INDIVIDUAL DIFFERENCES IN DETECTING HABITAT ELEMENTS IN THE CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM

BRIAN B. BOROSKI[1] Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720.

REGINALD H. BARRETT, Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720.

SUSAN D. DRAPER, U.S. Forest Service, Pacific Southwest Research Station, 2081 East Sierra Avenue, Fresno, CA 93710.

JOHN G. KIE, U.S. Forest Service, Pacific Northwest Research Station, 1401 Gekeler Lane, Le Grande, OR 97850.

ABSTRACT: Users of the California Wildlife-Habitat Relationships (CWHR) System are encouraged to collect information on special habitat elements when evaluating site-specific projects. We examined the level of disagreement between 12 pairs of individuals applying the information in *A Guide to Wildlife Habitats of California* to determine the presence or absence of 123 of these habitat elements on 182, 0.25-ha plots. The level of individual disagreement, in parentheses, varied ($P < 0.001$) among the 7 major categories: physical (33%), live vegetation (30%), habitat edge (14%), vegetative diet (14%), animal diet (10%), aquatic (5%), and man-made (0.4%). The level of disagreement also varied within subdivisions of the physical ($P < 0.001$), live vegetation ($P < 0.001$), and vegetative diet ($P < 0.001$) categories, but not in the subdivisions of the animal diet category ($P > 0.25$). Discrepancies were attributed to: (1) not detecting an element, (2) misidentifying plant species, (3) errors in size estimation, (4) uncertainty regarding the biology of organisms, (5) different interpretations of an element, (6) errors associated with the temporal period being sampled, (7) change in the status (present or absent) of elements due to environmental change between sampling events, and (8) errors in data entry. Using standard training procedures within planning units, measuring rather than estimating the size of elements where applicable, specifying a standard rate at which plots are sampled, and sampling at the time of year when the most important elements for species of concern are likely to be present, should substantially reduce individual differences in the detection of the special habitat elements described within *A Guide to Wildlife Habitats of California*.

Key words: California Wildlife Habitat Relationships System, habitat, individual differences, wildlife habitat relationship models.

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The California Wildlife Habitat Relationships (CWHR) System describes the management status, distribution, life history, and habitat requirements of 643 species of terrestrial vertebrates regularly occurring in California (Airola 1988, Timossi et al. 1994). Once habitats are classified based on their floristic and structural dimensions, the System can be used to predict wildlife communities occurring within landscapes. When the CWHR System is used to predict the structure of wildlife communities within smaller project areas, Mayer and Laudenslayer (1988) recommended using a set of 123 special habitat elements recognized by the System. These elements, such as burrows, are considered important for the existence of some species and are included to improve the accuracy of predictions over those based solely on floristic and structural dimensions of habitat.

Underlying this premise is the assumption that the investigator accurately records the occurrence of these special habitat elements. Failing to detect elements and excluding them from the model would result in errors of omission (species recorded in the field but not listed by CWHR). Avery and Van Riper (1990) considered errors of omission more serious than errors of commission (species listed by CWHR but not recorded in the field) since errors of omission reflect the completeness of the data base and its validity. Block et al. (1994) found a substantial number of species omitted from predictions of the CWHR model even when few habitat elements were excluded.

We hypothesized that individuals would apply the information in *A Guide to Wildlife Habitats of California* differently and contribute to errors of omission because the recognition of elements is based on individual interpretation and visual estimates requiring human judgment, rather than objective measurement techniques. To assess the level of disagreement between individuals and to iden-

[1] Present address: U.S.F.S. Pacific Southwest Research Station, 2081 E. Sierra Avenue, Fresno, CA 93710

tify why they disagreed, we examined the differences among habitat element surveys collected during repeat visits to quadrats in Trinity County, California.

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STUDY AREA

Our study was conducted in the 720 to 1,220 m elevational range around Trinity Lake in Trinity County, California (Fig. 1). Vegetation within each of 4 sites around Trinity lake were classified using 1:12,000, true-color, aerial photographs and a 16-ha minimum mapping unit. Land-cover classes were based on the vegetation, size class, and canopy cover descriptions prescribed by the CWHR System (Mayer and Laudenslayer 1988) and 8 aspect categories: 0-44, 45-89, 90-134, 135-179, 180-224, 225-269, 270-314, 315-359 degrees. Vegetation types within the study area included Klamath mixed conifer, montane hardwood-conifer, montane hardwood, Douglas-fir (*Pseudotsuga menziesii*), montane chaparral, and ponderosa pine (*Pinus ponderosa*) (Mayer and Laudenslayer 1988).

METHODS

We proportionally allocated 182 quadrats, 50-m x 50-m in size, based on the areas of the refined CWHR types within each of 4 sites. The particular land-cover polygon in which the quadrat was located and the placement of the quadrat within the polygon was randomly determined. One of 8, lone observers recorded whether 123 special habitat elements (Table 1) were present at any time during the year on each quadrat. On a subsequent visit to the quadrat, another lone observer assessed the year-long presence or absence of the 123 elements. In all, 12 unique observer pairs were used.

A Guide to Wildlife Habitats of California (Mayer and Laudenslayer 1988) was designed with definitions describing the special habitat elements used in the models. Since our goal was to assess the outcome of different individuals applying the information within the guide, the individuals did not receive standardized training as to the interpretation of the definitions nor instruction on how long to sample or how often to physically measure features of elements, such as diameter at breast height (dbh), to verify their ocular estimates. Each individual relied solely on the information within *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988). Furthermore, although all individuals had experience sampling vegetation within the study area, they had no prior experience working with the special habitat elements that would have biased their interpretation of the definitions.

Three of the 123 habitat elements that dealt with hollow logs and slash were incorrectly typed on the data form and, therefore, removed from the analysis. We used chi-square (χ^2) analyses (Zar 1984:61-70) to test whether levels of disagreement between individuals were similar in the 7 major habitat element categories and their subdivisions (Table 1). After data analysis, individuals participating were questioned to identify factors contributing to their disagreement.

RESULTS

The level of individual disagreement varied (χ^2 = 2,080, df = 6, $P < 0.001$) among the 7 major habitat element categories (Fig. 2) and within the subdivisions in the physical (χ^2 = 145.5, df = 1, $P < 0.001$), live vegetation (χ^2 = 247.4, df = 2, $P < 0.001$), and vegetative diet categories (χ^2 = 40.4, df = 2, $P < 0.001$), but not in the subdivisions of the animal diet category (χ^2 = 0.96, df = 1, $P > 0.25$) (Fig. 3). The level of disagreement for specific elements ranged from 0 (no disagreement between individuals concerning a particular element on 182 plots) for several elements up to 73% for the aerated soil element ($n = 55$, $x = 27.38$, $se = 2.83$) (Table 1).

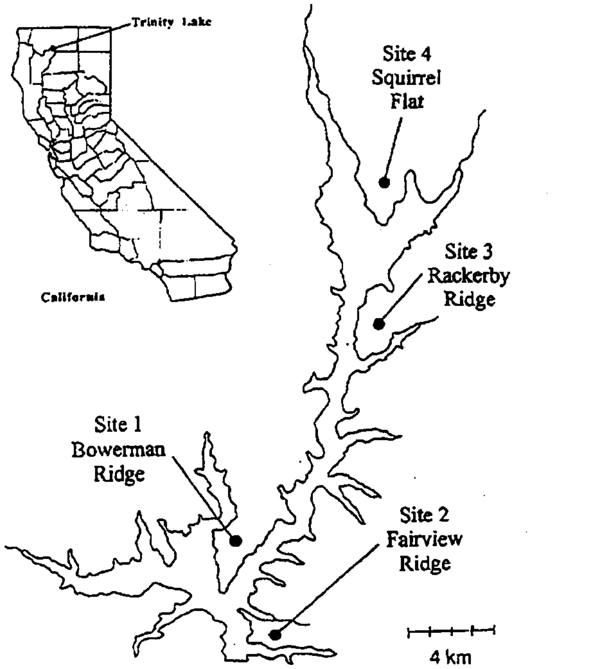

Fig. 1. The sites in which study plots were located around Trinity Lake in Trinity County, California.

Based on post data analysis discussions, discrepancies between individuals were attributed to: (1) not detecting an element; (2) misidentifying plant species; (3) errors in size estimation, such as under estimating dbh; (4) uncertainty regarding the biology of organisms, particularly invertebrates and amphibians; (5) different interpretations of an element which often resulted from judgments pertaining to the degree necessary before the element was considered present, such as the required size of a patch of barren ground or the height a soil bank must be before being considered a cliff; (6) errors associated with the temporal period being sampled (present day, seasonal, or yearlong); (7) change in the presence of elements due to environmental changes between sampling events, and (8) errors in data entry.

To identify the degree to which each of the 8 discrepancy classes contributed to individual disagreement, we assigned at least one class to each element, unless there was no disagreement (Table 1). Different interpretations by individuals, errors in size estimation, and an individual not detecting an element were the principal factors causing disagreement (Fig. 4).

At least 93% of the elements within the major habitat element categories with the highest levels of individual disagreement, physical and live vegetation, had at least 1 of these factors as a possible cause for disagreement.

Data entry errors could have contributed to individual disagreement in all of the elements, so we did not include that class in the analysis. We estimated the level of disagreement that could be attributed to data entry errors to be <1%, within any element, based on the results (Table 1) for the following elements that obviously did not occur within the study area: bogs, grass/agriculture, kelp, jetty, salt ponds, sand dune, shrub/agriculture, tide pools, tree/agriculture, water/agriculture, and wharf.

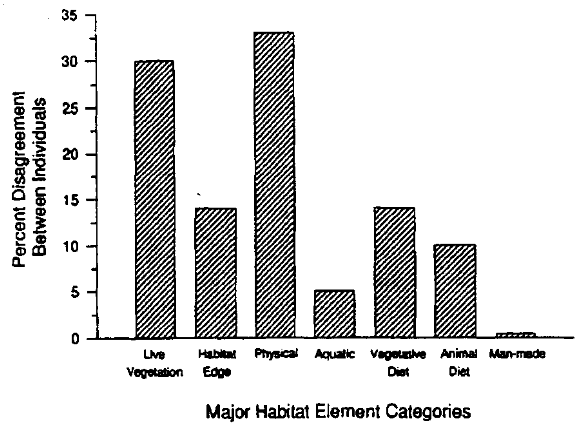

Fig. 2. Levels of individual disagreement in 7 habitat element categories identified within the California Wildlife Habitat Relationships System.

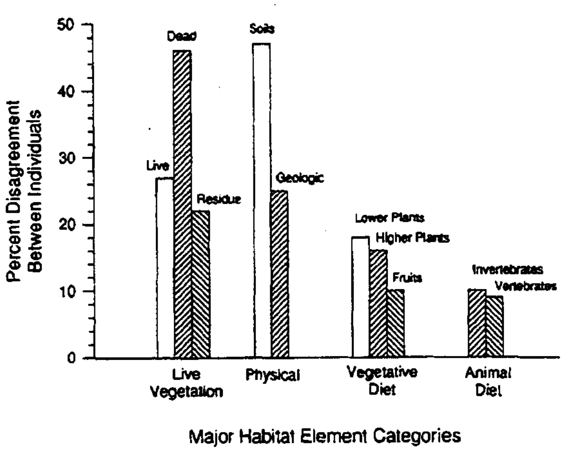

Fig. 3. Levels of individual disagreement in the subdivisions of 4 habitat element categories identified within the California Wildlife Habitat Relationships System.

DISCUSSION

As we hypothesized, there were significant differences between individuals applying the information within *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988) to determine the presence or absence of CWHR System special habitat elements. Individual differences in studies involving visual estimation of vegetation parameters have been reported by others (James and Shugart 1970, Gotfryd and Hansell 1985, Block et al. 1987).

Identifying the reasons why individuals disagreed in their assessments can be used to identify practices to reduce individual differences in the future. Although levels of individual disagreement would be expected to vary with different land-cover types in different geographic locations, we hypothesize the reasons for disagreement would be similar to those we identified. Our results suggest the principal causative factors were, in order of im-

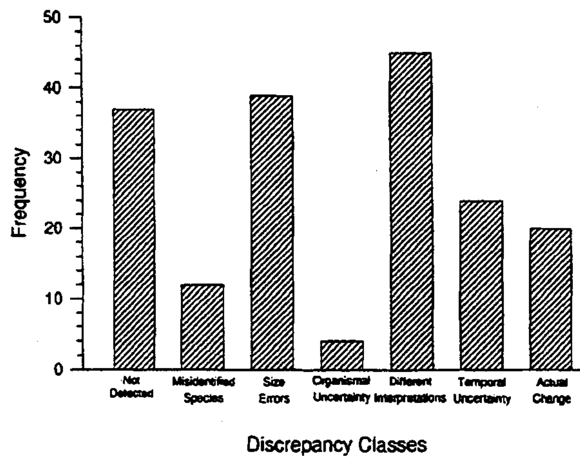

Fig. 4. The frequency of 7 discrepancy classes that could explain individual disagreement in detecting 120 habitat elements within the California Wildlife Habitat Relationships System.

portance: different interpretations of the special habitat element descriptions (Mayer and Laudenslayer 1988), errors in size estimation, an individual not detecting an element, errors associated with the temporal period being sampled, change in the presence of elements due to environmental changes between sampling events, misidentifying plant species, and uncertainty regarding the biology of organisms. Although it is possible that the status (presence or absence) of some elements changed between sampling events, we think this was unlikely. Rather, the differences that could have occurred due to actual changes probably resulted from different interpretations, errors in size estimation, or not detecting the element.

We suggest that individual differences can be reduced by using standard training procedures within planning units, measuring the size of elements, specifying a standard sampling rate, and sampling at the time of year when the most important elements to species of special concern are likely to be present (James and Shugart 1970, Noon 1981).

We agree with Johnson (1981) that variability among land-cover types, as will be found throughout the state of California, may make one set of standard training procedures insufficient. However, the development of training procedures within a planning unit should be valuable. Within planning units, a meeting of the individuals can be used to discuss definitions. Even though *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988) provides descriptions of each special habitat element, reading the descriptions was not always sufficient since there remained enough ambiguity for individual interpretation. Further elements of the training could include learning species that might be misidentified and discussing the biology of organisms that some individuals might not be familiar with.

Individuals should make physical measurements of those elements with a size component since physical measurements are typically more accurate than visual estimates (Schultz et al. 1961, Block et al. 1987), although they have their own associated biases. In most cases, a tape to measure dbh, a regular cloth tape, and a clinometer is all the equipment that will be needed. Since the objective is to assess the presence or absence of elements, little extra time should be required.

Some individuals tend to be better at observing objects than others (Kie and Boroski 1995). Specifying a standard sampling rate should reduce the frequency with which elements are missed and species misidentified if the rate is based on the less accomplished individuals. As with training procedures, variability among land-cover types will make a single standardized sampling rate inappropriate.

Our assessment of special habitat elements was aimed at determining whether elements were present at any time during the year. This design caused individuals to speculate on the past or future state of elements. Minimizing the degree to which individuals must speculate should reduce differences at scales similar to ours. If the area sampled was large, all individuals may be more likely to speculate that elements were present within the area, thus reducing disagreement. When the goal is a year long or seasonal assessment, more than one sampling may be necessary. Another suggestion is to sample at the time of the year when the elements most important to species of concern would be present.

We recommend using standard training procedures within planning units, measuring rather than estimating the size of elements where applicable, specifying a standard rate at which plots are sampled, and sampling at the time of year when the most important elements for species of concern are likely to be present. Implementing one or more of these approaches should reduce individual differences and improve the accuracy of predictions from the CWHR System.

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Table 1. Individual disagreement in determining the presence of special habitat elements listed in the California Wildlife Habitat Relationship System. Numbers in parentheses refer to discrepancy classes in the text.

Major category / Subdivisions / Elements	Percent disagreement	Elements	Percent disagreement
Live vegetation			
Live subcategory			
Tree layer (3)	7	Shrub layer (3)	32
Herbaceous layer (3)	44	Trees, hardwood (3)	6
Trees, pine (3)	21	Trees, fir (2,3)	12
Trees, broken top (1,3,7)	60	Trees, loose bark (1,5)	51
Trees, with cavities (1,7)	46	Riparian inclusion (1,5)	13
Aquatics, submerged (1,2,7)	14	Aquatics, emergent (7)	13
Dead subcategory			
Snag, small (rotten) (1,3,5)	52	Snag, small (sound) (1,3,5)	58
Snag, medium (rotten) (3,5)	46	Snag, medium (sound) (3,5)	51
Snag, large (rotten) (3,5)	26	Snag, large (sound) (3,5)	25
Stump (sound) (1,3,5)	57	Stump (rotten) (1,3,5)	54
Residue subcategory			
Duff (5)	11	Litter (1,3,5,6,7)	3
Slash, small (3)	27	Slash, large (sound) (3,5)	12
Slash, large (rotten) (3,5)	12	Slash, large (hollow)	na
Log, medium (sound) (3,5)	47	Log, medium (rotten) (1,3,5)	37
Log, medium (hollow)	na	Log, large (sound) (3,5)	25
Log, large (rotten) (1,3,5)	31	Log, large (hollow)	na
Brush pile (3)	15		
Habitat edge			
Tree/shrub (3,5)	43	Tree/grass (3,5)	27
Tree/water (3,6)	12	Tree/agriculture (8)	<1
Shrub/grass (3,5)	32	Shrub/water (3,6)	13
Shrub/agriculture (8)	<1	Grass/agriculture	0
Water/agriculture	0	Grass/water (3,5,6)	10
Physical			
Soils subcategory			
Soil, friable (5)	62	Soil, organic (3,5)	34
Soil, gravely (3)	41	Soil, sandy (3)	71
Soil, aerated (5)	73	Soil, saline (2)	1

Table 1. Continued.

Major category Subdivisions Element	Percent disagreement	Elements	Percent disagreement
Geologic subcategory			
Barren (5)	54	Bank (5)	28
Sand dune	0	Burrow (1,6,7)	16
Cave (1,5)	1	Cliff (5)	2
Lithic (3,5,7)	38	Talus (5)	3
Steep slope (3)	35		
Aquatic			
Water (6,7)	13	Vernal pools (1,5)	2
Ponds	0	Lakes (7)	<1
Streams, intermittent (1)	11	Streams, permanent (3,5)	2
Rivers (3,5)	1	Mud flats (5)	3
Springs (1,5,7)	8	Mineral springs (1,5,7)	<1
Bogs	0	Hot springs	0
Tide pools (8)	1	Water, slow (3,5,7)	16
Water, fast (3,5,7)	16		
Vegetative diet			
Lower plants subcategory			
Fungi (1,2,6,7)	23	Lichens (1,2,7)	7
Moss (1,2,7)	50	Ferns (1,6)	29
Kelp	0	Algae (1,2,6)	14
Higher plants subcategory			
Graminoids (1,2,6)	12	Forbs (1,2)	6
Shrubs (1,2)	7	Tree leaves (6)	4
Sap (8)	<1	Roots (5)	66
Fruits subcategory			
Seeds (1,6)	1	Acorns (1,6)	7
Grain (1,2,6)	40	Berries (6)	8
Fruits (1,2,6)	3	Nuts (1,6)	10
Cones (1,4,5)	3	Flowers (1,6)	2
Nectar (1,6)	15		
Animal diet			
Invertebrates subcategory			
Invertebrates (4)	31	Insect, terrestrial	0
Insect, flying (6)	<1	Aquatic invertebrates (1,4)(6,7)	17
Vertebrates subcategory			
Fish (1,7)	2	Amphibians (4,7)	43
Reptiles (4,6)	2	Birds, small	0
Birds, medium	0	Birds, large	0
Mammals, small	0	Mammals, medium	0
Mammals, large	0	Carrion (6)	48
Eggs (6)	7		
Man-made			
Nest island	0	Nest box	0
Nest platform (5,7,8)	1	Transmission lines	0
Buildings	0	Fences	0
Campgrounds (1,5)	<1	Pack station (5)	1
Water, man created (8)	<1	Dump (5)	1
Wharf	0	Jetty	0
Salt ponds	0		