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Habitat Suitability Index Procedure for Columbian Sharp-tailed Grouse

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ABSTRACT

Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) occupy <10 percent of their historic range. Because of recent increases in some sharp-tailed grouse populations, improved range condition, and the Conservation Reserve Program (CRP), interest in transplanting Columbian sharp-tailed grouse into historic range within the state of Idaho and surrounding Western States has increased. Unfortunately, a habitat suitability index (HSI) to systematically evaluate and rank potential release sites for the Columbian subspecies is not available. Therefore, after evaluating the HSI for the plains sharp-tailed grouse (*T. p. jamesi*), we developed an index more applicable to the Columbian subspecies. Four areas in southeastern Idaho, all known to support viable populations of sharp-tailed grouse, were chosen to develop the procedure.

The HSI is divided into 2 components, each representing a seasonal habitat of Columbian sharp-tailed grouse. Both winter food/cover habitat and nest/brood cover habitat were evaluated using the concept of percent equivalent optimum area. The equivalent optimum area concept assumes that a large area of low quality can have a habitat value equivalent to a smaller area of higher quality.

Our HSI provides a systematic method to evaluate habitat quality for Columbian sharp-tailed grouse. It can also provide values which are compatible with the U.S. Fish and Wildlife Services' Habitat Evaluation Procedure (HEP). The HSI can also be used to determine the amount of mitigation crediting a particular site may provide and be used by biologists without considerable experience in sharp-tailed grouse biology.■

ACKNOWLEDGMENTS

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■ Introduction

Columbian sharp-tailed grouse are one of six sharp-tailed grouse subspecies currently found in North America (Johnsgard 1973) and are the only subspecies native to the Pacific Northwest (Starkey and Schnoes 1976). This subspecies appears to have declined the greatest in terms of range and numbers (Hamerstrom and Hamerstrom 1961). Isolated populations remain in Colorado, Idaho, Montana, Utah, Washington, Wyoming and British Columbia (Marks and Marks 1987) (Fig. 1). Outside British Columbia, Idaho has the largest remaining population of Columbian sharp-tailed grouse. British Columbia may have the largest population, but little is known about sharp-tailed grouse in that area (Miller and Graul 1980). This subspecies no longer occurs in California, Nevada, and Oregon, but efforts are underway to reintroduce the subspecies to Oregon (Starkey and Schnoes 1976, Crawford 1986).

The Columbian subspecies was first discovered by Lewis and Clark in 1805 on the bunchgrass (Agropyron) and sagebrush (Artemisia) plains of the Columbia River. From the early 1900's, sharp-tailed grouse populations drastically declined; this coincided with the period in which the grasslands of the Pacific Northwest and intermountain area were settled, converted to agriculture, and heavily grazed by livestock (Yocom 1952). Today, as in the past, increased agricultural development of sharp-tailed grouse habitat has caused a decrease in their range and numbers (Yocom 1952, Buss and Dziedzic 1955, Olsen 1976).

Livestock grazing is also a major factor influencing abundance and distribution of sharp-tailed grouse (Hart et al. 1950, Hamerstrom and Hamerstrom 1961, Aldrich 1963, Rogers 1969, Parker 1970, Zeigler 1979). Grazing has or may have 2 major impacts on grouse habitat: 1) reduction of nesting and brood cover (Yocom 1952, Evans 1968), and 2) reduction of deciduous trees and shrubs, important for sharptail wintering habitat, by trampling, rubbing, and browsing (Marshall and Jensen 1937, Rogers 1969, Zeigler 1979). Livestock grazing is the dominant land use in the remaining Columbian sharp-tailed grouse habitat (Kessler and Bosch 1982). Current range management practices within grouse habitat include seasonal, deferred, and rotation grazing; prescribed burning; mechanical and chemical treatments; and reseeding of native and non-native forage plants. These practices affect the composition of grasses, forbs, and shrubs upon which sharptail populations depend (Sisson 1976).

Most of Idaho's Columbian sharp-tailed grouse occur in the southeastern portion of the state in Oneida, Power, Bannock, Bingham, Caribou, Franklin, Bear Lake, Bonneville, Fremont and Clark counties (Meints 1991). A small population also exists in west-central Idaho (Washington and Adams counties) (Marks and Marks 1987) (Fig. 2).

Improved grazing practices and CRP have recently resulted in increased sharptail habitat and, therefore, sharptail numbers in parts of southern Idaho (Meints 1991). However, some areas that have improved habitat are disjunct from existing sharptail populations and thus do not support sharp-tailed grouse. Translocation of Columbian sharp-tailed grouse into these areas could expand the range of this species in Idaho. Translocations may also allow future opportunities for expanding this species' range in other parts of the Northwest that may now, or soon will, provide suitable sharptail habitat.

Interest in receiving transplant stock from Idaho for release in other western states is intense. Idaho has received requests from Nevada, Oregon, Montana, Utah, Washington and California. Unfortunately, an HSI to systematically evaluate and rank potential release sites is not available.

A number of grouse species have been successfully translocated, including ruffed grouse (*Bonasa umbellas*) (Hanson 1985, White and Dimmick 1978) and sharp-tailed grouse (Ammann 1957, Rogers 1990, Rogers 1992). Recently, the Idaho Department of Fish and Game successfully translocated sage grouse (*Centrocercus urophasianus*) to central Idaho to augment a very low population (Musil 1989). Oregon is currently in its second year (spring 1992) of reintroducing sharp-tailed grouse. Unfortunately, most attempts to re-establish Columbian sharp-tailed grouse in the Pacific Northwest have failed, probably because of a lack of detailed planning and habitat evaluation. Therefore, we believe that only carefully planned

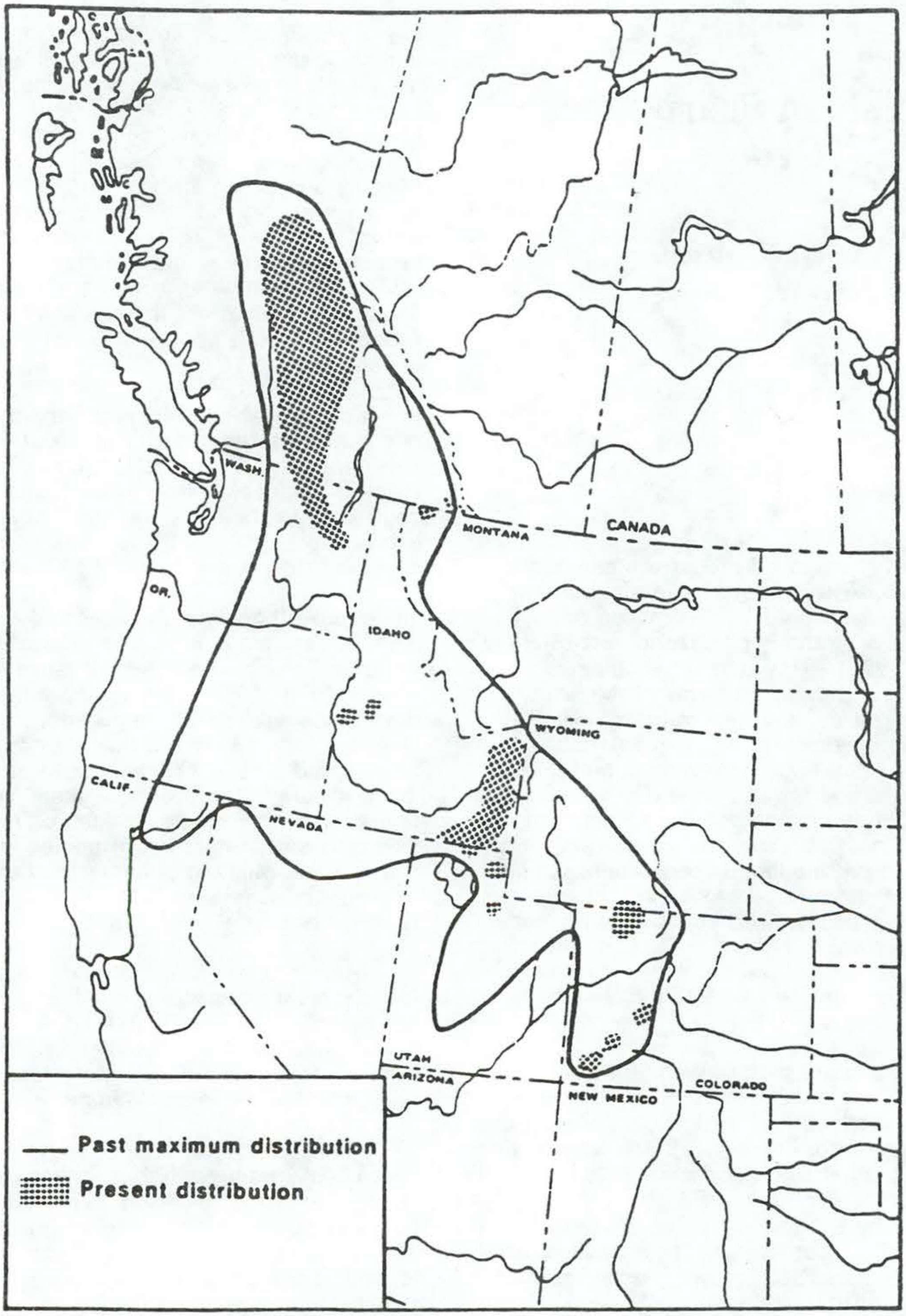

Figure 1. Past and present distribution of Columbian sharp-tailed grouse (modified by Miller and Graul 1980, from Marks and Marks 1987).

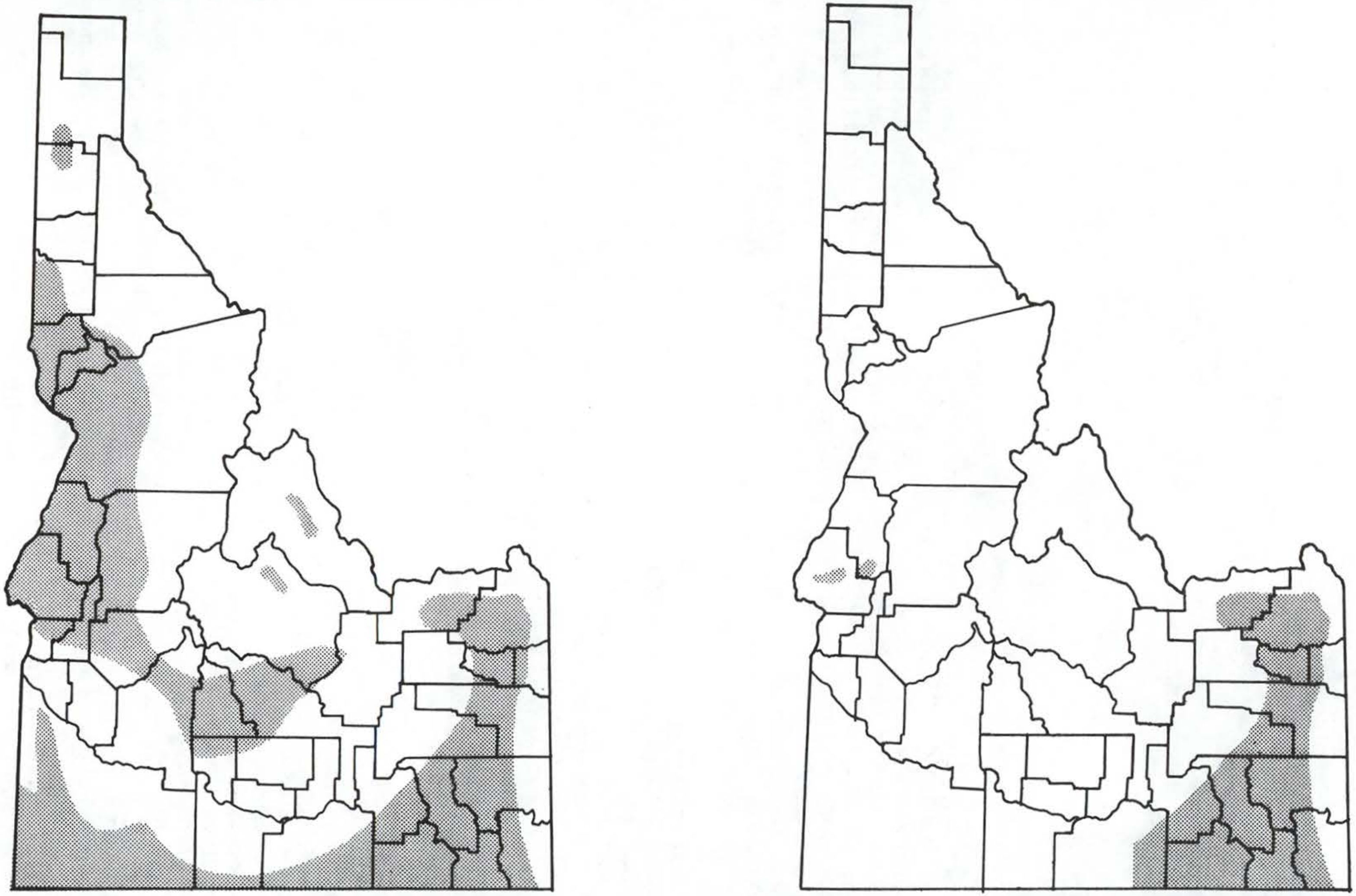

Figure 2. Past (left) and present (right) distribution of Columbian sharp-tailed grouse in Idaho (modified by Parker 1970, from Marks and Marks 1987).

efforts to translocate Columbian sharptails into suitable habitats have a high chance of success.

The objective of this study was to develop an HSI for the Columbian sharp-tailed grouse similar to that which was developed for the plains subspecies (Prose 1987). We urge readers to familiarize themselves with the plains HSI (Prose 1987) so they may obtain a more thorough understanding of the philosophy behind it and our HSI. What we present here is not a new HSI but a revision of the plains HSI to reflect the habitat needs of the Columbian subspecies.

Study Areas

The study areas were the Sand Creek Wildlife Management Area (SCWMA) located on the Upper Snake River Plain in Fremont County, approximately 9.5 km west of St. Anthony, Idaho; the Tex Creek Wildlife Management Area (TCWMA) located in Bonneville County, approximately 24 km southeast of Ririe, Idaho; the Malad area located in Oneida County approximately 6.5 km north of Malad City, Idaho; and the Curlew Valley, also in Oneida County approximately 33.5 km west of Malad City (Fig. 3). Each area provides a unique complex of cover types that presently support stable to increasing populations of Columbian sharp-tailed grouse.

The SCWMA, about 1500 m in elevation, is comprised of level plains and low, rolling hills. Soil depth varies from less than a few centimeters to several meters. Vegetation is dominated by basin big sagebrush (*Artemisia tridentata tridentata*), antelope bitterbrush (*Purshia tridentata*), and chokecherry (*Prunus virginiana*). Moving sand dunes cover several thousand hectares. The area has low precipitation (the annual mean is 31.6 cm), hot summers (the July mean is 30°C), and cold winters (the January mean is -15°C).

The TCWMA ranges in elevation from 1400 to 2200 m and is comprised of table benchlands used for agriculture dissected by steep-sloped canyons. Benchland vegetation is dominated primarily by basin big sagebrush and bitterbrush, while Utah juniper (*Juniperus osteosperma*), aspen (*Populus tremuloides*), and willow (*Salix* spp.) are common in the canyons. Temperatures range from -16°C in winter to 42°C during summer. Annual precipitation ranges from 30.0 cm to 46.0 cm.

The Malad area ranges in elevation from 1357 to 1658 m and is comprised of private agricultural land, much of which has been enrolled in the CRP program, and land administered by the USFS which is used for grazing. The USDA Forest Service land is dominated primarily by sagebrush, Utah juniper and maple (*Acer* spp.) with a mixture of Douglas-fir (*Pseudotsuga menziesii*), aspen, chokecherry and serviceberry (*Amelanchier alnifolia*) located at the higher elevations.

The Curlew Valley area is semiarid and ranges in elevation from 1390 m to 2086 m. The upper elevations are administered by the BLM, while the Curlew National Grassland is managed by the USFS. Private land used for cropland and grazing is interspersed throughout the area. The valleys are dominated by sagebrush and crested wheatgrass (*Agropyron cristatum*), while the foothills are dominated by sagebrush and Utah juniper. Maple-, bitterbrush-, chokecherry-, serviceberry-, and aspen-dominated draws are common within the foothills.

Methods

We first reviewed the current HSI procedure for the plains subspecies (Prose 1987). The only change we made before data collection occurred was the amount of area evaluated around each lek. The plains model considered only an area within a 1.3-km radius of each lek for nest/brood and winter habitat. We increased this distance to 2.0 km for nest/brood habitat and to 6.5 km for winter habitat, based on recent information on movements and habitat use (Rogers 1969, Oedekoven 1985, Giesen 1987, Marks and Marks 1987, Marks and Marks 1988, Klott and Lindzey 1990, Apa 1991, Meints 1991) of Columbian sharp-tailed grouse. Because nest cover and brood cover are intermixed, we combined these components. These changes were tested on 4 areas in southeastern Idaho known to support Columbian sharp-tailed grouse: SCWMA, TCWMA, the Malad City area, and the Curlew Valley. In each area, 3 leks were chosen and winter and nest/brood habitats were measured around each lek. Data were collected in the following manner.

Winter Habitat

Within a 6.5-km radius of each lek, the percent of each winter cover type was determined from color aerial photos and mapped on 1:24,000 orthophotoquads. After ground truthing, a dot count method (Bryant 1943) was used to estimate area. On 2 study areas, the TCWMA and the Malad City area, all 3 leks in each area could be encompassed by one 6.5-km radius circle. Thus, in each of these areas we surveyed only one 6.5-km radius circle (around the center lek) to eliminate bias from double sampling. We randomly selected a point within each stand of winter cover on orthophotoquads and measured the distance to the nearest nest/brood cover.

Nest/Brood Habitat

Within a 2.0-km radius of each lek (referred to as the lek site), the percent of each nest/brood

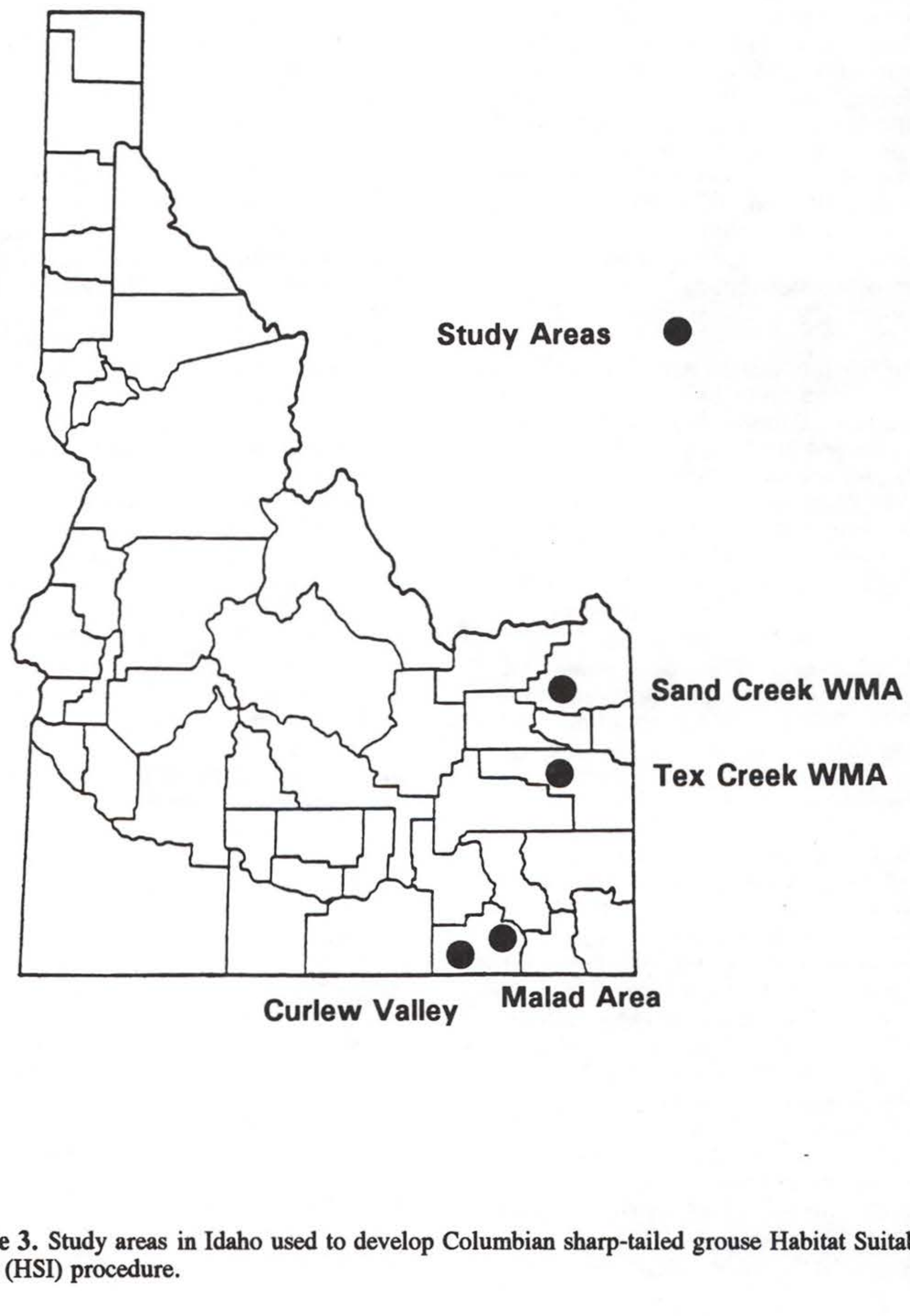

Figure 3. Study areas in Idaho used to develop Columbian sharp-tailed grouse Habitat Suitability Index (HSI) procedure.

cover type was determined from colored aerial photos and mapped on 1:24,000 orthophotoquads. After ground truthing, a dot count method (Bryant 1943) was used to estimate area of cover types. During June, we chose a random point and direction within each stand of nest/brood cover. From the nearest identifiable landmark, the distance and direction to the random point were determined. By starting at the landmark, we used the direction and distance to move to the random point. From this point, Robel pole (Robel et al. 1970) measurements were taken every 25 m along the predetermined direction to evaluate the quality of nest/brood cover. One Robel pole measurement was taken for every 1 percent of the lek site occupied by nest/brood habitat. If we moved outside the cover type and more Robel pole measurements were needed, we then selected another random point and direction and proceeded until we obtained the needed number of measurements. We read the pole from a distance of 4 m at 1 m above the ground. From each random point within each cover type, the distance to the nearest winter cover type was measured to the nearest 20 m on orthophotoquads.

Analysis

We used the Bartlett test to assess homogeneity of variance. If data proved to be non-normal, they were log transformed. Student t-tests (Ott 1984) and ANOVA (Conover 1980) were used to test for differences between and within study areas. The Tukey test (Hays 1988) was used to isolate differences when $P \leq 0.05$.

This HSI is divided into 2 components, each representing a seasonal habitat of Columbian sharp-tailed grouse. Both habitats (winter food/cover and nest/brood cover) were evaluated using the concept of percent equivalent optimum area (Prose 1987). The equivalent optimum area concept assumes that a large area of low-quality habitat can have a habitat value equivalent to a smaller area of higher quality habitat.

Appropriate variables (Appendix I) were entered into the plains HSI and the model was used to calculate habitat suitability with no modifications. The HSI was then modified based on the data we collected. The suitability index for an optimal (i.e., 1.0) mean visual obstruction reading was increased from 2.0 to 2.5 dm based on our data, and the suitability index for an optimal distance between cover types was halved. The scale used for the plains HSI did not adequately represent distance measurements found in the Columbian sharp-tailed grouse literature. Therefore, we used a separate suitability index for distances from nest/brood to winter cover types and for distances from winter to nest/brood cover types. We then compared the results of our HSI to those of the plains HSI (Prose 1987).

■ Results

Habitat Characteristics

Winter cover types at each location varied from 0.1 - 14.0 percent (Table 1). Sand Creek ($\bar{x} = 4.7 \pm 1.5$) had less ($P \leq 0.05$) total winter cover than all other locations (Tex Creek, $\bar{x} = 20.0 \pm 0.0$; Malad Area, 18.0 ± 0.0; and Curlew Valley, 16.3 ± 5.0) (Table 2). The overall mean for all locations was 12.6 ± 7.3 percent.

The mean distance from random points within each winter cover type to the nearest nest/brood cover type was less ($P \leq 0.05$) on Sand Creek ($\bar{x} = 0 \pm 20$ m) than on all other locations (Tex Creek $\bar{x} = 80 \pm 80$ m; Malad Area 160 ± 220 m; Curlew Valley 120 ± 120 m) (Table 3). The overall mean for all locations was 90 ± 110 m.

The mean number of birds (males) present during spring lek counts on leks that we surveyed for the HSI varied from 8 to 26 (Table 4). Lek counts not only varied yearly but also daily depending on weather conditions, female attendance and disturbance (e.g., predators, livestock, photographers).

The amount of nest/brood cover available by location at these lek sites ranged from 2 to 58 percent (Table 5). However, the amount of nest/brood habitat was similar ($P > 0.05$) among study areas (Table 6). The mean nest/brood cover available for all 4 study areas was 80.8 ± 11.9 percent.

Robel pole measurements within nest/brood cover types ranged from 1.9 - 5.7 dm (Table 7). Horizontal visual cover associated with nest/brood habitats differed among study areas (Table 8). Robel pole measurements taken in nest/brood cover types indicated that Sand Creek ($\bar{x} = 1.9 \pm 1.5$ dm) and Curlew Valley ($\bar{x} = 2.3 \pm 1.2$ dm) differed ($P \leq 0.05$) from each other and all other locations (Tex Creek, $\bar{x} = 2.7 \pm 1.2$ dm and Malad City Area, $\bar{x} = 3.3 \pm 1.9$ dm) (Table 8). The overall Robel pole measurement for all 4 locations was 2.5 ± 1.6 dm.

The mean distance from random points within each nest/brood cover type to the nearest winter cover type was less ($P \leq 0.05$) on Tex Creek ($\bar{x} = 200 \pm 180$ m) than those found in the Malad City Area ($\bar{x} = 660 \pm 840$ m) and Curlew Valley ($\bar{x} = 1260 \pm 680$ m) (Table 9). The overall mean distance from nest/brood cover to winter cover for all locations was 620 ± 500 m.

Table 1. Mean (± SD) available winter cover types by location.

Location	Cover Type	N[1]	$\bar{x}$ % Available/Location
Sand Creek	Chokecherry	3	3 ± 1
	Juniper	3	2 ± 1
Tex Creek	Aspen	1	14
	Conifer[2]	1	4
	Riparian[3]	1	2
Malad	Conifer	1	9
	Juniper	1	6
	Riparian	1	3
Curlew	Juniper	3	8 ± 6
	Mt. Shrub Mix[4]	3	5 ± 4
	Serviceberry	1	2
	Russian Olive	1	0.1

[1]N = number of areas with a 6.5-km radius within which the cover type occurred.
[2]Douglas-fir and lodgepole pine (*Pinus contorta*).
[3]Willow and chokecherry.
[4]Chokecherry, serviceberry, aspen, snowberry (*Symphoricarpos vaccinioides*).

Table 2. Winter habitat available within a 6.5-km radius of each lek at each location and overall mean.

Location	Lek	N[1]	% Available Per Lek	$\bar{x}$ % Available Per Location[2]
Sand Creek	Upper Grassy	2	6.0	
	Chokecherry	2	3.0	
	Miller's Corral	2	5.0	4.7 ± 1.5^a
Tex Creek	Headquarters	3	20.0	20.0^b
Malad Area	Grant Weeks	3	18.0	18.0^b
Curlew Valley	West Jacobson	3	11.0	
	Lower Badger	2	21.0	
	Vanderhoff	3	17.0	16.3 ± 5.0^b

Overall $\bar{x} = 12.6 \pm 7.3$

[1]N = number of different winter cover types available.
[2]Means followed by same letter are similar ($P > 0.05$).

Table 3. Distance[1] ($\bar{x} \pm SD$) from random points within each winter cover type to the nearest nest/brood cover.

Location	Lek	N	$\bar{x}$ /Lek	$\bar{x}$ /Location[2]
Sand Creek	Upper Grassy	31	0	
	Chokecherry	3	60 ± 60	
	Miller's Corral	11	0	0[a]
Tex Creek	Red Granary			
	Headquarters	96	80 ± 80	80 ± 80[b]
	Indian Fork			
Malad Area	Lookout			
	Grant Week	31	160 ± 220	160 ± 220[b]
	Calvin Dredge			
Curlew Valley	West Jacobson	23	100 ± 60	
	Lower Badger	25	160 ± 160	
	Vanderhoff	32	100 ± 140	120 ± 120[b]
			Overall $\bar{x}$ =	90 ± 110

[1]Measured in meters.
[2]Means followed by same letter are similar ($P > 0.05$).

Table 4. Spring lek counts from leks that were surveyed to develop the Columbian sharp-tailed grouse HSI.

Location	Lek	N[d]	Mean	Range
Sand Creek[a]	Upper Grassy	14	15	1-26
	Chokecherry	8	10	4-20
	Miller's Corral	10	8	3-10
Tex Creek[a]	Red Granary	8	11	10-14
	Headquarters	30	21	7-43
	Indian Fork	19	7	1-12
Malad Area[b]	Lookout	7	20	17-22
	Grant Weeks	6	26	22-31
	Calvin Dredge	10	12	10-16
Curlew Valley[c]	West Jacobson		12	
	Lower Badger		12	
	Vanderhoff		23	

[a]Censused over two breeding seasons, 1988-89.
[b]Censused during the 1991 breeding season.
[c]Estimated maximum number of birds attending over 4 breeding seasons, 1988-91 (pers. commun. A. Apa).
[d]Number of censuses.

Table 5. Mean (± SD) nest/brood cover types by location.

Location	Cover Type	N[1]	$\bar{x}$ % Available/Location
Sand Creek	Antelope Bitterbrush	3	49 ± 32
	Big Sagebrush	3	37 ± 32
Tex Creek	CRP	3	29 ± 8
	Big Sagebrush	3	22 ± 12
	Three-tip Sagebrush[2]	2	22 ± 28
	Snowberry	1	2 ± 0
Malad	CRP	3	35 ± 6
	Big Sagebrush	3	34 ± 12
	Alfalfa	2	7 ± 9
Curlew	Big Sagebrush	3	58 + 9
	Crested Wheatgrass	3	31 ± 13

[1]Number of times nest/brood cover type occurred per location.
[2]Three-tip sagebrush (*Artemisia tripartita*).

Table 6. Nest/brood habitat within a 2.0-km radius of each lek at each location and overall mean.

Location	Lek	N[1]	% Available Per Lek	$\bar{x}$ % Available Per Location[2]
Sand Creek	Upper Grassy	2	96.0	
	Chokecherry	2	93.0	
	Miller's Corral	2	67.0	85.3 $\pm$ 15.9
Tex Creek	Red Granary	3	74.0	
	Headquarters	4	69.0	
	Indian Fork	2	63.0	68.7 $\pm$ 5.5
Malad Area	Lookout	2	73.0	
	Grant Weeks	3	80.0	
	Calvin Dredge	3	77.0	76.7 $\pm$ 3.5
Curlew Valley	West Jacobson	2	90.0	
	Lower Badger	2	94.0	
	Vanderhoff	2	93.0	89.0 $\pm$ 5.6

Overall $\bar{x}$ = 80.8 $\pm$ 11.91

[1]N = number of different nest/brood cover types available.
[2]No differences occurred in nest/brood habitat availability between locations.

Table 7. Robel pole values (dm, $\bar{x} \pm SD$) within each nest/brood cover type.

Cover Type	N	$\bar{x} \pm SD$
Alfalfa	20	5.7 ± 0.6
CRP	201	3.9 ± 1.2
Snowberry	7	3.6 ± 2.9
Three-tip Sagebrush	46	3.0 ± 1.3
Crested Wheatgrass	61	2.4 ± 1.1
Big Sagebrush	478	2.0 ± 1.2
Antelope Bitterbrush	146	1.9 ± 1.4

Table 8. Robel pole values (dm) in nest/brood cover ($\bar{x} \pm SD$) for each lek, location and overall mean.

Location	Lek	N	$\bar{x}$/Lek	$\bar{x}$/Location[1]
Sand Creek	Upper Grassy	96	2.0 ± 1.6	
	Chokecherry	93	2.2 ± 1.5	
	Miller's Corral	67	1.4 ± 1.1	1.9 ± 1.5[a]
Tex Creek	Red Granary	74	3.0 ± 1.2	
	Headquarters	70	2.7 ± 1.2	
	Indian Fork	63	2.5 ± 1.1	2.7 ± 1.2[b]
Malad Area	Lookout	73	2.7 ± 1.7	
	Grant Week	80	3.4 ± 1.9	
	Calvin Dredge	76	3.9 ± 2.0	3.3 ± 1.9[b]
Curlew Valley	West Jacobson	90	2.5 ± 1.1	
	Lower Badger	94	2.2 ± 1.3	
	Vanderhoff	83	2.1 ± 1.3	2.3 ± 1.2[c]

Overall $\bar{x} = 2.5 \pm 1.6$

[1]Means followed by same letter are similar ($P > 0.05$).

Table 9. Distance[1] ($\bar{x} \pm$ SD) from random points within each nest/brood cover type to the nearest winter cover type.

Location	Lek	N	$\bar{x}$/Lek	$\bar{x}$/Location[2]
Sand Creek	Upper Grassy	5	240 $\pm$ 100	
	Chokecherry	4	400 $\pm$ 180	
	Miller's Corral	5	460 $\pm$ 480	360 $\pm$ 300[ab]
Tex Creek	Red Granary	12	240 $\pm$ 180	
	Headquarters	23	240 $\pm$ 200	
	Indian Fork	16	140 $\pm$ 160	200 $\pm$ 180[a]
Malad Area	Lookout	18	200 $\pm$ 100	
	Grant Weeks	24	220 $\pm$ 180	
	Calvin Dredge	19	1620 $\pm$ 940	660 $\pm$ 840[b]
Curlew Valley	West Jacobson	8	1000 $\pm$ 700	
	Lower Badger	8	1500 $\pm$ 800	
	Vanderhoff	12	1280 $\pm$ 540	1260 $\pm$ 680[b]

Overall $\bar{x}$ = 620 $\pm$ 500

[1]Measured in meters.
[2]Means followed by same letter are similar ($P > 0.05$).

Model Assumptions - (Prose 1987)

1. Winter food/cover and nest/brood cover are the most limiting habitat factors for stable populations of Columbian sharp-tailed grouse.

2. Winter food/cover suitability is a function of relative area of winter cover and availability of supplementary grain.

3. Nest/brood cover suitability is a function of the relative area of cover types used for nesting and brood rearing and the height and density of residual herbaceous vegetation.

4. Interspersion of cover types providing different life history requirements can be characterized by the distance between them.

5. A large area of low quality can have an overall habitat value equivalent to a small area of high quality (i.e., area can compensate for quality and quality can compensate for area).

6. The presence of available cultivated grains increases the winter food/cover value of an area by providing a supplemental food source and reducing the dependency of sharp-tailed grouse on woody cover.

7. Habitats lacking shrubs cannot have a suitability index for winter/food cover >0.5.

8. Residual vegetation within cover types providing potential nesting and brood-rearing cover exists in a variety of heights and densities.

Winter Food/Cover Component

Equation 1 is used to calculate the contribution of shrubby cover to the percent equivalent optimum area of winter food/cover.

$$PAWS = \sum_{i=1}^{n} (S_i)(SIV1_i) \qquad (1)$$

where PAWS = percent equivalent optimum area providing winter food/cover contributed by shrubby cover types

n = total number of shrubby cover types present

S_i = percent of available habitat in shrubby cover type i

$SIV1_i$ = mean suitability index for distance between winter cover type i and the nearest cover type providing nest/brood cover (Fig. 4)

Separate scales were used to evaluate the distances between winter cover types to nest/brood cover types and nest/brood cover types to winter cover types for the Columbian sharp-tailed grouse HSI. None (0/20) of the winter-to-nest/brood distance measurements exceeded 1.6 km, the optimal distance reported by Prose (1987). Therefore, we decreased the optimal distance measurement to 90 m (Fig. 4), which was the overall mean distance measurement from winter to nest/brood cover for Columbian sharp-tailed grouse (Table 3).

Columbian sharp-tailed grouse do not require cultivated grain, but grain can be a preferred winter food when available. Available grain crops in the plains subspecies HSI were those within 750 m of woody cover and $\leq$ 50 m from cropland's edge. Because grain crops may be unavailable to sharptails during periods of heavy snow cover, the percent equivalent optimum area of winter food/cover provided by grain crops (Equation 2) cannot exceed 5 percent (the percent corresponding to a suitability index of 0.5) (Fig. 5) for its contribution to the total percent equivalent optimum area for the study area (Equation 3).

$$PAWC = \sum_{j=1}^{n} (C_j)(SIV1_j) \qquad (2)$$

where PAWC = percent equivalent optimum area providing winter food/cover contributed by grain crop cover types

n = total number of available grain crop cover types

C_j = percent of available habitat in available grain crop cover type j

$SIV1_j$ = average suitability index for distance between available grain/crop cover type j and the nearest cover type providing nest/brood cover (Fig. 4)

Note: If PAWC exceeds 5 percent, it should be set to 5 percent for further calculations.

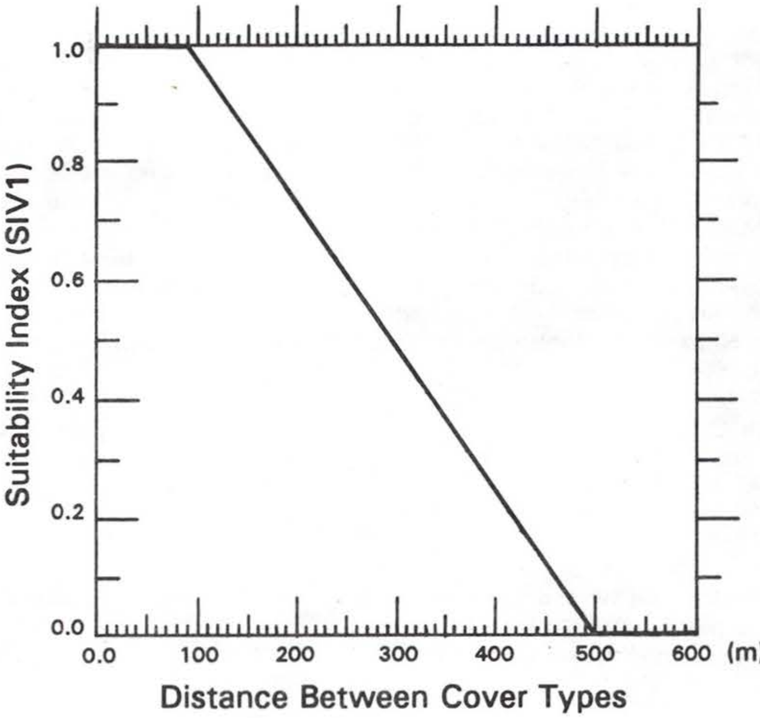

Figure 4. The relationship between distance from winter cover to nest/brood cover and suitability for Columbian sharp-tailed grouse.

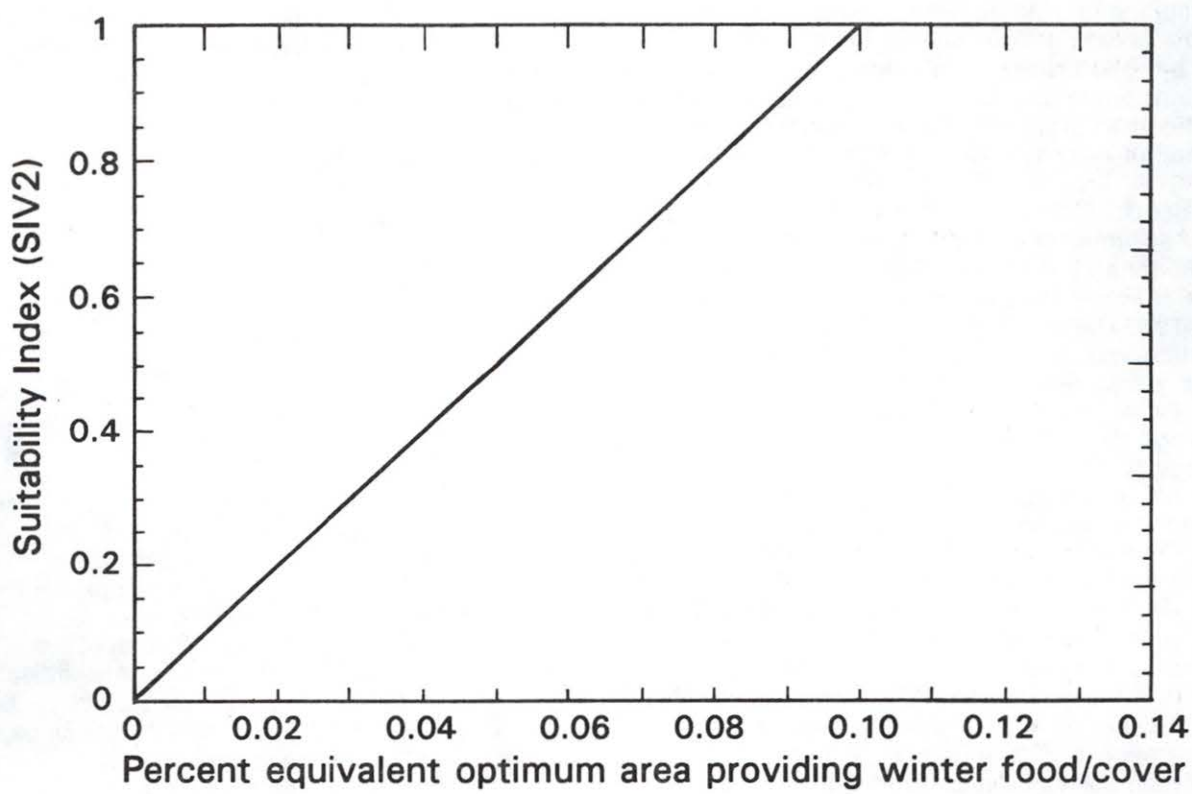

Figure 5. The relationship between percent equivalent optimum area providing winter food/cover and suitability of winter food/cover for Columbian sharp-tailed grouse.

The overall percent equivalent optimum area providing winter food/cover is equal to the sum of that provided by both shrubby cover (PAWS) and grain crops (PAWC) (Equation 3). Maximum winter food/cover suitability in this HSI is reached at 10 percent equivalent optimum area (Fig. 5). Shrubs are the primary source of native winter foods and are a critical food source during periods of heavy snow cover. The presence of grain crops need not be considered on study areas having $\geq$ 10 percent equivalent optimum area in winter food/cover that is provided by shrubby cover.

Percent Equivalent Optimum Area Providing Winter Food/Cover

$$= PAWS + PAWC \quad (3)$$

The suitability index for the winter food/cover requirement is equal to the suitability index for equivalent optimum area providing winter food/cover.

The Sand Creek leks were the only leks we studied where the area within a 6.5-km radius of each lek contained < 10 percent winter cover; all other locations exceed 10 percent winter cover, which is equivalent to a 1.0 optimum habitat suitability index. Moreover, the Sand Creek leks were the only ones in which no grain crop occurred within a 6.5-km radius. Therefore, the percent equivalent optimum area providing winter food/cover contributed by grain crop cover types for all leks in all locations was zero.

Nest/Brood Cover Component

We assumed that Robel pole readings (VOR) taken in spring (i.e., early nesting season) reflect factors affecting availability of nest/brood cover (Prose 1987). For the plains HSI, residual vegetation with a Robel pole mean $\geq$ 2.0 dm over the entire area represented optimal nesting and brood rearing conditions. When we analyzed nest/brood cover for Columbian sharp-tailed grouse, we found that only 34 percent (10/29) of Robel pole means fell below the 2.0 dm optimal measurement used in the plains sharp-tailed grouse model (Prose 1987). Therefore, we increased the optimal measurement to 2.5 dm (Fig. 6), which was our overall mean Robel pole measurement (Table 8). We also observed that only 7 percent (2/29) of the mean measurements taken from nest/brood cover to winter cover exceeded the optimal distance of 1.6 km. Thus, we decreased the optimal distance measurement to 620 m (Fig. 7), which was our overall mean distance measurement from nest/brood cover to winter cover (Table 9).

Nest/brood cover suitability in both the plains and Columbian sharp-tailed grouse HSI's is a function of height and density of vegetation in spring, relative size of nest/brood cover types, and relationship between distance from nest/brood cover to winter cover. This relationship is expressed as percent equivalent optimum area providing nest/brood cover and is derived with Equation 4.

Percent Equivalent Optimum Area Providing Nest/Brood Cover

$$= \sum_{i=1}^{n} (SIV3_i)(N_i)(SIV4_i) \quad (4)$$

where
- n = total number of nest/brood cover types
- $SIV3_i$ = the suitability index for cover in cover type i (Fig. 6)
- N_i = percent of study area in cover type i
- $SIV4_i$ = mean suitability index for distance between nest/brood cover type i and the nearest cover type providing winter food/cover (including available cropland) (Fig. 7)

The maximum nest/brood cover suitability in the HSI exists when the equivalent optimum area providing nest/brood cover is $\geq$ 50 percent (Fig. 8) and decreases as the percent equivalent optimum area decreases until zero suitability is reached at 5.0 percent. The suitability index for nest/brood cover is equal to the suitability index for percent equivalent optimum area providing nest/brood cover.

HSI Determination

The HSI is equal to the lower of the life requirement values for winter food/cover (SIV2) or nest/brood cover (SIV5).

After the Columbian sharp-tailed grouse data were entered into the plains sharp-tailed grouse HSI, before modifications took place, the 12 study leks were ranked from most optimal (West Jacobson, HSI = 1.0) to least optimal (Chokecherry, HSI = 0.30) (Table 10).

We then modified the plains HSI to include new optimal measurements and distances and re-analyzed the Columbian sharptail data. The 12 study leks were ranked from most optimal (Red Granary, West Jacobson, Headquarters, and Grant Weeks HSI = 1.00) to least optimal (Chokecherry, HSI = 0.30) (Table 11). Using our modifications, 75 percent (9/12) of the habitat suitability indices for our study leks changed and the rankings of 92 percent (11/12) of the leks changed. The mean HSI generated by the plains method was 0.70. However, after our modifications, this value increased to 0.75.

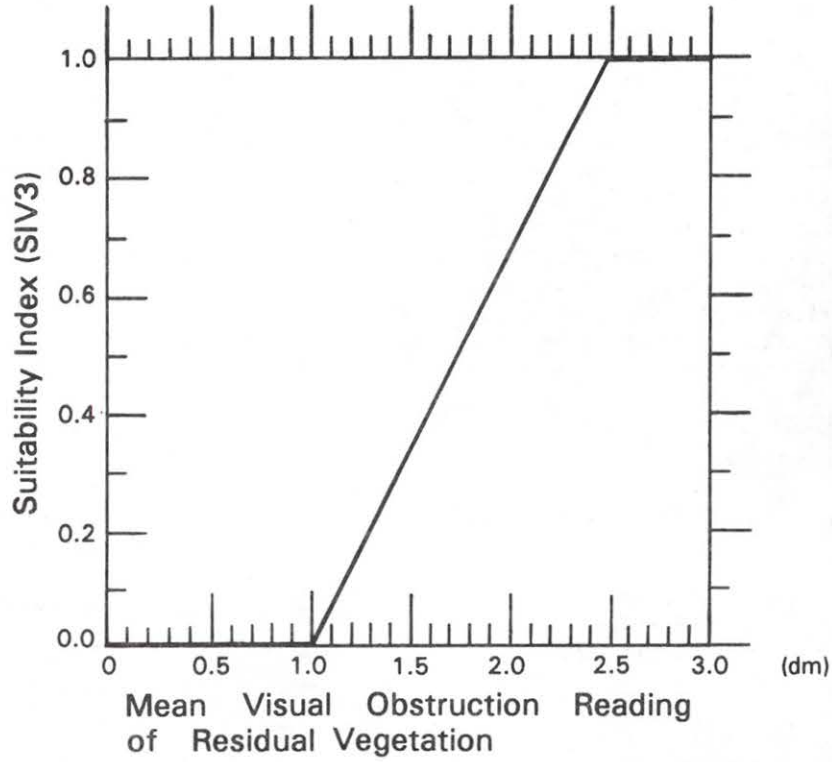

Figure 6. The relationship between mean visual obstruction of residual vegetation and nest/brood cover suitability for Columbian sharp-tailed grouse.

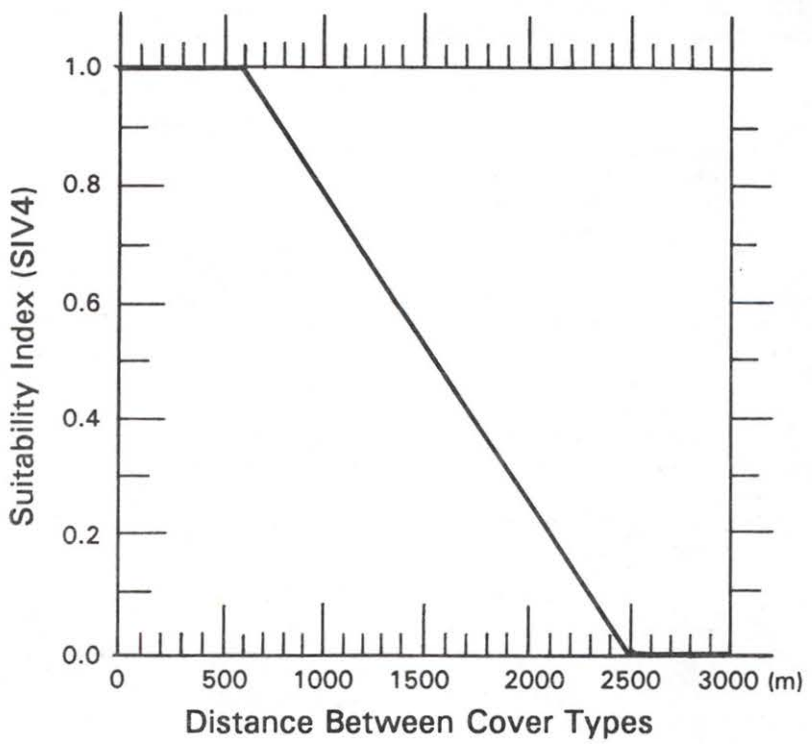

Figure 7. The relationship between distance from nest/brood cover to winter cover and suitability for Columbian sharp-tailed grouse.

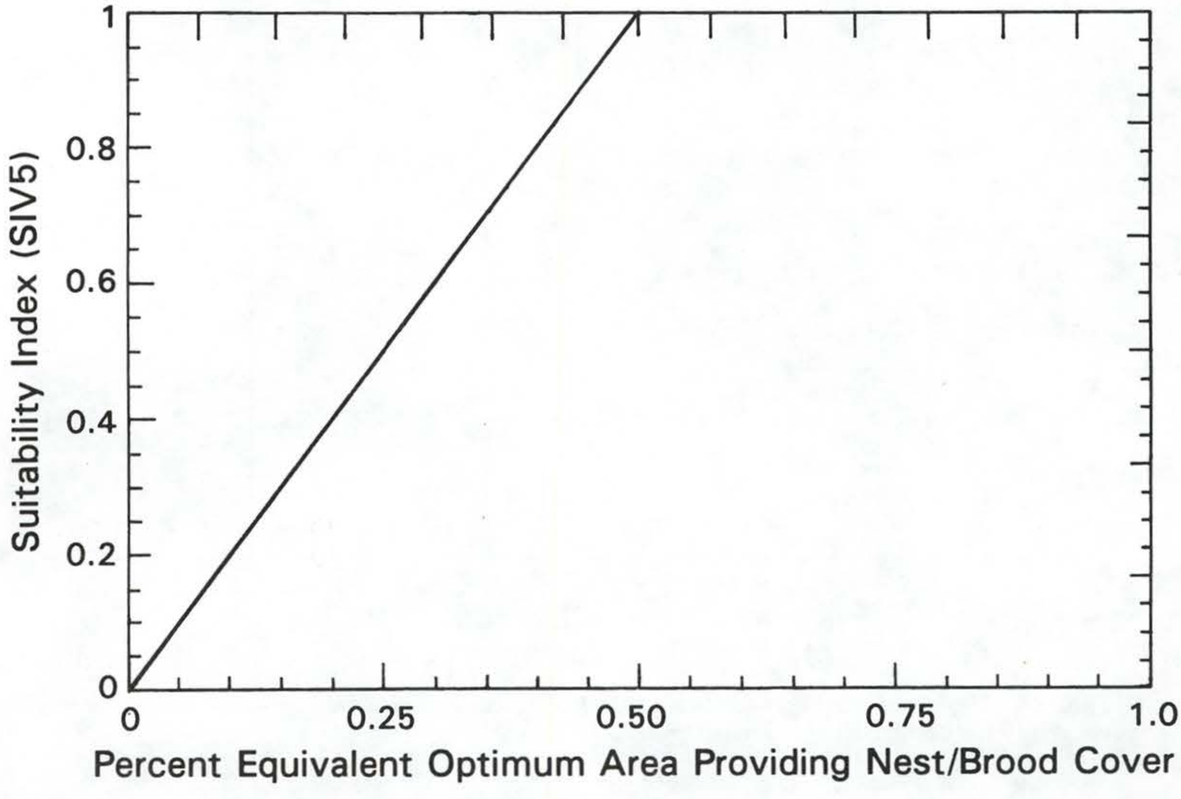

Figure 8. The relationship between percent equivalent optimum area providing nest/brood cover and suitability of nest/brood cover for Columbian sharp-tailed grouse.

Table 10. Habitat suitability index values and lek rankings using the plains sharp-tailed grouse method.

Location	Lek	Habitat Suitability Index	
		Nest/Brood	Winter
Sand Creek	Upper Grassy	0.90	0.60
	Chokecherry	1.00	0.30
	Miller's Corral	0.35	0.50
Tex Creek	Red Granary	0.80	1.00
	Headquarters	0.70	1.00
	Indian Fork	0.60	1.00
Malad Area	Lookout	0.65	1.00
	Grant Weeks	0.75	1.00
	Calvin Dredge	0.80	1.00
Curlew Valley	West Jacobson	1.00	1.00
	Lower Badger	0.80	1.00
	Vanderhoff	0.90	1.00

Ranking	Lek	HSI
1.	West Jacobson	1.00
2.	Vanderhoff	0.90
3.	Red Granary	0.80
4.	Calvin Dredge	0.80
5.	Lower Badger	0.80
6.	Grant Weeks	0.75
7.	Headquarters	0.70
8.	Lookout	0.65
9.	Upper Grassy	0.60
10.	Indian Fork	0.60
11.	Miller's Corral	0.35
12.	Chokecherry	0.30

Table 11. Habitat suitability index values and lek rankings using the Columbian sharp-tailed grouse method.

		Habitat Suitability Index	
Location	**Lek**	**Nest/Brood**	**Winter**
Sand Creek	Upper Grassy	1.00	0.55
	Chokecherry	1.00	0.30
	Miller's Corral	0.35	0.50
Tex Creek	Red Granary	1.00	1.00
	Headquarters	1.00	1.00
	Indian Fork	0.85	1.00
Malad Area	Lookout	0.95	1.00
	Grant Weeks	1.00	1.00
	Calvin Dredge	0.60	1.00
Curlew Valley	West Jacobson	1.00	1.00
	Lower Badger	0.60	1.00
	Vanderhoff	0.80	1.00

Ranking	Lek	HSI
1.	Red Granary	1.00
1.	West Jacobson	1.00
1.	Headquarters	1.00
1.	Grant Weeks	1.00
2.	Lookout	0.95
3.	Indian Fork	0.85
4.	Vanderhoff	0.80
5.	Calvin Dredge	0.60
6.	Lower Badger	0.60
7.	Upper Grassy	0.55
8.	Miller's Corral	0.35
9.	Chokecherry	0.30

■DISCUSSION

The greatest change made from the plains to the Columbian sharp-tailed grouse HSI was the distance measurements between the 2 components (nest/brood and winter habitat). Columbian sharp-tailed grouse habitat occurs in areas with great diversity where these two components are intermixed and usually occur in proximity. The plains sharptail uses areas with large expanses of brushy grasslands with limited diversity and, therefore, larger distances between the two components.

The greater Robel pole measurements associated with the Columbian sharptail nest/brood habitat are most likely because they were taken during June (late nesting) and not in April (prior to nesting), as they were for the plains HSI. We urge HSI users to take this into consideration when collecting Robel pole data. We collected data during June because of funding and time constraints for this project and not for any biological reasons.

We advise HSI users to refrain from reintroducing Columbian sharp-tailed grouse into areas where the HSI is < 0.75. In areas where the HSI is < 0.75, one or both of the habitat components may be limited to the point that introduced birds could not locate needed habitat to survive and reproduce. Introduced birds may disperse to find suitable habitat, food or cover, and never establish a lek and also suffer relatively high mortality rates (Musil 1989). Therefore, even though all 12 of the leks that were used to revise this procedure held viable populations, we would advise reintroducing birds into habitats that were similar to only 7 of these leks. The remaining leks may not provide adequate habitat components for a translocated population to become established.

There may not be a direct relationship between lek attendance (Table 4) and HSI values (Table 11). However, the number of leks in a given unit of habitat may vary, and this density of leks should reflect habitat quality.

This HSI provides a systematic method to evaluate habitat quality for Columbian sharp-tailed grouse. This method assesses the two key components for sharp-tailed grouse: nest/brood and winter habitat. This procedure can provide HSI values which are compatible with the HEP of the U.S. Fish and Wildlife Service. It can be used to determine the amount of mitigation crediting a particular site may provide and can also be used by biologists lacking considerable experience with sharp-tailed grouse biology.

This procedure could be further improved by collecting habitat data in other parts of the current range of Columbian sharp-tailed grouse as well as in areas that were once known to support Columbian sharp-tailed grouse, but due to habitat modifications are now abandoned. The results can then be compared to relationships in our HSI to determine if any further modifications to the procedure are needed.

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■APPENDIX I. Guidelines for Implementing the Columbian Sharp-tailed Grouse Habitat Suitability Index.

I. Determine location of existing or artificial (release site) leks.

A. This is commonly done by systematically searching areas from a vehicle during the early morning (i.e., 0.5 hours before sunrise to 1 hour after sunrise). Stops are made at 1-km intervals and observers listen for displaying birds as well as search relatively open areas with binoculars or a spotting scope.

II. Data Collection.

A. Determine percent availability of each winter cover type (including grain) within a 6.5-km radius of each lek or release site.

When determining availability of winter (or nest/brood) cover, several techniques can be used depending on the availability of resources. To determine availability for this project we used color aerial photos along with orthophotoquads. In some cases, only 1:24,000 topographic maps may be available, depending on the area examined. Each block of cover type that is $\geq$ 1% of the area defined by a 6.5-km radius should be included. Cover types can be delineated by dominant species and/or structure.

1. Select a random point within each winter cover type (select 1 random point for each 1 percent of winter cover type available) and determine the distance to the nearest nest/brood cover.

B. Determine percent of each nest/brood cover type within a 2.0-km radius of each lek or release site.

1. Select a random point and direction within each cover type.

   a. Use these as starting points in taking Robel pole measurements (take 1 measurement every 25 m for every 1 percent of nest/brood cover available). The pole is read from 4 m at 1 m above the ground.

   If a point falls outside the cover type and more Robel pole measurements are needed, select another random point and direction and proceed until the needed number of measurements are obtained.

   b. From each of these points, use a topographic map or orthophotoquad to determine the distance to the nearest wintering cover.

III. Calculating Winter Food/Cover Component.

1. Determine total percent availability of each winter cover type for each lek.

2. Determine mean distance between winter cover types and the nearest nest/brood cover for each lek.

3. Enter distance means into Fig. 4 to determine suitability for each winter cover type for each lek.

4. Enter values into Equation 1 (keeping leks separate) to determine percent equivalent optimum area providing winter food/cover available by shrubby cover.

5. Calculate percent equivalent optimum area providing winter food/cover contributed by grain if shrubby cover provides < 10 percent suitability (Fig. 5).

6. Determine suitability index (Fig. 5) for the winter food/cover life requisite.

IV. Calculating Nest/Brood Cover Component.

1. Determine total percent availability of each nest/brood cover type for each lek.

2. Determine mean distance between nest/brood cover types and the nearest winter cover for each lek.

3. Enter distance means into Fig. 7 to determine suitability for each nest/brood cover type for each lek.

4. Determine mean Robel pole measurements for each nest/brood cover type for each lek.

5. Enter mean measurements into Fig. 6 to determine suitability for each nest/brood cover type for each lek.

6. Enter values into Equation 4 (keeping leks separate) to determine percent equivalent optimum area providing nest/brood cover.

7. Determine suitability index (Fig. 8) for the nest/brood cover life requisite.

V. (HSI) Determination.

1. List each lek and its corresponding winter food/cover and nest/brood cover index values (Table 11).

2. Rank leks using the lower of the 2 index values.

3. We do not recommend introducing birds into an area with an HSI lower than 0.75.