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METHODOLOGIES USED TO ASSESS THE RELATIVE IMPORTANCE OF ECOLOGICAL LAND CLASSIFICATION UNITS TO BLACK BEARS IN BANFF NATIONAL PARK, ALBERTA

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Abstract: Methodologies of a 3-year study of black bear (*Ursus americanus*) habitat use in Banff National Park, Alberta are presented. The study was designed to determine if black bear habitat use could be described by an existing 1:50,000 scale Ecological (Biophysical) Land Classification (ELC) of Banff National Park. Fifteen bears were radio-collared and their use of ecological land units (ecosites) was determined through 1,855 locations. Feeding signs were recorded and 466 scats collected. Seasonal ecosite importance ratings on a 5-tier scale were assigned using a 3-step process. First, a subjective assessment was conducted that relied on the biologists' field experience during the study, results of scat analysis, and tabulation of feeding signs found. Second, the telemetry results were analyzed for the observed versus expected use of ecosites by bears as determined by the area of each ecosite. Third, a food habits model that was based on the relative percent occurrence of ELC vegetation types and key bear foods within each ecosite was used to derive a second set of seasonal ecosite importance ratings. From 77-90% of seasonal ecosite ratings either matched for all 3 methods, or differed by 1 rating class between the subjective and modeled techniques. This strong consistency between rating methods indicates that the relative importance of closed legend ecosites at a 1:50,000 scale of mappings can be discerned within a 5-tier rating system. It is cautioned that at this scale of mapping, the rating classes serve only as a first-order planning tool. High ratings should raise a red flag to managers who must then conduct site-specific investigations.

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Although black bear habitat use in North America has been documented by several authors (Lindzey and Mellow 1977, Unsworth 1984, Young 1984, and others), few studies have utilized an existing land classification as a framework to describe and evaluate habitat use. This paper reports on how an existing ecological (biophysical) land classification was used to organize and evaluate black bear habitat use patterns. The research was conducted as part of a 3-year study of black bear ecology in Banff National Park (BNP), Alberta (Kansas et al. 1989a).

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STUDY AREAS

We investigated the North Saskatchewan and the Bow Valley study areas in the north and south of BNP, respectively. The eastern two-thirds of both study areas occur in the front ranges of the southern portion of the Rocky Mountain Thrust Belt (Holland and Coen 1982). The Montane ecoregion occupies river valley bottoms from 1,350 m to 1,600 m. The Lower Subalpine ecoregion occurs on valley slopes ranging from 1,600 m to 2,000 m, while the Upper Subalpine ecoregion is found on upper valley slopes of from 2,000 m to 2,300 m. The Alpine ecoregion occurs above 2,300 m, but has a very limited area within the study areas.

Contrast Between the Study Areas

The 2 intensive study areas differ considerably in terms of their habitat features. A dry, montane influence is considerably more prevalent in the Bow Valley study area than in the North Saskatchewan study area. The greater extent of this montane climatic influence in the Bow Valley is reflected by a greater occurrence of typical montane vegetation such as Douglas-fir (*Pseudotsuga menziesii*) forest, xeric grassland and aspen (*Populus* spp.) forest. Roadside vegetation in the Bow Valley study area is less herbaceous and lush as a result of this climate difference. Avalanche tracts (especially south-facing) are more prevalent in the North Saskatchewan area, while there are more extensive tracts of riparian white spruce (*Picea glauca*)/horsetail (*Equisetum* spp.) and montane wet shrub vegetation types in the Bow Valley study area than in the North Saskatchewan area.

METHODS

Bear Monitoring

Bears were instrumented with radio-collars (LOTEK Engineering Ltd.) and monitored regularly. Monitoring of radio-collared bears included close approach telemetry, remote triangulation and follow-up site-specific investigations. Only 1 location was made per bear per day to ensure statistical independence of samples. All known black bear scats were collected and preserved. More detailed methods of bear capture, handling and monitoring are available in Kansas et al. (1989a).

Habitat Evaluation Transects

The existing ecological land classification (ELC) of Banff and Jasper National Parks (Holland and Coen 1982) is a semi-closed legend mapping system that maps 124 different ecological units or ecosites, at a 1:50,000 mapping scale. These ecosites are easily identifiable, holistic and repeating map unit concepts. The mapped ecosites were classified on the basis of broad vegetation physiognomy and, to some extent, floristic differences in vegetation as well as differences in soil parameters. Ecosites are grouped within 55 ecoregions that are based on broad differences in genetic materials and drainage classes as reflected by landform features. Ecoregions are in turn grouped within 4 ecoregions: Alpine, Lower and Upper Subalpine and Montane. The ecoregion is the broadest level of ecosystem classification and reflects major differences in macroclimate.

A plant association classification was also developed for the ELC of Banff and Jasper National Parks (Holland and Coen 1982). The vegetation was classified into 37 Closed Forest (C), 19 Open Forest (O), 12 Shrub (S), 7 Low Shrub Herb (L), and 20 Herb-Dwarf Shrub (H) types. A separate map of vegetation types was not produced, although detailed vegetation accounts (Holland and Coen 1982) discuss affinities between dominant vegetation types and ecosites.

To quantify the percentage occurrence of detailed vegetation types within ecosites, habitat evaluation transects were established. Transects were 0.5 km long and were limited to a single ecosite and aspect. Most transects were compassed in a straight line or followed the contour of the slope. The observer stopped at 50-m intervals along the length of the transect and recorded the ELC vegetation type for the area in a 10-m radius around the observer.

A running total of the number of microhabitat inclusions that were intersected was kept and recorded at the end of each transect. These were defined as local concentrations of preferred bear food items that could not be mapped at a scale of 1:50,000, and did not correspond to an existing ELC vegetation type.

Subjective Assessment of Seasonal Ecosite Importance

A subjective evaluation of ecosite importance to black bears was conducted for all ecosites represented in the 2 intensive study areas. Importance rating of nil, low, medium, high or very high were assigned to each ecosite for each of 4 black bear seasons (green-up, ant, buffaloberry [*Shepherdia canadensis*] and post-buffaloberry; Kansas et al. 1989a). Subjective assessments were con-

ducted for each of the 3 years of the study.

Initially, the field researchers independently assigned ratings to the ecosites that occurred in the study area(s) where they each had conducted intensive fieldwork. They used detailed vegetation and geomorphology descriptions from the Banff/Jasper ELC report (Holland and Coen 1982), and food habits data from scat analysis and seasonal observations of feeding sign.

The ratings were assigned within the context of BNP as a whole, since more than three-quarters of the total ecosites are common to both study areas. For those ecosites that occurred over a wide range of aspects, the rating was chosen for the aspect that produced the optimum food and cover requirements of black bears.

The results of the independent ratings were then compared, and finalized annual ratings were arrived at by consensus among the individual observers.

Modeled Assessment of Seasonal Ecosite Importance

A food habits-based computer model was also developed to generate ratings for the same ecosites and seasons used in the subjective evaluation. This model was similar conceptually to procedures developed by Mace (1986) and Hadden et al. (1986) for grizzly bears.

The first step in the modeling process was to identify all known and potential black bear foods in BNP from the results of 3 years of scat analysis and black bear feeding sign observations (Kansas et al. 1989a). All bear foods were then assigned an importance rating, or Food Importance Value (FIV) for each of the 4 black bear seasons. The rating scheme was subjective, and consisted of 6 classes and associated numerical ratings, as follows:

- 5 = A seasonally critical food
- 4 = A highly important food
- 3 = A moderately important food
- 2 = A food item of moderate to low importance
- 1 = A food item of low importance
- 0.5 = A food item of very low importance

Only food plants were included in the preliminary model. Graminoids were not integrated into the model because of their high percent cover and "masking influence" on more important bear foods. Ants were not integrated due to the difficulty in measuring a percent cover of logs inhabited by ants. Future versions of the model will integrate ants and graminoids.

The next step in model development was to calculate Vegetation Type Importance Values (VTIV). Calculation of VTIV followed 4 steps:

1. Downloading vegetation stand (releve) data from

the Banff, Jasper and Kootenay ELC's to a microcomputer.

2. Manipulating stand data using spreadsheet software to calculate the average percent cover and frequency of occurrence of each bear plant food for each ELC vegetation type.

3. Multiplying the average percent cover by the frequency of occurrence to produce an index of availability for each bear food within each vegetation type.

4. For each vegetation type and month, multiplying the index of availability times the monthly FIV, followed by summation across all available food items. This provides a (VTIV) for each month.

The final stage of the model involved the calculation of monthly Ecosite Importance Values (EIV) by integrating the monthly VTIV with the results of the habitat evaluation transects (i.e., the percent occurrence of ELC vegetation types within each ecosite).

The formula used to calculate an Ecosite Importance Value is:

$$\text{EIV} = \text{Sum of } (\% \text{ vegetation type occurrence} \times \text{VTIV})$$

The range of EIV's within each season were then split into 4 equal categories to obtain very high, high, moderate and low ratings. A rating of nil was given to ecosites having EIV's equal to zero.

Ecosite Preference/Avoidance Testing

Radio-telemetry locations were analyzed to determine if the observed bear use of ecosites was greater or lesser than the expected use based on the area of each ecosite. Analyses were conducted separately for each of the 2 intensive study areas.

To optimize sample sizes, we grouped ecosites into functional units based on similarities in geomorphology and vegetation (Kansas et al. 1989a). These groupings were adapted from the ecosite accounts of the Banff/Jasper Biophysical Inventory report (Holland and Coen 1982). Bear seasons were tested independently of one another.

The following rules were set to guide the grouping of ecosites into functional units:

- Ecosites were lumped within ecoregions. In a few cases, ecosites from different ecoregions were grouped if vegetation similarities warranted it.
- Cover as well as food values were taken into account when grouping.
- The lumping of ecosites with similar vegetation type occurrence, but significantly different surface expressions (e.g., hummocky versus inclined) was avoided because localized inclusions of key bear

foods resulting from landform irregularities could occur.

- Lumping criteria in the Upper Subalpine and Alpine ecoregions was not as critical because black bears rarely utilized them.

The relative area, or availability, of ecosites was first determined by delineating the composite home ranges of all study animals on a 1:50,000 ELC map. A 2-km buffer strip was then arbitrarily scribed around this composite home range. CanSIS (Canadian Agricultural Soils Information System) supplied ELC maps, with polygon by polygon area measurements. These were used to calculate the relative area of ecosites and functional units. A Geographical Information System (GIS) was used to calculate area totals by ecosite. The number of observed versus expected telemetry locations was compared as a test of ecosite preference or avoidance.

This test could not be performed statistically due to the large number of cells and the small sample sizes ($n < 5$) in many of the cells. Nevertheless, a rating system was designed to indicate trends in bear preference or avoidance of ecosites. An ecosite in a study area was considered to be used greater than expected if either the observed or expected value in the cell was ≥ 5 and if the ratio of observed to expected was ≥ 2.0 . An ecosite was considered to be used less than expected if either the observed or expected value was ≤ 5 , and if the ratio of observed to expected was ≤ 0.5 . No conclusion was drawn if both the observed and expected values were ≤ 5 or if the ratio of observed to expected was > 0.5 and < 2.0 .

RESULTS AND DISCUSSION

Bear Capture and Monitoring

Fifteen bears were radio-collared and 1,855 locations were made. Excluding 62 remote locations of den sites, 66% of the locations were classified as being site-specific; 26% as remote; 7% as incidental visual observations and 1% as trap-related.

We collected and analyzed 466 known black bear scats (Raine and Kansas 1990).

Habitat Evaluation Transects

We sampled 2,501 habitat evaluation transects (25,010 sampling points) for Banff (1,019), Jasper (868), Kootenay (386) and Yoho (228) National Parks (Kansas et al. 1989b). All ecosites in the 2 intensive black bear study areas were sampled. Data from ecosites in Jasper, Kootenay and Yoho National Parks that were conceptually the same as those present in BNP were used in the analyses

of vegetation type occurrence. We believe that detailed vegetation type affinities with ecosites may vary among national parks but for the purposes of this experimental model we have lumped data.

Up to 66 ($\bar{x} = 14$) transects were conducted and 2 to 29 ($\bar{x} = 15$) different vegetation types observed per ecosite. Most ecosites, however, were found to be composed of 4 or 5 dominant vegetation types.

Subjective Assessment of Ecosite Importance

The levels of consistency among observers for the subjective ecosite ratings were generally considered to be high and increased slightly as the study progressed (Kansas et al. 1989a). From 79 to 93% of independent seasonal ecosite rating were either the same rating for all 3 observers or 1 observer differed by only 1 rating class (Table 1). All 3 observers differed on from 4 - 10% of the ratings, although instances of 1 observer differing by 3 rating classes from the other 2 was very rare (0 - 5%).

Understanding ecosite habitat conditions and bear use improved considerably throughout the course of the study. Also the 2 principal researchers were involved in all 3 annual assessments, thus the Year 3 consensus ratings were usually considered as final subjective ratings for the project.

Modeled Assessment of Seasonal Ecosite Importance

The seasonal ecosite ratings generated from the food habits model were not intended to stand alone as final ratings. The function of the model was to refine final ratings in conjunction with subjective evaluations and preference/avoidance testing. The modeled ratings reflected the seasonal importance of ecosites based only on

key bear food occurrence.

One limitation of the food habits model is the current lack of integration of ants or ant inhabited deadfall into the modeling process. Raine and Kansas (1990) found that black bears fed extensively on ants during the early summer months. Unfortunately, little is known of differences in ant production relative to deadfall species, ecoregion, aspect, and moisture regime. Subjectively, we noted that certain habitats favour ant production (e.g., dry montane pine habitats), but integration of specifics into the modeling process cannot be achieved until further ant habitat research is conducted.

Another limitation of the food habits model was the integration of graminoids (grasses and sedges) into the modeling process. Graminoids were found to be important in the diet of bears in BNP (Raine and Kansas 1990) and most vegetation types contain graminoids with moderate to high cover and frequency of occurrence values. When VTIV's are calculated, the relatively high availability index of graminoids tends to obscure the influence of other more important bear foods on VTIV's. This was also complicated by the many different species of graminoids. The model mechanics were based on the derivation of availability indices for individual species, and hence the model was not suited for multiple grass/sedge species. Mace (1986) and Hadden et al. (1986) also faced similar problems with grasses and sedges and chose to either ignore them or reduce their availability indices by a standard fraction. In this first stage of model development, we chose to ignore graminoids.

Ecosite Preference/Avoidance Testing

A total of 112 ecosites were evaluated for this study. After similar ecosites were lumped into functional units

Table 1. Levels of consistency among 3 independently conducted subjective assessments of seasonal ecosite importance - Banff National Park black bear research - Year 2 - 1987.

Rating Consistency Class	Definition	Season							
		Green-up <i>n</i> =73		Ant <i>n</i> =73		Buffaloberry <i>n</i> =73		Post-Buffaloberry <i>n</i> =73	
Very High	Same rating from all 3 observers	32	(44%)	38	(52%)	35	(48%)	27	(37%)
High	One observer differs by 1 rating class	32	(44%)	20	(27%)	33	(45%)	40	(55%)
Moderate	One observer differs by 2 rating classes	2	(3%)	5	(7%)	2	(3%)	1	(1%)
Low	One observer differs by 3 rating classes	0		4	(5%)	0		1	(1%)
Very Low	All 3 observers differ	7	(10%)	6	(8%)	3	(4%)	4	(5%)

there were 51 units requiring evaluation for 4 bear seasons each. Hence use/availability comparisons were required for 204 space/time situations. Considering that 1,855 telemetry locations were collected, this allowed for an average of only 8.8 locations per assessment. As a result, standard Chi-square testing could not be justified. Nonetheless, the data provided a useful third technique for assessing ecosite importance. The preference/avoidance evaluation was used primarily to confirm matching subjective and modeled assessments, or to aid in sorting out discrepancies between the 2. For example, the subjective rating might have been low whereas the modeled assessment may have indicated high importance. If the preference/avoidance data indicated a strong preference (i.e., the ecosite appeared to have been used more often than would be expected based on its relative area) then the subjective evaluation would be accepted. In most cases it was necessary to refer to the raw data and to note sample sizes per cell.

We recognize that the preference/avoidance evaluation was based on habitat use, which can be quite variable, given year-to-year variations in bear food production, bear densities, etc. Conversely, our subjective and modeled assessments were based on an ecosite's potential to provide habitat for bears. However, we feel that by studying bears over a 3-year period, during which changes in berry production were documented (Kansas et al. 1989a), and by studying 2 different bear populations, that between-year and between-population differences in bear use of ecosites were ameliorated.

Consistency Comparison Between 3 Assessment Techniques

Table 2 presents a summary of the degree of consistency that occurred among the 3 different assessment techniques. Rating consistency was considered to be high, given the major differences between evaluation techniques. From 77 to 90% of ecosite/season ratings either matched for all 3 methods, or differed by 1 rating class between the subjective and modeled techniques, and had a corroborating preference/avoidance assessment.

In conclusion, by utilizing 3 independent habitat evaluation methods, we were able to produce final ecosite ratings that were often more accurate than if 1 method was used on its own. The process of annual independent subjective assessments, with a meeting to yield consensus, proved to be an important tool for understanding bear response to ecological land units. Iteration among the 3 evaluation techniques to achieve final ratings also forced us to look more closely at the habitat conditions within ecosites and their seasonal value to black bears.

We recognize that factors such as year-to-year food availability, bear densities, elevation, cover and fire history also influence black bear habitat use. However, since this is a preliminary stage of model development, we have not yet attempted to integrate these factors directly into the model.

The strong consistency among rating methods led us to believe that the relative importance of closed-legend ecological land units at a 1:50,000 scale of mapping can

Table 2. Seasonal ecosite rating consistency among 3 evaluation methods - Banff National Park black bear research, 1986-88.

Rating consistency	Definition	Season			
		Green-up	Ant	Buffaloberry	Post-Buffaloberry
Very High	Same rating for subjective and modeled (preference/avoidance on)	51%	55%	56%	43%
High	Same rating for subjective and modeled (preference/avoidance off)	15%	5%	7%	6%
Moderate	Subjective and modeled ratings differ by 1 class (preference/avoidance on)	30%	35%	28%	34%
Low	Subjective and modeled ratings differ by 1 (preference/avoidance off)	3%	4%	6%	8%
Very low	Subjective and modeled ratings differ by 2 classes	1%	1%	3%	9%

be discerned within a 5-tier rating system. Although black bears were found to use food items on the landscape in a more precise manner than can be mapped at 1:50,000, the existing land classification partitioned key bear foods to the degree that seasonal patterns of black bear habitat response could be described by mapped ecosites. We caution that at this scale of mapping, the rating classes serve only as a first-order planning tool. Very high or high ratings should raise a red flag to managers who must then conduct further field investigation if site-specific planning is required. Important black bear microhabitats cannot be mapped or rated at a 1:50,000 mapping scale.

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