animals.

Stock use and aircraft support would temporarily alter the setting and feeling of the cultural landscape through the addition of new elements into the landscape area. These activities are expected to have site specific adverse effects on the cultural landscape elements of integrity setting and feeling. Impacts from stock use would remain evident until the following monsoon season when native vegetation is reestablished. Impacts from the use of aircraft would persist only during the time aircraft were within sight and sound of the landscape; helicopters may pass by but would not be retrieving carcasses in the cultural landscape; fixed wing flights for aerial reconnaissance may also pass overhead, with the number depending on the weather and lethal culling locations throughout the North Rim.

Management Cycle. To fully understand the impacts associated with the implementation of alternative 2, the order of actions taken and their potential for interaction should be considered. As described in chapter 2, initiation of bison reduction activities would likely include nonlethal culling activities occurring in the grasslands and meadows during early summer. However, lethal culling would not likely occur in the cultural landscape. The park could implement hazing and herding actions to move bison toward capture facilities from other areas of the action area, such as shrublands and forests, but it is not likely that this would occur other than at the Little Park location. Given the types of effects on the cultural landscape, and the mitigation that would be followed to avoid or minimize impacts, it is unlikely that the collective use of these tools would have a synergistic impact on the cultural landscape that would result in greater impacts than previously described.

Local Exclusion Fencing. Placement of fencing would diminish national register integrity of setting, design, and feeling in the cultural landscape by introducing human-made intrusions in a largely undeveloped area. Exclusion fencing, although defined as temporary, would still be used for several years while reduction activities are ongoing. Staging of materials and construction would change land-use patterns in the landscape and also result in increased traffic, noise, dust and visual intrusion by backhoes, trucks, and trailers on the off road vehicle corridor access. Impacts would remain evident until the fencing was removed and native vegetation growth was reestablished.

Cumulative Impacts. Impacts from other actions considered in the cumulative impact analysis would be the same as those described for alternative 1 and would have both adverse and beneficial effects as a result of prescribed and wildland fire activities, vegetation/habitat restoration and exotic plant management, and North Rim roads maintenance and improvements.

Alternative 2 could result in increased ground disturbance—further disturbing meadow vegetation, adding human-made features to a largely undeveloped landscape area, and diminishing, for a time, the national register eligibility of the cultural landscape. Impacts would remain evident until the following monsoon season when native vegetation is reestablished, obscuring the damage to soils and/or until aircraft had exited the cultural landscape area. Reducing the size of the House Rock bison herd throughout the cultural landscape area would also have beneficial effects. Overall, alternative 2 would contribute mainly temporary adverse effects limited to one area near Little Park and long-term benefits over the entire

landscape. When added to the effects of the other cumulative actions, the overall cumulative effect on the North Rim Entrance Road Corridor cultural landscape would be beneficial.

Conclusion. Under alternative 2, bison effects on the North Rim Entrance Road Corridor cultural landscape are expected to decrease over time as the size of the House Rock bison herd is reduced, a beneficial impact that would last for many years. As described for alternative 1, the National Register nomination for the North Rim Entrance Road Corridor was written specifically for the cultural landscape of the area. The intensity of current impacts on the cultural landscape may be reduced but would not be eliminated without active mitigation. Vegetation is still expected to be grazed and barren areas created as a result of wallowing from the reduced bison herd, impacting the visual qualities of meadow areas, one of the character-defining elements of the cultural landscape. The use of appropriate mitigations, such as reseeding, would lessen the effects of those disturbances, and help retain the integrity of the landscape and its significance. Adverse effects from bison reduction activities (mainly nonlethal culling and hazing and herding) are expected to be limited to mainly the Little Park corral site and only be in place for the time needed for the capture operations to occur. Impacts would be minimized by use of appropriate mitigation and restoration activities that would be undertaken following project implementation (e.g., reseeding off road vehicle corridor access areas seasonally). Alternative 2 would result in beneficial effects on the cultural landscape as a direct result of the reduction of the House Rock bison herd throughout the landscape area. Compared to alternative 1, the smaller House Rock bison herd under alternative 2 would greatly reduce the potential for disturbance of the cultural landscape.

Overall, alternative 2 would contribute mainly temporary adverse effects limited to one area near Little Park and long-term benefits over the entire landscape. When added to the effects of the other cumulative actions, the overall cumulative effect on the North Rim Entrance Road Corridor cultural landscape would be beneficial.

TRADITIONAL CULTURAL PROPERTIES AND ETHNOGRAPHIC RESOURCES

Traditional cultural properties and ethnographic resources were described in chapter 3 and are only briefly summarized here. As described for "Methods and Assumptions" above, tribes see the entire canyon from rim to rim as a traditional cultural property. This world view focuses on the interrelatedness of all the resources within the canyon. Tribes ascribe both tangible and intangible qualities to all of the cultural and natural resources in the canyon. Many of the tribes consider themselves as direct caretakers of the canyon, and ceremonial songs and prayers are regularly recited for the health and wellness of the canyon.

Archeological sites are often recognized as traditional cultural properties. The Hopi for example, describe these locations as the "footprints" of the ancestors. Tribes typically do not approve when these places are described as "ruins" because these locations are the embodiment of their history and still imbued with the spirits of the ancestors. Consequently, any of the impacts described above under "Archeological Resources and Historic and Prehistoric Structures" would also affect the tribal values and association of tribes to that resource.

Many of the natural and cultural features throughout the canyon would be considered traditional cultural properties or ethnographic resources by one or more of the traditionally associated tribes. Specific geographic locations or features such as rock formations are often important in tribal oral histories related to emergence narratives, migrations, or clan origins. Seeps and springs, animals, and plants all play important parts in tribal oral histories. Natural and cultural resources regardless of type are often viewed as sentient beings.

Tribes place a very high value on a variety of cultural and natural resources within Grand Canyon National Park. These typically include archeological sites, water sources, native vegetation, and naturally

occurring healthy wildlife populations. Each of these resources individually has the potential to be a traditional cultural property and when combined become the components of a traditional cultural property (as in the case of the Grand Canyon from rim to rim). Therefore, all of the items considered above under "Methods and Assumptions" would apply to traditional cultural properties and ethnographic resources. The actions and effects that were considered in assessing impacts described in the resource sections "Water Resources in the Karst Landscape; Bison-Affected Vegetation; Soils; Wildlife and Wildlife Habitat; and Wilderness Character" would also apply because they would have similar impacts on traditional cultural properties and ethnographic resources.

Impacts of Alternative 1 (No Action) on Traditional Cultural Properties and Ethnographic Resources

Under the no-action alternative, direct bison effects on traditional cultural properties would continue, and are expected to increase, on the North Rim. Under this alternative, the House Rock bison herd is expected to increase to an estimated 1,200 to 1,500 individuals. These effects are likely to extend into new areas as the growing House Rock bison herd seeks new sources of water and forage. Bison effects, including trail development, trampling, bedding, and wallowing, would continue to expose, damage, and destroy *in situ* archeological resources/traditional cultural properties throughout the range and have the potential to damage and destabilize built features such as walls and artifact distributions and contexts. These effects are expected to be particularly damaging to artifact scatters, which have been shown (NPS, Brennan, pers. comm. 2015j) to be particularly sensitive to bison wallowing and trampling. Bison have been observed in places below the rim of the canyon where fragile architecture features of prehistoric age are located. Increased numbers of bison using these areas would destabilize the walls of such structures as bison seek shelter in the shaded alcoves where the features are constructed and as bison press against the stone masonry and mud mortar buildings.

Bison use on the North Rim likely affects seeps and springs within the inner canyon that are known traditional cultural properties and ethnographic sites such as Vasey's Paradise, Dutton Spring, and Deer Spring. Aquifer and dye trace studies (NPS, Tobin, pers. comm. 2016c; Zappitello et al. 2016; Jones, Springer, and Tobin 2016; Schindel 2015) reveal that surface water from the North Rim, discharges at these and other inner canyon springs. It is possible that these waters carry bacteria from concentrations of bison fecal matter from the Little Park Meadow area, though no studies have yet been undertaken to determine the presence of such contamination. If inner canyon springs are being contaminated by fecal bacteria, this would have serious consequences for the traditionally associated tribes who collect spring water for secular and non-secular purposes.

Cumulative Impacts. Past, current, and future actions have the potential to combine with the effects of the no-action alternative to produce cumulative impacts on traditional cultural properties and ethnographic resources on the North Rim within the range of the House Rock bison herd. These resources could be affected by prescribed and wildland fire activities, vegetation restoration and exotic plant management, road maintenance and improvement, vandalism, and commercial air tours and transportation flights. Prescribed fire could have a beneficial effect on some archeological site types by removing excess fuels from site areas that are sensitive to fire, such a wooden buildings and rock writing sites. Fire activities could also adversely affect rock writing sites causing rock writing exfoliation or causing the area to be covered with soot thus obscuring the rock writing elements (NPS 2011a).

Management activities, including prescribed and wildland fire management, vegetation/habitat restoration, and exotic plant management all have the potential to cause additional ground disturbance and loss of vegetation cover within traditional cultural properties and ethnographic resources. The additional damage from these activities and a growing House Rock bison herd could result in a loss of national register integrity or other attributes that tribal communities may ascribe to these resources such as a

natural habitat without intervention or disturbances from human activity. While the exact number of sites is unknown, the cumulative impacts may be greatest at locations near water sources.

The park actively manages exotic plants and engages in vegetation and habitat restoration activities. These activities would generally have beneficial impacts on archeological sites/traditional cultural properties by helping stabilize soils.

It is currently unknown if or to what extent tribal members might visit the North Rim or the project area to perform personal cultural practices such as prayer offerings. However, discussions of other park locations have indicated that during times when tribal cultural practices do occur, commercial air tours and transportation flights cause adverse effects, because the noise interferes with practices that require quiet and solitude and an environment that is conducive to uninterrupted contemplation.

Road maintenance activities could result in adverse effects on archeological and prehistoric structures/traditional cultural properties through activities such as grading roads, building drainage swales, and placing culverts all of which could result in artifact assemblage depletion and destabilization of prehistoric stone structure foundations.

Vandalism at traditional cultural properties, including stealing artifacts, modifying structures, putting graffiti on rock writing panels, and piling artifacts into collections, is an adverse effect on traditional cultural properties.

When the mainly adverse effects of the no-action alternative are added to the adverse and beneficial effects of these cumulative actions, there would be overall adverse impacts on ethnographic resources and traditional cultural properties such as archeological sites and seeps and springs in the range of the House Rock bison herd. Although some beneficial effects would occur from current and future actions, the adverse contribution of the expected increase in the size of the House Rock bison herd under the no-action alternative would have a considerable contribution to cumulative impact, given the trailing, trampling, and wallowing within archeological sites from the larger House Rock bison herd that is anticipated under this alternative, resulting in the overall adverse cumulative impact.

Conclusion. The increasing House Rock bison herd anticipated under the no-action alternative is expected to result in trailing, trampling, and wallowing that would cause increased adverse effects on traditional cultural properties and ethnographic resources throughout the range used by the herd. The House Rock bison herd would likely expand into new areas in search of forage and water. This expansion would result in a greater number of traditional cultural properties receiving adverse effects such as artifact context disturbances and artifact breakage. Artifact scatters, evidence of the cultures of some of the earliest peoples in the Grand Canyon area, appear to be most at risk from bison effects caused by trailing, wallowing, and trampling within these scatters. Prehistoric structures/traditional cultural properties on the rim and in protected alcoves below the rim as well as spring features could also be damaged by an increasing House Rock bison herd. Similar impacts on features at springs and seeps would continue or expand under this alternative as resources near water sources or the water sources themselves are at risk. Bison effects would continue and increase over time as the House Rock bison herd grows; these effects would result in more intense and wider distribution of ground disturbance that could expose, damage, or destroy traditional cultural properties and ethnographic resources located throughout the range used by the House Rock bison herd or impacted by bison activity within this range. Under the no-action alternative, bison impacts would continue and would lessen the integrity of sites, resources, and places that tribes value. All of these impacts would diminish national register integrity and negatively affect the context for associated tribal values.

Although there would be various beneficial cumulative effects on the cultural resources examined in this section from some fire, vegetation, and road maintenance, the growing House Rock bison herd would result in larger areas of disturbance and more cultural resources adversely affected by trailing, trampling, and wallowing. Despite the fact that some beneficial effects would occur from current and future actions, the adverse incremental effect of the resulting size of the House Rock bison herd under the no-action alternative would be considerable and overall cumulative impacts would be adverse.

Impacts on Traditional Cultural Properties and Ethnographic Resources on Adjacent Lands. The increase in the bison population under alternative 1 could cause more bison (compared to current conditions) to move on to USFS lands adjacent to the park as a result of density-dependent pioneering behavior. Although the number of bison that may disperse and their movements would be unpredictable, pioneering bison are expected to seek habitat similar to preferred habitat in the action area. Bison trailing, trampling, and wallowing would cause increased adverse effects on traditional cultural properties and ethnographic resources where bison congregate on adjacent USFS lands. This could result in impacts on traditional cultural properties and ethnographic resources, if present, similar to those described for the action area, although more bison are expected to remain inside the park than outside. Therefore the probability of impacts outside the park would be much lower. However, according to the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014), the US Forest Service would attempt to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. Additionally, according to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management is expected to ensure that cultural resources, including known traditional cultural properties would be preserved, protected, or restored (USFS 2014).

Impacts of Alternative 2 on Traditional Cultural Properties and Ethnographic Resources

Resulting Bison Population. Under alternative 2, the reduction in the number of bison to fewer than 200 bison (from a current estimate of 600 individuals) should result in a decrease in the intensity of impacts on traditional cultural properties and ethnographic resources and would be considered a beneficial action. This would be true across resource categories with a nexus to traditional cultural properties and ethnographic resources, including cultural resources, vegetation, water resources, and wildlife. Specifically, fewer bison on the landscape would reduce the amount of vegetation lost by trampling and wallowing allowing the area to recover from bison impacts and return to a more intact natural state. The intensity of current impacts may be reduced but would not be eliminated without active mitigations. The overall intensity of impacts on cultural and water resources would also be reduced, resulting in a benefit to traditional cultural properties and ethnographic resources by lessening the ongoing and potentially growing impacts described for alternative 1. Because tribes place great value on the natural and cultural resources both individually and as combined into a landscape level ecosystem, reducing the bison impacts aligns with tribal values for protection of park resources.

However, it is unknown if the geographic range of the bison will remain the same, change, or be reduced. Even with a reduction in bison numbers, there would still be bison activities that result in impacts on traditional cultural properties and ethnographic resources that would continue indefinitely as long as bison are on the landscape. Under alternative 2, these impacts would be less severe than under current conditions.

Tribes place high value on a variety of cultural and natural resources within Grand Canyon National Park. These typically include archeological sites, water sources, native vegetation, and naturally occurring healthy wildlife populations. Each of these resources individually has the potential to be a traditional cultural property and when combined become the components of a traditional cultural property (as in the case of Grand Canyon from rim to rim). A reduction in the size of the House Rock bison herd is perceived

by tribes as benefiting the cultural and natural resources in Grand Canyon but the bison reduction impacts as described in each resource section for each reduction tool may impact the integrity and associated tribal value of that resource.

Nonlethal Culling. For the purposes of this environmental assessment, impacts described for "Water Resources in the Karst Landscape," "Bison-Affected Vegetation," and "Wildlife" are considered to be the same for traditional cultural properties and ethnographic resources.

Lethal Culling. For the purposes of this environmental assessment, impacts described for "Archeological Sites," "Water Resources in the Karst Landscape," "Bison-Affected Vegetation," and "Wildlife" are considered to be the same for traditional cultural properties and ethnographic resources.

Hazing and Herding. For the purposes of this environmental assessment, impacts described for "Archeological Sites," "Water Resources in the Karst Landscape," and "Bison-Affected Vegetation" are considered to be the same for traditional cultural properties and ethnographic resources.

Management Cycle. In order to fully understand the impacts associated with the implementation of alternative 2, the order of actions taken and their potential for interaction should be considered. As described in chapter 2, initiation of bison reduction activities would likely include nonlethal culling activities occurring in the grasslands and meadows during early summer. This could coincide with a lethal culling event in other areas, likely shrublands, of the action area. In addition, the park could also implement hazing and herding actions to move bison toward capture facilities from other areas of the action area, such as shrublands and forests. Given the types of traditional cultural properties and ethnographic resources present, and the ability to notify tribes about reduction actions so that these areas can be avoided, it is unlikely that the collective use of these tools would have a synergistic impact on these resources that would result in greater impacts than previously described.

Local Exclusion Fencing. For the purposes of this environmental assessment, impacts described for "Archeological Sites," "Water Resources in the Karst Landscape," "Bison-Affected Vegetation," and "Wildlife" are considered to be the same for traditional cultural properties and ethnographic resources. In addition, fencing may have additional negative impacts as a literal and/or spiritual interruption of access to the location.

Cumulative Impacts. Impacts from other actions considered in the cumulative impact analysis would be the same as those described for alternative 1 above and would have both adverse and beneficial effects as a result of prescribed and wildland fire activities, vegetation/habitat restoration and exotic plant management, North Rim roads maintenance and improvements, vandalism, and commercial air tours and transportation flights.

The effects of alternative 2 could result in increased ground disturbance further exposing cultural resources resulting in damage or destruction and diminishing or eliminating the national register eligibility and associated tribal values of such resources located within the range used by the House Rock bison herd. These actions and the reduction of the House Rock bison herd throughout the current range would have beneficial effects on archeological resources/traditional cultural properties and prehistoric structures because impacts on fragile artifact scatters and structures would be reduced in range and intensity. Actions implemented to reduce the size of the House Rock bison herd combined with other activities such archeological data recovery, fire management, commercial air tours and transportation flights, and vegetation restoration and exotic plant management would continue to result in disturbances impacting traditional cultural properties diminishing or eliminating the national register eligibility and intangible qualities of these resources located within the range used by the House Rock bison herd. The cumulative actions of many of these activities would not change from those described for alternative 1.

However, under alternative 2, with fewer bison on the landscape these effects are expected to diminish while still remaining adverse and site specific. Some effects may be permanent but others only seasonal as native vegetation has time to reestablish. There would also be beneficial effects to ethnographic resources and traditional cultural properties as a result of reducing the size of the House Rock bison herd throughout the current range. When the cumulative impacts under alternative 2 are combined with past, current, and future actions, there would be an overall beneficial impact on traditional cultural properties and ethnographic resources compared to current conditions. Alternative 2 would contribute a noticeable benefit to the overall cumulative impact.

Conclusion. Under alternative 2, bison effects are expected to decrease over time as the size of the House Rock bison herd is reduced, and Alternative 2 would therefore result in beneficial effects on traditional cultural properties and ethnographic resources throughout the current range that bison use. Bison effects would continue to be adverse but minimal, localized, with some temporary and some permanent impacts. Adverse effects from bison reduction activities (lethal and nonlethal culling and hazing and herding) would be, limited to only certain times of the year and certain locations, and effects would be minimal especially if appropriate avoidance and restoration activities are undertaken following project implementation. Compared to alternative 1, the reduction in the size of the House Rock bison herd under alternative 2 would greatly improve conditions in terms of the potential for disturbance of the traditional cultural properties and ethnographic resources by reducing adverse impacts associated with an expanded bison population

When the cumulative impacts under alternative 2 are combined with past, current, and future actions, there would be an overall beneficial impact on traditional cultural properties and ethnographic resources compared to current conditions. Alternative 2 would contribute a noticeable benefit to the overall cumulative impact.

Impacts on Traditional Cultural Properties and Ethnographic Resources on Adjacent Lands. As previously described, reduction actions are expected to cause an increase in bison movement, including on to adjacent USFS land. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, some bison are expected to seek habitat outside the park that is similar to preferred habitat in the action area. Bison trailing, trampling, and wallowing would cause increased adverse effects on traditional cultural properties and ethnographic resources where bison congregate on adjacent USFS lands. The types of impacts dispersing bison would cause outside the park would be similar to the impacts described for the action area under the no-action alternative. These impacts could persist beyond the initial reduction phase if bison begin to spend more time outside of the park. However, because fewer bison would move outside the park (compared to the resulting bison population under alternative 1), the probability of impacts would be much lower. In addition, the *Kaibab National Forest Land and Resource Management Plan* (USFS 2014) notes that the goal of the US Forest Service is to develop site fidelity to the House Rock Wildlife Area and to use active management to minimize the impacts from bison on sensitive resources, particularly outside the House Rock Wildlife Area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management is expected to ensure that cultural resources, including known traditional cultural properties would be preserved, protected, or restored (USFS 2014).

WILDERNESS CHARACTER

METHODS AND ASSUMPTIONS

The analysis for impacts on wilderness character focuses on changes that would result from the implementation of reduction actions, specifically on the untrammeled, undeveloped, and natural qualities of the wilderness areas, as well as opportunities for solitude and primitive and unconfined recreation. The

analysis also briefly considers the effects on wilderness character, most notably the natural quality, as a result of where the House Rock bison herd is currently found or are likely to be found, and the expected size of the herd associated with implementation of each alternative. The impacts on the other features of value quality are assessed under cultural and tribal resources.

Potential impacts on wilderness were evaluated based on communications with park staff, and past vegetation classification data were used to identify baseline conditions within the action area, including information on the condition and composition of the wilderness in the park. Adherence to the Wilderness Act, including prohibitions on certain activities, a Minimum Requirements Analysis, and NPS wilderness management policies inform this analysis. NPS policy requires that all management decisions affecting wilderness must be consistent with the minimum requirements concept. This is a documented process to determine if administrative actions, projects, or programs undertaken by the park that affect wilderness character, resources, or the visitor experience are necessary, and if so, how to minimize impacts on wilderness (NPS 2008). To assess wilderness character, the context generally includes all wilderness qualities combined. Localized or site-specific impacts are described below as well as captured in the other impact analyses such as visitor use and experience. Additional assumptions are presented under each alternative as appropriate.

The following qualities of wilderness were considered in assessing impacts on wilderness character:

- **Untrammeled**—the natural world in wilderness is unhindered and free from the intentional actions of modern human control and manipulation
- **Natural**—ecological systems in wilderness are free from the effects of modern civilization; native plants and animals predominate, hydrologic and soil functions are within what are considered natural ranges, and natural processes dominate community organization
- **Undeveloped**—wilderness areas are essentially without permanent improvements or the sights and sounds of modern human occupation and use
- **Opportunities for solitude and primitive and unconfined recreation**—experiences in wilderness are for benefits derived from self-reliance, self-discovery, physical and mental challenges, and freedom from societal obligations

IMPACTS OF ALTERNATIVE 1 (NO ACTION) ON WILDERNESS CHARACTER

Under alternative 1, no action would be taken to reduce the size of the House Rock bison herd and no activity, action, or permanent improvements related to bison would be implemented; therefore, there would be no impacts on the untrammeled and undeveloped qualities of wilderness. In addition, no impacts on opportunities for solitude or primitive and unconfined recreation are expected because there would be no changes to the landscape or recreational uses in response to the growing House Rock bison herd.

Natural: The natural quality is preserved when native plant and animal populations and native biophysical processes predominate in relative balance. Bison populations can provide important influences on native plant and animal species and the associated ecosystem processes when managed in balance with available resources; however, unfettered population growth of the species can quickly affect the natural qualities of an ecosystem, as evidenced in the preceding analyses in this environmental assessment. A large House Rock bison herd would degrade native species populations and natural biophysical conditions and processes. The projected growth of the House Rock bison herd would continue to result in bison-related impacts that dominate ecological processes and cause an increase in adverse impacts on the natural quality of wilderness character.

NPS modeling indicates that the current herd of approximately 600 animals will grow to 1,200 to 1,500 in 10 years. The growth from a herd of 400 to 600 to 1,200 to 1,500 would increase intraspecific competition with other browsers as described under "Wildlife (Other than Bison) and Wildlife Habitat," forcing animals, including bison, into currently unoccupied parts of the action area such as Walhalla Plateau, which has experienced few bison-related impacts on springs, ponds, meadows, and wetlands present on the plateau. Vegetation trampling and consumption has been shown to reduce native vegetative cover in localized areas by up to 90% (Reimondo, Sisk, and Theimer 2015), and bare wallow areas would encourage the establishment of disturbance-adapted invasive exotic plant species (NPS 2015a; see generally the impacts discussion in "Bison-Affected Vegetation"). In southwestern US forests, the natural fire regime relies on fine fuels in the grass, herb, and shrub layers to carry fire across the landscape; grazing by bison could reduce these fuels. Soil compaction and erosion associated with vegetation removal and trampling would increase in both severity and extent commensurate with herd size (see the impact analysis in "Bison-Affected Vegetation" and "Soils"). In addition to coliform contamination from dung, unnaturally high numbers of bison would trample seeps, springs, and ephemeral ponds and entrain more soil and soil bacteria into these water sources, thereby decreasing water quality. Water quality impacts would extend outside the action area because the rapid recharge time of karst aquifers (2 days for Roaring Springs) prevents the filtering of bacteria (see the impact analysis in "Water Resources in the Karst Landscape"). Water in ephemeral ponds would be consumed by increased bison numbers at a faster pace, making the season when water is available to other wildlife shorter. The alteration and degradation of ecological processes such as water availability and flow would reduce the natural character of wilderness.

Cumulative Impacts

Past, present and reasonably foreseeable future actions that could affect wilderness qualities include fire management, exotic plant management, vandalism, flights over the park, and wildlife monitoring and management. Because there would be no impacts on the other qualities of wilderness character under alternative 1, the below cumulative analysis does not address those qualities.

Fire management actions include mechanical thinning or prescribed burning to reduce fuel loads and managing wildfires for resource benefit. These actions could improve natural quality by restoring natural communities of fire-adapted plants and animals and mitigating the risk of high-intensity wildfires and corresponding damage such fires can cause (Finney, McHugh, and Grenfell 2005; Agee and Skinner 2005). They also could degrade the natural condition by causing mortality of existing populations. Between 2000 and 2015, an average of 4,370 acres per year were treated with fire use and prescribed fire within the action area, but the emphasis was on forested areas rather than the meadows, springs, and wetland areas where bison have the greatest impacts. Commercial air tours and administrative aircraft use results in noise that degrades the natural soundscape. As described in the cumulative impact scenario, commercial air tours flew two routes over the action area in 2012, the highest daily total was 313 flights, the median was 138 flights, and 90% of days had at least 39 flights. Administrative flights in support of fire management, public safety, and research could occur throughout the action area, but much less frequently. During active fires, one to two flights are used to determine fire perimeters and, when needed, helicopters are used for aerial ignitions, water drops, or crew transport. Other types of administrative flights are rare in the action area, and generally do not exceed 15 per year. In addition, vandalism of natural resources could directly damage these resources and degrade the natural quality of wilderness. Wildlife studies and research activities may degrade the natural quality through trapping and immobilization of wildlife for collaring and the undeveloped character through subsequent monitoring actions using vehicles.

Past, present, and reasonably foreseeable future actions would adversely impact the natural quality of wilderness, based largely on impacts associated with overflights. The growing House Rock bison herd

under Alternative 1 would result in adverse impacts on the natural quality of wilderness character by affecting natural processes and ecosystems. When the impacts of alternative 1 are combined with past, present, and reasonably foreseeable future actions, the overall cumulative impacts on the natural quality of wilderness would be adverse, with alternative 1 contributing a substantial adverse impact.

Conclusion

Grand Canyon's wilderness resources are at the core of its mission, and are considered fundamental to the significance of the park, offering outstanding opportunities for visitor experiences including extended solitude, natural quiet, clean air, dark skies, and a sense of freedom from the mechanized world's rigors (NPS 2010c). A herd of 1,200 to 1,500 bison resulting from the unchecked growth of the House Rock bison herd would substantially degrade the natural quality of wilderness on the North Rim. Adverse impacts would occur to the biophysical environment, contributing to a relatively unbalanced system, where the natural quality of vegetation, hydrology, soils, and water are all affected. Past, present, and reasonably foreseeable future actions would adversely impact the natural quality of wilderness, based largely on impacts associated with overflights. The growing House Rock bison herd under Alternative 1 would result in adverse impacts on the natural quality of wilderness character by affecting natural processes and ecosystems. When the impacts of alternative 1 are combined with past, present, and reasonably foreseeable future actions, the overall cumulative impacts on the natural quality of wilderness would be adverse, with alternative 1 contributing a substantial adverse impact.

Impacts on Wilderness Character on Adjacent Lands. Wilderness areas outside the action area on adjacent USFS lands include Saddle Mountain Wilderness Area and the recommended Cockscomb, Grassy Canyon, and Aspen Canyon Wilderness Areas. As described for other resources, the increase in the bison population under alternative 1 could cause more bison (compared to current conditions) to move on to USFS lands adjacent to the park as a result of density-dependent pioneering behavior. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, pioneering bison are expected to seek habitat similar to the preferred habitat in the action area (i.e., grassland, meadow, shrubland, wetland-associated vegetation, and water sources). This could result in impacts on the natural quality of wilderness similar to those described for the action area, although more bison are expected to remain inside the park than outside. Therefore, impacts outside the park would be of a much lower magnitude. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to the plan's guidelines would keep bison numbers at a level that would minimize any potential impacts on wilderness (USFS 2014).

IMPACTS OF ALTERNATIVE 2 ON WILDERNESS CHARACTER

The following analysis describes how the implementation of the bison reduction tools would affect the untrammeled, natural, undeveloped wilderness character, and the opportunities for solitude or primitive and unconfined recreation. The analysis of other features of value is described in the "Cultural and Tribal Resources" section.

Resulting Bison Population

Although individual actions implemented to reduce the size of the House Rock bison herd under alternative 2 would affect the untrammeled, undeveloped qualities of wilderness character, and opportunities for solitude or primitive and unconfined recreation, the ultimate size of the herd would have no adverse impact on these qualities.

Natural. The reduced size of the House Rock bison herd would result in improvements to the natural quality due to reduced impacts on vegetation, soils, water quality, and hydrology compared to current conditions. Trampling and consumption of vegetation would decrease due to a smaller herd (fewer than 200 animals). Trailing, soil compaction, and erosion would be similarly reduced, as would impacts on surface runoff and the water quality and seasonal hydrology of springs and ephemeral ponds. These impacts are described in the sections of this chapter on "Bison-Affected Vegetation," "Soils," and "Water Resources in the Karst Landscape." The reduced population size of fewer than 200 animals would likely help to restore a relative balance to the ecosystems affected by high bison populations.

Bison Herd Reduction Tools

Untrammeled. The untrammeled quality of wilderness is degraded by activities or actions that intentionally control or manipulate the components or processes of ecological systems inside wilderness. Lethal and nonlethal culling and hazing and herding of bison to reduce the House Rock bison herd to fewer than 200 animals would be considered trammeling actions because they interfere with both the growth of the population and its interactions with the environment. By focusing on reproductively active herd members, lethal culling would reduce the overall reproductive rate of the herd. The removal of carcasses from the environment would also be a trammeling action because it would reduce the biological and physical functions of scavengers and decomposers in wilderness. Hazing and herding would control the movement of bison groups and alter their natural movement from one location to another. Hazing and herding by people on foot and horseback, using soft-handling methods would be used to prompt bison movement. In addition, up to 6 helicopter flights could be used from October 16 through May 14 for hazing bison away from rim edges and off of Powell Plateau (resulting in a total of no more than 12 helicopter flights per year for all bison-related actions). Flights would last from 1 to 2 hours each. These activities would reduce the untrammeled quality during the duration of operation, affecting the overall wilderness character for a limited period of time. In addition, attractants (salt licks, food, and water) would be used to concentrate bison in the corral and possibly lethal culling areas. This would control the movement and behavior of bison and other wildlife that would be attracted to or repelled by the food and water. Trammeling would be limited to the time necessary to complete these activities or the length of time the bait was in place. Similarly, the impacts would be localized to areas of the park where bison are congregated or the area over which they are hazed. In addition, the effect of baits and attractants would be limited to the area over which they alter bison or other wildlife movements. As a result, the placement of attractants in wilderness would be considered an intentional manipulation to the environment and would degrade the untrammeled quality of wilderness for up to 5 years.

Natural. As described for alternative 1, the natural quality of wilderness is preserved when native plant and animal populations and native biophysical processes predominate in relative balance. Although lethal and nonlethal culling and hazing/herding would be used to benefit the overall natural quality of the areas through the reduction of the House Rock bison herd size, they would adversely affect the natural quality of the wilderness character when used during reduction efforts (approximately 3 to 5 years). These actions would temporarily degrade the natural condition through trampling and mortality of plants, increases in soil compaction, and the displacement of other wildlife. The concentration of bison attracted to the corrals would disproportionately affect the local meadow and grassland systems where the corrals are located. However, no more than 2 acres of grassland and meadow vegetation would be disturbed from accessing installing, and using each of the five corral sites (for a total of up to 10 acres of disturbance). In addition, the National Park Service would restore the sites once nonlethal culling events are completed. Although these actions would be taken to benefit the overall natural quality of the areas through the reduction of the House Rock bison herd size, they would adversely affect the natural quality of the wilderness character during reduction efforts (approximately 3 to 5 years). Overall, the level of impact would be relatively low and localized, given the area affected, and would result in improvements once restored compared to existing conditions.

The increased noise (as described in "Wildlife (Other than Bison) and Wildlife Habitat") and presence of personnel, helicopters, and vehicles associated with lethal culling and hazing/herding could temporarily alter the behavior of wildlife species or inadvertently spread exotic plant seeds. However, noise would be limited to the areas where active lethal culling and hazing/herding is occurring, and species are expected to return to normal behavior quickly after actions cease as noise returns to background levels (0 dBA–40 dBA). In addition, the National Park Service would implement the weed-free hay policy and exotic invasive management measures to reduce potential impacts associated with the spread of exotics on the natural quality of wilderness character. The National Park Service would use "leave no trace" protocols would minimize the loss of vegetation and degradation of water and soil quality from litter, food scraps, and human-waste disposal.

Hazing and herding would also cause temporary changes in behavior and distribution of bison and other wildlife. Handlers on foot or horseback (or potentially in aircraft) would direct bison to areas where impacts on vegetation, soils, and surface water would be greater, but these impacts would be balanced by the lack of impacts in areas away from which bison were being directed. The presence of bait stations would create a temporary and localized degradation of the natural quality of wilderness in that the food, water, or minerals are not natural to the wilderness, but the effect would be vanishingly small. By attracting bison and non-target species, bait stations would increase the trampling of vegetation, compact soils, and create unnatural aggregations in certain areas. These activities also have the potential to spread exotic plants species; however, the National Park Service would implement the weed-free hay policy and exotic invasive management measures to reduce potential impacts on the natural quality of wilderness character. Overall, the impacts of hazing and herding on the natural quality would likely be small and limited in duration because these activities would not be the primary actions being implemented and would only occur as necessary to assist in lethal and nonlethal removal of bison.

The presence of gut piles and carcasses left in the field after lethal culling would alter the natural quality of wilderness by creating increased resources for coyotes, mountain lions, condors, and other scavengers during the 3 to 5 years of active reduction activities, which could change behavior or local distributions of these species. However, these impacts would likely cease upon the termination of lethal culling efforts. Overall, impacts on the natural quality of wilderness character would be localized to areas where removal efforts are occurring and limited in duration to days to weeks when actions are actually occurring.

Undeveloped. The presence of structures and installations, the use of motor vehicles, aircraft, or motorized equipment degrades the undeveloped quality of wilderness. In addition, undeveloped refers to areas where the imprint from modern man's work is largely unnoticed. Therefore, all bison reduction actions would affect the undeveloped quality of the North Rim recommended wilderness. The undeveloped quality would be degraded by the establishment of temporary roads for access to corral sites (up to five roads each approximately 0.25 miles long), placement of corrals, possible motorized/mechanized tools for corral construction, use of fixed-wing aircraft and helicopters for lethal culling, use of bait, and fencing because these actions would introduce elements of human use and activity into the area. Initially, corral construction and other developments would occur only at the Little Park corral site. Up to 30 motor vehicle trips would support approximately 10 removal efforts per year in the capture periods of June–July and August–September. If bison become wary of that site, four other corral sites (see figure 2) may be used. Overall, 30 trips would be required from up to five corral sites. Impacts on the undeveloped quality of wilderness character would increase depending on the distance the corral sites are from non-wilderness road corridors and the number of sites needed.

Similar to the impacts described for the natural quality of wilderness, impacts on undeveloped qualities from nonlethal culling actions would be limited in size and duration. The action area encompasses approximately 97,200 acres of wilderness and approximately 10 acres would be disturbed from the installation of the corrals. This installation would be temporary lasting no more than 3 to 5 years.

Lethal culling teams would be limited to the 7-month primary lethal culling period (i.e., mid-October through mid-May; approximately 1,440 vehicle days assuming 30 weeks of operations). During each 5-month secondary lethal culling period (mid-May through mid-October), a maximum of 4 vehicles would be used because only 1 team would be operating (approximately 352 vehicle days assuming 22 weeks of operations). All vehicle use would be restricted to established non-wilderness road corridors. In addition, up to 6 helicopter trips for retrieving carcasses per year could occur, with each trip lasting approximately 1 to 2 hours of total flight time. The use of helicopters for carcass removal or snow machines to support access for the lethal culling teams in areas where roads are snow covered would have negative impacts on the undeveloped quality of wilderness because they would represent human activity and work in wilderness. The use of helicopters up to 6 times per year for the delivery or removal of materials via sling loads is considered an aircraft landing in wilderness, according to NPS policy, and would be considered a temporary development that affects the undeveloped quality of wilderness character. Hazing and herding could require up to 6 helicopter flights from October 16 through May 14 for hazing bison away from rim edges and off of Powell Plateau (resulting in a total of no more than 12 helicopter flights per year for all bison-related actions). Flights would last from 1 to 2 hours each. These impacts would be short in duration, associated with periods of lethal culling and hazing/herding events followed by periods where the undeveloped quality would be similar to current conditions. The use of a helicopter in wilderness would detract from the undeveloped quality of wilderness since they are forms of mechanized transport. Similarly, a maximum of 52 fixed-wing flights related to bison reconnaissance would occur per year. These flights would be minimized along the rim and cliffs to the greatest extent possible. However, the impacts of using aircraft would be similar to those described above for helicopter use, but would occur more frequently. Impacts related to implementing lethal culling efforts are expected to only occur for the 3 to 5 years necessary to reduce the House Rock bison herd.

Because bait stations are left behind when crews leave the wilderness, the addition of water, food, and mineral licks would create localized, temporary evidence of man's imprint in the wilderness and affect the undeveloped quality of wilderness. The developments would be localized to areas where the National Park Service is hoping to concentrate bison and would be removed once they are no longer needed.

Installation of local exclosure fencing would also adversely affect the undeveloped quality of the wilderness until they are removed. Fencing is expected to remain while the House Rock bison herd size is reduced and until resources within the fenced areas can recover, or in the case of sensitive archeological resources, are no longer at high risk of being damaged by bison use.

Overnight camps on the North Rim are not anticipated. However, if an overnight camp within the park is determined to be necessary during field operations, the camp would be located at a previously designated or established location whenever possible. In the unlikely event that backcountry camping is necessary at a non-designated site, crews would use "leave no trace" protocols to avoid impacts and, if necessary, restoration would be undertaken at the site. When lethal culling crews stay in established camps outside of wilderness areas, no impacts on the undeveloped character of wilderness are expected.

Opportunities for Solitude or Primitive and Unconfined Recreation. This quality is related to opportunities for visitor's to connect with the natural world, practice traditional skills, and have transformative personal experiences. It is affected by visitor encounters with other people, signs of modern civilization within wilderness, and agency-provided recreational facilities. Impacts on the opportunity for solitude would result from encounters with crews and noise involved with establishing/managing corral sites, lethal culling, and hazing and herding when conducted over approximately 3 to 5 years. Noise disturbances associated with these activities would affect solitude for those within hearing distance and, depending on the action being taken, could substantially increase background noise levels for short periods. The potential corral site along the North Rim Entrance Road would have less impact on solitude and primitive or unconfined recreation, given the background noise

and presence of vehicles entering the park. However, impacts on this quality may be more severe in more remote, less travelled locations such as Swamp Point, where the ambient noise level is lower.

Helicopter use for carcass retrieval (up to 6 flights per year) and hazing and herding (up to 6 flights per year), and snow machine use when roads are snow covered would result in localized noise disturbances ranging from 60 dBA to 90 dBA compared to the 0 dBA–40 dBA of background noise levels. In addition, up to 52 fixed-wing aircraft flights for bison reconnaissance and monitoring are expected each year, approximately 40 more per year than under current conditions. Hazing and herding by people on foot and horseback would be used to prompt bison movement. Each aircraft flight would last from 1 to 2 hours. These activities would reduce the opportunities for solitude during the duration of operation, affecting this wilderness character for a limited period of time over different portions of the action area. The discharge of firearms would also contribute to impacts on solitude because ambient noises levels would be higher compared to background conditions. However, the sound of firearms would be instantaneous, and the background noise levels would be restored quickly. Most noise-related impacts would be localized and site specific to areas where bison are located and where the National Park Service hopes to concentrate them for removal activities. Other noise-related impacts would be transient as vehicles and aircraft traverse the action area to and from bison removal areas. These impacts would be limited to the duration of reduction operations, and the opportunity for solitude would return to background conditions upon completion of each reduction effort.

The National Park Service would limit the time necessary for reduction and retrieval actions to minimize impacts on visitor experience and only implement temporary closures of parts of the park during reduction and retrieval for safety reasons. Temporary closures would reduce opportunities for unconfined recreation because visitors would not be allowed to enter the area. Lethal culling and carcass removal in remote areas would result in temporary closures, thereby negatively affecting opportunities for primitive and unconfined recreation in portions of the North Rim wilderness, especially during peak visitation months of May through October. Based on the average use during 2013–2014, up to 415 visitors take wilderness trips during this time period. Backcountry use data from those years also indicates that Powell Plateau averaged 60 group-nights (161 user-nights) between May 15 and October 14, but only 1 or 2 group nights per year (5 user-nights) from January 1 through May 15. Lethal culling operations on Powell Plateau would be conducted in the latter period, resulting in minimal displacement of users during area closures. Site-specific closures implemented during lethal culling efforts would eliminate the opportunity for primitive or unconfined recreation in those areas due to visitor safety concerns. However, those opportunities would return upon completion of reduction efforts, limiting the overall duration of impact to intermittent closures over 3 to 5 years. Once activities cease, closures would be lifted, and opportunities for solitude or primitive and unconfined recreation would be restored to current conditions.

Local Exclusion Fencing

Untrammeled. Fencing would degrade the untrammeled quality of North Rim wilderness areas by intentionally manipulating the biophysical environment through the construction of fences that would prevent bison and potentially some non-target species from accessing small (1–2 acres) areas of water resources, wetland and spring vegetation that provide habitat/resources for wildlife. Impacts would be minimized by designing fences to allow most wildlife, excluding bison, to pass through fences.

Natural. Installation of fencing to protect sensitive resources would have both positive and negative effects on the natural quality of wilderness on the North Rim. Adverse impacts of the House Rock bison herd on sensitive and important plant species in wetlands and springs would be prevented by fencing off these areas. Exclusion fencing would also reduce contamination of water sources by dung, direct contact with bison, and entrainment of soil bacteria when animals enter springs and ponds and churn up the soil. Localized negative impacts would arise when small areas, totaling less than 20 square meters per

exclosure, need to be cleared of vegetation to install fencing. Any cleared vegetation is expected to become reestablished over time or through restoration efforts by NPS personnel. The expected overall impact on the natural quality of wilderness would be small given the amount of fencing that would likely be installed, compared to the larger action area.

Undeveloped. As shown in figure 3, up to 20 exclusion fences may be placed to protect water resources throughout the action area. Additional fencing could be placed elsewhere to protect archeological sites or other sensitive resources, as needed. Fencing is a form of development that degrades this wilderness character because it remains in the wilderness as a noticeable imprint of human-made work when those who install it leave. The deployment of fencing materials and fence construction may require motorized transportation or tools, which themselves would be a form of development that would temporarily degrade wilderness during transport and construction. Site-specific needs would be evaluated through the minimum requirements process. Because of the number of proposed exclosure fences, as described above, and the potential for use of motorized tools and/or transportation necessary for installation, impacts would be adverse, but limited to discrete locations distributed across the action area. However, the impacts would be lasting because the fences would be maintained as long as the House Rock bison herd continues to affect sensitive resources.

Opportunities for Solitude or Primitive and Unconfined Recreation. Effects on opportunities for solitude or primitive and unconfined recreation would result from encounters with crews and noise disturbances during fence transportation and installation. Impacts would be of short duration, limited to those likely brief encounters, and localized, occurring in areas being fenced and while crews transport materials to these areas. It is unlikely that fencing would affect recreational opportunities by restricting access. However, this quality could be impacted by installing fences that increase signs of modern civilization inside wilderness.

Management Cycle

Although the primary nonlethal culling area is at Little Park and in the nonwilderness corridor, the other five sites would be in wilderness areas accessible by vehicle. Nonlethal culling activities would affect wilderness qualities and may occur simultaneously with lethal culling activities, hazing and herding, and the installation of localized exclusion fencing so that the impacts on wilderness character would be compounded annually while reduction takes place. The suite of reduction actions would occur over the course of 3 to 5 years, resulting in potential ongoing or repeated disruption to and adverse impacts on wilderness character qualities during annual operations. However, once operations cease, most qualities would be restored, and some of the wilderness qualities, such as the natural quality, may be improved compared to current conditions because the House Rock bison herd would be more in relative balance with the natural system.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions with potential to have cumulative impacts on wilderness are the same as those described for alternative 1 and include fire management, invasive species management, commercial and administrative flights over the action area, wildlife studies and research activities within the action area. Overall, these actions would adversely affect the natural quality and undeveloped character of wilderness, based largely on impacts associated with overflights.

When the impacts of alternative 2 are combined with the impacts of other past, present, and reasonably foreseeable actions, cumulative impacts on the untrammeled quality, undeveloped quality, and opportunities for solitude or primitive and unconfined recreation would be adverse for the duration of the management actions (e.g., 3 to 5 years), and cumulative impacts on the natural quality of North Rim

wilderness would beneficial. The contribution of alternative 2 to the overall cumulative impacts would be substantial, but limited to the 3- to 5-year duration of reduction efforts with benefits to the natural quality extending well beyond the period of reduction efforts.

Conclusion

As described under alternative 1, Grand Canyon's wilderness is fundamental to the significance of the park. (NPS 2010c). Compared to current conditions, alternative 2 would create a marked improvement to the natural environment by allowing vegetation, soils, hydrology, and water quality to recover from the impacts of a large House Rock bison herd and reducing the spread of exotic species. Compared to alternative 1, the benefits to the natural quality of wilderness on the North Rim would be even greater, and the biophysical environment would be restored to a condition closer to what it was before the House Rock bison herd affected wilderness character. Some actions to achieve the bison reduction would create adverse impacts on the natural, untrammeled, undeveloped qualities of wilderness, and the opportunity for solitude or primitive and unconfined recreation. Many of these actions involve uses that are prohibited under Section 4(c) of the Wilderness Act, which states "except as necessary to meet minimum requirements for the administration of the area…there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area." Temporary corrals, roads, camps, exclusion fencing, and bait stations would create small developments within wilderness. The action area encompasses approximately 97,200 acres of recommended wilderness and approximately 10 acres would be disturbed from the installation of the corrals. This installation would be temporary lasting no more than 3 to 5 years. Therefore, although nonlethal culling actions would adversely affect wilderness character, the impacts would be comparatively small (relative to the area of wilderness), localized to meadow and grassland habitat, and limited to the 3 to 5 years of active reduction. Upon completion of capture activities, corrals would be removed each season. Restoration of corrals and access roads would likely require motorized transportation initially; however, specific methods for each site would be evaluated through a separate minimum requirements process for restoration activities.

The number of teams in the field would vary depending on the time of year. During the 7-month primary lethal culling period (i.e., mid-October through mid-May), there would be approximately 1,440 vehicle days assuming 30 weeks of operations. During each 5-month secondary lethal culling period (mid-May through mid-October), a maximum of 4 vehicles would be used because only 1 team would be operating (approximately 352 vehicle days assuming 22 weeks of operations). Lethal culling efforts would be supported by up to 52 fixed-wing aircraft flights necessary for reconnaissance and bison monitoring. In addition, up to 6 helicopter trips for retrieving carcasses per year could occur. Hazing and herding efforts could use up to 6 helicopter flights from October 16 through May 14 for hazing bison away from rim edges and off of Powell Plateau (resulting in a total of no more than 12 helicopter flights per year for all bison-related actions). Flights would last from 1 to 2 hours each. These noise-related impacts would be short in duration, associated with periods of lethal culling and hazing/herding events followed by periods where the wilderness quality would be similar to current conditions. These impacts are expected to only occur for the 3 to 5 years of reduction efforts.

In addition, mitigations such as minimizing incursions outside nonwilderness corridors, leave-no-trace best practices, and post-action restoration would prevent these impacts from becoming larger than necessary. The use of fixed-wing aircraft, helicopters, snow machines, motorized vehicles, and motorized equipment would temporarily degrade the undeveloped quality and opportunities for solitude and primitive and unconfined recreation, but in the context of current commercial overflights and fire management activities, they would represent a very small fraction of the time that disturbances occur.

The reduction of the House Rock bison herd, as well as hazing and herding of the herd, would constitute an intentional manipulation of the biophysical environment and would impact the untrammeled quality of wilderness character. These trammeling actions would affect a relatively small area compared to other cumulative actions which focus on protection of sensitive water, plant, and archeological resources. Compared to the no-action alternative, alternative 2 would adversely impact some qualities of wilderness character during the 3- to 5-year management cycle, but would benefit the natural quality of wilderness in the long-term through herd reduction.

Overall, when alternative 2 is combined with past, present, and reasonable foreseeable actions, cumulative impacts on the untrammeled quality, undeveloped quality, and opportunities for solitude or primitive and unconfined recreation would be adverse, and cumulative impacts on the natural quality of North Rim wilderness would be beneficial. The contribution of alternative 2 to the overall cumulative impacts would be substantial, but limited to the 3- to 5-year duration of reduction efforts with benefits to the natural quality extending well beyond the period of reduction efforts.

Impacts on Wilderness Character on Adjacent Lands. Similar to the conclusion described for the no-action alternative, the natural quality of the wilderness areas outside the action area on adjacent USFS lands could be affected under alternative 2. Hazing, herding, or lethal culling pressure is expected to cause an increase in bison movement, including on to adjacent USFS lands. Although the number of bison that may disperse and their movements in response to management actions would be unpredictable, dispersing bison are expected to seek areas outside the park that are similar to preferred habitat in the action area. The types of impacts dispersing bison would cause outside the park would be similar to those described for the action area under the no-action alternative, and these impacts could persist beyond the initial reduction phase if bison begin to spend more time outside of the park.

However, because fewer bison would move outside the park (compared to the resulting bison population under alternative 1), the impacts would be of a much lower magnitude, and any impacts on the natural quality of wilderness related to an overabundant bison population would be ameliorated. The increased presence of bison would not affect the other characteristics of wilderness because the National Park Service would not conduct reduction actions outside of the action area. According to the Final Environmental Impact Statement for the *Kaibab National Forest Land and Resource Management Plan*, USFS management of bison in adherence to the plan's guidelines would keep bison numbers at a level that would minimize any potential impacts on wilderness (USFS 2014).

VISITOR USE AND EXPERIENCE

METHODS AND ASSUMPTIONS

The impact analysis for visitor use and experience focuses on the types of visitor uses that could be affected as a result of the expected size of the House Rock bison herd and the effects on visitor use related to bison reduction actions, including effects of noise disturbances (as described in the "Methods and Assumptions" section of "Wildlife (Other than Bison) and Wildlife Habitat") during project implementation. For the purposes of this analysis, the affected areas include the developed road corridors of the North Rim, primarily the portion of Highway 67 within the park; areas adjacent to the scenic roads to Point Imperial and Cape Royal; and the park's backcountry areas accessible by vehicle. The effects on visitor experience in the park's wilderness are addressed in the "Wilderness Character" section of this chapter. Potential impacts on visitor use and experience were evaluated based on resource expert knowledge and professional judgment; review of park visitor use statistics; information provided by NPS recreation, natural resources, and public information experts; and the resource-specific issues identified in chapter 1. Additional assumptions are presented under each alternative as appropriate.

IMPACTS OF ALTERNATIVE 1 (NO ACTION) ON VISITOR EXPERIENCE

Under alternative 1, the estimated growth of the House Rock bison herd by approximately 250% in 10 years would increase the total number of bison groups across all seasons, with smaller groups likely becoming more common. The gathering of multiple smaller groups into one or more larger herds during mid-summer for the annual breeding rut would likely increase the number and frequency of visitor-viewing opportunities during the summer season. The increase in viewing of the House Rock bison herd would create opportunities for visitor education and interpretation intended to enhance enjoyment of bison viewing and increase visitor safety near bison congregations.

Under the no-action alternative, visitors would continue to have bison viewing opportunities along the entrance road, but would experience slow traffic and congestion along the roadside and pull-outs. This may occur more often because the increase in herd size would provide more opportunities to see the House Rock bison herd along the road. Safety concerns related to visitors' focus on the bison rather than their focus on driving would likely increase, as would the potential for bison interactions with people who leave there cars to view the bison. As the population grows, the House Rock bison herd may start moving to other areas north and/or east of the areas currently occupied, and the traffic problems and visitor safety concerns associated with bison viewing would intensify because the roads are very narrow and winding, and pull-outs are limited. Adverse effects resulting from traffic congestion would be of relative short duration lasting from minutes to hours on a daily basis when bison are present.

Motor vehicle-bison collisions are expected to occur at a rate similar to current conditions, and possibly at a higher rate as the herd increases or the House Rock bison herd expands to the east adjacent to scenic roads to Cape Royal and Point Imperial. Vehicle to vehicle collisions could also increase if drivers are distracted by bison as they travel through the park. In addition to the direct impacts to the victims of collisions, other negative impacts would result from traffic stops or slowing related to accident traffic management that impede the visitors' travel itineraries and affect the experience of North Rim visitors.

Point Sublime and Swamp Point are popular backcountry campsite areas accessible by backcountry roads. Overnight use of these camping areas is limited to 2 groups per night and requires a permit. During summer months, campsites are occupied nearly every night, and day use also occurs. Evidence of bison use at these sites includes vegetation damage and soil disturbance from wallowing or trampling and accumulation of bison dung. Visitor complaints and staff observations indicate that campsites at Point Sublime were unusable until piles of bison dung were removed (NPS, Bridgehouse, pers. comm. 2016n). In July 2016, park staff documented 14 piles of dung at Swamp Point, along with 33 dung piles on the first mile of the North Bass Trail to Powell Plateau. Dung piles at Swamp Point were located within and adjacent to designated tent camping sites (NPS, Jalbert, pers. comm. 2016l). The increased size of the House Rock bison herd and potential increase in dung accumulation may result in continued degradation of campsite quality, creation of new campsites to avoid dealing with unpleasant conditions at designated sites, and/or displacement of overnight campers. These impacts would continue indefinitely unless mitigation measures that address the presence of dung in the campsites are implemented. While bison sightings or encounters in the backcountry are currently rare, the likelihood of encounters may increase proportional to the population increase. Bison viewing may have a beneficial effect on the visitor experience; however, if bison are present when campsites are in use, visitors may have to vacate campsites for safety purposes, which would have a negative effect on their experience.

Cumulative Impacts

Past, present, and reasonably foreseeable actions with the potential to impact visitor use and experience include fire management activities on NPS and USFS lands, North Rim road maintenance and improvements, vandalism, and flights over the park (e.g., commercial air tours and administrative aircraft

use). Fire management activities may require temporary closure of backcountry roads and access to trailheads. Smoke associated with fire management activities could impede visibility or cause health risks associated with inhalation of smoky air. Fire management actions vary each year and road closures or helicopter use associated with this action could last from days to months, depending on the severity of the fire. The combined adverse effect would be considerable because of the extent of the area and the numbers of affected visitors. North Rim road maintenance could cause travel disruptions lasting minutes to days but could also improve conditions for visitor access to scenic drives, overlooks, and backcountry campsites. Vandalism of park structures or resources would have adverse effects to visitor experience because it would detract from visitors' experience of park facilities and amenities. Commercial air tours occur daily within designated flight corridors and could result in prolonged disturbance of the natural soundscape for visitors in areas beneath the designated air tour flight zones. Noise disturbances from these flights could last minutes to hours, depending on the amount of time visitors are in the affected area. Administrative aircraft use for fire management, search and rescue, or other activities are infrequent (except in the case of a major fire or search and rescue event) and could result in noise disturbances that could last for minutes to hours and up to several days within the affected area.

While the increasing size of the House Rock bison herd under the no-action alternative could result in beneficial outcomes derived from increased viewing opportunities and visitor education and interpretation, alternative 1 would contribute a considerable adverse impact on visitor experience because of the expected increase in the number of motor vehicle-bison collisions, possible vehicle to vehicle collisions, traffic congestion resulting from roadside viewing, degradation of campsites at Point Sublime and Swamp Point, and the potential for increased human-bison interactions. When the impacts from alternative 1 are added to the past, present, and reasonably foreseeable future actions, overall cumulative impacts on visitor use and experience would be adverse, with the incremental impacts of alternative 1 being substantial.

Conclusion

While the increasing size of the House Rock bison herd under the no-action alternative could result in beneficial impacts from increased viewing opportunities and visitor education and interpretation, the increase in the number of bison may lead to increased risk of motor vehicle-bison collisions, vehicle-vehicle collisions, human-bison interactions, increased vehicle congestion from viewing along park roads, and increased degradation of campsite conditions. The rate of motor vehicle-bison collisions is expected to increase proportional to the growth in the House Rock bison herd and congregation in Little Park. Similarly, roadside congestion and traffic slowing associated with bison viewing would occur more frequently and result in short-term impacts on visitors trying to get into or out of the park. These impacts could be substantial during peak hours during the primary visitor use season. Should the House Rock bison herd start moving to other areas north and/or east of the areas currently occupied, the traffic problems and visitor safety concerns associated with bison viewing would intensify, occurring more frequently in different areas. Campsite conditions at Point Sublime, Swamp Point, and other rim-accessible sites would continue to degrade, and safety concerns related to bison encounters would increase because of increased numbers of bison present at campsites. Past, present, and reasonably foreseeable future actions could beneficially affect visitor use and experience from road improvements that facilitate visitor access to scenic drives, overlooks, and backcountry campsites, but result in mostly adverse impacts from the effects of fire management activities, disruptions during road maintenance, vandalism, and noise and intrusion from flights over the park. When the impacts from alternative 1 are added to the past, present, and reasonably foreseeable future actions, overall cumulative impacts to visitor use and experience would be adverse, with the incremental impacts of alternative 1 being responsible.

IMPACTS OF ALTERNATIVE 2 ON VISITOR USE AND EXPERIENCE

The impacts from implementing herd reduction tools and other activities outside of the developed areas and designated backcountry campsites noted in this section are discussed in the "Wilderness Character" section of this chapter.

Resulting Bison Herd

Under alternative 2, the National Park Service would reduce the House Rock bison herd size to fewer than 200 animals. Opportunities for bison viewing along Highway 67 and near Little Park would continue, however; the number of bison would be decreased from the current condition, which would likely decrease the number of bison viewed. The effects on visitor experience from seeing fewer rather than more bison in one general area is unknown. The decrease in the number of bison would result in improvements to resource conditions compared to the current condition, which would benefit visitors that view and experience these areas. Adverse effects from slowing traffic and roadside congestion would be similar to or less than current conditions since the reduced number of bison may decrease the overall time the animals are in the area, and the effects may lessen proportionally. The reduced size of the House Rock bison herd would potentially decrease motor vehicle-bison collisions and the associated impacts on visitor experience and safety, as well as the potential for bison-human interactions, a beneficial impact that would continue indefinitely. Over time, improved educational messaging and resource interpretation would address potential hazards associated with roadside parking and congestion at pullouts. Beneficial effects would result from the ongoing education and interpretive programs associated with bison and bison reduction in the park, and these beneficial effects would continue indefinitely into the future.

With a reduction in the size of the House Rock bison herd, the impacts from accumulation of bison dung and vegetation trampling from wallowing at Point Sublime, Swamp Point, or other road accessible backcountry locations would likely be reduced compared to current conditions. While bison are expected to continue to use these areas, campsite conditions could improve proportionally as the House Rock bison herd size is reduced, and safety concerns related to the presence of bison at campgrounds are expected to be less than under current conditions.

Nonlethal Culling

In July 2014, the National Park Service and Arizona Game and Fish Department implemented a one-time experiment using nonlethal culling operations at the Little Park site (NPS 2015a). Observations and experiences associated with the operations are applied to this analysis. It is assumed that under alternative 2, the majority of the nonlethal culling operations would occur at Little Park adjacent to and relatively visible from the park entrance road, which in July 2016 was used by more than 26,500 vehicles (NPS 2016o). If bison become wary of that site, other corral sites (see figure 3) would be used.

Impacts on visitor use and experience from this activity include construction of the corrals and the corralling operations, which could disrupt the expected visitor experience in the park, and interruption of traffic flow from the number of trips planned to transport the animals out of the area. All of this would occur during the peak use season of June–September. Both noise and the visibility and presence of park staff and cooperators on site during corralling operations would adversely affect visitor experience in the vicinity of the corrals. While the corral construction would not take more than a day or two, corralling operations, which would attract large numbers of bison into meadows associated with corral sites, could last days to weeks. In addition, up to 30 truck/trailer trips would be needed per year to remove captured bison over a 3-year time period. The noise associated with vehicles and equipment (e.g., backhoes) used to construct the corrals and vehicles/stock trailers to remove bison from the corrals would exceed natural

sound conditions and cause periodic and temporary disruption of the natural soundscape as well as traffic patterns near the area.

While the corrals would not be highly visible from the road, bison congregations and visitor viewing combined with reduction activities such as off-road vehicle use and hazing or herding techniques, could present an "attractive nuisance" for visitors passing by the area and could result in increased traffic slowing and congestion during implementation. These impacts could result in considerable adverse impacts on visitor experience during the peak travel hours within the high use season, especially if multiple bison transport trips are conducted each day.

Lethal Culling and Carcass Removal

Under alternative 2, lethal culling and associated carcass removal teams of up to 25 people would access areas where bison occur by foot, truck, and/or snow machines on existing park roads, resulting in approximately 1,440 vehicle days over the course of the approximately 30 weeks each year that lethal culling would occur. In addition, a maximum of 52 fixed-wing aircraft flights could also be needed for locating and monitoring the House Rock bison herd. The noise associated with the presence of people; the use of vehicles, snow machines, and aircraft; and the discharging of firearms would exceed the natural sound conditions for up to 16 hours per day for approximately 4 days per week over 30 weeks. The current background noise levels range between 0 dBA and 40 dBA. Noise levels from lethal culling activities could range from 60 dBA to 90 dBA from vehicle use, with the discharge of firearms potentially exceeding 175 dBA. Noise impacts from vehicle use would last longer than the instantaneous noise associated with firearm use. These exceedances would occur in and around active shooting areas (i.e., where bison occur). While lethal culling could occur year round, most activity is expected during the April to mid-May and mid- October- to December, when 2 to 3 lethal culling teams would be present, and when fewer visitors are in the park. Those that could be affected in the off seasons would be primarily backcountry users in the fall months who may encounter reduction teams, although all areas where shooting would occur would be closed to visitors. After park roads are closed to traffic in the late fall and winter months, lethal culling is not expected to affect many visitors at all. Lethal culling could occur from July to September, with an estimated 352 vehicle days, but only one team would be working in the park during this time, and shooters would concentrate efforts in more remote areas and avoid the Little Park/Entrance Road area, where most visitors would be present.

The use of helicopters to retrieve bison carcasses from remote areas would also cause some exceedances of natural sound conditions and disturb visitors within the flight paths taken, but the impacts are expected to be limited to 6 times per year for 1 to 2 hours at a time. In addition, carcass processors would also access areas on foot with up to 12 to 16 stock animals per week. The disturbances from the noise and the presence of people associated with carcass processing would be much less than that of vehicles, helicopters/aircraft, and the discharge of firearms and would add a relatively small contribution to the impacts noted above.

Although the lethal culling activities would occur primarily in remote locations outside of the popular North Rim visitor use areas, indirect negative effects could result from increased traffic when teams of up to 25 people and associated equipment are deployed. The number of vehicles required for transport of teams and equipment may contribute slightly to slow traffic flow issues currently experienced during peak use times and the fall "leaf peeping" season. While most of the lethal culling would occur during the non-peak visitation periods, backcountry visitor use occurs during the shoulder months of October and November until the park roads close. Area closures associated with lethal culling and carcass removal would not affect visitor use outside of wilderness. Closures and other direct impacts of lethal culling and carcass removal in the wilderness are discussed in the "Wilderness Character" section of this chapter.

Hazing and Herding

Personnel conducting hazing and herding techniques to direct bison to other areas of the North Rim or for the purposes of corralling bison would have effects similar to those described for nonlethal culling. In the Little Park area, this activity may become an attractive nuisance and contribute to traffic issues and congestion, resulting in adverse impacts on visitor experience and visitor safety that would last for a few hours at a time in any specific location. Other areas where hazing and herding are conducted are discussed in the "Wilderness Character" section of this chapter. Potential road or area closures associated with hazing or herding activities could also adversely affect visitor experience because of the inability to visit an area or attraction.

Management Cycle

As described in chapter 2, bison reduction activities would likely start with nonlethal culling activities in the grasslands and meadows, especially at Little Park during early summer. These activities could coincide with a lethal culling event in the more remote locations of the action area. In addition, the park could also implement hazing and herding actions to move bison toward corrals from other portions of the action area, such as shrublands and forests. Although there would be purposeful efforts to ensure the actions are separated geographically, lethal and nonlethal culling could occur at the same time, and those visitors who travel through the park and experience more than one area would experience the combined impacts, including traffic congestion. In general, the suite of reduction actions would occur over the course of 3 to 5 years, resulting in potential ongoing or repeated disruption to visitor use and experience, but this disruption would be limited to the periods in which the reduction efforts are implemented.

Cumulative Impacts

Overall, past, present, and reasonably foreseeable future actions would be same as those described for alternative 1 and include fire management activities on NPS and USFS lands, North Rim entrance road maintenance and improvements, vandalism, and flights over the park (e.g., commercial air tours and administrative aircraft). These actions would have mostly adverse effects on visitor use and experience from noise and disturbance or closures of areas. Alternative 2 would contribute both beneficial and adverse impacts.

The decrease in the size of the House Rock bison herd would continue to provide opportunities for bison viewing, and resource conditions in bison viewing areas would improve. Campsite conditions would improve as a result of the smaller herd and bison, as well as bison dung, are less likely to be found in campsites. Beneficial effects include decreasing the presence of dung or impacts from wallowing, thus improving campsite conditions. The adverse effects of the resulting bison population and the implementation of herd reduction tools under alternative 2 could be considerable given the increased potential for closures associated with lethal culling, the increased traffic disruption from the nonlethal culling operations, the transport of bison from the Little Park area, and noise disturbances associated with the use of firearms and aircraft use for carcass removal and monitoring. Fire management actions, not associated with this proposed action, involving road closures or traffic management to address smoke impacts could add to the adverse effects on traffic congestion and safety concerns associated with viewing the House Rock bison herd and/or motor vehicle-bison collisions. When the impacts from alternative 2 are added to the past, present, and reasonably foreseeable future actions, overall cumulative impacts on visitor use and experience would be adverse, with the incremental impacts of alternative 2 being responsible while reduction actions are taking place.

Conclusion

Visitor use and experience on the North Rim can vary, with the more popular sites along the Entrance Road, Little Park, and lodge areas, receiving the majority of visitors, and the more remote regions visited by backcountry hikers. Under alternative 2, the decreasing size of the House Rock bison herd could result in beneficial outcomes derived from viewing opportunities, visitor education and interpretation, improved resource conditions at campsites and areas where viewing occurs, and a reduced potential for safety concerns such as bison-vehicle collisions, vehicle-vehicle collisions, and bison-human interactions. However, adverse impacts on visitor use and experience resulting from implementing herd reduction tools would include occasional closures, traffic congestion associated with lethal culling, herding, and corralling and transportation of bison in the Little Park area, and the noise and presence of teams in any area of the park where bison would be present. Impacts from implementing lethal culling would occur for short periods primarily during the fall to spring months when visitation is lower and in more remote areas of the park, but capture and herding would occur during peak visitation periods from June to September and in the Little Park area. Compared to alternative 1, impacts on visitor use and experience would be more adverse over the 3-year reduction period and would be more frequent during high visitation periods, but the benefits gained by having reduced safety concerns and improved resource conditions would be greater than benefits under alternative 1. When the effects of alternative 2 are combined with the effects of the other cumulative actions that affect visitor use and experience, an overall adverse cumulative impact is expected. Alternative 2 would contribute a considerable temporary adverse effect to the overall cumulative impact because of the increased potential for closures, increased traffic disruption from the nonlethal culling operations, the transport of bison from the Little Park area, and noise disturbances associated with the reduction teams and aircraft use for carcass removal and monitoring.

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CHAPTER 5: LIST OF AGENCIES AND TRIBES CONSULTED

Consultation began early in the EA process and is ongoing to ensure that all relevant issues were addressed. The following agencies have been or are being consulted:

- American Indian Tribes
  - The Hopi Tribe
  - Havasupai Tribe
  - Kaibab Band of Paiute Indians
  - The Pueblo of Zuni
  - Paiute Indian Tribe of Utah
  - Las Vegas Paiute Tribe
  - Yavapai-Apache Nation
  - The Haulapai Tribe
  - San Juan Southern Paiute Tribe
  - Moapa Band of Paiute Indians
  - The Navajo Nation
  - Yavapai-Prescott Indian Tribe
- US Fish and Wildlife Service
- US Forest Service-Kaibab National Forest
- Bureau of Land Management-Arizona Strip Office
- Arizona State Historic Preservation Office
- Arizona Game and Fish Department
- InterTribal Buffalo Council

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CHAPTER 7: ACRONYMS AND ABBREVIATIONS

AGFD	Arizona Game and Fish Department
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
dB	decibels
dBA	A-weighted decibels
DOI	US Department of the Interior
EA	environmental assessment
°F	degrees Fahrenheit
HRWA	House Rock Wildlife Area
national register	National Register of Historic Places
NEPA	National Environmental Policy Act
NPS	National Park Service
park	Grand Canyon National Park
USC	United States Code
USEPA	US Environmental Protection Agency
USFS	US Forest Service
USFWS	US Fish and Wildlife Service

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CHAPTER 8: GLOSSARY

Bio-richness—The variability among living organisms, including diversity within species as well as between species and ecosystems.

Biological crusts—Communities of living organisms on the soil surface in arid- and semi-arid ecosystems.

Bison herd—The group of bison that have common characteristics and interbreed among themselves. For the purposes of this plan, this term is synonymous with bison population and House Rock bison herd.

Cultural landscape—A geographic area (including both cultural and natural resources and the wildlife or domestic animals therein) associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values.

Demographic—Referring to the intrinsic factors that contribute to a population's growth or decline: birth, death, immigration, and emigration. The sex ratio of the breeding population and the age structure (the proportion of the population found in each age class) are also considered demographic factors because they contribute to birth and death rates.

Ecosystem—An ecological system; the interaction of living organisms and the nonliving environment producing an exchange of materials and energy between the living and nonliving.

Endemic—Native to or confined to a particular region.

Environment—The sum total of all biological, chemical, and physical factors to which organisms are exposed; the surroundings of a plant or animal.

Ethnographic resource—Any site, structure, object, landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it.

Evapotranspiration—The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.

Exclosure—A large area enclosed by fencing to keep out certain wildlife.

Exotic species—Any introduced species that is not native to the area and may be considered a nuisance; also called nonnative or alien species.

Genetic variation—The amount of genetic difference among individuals in a population.

Habitat—The environment in which a plant or animal lives (includes vegetation, soil, water, and other factors).

Herbaceous plants—Non-woody plants; includes grasses, wildflowers, and sedges and rushes (grass-like plants).

Herbivore—An animal that eats a diet consisting primarily of plant material.

Introgression—The transfer of genetic information from one species to another as a result of hybridization between them and repeated backcrossing.

Irreversible—A term that describes the loss of future options. Applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity that are renewable only over long periods of time.

Karst landscape (or karst formation)—Landforms and hydrologic system created by from the dissolution of soluble rocks such as limestone, dolomite, and gypsum and characterized by underground drainage systems with sinkholes and caves.

Lethal culling—The authorized shooting of animals by specially trained professionals and/or volunteers using appropriate weapons for means of effective and efficient lethal control.

Meta-population—A population of populations, or a group of groups, that is made up of the same species. Each subpopulation, or subgroup, is separated from all other subpopulations, but movement of individuals from one population to another occurs regularly.

Monitoring—A process of collecting information to evaluate if an objective and/or anticipated or assumed results of a management plan are being realized (effectiveness monitoring) or if implementation is proceeding as planned (implementation monitoring).

Pelage—The fur, hair, or wool of a mammal.

Population (or species population)—A group of individual plants or animals that have common characteristics and interbreed among themselves and not with other similar groups.

Recruitment—Number of organisms surviving and being added to a population at a certain point in time.

Refugia—Areas in which a population of organisms can survive through a period of unfavorable conditions.

Reproductive control—A method or methods used to limit the numbers of animals in a population by decreasing the reproductive success of the animals, such as contraception or sterilization.

Rut—An annually recurring condition or period of sexual excitement and reproductive activity in bison and other ungulates; the breeding season.

Sex ratio—The proportion of males to females (or vice versa), in a population. A sex ratio of 50:50 would mean an equal number of does and bucks in a deer population.

Species richness—The number of different species represented in an ecological community.

Ungulate—A hoofed, typically herbivorous, animal; includes horses, cows, deer, elk, and bison.

Vascular plant—A plant that contains a specialized conducting system consisting of phloem (food-conducting tissue) and xylem (water-conducting tissue). Ferns, trees, and flowering plants are all vascular plants.

Woody plants—Plants containing wood fibers, such as trees and shrubs (see “herbaceous plant”).

APPENDIX A: SPECIAL-STATUS SPECIES

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DRAFT SPECIES OF SPECIAL CONCERN LIST

Common Name	Scientific Name	Source	Status					Location of Species and Designated Critical Habitat[6]			Retain for analysis? Why or Why Not[6]
			ESA[1]	State[2]	NPS	USFS[5]	Navajo Tribal[7]	North Rim of GRCA	HRWA	USFS Land between GRCA North Rim and HRWA	
Birds											
Mexican Spotted Owl	*Strix occidentalis lucida*	USFWS IPaC, Internal Scoping, Public Comments, Letter received from USFWS Arizona Ecological Services Office	T	WSC	T	T	Group 3 (G3)	Species: Yes Critical Habitat: Yes	Species: No Critical Habitat: No	Species: No Critical Habitat: Yes	YES The North Rim of GRCA does not currently have breeding Mexican spotted owls present. However, surveys have found Mexican spotted owls foraging close to the canyon rim on the plateau. It is not known how/if Mexican spotted owls utilize this habitat for dispersal. Critical habitat is present in the action area. Removal actions have potential for disruption to this species due to noise and presence of removal crews depending on location and season. Note - No Mexican spotted owl nest sites have been located on Kaibab National Forest. No confirmed Mexican spotted owls have been located on Kaibab National Forest using protocol surveys.
California Condor	*Gymnogyps californianus*	USFWS IPaC, Public Comments, Letter received from USFWS Arizona Ecological Services Office	XN	WSC	T	P		Species: Yes Critical Habitat: No	Species: Yes Critical Habitat: No	Species: Yes Critical Habitat: No	YES HRWA and area between could be used for foraging. Removal actions have potential for disruption due to noise and presence of removal crews depending on location and season. Carcasses left in the field could serve as food source and there is concern about use of lead ammunition.
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	USFWS IPaC	E	WSC	E		Group 2 (G2)	Species: Not on North Rim Critical Habitat: exempt	Species: No Critical Habitat: No	Species: No Critical Habitat: No	NO This species is not found in the action area—it is a riparian obligate and only found along the Colorado River Corridor in GRCA.
Yellow-billed Cuckoo	*Coccyzus americanus*	USFWS IPaC	E	WSC	E		Group 2 (G2)	Species: not on North Rim Critical Habitat: exempt	Species: No Critical Habitat: No	Species: No Critical Habitat: No	NO This species is not found in the action area. GRCA is out of normal range and species has not been observed in a number of years (NPS n.d.). Last detection in GRCA was 2006 near river mile 275. No surveys have been completed since that time. It is a riparian species and its habitat is only known only to occur at river level in the far west end of GRCA.
Northern Goshawk	*Accipiter gentilis*	NPSpecies, Internal comments		WSC	WSC	S		Species: Yes Critical Habitat: NA	Species: No Critical Habitat: NA	Species: Yes Critical Habitat NA	YES GRCA has several documented nest locations on the North Rim. Removal actions have potential for disruption due to noise and presence of removal crews depending on location and season.

Common Name	Scientific Name	Source	Status					Location of Species and Designated Critical Habitat[6]			Retain for analysis? Why or Why Not[6]
			ESA[1]	State[2]	NPS	USFS[5]	Navajo Tribal[7]	North Rim of GRCA	HRWA	USFS Land between GRCA North Rim and HRWA	
Reptiles											
Northern Mexican Gartersnake	*Thamnophis eques megalops*	USFWS IPaC	T		T			Species: not present on N. Rim Critical Habitat: No	Species: No Critical Habitat: No	Species: No Critical Habitat: No	NO This species is not found in the action area. NPSpecies does not indicate this species is in GRCA, and it is not known to occur in GRCA, USFS or BLM in this area. It is a riparian obligate species, so would occur along the river or stream corridors only.
Snails and Amphibians											
Kanab Ambersnail	*Oxyloma haydeni kanabensis*	USFWS IPaC	E		E			Species: Not present on North Rim	Species: No Critical Habitat: No	Species: No Critical Habitat: No	NO The species is not known in the action area, and no designated critical habitat occurs in action area.
Northern Leopard Frog	*Lithobates pipiens*	Public Comments, Letter received from USFWS Arizona Ecological Services Office		WSC		S	Group 2 (G2)	Species: Yes Critical Habitat: NA	Species: Yes Critical Habitat: NA	Species: No Critical Habitat: NA	YES US Fish and Wildlife Service noted that three northern leopard frog refugia sites established at House Rock Wildlife Area. Individual leopard frogs have been found infrequently on the North Rim of the park. Bison use of frog habitat in wetland areas along the edges of seeps, springs, ponds, and lakes could adversely affect the species.
Mammals											
Black Footed Ferret	*Mustela nigripes*	USFWS IPaC	E		E	E		Species: Not present on North Rim	Species: No Critical Habitat: No	Species: No Critical Habitat: No	NO This species is not known in the action area, and no designated critical habitat occurs in the action area.
House Rock Kangaroo Rat	*Dipodomys microps leucotis*	Public Comments				S		Species: No Critical Habitat: NA	Species: No Critical Habitat: NA	Species: Yes Critical Habitat: NA	NO This species is not in the action area.
Kaibab Squirrel	*Sciurus aberti kaibabensis*	Public Comments						Species: Yes Critical Habitat: No, but has National Natural Landmark listing	Species: No Critical Habitat: No	Species: Yes Critical Habitat: No, but has National Natural Landmark listing	NO The Kaibab squirrel is found on the Kaibab Plateau in the park. Because it is not federally listed, it does not have designated critical habitat, however, the North Rim (GRCA&USFS) has a National Natural Landmark of 304,594 acres for the Kaibab squirrel. Given the behavior and life-history of the squirrel, removal actions are unlikely to disrupt the squirrel's normal behavior.
Fishes											
Apache Trout	*Oncorhynchus gilae apache*	USFWS IPaC, Public Comments, Letter received from USFWS Arizona Ecological Services Office	T		T	T		Species: No Critical Habitat: No	Species: No Critical Habitat: No	Species: Yes Critical Habitat: No	NO This species is not in the action area, which does not include the Colorado River corridor where it occurs. No designated critical habitat occurs in the action area.

Common Name	Scientific Name	Source	Status: ESA[1]	Status: State[2]	Status: NPS	Status: USFS[5]	Status: Navajo Tribal[7]	Location of Species and Designated Critical Habitat[6]: North Rim of GRCA	Location of Species and Designated Critical Habitat[6]: HRWA	Location of Species and Designated Critical Habitat[6]: USFS Land between GRCA North Rim and HRWA	Retain for analysis? Why or Why Not[6]
Humpback Chub	*Gila cypha*	USFWS IPaC	E				Group 2 (G2)				NO This species is not in the action area, which does not include the Colorado River corridor where it occurs. No designated critical habitat occurs in the action area.
Razorback Sucker	*Xyrauchen texanus*	USFWS IPaC	E				Group 2 (G2)				NO This species is not in the action area, which does not include the Colorado River corridor where it occurs. No designated critical habitat occurs in the action area.
Roundtail Chub	*Gila robusta*	USFWS IPaC	C								NO This species is not in the action area, which does not include the Colorado River corridor where it occurs. No designated critical habitat occurs in the action area.
Plants											
Brady Pincushion Cactus	*Pediocactus bradyi*	USFWS IPaC, Public Comments, Letter received from USFWS Arizona Ecological Services Office	E	HS	E			Species: No Critical Habitat: No	Species: No Critical Habitat: No	Species: No Critical Habitat: No	NO This species is not part of the flora known within GRCA boundary.
Fickeisen Plains Cactus	*Pediocactus peeblesianus fickeiseniae*	USFWS IPaC, Public Comments Letter received from USFWS Arizona Ecological Services Office	E	HS	E	E		Species: No Critical Habitat: No	Species: Yes Critical Habitat: Yes	Species: No Critical Habitat: No	NO This species is not part of the flora within GRCA boundary.
Sentry Milk-Vetch	*Astragalus cremnophylax* var. *cremnophylax*	USFWS IPaC	E	HS	E			Species: Yes Critical Habitat: No	Species: No Critical Habitat: No	Species: No Critical Habitat: No	NO The *Sentry Milk-Vetch Recovery Plan* (USFWS 2006) recommended 8 actions which GRCA is implementing, some of which are in the park's backcountry. Sentry milk-vetch is only found in remote locations of the action area on the Walhalla Plateau. Although bison have recently been documented occurring on the plateau, no actions are proposed for areas containing milk-vetch, and it is unlikely bison would use milk-vetch habitat.
Kaibab Bladderpod	*Lesquerella kaibabensis*	Public Comments, Letter received from USFWS Arizona Ecological Services Office	UR			S		Species: No Critical Habitat: No	Species: No Critical Habitat: No	Species: Yes Critical Habitat: No	NO This species is not part of the flora within GRCA boundary.
Kaibab Plains Cactus	*Pediocactus paradinei*	Public Comments, Letter received from USFWS Arizona Ecological Services Office		HS		S		Species: No Critical Habitat: No	Species: No Critical Habitat: No	Species: Yes Critical Habitat: No	NO This species is not part of the flora within GRCA boundary.

Notes:

[1] Endangered Species Act Status: E – Endangered, in danger of extinction; T – Threatened, severely depleted; C – Candidate for listing as threatened or endangered; XN – Experimental, non-essential population, in GRCA managed as federally threatened; D– Delisted; UR – under Review in the Candidate or Petition Process
[2] State Status: WSC Wildlife of Special Concern in AZ; HS Highly Safeguarded
[3] NPSpecies
[4] *Grand Canyon National Park Backcountry Management Plan Draft Environmental Impact Statement*, chapter 2, page 155
[5] US Forest Service sensitive
[6] Information on species presence obtained from Grand Canyon National Park, Arizona Game and Fish Department, and US Forest Service staff working on this environmental assessment
[7] Navajo Endangered Species List: Group 1 (G1) – No longer occurs on Navajo Nation lands (Navajo Nation 2008); Group 2 (G2) – Prospect of survival or recruitment is in jeopardy; Group 3 (G3) – Prospect of survival or recruitment is likely to be in jeopardy in the foreseeable future. Navajo status determination is not used by any other affiliated Grand Canyon tribes.

APPENDIX B: SUMMARY OF RELATIONSHIP OF BISON TO TRIBES TRADITIONALLY ASSOCIATED WITH GRAND CANYON NATIONAL PARK

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Summary of Relationship of Bison to Tribes Traditionally Associated With

Grand Canyon National Park

Not all of the tribes traditionally associated with Grand Canyon National Park have connections to the North Rim project area, and minimal information exists in the ethnographic literature regarding the connection that these tribes have to bison. Tribal representatives have provided some oral history information and described what role bison play in their respective cultures. Tribes have utilized bison as a food source and bison parts (especially hides, horns and hooves) for ceremonial purposes obtained through trade or hunting. In terms of the affected environment and impacts addressed in this environmental assessment, tribes have expressed concerns about the damage bison may be doing to archaeological sites, vegetation and water sources.

The following information is summarized from the ethnographic literature and/or oral history shared with the park. It is of a general nature and not specific to the project area.

Hopi

"During the Hopi migration period in the SW, clans traveled up to the southern area of Utah, then across to Colorado. Starving and desperate, the clans, the Greasewood and other clans, were met by several bands of Utes. The Utes offered help providing the Hopi people bison robes for clothing and shelter. They also gave them supplies of food including bison meat and jerky. The Greasewood clan leaders were thankful for the help and vowed to always remember the Utes for their friendship. After staying with the Utes for several more years, they traveled with the Utes who showed them the villages in the area now known as Mesa Verde National Park. Later, the Clan decided to complete their migration and departed for a village called Hoo'ovi, the Place of the Arrow, now referred to as Aztec National Monument near present-day Farmington. They later arrived at Orayvi (Old Oraibi) and settled there. Years later, Orayvi received word that a band of Utes had arrived north of the village. A group of Hopi warriors met them and realized the Utes had come in peace. The Utes were in search of their Hopi relatives, the Greasewood Clan members. So the Utes were escorted into the village and welcomed. The Greasewood clan was happy to re-unite with the Utes who they also considered their brothers and sisters. Surprisingly, the Utes had brought in a herd of bison as gifts for the Hopis! After several years, the Utes went back home. The bison roamed NW of Orayvi and later migrated west to the Little Colorado River and beyond. Today, the Hopi perform the buffalo dances to honor the Utes and the bison and the Greasewood clan occasionally performs the Ute Katsina and the Ute social dances to remember this history."

(Leigh J. Kuwanwisiwma, Tepwungwa (Greasewood Clan)

(E-mail with Janet Cohen, NPS November 2015)

Navajo

Bison (or buffalo) figure prominently in two important Navajo religious healing ceremonies: the Shooting Way Chant (*Na'at'oliijí*) and the Flint Way (*Béeshee*). Buffalo hides and hooves are used for rattles for these ceremonies. Prior to the creation of the reservation, Navajos traveled over large distances and did hunt buffalo for the meat and parts.

(Phone conversation between Janet Cohen, NPS 2016 and Timothy Begay, Navajo Cultural Specialist with the Navajo Nation Historic Department, June 2016.)

Jimmy Tom of the Navajo Nation provided the following story of buffalo:

This is the story that was told to me regarding buffalo that once ranged within the four sacred mountains. A band of Dine' (The People) used to follow the herd around for food, shelter, and medicine. They were considered to be sacred because they were the main livelihood for the People. As they ranged within the four sacred mountains, the People followed them. Reference was made to San Francisco Peak (western boundary). The origin of this story was here.

There was a vision that came to the leader of this band of Dine'. He had this vision in early dawn. In this vision, the herd was bedded down, and the people camped near the herd. Somewhere in the early dawn, the leader dreamed there was a young calf that left the herd and came towards the camp from the east. The she calf came near the camp and as it came closer, it turned into a beautiful young Indian maiden robed in a buffalo hide. She approached the leader's dwelling and stood at the doorway. The maiden spoke to the leader of the Dine' and told him there are hard times coming from the east. There's going to be death and the herd might be wiped out. The maiden said there's going to be a time when they will be slaughtered by the thousands. They knew the People that followed the herd depended on the herd and that they held the herd sacred. They depended on the herd for food, shelter and clothing. They coexisted with the buffalo for many years. However, the prophecy says they fear for themselves and they knew they may be subject to death. The buffalo talked among themselves and wanted to avoid this by traveling to the north, the dark world. They knew they would be slaughtered anyway but maybe the dark world will have mercy on them. If they leave, the People will have to find other resources or they can follow the herd north. The maiden then left it up to the People. She turned around clockwise and went back to the east. As she walked away, she turned back into a buffalo.

The next morning, the leader thought about his vision and called his elders together and told them about the visit. Some believed him and some did not. However, the leader was highly respected by the people and therefore, most believed in his vision. They discussed it among themselves and asked, "What are we going to do if they really leave us? Are we going to follow them? To the north is the land of the dark and we don't know what is there." The people talked about it. Some believed that you are not supposed to go to the dark world and it is the spirit world. Some were afraid and wanted to stay but were uncertain on how they were going to get by without the herd. Some said they were going to follow the herd. The People are also going to be oppressed and experience hardship too. The People were divided.

Shortly thereafter, the buffalo gathered and the lead buffalo headed north and the rest followed. The people watched and then followed the buffalo. At the border, some of the people followed the herd and others stayed behind. The elders talked and decided to divide the smoke and tobacco of the People and told the People to go ahead and go and maybe one day, we will unite again. One day they would reunite through the tobacco, language, culture and they would recognize one another. The People that stayed behind represent the current Dine' in the Southwest region. The People that followed the buffalo to the north are now located in Canada and are also known as Dine' and speak similar Athabascan language and have similar customs as the Dine' in the Southwest region.

Among the Dine' these stories were unwritten and were passed on from one generation to another. Some of the things were spoken by elders and my great uncles told me the good times as we know it will not last forever. Four things will happen:

- The clanship (ke') will disappear.
- The language will also disappear. There will only be one language.
- There will be a lot of leaders and the direction is going to be confusing. There will be a lot of bickering and chaos and will be ineffective. The way of the true Dine is going to vanish. Culture and tradition will vanish. Efforts now are to bring back Navajo tradition and culture.

- There will be a reunification that will occur. The Dine' will venture north and this happened in the late 1980s under the leadership of Peterson Zah. They ventured north, and the reunification occurred between the two groups. The relatives in the north acknowledged similar stories and gave the People three buffalos to bring back to the four sacred mountains. The buffalo did not adjust to Dine' country in the southwest and eventually died.

Currently the prophecy that was made is happening now on the Navajo Nation.

Places on the Navajo Nation are called buffalo (e.g. Buffalo Spring (Iyanbito) in New Mexico).

Timothy Begay, Cultural Resources Specialist and medicine man, also provided the following additional information on the Dine Story of Buffalo:

- One of the places whose name is associated with the buffalo is near the South Rim of the Grand Canyon (but not within the park).
- The buffalo is associated with two Navajo ceremonies—the Shootingway (*Na'at'oliijí)* and the Lifeway *('Iináájí).* When the buffalo turned into the maiden, the maiden gave ceremonial medicines to the people. These medicines are still used today.
- Other wild animals like elk and deer are also part of these oral histories but the buffalo figures prominently as the leader of the animals.
- Rattles used in the Shooting and Lifeway ceremonies are typically made from the hooves of buffalo, elk, or deer; these are still used today.
- Another rattle that uses the hide and tail of the buffalo is a more universal rattle and is used in many ceremonies today.

(Phone discussions between Timothy Begay, Navajo Cultural Specialist, Navajo Nation, and Janet Cohen, NPS, 2016; and between Jimmy Tom, Navajo Nation, and Craig McMullen, Arizona Game and Fish Department).

Havasupai

Oral history and ethnographic sources indicate the Havasupai did have some contact and traditions associated with bison. It is unclear whether they hunted bison or obtained meat or parts through trade.

Interestingly, in the journals associated with Father Francisco Garces' visits to the Havasupai in the 1700s, he reported 'buffos.' Scholars feel it is unlikely that Garces would have mixed up either the animals themselves, or the language for vacas (cows).

(E-mails between Stephen Hirst, Havasupai scholar and Janet Cohen, NPS 2016)

Hualapai

According to a Walapai Ethnography, the Walapai hunted almost every variety of large game except elk and buffalo. Only a few buffalo made it into Walapai country and because of their large size, they were left undisturbed.

(Memoirs of the American Anthropological Association, edited by A.L. Kroeber, hunting chapter by R. McKennan)

Kaibab Paiute

Glendora Homer, a Kaibab Paiute member knowledgeable about Kaibab traditions, identified three sources of evidence that indicate that the ancestors of the Kaibab Paiute knew about bison. These include: John Wesley Powell's ethnographic documentation of a 'legend' about wolf, porcupine and buffalo; a Kaibab Paiute dictionary with the Kaibab Paiute word for buffalo, and a rock 'art' panel (the tribe prefers rock 'writing') panel north of Kanab, Utah that depicts a buffalo.

(E-mails and phone calls between Glendora Homer and Janet Cohen, NPS, 2015 and 2016)

Yavapai-Apache

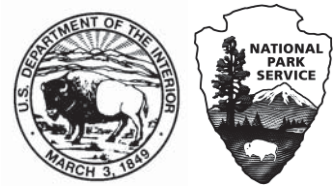
There is an old Dilzhe'e Apache story regarding the tribe's cultural hero and the killing of the last buffalo in their region. The tribal archaeologist believes this to be an event that has come down as oral history from a time when there were buffalo in Arizona.

(E-mail from Chris Coder to Janet Cohen, NPS, January 2016)

Zuni

In historic and modern times, the Zuni hunted buffalo off reservation. The Zuni do have a buffalo dance according to religious leader and Zuni Cultural Resource Advisory Team member, Octavius Seowtewa. The buffalo dance can be either religious or social—identifiable as religious if the dancers are wearing masks.

(Conversations between Octavius Seowtewa and Janet Cohen, NPS, 2016)



As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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