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Landscape Changes within the Historical Distribution of Columbian Sharp-tailed Grouse in Eastern Washington: Is There Hope?

Abstract

Landscape changes within the historical distribution of Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) in eastern Washington were assessed and analyzed to predict the most suitable areas for habitat improvement. The most significant changes involved the decline and fragmentation of grassland and sagebrush (*Artemisia* spp.) cover types, and the emergence of the cropland/hay/pasture cover type. Grasslands decreased from 25% to 1% of the landscape, while mean patch size declined from 3,765 ha to 299 ha. Sagebrush decreased from 44% to 16% of the landscape and has become extremely fragmented. Grasslands and sagebrush are two of the habitats most frequently used by Columbian sharp-tailed grouse. Conversion of most grassland and sagebrush to cropland is responsible for the decline of sharp-tailed grouse, and has resulted in disjunct populations. Future efforts to expand the range and number of birds should be centered around the Dyer Hill and Colville populations due to current landscape characteristics and population sizes.

Introduction

Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) were once considered one of the most abundant and well known gamebirds in eastern Washington (Bendire 1892, Yocom 1952). This subspecies of sharp-tailed grouse inhabited steppe, meadow-steppe, and shrub-steppe communities (Daubenmire 1988). Historically, population numbers were greatest in grassland (steppe and meadow-steppe) habitat (Bendire 1892, Yocom 1952, Jewett et al. 1953), the majority of which occurred on the Palouse Prairie, in southeastern Washington. Sharp-tailed grouse occupied sagebrush (shrub-steppe) regions of its range in lesser numbers.

By 1920, approximately 80% of the Palouse was under cultivation (Buss and Dziedzic 1955). Sharp-tailed grouse nested in the stubble of wheat fields until burning and plowing stubble became common practices by 1910 (Yocom 1952, Buss and Dziedzic 1955). Within a span of 10 years (1910 - 1920) sharp-tailed grouse decreased from being abundant to scarce in southeastern Washington (Buss and Dziedzic 1955).

Currently, Columbian sharp-tailed grouse occupy < 11% of their historic range and are estimated to number fewer than 1000 birds in Washington (Idaho Department Fish and Game, pers. comm.). Moreover, the situation is dire because there are only four core populations that are relatively moderate in size (≥ six leks), and populations are disjunct with genetic flow unlikely due to habitat fragmentation.

Habitat fragmentation may have substantial effects on population stability and persistence. In the past, ecologists considered most populations and associated ecological processes only on local spatial scales (Dunning et al. 1992). However, the emergence of metapopulation theory (Gilpin and Hanski 1991), patch dynamics theory (Pickett and White 1985), and landscape ecology (Forman and Godron 1986), emphasized the importance of the effects of landscape level changes on vertebrate distributions and population dynamics.

The objectives of this paper are to 1) describe changes in composition and configuration of patches within the landscape corresponding to historical distribution of Columbian sharp-tailed grouse within Washington, and 2) determine future areas most suitable for habitat improvement given the current vegetation pattern and core grouse population distribution.

Study Area

The study area is delineated by the historical distribution of Columbian sharp-tailed grouse within Washington (Figure 1), and ranges from the Canadian border south to Oregon, east to Idaho, and west to the eastern Cascade foothills (Jewett et al. 1953). Our map differs slightly from that of Miller and Graul (1980) by being a minor, recent

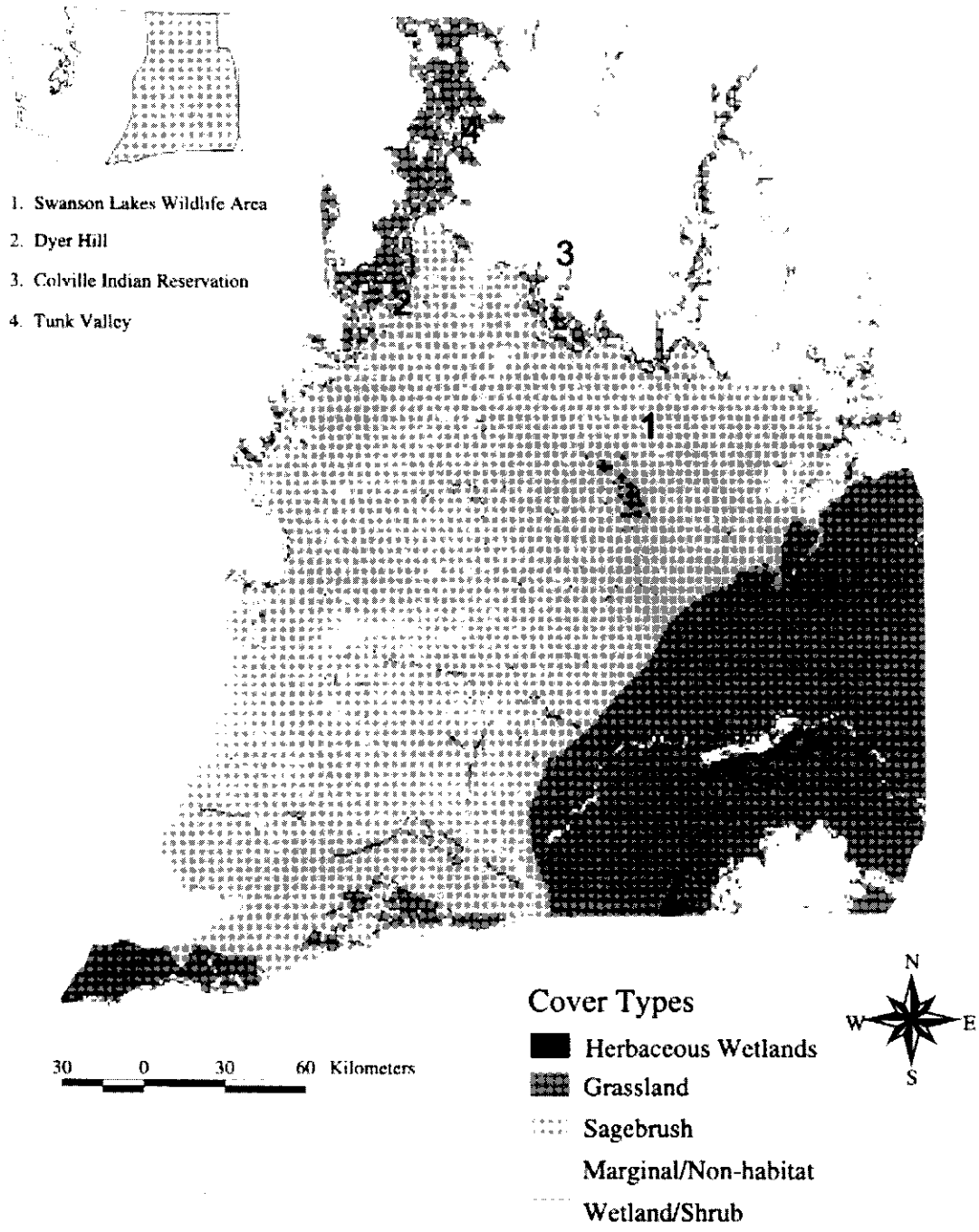

Figure 1. Historical (circa 1900) cover type map corresponding with the historical distribution of Columbian sharp-tailed grouse in Washington (Washington Department of Fish and Wildlife 1995).

refinement by the Washington Department of Fish and Wildlife (1995). This expansive area was not a continuous range, but contained scattered populations in areas of suitable habitat.

Historically, the southeastern part of the study area was dominated by grassland consisting of bluebunch wheatgrass (*Agropyron spicatum*) and fescue (*Festuca* spp.) grasses. Grassland also occurred along the major rivers. Sagebrush communities, consisting of big sagebrush (*Artemisia tridentata*), three-tip sagebrush (*A. tripartita*), and rigid sagebrush (*A. rigida*), occupied the central and southwestern portions of the study area. Coniferous forests existed mainly in the northern portion of the study area.

Four core populations of sharp-tailed grouse occur in Washington (Figure 1). One population exists on Swanson Lakes Wildlife Area and surrounding land, located in the channeled scablands. The majority of this area is sagebrush with scattered areas of former agricultural lands currently in the Conservation Reserve Program (CRP). The second population occurs in the vicinity of Dyer Hill. The general area is mostly cropland, however, there are areas of remnant sagebrush and a state wildlife area (Central Ferry Canyon) created as a refuge for sharp-tailed grouse. The third population, on the Colville Indian Reservation, inhabits steppe habitat around the town of Indian Agency. This area has the most extensive grassland and riparian habitat of the core population areas and has the largest population of Columbian sharp-tailed grouse in Washington. The fourth population occurs in the Tunk Valley, where sagebrush dominates the valley, surrounded by forest. Cropland and CRP patches are also part of the habitat mosaic. There are also birds disjunct from the core populations. Due to the small number of birds and their relative isolation, they are not considered to contribute to the overall population (Washington Department of Fish and Wildlife 1995).

Methods

Geographic information systems software, ARC/INFO and ARCView, were used to generate maps of historical (circa 1900) and current (1990) vegetation patterns coinciding with historical range of Columbian sharp-tailed grouse in Washington (Washington Department of Fish and Wildlife 1995). Historical and current vegetation maps were produced using coverages from the Interior Columbia Basin Ecosystem Management Project (ICBEMP) Historical and Current Cover Type Maps, respectively (Quigley et al. 1996). These cover type maps were intended for use at the regional level (> 300,000 ha) (J. P. Menakis, USDA Forest Serv. Intermountain Fire Sciences Lab, pers. comm.) and were considered appropriate for landscape level analysis. Both the historical and current vegetation maps have a 100-ha pixel resolution, adequate for Columbian sharp-tailed grouse because their seasonal home ranges are larger than 100 ha both for winter and summer (Gratson 1988, Northrup 1991, Ulliman 1995). Grassland, sagebrush and herbaceous wetlands are of primary importance to Columbian sharp-tailed grouse during breeding and brood-rearing, while deciduous trees and shrubs in riparian and mountain shrub cover types are used for both food and cover in winter (Marks and Marks 1988, Ulliman 1995, Washington Department of Fish and Wildlife 1995). Cover types from ICBEMP data were reduced to five categories by combining similar cover types used by Columbian sharp-tailed grouse. For example, big sagebrush, mountain big sagebrush (*A. t. vaseyana*), and low sagebrush (rigid sagebrush) cover types were combined into one cover type "sagebrush", and fescue/bunchgrass and Agropyron bunchgrass were combined into the "grassland" cover type. The marginal/non-habitat cover type consists of cover types that sharp-tailed grouse may use infrequently (e.g., bitterbrush (*Purshia tridentata*)/bluebunch wheatgrass, juniper (*Juniperus* spp.)/sagebrush, salt desert shrub, etc.), in addition to cover types that Columbian sharp-tailed grouse rarely use (e.g., coniferous forests). Cover types potentially used as winter habitat (riparian zones, mountain shrubs) are not-represented due to their linear shape and small area, and because of the large scale of the maps.

The vector version of program FRAGSTATS (McGarigal and Marks 1995) was used to calculate metrics deemed relevant to sharp-tailed grouse on a landscape scale, including area of each cover type and percentage of landscape composed of the cover type of interest, and the largest patch index (percent of the landscape that the largest patch comprises; McGarigal and Marks 1995). Changes in pattern between historical and current landscapes were described at the cover type level.

Range Expansion Efforts

To determine areas most suitable for habitat improvement given the current vegetation pattern and distribution of core grouse populations, grassland and sagebrush cover types (suitable habitat) were mapped in relation to core populations. Dispersal zones of 20 km from each core population were mapped to determine potential suitable habitat within reach of dispersing juvenile and adult female sharp-tailed grouse. Females were used as a measure of dispersal, because they generally make longer movements than males (Robel et al. 1972, Gratson 1988). The 20-km dispersal distance was used because mean dispersal distance for juvenile female Plains sharp-tailed grouse (*T. p. jamesi*) was 21.6 + 4.0 (SE) km (Robel et al. 1972). In addition, Meints (1991) documented two adult female Columbian sharp-tailed grouse moving 20 km from the lek where they were captured.

Grassland and sagebrush habitats were considered potentially suitable habitat for dispersing grouse, however, patch size must also be considered (Morrison et al. 1992). Home range size was used to determine the minimum patch size which could potentially meet the habitat requirements of an individual. Gratson (1988) found mean fall home ranges for sharp-tailed grouse hens to be 556 ha. Winter home ranges have been reported at 400 ha for males and 251 ha for females (Gratson 1988), 268 ha for sexes combined (Northrup 1991), and 313 ha for males and 177 ha for females (Ulliman 1995). Thus, 556 ha was used as a conservative estimate of sharp-tailed grouse spatial requirements. Grassland and sagebrush patches ≥ 556 ha intersecting 20-km dispersal zones of core populations were used to determine areas most suitable for habitat improvement.

Results

The historical distribution of Columbian sharp-tailed grouse in Washington covered 8,124,201 ha. On the landscape level, patchiness increased from 1,816 patches on the historic landscape to 2,844 patches on the current landscape (Table 1). Consequently, the mean patch size (MPS) decreased by 36%, from 4,474 ha to 2,857 ha.

The largest changes in cover types from the historical landscape to the current landscape occurred in grassland, sagebrush, and cropland/hay/pasture (Table 1). Grasslands diminished from historically occupying 25% of the landscape to 1.3%. The number of grassland patches decreased by 190 (35%), and the largest patch index (LPI) decreased from 17.9% to <0.1%. Furthermore, the grassland MPS decreased from 3,765 ha to 299 ha. The corresponding variability in patch

TABLE 1. Changes from historical (H) to current (C) cover type patterns corresponding with the historical distribution of Columbian sharp-tailed grouse in Washington.

Cover type	CA[1]	%LAND[2]	LPI[3]	NP[4]	MPS[5]	PSSD[6]	PSCV[7]
H-Grassland	2029216	25.0	17.9	539	3765	63025	1675
C-Grassland	104280	1.3	< 0.1	349	299	444	149
H-Sagebrush	3583062	44.1	43.2	267	13420	214113	1596
C-Sagebrush	1264506	15.6	8.3	370	3418	36755	1076
H-Herbaceous wetlands	56313	0.7	0.2	73	7718	2700	3506
C-Herbaceous wetlands	0	0	-	-	-	-	-
H-Wetland shrub	35626	0.4	< 0.1	85	4198	786	1876
C-Wetland shrub	9844	0.1	< 0.1	27	365	560	154
H-Cropland/hay/pasture	0	0	-	-	-	-	-
C-Cropland/hay/pasture	4161861	51.2	38.4	735	5662	115230	2035
Total: Historic	8124201	100	-	1816	4474	-	-
Current	8124201	100	-	2844	2857	-	-

[1] Cover type area (ha)
[2] Percent of landscape (%)
[3] Largest patch index (percent of the landscape that the largest patch comprises; McGarigal and Marks 1995)
[4] Number of patches
[5] Mean patch size (ha)
[6] Patch size standard deviation (ha)
[7] Patch size coefficient of variation (%)

size decreased drastically in both absolute (historical = 63,025 ha, current = 444 ha) and relative (historical = 1,675%, current = 149%) terms.

Sagebrush decreased from being the most prevalent cover type (44.1%) on the historical landscape to occupying only 15.6% of the current landscape. While the number of patches increased through fragmentation from 267 to 370, MPS decreased from 13,420 ha to 3,418 ha. Furthermore, the largest patch decreased from accounting for 43.2% of the landscape to only 8.3% currently (Table 1).

Losses of grassland and sagebrush were due to conversion of these areas to cropland (cropland/hay/pasture). Although cropland was a minor part of the landscape prior to 1900, it currently dominates the southern half of the landscape. The cropland/hay/pasture cover type currently accounts for 51.2% of the landscape and has the highest LPI at 38.4%. In addition, it has the most patches (735) and largest MPS (5,662 ha).

Herbaceous wetlands, which historically covered 56,313 ha, completely disappeared from the landscape, while the wetland shrub cover type diminished by 78% to only 9,844 ha (Table 1). The number of patches of wetland shrub decreased from 85 to 27. These cover types, while only accounting for 1.1% of the historical landscape, may have been very important to sharp-tailed grouse brood-rearing (Gratson 1988, Washington Department of Fish and Wildlife 1995) given their juxtaposition on the landscape (Figure 1).

Range Expansion Efforts

Fifty-seven (16%) of the existing grassland patches occur within or intersect the 20-km dispersal zones surrounding core grouse populations (Figure 2), and six are ≥ 556 ha (median = 751 ha, range = 601 - 1,102 ha) (Table 2). Five of these patches are in the vicinity of the Dyer Hill population, while one is within the Tunk Valley dispersal zone (Figure 2).

Similarly, 37 (10%) of the existing sagebrush patches occur within or intersect the 20-km dispersal zones (Figure 2), and 11 are ≥ 556 ha (median = 4,407 ha, range = 601 - 671,441 ha) (Table 2). The Dyer Hill area accounts for seven patches, Swanson Lakes Wildlife Area for two, Colville Indian Reservation for one, and one patch stretches from Dyer Hill to the Colville Indian Reservation.

TABLE 2. Location and area (ha) of grassland and sagebrush patches ≥ 556 ha intersecting core population dispersal zones of Columbian sharp-tailed grouse in Washington.

Grassland		Sagebrush	
Location	Area	Location	Area
Dyer Hill	1102	Dyer Hill	671441
Dyer Hill	901	Dyer Hill, Reservation	32050
Dyer Hill	801	Swanson Lakes	21733
Dyer Hill	701	Dyer Hill	7712
Dyer Hill	701	Dyer Hill	4607
Tunk Valley	601	Dyer Hill	4407
		Dyer Hill	1202
		Swanson Lakes	1102
		Dyer Hill	1102
		Dyer Hill	901
		Reservation	601

Discussion

The decrease in land area of both grassland and sagebrush, and the increase in patchiness and fragmentation of sagebrush in the study area have resulted from the conversion of native grasslands and sagebrush areas to cropland. These changes and associated agricultural practices, such as plowing stubble, were devastating to the overall population of Columbian sharp-tailed grouse in Washington (Yocom 1952, Buss and Dziedzic 1955).

Grasslands diminished from covering 25% of the landscape to only 1.3%, and grassland MPS decreased from 3,765 to 299 ha. These changes impacted sharp-tailed grouse habitat in two ways. First, total area of the most suitable habitat virtually disappeared. Secondly, the number of patches functioning as quality nesting and brood-rearing habitat for local populations declined drastically. Moreover, the remaining grassland patches might occur in habitat mosaics offering insufficient winter habitat (e.g., riparian areas and mountain shrub patches). For example, the current grassland and sagebrush coverage map (Figure 2) shows that the largest grassland patches occur in the southern part of the historical range, yet no populations exist in these areas. In addition, grouse might be absent from some of these grassland patches due to their position on the landscape (e.g., patch isolation) rather than habitat suitability.

The disappearance of almost all grassland in the Palouse area resulted in the loss of the largest and most contiguous sharp-tailed grouse habitat

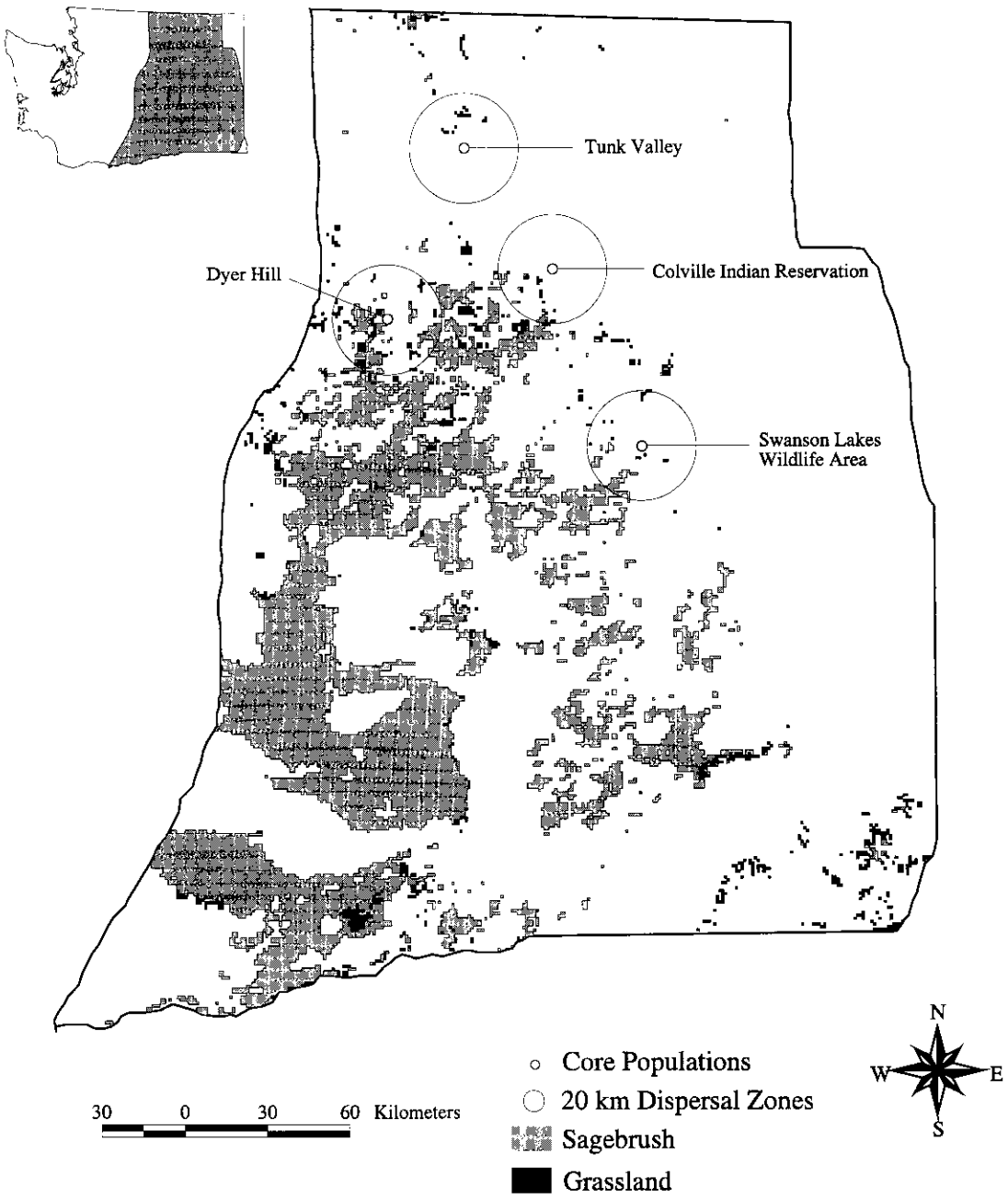

Figure 2. Current (1990) grassland and sagebrush coverage in relation to 20-km dispersal zones for core populations of Columbian sharp-tailed grouse.

within the state (historical LPI = 17.9%). The suitability of this area for sharp-tailed grouse may have been high due to the historical juxtaposition of wetlands within the area (Figure 1). The herbaceous wetlands and wetland shrub cover types occurring in the center of this area most likely offered excellent brood-rearing habitat due to the availability of invertebrates associated with mesic sites. Sharp-tailed grouse broods, similar to other Galliformes, require a diet high in invertebrates during the first few weeks after hatch (Kobriger 1965, Jones 1966).

Sagebrush currently covers 35% of its historical area, and the LPI for sagebrush declined from 43.2% to 8.3%, attesting to the extent of fragmentation. The sagebrush area suffering the greatest fragmentation is in the center of the landscape, adjacent to the Palouse where soils are most productive. This portion of the sagebrush zone may have supported moderate populations of sharp-tailed grouse due to its proximity to the Palouse.

Following the mass conversion and fragmentation of native cover types, distance between suitable habitat patches and landscape resistance to dispersers (decrease in rate of flow of species over a landscape due to structural characteristics) (Forman 1997) have increased, while patch size has decreased. The mean distance from a core grouse population to its nearest neighbor is currently 60.9 km (range = 54.8-71.1 km), triple the mean dispersal distance of females (Robel et al. 1972, Meints 1991), therefore, local population extirpation may likely be permanent. If Columbian sharp-tailed grouse, currently estimated at < 1000 birds in Washington, are to persist, efforts are needed to reconnect remaining core populations through habitat improvement and/or reintroduce grouse into suitable habitats.

Range Expansion Efforts

Habitat improvement and/or reintroduction efforts should be conducted in the vicinity of existing core populations to increase the chances of viable range expansion within Washington. Of the four core populations, the vicinity of the Dyer Hill population has the greatest potential for habitat improvement and range expansion efforts for several reasons. The Dyer Hill population has five of six grassland patches ≥ 556 ha intersecting core population dispersal zones. These five patches are also the largest in size and occur adjacent to relatively large sagebrush patches. Likewise, the majority of sagebrush patches ≥ 556 ha intersecting core population dispersal zones occur in the vicinity of the Dyer Hill population. Because this area has relatively more frequent grassland and sagebrush patches of suitable sizes, it should offer the least landscape resistance to the dispersal and seasonal movements of sharp-tailed grouse.

Efforts should also be made to connect the Dyer Hill population with the Colville population, due to the extent and distribution of grassland and sagebrush patches between the populations. Moreover, the Colville population is the largest of the core populations, and thus may offer the greatest genetic variability and viable source of dispersal.

Riparian zones are one of the most important cover types used during winter, but due to their linear shape and large scale at which the landscape was mapped, are not included in our analysis. These winter habitats need not be large in size, however, they should be distributed throughout the area and juxtaposed to habitats used during the reproductive stage of life (Meints et al. 1992). This habitat mosaic is necessary to meet the seasonal habitat requirements of Columbian sharp-tailed grouse.

A disadvantage to using large scale maps is that some core populations are plotted in the wrong cover type. For example, the Colville population is depicted as occurring in marginal/non-habitat, when it occurs in steppe habitat. While inconsistencies such as this may occur, they should not affect the large-scale changes on the landscape discussed above. However, the results of the grassland and sagebrush coverage intersecting the 20-km dispersal zones of the core populations should be ground-truthed to assess their accuracy and the possibility that suitable patches were not depicted.

Our large-scale analysis provides evidence that appropriate cover types in adequate patch sizes for the recovery of Columbian sharp-tailed grouse populations exist in the study area. Management agencies should determine the quality of these habitat areas and initiate programs to expand the range and promote the conservation of Columbian sharp-tailed grouse in Washington.

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