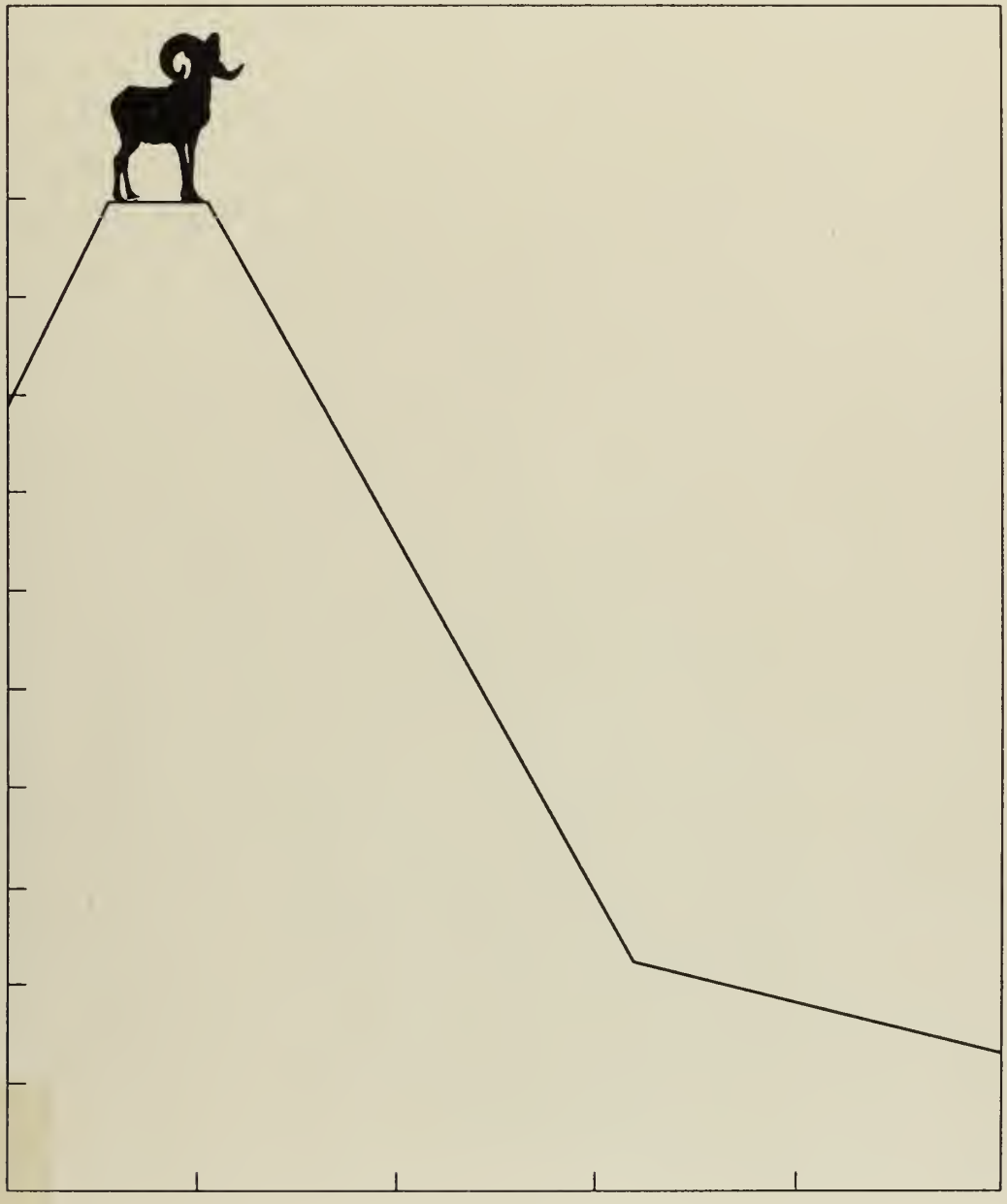
Technical Note 384

HABITAT SUITABILITY RATING SYSTEM FOR DESERT BIGHORN SHEEP IN THE BASIN AND RANGE PROVINCE



U. S. Department of the Interior

Bureau of Land Management

BLM Technical Note 384

HABITAT SUITABILITY RATING SYSTEM FOR DESERT BIGHORN SHEEP IN THE BASIN AND RANGE PROVINCE

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September 1988

BLM/YA/PT-88/007+6600

United States Department of the Interior
Bureau of Land Management

Available from:

Printed Materials Distribution Section
BLM Service Center (D-558B)
Denver, CO 80227-0047

and

National Technical Information Service
5285 Port Royal Rd.
Springfield, VA 22161

ABSTRACT

Many habitat evaluation systems have been developed for desert bighorn sheep *(Ovis canadensis nelsoni)*. However these systems may not satisfy all of the following needs: 1) be applicable to a broad geographical area; 2) provide data for a diversity of habitats; 3) allow ready determination of potential carrying capacity connected with habitat condition and condition changes; 4) provide for computer analysis and modeling capabilities and; 5) provide land managers with an understandable habitat rating score. Our proposed system analyzes the need of cover, water, forage, and space by desert bighorn sheep using current computer applications while allowing for documentation of what an experienced observer knows by just looking at the habitat.

INTRODUCTION

This rating system was developed to provide wildlife biologists with a standardized method to evaluate desert bighorn sheep habitat. The system is designed to: 1) be applicable to a broad geographical area; 2) provide data for a broad spectrum of habitats; 3) allow ready determination of potential carrying capacity in connection with habitat condition and condition changes; 4) provide for computer analysis and modeling capabilities and; 5) provide land managers with an understandable habitat rating score. The system is basically a Habitat Suitability Index (HSI) Model (U.S. Fish and Wildlife Service 1981). Habitat suitability index models are unique because they are often constrained to habitat information which emphasizes quantitative relationships between key environmental variables and habitat suitability. Habitat information is compiled into a distinct habitat model useful in quantitative assessments for reintroduction, monitoring existing use, and predicting impacts of management actions. The system uses an HSI ranging from 0.0 (unsuitable) to 1.0 (optimum). This is based on the assumption that the index and habitat carrying capacity are positively related. The system can also be used as a support model for analysis within the Bureau of Land Management's Geographical Information System (GIS), and is directly applicable to the U.S. Fish & Wildlife Service's Habitat Evaluation Procedures (HEP).

Most variables evaluated within this system are tied by previous research, to the habitat requirements (life requisites) for desert bighorn sheep. Those variables not thoroughly addressed in the past will be discussed in this paper. Suitability indices (SI) are the numeric score between 0.0 and 1.0 which are applied to each variable. A life requisite SI can be an SI for a single variable or an SI averaged over several variables. The variables measured and applicable life requisites are as follows:

Variables	Life Requisites
Topography (V_1)	Cover and Reproduction
Water Amount & Permanence (V_2) Distance From Escape Cover (V_3) Competition (V_4) Visual Obstruction (V_5) Water Distribution (V_6)	Water
Forage Forage Areas (V_7) Seral Stage or Condition (V_8) Distance to Escape Cover (V_3) Visual Obstruction (V_5)	Food
Human Conflicts (V_9)	Space
Domestic Livestock Use Conflicts (V_{10})	Space

Fixed Criteria

1. The area evaluated must have been free of domestic sheep for at least 2 years.

2. Using aerial photographs, orthophotoquads, or topographic maps, divide the entire use area into plant communities. Acreages are calculated for each plant community.

3. If a rating for a part, or all of a cover type or plant community will result in a zero weighted index, discontinue evaluation and discard that segment of the area.

4. When using descriptive models if an area cannot be accurately classified, a score between the two most appropriate descriptions is used.

5. Unless there is at least one area of cover greater than 5.0 acres (Lambing Cover) that scores 1.0 the cover SI will equal 0.0.

6. If any Life Requisite SI equals 0.0 the overall Habitat Suitability Rating will equal 0.0.

METHODS

Cover SI

Topography has been identified as the primary source of cover for the desert bighorn (Dobel 1985, Ferrier and Bradley 1970, Golden and Tsukamoto 1980, Hansen 1980, McQuivey 1978, and Wilson et al. 1980). Size of topographic features is critical to the type of use by bighorn sheep. Bedding cover can be unstable talus slopes, steep broken escarpments or rock outcrops at least 0.4 acre in size, with traversable terraces. Escape cover can be the same as bedding cover as well as steep slopes and boulder fields. Lambing cover requires steep broken escarpments or rock outcrops at least 5.0 acres in size with traversable terraces. This is a descriptive model with base values (Table 1). This variable is the only one used to establish the cover SI.

Water SI

The potential for water use is contingent upon several variables (Hansen 1980, McQuivey 1978, and Wilson et al. 1980). Therefore, the Water SI is determined using the following formula. SIV_2 x ((SIV_3 + SIV_4 + SIV_5 + SIV_6)/4)

1. **Amount and Permanence (V_2):** The need for sufficient water at the critical times of year such as summer has been well documented (Hansen 1980, McQuivey 1978, and Wilson et al. 1980). The SI for amount and permanence is determined using a descriptive model (Table 2) and its base values. The water source must be available for bighorn use, e.g., not improperly fenced, etc.

2. **Distance From Escape Cover (V_3):** The usefulness of water sources and forage areas to bighorn sheep can be influenced by distance to escape cover (Hansen 1980, Van Dyke et al. 1983, Wilson et al. 1978). A graph (Figure 1) is used to determine this SI. Distance from escape cover is measured from the water source or center of the forage area to the edge of the closest escape cover. If the water source is a stream, distance is measured along the shortest route between the stream and the edge of the escape cover.

3. **Competition (V_4):** Use of a water source by bighorn sheep can be influenced by interspecific competition (Dobel 1985, Golden and Tsukamoto 1980, Hansen 1980, McQuivey 1978, Sands 1976, Wilson et al. 1978, and Wilson et al. 1980). Using the descriptive model (Table 3) develop the SI.

4. **Visual Obstruction (V_5):** Dobel (1985), Golden and Tsukamoto (1980), and Hansen (1980)have discussed impacts of visual obstruction on habitat use. One of the first attempts to provide data on the affects of visual obstruction was published by Risenhoover and Bailey (1985). The proposed method is an attempt to quantify impacts of visual obstruction using simple field techniques. Visual obstruction caused by vegetation is measured in the four cardinal directions using a range pole or density board. Percent obstruction is recorded for heights up through the 3 foot level. The recorder should kneel or squat to obtain the most accurate obstruction reading. Using the graph (Figure 2) record the SI.

5. **Water Distribution (V_6):** Hansen (1980) and others have recorded the importance of water distribution to bighorn sheep use. Water distribution is measured by placing a 1.0 mile radius zone around each water source in the use area. Determine the percent of the total use area covered by the 1.0 mile radius zones. This percent is the value applied, e.g., 80 percent coverage equals 0.8.

Forage SI

It would be nice if the value of a given forage area could be determined through production of a given species without modification. Wehausen (1983) and others have documented that bighorn sheep use a broad spectrum of plant communities, therefore precluding use of just the Soil Conservation Service's ecological sites with a base value. Several variables must be considered in assessing Bighorn sheep foraging areas. The Forage SI is derived using $(SIV_3 + SIV_5 + SIV_7 + SIV_8)/4$.

1. **Forage Areas (V_7):** Plant communities and their associated ecological sites have been developed for each Major Land Resource Area (MLRA) in the state of Nevada. Each of these plant communities is given a base value using its position on the landform, and percent preferred forage as well as vegetation height under normal circumstances (Appendix 2). The SI for the forage area is determined by locating which MLRA the area is in and using the appropriate plant community listed. Record the base value for the plant community being evaluated. For example, if a forage area is a seasonally wet meadow (SCS MLRA29 number 029X044N Wetland 3-12" p.z.) the rating would be 1.0. This rating is given because this community, under optimal conditions, provides the preferred forage (Dealy, Leckenby and Concannon 1981).

2. **Seral Stage or Condition (V_8):** The base value of the forage available is adjusted by seral stage if ecological sites are used or condition if broad vegetation types are mapped as follows:

Ecological Sites	Vegetation Types	Value
Potential Natural Community (PNC)	Excellent	1.0
Late Seral	Good	0.75
Mid Seral	Fair	0.50
Early Seral	Poor	0.25

Human Use Conflicts SI (V_9)

Impacts of human use on bighorn sheep habitat use are well documented (Dobel 1985, Golden and Tsukamoto 1980, Hansen 1980, and Wilson et al. 1980). The human use conflicts SI is determined using the word model (Table 4) and its base values. Percent of each plant community impacted specifically by roads or fences is also stated for a base score.

Domestic Livestock Use Conflicts SI (V_{10})

The parameters for this variable were established using (Golden and Tsukamoto 1980; Hansen 1980; Jessup 1985; Kistner 1982; McQuivey 1978; Van Dyke et al. 1983; Wilson 1978; Wilson et al. 1980; and Wishart 1978). The SI for this variable is determined using the graph shown on Figure 3. Distances are measured from the boundary of the use area.

Intrasystem Relationships

Figure 4 illustrates the relationship of bighorn life requisites and plant communities. Figure 4 also introduces the derived variables which are the weighted indices.

1. **Weighted Indices (Derived Values)**: Steps used to determine each of the weighted indices are the same. As an example we will use the Cover SI.

    1. Multiply the area of each plant community by its respective SI value.

2. Sum these products.

3. Divide the sum by the total area for all plant communities.

The result is the WCI. Perform the same steps to obtain the WFI, WWI, WHI, and WSI.

Habitat Suitability Rating (HSR)

The HSR is determined by calculating the geometric mean of the WCI, WFI, WWI, WHI, and WSI values. The equation for this is shown on Figure 4.

Approximating Carrying Capacity

The carrying capacity is calculated for the use area as follows:

1. Convert the total area from acres to square miles.

2. Using the literature or experience determine the optimum number of bighorns per square mile one would expect to find in optimum habitat in this location.

3. Multiply the HSR times the Total Square Miles (TSM) times the Optimum Carrying Capacity (OCC). Therefore: HSR X TSM X OCC = Carrying Capacity for the area evaluated, as it occurs now. Habitat improvements or degradation would cause the carrying capacity to change.

Special Considerations:

1. **Weighted Indices Which Equal Zero**: Use of a geometric mean to determine the HSR precludes evaluating plant communities, or areas having a zero value. For example: If domestic sheep grazing occurs on the boundary of the use area, the cover types and plant communities along the boundary will have to be used as a buffer zone. The wildlife biologist will then have to decide if the buffer zone will work or if no bighorn use is possible at this time.

2. **Lack of Water:** If a plant community lacks water the area may still be available as winter habitat. The wildlife biologist will have to decide if the area will suffice as marginal habitat or if pre-reintroduction water development is necessary.

3. **Common Sense:** Although this system will be computerized, the wildlife biologist cannot eliminate common sense. The wildlife biologist must use the results as an aid to make a final realistic decision.

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APPENDIX ONE

Table 1. Topography (V_1) Description Providing Base Values Used in Classifying Cover.

Value	Description
0.0	Level of slightly undulating (1-3% slope), 100% of area. (Example: dry lake beds and their margins, blue clay, or slick rock); more than 1.6 km (1 mi) rom steep and rocky terrain. (Alluvial Flat, Alluvial Plain, Sand Sheet, Beach Plain, Lake Plain, Axial-Stream Floodplain, Playa) *
0.2	Level or gently undulating (5-8% slope), 100% of area within 1.6 km (1 mi) of steep and rocky terrain. (Fan Piedmont and Mountain Valley Fans) *
0.4	Rolling hills (8-16% slope), such as alluvial fans, without washes or 4.6 m (15 ft.) wide and/or more than 1.6 km (1 mi) from steep and rocky terrain. (Alluvial Fans particularly Fan Collars and Fan Aprons) *
0.6	Rolling hills (18-30% slope) broken frequently by broad washes and within 1.6 km (1 mi) of steep and rocky terrain. (Ballenas and Erosional Fan Remnants) * (Bedding Cover)
0.6	Mesa-type terrain. (Bedding Cover)
0.7	Steep and rocky (60%+ slope), 100%; no washes. (Mountain Valley Fans) * (Bedding and Escape Cover)
0.8	Steep and rocky terrain (60%+ slope) with washes, 50 to 90%; plus level or rolling hills, 10 to 50%. (Bounding Mountains) ** (Bedding and Escape Cover)
0.9	Steep and rocky terrain (60%+ slopes), broken frequently by washes of varying widths, with at least one main wash about 15 m (50 ft) wide, and side washes at various angles for protection from the weather and for escape. (Bounding Mountains) ** (Bedding and Escape Cover)
1.0	Steep broken escarpments (60%+ slope) or rock outcrops at least 5.0 acres in size with traversable terraces - lambing cover (Bounding Mountains) **

**Major landform components described by Peterson 1981*

***Landforms not yet completely described.*

Table 2. Amount and Permanence of Water (V_2) Descriptions Used to Evaluate Each Water Source

Value	Description
0.1	Water lacking greater than 75 percent of all years, present mainly in winter (ephemeral).
0.4	Dry in summer in 50 to 75 percent of all years.
0.6	Dry in summer in 25 to 50 percent of all years.
0.8	Dry in summer less than 25 percent of all years.
1.0	Sufficient and always present (Perennial).

Table 3. Interspecific Competition For Water (V_4) Is Determined Using the Descriptions Provided.

Value	Description
0.0	Frequent domestic livestock at a point source.
0.1	Some domestic cattle use at a point source.
0.2	Some native or feral horse and burro use at a point source.
0.5	More native big game use other than bighorn at a point source, or moderate, feral animal and big game use along a stream.
0.7	Some big game use other than bighorn but mostly bighorn at a point source or some feral animal and big game use along a stream.
1.0	Only bighorn use.

From: Sands, A. 1976

Table 4. Human Use Conflicts (V_9) Are Described For Comparison To The Area Being Evaluated.

Value	Description
0.0	High density human use and/or economic potential. Roads or fences impact 50% of the plant community.
0.1	Medium to low density human use and/or economic potential, unrestricted. Impacts 45% but <50%.
0.2	Medium density human use and/or economic potential with some restrictions. Impacts 40% but <45%.
0.3	High density human use restricted, and medium economic potential, all with some emphasis on bighorn. Impacts 35% but <40%.
0.4	Medium density human use restricted, and low or no economic potential. Impacts 30% but <35%.
0.5	Planned development for wildlife with some unrestricted human use and with some degree of economic potential or value. Impacts 25% but <30%.
0.7	Medium density human use with restrictions and no economic potential. Impacts 20% but <25%.
0.8	Low density human use restricted, and low or no economic potential. Impacts 5% but <20%.
0.9	Almost no human use and no economic potential. Impacts 10% but <5%.
0.9	Park Situation.
1.0	Planned development for bighorn, with human use where and when consistent with bighorn use. No adverse impacts due to roads or fences.

Figure 1. The SI For Distance From Escape Cover (V_3) Is Determined By Equating the Distance with the Appropriate SI.

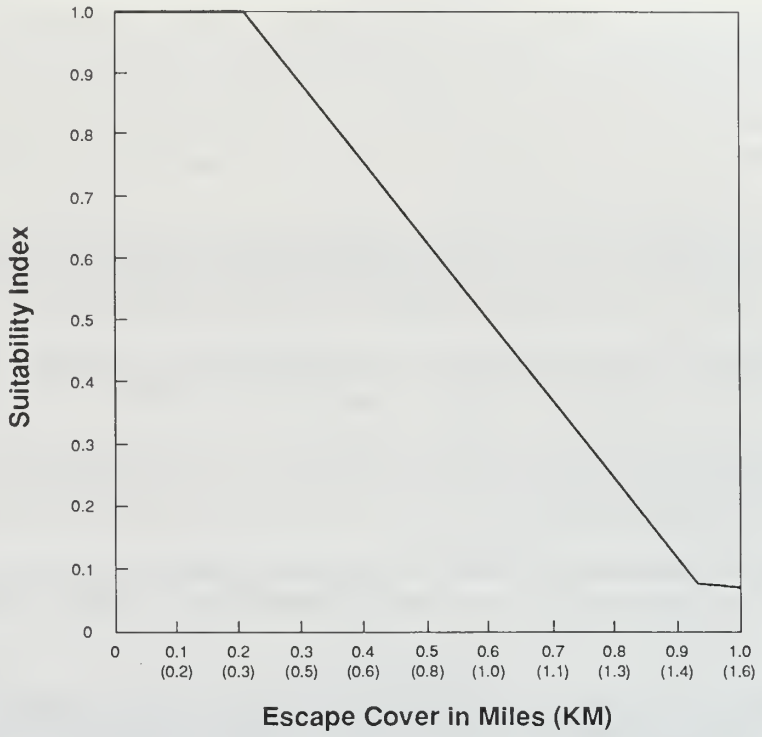


Figure 2. Visual Obstruction Is Evaluated By Relating The Percent Obstruction To The Appropriate SI.

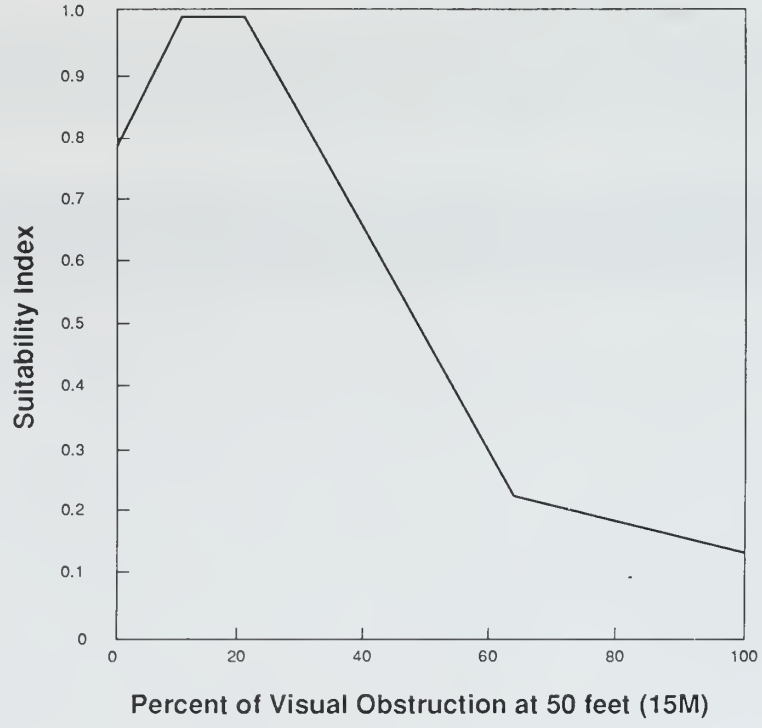


Figure 3. Domestic Sheep Conflicts (V_{10}) SI Is Derived By Equating The Distance Of Separation With The Appropriate Score.

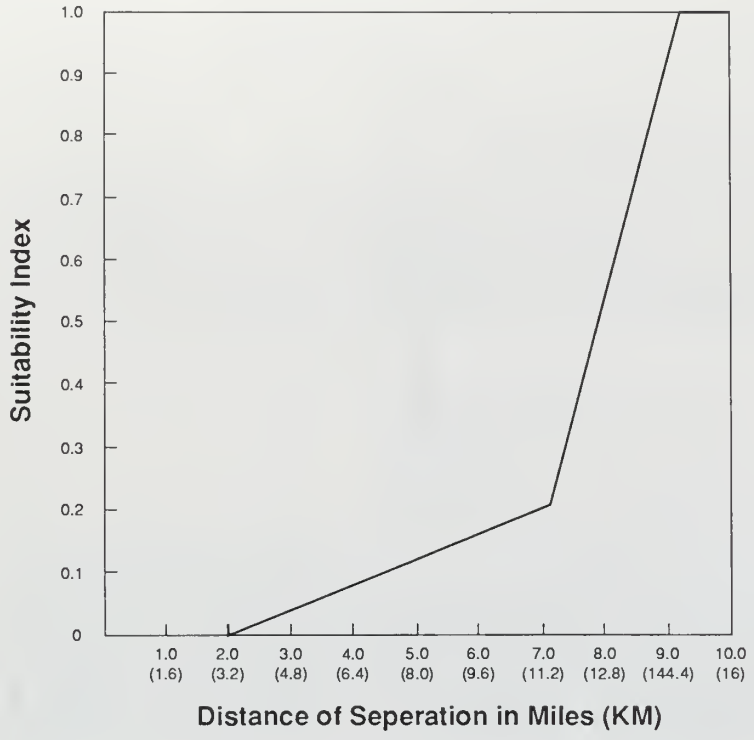
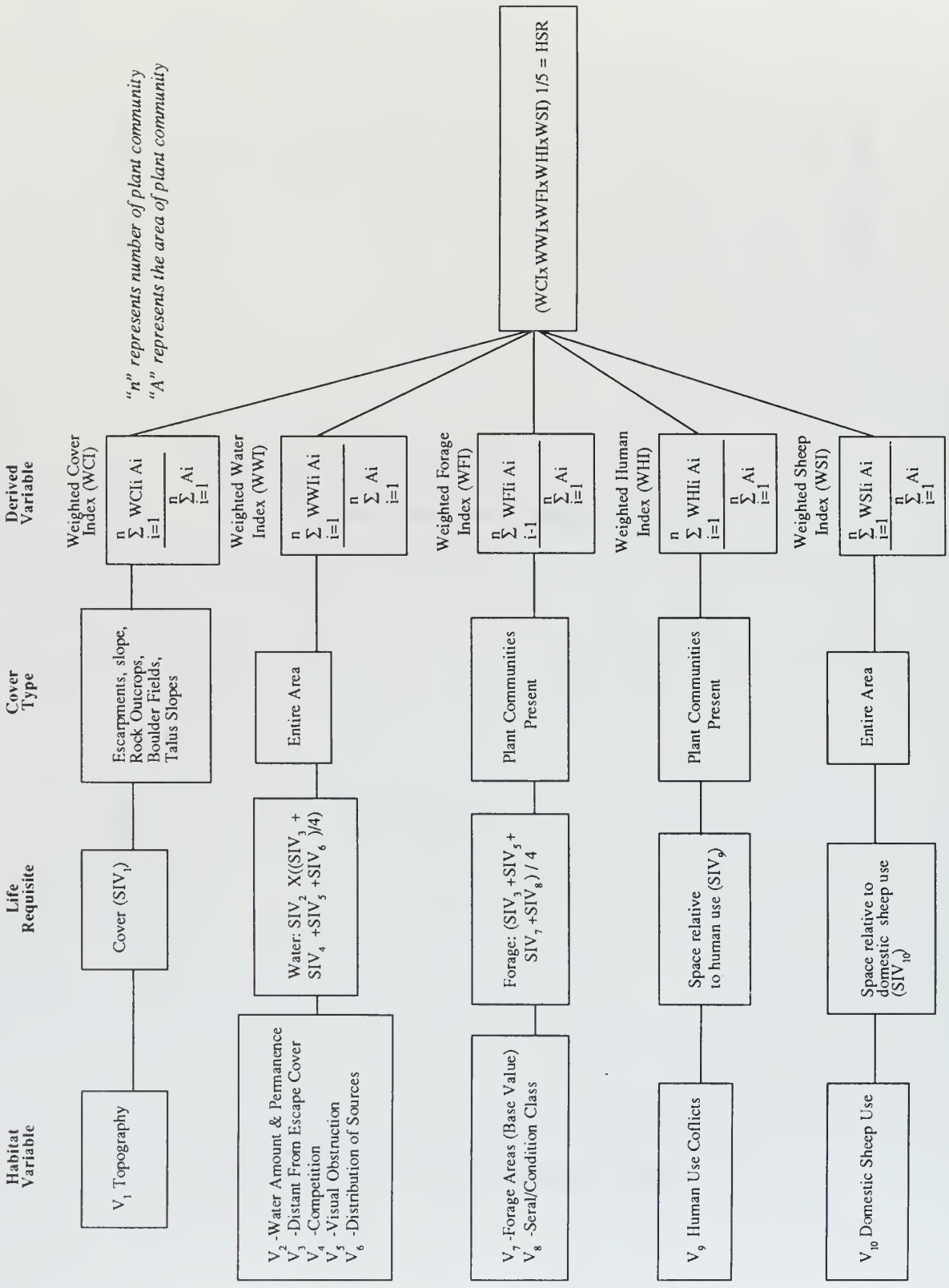


Figure 4. Relationship of habitat variables, life requisites, cover types and derived variables to the habitat suitability rating (HSR) for desert bighorn sheep.



APPENDIX TWO

BIGHORN SHEEP BASE FORAGE RATING BY MAJOR LAND RESOURCE AREA

Base Value	Plant Communities with Applicable Ecological Sites MLRA27 *
0.9	Scab sagebrush/Bunchgrass 027X051N Eroded Slope 8-10" p.z. 027X070N Channery Hills 8-10" p.z.
0.9	Low sagebrush/Bunchgrass 027X020N Claypan 8-10" p.z. 027X046N Claypan 10-12" p.z. 027X049N Claypan 8-10" p.z. (s) 027X068N Shallow Granitic Upland 8-10" p.z.
0.9	Black sagebrush/Bunchgrass 027X032N Shallow Calcareous Loam 8-10" p.z. 027X048N Chalky Knolls 8-10" p.z. 027X061N Shallow Calcareous Loam 6-8" p.z. 027X066N Breaks 6-12" p.z..
0.8	Meadow, permanently wet 027X004N Wet Meadow 4-14" p.z.
0.8	Wyoming big sagebrush/Bunchgrass 027X007N Loamy Slope 8-10" p.z. 027X008N Loamy 8-10" p.z. 027X011N South Slope 8-10"p.z. 027X045N Sandy 8-10"p.z. 027X065N Droughty Slope 8-10"p.z. 027X067N Droughty Loam 8-10"p.z. 027X072N Granitic Slope 8-10" p.z.
0.8	Mountain big sagebrush/Bunchgrass 027X058N Loamy 10-12" p.z. 027X073N Granitic Slope 12-14" p.z.
0.7	Basin big sagebrush/Bunchgrass 027X029N Wash 8-10" p.z. 027X054N Loamy Slope 10-12" p.z.
0.5	Riparian 027X002N Moist Floodplain 4-8" p.z.

* Forage ratings have been established for MLRAs 23 through 30, and are available from authors.

Base Value	Plant Communities with Applicable Ecological Sites MLRA27
0.3	Shadscale saltbush/Bunchgrass 027X013N Loamy 4-8" p.z. 027X017N South Slope 4-8" p.z. 027X019N Shallow Stony Loam 4-8" p.z. 027X028N Loamy Slope 6-8" p.z. 027X071N Shallow Silty 4-8" p.z.
0.3	Shadscale saltbush/Bailey greasewood/Bunchgrass 027X015N Very Stony Loam 4-6" p.z. 027X018N Gravelly Loam 4-6" p.z. 027X027N Shallow Slope 4-8" p.z. 027X030N Gravelly Loam 6-8" p.z. 027X043N Gravelly Loam 3-6" p.z.
0.3	Fourwing saltbush/Bunchgrass 027X009N Sandy 5-8" p.z. 027X023N Dunes 4-8" p.z. 027X053N Dunes 8-10" p.z. 027X060N Sandy 3-5" p.z.
0.3	Winterfat/Bunchgrass 027X014N Silty 6-8" p.z.
0.3	Anderson wolfberry/Bunchgrass 027X047N Shallow Granitic Upland 4-8" p.z.
0.3	Bailey greasewood/Rubber rabbitbrush/Bunchgrass 027X022N Wash 4-8" p.z.
0.1	Black greasewood/Bunchgrass 027X005N Wet Sodic Bottom 4-8" p.z. 027X006N Saline Bottom 4-8" p.z. 027X012N Sodic Sands 4-8" p.z. 027X016N Sodic Dunes 4-8" p.z. 027X024N Sodic Terrace 4-8" p.z. 027X025N Sodic Flat 4-8" p.z. 027X036N Sodic Flat 3-6" p.z. 027X041N Deep Sodic Fan 4-8" p.z. 027X044N Saline Flat 5-8" p.z.

50272 - 101

REPORT DOCUMENTATION PAGE	1. Report No. BLM/YA/PT-88/007+6600	2.	3. Recipient's Accession No.

4. Title and Subtitle
Habitat Suitability Rating System for Desert Bighorn Sheep in the Basin and Range Province.

5. Report Date
September 1988

6.

7. Author(s)
Donald J. Armentrout and William R. Brigham

8. Performing Organization Rept. No.
TN 384

9. Performing Organization Name and Address
U.S. Department of the Interior
Bureau of Land Management Service Center
P.O. Box 25047
Denver, CO 80225-0047

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U.S. Department of the Interior
Bureau of Land Management Service Center
P.O. Box 25047
Denver, CO 80225-0047

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

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17. Document Analysis a. Descriptions
Models 1402

b. Identifiers/Open-Ended Terms
Desert Bighorn Sheep
Ovis Canadensis Nelsoni
Habitat Suitability Index Model
Habitat Carrying Capacity
Habitat Evaluation System

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release Unlimited	Unclassified	22
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse*

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

GPO 573-003/93003