Appendix C. Example Application of Model for the Red-tailed Hawk

C.1 Introduction. This appendix provides a sample data set which has been applied to the red-tailed hawk model (Appendix B) to calculate a Habitat Suitability Index. The data set is hypothetical and to some degree represents a realistic model application.

A hypothetical project area has been used to facilitate this application, consisting of 1,600 ha (4,000 ac) of available habitat for the red-tailed hawk. This is comprised of 1,000 ha (2,500 ac) of deciduous forest and 600 ha (1,500 ac) of grassland. Example data (Table C-1) are presented for three sample sites in forest and two sites in grassland cover types. The symbol "N/A" in Table C-1 indicates a specific variable which does not apply to the HSI model in that cover type.

Table C-1. Example field data for hypothetical project area.

	Variable	Sites				
		Forest			Grassland	
		1	2	3	1	2
V_1	% herbaceous canopy cover	N/A	N/A	N/A	20%	42%
V_2	% of herbaceous vegetation that is 8 to 46 cm (3 to 18 in) tall	N/A	N/A	N/A	10%	18%
V_3	Number of trees $\geq$ 25 cm (10 in) dbh per 0.4 ha (1 ac)	N/A	N/A	N/A	1	2
V_4	% tree canopy closure	65%	80%	35%	N/A	N/A
V_5	Number of trees $\geq$ 50 cm (20 in) dbh per 0.4 ha (1 ac)	4	12	2	N/A	N/A

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HSI determination for a multi-cover type species, such as the red-tailed hawk, consists of three major steps: 1) Life requisite values must be determined for each cover type; 2) interspersion of life requisites must be considered; and 3) the relationship of life requisites to HSI must be defined.

These three steps are outlined in detail below.

C.2 Step 1. Calculate life requisite values in each cover type.

A. Example field data are entered for all sites in Figs. C-1 and C-2, Block 9. Mean values for field data from each variable are then calculated and entered in Block 10. Suitability Index (SI) values are determined for each variable by applying this mean value to the Suitability Index Curves provided in the HSI model. The resulting SI value is entered in Block 11.

B. Life requisite values are determined by entering the mean SI value into the appropriate aggregation functions, as provided in the HSI model and also displayed in Block 13. The computed life requisite values are entered in Block 14. For single cover type users, HSI equals the lowest life requisite value, and is entered in Block 15. For multi-cover type species life requisite values are computed and recorded (Figs. C-1 and C-2) by cover type. The life requisite values for each cover type are summarized in Fig. C-3. Additional calculations (Figs. C-4 to C-7) are required to integrate life requisite values from each cover type through consideration of interspersion parameters.

C.3 Step 2. Consider interspersion of life requisites

Two additional factors must be considered before an HSI can be determined: 1) The distance between cover types must be considered when one or more cover types is missing a life requisite. If the distance between life requisites exceeds the ability of the species to obtain them, then there is effectively less useable area of the habitat. 2) The relative amount (% area) of cover types actually providing each life requisite must be considered. These two factors are quantitatively considered and an HSI calculated using the forms in Figs. C-4 through C-7.

Figure C-4 is used to assess the distance between cover types and to compute an interspersion index. A separate form is used for each cover type that is missing a life requisite. In this example, the project area

consists of two cover types, both of which are used by the red-tailed hawk. The deciduous forest cover type provides all life requisites for the hawk whereas grassland provides only food. To determine the distance from grassland (food) to forest (reproduction), random points are selected in grassland, and a measurement is taken from each point to the edge of the nearest deciduous forest. These measurements are recorded in the upper right hand portion of Block 9 in Fig. C-4. Each of these distance measurements is then entered into the suitability index curve titled "Distance between cover types" in the red-tailed hawk model. The resulting index value is recorded in the lower right hand portion of Block 9. These index values are then averaged to produce the average interspersion index which is recorded in Block 10 and Block 11.

The average interspersion index is used to modify the relative amount (%) of each cover type to determine the effective amount of useable area (%) as shown in Fig. C-5. The area of each cover type used by the red-tailed hawk is recorded in Block 7 of Fig. C-5, and the relative area (%) of each is calculated and noted in Block 9. The relative area (%) is multiplied by the interspersion index to determine the useable area (%) for each cover type which is recorded in Block 11.

To determine the overall life requisite value, the useable area (%) of each cover type must be integrated with the life requisite quality for each cover type. Fig. C-6 shows the computations used to determine the overall life requisite value for food for the red-tailed hawk in all cover types. Cover types are listed in Block 7, useable area (%) in Block 8, and life requisite values for each cover type in Block 9. For each cover type, the value in Block 8 is multiplied by the value in Block 9 to yield a percent. These percents are then summed and recorded in Block 11 as % area in equivalent optimal condition. The total % area in equivalent optimal condition is entered into the suitability index curve titled "Percent area in equivalent optimum food" in the red-tailed hawk model to determine the overall life requisite value for food, which is recorded in Block 12.

Fig. C-7 shows the calculations to determine the overall reproductive life requisite value for the red-tailed hawk.

C.4 Step 3. Determine relationships of life requisite values to HSI

The final step in applying the red-tailed hawk model is to determine the relationship of the life requisite values to the HSI. For this model, this determiantion is based on the limiting factor concept, and it is assumed that the HSI is equal to the lowest of the overall life requisite values. The HSI for the red-tailed hawk using the data in this hypothetical project area is thus equal to the food value, which is 0.59.

1. Study Hypothetical Project Area	2. Proposed action Baseline
3. Evaluation species Red-tailed hawk	4. Sample date
5. Target year 0	6. Cover type - Deciduous Forest

7. Habitat use pattern Multi-cover type species

8. Variable	9. Sample site value								10. Mean value	11. SI value
	1	2	3	4	5	6	7	8		
V_4	65	80	35						60	0.8
V_5	4	12	2						6	0.6

Life requisite value computations

12. Life requisite	13. Aggregation function	14. Computed life requisite value
Food	V_4 x 0.6)	0.48
Reproduction	V_5	0.6

15. For Single cover type users, HSI = Lowest life requisite value = _____

16. For multi-cover type users, use Forms 2, 3, 4, and 5 to compute HSI.

Figure C-1. Form 1. Tabulation form: Determination of HSI for single cover type species or determination of life requisite values by cover type for multi-cover type species.

1. Study Hypothetical project area	2. Proposed action Baseline
3. Evaluation species Red-tailed hawk	4. Sample date
5. Target year 0	6. Cover type Grassland
7. Habitat use pattern Multi-cover type user	

8. Variable	9. Sample site value								10. Mean value	11. SI value
	1	2	3	4	5	6	7	8		
V_1	20	42							31	0.45
V_2	10	18							14	0.3
V_3	1	2							1.5	0.75

Life requisite value computations

12. Life requisite	13. Aggregation function	14. Computed life requisite value
Food	$(V_1^2 \times V_2 \times V_3)^{1/4}$	0.46

15. For single cover type users, HSI = Lowest life requisite value = _____

16. For multi-cover type users, use Forms 2, 3, 4, and 5 to compute HSI.

Figure C-2. Form 1. Tabulation form: Determination of HSI for single cover type species or determination of life requisite values by cover type for multi-cover type species.

1. Study Hypothetical project area	2. Proposed action Baseline		
3. Evaluation species Red-tailed hawk		4. Sample date	5. Target year 0

Fill in the matrix below with cover types and life requisite values summarized from Form 1, for all available cover types used by the species. If any life requisite is not present, or present at a 0.0. value in all cover types, the HSI = 0.0. If life requisites are all present at > 0.0, continue with Forms 3, 4, and 5.

	6. Life requisite category							
7. Cover type	Food Value	Reproduction Value						
Deciduous Forest	0.48	0.6						
Grassland	0.46	NA						

Figure C-3. Form 2. Summary of life requisite values for multi-cover type species.

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1. Study Hypothetical project area
2. Proposed Action Baseline
3. Evaluation Species Red-tailed hawk
4. Sample date
5. Target year 0
6. Cover type Grassland

7. Cover type(s) providing life requisite(s).	8. Life Requisite(s) Provided	9. Display of distance measurements and corresponding interspersion indices.										10. Average of indices in each row of column 9.
		1	2	3	4	5	6	7	8	9	10	
Deciduous Forest	Reproductive	1.0 km / 1.0	1.6 km / 0.83	0.8 km / 1.0	4.3 km / 0.0	3.0 km / 0.25						0.62

11. Interspersion Index = 0.62

Figure C-4. Form 3. Determination of interspersion index for multi-cover type species.

Appendix C. Example Application of Model for the Red-tailed Hawk

1. Study Hypothetical project area			2. Proposed Action Baseline	
3. Evaluation Species Red-tailed hawk		4. Date		5. Target year 0
6. Cover type	7. Area of Cover Types	9. Relative Area (%)	10. Interspersion Index (from Form 3) for each cover type	11. Useable Area (%)
Deciduous Forest	2,500	62.5%	1.0	62.5%
Grassland	1,500	37.5%	0.62	23%
8. Σ =	4,000			

Figure C-5. Form 4. Determination of Useable Area (%).

Appendix C. Example Application of Model for the Red-tailed Hawk

1. Study Hypothetical project area		2. Proposed Action Baseline	
3. Evaluation Species Red-tailed hawk		4. Date	
5. Target year 0		6. Life Requisite Food	
7. Cover Type	8. Useable Area (%) (Form 4)	9. Life Requisite Value (Form 2)	10. Column 8 x Column 9
Deciduous Forest	62.5%	0.48	30%
Grassland	23%	0.46	11%
		11.% Area in equivalent optimal condition =	41%

12. Overall life requisite value = .59

HSI Determination. The HSI is equal to the lowest of the overall life requisite values (from Block 12 of each Form 5 used).

HSI = .59

Figure C-6. Form 5. Determination of overall Life Requisite Values and HSI

Appendix C. Example Application of Model for the Red-tailed Hawk

1. Study Hypothetical project area		2. Proposed Action Baseline	
3. Evaluation Species Red-tailed hawk		4. Date	
5. Target year 0		6. Life Requisite Reproduction	
7. Cover Type	8. Useable Area (%) (Form 4)	9. Life Requisite Value (Form 2)	10. Column 8 x Column 9
Deciduous Forest	62.5%	0.6	37.5%
		11. % Area in equivalent optimal condition =	37.5%

12. Overall life requisite value = 1.0

HSI Determination. The HSI is equal to the lowest of the overall life requisite values (from Block 12 of each Form 5 used).

HSI = .59

Figure C-7. Form 5. Determination of overall Life Requisite Values and HSI