THE ROLE OF TOPOGRAPHY IN HABITAT SELECTION BY GRIZZLY BEARS IN THE NORTHCENTRAL ALASKA RANGE

By

Toby A. Boudreau

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THE ROLE OF TOPOGRAPHY IN HABITAT SELECTION BY GRIZZLY BEARS IN THE NORTHCENTRAL ALASKA RANGE

A

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By

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ABSTRACT

Patterns of topographic habitat selection by grizzly bears (Ursus arctos) in the northcentral Alaska Range were determined for bears captured during 1982-91. Aerial relocations of radio-marked individuals and family groups occurred from 15 April through 1 October. Topographic habitat was defined and measured using slope, aspect and elevation categories. Habitat use was measured using the log-likelihood technique for categorized habitats and estimated availability of habitat. Habitat selection was related to reproductive status of bears. Differences in habitat selection occurred for females with cubs, females with yearlings, females with 2-year-olds, lone adult males, lone adult females and subadults. Selection of habitats by all age and sex classes may be closely related to the balancing of nutritional needs, avoidance of negative intraspecific interactions and reproduction, with selection of topography to enhance overall fitness and increase reproductive success.

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INTRODUCTION

General Background

The grizzly bear (Ursus arctos horribilis) is a threatened species in the contiguous United States and Mexico (Servheen 1990). Small populations of this large carnivore remain in Glacier National Park, Bob Marshall Wilderness Area, and Yellowstone National Park, for example; but even these protected populations are threatened by human developments, ranching, and recreational use within and around these protected areas (Servheen 1990). An understanding of how and why bears from a healthy and productive population in Interior Alaska use landscape or topographic habitats would be useful, and could help to determine whether particular habitats are critical for production or survival of grizzly bears. These data might be especially useful in areas where the continued existence of grizzly bears is threatened. Habitat in pristine areas could then be better managed to promote recruitment and enhance the recovery efforts for this unique species. This research can be complementarily applied to findings on grizzly bear habitat in the contiguous 48 United States and in Canada (Craighead 1980, Hamer and Herrero 1983, Servheen 1983, Zager et al. 1983, Weilgus and Bunnell 1994) and to studies of habitat conducted elsewhere in Alaska by Stelmock (1981), Phillips (1987), Darling (1987), Schoen and Beier (1990), Smith and Van Daele (1991), and Ballard et al. (1993).

Project Background

During 1981-1994, the Alaska Department of Fish and Game (ADF&G) conducted a long-term study on the effects of harvest on the population of grizzly bears in the foothills and mountains of the northcentral

Alaska Range (Reynolds 1993). The emphasis of the project was to analyze changes in the dynamics of the population in relation to differing levels of hunting pressure. A large proportion of this population was fitted with radio collars; consequently, patterns of habitat use could be determined during routine aerial monitoring of bears. Grizzly bears occur throughout the entire study area at a density of about 20 bears/1,000 km^2 (Reynolds 1993). I was able to analyze use patterns of 103 individuals, including all sex and age classes so that I could analyze selection of slope, aspect, and elevation by various sex and age classes of grizzlies.

Habitat use by grizzly bears, differentiated by sex and age classes, has been documented in Alaska (Darling 1987, Schoen and Beier 1990, Smith and Van Daele 1991, and Ballard et al. 1993). None of these Alaskan studies, however, have analyzed long-term data (≥10 years) to examine the effects of interannual variation in use of habitat reported by Schoen and Beier (1990) and Darling (1987). Many studies of bears comparing use and availability also have been conducted outside of Alaska (Craighead 1980, Hamer and Herrero 1983, Servheen 1983, Mattson et al. 1987, McLellan and Shackleton 1988, Wielgus and Bunnell 1994).

Three explanations for differences in use of habitat by different sex and age classes of bears have been proposed by many researchers. Mattson et al. (1987) and McLellan and Shackleton (1988) hypothesized that differential habitat use by female grizzly bears with young compared with adult males was the result of an avoidance response to cannibalistic behavior of adult males. Hornocker (1962), Egbert and Stokes (1976), and McCullough (1981) reported that subadults and females with young avoided adult males because of food competition. A third hypothesis proposed that females with young avoid males because males that are not the sire may kill the young, which would result in the female coming back into estrus (Stringham 1980, LeCount 1987). Weilgus (1993) was the first to attempt to test these hypotheses on grizzly bears and found that he could only support the avoidance of nonsire adult males to enhance breeding success hypothesis.

All three hypotheses implicate differential habitat selection by females with young as a direct response to the presence of adult males. I neither dispute that these situations occur nor that occurrences of these behaviors profoundly affect grizzly bear habitat selection. I propose, however, to expand on these hypotheses to try and examine the ultimate causes for habitat selection. I believe that habitat selection in bears is dictated by the basic social hierarchy of grizzly bears, as described in Hornocker (1962), with adult males as the dominant social/behavioral class, females with young subordinate to adult males, and juveniles subordinate to all other classes. I refer to this hypothesis as general avoidance of conspecifics, stating that social hierarchy, to some extent, drives avoidance, and includes all age and sex classes, not just adult males. Avoidance of conspecifics, then creates the framework for differential habitat selection by all sex and age classes. Two secondary and interconnected elements affecting avoidance of conspecifics in bears are food and reproduction (Hornocker 1962).

Two of the three hypotheses explain the differences in habitat selection as a function of cannibalistic behavior or reproductively-based infanticide by adult males. My expanded hypothesis of general avoidance of conspecifics is substantiated by Murie's (1961) report of an adult female killing another female's cubs. Other workers in Alaska (Miller 1990, Schoen and Beier 1990, and Smith and Van Daele 1991) also speculated adult male involvement in documented cub mortality, but were unable to collect evidence to support their speculations of male-caused infanticide. This evidence supports the hypothesis that all sex and age classes of grizzlies avoid most intraspecific interactions by selecting different habitats, not just those habitats selected by adult males. If avoidance of conspecifics is not an accurate hypothesis, then I would expect to see all sex and age classes of bears avoid adult males and use all habitats, not used by adult males, in proportion to availability.

Habitat selection by grizzly bears has been reported throughout their range. Both Stelmock and Dean (1986) and Darling (1987) described habitat selection and food habits for interior grizzlies in Denali National Park and Preserve. They reported differences in characteristics of forage species and feeding site use by bears of different reproductive status through the study season and, in Darling's case, reported interannual differences in habitat selection. Hamer and Herrero (1983) reported that grizzly bears in Alberta did not change selection of forage species as much as they did slope, aspect, and elevation to take advantage of changes in plant phenology over the summer. This information supports the hypothesis that food availability and its relationship to slope, aspect, and elevation is a major influence on grizzly bear habitat selection. These findings suggest that bears select habitats to maximize food intake, although social hierarchy may also influence selection.

Reproduction in grizzly bears has not been presented widely in the literature as an important component of habitat selection. Hamer and Herrero (1990), however, described courtship and mating areas as components located on summits or high ridges that were not typical feeding habitat. During mating season, breeding adults must use similar habitats if they are to maximize the potential for finding mates. Because these areas are frequented by adult males, they are conversely avoided by females with young (Stringham 1980, Lecount 1987). Nonetheless, selection for these habitats during mating season is a key component in overall habitat use by grizzly bears. This evidence supports the hypothesis that reproduction directly influences habitat selection in grizzly bears.

Probably no single factor determines differential habitat selection; rather, a combination of factors may contribute including age, sex, and reproductive status of the bear. I hypothesize that the following three factors drive habitat selection by bears: (1) avoidance of conspecifics, (2) availability of food, and (3) reproductive interactions.

Although other workers studying habitat use by grizzly bears have described or quantified some aspects of the relative importance for these variables to grizzly bears, their primary emphasis was placed on selection of vegetative types (Pearson 1975, Russell et al. 1979, Hamer and Herrero 1983, Darling 1987, Weilgus and Bunnell 1994). However, none of these studies attempted to quantify or compare use and availability of topographic features by grizzlies.

Most studies of grizzly bear habitat use were hampered by small sample sizes of individual bears; therefore, pooling of sex and age classes was necessary for analysis. Both Darling (1987) and Wielgus and Bunnell (1994) attempted to measure selection by different sex and age classes, but were still hampered by small sample sizes. In contrast to most other investigations of habitat use by bears, I studied the topographic components of habitat on the scale of the landscape, not on the scale of the microhabitat or associated vegetative components. I described, measured, and analyzed habitat using the topographic characteristics of slope, aspect, and elevation.

Even so, topography and vegetative composition of habitat are directly related (Heebner 1982). Heebner (1982) reported that slope, aspect, and elevation all played important roles in plant community distribution. Therefore, my results of topographic use are also related to vegetative habitat use. An advantage of this approach is that it allows a much larger area to be measured for availability than could be effected analyzing vegetative composition alone.

OBJECTIVE AND HYPOTHESES

The objective of this research was to evaluate the influence of the topographic characteristics of slope, aspect, and elevation on the selection of these habitats by different sex and age classes of a grizzly bear population. My hypotheses are:

H_{01}: Individually, all age and sex classes of grizzly bears select habitats in proportion to availability. I predict that females with young will use steep and high elevation areas; that breeding females will use areas of medium steepness and medium elevation; that juvenile females will use areas of higher elevation with moderately steep slopes; that adult males will use lower elevations with gentler slopes; and that juvenile males will use medium elevations and slopes from gentle to moderate steep. I predict that southern aspects will be used more frequently than northern aspects for all sex and age classes.

H_{02}: Individual sex and age classes each select habitats of similar topographic characteristics. I predict that females with cubs will select habitats with steep slopes and at higher elevations; that females with yearlings will select less steep and lower elevation habitats than females with cubs; that females with 2-year-olds will select moderate slopes at lower elevations; that all females with young will select habitats that adult males do not; that breeding females will select habitats similar to adult males; that juvenile females will select habitats similar to females with young; that adult males will select lower habitats that are not selected by other sex and age classes, except breeding females; and that juvenile males will select habitats similar to adult males. I predict that all sex and age classes will show differences in aspect use. Also, my hypothesis of avoidance of conspecifics will be supported if all sex and age classes of bears select some topographic habitats differently.

STUDY AREA

The 3,900 km^2 study area is located in the foothills and mountains of the northcentral Alaska Range. The boundaries are the southern edge of the Tanana Flats (ca. 64°15'N 148°00'W, northwestern corner) to the north, the drainages of Gold King Creek and the Wood River to the west, the crest of

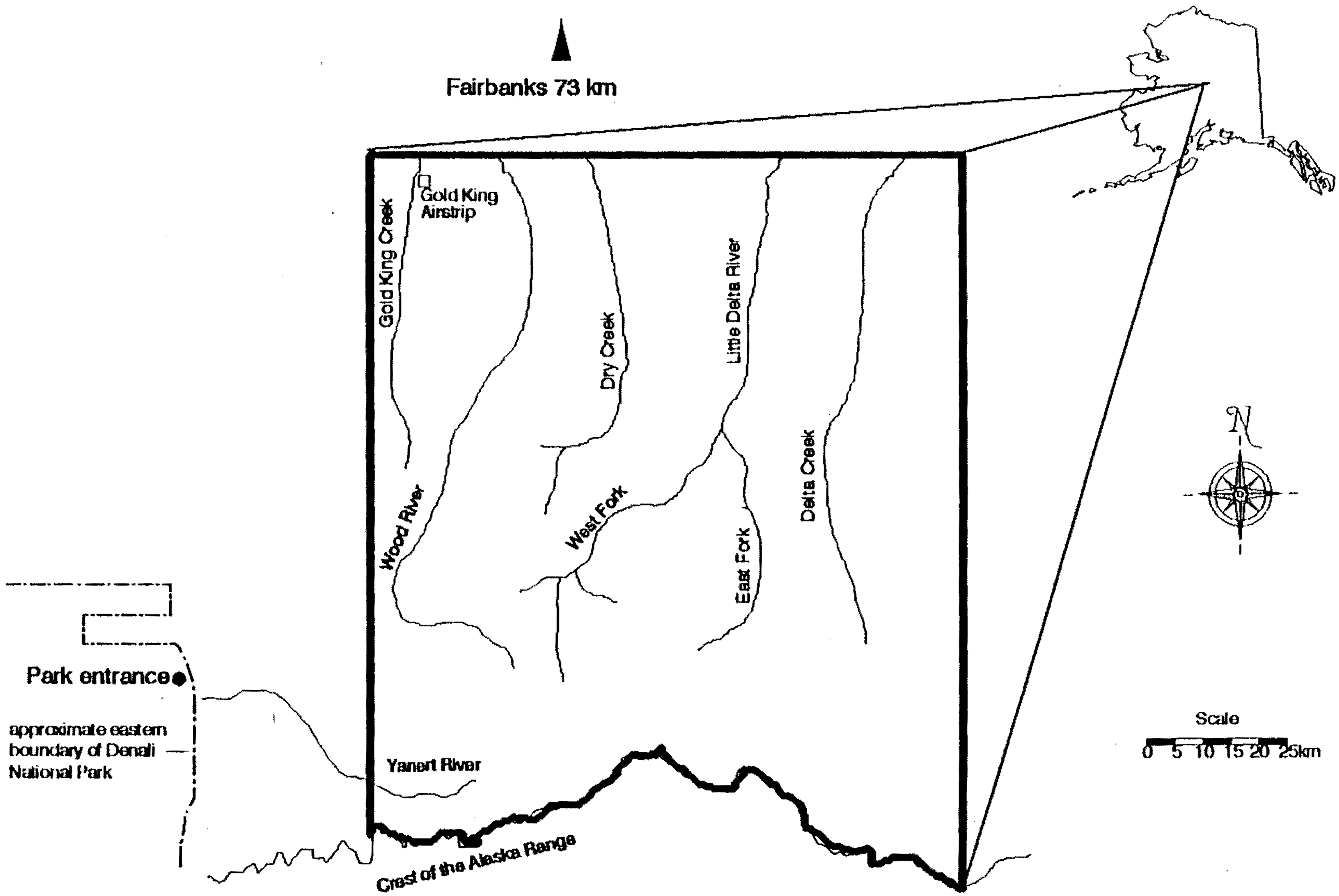

Figure 1. The grizzly bear study area in the northcentral Alaska Range, Alaska, 1982-1991.

the Alaska Range to the south, and the Delta Creek drainage to the east (Fig. 1) (Reynolds 1993).

The study area is physiographically diverse and lies within the drainage of the Tanana River. Elevations range from 185 to 3,210 m. Mountains of the Alaska Range are the dominant feature of the study area, running east-west along its southern boundary. Watersheds, predominately oriented north-south, drain northward through the foothills. The foothills are 10-40 km wide, 1,000-1,500 m in elevation, and rise abruptly from the Tanana Flats (150-600 m) (Wahrhaftig 1965).

The vegetation of the study area is similar to that described by Heebner (1982) for Denali National Park and Preserve located immediately to the west. The study area is characterized by highly diverse communities caused by topographic heterogeneity with distribution patterns related to the climatic stress of higher altitudes. Fire also has been a major disturbance factor influencing the plant communities.

A mixture of conifer, deciduous, and mixed deciduous forests dominate from 185 m to treeline at approximately 1,020 m. Conifers include black and white spruce (Picea mariana, P. glauca), and deciduous trees include quaking aspen (Populus tremuloides) and paper birch (Betula papyrifera). Shrub tundra occurs from 820-1,310 m, and alpine tundra from 1,060-1,650 m. Tundra communities are dominated by willow (Salix sp.), shrub birch (B. glandulosa), ericaceous shrubs, sedges (Carex sp., Eriophorum sp.), lichens, and mosses.

Climate of the study area is continental, and the Alaska Range blocks many weather fronts flowing from the south. The approximate annual temperature range is from 30° to -50°C, and the mean annual temperature is -3°C (Wahrhaftig 1958). Average annual precipitation is 30 cm; and the average snow accumulation is 0-50 cm, seldom reaching depths >80 cm. The study area is mostly snow-free from May through September (Davis et al. 1987).

METHODS

Capture

Bears were chemically immobilized from a helicopter using a Palmer CAPCHUR dart syringe with Sernylan (100 mg Phencyclidine hydrochloride/ml; Bio-Ceutic Laboratories, St. Joseph, MO.) and acepromazine maleate (10 mg/ml; Ayerst Labs, New York, NY.) from 1981-1983, and with etorphine (1 mg M99/ml, D-M Pharmaceuticals, Inc. Rockville, MD.) from 1983-1985 (Reynolds and Hechtel 1984). Since 1986, Telazol (A. H. Robins Co. Richmond, VA.; a mixture of 50 mg/ml Tiletamine hydrochloride and 50 mg/ml Zolezepam hydrochloride) was used for immobilization at 7-9 mg/kg (Taylor et al. 1989).

Bears ≥2 years-of-age were fitted with radiocollars (Telonics Mesa, AZ), ear tags, and ear flags. Permanent identification numbers were tattooed to the inside upper lip and on the chest, under the left front shoulder (Reynolds and Hechtel 1984). A premolar tooth was extracted to determine age using cementum annuli (Craighead et al. 1970). Offspring accompanying radiocollared females were usually not captured and marked until they reached 2 years-of-age to reduce the stress of capture (Reynolds and Hechtel 1984).

One hundred and fifteen individual bears were captured from 1981 to 1991, of which 103 bears were radio-collared: 36 young males (≤ 5 years), 19 adult males (> 5 years), 25 young females (≤ 5 years), and 23 adult females (> 5 years). Eighty-nine of those bears were recaptured at least once to replace radiocollars. From 1981 to 1983, captures included bears of all age and sex classes. Beginning in 1984, the capture effort focused on previously-captured individuals and their offspring. By autumn 1991, 30 bears carried functioning collars; 16 had shed their collars, 58 were known dead, 1 was presumed dead, and 10 could not be located, presumably because of collar failure or long-range movements (Reynolds and Boudreau 1992).

Data Collection

Collared bears were periodically monitored using radiotelemetry from fixed-wing aircraft. Aircraft used were a Piper PA-18 "Supercub," primarily, and occasionally a Cessna 185. Data were gathered both during radiotracking flights and during capture operations from 1982-1991. Relevant data were recorded, and locations were plotted on 1:250,000 United States Geological Survey (USGS) maps. The error associated with the plotting of the locations was estimated to be ±400 m. A total of 1,029 locations was used for the analysis, including 192 locations of females with cubs, 107 locations of females with yearlings, 56 locations of females with ≥2-year-old offspring, 283 locations of lone adult females, 124 locations of adult males, 170 locations of juvenile females (independent 3- to 5-year-olds), and 97 locations of juvenile males. On those rare instances when bears were located outside of the boundaries of the study area, such locations were excluded from analysis.

I analyzed habitat characteristics of sites where bears were located from 15 April to 1 October. All data were collected between 0600 and 1800 h (AST). Differences between diurnal and nocturnal habitat use have been reported for grizzly bears (Pearson 1975, Servheen 1983, McLellan and Shackleton 1988, Schoen and Beier 1990), but my analysis is based only on diurnal observations. Due to the latitude of the study area, however, the amount of daylight during the summer is high (21 hours 18 min [sunrise to sunset] on June 21) so that duration of darkness during summer was short.

All locations were digitized into latitude and longitude coordinates from 1:250,000 USGS quadrangle maps using a CALCOMP 9000 digitizer (Calcomp, Scottsdale, AZ) and ADF&G digitizing software. ASCII files of digitized locations were edited in Microsoft Word (Microsoft Corp. Redmond, WA) and combined into separate annual files. The files were then loaded to a workstation and analyzed using ARC/INFO (ESRI, Inc. Redlands, CA).

To analyze these data in ARC/INFO, a digital-topographic map of the study area was created. The study area is located within the corners of four USGS 1:250,000 quadrangle maps: Fairbanks, Big Delta, Healy, and Mt. Hayes. The USGS digital elevation models (DEM) also are divided by the same quadrangle boundaries. To create a single map, the four DEMs were joined electronically using the USGS Land Analysis System (LAS) software on a VAX mainframe computer at University of Alaska Fairbanks.

The digital map of the study area was created from the center of the larger map, pixel size was 93 m^2.

This digital "map" was converted from LAS to ARC/INFO format and transferred to a SUN 690 File Server (Sun Microsystems, Inc., Mountain View, CA) to create slope, aspect, and elevation coverages using the Triangular Irregular Network (TIN) module in ARC/INFO. The TIN module operates by creating irregularly shaped triangles (referred to as polygons in this paper) in between topographic contour lines. From these polygons, ARC/INFO is then able to measure the slope, aspect, and elevation for each polygon. The digitized location of bears were converted to ARC/INFO format and measured for the slope, aspect, and elevation for each data point.

Individual slopes were divided into 10 categories of 5° increments. Aspect was divided into nine categories: eight were based on compass directions (45° arcs, starting at 1°); one was flat and therefore had no directional aspect. Elevational categories were established at 275-m increments by locating the highest and lowest elevations and dividing that difference into 15 intervals (Appendix A). All categorical data were transferred from the SUN File Server to a personal computer and combined with the location data using Foxpro (Microsoft, Inc. Redmond, WA) to create the master database.

To reduce the potential for autocorrelation in the data, I randomly eliminated all but one location for any individual bear on any specific date. This technique also was used in a habitat use study on grizzly bears in Montana (Servheen 1983). Further, to examine the data on location of bears for autocorrelation, the 12 largest (>10 locations) data sets for individual bears were processed using BLOSSOM software (Slauson et al. 1991) using the MRSP command that assesses autocorrelated data following the method of Solow (1989). No data sets were significantly ($P \leq 0.05$) autocorrelated.

Data on habitat use for grizzly bears were pooled into the following seven categories of reproductive and age status to increase sample sizes (Manly et al. 1993): females with cubs; females with yearlings; females with 2-year-olds; adult females; juvenile females; adult males; and juvenile males. I defined cubs as young-of-the-year; yearlings were young that denned for one entire winter, emerged the following spring and were >1 year of age; and 2-year-olds are young that denned two entire winters and were >2 years-of-age i.e. in their 3rd year. Adult females and males were defined as being >5 years old, the age of reproductive maturity. Juvenile females and males were ≤ 5 years old and had been weaned.

Data Analyses

Estimation of Habitat Availability.--I used random-point estimation to estimate availability of topographic habitat types within the study area (Marcum and Loftsgaarden 1980). A total of 1,052 random points was used to estimate slope, aspect, and elevation by overlaying the random points on ARC/INFO coverages and extracting point intersect data. These data were tabulated into categories and used to estimate the topographic habitat available for the study area. Using this methodology, availability may underrepresent those topographic features that occur rarely (< 1%) and thus have a low probability of being selected.

Selection of Topographic Habitat.--I defined habitat selection as any use of a habitat type that did not occur in direct proportion to its availability. I use the term "selection" to describe both preference (use > availability) and avoidance (use < availability) by bears of any category. It is important to define the terms preference and avoidance as used in my study because they have been used and interpreted in many ways. The term "preference" is used to describe selection <u>for</u> a habitat that shows significantly ($\alpha = 0.10$) greater use than availability. The term "avoidance" is used to describe selection <u>against</u> a habitat; that is, use is significantly ($\alpha = 0.10$) less than availability. Topographic categories in which bears representing different sex and age classes were never seen were classified as indicating strong avoidance for that category.

I chose to use an $\alpha = 0.10$, rather than $\alpha = 0.05$, for the analysis for two main reasons: 1) the sample size of bears was small, specifically after dividing them into seven sex and age classes, and 2) some bears were used more than once in the same sex or age class.

This doesn't inherently mean that estimates of use for that sex or age class are biased, in as much as the bears were assumed to represent a random sample before proceeding with the analysis, and the opportunity for a bear to occur twice was not predetermined when the bear was selected. Estimates of precision (sampling variance) may be biased to indicate better precision than we really had, and degrees of freedom are over estimated.

In studies of habitat use and availability with relatively small sample sizes, I believe it is important to select a larger α-level to allow greater detection of habitat selection. I believe this increased ability to detect differences in habitat use and availability studies will more accurately reflect biological significance. Although, when selecting larger α-levels, you are forced with the choice between very little power (Type II error) and accepting a higher probability of a type I error.

Habitat selection was measured by comparing the topographic habitat at each relocation site of a grizzly bear individual or family group to the availability of the same habitat variable within the entire study area. To test for habitat selection, I used a modified chi-square test described by Marcum and Loftsgaarden (1980) that was further adapted by Manly et al. (1993) using log-likelihood statistics. This technique is especially appropriate for studies like mine where use data are categorized and habitat availability is estimated. This approach allows calculation of both selection coefficients and simultaneous 90% confidence intervals.

The selection coefficient is used to calculate the confidence intervals that indicate significance if the confidence intervals do not contain the value 1.0. If the upper confidence limit is below 1, then selection is significantly less than availability (avoidance); conversely, if the lower limit is greater than 1.0, then selection is significantly greater than availability (preference). If the confidence interval encompasses 1.0, then use is in proportion to availability. If bears of a given age or sex class were never located in a particular category, such nonuse was considered significant avoidance.

Frequency of Topographic Habitat Use.--I examined habitat use within the study area by measuring the frequency with which bears used topographic habitats. I did this by dividing the number of bears (individual or family group) located in any specific habitat category by the total number of bears (individual or family group) located that year. These calculations differ from where I used the number of individuals or family groups, and the log-likelihood calculations where I used all relocations of all individuals or family groups within a sex or age class. I used the total number of grizzly bears (individuals or groups) as the denominator instead of the number within each specific sex and age class to increase sample sizes. I defined a group as any number of bears in association with one another that were located at one site. To facilitate interpretation, I separated the frequency of use data into four categories: high, moderate, low, and never used. These categories were defined differently for slope, aspect, and elevation. Slope categories determined to be of high use had medians ranging from 38-49%, moderate use had medians ranging from 10-29.5%, and low use had medians ranging from 0-3%. Aspect categories determined to have high use had medians ranging from 30.5-38.5% and moderate use had medians ranging from 14.5.-26.5%, with no low use aspects. Elevation categories determined to be of high use had medians ranging from 44.5-65.5%, moderate use had a median of 17.5%, and low use had medians ranging from 0-9.5 %.

I used Friedman's test (Systat Inc. Evanston, IL) to measure interannual variation in the frequency of habitat use. Because the results of the Friedman's test indicated that the frequency of habitat use were significantly different ($\alpha = 0.10$) in some years than in others, I used the multiple-comparisons test for the Friedman's test to indicate which years were different (Conover 1980). To compare the medians of all years of frequency of habitat use and the medians from the six years of frequency of habitat use, I used the paired-sample T-test on the medians from each category and within each variable between the two data sets (Zar 1984).

During this study, the following project objectives were accomplished: (1) description of topographic scale habitat use by different sex and age classes of grizzly bears, (2) description of differences and similarities in use between classes and (3) determination of whether habitat use was in proportion to habitat availability on the study area. I accomplished these objectives using single variate statistical tests. I considered using more elaborate multivariate statistical techniques, but decided against it because: (1) I was able to meet my objectives with the tests I used, (2) the data set I used for the analysis was not large enough to support those tests, and (3) if I had tried to compare different sex and age classes, I would have had to model the lack of independence.

RESULTS

To varying degrees, grizzly bears used all topographic habitats present in the study area at elevations <2,386 m; available habitats above this elevation were not used. Each sex and age class of bears exhibited some degree of selection for slope, aspect, and elevation (Appendices B-D). Topographic habitat use varied between different sex and age classes of bears. The results of the log-likelihood test indicate that females accompanied by different age young (cubs, yearlings, or 2-year-olds) occurred on different degree slopes and at different elevations. Females with young all used slopes and elevations that were to some degree different from adult males and all other sex and age classes. Adult males were found in, at least in proportion to availability, many topographic categories significantly avoided by other bears. Juveniles occurred in topographies similar to females with young. Breeding females were found in areas where adult males were found also.

Topographic Availability

The topography of the study area was predominantly flat to gently sloping terrain; about 48% of the entire study area has slopes of ≤5°, and 76% possesses slopes ≤15°. Of the remaining 24%, 20% has moderate slopes (15.01-30.00°) and 4% steep slopes (between 30.01 to >45.00°) (Table 1).

Aspects were heavily influenced by the position of the study area on the north side of the Alaska Range. Comparisons of northerly-facing polygons with southerly-facing polygons show that north was the predominant aspect with 60% of the random points falling on northerly-facing slopes (90-270°) and 33% on southerly-facing (91-269°) ones. The remaining 7% of the study area was flat (Table 1). A similar comparison of random easterly-facing (1-180°) polygons and westerly-facing (181-360°) polygons on nonflat terrain showed that 60% of polygons face easterly and 40% face westerly. When the scope was reduced to 90° arcs (NE 1-90°, SE 91-180°, SW 181-270°, and NW 271-360°), with 38% of slopes faced predominantly northeasterly, 22% of slopes faced predominantly northwesterly, 18% of slopes faced prediminately southeasterly, and 15% of slopes faced predominantly southwesterly.

Although elevation in the study area ranges from 185 to 3,200 m, 56% of the study area was <1,011 m, the approximate elevation of

Table 1. Topographic availability estimated from random points (counts, percentages, and cumulative percentages) for the study area in the northcentral Alaska Range, Alaska[a], 1982-1991.

Slope degrees	Random points (count)	%	cumul.%[b]	Aspect[c]	Random points (count)	%	cumul.%[b]	Elevation above sea level (m)	Random points (count)	%	cumul.%[b]
0-5.00	(508)	48	48	NNE	(256)	24	24	0-185	(0)	0	0
5.01-10.00	(151)	14	62	ENE	(151)	14	38	186-460	(182)	17	17
10.01-15.00	(143)	14	76	ESE	(97)	9	47	461-735	(227)	21	38
15.01-20.00	(91)	9	85	SSE	(97)	9	56	736-1010	(186)	18	56
20.01-25.00	(59)	6	91	SSW	(90)	9	65	1011-1285	(158)	15	71
25.01-30.00	(49)	5	96	WSW	(64)	6	71	1286-1560	(134)	13	84
30.01-35.00	(23)	2	98	WNW	(58)	6	77	1561-1835	(94)	9	93
35.01-40.00	(15)	1	99	NNW	(166)	16	93	1836-2110	(47)	4	97
40.01-45.00	(7)	0.7	99.7	FLAT	(73)	7	100	2111-2385	(15)	2	99
>45.01	(3)	0.3	100					2386-2660	(5)	0.5	99.5
								2661-2935	(3)	0.4	99.9
								2936-3210	(1)	0.1	100
TOTAL	(1052)	100	100	TOTAL	(1052)	100	100	TOTAL	(1052)	100	100

[a] Study area is located approximately 30 km to the east of Denali National Park and Preserve.

[b] Definition of aspects-- NNE is midpoint of arc between 0.01° and 45°, ENE is midpoint of arc between 45.01°and 90°, ESE is midpoint of arc between 90.01°and 135°, SSE is midpoint of arc between 135.01°and 180°, SSW is midpoint of arc between 180.01°and 225°, WSW is midpoint of arc between 225.01°and 270°, WNW is midpoint of arc between 270.01°and 315°, NNW is midpoint of arc between 315.01°and 360°, and Flat is no aspect.

[c] Cumulative percentages are for each individual column of random points percentages.

treeline. In comparison, 15% of the random points fell between treeline and 1,285 m, the approximate elevational limit of shrub growth. Twenty-nine percent of the random points fell between 1,286-2,386 m, a category that vegetatively consists mostly of alpine tundra, rock, and ice. Less than 1% of the study area was >2,386 m elevation (Table 1); no bears were located in this portion of the study area.

Frequency of Topographic Habitat Use by Bears

Frequency of topographic use measures use independently of availability. I believe the utility of this measure is that it depicts gross topographic use. This compares the use of topographic categories with the combined locations of all bears during any specific year. The medians of the frequency of topographic use by topographic category for all years illustrates the gradations and levels of use. Using these medians, I was able to describe patterns of high, moderate, and low or never-used topographic categories. I pooled topographic habitat use by all bears, by category, and by year to increase sample sizes.

Bears were most often observed on slopes from 0-20°. They were periodically located on slopes from 20.01-35.00° and located least often on slopes >35.01° (Table 2). Bears were located most often on northfacing slopes and on SSE facing slopes. Periodically, they were located on WNW, WSW, ESE, and SSW slopes and on flat areas (Table 3). Bears were located most often between 735-1,560 m. Elevations from 461-735 m and 1,561-1,835 m were used periodically by bears. Areas between 186-460 m and above 1,836 m were rarely or never used by bears (Table 4).

Table 2. Percent of habitat use of slope categories by year for all bears combined in the northcentral Alaska Range, Alaska, 1982-1991. Percent habitat use was calculated by dividing the number of individuals located in a category by the total number of individual bears located in that year. The medians and slope availability are presented for reference. (n = 1029 locations of 103 bears). Years in which habitat use percentages remained after censoring the data are indicated by [a]; included are the medians calculated from those 6 years of data are indicated by [b] for comparison. The medians calculated for all year and the medians calculated for the 6 homogenous years were significantly different ($0.002 < P < 0.005$) using a paired t-test.

	Slope Category (degrees)									
Year	0-5.00	5.01-10	10.01-15	15.01-20	20.01-25	25.01-30	30.01-35	35.01-40	40.01-45	>45
1982	72	41	52	45	62	17	10	0	0	0
1983a	45	39	30	30	30	12	6	0	3	3
1984	86	89	79	79	57	39	21	11	4	0
1985a	57	70	39	39	17	22	9	4	0	4
1986a	33	47	27	40	13	20	20	0	6	6
1987	58	53	68	63	37	26	21	5	5	0
1988a	46	63	33	38	29	17	4	0	4	0
1989a	51	34	37	49	29	9	11	3	3	0
1990	47	23	17	30	27	23	10	0	3	0
1991a	47	33	43	47	30	20	7	0	0	3
Range	33-86	23-89	17-79	30-79	13-57	9-39	4-21	0-11	0-6	0-6
Median	49	44	38	42.5	29.5	20	10	0	3	0
Median[b]	46.5	43	35	39.5	29	18.5	8	0	3	3
% Avail[c]	48.6	14.3	13.6	8.7	5.6	4.7	2.2	1.4	0.7	0.3

a -- Denotes years within which the data was most homogenous as measured using Friedman's test.
b -- medians calculated using the 6 years of frequency of habitat use percentages after censoring.
c -- Percentage of available landscape habitat within the study area as estimated by random point estimation (Marcum and Loftsgaarden 1980)

Table 3. Percent of habitat use of aspect categories by year for all bears combined in the northcentral Alaska Range, Alaska, 1982-1991. Percent habitat use was calculated by dividing the number of individuals located in a category by the total number of individual bears located in that year. The medians and aspect availability are presented for reference. (n=1029 locations of 103 bears). Years in which habitat use percentages remained after censoring the data are indicated by [a]; included are the medians calculated from those 6 years of data are indicated by [b] for comparison. The medians calculated for all year and the medians calculated for the 6 homogenous years were significantly different ($0.01 < P < 0.02$) using a paired t-test.

	Aspect Category								
Year	Flat	NNE	ENE	ESE	SSE	SSW	WSW	WNW	NNW
1982	31	55	45	28	34	48	28	28	52
1983[a]	15	39	30	15	30	24	15	18	27
1984	46	79	57	54	64	64	46	64	57
1985[a]	30	35	30	35	35	26	9	22	30
1986[a]	20	27	33	6	27	13	13	27	20
1987	21	58	53	26	32	47	21	42	37
1988[a]	21	33	25	21	38	13	33	8	42
1989[a]	29	20	31	17	23	29	14	20	40
1990	13	27	23	13	30	23	7	10	27
1991[a]	17	50	20	17	33	27	10	27	40
Range	13-46	20-79	20-57	6-54	23-64	13-64	7-46	8-64	20-57
Median	21	37	30.5	19	32.5	26.5	14.5	24.5	38.5
Median[b]	20.5	36	30	19	31.5	25	13.5	21	35
% Avail[c]	6.7	24.3	14.3	9.2	9.2	8.6	6.1	5.5	15.8

a -- Denotes years within which the data was most homogenous as measured using Friedman's test.
b -- medians calculated using the 6 years of frequency of habitat use percentages after censoring.
c -- Percentage of available landscape habitat within the study area as estimated by random point estimation (Marcum and Loftsgaarden 1980)

Table 4. Percent of habitat use of elevation categories by year for all bears combined in the northcentral Alaska Range, Alaska, 1982-1991. Percent habitat use was calculated by dividing the number of individuals located in a category by the total number of individual bears located in that year. The medians and elevation availability are presented for reference. (n=1029 locations of 103 bears). Years in which habitat use percentages remained after censoring the data are indicated by [a]; included are the medians[b] calculated from those 6 years of data are indicated by [b] for comparison. The medians calculated for all year and the medians calculated for the 6 homogenous years were significantly different ($0.02 < P < 0.05$) using a paired t-test.

	Elevation Category (meters)							
Year	186-460	461-735	736-1010	1011-1285	1286-1560	1561-1835	1836-2110	2111-2385
1982	3	38	72	86	38	7	3	0
1983[a]	0	18	58	48	42	15	0	0
1984	0	39	82	93	79	39	14	0
1985[a]	0	22	48	65	48	4	4	0
1986[a]	0	20	33	53	47	0	0	0
1987	0	11	58	79	58	37	0	0
1988[a]	4	13	63	71	38	13	0	0
1989[a]	3	17	60	46	34	9	0	0
1990	0	10	33	60	37	7	3	0
1991[a]	0	13	30	66	47	10	0	7
Range	0-4	10-39	30-82	46-93	34-79	0-39	0-14	0-7
Median	0	17.5	58	65.5	44.5	9.5	0	0
Median[b]	0	17.5	53	59	44.5	9.5	0	0
% Avail[c]	17.3	20.9	17.6	15	12.7	8.9	4.4	1.4

[a] -- Denotes years within which the data was most homogenous as measured using Friedman's test.
[b] -- medians calculated using the 6 years of frequency of habitat use percentages after censoring.
[c] -- Percentage of available landscape habitat within the study area as estimated by random point estimation (Marcum and Loftsgaarden 1980)

Further, frequencies of topographic use were much higher or lower across all categories during some years. To examine the extent of possible heterogeneity between years, I tested frequencies of use for significant interannual variation.

Friedman's tests were significant ($\alpha = 0.10$) for slope, aspect, and elevation, which all indicated a significant difference among frequency of topographic use among years (Table 5). By applying a multiple comparisons test (Conover 1980) for Friedman's statistic, I determined that annual selection during 1982, 1984, and 1987 contributed the greatest amount to the variance. These three years had the highest number of bear locations per bear each year (Table 5).

Therefore, I censored 1982, 1984, and 1987 data. The test statistics decreased for slope, aspect and elevation (Table 6), changes which confirmed that those years were responsible for the high variances. Further, 1990 was also an outlier year, having a low rank sum (Table 6) and the lowest average number of bear locations per year (Table 5). By omitting 1990 from the analysis, the test statistic for aspect decreased and the P-value increased (Table 7). Only those six years in which the frequency data behaved consistently for the Friedman's test were used for analyses using frequency data.

To further examine the differences between medians calculated from all the years and the six years remaining after censoring, I used the paired-sample T-test (Zar 1984). Medians from the censored data were significantly different than medians from all the years of data for slope

Table 5. Ordered sums of ranks of frequency use and locations per grizzly bear per year for all years with F-values from Friedman's test and corresponding P-values($\alpha = 0.10$) for the study area; northcentral Alaska Range, Alaska, 1982-1991. This indicates which years of data contributed the most (highest ranks) to the variance within each variable type.

Slope			Aspect			Elevation		
year	Σ ranks	$\bar{x}$ location per bear	year	Σ ranks	$\bar{x}$ location per bear	year	Σ ranks	$\bar{x}$ location per bear
1984	88.0	9.5	1984	90.0	9.5	1984	69.0	9.5
1987	86.5	5.3	1982	74.0	4.8	1982	55.0	4.8
1985	56.5	3.2	1987	64.5	5.3	1988	47.5	3.1
1982	54.5	4.8	1985	50.5	3.2	1987	46.0	5.3
1986	52.0	2.7	1988	47.0	3.1	1985	45.0	3.2
1989	51.5	2.9	1991	43.5	3.2	1991	40.5	3.2
1988	45.5	3.1	1989	42.0	2.9	1983	39.0	2.6
1991	43.0	3.2	1983	34.5	2.6	1989	36.0	2.9
1990	38.0	2.4	1986	29.5	2.7	1986	32.5	2.7
1983	34.5	2.6	1990	19.5	2.4	1990	29.5	2.4
Test stat = 32.256 $P < 0.000$			Test stat = 49.576 $P < 0.000$			Test stat = 16.459 $P < 0.058$		

Table 6. Ordered sums of ranks of frequency use data for grizzly bears for 1983, 1985, 1986, 1988, 1989, 1990, 1991 for slope, aspect and elevations with Friedmans test statistics and corresponding P-values ($\alpha = 0.10$) for the study area; northcentral Alaska Range, Alaska. This indicates which years of data contributed most (highest ranks) to the variation within each variable type and that after censoring the three years of data neither slope nor elevation frequency use data are significantly different with aspect remaining significantly different.

Slope		Aspect		Elevation	
year	Σ ranks	year	Σ ranks	year	Σ ranks
1985	50.5	1985	45.5	1988	39.0
1989	44.5	1988	41.5	1985	38.5
1986	42.5	1991	41.5	1991	33.0
1991	42.5	1989	40.0	1983	32.5
1988	35.5	1983	34.5	1989	28.5
1983	32.5	1986	29.5	1986	27.5
1990	32.0	1990	19.5	1990	25.0
Test stat = 6.075 P < 0.415		Test stat = 11.512 P < 0.074		Test stat = 4.661 P < 0.588	

Table 7. Ordered sums of ranks of habitat use frequency data for grizzly bears for 1983, 1985, 1986, 1988, 1989, and 1991 for aspect with Friedmans test statistic and P-values ($\alpha = 0.10$) for the study area; northcentral Alaska Range, Alaska. This indicates the 1990 data was causing the significant variation between years of data for aspect.

Year	Σ ranks
1985	36.5
1988	34.5
1991	33.5
1989	33.0
1983	26.5
1986	25.0

Friedman's test statistic = 3.413 $P < 0.637$

(0.002< P <0.005), aspect (0.01< P <0.02), and elevation (0.02< P <0.05).

Therefore, I believe it was better to include all years in the analysis, instead of excluding years that were contributing to the high variance. Results of the Friedman's test and the multiple comparisons indicate that sample size (mean no. locations per bear) has a considerable effect on the results of the frequency data analysis. Further, it is logical that with more observations per bear, any individual bear has a higher probability of being observed in any specific category. So when sample sizes (locations per bear) are very small compared to the average in all groups being compared, there is a lower probability that the frequency data will correctly reflect habitat preference or avoidance.

Selection of Topographic Habitats by Grizzly Bears

Grizzly bears within different sex and age classes selected topographic variables differently. Indications of spatial separation are especially evident for the slope and elevation categories between sex and age classes (Figs. 2 and 3). Indications of spatial separation on aspect categories were not as clear as with the other variables. Data however do indicate that some sex and age classes selected some aspects (Fig. 4).

The results from the data analyses using the log-likelihood test generally agreed with those using the frequency analysis, although the levels of resolution were very different. Resolution was different because specific comparisons of sex and age classes between analysis methods was not possible.

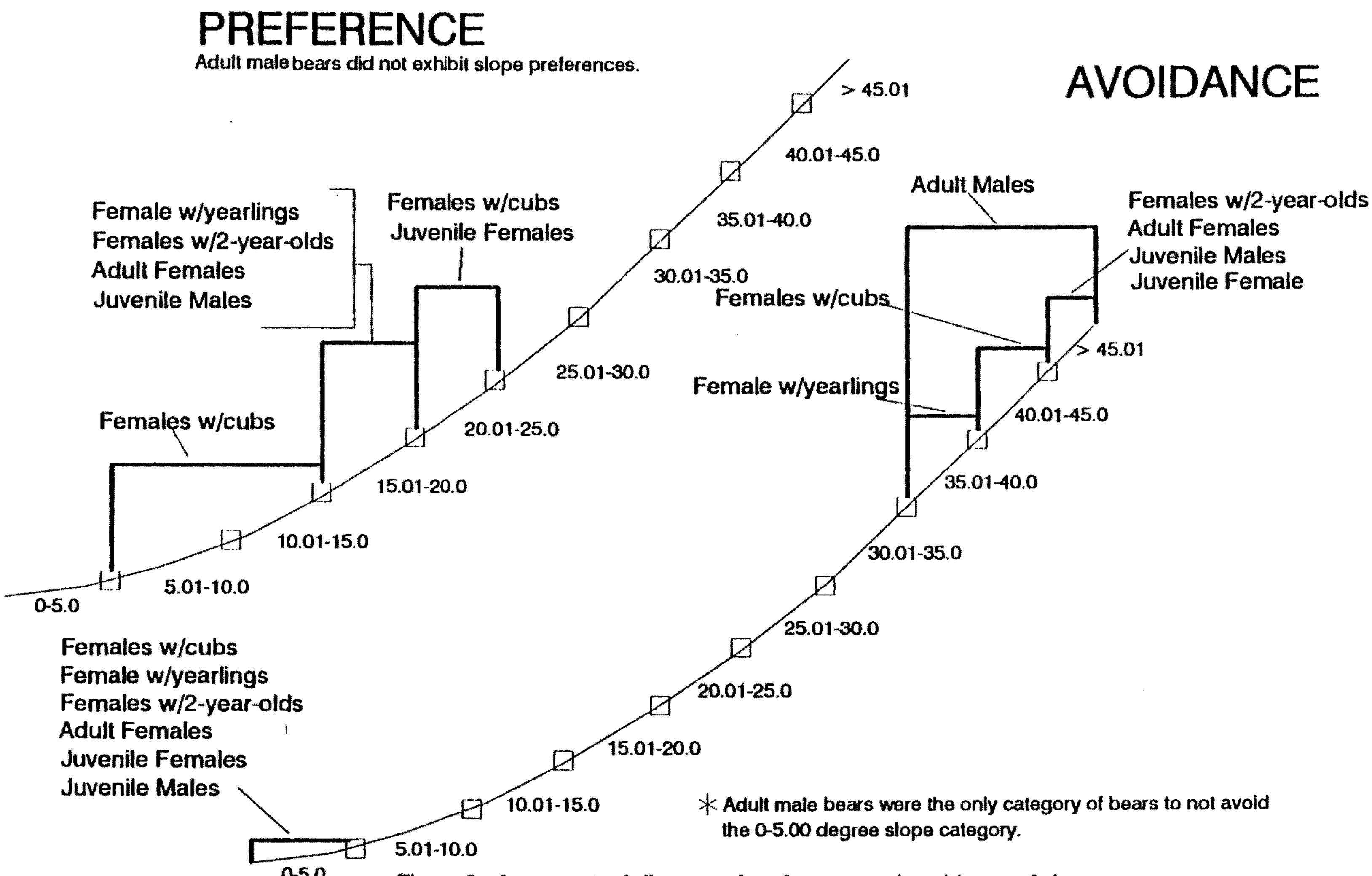

Figure 2. A conceptual diagram of preference and avoidance of slope categories for sex and age classes of grizzly bears in the northcentral Alaska Range, Alaska, 1982-1991. Horizontal bars indicate significantly preferred or avoided slopes and vertical bars are for easy reference.

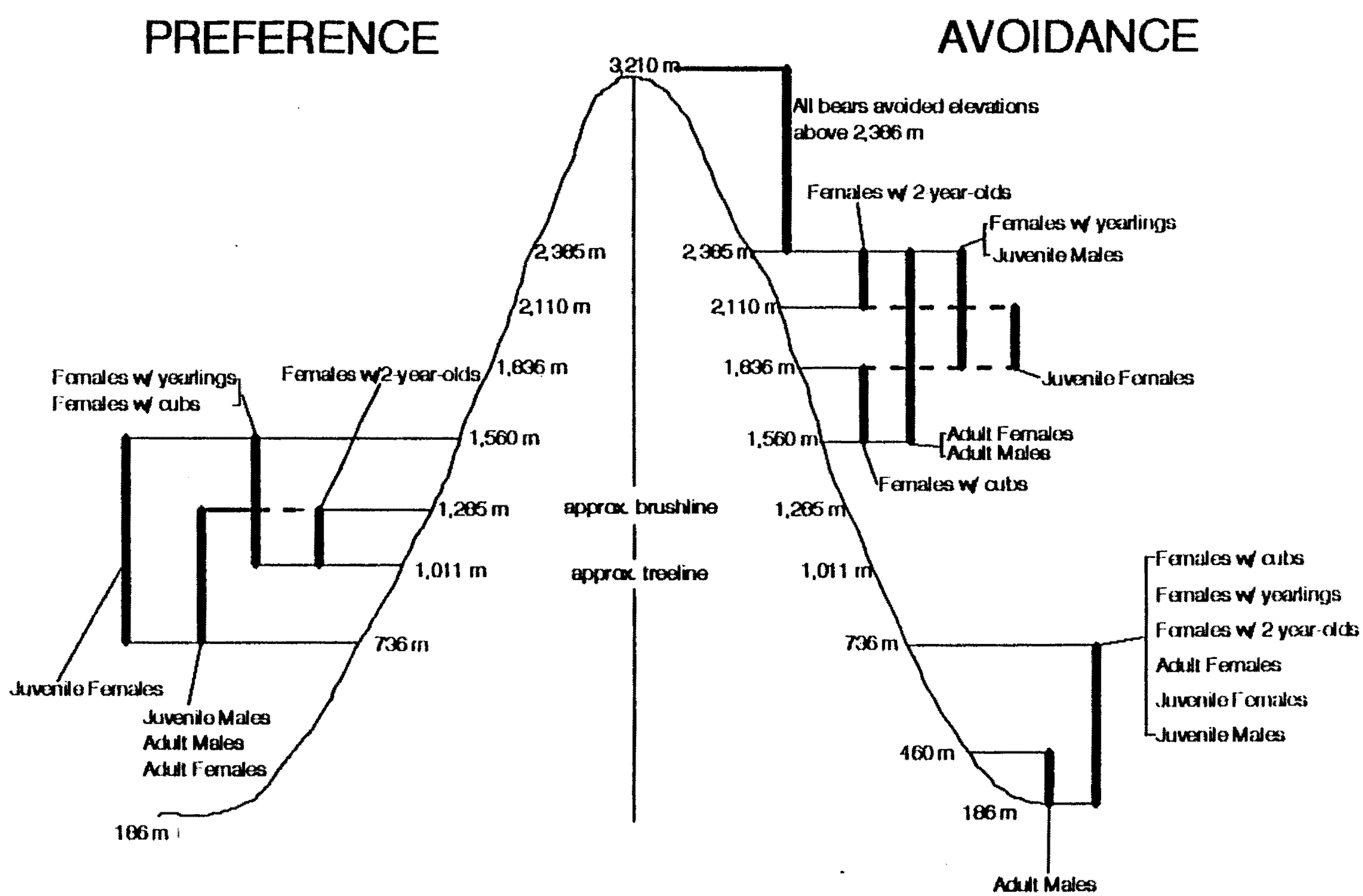

Figure 3. A conceptual diagram depicting preference and avoidance of elevational categories by age and sex classes of grizzly bears in the northcentral Alaska Range, Alaska, 1982-1991. The left-hand side of the figure illustrates preferred elevations and the right-hand side avoided the elevations. Elevation categories where a sex or age class used in proportion to availability are the corresponding blank areas.

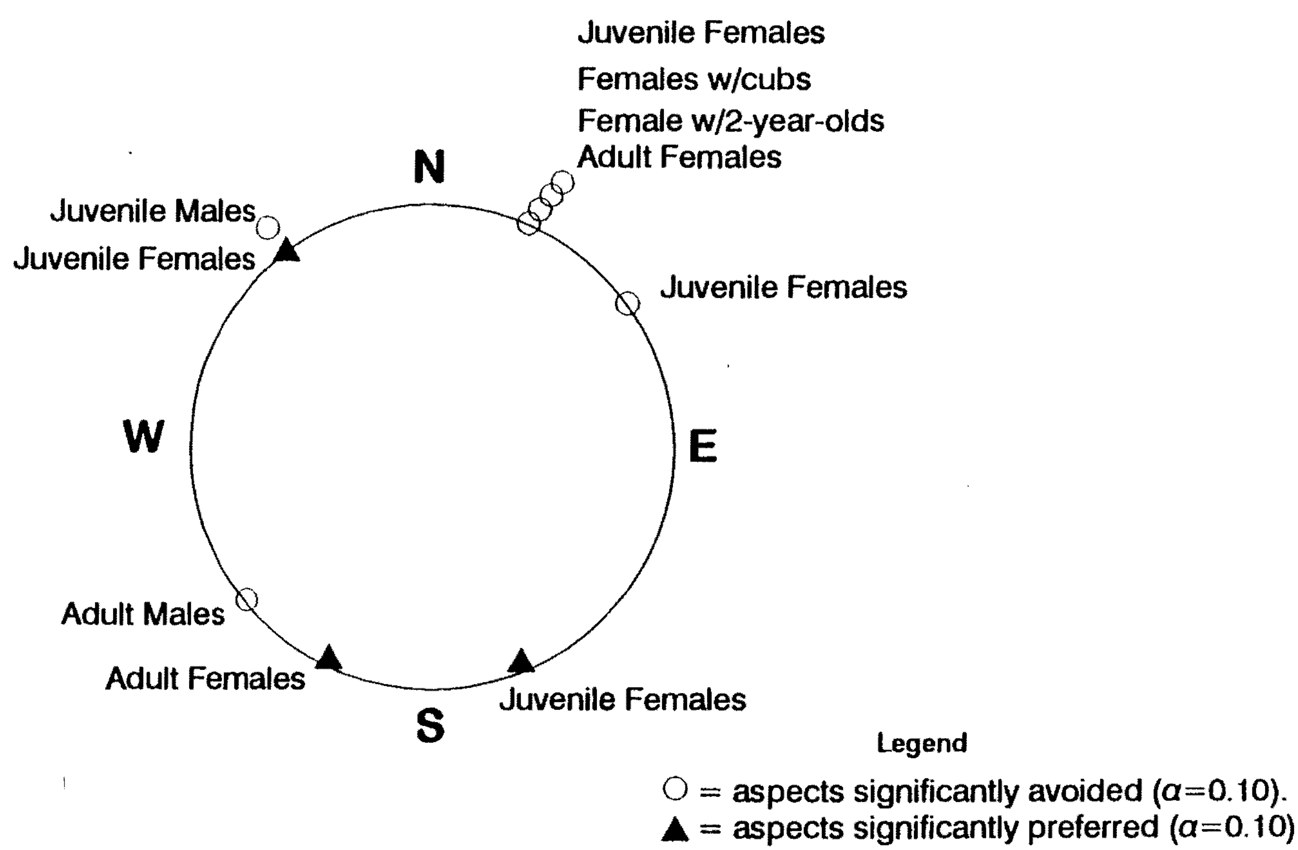

Figure 4. A conceptual diagram of preference and avoidance of aspect categories for sex and age classes of grizzly bears in the northcentral Alaska Range, Alaska, 1982-1991. Aspects without significant preference or avoidance are without markers and were used in proportion to availability.

Females with Cubs.--Females with cubs showed significant preference for slopes of 5.01-15.00° and 20.01-25.00° and selection was nearly significant for the 15.01-20.00° category (90% CI, lower 0.93, upper 2.56) (Table 8). Avoidance of the 0-5.00° category was significant and females with cubs were not located on slopes between 40.01-45.00°. All other slope categories were used in proportion to availability, including the >45° category. Females with cubs did not prefer any aspect category, but avoided NNE. Females with cubs used all other aspect categories in proportion to availability (Table 9).

Females with cubs preferred elevations from 1,011-1,560 m, but avoided elevations between 186-735 m, 1,561-1,835 m, and >2,386 m. All other elevation categories were used in proportion to availability (Table 10).

Females with yearlings.--Females with yearlings preferred slopes of 15.01-20.00° and avoided slopes of 0-5.00° and 35.01-40.00°. The remaining slope categories were used in proportion to availability (Table 8).

Females with yearlings used all aspect categories in proportion to availability (Table 9). The confidence interval for the SSW category was close to indicating significant preference, and the confidence limits for NNE and ENE were close to indicating significant avoidance (Appendix M).

Females with yearlings preferred elevations from 1,011- 1,560 m (Table 10). They avoided elevations from 186-735 m and >1,836 m. All other categories were used in proportion to availability (Table 10).

Table 8. Use[a] of slope categories by grizzly bears in the northcentral Alaska Range, Alaska, 1982-1991.

	Slope (degrees)									
	0-5	5.01-10	10.01-15	15.01-20	20.01-25	25.01-30	30.01-35	35.01-40	40.01-45	>45.00
Female w/cubs	AVOID[b]	PREFER	PREFER	NS	PREFER	NS	NS	NS	AVOID	NS
Female w/yearlings	AVOID	NS	NS	PREFER	NS	NS	NS	AVOID	NS	NS
Female w/2-yr-olds	AVOID	NS	NS	PREFER	NS	NS	NS	NS	NS	AVOID
Adult females	AVOID	NS	NS	PREFER	NS	NS	NS	NS	NS	NS
Juvenile females	AVOID	NS	NS	NS	PREFER	NS	NS	NS	NS	AVOID
Juvenile males	AVOID	NS	NS	PREFER	NS	NS	NS	NS	NS	AVOID
Adult males	NS	NS	NS	NS	NS	NS	NS	AVOID	AVOID	AVOID

[a] Preference, avoidance, and use proportional to availability (NS) as determined using log-likelihood tests (Manly et al. 1993)

[b] NS, use was in proportion to availability (use = availability); PREFER, preference was significant at the $P<0.10$ level (use > availability); AVOID, avoidance was significant at the $P<0.10$ level or bears were never located in this category (use < availability).

TABLE 9. Use[a] of aspect categories by grizzly bears in the northcentral Alaska Range, Alaska, 1982-1991.

	Aspect								
	NNE	ENE	ESE	SSE	SSW	WSW	WNW	NNW	FLAT
Female w/cubs	AVOID[b]	NS	NS	NS	NS	NS	NS	NS	NS
Female w/yearlings	NS	NS	NS	NS	NS	NS	NS	NS	NS
Female w/2-yr-olds	AVOID	NS	NS	NS	NS	NS	NS	NS	NS
Adult females	AVOID	NS	NS	PREFER	NS	NS	NS	NS	NS
Juvenile females	AVOID	AVOID	NS	NS	PREFER	NS	PREFER	NS	NS
Juvenile males	NS	NS	NS	NS	NS	NS	NS	AVOID	NS
Adult males	NS	NS	NS	NS	NS	AVOID	NS	NS	NS

[a] Preference, avoidance, and use proportional to availability (NS) as determined using log-likelihood tests (Manly et al. 1993).

[b] NS, use was in proportion to availability (use = availability); PREFER, preference was significant at the $P<0.10$ level (use > availability); AVOID, avoidance was significant at the $P<0.10$ level (use < availability).

Table 10. Use[a] of elevation categories by grizzly bears in the northcentral Alaska Range, Alaska, 1982-1991.

	Elevation (meters)								
	186-460	461-735	736-1010	1011-1285	1286-1560	1561-1835	1836-2110	2111-2385	>2386
Female w/cubs	AVOID[b]	AVOID	NS	PREFER	PREFER	AVOID	NS	NS	AVOID
Female w/yearlings	AVOID	AVOID	NS	PREFER	PREFER	NS	AVOID	AVOID	AVOID
Female w/2-yr-Olds	AVOID	AVOID	NS	PREFER	NS	NS	NS	AVOID	AVOID
Adult females	AVOID	AVOID	PREFER	PREFER	NS	AVOID	AVOID	AVOID	AVOID
Juvenile females	AVOID	AVOID	PREFER	PREFER	PREFER	NS	AVOID	NS	AVOID
Juvenile males	AVOID	AVOID	PREFER	PREFER	NS	NS	AVOID	AVOID	AVOID
Adult males	AVOID	NS	PREFER	PREFER	NS	AVOID	AVOID	AVOID	AVOID

[a] Preference, avoidance, and use proportional to availability (NS) as determined using log-likelihood tests (Manly et al. 1993)

[b] NS, use was in proportion to availability (use = availability); PREFER, preference was significant at the $P<0.10$ level (use > availability); AVOID, avoidance was significant at the $P<0.10$ level or bears were never located in this category (use < availability).

Females with 2-year-olds.--Females with 2-year-old offspring preferred slopes of 15.01-20.00°. They avoided slopes of 0-5.00° and >45.00° slopes. Females with 2-year-olds were located in all other categories in proportion to availability (Table 8).

Females with 2-year-olds showed no significant preference for aspect; however, they did significantly avoid NNE. All the other aspects were used in proportion to their availability (Table 9).

Family groups composed of adult females with 2-year-olds preferred elevations from 1,011-1,285 m (Table 10). They significantly avoided elevations from 461-735 m and were not located at elevations from 186-460 m and >2,111 m. The remaining elevation categories were used in proportion to availability (Table 10).

Breeding Females.--Breeding females preferred slopes of 15.01-20.00°. Their use of slopes of 5.01-10.00 and 20.01-25.00° was in proportion to availability; however, this use was characterized by lower confidence limits approaching significant preference (Appendix H). They avoided slopes of 0-5.00° and used all other slope categories in proportion to availability (Table 8).

Breeding females significantly preferred SSE aspects and significantly avoided NNE aspects. No preference or avoidance was indicated for any other aspect category (Table 9).

These females preferred elevations from 736-1,285 m and avoided those from 461-736 m and 1,561-2,110 m. They were not observed at elevations from 186-460 m or >2,111 m. All other elevations were used in proportion to their availability (Table 10).

Juvenile Females.--Juvenile females showed significant preference for slopes of 20.01-25° and significant avoidance of slopes <5.01°. They were never located on slopes >45.01°. All other slope categories were used in proportion to their availability (Table 8).

Juvenile females preferred SSW and WNW aspects, and avoided NNE and ENE aspects. No preference or avoidance was noted for any other aspect (Table 9).

Juvenile females preferred elevations from 736-1,560 m and avoided elevations from 461-735 m. They were not located at elevations from 186-460 m, 1,836-2,110 m, and >2,386 m. All other elevation categories were used in proportion to availability (Table 10).

Adult Males.--Adult males used slopes from 0-35° in proportion to availability and were never located in areas of greater than 35° slope (Table 8). Although they did not prefer any aspect category, they did avoid WSW aspects. All other aspect categories were used in proportion to availability (Table 9).

Adult males preferred elevations from 736-1,285 m and avoided elevations from 186-460 m and 1,561-2,110 m. They were not located at elevations >2,111 m. All other elevation categories were used in proportion to availability (Table 10).

Juvenile Males.--Juvenile males preferred slopes of 15.01-20.00°, avoided slopes from 0-5.00°, and were never located on slopes >45°. Juvenile males used all other slopes in proportion to availability (Table 8).

Juvenile males did not select for any aspect category; however, they avoided NNW aspects and used all other aspects in proportion to availability (Table 9).

Juvenile males preferred elevations from 736-1,285 m, and avoided elevations from 461-735 m and 1,836-2,110 m. Juvenile males were not located at elevations from 186-460 m or >2,111 m. They used all other elevation categories in proportion to availability (Table 10).

DISCUSSION

Grizzly bears of different sex and age classes used slope, aspect and elevation within the study area differently and did not use the variables in proportion to availability. Therefore, I reject H_{01} that all sex and age classes of grizzly bears select topographic habitats in proportion to availability, and my predictions were supported by the results. I also reject H_{02} that all sex and age classes select topographic habitats similarly, and my predictions were also supported by my results. Spatial separation may be an important mechanism for grizzly bears to reduce competition for resources. Some sex and age classes preferred similar topographic habitats. I speculate the overlap occurred in habitats that contained essential components to those specific sex and age classes of grizzly bears. Analysis of the differences and overlaps can be used to better understand bear topographic selection and to define critical grizzly bear habitat.

Slope

Selection of slope categories by grizzly bears of different sex and age classes probably depends on a balance between (a) requirements for food and cover, (b) interspecific interactions, and (c) the overall goal to increase reproductive success and genetic fitness. I define food requirements as including both vegetative forage and prey species. Slope is a major factor affecting plant distribution as it influences soil moisture via changes in drainage (Heebner 1982). The term cover is defined as either thermal cover (e.g., dense black spruce stand) or escape cover (e.g., steep terrain). Intraspecific interactions can be either positive (e.g., breeding) or negative (e.g., cannibalism). Darling (1987) and Weilgus and Bunnell (1994) reported that selection for different slopes changes both within sex and age classes and between seasons.

Females with cubs preferred both gentle and steep slopes that were not preferred by any other sex or age class of bears. The exception was for juvenile females, which possibly shared preference with their mothers for one slope category (20-25.01°). Juvenile females that share this common category are likely: (1) the previous offspring of the female with cubs (Reynolds and Boudreau 1992); and (2) at the bottom of the social hierarchy (Hornocker 1962); these bears are unlikely to pose a threat to cubs. Females with cubs preferentially used slopes from 5.01-15.00 and 20.01-25.00° and were the only class of bears to select for slopes from 5.01-15.00° (Table 8, Fig. 2).

Females with cubs most likely select steep sloped areas to avoid intraspecific interactions. Deleterious interactions have been reported by many researchers; Murie (1961) witnessed a female accompanied by cubs kill another female's cubs in Denali National Park and Preserve; Dean et al. (1986) reported seeing two instances of adult male infanticide of yearlings;

and Glenn (1970) and Reynolds (1982) witnessed adult grizzlies with dead cubs-of-the-year in their mouths, but did not see the actual killing occur. Spatial avoidance of adult males by females with cubs in Alaska has been hypothesized but not tested by Schoen and Beier (1990), Smith and Van Daele (1991), and Ballard et al. (1993). The major trade off of selecting these steep areas is usually they are associated with little or no forage, thus compromising the nutritional requirements of the maternal female.

Females with cubs preferred slopes 5.01-15.00°, most likely once the cubs were larger and stronger, as also reported by Stelmock (1981) and Darling (1987). These slopes were probably selected for their potential for greater diversity of vegetation with possible higher nutritional value. Nonetheless, females with cubs still remain in proximity to escape terrain as reported by Stelmock (1981) and Darling (1987), who both observed females with cubs in steep areas in spring and observed those same groups on gentler slopes, yet still close to escape terrain, later in the summer when the cubs were larger.

Females with yearlings preferred slopes of 15.01-20.00°, but used all slope categories except those between 35.01-40.00° (Table 8). This exception could be a function of small sample size ($n = 107$). There was no overlap of slope preference between females with yearlings and females with cubs, possibly indicating changes in the habitat requirements for females with yearlings. As a family group, to accommodate lactation by the sow and growth of the yearlings, they require larger quantities of higher-quality resources (Robbins 1983). Because the young have grown, they are also less vulnerable to negative intraspecific interactions. As vulnerability for the young decreases, (Reynolds and Boudreau 1992) this allows family groups more access to gentler slopes that probably have differing plant communities than on steeper slopes. Females with yearlings also avoided 0-5.00° slopes, the same category that adult males used in proportion to availability (Fig. 2). Females with yearlings still may avoid certain terrain to protect their young from possible harmful interactions or from competition from other bears.

Females with 2-year-olds preferred slopes from 15.01-20.00°, slopes which also were selected by females with yearlings and breeding females (Table 8, Fig. 2). The attraction of this terrain to these classes of bears is probably related to the presence of high-quality food resources, such as berries (Arctostaphylos and Vaccinium spp.), Hedysarum roots, or ground squirrels (Spermophilus undulatus) (Stelmock and Dean 1986), because the nutritional needs to raise yearlings and 2-year-olds and to attain good prenatal body condition are high (Robbins 1983). Why females with 2-year-old offspring were not observed on slopes of >45.00° may be the result of a decrease in the vulnerability of these young to predation. Reynolds and Boudreau (1992) reported mean natural rates of mortality from 1982-1991 for this study area as 23% for cubs, 5% for yearlings, and 5% for 2-year-olds. If threatened, 2-year-olds have a good chance of evading adult males. In addition, these young bears are usually ready for weaning, being sufficiently self-reliant at this age (Reynolds and Boudreau 1992).

Breeding females exhibited slope preference and avoidance similar to females with 2-year-old offspring, but also used slopes of >45.00° (Table 8, Fig. 2). These similarities in habitat use may be because females usually weaned their offspring as 2-year-olds, and that the habitat used immediately prior to weaning is likely similar to that used shortly afterwards. These two classes also share increased nutritional needs associated with pregnancy and lactation (Robbins 1983). Breeding females avoided slopes from 0-5.00°. I speculate that there is both a negative nutritional and intraspecific interaction component to this avoidance because these gently-sloped areas are usually dominated by spruce (Picea sp.), wet sedge, and muskeg, vegetative types that are probably not as nutritionally rich as those found on well-drained slopes (Heebner 1982), and are used in proportion to availability by adult males. Breeding females used every slope category, which could be a function of the amount of movement they undertake to find a mate during the mating season.

Juvenile females preferred slopes of 20.01-25.00° and avoided those of 0-5.00°. They preferred the same steeper slopes preferred by females with cubs (Table 8, Fig. 2). These steep areas are familiar to juvenile females from their recent familial associations and therefore enhance their security. Familiarity with these areas is likely because weaned female offspring remain within or adjacent to their maternal home range in this area (Reynolds 1993). Similarly, juvenile females were not often located in the 0-5.00° slope category, probably because they avoided these areas while accompanied by their mothers. Juvenile females did not use slopes of >45.00°. I believe that while steep slopes can provide safety, they do not support vegetation that is nutritionally adequate for subadult growth.

Adult males showed no preference for any slope categories, but did not occur on slopes of >35°. A reason for this could be that they have large home ranges encompassing more diverse topography (Reynolds and Hechtel 1983) and dominance in the social hierarchy reduces social pressures from governing their distribution (Hornocker 1962) and, therefore, have a higher probability of being located on a particular slope. Adult males were the only class of bears using the 0-5.00° slope category in proportion to its availability (Table 8, Fig. 2). Adult males may use the flat areas for several reasons. More gentle slopes are natural movement corridors for ungulate prey, such as moose (Alces alces) and caribou (Rangifer tarandus) and, therefore, present increased predation or scavenging opportunities. Also, there is usually more carrion left from wolf predation in these habitats (Bergerud et al. 1984). River bottoms also tend to be snow-free first in the spring and thus provide the earliest new vegetation. I believe adult males avoid steep areas (>35°) because of decreased food availability; additionally, the potential prey associated with such slopes, such as Dall's sheep (Ovis dalli) and young bears, are difficult to catch. Also, steep terrain is energetically expensive to traverse, and opportunities for mating are better on less steep slopes where breeding females are more likely to occur.

Juvenile males preferred slopes from 15-20.00°, avoided slopes of 0-5.00°, and did not use areas with >45.00° slopes (Table 8). Juvenile males were present in areas similar to breeding females and family groups with young older than cubs, probably because of recently being weaned from their mothers (Fig. 2). Nonetheless, young males tend to use lower areas with gentle slopes more than do juvenile females. I speculate that differences in selection between juvenile males and females are similar to those between the adult sexes as previously mentioned and that juvenile males are not found in extremely steep areas for the same nutritional reasons that affect juvenile females.

Aspect

Grizzly bears may select aspect on the basis of its direct relationship to vegetation composition and phenology. The amount and timing of solar energy received by vegetation is dependent upon the aspect of that slope (Hamer and Herrero 1983). Hamer and Herrero (1983) reported that bears selected different aspects based on the presence of certain forage species. Darling (1987) and Weilgus and Bunnell (1994) both reported that use of aspect by grizzly bears changed throughout summer. My findings of selection of aspect by bears are different than those of Darling (1987) in nearby Denali National Park and Preserve. Darling's analyses indicated that bears tended to prefer northerly-facing slopes, particularly those facing NNW and NNE. My analyses indicated that only juvenile females preferred NNW aspects and all other classes, except adult males, avoided or used in proportion to availability northerly-facing slopes. Other than the juvenile female class that indicated a preference for both NNW and SSE aspects, only the adult female class indicated preference for any aspect. I believe that the differences in scope between Darling's work and this study make our results somewhat incomparable, and are that Darling had a much smaller sample of bears, studied bears in a smaller area, and only collected information for two years. Therefore, the substantial differences in data collected inherently predispose Darling's conclusions to be different from my results.

Females accompanied by young (i.e. cubs, yearlings, or 2-year-olds) did not prefer any aspect. They did, however, tend to avoid NNE (Table 9, Fig. 4). I believe this apparent lack of preference is the product of the family group utilizing all aspects as reported by Hamer and Herrero (1983). In their study, grizzly bears, while foraging on similar vegetative species, changed the aspects they fed on to coincide with that plant species' timing of phenological events, which were effected by aspect.

Breeding females preferred SSE aspects and avoided those facing NNE (Table 9, Fig. 4). Preference for SSE aspects is probably nutritionally based because females need to have adequate energy stores for the possible upcoming pregnancy (Robbins 1983). Juvenile females showed the greatest preference and avoidance aspect of all age and sex classes. They preferred SSW and WNW aspects and avoided those that were NNE and ENE (Table 9, Fig. 4). I speculate that the WNW aspect was selected because of social pressures of trying to establish a home range close to the maternal home range, while minimizing potential competition with other bears and conflict with the maternal female. Juvenile females also significantly avoided NNE and ENE aspects (Table 9, Fig. 4). I believe this avoidance could be explained by the differences in plant species composition and diversity of north facing slopes (Heebner 1982), coupled with the energetic demands of the growth of subadult bears.

Adult males significantly avoided the WSW aspect. Although adult males did not prefer northern aspects, they did use them in proportion to availability, unlike most female age and sex classes (Table 9, Fig. 4). Juvenile males used all aspects in proportion to availability except for that of NNW, which was avoided. Like adult males, they used almost all of the same aspects in proportion to availability, although they avoided different aspects.

Elevation

Grizzly bears, as with many large animals, must spend a large amount of their lives eating. They have a large gut volume to allow them to eat great quantities of food (Pritchard and Robbins 1990) to restore annual fat reserves, to hibernate, or in the case of females with young, to maintain lactation (Robbins 1983). Elevation and its influences on wind exposure, temperature, and soil formation affect plant growth and distribution (Heebner 1982). Elevation is a key component to selection of habitat by grizzly bears, because elevation has such an effect on vegetation (i.e. food) distribution and availability.

Females with cubs occurred from 461-2,385 m and avoided areas from 186-735 m and from 1,561-1,835 m. Females with cubs preferred elevations from 1011-1560 m (Table 10, Fig. 3). Females with cubs probably preferred higher and avoided lower elevations, most likely to avoid predation on young or competition by other adult bears (especially males) (Pearson 1975, Smith and Van Daele 1991, and Ballard et al. 1993). I believe the 1,561-1,835 m elevation was avoided because it is a transitional zone between lower-elevation, nutritionally-rich areas and higher-elevation nutritionally-poor but safe landscapes that were rarely used by potentially confrontational adult males. I speculate adult males do not use these upper elevations because there is little food available. Preference for elevations from 1,011-1,560 m probably resulted from a balance between nutritional values and proximity to escape terrain provided by this zone. Females with cubs used elevations from 1,836-2,110 m in proportion to availability, and was the only sex or age class of bears observed above 2,111 m. Females with cubs seek high elevations away from all other bears to avoid predation and increase the survival potential of their offspring. Stelmock and Dean (1986) and Darling (1987) also reported females with cubs using higher elevations during spring and lower elevations later in the summer.

Females with yearlings selected similar elevations to those frequented by females with cubs, except they did not select those >1,835 m. They used the 1,561-1,835 m zone in proportion to its availability, habitat that females with cubs avoided. They avoided, but occasionally used, elevations from 186-460 m; while females with cubs did not (Table 10, Fig. 3). Females with yearlings are better able to use lower elevations than females with cubs, thus taking advantage of the vegetation with higher nutritional qualities that are present at those elevations.

Females with 2-year-old offspring preferred elevations from 1,011-1,285 m, but avoided lower elevations and were not found at higher elevations >2,110 m (Table 10, Fig. 3). Mortality decreases with age to adulthood (Reynolds and Boudreau 1992). This decrease expands this class's options for habitat use, allows some security in the preference of the 1,011-1,285 m elevation category, and allows use of other areas in proportion to availability. Females with 2-year-old offspring still concentrated their activities in nutritionally-good habitat, because they were still lactating and storing reserves for the winter or the next reproductive cycle.

Breeding females avoided lower (186-735 m) and higher (1,561-2,110 m) elevations. They preferred elevations from 736-1,285 m (Table 10, Fig. 3). This pattern is similar to that of adult males possibly indicating that adults in breeding condition utilize similar habitats to increase the likelihood of mating. I speculate that similar use patterns tend to optimize energy intake and mating success.

Juvenile females avoided lower elevations and preferred elevations from 736-1,560 m (Table 10, Fig. 3). This elevational preference reflects the reduced vulnerability of this age class and the increased nutritional requirements necessary for growth. These juveniles also used elevations between 2,111-2,385 m, which could indicate that the loss of security that had been provided by a family group, but which ceased upon weaning, resulted in a consequent retreat to higher and safer elevations. Use of these higher areas could also allow spatial separation within a home range shared with a mother of a juvenile female. Fidelity of juvenile females to their maternal home range was documented in the study area (Reynolds 1993) and could serve to reduce competition between juvenile females and unrelated bears in adjacent home ranges.

Juvenile males used elevations similar to juvenile females, but did not prefer elevations from 1,286-1,560 m, and avoided elevations >1,836 m. Juvenile males used elevations similarly to adult males (Table 10, Fig. 3). Juvenile males, once weaned, disperse to areas far removed from their maternal home range (Reynolds 1993) prior to establishing their own home range. They used lower elevations where mobility and nutritional requirements are optimized.

Adult males used the lowest (186-735 m) elevations of any sex and age class, areas that were avoided or were never used by any other classes (Table 10, Fig. 3). Potential advantages of using these elevations include greater availability of carrion, increased prey density, early green-up of vegetation, important forage species, and energetically efficient mobility. They preferred elevations from 736-1,285 m for possibly three reasons: (1) they were searching for females that also preferred these elevations, (2) there was some desired nutritional attribute available at these elevations, or (3) a combination of those factors. I believe adult males avoided the higher elevations because of the energetic costs for larger, heavier bears to climb or forage in higher elevations; such costs are likely not conducive to the overall fitness of the individual. For example, it is easier to steal a moose carcass from a smaller predator (i.e., wolf [Canis lupus]) than it is to chase and kill a Dall's sheep lamb.

CONCLUSIONS

Grizzly bears of different age and sex classes use some topographic habitat variables of slope, aspect, and elevation differently and some alike, thus I reject both null hypotheses. Changing habitat requirements, spatial separation, and overlaps in habitat selection occurred between different sex and age classes of grizzly bears in the Alaska Range. These conclusions thus support my hypothesis of avoidance of conspecifics.

Elevation is most important to bears because of its direct relationship to distribution of plant communities as described by Heebner (1982). Slope is also important to bears because extreme slopes offer escape terrain while

Figure 5. A hypothetical graph of the dynamics of motivation for habitat selection of different sex and age classes of grizzly bears using nutrition, avoidance, and reproduction as the primary motivating factors. Size of the bar relates to the factor's relative influence on habitat selection. Based on observations of interior Alaska grizzly bears, northcentral Alaska Range, Alaska 1982-1991.

The need for females with young to use topographic habitats that are avoided by other bears declines as the young grow older and more able to avoid risks themselves. Concurrent with the decline in vulnerability to negative intraspecific interactions, increasing food requirements provide an impetus to exploit higher quality topographic habitat that may be less secure from mortality risk. When the young are at least 2 years old, the changes in reproductive status that adult females undergo may also influence topographic habitat selection. Avoidance is a lower motivating factor during this period. Topographic habitat selection by juvenile females and males is influenced primarily by avoidance considerations and secondarily by food requirements for growth. Reproduction has little or no effect on selection by juvenile females; however, juvenile males select topographic habitats with increasing reproductive consideration as they approach adulthood. Adult males select topographic habitats primarily based on reproductive strategies and secondarily on food considerations. However, topographic habitat selection by adult males may also be influenced by the presence of other adult males.

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Appendix A. Categories used for the analysis of slope, aspect and elevation.

SLOPE (degrees)

1)	0-5
2)	5.01-10
3)	10.01-15
4)	15.01-20
5)	20.01-25
6)	25.01-30
7)	30.01-35
8)	35.01-40
9)	40.01-45
10)	>45.00

ASPECT (degrees)

1)	1-45	NNE
2)	45.01-90	ENE
3)	90.01-135	ESE
4)	135.01-180	SSE
5)	180.01-225	SSW
6)	225.01-270	WSW
7)	270.01-315	WNW
8)	315.01-360	NNW
9)	Flat (no aspect)	

ELEVATION (meters)

1)	0-186
2)	187-460
3)	461-735
4)	736-1010
5)	1011-1285
6)	1286-1560
7)	1561-1835
8)	1836-2110
9)	2111-2385
10)	2386-2660
11)	2661-2935
12)	2936-3210
13)	3211-3485
14)	3486-3760
15)	3761-4145

Appendix B. Use of slope by grizzly bears of various sex and age categories in comparison with the availability of slopes, as determined from a selection of random points, northcentral Alaska Range, 1982-1991.

Slope	Random points		Female w/cub		Female w/yrlg		Female w/2-yr-old		Lone adult female		Lone juvenile female		Lone juvenile male		Lone adult male	
(degrees)	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%
0-5.00	(508)	48	(33)	17	(18)	17	(5)	9	(77)	27	(42)	25	(29)	30	(48)	39
5.01-10.00	(151)	14	(46)	24	(17)	16	(7)	13	(55)	19	(30)	18	(19)	20	(21)	17
10.01-15.00	(143)	14	(42)	22	(19)	18	(7)	13	(45)	16	(31)	18	(16)	16	(20)	16
15.01-20.00	(91)	9	(29)	15	(26)	24	(17)	30	(47)	17	(26)	15	(20)	21	(13)	10
20.01-25.00	(59)	6	(24)	13	(9)	8	(9)	16	(29)	10	(29)	17	(4)	4	(10)	8
25.01-30.00	(49)	5	(10)	5	(8)	7	(5)	9	(14)	5	(8)	5	(4)	4	(9)	7
30.01-35.00	(23)	2	(6)	3	(8)	7	(3)	5	(9)	3	(2)	1	(3)	3	(3)	2
35.01-40.00	(15)	1	(1)	0.5	(0)	0	(1)	2	(3)	1	(1)	0.5	(1)	1	(0)	0
40.01-45.00	(7)	0.7	(0)	0	(1)	1	(2)	4	(2)	0.5	(1)	0.5	(1)	1	(0)	0
> =45.01	(3)	0.3	(1)	0.5	(1)	1	(0)	0	(2)	0.5	(0)	0	(0)	0	(0)	0
TOTAL	(1052)	100	(192)	100	(107)	100	(56)	100	(283)	100	(170)	100	(97)	100	(124)	100

Appendix C. Use of aspect by grizzly bears of various sex and age categories in comparison with the availability of aspects, as determined from a selection of random points, northcentral Alaska Range, 1982-1991.

	Random points		Female w/cub		Female w/yrlg		Female w/2-yr-old		Adult female		Juvenile female		Juvenile male		Adult male	
Aspect	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%
NNE	(256)	24	(33)	17	(18)	17	(5)	9	(44)	16	(24)	14	(20)	21	(27)	21
NE	(151)	14	(29)	15	(10)	9	(4)	7	(34)	12	(14)	9	(13)	13.5	(16)	13
SE	(97)	9	(13)	7	(8)	8	(6)	11	(29)	10	(9)	5	(9)	9	(6)	5
SSE	(97)	9	(29)	15	(13)	12	(10)	18	(48)	17	(19)	11	(15)	15	(17)	14
SSW	(90)	9	(17)	9	(19)	18	(12)	21	(24)	8	(34)	20	(7)	7.5	(12)	10
SW	(64)	6	(14)	7	(8)	8	(7)	13	(21)	7	(9)	5	(3)	3	(2)	2
NW	(58)	6	(11)	6	(10)	9	(3)	5	(27)	10	(24)	14	(10)	10	(10)	8
NNW	(166)	16	(30)	16	(15)	14	(4)	7	(38)	14	(24)	14	(7)	7.5	(24)	19
FLAT	(73)	7	(16)	8	(6)	5	(5)	9	(18)	6	(13)	8	(13)	13.5	(10)	8
TOTAL	(1052)	100	(192)	100	(107)	100	(56)	100	(283)	100	(170)	100	(97)	100	(124)	100

Appendix D. Use of elevation by grizzly bears of various sex and age categories in comparison with the availability of elevational categories, as determined from a selection of random points, northcentral Alaska Range, 1982-1991.

Elevation (m)	Random points		Female w/cub		Female w/yrlg		Female w/2-yr-old		Adult female		Juvenile female		Juvenile male		Adult male	
	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%	(count)	%
0-185	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
186-460	(182)	17	(0)	0	(1)	1	(0)	0	(0)	0	(0)	0	(0)	0	(2)	2
461-735	(227)	21	(11)	6	(3)	3	(1)	2	(32)	11	(11)	6	(6)	6	(20)	16
736-1010	(186)	18	(39)	21	(28)	26	(11)	20	(90)	32	(47)	28	(42)	43	(52)	42
1011-1285	(158)	15	(72)	38	(34)	32	(25)	45	(100)	35	(58)	34	(30)	31	(36)	29
1286-1560	(134)	13	(60)	31	(33)	31	(13)	23	(47)	17	(45)	26	(14)	15	(10)	8
1561-1835	(94)	9	(7)	4	(8)	7	(5)	9	(12)	4	(8)	5	(4)	4	(3)	2
1836-2110	(47)	4	(2)	1	(0)	0	(1)	2	(2)	1	(0)	0	(1)	1	(1)	1
2111-2385	(15)	2	(1)	1	(0)	0	(0)	0	(0)	0	(1)	1	(0)	0	(0)	0
2386-2660	(5)	0.5	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
2661-2935	(3)	0.4	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
2936-3210	(1)	0.1	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
TOTAL	(1052)	100	(192)	100	(107)	100	(56)	100	(283)	100	(170)	100	(97)	100	(124)	100

APPENDIX E. Use and availability of slope by female grizzly bears with cubs as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Slope (Degrees)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
0-5.00	511	33	8.301471	0.485741	0.000237	0.353840	0.056409	0.499375	0.208305
5.01-10	151	46	10.33997	0.143536	0.000116	1.669150	0.224073	2.247259	1.091040
10.01-15	143	42	10.03418	0.135931	0.000111	1.609265	0.229205	2.200615	1.017915
15.01-20	91	29	9.317558	0.086501	0.000075	1.746108	0.316283	2.562118	0.930097
20.01-25	59	24	9.381557	0.056083	0.000050	2.228813	0.461228	3.418784	1.038842
25.01-30	49	10	6.350710	0.046577	0.000042	1.118197	0.366030	2.062556	0.173837
30.01-35	23	6	5.342515	0.021863	0.000020	1.429347	0.635125	3.067972	0
35.01-40	15	1	3.002151	0.014258	0.000013	0.365277	0.388329	1.367168	0
40.01-45	7	0	0	0	0	0	0	0	0
>45.00	3	1	0.974339	0.002851	0.000002	1.826388	2.428686	8.092400	0
TOTAL	1052	192	126.0889						

APPENDIX F. Use and availability of slope by female grizzly bears with yearlings as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Slope (Degrees)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	SE($\hat{\pi}$)	$\hat{W}$	SE($\hat{W}$)	Confidence Limits Upper	Confidence Limits Lower
0-5	511	18	7.702188	0.485741	0.000237	0.346324	0.074796	0.539298	0.153350
5.01-10	151	17	8.073660	0.143536	0.000116	1.106888	0.252490	1.758312	0.455464
10.01-15	143	19	8.566952	0.135931	0.000111	1.306319	0.279676	2.027884	0.584755
15.01-20	91	26	11.70773	0.086501	0.000075	2.809078	0.507521	4.118483	1.499673
20.01-25	59	9	7.047682	0.056083	0.000050	1.499762	0.502428	2.796027	0.203497
25.01-30	49	8	6.847153	0.046577	0.000042	1.605187	0.577124	3.094170	0.116205
30.01-35	23	8	8.375604	0.021863	0.000020	3.419748	1.308420	6.795473	0.044022
35.01-40	15	0	0	0	0	0	0	0	0
40.01-45	7	1	1.875851	0.006653	0.000006	1.404539	1.597274	5.525506	0
>45.00	3	1	0.907764	0.002851	0.000002	3.277258	4.351212	14.50338	0
TOTAL	1052	107	122.2091						

APPENDIX G. Use and availability of slope by female grizzly bears with 2-year-olds as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Slope (Degrees)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
0-5.00	511	5	6.813261	0.485741	0.000237	0.183813	0.078633	0.386686	0
5.01-10	151	7	6.755992	0.143536	0.000116	0.870860	0.312835	1.677976	0.063745
10.01-15	143	7	6.779822	0.135931	0.000111	0.919580	0.330677	1.772727	0.066433
15.01-20	91	17	12.82695	0.086501	0.000075	3.509419	0.745540	5.432914	1.585923
20.01-25	59	9	9.480057	0.056083	0.000050	2.865617	0.920934	5.241627	0.489607
25.01-30	49	5	6.667960	0.046577	0.000042	1.916909	0.855400	4.123844	0
30.01-35	23	3	5.429451	0.021863	0.000020	2.450310	1.480478	6.269945	0
35.01-40	15	1	2.673942	0.014258	0.000013	1.252380	1.323450	4.666882	0
40.01-45	7	2	4.641698	0.006653	0.00006	5.367346	4.488560	16.94783	0
>45.00	3	0	0	0	0	0	0	0	0
TOTAL	1052	56	124.1382						

APPENDIX H. Use and availability of slope by breeding female grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Slope (Degrees)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
0-5.00	511	77	9.561021	0.485741	0.000237	0.560143	0.055025	0.702109	0.418176
5.01-10	151	55	9.714206	0.143536	0.000116	1.353988	0.171552	1.796595	0.911382
10.01-15	143	45	9.088700	0.135931	0.000111	1.169784	0.166985	1.600606	0.738961
15.01-20	91	47	9.960471	0.086501	0.000075	1.919931	0.275013	2.629466	1.210396
20.01-25	59	29	8.703923	0.056083	0.000050	1.827154	0.350671	2.731888	0.922421
25.01-30	49	14	6.607764	0.046577	0.000042	1.062089	0.297410	1.829410	0.294769
30.01-35	23	9	5.775046	0.021863	0.000020	1.454601	0.538955	2.845107	0.064095
35.01-40	15	3	3.727538	0.014258	0.000013	0.743462	0.475814	1.971065	0
40.01-45	7	2	2.647251	0.006653	0.000006	1.062089	0.899070	3.381690	0
>45.00	3	2	2.144408	0.002851	0.000002	2.478209	2.569869	9.108474	0
TOTAL	1052	283	135.8606						

APPENDIX I. Use and availability of slope by juvenile female grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Slope (Degrees)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
0-5.00	511	42	8.734510	0.485741	0.000237	0.508622	0.068612	0.685642	0.331601
5.01-10	151	30	8.914336	0.143536	0.000116	1.229450	0.210672	1.772986	0.685914
10.01-15	143	31	9.135537	0.135931	0.000111	1.341505	0.225974	1.924519	0.758491
15.01-20	91	26	9.279837	0.086501	0.000075	1.768067	0.336879	2.637216	0.898917
20.01-25	59	29	11.15219	0.056083	0.000050	3.041674	0.563060	4.494369	1.588980
25.01-30	49	8	5.984135	0.046577	0.000042	1.010324	0.368355	1.960682	0.059965
30.01-35	23	2	3.749406	0.021863	0.000020	0.538107	0.401139	1.573046	0
35.01-40	15	1	2.949058	0.014258	0.000013	0.412549	0.438444	1.543737	0
40.01-45	7	1	1.977817	0.006653	0.000006	0.884033	1.006879	3.481783	0
>45.00	3	0	0	0	0	0	0	0	0
TOTAL	1052	170	123.7536						

APPENDIX J. Use and availability of slope by adult male grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Slope (Degrees)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
0-5.00	511	48	9.525374	0.485741	0.000237	0.796919	0.090853	1.031320	0.562518
5.01-10	151	21	8.449187	0.143536	0.000116	1.179876	0.241349	1.802558	0.557193
10.01-15	143	20	8.353134	0.135931	0.000111	1.186555	0.250154	1.831953	0.541157
15.01-20	91	13	7.452944	0.086501	0.000075	1.211981	0.330201	2.063901	0.360061
20.01-25	59	10	7.062400	0.056083	0.000050	1.437944	0.459002	2.622169	0.253718
25.01-30	49	9	6.908979	0.046577	0.000042	1.558262	0.530535	2.927044	0.189479
30.01-35	23	3	4.302848	0.021863	0.000020	1.106591	0.678176	2.856286	0
35.01-40	15	0	0	0	0	0	0	0	0
40.01-45	7	0	0	0	0	0	0	0	0
>45.00	3	0	0	0	0	0	0	0	0
TOTAL	1052	124	104.1097						

APPENDIX K. Use and availability of slope by juvenile male grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Slope (Degrees)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
0-5.00	511	29	8.587669	0.485741	0.000237	0.615490	0.096314	0.863982	0.366998
5.01-10	151	19	8.765563	0.143536	0.000116	1.364648	0.288480	2.108928	0.620367
10.01-15	143	16	8.179878	0.135931	0.000111	1.213466	0.284552	1.947611	0.479321
15.01-20	91	20	10.43286	0.086501	0.000075	2.383595	0.498800	3.670500	1.096691
20.01 25	59	4	5.213358	0.056083	0.000050	0.735278	0.371742	1.694375	0
25.01-30	49	4	5.169194	0.046577	0.000042	0.885335	0.450671	2.048066	0
30.01-35	23	3	4.531009	0.021863	0.000020	1.141612	0.864157	3.644138	0
35.01-40	15	1	2.772887	0.014258	0.000013	0.723024	0.766801	2.701372	0
40.01-45	7	1	1.859666	0.006653	0.000006	1.549337	1.761191	6.093211	0
>45.00	3	0	0	0	0	0	0	0	0
TOTAL	1052	97	111.0241						

APPENDIX L. Use and availability of aspect by female grizzly bears with cubs as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Aspect	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
NNE	256	33	8.395317	0.243346	0.000175	0.706298	0.113974	0.995794	0.416803
NE	151	29	8.492116	0.143536	0.000116	1.052290	0.186012	1.524763	0.579817
SE	97	13	6.734350	0.092205	0.000079	0.734321	0.203520	1.251263	0.217378
SSE	97	29	9.185998	0.092205	0.000079	1.638101	0.295605	2.388940	0.887262
SSW	90	17	7.392175	0.085551	0.000074	1.034953	0.250158	1.670356	0.399550
SW	64	14	7.104247	0.060836	0.000054	1.198567	0.326019	2.026656	0.370478
NW	58	11	6.512865	0.055133	0.000049	1.039152	0.321137	1.854840	0.223463
NNW	166	30	8.492721	0.157794	0.000126	0.990210	0.171087	1.142772	0.555649
FLAT	73	16	7.390912	0.069391	0.000061	01.200913	0.302756	1.969913	0.431912
TOTAL	1052	192	139.4014						

APPENDIX M. Use and availability of aspect by female grizzly bears with yearlings as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Aspect	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
NNE	256	18	7.764570	0.243346	0.000175	0.691296	0.150647	1.073941	0.308651
NE	151	10	6.733399	0.143536	0.000116	0.651110	0.199735	1.158437	0.143784
SE	97	8	6.372126	0.092205	0.000079	0.810868	0.283348	1.530573	0.091163
SSE	97	13	7.727812	0.092205	0.000079	1.317660	0.354865	2.219019	0.416301
SSW	90	19	9.652758	0.085551	0.000074	2.075597	0.452922	3.226019	0.925175
SW	64	8	6.575460	0.060836	0.000054	1.228971	0.435982	2.336368	1.121575
NW	58	10	7.483383	0.055133	0.000049	1.695133	0.538000	32.061654	0.328613
NNW	166	15	7.596109	0.157794	0.000126	0.888413	0.217209	1.440125	0.336701
FLAT	73	6	5.841865	0.069391	0.000061	0.808091	0.330820	1.648374	0
TOTAL	1052	107	131.4949						

APPENDIX N. Use and availability of aspect by female grizzly bears with 2-year-olds as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Aspect	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
NNE	256	5	6.338509	0.243346	0.000175	0.366908	0.157674	0.767401	0
NE	151	4	5.855829	0.143536	0.000116	0.497634	0.242589	1.113810	0
SE	97	6	6.602678	0.092205	0.000079	1.162002	0.459127	2.328186	0
SSE	97	10	8.625713	0.092205	0.000079	1.936671	0.573185	3.392563	0.480779
SSW	90	12	9.965967	0.085551	0.000074	2.504761	0.666376	4.197357	0.812166
SW	64	7	7.744306	0.060836	0.000054	2.054687	0.756593	3.976433	0.132941
NW	58	3	5.135288	0.055133	0.000049	0.971674	0.561592	2.398120	0
NNW	166	4	5.902807	0.157794	0.000126	0.452667	0.220397	1.012477	0
FLAT	73	5	6.270453	0.069391	0.000061	1.286692	0.565540	2.723164	0
TOTAL	1052	56	124.8831						

APPENDIX O. Use and availability of aspect by breeding female grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Aspect	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
NNE	256	44	8.622993	0.243346	0.000175	0.638913	0.090404	0.868540	0.409286
NE	151	34	8.254071	0.143536	0.000116	0.837011	0.139394	1.191074	0.482947
SE	97	29	8.125183	0.092205	0.000079	1.111362	0.205915	1.634388	0.588335
SSE	97	48	9.928829	0.092205	0.000079	1.839495	0.259161	2.497766	1.181225
SSW	90	24	7.664324	0.085551	0.000074	0.991283	0.203646	1.508546	0.474020
SW	64	21	7.522026	0.060836	0.000054	1.219746	0.274003	1.915711	0.523776
NW	58	27	8.454610	0.055133	0.000049	1.730473	0.344935	2.606611	0.854336
NNW	166	38	8.475179	0.157794	0.000126	0.850951	0.132758	1.188157	0.513745
FLAT	73	18	7.064671	0.069391	0.000061	0.916598	0.220745	1.477291	0.355904
TOTAL	1052	283	148.2237						

APPENDIX P. Use and availability of aspect by juvenile female grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Aspect	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
NNE	256	24	7.847261	0.243346	0.000175	0.580147	0.111459	0.863254	0.297039
NE	151	14	6.943144	0.143536	0.000116	0.573743	0.150144	0.955109	0.192377
SE	97	9	6.203798	0.092205	0.000079	0.574166	0.191627	1.060899	0.087433
SSE	97	19	7.910312	0.092205	0.000079	1.212128	0.273425	1.906628	0.517628
SSW	90	34	10.74410	0.085551	0.000074	2.337777	0.382351	3.308951	1.366604
SW	64	9	6.182575	0.060836	0.000054	0.870220	0.295060	1.619674	0.120766
NW	58	24	10.02235	0.055133	0.000049	2.560649	0.526106	3.896959	1.224338
NNW	166	24	8.073631	0.157794	0.000126	0.894684	0.173784	1.336096	0.453272
FLAT	73	13	7.017479	0.069391	0.000061	1.102014	0.307773	1.883759	0.320269
TOTAL	1052	170	141.8893						

APPENDIX Q. Use and availability of aspect by adult male grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Aspect	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
NNE	256	27	8.589531	0.243346	0.000175	0.894783	0.154948	1.288352	0.501213
NE	151	16	7.590581	0.143536	0.000116	0.898953	0.214837	1.444639	0.353266
SE	97	6	5.805909	0.092205	0.000079	0.524775	0.213902	1.068087	0
SSE	97	17	8.358235	0.092205	0.000079	1.486863	0.348902	2.373075	0.600652
SSW	90	12	7.210950	0.085551	0.000074	1.131182	0.321835	1.948664	0.313721
SW	64	2	4.707415	0.060836	0.000054	0.265120	0.189841	0.747317	0
NW	58	10	7.082928	0.055133	0.000049	1.462736	0.467343	2.649788	0.275683
NNW	166	24	8.799894	0.157794	0.000126	1.226583	0.231066	1.813493	0.639674
FLAT	73	10	6.849340	0.069391	0.000061	1.162174	0.367196	2.094853	0.229494
TOTAL	1052[1]	124	129.9895						

APPENDIX R. Use and availability of aspect by juvenile male grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Aspect	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
NNE	256	20	8.189012	0.243346	0.000175	0.847293	0.171306	1.282412	0.412174
NE	151	13	7.453906	0.143536	0.000116	0.933706	0.246282	1.559263	0.308149
SE	97	9	6.782123	0.092205	0.000079	1.006270	0.328901	1.841679	0.170861
SSE	97	15	8.623484	0.092205	0.000079	1.677117	0.413838	2.728267	0.625967
SSW	90	7	6.223448	0.085551	0.000074	0.843528	0.315675	1.645342	0.041713
SW	64	3	4.921657	0.060836	0.000054	0.508376	0.296396	1.261224	0
NW	58	10	7.793677	0.055133	0.000049	1.869889	0.590464	3.369669	0.370110
NNW	166	7	6.290084	0.157794	0.000126	0.457334	0.168822	0.886143	0.028525
FLAT	73	13	8.570445	0.069391	0.000061	1.931365	0.523099	3.260039	0.602691
TOTAL	1052	97	129.6956						

APPENDIX S. Use and availability of elevation by female grizzly bears with cubs as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Elevation (m)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
186 460	182	0	0	0	0	0	0	0	0
461-735	227	11	6.836628	0.215779	0.000160	0.265510	0.078644	0.470772	0.060247
736-1010	186	39	9.222765	0.176806	0.000138	1.148857	0.169305	1.590745	0.706969
1011-1285	158	72	12.78670	0.150190	0.000121	2.496835	0.246058	3.139047	1.854623
1286-1560	134	60	12.20499	0.127376	0.000105	2.453358	0.278592	3.180485	1.726230
1561-1835	94	7	5.873951	0.089353	0.000077	0.408023	0.155333	0.813443	0.002602
1836-2110	47	2	4.550312	0.044676	0.000040	0.233156	0.168744	0.673578	0
2111-2385	15	1	3.002151	0.014258	0.000013	0.365277	0.388329	1.378818	0
2386-2660	5	0	0	0	0	0	0	0	0
2661-2935	3	0	0	0	0	0	0	0	0
2936-3210	1	0	0	0	0	0	0	0	0
TOTAL	1052	192	108.9550						

APPENDIX T. Use and availability of elevation by female grizzly bears with yearlings as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Elevation (m)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
186-460	182	1	5.701981	0.173003	0.000136	0.054020	0.054013	0.194995	0
461-735	227	3	6.053986	0.215779	0.000160	0.129935	0.074407	0.324140	0
736-1010	186	28	9.726515	0.176806	0.000138	1.480052	0.246886	2.124426	0.835667
1011-1285	158	34	11.35383	0.150190	0.000121	2.115698	0.311077	2.927610	1.303786
1286-1560	134	33	11.81369	0.127376	0.000105	2.421258	0.366283	3.377258	1.465257
1561-1835	94	8	6.379406	0.089353	0.000077	0.836746	0.292666	1.600607	0.072886
1836-2110	47	0	0	0	0	0	0	0	0
2111-2385	15	0	0	0	0	0	0	0	0
2386-2660	5	0	0	0	0	0	0	0	0
2661-2935	3	0	0	0	0	0	0	0	0
2936-3210	1	0	0	0	0	0	0	0	0
TOTAL	1052	107	102.0588						

APPENDIX U. Use and availability of elevation by female grizzly bears with 2-year-olds as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Elevation (m)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
186-460	182	0	0	0	0	0	0	0	0
461-735	227	1	5.688670	0.215779	0.000160	0.082756	0.082300	0.297559	0
736-1010	186	11	7.845758	0.176806	0.000138	1.110983	0.305194	1.907541	0.314424
1011-1285	158	25	13.30417	0.150190	0.000121	2.972423	0.458298	4.168580	1.776265
1286-1560	134	13	9.190400	0.127376	0.000105	1.822494	0.454797	3.009517	0.635471
1561-1835	94	5	6.151745	0.089353	0.000077	0.999240	0.436138	2.137560	0
1836-2110	47	1	3.970617	0.044676	0.000040	0.399696	0.404235	1.454750	0
2111-2385	15	0	0	0	0	0	0	0	0
2386-2660	5	0	0	0	0	0	0	0	0
2661-2935	3	0	0	0	0	0	0	0	0
2936-3210	1	0	0	0	0	0	0	0	0
TOTAL	1052	56	92.30273						

APPENDIX V. Use and availability of elevation by breeding female grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Elevation (m)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	SE($\hat{\pi}$)	$\hat{W}$	SE($\hat{W}$)	Confidence Limits Upper	Lower
186-460	182	0	0	0	0	0	0	0	0
461-735	227	32	8.053700	0.215779	0.000160	0.524026	0.089051	0.756451	0.291601
736-1010	186	90	11.39092	0.176806	0.000138	1.798700	0.164535	2.228139	1.369261
1011-1285	158	100	12.35454	0.150190	0.000121	2.352730	0.201847	2.879551	1.825909
1286-1560	134	47	9.317659	0.127376	0.000105	1.303834	0.182165	1.779285	0.828382
1561-1835	94	12	6.439824	0.089353	0.000077	0.474550	0.138652	0.836433	0.112667
1836-2110	47	2	4.819918	0.044676	0.000040	0.158183	0.114671	0.457477	0
2111-2385	15	0	0	0	0	0	0	0	0
2386-2660	5	0	0	0	0	0	0	0	0
2661-2935	3	0	0	0	0	0	0	0	0
2936-3210	1	0	0	0	0	0	0	0	0
TOTAL	1052	283	104.7531						

APPENDIX W. Use and availability of elevation by juvenile female grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Elevation (m)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	SE($\hat{\pi}$)	$\hat{W}$	SE($\hat{W}$)	Confidence Limits Upper	Confidence Limits Lower
186-460	182	0	0	0	0	0	0	0	0
461-735	227	11	6.807005	0.215779	0.000160	0.299870	0.088476	0.530793	0.068947
736-1010	186	47	10.42841	0.176806	0.000138	1.563693	0.200933	2.088130	1.039257
1011-1285	158	58	12.13898	0.150190	0.000121	2.271630	0.254325	2.935420	1.607840
1286-1560	134	45	11.13805	0.127376	0.000105	2.078138	0.279176	2.806789	1.349488
1561-1835	94	8	6.035911	0.089353	0.000077	0.526658	0.186869	1.014388	0.038927
1836-2110	47	0	0	0	0	0	0	0	0
2111-2385	15	1	2.949058	0.014258	0.000013	0.412549	0.438444	1.556890	0
2386-2660	5	0	0	0	0	0	0	0	0
2661-2935	3	0	0	0	0	0	0	0	0
2936-3210	1	0	0	0	0	0	0	0	0
TOTAL	1052	170	98.99485						

APPENDIX X. Use and availability of elevation by adult male grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Elevation (m)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	SE($\hat{\pi}$)	$\hat{W}$	SE($\hat{W}$)	Confidence Limits Upper	Confidence Limits Lower
186-460	182	2	5.825627	0.173003	0.000136	0.093229	0.065812	0.265001	0
461-735	227	20	7.873845	0.215779	0.000160	0.747477	0.155651	1.153729	0.341226
736-1010	186	52	12.75276	0.176806	0.000138	2.371834	0.261130	3.053384	1.690285
1011-1285	158	36	10.91575	0.150190	0.000121	1.933033	0.281802	2.668538	1.197529
1286-1560	134	10	6.611420	0.127376	0.000105	0.633124	0.196091	1.144924	0.121324
1561-1835	94	3	5.243979	0.089353	0.000077	0.270761	0.157044	0.680648	0
1836-2110	47	1	4.214301	0.044676	0.000040	0.180507	0.183447	0.659306	0
2111-2385	15	0	0	0	0	0	0	0	0
2386-2660	5	0	0	0	0	0	0	0	0
2661-2935	3	0	0	0	0	0	0	0	0
2936-3210	1	0	0	0	0	0	0	0	0
TOTAL	1052	124	106.8753						

APPENDIX Y. Use and availability of elevation by juvenile male grizzly bears as determined by the Log Likelihood Test, northcentral Alaska Range, Alaska, 1982-1991.

Elevation (m)	Random points	No. of Locations	Log/Like	$\hat{\pi}$	$SE(\hat{\pi})$	$\hat{W}$	$SE(\hat{W})$	Confidence Limits Upper	Confidence Limits Lower
186-460	182	0	0	0	0	0	0	0	0
461-735	227	6	6.319121	0.215779	0.000160	0.286661	0.114342	0.585094	0
736-1010	186	42	12.81193	0.176806	0.000138	2.448952	0.295383	3.219903	1.678001
1011-1285	158	30	11.07604	0.150190	0.000121	2.059245	0.323539	2.903682	1.214808
1286-1560	134	14	7.800500	0.127376	0.000105	1.133097	0.287506	1.883490	0.382704
1561-1835	94	4	5.429922	0.089353	0.000077	0.461504	0.230415	1.062888	0
1836-2110	47	1	4.117544	0.044676	0.000040	0.230752	0.234250	0.842145	0
2111-2385	15	0	0	0	0	0	0	0	0
2386-2660	5	0	0	0	0	0	0	0	0
2661-2935	3	0	0	0	0	0	0	0	0
2936-3210	1	0	0	0	0	0	0	0	0
TOTAL	1052	97	95.11014						