Habitat Evaluation Procedures Report
Carl Property – Yakama Nation

February 2008

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Abstract

A baseline habitat evaluation procedures (HEP) analysis was conducted on the Carl property (160 acres) in June 2007 to determine the number of habitat units to credit Bonneville Power Administration (BPA) for providing funds to acquire the property as partial mitigation for habitat losses associated with construction of McNary Dam.

HEP surveys also helped assess the general ecological condition of the property. The Carl property appeared damaged from livestock grazing and exhibited a high percentage of invasive forbs. Exotic grasses, while present, did not comprise a large percentage of the available cover in most areas. Cover types were primarily grassland/shrubsteppe with a limited emergent vegetation component.

Baseline HEP surveys generated 356.11 HUs or 2.2 HUs per acre. Habitat units were associated with the following HEP models: California quail (47.69 HUs), western meadowlark (114.78 HUs), mallard (131.93 HUs), Canada goose (60.34 HUs), and mink (1.38 HUs).

Introduction

The Yakama Nation (YN) acquired the 160 acre Carl property to supplement wetland restoration efforts. A HEP (USFWS 1980) analysis was conducted by the Columbia Basin Fish and Wildlife Authority's (CBFWA) Regional HEP Team (RHT) in 2007 to determine the number of habitat units (HUs) to credit BPA for providing the funds to acquire the property. Details and results of the HEP analysis are described in this report.

Study Area

General Description

Location

The Carl property is located on the Yakama Reservation approximately 8.5 miles southwest of Toppenish, Washington adjacent to Marion Drain Road at UTM[1] coordinates 10U 0693450E, 5132458N. The general property location is shown in Figure 1. Carl property boundaries are illustrated in Figure 2 while an aerial photograph of the parcel is depicted in Figure 3 (map products provided by T. Elliot –YN Wildlife Department).

[1] Universal Transverse Mercator

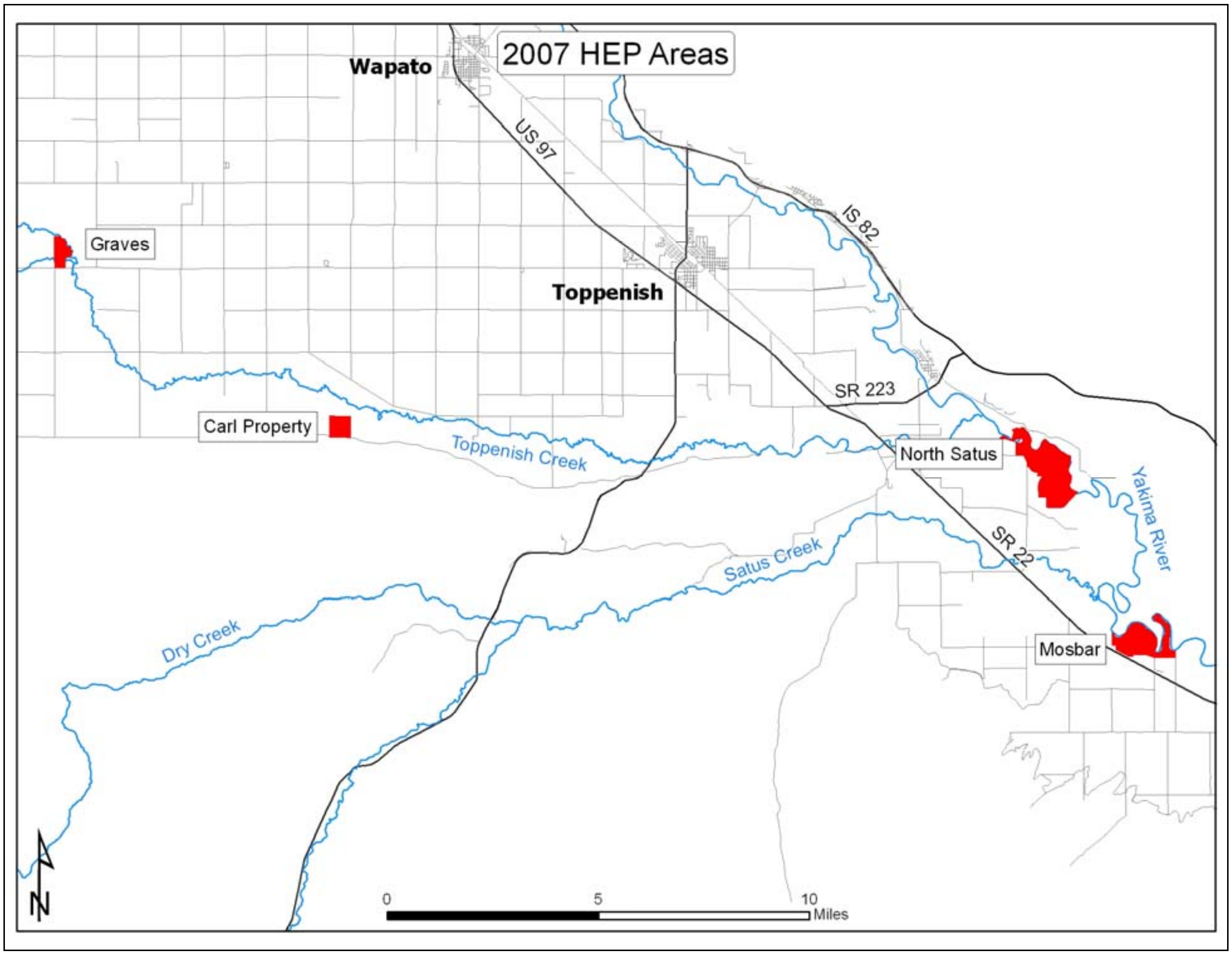

Figure 1. Project location map

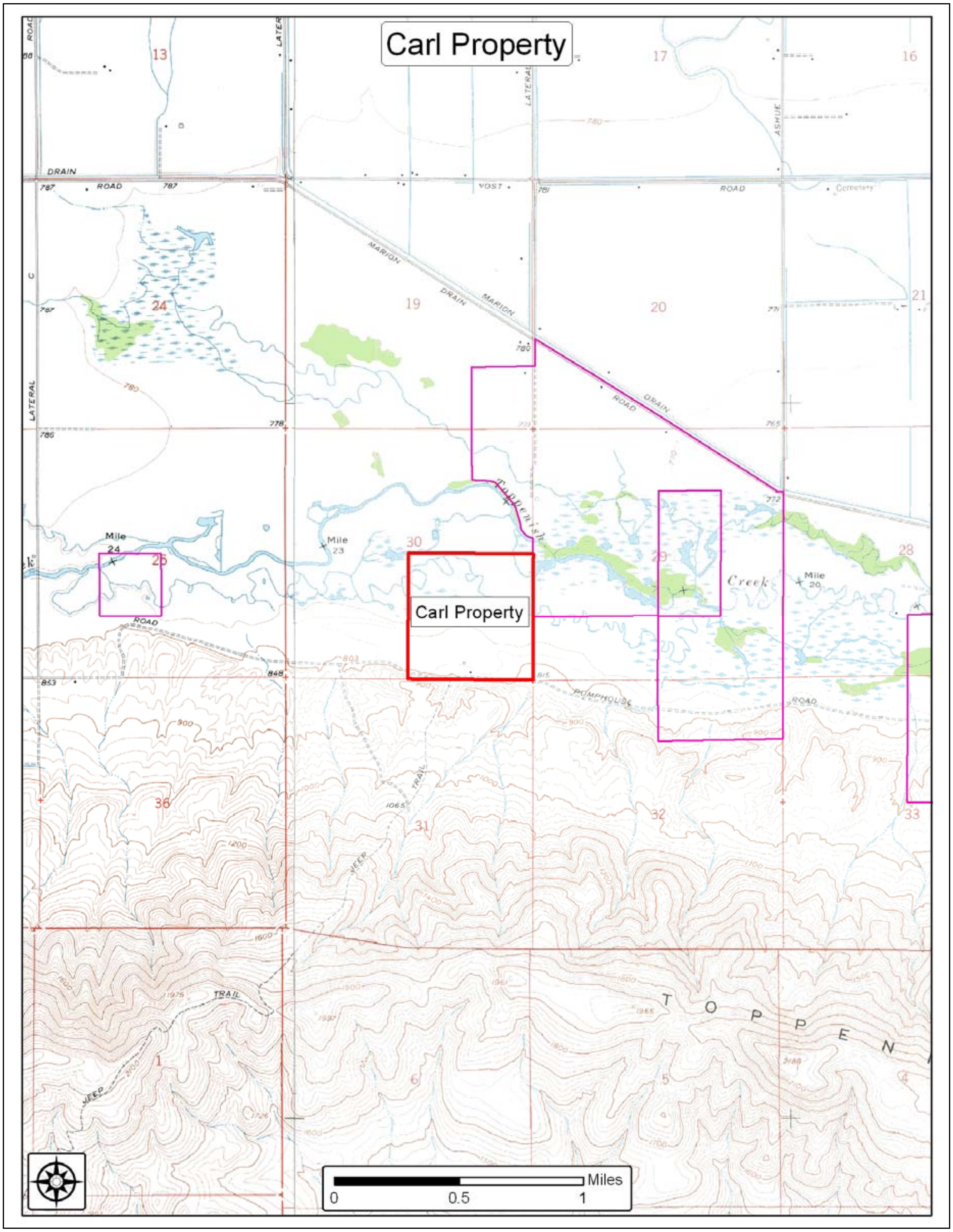

Figure 2. Carl property location

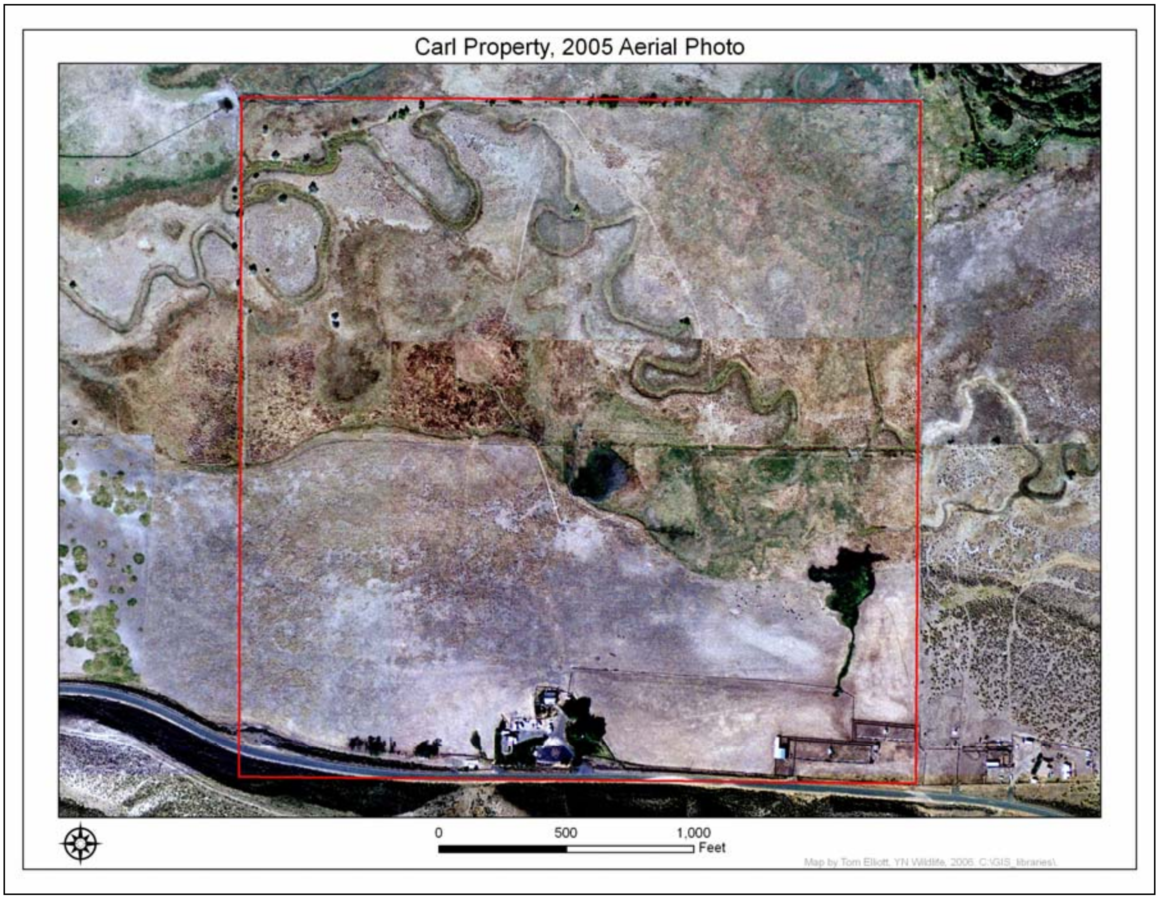

Figure 3. Aerial Photo of Carl Property

Topography

The terrain is primarily flat pasture with occasional seasonally flooded areas. Braided channels from Toppenish Creek wind through the property. Elevation is approximately 800 feet above sea level (Maptech Software ®).

Cover Types

The Regional HEP Team initially identified four major cover types including grassland, shrubsteppe, riparian herb, and emergent vegetation. Yakama Nation wildlife biologists, however, combined shrubsteppe and grassland cover types into a single cover type i.e., shrubsteppe (T. Hames, pers. comm.). Cover types and associated acres delineated by YN biologists are listed in Table 1 and illustrated in Figure 4.

Table 1. Yakama Nation Carl property baseline HEP cover type summary

Cover Type	Acres	Percent of Area
Shrubsteppe/Grassland	99	≈63
Riparian Herb	59	≈37
Emergent Vegetation (Emergent Wetland)	2	<1
Total	**160**	**100**

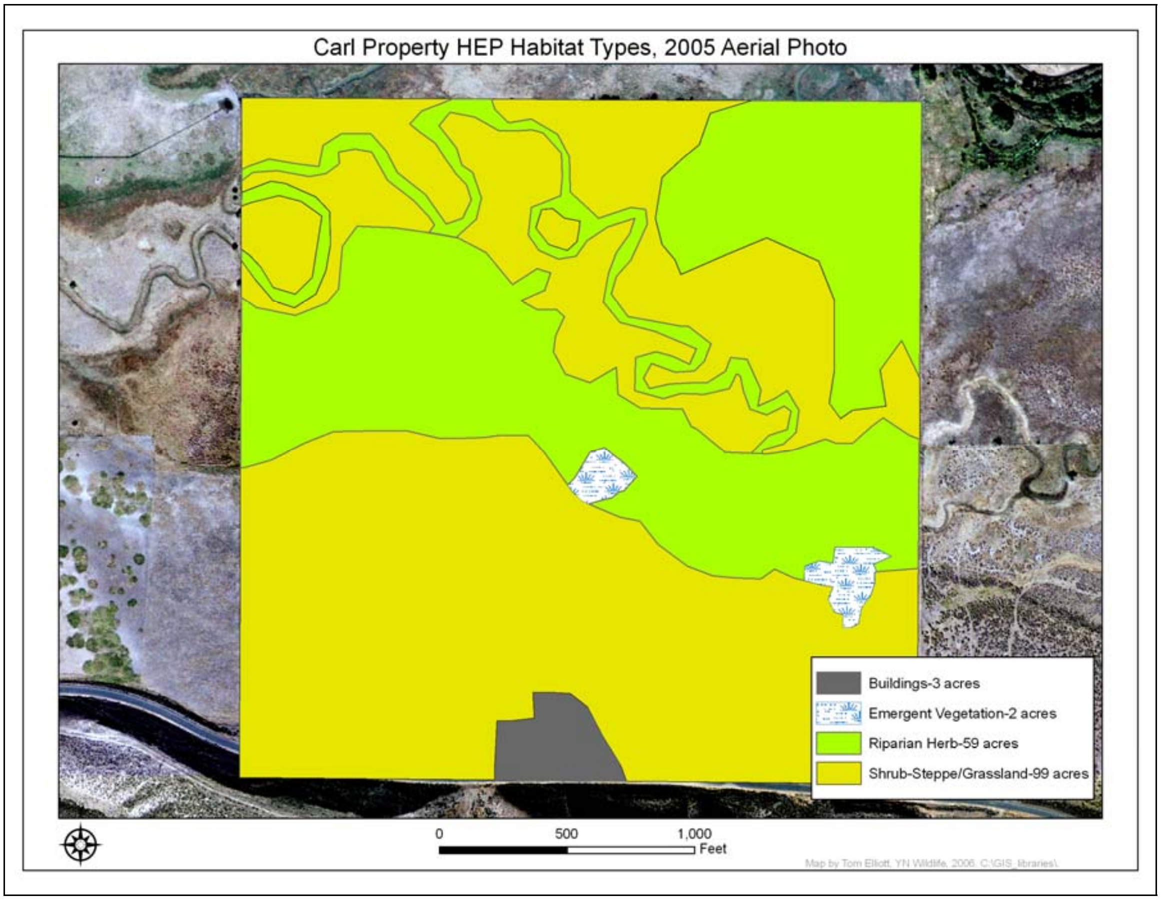

Figure 4. Cover type map

The Regional HEP Team "ground truthed" cover types in the field and reported boundaries between grassland (shrubsteppe) and riparian herb cover types were not distinct when HEP surveys were conducted in June 2007. Riparian herb appeared to be a mixed ecotone that included vegetative species from both grassland and riparian herb cover types. Vegetation composition and structure, however, appeared to be dominated by grassland herbaceous species.

As a result, riparian herb and grassland cover types were combined by the RHT and evaluated as grassland (shrubsteppe) for this baseline HEP analysis. Modified cover types/acres are listed in Table 2.

Table 2. Modified Carl property cover type summary

Cover Type	Acres	Percent of Area
Shrubsteppe/Grassland (includes riparian herb)	158	99
Emergent Vegetation (Emergent Wetland)	2	1
Total	**160**	**100**

Cover Type Descriptions

Although cover types were combined by the RHT and/or Yakama Nation Wildlife Department Biologists to facilitate HEP surveys, descriptions and photographs for shrubsteppe, riparian herb, and emergent vegetation cover types are included in the following paragraphs. Shrubsteppe components i.e., shrubland and grassland, are described separately.

Shrubsteppe

Shrubsteppe included both shrubland and grassland (steppe) components. Although considered a single cover type by YN wildlife biologists, the RHT defined the two components separately as follows.

Shrubland

The shrubland component was classified as having greater than 5% shrub cover and less than 5% tree canopy cover. All woody vegetation less than 16 feet tall was categorized as a shrub, regardless of species (it was assumed that trees less than 16 feet in height function more like shrubs rather than trees relative to wildlife needs). The RHT team observed only greasewood (*Sarcobatus vermiculatus*) on HEP transects (Figure 5). Although present on the project area, Russian olive (*Elaeagnus angustifolia*) was not detected on HEP transects.

Figure 5. Example of the shrubsteppe cover type

Grassland (steppe)

The grassland component was dominated by herbaceous vegetation with less than 5% shrub cover. Grass species included wildrye (*Elymus* spp.) and various native and introduced grass species. A number of forbs, most notably whitetop (*Cardaria draba*), buttercup (*Ranunculus* spp.), and fleabane (*Erigeron* spp.), were also present (Figure 6).

Figure 6. Example of a grassland cover type

Riparian Herb

The riparian herb cover type was comprised of upland and hydrophytic herbaceous species. Shrubs and trees were occasionally present in trace amounts (< 1% cover). The riparian herb cover type is shown in Figure 7.

Figure 7. Riparian herb cover type example.

Emergent Vegetation (Wetland)

The emergent vegetation cover type is characterized by partially submerged herbaceous vegetation located within a few small, seasonally flooded flats. Tall bulrush (*Scirpus* spp.) and reed canarygrass (*Phalaris arundinacea*) dominated the plant community (Figure 8).

Figure 8. Example of an emergent vegetation (wetland) cover type.

Methods

Habitat Evaluation Procedures

A habitat evaluation procedures analysis was conducted on the Carl acquisition to document baseline habitat conditions and to determine how many protection habitat units to credit BPA for providing funds to acquire the project site as partial mitigation for habitat losses associated with construction of McNary Dam. HEP, developed by the U.S. Fish and Wildlife Service (USFWS), is used to quantify the impacts of development, protection, and restoration projects/measures on terrestrial and aquatic habitats by assessing changes, both negative and positive, in habitat quality and quantity (USFWS 1980), (USFWS 1980a).

HEP is a habitat based approach to impact assessment that documents change through use of a habitat suitability index (HSI). The HSI value is derived from an evaluation of the ability of key habitat components to provide the life requisites of selected wildlife and fish species.

The HSI value is an index to habitat carrying capacity for a specific species or guild of species based on a performance measure (e.g. number of deer per square mile) described in HEP species models. The index ranges from 0.0 to 1.0. A HSI of 0.3 indicates that habitat quality/carrying capacity is marginal while a HSI of 0.7 suggests that habitat quality/carrying capacity is relatively good for a particular species (Table 3).

Table 3. Habitat suitability index verbal equivalency table.

Habitat Suitability Index	Verbal Equivalent
0.0 < 0.2	Poor
0.2 < 0.4	Marginal
0.4 < 0.6	Fair
0.6 < 0.9	Good
0.9 < 1.0	Optimum

Each increment of change is identical. For example, a change in HSI from 0.1 to 0.2 represents the same magnitude of change as a change from 0.2 to 0.3, and so forth. Habitat variables, suggested mensuration techniques, and mathematical aggregations of assessment results are included in HEP evaluation species models.

Habitat units are determined by multiplying the habitat suitability index by the number of acres of habitat (cover type) protected. For example, if the HSI output for a mule deer HEP model is 0.5 and the number of acres of shrubsteppe habitat protected is 100, then the number of HUs are 50 (0.5 HSI x 100 acres = 50 HUs).

HEP Model Selection

HEP model selection was based on habitat types and species models identified in the McNary Dam Loss Assessment (Rasmussen and Wright 1990) (Table 4). HEP species models included California quail (*Callipepla californica*), western meadowlark (*Sturnella neglecta*), mallard (*Anas platyrhynchos*), Canada goose (*Branta canadensis*), downy woodpecker (*Picoides pubescens*), yellow warbler (*Dendroica petechia*), spotted sandpiper (*Actitis macularia*), and mink (*Neovison vison*). Models were the same as those used in previous Yakama Nation wildlife mitigation projects and are included in Bich et. al. (1991) and Appendix A. The Carl property cover type/species matrix is illustrated in Table 5.

Table 4. McNary Dam loss assessment cover type/species matrix.

HEP MODEL	McNARY DAM COVER TYPE/SPECIES MATRIX								
	Rip. Tree	Rip. Shrub	Rip. Herb	Sa/Gr/ Co/Mud[1]	Emergent Wetland	Shrub-steppe/ Grassland	Agricultural	Islands	Open Water - Riverine[2]
California Quail		X	X			X	X		
Canada Goose			X	X		X	X	X	
Mallard			X		X	X	X	X	X
Spotted Sandpiper				X					
Mink	X	X	X	X	X				
Western Meadowlark						X			
Yellow Warbler		X							
Downy Woodpecker	X								
TOTAL	2	3	4	3	2	4	3	2	1

[1] Sand, gravel, cobble, and mud cover type.

[2] The open water cover type (reservoir) also includes 10,955 mallard HU gains (80% of 13,744 HUs). This matrix, however, includes only loss assessment species.

Table 5. Graves cover type/species selection

Cover Type	Species
Shrubsteppe/Grassland	California quail, Canada goose, Mallard, Western Meadowlark
Emergent Vegetation/Wetland	Mallard, Mink

HEP Species Model Selection Rationale

Species selection rationale described in the Yakima Indian Nation Wildlife Mitigation Plan (Bich et. al. 1991) is recorded in Table 6. The Regional HEP Team slightly modified the rationale.

Table 6. HEP Selection Rationale

HEP Model	Rationale
Mallard	The mallard utilizes a broad range of shrubsteppe/grassland, riparian herb, and island habitats to some degree for nesting. Wetlands are necessary for brood reading while open water and agricultural areas provide winter resting and feeding.
Western meadowlark	A species common to shrubsteppe/grassland habitat.
Canada Goose	A migratory bird of national significance, sensitive to island nesting habitat and associated shoreline brooding areas.
Yellow Warbler	Represents species which reproduce in riparian shrub habitat and make extensive use of adjacent wetlands.
California Quail	A species commonly associated with brushy thickets, riparian shrubs, agricultural lands, and shrubsteppe/grasslands.
Mink	Carnivorous furbearer, feeds on a wide range of vertebrates. Uses shoreline and adjacent shallow water habitats.
Spotted Sandpiper	A representative of migratory shorebirds which utilizes sparsely vegetated islands, mudflats, shorelines and sand and gravel bars.
Downy Woodpecker	This woodpecker represents a species which feeds and reproduces in a tree environment. Its diet is primarily insects with some seeds and fruits. The downy woodpecker HEP model was selected to measure the riparian tree cover type.

Sampling Design and Measurement Protocols

Meta Data

Field surveys were conducted by the Columbia Basin Fish and Wildlife Authority Regional HEP Team with assistance from Yakama Nation biologist Tracy Hames. Cover maps were provided by GIS specialist Tom Elliot (YN). Regional HEP Team members included Paul Ashley (RHT Coordinator), Mike Catanese (Team Leader), Anthony Muse, Paul Walker, and Tiffany Baker (contact Paul Ashley at prashley@bpa.gov, or through CBFWA at: [503] 229-0191).

Funding for the HEP analyses was provided by the Bonneville Power Administration with RHT administrative support provided by CBFWA. Specific measurement techniques and protocols are described in detail in Appendix B. Measurements were recorded in standard U.S. units except for the Robel pole (Robel et al. 1975), which was recorded in metric units.

Transect Methods

In most cases, the Regional HEP team used measurement techniques and protocols described in HEP models to evaluate habitat variables; however, ocular estimations were used when direct measurements could not be taken. Measured techniques were occasionally modified to meet unique habitat and/or physiographic conditions. Metrics generally followed those described by Hays et al. (1981) and/or Avery (1994).

Stratified (by cover type), random transects were established and documented using global positioning system (GPS) coordinates and, in many cases, rebar stakes. Ashley (2006) described the methods and protocols used by Regional HEP Team staff to collect HEP model variable data and additional floristic information (Appendix B). Field data was summarized and applied to HEP model variables to determine habitat suitability indices and habitat units for each HEP species model. Field data collection and processing procedures are illustrated in Figure 9 and summarized as follows.

HEP model variable field data was entered onto Allegro CE® data logger spreadsheets (1), or recorded on paper data sheets (2). The raw field data (3) was downloaded from the data loggers or manually entered from paper data sheets onto computers (transect photos were also downloaded and stored on field computers). The raw data and photos were compiled for each transect into three basic products/files (4) that are provided to project managers as report appendices and/or separate CD files.

Product files included raw field data downloaded from the data loggers (5), data summary spreadsheets (6) which are the results of compiling/processing the raw data, and transect photo files (7). Summarized/processed data from each transect was applied to appropriate HEP model variables to determine suitability index (SI) ratings that were combined on habitat suitability index (HSI) spreadsheets (8) to determine the HSI for a particular HEP species model/cover type. The habitat suitability index was then multiplied by the number of cover type acres to determine the number of habitat units (9).

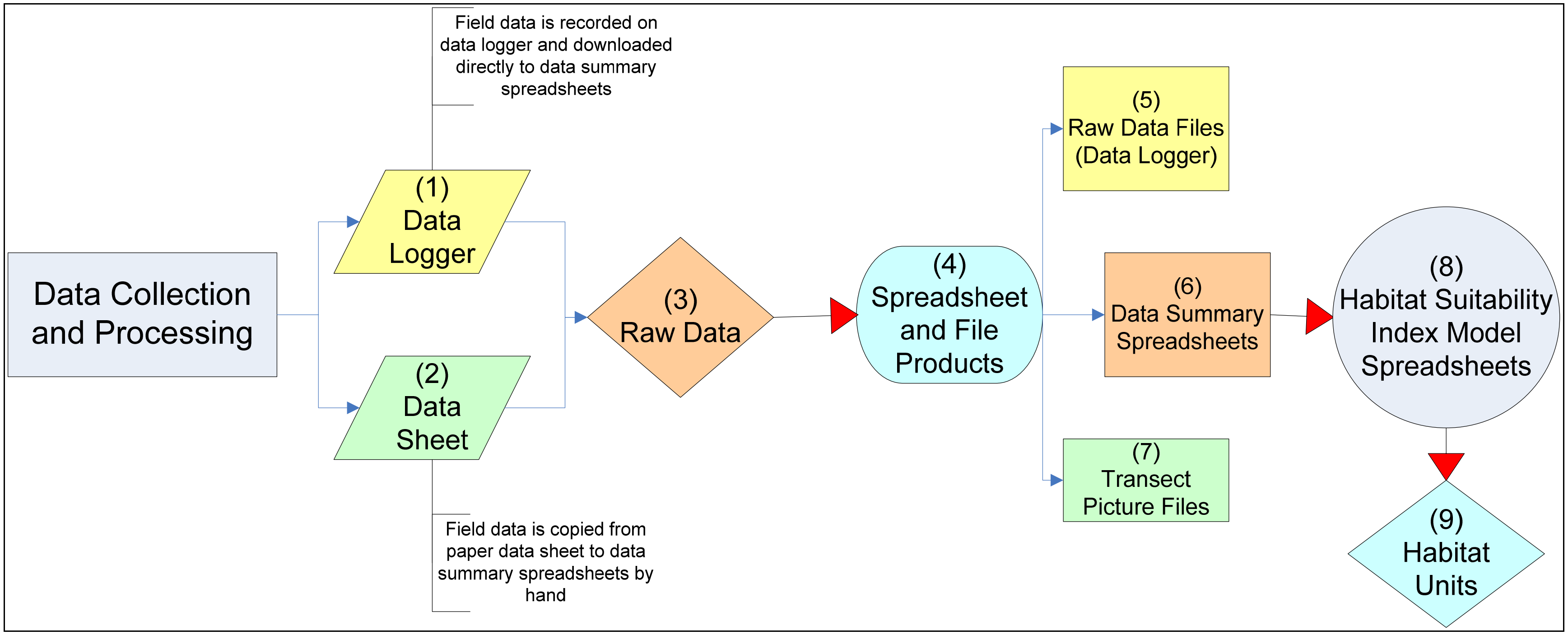

Figure 9. HEP data flow chart.

Transect Locations

Transect initial points (IPs) were established based on stratified random sampling protocols with cover types defining the strata. The number of samples initially allocated per cover type strata were determined based on a proportional allocation strategy (Husch et al. 2003). Specific IP locations were identified by overlaying a 100m x 100m grid over cover types and selecting random numbers to identify "XY" point coordinates (P. Ashley, pers. comm.). Random IPs are illustrated in Figure 10.

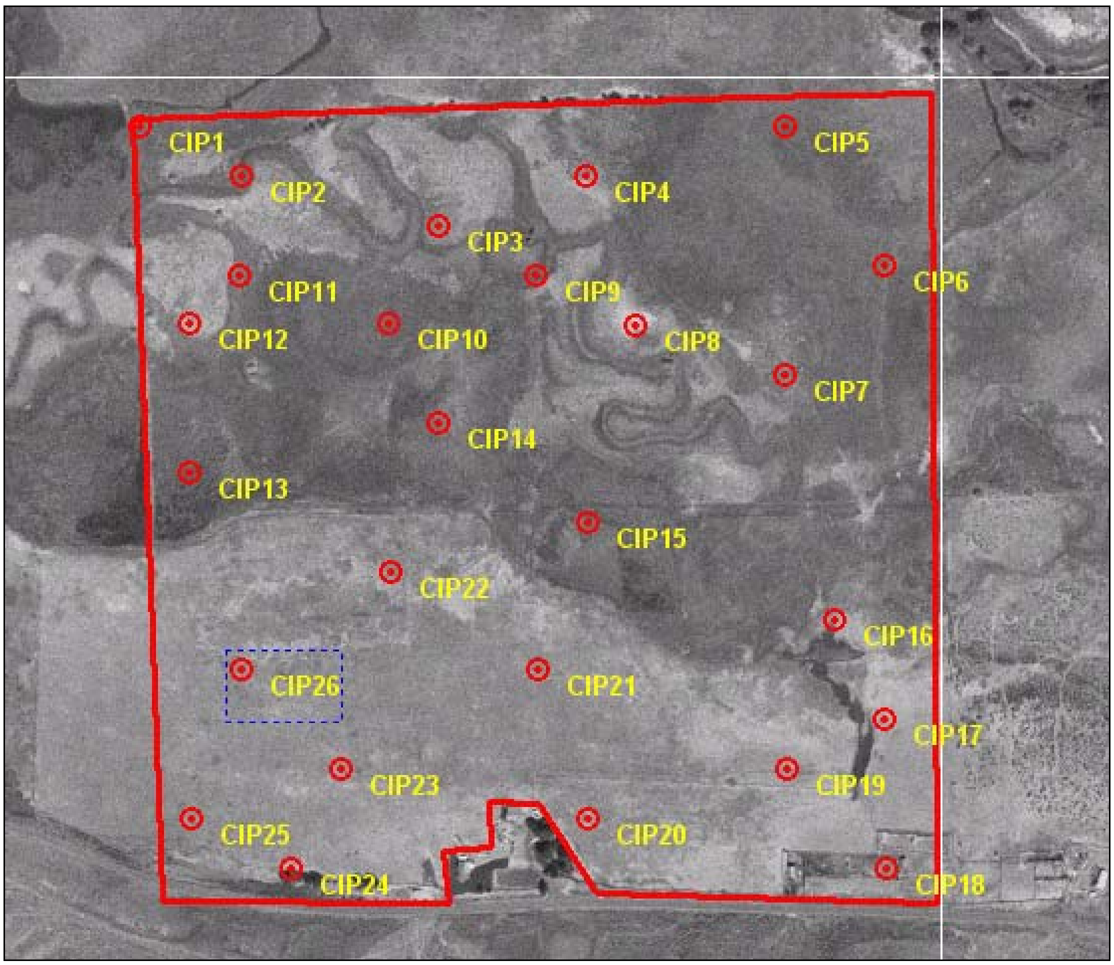

Figure 10. Random initial point locations.

The proportional allocation strategy was modified in the field as needed to compensate for the relative homogeneity of a particular cover type, to account for unanticipated access issues and/or physiographic restrictions, and/or to meet temporal considerations. In addition, initial points were moved when they did not fall within the cover type(s) of interest.

Transect UTM coordinates (NAD 27) for start, turn, and end points were recorded in the field on a Garmin IIIA ® GPS unit and a Garmin 5® GPS unit. Transect start and end locations are shown in Figure 11 while transect UTM coordinates, transect magnetic azimuths, and transect lengths are summarized in Table 7.

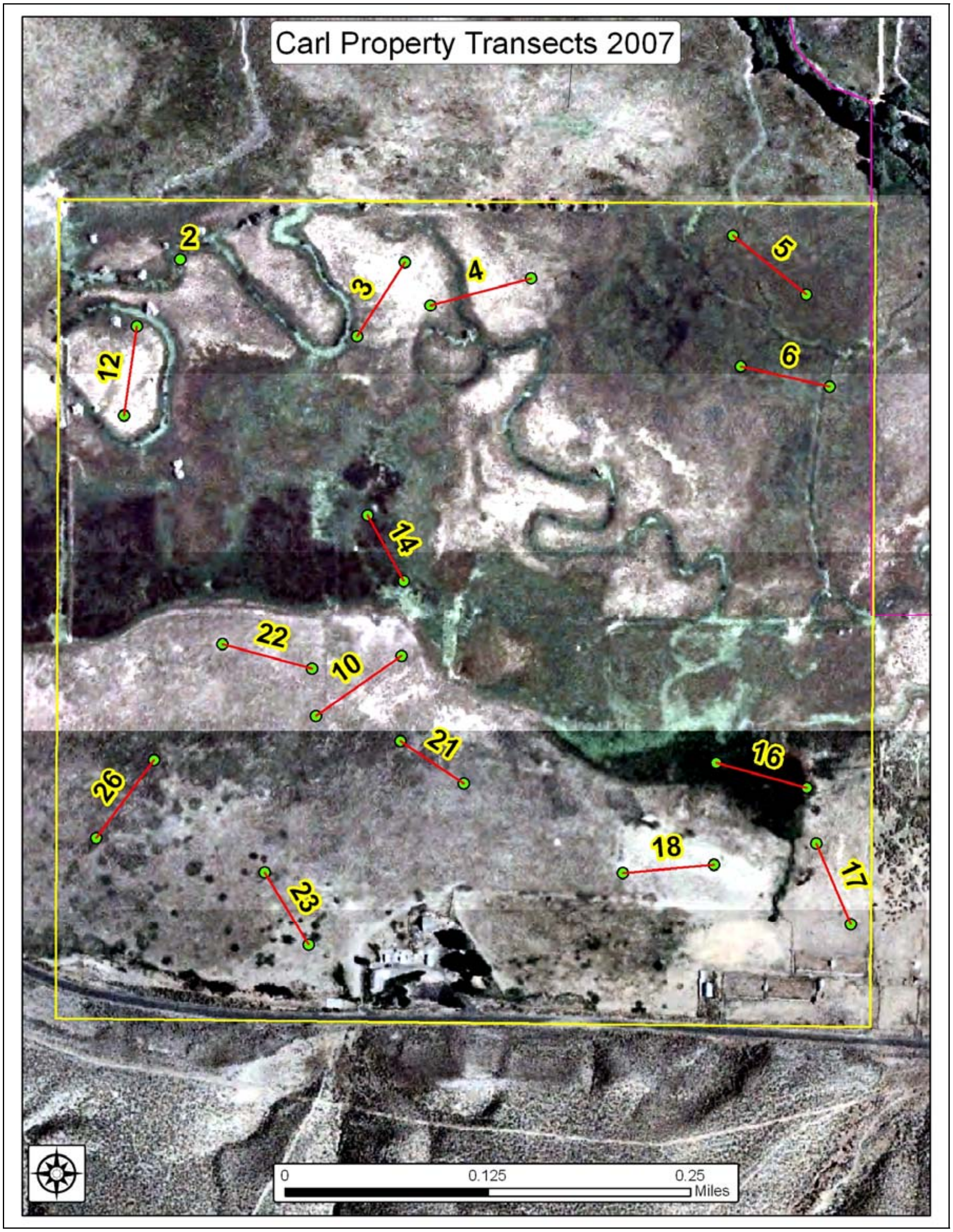

Figure 11. Carl property transect locations.

Table 7. Transect UTMs, Lengths, and Magnetic Azimuths

Transect	Point	GPS		Magnetic Azimuth	Length	Total Length
		E	N			
2	start	0693301	5132907	-	ocular	ocular
3	start	0693524	5132911	194	300	300
	end	0693479	5132836			
4	start	0693650	5132899	239	300	300
	end	0693551	5132869			
5	start	0693849	5132948	112	300	300
	end	0693924	5132892			
6	start	0693950	5132801	260	300	300
	end	0693861	5132818			
10	start	0693533	5132520	213	300	300
	end	0693450	5132458			
12	start	0693250	5132750	347	300	300
	end	0693260	5132839			
14	start	0693495	5132659	121	300	300
	end	0693533	5132595			
16	start	0693940	5132402	-	300	300
	end	0693849	5132424			
17	start	0693951	5132347	142	300	300
	end	0693988	5132268			
18	start	0693760	5132312	-	300	300
	end	0693850	5132323			
21	start	0693599	5132396	290	300	300
	end	0693535	5132436			
22	start	0693445	5132505	268	300	300
	end	0693355	5132526			
23	start	0693404	5132301	127	300	300
	end	0693450	5132231			
26	start	0693291	5132409	202	300	300
	end	0693236	5132330			

Transect Photo Documentation

Transects were photographed with a Canon G1® 3.3 mega pixel digital camera (with and without magnification). Transect photographs are included in Appendix C.

Photo Methods

Photo points were established at the start point of each transect to document extant habitat conditions. Digital photographs were recorded from a height of three feet at the beginning of each transect facing the same direction as the transect azimuth. A transect reference board[2] was placed at the 15 foot interval while a cover board, divided into 3 inch x 4 inch (8cm x 10cm) rectangles, was set at the 30 foot mark on each transect. Panoramic photographs were also recorded to document dense vegetation, linear/narrow cover types, etc. An example of a photo documentation point is illustrated in Figure 12.

Figure 12. Photo point example

Results

A habitat evaluation procedures (HEP) analysis was conducted on the Carl property in June 2007 to assess habitat quality and to determine the number of baseline/protection habitat units (HUs) to credit BPA as partial mitigation for habitat losses associated with McNary Dam (Ashley and Wagoner 2007). Baseline HEP survey results generated 356.11 HUs or 2.2 HUs per acre. HEP survey results are illustrated in Table 8.

[2] Showing transect number, project name, date, GPS reference number

Table 8. HSI and HU summary

Cover Type	Acres	Model	Variable	SI	HSI	HUs[3]
Shrubsteppe/Grassland (includes riparian herb)	158	**California Quail**	V1: Percent herbaceous cover	0.88	0.30	47.69
			V2: Average shrub height	0.03		
			V3: Distance to escape cover	1.00		
			V4: Average diameter of escape cover	0.61		
			V5: Distance between escape cover patches	0.47		
		Western Meadowlark	V1: Percent herbaceous CC	0.89	0.73	114.78
			V2: Percent herbaceous CC composed of grass	0.85		
			V3: Average height of herbaceous CC	0.84		
			V4: Distance to perch	0.92		
			V5: Percent shrub CC	0.95		
		Mallard	V3: Distance between nest and emergent cover (miles)	1.00	0.83	131.23
			V4: Height of residual nesting cover	0.63		
			V5: Cover of nesting vegetation	0.87		
			V6: Human disturbance	1.00		
		Canada Goose	V1: Presence of trees	0.20	0.38	60.34
			V3: Brood areas	0.96		
			V4: Human disturbance	0.50		
Cover Type	**Acres**	**Model**	**Variable**	**SI**	**HSI**	**HUs**
Emergent Vegetation (Wetland)	2	**Mallard**	V7: Ratio of vegetative cover to open water	0.35	0.35	0.70
		Mink	V1: Percent of year with surface water present	0.75	0.69	1.38
			V2: Percent tree CC	0.37		
			V3: Percent shrub CC	0.20		
			V4: Percent CC of emergent vegetation	0.72		
			V5: Percent CC of trees/shrubs within 100m of water edge	0.10		
Total Acres	**160**				**Total HUs**	**356.11**

[3] HU totals are rounded numbers from original spreadsheets and may vary slightly when compared to results from multiplying individual HSIs and acres displayed on Table 7.

Discussion

HSI Summary

Comments are limited to HEP model species that received a habitat suitability index rating less than 0.50[4]. Western meadowlark and mallard habitat suitability (shrubsteppe) was 0.73 and 0.83 respectively and, therefore, will not be further addressed. The mink HSI for the emergent vegetation cover type was 0.69 and will also not be discussed further.

Shrubsteppe

California quail

The California quail model output value of 0.30 was due to a low average shrub height. All other model variable suitability indices were adequate to support quail.

Canada goose

The Canada goose model HSI rating of 0.38 was primarily due to a lack of tree cover (V1) on the property. Human disturbance (V4) was moderate (0.5) while brood areas (V4) were rated exceptionally high at 0.95 HSI.

Emergent Vegetation (Wetland)

Mallard

The low mallard model output (0.35) indicates habitat quality is “marginal” for this species at this juncture. The lack of open water (when the area was surveyed) was the limiting factor for this cover type/species (V7: “ratio of open water to emergent vegetation” is the only variable rated in this cover type).

Acknowledgements

I gratefully acknowledge the support of Regional HEP Team members and Yakama Tribe Wildlife Department Staff who collected the field data presented in this report. Sincere appreciation is extended to Tracy Hames (Yakama Nation) and Tom Elliot (Yakama Nation) for their leadership and/or collaboration on drafting this document. I also gratefully acknowledge Joe DeHerrera (BPA) for his contributions and support.

[4] It is assumed that HSIs ≥ 0.5 reflect habitat quality suitable enough to sustain a wildlife population.

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Appendix A – HEP Models

Canada Goose

Species: CANADA GOOSE
Model: De Waard 1990
Cover type: Sand/Gravel/Cobble/Mud, Agricultural, SS Grassland, Riparian Herb, Lacustrine.

Variable 1:	Mature riparian forest adjacent to river, snags, etc.	=	1.0
	Mature trees in limited supply, few snags	=	0.5
	Few mature trees	=	0.2
Variable 3:	Brood areas		
	Short grass, easy access <1 mile from nesting	=	1.0
	Short grass access restricted or 1-2 miles from nesting	=	0.5
	Brood areas not apparent or >2 miles from nesting areas	=	0.2
Variable 4:	Human disturbance > 1/2 mile away	=	1.0
	Human disturbance 1/4 - 1/2 mile away	=	0.5
	Human disturbance < 1/4 mile away	=	0.1

Canada Goose HSI = $[V1 \times (V3 + V4)/2]^{1/2}$

Notes: Nesting goose HUs lost through inundation by the Lower Columbia River Project were primarily associated with the mainstem Columbia island cover type. Due to the breadth of the Columbia channel and the distance from main shoreline to island shorelines, these islands offered isolation from nest predators. The size of the Columbia is unique within the Northwest; along the Yakima River, as well as most other regional streams, islands do not provide the same isolation from predators as was typical of the Columbia. Smaller islands in most regional streams also make them more prone to flooding during spring runoff, substantially reducing their value to ground nesting birds. Therefore, other local cover types provide the bulk of nesting goose habitat along the smaller order streams. Along the Yakima River, riparian forest communities provide the best, most secure habitat for nesting Canada geese. To reflect this, the goose model was modified to provide estimates of the HUs available for nesting geese in the local project area. Canada geese were selected in the loss assessment due to their regional significance, not due to the importance of islands per se.

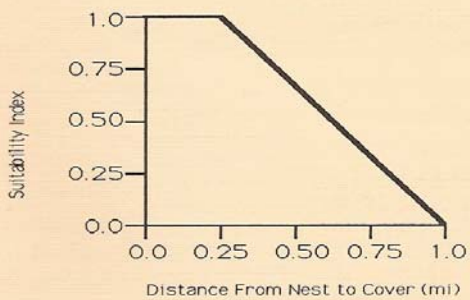
Human disturbance was considered any disturbance associated with human presence. These disturbances included livestock, pets, machinery, traffic, etc.

50

Mallard

Species: MALLARD
Model: Rasmussen and Wright, 1990b,d
Cover Type: Emergent Wetland, Agricultural, SS Grassland, Riparian Herb, Riverine, Lacustrine.

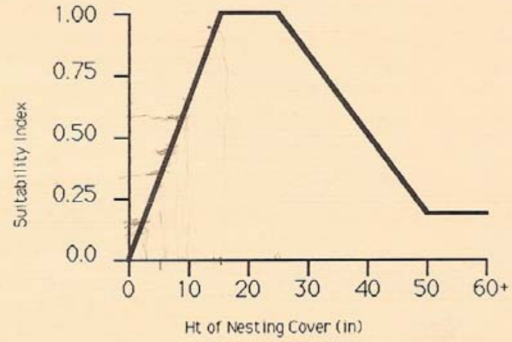
Variable 3: Distance between nest & water with emergent cover (miles)



V3 Field Values

< 0.25 mi	=	1.0
0.25-0.75 mi	=	0.5
> 0.75 mi	=	0.1

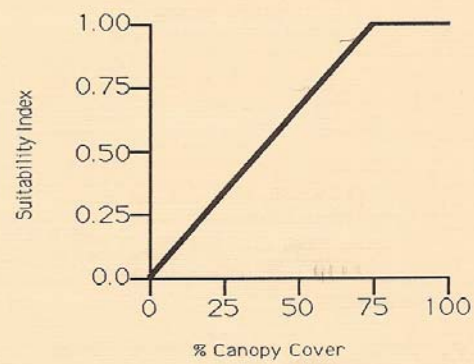
Variable 4: Height of residual nesting cover (inches)



V4 Field Values

0 in	=	0.0
1-15 in	=	0.5
16 - 24 in	=	1.0
25-48 in	=	0.6
> 48 in	=	0.3

Variable 5: % Canopy cover of nesting vegetation



V5 Field Values

<50%	=	0.3
51-75%	=	0.7
>75	=	1.0

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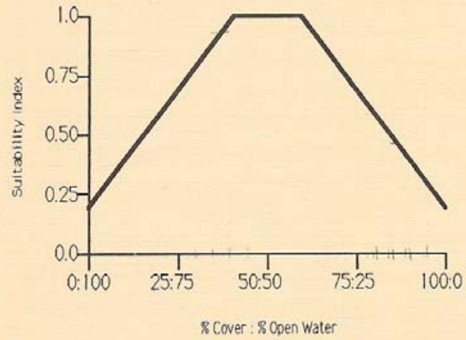
Variable 6: Human disturbance

None	=	0.8-1.0
Moderate	=	0.4-0.7
High	=	0-0.3

V6 Field Values

None	=	1.0
Moderate	=	0.5
High	=	0.2

Variable 7: Ratio of vegetative cover to open water



V7 Field Values

<40:60	=	0.5
40:60-60:40	=	1.0
>60:40	=	0.5

In emergent wetlands:
Mallard HSI = V7

In other cover types:
Mallard HSI = (V3 + V4 + V5)/3 X V6

Notes: All variables were estimated at the field sampling sites using the field scales.

The mallard model was applied in the field considering estimated vegetative conditions on April 1, the approximate date of mallard nest initiation.

Human disturbance included any disturbance associated with human presence, such as livestock, pets, machinery, and traffic.

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Mink

Species: MINK
Model: Allen 1986
Cover Type: Riverine, Emergent Wetlands, Riparian Forest, Riparian Shrub, Sand/Gravel/Cobble/Mud

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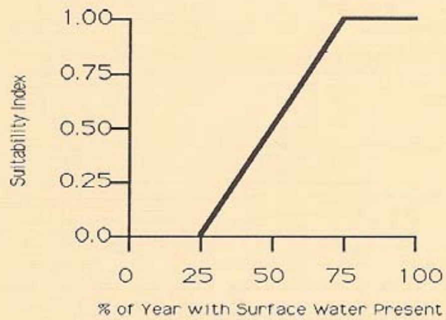
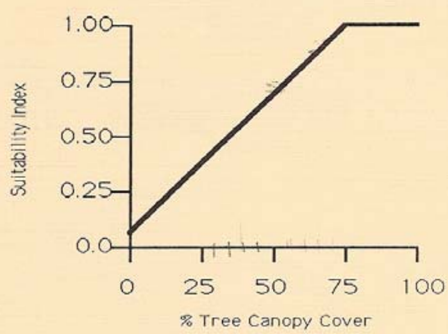
Variable 1: % of year w/surface water present



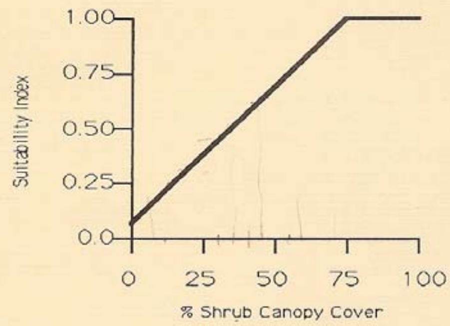
V1 Field Values

0-25%	=	0.0
26-50%	=	0.25
51-75%	=	0.75
> 75%	=	1.0

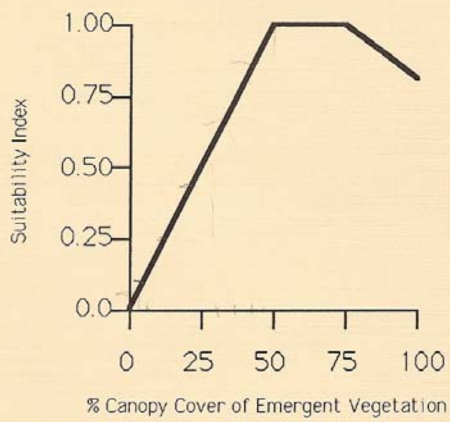
Variable 2: % Tree canopy cover



Variable 3: % Shrub canopy cover



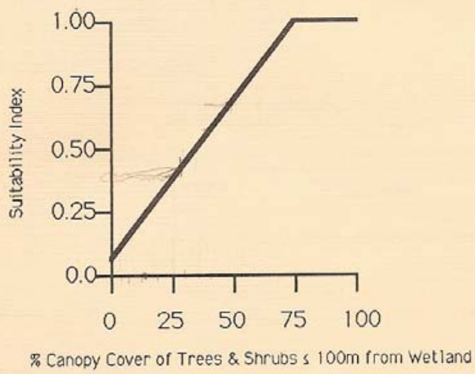
Variable 4: % Canopy cover of emergent vegetation



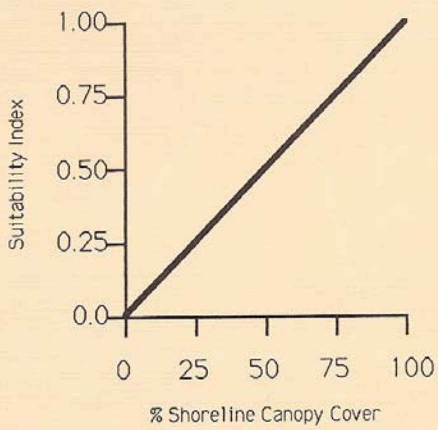
V4 Field Values

0%	=	0.00
1-25%	=	0.25
26-50%	=	0.75
51-75%	=	1.00
76-100%	=	0.90

Variable 5: % Canopy cover of trees and shrubs within 100m of wetland edge



Variable 6: % Canopy cover along shoreline



<u>V6 Field Values</u>

0%	=	0.00
1-20%	=	0.10
21-50%	=	0.35
51-80%	=	0.65
81-99%	=	0.90
100%	=	1.00

In Riparian Forest and Riparian Shrub:

Water SI = V1

Cover SI = $\frac{\text{MIN (1.0, V2 + V3 + V4) + V5}}{2}$

$\geq \frac{1.0 : (v2 + v3 + v4) + v5}{2}$

In Emergent Wetlands:

Water SI = V1

Cover SI = $\frac{(4 \times V4) + V5}{5}$

In Riverine and Sand/Gravel/Cobble/Mud Shoreline:

Water SI = V1

Cover SI = $(V5 \times V6)^{1/2}$

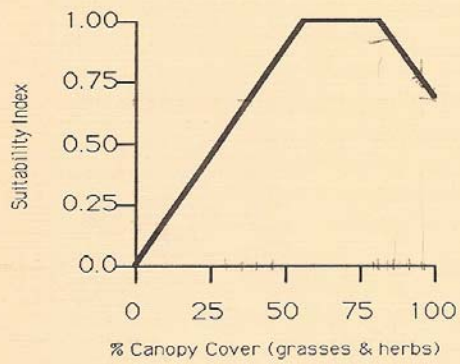
Mink HSI = Lowest Value for either Water SI or Cover SI.

Notes: Variables 2, 3, 5 were estimated from 1:20,000 color aerial photographs using the continuous variable functions; all other variables estimated at the field sampling sites using the field scales.

California Quail

Species: CALIFORNIA QUAIL
Model: U.S. Fish & Wildl. Serv. 1978
Cover Types: Riparian Shrub, Agricultural, Shrub-steppe Grassland, Riparian Herb

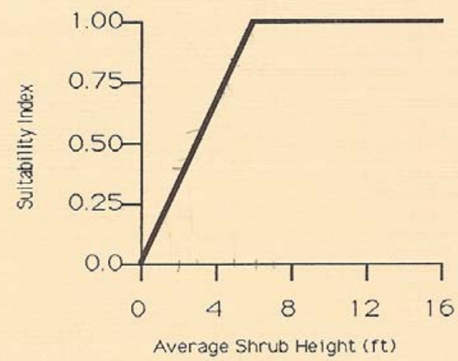
Variable 1: % Canopy cover of grasses and herbs



V1 Field Values

0%	=	0.0
1-20%	=	0.2
21-40%	=	0.6
41-90%	=	1.0
91-100%	=	0.8

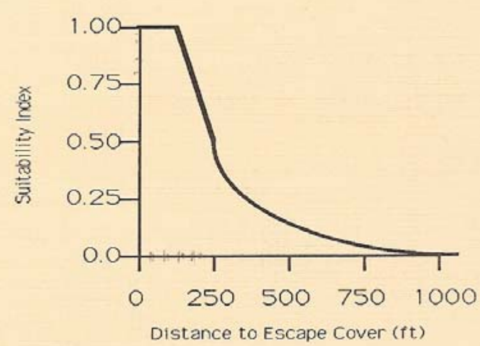
Variable 2: Average shrub height (ft)



V2 Field Values

0 ft	=	0.0
1-2 ft	=	0.2
3-4 ft	=	0.5
5-6 ft	=	0.9
≥ 7 ft	=	1.0

Variable 3: Distance to escape cover (ft) (escape cover = dense vegetation, > 8" high)



V3 Field Values

≤ 100 ft	=	1.0
101-180 ft	=	0.8
181-300 ft	=	0.5
301-500 ft	=	0.3
501-874 ft	=	0.1
≥875 ft	=	0.0

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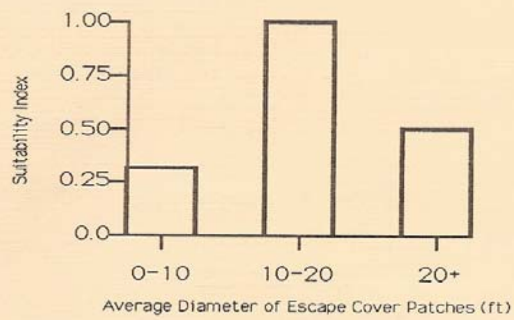
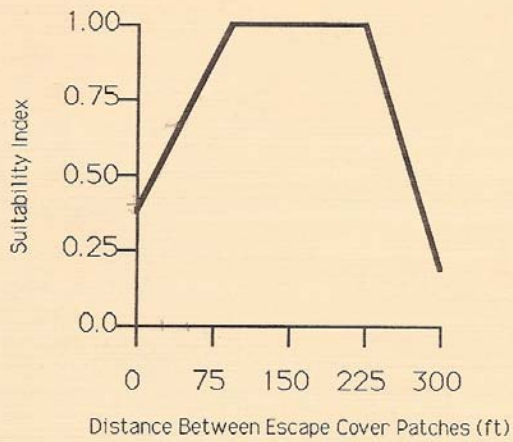
Variable 4: Average diameter of escape cover patches (ft)



Variable 5: Distance between escape cover patches (ft)



V5 Field Values

< 30 ft	=	0.4
31-90 ft	=	.75
91-200 ft	=	1.0
201-300 ft	=	0.6
> 300 ft	=	0.1

Quail HSI = $\frac{V1 + V2 + (V3 \times V4 \times V5)^{1/3}}{3}$

Notes: All variables were estimated at the field sampling sites using the field scales.

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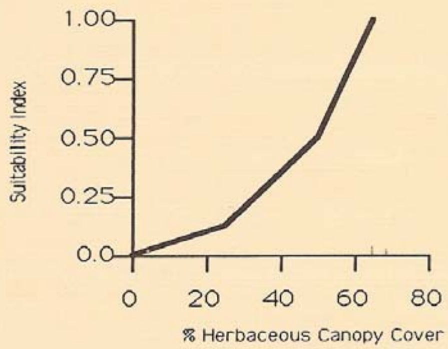
Species: WESTERN MEADOWLARK
Model: modified from Schroeder and Sousa 1982
Cover Type: Shrub-Steppe Grassland/Pasture

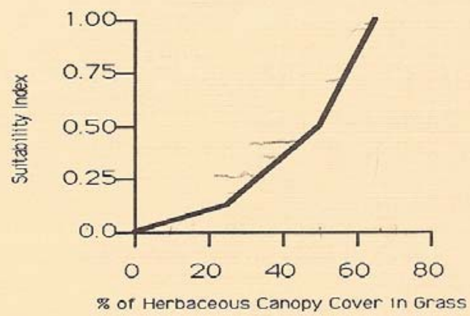
Variable 1: % Canopy cover of herbaceous plants



V1 Field Values

0%	=	0.0
1-30%	=	0.1
31-50%	=	0.3
51-64%	=	0.8
≥ 65%	=	1.0

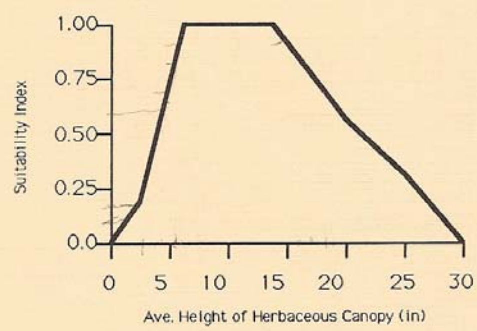
Variable 2: % of herbaceous canopy cover composed of grass.



V2 Field Values

0%	=	0.0
1-30%	=	0.1
31-50%	=	0.3
51-64%	=	0.8
>65%	=	1.0

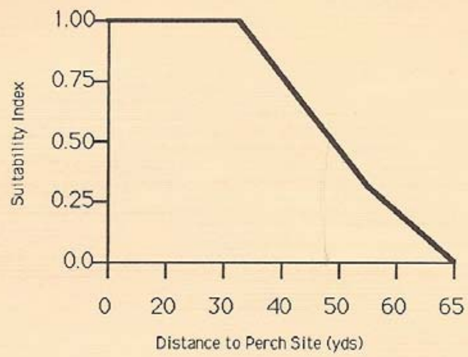
Variable 3: Average height of herbaceous canopy (inches)



V3 Field Values

0"	=	0.0
1-3"	=	0.2
4-6"	=	0.8
7-13"	=	1.0
14-20"	=	0.8
21-29"	=	0.3
> 29"	=	0.0

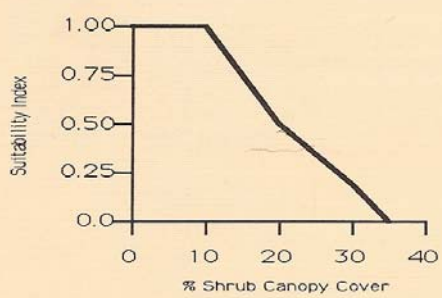
Variable 4: Distance to perch site (yds) (see notes below).



V4 Field Values

if shrub steppe	=	1.0
if idle field	=	1.0
if fenced pasture	=	1.0
if unfenced pasture (no weeds or shrub)	=	0.2

Variable 5: % Shrub canopy cover



V5 Field Values

0-10%	=	1.0
11-20%	=	0.7
21-34%	=	0.2
≥35%	=	0.0

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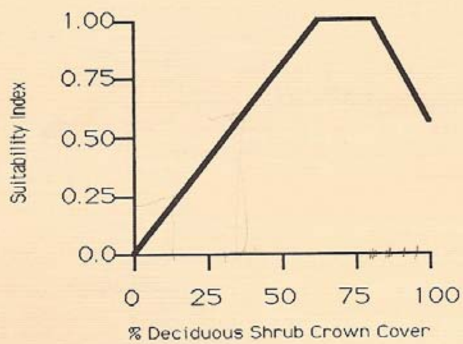
Meadowlark HSI = $(V1 \times V2 \times V3 \times V4)^{1/2} \times V5$

Notes: All variables were estimated at the field sampling sites using the field scales. For variable 4, it was assumed that where there are shrubs, erect woody forbs, or fences, perch sites would not be limited. In unfenced pastures where shrubs and erect forbs were absent, perch sites for western meadowlarks were assumed to be limited.

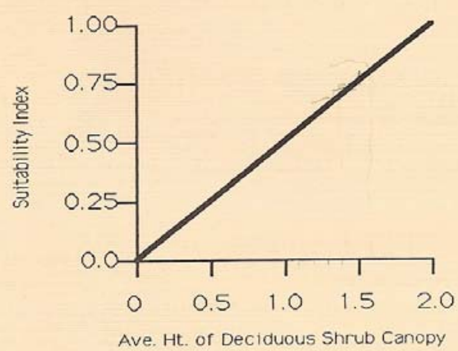
Yellow Warbler

Species: YELLOW WARBLER
Model: Schroeder 1982
Cover Type: Riparian Shrub

Variable 1: % Deciduous shrub crown cover



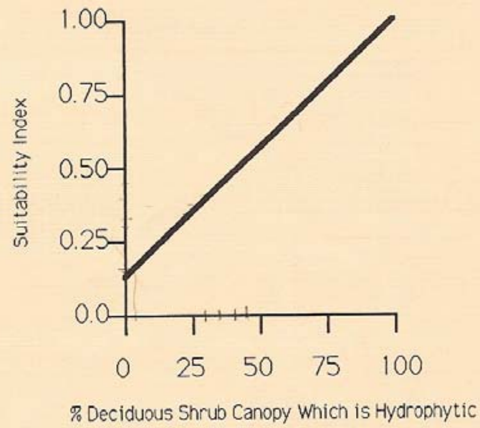
Variable 2: Average height of deciduous shrub canopy



V2 Field Values

<1.0 m	=	0.25
1.0 - 2.0 m	=	0.50
>2.0 m	=	1.00

Variable 3: % Deciduous shrub canopy comprised of hydrophytic shrubs



Warbler HSI = $(V1 \times V2 \times V3)^{1/3}$

Notes: Variable 1 was estimated from 1:20,000 color aerial photographs using the continuous variable function. For variable 3, field observations indicated that all shrubs associated with the riparian corridors were hydrophytic in the proposed project area; therefore, V3 = 1.0.

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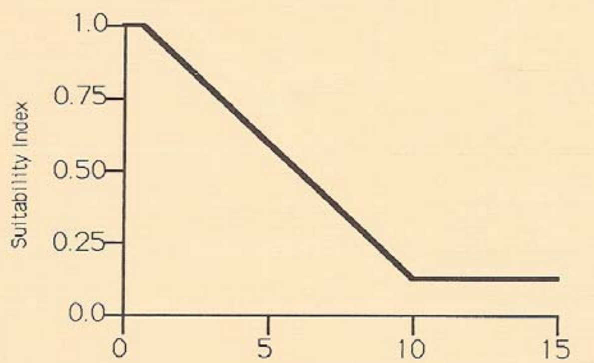
Great Blue Heron

Species: GREAT BLUE HERON
Model: Short and Cooper 1985.
Cover Type: Riparian Forest, Sand/Gravel/Cobble/Mud, SS Grassland, Riverine, Lacustrine.

Variable 1: Distance from feeding area to potential nesting area (km)



Variable 2: Foraging habitat quality

Shallow, clear water with firm substrate and forage fish	=	1.0
Wet pasture (see notes below)	=	0.5
Quality foraging conditions absent or scarce	=	0.0

Variable 3: Human disturbance level near potential foraging zone

No frequent human disturbance within 100m (or foraging zone ≥ 50m from low-use road)	=	1.0
Frequent disturbance within 100m	=	0.0

Variable 4: Availability of potential nesting areas

Trees ≥5m with an open canopy located ≤ 250m from water	=	1.0
Quality nesting conditions absent or scarce	=	0.0

Variable 5: Disturbance level in vicinity of potential nesting areas

Low disturbance within 250m on land or 150m on water	=	1.0
Disturbance sources within 250m on land or 150m on water	=	0.0

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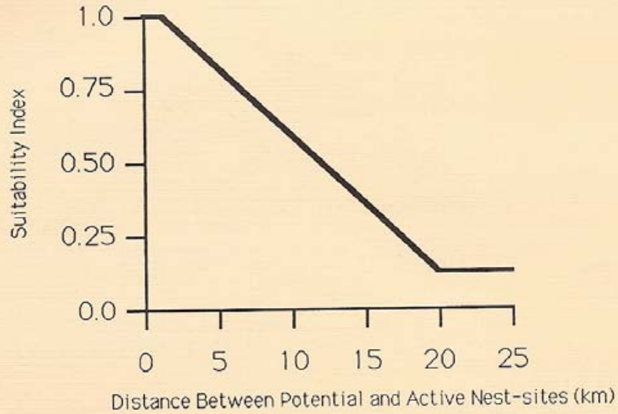
Variable 6: Distance between potential nest site and nearest active nest site



Heron HSI (Riparian Forest) = $(V1 \times V2 \times V3 \times V4 \times V5 \times V6)^{1/2}$

Heron HSI (all other cover types) = $(V1 \times V2 \times V3)$

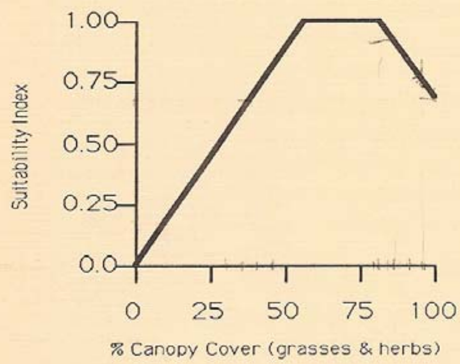
Notes: All variables estimated from 1:20,000 color aerial photographs. The continuous variable function was used for variable 1. Modification of variable 2 reflected some foraging value associated with wet pastures. Observations indicated herons foraged locally in wet pastures, apparently consuming small mammals, snakes, frogs, and possibly some invertebrates.

Human disturbance was considered any disturbance associated with human presence. These disturbances included livestock, pets, machinery, traffic, etc.

Black-capped Chickadee

Species: CALIFORNIA QUAIL
Model: U.S. Fish & Wildl. Serv. 1978
Cover Types: Riparian Shrub, Agricultural, Shrub-steppe Grassland, Riparian Herb

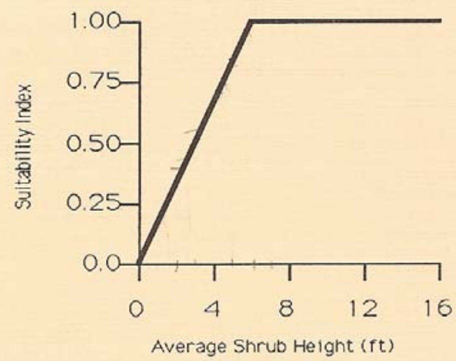
Variable 1: % Canopy cover of grasses and herbs



V1 Field Values

0%	=	0.0
1-20%	=	0.2
21-40%	=	0.6
41-90%	=	1.0
91-100%	=	0.8

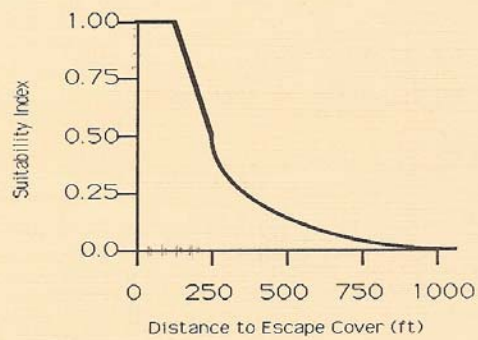
Variable 2: Average shrub height (ft)



V2 Field Values

0 ft	=	0.0
1-2 ft	=	0.2
3-4 ft	=	0.5
5-6 ft	=	0.9
≥ 7 ft	=	1.0

Variable 3: Distance to escape cover (ft) (escape cover = dense vegetation, > 8" high)



V3 Field Values

≤ 100 ft	=	1.0
101-180 ft	=	0.8
181-300 ft	=	0.5
301-500 ft	=	0.3
501-874 ft	=	0.1
≥875 ft	=	0.0

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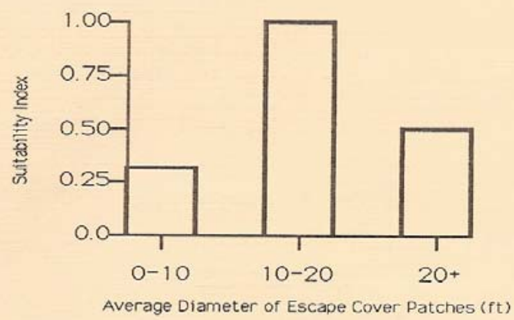
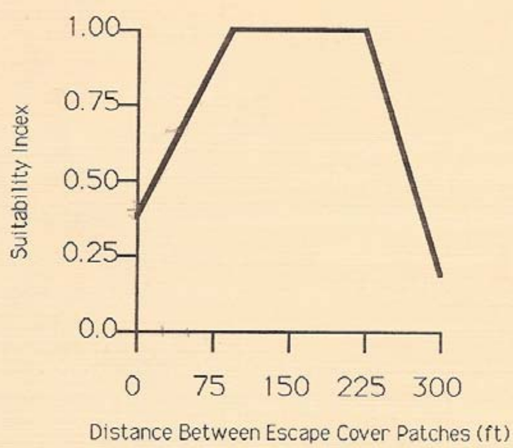
Variable 4: Average diameter of escape cover patches (ft)



Variable 5: Distance between escape cover patches (ft)



V5 Field Values

< 30 ft	=	0.4
31-90 ft	=	.75
91-200 ft	=	1.0
201-300 ft	=	0.6
> 300 ft	=	0.1

$$\text{Quail HSI} = \frac{V1 + V2 + (V3 \times V4 \times V5)^{1/3}}{3}$$

Notes: All variables were estimated at the field sampling sites using the field scales.

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Appendix B-Measurement Protocols

Locations

HEP Sampling Design and Measurement Protocols

Introduction
This document was developed to fulfill a request by the Upper Columbia United Tribes (UCUT) and Bonneville Power Administration (BPA) to develop a "stand alone" reference for Habitat Evaluation Procedures (HEP) transect protocols used by the Regional HEP Team (RHT). General and specific protocols are described. General protocols include a brief description of pre HEP survey pilot studies; transect establishment guidelines, and photo documentation parameters. In contrast, specific metrics detail actual habitat variable measurement techniques including diagrams where additional explanation is needed.

Specific metrics are identified with an alpha-numeric code. This allows project managers and others to identify specific measurement techniques in report tables without lengthy, redundant explanations. This report is intended to be a "living" document and will be modified as needed. The following standardized protocols and measurement techniques are used by the Regional HEP team to measure habitat variables described in HEP models.

General Protocols

Pilot Studies
Pilot studies are conducted in new habitat types and/or familiar habitat types that are comprised of unique structural conditions/key ecological correlates. Pilot study data is used to estimate the sample size needed for a confidence level ≥ 80% with a 10% tolerable error level (Avery 1994) and to determine the most appropriate sampling unit[5] for the habitat variable of interest i.e., a coefficient of variation analysis (BLM 1998). In addition, a power analysis is conducted on pilot study data (and periodically throughout data collection) to ensure that sample sizes are sufficient to identify a minimal detectable change of 20% in the variable of interest with a Type I error rate ≤0.10 and P = 0.9 (BLM 1998, Block et al. 2001). All field data is recorded on data loggers or data sheets and downloaded/transferred to data summary spreadsheets.
Transects
Transect cover sheets are used to document specific transect information including transect identification, cover type, HEP Team members, global positioning system (GPS) coordinates, and other pertinent information.
Transects are established at least 300 feet (100 meters), where possible, from ecotones, roads, and other anthropogenic influences. Transect starting points and azimuths (direction) are randomly selected for each cover type. Start points are selected based on superimposing a UTM grid over cover type maps and identifying specific X/Y

[5] Includes micro-plot grid size and shape etc.

coordinates with the aid of a random numbers table, or computer generated random number generator/point locater program.
Transect start, turn, and end points are marked with 14-inch (36 centimeter) 0.25 inch (0.6 centimeter) diameter rebar stakes[6] painted fluorescent orange or red. GPS positions (UTM coordinates-NAD 27) are recorded at start, turn, and end points. If cover types change or transect length is greater than 300 feet, another transect azimuth is randomly selected, or the original azimuth is varied by 45 degrees (direction [left or right] is determined by the flip of a coin where more than one choice is possible). Compass azimuths (headings) are magnetic bearings i.e., not corrected for local declination. Transects are divided into 100 foot (30 meter) sample units for statistical purposes.

Photo Points

Photo points are established at the start point of each transect. Pictures are recorded from a height of three feet at the beginning of each transect while facing in the direction of the transect azimuth. A transect reference board (includes transect number, project name, date, GPS reference number) is placed at the 15 foot interval while a cover board is placed at the 30 foot mark on each transect. Occasionally, panoramic photographs are also needed e.g., dense vegetation, linear/narrow cover types. Habitat conditions are photographed with a Canon G1® 3.3 mega pixal digital camera (with and without magnification).

Specific Metrics

Metrics generally follow those described by Hays et al. (1981) and/or Avery (1994) unless otherwise noted. Some metrics have been modified due to extreme field conditions and/or to better meet Regional HEP Team needs.

Herbaceous Measurements

Percent Cover

1. Herbaceous percent cover measurements are recorded at 20 or 25-foot intervals on the right side of the transect tape (the right side is determined by standing at 0 feet and facing the line of travel/transect azimuth). RHT members walk on the left side of the transect line to reduce sample disturbance.
   A square $0.1m^2$ micro-plot grid is used in grasslands to estimate percent cover of herbaceous vegetation while a rectangular $0.5m^2$ grid is generally used in shrublands (the $0.5m^2$ grid may also be used in grasslands if desired). The near right hand corner of the grid is placed at the sampling interval (rectangle grids are placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval). An example of micro-plot grid placement is shown in Figure 1. Approximately 20% of the micro plot is covered by vegetation in the example. Grid samples are considered independent samples for statistical purposes.
   1A: $0.1m^2$ micro-plot grid/20’ interval
   1B: $0.1m^2$ micro-plot grid/25’ interval

[6] Marking transect points with rebar stakes is at the discretion of the project proponent. Therefore, not all transects are marked in this manner.

1C: $0.5m^2$ micro-plot grid/20' interval
1D: $0.5m^2$ micro-plot grid/25' interval

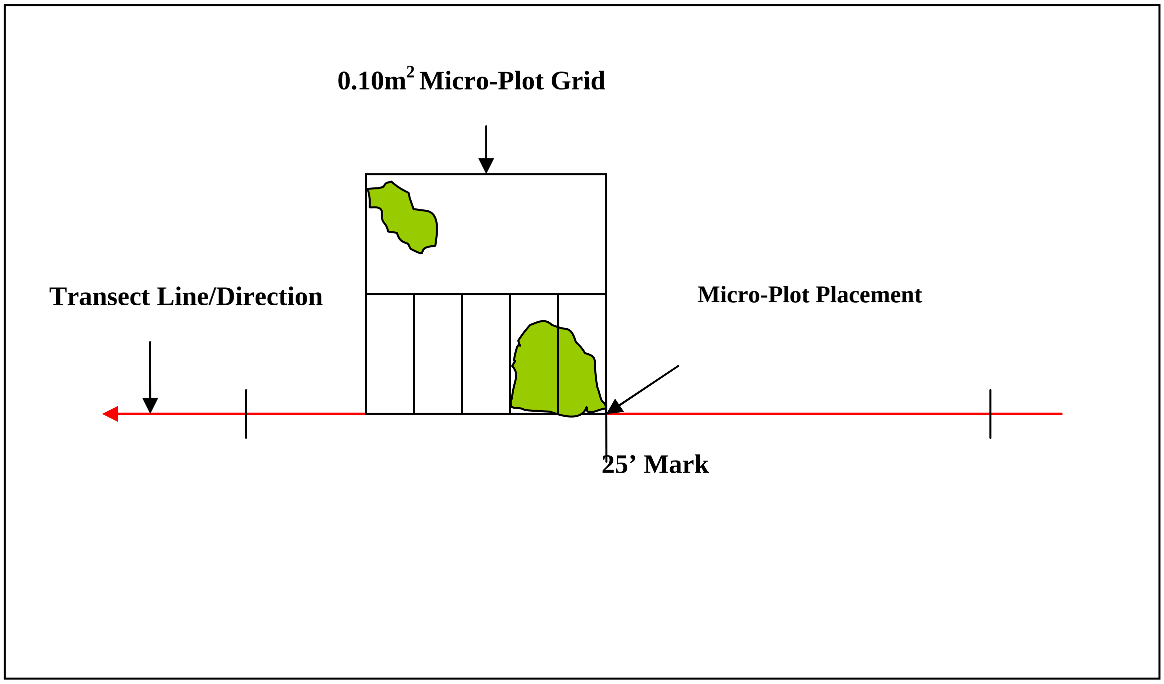

Figure 1. Micro-plot grid placement and percent cover example.

Height

2. Herbaceous height is measured with a measuring rod placed within the grid frame (scale = 10ths/ft.). Three evenly spaced measurements are recorded and averaged for each sample. Only leaf material is measured (leaves provide the greatest amount of cover). "Leaf material" may include residual cover and/or new growth predicated on HEP model variable requirements. <u>Grass inflorescence is not included in height measurements.</u>

2A. Four measurements, one from each corner of the micro plot grid, are recorded and averaged for each sample. Only leaf material is measured (leaves provide the greatest amount of cover). Grass inflorescence is not included in height measurements.

2B. A measuring rod is held vertical at the interval point: the highest vegetation to cross the measuring rod at that point is measured to the nearest tenth of a foot.

2B-1: 10' interval
2B-2: 20' interval
2B-3: 25' interval

Visual Obstruction Readings (VOR)

3. A Robel pole (Robel 1975) is used to document vertical and/or horizontal cover for herbaceous vegetation i.e., visual obstruction readings (VOR). Measurements are recorded at 20, 25, or 50-foot intervals. Intervals are determined by the length of each transect, i.e., a minimum of 12 measurements are required for each

transect, or cover type heterogeneity (structurally diverse cover types generally require larger sample sizes).

The Robel pole (Robel 1975) is placed on the transect line at the appropriate interval. Four observations are taken from a distance of four meters from the Robel pole and averaged to obtain a single visual obstruction reading or VOR. Observers sight over a one meter pole and record how much of the Robel pole is totally obscured from the ground up (Figure 2). Measurements are reported in 0.25 decimeter increments.

Two measurements are taken on the transect line on opposite sides of the Robel pole; two identical measurements are taken from the same point perpendicular to the transect line for a total of four "readings" (Figure 3). Sample size is determined to be adequate when the "running mean" varies ≤ 10% of the mean. VOR samples are considered independent for statistical purposes.

3A: 20' interval
3B: 25' interval
3C: 50' interval

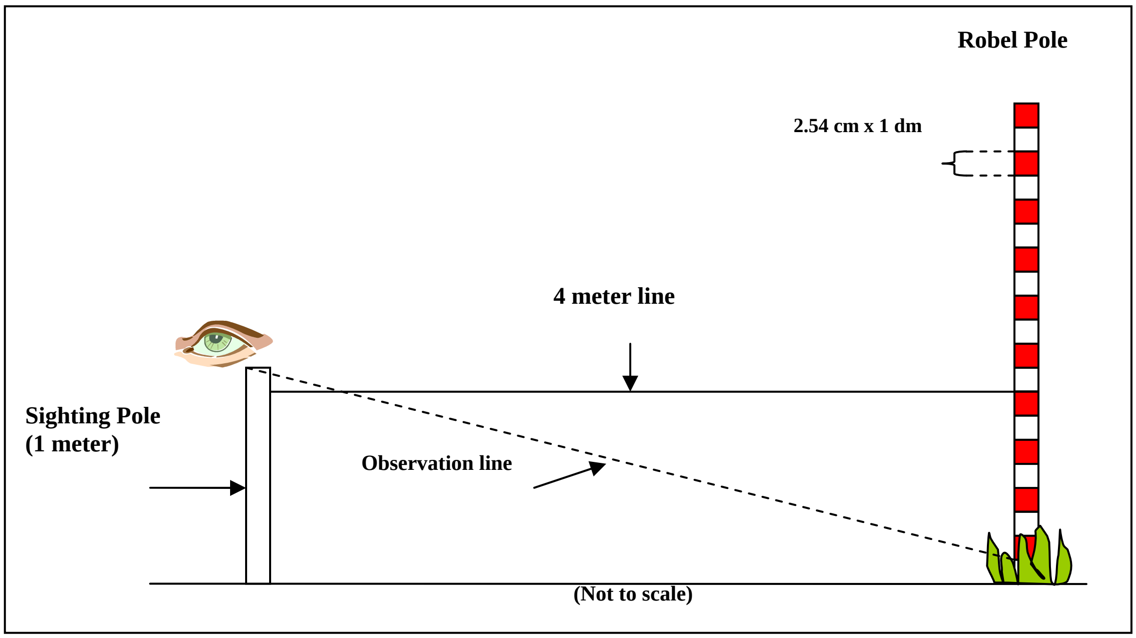

Figure 2. Visual obstruction reading diagram.

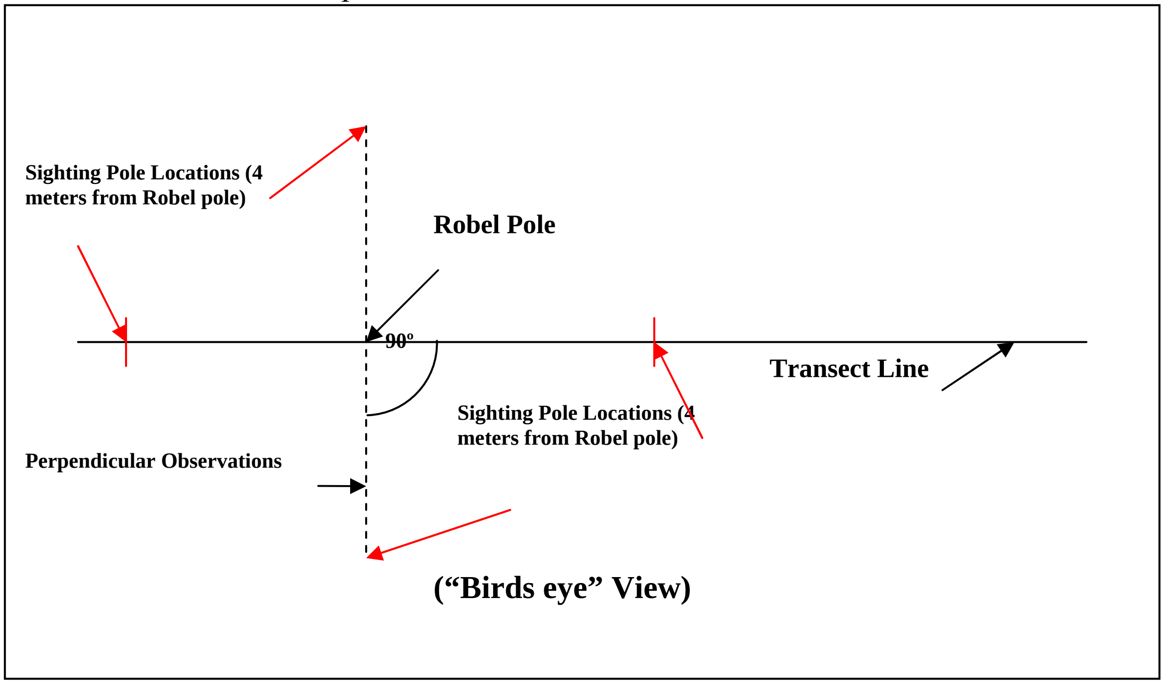

Figure 3. Robel pole "readings" layout diagram.

Shrub Measurements

Percent Cover

4. Line intercept or point intercept (USFWS 1981) is used to determine shrub cover. Line intercept is generally used when shrub cover is estimated at < 5% (the most accurate results are obtained using the line intercept method). In contrast, the point intercept method is used if shrub cover is estimated at > 5%.

4A: Line intercept is used to measure the amount of cover that intercepts the transect line as illustrated by the red lines shown in Figure 4. Measurements are in 10ths of feet. Gaps in vegetation less than four tenths of a foot (5 inches) are ignored. The amount covered by shrubs is added to determine shrub intercept for each transect. For example, if 7.5 feet of a 100-foot long transect is covered by shrubs, percent cover is 7.5%.

Shrub cover is recorded by species. Where shrubs overlap, shrub intercept is recorded for the tallest shrub and noted for the lower shrub(s).

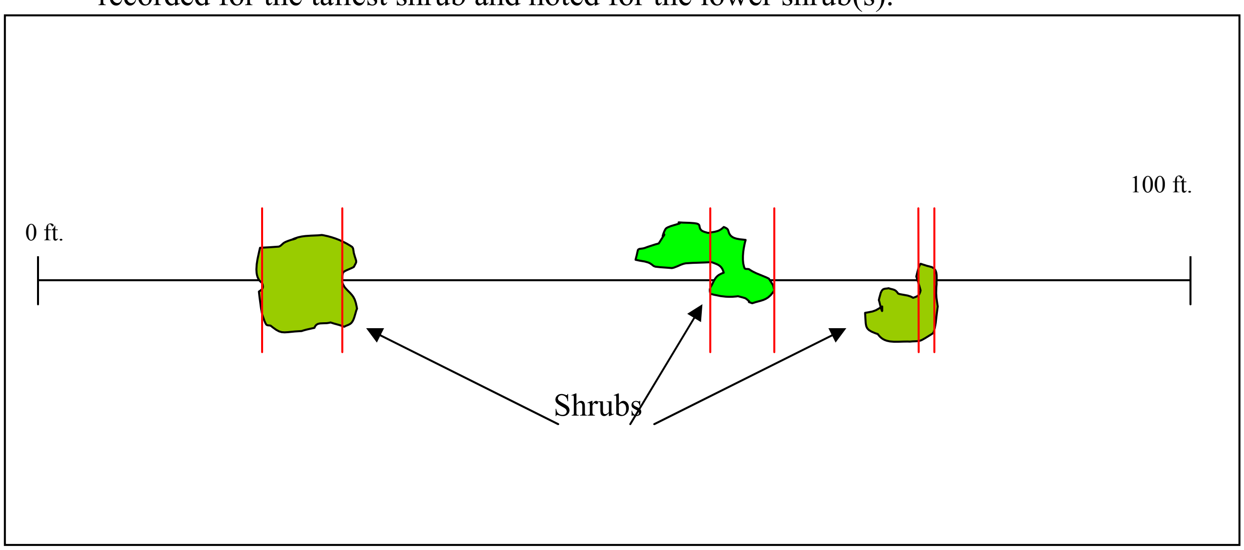

Figure 4. Line intercept method example.

4B: Point intercept is used when shrub canopy cover is estimated at ≥5%. Shrub cover is determined by recording the number of "hits" at specific intervals along a transect line. To be counted as a "hit", a portion of the shrub must cross the transect tape's interval number line e.g., 2', 4', 6'…. nth. If a portion of the shrub does not break the vertical plane at the interval number line, it is reported as a miss (Figure 5). Either a "hit" or "miss" is recorded on data loggers and/or paper data sheets for each designated interval.

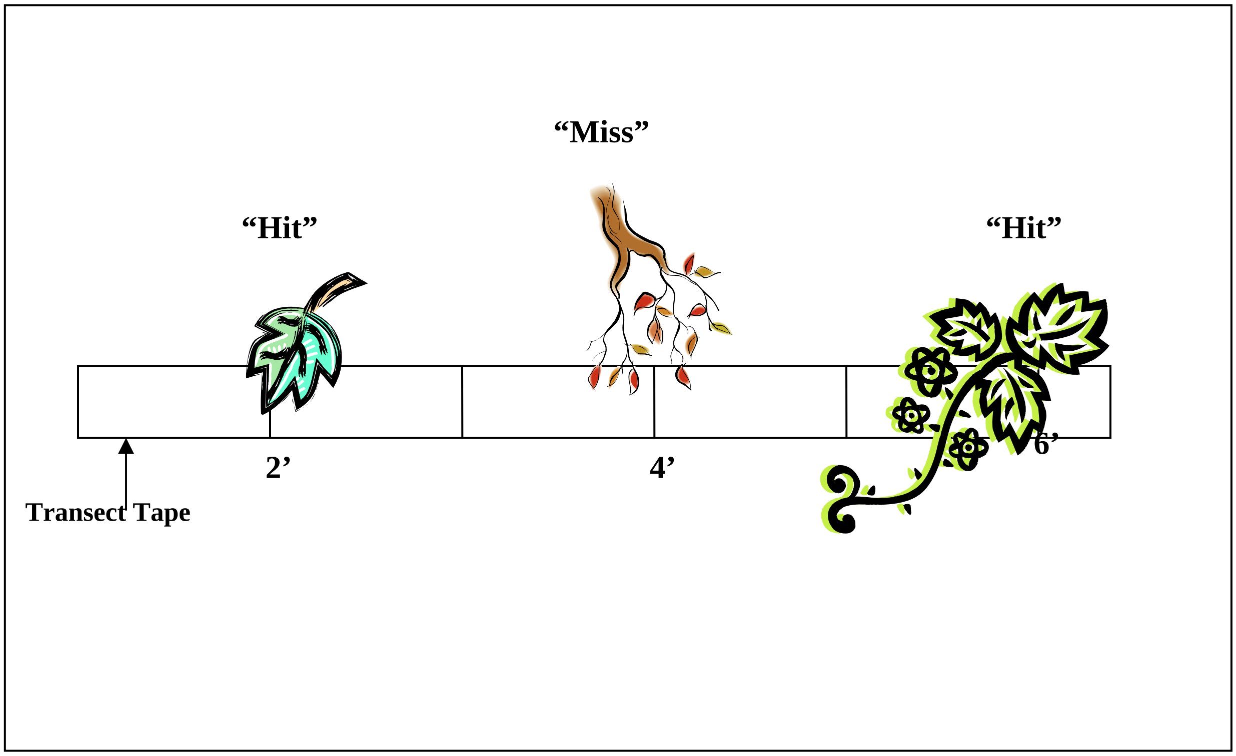

Figure 5. Point intercept method example showing "hits" and "misses" at two foot intervals.

From 5% to 20% cover, point data is collected at two-foot intervals (50 possible "hits" per 100 ft. sample unit). If shrub cover is estimated at >20%, shrub point data is collected at five foot intervals (20 possible "hits" per 100 ft. sample unit). On rare occasions, ten-foot intervals may be used when shrub cover exceeds 50% (10 possible "hits" per 100 ft. sample unit). The ten-foot interval is generally applied to shrub monocultures, or areas with few shrub species that exhibit relatively equal shrub distribution/density.
Shrub "hits" are recorded by species. Where shrubs overlap, shrub intercept is recorded for the tallest shrub and noted for the lower shrub(s).

4B-1: 2' interval
4B-2: 5' interval
4B-3: 10' interval

4C: Modified point method is used when shrub cover is impenetrable or otherwise inaccessible. A baseline transect is established along the shrub edge. A six-foot measuring rod is then inserted into the shrub cover at right angles to the baseline tape at appropriate intervals. Recorders estimate shrub “hits”, species information, and height data where the end of the six-foot measuring rod intercepts the shrub cover (Figure 6). As with point intercept, intervals may very. Shrubs are identified by species.

4C-1: 2’ interval
4C-2: 5’ interval
4C-3: 10’ interval

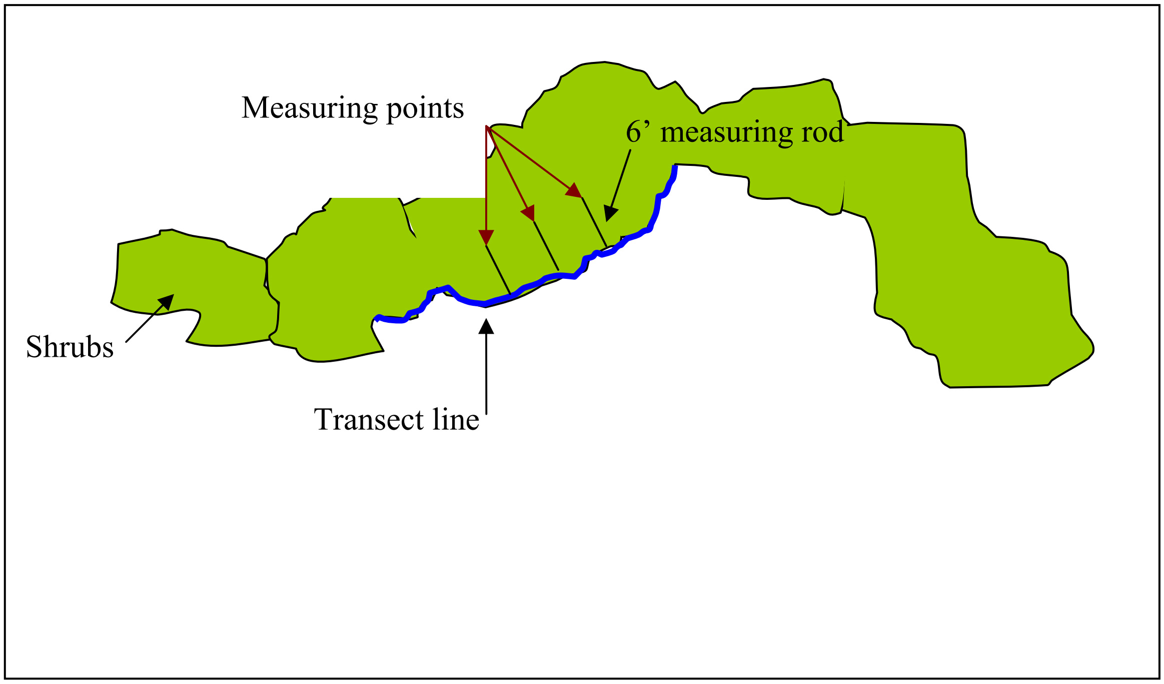

Figure 6. Modified point intercept layout example.

4D: Complex shrub intercept is used to determine percent shrub cover in multi strata shrub communities. This method is generally associated with point intercept methods whereas overlapping shrubs are identified for each stratum. Percent cover is determined for each of four possible strata as well as total percent shrub cover and overlapping percent cover.

The complex shrub intercept method is identified by adding the suffix “4D” after the appropriate line or point intercept method. For example, “4B-1-4D designates that complex shrub point intercept measurements were taken at two foot intervals. Similarly, 4C-2-4D designates that modified point intercept at five foot intervals was used to determine percent shrub cover for strata in a complex shrub community.

Shrub Height

5. Shrubs are defined as woody vegetation including trees <16 feet in height unless otherwise defined in HEP models. The Regional HEP Team assumes that trees <16 feet tall function ecologically more like shrubs than trees.

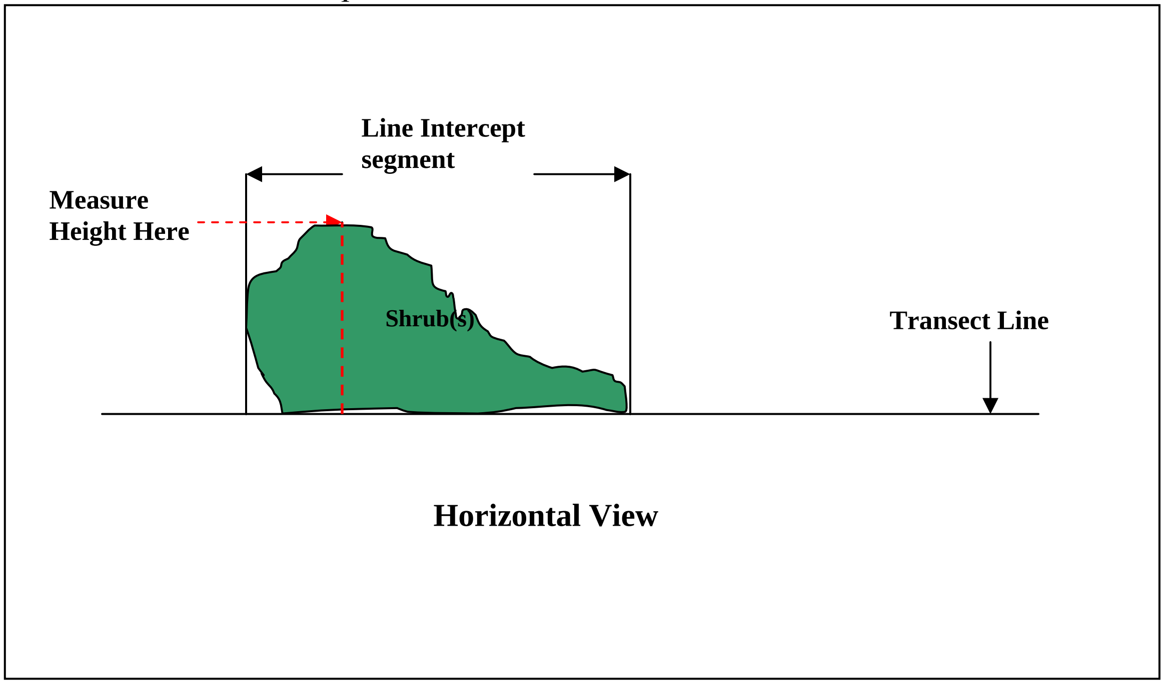

Figure 7. Line intercept shrub height measurement example.

Shrub height is measured in 10ths of feet at the highest point for each uninterrupted line intercept segment as depicted in Figure 7, or the highest point that crosses each point intercept interval mark on the transect tape (Figure 8).
In structurally complex (overlapping) shrub communities, height is measured for each stratum (maximum of four) as illustrated in Figure 9. It is assumed that shrub height measurements correspond to the method used to determine percent shrub cover. For example, if percent shrub cover is determined using the line intercept method (Figure 4), then it is assumed that shrub height will be obtained as illustrated in Figure 7.

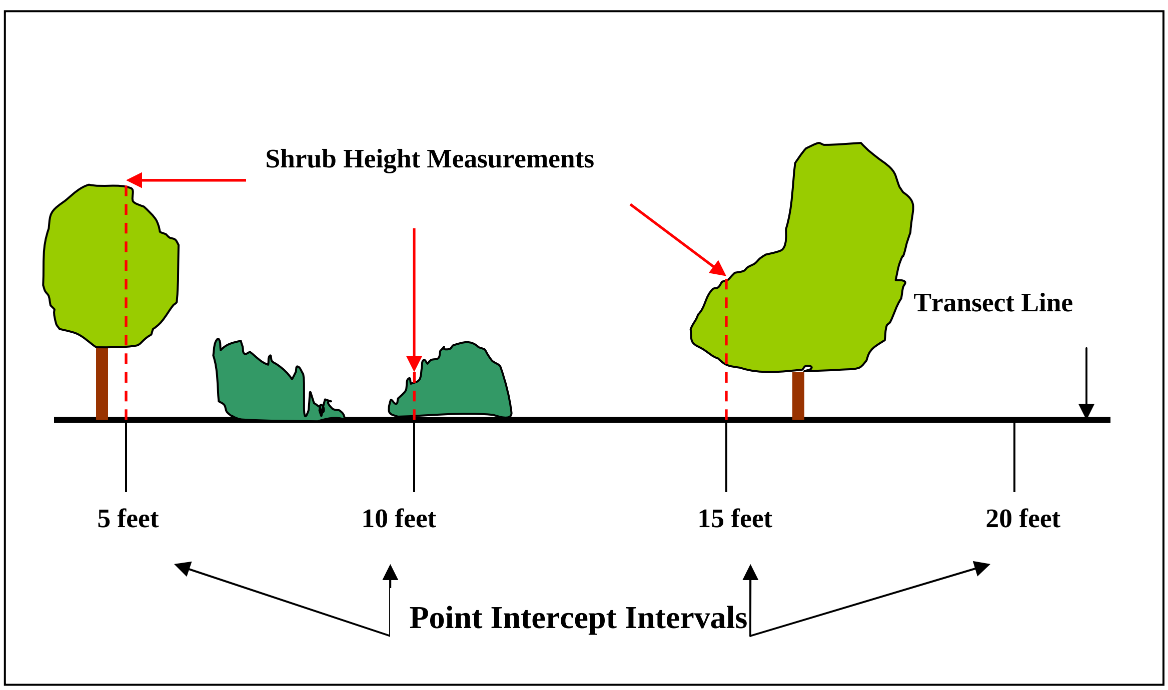

Figure 8. Point intercept shrub height example.

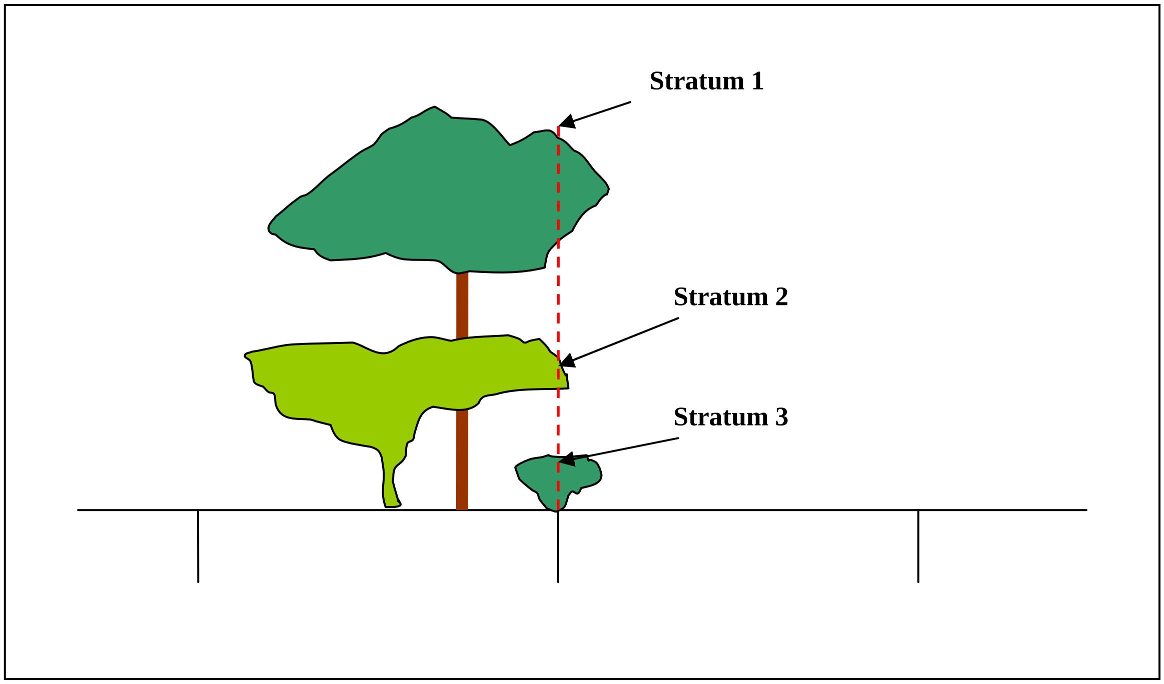

Figure 9. Complex shrub community shrub height measurement example.

Tree Measurements

Percent Canopy Cover

6. Tree canopy cover measurements are recorded at five or ten foot intervals with a densitometer (point intercept). Measurement intervals are determined by visually estimating tree canopy closure prior to initiating the survey. If estimated canopy closure is < 20% and estimated transect length ≤ 900 feet, measurements are recorded at five-foot intervals; if estimated canopy closure is > 20% and estimated transect length is ≥ 600 feet, ten-foot intervals are used. The size of the sample area strongly influences transect length. In small areas, data from several short (300 foot) transects may be “pooled” in order to determine percent tree canopy cover. As with shrubs, sampled trees are identified by species and the sampling unit is a 100 foot segment of the transect.

6A: 5’ interval

6B: 10’ interval

Height

7. Tree height is determined generally using a clinometer. In open areas, an electronic height measurement instrument may be used. Measurements are taken at the beginning and end of each transect and at 100 foot intervals. Additional samples may be taken if needed. HEP model variable requirements determine the extent of tree height measurements e.g., multi-canopy, overstory, etc.

Basal Area

8. Tree basal area data is collected at 100-foot intervals using a “factor 10” prism. Each 100-foot interval basal area observation (all tree “hits” at each 100-foot point) is considered an independent sample.

Snag DBH

9. Snag data is collected on belt transects. RHT members collect snag data in conjunction with tree canopy closure measurements using the same baseline transect. The diameter breast height (DBH) of all snags present within tenth-acre belt transects paralleling the baseline transect is measured. Either the actual DBH is recorded, or snag data is reported by class e.g., 5 snags <4" DBH, 2 snags >20" DBH etc.

Belt transects are 44 feet wide by 100 feet long i.e., 22 feet on each side of the baseline transect. Belt transect layout is depicted in Figure 10. As with shrubs and trees, the sampling unit is each 100-foot segment.

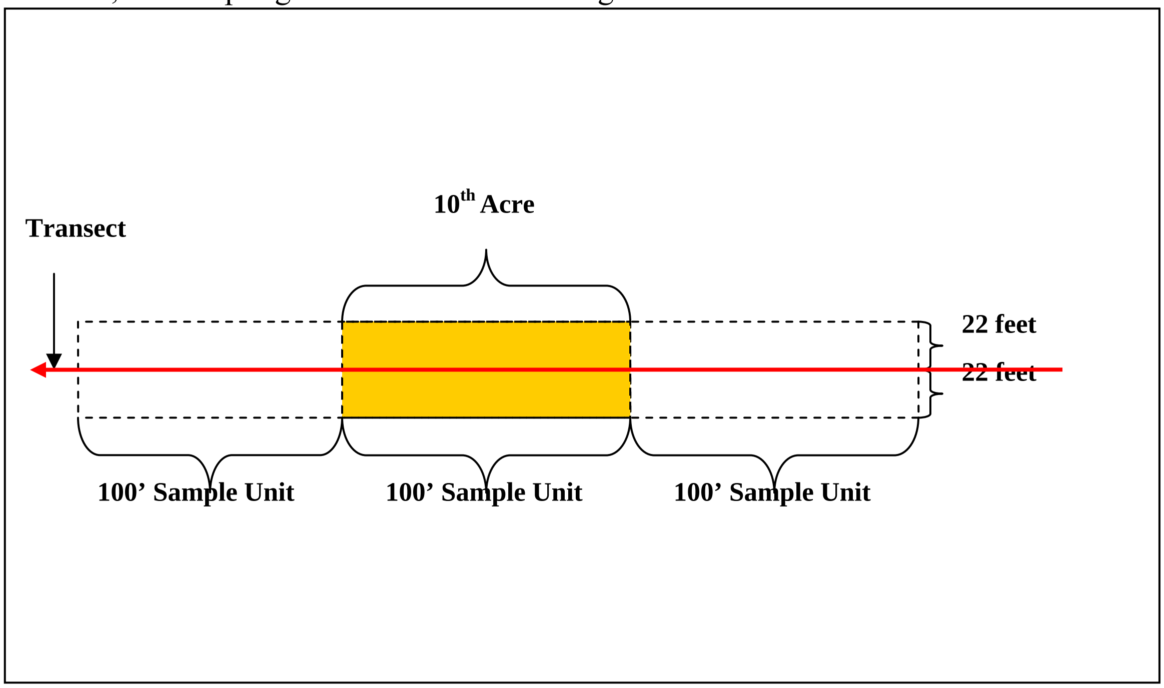

Figure 10. Belt transect layout diagram.

Sample Size Determination

The process for determining sample size (transect length) varies based on the variable measured. Shrub and tree cover and grid sample sizes are estimated as follows:

The amount of cover within each 100 foot sample unit is divided by sample unit length to obtain percent shrub/tree cover per sample unit (e.g. 10 feet of cover/100 feet = 10% shrub cover). The standard deviation for each transect is calculated for percent cover data from transect sample units. Sample size (transect length) is then determined through use of the following equation (Avery 1994):

$$n = \frac{t^2 s^2}{E^2}$$

Where: t = t value at the 95 percent (0.05) confidence interval for the appropriate degrees of freedom (df); s = standard deviation; and E = desired level of precision, or bounds (± 10 percent). Confidence intervals may vary from 80 percent (0.20) to 95 percent (0.05) depending on habitat variable heterogeneity and project management needs. The same method is used to determine sample size for micro plot samples based on total percent cover for herbaceous species.

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Appendix C-Transect Photographs

Transect 2

Transect 3

Transect 4

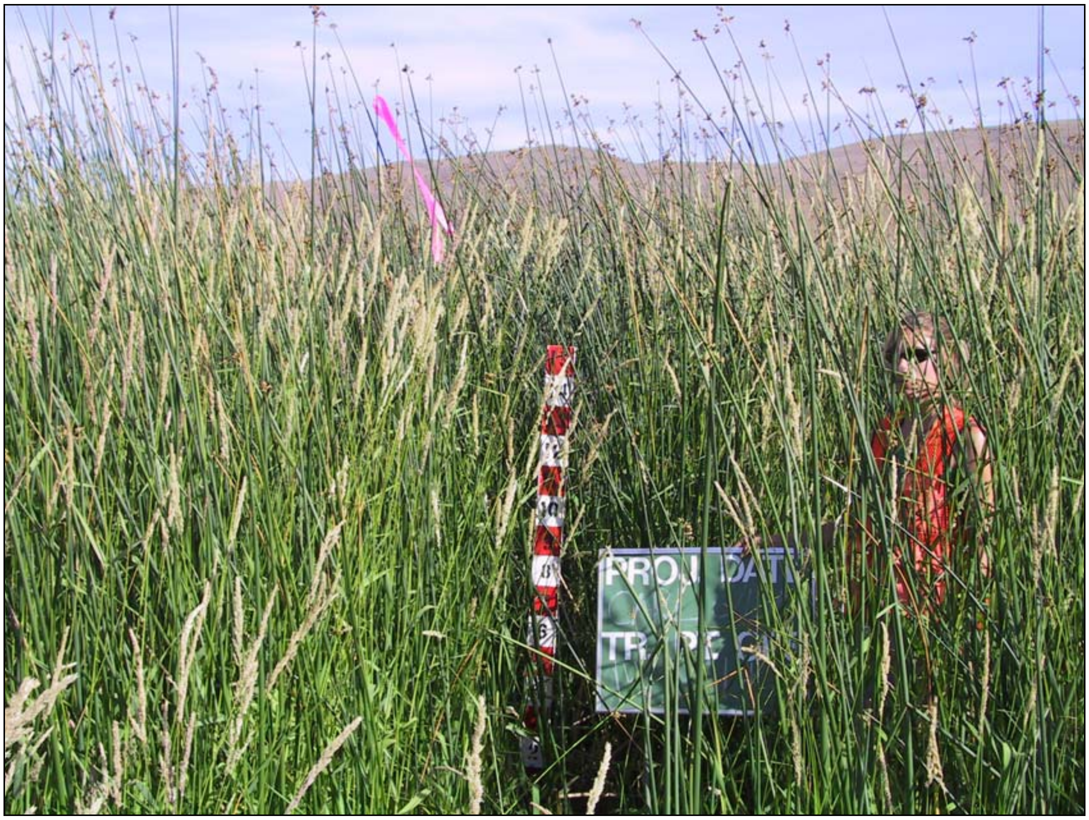
Transect 5

Transect 6

Transect 10

Transect 12

Transect 14



Transect 16

Transect 17

Transect 18

Transect 21

Transect 22

Transect 23

Transect 26

No Photograph