

Prairie Management Recommendations for George Washington Carver National Monument

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Michael P. Burfield

Charles H. Nilon

University of Missouri

Department of Fisheries and Wildlife

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Introduction

The purpose of this report is to provide prairie management recommendations for George Washington Carver National Monument (GWCA). The physical structure of each prairie management unit at GWCA has been evaluated using a Habitat Suitability Index (HSI) model developed for each of four indicator species. The HSI models are being developed over the course of this project for the use of park staff in determining what limiting factors must be addressed to improve habitat quality. The management actions used to address these factors are the same as those already used to improve native prairie cover at the site. Management will be guided in a manner that provides a “suite” of varied habitat types that provide for a more diverse array of species.

As a result of this evaluation, recommendations for future management will be made using the habitat suitability indices as a guide for management decisions. Our recommendations will be concentrated in wildlife habitat improvement, but will not directly address the species makeup (native vs. non-native) of the prairie plantings. However, the management actions to be recommended based on the HSI limiting factors are the same as those used for prairie restoration. GWCA staff, the Heartland Network, and the National Park Service have the ultimate responsibility of establishing management actions.

The initial benefit of assessing habitat suitability is to create a baseline quantitative representation of habitat features. We can use HSIs to determine the factors that limit the use of GWCA’s prairie units by the four indicator species: Henslow’s sparrow (*Ammodramus henslowii*), ornate box turtle (*Terrapene ornata ornata*), northern bobwhite quail (*C. virginianus*), and prairie vole (*Microtus ochrogaster*).

Management recommendations prepared by Craig Young and Sherry Leis of the National Park Service Heartland Network (HTLN) Inventory and Monitoring Program have been consulted in preparing these recommendations.

To summarize, HSI data was collected via the methods described in the next section. Limiting factors, or the features that need to be improved through management, are then recognized as those with the lowest HSI scores. Management actions are then identified to address these limiting factors and other factors observed while scoring prairie units. Finally,

these actions have been compiled into a comprehensive recommendations section (Management Recommendations) and into a concise table (Appendix II).

Methods

The first step in evaluating the restoration program is to establish the status of existing habitat at the Monument. To do this, we have compiled habitat suitability models to assess the availability of habitat for four indicator species: Henslow's sparrow (*Ammodramus henslowii*), ornate box turtle (*Terrapene ornata ornata*), northern bobwhite quail (*Colinus virginianus*), and prairie vole (*Microtus ochrogaster*). Using this method we have assessed existing prairie restoration conditions and identified limiting factors of habitat suitability for the indicator species.

The HSI models for the Henslow's sparrow and prairie vole are adapted from Baskett et al. (1980). The HSI model for northern bobwhite quail is adapted from a combination of Baskett et al. (1980) and Bidwell et al. (2009). Due to the lack of a previously published HSI model for the ornate box turtle, one was created for these recommendations combining information from reviewed literature (including Bernstein and Black 2005, Converse et al. 2002, Converse and Savidge 2003, Dodd 2001, Legler 1960, and Redder et al. 2006) and following the Fish and Wildlife Service's guidelines for habitat appraisal (USFWS 1980).

Habitat Suitability Index Models

An HSI measures a set of variables that relate to the suitability of a particular site for the species in question, based on reviews of literature pertaining to the ecology and habitat requirements of the target species. Higher HSI scores are typically indicative of habitat that promotes reproductive success and survivorship. The dynamic contrast of varying levels of habitat quality can also be measured using this method (Burgman et al. 2001).

For the purpose of these recommendations, the HSIs will be used to monitor habitat change. In particular, we will be able to quantify the changes in the landscape over time, and how they will affect the species being addressed by the models. While the particular suite of four species was chosen to assess a range of habitat features at GWCA, improving habitat for any one of these species is not necessarily intended to affect the number of species in each unit.

Additionally, there is very little overlap or contradiction in the habitat features to be assessed. One case of each is seen between the prairie vole and the Henslow's sparrow. Shade producing woody invasion is assessed on both HSI models using the same scale, and this overlap indicates the importance of this feature as a limiting factor. Litter depth is assessed differently for prairie voles and Henslow's sparrows. Despite this contradiction, there is still an optimal litter depth.

The Heartland Network has expressed interest in maintaining the prairies at GWCA using a "suite" of habitat types. For example, one section of the park could be used to promote Henslow's sparrow habitat while another is used to promote bobwhite quail habitat. Because these two birds have very different habitat requirements, the intention would be to improve habitat for each in different sections of the park at a given time. This practice would obviously affect HSI scores in particular areas, but the steps taken to maintain these habitat features are simulating natural prairie succession. Conversely, the size of GWCA allows for "suites" to be maintained without causing too much habitat degradation for the other indicator species. For example, quail generally require all vegetation levels when they are within a close proximity, from bare ground to established woodlands (Pierce and Gallagher 2005). Henslow's Sparrows require at least 30 ha (~48 acres) of native grassland (Reinking et al. 2000). GWCA's northern units (~36 ha or 57 acres) and southern units (~44 ha or 71 acres, not including unit 9), when grouped together, are capable of supporting habitats for each species, potentially even simultaneously.

By addressing low HSI scores, we can prescribe management actions, and predict the effects on prairie structure the actions should have over a given area. Species presence cannot necessarily be guaranteed or predicted using these models, but specific scores for each habitat feature can be obtained (except for distances to features that cannot be controlled by GWCA).

HSI Data Collection

The locations of HSI plots were adapted from the latest Heartland Network Inventory and Monitoring GWCA bird monitoring status report (Pietz 2009). A total of 70 permanent monitoring points or "plots" were established on the grounds of GWCA for point counts. According to the methods for site selection in the Heartland Network's report, the plots were established "by overlaying a systematic grid of 100 x 100 meter cells (originating from a random

start point). The orientation of the grid was rotated 45 degrees to prevent monitoring sites from being influenced by man-made features (roads, fences, etc.) located along cardinal directions” (Pietz 2009). Of the 70 established plots, eighteen are located in wooded areas, and were either moved if near a prairie unit edge or not evaluated in this study. After modifications there were 56 plots for 150 acres of grassland habitat (including the newly acquired 30 acres of fescue pasture). These plots were chosen for use in this study due to uniform spatial coverage of the grounds and to maintain continuity with Heartland Network Inventory and Monitoring reports. All waypoint coordinates were entered into a GPS unit for location then marked with temporary flags before data collection. Flags were collected at the conclusion of data collection.

To collect HSI data, I walked from the edge of each prairie unit to the marker (wooden stake with a red flag) designating each HSI plot. Then I would loop one end of a 10 m string over the end of the marker. This string would then be stretched out to its full length. I took a picture of each plot from its northernmost point, facing south. These pictures have been saved for reference. Next, I explored the circle created by the radius of the 10 m string. I made observations on ground cover, what native warm season grasses were present, invasive species, forb cover, and any other notable features. Following the visual assessment, I completed the HSI models, making observations and taking measurements as necessary. I also took pictures of many forbs, grasses, and wildlife species for the purpose of identification and archiving important or unusual flora and fauna. When the HSI models were completed, I wrapped the string around my hand, made sure to collect all my equipment, and moved on to the next point. Each plot required approximately 15-30 minutes to complete.

HSI model features were scored on a scale of one to ten or one to five, one being the lowest, depending on the importance of the characteristic. When scoring for each plot was completed, the characteristic scores were summed and divided by the maximum possible score to determine the overall HSI score for the plot. Scores range from 0.01 to 1.00, with 1.00 being optimum habitat. When all plots had been assessed, the scores for plots contained within each management unit were averaged to provide a score for the entire unit. The scores for each characteristic were also averaged across each unit. This process identified factors that have helped determine proposed management actions for 2010.

Features

The actual HSI models used for data collection are included in Appendix I. The following features were scored for each indicator species (with maximum score in parenthesis):

Henslow's Sparrow (40)

1. Average height of vegetation (10)
2. Diversity of vegetation heights (5)
3. Shade producing woody invasion (10)
4. Average litter depth (5)
5. Forb canopy (5)
6. Distance to water (5)

Prairie Vole (45)

1. Grass and forb cover (10)
2. Shade producing woody invasion (10)
3. Average litter depth (10)
4. Size of oldfield/grassland (5)
5. Number of important food plant species comprising more than 1% of total plants present (5)
6. Soil texture: internal drainage (5)

Ornate Box Turtle (35)

1. Availability of thermoregulatory cover (10)
2. Number of available food groups within 100 m (10)
3. Soil types (10)
4. Distance to water (5)

Northern Bobwhite Quail (70)

1. Distance from center of plot to nearest bare or sparsely vegetated ground (10)
2. Nesting cover quantity (10)
3. Grassland management practices (10)
4. Habitat Edge (10)
 - a. Average width of habitat edge (5)
 - b. Habitat edge surrounds (5)
5. Vegetative escape and concealment cover: shrubs and herbs (5)

6. Distance to cropland (10)
7. Distance to water (5)
8. Distance to forest (5)
9. Distance to oldfield (5)

HSI Scores

The following is an explanation of HSI data for each species in each management unit. Scores of 0.01-0.50 are considered “Limiting Factors”, scores of 0.51-0.75 are considered “Intermediate Factors”, and scores of 0.76-1.00 are considered “Optimum Features”. Limiting factors are features that need immediate attention in management. Intermediate factors are less urgent, but should be observed for negative trends. Optimal features are the positive features of habitat suitability that should be conserved. HSI score for each characteristic is in parenthesis.

Management recommendations will be presented in the following section for simple reference.

GWCA Management Unit #1

Limiting Factors

Henslow’s Sparrow (Overall Score: 0.60): Shade producing woody invasion (0.10) indicates the invasion of sumac (*Rhus* spp.) throughout the unit. Forb canopy (0.20) indicates that little or no forb cover is available for food or song perches.

Prairie Vole (0.49): Grass and forb cover (0.10) refers again to the invasion of sumac in Unit 1. Both are important food species for prairie voles. Shade producing woody invasion (0.10) is related to sumac invasion. Prairie voles avoid woody vegetation (Schwartz and Schwartz 2001). Food plant species (0.40) shows low vegetative diversity.

Ornate Box Turtle (0.71): Available food groups (0.50) are an indicator of biodiversity. This characteristic includes several food sources (grasses, legumes, fruit, etc.) due to the omnivorous nature of this species. (See HSI model in Appendix I.) Distance to water (0.40) cannot be altered, but is included for assessing habitat quality.

Northern Bobwhite Quail (0.69): Nesting cover quantity (0.30) indicates the percentage of warm season grasses in the unit, and is affected by the sumac invasion. Grassland management (0.20) refers to grass and forb cover, which provide cover and food for this species.

Intermediate Factors

Henslow’s Sparrow: Average litter depth (0.60).

Northern Bobwhite Quail: Distance to oldfield (0.60)

Optimum Features

Henslow's Sparrow: Average height of vegetation (1.00); diversity of vegetation heights (1.00); distance to water (0.80).

Prairie Vole: Average litter depth (0.80); size of grassland (1.00); soil drainage (1.00).

Ornate Box Turtle: Thermoregulatory cover (0.80); soil type (1.00).

Northern Bobwhite Quail: Distance to bare or sparsely vegetated ground (1.00); habitat edge (1.00); vegetative escape and concealment cover (1.00); distance to water (1.00); distance to forest (1.00).

GWCA Management Unit #2

Limiting Factors

Henslow's Sparrow (0.79): Average litter depth (0.40) indicates that the unit has been hayed or burned recently and has not yet developed a suitable litter layer. This is not necessarily negative, but the litter layer is important for nutrient cycling and nest building.

Prairie Vole (0.69): Food plant species (0.40) shows low vegetative diversity. Soil drainage (0.40) indicates that soil is not sandy enough for digging runways, but cannot be easily changed.

Ornate Box Turtle (0.76): Soil type (0.40) is not easily managed, but means that soil is not suitable for digging forms (burrows) used for nesting, hibernating, or escape from weather conditions.

Northern Bobwhite Quail (0.82): Distance to cropland (0.50) cannot be changed by GWCA management. Cropland is a valuable food source for Bobwhite.

Intermediate Factors

Henslow's Sparrow: Diversity of vegetation height (0.70); shade producing woody invasion (0.75); forb canopy (0.70).

Prairie Vole: Shade producing woody invasion (0.75); average litter depth (0.60).

Optimum Features

Henslow's Sparrow: Average height of vegetation (1.00); distance to water (1.00).

Prairie Vole: Grass and forb cover (0.85); size of grassland (1.00).

Ornate Box Turtle: Thermoregulatory cover (0.90); available food groups (0.85); distance to water (1.00).

Northern Bobwhite Quail: Distance to bare or sparsely vegetated ground (1.00); nesting cover quantity (0.90); grassland management (0.90); habitat edge (1.00); vegetative escape and concealment cover (0.90); distance to water (1.00); distance to forest (1.00); distance to oldfield (1.00).

GWCA Management Unit #3

Limiting Factors

Henslow's Sparrow (0.61): Forb canopy (0.30) indicates that little or no forb cover is available for food or song perches. Distance to water (0.30) cannot be altered, but is included for assessing habitat quality.

Prairie Vole (0.64): Food plant species (0.40) shows low vegetative diversity. Average litter depth (0.50) means that the unit has been hayed or burned recently and has not yet developed a suitable litter layer. This is not necessarily negative, but the litter layer is important for nutrient cycling and for voles to construct their runway networks and nests.

Ornate Box Turtle (0.83): Distance to water (0.40) cannot be altered, but is included for assessing habitat quality.

Northern Bobwhite Quail (0.74): Distance to cropland (0.20) cannot be changed by GWCA management. Cropland is a valuable food source for Bobwhite.

Intermediate Factors

Henslow's Sparrow: Average vegetation height (0.75); shade producing woody invasion (0.60).

Prairie Vole: Grass and forb cover (0.60); shade producing woody invasion (0.60).

Optimum Features

Henslow's Sparrow: Diversity of vegetation height (0.80); average litter depth (0.80).

Prairie Vole: Size of grassland (1.00); soil drainage (1.00).

Ornate Box Turtle: Thermoregulatory cover (0.90); available food groups (0.80); soil type (1.00).

Northern Bobwhite Quail: Distance to bare or sparsely vegetated ground (1.00); nesting cover quantity (0.85); grassland management (0.80); habitat edge (0.80); vegetative escape and concealment cover (1.00); distance to water (0.80); distance to forest (1.00); distance to oldfield (1.00).

GWCA Management Unit #4

Limiting Factors

Henslow's Sparrow (0.59): Shade producing woody invasion (0.43) indicates the invasion of sumac throughout the unit. Average litter depth (0.50) indicates that the unit has been hayed or burned recently and has not yet developed a suitable litter layer. This is not necessarily negative, but the litter layer is important for nutrient cycling and nest building. Distance to water (0.35) cannot be altered, but is included for assessing habitat quality.

Prairie Vole (0.66): Shade producing woody invasion (0.43) Shade producing woody invasion (0.10) is related to sumac invasion. Prairie voles avoid woody vegetation (Schwartz and Schwartz 2001). Food plant species (0.40) shows low vegetative diversity.

Ornate Box Turtle (0.86): Distance to water (0.45) cannot be altered, but is included for assessing habitat quality.

Northern Bobwhite Quail (0.70): Distance to cropland (0.23) cannot be changed by GWCA management. Cropland is a valuable food source for Bobwhite.

Intermediate Factors

Henslow's Sparrow: Average vegetation height (0.75); forb canopy (0.60).

Prairie Vole: Grass and forb cover (0.63); average litter depth (0.73).

Northern Bobwhite Quail: Grassland management (0.75); habitat edge (0.60).

Optimum Features

Henslow's Sparrow: Diversity of vegetation height (0.85).

Prairie Vole: Size of grassland (1.00); soil drainage (1.00).

Ornate Box Turtle: Thermoregulatory cover (1.00); available food groups (0.80); soil type (1.00).

Northern Bobwhite Quail: Distance to bare or sparsely vegetated ground (1.00); nesting cover quantity (0.80); vegetative escape and concealment cover (1.00); distance to water (0.85); distance to forest (0.90); distance to oldfield (0.85).

GWCA Management Unit #5

Limiting Factors

Henslow's Sparrow (0.71): Forb canopy (0.32) indicates that little or no forb cover is available for food or song perches. Distance to water (0.40) cannot be altered, but is included for assessing habitat quality.

Prairie Vole (0.82): Food plant species (0.40) shows low vegetative diversity.

Ornate Box Turtle (0.76): Distance to water (0.40) cannot be altered, but is included for assessing habitat quality.

Northern Bobwhite Quail (0.74): Distance to cropland (0.19) cannot be changed by GWCA management. Cropland is a valuable food source for Bobwhite.

Intermediate Factors

Henslow's Sparrow: Average litter depth (0.60).

Ornate Box Turtle: Thermoregulatory cover (0.75); available food groups (0.72).

Northern Bobwhite Quail: Habitat edge (0.60).

Optimum Features

Henslow's Sparrow: Average vegetation height (0.88); diversity of vegetation height (0.87); shade producing woody invasion (0.87).

Prairie Vole: Grass and forb cover (0.81); shade producing woody invasion (0.87); average litter depth (0.83); size of grassland (1.00); soil drainage (1.00).

Ornate Box Turtle: Soil type (1.00).

Northern Bobwhite Quail: Distance to bare or sparsely vegetated ground (1.00); nesting cover quantity (0.90); grassland management (0.89); vegetative escape and concealment cover (1.00); distance to water (0.92); distance to forest (0.93); distance to oldfield (0.88).

GWCA Management Unit #6

Limiting Factors

Henslow's Sparrow (0.74): Average litter depth (0.40) indicates that the unit has been hayed or burned recently and has not yet developed a suitable litter layer. This is not necessarily negative, but the litter layer is important for nutrient cycling and nest building. Forb canopy (0.44) indicates that little or no forb cover is available for food or song perches.

Prairie Vole (0.75): Average litter depth (0.48) means that the unit has been hayed or burned recently and has not yet developed a suitable litter layer. This is not necessarily negative, but the litter layer is important for nutrient cycling and for voles to construct their runway networks and nests. Food plant species (0.40) shows low vegetative diversity.

Ornate Box Turtle (0.77): None.

Northern Bobwhite Quail (0.81): Distance to cropland (0.28) cannot be changed by GWCA management. Cropland is a valuable food source for Bobwhite.

Intermediate Factors

Henslow's Sparrow: Average height of vegetation (0.70).

Ornate Box Turtle: Thermoregulatory cover (0.74); available food groups (0.72); distance to water (0.60).

Optimum Features

Henslow's Sparrow: Diversity of vegetation height (0.88); shade producing woody invasion (0.96); distance to water (0.84).

Prairie Vole: Grass and forb cover (0.78); shade producing woody invasion (0.96); size of grassland (1.00); soil drainage (0.92).

Ornate Box Turtle: Soil type (0.90).

Northern Bobwhite Quail: Distance to bare or sparsely vegetated ground (1.00); nesting cover quantity (0.98); grassland management (0.96); habitat edge (1.00); vegetative escape and concealment cover (1.00); distance to water (0.92); distance to forest (1.00); distance to oldfield (1.00).

GWCA Management Unit #7

Limiting Factors

Henslow's Sparrow (0.70): Shade producing woody invasion (0.44) indicates the invasion of sumac in patches throughout the unit. Forb canopy (0.35) indicates that little or no forb cover is available for food or song perches.

Prairie Vole (0.63): Shade producing woody invasion (0.44) indicates the invasion of sumac in patches throughout the unit. Food plant species (0.43) shows low vegetative diversity.

Ornate Box Turtle (0.77): None.

Northern Bobwhite Quail (0.80): None.

Intermediate Factors

Henslow's Sparrow: Average litter depth (0.62).

Prairie Vole: Grass and forb cover (0.67); average litter depth (0.56).

Ornate Box Turtle: Available food groups (0.72); distance to water (0.60).

Northern Bobwhite Quail: Grassland management (0.75); distance to oldfield (0.60).

Optimum Features

Henslow's Sparrow: Average height of vegetation (1.00); diversity of vegetation height (0.76); distance to water (0.96).

Prairie Vole: Size of grassland (1.00); soil drainage (0.88).

Ornate Box Turtle: Thermoregulatory cover (0.84); soil type (0.86).

Northern Bobwhite Quail: Distance to bare or sparsely vegetated ground (0.98); nesting cover quantity (0.81); habitat edge (1.00); vegetative escape and concealment cover (1.00); distance to cropland (0.76); distance to water (1.00); distance to forest (1.00).

GWCA Management Unit #9 (New Unit)

Limiting Factors

Henslow's Sparrow (0.64): Average litter depth (0.23) is due to thick ground cover of tall fescue (*Schedonorus phoenix*). There is not enough bare ground around stands of grass to allow a litter layer. Forb canopy (0.23) indicates that little or no forb cover is available for food or song perches.

Prairie Vole (0.81): Food plant species (0.37) shows low vegetative diversity.

Ornate Box Turtle (0.56): Thermoregulatory cover (0.49) is primarily due to the thickness of the understory of tall fescue. There is very little bare ground between grass stands for turtles to traverse. Available food groups (0.49) are an indicator of biodiversity. This characteristic includes several food sources (grasses, legumes, fruit, etc.) due to the omnivorous nature of this species. (See HSI model in Appendix I.)

Northern Bobwhite Quail (0.57): Nesting cover quantity (0.21) indicates the percentage of warm season grasses in the unit, and is affected by the presence of tall sumac. Grassland management (0.43) refers to grass and forb cover, which provide cover and food for this species. Distance to cropland (0.16) cannot be changed by GWCA management. Cropland is a valuable food source for Bobwhite.

Intermediate Factors

Henslow's Sparrow: Shade producing woody invasion (0.71); distance to water (0.54).

Prairie Vole: Shade producing woody invasion (0.73).

Ornate Box Turtle: Distance to water (0.57).

Northern Bobwhite Quail: Vegetative escape and concealment cover (0.54).

Optimum Features

Henslow's Sparrow: Average vegetation height (0.93); diversity of vegetation height (0.86).

Prairie Vole: Grass and forb cover (0.76); average litter depth (0.97); size of grassland (1.00); soil drainage (1.00).

Ornate Box Turtle: Soil type (0.86).

Northern Bobwhite Quail: Distance to bare or sparsely vegetated ground (1.00); habitat edge (1.00); distance to water (0.80); distance to forest (1.00); distance to oldfield (1.00).

2010 GWCA Prairie Management Recommendations

(A two-page summary table of management recommendations is provided in Appendix II.)

GWCA Management Unit #1:

Recommendation: Follow recommendations of Heartland Network for sumac control. Perform prescribed burn in spring 2010.

Unit	Species	Limiting Factor	Management Action	Expected Outcome
1	Henslow's Sparrow	Shade producing woody invasion	Follow HTLN sumac control recommendations. Mow only areas where sumac is growing.	Decrease sumac coverage and increase native warm season grass (NWSG) cover.
1	Henslow's Sparrow	Forb canopy	Seed with native forb mix from local seed distributor (optional for 2010). May postpone in areas where sumac is being treated.	Increase forb cover and diversity.
1	Prairie Vole	Grass and forb cover	See recommendations for Henslow's Sparrow, and perform prescribed burn in 2010.	Increase NWSG and forb cover.
1	Prairie Vole	Shade producing woody invasion	Follow HTLN sumac control recommendations. Mow only areas where sumac is growing.	Decrease sumac coverage and increase native warm season grass (NWSG) cover.
1	Prairie Vole	Food plant species	Seed with native forb mix from local seed distributor (optional for 2010). May postpone in areas where sumac is being treated.	Increase forb cover and diversity.
1	Ornate Box Turtle	Available food groups	Seed with native forb mix from local seed distributor (optional for 2010). May postpone in areas where sumac is being treated.	Increase forb cover and diversity.
1	Northern Bobwhite Quail	Nesting cover quantity	Follow HTLN sumac control recommendations. Mow only areas where sumac is growing.	Decrease sumac coverage and increase native warm season grass (NWSG) cover.
1	Northern Bobwhite Quail	Grassland management	Perform prescribed burn in 2010.	Increase NWSG and forb cover.

The most important action to be taken in Unit 1 is to control the invasion of smooth sumac (*Rhus glabra*) and winged sumac (*Rhus copallinum*). Several limiting factors from HSI data can be addressed if sumac cover decreases. Sumac is responsible for high levels of woody invasion, and was observed in the field to shade out native prairie grasses and forbs. It also decreases diversity of grasses and forbs. Food availability and nesting structure are strongly affected by these factors. As grasses are driven out, litter from the previous season's growth is unavailable.

The recommendations of the Heartland Network for sumac control will be effective in addressing these factors. It is also recommended that park staff only mow in the areas that sumac is currently growing to allow flowering of native species. In the future when sumac is under control, Unit 1 should be managed as an extension of Unit 7, which is considerably larger. It may also be managed to provide diversity in habitat features, which is a requirement of Northern Bobwhite (Pierce and Gallagher 2005). For example, it could be burned in a separate year from Unit 7 to provide bare ground for foraging. The proposed management actions by the Heartland Network will provide this effect in the interim.

Johnsongrass in this unit should be controlled using Plateau herbicide (Kansas Department of Agriculture 2006). Seeding procedures are outlined in the 1999 *Springs of Genius* report (Harrington et al. 1999).

GWCA Management Unit #2

Recommendation: Perform prescribed burn in spring 2010. Monitor woody species invasion.

Spot application of Roundup herbicide for sericea lespedeza (*lespedeza cuneata*).

Unit	Species	Limiting Factor	Management Action	Expected Outcome
2	Henslow's Sparrow	Average litter depth	Perform prescribed burn in spring 2010.	Eliminate woody encroachment from Carver Woods; promote growth of NWSG to provide suitable litter layer in 1-2 years. Recycle nutrients.
2	Prairie Vole	Food plant species	Seed with native forb mix from local seed distributor (optional for 2010). Perform prescribed burn.	Improve native plant species cover and diversity.

Based on HSI data, the main limiting factors that could be addressed are litter depth and diversity of plant species. Litter depth will vary based on management from the previous year, and should be controlled as an extension to the much larger Unit 7.

It is recommended that Unit 2 be part of a prescribed burn in 2010. This would help to control encroaching woody invasion from Unit 7 and Carver Woods. It would also promote native warm season grass cover and address areas with too much litter.

Spot herbicide application of Roundup is an effective control for sericea lespedeza. Care must be taken to avoid non-target killing of native plants near lespedeza (MDC 1997). Seeding procedures are outlined in the 1999 *Springs of Genius* report (Harrington et al. 1999).

GWCA Management Unit #3

Recommendation: Follow the Heartland Network’s recommendations for sumac control for mowed units. Perform a prescribed burn in 2011.

Unit	Species	Limiting Factor	Management Action	Expected Outcome
3	Henslow’s Sparrow	Forb canopy	Follow HTLN recommendations for sumac control including mowing. Seed with native forb mix from local seed distributor (optional for 2010).	Reduce sumac cover and allow forb canopy to cover more area.
3	Prairie Vole	Food plant species	Seed with native forb mix from local seed distributor (optional for 2010).	Improve diversity and cover of native species.
3	Prairie Vole	Average litter depth	Follow HTLN recommendations for sumac control including mowing.	Improve litter depth for prairie vole nests and runways. Recycle nutrients lost from haying.

Limiting factors for this unit include forb canopy cover and lack of plant diversity. These two factors are related. There are some areas lacking in grass and forb cover, which appear to be due to stress from haying implements. This is visible from tire tracks and straight lines of bare ground through the unit. There are also some areas being affected by sumac invasion.

The Heartland Network’s recommendations for sumac removal should be applied to this unit. However, sumac does not dominate large tracts as it does in Unit 1 or Unit 7. It is mixed throughout grass cover, and extreme care should be taken with any herbicide application. It is recommended that this unit be mowed for sumac control, but not burned in 2010. Areas not affected by sumac should be allowed to grow to flowering height.

Seeding procedures are outlined in the 1999 *Springs of Genius* report (Harrington et al. 1999).

GWCA Management Unit #4

Recommendation: Follow the Heartland Network’s recommendations for sumac control for mowed units. Possibly perform a prescribed burn in 2011.

Unit	Species	Limiting Factor	Management Action	Expected Outcome
4	Henslow’s Sparrow	Shade producing woody invasion	Follow HTLN sumac control recommendations for mowed units. Mow only areas where sumac is growing.	Decrease sumac coverage and increase native warm season grass (NWSG) cover.
4	Henslow’s Sparrow	Average litter depth	Mow areas where sumac is growing. Allow to rest where it is not. Prescribed burn in 2011.	Goal is to reduce sumac cover and provide suitable litter depth by 2012.
4	Prairie Vole	Shade producing woody invasion	Follow HTLN sumac control recommendations. Mow only areas where sumac is growing.	Decrease sumac coverage and increase native warm season grass (NWSG) cover.
4	Prairie Vole	Food plant species	Seed with native forb mix from local seed distributor (optional for 2010).	Improve diversity and cover of native species.

Sumac invasion is universal across this unit. It is distributed evenly among grasses across the southern section of the unit and dominant in patches across the northern section. This contributes to the low score in shade producing woody invasion for Henslow’s Sparrow and Prairie Vole. There are large areas where plant species diversity is lacking, but also some areas near the Carver cemetery where forbs flourish among native warm season grasses. Vegetation height was also a bit low, which may have also been affected by the distribution of sumac.

It is recommended that this unit also follow the proposed management actions for sumac removal as presented by the Heartland Network. The exception would be in the area to the west of the Carver Trail and cemetery where the wildflowers are growing well. This area should be allowed to rest until fire treatment is prescribed.

Seeding procedures are outlined in the 1999 *Springs of Genius* report (Harrington et al. 1999).

GWCA Management Unit #5

Recommendation: Allow to rest in 2010. Apply Plateau herbicide to Johnsongrass using Heartland Network vehicle-mounted methods.

Unit	Species	Limiting Factor	Management Action	Expected Outcome
5	Henslow's Sparrow	Forb canopy	Allow to rest. Seed with native forb mix from local seed distributor (optional for 2010).	Improve native species diversity and cover. Allow litter layer to develop and recycle nutrients.
5	Prairie Vole	Food plant species	Seed with native forb mix from local seed distributor (optional for 2010).	Improve native species diversity and cover.

Low forb canopy indicates that the unit should be seeded for forbs or receive transplants in the future. It also denotes that plant diversity overall should be improved.

This unit should also follow the management actions prescribed by the Heartland Network for both sumac and Johnsongrass (*Sorghum halepense*). This unit may be a candidate for the proposed "Untreated Unit" to be treated with the vehicle-mounted wick applicator. Johnsongrass should also be treated using Plateau herbicide (Kansas Department of Agriculture 2006). However, sumac and Johnsongrass may not occur in close enough proximity to one another to be captured in the same experimental unit. Unit 5 does have the greatest Johnsongrass invasion, however.

This unit may also benefit from one or two "rest" years from haying to allow native grass cover to be rehabilitated. There were areas of bare ground either in or near HSI plots, which show signs of compaction by tractor tires.

Seeding procedures are outlined in the 1999 *Springs of Genius* report (Harrington et al. 1999).

GWCA Management Unit #6

Recommendation: Allow unit to rest in 2010. Sumac in the unit should be monitored. It has not become problematic in this unit, but given its invasiveness to other units, it has the potential to be. If deemed problematic, refer to the Heartland Network's sumac control recommendations. Seed the unit with native forbs.

Unit	Species	Limiting Factor	Management Action	Expected Outcome
6	Henslow's Sparrow	Average litter depth	Allow to rest in 2010. Possible prescribed burn in 2011 or 2012.	Allow a litter layer to develop and recycle nutrients.
6	Henslow's Sparrow	Forb canopy	Seed with native forb mix from local seed distributor (optional, but encouraged for 2010).	Improve native species diversity and cover.
6	Prairie Vole	Food plant species	Seed with native forb mix from local seed distributor (optional, but encouraged for 2010).	Improve native species diversity and cover.

The two factors that need to be addressed in Unit 6 are litter depth and plant species diversity. Native warm season grass cover is adequate, but there are also areas of thin vegetation due to tire tracks from haying and mowing implements.

This unit would benefit from a year or two of rest, followed by a spring burn. Specific areas where sumac is beginning to invade should be addressed using the recommendations provided by the Heartland Network. This unit would also benefit greatly from a seeding program to establish native plant species in bare spots occurring due to haying or spot herbicide treatments of invasive species. Establishment of native species in these areas will prevent non-natives from encroaching.

A long-term goal for this unit would be to address tall fescue that is growing on the service road between the unit and Carver Woods. While driving the gator on this road, seeds were released in the vehicle and surrounding areas. To address this invasion, conduct a prescribed burn in late winter (February or March) along the service road. Apply Plateau imazapic herbicide (12 oz./acre with a surfactant) in April along the road (Barnes 2004). Reseed using native seed collected and treated on-site, or purchase from a local vendor. Seeding

procedures are outlined in the 1999 *Springs of Genius* report (Harrington et al. 1999). The land does not need to be tilled (Washburn et al. 1999). There is a USDA Natural Resources Conservation Service Center located in Neosho, MO that could be consulted for materials and guidance

(<http://offices.sc.egov.usda.gov/locator/app?service=page/ServiceCenterSummary&stateCode=29&cnty=145>).

GWCA Management Unit #7

Recommendation: Follow recommendations of Heartland Network for sumac control. Perform prescribed burn in 2010. Seed the unit with native forbs.

Unit	Species	Limiting Factor	Management Action	Expected Outcome
7	Henslow's Sparrow	Shade producing woody invasion	Perform prescribed burn in 2010. Follow HTLN sumac control recommendations. Mow only areas where sumac is growing.	Decrease sumac coverage and increase native warm season grass (NWSG) cover.
7	Henslow's Sparrow	Forb canopy	Seed with native forb mix from local seed distributor (optional, but encouraged for 2010).	Improve native species diversity and cover.
7	Prairie Vole	Shade producing woody invasion	Perform prescribed burn in 2010. Follow HTLN sumac control recommendations. Mow only areas where sumac is growing.	Decrease sumac coverage and increase native warm season grass (NWSG) cover.
7	Prairie Vole	Food plant species	Seed with native forb mix from local seed distributor (optional, but encouraged for 2010).	Improve native species diversity and cover.

Limiting factors for this unit include shade producing woody invasion and overall plant diversity. There are expanses which could benefit from the seeding of forbs.

Unit 7 contains areas that need immediate attention and areas that are in good condition. Near Unit 1 and in the eastern section of the unit are areas of sumac invasion that could be addressed using the Heartland Network's suggestions for sumac control. There are also isolated Johnsongrass invasions that could be addressed using their recommendations. This unit is likely the best candidate to contain the proposed "Untreated Unit" to be treated with the vehicle-mounted wick applicator, particularly in the northeast corner of the park.

Seeding procedures are outlined in the 1999 *Springs of Genius* report (Harrington et al. 1999).

GWCA Management Unit #9 (New Unit)

Unit 9 has several potential options for management. The unit is currently dominated by tall fescue in the grassland areas and trees along the intermittent Dry Branch creek. Native warm season grasses were observed in the eastern portion of the unit encroaching from Unit 5.

There are three options for GWCA regarding this unit:

1. Use appropriate fescue control to re-plant to native prairie. Seeding of the unit could be accomplished through seed collections done by volunteers or through purchasing of seed through a local vendor.

Appropriate control would include conducting a prescribed burn in late winter when fescue begins to green up (late February). The burn should be followed by a spring application of Plateau imazapic (12 oz./acre with a surfactant) Plateau does not harm native grasses, and re-planting to native grasses can be done in a single year (Washburn et al. 1999). Native grass and forb seed from on-site seed collection and treatment or from a local seed dealer can be seeded directly into the dead fescue field without tilling (Barnes 2004). There is a USDA Natural Resources Conservation Service Center located in Neosho, MO that could be consulted for materials and guidance (<http://offices.sc.egov.usda.gov/locator/app?service=page/ServiceCenterSummary&stateCode=29&cnty=145>).

2. Leave the unit as-is and use as an interpretive tool. Because this unit is already fenced, this area could be used as a grazing pasture. This would benefit the cultural aspect of the park, and it would prevent further encroachment of woodlands into the grassland area.
3. Observe the progress of native warm season grasses invading from the east. If progress is steady, it could be encouraged by spraying areas of fescue and re-seeding prior to warm season green up (Barnes 2004).

Site-Wide Recommendations

Seed Collection and Treatment

A potential project for GWCA would be to collect seeds from native grasses and treat them on site. This would be a valuable interpretive and educational tool for children and volunteers. It would aid in appreciation of native vegetation and teach students how seeds are collected and processed for this purpose. The seeds could then be used to enhance the Prairie Management Units at the park. Given the strong volunteer support the park receives, this program would be beneficial to the volunteers and the park by providing a valuable resource for a relatively small start-up cost. If the park is interested in setting up such a program, we would be more than willing to provide resources and guidance.

Aesthetic Improvements

Some observations were made regarding aesthetic improvements during sampling in 2010. These recommendations will accomplish goals in cultural interpretation and natural resources conservation. They will recreate some aspects of the historic scene and/or provide easier management of prairie units.

1. Thin the woodlands on either side of Carver Branch near the western edge of the park. Identify any Bur Oak (*Quercus macrocarpa*), and leave these trees standing, as this species is naturally-occurring in prairie ecosystems. Eliminating any woodland that was not present historically will provide more connectivity between north and south prairie management units. It also prevents woodland encroachment on to prairie units. According to Dr. James Jackson (1995), woodlands only covered approximately 10 m on either side of the creeks on site prior to fire and grazing suppression.
2. Similar to the first aesthetic recommendation, trees could be thinned from the Carver House back to Williams Branch. Though the house was not previously located here, and Williams Pond is an important park resource (and should not be removed), thinning the woodlands would recreate scenery closer to the way it existed during the Carvers' residence on the site.
3. The trees in the northeast corner of Unit 9 should be removed. This would provide for continuity of the large grassland ecosystem on the southern half of the park. It will also

prevent woody plant invasion. One or two Bur Oak trees would create a wonderful scene in this area of the park.

4. Woody growth should be removed from the area known as Unit 7B near the eastern end of the park. This area has been mentioned as a possible interpretation site for prairie management in previous restoration action plans (Jackson 1995).

Cleaning Haying and Mowing Implements

Johnsongrass introduction at the park has long been linked to haying implements that were not sanitized of non-native seeds prior to use. When any park or contractor implements are used at GWCA, they should be thoroughly cleaned in the maintenance area or prior to arriving at the park, respectively.

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Appendix I: Habitat Suitability Index Models

Appendix II: Summary Table of Management Recommendations

Unit	Size (Acres)	Management Action	Expected Outcome
1	4	Follow recommendations of Heartland Network for sumac control. Mow only where sumac is growing. Perform prescribed burn in spring 2010. Seed with native forb mix from local seed distributor (optional for 2010). May postpone in areas where sumac is being treated.	Reduction in sumac cover accompanied by increased native warm season grass (NWSG) and forb cover.
2	3	Perform prescribed burn in spring 2010. Monitor woody species invasion. Spot application of Roundup herbicide for sericea lespedeza (<i>lespedeza cuneata</i>). Seed with native forb mix from local seed distributor (optional for 2010).	Eliminate woody encroachment from Carver Woods; promote growth of NWSG. Improve native plant species cover and diversity.
3	4.5	Follow the Heartland Network's recommendations for sumac control for mowed units. Perform a prescribed burn in 2011.	Reduce sumac cover and allow forb canopy to cover more area. Improve diversity and cover of native species.
4	15	Follow the Heartland Network's recommendations for sumac control for mowed units. Possibly perform a prescribed burn in 2011. Mow areas where sumac is growing. Allow to rest where it is not. Allow area to the west of Carver trail to rest until fire is prescribed.	Reduction in sumac cover accompanied by increased native warm season grass (NWSG) and forb cover. Create a seed bank for forbs in the park.
5	41	Allow to rest in 2010. Apply Plateau herbicide to Johnsongrass using Heartland Network vehicle-mounted methods.	Reduce Johnsongrass cover and improve native plant species cover and diversity. Allow a litter layer to develop and recycle nutrients.

6	16	Allow unit to rest in 2010. Sumac in the unit should be monitored. Seed with native forb mix from local seed distributor (optional, but encouraged for 2010). Consider addressing fescue invasion on service road between the unit and Carver Woods.	Improve native plant species cover and diversity. Allow a litter layer to develop and recycle nutrients. Reduce potential for invasion of unit by tall fescue and other non-native species.
7	49	Perform prescribed burn in 2010. Follow recommendations of Heartland Network for sumac control. Seed with native forb mix from local seed distributor (optional, but encouraged for 2010).	Decrease sumac coverage and increase native warm season grass (NWSG) cover. Improve native species diversity and cover.
9	30	See options provided in Management Recommendations section.	Differing outcomes based on chosen management method.