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Use of Clearcut Habitats by Black Bears in the Pacific Northwest

Kim R. Barber
Utah State University

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USE OF CLEARCUT HABITATS BY BLACK BEARS
IN THE PACIFIC NORTHWEST

by

Kim R. Barber

A thesis submitted in partial fulfillment
of the requirements for the degree
of
MASTER OF SCIENCE
in
Fisheries and Wildlife

UTAH STATE UNIVERSITY
Logan, Utah
1983
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Patterns of vegetation use by black bears (Ursus americanus) on Long Island, Washington were documented using radio-telemetry in 1973-74 and 1980-81. Secondary succession altered the vegetative composition of clearcut areas through this time, reducing the areas dominated by productive brush species by nearly 50%. Seasonal food habits, consisted primarily of grasses and forbs in spring (den emergence-May) and flowers and fruits of shrub species in summer (June-September) and fall (October-den entrance).

Bears selected for clearcuts (5-21 years of age) over all other vegetation types for feeding but preferred areas dominated by large trees when inactive during both the day and night. Inactivity in clearcut areas occurred most frequently in clearcuts offering the greatest amount of horizontal cover. Although preferred in all seasons, clearcuts received the greatest use during the summer months when
flowers and fruits of shrubs species were most abundant. Tidelands and meadows were used more in the spring than during other seasons and conifer stands received the greatest proportionate use in spring and fall. Old growth timber (200 + years of age) was used similarly to mature second growth.

Adult males were less influenced than other classes of bears by availability of horizontal cover and proximity of cover provided by adjacent vegetation types when feeding in clearcut areas. Adult females with cubs fed in timber stands and clearcuts with abundant horizontal cover more than other bears and generally remained in close proximity to bordering timber stands when feeding in clearcuts. Subadults, as well as adult females with cubs, appeared to use available habitats in a manner that allowed them to avoid other bears.

Areas in large timber stands that were long distances from clearcuts were used by bears more during the 1980-81 phase of the study, apparently because of the increased competition for declining resources in clearcut areas. Home ranges of the adult females present during both phases of the study were similar in both size and location.

(169 pages)
INTRODUCTION

The major land use of forested areas in the Pacific Northwest is clearcut logging. Over one-third of the U.S. harvest of sawtimber was cut in the Pacific coast states alone in 1970 (U.S. Dep. Agric. 1977). Although clearcut logging causes extreme alterations of forest environments, because it appears the most economical and silviculturally sound method of harvesting timber in coastal forests, it is likely that it will remain the dominant means by which forests are harvested in the future.

Coastal forests are composed of various populations of animals and plants that interact with one another and their environment forming distinctive communities. Disturbance of these communities by clearcut logging will generally affect all members of the community (Hagar 1960, Gashwiller 1970, Resler 1972, Hooven 1973, Black and Hooven 1974, Wight 1974). Secondary succession, the process of recovery of the forest towards its original stage, is very dynamic. Short-term increases of shrub and herb species are common, with concurrent increases of both forage and edge habitats. Values provided by large trees are lost, however, for a number of decades.

The affect of clearcut logging on deer (Odocoileus hemionus) and elk (Cervus elaphus), because of the status of these species as game animals, has received considerable attention by wildlife researchers. Use of old growth forest systems by black-tailed deer may increase after clearcutting because of increases in both forage and edge (Brown 1961,
Shay 1971). Both deer and elk, however, apparently use clearcuts with a
definite preference for the edge of these openings (Brown 1961, Harper
1971). Droilet (1978) also found that intensity of browsing by
white-tailed deer (Odocoileus virginianus) decreased away from the edge
in large clearcuts. Use of smaller clearcuts (<60 ha) was total because
of the closeness of security cover provided by adjacent timber stands.
When timber next to open foraging areas was harvested, use of these
areas by roosevelt elk decreased by 55 percent (Harper 1971).

Age of clearcuts also appears to influence their use by deer and
elk (Resler 1972, Hooven 1973). Roosevelt elk use of clearcuts in
Oregon was light the year after logging but rose rapidly to a peak in
use 5 to 8 years after harvest (Harper 1971). Blacktailed-deer use of
naturally regenerated clearcuts in coastal forests was generally
greatest 15-25 years after harvest (Brown 1961), somewhat later in the
sere than elk. Patton (1976) emphasized that the needs of ungulates
included both food and cover and recommended that timber managers be
concerned with not only how much timber to leave for cover but also how
much timber should ideally be removed to stimulate forage production to
allow maximum utilization by deer and elk.

While timber management plans in the Pacific Northwest as well as
in other areas of the country often include considerations that will
increase the value of clearcut areas for elk and deer, current
information is inadequate to allow similar considerations to be given
the black bear (Ursus americanus). The position of clearcuts relative
to timber may be as important in the utilization of these areas by black bears as has been shown for deer and elk. McCollum (1973) found an inverse relationship in western Oregon between the number of bear tracks and the distance into the clearcuts in which they were found. He also noted that the age of a clearcut apparently influenced use by black bears; clearcuts less than 4 years of age were not used. These conclusions were made, however, solely on the basis of observed scats and tracks. Jonkel and Cowan (1971) found that black bears avoided "recently" logged clearcuts in Montana but used clearcuts 10 years of age and older as much as surrounding areas. Erickson (1965) noted that black bears very seldom visited garbage dumps in the open, suggesting that adjacent cover is required to most effectively exploit food resources. However, the black bear has recently extended its range into the treeless regions of Canada, apparently as a result of the decreasing grizzly bear (Ursus arctos) populations in these areas (Jonkel and Miller 1970).

As Peek et al. (1982) pointed out, apparent preference for specific qualities of a habitat by a species does not necessarily mean it is required to assure survival of that species. For example, cover provided by large trees may not necessarily be a requirement for species such as deer, elk or bear, only a preference. An animal can, however, be expected to use preferred habitats in its geographic range and home area even if it could survive elsewhere. Habitat alterations may cause changes in the distribution of animals, often concentrating them in preferred habitats. However, if preferred habitats are removed or
altered, abandonment of traditional home areas may result (Peek et al. 1982). Responses of vegetation to clearcutting differ with geographical area and thus the predictability of use by deer, elk and other species is not constant for all locations and habitats. Although Thomas et al. (1979) indicated that optimal elk habitat in the Blue Mountains consisted of 40% cover (timber stands) and 60% forage areas, a small but thriving population of elk live on sagebrush grasslands in southern Washington (Richard et al. 1977); an area devoid of large trees.

The black bear has always been a source of visual enjoyment for the tourist and wildlife observer and recently it has become a more sought after trophy by hunters. Bears in coastal forests, however, are responsible for damage to second-growth timber through their habit of peeling bark from coniferous trees and eating the exposed sapwood. This damage may result in the death of the tree, growth retardation or deterioration of wood quality (Poelker and Parsons 1980).

Bear damage to conifers is widespread in western Washington and Oregon (Poelker and Hartwell 1973) and occurs in conifer plantations in Japan (Watanabe 1980) as well. Damage usually occurs between April and June when a shortage of other nutritious foods is often implicated as the cause of sapwood feeding (Schreuder 1976). Trees damaged vary in age from 10 to 250 years, but most damage occurs in the 20-40 year age class. Conifers are much more frequently damaged than deciduous trees, with preference for specific species varying with geographical area and
forest type. Bears tend to damage the most vigorous trees, which most often occur in intensively managed forests (Poelker and Hartwell 1973). Schreuder (1976) indicated that the most severe damage occurred where large areas of relatively similar habitat had been created by timber harvests or forest fires. Additionally, Poelker (1979) noted that much of the damage takes place in those areas where a dense bear population exists in habitat which is declining in quality.

Cooperative organizations comprised of state, federal and private parties, common in the Pacific coast states, typically work with state game agencies to control bear numbers. Special spring damage hunts, allowing sport hunters to harvest bears in heavy-damage areas, have been used as a tool to minimize bear damage. Professional hunters are employed to kill bears in areas of extensive damage when sport hunting efforts fail. These efforts, however, frequently take place after much of the damage has occurred.

Black bear management efforts in the coastal Northwest currently revolve principally around the annual harvest of bears. Programs to manipulate vegetation to benefit black bears, even if sufficient data were available to direct these efforts, would probably be both economically and logistically unfeasable, because of size of vegetative units involved. However, clearcut logging because it is the dominant means by which coastal habitats are altered may be an untapped management source, requiring only direction to be of value in black bear management. Presumably, a knowledge of how black bears use clearcut
areas coupled with a knowledge of results of specific timber harvest and
treatment alternatives could provide the manager with a tool to roughly
predetermine the size of the black bear population that will occur in
the ensuing forest.

The purpose of this paper is to characterize the habitat use
patterns and preferences of black bears as they relate to the
successional status and physical characteristics of the clearcut forest.
Results presented are from 2 phases of research on Long Island,
Washington combined to illustrate the changes in resource use patterns
by black bears as the habitat they occupied was continuously altered by
succession.
STUDY AREA

Long Island is a 21.1 km$^2$ island located in the southern half of Willapa bay in southwestern Washington. It is approximately 19 km north of the mouth of the Columbia river and is managed by the Willapa National Wildlife Refuge. The island, 9.9 km in length and 0.8 to 3.9 km in width, is separated from the mainland by as little as 300 m. Climate is typically cool marine with mild winters and cool summers. Average annual precipitation is 280 cm with the majority occurring as rain in the winter. Fog and drizzle are common during the summer and account for about one-fourth of the annual precipitation. Temperature fluctuates from an average of 1.6°C in the winter to 18-20°C in the summer months. Two major slough systems enter the interior of the island from the east, with numerous small ravines running east and west from a central ridge. The maximum elevation is about 80 m.

Long Island is situated in the Picea sitchensis Zone (Franklin and Dryness 1973), a belt of vegetation along the coast of Oregon and Washington. Major tree species on the island are Sitka spruce (Picea sitchensis), western red cedar (Thuja plicata), western hemlock (Tsuga heterophylla), red alder (Alnus rubra), douglas fir (Psuedotsuga menziesii) and cascarra (Rhamnus purshiana), which occurs both as a small tree and a large bush. Major brush species present are salal (Gaultheria shallon), evergreen huckleberry (Vaccinium ovatum), red huckleberry (Vaccinium parvifolium), elderberry (Sambucus callicarpa), and salmonberry (Rubus spectabilis).
The *Picea sitchensis* Zone can be considered a variant of the *Tsuga heterophylla* Zone; distinguished mainly by the presence of Sitka spruce, frequent summer fogs and proximity to the ocean (Franklin and R. Dryness 1973). The *Tsuga heterophylla* and *Picea sitchensis* zones occupy most of the area west of the Cascade range in Washington and northern Oregon. Secondary successional trends in these zones are very similar, except that dense shrub communities more often develop in the *Picea sitchensis* Zone (Franklin and R. Dryness 1973). The general successional trend following clearcut logging and the controlled burning of logging debris includes a weed dominated stage for 3-5 years followed by a shrub dominated stage. A transition period follows the shrub stage where small trees and shrubs codominate. This stage lasts until trees outcompete the shrubs and canopy closure generally eliminates all but the most tolerant shrub species. Reestablishment of shrubs in the understory takes place after mortality of trees begins to open the stand (Franklin and R. Dryness 1973). There are 2 major types of seral forest stands in coastal areas (Franklin and R. Dryness 1973); mixed conifer forests and red alder stands. Composition and species density in the individual stand depends on the type of disturbance, environmental conditions and available seed sources. Long (1973) studied successional trends in a series of stands in the douglas fir/salal community of the *Tsuga heterophylla* Zone in the Cedar River watershed about 55 miles south-east of Seattle. Stands ranged in age from 5 to 73 years and with the exception of 1 5-year old stand, all were untreated after harvest and were of the same site quality (IV). Long (1973) noted 2 general
trends in understory development. The first trend was a decrease in the number and diversity of understory species with a nearly absolute domination of the understory by salal, from the 5 to the 22 year old stand. The second trend, characterized by the difference between a 22 and 73 year old stand evidenced increasing species richness and diversity and the decrease in the understory dominance of salal. The importance of salal and other brush species in the understory was inversely proportional to the increasing canopy biomass. Succession in the douglas fir/salal community is controlled by the development of the tree canopy, and is only indirectly a function of factors such as time, density and site quality (Long 1973).

Long Island has a long history of logging. Most of the island was harvested in small tracts between 1900 and 1935. Between 1952 and 1968 approximately 44% of the forested areas of the island were clearcut in large tracts. No timber has been harvested since 1968. As a result of past logging, the island, through the course of study, has supported clearcuts and timber stands in various stages of secondary succession. Timber on the island was harvested using a combination of high lead logging and tractor skidding; resulting in various degrees of soil disturbance and considerable variation in the revegetation of clearcut areas. Records are incomplete as to the post harvest treatments, but, most areas harvested before 1963 received little if any treatment after harvest. In some small areas harvested between 1963 and 1968 attempts were made to burn slash and aerial seed with douglas fir. Burns were generally incomplete and seedings were generally not successful.
Clearcuts on the island were allowed to revegetate naturally, resulting in a mosaic of seral communities. Species domination largely reflected age of the stand and/or the degree of soil disturbance during logging.

About, one-third of Long Island was owned by Weyerhaeuser company, 40 ha by Burlington Northern railroad and 0.5 ha by an individual. The rest of the island was owned by the U. S. Fish and Wildlife Service and the entire island was managed by the Willapa National Wildlife Refuge through a cooperative agreement with the other landowners.

Recreational use of the island was generally restricted to shoreline camping. Five permanent campgrounds accessible only by boats were located along the perimeter of the island. However, for approximately 10 weeks each fall an archery hunt for black-tailed deer, Roosevelt elk, grouse and black bear was allowed on the island. The island was closed to bear hunting in 1981 and 1982. According to J. Welch (cited in the U.S. Fish and Wildl. Serv. 1978) the Island supports 40-45 elk, 250 black-tailed deer, 100 ruffed grouse (Bonasa umbellus), 300 blue grouse (Dendragapus obscurus), 50 raccoons (Procyon lotor) and 10 coyotes (Canis latrans). The bear population has varied from 24 to 33 bears over 1 year of age during the period of study on the island (Lindzey and Meslow 1977b, this study). The tidelands and bays around the island are important resting, feeding and wintering areas for many species of waterfowl.

The mosaic of seral communities provided by past logging, access on the island facilitated by 23 km of passable logging roads and the
density of black bears made the island an excellent site to study use by
black bears of clearcut habitats. Its ecological similarity to much of
coastal Oregon and Washington should allow general application of study
results. The fact that it is an island restricted but did not prohibit
emigration and immigration of bears.
METHODS

Capture and Monitoring

Bears were captured in Aldrich foot snares or culvert traps between May 1973 and August 1974 and April 1980 and August 1981 using techniques similar to those described by Lindzey and Meslow (1977a). Upon capture, bears were immobilized with intramuscular injections of M-99 (Etorphine). Each bear was tattooed with an identification number in the upper right lip and ears tagged with color coded, numbered tags. A lower 1st or 4th premolar was extracted for age determination (Lindzey and Meslow 1972). All bears were weighed, measured and reproductive status noted. Most Bears captured were fitted with radio transmitter collars. In 1980-81 mercury tip-switches were incorporated in the collars (Telonics; Mesa, Arizona). After release bears were relocated from the ground using portable telemetry equipment. Attempts were made to relocate bears at least once daily (generally 2-3 times) and to vary the time of day individual bears were relocated. In addition to daily relocations, selected bears were relocated hourly during their periods of activity for 48-hour periods at intervals throughout the year in 1981. Selected bears were also relocated periodically at night during 1980 and 1981. The abundance of logging roads on the island made it possible to minimize the time between successive bearings and the distance to the bear, which seldom exceeded 300 meters. Attempts were also made to insure that at least 2 of the multiple bearings intercepted at 90 degrees. Relocations were subjectively rated as to their quality
and no relocations of rapidly moving bears were used in analyses. Visual sightings supplemented and substantiated telemetric relocations. Periodic checks in areas where a bear could be observed without disturbing it, indicated that telemetric relocations were accurate, with only occasional errors of up to 25 meters. All relocations were plotted on aerial photographs and vegetation type in which they were found, with time of day and weather noted.

Bears were recorded as active or inactive when relocated. Activity was determined using audible qualities of the radio signal alone in 1973 and 1974, probably biasing results towards activity (Lindzey and Meslow 1977a). In 1980-81 changes in signal pulse rates, supplemented by the integrity of the signal were used to determine activity level (Garshelis and Pelton 1981). No changes in pulse rate or sometimes 1 or 2 quick changes, accompanied by little or no change in quality of the signal was interpreted as inactivity. The audible signal was evaluated while taking bearings and during a 3-minute period following the relocation. Occasionally, when level of activity was not obvious during the first period, bears were monitored for a second 3-minute period. Some subjectivity remained in our interpretations of activity in 1980-81 even with the added enhancement offered by the signal rate capabilities of the transmitters.

Bears were monitored at 2-hour intervals for 3-minute periods each throughout the night on a bimonthly basis in 1973 and 1974 to discern nocturnal activity patterns. In 1980 and 1981 bears were monitored for
24-hour periods in a similar manner. A fixed tower on the highest point of the island made it possible to monitor most of the transmitted bears during each session.

Vegetation Analyses

The island's vegetation was placed into 1 of 7 vegetation types, based principally on time of harvest, thus seral stage. These areas were delineated and grouped following interpretations of aerial photographs, determination of year of harvest and field reconnaissance. Extensive analysis of the major seral communities was done in 1979 and less extensive analyses in 1974 and 1981. Alder stands (ALS) and old growth (OGS) were only sampled in 1974.

Transects were run within vegetation types in 1974 (Lindzey and Meslow (1977a) and plant species known to provide either food or cover value to the bears assigned a prominence value (Anderson and Poulton 1958) and a cover percentage value (Daubenmire 1959).

Transects were again established and vegetation sampled using 4x4 meter quadrats at predetermined intervals along transects in 1979. Within quadrats, percent cover, average height, and number of stems of each species were recorded (Puri et al. 1968). In addition, average berry production per stem of the major food producing shrub species was determined at the height of food production by counting berries per stem on shrub species encountered along established transects.
Horizontal cover density was estimated for the major vegetation types in 1981. Transects were established in vegetation types on the island and in a 1975 clearcut on the adjacent Stanley peninsula. Transects on Stanley peninsula were run to determine the horizontal cover of 1960 clearcuts (60C) in 1973-74. Percent visibility at distances of 2, 10, 25 and 75 m was determined at a height of 1 m using a 1 m² density board (20 individual squares), in each of the 4 cardinal directions from a transect point. Average distance at which the board was completely obliterated was determined by checking the board at 5 m intervals until it could no longer be seen.

Food Habits

Diet of bears on the Island was monitored by continually collecting and analysing scats that could be reliably dated within 3 days. A hand lens was used to aid in determination of items in the scats. Food items that could not be identified in the field were later examined with a binocular microscope and compared to a plant collection. Contents were recorded on the basis of occurrence and estimated volume they comprised of the scat. The availability of known bear foods was determined at least biweekly by recording the growth form or phenological stage of major food species on permanently established 100-150 meter transects.

Analyses of Spatial and Vegetation Use

All relocations were assigned coordinate values using a digitizer (Gilmer et al. 1973). Additionally, the digitizer was used to measure
the distance between a relocation and the border of 1 or 2 adjacent vegetation types. Relocations in conifer stands (LCS, OGS) were measured to the nearest clearcut (60C, 50C). If a tideland or meadow (TLM) edge was closer this distance was also recorded. The distance to the nearest timber stand (LCS, SCS, ALS, OGS) was measured for all relocations in clearcuts. If the relocation was in a 1950 clearcut (50C) the distance to the nearest tideland (TLM) or 1960 clearcut (60C) edge was also measured. For points in 1960 clearcuts the distance to the nearest 1950 clearcut was measured if this type provided most of the 1960 clearcut border. Relocations in tidelands and meadows were measured for the distance to the nearest bordering vegetation type and the distance to the nearest timber stand which was often the same measurement. These measurements were grouped into either 35 m or 70 m intervals for analysis, depending of the vegetation type of the relocation, and the proportion of relocations in each interval determined.

The availability of each of the 7 major vegetation types on the island and within home ranges was determined from aerial photographs using a digitizer and an associated area program. Refinement in delineation of these vegetation types and more accurate measurements through the use of computer graphics systems, provided slightly different estimates of availability than reported earlier by Lindzey and Meslow (1977a). All analyses were done on the more recent estimates of availability.
Spatial, concentric bands were delineated on aerial photographs within vegetation types relative to the distance from bordering vegetation types. Tidelands and meadows were divided into 3 spatial bands (0-35 m, 36-70 m, >70 m) relative to the distance from the edge, regardless of the specific bordering vegetation type. Large conifer stands (LCS) and old growth conifer stands (OGS) were combined as one type and were divided into 70 m bands in relation to the distance from clearcuts. Additionally, the availability of areas 0-70 m from tidelands or meadows and 0-70 m from each clearcut type was determined for these stands. All 1950 clearcuts and the 1960 clearcuts that were bordered mostly by conifer stands were divided into 70 m bands relative to their distance from conifer stands (LCS, SCS, OGS). Additionally, 70 m bands were delineated in 1960 clearcuts that were bordered by 1950 clearcuts in relation to the distance from these 1950 clearcuts. Bands were not delineated in alder stands as these stands did not border clearcut areas. Small conifer stands were not delineated in this manner as 99.6% of the area of these stands was within 140 m of clearcut areas. The availability of each of these spatial areas on the island was determined using the digitizer.

Home ranges of bears were delineated using the convex polygon method (Mohr 1947), except where adherance to convex polygons would have included the bay surrounding the island. These ranges were used in all analyses of vegetation use. Occasional relocations determined to be excursions out of the bears range (singular and distant from the delineated home range) were not used in home range delineation or
analyses of patterns of vegetation use. Home range sizes, determined by the convex polygon method, were calculated using the digitizer. Home range area was also determined using 95% confidence ellipse methods described by Jennrich and Turner (1969). This method was employed to facilitate comparisons of home range size between study phases. Fisher’s randomization test was used in these comparisons of home range size.

Inferences about preference for various vegetation types and spatial bands within these vegetation types were made for specific population segments or "classes" of bears as sample sizes permitted. All bears, adult males, adult females, adult females with cubs, adult females present during both phases of the study and subadults were the major classes used. Bears on the island were generally sexually mature at 3 years of age (Lindzey and Meslow 1977b). Bears 1 and 2 years of age were classified as subadults. Subadults were not separated on the basis of sex because resulting sample sizes generally precluded analyses. In those cases where sample sizes did permit separation, however, initial analyses indicated similar patterns of use between the sexes.

Chi-square (goodness-of-fit) tests were used to determine if use of vegetation types differed from that expected if all types were used in proportion to their availability. The "preference" for each type was then determined using the methods of Neu et al. (1974). Statistical significance for both tests was established at a probability level of
P < 0.05. Availability of vegetation types to bears on the island was examined at 2 levels. First, the number of relocations of bears in each of the 7 vegetation types was compared to that expected if bears used each type with respect to its availability on the island. Only relocations judged to be independent of the preceding location (1 hour apart), captures, the first location at each den site, and of sufficient quality that the vegetation type was not in question were used in these analyses. This level of analysis is perhaps the most commonly employed in studies of wildlife habitat use. However, the underlying assumption in the use of this level of analysis is that all areas on the island were equally available to all bears. I next tested how the 7 vegetation types were included within the bears' ranges relative to the availability of these types on the island. Because home ranges overlapped I felt this comparison should provide an initial indication of preferred vegetation types. The area of each of the 7 vegetation types in each of the bear's ranges was determined using the digitizer. The hectares of each vegetation type included in a bear's range was then compared to the availability of each type on the island. The expected value was generated by multiplying the proportion of each vegetation type on the island by the size in hectares of the individual bear's range. For each class of bears, the hectares of each vegetation type in each bear's range was summed with others of the same class. The expected value for this test was determined by summing the total home range size for each bear in the class and multiplying this total by the proportion of each of the vegetation types present on the island.
The second level of analysis compared the proportionate use of vegetation types included within home ranges to what would have been expected if they were used randomly. The number of relocations in each of the 7 vegetation types was compared to expected relocations, generated by multiplying the proportion of each vegetation type included in the bear's range by the total number of relocations. Similarly, for each class's relocations in each vegetation type for individuals in that class were summed and compared to the number of relocations expected in each type, assuming all types were used at random. The expected value for each vegetation type was determined by multiplying the total relocations for that class by the proportion of the respective vegetation type included in that classes total of home ranges determined in the previous comparison. Relocations used in this analysis were of similar quality and independence as those in level 1. However, bears used in this analysis and in the analysis of inclusion of vegetation types within home ranges had a minimum of 35 independent relocations per study phase.

Analyses of seasonal use of vegetation types was done at the second level. The annual active period of the bears was divided into 4 seasonal periods based principally on food availability and the breeding season. The 4 periods were: den emergence-May; June-July; August-September; and October-dén entrance.

Differences between patterns of use vegetation types in each phase of the study and between study phases for the various sexes and ages of
bears were initially determined using chi-square tests of independence ($P < 0.05$). This test was also used to compare use of vegetation types among seasons and to identify differences between activity levels associated with use of these types. Occasionally when these tests indicated no significant difference in patterns of use for various categories, chi-square goodness-of-fit tests and Neu et al.'s (1974) method for determining preference indicated differences in the proportionate use of vegetation types. This discrepancy is apparently due to the difference in expected values for tests of independence and tests for goodness-of-fit. The test for independence generates its own expected value based on the row and column totals whereas the goodness-of-fit test uses expected values generated from the proportion of each vegetation type available. Patterns of use compared with the test for independence may not differ significantly from one another but 1 or more may differ from that expected based on the availability of vegetation types using goodness-of-fit tests.

The proportion of diurnal inactivity in each vegetation type was compared to the overall mean diurnal inactivity level for each class during each study phase using a 1-tailed z-test at the 0.05 level. The expected value for each vegetation type was generated by dividing diurnal inactive relocations in each type by the total diurnal relocations in each vegetation type within home ranges. Similarly, differences between the overall proportion of diurnal inactivity for each class was compared between other classes in the same study phase using a 2-tailed z-test at the 0.05 level. Comparison between use of
vegetation types for diurnal inactivity and nocturnal inactivity were made using chi-square tests of independence. Selection for or against individual vegetation types for diurnal and nocturnal inactivity was examined using methods described by Neu et al. (1974).

Analyses of spatial use of vegetation types in relation to the distance from bordering vegetation types was completed at level 1, due to the impracticality of delineation of spatial types for each bear's range. However, these analyses included only bears for which home ranges were determined. Occasionally, specific vegetation types used in these analyses were not found within home ranges of a specific class and analyses were not performed. All analyses of preferences for spatial areas within each vegetation type, including selection at various activity levels and seasonal preferences were tested using the methods of Neu et al. (1974). Small sample sizes occasionally precluded analyses of activity and seasonal data in specific vegetation types. Chi-square tests of independence were used to identify differences in use patterns among classes, including seasonal and activity level differences as well as differences between study phases.

Expected values for all chi-square tests were examined on the basis of recommendations of Roscoe and Byars (1971). They indicated that in goodness-of-fit tests with extreme departure from uniformity that an average (over all cells) expected value of 2 or more is adequate for reliable tests at the 0.05 level, and 4 or more at the 0.01 level. In tests of independence an average expected value of 6 and 10 provide
acceptable approximations at the 0.05 and 0.01 levels respectively. In most analyses the traditional method of no more than 20% of the expected values less than 5 and none less than 1 was employed. In the few instances where sample sizes did not meet this traditional minimum, tests were also performed with some cells lumped to provide the minimum expected value and results compared to results using all cells. Results of the tests were similar in most cases where I made these comparisons. Occasionally some lumping of cells was required for accurate tests in analysis of spatial use of vegetation types.
RESULTS

Bears Monitored

Twenty-three bears (9 adult females, 6 adult males, 4 subadult males and 4 subadult females) were captured during the 1973-74 phase of the research (Lindzey and Meslow 1977b) and 25 bears (15 adult females, 6 adult males, 3 subadult males and 1 subadult female) during the 1980-81 phase. Sixteen and 24 bears were fitted with radio transmitter collars during the 2 study phases respectively. Monitoring of these bears resulted in 1867 and 4729 independent relocations (>1 hr apart) in 1973-74 and 1980-81 respectively. Sufficient data were obtained to define home ranges for 14 bears (6 adult females, 3 adult males, 3 subadult males and 2 subadult females) in 1973-74 and 22 bears (14 adult females, 4 adult males, 3 subadult males and 1 subadult female) in 1980-81. Bears for which home ranges were determined were monitored for 6 to 14 month periods (X̄ = 10.5 mos.) in 1973-74 and 1.5 to 19 months (X̄ = 12.0 mos.) in 1980-81 (Fig. 1). Six females were present during both phases of the study (nos. 2,3,5,9,14,15). Females 2,3,5 and 9 were adults during both phases of study and were used as a separate class in most analyses. Females 14 and 15, although present during both study phases, were not used in these comparisons because they were subadults in 1973-74. Twenty-four and 27 bears over 1 year of age were present on the island in 1973 and 1974 respectively. By 1980, the population had increased to 33 bears and by 1981 numbers had decreased.
Figure 1. Periods radio-collared black bears were monitored on Long Island, Washington in 1973-74 and 1980-81. (a = subadults during initial phase monitored).
to 24 bears. Average age of the population, excluding cubs, increased from 3.8 in 1973 to 7.5 in 1981 (Lindzey and Meslow 1977b, this study).

Vegetation Characteristics

No clearcuts younger than 5 years of age (weed stage) were present during the study (Table 1, Fig. 2). These areas, particularly those most heavily scarified, probably provided few berries during the first 5 years. Grasses and forbs such as false dandelion (Hypochaeris radicata) undoubtedly dominated these areas and were perhaps used by bears. Harper (1971) noted that in clearcut areas of western Oregon that were heavily scarified, grasses and forbs comprised 67% of ground cover 5 years after logging; by 8-9 years 78% of the cover was shrub species. Clearcuts between 5 and 10 years of age on the island (60C 1973-74, Table 2) were dominated by shrubs, mostly salal. These young clearcuts provided the least horizontal cover of all seral communities (Table 3). Because clearcuts of this age were not available at the time estimates were made, no data were collected on berry production of the major brush species in this age class, however, production per stem was presumably similar to that estimated for stems in the 12-17 year old stands (Type 60C; Table 4). However, overall production of berries in clearcuts between 5 and 10 years of age, because shrubs were most abundant and less shaded in these communities, was probably greater than in older or younger clearcuts. Analyses of vegetation in areas between 12 and 21 years of age (50C 1973-74, Table 2; 60C 1980-81, Table 4) demonstrated the increasing prominence of conifers with clearcut age; salal still
Table 1. Vegetation types on Long Island, Washington. Percent of total in parentheses.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Age 1973</th>
<th>Age 1980</th>
<th>Total ha</th>
<th>Range(ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>Tidelands/Meadows</td>
<td>-</td>
<td>-</td>
<td>324(15.4)</td>
<td>0.5-97.3</td>
</tr>
<tr>
<td>60C</td>
<td>1960 Clearcuts</td>
<td>5-10</td>
<td>12-17</td>
<td>456(21.7)</td>
<td>4.0-235.4</td>
</tr>
<tr>
<td>50C</td>
<td>1950 Clearcuts</td>
<td>14-21</td>
<td>21-28</td>
<td>328(15.6)</td>
<td>1.3-161.3</td>
</tr>
<tr>
<td>LCS</td>
<td>Large Conifer Stands</td>
<td>38-73</td>
<td>45-80</td>
<td>806(38.3)</td>
<td>10.1-248.5</td>
</tr>
<tr>
<td>SCS</td>
<td>Small Conifer Stands</td>
<td>38-73</td>
<td>45-80</td>
<td>38(1.8)</td>
<td>0.2-5.9</td>
</tr>
<tr>
<td>ALS</td>
<td>Alder Stands</td>
<td>38-73</td>
<td>45-80</td>
<td>30(1.4)</td>
<td>6.8-23.4</td>
</tr>
<tr>
<td>OGS</td>
<td>Old Growth Conifer</td>
<td>200+</td>
<td>200+</td>
<td>123(5.9)</td>
<td>123</td>
</tr>
</tbody>
</table>
Figure 2. Vegetation types on Long Island, Washington.
Table 2. Prominence ratings\(^a\) and cover %\(^b\) values for vegetation types on Long Island, Washington, 1974.

<table>
<thead>
<tr>
<th>Species</th>
<th>60C (N=7)</th>
<th>50C (N=3)</th>
<th>LCS,SCS (N=4)</th>
<th>ALS (N=1)</th>
<th>OGS (N=1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prominence</td>
<td>% cover</td>
<td>Prominence</td>
<td>% cover</td>
<td>Prominence</td>
</tr>
<tr>
<td></td>
<td>Mode (Range)</td>
<td>Mean (Range)</td>
<td>Mode (Range)</td>
<td>Mean (Range)</td>
<td>Mode (Range)</td>
</tr>
<tr>
<td>Tsuga heterophylla</td>
<td>4 (3-4)</td>
<td>7 (4-12)</td>
<td>5 (5-5)</td>
<td>58 (43-73)</td>
<td>5 (5-5)</td>
</tr>
<tr>
<td>Picea species</td>
<td>-</td>
<td>-</td>
<td>2 (1-3)</td>
<td>T (T-15)</td>
<td>1 (1-3)</td>
</tr>
<tr>
<td>Thuja plicata</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Alnus rubra</td>
<td>2 (2-3)</td>
<td>2 (1-8)</td>
<td>1 (1-1)</td>
<td>T (T-1)</td>
<td>2 (2-2)</td>
</tr>
<tr>
<td>Rhamnus purshiana</td>
<td>2 (1-3)</td>
<td>0.4 (T-1)</td>
<td>3 (2-3)</td>
<td>T (T-1)</td>
<td>3 (1-3)</td>
</tr>
<tr>
<td>Gaultheria shallon</td>
<td>5 (5-5)</td>
<td>52 (35-70)</td>
<td>4 (4-4)</td>
<td>19 (15-22)</td>
<td>3 (3-3)</td>
</tr>
<tr>
<td>Vaccinium ovatum</td>
<td>2/3 (2-3)</td>
<td>2 (T-4)</td>
<td>3 (3-3)</td>
<td>1 (1-1)</td>
<td>3 (3-4)</td>
</tr>
<tr>
<td>V. parvifolium</td>
<td>3 (3-4)</td>
<td>3 (2-4)</td>
<td>3 (3-3)</td>
<td>1 (1-1)</td>
<td>2/3 (2-3)</td>
</tr>
<tr>
<td>Sambucus caliicarpa</td>
<td>3 (1-3)</td>
<td>1 (1-1)</td>
<td>1 (1-1)</td>
<td>T (T-T)</td>
<td>1 (1-2)</td>
</tr>
<tr>
<td>Rubus spectabilis</td>
<td>3 (1-3)</td>
<td>0.5 (0-1)</td>
<td>3 (3-3)</td>
<td>0.3 (0.2-0.3)</td>
<td>2 (2-3)</td>
</tr>
<tr>
<td>Polystichum munitum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>T (T-0.5)</td>
<td>3 (2-3)</td>
</tr>
<tr>
<td>Hypocheris radicata</td>
<td>3 (3-4)</td>
<td>3 (1-2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

\(^a\)Ratings range from 5, the most dominant species in the stand to 1, occurring only rarely. (Anderson and Poulton 1958)

\(^b\)All values rounded to nearest whole number except when less than 1.
Table 3. Horizontal cover values of vegetation types on Long Island, Washington, 1981.

<table>
<thead>
<tr>
<th>Type</th>
<th>% of board visible</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2m (SE)</td>
<td>5m (SE)</td>
<td>25m (SE)</td>
<td>75m (SE)</td>
<td>X distance totally obscured</td>
</tr>
<tr>
<td>Stanley Peninsula(^a)</td>
<td>89 (2.6)</td>
<td>21 (5.4)</td>
<td>8 (4.1)</td>
<td>4 (2.2)</td>
<td>27 (5.1)</td>
</tr>
<tr>
<td>(N = 28)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60C(^b)(N = 100)</td>
<td>59 (3.3)</td>
<td>6 (1.5)</td>
<td>1 (0.4)</td>
<td>0 (0)</td>
<td>9 (0.6)</td>
</tr>
<tr>
<td>50C (N = 52)</td>
<td>83 (3.5)</td>
<td>55 (6.8)</td>
<td>4 (1.6)</td>
<td>0 (0)</td>
<td>16 (1.2)</td>
</tr>
<tr>
<td>SCS, LCS (N = 36)</td>
<td>76 (5.1)</td>
<td>17 (4.4)</td>
<td>4 (1.7)</td>
<td>4.5 (0.8)</td>
<td>17 (2.6)</td>
</tr>
<tr>
<td>OGS (N = 8)</td>
<td>92 (5.2)</td>
<td>7 (4.1)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>10 (1.3)</td>
</tr>
</tbody>
</table>

\(^a\)Representative of 60C in 1973-74.

\(^b\)Also represents 50C in 1973-74.

<table>
<thead>
<tr>
<th>Type</th>
<th>Measurement</th>
<th>Issoria heterocarpa</th>
<th>Picea sitchensis</th>
<th>Thuja plicata</th>
<th>Alnus rubra</th>
<th>Pseudotsuga menziesii</th>
<th>Rhamnus purshiana</th>
<th>Salix malicola</th>
<th>Vaccinium ovatum</th>
<th>Vaccinium parvifolium</th>
<th>Sambucus racemosa</th>
<th>Rubus spectabilis</th>
<th>Polystichum munitum</th>
<th>Rare ground</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% cover</td>
<td>29 (7)</td>
<td>3 (1)</td>
<td>3 (2)</td>
<td>2 (1)</td>
<td>3 (1)</td>
<td>36 (6)</td>
<td>5 (2)</td>
<td>5 (2)</td>
<td>7 (2)</td>
<td>7 (2)</td>
<td>7 (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60°C</td>
<td>Avg height (m)</td>
<td>3 (0.3)</td>
<td>3 (0.4)</td>
<td>4 (0.1)</td>
<td>2 (0.1)</td>
<td>2 (0.2)</td>
<td>0.9 (0.1)</td>
<td>1 (0.1)</td>
<td>1 (0.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stems/ha</td>
<td>1256 (452)</td>
<td>156 (82)</td>
<td>19 (14)</td>
<td>56 (36)</td>
<td>69 (42)</td>
<td>301 (110)</td>
<td>35,388 (4910)</td>
<td>619 (305)</td>
<td>1656 (447)</td>
<td>263 (158)</td>
<td>2437 (860)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Berries/stem</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7 (3)</td>
<td>249 (19)</td>
<td>59 (17)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50°C</td>
<td>% cover</td>
<td>3b (5)</td>
<td>2b (0.9)</td>
<td>5b (4)</td>
<td>-</td>
<td>-</td>
<td>0.6 (0.2)</td>
<td>2 (1)</td>
<td>2 (1)</td>
<td>0.6 (0.5)</td>
<td>37 (3)</td>
<td>47 (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avg height (m)</td>
<td>8 (0.5)</td>
<td>6 (0.1)</td>
<td>8 (0.4)</td>
<td>-</td>
<td>-</td>
<td>0.4 (0.1)</td>
<td>1 (0.1)</td>
<td>1 (0.2)</td>
<td>3 (0.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stems/ha</td>
<td>1600 (172)</td>
<td>63 (7)</td>
<td>119 (50)</td>
<td>-</td>
<td>-</td>
<td>669 (164)</td>
<td>625 (322)</td>
<td>44 (19)</td>
<td>91 (46)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Berries/stem</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0 (0)</td>
<td>6 (3)</td>
<td>1 (0.7)</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCS, SCS</td>
<td>% cover</td>
<td>8b (6)</td>
<td>8b (5)</td>
<td>-</td>
<td>-</td>
<td>12 (5)</td>
<td>5 (2)</td>
<td>1 (0.1)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td>46 (5)</td>
<td>31 (4)</td>
</tr>
<tr>
<td></td>
<td>Avg height (m)</td>
<td>25b (0.8)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.6 (0.1)</td>
<td>0.7 (0.1)</td>
<td>0.5 (0.1)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stems/ha</td>
<td>2193b (7)</td>
<td>6 (6)</td>
<td>6 (6)</td>
<td>-</td>
<td>100 (78)</td>
<td>2444 (485)</td>
<td>1256 (479)</td>
<td>419 (87)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Berries/stem</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>4 (3)</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*aOnly dominant species listed; all values rounded to nearest whole number except when less than 1; data used to approximate the characteristics of vegetation types in 1980-81; (E = 20 for % cover, Avg height, Stems/ha; E = 30 for Berries/stem).

bOverstory.

cUnderstory.

dOverstory and understory.
dominated the understory. Vegetation in this type was very dense and provided the greatest amount of horizontal cover for bears of vegetation types on the island. Berry production per stem, for the 3 major brush species, was considerably higher in these areas than in all other areas sampled. Stands between 21 and 28 years of age (50C 1980-81, Table 4) were almost completely dominated by western hemlock, had closed canopies, and very little vegetation in the understory. As a result, these stands generally offered slightly greater horizontal visibility than other stands except in occasional openings where brush species dominated. Berry production by the brush species was generally limited to those plants in openings and evergreen huckleberry was the only species producing significant amounts of fruit (Table 4). Stands 38-80 years of age (LCS, SCS; Tables 2,4) were dominated by mature or nearly mature conifers, mostly western hemlock. The canopy was considerably more open than it was in the 21-28 year old stands apparently permitting an increase in sunlight penetration and accompanying increase in brush species in the understory. A slight increase in the horizontal visibility occurred. Production by red huckleberry and especially salal increased, but evergreen huckleberry seldom produced fruit in these stands. Clearcut areas 38-80 years of age vegetated by red alder (ALS) had understories dominated by sword fern (Pteridium aquillinum). The oldest timber stand on the Island (OGS, Table 2) was a stand dominated by old growth (>200 yrs) western hemlock and western red cedar. Openings in the canopy of the old growth stand were larger and more frequent than in the 38-80 year old stands. Brush species occurred
frequently in the understory, providing almost as much horizontal cover, along with trunks of trees, as found in stands 12-21 years of age (Table 3). Berry production was not measured in this stand, however, it appeared to be slightly higher than in the 38-80 year old stands.

Tidelands vegetation type (TLM) includes the high tidelands along the borders of the sloughs and on the flats where the sloughs meet the bay and wet and dry upland meadows. Grasses generally predominated in these areas with sedges (Carex spp.) and rushes (Scirpus spp.) common members of the tideland communities.

Secondary succession on Long Island, as characterized by vegetation analyses, appears similar to the general trends described for coastal areas by Franklin and Dryness (1973) and Long (1973). Figure 3 is a composite of productivity estimates and structural characteristics of seral stands measured on Long Island. Trends were supplemented where necessary by the descriptions of secondary succession in coastal forests presented by Franklin and Dryness (1973) and Long (1973).

Food Habits

Contents were determined for 195 and 225 scats collected between April and December of 1973 and 1980, respectively (Table 5). Analyses of many additional scats in 1974 and 1981 provided no indication that these samples were not representative of food habits of the bears during each study phase. The diet, basically similar during both phases, was predominantly vegetative and temporally keyed to the phenological development of the major fruit producing brush species. Figure 4
Figure 3. Composite representation of food and cover values of stands on Long Island, Washington to black bears at various successional stages: (WS) weed stage; (BS) brush stage; (IS) brush/conifer; (CC) closed canopy; (SG) second growth; (OG) old growth.
Table 5. Frequency of occurrence of food items\textsuperscript{a} in 195 and 225 black bear scats collected on Long Island, Washington in 1973 and 1980 respectively. Results presented in percentages for each of 4 seasonal periods. Seasonal sample sizes are in parentheses.

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Seasonal Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jan-May</td>
</tr>
<tr>
<td>False dandelion \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Skunk cabbage \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Sweet colts foot \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Beens and ants \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Termites \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Blacktailed deer \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Red elderberry \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Red huckleberry \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Evergreen huckleberry \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Salal \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Cascara \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Shelf fungus \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Wild crabapple \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Coast trailing current \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
<tr>
<td>Salmonberry and blackberry \textsuperscript{b}</td>
<td>1973(12)</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Items identified, but which occurred only once, are not included.
\textsuperscript{b}Combined in 1980.
Figure 4. Phenological development of major fruit producing brush species on Long Island, Washington, 1973 and 1980. Lines from left to right represent a) % flowers, b) % ripe fruit, and c) % fruit loss (1973 only).
represents the phenological development (availability) of fruits of these brush species in 1973 and 1980. Trends shown are an average of vegetation types but, the 1960 clearcuts were emphasized during both phases. Flower and fruit development in areas dominated by trees was about 2-weeks behind development of flowers and fruits of the same brush species in more open sites. Phenology was similar in 1974 and 1981 to what it was in 1973 and 1980. Most fruits apparently ripened slower and less completely in the 1980's than they had in the 1970's (Fig. 4), even though mean monthly temperatures and precipitation were similar during both study phases. Increased shading by conifers may have contributed to ripening of berries being retarded in 1980 and 1981.

Tideland grasses and sedges, blooms of evergreen huckleberry and to a lesser degree upland grasses dominated the spring (den-May) diet during both study phases (Table 5). Salal blooms, false dandelion, upland grasses and fruits of red huckleberry and elderberry were the dominant food items in early summer (June-July). Insects occurred frequently during spring and early summer. Fruits of salal and evergreen huckleberry dominated the diet of bears during both study phases in late summer (Aug-Sept). Shelf fungus or conch occurred frequently during this period as well. While cascarra fruits often dominated scats in 1973-74 this food was much less common in the diet in 1980-81. False dandelion was also a common item in the diet during late summer in 1980 and 1981, while it had not been in 1973-74. Evergreen huckleberry was the most common item found in scats during both study phases during the fall period (Oct-den).
Vegetation Use Patterns

Level 1: Use of Vegetation Types on Island.--We assumed the entire island to be available to each bear at this level of analysis. Comparisons indicated that bears on the island during both the 1973-74 and 1980-81 phases used the 7 vegetation types disproportionately to their occurrence on the island ($P < 0.001$; Appendix A, Tables 8, 9). Patterns of use differed significantly as well between the 2 phases ($X^2 = 654.9$, df = 6, $P < 0.001$). Use patterns differed most in 1960 and 1950 clearcuts and small conifer stands. Use of 1950 clearcuts decreased from 35.4% of all relocations of bears in 1973-74 to 15.1% in 1980-81. Twenty-eight percent of relocations were in the 1960 clearcuts in 1973-74 whereas by 1980-81 57.8% were in this type. Use of small conifer stands decreased from 8.7% to 2.4%.

Adult females, adult males and subadults differed significantly in their patterns of use of vegetation types on the island in 1973-74 ($X^2 = 252.5$, df = 6, $P < 0.001$) and each class of bears used vegetation types disproportionately to their occurrence ($P < 0.001$; Fig. 5; Appendix A, Table 8). All classes used tidelands and large conifer stands significantly less than expected and small conifer stands significantly more. However, adult females apparently selected for 1950 clearcuts, adult males for 1960 clearcuts and subadults for both 1950 and 1960 clearcuts. Alder stands and old growth were used less than expected, except by adult females which used old growth in proportion to its availability, and adult males which used alder stands as expected.
Figure 5. Differences between the % of relocations of black bears in each vegetation type and the % of that type available on Long Island, Washington. Selection significant at $P < 0.05$ (Neu et al. 1974) indicated by an asterisk.
Classes of bears differed in their use patterns of vegetation types on the island in 1980-81 ($X^2 = 196.2$, df = 12, $P < 0.001$) as they did in 1973-74 and again each class used vegetation types disproportionately to their occurrence ($P < 0.001$; Fig. 5; Appendix A, Table 9). Bears used tidelands significantly less than expected as they had in 1973-74. All classes used 1960 clearcuts significantly more than expected, whereas in 1973-74 only adult males and subadults had selected for this vegetation type. The 1950 clearcuts that were apparently selected for by adult females and subadults in 1973-74 were used only in proportion to their availability by all classes in 1980-81. Adult females and adult males used large conifer stands less than expected as they had in 1973-74. Subadults that had apparently selected against these stands in 1973-74 used them in proportion to their availability in 1980-81. Small conifer stands, selected for by all classes in 1973-74, were used in proportion to their availability by adult males, less than expected by subadults, and slightly more than expected by adult females in 1980-81. Apparent selection for small conifer stands by adult females was, however, not to the degree exhibited in 1973-74. Alder stands and old growth were used less than expected by all classes in 1980-81 except subadults which used alder stands in proportion to their availability.

Females 2,3,5 and 9 also used vegetation types disproportionately to their availability in 1973-74 and 1980-81 ($P < 0.001$; Appendix A, Tables 8, 9) and there was a significant difference in how these females used the island's vegetation between study phases ($X^2 = 167.4$, df = 6, $P < 0.001$). Although females 2,3,5 and 9 did not differ significantly
from all females as a group in their use of vegetation types in 1973-74 ($X^2 = 4.31, df = 6, P > 0.5$) they did in 1980-81 ($X^2 = 53.6, df = 6, P < 0.001$). The major difference in 1980-81 was the apparent selection against 1950 clearcuts by the 4 females whereas all females as a group used them as expected. Females 2, 3, 5 and 9 comprised 67% of the adult females monitored in 1973-74 whereas, in 1980-81 they represented only 29% of the sample. Even though there was a significant difference between all females and females 2, 3, 5 and 9 in 1980-81 in the use of the 1950 clearcuts, neither group selected for this vegetation type in 1980-81 as they had in 1973-74.

Inclusion of Vegetation Types in Home Ranges.--Vegetation types were included in bear's ranges disproportionately to their occurrence on the island in both 1973-74 and 1980-81 ($P < 0.001$; Appendix A, Tables 10, 11). Proportionate inclusion of the 7 vegetation types by bears also differed significantly between study phases ($X^2 = 139.1, df = 6, P < 0.001$). Bears included less 1950 clearcuts in their home ranges in 1980-81 than they had in 1973-74. In 1973-74 bears included this type significantly greater than expected, however, by 1980-81 bears included 1950 clearcuts only proportionally to the occurrence of this type on the island. The 1950 clearcuts comprised 23.6% of the vegetation types included in bears ranges in 1973-74 and only 16.5% in 1980-81. Also, the apparent selection against inclusion of large conifer stands in home ranges was greater in 1973-74 than in 1980-81. The percent of large conifer stands included in bears' ranges increased from 28.1% to 33.3%.
Adult females, adult males and subadults differed significantly in their selection of vegetation types for inclusion in their home ranges in 1973-74 ($\chi^2 = 137.5$, df = 12, $p < 0.001$) and each individual class included the 7 vegetation types on the island disproportionately to the availability of these types ($p < 0.001$; Fig. 6; Appendix A, Table 10). However, all classes included 1960 and 1950 clearcuts significantly more than expected, tidelands and large conifer stands significantly less and small conifer stands proportionately to their availability. The differences among classes in the inclusion of these 5 types was only in the degree to which each was selected for or against; adult males generally exhibited less and subadults greater degrees of selection. Old growth stands were included in home ranges of adult females more than expected but included proportionately to availability by adult males and subadults. Alder stands were included as expected by adults but were not included in the home range of any subadults.

Classes of bears also differed in their selection of vegetation types for inclusion in their home ranges in 1980-81 ($\chi^2 = 297.7$, df = 12, $p < 0.001$) and again each class included vegetation types in their ranges disproportionally to the occurrence of the vegetation types on the island ($p < 0.001$; Fig. 6; Appendix A, Table 11). Tidelands and large conifer stands were included significantly less than expected by bears as they had been in 1973-74, except that subadults included large conifer stands significantly more than expected in 1980-81. Adult bears (males and females) still included 1960 clearcuts more than expected as they had in 1973-74, but subadults included this
Figure 6. Differences between the % of each vegetation type included in black bears' home ranges and the % of that type available on Long Island, Washington. Selection significant at $P < 0.05$ (Neu et al. 1974) indicated by an asterisk.
type only proportionately to its availability. The 1950 clearcuts that were apparently selected for in 1973-74 by all classes were included only in proportion to their availability in 1980-81 by all bears except adult females which apparently still selected for them, but to a lesser degree. Small conifer stands were included apparently at random by all classes, as they were in 1973-74. Alder stands, not included in home ranges of subadults in 1973-74, were included significantly more than expected by this class in 1980-81. Adult females still included this type proportionately to its availability as they had in 1973-74. Adult males included alder stands less then expected. Old growth timber, found in proportion to its occurrence in subadult ranges in 1973-74, was not included in the range of any subadults in 1980-81. Adult females included old growth more than expected, and adult males included this type as expected, as they had in 1973-74.

Adult females present during both study phases (nos.2,3,5 and 9) included vegetation types in their ranges disproportionately to the occurrence of these types on the island in both 1973-74 and 1980-81 ($P < 0.001$, Appendix A, Tables 10, 11), as did all adult females as a group. The manner in which these females included vegetation types in their ranges also differed significantly between the 2 phases ($\chi^2 = 34.5$, df = 6, $P < 0.001$). All adult females as a group exhibited similar patterns. However, significant differences existed between females 2,3,5 and 9 and all females in the inclusion of vegetation types in their ranges during both study phases ($\chi^2 = 33.8$ (1973-74); $\chi^2 = 82.9$ (1980-81); df = 6, $P < 0.001$). In 1973-74 all females as a group
included 1950 clearcuts and old growth greater than expected but females 2, 3, 5 and 9 included these 2 types only in proportion to availability of these types. Additionally, the 4 females included alder stands more than expected, whereas all females included this type only in proportion to its availability on the island. This same difference existed between these 2 groups of females in 1980-81. The 1950 clearcuts were included less than expected by females 2, 3, 5 and 9 in 1980-81, whereas all females included this type significantly more than expected. However, the trend in both groups was for a lower degree of selection for this type in 1980-81 than in 1973-74. Additionally, in 1980-81 large conifer stands were included significantly less than expected by all adult females and less than expected by females 2, 3, 5 and 9 although not significantly. These 4 females and all females as a group exhibited less apparent selection against this type than they had in 1973-74.

Level 2: Use of Vegetation Types in Home Ranges.—Only vegetation included in the home ranges of bears was considered available to them at this level of analysis. Bears during both study phases used the 7 vegetation types within their ranges disproportionately to the respective occurrence of each type within their ranges ($P < 0.001$; Appendix A, Tables 12, 13) and patterns of use of vegetation types included in bears' ranges differed significantly between study phases ($\chi^2 = 640.4$, df = 6, $P < 0.001$). Use of vegetation types in home ranges was disproportionate to occurrence for 13 of 14 individual bears in 1973-74 and 18 of 22 in 1981. The major differences between study phases were in the proportionate use of 1950 and 1960 clearcuts and
small conifer stands. In 1973-74 bears used 1950 clearcuts and small conifer stands significantly more than expected, with 36.3% and 8.1% of all relocations in these 2 types respectively. In 1980-81 only 15.2% and 2.5% of relocations were in these 1950 clearcuts and small timber stands, with both types being used only in proportion to their availability. The 1960 clearcuts supported 28% of all relocations of bears in 1973-74 and were used in proportion to their availability in ranges. However, in 1980-81 58% of relocations were in this type and use was significantly more than expected.

Each class used vegetation types disproportionately to their occurrence within their ranges during 1973-74 (P < 0.001; Fig. 7; Appendix A, Table 12), however, classes differed in their patterns of use of vegetation types within their home ranges ($X^2 = 221.2, df = 12, P < 0.001$). Tidelands and old growth were used significantly less than expected and small conifer stands significantly more than expected by all classes. Adult males and subadults used 1960 clearcuts proportionally to their occurrence in their ranges, however, adult females apparently selected against this type. Adult males used 1950 clearcuts significantly less than expected and large conifer stands in proportion to their availability, whereas adult females and subadults used 1950 clearcuts significantly more than expected and large conifer stands significantly less. Alder stands, used proportionately to their availability by adult males, were used less than expected by adult females. Subadults did not include alder stands in their ranges.
Figure 7. Differences between the % of relocations of black bears in each vegetation type in their home ranges and the % of that type available in their home ranges on Long Island, Washington. Selection significant at P < 0.05 (Neu et al. 1974) indicated by an asterisk.
Each class also used vegetation types disproportionately to their occurrence in home ranges in 1980-81 ($P < 0.001$; Fig. 7, Appendix A, Table 13) and classes again differed in their use patterns of vegetation types within home ranges ($X^2 = 206.3$, df = 12, $P < 0.001$) as they had in 1973-74. All classes used tidelands and most used all timber stands (LCS, SCS, ALS, OGS) in their ranges significantly less than expected. The only exception was that adults (males and females) used small conifer stands in proportion to their availability. The 1960 clearcuts which were either used in proportion to their availability (adult males, subadults) or selected against (adult females) in 1973-74 were used significantly more than expected by all classes in 1980-81. Adult females used 1950 clearcuts less than expected and subadults used these clearcuts in proportion to their availability. In 1973-74 1950 clearcuts were used significantly more than expected by both classes. Adult males used 1950 clearcuts less than expected in 1973-74 and in 1980-81, however, in 1980-81 the difference between use and expected was not significant.

Adult females present during both phases of the study also used the vegetation types included in their ranges disproportionately to their availability in both 1973-74 and 1980-81 ($P < 0.001$; Appendix A, Tables 12, 13). Use patterns were also significantly different between study phases ($X^2 = 302.9$, df = 6, $P < 0.001$). Patterns of use did not differ significantly between these 4 females and all females as a group in 1973-74 ($X^2 = 3.8$, df = 6, $P > 0.2$) but they did in 1980-81 ($X^2 = 53.2$, df = 6, $P < 0.001$). All adult females and females 2,3,5 and 9 exhibited
similar trends in use of the vegetation types in their home ranges in 1973-74, but differed in the use of 1950 clearcuts in 1980-81. Both groups used 1950 clearcuts less than expected, however, differences were not significant for females 2,3,5 and 9.

**Seasonal Use in Home Ranges.**--Bears' patterns of use of the vegetation types included in their home ranges differed significantly among the 4 seasonal periods (den-May; June-July; Aug-Sept; Oct-den) both in 1973-74 ($\chi^2 = 264.3$, df = 18, $P < 0.001$) and in 1980-81 ($\chi^2 = 375.1$, df = 18, $P < 0.001$). Additionally, use was disproportionate to the availability of vegetation types within each seasonal period during both phases of the study ($P < 0.001$; Appendix A, Tables 14, 19).

Use patterns of vegetation types by adult females ($\chi^2 = 98.4$ (1973-74), $\chi^2 = 277.5$ (1980-81); df = 18, $P < 0.001$), adult males ($\chi^2 = 139.1$, df = 18, $P < 0.001$ (1973-74); $\chi^2 = 63.4$, df = 6, $P < 0.001$ (1980-81)) and subadults ($\chi^2 = 132.5$ (1973-74); $\chi^2 = 54.9$ (1980-81); df = 18, $P < 0.001$) each differed significantly among seasonal periods and each class during each season of both study phases used the vegetation types included in their ranges disproportionately to the occurrence of these types (Figs. 8, 9; Appendix A, Tables 15-17, 20-22). Adult males, however, were only part-year residents of the island during 1980-81. The few relocations of adult males on the island after July in 1980 and 1981 ($N = 35$) were not used in these analyses. Differences in
Figure 8. Differences between the % of relocations of black bears in each vegetation type in their home ranges during each of 4 seasonal periods and the % of that type available in their home ranges on Long Island, Washington, 1973-74. Selection significant at $P < 0.05$ (Neu et al. 1974) indicated by an asterisk.
Figure 9. Differences between the % of relocations of black bears in each vegetation type in their home ranges during each of 4 seasonal periods and the % of that type available in their home ranges on Long Island, Washington, 1980-81. Selection significant at P < 0.05 (Neu et al. 1974) indicated by an asterisk.
seasonal use patterns between study phases and among classes in each phase is presented in the following analyses.

Each class used tidelands in proportion to their availability within ranges in spring (Den-May) in both 1973-74 and 1980-81 but in all other seasonal periods during both study phases all classes used tidelands significantly less than expected. Small sample size for subadults in 1973-74 precluded accurate analyses, however, only 2 relocations on tidelands were recorded for this class from June-den of 1973 and 1974.

In 1973-74 1960 clearcuts were generally used proportionately or less than expected by all classes. Adult males and subadults exhibited apparent selection for 1960 clearcuts during early summer (June-July) and adult females, which had selected against this type during all other seasons, used them in proportion to their availability during this period. The 1960 clearcuts were selected for during each season by each class in 1980-81. However, selection for these clearcuts was greatest during early summer by all classes.

Adult females selected for 1950 clearcuts in 1973-74 during each seasonal period except fall (October-den), with the greatest degree of selection occurring during early (June-July) and late summer (August-September). Subadults also selected for this type during each season except early summer, and exhibited the greatest apparent selection for 1950 clearcuts in late summer. Adult males used this type in proportion to its availability during each season in 1973-74 except
in spring when they used 1950 clearcuts less than expected. The 1950 clearcuts were used less than expected or in proportion to their availability in each season by all classes in 1980-81 except by subadults which selected for this type in late summer.

Large conifer stands received the least use in early summer and the greatest in spring and fall, with adult males using these stands significantly more than expected in the fall during 1973-74. Although large conifer stands were generally used less than expected in 1980-81 as well they received the greatest use by each class during spring and fall. Subadults used large conifer stands in proportion to their availability in both spring and fall and adult females used them as expected in the spring. These stands were also used the least by all classes during early summer in 1980-81.

Adult females selected for small conifer stands in spring and early summer, adult males in spring and late summer and subadults in early summer in 1973-74. Small conifer stands were used, however, only in proportion to their availability during each seasonal period by all classes in 1980-81.

Alder stands received very little use by bears in either 1973-74 or 1980-81. Sample sizes did not permit adequate statistical tests but no seasonal trends in use of these stands were apparent.

Old growth was either used less than expected or in proportion to its availability during each seasonal period by all classes during both
study phases. The only apparent trend in seasonal use of old growth was in the adult female class. During both study phases adult females apparently selected against use of old growth during spring and early summer but used it in proportion to its availability during late summer and fall.

Use of vegetation types by females 2, 3, 5 and 9 differed significantly among the 4 seasonal periods in both 1973-74 ($\chi^2 = 77.57$, df = 18, $p < 0.001$) and 1980-81 ($\chi^2 = 97.1$, df = 18, $p < 0.001$). In each phase during each season these 4 females, like all females as a group used the vegetation types in their home range disproportionately to their occurrence ($p < 0.001$, Appendix A, Tables 18, 23). Trends in seasonal use exhibited by these females were similar to those noted for all females during each study phase.

Females with cubs: Females 2, 3, 5, 9 and 13 were accompanied by cubs in 1974 but did not have cubs in 1973. Early summer was, however, the only seasonal period in which these bears were monitored in both 1973 and 1974. Comparisons for this period indicated that their patterns of use of vegetation types available to them in their home ranges were not significantly different between when they had cubs and when they did not ($\chi^2 = 10.9$, df = 6, $p > 0.05$). Vegetation types were used disproportionately to their occurrence during early summer in both 1973 and 1974 (Appendix A, Table 24). Although overall use patterns were not significantly different, these females selected for use of small conifer
stands when they did not have cubs (15.9% of relocations) and used these stands as expected when they did (4% of relocations).

During the 1980-81 phase, females 9 and 23 were accompanied by cubs throughout the year in 1981. Female 45 had cubs early in 1981 but lost them about 1 June. None of the other females monitored in 1981 were accompanied by cubs, and no females had cubs in 1980. Females 9, 23 and 45 were not monitored during the spring in 1980, however, and as a result no comparison between years in the use of vegetation types for these females for this season could be made. However, comparisons between these 3 females with cubs and the other females without cubs in 1981 indicated that these 2 groups of bears differed in their use patterns of vegetation types in their home ranges during the spring period ($X^2 = 141.0$, df = 6, $P < 0.001$). All females used the vegetation types in their ranges disproportionately to their occurrence during spring of 1981 ($P < 0.001$; Appendix A, Table 25). However, 1960 clearcuts were used more than expected by females without cubs, but only proportionately by females with cubs. The 1950 clearcuts were apparently selected against by females without cubs, while females with cubs used them as expected. In addition, females with cubs apparently selected for large conifer stands and females without cubs selected against them. Tidelands were used less than expected by females with cubs whereas females without cubs used them in proportion to their availability as did other groups of bears during the spring. Cubs did not generally accompany their mothers when they did feed on tidelands in the spring.
Data were available for females 9 and 23 when they did and did not have cubs for the other seasonal periods. These females used vegetation types in their ranges disproportionately to their occurrence during early summer, late summer and fall in both 1980 and 1981 (Appendix A, Table 26). There was no significant difference, however, in their patterns of use of vegetation types in their ranges when they had cubs and when they did not in early summer \( (X^2 = 0.82, \text{df} = 3, P > 0.9) \), fall \( (X^2 = 5.6, \text{df} = 3, P > 0.1) \) or late summer \( (X^2 = 7.71, \text{df} = 3, P > 0.05) \), but they tended to use large conifer stands more and 1960 clearcuts less when accompanied by cubs in late summer as well as fall.

**Activity**

**Diel Activity Schedules.**--Bears were active 81% \( (N = 1997) \) of the time when monitored in the day (includes relocations) and 31% \( (N = 313) \) of the time when monitored at night in 1973-74. Bears were active 76% \( (N = 1285) \) of the time during the day and only 11% \( (N = 672) \) of the time at night in 1980-81. These data represent all 4 seasonal periods although diurnal inactivity was less common during late summer in both phases (Fig. 10). The greater activity apparently exhibited by bears in 1973-74 during both day and night monitoring may be a result of biases in methods employed to determine activity during that phase of the study (see Lindzey and Meslow 1977a). Although differences in sampling techniques make direct comparisons tenuous, bears were principally diurnal with crepuscular activity peaks during both phases. The diurnal active period of individual bears was frequently interrupted by 1 or 2
Figure 10. Diel activity patterns of black bears on Long Island, Washington, 1980-81 (N = 1957). Mean sunrise and sunset (Pacific daylight savings time) for each seasonal period are indicated by asterisks.
short periods of inactivity seldom lasting longer than 1-2 hours. Once bears became inactive at night they generally remained inactive until sunrise or shortly before. Classes exhibited similar activity schedules within seasons during both study phases.

**Vegetation Types and Level of Diurnal Activity.**--These analyses include only diurnal relocations when activity level was recorded. Bears' patterns of use of vegetation types in their home ranges was significantly different when active from when inactive both in 1973-74 ($X^2 = 64.7$, df = 6, $P < 0.001$) and 1980-81 ($X^2 = 86.3$, df = 6, $P < 0.001$).

Interestingly, bears were inactive significantly more often than expected when it was raining in 1980-81 ($z = 4.1$, $P < 0.05$). Proportion of time inactive on overcast ($z = -0.94$, $P > 0.05$) and partly cloudy or clear days ($z = -0.94$, $P > 0.05$) did not differ from expected.

Bears were inactive 16.9% ($N = 4442$) of the time during the day in 1980-81 and 9.0% ($N = 1773$) of the time in 1973-74. Higher levels of activity indicated by these data than that from diel monitoring probably results from the longer period of monitoring employed in activity determination when relocating bears. We compared the proportion of relocations of inactive bears (inactive relocations/total relocations) in each vegetation type with the expected level generated from the mean % of the time bears were inactive during each study phase (Tables 6, 7). Bears were inactive significantly less often than expected when relocated on tidelands and in 1960 and 1950 clearcuts in 1973-74.
Table 6. Proportion of total diurnal relocations of classes of black bears in each vegetation type when inactive compared to the overall mean proportion of diurnal inactivity for each class in 1973-74 on Long Island, Washington. Significance at $P < 0.05$ indicated by an asterisk.

<table>
<thead>
<tr>
<th>Type</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>0.031</td>
<td>-2.74*</td>
<td>0.059</td>
<td>-0.12</td>
<td>0.059</td>
</tr>
<tr>
<td>60C</td>
<td>0.050</td>
<td>-4.10*</td>
<td>0.019</td>
<td>-3.53*</td>
<td>0.014</td>
</tr>
<tr>
<td>50C</td>
<td>0.059</td>
<td>-3.34*</td>
<td>0.039</td>
<td>-2.11*</td>
<td>0.047</td>
</tr>
<tr>
<td>LCS</td>
<td>0.164</td>
<td>3.85*</td>
<td>0.139</td>
<td>2.12*</td>
<td>0.100</td>
</tr>
<tr>
<td>SCS</td>
<td>0.193</td>
<td>3.09*</td>
<td>0.136</td>
<td>1.35</td>
<td>0.150</td>
</tr>
<tr>
<td>ALS</td>
<td>0.200</td>
<td>0.87</td>
<td>0.0</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>OGS</td>
<td>0.093</td>
<td>0.07</td>
<td>0.940</td>
<td>0.54</td>
<td>0.143</td>
</tr>
</tbody>
</table>

$\bar{x}$ prop. Inactive 0.090 0.066 0.066 0.098 0.101

$^a$ Adult females present during both study phases.

$^b$ Observed proportion inactive.

$^c$ Z-value calculated by a 1-tailed test.
Table 7. Proportion of total diurnal relocations of classes of black bears in each vegetation type when inactive compared to the overall mean proportion of diurnal inactivity for each class in 1980-81 on Long Island, Washington. Significant difference at $P < 0.05$ indicated by an asterisk.

<table>
<thead>
<tr>
<th>Type</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9$^a$</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>obs. $^b$</td>
<td>$Z^c$</td>
<td>obs. $^b$ $Z$</td>
<td>obs. $^b$ $Z$</td>
<td>obs. $^b$ $Z$</td>
</tr>
<tr>
<td>TLM</td>
<td>0.068</td>
<td>-4.61*</td>
<td>0.063</td>
<td>-3.66*</td>
<td>0.154</td>
</tr>
<tr>
<td>60C</td>
<td>0.138</td>
<td>-4.57*</td>
<td>0.131</td>
<td>-4.27*</td>
<td>0.144</td>
</tr>
<tr>
<td>50C</td>
<td>0.189</td>
<td>1.30</td>
<td>0.199</td>
<td>1.98*</td>
<td>0.133</td>
</tr>
<tr>
<td>LCS</td>
<td>0.266</td>
<td>5.99*</td>
<td>0.265</td>
<td>5.08*</td>
<td>0.319</td>
</tr>
<tr>
<td>SCS</td>
<td>0.223</td>
<td>1.32</td>
<td>0.190</td>
<td>0.63</td>
<td>0.118</td>
</tr>
<tr>
<td>ALS</td>
<td>0.400</td>
<td>1.83*</td>
<td>0.455</td>
<td>1.94*</td>
<td>0.333</td>
</tr>
<tr>
<td>OGS</td>
<td>0.194</td>
<td>0.85</td>
<td>0.167</td>
<td>0.13</td>
<td>0.250</td>
</tr>
</tbody>
</table>

$x$ prop Inactive 0.169 0.163 0.182 0.200 0.167

$^a$Adult females present during both study phases.

$^b$Observed proportion inactive.

$^c$Z-value calculated by a 1-tailed test.
Similarly, in 1980-81, bears apparently selected against tidelands and 1960 clearcuts when inactive. However, 1950 clearcuts were used as expected by inactive bears in 1980-81. Bears apparently selected for large and small conifer stands for inactivity in 1973-74 and large conifer stands and alder stands in 1980-81.

The proportion of time inactive for each class was compared to other classes during each phase. No differences in level of diurnal inactivity was noted between classes in 1973-74 (Table 6) but, adult males were significantly more inactive overall than adult females in 1980-81 (Table 7). Adult males were not monitored after July in 1980-81.

All classes selected against 1950 and 1960 clearcuts when inactive in 1973-74 (Table 6). By 1980-81 only 1960 clearcuts were selected against. The 1950 clearcuts were used more than expected by adult females when inactive and as expected by adult males and subadults in 1980-81 (Table 7). All bears selected for large conifer stands when inactive during both study phases. Adult males and subadults selected for small conifer stands when inactive in 1973-74 and adult females used them to the degree expected. All classes used small conifer stands as expected when inactive in 1980-81. Old growth and alder stands were used as expected by inactive bears in 1973-74. Similar use of these stands was noted in 1980-81, except that adult females apparently selected for alder stands when inactive and adult males for old growth. Tidelands were used less than expected by inactive adult bears in

The adult females present during both study phases used vegetation types slightly differently when inactive than all females as a group, both in 1973-74 and 1980-81. In 1973-74 females 2, 3, 5 and 9 used 1950 clearcuts and large conifer stands as expected whereas all females as a group selected against 1950 clearcuts and for large conifer stands. Additionally, in 1980-81 females 2, 3, 5 and 9 also used 1950 clearcuts as expected whereas all adult females as a group selected for this type when inactive.

Vegetation Types and Nocturnal Inactivity.—Five adult females (nos. 5, 14, 39, 45, 47) were relocated periodically at night during 1980-81. These 5 females were inactive 107 of 121 times that they were relocated at night. Comparisons indicated little difference ($X^2 = 9.25$, df = 6, $P > 0.1$) in their patterns of use of vegetation types when inactive at night and when inactive during the day; vegetation types were used disproportionately to availability at night and during the day (Appendix A, Table 27). Their use of vegetation types within their home ranges in regard to activity level were similar to all adult females as a group.

Although differences in activity level within the 7 vegetation types were not significant (chi-square tests for independence) preference ranking (Neu et al. 1974) indicated that 1960 clearcuts were used more than expected by inactive bears during the day but only in
proportion to their availability by bears when inactive at night. Large conifer stands were used in proportion to their availability at night, but less than expected during the day by inactive bears. Small conifer stands received proportionately greater use at night than in the day but small sample sizes did not allow accurate statistical comparisons. Other vegetation types were used to similar degrees when these bears were inactive at night and when they were inactive during the day.

Vegetation Types Selected for Denning

Bears on Long Island entered dens in late October or early November during both study phases and emerged between late March and mid April (Lindzey and Meslow 1976). We located 15 dens in 1973-74 and 28 in 1980-81. Ten of twenty-four dens of adult females in 1980-81 were in conifer stands 9 in 1960 clearcuts and 5 in 1950 clearcuts. In 1973-74 1 adult female denned in a 1960 clearcut, 2 in 1950 clearcuts and 2 in large conifer stands. Only 2 dens of subadults were located in 1980-81, 1 in a large conifer stand and 1 in a 1950 clearcut. In contrast, in 1973-74 all but 2 of 6 dens of subadults were in 1960 clearcuts. The other 2 dens were of the same subadult female and both were located in a large conifer stand. Although most adult males denned on the mainland in 1980-81 we located the den of 1 male on the island both years; both dens were in the same 1950 clearcut. Adult males all denned on the island in 1973-74 with 3 dens being located in large conifer stands and 1 in a 1950 clearcut. See Lindzey and Meslow (1976) for characteristics of black bear dens on Long Island.
Vegetation Use Summary

Preference for the various vegetation types by bears on the island changed over the course of the study as succession altered these areas. In the first phase nearly half of the forested areas on the island (1960 and 1950 clearcuts) were dominated or codominated by brush species which provided abundant food for the bears. By 1980, only 26% of the island (1960 clearcuts) supported brush species which were still highly productive. Bears used both clearcut types more than expected based on the availability of these clearcuts on the island in 1973-74, but only 1960 clearcuts were preferred for use by bears in 1980-81. Small conifer stands, although affected little by succession, were apparently preferred by bears in 1973-74 but used only in proportion to their availability in 1980-81. Large timber stands, tidelands and meadows, also not affected significantly by succession, were used similarly in each study phase. Sex and age specific differences, however, occurred in use of vegetation types in each phase and between study phases. Differences existed as well in how individual classes included the various vegetation types in their home ranges and in the use made of vegetation types within their home ranges. Use also varied with season and activity associated with individual vegetation types.

**Tidelands and Meadows.**—Tidelands were used similarly by bears during both study phases. Although included in home ranges less than expected, they were used in proportion to their availability within ranges by most classes during the spring and less than expected during
other seasons. Adult males used tidelands proportionately more than other bears during the spring. Although, bears occasionally rested on tideland edges, use was generally restricted to foraging on grasses and sedges. Use of tidelands declined in early to mid-May as other foods became available on upland areas and tideland grasses and sedges matured. Adult females with cubs used tidelands very little during the early spring when they were used heavily by other bears and left their cubs in cover when they did feed in these areas. Adult females with cubs, in 1980-81, used these areas mostly in late spring and early summer, when few other bears used them.

1950 Clearcuts.—These clearcuts offered dense horizontal cover as well as food in 1973-74, although food was not as abundant in these cuts as in 1960 clearcuts which were also available to bears. All classes included 1950 clearcuts more than expected in their home ranges in 1973-74. Adult females and subadults used these clearcuts significantly more than expected and adult males significantly less. Adult males used the 1960 clearcuts more than other bears and subadults more than adult females. Adult females selected for 1950 clearcuts in all seasons, but used them to the greatest degree in early and late summer. Adult males used them in proportion to their availability during all seasons except spring when they used them less than expected. Subadults selected for 1950 clearcuts in all seasons except early summer, with the greatest use occurring in late summer. Although bears were occasionally found to be inactive during the day in 1950 clearcuts, all classes selected against these areas for resting.
By 1980-81 the overstory canopy of conifers had closed considerably in the 1950 clearcuts and the few shrubs that remained provided abundant berries only in occasional openings. The 1950 clearcuts were included more than expected in only the home ranges of adult females by 1980-81. Most classes used 1950 clearcuts in proportion to their availability or less than expected in each season. Subadults, however, used these clearcuts more than expected in late summer. Evergreen huckleberry was fairly abundant and productive in openings in these 1950 clearcuts and berries were most available in late summer. Female 45, the only adult female with cubs that included 1950 clearcuts in her home range, used these clearcuts more than other bears that had these clearcuts available to them during the spring period. The 1950 clearcuts were apparently preferred as a resting area by adult females in 1980-81 and adult males and subadults used them at random for resting where all classes had selected against them for diurnal inactivity 7-8 years earlier. Adult females relocated at night in 1980-81 used these clearcuts similarly when inactive at night and when inactive during the day.

1960 Clearcuts.—These clearcuts offered the most abundant food on the island in 1973-74, but little cover. Only tidelands afforded less horizontal cover for bears. All classes included 1960 clearcuts more than expected in their home ranges in 1973-74, but none used them more than expected. Adult males used these areas more than other classes and they received the greatest use by all classes during early summer when bears were feeding on upland grasses, false dandelion, salal blooms, and
the fruits of evergreen and red huckleberry. All classes used 1960 clearcuts less than expected for diurnal inactivity and exhibited even stronger selection against these clearcuts for resting than they had the 1950 clearcuts during this phase.

By 1980, the 1960 clearcuts offered cover and food in about the same abundance that the 1950 clearcuts had in 1973-74. These clearcuts were included significantly more than expected only in the home ranges of adult bears. However, all classes, except females with cubs, used the 1960 clearcuts available to them in their ranges more than expected during each season. These clearcuts received the greatest amount of use in early summer as they had in 1973-74. However, adult females were never observed with their cubs when they fed in these clearcuts in early summer. Adult females with cubs used 1960 clearcuts only in proportion to their availability during other seasons. Again, similarly to that reported for both 1960 and 1950 clearcuts in 1973-74, all classes used these clearcuts less than expected for diurnal inactivity. The adult females monitored at night in 1980-81 evidenced even greater selection against 1960 clearcuts when inactive at night than when inactive during the day.

**Large Conifer Stands.**--These stands were dominated by mature conifers and although foods were available berry production by individual brush species was up to 250 times less than in clearcut areas. These stands, although present in the ranges of all bears, were not preferred for inclusion in home ranges or for use within ranges by
any class in 1973-74. Large conifer stands were used proportionately more during spring and fall than during the summer months, however. Although apparently not preferred as feeding areas, all classes used these stands significantly more than expected when inactive during the day.

In 1980-81 large conifer stands offered essentially the same amount of cover and food to bears as they had in 1973-74 and again adult bears included these stands less than expected in their home ranges. Subadults, however, now selected for the large conifer stands for inclusion in their ranges. Seasonal preferences were similar to what they had been in 1973-74, with the greatest use occurring in spring and fall by all classes. All classes again preferred these areas for diurnal inactivity with the adult females monitored at night in 1980-81 exhibiting ever stronger selection for conifer stands when inactive at night than when inactive during the day.

**Small Conifer Stands.**--These stands were similar to large conifer stands in cover and food availability. Sixteen of the 22 small conifer stands on the island were located within or bordering 1960 clearcuts and 15 of these stands also bordered tideland areas. All classes included small stands in their home ranges randomly during 1973-74, but use of these small stands was greater than expected by all classes. Most bears exhibited the greatest preferential use of these areas during spring and early summer when utilization of tidelands and 1960 clearcuts was greatest. Additionally, subadults and adult males, which made the
greatest use of the 1960 clearcuts also selected for these stands for diurnal inactivity.

In 1980-81 bears still included these small conifer stands in proportion to their availability, but use by all classes was now only as expected. Small stands were also used only as expected by inactive bears.

Old Growth Conifer Stand.—Berry producing shrubs were more abundant and slightly more productive in the old growth stand than in other conifer stands on the island. Use of old growth by all classes was similar to patterns exhibited by bears in large conifer stands and generally less than expected in both study phases. Adult females did include this stand in their home ranges more than expected, however, in both phases. No class evidenced significant selection for use of old growth and the only seasonal trends in its use were exhibited by adult females which used this stand more in late summer and fall than other seasons in both study phases. Most bears used old growth as expected when inactive during the day in both study phases, but, adult males apparently selected for this stand for diurnal inactivity in 1980-81. Adult females sampled in 1980-81 used old growth proportionately more when inactive at night than when inactive during the day.

Alder Stands.—Alder stands had an understory dominated by sword fern and offered little foods for bears. These stands received little use by bears in either study phase and were generally included in home ranges at random.
Spatial Use of Vegetation Types

Spatial bands in individual vegetation types radiated from the edge towards the middle. Bands were delineated in 70 m intervals in all vegetation types except tidelands, where 35 m bands were used. The following analyses are based on the availability of these spatial bands in each vegetation type on the island.

Spatial Use of Tidelands.—Bears used tidelands relative to the distance from the edge of the tideland disproportionally to the availability of the 35 m bands on the island in both 1973-74 and 1980-81 (Appendix B, Tables 28, 29; \( P < 0.001 \)). Approximately 43% of tidelands on the island were within 35 m of an edge, 25% 36-70 m and 32% greater than 70 m. Spatial use patterns of tidelands did not differ between study phases \( (X^2 = 0.0, \text{df} = 2, P > 0.99) \). In both phases bears apparently selected for bands within 35 m of the edge. Bands 36-70 meters from the border were used as expected and those greater than 70 m used significantly less than expected.

Spatial use patterns of tidelands did not differ significantly among adult males, adult females and subadults in either 1973-74 \( (X^2 = 2.4, \text{df} = 2, P > 0.5) \) or 1980-81 \( (X^2 = 4.4, \text{df} = 2, P > 0.3) \). All classes during both study phases, including the adult females present during both study phases and adult females with cubs, used the spatial bands within tidelands differently than expected (Appendix B, Tables 28, 29). Each class during both study phases exhibited similar patterns.
of spatial use of tidelands to that described above for all bears as a group. Additionally, similar proportions of relocations of adult males on tidelands were within 35 meters of timber stands (LCS, SCS, ALS, OGS), during the 2 study phases (57%, N = 37 and 51%, N = 47 respectively). Although sample sizes were small, 47% (N = 17) of relocations of adult females and 89% (N = 11) of relocations of subadults were within 35 m of timber stands in 1973-74. In 1980-81 only 33% (N = 81) and 67% (N = 9) respectively for these 2 classes were within this spatial band.

Spatial Use of 1960 Clearcuts.--Most of the 1960 clearcuts on the island were bordered primarily by timber stands (LCS, SCS, OGS). Two were almost completely surrounded by 1950 clearcuts, however. Comparisons indicated that bears' spatial use patterns differed significantly between 1960 clearcuts bordered by timber and those bordered by 1950 clearcuts in both 1973-74 ($X^2 = 19.4, df = 5,$ $P < 0.001$) and 1980-81 ($X^2 = 27.3, df = 5, P < 0.001$). Because of this difference, analyses of patterns of spatial use of these 2 1960 clearcut types are presented separately.

Bordered by timber: Comparisons of the use of 1960 clearcuts relative to the distance from bordering timber stands indicated that bear's patterns of spatial use of these clearcuts differed significantly between study phases ($X^2 = 14.3, df = 6, P < 0.05$). Spatial use was not significantly different from expected based on the availability of the spatial bands in 1960 clearcuts on the island in 1973-74, but it was in
1980-81 (Appendix B, Tables 30,31). In 1980-81 bands within 70 m of timber were apparently selected against by bears and bands 71-140 m selected for. Other bands within these clearcuts were used to the degree expected.

Spatial use patterns of 1960 clearcuts differed significantly among adult females, adult males and subadults in 1973-74 ($X^2 = 41.1$, df = 12, $P < 0.001$). Adult males used the spatial bands in proportion to their availability and adult females and subadults used them significantly differently than expected (Fig. 11; Appendix B, Table 30). Adult females evidenced apparent selection for bands 0-70 m from timber and against bands greater than 210 m distant. Bands greater than 280 m from timber were never used. Although sample sizes for adult females with cubs ($N = 17$) in 1973-74 prohibited accurate statistical tests, use patterns were apparently similar to all females as a group. Subadult use of bands 71-140 m from timber was significantly less than expected and use of bands 211-350 m from timber greater than expected although differences were not significant.

Patterns of spatial use of these clearcuts differed significantly among adult females, adult males and subadults in 1980-81 as well ($X^2 = 25.2$, df = 12, $P < 0.02$). Adult males used the spatial bands in proportion to their availability in 1980-81 as they had in 1973-74. Adult females and adult females with cubs used these clearcuts disproportionately to the availability of the bands (Fig. 11; Appendix B, Table 31). Adult females selected against the bands closest to
Figure 11. Percent use by black bears of 1960 clearcuts bordered by timber stands and those bordered by 1950 clearcuts at 70 m intervals from the border on Long Island, Washington. Use significantly different from expected at $P < 0.05$ (Neu et al. 1974) indicated by an asterisk. Number of relocations for each class of bears are presented in parentheses.
timber and for the bands 71-140 m distant. Other bands were used in proportion to their availability. Use of areas 0-140 m from timber by adult females decreased from 83% of all relocations in 1973-74 to 63% in 1980-81. Adult females with cubs selected for bands 0-70 m from timber and against bands greater than 140 m distant. Ninety-six percent (N = 118) of all relocations of adult females with cubs in these 1960 clearcuts in 1980-81 were within 140 m of timber, compared to 63% of relocations of adult females as a group. Subadult use of 1960 clearcuts bordered by timber stands was as expected in 1980-81. Although no significance was noted in use of individual spatial bands, there was, however, a general tendency for subadults to select for bands 0-140 m from timber and against bands greater than 140 m distant. Subadults had selected against these closer bands and for the more distant bands in 1973-74 (Fig. 11).

Females present during both study phases used the spatial bands within these 1960 clearcuts disproportionately to their availability in both 1973-74 and 1980-81 (Appendix B, Tables 30, 31). A significant difference existed as well in their spatial use patterns of these 1960 clearcuts between study phases ($X^2 = 9.9$, df = 4, $P < 0.05$). Although females 2, 3, 5 and 9 did not differ significantly in their spatial use patterns of 1960 clearcuts from all females as a group in 1973-74 ($X^2 = 0.2$, df = 3, $P > 0.98$) they did in 1980-81 ($X^2 = 15.8$, df = 6, $P < 0.02$). Females as group selected against bands 0-70 m from timber in 1980-81 whereas the females present both study phases used this spatial band in proportion to its availability. Both groups of females
exhibited less selection for bands 0-140 m from timber in 1980-81 than they had in 1973-74.

Bordered by 1950 clearcuts: Bears' patterns of use of the spatial bands in 1960 clearcuts bordered by 1950 clearcuts differed significantly between study phases ($X^2 = 16.9, df = 5, p < 0.01$). While bears used bands in these clearcuts in proportion to their availability on the island in 1973-74, use was significantly different than expected in 1980-81 (Appendix B, Tables 32, 33). Bears selected against the center of these clearcuts (351-420 m from the edge) with other bands used as expected in 1980-81.

Small sample sizes for adult females and adult males required the lumping of relocations for these 2 classes in 1973-74. Adults and subadults differed significantly in their patterns of use of spatial bands in these clearcuts ($X^2 = 13.7, df = 6, p < 0.05$). Spatial use was not significantly different from expected based on availability for adults but was for subadults (Fig. 11; Appendix B, Table 32). Although no significance was noted in the use of individual spatial bands for adults, there was a tendency for these bears to use bands 71-210 m from 1950 clearcuts more than expected with only 2 relocations in areas greater than 210 m distant. Subadults selected against bands 71-140 from the edge and although not significant, they tended to use bands greater than 210 m from timber more than expected. Both classes used bands 0-70 m from 1950 clearcuts in proportion to their availability. The small number of relocations of adult females with cubs in these
clearcuts precluded analyses but 5 of 7 relocations were with 70 m of the edge.

Patterns of use of spatial bands in 1960 clearcuts bordered by 1950 clearcuts differed significantly among adult males, adult females and subadults in 1980-81 ($\chi^2 = 11.1, \text{df} = 5, P < 0.01$), as well. Adult females used the spatial bands disproportionately to the overall availability of the bands on the island whereas subadults and adult males used them as expected (Fig. 11; Appendix B, Table 33). Adult females selected against the center of these clearcuts (351-420 m from the edge) and for bands 141-210 m distant from the 1950 clearcut border. Although sample sizes were small in 1973-74, adults tended to use spatial bands in these clearcuts more proportionately in 1980-81 than they had in 1973-74. Subadults made greater use of bands 0-140 m from 1950 clearcuts than expected and lesser use of areas greater than 140 m distant, but differences were not significant. Trends in use of these clearcuts by subadults were the reverse of those exhibited in 1973-74 (Fig. 11).

Spatial Use of 1950 Clearcuts.--Spatial bands within 1950 clearcuts were used disporportionately to their availability both in 1973-74 and 1980-81 (Appendix B, Tables 34, 35). No significant difference in spatial use patterns was present between study phases ($\chi^2 = 6.8, \text{df} = 6, P > 0.3$). Bears used bands 0-70 m from timber stands significantly less than expected and bands 281-350 m distant significantly more than expected in both 1973-74 and 1980-81. Bands
211-280 m from timber were used more than expected in both study phases, however, differences were not significant in 1980-81. Other bands were used in proportion to their availability.

Adult females, adult males and subadults did not differ significantly in their spatial use patterns of these clearcuts in 1973-74 ($\chi^2 = 15.9$, df = 12, $P > 0.1$). Adult females, adult females with cubs and adult males all used the spatial bands in proportion to their availability, but subadults selected for bands 211-280 m from timber and against bands 0-70 m distant (Fig. 12; Appendix B, Table 34). Although adult females and adult males displayed trends similar to the subadults, selection was not significant. Spatial use patterns by adult females with cubs were similar to those exhibited by all females as a group.

Although trends in the use of spatial bands were similar for adults and subadults, comparisons indicated a significant difference between the 2 classes in the number of relocations in these bands that were also within 70 m of tidelands or 1960 clearcuts ($\chi^2 = 24.7$, df = 5, $P < 0.001$). Thirty-three percent of the relocations of subadults ($N = 55$) and only 14% ($N = 73$) of relocations of adults in bands 0-70 m from timber were also within 70 m of tidelands or 1960 clearcuts. Conversely, an average of 58% ($N = 191$) of relocations of adults in the 3 bands 141-350 m from timber were also within 70 m of 1960 clearcuts or tidelands but only 13% of relocations of subadults were. Other bands were used in similar proportions by both subadults and adults. Twenty
Figure 12. Percent use by black bears of 1950 clearcuts at 70 m intervals from bordering timber stands on Long Island, Washington. Use significantly different from expected at $P < 0.05$ (Neu et al. 1974) indicated by an asterisk. Number of relocations for each class of bears presented in parentheses.
percent of all relocations of subadults and 35% of adults in 1950 clearcuts were within 70 m of 1960 clearcuts or tidelands.

Adult females, adult males and subadults differed in their patterns of use of spatial bands in 1950 clearcuts in 1980-81 ($X^2 = 25.2$, df = 12, $P < 0.001$). Additionally, adult females and subadults used the spatial bands disproportionately to their occurrence and use by adult males was as expected (Fig. 12; Appendix B, Table 35). All 3 classes used bands 0-70 m from timber significantly less than expected. Subadults selected for bands 211-280 m from timber and adult females for bands 281-350 m distant. Subadults also used bands 281-350 m from timber more than expected but this difference was not significant.

Trends in spatial use of these clearcuts were very similar to those observed in 1973-74 (Fig. 12). The single adult female with cubs that used these clearcuts evidenced greater selection for bands 71-140 m from timber than did all females as a group. Fifty-four percent of her relocations were in this band compared to 24% for all adult females. Only 2 relocations of this female when she was accompanied by cubs were greater than 210 m from a timber stand.

The number of relocations in spatial bands that were also within 70 m of 1960 clearcuts or tidelands was significantly different between adults and subadults in 1980-81 ($X^2 = 17.0$, df = 5, $P < 0.01$) as it was in 1973-74. Nine percent of relocations of subadults and 20% of relocations of adults in bands 0-70 m from timber were also within 70 m of tidelands or 1960 clearcuts. In 1973-74 more relocations of
subadults than adults were closer to another food-rich area. The trend in the 2 bands 211-350 m was reversed as well; 75% of relocations of subadults and 50% of relocations of adults were within 70 m of a food-rich area. Fifty-one percent of all relocations of subadults in 1950 clearcuts were within 70 m of 1960 clearcuts or tidelands and only 37% of relocations of adults were. A greater proportion of the total relocations of subadults in 1950 clearcuts were within 70 m of areas with abundant foods in 1980-81 (51%) than in 1973-74 (20%). Proportions of relocations within 70 m of these other areas were similar for adults in both phases.

Adult females present during both study phases used the spatial bands in these clearcuts in proportion to their availability in both 1973-74 and 1980-81 (Appendix B, Tables 34, 35). Spatial use patterns of these females were similar between study phases ($\chi^2 = 10.6$, df = 5, $0.1 > P > 0.05$). Additionally, comparisons indicated no significant differences between females 2, 3, 5 and 9 and all females as a group in spatial use patterns of these clearcuts in either 1973-74 ($\chi^2 = 0.8$, df = 5, $P > 0.95$) or 1980-81 ($\chi^2 = 7.4$, df = 5, $P > 0.1$).

Spatial Use of Timber Stands.--Bears differed significantly in their spatial use patterns of timber stands (LCS, OGS) between study phases ($\chi^2 = 39.7$, df = 8, $P < 0.001$). Additionally, use of spatial bands within the timber stands was disproportionate to the availability of the spatial bands in both 1973-74 and 1980-81 (Appendix B, Tables 36, 37). Bears exhibited apparent selection for the 2 bands between 0 and
140 m from the clearcut edge in both phases. Bands more than 280 m and 350 m from the edge were selected against by bears in 1973-74 and 1980-81 respectively. Bears tended to use areas of timber stands in close proximity to clearcuts more in 1973-74 than in 1980-81.

About 11% and 8% of the area of these timber stands were within 70 m of 1960 and 1950 clearcuts respectively. In 1973-74, 32% of relocations of bears in timber stands were within 70 m of 1960 clearcuts and 13% within 70 m of 1950 clearcuts. The percent of relocations in 1980-81 within 70 m of clearcuts had decreased to 27% near 1960 clearcuts and 7% near 1950 clearcuts. An additional 21% of the area of timber stands on the island were within 70 m of tidelands. About 26% of all relocations of bears in timber stands, excluding those within 70 m of clearcuts, were within 70 m of tidelands in 1973-74 and 16% in 1980-81. A total of 71% of all relocations in timber stands were within 70 m of clearcuts or tidelands in 1973-74 and 50% in 1980-81.

Patterns of use of spatial bands in timber stands differed among adult females, adult males and subadults in 1973-74 ($\chi^2 = 58.3, df = 12, p < 0.001$). Each class used spatial bands disproportionately to their availability on the island (Fig. 13; Appendix B, Table 36). All selected for bands 0-70 m from clearcuts and against areas greater than 280 distant. Adult females also selected for bands 71-140 m from clearcuts and adult males for bands 141-210 m. In general, subadults exhibited greater selection than adults for areas in close proximity to clearcuts (0-70 m). Adult females with cubs also used these bands.
Figure 13. Percent use by black bears of timber stands at 70 m intervals from bordering clearcuts (1960 and 1950) on Long Island, Washington. Use significantly different from expected at $P < 0.05$ (Neu et al. 1974) indicated by an asterisk. Number of relocations for each class of bears presented in parentheses.
disproportionately to their occurrence. Patterns of use by females with cubs were very similar to those of all females as a group.

Use patterns of spatial bands in timber stands were also significantly different among adult females, adult males and subadults in 1980-81 \( (X^2 = 27.5, \text{df} = 16, \ P < 0.05) \). Adult females, adult males and subadults again all exhibited significant differences between use of these bands from that expected if all were used in proportion to their availability on the island (Fig. 13; Appendix B, Table 37). Adult females and adult males used the bands 0-140 m from clearcuts significantly more than expected. Adult females selected against bands more than 280 m from clearcuts and adult males against bands more than 420 m from clearcuts. Subadults and adult females with cubs exhibited significant selection only against areas greater than 560 m from clearcuts and used all other bands in proportion to their availability. In general, adult females with cubs used the spatial bands similarly to all adult females as a group, however, they used areas 0-70 m from clearcuts less and areas greater than 560 m more. All classes showed less selection for the clearcut edge (0-70 m) of these timber stands than they had in 1973-74.

Spatial use patterns of adult females present during both study phases differed significantly between study phases \( (X^2 = 21.2, \text{df} = 6, \ P < 0.01) \) as did all females as a group. Use differed from expected based on availability both in 1973-74 and in 1980-81 (Appendix B, Tables 36, 37). These 4 females did not differ in the spatial manner in which
they used timber from all adult females as a group in 1973-74 ($X^2 = 1.4$, df = 5, $P > 0.90$) but differences were significant in 1980-81 ($X^2 = 15.8$, df = 8, $P < 0.05$). The only difference between the 2 groups was that all females selected for bands 71-140 m from clearcuts and the 4 females used these bands only in proportion to their availability.

**Seasonal Variation in Spatial Use of Clearcuts.**—The following analyses were completed only for all bears as a group as sample sizes prohibited accurate comparisons using individual classes. Comparisons indicated no significant difference in seasonal use patterns of spatial bands in 1960 clearcuts bordered by timber stands in 1973-74 ($X^2 = 12.8$, df = 15, $P > 0.5$). Use was as expected based on the availability of bands during all seasons (Appendix B, Table 38). Although differences were not significant, use of bands 0-70 m from timber in 1973-74 accounted for 47% and 43% of all relocations of bears in these clearcuts in spring and fall respectively, with 35% and 39% of all relocations in these bands in early and late summer.

Bears' patterns of use of spatial bands in 1960 clearcuts bordered by timber differed significantly among the 4 seasonal periods in 1980-81 ($X^2 = 71.2$, df = 18, $P < 0.001$). In all seasons, except spring, use was disproportionate to availability of spatial bands on the island (Fig. 14; Appendix B, Table 39). Bears again made greater use of areas close to timber stands (0-70 m) in the spring and fall than during the summer (Jun-Aug). Areas 211-350 m from timber were used in greater proportions in the summer months.
Figure 14. Percent use by black bears of 1960 clearcuts at 70 m intervals from bordering timber stands in each of 4 seasonal periods on Long Island, Washington, 1980-81. (+ = use significantly greater than expected, x = use significantly less than expected; P < 0.05 (Neu et al. 1974)).
Bears' patterns of use of spatial bands in 1960 clearcuts bordered by 1950 clearcuts did not differ significantly among seasons in 1980-81 ($X^2 = 11.7, df = 12, P > 0.3$). Bears used bands in proportion to their availability during all seasons (Appendix B, Table 40). However, 80% of relocations of bears during spring were within 140 m of 1950 clearcuts, compared to 55%, 59% and 55% for early summer, late summer and fall, respectively. Sample sizes were too small for accurate comparisons of seasonal use of these clearcuts in 1973-74.

Patterns of spatial use of 1950 clearcuts did not differ seasonally in 1973-74 ($X^2 = 13.3, df = 15, P > 0.5$). Bears used spatial bands in the 1950 clearcuts in proportion to their availability in spring, early summer and fall and significantly different from expected in late summer (Appendix B, Table 41). Although differences were not significant, only 14% of the relocations were within 70 m of timber in late summer, compared to 21%, 26% and 21% for spring, early summer and fall, respectively. Similar comparisons were not made for 1950 clearcuts in 1980-81.

**Diurnal Activity Level and Spatial Use.** These analyses were done only for all bears as a group and included only diurnal relocations. Bears did not use spatial bands in 1960 clearcuts bordered by timber stands significantly differently when active than when inactive in either 1973-74 ($X^2 = 3.4, df = 4, P > 0.3$) or 1980-81 ($X^2 = 7.6, df = 6, P > 0.2$). However, chi-square goodness-of-fit tests indicated that bears used the spatial bands disproportionately to their availability.
when active and proportionately when inactive in 1980-81 (Appendix B, Table 42). Bears selected against bands 0-70 m from timber and for bands 71-140 m when they were active. These 2 bands were used as expected when bears were inactive. Use was in proportion to availability when bears were active and when they were inactive in 1973-74 (Appendix B, Table 42). However, there was a tendency for bears to be inactive proportionately more often than active in bands 0-70 m from timber. Fifty-eight percent (N = 19) of relocations of inactive bears were within 70 m of timber whereas only 40% (N = 376) of relocations of active bears were in these bands.

Small sample sizes for inactive bears in 1960 clearcuts bordered by 1950 clearcuts in 1973-74 (N = 6) precluded accurate comparisons. However, comparisons of 1980-81 data indicated significant differences in patterns of use of these bands by bears when active and inactive in 1980-81 (X^2 = 13.0, df = 5, P < 0.02). Spatial use was disproportionate to availability for inactive and active bears (Appendix B, Table 43). Bears used bands 141-210 m from timber more when active (22.7%) than when inactive (5.3%). Other bands were used similarly for each activity class.

Use patterns of 1950 clearcuts by active bears differed significantly from patterns exhibited when they were inactive in 1973-74 (X^2 = 15.2, df = 5, P < 0.01). Use of these bands differed from expected for both active and inactive bears (Appendix B, Table 44). Bears selected for bands 211-280 m from timber when active and used
these bands only in proportion to their availability when inactive. Other bands were used similarly when active and when inactive. Similar comparisons were not made for 1950 clearcuts in 1980-81.

Patterns of use of spatial bands in timber stands did not differ significantly when bears were active and inactive in 1973-74 ($X^2 = 11.0$, df = 8, $P > 0.2$) but did in 1980-81 ($X^2 = 21.4$, df = 8, $P < 0.01$). Use differed from expected for both active and inactive bears in both phases (Appendix B, Table 45). There was a slight tendency for bears to use areas greater than 560 m from clearcuts proportionately more when inactive than when active in both study phases.

**Nocturnal Inactivity and Spatial Use.**--The following analyses includes only relocations of females 5, 14, 39, 45, and 47 at night when they were inactive in 1980-81. These females were inactive 28 times in 1960 clearcuts bordered by timber stands. Use of these clearcuts for nocturnal inactivity was in proportion to availability of the spatial bands ($X^2 = 5.8$, df = 5, $P > 0.3$). Small sample sizes ($N = 15$)

prohibited accurate analysis for 1960 clearcuts bordered by 1950 clearcuts but trends in use appeared similar to that exhibited by bears in clearcuts bordered by timber stands. Ninety-two percent ($N = 26$) of the relocations of these females in timber stands (LCS, OGS) were within 210 m of clearcut areas; 14 in bands 0-70 m from clearcuts, 6 in bands 71-140 m distant and 4 141-210 m from clearcuts.
Spatial Use Summary

Spatial use patterns of clearcuts and timber stands on the island changed between study phases, as did overall patterns of use of vegetation types. Succession significantly altered the character of clearcut areas and generally increased horizontal cover. Use of most areas in relation to the distance from the bordering vegetation types differed with the sex and age of the bears in each phase and between study phases. Some differences in the spatial use patterns appeared related to season and activity.

Tidelands--These areas offered the least horizontal cover of all vegetation types in both study phases. Bears used these areas similarly during both study phases. All classes selected for areas 0-35 m from the edge of tidelands regardless of the vegetation type bordering them. Areas 36-70 m from the edge were used as expected and areas greater than 70 m were used less than expected.

1960 Clearcuts--These clearcuts offered slightly more horizontal cover than tidelands and the most abundant source of foods in 1973-74. Significant differences existed between the patterns of use of 1960 clearcuts bordered by timber stands and those bordered by 1950 clearcuts in 1973-74. However, proportionate use of individual spatial bands was generally similar for these 2 1960 clearcut types, with some small differences. Subadults selected against areas 71-140 m from the border in both 1960 clearcut types and, although not significant, areas 211-350 m from the edge were used more than expected. Adult males used bands in
1960 clearcuts bordered by timber in proportion to their availability, with bands 71-140 m from timber used slightly more than expected. Adult females, including adult females with cubs, selected for bands 0-70 m from timber and against bands 71-140 m distant. Although sample sizes were small, adults tended to use areas 71-210 m from the border more than expected and bands greater than 210 m distant less than expected in 1960 clearcuts bordered by 1950 clearcuts. Additionally, 5 of the 7 relocations of adult females with cubs in 1960 clearcuts bordered by 1950 clearcuts were within 70 m of the border. Although no significant differences in patterns of seasonal use of spatial bands in 1960 clearcuts bordered by timber were evident, bears tended to use areas close to timber stands (0-70 m) more in spring and fall than in the summer months. Additionally, bears tended to be inactive proportionately more often than active in areas 0-70 m from timber.

By 1980-81 horizontal cover had increased considerably in the 1960 clearcuts and spatial use patterns of most bears had changed. Again, although significant differences existed, adult males and subadults each used 1960 clearcuts bordered by both timber and 1950 clearcuts in a similar manner. Adult males and subadults used spatial bands in proportion to their availability but subadults tended to use areas 0-140 from the edge more than expected and areas greater than 140 m less than expected. Adult females used 1960 clearcuts significantly differently than expected in 1980-81. Bands 0-70 m from the edge were used less than expected and areas 71-140 m more than expected in 1960 clearcuts bordered by timber. Both of these bands were used in proportion to
their availability in clearcuts bordered by 1950 clearcuts. Additionally, bands 141-210 m from the border were used significantly more than expected in 1960 clearcuts bordered by 1950 clearcuts. Other bands were used as expected in both types. Females tended to use bands closest to the adjoining vegetation type less and bands further away more in 1980-81 than they had in 1973-74. Adult females with cubs, however, still exhibited selection for areas in close proximity to timber (0-70 m) and against areas greater than 140 m distant.

Bears used the spatial bands in 1960 clearcuts bordered by timber stands significantly differently among seasonal periods in 1980-81. Trends were similar to those observed in 1973-74, with the greatest use of areas close to timber (0-70 m) occurring in spring and fall. Use patterns did not differ significantly among seasons in 1960 clearcuts bordered by 1950 clearcuts, but use of bands close to 1950 clearcuts (0-70 m) was greatest during the spring. Bears used all spatial bands in clearcuts bordered by timber in similar proportions when active and when inactive in 1980-81 while they had used the band closest to timber more when inactive than when active in 1973-74. In 1960 clearcuts bordered by 1950 clearcuts bears used bands 141-210 m from the border more when active than when inactive. The adult females monitored at night in 1980-81 apparently did not select for any specific band when inactive.

1950 Clearcuts.--Horizontal cover in these clearcuts was similar in 1973-74 to that in the 1960 clearcuts in 1980-81. Although timber
stands generally bordered these clearcuts, they were occasionally adjacent to 1960 clearcuts and tidelands. Subadults used spatial bands in these clearcuts disproportionately to their availability, selecting for areas 211-280 m from timber and against areas 0-70 m distant. Although not significant, adults, including females with cubs, tended to use spatial bands in a manner similar to subadults. A greater proportion (35%) of all relocations of adult bears than subadults (20%) in these clearcuts were also within 70 m of tidelands and 1960 clearcuts. Patterns of use of these clearcuts did not differ significantly among seasons. However, proportionately fewer relocations of bears were within 70 m of timber stands during late summer than during the other seasons. Bears used the bands 211-280 m from timber more when active during the day than when inactive. Other bands were used similarly for each activity level.

By 1980-81 1950 clearcuts still offered abundant horizontal cover, trees were larger, but foods were available only in small openings. Spatial use of these clearcuts in 1980-81 by most classes was similar to the patterns observed in 1973-74. All classes, except females with cubs, selected against areas 0-70 m from timber and subadults still exhibited significant selection for areas 211-280 m from timber. Adult females selected for areas 281-350 m distant from timber. The 1 adult female with cubs that used these clearcuts selected for areas 71-140 m from timber and selected against areas greater than 210 m distant. Fifty-one percent of relocations of subadults in these clearcuts in 1980-81 were within 70 m of clearcuts or tidelands, compared to 20% in
1973-74. Proportion of relocations of adult bears within 70 m of tidelands or 1960 clearcuts was similar in 1980-81 (37%) and 1973-74 (35%).

Timber Stands.—Large conifer stands and the old growth stand were combined for these analyses. These stands supported mature conifers and locally abundant brush species in the understory. All classes of bears selected for bands 0-70 m from clearcuts and against areas greater than 280 m distant in 1973-74. Similar patterns were exhibited by most bears in 1980-81. However, neither selection for bands 0-70 m from clearcuts or selection against areas greater than 280 m were as great as they were in 1973-74. Subadults differed more than other classes between the 2 study phases. This class displayed the greatest selection of all classes for areas 0-70 m from clearcuts in 1973-74 but use of this band was only in proportion to its availability in 1980-81. Subadults used bands greater than 210 m from clearcuts less than expected in 1973-74, but only selected against areas more than 560 m from clearcuts in 1980-81. Females with cubs used the spatial bands in timber stands similar to all adult females in 1973-74, but used areas 0-70 m from clearcuts less and areas 560 m distant more than all adult females as a group in 1980-81. Bears displayed greater selection for areas within 70 m of 1960 clearcuts than for areas within 70 m of 1950 clearcuts during both study phases. An additional 26% and 16% of relocations of bears in timber stands were within 70 m of tidelands in 1973-74 and 1980-81 respectively. Bears used the spatial bands in timber stands similarly when inactive and active during the day in both
phases. However, 24 of 26 inactive relocations of adult females at night in timber stands in 1980-81 were within 210 m of clearcut areas.

Use of Roads and Skid Trails

Bears were often observed on the 23 km of main roads on the island during both study phases. Roadsides were vegetated by self-thinning alders, grasses and forbs. Bears used these roads and the abundant smaller logging roads and skid trails as travelways. Additionally, bears were often observed feeding along roads and trails during the spring and early summer. Because succession was retarded on the smaller logging roads and skid trails they typically provided vegetation common to earlier seral communities. Bears seldom used roads, however, that were covered with large, crushed rocks.

Home Ranges

Home ranges of adult males (N = 3) averaged 821 ha (SE = 360), adult females 392 ha (N = 6, SE = 121) and subadults 292 ha (N = 5, SE = 86) in 1973-74. Adult male ranges were only marginally larger than subadult (t = 1.8, P = 0.07) and adult female (t = 1.5, P = 0.12) ranges during this phase of the study. Adult female ranges were not significantly larger than subadults (t = 0.64, P = 0.3). In 1980-81 adult males ranges averaged 1968 ha (N = 4, SE = 404), adult females 362 ha (N = 14, SE = 46) and subadults 193 ha (N = 4, SE = 31). Adult male ranges were significantly larger than ranges of both the adult females (t = 7.4, P = 0.001) and subadults (t = 4.4, P = 0.01) during this
phase. Additionally, ranges of adult females were now significantly larger than ranges of subadults ($t = 1.9, P = 0.01$). Home ranges of all classes of bears, during both study phases, however, were small enough to allow each bear to travel to any portion of its range in 1 hour.

Although average home range size differed between study phases, differences were not significant (adult females $t = 0.29, P = 0.38$; subadults $t = 0.97, P = 0.21$; adult males $t = 2.0, P = 0.06$). However, more of the adult males used almost the entire island on a seasonal basis (breeding season) in 1980-81 than in 1973-74.

Adult females present during both study phases occupied home ranges of similar size (1973-74 $x = 226, SE = 42$; 1980 $x = 223, SE = 38$; $t = 0.49, P = 0.94$) during the 2 phases. Ranges of these 4 females were also spatially stationary (Fig. 15). Females 14 and 15, subadults in 1973-74, also remained in similar areas of the island. Female 14 increased her home range from 196 ha in 1973-74 to 535 ha by 1980 and female 15 347 ha to 429 ha.

Female 3 was killed on the island in the fall of 1980 by an archer and female 5 who occupied a range adjacent to her expanded her range in 1981 to include the entire area previously occupied by female 3. Similarly, female 15 expanded her range to include that of female 2 after this female left the island in the fall of 1980. Female 5's expansion of her range increased the proportion of 1960 clearcuts within her range (convex polygon) from 37% to 44% and decreased the amount of 1950 clearcuts from 37% to 24%. However, she used vegetation types in
Figure 15. Home ranges of female black bears present during both 1973-74 and 1980 on Long Island, Washington. Females 14 and 15 were subadults (< 3 years) in 1973-74.
her home range proportionately similarly both years. Female 15 did not significantly alter the proportion of vegetation types in her home range by including the range of female 2. Female 9 also left the island periodically during 1980-81 but returned to den on the island both years. No females adjacent to her range altered their ranges to include part of hers while she was on the mainland. Additionally, female 5 abandoned her home range for the mainland in the early summer of 1982.

Although adult females exhibited a fidelity to home ranges between study phases, home ranges of all females were overlapped by other females (Fig. 15). Ranges of subadults and adult males overlapped also but not to the degree exhibited by the females. Bears were generally tolerant of other bears. On numerous occasions up to 4 adult females were relocated in the same clearcut within 200 m of each other, however most use of overlapping areas was spaced temporally.
DISCUSSION

Vegetative composition of the clearcuts on Long Island changed dramatically over the period of the study. Successional changes gradually altered the food-cover ratio until conifers dominated in the older clearcuts and food abundance reached its lowest point. Structure and composition of vegetation in timber stands, on the other hand, changed very little. The black bear population on the island grew rapidly, apparently in response to abundant food supplies in clearcut areas, but reproductive success began to decline in 1975 (F. G. Lindzey, pers. commun.) as the quality of the habitat apparently declined.

Clearcut areas appeared to be utilized principally for the seasonally abundant foods they offered. Bears during both phases of the study selected for clearcut areas (5-21 years of age) over all other vegetation types for feeding areas, but preferred to rest in areas dominated by large trees. This trend was even more dramatic at night when even fewer bears were inactive in clearcuts. Inactivity in clearcut areas occurred most frequently in those clearcuts offering the most horizontal cover (high-cover). Selection of timber stands for resting may have been for the protection these areas offered against solar radiation, although this seems less likely on Long Island where days are frequently overcast than in other portions of the species range. Bears on the island were inactive more often than expected when it was raining and generally in timber suggesting these areas offered bears some protection from precipitation. Avoidance of conspecifics (or
hunters) may also be be important in the selection of vegetation types that offer cover and or climbable trees. Also, by resting in areas that are not preferred feeding areas bears could minimize contact with active bears. Herrero (1972:217) felt that mature trees were significant in the day to day existence of black bears, especially cubs and subadults. He concluded that bears climbed "..for the implied functions of shelter, sleeping, nursing, playing and protection".

Patterns of use of clearcuts for feeding by most classes of bears was also apparently influenced by the amount of horizontal cover present and or the proximity of large trees. Several authors have reported on the hesitancy of bears to venture far from timber in open areas (Erickson 1965, Herrero 1972, McCollum 1973). During the first phase of the research on the island (1973-74) when bears had a choice of clearcuts with little cover but abundant food and clearcuts with dense horizontal cover but less abundant foods, adult males chose the former with apparent disregard to the proximity of cover provided by adjacent vegetation types. Females, including those with cubs, and subadults preferred to utilize the older clearcuts that offered cover as well as food. Adult bears appeared to use these older clearcuts more peripherally than subadults and generally in close proximity to the younger clearcuts or tidelands which offered more abundant foods. Adult females, especially those with cubs, chose areas in close proximity to adjacent vegetation types that offered more horizontal cover and larger trees when they did use the younger clearcuts. Subadults, on the other hand, tended to use the center of these young clearcuts when they fed in
them, possibly because these more central areas provided them the best opportunity to avoid adult females. Even though horizontal cover was very low and large trees distant, the reduced risk of encountering other bears may have made such areas attractive to subadults.

Except for females with cubs in 1980-81, bears did not exhibit a strong preference for the edge of the older clearcuts bordered by timber stands during either study phase. Areas in older clearcuts most selected for by adult females with cubs were 71-140 m from timber. Apparently horizontal cover was adequate for other classes of bears to feel secure throughout these clearcuts. Most bears even selected against areas within 70 m of timber in the older clearcuts in 1973-74 and against this band in all clearcuts in 1980-81. Avoidance of this band may have been due to greater conifer regeneration occurring in proximity to a seed source and differences in microclimate (Wagner 1980). Hanley (1983) found a similar response by elk and deer in their use of clearcuts in the Cedar River Watershed in Washington. He noted that there was an "edge effect", but use by elk and deer was greatest 1-2 "cells" distant from the edge in clearcuts. Use by bears of many areas distant from timber in these older clearcuts appeared, at least partially, in response to their proximity to other vegetation types which offered more abundant foods.

Most bears used the young clearcuts bordered by older clearcuts spatially similarly to those bordered by timber stands in each phase of the study. Apparently the proximity of these older clearcuts provided
functionally similar security to bears as that offered by timber stands when they fed in these younger more open clearcuts. Because clearcuts bordered by other clearcuts were of limited availability to females with cubs their use of such areas was not determined. However, because they used clearcuts bordered by timber stands with a greater preference for areas close to timber than other classes of bears, it is probable that they would have made little use of young clearcuts bordered by the older clearcuts even if they had been available to them.

Small timber stands, in or bordering clearcut areas, received heavy use by bears (except females with cubs) during the early study phase but use of these small stands was much reduced in 1980-81. These stands apparently provided security cover within and in some cases approach lanes to the young clearcuts that were lacking in cover in 1973-74. Presumably, the increased cover in these cuts by 1980 reduced the reliance of bears on the small isolated timber stands. McCollum (1973) noted that bears traveling through large clearcuts in western Oregon utilized available timber strips as travelways.

Females with cubs on the island used large timber stands and high-cover clearcuts more frequently than other bears and fed only infrequently on the tidelands. When they did use the tidelands they generally left their cubs in adjacent timber. McIlroy (1972) noted a similar pattern in the manner adult females with cubs used tidelands in Prince William Sound, Alaska.
Adult males, typically the most aggressive and dominant class in a bear population, appeared least affected by the need for horizontal cover or the proximity of climbable trees when feeding in clearcut areas on the island. Adult females with cubs and subadults, on the other hand, were more unlikely to feed far from some form of "security cover". Willey (1971) suggested that males were more vulnerable to hunting in Vermont because they were less wary and more prone to seeking food supplies in more open areas than other bears. Adult females because they avoided open areas were seldom shot in cover types other than wooded areas. McIlroy (1972) also indicated that the greater use of open tideland areas by males than females increased the vulnerability of adult males to hunting.

Behaviors of subordinate bears, thus habitat selection, should also evidence their subordinate status. Subadult bears might be expected to develop movement and activity patterns that best allowed them to avoid more dominant bears. Females with young cubs to protect might be expected to adjust their resource use patterns as well. Erickson (1965) noted that females with cubs avoided concentrations of bears at garbage dumps and Reynolds and Beecham (1980) found that females with cubs in Idaho avoided other bears by restricting their movements to that part of their range where contact with other females was least likely.

Overall habitat quality and food availability on the island had declined by 1980-81 and bears no longer had the young productive clearcuts (harvested 1963-1968) to exploit. The canopy had closed in
the older clearcuts (harvested 1952-1959) and little food was available. Horizontal cover was apparently adequate in the younger clearcuts by 1980 that bears, except females with cubs, felt secure anywhere in the cut. It is possible, however, that bears made greater use of all areas within these younger clearcuts simply because these clearcuts now offered the only abundant food supplies on the Island. Horizontal cover, however, was similar in these clearcuts to what it had been in the older clearcuts during the first phase of the study when bears had used the older clearcuts with apparent disregard to the proximity of standing timber suggesting that amount of horizontal cover is a major determinant in patterns of use of clearcut areas. Additionally, small conifer stands in or bordering the younger clearcuts were not selected for by bears during the latter phase where they had been during the earlier phase. Only adult females with cubs and subadults selected areas in these younger clearcuts in close proximity to timber stands during the latter phase. While subadults had apparently been able to avoid more dominant bears by using the center of these clearcuts in 1973-74, the likelihood of confronting an adult bear was equally probable in all areas of these clearcuts in 1980-81. Areas in close proximity to timber apparently provided subadults the greatest security. Subadults also used the older clearcuts more than other bears in 1980-81.

Although population density was greater in 1980 than it had been in 1973-74, population numbers were similar to 1973-74 by 1981 (Lindzey and Meslow 1977b, this study). However, relative density had increased
considerably as the proportion of areas providing abundant foods for bears on the island had decreased by about 50%. Patterns of habitat use at low densities may differ from that at high densities. Bears made proportionally greater use of areas in timber stands that were long distances from clearcut areas in 1980-81 than they had in 1973-74. Adult females with cubs and subadults made even greater use of these areas than other bears. Densities of adults in preferred feeding areas apparently forced subadult bears to establish home ranges in more marginal habitats. Subadult bears were the only class that did not include young clearcuts more than expected in their home ranges and the only class to include significantly more large timber stands than expected. The degree to which bears will tolerate other bears in the same area probably depends on food availability and sex and age dependent relationships among bears (Garshelis and Pelton 1981). Kelleyhouse (1980) felt that when food was scarce and adult bears relatively dense, aggression or intolerance by the adult bears probably required subadults to use suboptimal habitat. By 1980-81, subadults on Long Island dispersed at a younger age than they had in 1973-74 (F. G. Lindzey, pers. commun.).

Bears in this study and in other areas in western Washington (Poelker and Hartwell 1973) are primarily diurnal with crepuscular activity peaks. Although subordinate bears could have reduced contact with more dominate bears by simply feeding when most adult bears were inactive, all classes of bears exhibited similar diel activity patterns during each season and no class exhibited significant nocturnal
activity. Bears may not feed at night because of their reliance on vision when harvesting berries. Bacon and Burghardt (1976) in a study of the feeding behaviors of captive black bears, suggested that orientation to food items appeared to involve both sight and smell, with orientation to blackberries being primarily visual. The frequent use of sight suggested a high degree of visual acuity and pattern discrimination in bears. Garshelis and Pelton (1980) found that bears in the Great Smokey Mountains increased their nocturnal feeding in the fall when acorns were abundant and speculated that the larger-sized acorns may be more perceptible at night than berries. They noted no extensive nocturnal activity when bears were feeding on berries but diurnal activity increased considerably over that observed prior to berry ripening.

In spring, before abundant foods were available in clearcut areas, most bears foraged on young grasses and sedges on tidelands and in meadows. Other, more upland, riparian areas and roadsides in clearcuts supported abundant grasses as well, and were commonly used by bears. It seems probable that these upland areas could have adequately met the needs of the bears in the spring if tidelands and meadows had not been available. Several bears were never relocated on tidelands or meadows. Use of tidelands and meadows occurred in close proximity to areas providing some cover during both study phases. However, a greater proportion of relocations on tidelands and meadows in 1973-74 were closer to timber stands than other vegetation types than in 1980-81. The increased cover in clearcut areas by 1980-81 presumably allowed
bears to feed over more of the tidelands and still remain close to cover.

Seasonal food availability was apparently the major factor influencing the degree to which most bears used clearcuts on Long Island. Overall use of clearcuts was greatest during the summer months when food was most abundant. Bears tended to forage furthest into the clearcuts during this period. Conversely, bears generally used clearcuts proportionally less and used them more peripherally during spring and fall. Although it seems unlikely that cover requirements of bears on the island should change with seasons, proximity of cover appeared less important to the bears when food was very abundant in these clearcuts. It is possible that food availability was reduced by the bears feeding in the outer bands in the spring making areas greater distances from cover with abundant foods more attractive. Further, the greater number of bears using clearcut areas during the summer may have forced bears to disperse more evenly throughout the clearcut.

Large conifer stands received the greatest overall use by bears in spring and fall, partially because of the tendency for bears to be more inactive during these seasons and to select timber when inactive. However, food availability may have influenced this pattern. Foods although available in conifer stands, were not nearly as abundant as in clearcut areas. But, because most bears concentrated their feeding activities in clearcut areas during the summer, food resources may have been depleted to the point (especially 1980-81) that by the fall it was
equally efficient to feed in conifer stands where fruits ripened slower and thus reached their peak in abundance later. Conifer stands, due to minimal understory, were also convenient travel-ways for bears when moving between clearcut areas.

The importance of old growth to bears may not have been adequately determined. There was only 1 old growth stand on the island and it was undoubtedly not equally available to all bears. Additionally, the high food value of clearcut areas on the island probably masked any preference bears may have had for old growth stands over younger timber stands as feeding areas.

Subadult bears in 1980-81 and the adult females present during both study phases indicated a selection for the inclusion of alder stands in their home ranges. The largest alder stand on the island was situated between 2 young clearcuts, although not directly adjacent to them, and was probably included incidentally to the inclusion of these clearcuts in the bear's ranges. In the absence of conifer stands, alder stands may provide similar structural qualities as conifer stands and be used by bears for the resting cover they provide. Although, bears used tideland areas bordered by alder stands similarly to those bordered by conifer stands they spent little time in alders. Small inclusions of young alders found within most clearcuts appeared to be used similarly to the surrounding clearcuts.

The diversity of locations of den sites suggests that clearcut logging at cutting intervals greater than 50 years will not limit den
site availability to the point where it would adversely affect the population. Logging in this area may actually increase the value of forested areas for denning sites as most bears denned under partially decayed stumps or fallen trees left from previous logging efforts. Johnson and Pelton (1981) suggested that elimination of mature trees with den cavities in coastal North Carolina resulted in selection of ground dens by bears. Ground dens provide less protection from weather, high water, man and dogs (Landers et al. 1979). However, only 1 bear in this study denned in a cavity in a live standing tree. No bears denned in the old growth stand, even in ground dens, during either study phase.

The consistent use of roads and skid trails by bears reflects their value to bears. In many cases these roads provided easy access to and travel in densely vegetated areas. Succession was generally retarded on old road beds and brush species remained more productive than those in the surrounding older clearcuts where the canopy had closed. Additionally, most roadsides were vegetated with grasses or forbs which provided spring foods. Use of logging roads by bears in other areas appears variable. Tisch (1961) concluded that logging roads were important to black bears in Montana because of the numerous scats he found on them. In contrast, McCollum (1973) found only 1 scat on a road during a 5.5 month study in western Oregon. The degree to which bears use logging roads as feeding areas or for travel probably depends on the foods available and to a larger extent the the amount of human activity
on them. Hunting from roads with dogs is a common hunting method in many states.

Home range boundaries appeared to be recognized and adhered to by neighboring bears even though home ranges overlapped considerably. Although bears were often relocated in close proximity to each other, most use of overlapping areas was spaced temporally. Further, the adherence by the females present during both study phases to their original home areas (7-8 years) suggests that individuals were not free to expand their ranges even though habitat quality, from the standpoint of food availability, had deteriorated. Only after adjacent females were removed or left the island did long-term resident females expand their ranges. Females 2 and 5, apparently unable to expand their ranges, abandoned their traditional home ranges and moved to the mainland. Displaced residents and dispersing subadults both will contribute to new populations that grow to take advantage of rich food resources found in other areas recently clearcut logged.

Home ranges of black bears on Long Island were smaller than ranges of black bears in most other areas of the species range. It is generally assumed that quality of habitat influences the size of home ranges of bears; high quality habitat allowing bears to meet most of their needs in relatively small areas. However, home range size alone may not be a reliable indicator of habitat quality. While habitat decreased in quality on the island and reproductive performance of the population decreased, range sizes changed little, presumably because of
intraspecific behaviors which precluded enlargement. Young and Ruff (1982) found that female bears in Alberta responded to an increase in population density by decreasing the size of their home ranges. While it seems that in more stable and predictable habitats, range size may provide a relative measure of habitat quality among areas, when habitats are modified relatively quickly by succession, such as in coastal forests modified by logging, such comparisons are tenuous.

Although densities of bears and social interactions affect how bears use clearcut areas, availability of foods, horizontal cover and proximity of other cover are major factors which dictate patterns of use of clearcut habitats. However, because habitat use patterns differ with sex, age and reproductive status of bears, design of research and interpretations of research results should reflect a knowledge of these differences. Patterns of resource use documented during this study occurred under the unique set of vegetative and population variables described. Patterns described thus represent preferences of the bears given this unique combination of variables and may or may not represent absolute needs for survival. Peek et al. (1982) illustrate this point for elk. General patterns, however, should provide needed guidelines to allow considerations to be given the black bear in logging programs whether the management goal is to increase or decrease population size in the ensuing second-growth forests.
CONSIDERATIONS FOR TIMBER MANAGEMENT

Clearcut logging is, and probably will remain, the dominant means of harvesting timber in Pacific coast forests. Size, configuration and age of clearcuts, as well as the spatial relationships and availability of other different aged clearcuts and timber stands will all influence density, dispersion and sex and age composition of local bear populations and the manner in which they use the habitat. Heavy hunting pressure may also influence patterns of use of clearcut habitats by increasing the value of cover.

The general nature of the relationship is that clearcut logging often provides a rich, abundant food source for many species. This food source often allows for an increase in reproduction and survival of offspring and thus population growth. Successional patterns in the vegetative community, however, act to make these sources ephemeral in nature. The ability of the habitat to support the enlarged population is short-lived. Management of populations should reflect this basic knowledge.

Vegetation response to clearcutting may differ depending on the geographical area. Kellyhouse (1980) found little use by black bears of areas that had been partially cut in northern California. He attributed the lack of use of these areas to arid conditions of the site and very low availability of berry producing shrubs or herbaceous plants in these cuts. Clearcuts were seldom used as feeding areas by bears until they
were 10 years old in Montana (Jonkel and Cowan 1971). In contrast, McCollum (1973) found bears in western Oregon to use all clearcut areas older than 4 years. Vegetation response to clearcutting in McCollum's study area was similar to what was observed on Long Island. It seems likely that bears in most of coastal Washington and Oregon will respond in general to clearcut logging in a manner similar to that observed on Long Island. Post harvest treatments that enhance conifer regeneration (burning, spraying, planting) will presumably reduce the period over which clearcuts are of greatest value to bears.

As an example, assume a 90 ha clearcut (maximum distance from timber 250 m) is made in a mature forest in the coastal Northwest within the home range of a single adult female bear. I would expect her to respond by making some initial use of this clearcut by foraging on grasses and forbs in the spring as they become available in close proximity to the adjacent timber. By the time the clearcut was about 3 to 5 years of age, brush species will be fairly abundant and she would probably increase her use of the edges of the clearcut during the summer months when flowers and fruits of the shrub species were available. The increased food availability in the clearcut, compared to what it had been in the mature forest, would probably result in her female offspring establishing residency in part of her range. Additionally, emigrating adult females from surrounding areas where habitat quality, due to successional changes, was decreasing may begin to use the clearcut. As horizontal cover increased in the clearcut the bears would start to make greater use of the center portion of the cut. Maximum use of the entire
clearcut would probably occur between 12 to 18 years of age. The increased availability of the entire clearcut, due to increased horizontal cover, would probably allow for even more bears to utilize the clearcut (up to 9 bears, this study). However, as conifers began to suppress the brush species the declining availability of foods might decrease intraspecific tolerance. Subadult bears, including new female offspring, would be forced to disperse and no new emigrating females would be able to establish residency. The increased competition for declining food resources would probably force adult females with cubs, due to their avoidance of other bears, into making greater use of timbered areas where foods were not nearly as abundant. Nutritional stress would undoubtedly affect cub production and survival. Additionally, crowding may increase the chances of females without cubs killing cubs of other females. Further, as canopy closure approached and food availability reached its lowest point, even resident adult females would begin to abandon their ranges for more productive habitats.

This population could be sustained by continued logging in the immediate vicinity at appropriate intervals. When the initial clearcut was approximately 12-13 years of age other clearcuts could be made in the surrounding forest leaving mature timber adjacent to the initial clearcut to allow for continued use by females with cubs. Some of the timber surrounding the initial clearcut could be harvested after the newer clearcuts were 12-13 years old, as long as some timber was left
adjacent to these clearcuts. The remaining timber could be harvested after the initial clearcut was at least 40 years of age.

For purposes of habitat management, it seems adult females should be given maximum consideration, especially as it relates to their ability to raise cubs. Adult males apparently are little affected by horizontal cover and the proximity of adjacent timber types. Subadults probably use habitats to avoid other more dominant bears.

Size of clearcuts for maximum use by adult females with cubs will depend on the shape of the clearcut. Long, narrow clearcuts with irregular borders that increase the amount of edge will be most preferred. No part of a clearcut, regardless of shape, should be greater than 210 m from available timber stands (40 + years of age) for the clearcut to receive maximum initial and continued use by adult females with cubs.

No timber next to clearcuts should be harvested until the clearcut is at least 12-13 years of age. The horizontal cover available in the clearcut at this age will provide security cover for most bears when using the clearcut and provide some security for use of the newer bordering clearcuts. Timber strips at least 100 m wide should be left bordering part of the clearcut when surrounding areas are harvested for continued use by adult females with cubs. Small timber stands (>1 ha) should be left on other borders of the clearcut where possible. The remaining timber could be harvested after the initial clearcut was 40 + years of age.
Home range size should be considered in management plans directed at enhancing the quality of clearcut areas for bears. An ideal cutting regime would be to make clearcuts of a size so that small clearcuts of various ages and mature timber stands were in a continual state of rotation within the home range of an adult female (5.1 km², Poelker and Hartwell 1973; 3.8 km², this study) with the most mature timber stands (40 + years of age) next to the youngest clearcuts. Strips of timber (100 m wide) should be left permanently bordering meadow areas to provide cover for bears using these areas in the spring.

Soil disturbance may enhance shrub and forb production, but scarification to mineral soil will probably increase the chances of the site being dominated by alder. Heavy scarification confined to roads, landings and skid trails will probably enhance the area for bears if they are reseeded with grasses and forbs (especially false dandelion). All roads not necessary for fire protection or reconnaissance should be closed to vehicular traffic.

While piles or windrows of unburned slash may restrict movements of ungulates, this does not seem to be a problem for black bears. Slash may actually constitute an important habitat component for bears by providing a habitat for insects. Additionally, stumps and downed trees may provide denning sites.

Treatment of clearcut areas with herbicides to eliminate brush species will reduce the value of the area for bears. The general
absence of post-logging treatment of clearcut areas on Long Island allowed a maximum duration of the brush stage. There is some evidence to suggest that current intensive forest management practices, specifically the use of herbicides to eliminate brush species and hasten conifer regeneration, in the coastal Northwest may actually decrease timber production (Campbell and Evans 1975, Starkey et al. 1982). The lack of preferred browse and forb species for deer and elk in clearcut areas may increase deer and elk browsing on Douglas fir seedlings. Additionally, Poelker (1979) suggested that much of the bear damage to second growth conifers (most commonly at 20-40 years of age) resulted from high bear densities occurring in areas with declining carrying capacity. Perhaps timber and wildlife production could be more compatible if shrub and forb species were not controlled in clearcuts and possibly even introduced where they were absent (Campbell and Evans 1975, Starkey et al. 1982). Furthermore, the continual availability of early successional communities within the home ranges of these species through the proper size of clearcuts, spacing and timing of harvest, might minimize ungulate as well as bear damage to conifers.

Black bears, deer and elk all utilize clearcut habitats in coastal Oregon and Washington. Early successional stages are preferred by all 3 species, although the timing of maximum use varies for the 3. Elk use generally peaks at 5 to 8 years after harvest (Harper, 1971), deer use is greatest from 15 to 25 years (Brown 1961) and bears made extensive use of clearcuts 5 to 21 years of age in this study with the greatest overall use in clearcuts 12 to 21 years old. The size of the clearcuts
and the proximity of standing timber affects use by deer and elk (Brown 1961, Harper 1971) as well as bear (McCollum 1973, this study) in coastal forests. Lyon and Jensen (1980) in Montana felt that elk have higher security requirements than deer, relative to the distance they would venture into open areas. I found that adult female black bears with cubs exhibited the greatest selection for nearby timber in the use of clearcuts of all classes of bears. In general, I feel that current timber management recommendations for clearcut size for elk (Harper 1971, Thomas et al. 1979) would benefit bears as well. However, bears may not require timbered areas as large as those recommended for elk and will benefit most from cuts being maintained in the brush stage while the grass-forb stage of succession is of most value to elk. Larger clearcuts may be used more by deer and adult male bears than by elk.

As Peek et al. (1982) have noted, habitats preferred by a species in one area may not necessarily be required to ensure their survival in another with habitat preferences varying depending on weather, climate and available habitats as well as other factors. Although Brown (1961) found clearcuts (15 to 25 years of age) to receive considerable use by coastal black-tailed deer (Odocoileus hemionus columbianus), Wallmo and Schoen (1980) indicated that heavy winter snows in coastal Alaska made many young clearcuts inaccessible to Sitka black-tailed deer (Odocoileus hemionus sitkensis). Even elk which respond by foraging in early successional communities created by clearcut logging in the coastal Northwest, apparently prefer old growth forests for cover and foraging throughout most of the year when it is available (Starkey et al. 1982).
However, given that preferences for habitats by a species may vary depending on the specific area in question, it seems that with a knowledge of the ramifications of silvicultural practices on subsequent vegetative communities their affects, in general, on deer, elk and bear populations can be predicted and plans developed to maximize or minimize the value of clearcut habitats for these species.

If timber management plans can be developed to improve the value of clearcut habitats for a species then the opposite may also be true. If it is assumed that black bear density is correlated with amount of bear damage to conifers (Appendix C), although little supportive data is available, current silvicultural treatments and harvest alternatives may be used to reduce the buildup of bears in the early successional communities that follow clearcut logging. Such practices, however, may result in the concurrent decrease in the quality of these areas for deer and elk which are viewed by many as very desirable species. Inhabition of fruit production through chemical means would significantly reduce the value of these areas to bears while largely maintaining their value to deer and elk. Other species of wildlife whose diet included fruits would be influenced along with bears.
LITERATURE CITED


APPENDICES
Appendix A

Major Vegetation Use-Availability Comparisons
Table 8. Chi-square (goodness-of-fit) analyses comparing the observed number of relocations of classes of bears in each vegetation type to the expected number of relocations based on the availability of each type on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Type</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9(^a)</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>72(-) 288</td>
<td>17(-) 85</td>
<td>17(-) 66</td>
<td>44(-) 82</td>
<td>11(-) 120</td>
</tr>
<tr>
<td>60C</td>
<td>526(+) 405</td>
<td>112(0) 120</td>
<td>72(0) 93</td>
<td>165(+) 115</td>
<td>249(+) 170</td>
</tr>
<tr>
<td>50C</td>
<td>661(+) 291</td>
<td>234(+) 86</td>
<td>197(+) 67</td>
<td>87(0)  83</td>
<td>340(+) 122</td>
</tr>
<tr>
<td>LCS</td>
<td>391(-) 715</td>
<td>105(-) 212</td>
<td>74(-) 164</td>
<td>147(-) 204</td>
<td>139(-) 300</td>
</tr>
<tr>
<td>SCS</td>
<td>162(+) 34</td>
<td>50(+) 10</td>
<td>45(+)  8</td>
<td>79(+)  10</td>
<td>33(+)  14</td>
</tr>
<tr>
<td>ALS</td>
<td>11(-) 26</td>
<td>2(-) 8</td>
<td>2(0)  6</td>
<td>9(0)  7</td>
<td>0(-)  11</td>
</tr>
<tr>
<td>OGS</td>
<td>44(-) 110</td>
<td>33(0) 33</td>
<td>21(0) 25</td>
<td>1(-) 31</td>
<td>10(-) 46</td>
</tr>
<tr>
<td>Total</td>
<td>1867</td>
<td>553</td>
<td>428</td>
<td>532</td>
<td>782</td>
</tr>
<tr>
<td>(\chi^2)</td>
<td>1352.9</td>
<td>527.3</td>
<td>528.3</td>
<td>587.9</td>
<td>676.8</td>
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<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>(P)</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

\(^a\)Adult females present during both 1973-74 and 1980-81.

\(^b\)S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \(P = 0.05\), Neu et al. (1974)).
Table 9. Chi-square (goodness-of-fit) analyses comparing the observed number of relocations of classes of bears in each vegetation type to the expected number of relocations based on the availability of each type on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Type</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>147(-) 728</td>
<td>90(-) 547</td>
<td>14(-) 128</td>
<td>48(-) 113</td>
<td>9(-) 68</td>
</tr>
<tr>
<td>60C</td>
<td>2737(+1026</td>
<td>2136(+771</td>
<td>533(+181</td>
<td>419(+159</td>
<td>182(+96</td>
</tr>
<tr>
<td>50C</td>
<td>713(0) 738</td>
<td>526(0) 554</td>
<td>61(-) 130</td>
<td>98(0) 115</td>
<td>89(0) 69</td>
</tr>
<tr>
<td>LCS</td>
<td>802(-1811</td>
<td>528(-1361</td>
<td>173(-) 319</td>
<td>118(-) 281</td>
<td>156(0) 169</td>
</tr>
<tr>
<td>SCS</td>
<td>116(0) 85</td>
<td>92(+64</td>
<td>21(0) 15</td>
<td>22(0) 13</td>
<td>2(-) 8</td>
</tr>
<tr>
<td>ALS</td>
<td>17(-) 66</td>
<td>12(-) 50</td>
<td>6(0) 12</td>
<td>2(-) 10</td>
<td>3(0) 6</td>
</tr>
<tr>
<td>OGS</td>
<td>197(-) 279</td>
<td>170(-) 210</td>
<td>26(-) 49</td>
<td>27(-) 43</td>
<td>0(-) 26</td>
</tr>
<tr>
<td>Total</td>
<td>4729</td>
<td>3554</td>
<td>834</td>
<td>734</td>
<td>441</td>
</tr>
</tbody>
</table>

\[ x^2 \]

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<tr>
<th></th>
<th>3951.1</th>
<th>3357.2</th>
<th>906.6</th>
<th>576.6</th>
<th>168.0</th>
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<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
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<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

<sup>a</sup>Adult females present during both 1973-74 and 1980-81.

<sup>b</sup>S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \( P = 0.05 \), Neu et al. (1974)).
Table 10. Chi-square (goodness-of-fit) analyses comparing the hectares of each vegetation type included in home ranges of classes of bears to the expected hectares based on the availability of each type on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Type</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>404(-)</td>
<td>764</td>
<td>133(-) 262</td>
<td>76(-) 110</td>
<td>234(-) 319</td>
</tr>
<tr>
<td>60C</td>
<td>1454(+1077)</td>
<td>504(+369)</td>
<td>190(+155)</td>
<td>555(+450)</td>
<td>395(+258)</td>
</tr>
<tr>
<td>50C</td>
<td>1171(+774)</td>
<td>365(+265)</td>
<td>128(0) 111</td>
<td>471(+323)</td>
<td>335(+186)</td>
</tr>
<tr>
<td>LCS</td>
<td>1395(-1900)</td>
<td>463(-651)</td>
<td>218(-273)</td>
<td>615(-794)</td>
<td>317(-456)</td>
</tr>
<tr>
<td>SCS</td>
<td>109(0)</td>
<td>89</td>
<td>35(0) 31</td>
<td>17(0) 13</td>
<td>51(0) 37</td>
</tr>
<tr>
<td>ALS</td>
<td>62(0)</td>
<td>69</td>
<td>39(0) 24</td>
<td>39(+10)</td>
<td>23(0) 29</td>
</tr>
<tr>
<td>OGS</td>
<td>367(+293)</td>
<td>162(+100)</td>
<td>44(0) 42</td>
<td>123(0) 122</td>
<td>82(0) 70</td>
</tr>
<tr>
<td>Total</td>
<td>4962</td>
<td>1701</td>
<td>712</td>
<td>2072</td>
<td>1190</td>
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<td>$\chi^2$</td>
<td>663.8</td>
<td>252.9</td>
<td>118.0</td>
<td>161.4</td>
<td>368.8</td>
</tr>
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<td>df</td>
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<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

<sup>a</sup>Adult females present during both 1973-74 and 1980-81.

<sup>b</sup>$S$ = selection value (+ = included more than expected, - = included less than expected, 0 = included in proportion to availability, $P = 0.05$, Neu et al. (1974)).
Table 11. Chi-square (goodness-of-fit) analyses comparing the hectares of each vegetation type included in home ranges of classes of bears to the expected hectares based on the availability of each type on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Type</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>1085(-)1592</td>
<td>332(-) 660</td>
<td>77(-) 122</td>
<td>706(-) 836</td>
<td>47(-) 97</td>
</tr>
<tr>
<td>60C</td>
<td>3026(+2244</td>
<td>1384(+929</td>
<td>235(+172</td>
<td>1511(+1178</td>
<td>131(0) 137</td>
</tr>
<tr>
<td>50C</td>
<td>1709(0)1613</td>
<td>751(+666</td>
<td>70(-) 124</td>
<td>842(0) 847</td>
<td>116(0) 98</td>
</tr>
<tr>
<td>LCS</td>
<td>3439(-3926</td>
<td>1320(-1640</td>
<td>283(0) 304</td>
<td>1828(-2079</td>
<td>291(+241</td>
</tr>
<tr>
<td>SCS</td>
<td>212(0) 186</td>
<td>83(0) 77</td>
<td>13(0) 14</td>
<td>122(0) 98</td>
<td>8(0) 11</td>
</tr>
<tr>
<td>ALS</td>
<td>154(0) 144</td>
<td>68(0) 60</td>
<td>41(+) 11</td>
<td>49(-) 76</td>
<td>37(+) 9</td>
</tr>
<tr>
<td>OGS</td>
<td>715(+610</td>
<td>345(+253</td>
<td>75(+) 47</td>
<td>370(0) 320</td>
<td>0(-) 37</td>
</tr>
<tr>
<td>Total</td>
<td>10,340</td>
<td>4283</td>
<td>794</td>
<td>5428</td>
<td>630</td>
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</table>

<table>
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<th></th>
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<th>df</th>
<th>( P )</th>
<th>df</th>
<th>( P )</th>
<th>df</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
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<td>&lt; 0.001</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>60C</td>
<td>493.1</td>
<td>6</td>
<td>&lt; 0.001</td>
<td>6</td>
<td>&lt; 0.001</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>50C</td>
<td>161.8</td>
<td>6</td>
<td>&lt; 0.001</td>
<td>6</td>
<td>&lt; 0.001</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>LCS</td>
<td>168.1</td>
<td>6</td>
<td>&lt; 0.001</td>
<td>6</td>
<td>&lt; 0.001</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>SCS</td>
<td>167.7</td>
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<td>&lt; 0.001</td>
<td>6</td>
<td>&lt; 0.001</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

<sup>a</sup>Adult females present during both 1973-74 and 1980-81.

<sup>b</sup>S = selection value (+ = included more than expected, - = included less than expected, 0 = included in proportion to availability, \( P = 0.05 \), Neu et al. (1974))
Table 12. Chi-square (goodness-of-fit) analyses comparing home range relocations of classes of bears in each vegetation type to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Type</th>
<th>All bears Obs. S&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Ad F Obs. S Exp.</th>
<th>2,3,5,9&lt;sup&gt;a&lt;/sup&gt; Obs. S Exp.</th>
<th>Ad M Obs. S Exp.</th>
<th>Subadults Obs. S Exp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>65(-)147</td>
<td>17(-) 43</td>
<td>17(-) 45</td>
<td>37(-) 55</td>
<td>11(-) 25</td>
</tr>
<tr>
<td>6OC</td>
<td>504(0)527</td>
<td>108(-)162</td>
<td>72(-)114</td>
<td>153(0)130</td>
<td>243(0)254</td>
</tr>
<tr>
<td>5OC</td>
<td>654(+)425</td>
<td>233(+)117</td>
<td>197(+)77</td>
<td>86(-)111</td>
<td>335(+)216</td>
</tr>
<tr>
<td>LCS</td>
<td>378(-)506</td>
<td>105(-)149</td>
<td>74(-)131</td>
<td>138(0)145</td>
<td>135(-)205</td>
</tr>
<tr>
<td>SCS</td>
<td>146(+) 40</td>
<td>49(+) 11</td>
<td>45(+) 10</td>
<td>65(+) 12</td>
<td>32(+) 15</td>
</tr>
<tr>
<td>ALS</td>
<td>10(-) 22</td>
<td>2(-) 13</td>
<td>2(-) 23</td>
<td>8(0) 5</td>
<td>0 0</td>
</tr>
<tr>
<td>OGS</td>
<td>43(-)133</td>
<td>32(-) 52</td>
<td>21(0) 27</td>
<td>1(-) 29</td>
<td>10(-) 53</td>
</tr>
<tr>
<td>Total</td>
<td>1800</td>
<td>546</td>
<td>428</td>
<td>488</td>
<td>766</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>$\chi^2$</th>
<th>Obs. S</th>
<th>df</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All bears</td>
<td>556.4</td>
<td>299.1</td>
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<td>$&lt;0.001$</td>
</tr>
<tr>
<td>Ad F</td>
<td>382.8</td>
<td>273.3</td>
<td>6</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>2,3,5,9</td>
<td>152.8</td>
<td></td>
<td>5</td>
<td>$&lt;0.001$</td>
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</tbody>
</table>

<sup>a</sup>Adult females present during both 1973-74 and 1980-81.

<sup>b</sup>S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $P = 0.05$, Neu et al. (1974)).
Table 13. Chi-square (goodness-of-fit) analyses comparing home range relocations of class: of bears in each vegetation type to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Type</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>137(-) 488</td>
<td>81(-) 269</td>
<td>13(-) 80</td>
<td>47(-) 94</td>
<td>9(-) 33</td>
</tr>
<tr>
<td>6OC</td>
<td>2697(+1362)</td>
<td>2106(+1127)</td>
<td>533(+245)</td>
<td>411(+200)</td>
<td>180(+91)</td>
</tr>
<tr>
<td>5OC</td>
<td>706(0) 767</td>
<td>520(-) 611</td>
<td>61(0) 72</td>
<td>97(0) 112</td>
<td>89(0) 80</td>
</tr>
<tr>
<td>LCS</td>
<td>782(-1548)</td>
<td>511(-1075)</td>
<td>168(-294)</td>
<td>116(-243)</td>
<td>155(-202)</td>
</tr>
<tr>
<td>SCS</td>
<td>115(0) 98</td>
<td>92(0) 66</td>
<td>21(0) 13</td>
<td>22(0) 16</td>
<td>1(-) 5</td>
</tr>
<tr>
<td>ALS</td>
<td>15(-) 70</td>
<td>11(-) 56</td>
<td>6(-) 42</td>
<td>1(-) 6</td>
<td>3(-) 26</td>
</tr>
<tr>
<td>OGS</td>
<td>196(-) 321</td>
<td>169(-) 279</td>
<td>25(-) 79</td>
<td>27(-) 49</td>
<td>0 0</td>
</tr>
<tr>
<td>Total</td>
<td>4648</td>
<td>3490</td>
<td>827</td>
<td>721</td>
<td>437</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\chi^2$</th>
<th>df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2039.7</td>
<td>6</td>
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</tr>
<tr>
<td></td>
<td>1379.7</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
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<td>523.9</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>329.7</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>140.2</td>
<td>5</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

<sup>a</sup> Adult females present during both 1973-74 and 1980-81.

<sup>b</sup> $S$ = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $P = 0.05$, Neu et al. (1974)).
Table 14. Chi-square (goodness-of-fit) analyses comparing home range relocations of all bears in each vegetation type during each of 4 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>45(0) 50</td>
<td>8(-) 31</td>
<td>7(-) 34</td>
<td>5(-) 29</td>
</tr>
<tr>
<td>60C</td>
<td>161(0) 183</td>
<td>182(+) 113</td>
<td>88(-) 124</td>
<td>78(-) 108</td>
</tr>
<tr>
<td>50C</td>
<td>214(+) 147</td>
<td>120(0) 91</td>
<td>198(+) 100</td>
<td>122(+) 87</td>
</tr>
<tr>
<td>LCS</td>
<td>136(-) 175</td>
<td>29(-) 108</td>
<td>72(-) 119</td>
<td>141(+) 103</td>
</tr>
<tr>
<td>SCS</td>
<td>60(+) 13</td>
<td>42(+) 8</td>
<td>32(+) 9</td>
<td>12(0) 8</td>
</tr>
<tr>
<td>ALS</td>
<td>5(0) 7</td>
<td>0(-) 5</td>
<td>3(0) 5</td>
<td>2(0) 4</td>
</tr>
<tr>
<td>OGS</td>
<td>2(-) 46</td>
<td>4(-) 28</td>
<td>24(0) 31</td>
<td>13(-) 27</td>
</tr>
<tr>
<td>Total</td>
<td>623</td>
<td>385</td>
<td>424</td>
<td>368</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>(\chi^2)</th>
<th>df</th>
<th>(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>den-May</td>
<td>241.7</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>June-July</td>
<td>285.4</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Aug-Sept</td>
<td>204.5</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Oct-den</td>
<td>70.4</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

<sup>a</sup>S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \(P = 0.05\), Neu et al. (1974)).
Table 15. Chi-square (goodness-of-fit) analyses comparing home range relocations of adult female bears in each vegetation type during each of 4 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>10(0) 9</td>
<td>2(-)11</td>
<td>4(-)14</td>
<td>1(-) 9</td>
</tr>
<tr>
<td>60C</td>
<td>15(-)34</td>
<td>42(0)43</td>
<td>32(-)52</td>
<td>19(-)33</td>
</tr>
<tr>
<td>50C</td>
<td>43(+25)</td>
<td>71(+31)</td>
<td>83(+37)</td>
<td>36(0)24</td>
</tr>
<tr>
<td>LCS</td>
<td>29(0)31</td>
<td>9(-)39</td>
<td>24(-)47</td>
<td>43(0)31</td>
</tr>
<tr>
<td>SCS</td>
<td>16(+2)</td>
<td>18(+3)</td>
<td>11(0)4</td>
<td>4(0)2</td>
</tr>
<tr>
<td>ALS</td>
<td>0(0)3</td>
<td>0(0)3</td>
<td>1(0)4</td>
<td>1(0)3</td>
</tr>
<tr>
<td>OGS</td>
<td>1(-)11</td>
<td>3(-)14</td>
<td>19(0)17</td>
<td>9(0)11</td>
</tr>
<tr>
<td>Total</td>
<td>114</td>
<td>145</td>
<td>174</td>
<td>113</td>
</tr>
<tr>
<td>$x^2$</td>
<td>113.5</td>
<td>167.3</td>
<td>98.6</td>
<td>26.1</td>
</tr>
<tr>
<td>df</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>p</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

$^a$S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $P = 0.05$, Neu et al. (1974)).
Table 16. Chi-square (goodness-of-fit) analyses comparing home range relocations of adult male bears in each vegetation type during each of 4 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>26(0)17</td>
<td>6(-)14</td>
<td>3(-)13</td>
<td>2(-)11</td>
</tr>
<tr>
<td>60C</td>
<td>41(0)41</td>
<td>69(+)34</td>
<td>32(0)30</td>
<td>11(-)25</td>
</tr>
<tr>
<td>50C</td>
<td>9(-)35</td>
<td>27(0)29</td>
<td>26(0)26</td>
<td>24(0)22</td>
</tr>
<tr>
<td>LCS</td>
<td>42(0)46</td>
<td>12(-)37</td>
<td>32(0)34</td>
<td>52(+)28</td>
</tr>
<tr>
<td>SCS</td>
<td>31(+)4</td>
<td>11(0)3</td>
<td>18(+)3</td>
<td>5(0)2</td>
</tr>
<tr>
<td>ALS</td>
<td>5(0)2</td>
<td>0(0)1</td>
<td>2(0)1</td>
<td>1(0)1</td>
</tr>
<tr>
<td>OGS</td>
<td>0(-)10</td>
<td>1(-)8</td>
<td>0(-)7</td>
<td>0(-)6</td>
</tr>
<tr>
<td>Total</td>
<td>154</td>
<td>126</td>
<td>113</td>
<td>95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>x²</th>
<th>df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>den-May</td>
<td>230.8</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>June-July</td>
<td>85.4</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Aug-Sept</td>
<td>96.3</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Oct-den</td>
<td>44.2</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

ᵃS = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; P = 0.05, Neu et al. (1974)).
Table 17. Chi-square (goodness-of-fit) analyses comparing home range relocations of subadult bears in each vegetation type during each of 4 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>9(0)</td>
<td>11</td>
<td>0(0) 4</td>
<td>0(0) 4</td>
</tr>
<tr>
<td>60C</td>
<td>105(0)</td>
<td>118</td>
<td>71(+) 37</td>
<td>24(-) 45</td>
</tr>
<tr>
<td>50C</td>
<td>162(+)</td>
<td>100</td>
<td>22(0) 32</td>
<td>89(+) 39</td>
</tr>
<tr>
<td>LCS</td>
<td>65(-)</td>
<td>95</td>
<td>8(-) 30</td>
<td>16(-) 37</td>
</tr>
<tr>
<td>SCS</td>
<td>13(0)</td>
<td>7</td>
<td>13(+) 2</td>
<td>3(0) 3</td>
</tr>
<tr>
<td>ALS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>OGS</td>
<td>1(-)</td>
<td>25</td>
<td>0(-) 8</td>
<td>5(0) 9</td>
</tr>
<tr>
<td>Total</td>
<td>355</td>
<td>11</td>
<td>137</td>
<td>160</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$x^2$</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>den-May</td>
<td>77.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June-July</td>
<td>114.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sept</td>
<td>93.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct-den</td>
<td>14.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>df</th>
<th>5</th>
<th>5</th>
<th>5</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

$a$ = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $P = 0.05$, Neu et al. (1974)).
Table 18. Chi-square (goodness-of-fit) analyses comparing home range relocations of bears 2,3,5,9\(^a\) in each vegetation type during each of 4 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>10(0)11</td>
<td>2(-)14</td>
<td>4(-)14</td>
<td>1(-)6</td>
</tr>
<tr>
<td>60C</td>
<td>10(-)28</td>
<td>35(0)35</td>
<td>27(0)36</td>
<td>0(-)15</td>
</tr>
<tr>
<td>50C</td>
<td>43(+)19</td>
<td>69(+)24</td>
<td>60(+)24</td>
<td>25(+)10</td>
</tr>
<tr>
<td>LCS</td>
<td>24(0)32</td>
<td>8(-)40</td>
<td>21(-)41</td>
<td>21(0)17</td>
</tr>
<tr>
<td>SCS</td>
<td>16(+)2</td>
<td>15(+)3</td>
<td>10(0)3</td>
<td>4(0)1</td>
</tr>
<tr>
<td>ALS</td>
<td>0(-)6</td>
<td>0(-)7</td>
<td>1(-)7</td>
<td>1(0)3</td>
</tr>
<tr>
<td>OGS</td>
<td>1(-)6</td>
<td>3(-)8</td>
<td>12(0)8</td>
<td>5(0)4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>104</th>
<th>132</th>
<th>135</th>
<th>57</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\chi^2)</td>
<td>128.2</td>
<td>177.0</td>
<td>93.2</td>
<td>48.4</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>(P)</td>
<td>(&lt;0.001)</td>
<td>(&lt;0.001)</td>
<td>(&lt;0.001)</td>
<td>(&lt;0.001)</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Adult females present during both 1973-74 and 1980-81.

\(^S\) = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \(P = 0.05\), Neu et al. (1974)).
Table 19. Chi-square (goodness-of-fit) analyses comparing home range relocations of all bears in each vegetation type during each of 4 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>73(0) 90</td>
<td>26(-) 186</td>
<td>20(-) 134</td>
<td>18(-) 78</td>
</tr>
<tr>
<td>60C</td>
<td>382(+) 250</td>
<td>1184(+) 520</td>
<td>785(+) 374</td>
<td>346(+) 218</td>
</tr>
<tr>
<td>50C</td>
<td>112(-) 141</td>
<td>276(0) 293</td>
<td>199(0) 210</td>
<td>119(0) 123</td>
</tr>
<tr>
<td>LCS</td>
<td>237(-) 284</td>
<td>186(-) 591</td>
<td>162(-) 425</td>
<td>197(-) 248</td>
</tr>
<tr>
<td>SCS</td>
<td>20(0) 18</td>
<td>39(0) 37</td>
<td>30(0) 27</td>
<td>26(0) 16</td>
</tr>
<tr>
<td>ALS</td>
<td>7(0) 13</td>
<td>3(-) 27</td>
<td>2(-) 19</td>
<td>3(-) 11</td>
</tr>
<tr>
<td>OGS</td>
<td>22(-) 59</td>
<td>60(-) 122</td>
<td>78(0) 88</td>
<td>36(0) 51</td>
</tr>
<tr>
<td>Total</td>
<td>853</td>
<td>1774</td>
<td>1276</td>
<td>745</td>
</tr>
</tbody>
</table>

| x²   | 112.5 | 1317.8 | 729.3 | 149.2 |
| df   | 6     | 6      | 6     | 6     |
| P    | < 0.001 | < 0.001 | < 0.001 | < 0.001 |

⁹S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; P = 0.05, Neu et al. (1974)).
Table 20. Chi-square (goodness-of-fit) analyses comparing home range relocations of adult female bears in each vegetation type during each of 4 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>29(0) 39</td>
<td>17(-) 99</td>
<td>19(-) 85</td>
<td>16(-) 47</td>
</tr>
<tr>
<td>60C</td>
<td>213(+163</td>
<td>873(+416</td>
<td>721(+355</td>
<td>299(+196</td>
</tr>
<tr>
<td>50C</td>
<td>80(0) 88</td>
<td>210(0)224</td>
<td>143(-)192</td>
<td>96(0)106</td>
</tr>
<tr>
<td>LCS</td>
<td>147(0)155</td>
<td>123(-)394</td>
<td>106(-)338</td>
<td>135(-)187</td>
</tr>
<tr>
<td>SCS</td>
<td>12(0) 10</td>
<td>26(0)24</td>
<td>30(0)21</td>
<td>24(0)12</td>
</tr>
<tr>
<td>ALS</td>
<td>6(0) 8</td>
<td>2(-)20</td>
<td>1(-)18</td>
<td>2(-)10</td>
</tr>
<tr>
<td>OGS</td>
<td>17(-)40</td>
<td>38(-)102</td>
<td>78(0)88</td>
<td>36(0)49</td>
</tr>
<tr>
<td>Total</td>
<td>504</td>
<td>1280</td>
<td>1098</td>
<td>608</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>33.8</td>
<td>815.8</td>
<td>622.0</td>
<td>112.3</td>
</tr>
<tr>
<td>df</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>p</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

\textsuperscript{a}S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $p = 0.05$, Neu et al. (1974)).
Table 21. Chi-square (goodness-of-fit) analyses comparing home range relocations of adult male bears in each vegetation type during each of 2 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>39(0) 37</td>
<td>8(-) 52</td>
</tr>
<tr>
<td>60C</td>
<td>141(+) 79</td>
<td>256(+)111</td>
</tr>
<tr>
<td>50C</td>
<td>31(0) 44</td>
<td>63(0) 62</td>
</tr>
<tr>
<td>LCS</td>
<td>59(-) 96</td>
<td>39(-)135</td>
</tr>
<tr>
<td>SCS</td>
<td>8(0) 6</td>
<td>12(0) 9</td>
</tr>
<tr>
<td>ALS</td>
<td>1(0) 3</td>
<td>0(0) 4</td>
</tr>
<tr>
<td>OGS</td>
<td>5(-) 19</td>
<td>22(0) 27</td>
</tr>
<tr>
<td>Total</td>
<td>284</td>
<td>400</td>
</tr>
</tbody>
</table>

\[ x^2 \]
<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>78.9</td>
</tr>
<tr>
<td>299.6</td>
</tr>
<tr>
<td>df</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>( P )</td>
</tr>
<tr>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

^aS = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \( P = 0.05 \), Neu et al. (1974)).
Table 22. Chi-square (goodness-of-fit) analyses comparing home range relocations of subadult bears in each vegetation type during each of 4 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>5(0) 5</td>
<td>1(-) 7</td>
<td>1(-)13</td>
<td>2(-) 8</td>
</tr>
<tr>
<td>60C</td>
<td>28(+14</td>
<td>55(+20</td>
<td>63(+37</td>
<td>34(+21</td>
</tr>
<tr>
<td>50C</td>
<td>1(-)12</td>
<td>12(0)17</td>
<td>56(+33</td>
<td>20(0)19</td>
</tr>
<tr>
<td>LCS</td>
<td>31(0)30</td>
<td>24(-)44</td>
<td>56(-)82</td>
<td>44(0)47</td>
</tr>
<tr>
<td>SCS</td>
<td>0(0) 1</td>
<td>1(0) 1</td>
<td>0(0) 2</td>
<td>0(0) 1</td>
</tr>
<tr>
<td>ALS</td>
<td>0(0) 4</td>
<td>1(-) 6</td>
<td>1(-)10</td>
<td>1(-) 6</td>
</tr>
<tr>
<td>OGS</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>94</td>
<td>177</td>
<td>101</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>30.2</td>
<td>83.6</td>
<td>65.7</td>
<td>17.7</td>
</tr>
<tr>
<td>df</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>$P$</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

$^a$S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $P = 0.05$, Neu et al. (1974)).
Table 23. Chi-square (goodness-of-fit) analyses comparing home range relocations of bears 2,3,5,9<sup>a</sup> in each vegetation type during each of 4 seasonal periods to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Type</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>3(-) 16</td>
<td>6(-) 30</td>
<td>2(-) 21</td>
<td>2(-) 15</td>
</tr>
<tr>
<td>60C</td>
<td>84(+) 49</td>
<td>203(+) 85</td>
<td>163(+) 65</td>
<td>83(+) 46</td>
</tr>
<tr>
<td>50C</td>
<td>15(0) 15</td>
<td>24(0) 25</td>
<td>19(0) 19</td>
<td>3(-) 14</td>
</tr>
<tr>
<td>LCS</td>
<td>58(0) 59</td>
<td>41(-) 103</td>
<td>16(-) 78</td>
<td>53(0) 55</td>
</tr>
<tr>
<td>SCS</td>
<td>1(0) 3</td>
<td>9(0) 5</td>
<td>8(0) 3</td>
<td>3(0) 2</td>
</tr>
<tr>
<td>ALS</td>
<td>3(0) 9</td>
<td>2(-) 15</td>
<td>1(-) 11</td>
<td>0(-) 8</td>
</tr>
<tr>
<td>OGS</td>
<td>3(-) 16</td>
<td>3(-) 27</td>
<td>9(-) 21</td>
<td>10(0) 15</td>
</tr>
<tr>
<td>Total</td>
<td>167</td>
<td>288</td>
<td>218</td>
<td>154</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>50.0</td>
<td>253.7</td>
<td>238.2</td>
<td>59.6</td>
</tr>
<tr>
<td>df</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>$P$</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

<sup>a</sup>Adult females present during both 1973-74 and 1980-81.

<sup>b</sup>S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $P = 0.05$, Neu et al. (1974)).
Table 24. Chi-square (goodness-of-fit) analyses comparing home range relocations of adult female bears (nos. 2, 3, 5, 9, 13), both with and without cubs, in each vegetation type during the June-July period to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1973 and 1974.

<table>
<thead>
<tr>
<th>Type</th>
<th>without cubs (1973)</th>
<th>with cubs (1974)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Obs. S&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Exp.</td>
</tr>
<tr>
<td>TLM</td>
<td>1(−) 9</td>
<td></td>
</tr>
<tr>
<td>60C</td>
<td>25(0) 26</td>
<td></td>
</tr>
<tr>
<td>50C</td>
<td>35(+) 15</td>
<td></td>
</tr>
<tr>
<td>LCS</td>
<td>5(−) 25</td>
<td></td>
</tr>
<tr>
<td>SCS</td>
<td>13(+) 2</td>
<td></td>
</tr>
<tr>
<td>ALS</td>
<td>0(0)  3</td>
<td></td>
</tr>
<tr>
<td>OGS</td>
<td>3(0)  3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>x^2</td>
<td>116.1</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.001</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>S = selection value (+ = used more than expected, − = used less than expected, 0 = used in proportion to availability; t = 0.05, Neu et al. (1974)).
Table 25. Chi-square (goodness-of-fit) analyses comparing home range relocations of adult female bears with cubs and those without cubs in each vegetation type during the den-May period to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1981.

<table>
<thead>
<tr>
<th>Type</th>
<th>Ad F 9,23,45 (with cubs)</th>
<th>Ad F (without cubs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>7(-) 19</td>
<td></td>
</tr>
<tr>
<td>60C</td>
<td>29(0) 35</td>
<td></td>
</tr>
<tr>
<td>50C</td>
<td>26(0) 15</td>
<td></td>
</tr>
<tr>
<td>LCS</td>
<td>110(+)= 83</td>
<td></td>
</tr>
<tr>
<td>SCS</td>
<td>5(0) 2</td>
<td></td>
</tr>
<tr>
<td>ALS</td>
<td>3(-) 9</td>
<td></td>
</tr>
<tr>
<td>OGS</td>
<td>1(-) 18</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>181</td>
<td></td>
</tr>
</tbody>
</table>

\[ x^2 \] 48.3 \hspace{1cm} 85.4
\[ df \] 6 \hspace{1cm} 6
\[ P \] \textless 0.001 \hspace{1cm} \textless 0.001

^aS = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \textit{P} = 0.05, Neu et al. (1974)).
Table 26. Chi-square (goodness-of-fit) analyses comparing home range relocations of adult female bears (9, 23), both when accompanied by cubs (1981) and without cubs (1980), in each vegetation type during each season monitored to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington.

<table>
<thead>
<tr>
<th>Type</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>60C</td>
<td>2(0) 3</td>
<td>6(-)16</td>
<td>6(-)11</td>
</tr>
<tr>
<td>LCS, ALS</td>
<td>6(-)11</td>
<td>33(-)62</td>
<td>16(-)42</td>
</tr>
<tr>
<td>SCS</td>
<td>1(0) 1</td>
<td>4(0) 2</td>
<td>4(0) 1</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>98</td>
<td>66</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 13.5 \quad 93.9 \quad 85.4 \quad 28.1 \quad 43.0 \quad 9.9
\]

\[
df = 3 \quad 3 \quad 3 \quad 3 \quad 3 \quad 3
\]

\[
p < 0.01 \quad < 0.001 \quad < 0.001 \quad < 0.001 \quad < 0.001 \quad < 0.02
\]

*Selection values (+) = used more than expected, (-) = used less than expected, 0 = used in proportion to availability; P = 0.05, Neu et al. (1974)).

b1 relocation in alder stands in the June-July period 1981, 1 in the Aug-Sept period 1980 and 2 in the Oct-den period 1980 were pooled with large conifer stands for this comparison.
Table 27. Chi-square (goodness-of-fit) analyses comparing home range relocations of adult female bears (nos. 5, 14, 39, 45, 47) in various activity categories in each vegetation type to the expected number of relocations based on the availability of each type in their home ranges on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Type</th>
<th>Active diurnal</th>
<th>Inactive total</th>
<th>Inactive diurnal</th>
<th>Inactive nocturnal</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLM</td>
<td>32(-) 67</td>
<td>4(-) 17</td>
<td>3(-) 13</td>
<td>1(-) 4</td>
</tr>
<tr>
<td>60C</td>
<td>989(+467</td>
<td>203(+120</td>
<td>160(+90)</td>
<td>43(0) 30</td>
</tr>
<tr>
<td>50C</td>
<td>363(-503</td>
<td>122(0)130</td>
<td>91(0) 98</td>
<td>31(0) 33</td>
</tr>
<tr>
<td>LCS</td>
<td>103(-329</td>
<td>48(-) 85</td>
<td>32(-) 64</td>
<td>16(0) 21</td>
</tr>
<tr>
<td>SCS</td>
<td>30(0) 25</td>
<td>11(0) 6</td>
<td>5(0) 5</td>
<td>6(0) 2</td>
</tr>
<tr>
<td>ALS</td>
<td>0(0) 5</td>
<td>2(0) 1</td>
<td>2(0) 1</td>
<td>0(0) 1</td>
</tr>
<tr>
<td>OGS</td>
<td>127(-)252</td>
<td>36(-) 65</td>
<td>26(-) 49</td>
<td>10(0) 16</td>
</tr>
<tr>
<td>Total</td>
<td>1644</td>
<td>426</td>
<td>319</td>
<td>107</td>
</tr>
</tbody>
</table>

\[ \chi^2 \]

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>\chi^2</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>df</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>P</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

\[ ^a \text{S} = \text{selection value} (+ = \text{used more than expected}, - = \text{used less than expected}, 0 = \text{used in proportion to availability}; P = 0.05, Neu et al. (1974)) \]
Appendix B

Spatial Use-Availability Comparisons
Table 28. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears on tidelands and meadows at 35 m intervals from the edge to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ad F/cubs</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-35</td>
<td>48(+28)</td>
<td>14(+7)</td>
<td>14(+7)</td>
<td>10(+5)</td>
<td>25(+16)</td>
<td>9(+5)</td>
</tr>
<tr>
<td>36-70</td>
<td>14(017)</td>
<td>2(04)</td>
<td>2(04)</td>
<td>1(-3)</td>
<td>10(09)</td>
<td>2(03)</td>
</tr>
<tr>
<td>&gt;·70</td>
<td>3(-21)</td>
<td>1(-5)</td>
<td>1(-5)</td>
<td>0(-3)</td>
<td>2(-12)</td>
<td>0(-3)</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>17</td>
<td>17</td>
<td>11</td>
<td>37</td>
<td>11</td>
</tr>
</tbody>
</table>

χ²: 30.3  11.1  11.1  10.6  13.5  7.7

df: 2  2  2  2  2  2

P: < 0.001  < 0.01  < 0.01  < 0.01  < 0.01  < 0.05

<sup>a</sup>Adult females present during both 1973-74 and 1980-81.

<sup>b</sup>S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; P = 0.05, Neu et al. (1974)).
Table 29. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears on tidal lands and meadows at 35 m intervals from the edge to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ad F/cubs</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-35</td>
<td>100(+) 58</td>
<td>54(+) 35</td>
<td>7(0) 6</td>
<td>11(0) 8</td>
<td>38(+) 20</td>
<td>8(+) 4</td>
</tr>
<tr>
<td>36-70</td>
<td>30(0) 35</td>
<td>22(0) 21</td>
<td>6(0) 3</td>
<td>7(0) 5</td>
<td>7(0) 12</td>
<td>1(0) 2</td>
</tr>
<tr>
<td>&gt; 70</td>
<td>7(-) 44</td>
<td>5(-) 26</td>
<td>0(-) 4</td>
<td>0(-) 6</td>
<td>2(-) 15</td>
<td>0(-) 3</td>
</tr>
<tr>
<td>Total</td>
<td>137</td>
<td>81</td>
<td>13</td>
<td>18</td>
<td>47</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\chi^2$</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.8</td>
<td>2</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>27.7</td>
<td>2</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>6.7</td>
<td>2</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>8.4</td>
<td>2</td>
<td>&lt; 0.02</td>
</tr>
<tr>
<td>29.3</td>
<td>2</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>8.1</td>
<td>2</td>
<td>&lt; 0.02</td>
</tr>
</tbody>
</table>

<sup>a</sup>Adult females present during both 1973-74 and 1980-81.

<sup>b</sup>S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $p = 0.05$, Neu et al. (1974)).
Table 30. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears in 1960 clearcuts at 70 m intervals from bordering timber stands to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Dist. (m)</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>164(0)148</td>
<td>50(+34</td>
<td>26(0)17</td>
<td>52(0)52</td>
<td>62(0)62</td>
</tr>
<tr>
<td>71-140</td>
<td>102(0)110</td>
<td>26(0)25</td>
<td>14(0)13</td>
<td>48(0)39</td>
<td>28(-46</td>
</tr>
<tr>
<td>141-210</td>
<td>57(0)60</td>
<td>13(0)14</td>
<td>7(0)7</td>
<td>19(0)21</td>
<td>25(0)25</td>
</tr>
<tr>
<td>211-280</td>
<td>46(0)40</td>
<td>3(-9</td>
<td>1(-5</td>
<td>13(0)14</td>
<td>30(0)18</td>
</tr>
<tr>
<td>281-350</td>
<td>22(0)26</td>
<td>0(-6</td>
<td>0(0)3</td>
<td>7(0)9</td>
<td>15(0)11</td>
</tr>
<tr>
<td>351-420</td>
<td>8(0)14</td>
<td>0(0)3</td>
<td>0(0)2c</td>
<td>3(0)5</td>
<td>5(0)6</td>
</tr>
<tr>
<td>&gt; 420</td>
<td>2(0)2</td>
<td>0(0)1</td>
<td>0(0)1</td>
<td>2(0)1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>401</td>
<td>92</td>
<td>48</td>
<td>142</td>
<td>167</td>
</tr>
</tbody>
</table>

| x² | 7.0 | 21.7 | 12.1 | 4.7 | 20.7 |
| df | 6   | 6    | 5    | 6   | 6    |
| P  | > 0.3 | < 0.01 | < 0.05 | > 0.5 | < 0.01 |

<sup>a</sup>Adult females present during both 1973-74 and 1980-81.

<sup>b</sup>S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; P = 0.05, Neu et al. (1974)).

<sup>c</sup>These bands pooled.
Table 31. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears in 1960 clearcuts at 70 m intervals from bordering timber stands to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9a</th>
<th>Ad F/cubs</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>752(-1862)</td>
<td>570(-1677)</td>
<td>192(0)196</td>
<td>70(+)44</td>
<td>114(0)131</td>
<td>68(0)54</td>
</tr>
<tr>
<td>71-140</td>
<td>739(+640)</td>
<td>583(+503)</td>
<td>174(+)145</td>
<td>44(0)32</td>
<td>111(0)98</td>
<td>45(0)40</td>
</tr>
<tr>
<td>141-210</td>
<td>355(0)351</td>
<td>283(0)275</td>
<td>78(0)80</td>
<td>4(-)18</td>
<td>59(0)53</td>
<td>13(0)22</td>
</tr>
<tr>
<td>211-280</td>
<td>256(0)234</td>
<td>212(0)183</td>
<td>55(0)53</td>
<td>0(-)12</td>
<td>35(0)36</td>
<td>9(0)15</td>
</tr>
<tr>
<td>281-350</td>
<td>148(0)154</td>
<td>123(0)121</td>
<td>26(0)35</td>
<td>0(-)8</td>
<td>19(0)23</td>
<td>6(0)10</td>
</tr>
<tr>
<td>351-420</td>
<td>64(0)84</td>
<td>48(0)66</td>
<td>5(0)19</td>
<td>0(-)5c</td>
<td>18(0)15c</td>
<td>5(0)5</td>
</tr>
<tr>
<td>&gt; 420</td>
<td>23(0)17</td>
<td>15(0)9</td>
<td>0(0)3</td>
<td>0(-)5c</td>
<td>18(0)15c</td>
<td>5(0)5</td>
</tr>
<tr>
<td>Total</td>
<td>2337</td>
<td>1834</td>
<td>530</td>
<td>118</td>
<td>356</td>
<td>147</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>x²</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>47.5</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>43.1</td>
<td>6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>21.2</td>
<td>6</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>55.3</td>
<td>5</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>6.4</td>
<td>5</td>
<td>&gt; 0.2</td>
</tr>
<tr>
<td></td>
<td>11.5</td>
<td>6</td>
<td>&gt; 0.05</td>
</tr>
</tbody>
</table>

aAdult females present during both 1973-74 and 1980-81.

bSelection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; p = 0.05, Neu et al. (1974)).

cThese bands pooled.
Table 32. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears in 1960 clearcuts at 70 m intervals from bordering 1950 clearcuts to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington 1973-74.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>All bears</th>
<th>Adults</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>obs. S(^a)</td>
<td>exp.</td>
<td>obs. S</td>
</tr>
<tr>
<td>0-70</td>
<td>29 (0)</td>
<td>31</td>
<td>8 (0)</td>
</tr>
<tr>
<td>71-141</td>
<td>16 (0)</td>
<td>26</td>
<td>8 (0)</td>
</tr>
<tr>
<td>141-210</td>
<td>24 (0)</td>
<td>19</td>
<td>9 (0)</td>
</tr>
<tr>
<td>211-280</td>
<td>17 (0)</td>
<td>14</td>
<td>1 (0)</td>
</tr>
<tr>
<td>281-350</td>
<td>13 (0)</td>
<td>9</td>
<td>1 (0)</td>
</tr>
<tr>
<td>351-420</td>
<td>4 (0)</td>
<td>3</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total</td>
<td>103</td>
<td>27</td>
<td>76</td>
</tr>
</tbody>
</table>

\( \chi^2 \) = 8.0, 6.9, 15.4

\( df \) = 5, 5, 5

\( P \) = > 0.1, > 0.2, < 0.01

\( ^a S = \) Selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \( P = 0.05 \), Neu et al. (1974)).
Table 33. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears in 1960 clearcuts at 70 m intervals from bordering 1950 clearcuts to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>All bears</th>
<th>Ad F</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>119(0)109</td>
<td>84(0)83</td>
<td>23(0)17</td>
<td>12(0)10</td>
</tr>
<tr>
<td>71-140</td>
<td>91(0)92</td>
<td>63(0)69</td>
<td>15(0)14</td>
<td>13(0)8</td>
</tr>
<tr>
<td>141-210</td>
<td>85(0)67</td>
<td>72(+51</td>
<td>8(0)10</td>
<td>5(0)6</td>
</tr>
<tr>
<td>211-280</td>
<td>41(0)48</td>
<td>33(0)36</td>
<td>6(0)7</td>
<td>2(0)4</td>
</tr>
<tr>
<td>281-350</td>
<td>22(0)32</td>
<td>18(0)24</td>
<td>3(0)5</td>
<td>1(0)3</td>
</tr>
<tr>
<td>351-420</td>
<td>2(-)12</td>
<td>2(-)9</td>
<td>0(0)2</td>
<td>0(0)1</td>
</tr>
<tr>
<td>Total</td>
<td>360</td>
<td>272</td>
<td>55</td>
<td>33</td>
</tr>
</tbody>
</table>

\[ \chi^2 \]
\[ df \]
\[ p \]

| \( \chi^2 \) | 18.0 | 16.9 | 5.7 | 6.8 |
| df           | 5 | 5 | 5 | 5 |
| p            | < 0.01 | < 0.01 | > 0.3 | > 0.2 |

\( ^aS = \) selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \( p = 0.05 \), Neu et al. (1974)).
Table 34. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears in 1950 clearcuts at 70 m intervals from bordering timber stands to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington 1973-74.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9(^a)</th>
<th>Ad F/cubs</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>128(-) 190</td>
<td>57(0) 67</td>
<td>47(0) 57</td>
<td>17(0) 22</td>
<td>16(0) 23</td>
<td>55(-) 97</td>
</tr>
<tr>
<td>71-140</td>
<td>165(0) 158</td>
<td>68(0) 56</td>
<td>57(0) 48</td>
<td>22(0) 19</td>
<td>20(0) 21</td>
<td>77(0) 81</td>
</tr>
<tr>
<td>141-210</td>
<td>128(0) 126</td>
<td>45(0) 45</td>
<td>37(0) 38</td>
<td>12(0) 15</td>
<td>18(0) 17</td>
<td>65(0) 65</td>
</tr>
<tr>
<td>211-280</td>
<td>141(+) 95</td>
<td>38(0) 34</td>
<td>37(0) 29</td>
<td>17(0) 11</td>
<td>18(0) 13</td>
<td>85(+) 49</td>
</tr>
<tr>
<td>281-350</td>
<td>72(+) 53</td>
<td>21(0) 19</td>
<td>17(0) 16</td>
<td>8(0) 6</td>
<td>10(0) 7</td>
<td>41(0) 27</td>
</tr>
<tr>
<td>351-420</td>
<td>15(0) 24</td>
<td>3(0) 8</td>
<td>2(-) 7</td>
<td>1(0) 3</td>
<td>3(0) 3</td>
<td>9(0) 12</td>
</tr>
<tr>
<td>&gt; 420</td>
<td>5(0) 8</td>
<td>1(0) 3</td>
<td>0(0) 2</td>
<td>0(0) 1</td>
<td>1(0) 1</td>
<td>3(0) 4</td>
</tr>
<tr>
<td>Total</td>
<td>654</td>
<td>233</td>
<td>197</td>
<td>77</td>
<td>86</td>
<td>335</td>
</tr>
</tbody>
</table>

\( \chi^2 \) 53.4 9.4 12.2 7.9 7.1 53.5

\( df \) 6 6 6 6 6 6

\( P \) < 0.001 > 0.1 > 0.05 > 0.2 > 0.3 < 0.001

\(^a\)Adult females present during both 1973-74 and 1980-81.

\(^b\)S = selection value \(+\) = used more than expected, \(-\) = used less than expected, 0 = used in proportion to availability; \( P = 0.05 \), Neu et al. (1974))
Table 35. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears in 1950 clearcuts at 70 m intervals from bordering timber stands to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9(^a)</th>
<th>Ad F/cubs</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>134(-1)205</td>
<td>108(-1)151</td>
<td>18(0) 18</td>
<td>6(0) 8</td>
<td>15(-1) 28</td>
<td>11(-1) 26</td>
</tr>
<tr>
<td>71-140</td>
<td>170(0)171</td>
<td>125(0)126</td>
<td>16(0) 15</td>
<td>14(+1) 6</td>
<td>31(0) 23</td>
<td>14(0) 22</td>
</tr>
<tr>
<td>141-210</td>
<td>148(0)136</td>
<td>108(0)100</td>
<td>10(0) 12</td>
<td>4(0) 5</td>
<td>20(0) 19</td>
<td>20(0) 17</td>
</tr>
<tr>
<td>211-280</td>
<td>128(0)103</td>
<td>83(0) 76</td>
<td>4(0) 9</td>
<td>1(0) 4</td>
<td>18(0) 14</td>
<td>27(+1) 13</td>
</tr>
<tr>
<td>281-350</td>
<td>92(+1) 57</td>
<td>67(+1) 42</td>
<td>11(0) 5</td>
<td>9(0) 8</td>
<td>16(0) 7</td>
<td></td>
</tr>
<tr>
<td>351-420</td>
<td>28(0) 25</td>
<td>24(0) 19</td>
<td>2(0) 2</td>
<td>1(0) 3(^c)</td>
<td>4(0) 3</td>
<td>0(0) 3</td>
</tr>
<tr>
<td>&gt; 420</td>
<td>6(0) 9</td>
<td>5(0) 6</td>
<td>0(0) 1</td>
<td>0(0) 1</td>
<td>1(0) 1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>706</td>
<td>520</td>
<td>61</td>
<td>26</td>
<td>97</td>
<td>89</td>
</tr>
<tr>
<td>(\chi^2)</td>
<td>54.1</td>
<td>30.1</td>
<td>11.3</td>
<td>13.7</td>
<td>11.2</td>
<td>40.7</td>
</tr>
<tr>
<td>df</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>p</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&gt; 0.05</td>
<td>&lt; 0.01</td>
<td>&gt; 0.05</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

\(^a\)Adult females present during both 1973-74 and 1980-81.

\(^b\)S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \(p = 0.05\), Neu et al. (1974)).

\(^c\)These bands pooled.
Table 36. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears in timber stands at 70 m intervals from bordering clearcuts to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9(^a)</th>
<th>Ad F/cubs</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>187 (+)</td>
<td>80</td>
<td>57 (+)</td>
<td>26</td>
<td>33 (+)</td>
<td>18</td>
</tr>
<tr>
<td>71-140</td>
<td>98 (+)</td>
<td>60</td>
<td>33 (+)</td>
<td>19</td>
<td>26 (+)</td>
<td>14</td>
</tr>
<tr>
<td>141-210</td>
<td>65 (0)</td>
<td>48</td>
<td>18 (0)</td>
<td>16</td>
<td>14 (0)</td>
<td>11</td>
</tr>
<tr>
<td>211-280</td>
<td>33 (0)</td>
<td>43</td>
<td>19 (0)</td>
<td>14</td>
<td>14 (0)</td>
<td>10</td>
</tr>
<tr>
<td>281-350</td>
<td>11 (-)</td>
<td>37</td>
<td>5 (0)</td>
<td>11</td>
<td>4 (0)</td>
<td>8</td>
</tr>
<tr>
<td>351-420</td>
<td>11 (-)</td>
<td>31</td>
<td>3 (-)</td>
<td>10</td>
<td>3 (0)</td>
<td>7</td>
</tr>
<tr>
<td>421-490</td>
<td>4 (-)</td>
<td>24</td>
<td>1 (-)</td>
<td>8</td>
<td>0 (-)</td>
<td>6</td>
</tr>
<tr>
<td>491-560</td>
<td>2 (-)</td>
<td>21</td>
<td>0 (-)</td>
<td>7</td>
<td>1 (-)</td>
<td>5</td>
</tr>
<tr>
<td>&gt; 560</td>
<td>10 (-)</td>
<td>77</td>
<td>0 (-)</td>
<td>25</td>
<td>0 (-)</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>421</td>
<td>137</td>
<td>95</td>
<td>33</td>
<td>139</td>
<td>145</td>
</tr>
<tr>
<td>(x^2)</td>
<td>299.4</td>
<td>95.4</td>
<td>57.4</td>
<td>25.8</td>
<td>94.1</td>
<td>155.7</td>
</tr>
<tr>
<td>df</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>p</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

\(^a\)Adult females present during both 1973-74 and 1980-81.

\(^b\)Selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \(P = 0.05\), Neu et al. (1974).
Table 37. Chi-square (goodness-of-fit) analyses comparing the observed relocations of classes of bears in timber stands at 70 m intervals from bordering clearcuts to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>All bears</th>
<th>Ad F</th>
<th>2,3,5,9&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ad F/cubs</th>
<th>Ad M</th>
<th>Subadults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>324(+185)</td>
<td>234(+129)</td>
<td>62(+36)</td>
<td>47(0) 38</td>
<td>45(+27)</td>
<td>45(0) 29</td>
</tr>
<tr>
<td>71-140</td>
<td>231(+140)</td>
<td>152(+97)</td>
<td>33(0) 28</td>
<td>37(0) 29</td>
<td>44(+20)</td>
<td>35(0) 22</td>
</tr>
<tr>
<td>141-210</td>
<td>121(0) 112</td>
<td>88(0) 78</td>
<td>24(0) 22</td>
<td>25(0) 23</td>
<td>22(0) 16</td>
<td>1(0) 18</td>
</tr>
<tr>
<td>211-280</td>
<td>95(0) 99</td>
<td>66(0) 69</td>
<td>19(0) 19</td>
<td>26(0) 20</td>
<td>11(0) 14</td>
<td>18(0) 16</td>
</tr>
<tr>
<td>281-350</td>
<td>64(0) 86</td>
<td>39(-60)</td>
<td>11(0) 17</td>
<td>11(0) 18</td>
<td>8(0) 13</td>
<td>17(0) 14</td>
</tr>
<tr>
<td>351-420</td>
<td>49(-71)</td>
<td>34(-50)</td>
<td>7(0) 14</td>
<td>13(0) 15</td>
<td>7(0) 10</td>
<td>8(0) 11</td>
</tr>
<tr>
<td>421-490</td>
<td>26(-55)</td>
<td>15(-38)</td>
<td>5(0) 11</td>
<td>10(0) 11</td>
<td>3(-8)</td>
<td>8(0) 9</td>
</tr>
<tr>
<td>491-560</td>
<td>25(-50)</td>
<td>21(-35)</td>
<td>11(0) 10</td>
<td>11(0) 10</td>
<td>0(-7)</td>
<td>4(0) 8</td>
</tr>
<tr>
<td>&gt; 560</td>
<td>43(-178)</td>
<td>31(-124)</td>
<td>21(-35)</td>
<td>20(-36)</td>
<td>3(-26)</td>
<td>9(-28)</td>
</tr>
<tr>
<td>Total</td>
<td>978</td>
<td>680</td>
<td>193</td>
<td>200</td>
<td>143</td>
<td>165</td>
</tr>
</tbody>
</table>

**<sup>a</sup>**Adult females present during both 1973-74 and 1980-81.

**<sup>b</sup>**Selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; <i>P</i> = 0.05, Neu et al. (1974)).

<table>
<thead>
<tr>
<th></th>
<th>307.5</th>
<th>215.8</th>
<th>33.7</th>
<th>16.8</th>
<th>75.4</th>
<th>35.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>&lt;i&gt;P&lt;/i&gt;</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.05</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>
Table 38. Chi-square (goodness-of-fit) analyses comparing the observed relocations of all bears as a group in 1960 clearcuts at 70 m intervals from bordering timber stands during each of 4 seasonal periods to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>59(0)46</td>
<td>48(0)50</td>
<td>32(0)30</td>
<td>25(0)21</td>
</tr>
<tr>
<td>71-140</td>
<td>30(0)34</td>
<td>39(0)37</td>
<td>24(0)22</td>
<td>9(0)16</td>
</tr>
<tr>
<td>141-210</td>
<td>17(0)19</td>
<td>19(0)20</td>
<td>12(0)12</td>
<td>9(0)9</td>
</tr>
<tr>
<td>211-280</td>
<td>13(0)13</td>
<td>15(0)14</td>
<td>8(0)8</td>
<td>10(0)6</td>
</tr>
<tr>
<td>281-350</td>
<td>4(0)8</td>
<td>9(0)9</td>
<td>5(0)5</td>
<td>4(0)4</td>
</tr>
<tr>
<td>351-420</td>
<td>2(0)5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6(0)6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1(0)3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1(0)2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>&gt; 420</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>125</td>
<td>136</td>
<td>82</td>
<td>58</td>
</tr>
<tr>
<td>(x^2)</td>
<td>8.5</td>
<td>0.4</td>
<td>1.9</td>
<td>7.5</td>
</tr>
<tr>
<td>df</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>(P)</td>
<td>(&gt; 0.1)</td>
<td>(&gt; 0.99)</td>
<td>(&gt; 0.8)</td>
<td>(&gt; 0.1)</td>
</tr>
</tbody>
</table>

<sup>a</sup>S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \(P = 0.05\), Neu et al. (1974)).

<sup>b</sup>These bands pooled.
Table 39. Chi-square (goodness-of-fit) analyses comparing the observed relocations of all bears as a group in 1960 clearcuts at 70 m intervals from bordering timber stands during each of 4 seasonal periods to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>127(0)132</td>
<td>270(-)370</td>
<td>218(-)254</td>
<td>137(+107</td>
</tr>
<tr>
<td>71-140</td>
<td>111(0)98</td>
<td>321(+275</td>
<td>213(0)189</td>
<td>94(0)79</td>
</tr>
<tr>
<td>141-210</td>
<td>58(0)54</td>
<td>155(0)150</td>
<td>111(0)103</td>
<td>31(0)44</td>
</tr>
<tr>
<td>211-280</td>
<td>30(0)36</td>
<td>131(+100</td>
<td>78(0)69</td>
<td>17(-)29</td>
</tr>
<tr>
<td>281-350</td>
<td>16(0)24</td>
<td>80(0)66</td>
<td>46(0)45</td>
<td>6(-)19</td>
</tr>
<tr>
<td>351-420</td>
<td>11(0)13</td>
<td>36(0)36</td>
<td>15(0)25</td>
<td>2(-)10</td>
</tr>
<tr>
<td>&gt; 420</td>
<td>4(0)2</td>
<td>9(0)5</td>
<td>1(0)3</td>
<td>3(0)1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>357</td>
<td>1002</td>
<td>688</td>
<td>290</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\chi^2$</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>8.7</td>
<td>50.5</td>
<td>17.6</td>
<td>37.1</td>
</tr>
<tr>
<td>df</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>p</td>
<td>$&gt;0.1$</td>
<td>&lt;0.001</td>
<td>&lt;0.01</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

$^a$S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; P = 0.05, Neu et al. (1974)).
Table 40. Chi-square (goodness-of-fit) analyses comparing the observed relocations of all bears as a group in 1960 clearcuts at 70 m intervals from bordering 1950 clearcuts during each of 4 seasonal periods to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>13(0) 8</td>
<td>55(0)55</td>
<td>36(0)29</td>
<td>15(0)17</td>
</tr>
<tr>
<td>71-140</td>
<td>7(0) 6</td>
<td>46(0)46</td>
<td>22(0)25</td>
<td>16(0)14</td>
</tr>
<tr>
<td>141-210</td>
<td>4(0) 5</td>
<td>47(0)34</td>
<td>22(0)18</td>
<td>12(0)10</td>
</tr>
<tr>
<td>211-280</td>
<td>0(0) 3</td>
<td>20(0)24</td>
<td>11(0)13</td>
<td>10(0) 8</td>
</tr>
<tr>
<td>281-350</td>
<td>1(0) 2</td>
<td>13(0)16</td>
<td>6(0) 9</td>
<td>2(0) 5</td>
</tr>
<tr>
<td>351-420</td>
<td>0(0) 1</td>
<td>1(--) 6</td>
<td>0(0) 3</td>
<td>1(0) 2</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>182</td>
<td>97</td>
<td>56</td>
</tr>
</tbody>
</table>

\[ \chi^2 \]

<table>
<thead>
<tr>
<th>df</th>
<th>5</th>
<th>5</th>
<th>5</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>&gt; 0.1</td>
<td>&gt; 0.05</td>
<td>&gt; 0.2</td>
<td>&gt; 0.5</td>
</tr>
</tbody>
</table>

\( ^a S = \) selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \( P = 0.05 \), Neu et al. (1974)).
Table 41. Chi-square (goodness-of-fit) analyses comparing the observed relocations of all bears as a group in 1950 clearcuts at 70 m intervals from bordering timber stands during each of 4 seasonal periods to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>den-May</th>
<th>June-July</th>
<th>Aug-Sept</th>
<th>Oct-den</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>44(-)62</td>
<td>31(0)35</td>
<td>28(-)58</td>
<td>25(0)36</td>
</tr>
<tr>
<td>71-140</td>
<td>53(0)52</td>
<td>29(0)29</td>
<td>50(0)48</td>
<td>33(0)30</td>
</tr>
<tr>
<td>141-210</td>
<td>45(0)41</td>
<td>18(0)23</td>
<td>44(0)38</td>
<td>21(0)24</td>
</tr>
<tr>
<td>211-280</td>
<td>41(0)31</td>
<td>27(0)18</td>
<td>48(+29)</td>
<td>25(0)18</td>
</tr>
<tr>
<td>281-350</td>
<td>22(0)17</td>
<td>14(0)10</td>
<td>24(0)16</td>
<td>12(0)10</td>
</tr>
<tr>
<td>351-420</td>
<td>6(0)8</td>
<td>2(0)4</td>
<td>4(0)7</td>
<td>3(0)4</td>
</tr>
<tr>
<td>&gt;420</td>
<td>2(0)3</td>
<td>0(0)1</td>
<td>0(0)2</td>
<td>3(0)1</td>
</tr>
<tr>
<td>Total</td>
<td>214</td>
<td>120</td>
<td>198</td>
<td>122</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>10.6</td>
<td>11.2</td>
<td>36.5</td>
<td>9.2</td>
</tr>
<tr>
<td>df</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>p</td>
<td>&gt; 0.1</td>
<td>&gt; 0.05</td>
<td>&lt; 0.001</td>
<td>&gt; 0.1</td>
</tr>
</tbody>
</table>

$^aS =$ selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $p = 0.05$, Neu et al. (1974)).
Table 42. Chi-square (goodness-of-fit) analyses comparing the observed relocations of all bears as a group in 1960 clearcuts at 70 m intervals from bordering timber stands when active and when inactive during the day to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1973-74 and 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>1973-74</th>
<th>1980-81</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active</td>
<td>Inactive</td>
</tr>
<tr>
<td>0-70</td>
<td>151(0)139</td>
<td>11(0) 7</td>
</tr>
<tr>
<td>71-140</td>
<td>98(0)103</td>
<td>4(0) 5</td>
</tr>
<tr>
<td>141-210</td>
<td>54(0) 56</td>
<td>1(0) 3</td>
</tr>
<tr>
<td>211-280</td>
<td>43(0) 38</td>
<td>1(0) 2</td>
</tr>
<tr>
<td>281-350</td>
<td>21(0) 25</td>
<td>1(0) 1</td>
</tr>
<tr>
<td>351-420</td>
<td>9(-) 15b</td>
<td>1(0) 1b</td>
</tr>
<tr>
<td>&gt; 420</td>
<td>19</td>
<td>21(0) 10</td>
</tr>
<tr>
<td>Total</td>
<td>376</td>
<td>19</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1973-74</th>
<th>1980-81</th>
</tr>
</thead>
<tbody>
<tr>
<td>(X^2)</td>
<td>5.5</td>
<td>44.2</td>
</tr>
<tr>
<td>df</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>(P)</td>
<td>&gt; 0.3</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

° Selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \(P = 0.05, \) Neu et al. (1974))

<table>
<thead>
<tr>
<th></th>
<th>1973-74</th>
<th>1980-81</th>
</tr>
</thead>
<tbody>
<tr>
<td>(X^2)</td>
<td>4.3</td>
<td>9.7</td>
</tr>
<tr>
<td>df</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>(P)</td>
<td>&gt; 0.5</td>
<td>&gt; 0.1</td>
</tr>
</tbody>
</table>

b These bands pooled.
Table 43. Chi-square (goodness-of-fit) analyses comparing the observed relocations of all bears as a group in 1960 clearcuts at 70 m intervals from bordering 1950 clearcuts when active and when inactive during the day to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Active</th>
<th>Inactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>97(0)88</td>
<td></td>
</tr>
<tr>
<td>71-140</td>
<td>81(0)74</td>
<td></td>
</tr>
<tr>
<td>141-210</td>
<td>59(0)54</td>
<td></td>
</tr>
<tr>
<td>211-280</td>
<td>37(0)39</td>
<td></td>
</tr>
<tr>
<td>281-350</td>
<td>16(0)26</td>
<td></td>
</tr>
<tr>
<td>351-420</td>
<td>1(-)10</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>291</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Active</th>
<th>Inactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \chi^2 )</td>
<td>13.2</td>
<td>21.1</td>
</tr>
<tr>
<td>df</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>( P )</td>
<td>&lt; 0.05</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

\( ^a \) S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \( P = 0.05 \), Neu et al. (1974)).
Table 44. Chi-square (goodness-of-fit) analyses comparing the observed relocations of all bears as a group in 1950 clearcuts at 70 m intervals from bordering timber stands when active and when inactive during the day to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1973-74.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Active</th>
<th>Inactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-70</td>
<td>119(-)177</td>
<td></td>
</tr>
<tr>
<td>71-140</td>
<td>155(0)147</td>
<td></td>
</tr>
<tr>
<td>141-210</td>
<td>117(0)117</td>
<td></td>
</tr>
<tr>
<td>211-280</td>
<td>138(+)89</td>
<td></td>
</tr>
<tr>
<td>281-350</td>
<td>60(0)49</td>
<td></td>
</tr>
<tr>
<td>351-420</td>
<td>14(0)22</td>
<td></td>
</tr>
<tr>
<td>&gt; 420</td>
<td>4(0)7</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>607</td>
<td></td>
</tr>
</tbody>
</table>

| $\chi^2$ | 53.5 | 19.9 |
| df    | 6    | 5    |
| $P$   | < 0.001 | < 0.01 |

$^a$S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; $P = 0.05$, Neu et al. (1974)).

$^b$These bands pooled.
Table 45. Chi-square (goodness-of-fit) analyses comparing the observed relocations of all bears as a group in timber stands at 70 m intervals from bordering clearcuts when active and when inactive during the day to the expected number of relocations based on the availability of these spatial bands on Long Island, Washington, 1973-74 and 1980-81.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>1973-74</th>
<th>1980-81</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active</td>
<td>Inactive</td>
</tr>
<tr>
<td>0-70</td>
<td>152(+) 66</td>
<td>30(+) 12</td>
</tr>
<tr>
<td>71-140</td>
<td>85(+) 50</td>
<td>12(0) 9</td>
</tr>
<tr>
<td>141-210</td>
<td>56(0) 40</td>
<td>9(0) 7</td>
</tr>
<tr>
<td>211-280</td>
<td>28(0) 35</td>
<td>5(0) 7</td>
</tr>
<tr>
<td>281-350</td>
<td>9(-) 31</td>
<td>2(0) 6</td>
</tr>
<tr>
<td>351-420</td>
<td>10(-) 26</td>
<td>1(-) 5</td>
</tr>
<tr>
<td>421-490</td>
<td>3(-) 20</td>
<td>1(0) 4</td>
</tr>
<tr>
<td>491-560</td>
<td>2(-) 18</td>
<td>0(0) 3</td>
</tr>
<tr>
<td>&gt; 560</td>
<td>5(-) 64</td>
<td>5(-) 12</td>
</tr>
<tr>
<td>Total</td>
<td>350</td>
<td>65</td>
</tr>
</tbody>
</table>

\(x^2\) \(\begin{array}{llll} 
\quad & \quad & \quad & \quad \\
250.6 & 41.6 & 232.0 & 61.4 \\
\end{array}\)

\(\text{df}\) \(\begin{array}{llll} 
\quad & \quad & \quad & \quad \\
8 & 8 & 8 & 8 \\
\end{array}\)

\(p\) \(\begin{array}{llll} 
\quad & \quad & \quad & \quad \\
< 0.001 & < 0.001 & < 0.001 & < 0.001 \\
\end{array}\)

\(^a\)S = selection value (+ = used more than expected, - = used less than expected, 0 = used in proportion to availability; \(\text{P} = 0.05\), Neu et al. (1974))
Appendix C

Black Bear Damage to Conifers
The following is a brief summary of results of efforts to document level and timing of black bear damage to coniferous trees on Long Island. Initial efforts were also made to link damage to specific bears and to investigate the relationship between level of damage to trees to intensity of use of specific areas by bears.

METHODS AND RESULTS

Twenty permanent bear-damage transects were established randomly in selected clearcuts and timber stands on Long Island in 1980. Three additional transects were established in mature timber stands in 1981 to assure proportional representation of this type. The 23 transects averaged 145 m in length and were either 6 m or 12 m in width, depending on the tree density of the sampled stand. Transects were established and data recorded as recommended by Poelker and Hartwell (1973). The number of transects in each type roughly corresponded to the relative abundance of various ages of clearcuts and timber stands on the island. Number of trees per transect was determined from a timber survey on Long Island (unpubl. rep., Willapa Natl. Wildl. Refuge, Illwaco, Wash., 1976).

I examined about 8,800 individual trees on the transects and found a total of 398 trees that had been damaged by bears. Western Hemlock comprised an average of 80% of the trees on the transects and sustained 88% of the damage observed. Ten percent (39 trees) of damage occurred in the current year (1981), 12% (46 trees) in the previous year (1980) and the remaining 78% (313 trees) in years prior to 1980. About 0.5% of
the trees examined in all clearcut and timber types were damaged in 1980 or 1981. Two percent of the trees in areas harvested between 1952 and 1959 (\(N = 4480\)) and 1% of the trees in areas harvested between 1963 and 1968 (\(N = 3740\)) had been damaged before 1980. Thirty-four percent of the trees in mature timber stands (\(N = 580\)) had been damaged in years prior to 1980. Trees damaged in 1980 or 1981 had a dbh between 5 and 60 cm.

The original 20 transects were run at 2 different times in 1981 to document the timing of damage. The transects were first run on 8-9 May. Only 4 damaged trees were found. All damaged trees were located on 2 transects, both in areas harvested between 1952 and 1959. Damage was done after 15 March 1981 (bears emerged from dens). These same transects were run again between 16 July and 27 August 1981. A total of 30 damaged trees were found on 5 transects that were located in areas harvested between 1952 and 1968. Based on characteristics of the damage this damage was apparently done prior to 16 July. No new damage was found on transects in the mature timber type (LCS, SCS). However, current-year damage was found on the 3 additional transects established in the mature timber; timing of this damage was not documented.

In addition to the 23 permanent transects, 8 transects were established to compare levels of damage to intensity of bear use of the area. These transects were established in areas harvested between 1952 and 1959 because this age clearcut generally had the highest levels of new damage. Poelker and Hartwell (1973) indicated that most damage in
western Washington occurred in the 20-40 year old age class. Four transects were established in areas known to have relatively high bear use during 1980 and 1981 and 4 transects were established in areas that had little or no use by instrumented bears during this period. These transects were established in 4 groups or sets. Each set (1 in high- and 1 in low-use areas) was in the same general area of the island and had similar tree densities, understory composition and site quality (Timber survey on Long Island, unpubl. rep., Willapa Natl. Wildl. Refuge, Illwaco, Wash., 1976). Additionally, each transect set showed similar levels of previous damage. Poelker and Hartwell (1973) indicated that levels of damage were influenced by stand density and site class. The occurrence of new damage on all transects was low (0-3 trees) with no apparent differences between the high- and low-use areas with the exception of 1 of the high-use transects. The damage on this transect (29 trees) was attributed to an adult female with cubs who remained in the area during the last weeks of April. None of the other high-use areas sampled was used by females with cubs. Additionally, females with cubs appear to commonly damage trees in the vicinity of their dens. I found freshly damaged trees in the immediate vicinity of the dens of the 4 females that emerged from the den with cubs. No damaged trees, on the other hand, were found at den sites of 4 other bears (2 adult females without cubs, 1 adult male and 1 yearling male). Additionally, I found current-year damage in mature timber stands intensively used by 2 other adult females with cubs. The tendency for females with cubs to remain at the den site later in the spring than
other bears may contribute to the frequency of damage around the dens of these bears.

While these data do indicate that females with cubs damage trees it does not necessarily mean that they damage trees more frequently than other bears. Because they tend to localize their movements more than other classes of bears it was easier to link them with damage. Additionally, based on radio locations, some of the damage found was not done by females with cubs.

Further analyses of these data in relation to movement and activity patterns of specific bears may provide additional insight into the relationship between density of bears and level of damage as well as the potential of the various classes of bears to damage trees.