BLACK-TAILED DEER

(*Odocoileus hemionus columbianus*)

General

- Common year-round resident in the deciduous and mixed forests of the transition zone within the ecoregion (Cowan 1956).
- Also inhabits lowland riparian areas of willow (*Salix* spp.) and brush along streams and wetlands (Cowan 1945, 1956).
- Migratory populations use areas above 2,200 feet as summer range (Ruediger and Garcia 1980).

Food Requirements

- The annual deer diet consists of 65 percent browse, 25 percent forbs, and 10 grasses (Brown 1961).
- Important browse species are trailing blackberry, vine maple, salmonberry, and red huckleberry.
- During winter deer feed heavily on arboreal lichens and other litterfall (Cowan 1945, Jones 1974, Rochelle 1980) and browse (Brown 1961).
- Forest openings and early successional stages are used most commonly for feeding areas in the Cascades of western Washington and Oregon (Wallmo 1981).
- Forest stands are used as forage areas in heavy snowfall periods (Jones 1974).
- Optimal forage habitats have >50 percent herbaceous cover, and 30 to 60 percent deciduous shrub cover <1.5 meters tall.
- Heavily traveled roads reduce deer use of adjacent forage and cover areas (Lyon 1983). Closed roads have minor impact on deer use, and may actually provide forage, bedding areas, and travel lanes (Willms 1975, Witmer 1981).

Water Requirements

- Deer require free water in the summer (Lemos and Hines 1974).
- Water is generally not limited within the home ranges of deer in the central Cascades of western Washington (Taber 1976).

Cover Requirements

Thermal Cover

- Forest stands at least 40 feet high, with a tree canopy of at least 70 percent closure provides thermal cover (Thomas et al. 1979, Witmer et al. 1985).
- Deciduous stands may provide summer but not winter thermal cover (Thomas et al. 1979).
- Old-growth and mature forest stands are preferred thermal cover stands (Zahn 1985, Jones 1974).

Hiding-escape Cover

- Shrubs and young conifers provide vegetation cover for screening of deer (Witmer et al. 1985).

Optimal or Winter Stress Cover

- Optimal cover stands provide forage in addition to thermal cover during winter.
- Provided by conifer forest stands with four canopy layers (overstory, subcanopy, shrub layer, and herbaceous layer).
- Canopy comprised of trees with DBH of 21", and crown closure of 70 percent or more, for snow interception (Jones 1974).

Reproduction (Fawning)

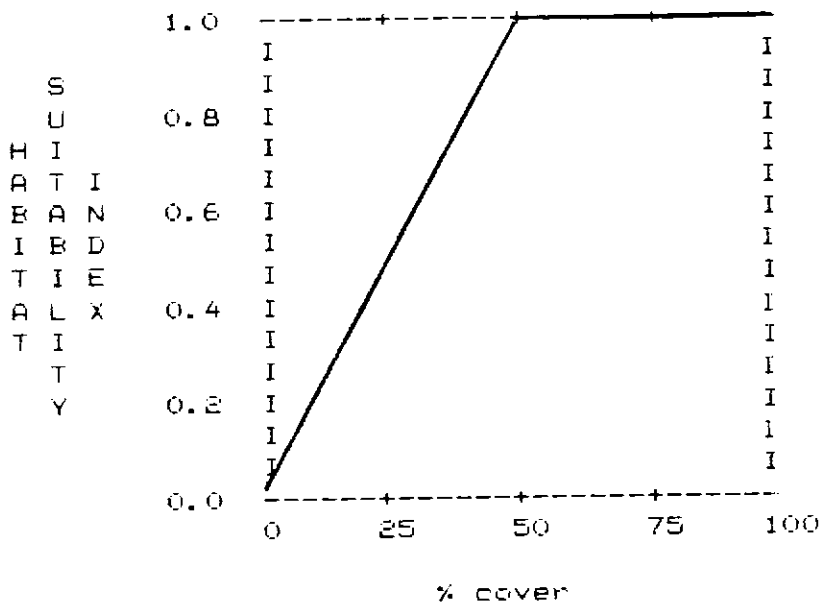
- Warm exposures, gentle slopes, with low woody vegetation (Lemos and Hines 1974, Black et al. 1976).
- Succulent forage and water within 600 feet (Black et al. 1976).

Interspersion

- Optimal summer range habitat contains 60 percent ideal food producing areas, and 40 percent ideal thermal or hiding-escape cover (Thomas et al. 1979).
- Optimal winter range habitat contains 50 percent ideal food producing areas, 30 percent ideal thermal cover, and 20 percent optimal thermal cover (winter stress cover).
- Greatest use of cover is from 200 to 800 feet from forest-cover edge (Wisdom et al. 1985).

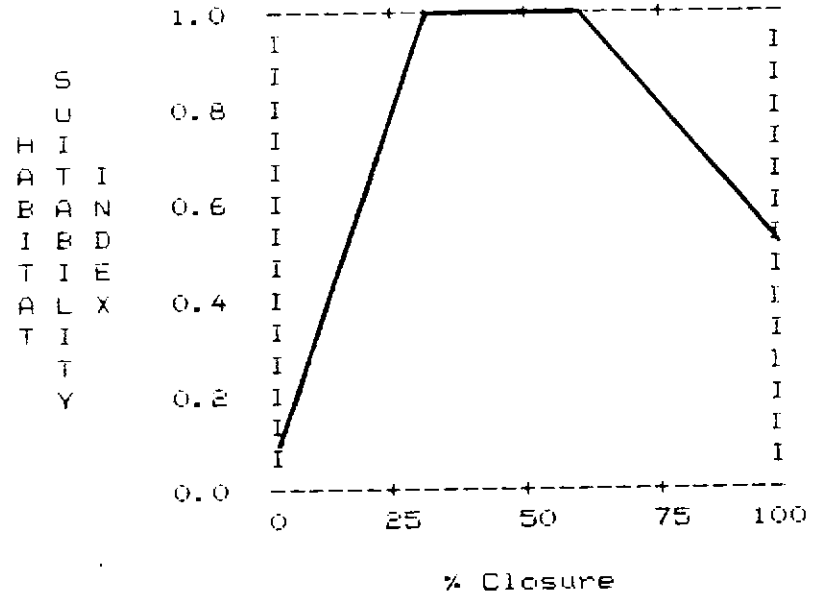
- Use of forage declines after 600 feet from the forage-cover edge, with little use of forage more than 1,200 feet from cover (Witmer et al. 1985, Hanley 1983).

- Optimal forage openings are 1,200 to 1,500 feet wide. Use is greatest within 600 feet of cover edge (Hanley 1983).



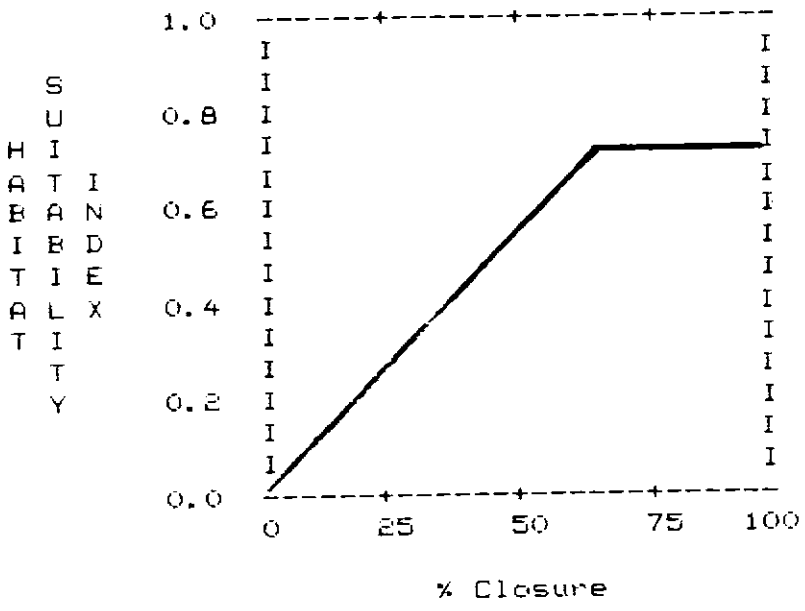
Variable 1

Percent Herbaceous Cover



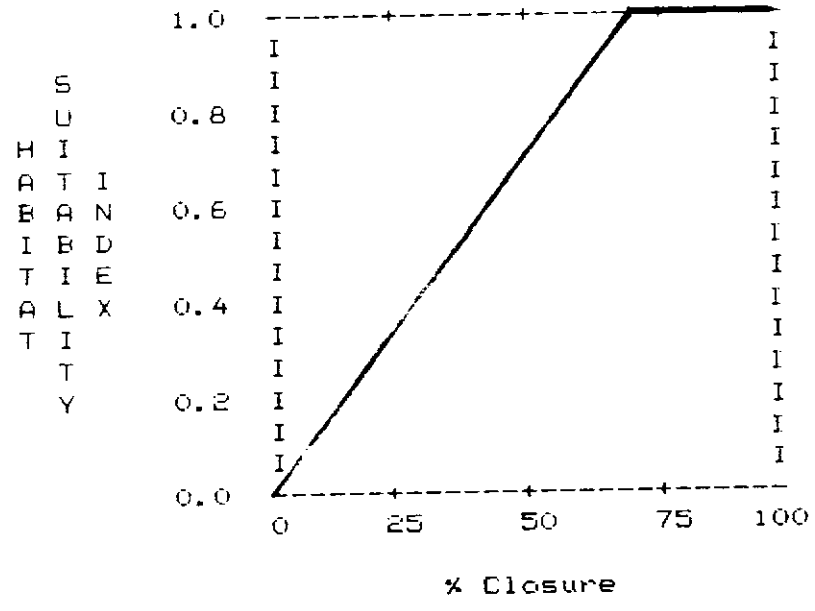
Variable 2

Percent canopy closure of deciduous shrubs (1.5 meters tall



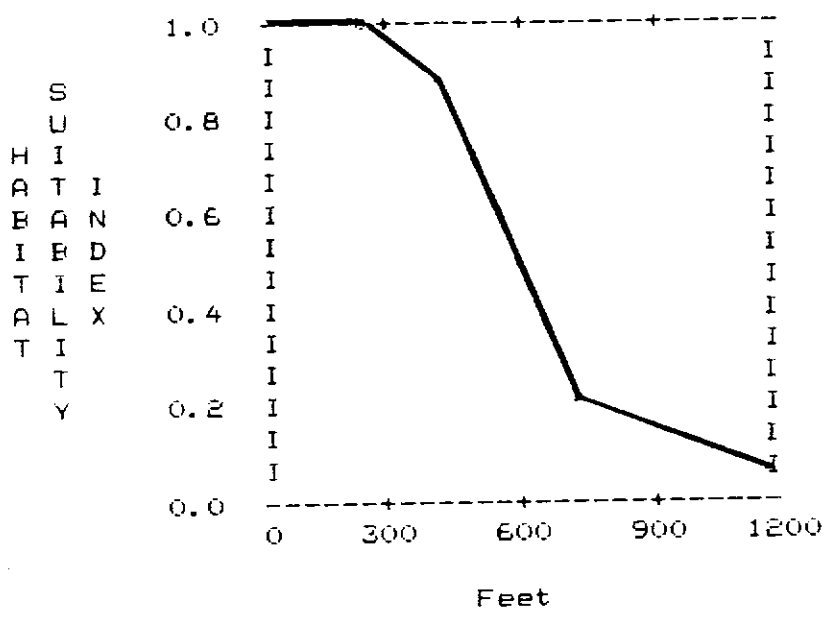
Variable 3

Percent canopy closure of shrubs >1.5 meters tall



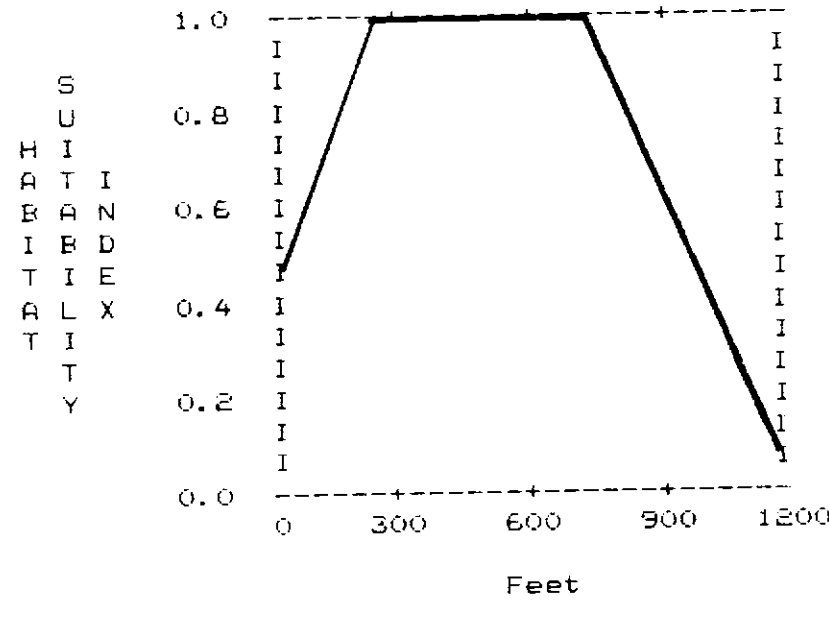
Variable 4

Percent closure of evergreen tree canopy



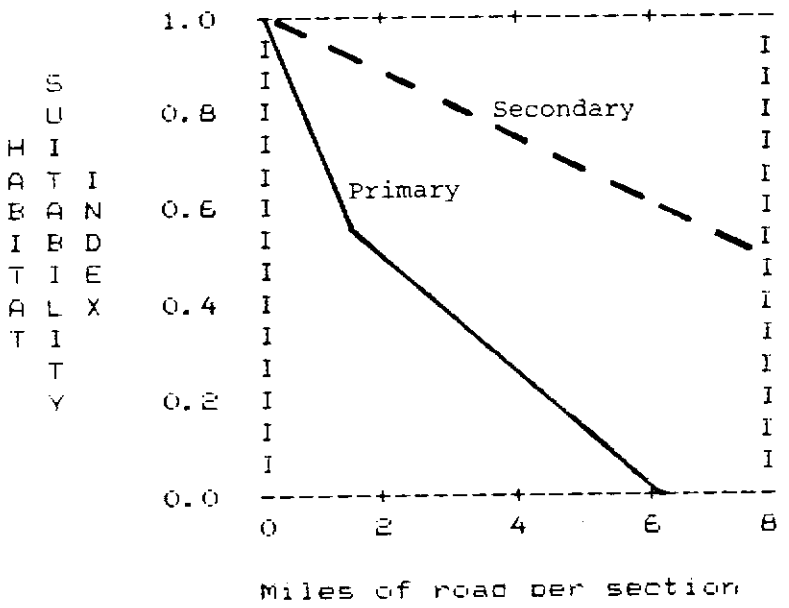
Variable 5

Mean Distance to Cover



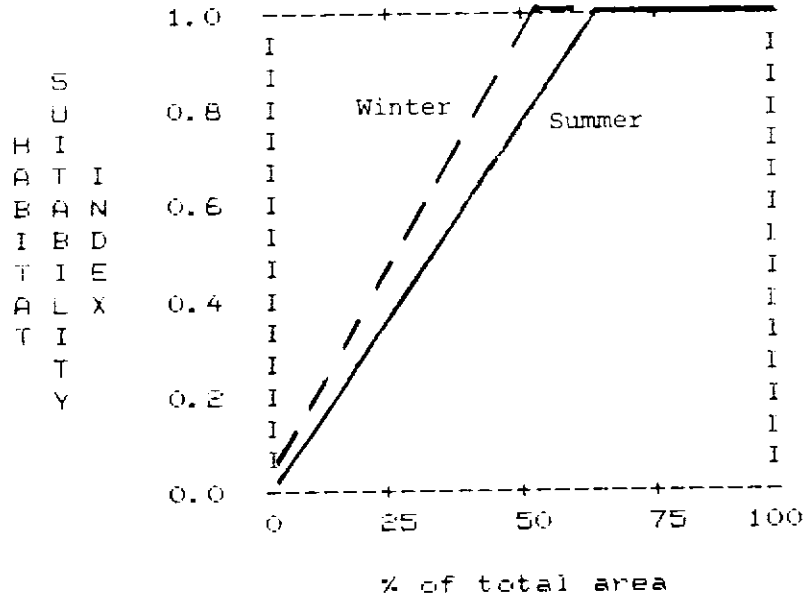
Variable 6

Mean distance to forage



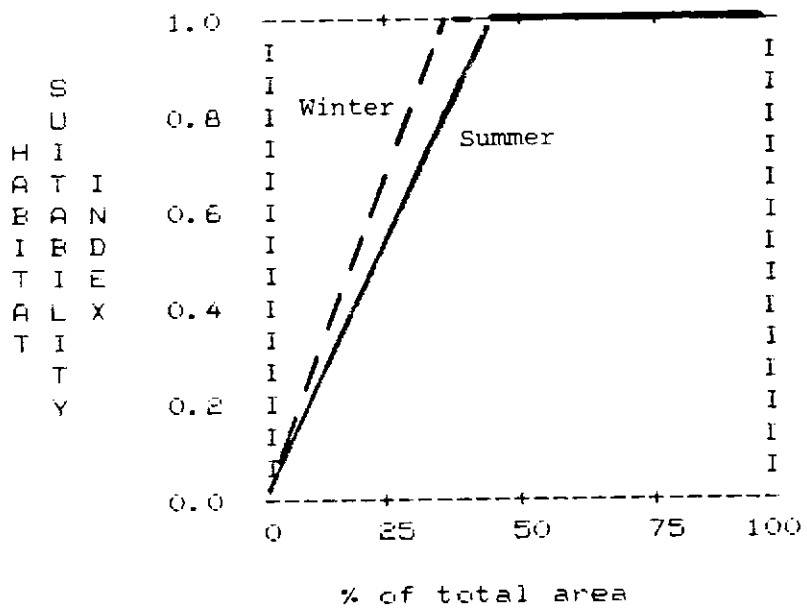
Variable 7

Road density



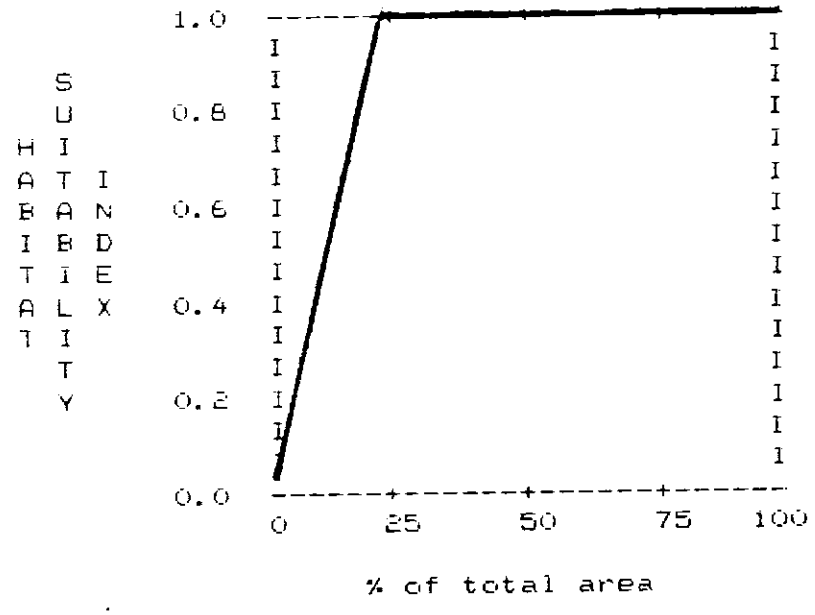
Variable 8

% area in equivalent optimum forage



Variable 9

% of area in equivalent thermal cover



Variable 10

% of area in equivalent optimum thermal cover

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Appendix A

Word model used in original HEP study (WDG 1982)

BLACK-TAILED DEER
Coniferous Forests

General

The Columbian black-tailed deer (Odocoileus hemionus columbianus) is a common herbivore which occurs in most habitat types in this Ecoregion.

Food Requirements

Early successional stages of forest communities generally provide both increased diversity and biomass of forage species for black-tailed deer (Cowan 1956). Southeast exposures with adequate shrub cover are preferred feeding areas compared to northeast exposures, since more desirable food species are produced in the former situation (Cowan 1956; Meehan 1973). The black-tail climbs well and may utilize plants on precipitous rock ledges (Cowan 1956). Deer feed on vegetation up to 50 inches (127 cm) above the ground.

Southern exposures at lower elevations are preferred foraging areas for deer in early spring because of the new emergent vegetation (Miller 1966). Deer forage on the leaves of alder (Alnus rubra), red huckleberry (Vaccinium parviflorum), vine maple (Acer circinatum), trailing blackberry (Rubus ursinus), and the new growth of forbs as they become available.

Thimbleberry (Rubus parviflorus) is the principle food item during the summer and early fall (Miller 1966). It is most valuable to black-tails when found in a vine maple community. Use of bigleaf maple (Acer macrophyllum) communities increases through the summer and fall with peak use occurring in October.

Prior to leaf-fall deer feed extensively on the foliage of broadleaf trees and shrubs. Trailing blackberry, red huckleberry, salal (Gaultheria shallon) and grasses make up the bulk of the deer diet during fall, winter, and early spring (vine maple and huckleberry-salal communities) (Miller 1966).

Crouch (1968) reported that red huckleberry is the most valuable winter food of the black-tail. In the Tillamook burn, Miller (1966) considered Douglas-fir (Pseudotsuga menziesii), vine maple, alder, sword fern (Polystichum spp.), and Oregon grape (Berberis aquifolium) to be winter survival foods. The buds and twigs of hazel (Corylus cornuta), vine maple, and alder are used when leafy forage is unavailable (Crouch 1968). As highly preferred foliage becomes unavailable during winter, deer increase their use of Douglas-fir seedlings (Crouch 1966).

Water Requirements

Daily and even more frequent trips to a stream or pond become important during the heat of summer (Cowan 1956). Free water is less important to the black-tailed deer in the winter and spring.

Cover Requirements

Black-tailed deer prefer dense areas of tall shrubs and herbaceous vegetation (Dealy 1959). Open areas without sufficient cover are not used by deer even when food is available there (Hines and Lands 1974). Deer in Arizona did not utilize areas that were more than 600 feet (183 m) from the forest edge (Reynolds 1966a,b).

Deer spend much of their time in shaded draws, thickets, and just inside the forest edge during the hot summer months (Anderson 1959). Protection from summer heat is provided when crown closure is 60% or greater (Oregon Dept. Fish and Wildlife unpubl. ms.). Miller (1966) reported that deer often make bedding grounds in the bigleaf maple communities during the summer.

Protection from winter weather is provided when there are 250 to 300 trees/acre (617 to 741 trees/ha.) with a mean dbh of 7 to 8 inches (17.8 to 20.3 cm) in Douglas-fir communities (Oregon Dept. Fish and Wildlife unpubl. ms.). These sites deter deep snow accumulation. Black-tails show a strong preference for areas sheltered from prevailing winds (Miller 1970). Black-tailed deer may die of malnutrition because they generally do not forage far from winter bedding and feeding areas even when available food becomes scarce (Miller 1966). Deer winter in areas of bigleaf maple, vine maple, and red huckleberry associations.

Reproductive Requirements

Specific information on the reproductive requirements of black-tailed deer was not found in the literature; however, reproductive cover requirements are likely to be similar to other cover requirements.

Special Habitat Requirements

No special habitat requirements were found in the literature.

Interspersion Requirements

Black-tailed deer prefer diversified habitat that contains forest edges, dense cover, and openings (Lindzey 1944; Dealy 1959). Black-tails prefer areas where these habitat elements are in close juxtaposition (Taber 1960). Adequate food supply, in quality and quantity, is of critical importance, especially during periods of lowest availability and nutritive worth (Cowan 1956). The ideal deer range should have forest stands of various age classes.

Annual home ranges of the black-tailed deer vary from 0.1 to 0.5 mi^2 (0.3 to 1.3 km^2) (Miller 1970), depending on the availability of food, water, cover, and discontinuity of terrain in close association (Miller 1966). Does sharply reduce the size of their home range during fawning (Miller 1970).

Special Considerations

The black-tailed deer is dependent upon early successional stages (Cowan 1956) and its habitat is thereby transitory in nature (Robinson 1958). Fire traditionally reinitiates forest succession, but logging has become a substitute agent for reintroducing early seral stages (Cowan 1956).

Some black-tailed deer populations migrate along drainages from high summer ranges to lower winter ranges and use much the same route year after year (Cowan 1956).

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Ruffed Grouse

(Bonasa umbellus)

General

- The Ruffed Grouse (Bonasa umbellus) is a year-round resident in deciduous and mixed deciduous/coniferous forests of western Washington (Brewer 1980).

Food Requirements

- Diet consists of a wide variety of plant and animal foods. Spring diets in western Washington consist primarily of leaves and flowers, while primary summer food consists of fruits. (Brewer 1980).

- Buds and twigs of black cottonwood, birch, cherry, and buttercup leaves are important winter food items in western Washington. (Brewer 1980).

- Brooding chicks depend upon insects and other invertebrates for protein during their first 15 to 20 weeks of life (Bump et al. 1947).

Cover Requirements

- Inhabit early to middle-aged (40 to 70 years) mixed forests, deciduous and riparian communities (Edminster 1947) below 2000 ft. in western Washington, especially thickets of black cottonwood, vine maple, and bigleaf maple (Brewer 1980).

- Conifers are used for winter and escape cover (Edminster 1947).

- Found in lowlands and river bottoms, in deciduous thickets, ecotones between clearcuts and forests, and in brush of burned or logged areas (Edminster 1947).

Reproductive Requirements

Drumming:

- Typically drum from a relatively level fallen log, rock, or stump which is of sufficient height to allow a view of the surroundings (Gullion 1967).

- Drumming sites typically are in areas having a high density of woody stems, especially in the shrub and sapling layers (Brewer 1980).

- Optimal drumming habitat is predominantly deciduous forest with scattered conifers, vine maple, mature bigleaf maple and mature black cottonwood; ground cover between 16 in. and 47 in. tall, providing 20-50 percent vertical obscurity, at least one other log within 32 ft. of the drumming

stage, and proximity to an edge between mature forest and early successional stages (Gullion 1967, Brewer 1980, Johnsgard 1983).

- Horizontal vegetation structure (leaves and branches) discourages the presence of ruffed grouse (Brewer 1980).

Nesting/Broods:

- Brood habitat is best provided in lowland and transitional areas with a dense shrub stratum. Deciduous components of clearcuts, edges, and mixed forest are important habitats for the invertebrate foods broods require and provide cover for chicks (Edminster 1947, Brewer 1980).

- Nest sites are typically at the bases of trees in open hardwood stands, bases of stumps, bushes or brush piles (Bump 1947).

- Clearings less than five acres in forests of mixed deciduous and coniferous trees may enhance brood habitat (Edminster 1947, Sharp 1963).

Interspersion Requirements

- Require a high degree of interspersion of clearcut, sapling, pole stage and mature age classes in riparian, deciduous, and mixed conifer/deciduous cover types to meet seasonal food and cover needs (Edminster 1947, Brewer 1980, Sharp 1963).

Special Considerations

- Winter food and brood habitat appear to be critical limiting factors to ruffed grouse populations in western Washington (Brewer 1980). If good brood habitat is present, adults can easily survive in the same conditions (Berner and Gysel 1969).

- Pure coniferous forest discourages ruffed grouse use (Brewer 1980).

- Alder is not a preferred food source in western Washington, but may be utilized by broods and as a food source in the absence of other hardwoods (Brewer 1980).

- Logging slash that if not properly treated may inhibit movement, especially of chicks (Sharp 1963).

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APPENDIX A

Word models used in original HEP Study (WDG 1982)

RUFFED GROUSE
Riparian Communities

General

The ruffed grouse (Bonasa umbellus) inhabits early successional deciduous communities. Two subspecies of the ruffed grouse occur in the Willamette Valley-Puget Trough Ecoregion: the Olympia ruffed grouse (B. u. castanea), which occurs in the Olympic peninsula, and the Oregon or Pacific ruffed grouse (B. u. sabini), which is found throughout central Washington and Oregon (Jackman and Scott 1975).

Food Requirements

Ruffed grouse feed on a wide variety of plant and animal foods, although animal foods rarely exceed 5-10% of the adult diet (Edminster 1947; Johnsgard 1973). Edminster (1947) reported that between 400 and 500 plant species provide food for the ruffed grouse. Bump et al. (1947) identified 580 kinds of animal foods, predominantly insects, eaten by ruffed grouse in New York.

Composition of the diet depends on plant species availability and the seasonal distribution of the grouse (Korschgen 1966). During winter, ruffed grouse feed primarily on buds and twigs of hardwood shrubs and trees (Johnsgard 1973). Where aspens (especially Populus tremuloides) are a component of the forest canopy, the staminate flower buds provide the critical winter food resource (Phillips 1967; Gullion and Svoboda 1972). In western Washington, black cottonwood (P. trichocarpa) is the only tree species that ranks in the top five food items (Brewer 1978). Buds and catkins, leafy vegetation, and available insects form the bulk of the spring diet (Johnsgard 1973). Summer foods are dominated by numerous fruits and berries and green vegetation, although a considerable amount of insects are also eaten (Edminster 1947). Fall food items include numerous nuts and other fruits from trees, shrubs, and herbaceous vegetation (Johnsgard 1973), leaves, seeds, buds, and twigs. A diversity of habitats is necessary to meet the seasonal food needs of ruffed grouse. In Missouri, Korschgen (1966) found that 15% (by volume) of all plant foods were from high canopy trees, 45% from understory trees, shrubs, vines, and brambles, and 40% from herbaceous vegetation.

Water Requirements

Most grouse foods contain considerable water (Johnsgard 1973) and it is unlikely that ruffed grouse need a permanent drinking water supply. When grouse are found near water, it is related to their preference for the food or cover in those wet habitats rather than a dependence on free water (Edminster 1947).

Cover Requirements

Ruffed grouse are not migratory, but do inhabit different types of habitat at different times of the year. They are associated with deciduous trees, especially pole-sized or second-growth hardwoods (Berner and Gysel 1969; Muehrcke and Kirkpatrick 1969), throughout the year but conifers are used for winter and escape cover (Edminster 1947; Masson and Mace 1962 cited in Jackman and Scott 1975). Ruffed grouse in

this Ecoregion are typically found in lowlands and river bottoms, in ecotones between forests and clearings, in alder thickets, and in brush tangles in burned or logged areas (Jackman and Scott 1975). In western Washington, red alder (Alnus rubra) is the dominant cover species in grouse habitat (Brewer 1978).

Ruffed grouse require a high degree of interspersion of cover types or forest age classes. In New York, Edminster (1947) described ideal grouse cover as 80-85% woods (hardwood to conifer ratio of 50:50), 2-4% open land, and the remainder in brushland. Ideal grouse habitat in Minnesota is provided by a mixture of four age classes of aspen (P. tremuloides and P. grandidentata) stands with a common corner, with each aged block less than 10 acres (4 ha) in size and differing from adjacent blocks by 10 to 15 years (Gullion 1977).

Spring habitats are associated with breeding and are discussed under Reproductive Requirements.

Summer grouse habitat in Utah is characterized by higher shrub densities and effective cover height (17.3 in., 44.1 cm) than are found on surrounding areas (Robertson 1976). Habitat used in the autumn is similar to drumming cover (discussed below) and has less ground cover than habitat used by adults in the summer (Berner and Gysel 1969). Optimal winter habitat is aspen stands with 5000 to 8000 stems per acre (12,500-20,000/ha) with a canopy closed about 30 feet (10 m) overhead (Gullion 1977).

Reproductive Requirements

Drumming. Ruffed grouse typically drum from a fallen log, although other objects are also used. Characteristics of an acceptable drumming site are sufficient height to allow a view of the surroundings and a relatively level stage (Boag and Sumanik 1969). Drumming sites are typically located in areas having a high density of woody stems (Palmer 1963; Boag and Sumanik 1969; Gullion 1970; Rusch and Keith 1971; and Robertson 1976), especially in the shrub and sapling layers. Tree density is less important than the density of the smaller stems (Boag and Sumanik 1969).

In Alberta, Boag and Sumanik (1969) found that young white spruce (Picea glauca) less than 3.94 inches (1 dm) dbh provided the necessary drumming cover. In Maine, Schemnitz (1976) found a greater canopy closure at drumming sites (76.7%) than further away from (64.6%) the sites; in contrast, Gullion et al. (1962) reported a preference in Minnesota for stands with less than 60% crown closure. Optimal drumming habitat in Minnesota is in aspen stands with 5000 to 8000 stems per acre (12,500-20,000/ha) (Gullion 1970). Stands with stem densities lower than 2000 stems per acre (4940/ha) do not support drumming grouse.

Drumming sites in Utah were located within 41 feet (12.5 m) of the nearest opening (Robertson 1976). In Maine, average distance from the drumming sites to a vegetative edge was 105 feet (32 m) (range 0-500', 0-152 m) (Schemnitz 1976). The best grouse drumming habitat in western Washington is found in a predominantly deciduous forest with scattered conifers and mature (25+ years old) black cottonwood (Brewer 1978). Such sites are characterized by ground cover (less than 15.7 in., 40 cm, tall), which provides 30-50% horizontal obscurity, at least one other

log within 33 feet (10 m) of the drumming stage, and proximity to an edge between mature forest and early successional stages dominated by shrubs. Gullion and Marshall (1968) concluded that drumming grouse survive longest in a uniform forest type.

Social interaction is also important in the selection of drumming sites by ruffed grouse (Boag 1976).

Nesting. Most ruffed grouse nests are located at the bases of trees in open hardwood stands, although other sites such as the bases of stumps, under slash, bushes, or brush piles are commonly used (Edminster 1947). Aspen stands in Minnesota with stem densities less than 2000 stems per acre (4940/hectare) are preferred nesting cover; nesting females make extensive use of emerging aspen leaves (Gullion 1977). Nesting habitat in New York is chosen to provide visibility, protection, an escape route, proximity to edges, and to satisfy an apparent desire for sunlight (Edminster 1947). Nearby undergrowth is usually sparse and canopy closure is low (Edminster 1947; Gullion 1977).

Broods. Insects and other invertebrates make up 50-75% of the diet of ruffed grouse chicks during their first few weeks of life (Edminster 1947; Johnsgard 1973), decreasing in importance with age. By late July or early August, the diet of the chicks is similar to that of the adults, with plant foods comprising the bulk of the diet.

Brood cover is the most important component of ruffed grouse habitat (Berner and Gysel 1969) and is typically provided by lowland situations with a dense shrub stratum. Prime brood habitat in Minnesota is found in regenerating aspen stands with 5000-12,000+ stems per acre (12,350-29,640/ha) (Gullion 1970). Regenerating hardwood stands provide brood habitat for 7-10 years following cutting, after which they become too open for brood use (Sharp 1963; Gullion 1977). Lowland species such as alders (Alnus spp.) (Palmer 1963; Godfrey 1975) and willows (Salix spp.) (Robertson 1976) are usually the most important woody species in brood habitat. A shift in brood habitat use was noted in Michigan from lowlands (early summer) to uplands and the upland-transition zone (mid-summer) (Berner and Gysel 1969). The transition zone between a lowland soil and a well-drained upland soil is the focal point of brood activity.

Although hens with broods may travel long distances through upland areas during the first few weeks after hatching (Godfrey 1975), they remain in a relatively small area once on the brood range. Chambers and Sharp (1958) reported that the cruising radius of most broods was less than 0.25 mile (0.4 km). Broods may range over 10-20 acres (4.0-8.1 ha) once established on their summer range (Gullion unpub. ms.).

Conifers are used by broods for roosting (Godfrey 1975). Typical brood roosting sites are clumps of three or more conifers 2-6" (5.1-15.2 cm) dbh (Hungerford 1951).

Special Habitat Requirements

Ruffed grouse require dusting sites for feather care and to keep ectoparasites at a minimum. Dusting sites are selected which provide a sandy substrate, exposure to the sun, proximity to dense cover, and maximum visibility to detect approaching predators (Hein 1970). Dusting sites can be provided by a variety of situations and are probably never limiting.

Interspersion Requirements

The interspersion of cover types is very important to ruffed grouse (see Food, Cover, and Reproductive Requirements).

Home ranges of ruffed grouse vary by sex, age, and season. In Minnesota, males occupied an average home range of 22 acres (8.9 ha) from March-June, but had a reduced range of 16.5 acres (6.7 ha) during the drumming season (Archibald 1975). In the same study, females occupied home ranges of 40.8 acres (16.5 ha) related to change in habitats from a lowland-upland edge in early spring to upland sites for nesting. In the fall, juveniles are more mobile than adults (Hale and Dorney 1963), and juvenile females are more mobile than juvenile males; in Minnesota, juvenile males occupied fall ranges averaging 7.7 acres (3.1 ha) compared to an average range of 13.4 acres (5.4 ha) for females (Godfrey and Marshall 1969). Hale and Dorney (1963) found that in Wisconsin one-half to two-thirds of a grouse population remained in an area 0.5 miles (0.8 km; 125 acres, 50.6 ha) in diameter throughout the year.

Special Considerations

The ruffed grouse is a bird of disturbed forest habitats (Gullion 1977). However, alteration of forest cover over an area greater than 10 acres (4 ha) in size will result in reduced breeding densities (Gullion 1970). Extensive areas of a single cover type are not as valuable to ruffed grouse as is the interspersion of several habitat types.

Spot-lumbering (Edminster 1947), burning (Sharp 1970), and timber management may improve grouse habitat (Gullion 1977). Grazing by livestock may adversely affect brood habitat (Robertson 1976), extensive timber harvesting may reduce breeding densities, and lack of timber management may allow forested areas to become unsuitable for ruffed grouse (Gullion 1977).

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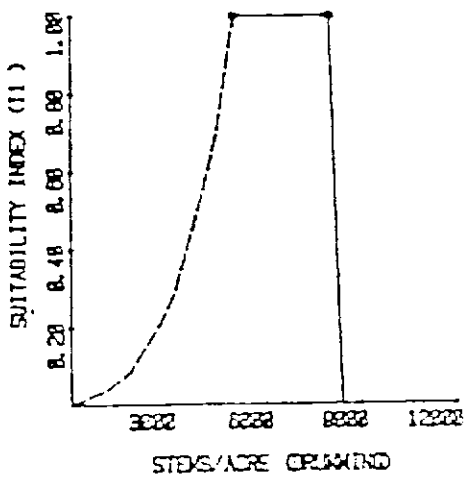
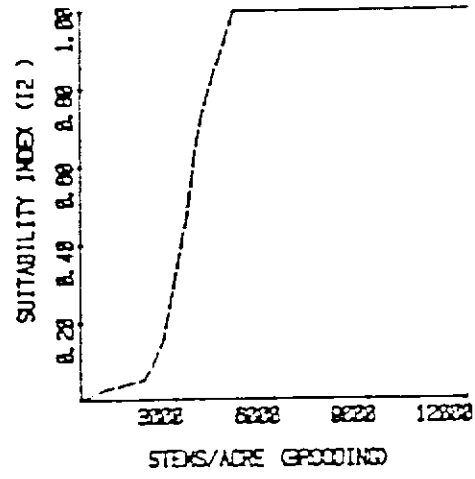
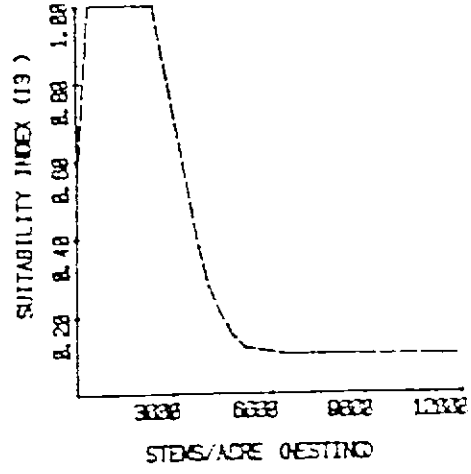
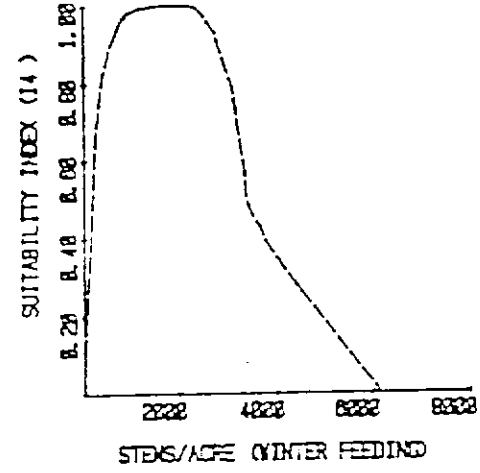
RUFFED GROUSE

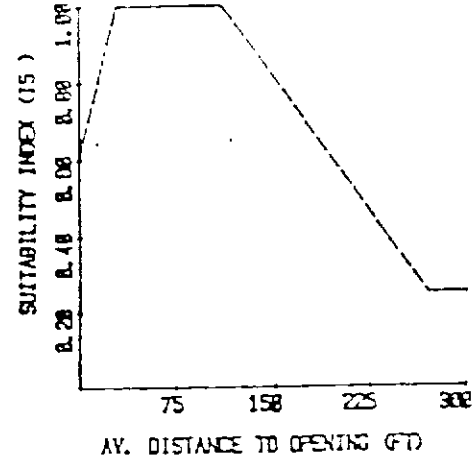
RIPARIAN COMMUNITIES











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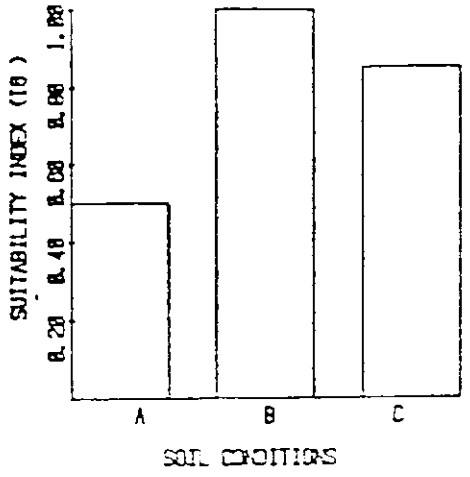
RUFFED GROUSE

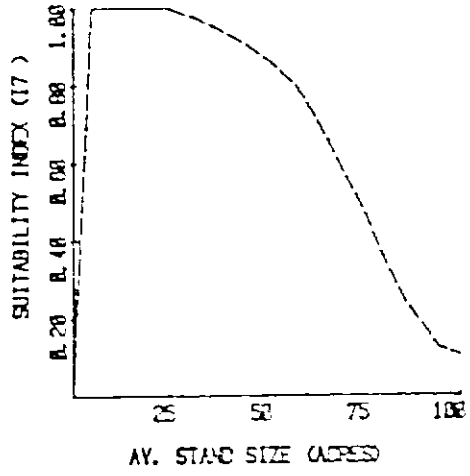
RIPARIAN COMMUNITIES



A-DRY, UPLAND SOILS DOMINATE AREA

B-TRANSITION ZONE BETWEEN UPLAND AND LOWLAND SOILS COMMON IN AREA, MODERATELY WELL-DRAINED SOILS

C-LOWLAND SOILS COMMON, SMALL PATCHES (LESS THAN 2.5 ACRES) SCATTERED THROUGHOUT AREA



STAND SIZE DETERMINED FROM AERIAL PHOTOS, STANDS BASED ON SPECIES COMPOSITION, STEM DENSITIES, AND AGE. LOW AV. STAND SIZE INDICATES GOOD INTERSPERSION OF COVER TYPES

DRAFT

HABITAT SUITABILITY INDEX

Ruffed Grouse in Riparian Communities

Ecoregion 2410

Winter Food Value (X_1) = I_4

Where: I_4 = Suitability Index (SI) of stems/acre (winter feeding).

Cover Value

Because ruffed grouse require interspersion of several forest age classes to meet their life requisites, an overall cover value based on seasonal needs is not possible.

Reproductive Values

Drumming(X_3) = $(I_1 \times I_5)^{1/2}$

Where: I_1 = SI of stems/acre (drummers)

I_5 = SI of average distance to opening.

Nesting (X_4) = I_3

Where: I_3 = SI of stems/acre (nesting).

Brooding (X_5) = $(I_2 \times I_6)^{1/2}$

Where: I_2 = SI of stems/acre (broods).

I_6 = SI of soil conditions.

Interspersion Value (X_6) = I_7

Where: I_7 = SI of average stand size.

The Habitat Suitability Index is the lowest X_n value.

D3105
9/2/86

Black-capped Chickadee

(Parus atricapillus)

General

- Common year-round resident in deciduous and mixed conifer/deciduous forests. (Gabrielson and Jewett 1940, Brown 1985).
- Also inhabits lowland riparian areas of willow (Salix spp.) and brush along streams (Larrison and Sonnenberg 1968).

Food Requirements

- Food supply may be most important feature of habitat (WDG 1982).
- Over 50% of diet is animal matter, including insects and their eggs, caterpillars and moths, plant lice, weevils and spiders (Pearson 1936).
- Vegetable matter eaten includes small seeds, buds, bud scales (Pearson 1936).
- Caterpillars are especially important for young (Sturman 1968a).
- Forage by gleaning food from the bark of twigs, branches, boles, foliage, flowers, and fruits of trees and shrubs (Brewer 1963).
- During breeding season, forage predominately in the subcanopy (inside the canopy with little or no living foliage) (Sturman 1968b).
- In western Oregon 30 to 40% of fall and winter foraging occurred in shrubs (Anderson 1970).
- Most foraging is done within 30 ft. of the ground (Brewer 1963).
- Optimum canopy closures for foraging occur between 50 and 75% (Schroeder 1982).
- Optimum habitats contain overstory trees 49 ft. or more in height (Schroeder 1982).

Water Requirements

- Drinking water requirements are met with surface water and snow (Odum 1942).

Cover Requirements

- From late fall through spring, black-capped chickadees excavate nest cavities for roosting (Brewer 1963, Thomas et al. 1979).
- Prefer deciduous forest types in western Washington (Sturman 1968a).
- Excavates cavities in soft, decayed wood, occupies cavities made by other species, and occupies "natural" cavities created by decay (Brown 1985).

Reproductive Requirements

- Primary cavity nester in decayed or soft wood (Odum 1941a; Brewer 1963). Also nests in cavities created by other primary excavators (Brown 1985).
- Optimum habitats provide 2 snags/acre (Schroeder 1982).
- Willow (Salix spp.) and cottonwood (Populas trichocarpa) are the common nest trees. Decayed hardwoods also used (Schroeder 1982).
- Number of nest sites in the habitat does not seem to be a critical factor in territorial selection (Sturman 1968a).
- Used second-growth alder (Alnus rubra) for nesting in British Columbia (Smith 1967).
- Optimal nest trees are 9 in. dbh and 10 ft. or greater in height (Brown 1985).

Special Consideration

- Feed on a variety of insects, including many regarded as forest pests (WDG 1982).

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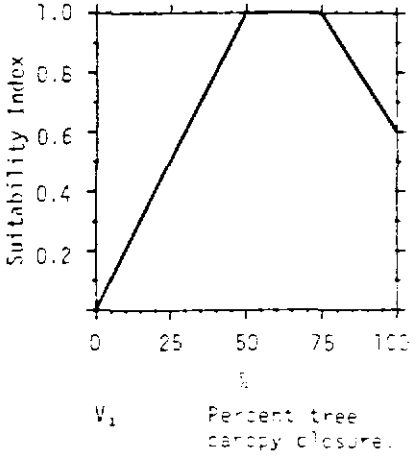
APPENDIX A

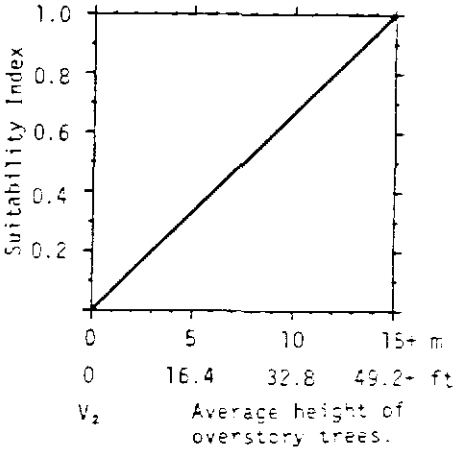
Aggregation formula and suitability indices obtained from the USFWS Habitat Suitability Index Models - black-capped chickadee (Schroeder 1982).

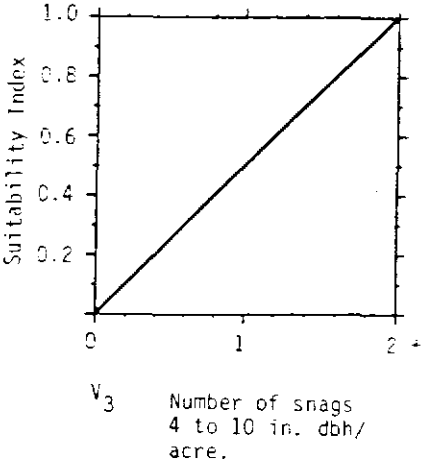
Black-capped chickadee

All terrestrial cover types

- Food
  - Percent tree canopy closure (V_1)
  - Average height of overstory trees (V_2)
- Reproduction
  - Number of snags 4 to 10 in. dbh/acre (V_3)







Life requisite	Cover type	Equation
Food	All terrestrial	$(V_1 \times V_2)^{1/2}$
Reproduction	All terrestrial	V_3

HSI determination. The HSI for the black-capped chickadee is equal to the lowest life requisite value.

APPENDIX B

Word model used in original HEP Study (WDG 1982)

BLACK-CAPPED CHICKADEE
Deciduous Woodlands

General

The black-capped chickadee (Parus atricapillus) is a common year-around resident in the deciduous and mixed deciduous forests of the Transition Zone within this Ecoregion (Gabrielson and Jewett 1940). It also inhabits lowland riparian areas of willow (Salix spp.) and brush along streams (Larrison and Sonnenberg 1968).

Food Requirements

Over half of the food eaten by the black-capped chickadee is animal matter, including insects and their eggs, caterpillars and moths, plant lice, weevils and spiders (Pearson 1936). Vegetable matter eaten includes small seeds, buds, and bud scales. Caterpillars are an especially important food item for young chickadees (Sturman 1968a). The food supply may be the most important feature of the chickadee's environment. Black-capped chickadees may use canopy volume of hardwood trees as a visual clue to insect abundance and breeding habitat selection.

Black-capped chickadees during the breeding season forage predominatly in the sub-canopy (area inside the canopy with little or no living foliage) (Sturman 1968b). In the winter, they spend most of their time feeding in the thin outer twigs of trees (Smith 1967). Chickadees forage by gleaning food from the bark of twigs, branches, boles, foliage, flowers, and fruits of trees and shrubs (Brewer 1963). In western Oregon, 30 to 40 percent of fall and winter foraging occured in shrubs (Anderson 1970). Most of the winter feeding is done in deciduous trees (Smith 1967). Most foraging is done within 30 feet (9.1 m) of the ground (Brewer 1963).

Water Requirements

No specific water requirements were found in the literature.

Cover Requirements

Little information was found in the literature regarding cover requirements other than reproductive needs. From late fall through spring, black-capped chickadees use nest cavities for roosting (Brewer 1963).

Reproductive Requirements

Black-capped chickadees are primary cavity nesters in decayed or soft wood (Odum 1941a; Brewer 1963). Willow and cottonwood trees (Populas trichocarpa) are the common nest trees. Decayed hardwood trees are also used for nesting. Chickadees in New York frequently excavated nests in well-decayed stubs or limbs of trees (Odum 1968a). The number of nest sites in the habitat does not seem to be a critical factor in territorial selection (Sturman 1968a). In British Columbia, black-capped chickadees used second-growth alder (Alnus rubra) for nesting (Smith 1967). A second growth mixed forest (55% deciduous and 45% coniferous) that contained many old alders and maples (Acer macrophyllum) had an excess of nest sites. Diameters of tree stubs used for nesting

in New York were between 3.5 and 6.0 inches (8.9-15.2 cm) with nest heights ranging from 1 to 40 feet (0.3-12.2 m) (Odum 1941b).

Sturman (1968a) found that the abundance of black-capped chickadees was positively correlated with tree canopy volume. In western Oregon, Oregon white oak (Quercus garryana) stands with tree densities of 120 to 150 per acre (296 to 372/ha), and relatively dense canopy coverage had higher breeding densities than stands with a low number of trees per acre (56; 138/ha) regardless of the density of canopy coverage. The maximum and minimum breeding densities occurred in stands with the highest and lowest tree densities, respectively.

Special Habitat Requirements

No special habitat requirements for black-capped chickadees were found in the literature.

Interspersion Requirements

No specific interspersion requirements were found in the literature.

Special Considerations

Black-capped chickadees feed on a wide variety of insects, including many regarded as forest pests.

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D3105
9/2/86

Pileated Woodpecker

(Dryocopus pileatus)

General

- A year-round, though uncommon, resident of dense mature and old growth coniferous forests in western Washington (WDG 1982).

Food Requirements

- Feeding habitat includes areas with high density of logs and snags, dense canopies and tall shrub cover (Bull and Meslow 1977).
- Spend 36 percent of feeding time foraging on logs, 35 percent on live trees, and 29 percent on snags in Oregon (Bull 1981).
- Animal matter comprises 75 percent of diet (Terres 1980).
- Feed by excavation and by scaling bark in search of insects.
- Optimum habitat occurs with 10 or more logs 7 in. or greater diameter and/or stumps of the same diameter and greater than 1 ft. in height per acre (Schroeder 1982).

Water Requirements

- Require large amounts of water in captivity which may indicate their water requirements in the wild (Pfitzenmeyer 1956 cited by Jackman and Scott 1976).

Cover Requirements

- Cover requirements are similar to reproductive requirements.
- Preferred old stands with 70% crown closure in Blue Mountain of Oregon (Thomas et al. 1979).
- Optimum habitat has 75% or greater canopy closure; stands with less than 25% canopy closure are unsuitable (Schroeder 1982).
- Prefer timber stands with sawtimber of 15 to 18 in. dbh if nest sites are available (Conner et al. 1975).

Reproductive Requirements

- Trees selected were at least 20 in. dbh (Jackman 1974) and were at least 40 ft. tall (Bull 1975).
- Prefer tall, dead trees with few limbs (Scott et al. 1977).
- Optimum habitat contains 30 or more trees greater than 20 in. dbh/acre; habitat with less than 3 such trees is unsuitable (Schroeder 1982).
- Optimum habitat contains snags suitable for nesting at a density of 6 to 15 snags per 100 acres (Bull 1977 and Neitro et al. 1985).

Special Habitat Requirements

- Utilize holes for roosting year-round (Jackman and Scott 1975).
- Fresh roosting holes usually excavated in the fall (Jackman and Scott 1975).
- Roost holes are usually in live trees and higher in the tree than nest holes (Hoyt 1957).

Interspersion Requirements

- Home range is 300 to 600 acres (Brown 1985).

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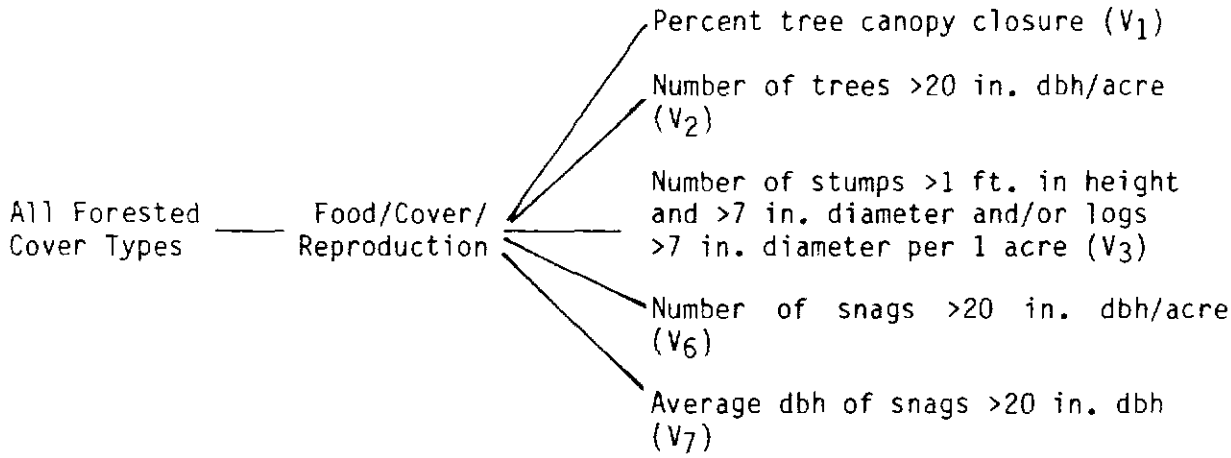
APPENDIX A

Aggregation formula and suitability indices obtained from the USFWS Habitat Suitability Index Models - pileated woodpecker (Schroeder 1982).

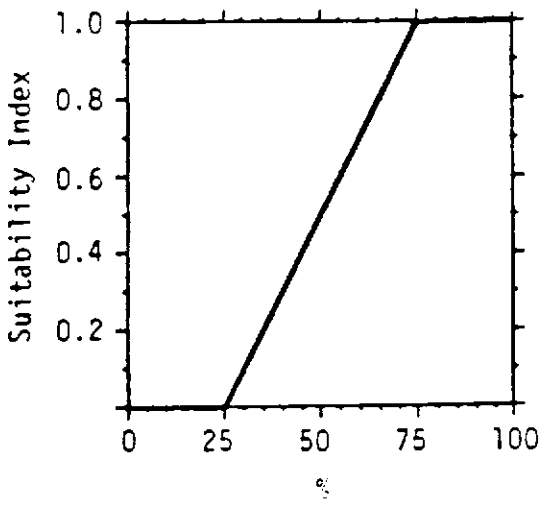


Western portion of range:
Food/cover/reproduction

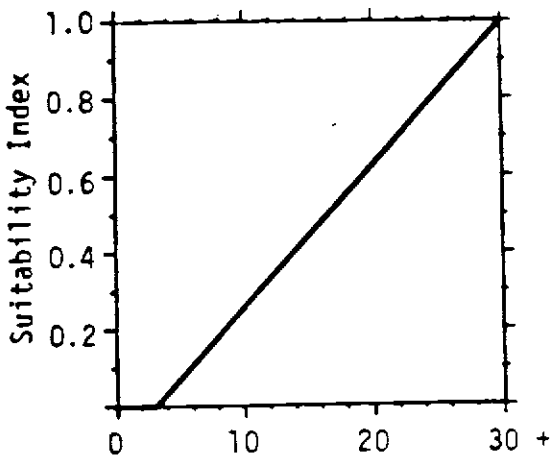
$$\text{Lower of } (V_1 \times V_2 \times V_3)^{1/2} \text{ or } (V_6 \times V_7)^{1/2}$$

HSI determination. The HSI for the pileated woodpecker is equal to the life requisite value of food/cover/reproduction.

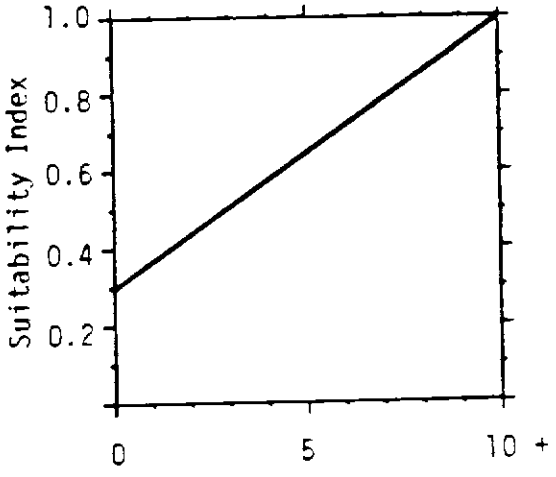
Pileated woodpecker



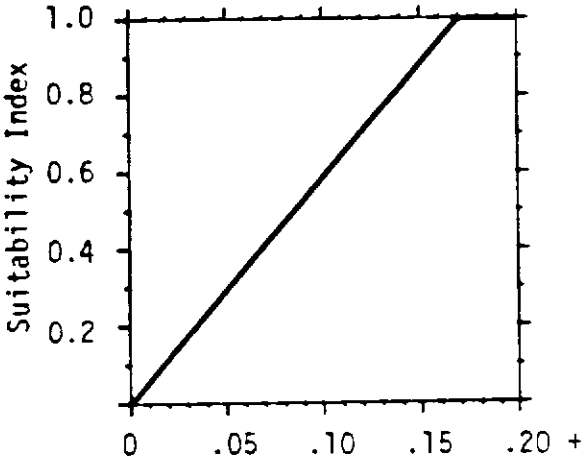
V_1 Percent tree canopy closure.



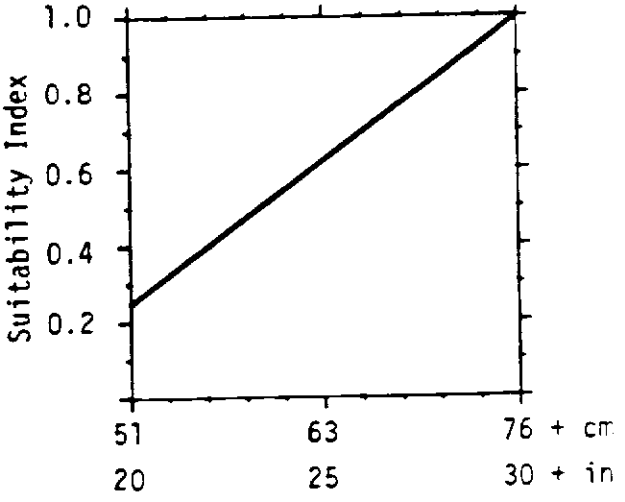
V_2 Number of trees > 51 cm (20 inches) dbh/0.4 ha (1.0 acre).



V_3 Number of tree stumps > 0.3 m (1.0 ft) in height and > 18 cm (7 inches) diameter and/or logs > 18 cm (7 inches) diameter/ 0.4 ha (1.0 acre).



V_6 Number of snags > 51 cm (20 inches) dbh/0.4 ha (1.0 acre).



V_7 Average dbh of snags > 51 cm (20 inches) dbh.

APPENDIX B

Word model used in original HEP Study (WDG 1982)

PILEATED WOODPECKER
Coniferous Forest

General

The pileated woodpecker (Dryocopus pileatus) is a year-around, though uncommon, resident of dense old-aged coniferous forests in Eco-region 2410.

Food Requirements

Pileated woodpeckers forage on snags in 100+ year old forests in western Oregon (Mannan 1977). Snags of 19 inches (48 cm) dbh or larger were used most frequently. Insects comprise most of this woodpecker's diet, with carpenter ants (Componotus spp.) and termites (Termes spp.) being the most preferred foods (Beal 1911). Pileateds feed on many species of fruits and nuts in the fall.

Water Requirements

Pileated woodpeckers require large amounts of water in captivity which may indicate their water requirements in the wild (Pfitzenmeyer 1956 cited by Jackman and Scott 1976). Hoyt (1957) found very few nests located far from a source of water.

Cover Requirements

Pileated woodpeckers are dependent on snags for foraging, roosting, and nesting (Scott et al. 1977). In the Blue Mountains of Oregon, pileateds preferred mature old stands with a 70% crown closure (Thomas et al. in press). Conner et al. (1975) reports a preference for timber stands with sawtimber of 15 to 18 inches (38.1-45.7 cm) dbh if nest sites are available.

Reproductive Requirements

Bull (1975) reports that pileated woodpeckers nest in cavities of ponderosa pine (Pinus ponderosa) and western larch (Larix occidentalis). Trees selected had an average dbh of 23 inches (58 cm) or greater and were at least 40 feet (12 m) tall. Jackman (1974) reported that pileateds require a nest tree of at least 20 inches (50 cm) dbh. These woodpeckers show a preference for tall, dead trees with few limbs (Scott et al. 1977).

Special Habitat Requirements

Pileated woodpeckers utilize holes for roosting year-around (Jackman and Scott 1975). Fresh roosting holes are usually excavated in the fall. Bull (1975) reports that several roost trees are used. The hole used for roosting is usually in a live tree and frequently higher in the tree than nest holes (Hoyt 1957).

Interspersion Requirements

Stand sizes of at least 300 acres (121 ha) are required to meet the home range requirements of pileated woodpeckers in the Blue Mountains of Oregon (Thomas et al. in press). Optimal habitat should have at least 1.2 snags/2.5 acres (1 ha). Snags should be over 20 inches (50 cm) dbh.

Special Considerations

Pileated woodpeckers prefer dense secluded timber and are intolerant of human disturbance (Jackman and Scott 1975).

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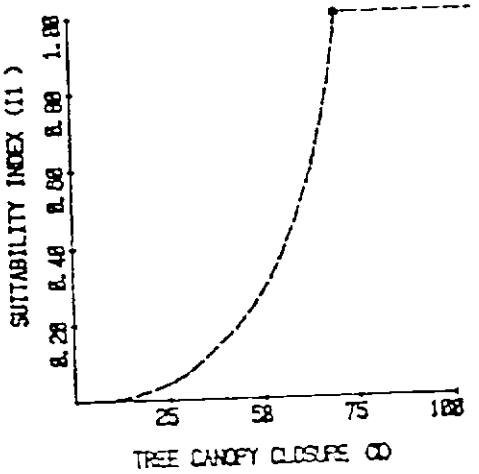
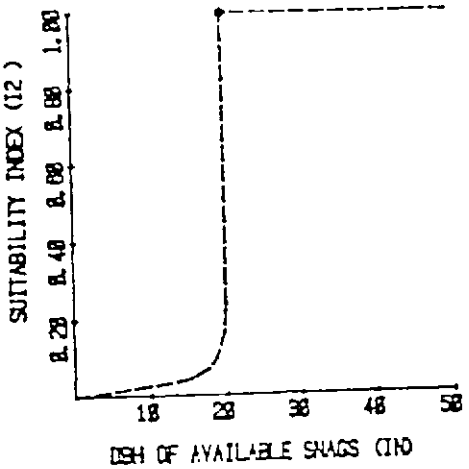
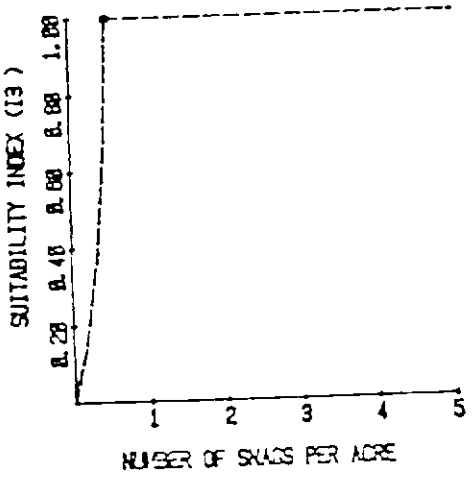
DRAFT

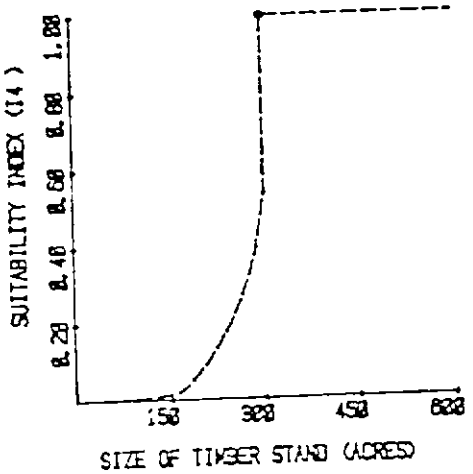
PILEATED WOODPECKER

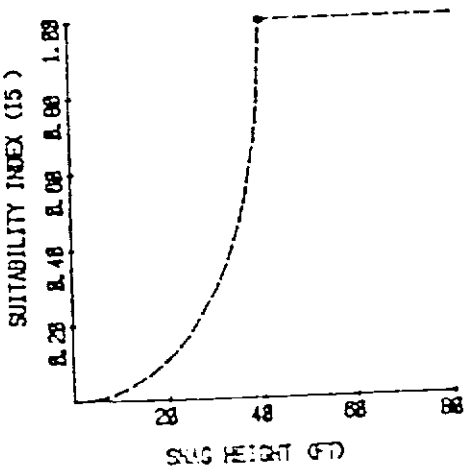
CONIFEROUS FOREST

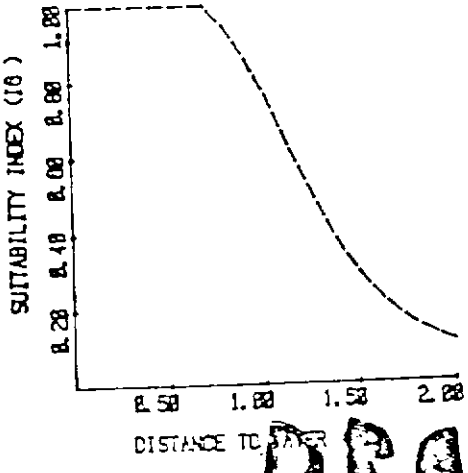












HABITAT SUITABILITY INDEX

Pileated Woodpecker in Coniferous Forest

Ecoregion 2410

Food Value $(X_1) = (I_2 \times I_3)^{1/2}$

Where: I_2 = Suitability Index (SI) of dbh of available snags.

I_3 = SI of number of snags per acre.

Cover Value $(X_2) = (I_1 \times I_4)^{1/2}$

Where: I_1 = SI of tree canopy closure.

I_4 = SI of size of timber stand (acres).

Reproductive Value $(X_3) = (I_2 \times I_3 \times I_5)^{1/3}$

Where: I_2 = SI of dbh of available snags.

I_3 = SI of number of snags per acre.

I_5 = SI of snag height.

Water Value $(X_4) = I_6$

Where: I_6 = SI of distance to water.

The Habitat Suitability Index is the lowest X_n value.

D3105
9/2/86

Pine Marten

(Martes americana)

General

- The martin (Martes americana) inhabits mature and old-growth forest communities throughout North America (Allen 1982).
- The species is mostly carnivorous, generally nocturnal, and active throughout the year (Allen 1982).

Food Requirements

- Consume a wide variety of food types on an annual basis.
- Mammals are the most important food item in winter. Winter foods incude Douglas' squirrel, voles, snowshoe hares and flying squirrel (Koehler and Hornocker 1977, Soutierre 1979, Zielinski et al. 1983).
- Voles are utilized more than any other species in winter (Weckwerth and Hawley 1962, Koehler and Hornocker 1977, Zielinksi et al. 1983).
- Invertebrates, berries, and passerine birds are common food items spring through fall (Weckwork and Hawley 1962, Zielinski et al. 1983).
- Dense conifers on mesic sites are the major foraging areas used in the winter (Koehler et al. 1975).
- Forages in Douglas-fir/hemlock forests during winter in Washington (de Vos and Guenther 1952).

Water Requirements

- No information on water requirements was found in the literature.

Cover Requirements

- Inhabits coniferous forests with greater than 40% canopy closure (Spencer et al. 1983, Brown 1985).
- Found from sea-level to timberline at all times of the year in western Washington (WDG 1975, Maser et al. 1981).
- Use areas above timberline during the summer months for foraging and as travel routes (Koehler and Hornocker 1977, Spencer 1986).
- Primary habitat is mature and old growth coniferous forest. Sapling and pole stage coniferous forests are secondary foraging habitats (Brown 1985).

- Snags, caves, ground burrows, rock piles, slash piles, Douglas' squirrel middens (winter only) and stumps are frequent refuge sites (Master 1980, Spencer et al. 1983, Buskirk 1984).

- Downfall allows marten access to rodent prey activity under deep snow (Steventon and Major 1982).

- Openings (e.g., clearcuts, meadows, roads) are usually avoided in winter (Spencer et al. 1983), though crossings of up to 180 yards in winter have been recorded in Maine (Soutierre 1979).

- Marten rarely use clear-cut stands less than 15 years old in Maine (Soutierre 1979).

Reproductive Requirements

- Reproductive requirements are assumed to be identical with cover requirements (Allen 1982).

- Den is commonly in a hollow tree or tree cavity, although any refuge site may be used for breeding.

Special Habitat Requirements

- Home ranges of males average 640 acres in Maine and females average 160 acres in Montana (Steventon and Major 1982, Hawley and Newby 1957).

- Home range size varies with clearcut acreage (Steventon and Major 1982).

- Pacific Northwest Regional Forest Service guidelines recommend minimum habitat size units of 160 contiguous acres of mature or old growth forest (U.S. Forest Service 1983).

- Home ranges of females may overlap, but males defend rigid territories.

- Home range boundaries often coincide with the edges of topographic or vegetative features, such as large, open meadows, burns and streams (Hawley and Newby 1957).

- The percent tree canopy closure (see V_1) and successional (see V_3) stage of the stand are two limiting variables for determining the suitability of marten winter habitat (Koehler and Hornocker 1977, Soutiere 1979, Spencer et al. 1983).

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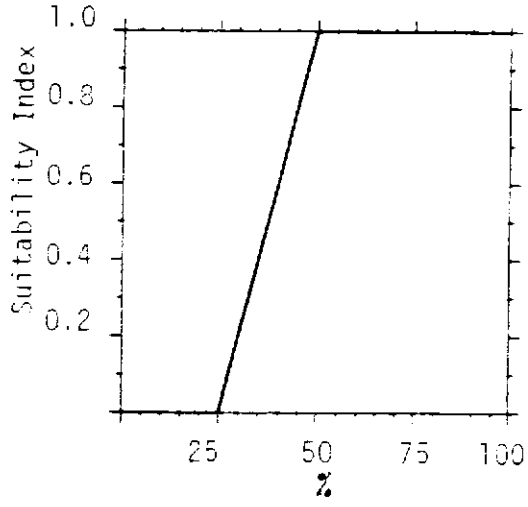
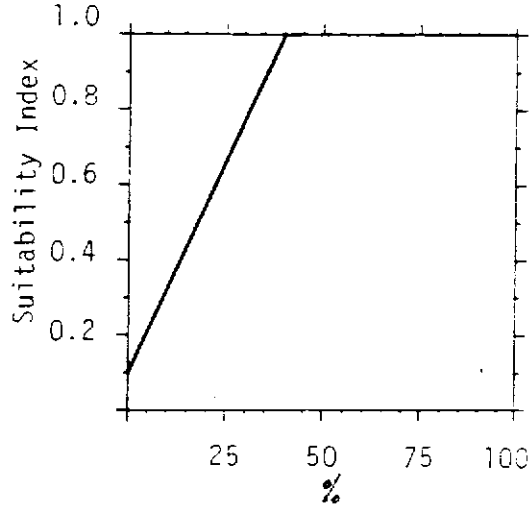
APPENDIX A

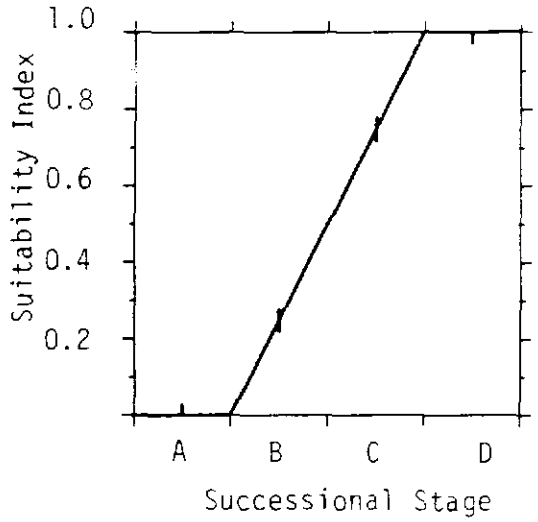
Aggregation formula and suitability indices obtained from USFWS Habitat Suitability Models - marten (Allen 1982).

Suitability Index (SI) graphs for habitat variables. The relationships between various conditions of habitat variables and habitat suitability for the marten are graphically represented in this section.

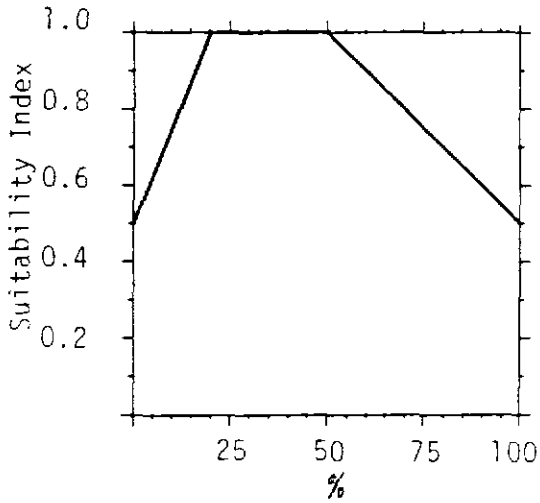
Cover type	Variable		
EF	(V_1)	Percent tree canopy closure.	
EF	(V_2)	Percent of overstory canopy closure comprised of fir or spruce.	

EF (V_3) Successional stage of stand.

A) shrub-seedling
B) pole sapling
C) young
D) mature or old growth



EF (V_4) Percent of ground surface covered by downfall which is ≥ 7.6 cm (3 in) in diameter.



Equations. In order to obtain life requisite values for the marten, the SI values for appropriate variables must be combined through the use of equations. A discussion and explanation of the assumed relationships between variables was included under Model Description, and the specific equation in this model was chosen to mimic these perceived biological relationships as closely as possible. The suggested equation for obtaining a winter cover value is presented below.

Life requisite	Cover type	Equations
Winter cover	EF	$(V_1 \times V_2 \times V_3 \times V_4)^{1/2}$

HSI determination. Since winter cover was the only life requisite considered in this model, the HSI equals the winter cover value.

APPENDIX B

Word model used in original HEP Study (WDG 1982)

MARTEN

General

The marten (Martes americana) is a small carnivore inhabiting montane and subalpine conifer forests in the Pacific Northwest. This member of the mustelid family is found in the Olympic Mountains, Coast Range and Cascade Mountains of Washington and Oregon eastward through the Okanogan Highlands and Selkirk Mountains (Hagmeier 1956; Yocom 1974).

Food Requirements

Martens eat a wide variety of items, but small mammals are the main prey. Martens prey largely on microtines, such as meadow voles (Microtus spp.), red-backed voles (Clethrionomys spp.), heather voles (Phenacomys intermedius), and bog lemmings (Synaptomys spp.) (Cowan and MacKay 1950; Koehler and Hornocker 1977, and others). Tree squirrels (Tamiasciurus spp., Glancomys sabrinus) were important components of the diet in Washington (Newby 1951) and Montana (Marshall 1946; Weckwerth and Hawley 1962); their importance appears to vary greatly from site to site (Koehler et al. 1975). Ground squirrels (Spermophilus spp.) are taken during the summer from forest openings (Cowan and Mackay 1950; Murie 1961). Pikas (Ochotona princeps) also appear in the diet (Cowan and MacKay 1950; Streeter and Braun 1968). Deer mice (Peromyscus spp.) and chipmunks (Eutamias spp.) are taken only in low numbers (Cowan and MacKay 1950; Koehler and Hornocker 1977).

The utilization of birds, insects, and berries varies seasonally. Young birds and eggs are taken in the spring (Lensink et al. 1952; Weckwerth and Hawley 1962) and grouse during the winter (Newby 1951; Quick 1955). Insects may be heavily exploited during the summer in some areas. Carpenter ants (Camponotus spp.) and hornets (Vespula spp.) were found in over 90% of the scats collected in the Washington Cascades during the summer (Newby 1951). Blueberries (Vaccinium spp.) and hawthorn berries (Crataegus sp.) are consumed in the Northern Rockies during late summer and fall (Murie 1961; Weckwerth and Hawley 1962; Koehler and Hornocker 1975).

The marten forages largely on the ground. The species actively searches the bases of trees for rodent burrow entrances during the winter (Koehler et al. 1975). Martens are also partly arboreal, as indicated by the presence of tree squirrels and small birds in the diet (Larrison and Sonnenberg 1968). The species caches captured prey under the snow or in tree cavities (Murie 1961).

Dense conifers on mesic sites are the major foraging areas used by martens in the winter (Koehler et al. 1975). Mesic sites generally support higher vole populations than hydric or xeric sites (Koehler et al. 1975). A dense stand of conifers (canopy closure of more than 30%) provides both cover and a large number of tree bases for foraging activities (Koehler et al. 1975).

However, a completely closed canopy may shade out the vegetative ground cover that provides food and cover for prey species. Martens foraged in mature Douglas fir (Pseudotsuga menziesii) forests and mixed stands of Douglas fir, western hemlock (Tsuga heteroplylla) and western redcedar (Thuja plicata) during the winter in Washington (deVos and Guenther 1952). Most winter foraging areas were below 1067 m (3500 ft.) elevation (Newby 1951). Dense spruce (Picea sp.) and subalpine fir (Abies lasiocarpa) forests more than 100 years old were used for winter foraging in Idaho (Koehler et al. 1975). Elevations varied from 1341 to 2377 m (4400 to 7800 ft.) (Koehler and Hornocker 1977). Marten do not hunt in openings during the winter and avoid openings more than 100 m (328 ft.) wide (Koehler et al. 1975).

Summer foraging areas for martens includes mesic conifer forests and adjacent openings. Martens search for voles, berries, insects, and ground squirrels in open meadows and burns (Koehler and Hornocker 1977). The species has been observed hunting in rock slides at or near timberline in British Columbia (Cowan and MacKay 1950), Colorado (Streeter and Braun 1968), and Utah (Hayward 1952). Martens foraged in subalpine fir-mountain hemlock (Tsuga mertensiana) forests between 1219 and 1676 m (4000 and 5500 m) elevation during the summer in Washington (Newby 1951). Subalpine fir-spruce forests at 2743 to 3353 m (9000 to 11,000 ft.) elevation were used in Colorado (Yeager and Remington 1956).

Prey availability is probably the major factor influencing marten distribution (Koehler et al. 1975). Mature mesic forest stands support a high vole population and show high marten use. Openings provide abundant voles, insects, and berries and receive high marten use when these are available. When abundant but clumped food resources were present in Alaska, marten movements were reduced (Lensink et al. 1955).

Water Requirements

No information on water requirements was found in the literature.

Cover Requirements

During the winter, the marten is most active in stands with more than 30% canopy cover to provide protection from weather (Koehler et al. 1975). The species avoids openings; if the opening is more than 100 m (328 ft.) wide, martens will not cross it. Winter den sites are located beneath snow under and around leaning trees, stumps, windfalls and heavy undergrowth (Newby 1951). Martens will use fallen logs as travelways.

Martens will use openings as well as forest during the summer. Areas without overhead cover, such as recently logged and burned areas, are avoided (deVos 1951; Hawley and Newby 1957). Cover in openings may be provided by brush, downed trees, and herbaceous vegetation; this low layer of cover is usually buried by snow in the winter.

Ground burrows, rock crevices, and trees may be used by martens as resting sites. Marten in Minnesota usually utilized burrows beneath boulders and logs, rock piles, and rock crevices for resting; only 1 of 13 rest sites was located in a tree (Mech and Rogers 1976). All 5 resting sites identified in

a New York study were placed in trees (Masters 1980). Both deciduous and coniferous trees were used; their dbh ranged from 26 to 55 cm (10.2 to 21.7 in.). Rock crevices were used for cover on alpine rock slides in Colorado (Streeter and Braun 1968).

Reproductive Requirements

Snags are an important component of breeding habitat for marten. Tree cavities and hollow logs are used as denning sites (deVos 1951). Of 16 marten dens in Idaho, 13 were in hollow logs and 3 were in hollow stumps (Marshall 1951). Such snags are probably only available in mature conifer stands, although quantiative data on denning habitat are lacking. Rock piles are potential den sites; young marten were found beneath one in Colorado (Remington 1952).

Special Requirements

The marten requires geographic isolation to prevent overtrapping (Koehler et al. 1975). Marten are easily trapped and roads may allow too much access to their habitat.

Interspersion Requirement

Marten require mature mesic forest stands for food and cover during the winter and for den sites in the summer. They forage in forests and openings such as old burns, meadows, and rock piles in the summer. Old-growth forest with some interspersed openings appears to represent optimal marten habitat (Newby 1951; Koehler et al. 1975).

Marten populations may undergo seasonal movements in some areas (Newby 1951) but not in others (Hawley and Newby 1957). Home range sizes in Glacier National Park averaged 2.4 km^2 (0.94 $mi.^2$) for males and 0.7 km^2 (0.27 $mi.^2$) for females (Hawley and Newby 1957). Size ranges were 0.8 to 4.4 km^2 (0.34 to 1.68 $mi.^2$) and 0.1 to 1.8 km^2 (0.03 to 0.70 $mi.^2$) for males and females respectively. The home range of radiotracked male marten in Minnesota was 10.5 to 19.9 km^2 (3.9 to 7.7 $mi.^2$) in area (Mech and Rogers 1976). The one female tracked in this study ranged over an area of 4.3 km^2 (1.7 $mi.^2$).

Special Considerations

Extensive logging of high elevation forests eliminates marten habitat (Yeager 1950). Cutting or burning small areas of forest increases forest community diversity and the variety and abundance of prey species (Yeager 1950; Koehler et al. 1975). Intensive grazing on high mountain meadows decreases herbaceous cover and vole populations (Yeager 1950).

Management recommendations for marten include leaving large blocks of mature forest undisturbed, connecting smaller blocks with forested corridors, and preserving a high canopy closure by selective cutting rather than clear cutting (Koehler et al. 1975).

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MARTEN

Herbland - High elevation grasslands and meadows

HABITAT REQUIREMENT	FIELD MEASUREMENT
Food	Relative prey abundance
Cover	Width of opening Abundance of cover

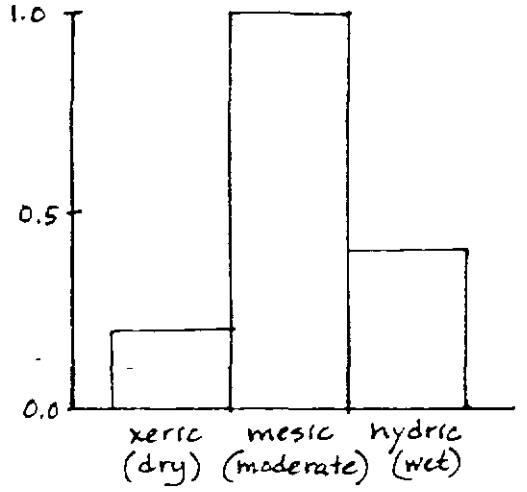
MARTEN

Evergreen Forest

HABITAT REQUIREMENT	FIELD MEASUREMENT
Food	Moisture conditions Relative prey abundance Stand age Percent canopy closure Proportion of open area within forest
Cover	Stand age Percent canopy closure Proportion of open area within forest
Reproduction	Stand age
Interspersion	Proportion of open area within forest

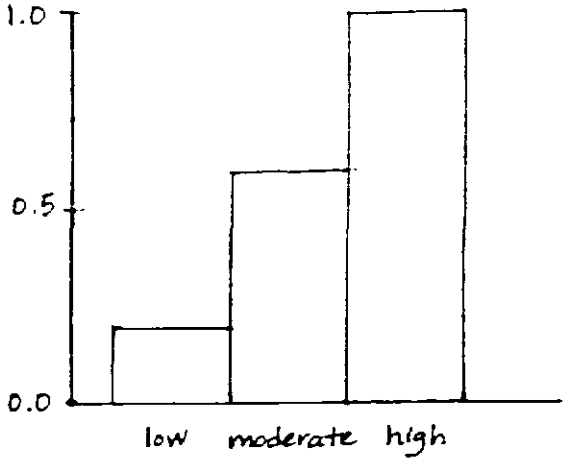
Evergreen Forest

1. Moisture conditions = visual assessment of the general moisture regime using current soil moisture, ~~and~~ plant community type, and topography as guides



Assumes:
- Prey population is lowest in a dry (xeric) forest, highest in a mesic forest, and moderate in a wet forest (Koehler et al. 1975)

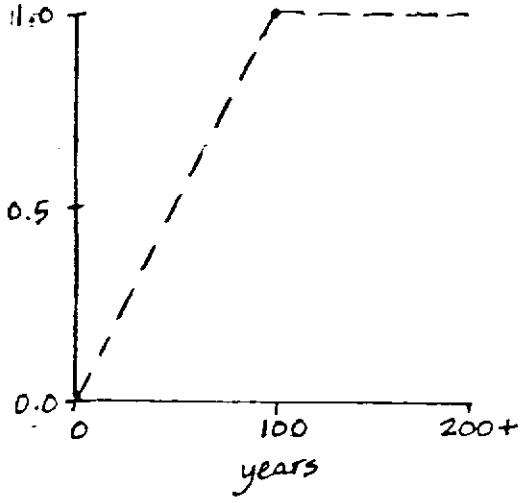
2. Relative prey abundance = subjective estimate of the amount of food available to a marten within its home range of 2.4 km^2 (0.9 mi^2) Abundance of fruit-bearing shrubs as well as the abundance of small animal species should be considered when estimating this index.



Assumes:
- Marten use is proportional to prey abundance (Hawley and Newby 1957; Koehler et al. 1975).
- Some population data on small mammals is available.

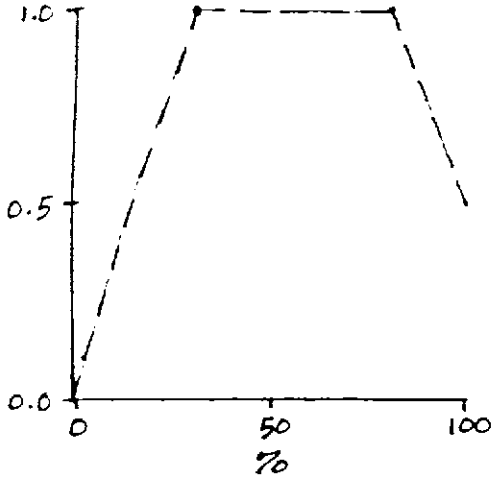
Evergreen Forest

3. Stand age



Assumes:
- Marten require mature forest to satisfy food, cover, and den needs.
- Suitability does not decrease for very old forests.

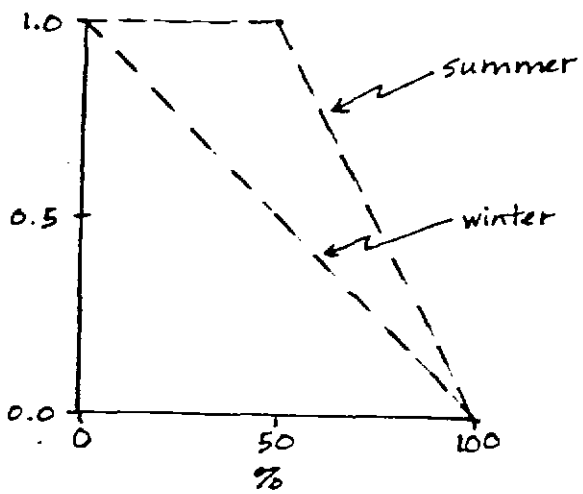
4. Percent canopy closure = measured on an area the size of a marten's home range (2.4 km^2, 0.9 mi^2)



Assumes:
- More than 30% canopy closure is needed for cover requirements (Koehler and Hornocker 1977). However, less than 100% is needed for optimal prey availability, because a completely closed canopy will shade out the herbaceous growth that serves as food and cover for vole species (Koehler and Hornocker 1977).

Evergreen Forest

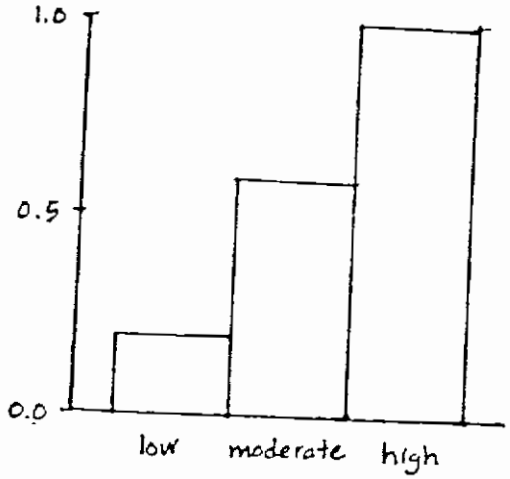
5. Proportion of open area within forest = measured on an area the size of a marten's home range (2.4 km^2, 0.9 mi^2)



Assumes:
- Forest is more suitable as marten habitat than openings. The difference in suitability is greater in the winter than in the summer.
- Martens use openings in summer, but not in winter (Koehler and Hornocker 1977).

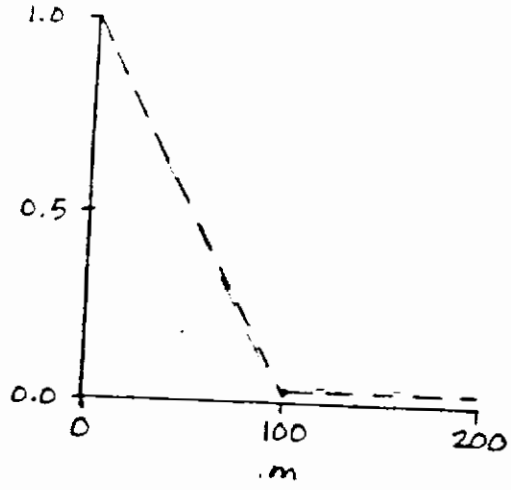
Herbland - High elevation meadows and grasslands

1. Relative prey abundance = subjective estimate of the amount of food available to a marten within its home range of 2.4 km² (0.9 mi²). Abundance of fruit-bearing shrubs as well as the abundance of small animal species should be considered when estimating this index.



Assumes:
- Marten use is proportional to prey abundance (Hawley and Newby 1957; Koehler et al. 1975)
- Some population data on small mammals is available.

2. Width of opening = measured across shortest dimension of herbland

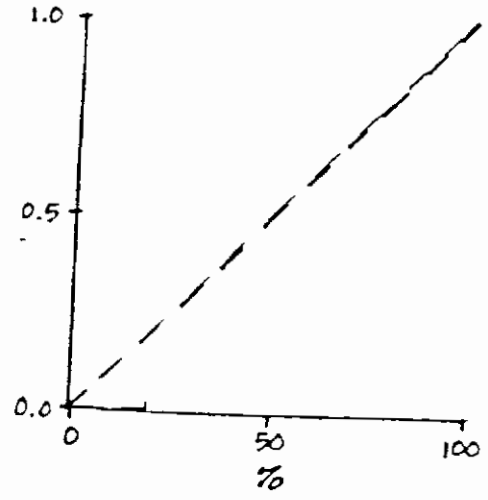


Assumes:
- This feature is only important to martens during the winter.
- Martens will cross an opening < 100 m wide but will not cross any opening wider than 100 m during the winter (Koehler et al. 1975; Koehler and Hornocker 1977)

Herbland – High elevation meadows and grasslands

3. Abundance of cover = amount of overhead cover provided to a marten by deadfall and debris, tall herbaceous plants, and shrubs. May be measured as a percent (Graph a) or subjectively estimated (Graph b).

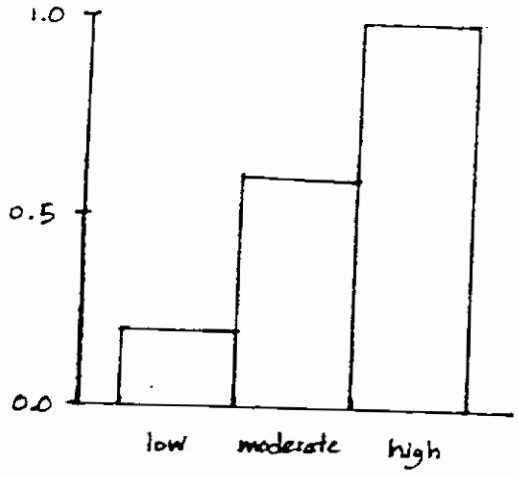
Graph a



Assumes:

- This feature is important to martens only during the summer
- Marten use is proportional to the abundance of overhead cover

Graph b



D3105
9/2/86

Douglas' Squirrel

(Tamiasciurus douglasii)

General

- Primarily associated with Douglas fir forests, although it occurs in mixed stands of coniferous trees and of coniferous and deciduous trees (Bailey 1936, Ingles 1965).
- Cone production is most important factor influencing habitat (Smith 1965 and 1968).

Food Requirements

- Major food is seeds of conifers, especially Douglas fir, Sitka spruce, hemlock, true firs and lodgepole pine (Bailey 1936, Smith 1965 and 1968).
- Conifer pollen, birch and alder catkins, maple samaras, nuts, acorns, some soft fruits, buds and bark are also eaten (Bailey 1936, Smith 1965).
- Eat terminal and lateral buds of Douglas fir, especially during winter and spring (Fisch and Dimmock 1978).
- Mushrooms and hypogeous fungi eaten (Smith 1965, Maser et al. 1978, Fogel and Trappe 1978).
- Prefers mature conifer forests without dense understory for feeding. Occassionally feeds in deciduous riparian zones (Brown 1985).
- Presence of cone caches is a good indicator of Douglas' squirrel presence.

Water Requirements

- Most of the water requirements are met by metabolic water (Smith 1965 and 1968).

Cover Requirements

- Shelter in cavities in trees and sometimes in openings between rocks on talus slopes (Ingles 1965).
- Globular nest may be built in crowns of trees, and, at least in winter, the subterrainean food caches themselves may be used for shelter (WDG 1982).
- Nest, forage and travel in mature coniferous trees (Smith 1965, 1968).

Reproductive Requirements

- Occurrence and timing of breeding and size of litters vary directly in response to changes in production of conifer seed crops (Smith 1965 and 1968).

- Nests are usually in cavities at least 20 ft. above ground in trees that are at least 17 in. dbh (Brown 1985).

Special Habitat Requirements

- Body size, jaw musculature, anatomy, and reproductive activity appear to be adapted to life in forests where Douglas fir trees predominate (Smith 1965 and 1968).

- Territorial throughout the year, territory size varies from 1 acre to 2+ acres (Smith 1965 and 1968).

Special Considerations

- Particularly dependent on cones of Douglas fir trees, which are relatively easy to open compared to the cones of such conifers as lodgepole pine (Smith 1965, 1968).

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APPENDIX A

Word models used in original HEP Study (WDG 1982)

DOUGLAS SQUIRREL
Coniferous Forests

General

The Douglas squirrel (Tamiasciurus douglasii) is primarily associated with Douglas-fir (Pseudotsuga menziesii) forests, although it also occurs in mixed stands of coniferous trees and of coniferous and deciduous trees (Bailey 1936;Ingles 1965). The most important factor influencing the use of habitat by Douglas squirrels appears to be the production of cones by coniferous trees (Smith 1965, 1968).

Food Requirements

Smith (1965, 1968) provided a detailed list of food eaten or stored by Douglas squirrels and red squirrels, and concluded that both species are adapted to an energy-rich diet. The major food of Douglas squirrels is seeds of conifers, especially of Douglas-fir, Sitka spruce (Picea sitchensis), hemlock (Tsuga spp.), firs (Abies spp.), and lodgepole pine (Pinus contorta) (Bailey 1936; Smith 1965, 1968). Conifer pollen, birch (Betula spp) and Alder (Alnus spp.) catkins, maple, (Acer spp.) samaras, nuts, acorns, some soft fruits, buds and bark are also eaten (Bailey 1936; Smith 1965), as are mushrooms and hypogeous fungi (Smith 1965; Maser etal 1978; Fogel and Trappe 1978). During the late summer and in fall, the squirrels store thousands of cones, nuts and catkins in food caches. These food stores are exploited during the winter and, in the event of a cone crop failure, during the following summer (Smith 1965, 1968).

Water Requirements

Free water may or may not be abundant in the habitat of Douglas squirrels. Smith (1965, 1968) stated that the squirrels seldom drank water when it was present; however, he noted that the fungi eaten by the squirrels are an important source of preformed water in summer, and concluded that most of the water requirements of the squirrels are met by preformed water.

Cover Requirements

Douglas squirrels shelter in cavities in trees, and sometimes in openings between rocks on talus slopes (Ingles 1965). Globular nests may be built in the crowns of trees, and, at least in winter, the food caches themselves may be used for shelter.

Smith (1965, 1968) presented data showing a relationship between numbers of coniferous trees over 20 inches in circumference and cone crops on squirrel territories, but this relationship was addressed to food supply rather than directly to cover. Douglas squirrels, however, are thoroughly arboreal; not only do they nest and forage in mature coniferous trees, but also travel on and in them whenever possible.

Reproductive Requirements

Smith (1965, 1968) reported that occurrence and timing of breeding and size of litters vary directly in response to changes in production of conifer seed crops available to Douglas squirrels. Litters are produced at a time that would provide mothers with a large food supply near the end of lactation. Smith suggested that the squirrels may be able to assess, before breeding, the success of conifer pollination in a given year, and also how much cached food is available to support a spring litter. Nests are usually in cavities at least 15 feet (4.5m) above the ground in trees that are at least 12 inches (30.5cm) dbh (Thomas et al. in press).

Special Habitat Requirements

Douglas squirrel body size, jaw musculature, anatomy, and reproductive activity appear to be adapted to life in forests where Douglas-fir trees predominate (Smith (1965, 1968).

Interspersion Requirements

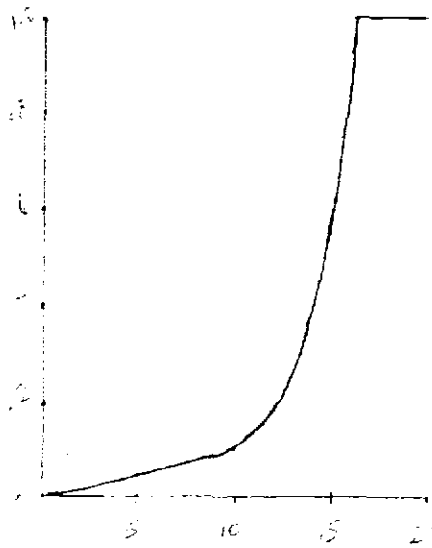
Douglas squirrels of both sexes are territorial throughout the year; territories vary in size from about 1 acre to more than 2 acres (Smith 1965, 1968). The distribution of food and time of year regulate how territories are established (Smith 1965, 1968).

Special Considerations

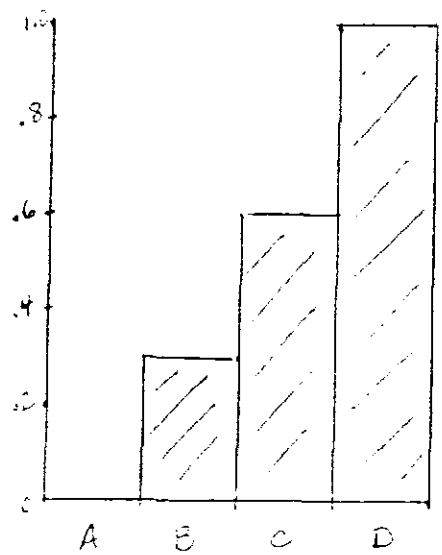
Smith (1965, 1968) showed that Douglas squirrels and the closely related red squirrels depend heavily on the available crop of conifer seeds for over-winter survival and for reproduction in the following spring. The Douglas squirrel is particularly dependent on the cones of Douglas-fir trees, which are relatively easy to open compared to the cones of such conifers as lodgepole pine. Smith (1965, 1968) showed that a lactating red squirrel extracted energy from Douglas-fir cones four times faster than she did from lodgepole pine cones, and that red squirrels had significantly smaller litters in years in which Douglas-fir cones were not available during lactation. Since Douglas squirrels can exploit alternative cone sources even less effectively than can red squirrels, their life history is apparently directly dependent on the presence of Douglas-fir trees of suitable age and fecundity.

Although Douglas squirrels feed primarily on seeds of conifers , they may also feed on the terminal and lateral buds of Douglas fir, especially during winter or early spring (Fisch and Dimmock 1978). The percentage of trees affected by shoot clipping by squirrels ranged from 1-38% but resulting height loss was found to be temporary and minimal.

DOUGLAS' SQUIRREL



V1 Average dbh of trees



V2 Stand composition

A-- No Douglas-fir present
B-- Douglas-fir occurs in small (< 1 acre) scattered stands
C-- Stand composed of 50% Douglas-fir
D-- Pure Douglas-fir stand

Food Value (X_1) = $(V1 \times V2)^{1/2}$

Where: V1 = Suitability Index (SI) of average dbh of trees.

V2 = SI of stand composition.

Reproductive Value (X_2) = V1

Where: V1 = SI of average dbh of trees.

The Habitat Suitability Index is the lowest X_n value.

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D3105
9/2/86

Common Merganser

(Mergus merganser)

General

- The common merganser (Mergus merganser) is found throughout the year in western Washington. Approximately 300 pair breed in western Washington while 2,300 individuals winter in the Puget Sound region (Bellrose 1976).

Food Requirements

- Many kinds of fish, especially juvenile salmon and trout (Wood 1986).
- Also mussels, frogs, small eels, salamanders, crawfish, other small crustaceans, leeches, worms, aquatic insects and larvae, and the stems of roots of aquatic plants (Bent 1923, Terres 1980).
- Swims on surface searching visually, then dives and catches fish by direct persuit; usually in clear, shallow water 1 to 6 ft deep (Bellrose 1976).
- Probes among submerged rocks to flush prey (Bent 1923).

Water Requirements

- Spring and summer - use lakes and rivers bordered by suitable habitat for nesting (Bellrose 1976).
- Winter - use salt water, also lowland lakes and rivers to some extent (Bellrose 1976).
- Must have clear water. Mated pairs will abandon streams that become turbid (Bellrose 1976).
- The creation of reservoirs has caused an increase in wintering populations in many areas (Bellrose 1976).

Cover Requirements

- Typically use mature and old growth deciduous riparian, mixed conifer, and coniferous forests when located along lakes or streams (Brown 1985).

Reproductive Requirements

- Prefer nesting along mid-to-high elevation lakes and streams in western Washington (Larrison and Sonnenberg 1968).

- Secondary cavity nester - primarily nests in cavity-bearing trees near water, also nests in caves, cliffs, root tangles, well hidden locations on the ground, in nest boxes and buildings. Prefer using abandoned pileated woodpecker cavities (Brown 1985).

- Nest height ranges from 0-200 ft. Nesting may occur as far as 575 ft. from water (Bellrose 1976).

- Nesting occurs between May and mid-July (Bellrose 1976).

- The same nesting cavity may be used year after year.

- Rivers and lakes are preferred brooding areas (Wood 1986).

Interspersion Requirements

- Rivers and lakes must be bordered by suitable nesting habitat (snags dead down material) in spring.

- Home ranges are approximately 2-3 river miles (Brown 1985).

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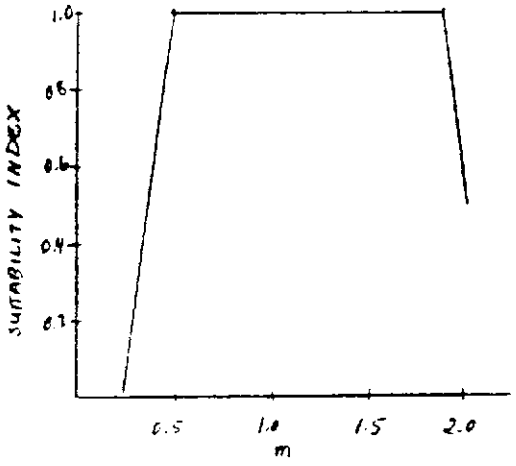
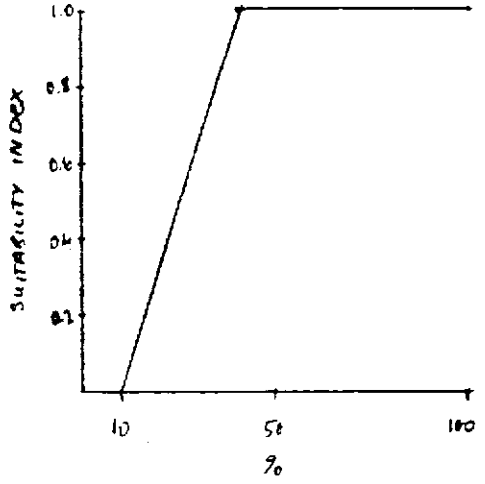
APPENDIX A

Suitability indices and aggregation formula obtained from the North Fork Snoqualmie Study (BEAK 1985).

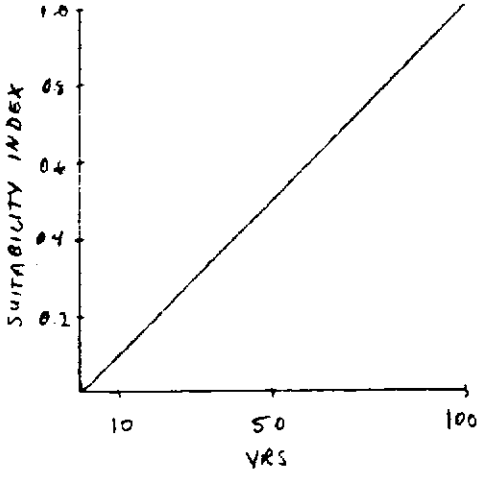
Common MERGANSER



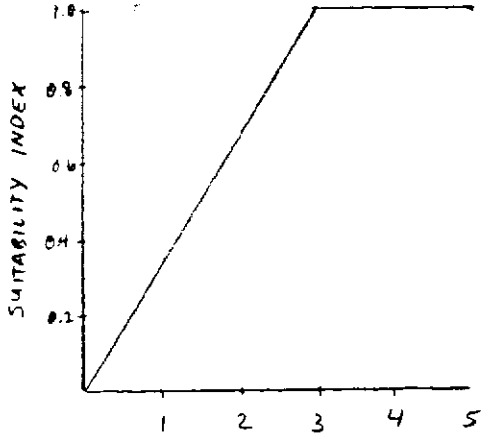
V_1 Water depth



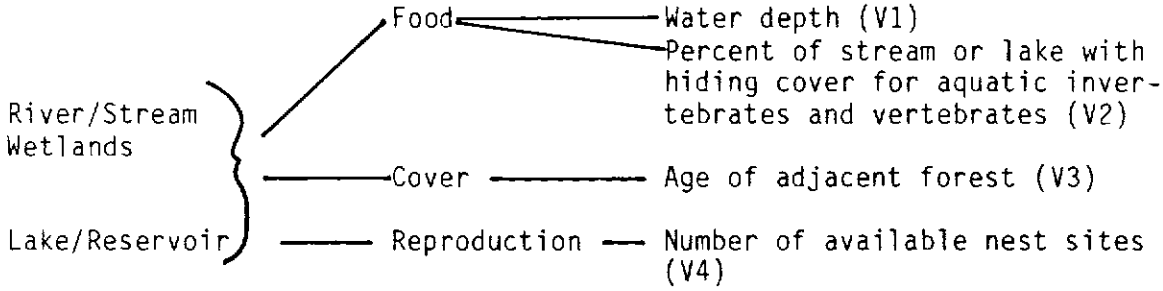
V_2 Percent of stream or lake with hiding cover for aquate vertebrates and invertebrates.



V_3 Age of adjacent forest community



V_4 Number of available nest sites



The Habitat Suitability Index is:

$$\frac{V_1 + V_2 + V_3 + V_4}{4}$$

APPENDIX B

Word model used in original HEP Study (WDG 1982)

COMMON MERGANSER

CORPS OF ENGINEERS - CRUNER

General

The common merganser (Mergus merganser) is a common permanent resident on lakes and rivers, though moving to salt water in winter.

Food Requirements

The common merganser eats many kinds of fish throughout the year, especially salmon and trout. Local texts mention only fish as the food for this species, and even state that it does damage to populations of salmon and trout. It is assumed that in Western Washington they also eat some of the following prey items listed by A.C. Bent: mussels, frogs, small eels, salamanders, crawfish, other small crustaceans, leeches, worms, aquatic insects and larvae, and the stems and roots of aquatic plants.

Water Requirements

In spring and summer, lakes and rivers bordered by suitable habitat for nesting, and (usually) salt water (strait of Juan de Fuca, Puget Sound) in winter, though also utilizing lowland lakes and rivers to some extent.

Cover Requirements

Usually a cavity for nesting, or well hidden nests on the ground.

Reproductive Requirements

In Western Washington, seem to prefer nesting along mid- to high-elevation lakes and streams. Usually the nest is located in

in a cavity in a tree. Sometimes the common merganser nests in cavities in cliffs close to water. They have also nested in well-hidden locations on the ground, and in old hawk or crow nests. The nest is always lined with "weeds, grasses, and rootlets, and plentifully supplied with down from the birds breast." (A.C Bent). Nesting occurs between early May and mid-July.

Interspersion Requirements

Rivers and lakes in spring must be bordered closely by suitable nesting habitat.

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D3105
9/2/86

Mallard

(Anas platyrhynchos)

General

- The mallard, (Anas platyrhynchos) is a widespread freshwater waterfowl species, common throughout the year in western Washington.
- Approximately 50,000 mallards winter in the Puget Sound region.

Food Requirements

- Plants comprise 90 percent of diet. Plants eaten include sedges, pondweed, duckweed, and many kinds of seeds (Martin et al. 1951, Pehrsson, 1984).
- Juveniles less than three weeks old feed primarily on animal matter. Aquatic beetles, larvae and nymphs of mayflies, stoneflies, caddisflies, dragonflies, damselflies, tadpoles, fish fry, and crustaceans are important animal food (Bent 1923, Yocum 1957).
- Seeds are important food sources during spring migration and during brood rearing (Krapu 1981).
- Food is picked up from the surface or just below the surface.
- Must have open, shallow water areas for feeding (Johnsgard 1975).
- Grain crops (including corn, wheat, and barley) and pastures are heavily utilized in winter (Yocum 1957).

Water/Cover Requirements

- Found in freshwater, prefer sloughs, ponds, marshes, slow-moving streams and rivers and swamps (Johnsgard 1975).
- Long narrow sloughs, floating islands, and gradually sloping shorelines are used for loafing (Girard 1941). Areas with dense vegetation are avoided for loafing (Sowls 1955).
- Seasonal wetlands are preferred feeding habitat by laying hens (Krapu et al. 1983; Cowardin et al. 1985
- Reservoirs are utilized during winter months and during migration periods in western Washington. (WDG 1982, Walters 1986).
- Broods utilize wetlands having sparse to dense emergent vegetation and open water. Wetlands without emergent vegetation or open water are usually avoided. Shorelines bare of emergent vegetation are seldom used (Berg 1956, Rumble and Flake 1983).

- Artificial islands and environments with reduced numbers of predators significantly increase nesting densities and hatching success (Duebbert and Lokemoen 1980).

Reproductive Requirements

- Nesting density (pairs/acre) is higher in seasonal wetlands than deep marshes and permanent water areas (Duebbert et al. 1983). Seasonal wetlands without fish populations provide larger-sized insects and greater overall insect abundance (Pehrsson 1984).

- Deep marshes and permanent water areas are used for rearing of young (Duebbert et al. 1983). These areas are preferred during migration and rearing, when vegetation and seeds are the primary food source (Pehrsson 1984).

- Beaver impoundments often create suitable nesting habitat (Beard 1953).

- Nests are placed in relatively tall herbaceous vegetation in close proximity to water. Vegetation height varies between 8 in. and 30 in. in nesting areas. Most nests are within 300 ft. of water (Bellrose 1976, Lokemoen et al. 1984).

- Mature, relatively dense grasses, rushes, and shrubs are preferred for nesting. In areas with high breeding densities, thicker, dense shrub vegetation (nearly 100 percent visual obscurity) is preferred (Lokemoen et al. 1984).

Interspersion Requirements

- Home ranges during the breeding season can be as large as 700 acres (Brown 1985).

- Home ranges often overlap (Lokemoen et al. 1984), though pairs may defend nesting ponds against other mallards (Dzubin 1969).

- A minimum of three acres of nesting and rearing wetland habitat is needed within hen breeding home range to support one mallard pair. Maximum production will result from the proximity and interspersion of nesting and rearing habitat (Dzubin 1969).

- Deep marshes should be within a 1 mile radius of shallow marshes (Jahn and Hunt 1964).

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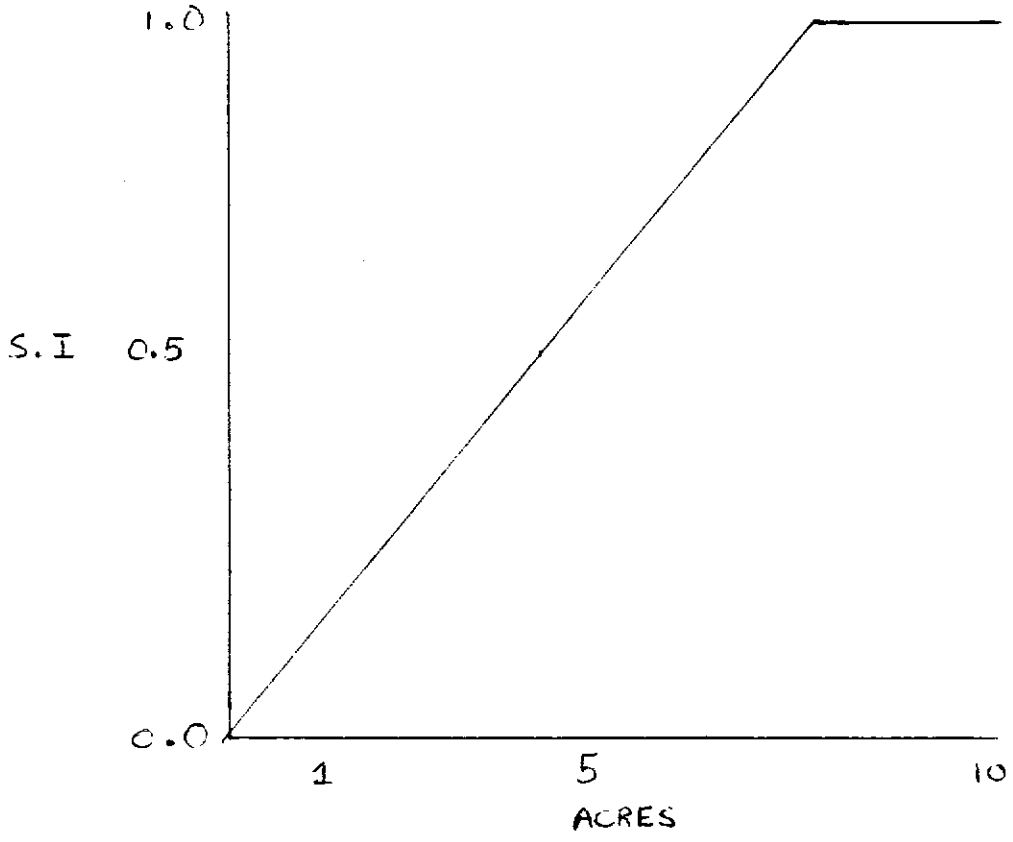
APPENDIX A

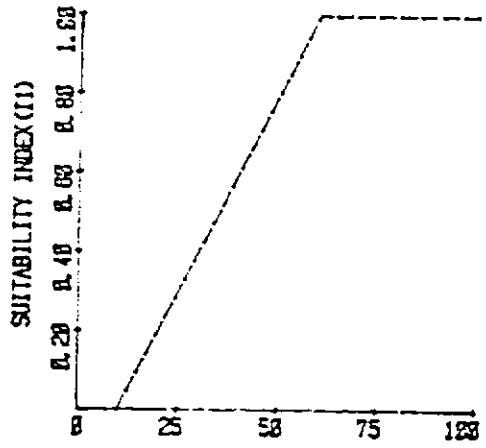
Suitability index obtained from the USFWS draft Habitat Suitability Index Models - mallard (USFWS 1985).

Size of Water Body (Winter & Migration)
(USFWS 1985)

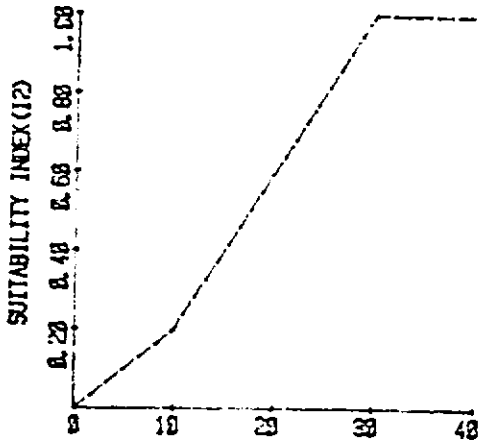


MALLARD

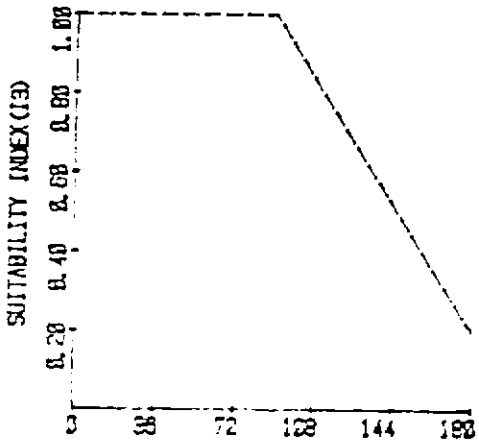
TREE-DOMINATED WETLAND



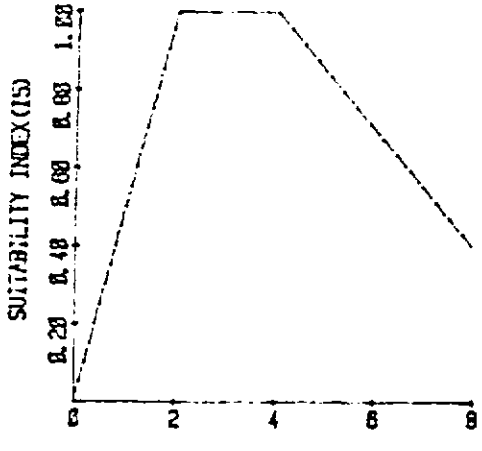
HERBACEOUS CANOPY COVER (%)



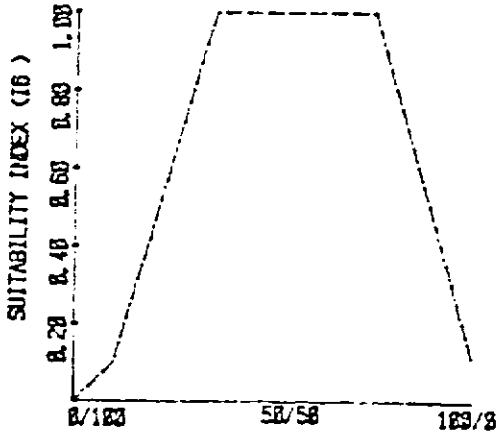
AV HEIGHT OF HERBACEOUS VEGETATION (CM)



DISTANCE TO WATER (M)



SIZE OF WATER BODY (HA)
(BREEDING)



RATIO OF EMERGENT VEGETATION TO OPEN WATER

D3105
9/2/86

Beaver

(Castor canadensis)

General

- A common mammal in the western Washington lowlands where numerous watercourses provide suitable habitat (Dalquest 1948).
- Factors affecting range potential include topography, stream gradient, adequate water, abundance of food species and land use (Dickinson 1971; Williams 1961).

Food Requirements

- Diet includes a wide variety of aquatic and emergent vegetation, forbs, ferns, shrubs, and trees. Preferred species are willow (Salix spp.), cottonwood (Populus spp.), alder (Alnus spp.), maple (Acer spp.) and ash (Fraxinus spp.) (Denny 1950).
- In streams which flow west from the Cascades to Puget Sound beavers ate a variety of species of willow as their principal food (Dalquest 1948).
- Also eat other plant species such as alder, cascara (Rhamnus purshiana), Douglas fir (Pseudotsuga menziesii), red huckleberry (Vaccinium parvifolium) and salmonberry (Rubus spectabilis) in lesser amounts (Dalquest 1948).
- Water lilies (Nymphaea spp.) with thick, fleshy rhizones provide a good winter food source (Jenkins 1981).
- Majority of foraging occurs within 300 ft. of the water's edge, although can forage within 650 ft. of water (Allen 1982).
- The dbh of trees should range from 1 to 6 in. (Allen 1982), but prefer trees 3 to 4 in. dbh (Bradt 1947; Hodgdon and Hunt 1953; Longley and Moyle 1963; Nixon and Ely 1969).
- Tree and/or shrubs canopy closure between 40 and 60% is an indication of optimum food availability (Allen 1982).

Water Requirements

- Require permanent supply of water (Allen 1982).
- Stable water levels are optimal. Large rivers and lakes where water depth and/or fluctuation cannot be controlled are less suitable (Murray 1961; Slough and Sadliev 1977).
- Stream gradients of less and 6 percent are optimal (Retzer et al. 1956).

Cover Requirements

- Most dig bank burrows in deep and wide water courses (Dalquest 1948; Kebbe 1978; Thoriley 1978).
- Dams are built in shallower low gradient mountain streams (WDG 1982).
- Actively eroding stream banks, rocky channels and sandy soils are unfavorable habitat (Retzer et al. 1956, Henderson 1960).
- On lakes and ponds, lodges are frequently situated in areas that provide shelter from wind, wave and ice action (e.g., convoluted shorelines) (Allen 1982).

Reproductive Requirements

- See cover requirements.

Special Habitat Requirements

- Association of wide valleys with loamy soils and streams of low gradient is favorable to beaver occupancy (Hall 1960).
- Rapid water level fluctuations that exposed or flooded river bank dens are detrimental to beaver survival (Claire et al. 1971).
- Frequent small fluctuations had little adverse effects (Claire et al. 1971).

Interspersion Requirements

- Interspersion of food and water is important. Chief limiting factor in beaver carrying capacity was the amount of available food (MacDonald 1956).
- Usually travel up to 300 ft. for food, but maximum distance recorded was 656 ft. (Bradt 1936, 1947, Hodgdon and Hunt 1953).
- 90% of tree cutting occurred within 100 ft. (30.5 m) of the stream (Hall 1960).

Special Considerations

- Will live in close proximity to man if habitat requirements are satisfied (Henderson 1960).

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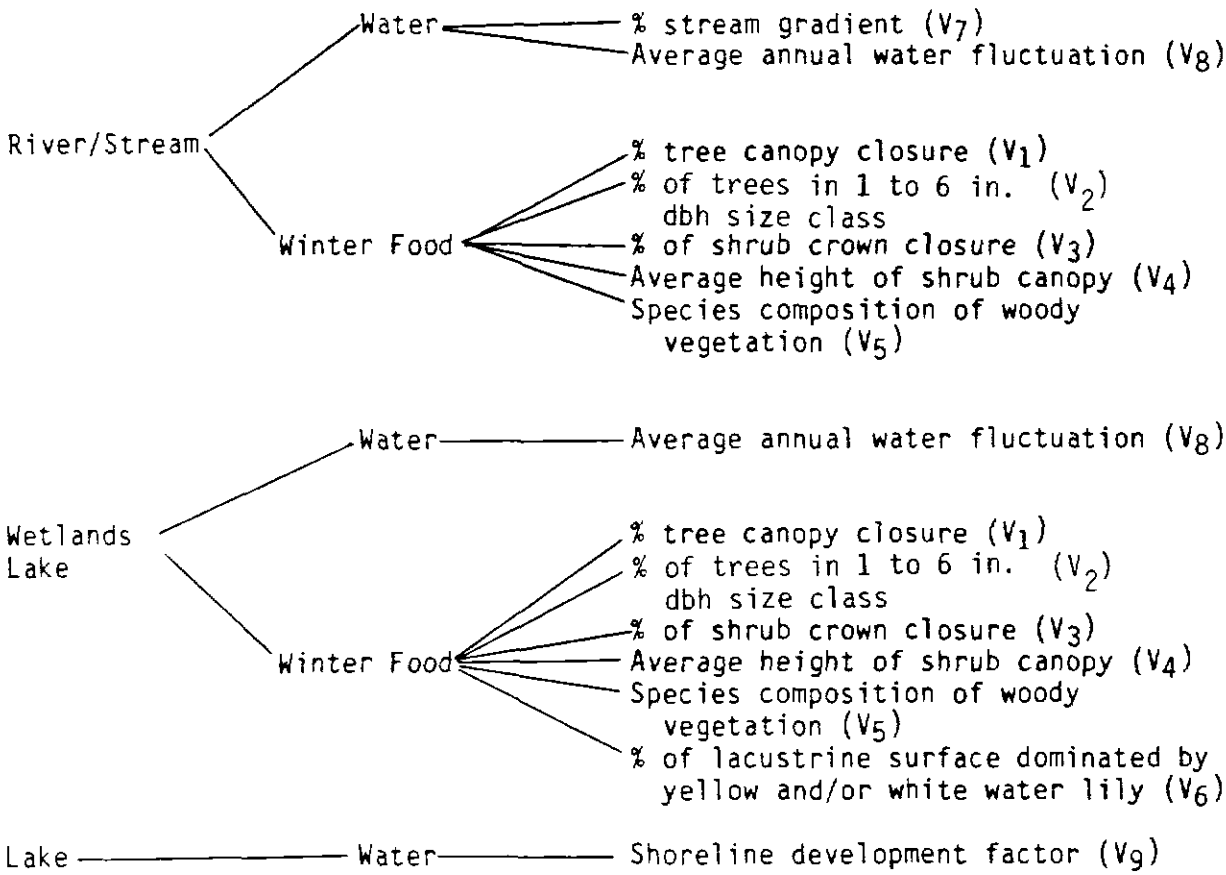
APPENDIX A

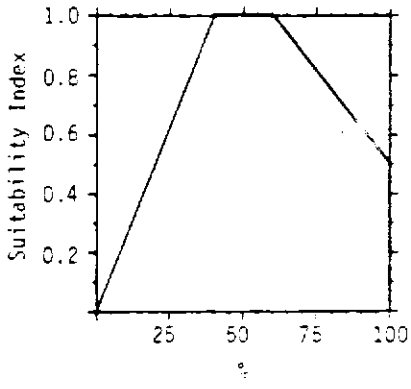
Suitability indices and aggregation formula obtained from the USFWS Habitat Suitability Index Model - beaver (Allen 1982).

BEAVER

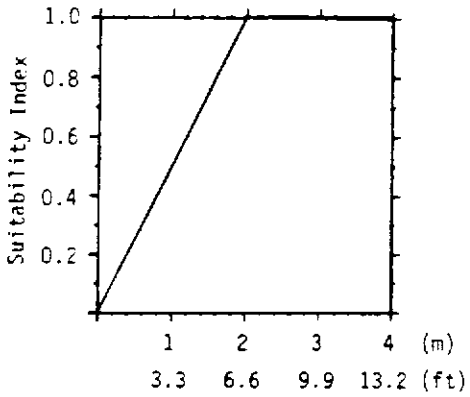


Note: Water provides cover for the feeding and reproductive activities of the beaver.

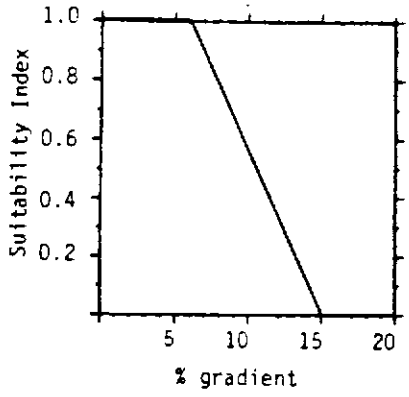
Beaver



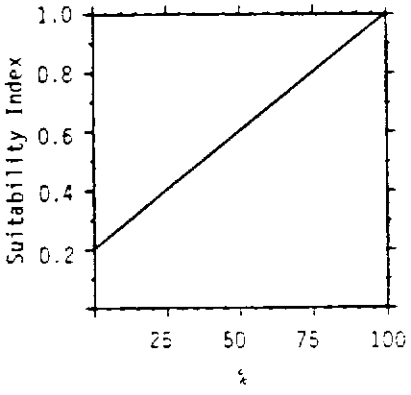
V_1 Percent tree canopy closure.



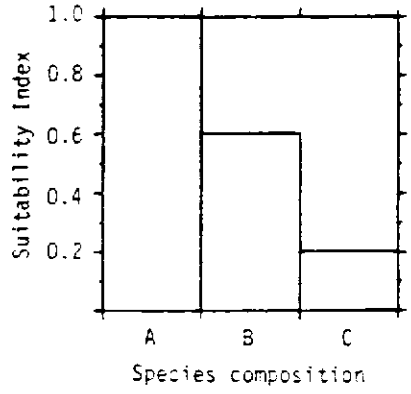
V_4 Average height of shrub canopy.



V_7 Percent stream gradient.

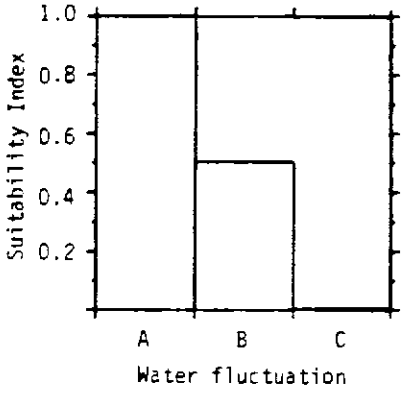


V_2 Percent of trees in 2.5 to 15.2 cm (1 to 6 inches) dbh size class.



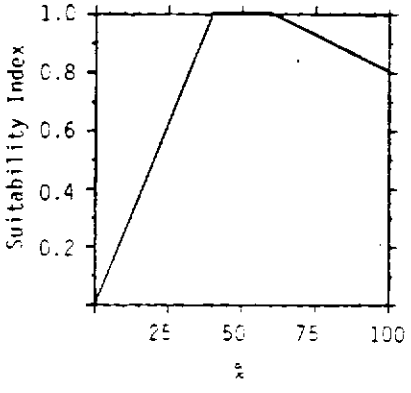
V_3 Species composition of woody vegetation (trees and/or shrubs)

A) Woody vegetation dominated (≥ 50%) by one or more of the following species: aspen; willow; cottonwood; or alder.
B) Woody vegetation dominated by other deciduous species.
C) Woody vegetation dominated by coniferous species (e.g., fir and pine).

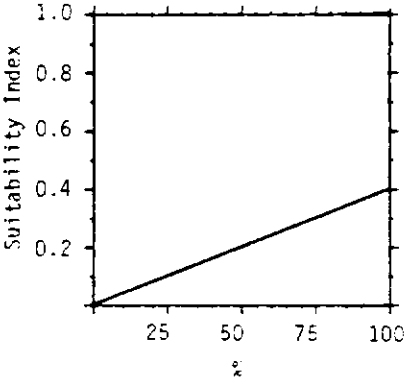


V_6 Average water fluctuation on annual basis.

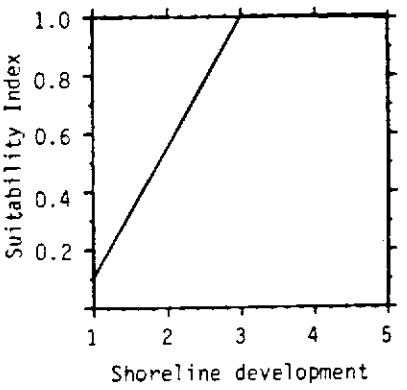
A) Small fluctuations that have no effect on burrow or lodge entrances.
B) Moderate fluctuations that affect burrow or lodge entrances.
C) Extreme fluctuations or water absent during part of year.



V_5 Percent shrub crown cover.



V_8 Percent of lacustrine surface dominated by yellow and/or white water lily.



V_9 Shoreline development factor (see variable definition in Figure 4).

Life requisite	Cover type	Equation
Winter food	Wetlands /bog/pond	$\frac{a+b+c}{2.5}$
Winter food	River	$\frac{b+c}{1.5}$
Winter food	Lake/Reservoir	$\frac{b+c}{1.5} + V_6$

where: a = woody vegetation value within actual wetland boundary. The suggested equation is:

$$[(V_1 \times V_2)^{1/2} \times V_5]^{1/2} + [(V_3 \times V_4)^{1/2} \times V_5]^{1/2}$$

b = woody vegetation value within 100 m (328 ft) from the water's edge. The suggested equation is:

$$[(V_1 \times V_2)^{1/2} \times V_5]^{1/2} + [(V_3 \times V_4)^{1/2} \times V_5]^{1/2}$$

c = woody vegetation value within 100 m (328 ft) to 200 m (656 ft) from the water's edge. The suggested equation is:

$$0.5\ [(V_1 \times V_2)^{1/2} \times V_5]^{1/2} + [(V_3 \times V_4)^{1/2} \times V_5]^{1/2}$$

Water	River	V_7 or V_8, whichever is lowest.
Water	Lake/Reservoir	V_8 or V_9, whichever is lowest, if lacustrine area ≥ 8 ha (20 acres) in surface area. V_8, if lacustrine area is < 8 ha (20 acres) in surface area.
Water	Wetlands /bog/pond	V_8

HSI determination. Based on the limiting factor concept, the HSI is equal to the lowest life requisite value obtained for either food or water.

APPENDIX B

Word model used in original HEP Study (WDG 1982)

BEAVER

Riparian Communities

General

The beaver (Castor canadensis) is a common mammal in the western Washington lowlands where numerous watercourses provide suitable habitat (Dalquest 1948). It also occurs throughout the Willamette Valley of Oregon (Ingles 1965). The following factors affect beaver range potential: topography, stream gradient, adequate water, abundance of food species and land use (Dickinson 1971; Williams 1961).

Food Requirements

Beavers are generalized herbivores (Jenkins 1975). Their diet includes a wide variety of aquatic and emergent vegetation, forbs, ferns, shrubs and trees. Listed in order of preference the preferred food species of beaver in Colorado are aspen (Populus spp.), willow (Salix spp.), cottonwood (Populus spp.), alder (Alnus spp.), maple (Acer spp.) and ash (Fraxinus spp.) (Denny 1950). In California, beavers utilized willow in the absence of aspen (Hall 1960). Rutherford (1954) found that, in Colorado, the principal beaver food species of the plains riverbottom habitat was cottonwood with species of willow also supplying an important part of the diet. Agricultural crops such as corn and alfalfa are eaten if accessible within their cruising radius from water. Retzer et al. (1956) found that aspen was the most palatable species in Colorado, although willow was eaten in large quantities. Beavers inhabiting streams which flow west from the Cascades to the Puget Sound ate a variety of species of willow as their principal food (Dalquest 1948). Other plant species such as alder, cascara (Rhamnus purshiana), Douglas fir (Pseudotsuga menziesii), red huckleberry (Vaccinium parvifolium) and salmonberry (Rubus spectabilis) were eaten in lesser amounts. Beaver showed a tendency in the summer to use both terrestrial and aquatic species of herbaceous vegetation.

Eelgrass (Zostera marina), duckweed (Lemna spp.), waterweed (Elodea canadensis), water lily roots (Brasenia sp; Nuphar sp.), cattail (Typha latifolia), blackberry (Rubus sp.), goldenrod (Solidago spp.), sedge (Carex spp.), bulrush (Scirpus spp.) and bur-reed (Sparganium spp.) were eaten in Colorado (Denny 1950). The sprouting capacity of willow made it a durable mainstay of the beaver economy in California; overbrowsed sections recovered vigorously and the willow was utilized on a sustained use basis (Hall 1960).

Water Requirements

No drinking water requirements were found in the literature.

Cover Requirements

Most of the beavers in this ecoregion dig bank burrows rather than construct lodges (Dalquest 1948; Kebbe 1978; Thoriley 1978). Burrows are usually associated with deep watercourses. Where deep water is not available, as in the shallower mountain streams, the beaver constructs dams. The deep pool which forms behind the dam provides escape cover. Retzer et al (1956) found that eroding, rocky channels were unfavorable beaver habitat. Sandy soils may prevent burrow construction (Henderson 1960).

Reproductive Requirements

Cover for the young is provided by the adult lodge or burrow (Henderson 1960) Kits are born in April and May (Ingles 1965).

Special Habitat Requirements

The association of wide valleys with streams of low gradient is favorable to beaver occupancy (Hall 1960). In Colorado, valley floodplains that are wider than the width of the channel provide suitable beaver habitat whereas valleys which are only channel wide or narrower are only marginal (Retzer et al 1956). Stream gradients of less than 6% are optimal. Gradients from 7 to 12% are good, and 13 to 15% are of questionable value. Streams with gradients greater than 15% are unsuitable.

Rapid water level fluctuations that exposed or flooded river bank dens were found to be detrimental to beaver survival (Claire et al. 1971). These fluctuations are most damaging during the kitting season. Frequent small fluctuations had little adverse effects.

Interspersion Requirements

MacDonald (1956) found that one of the chief limiting factors in beaver carrying capacity was the amount of available food. Most investigators have determined that beaver will travel up to 300 feet (91.4 m) on land to suitable food supplies; 656 feet (200 m) was the maximum observed distance (Bradt 1938, 1947; Hodgdon and Hunt 1953). Hall (1960) reported that 90 percent of tree cutting occurred within 100 feet (30.5 m) of the stream.

Special Considerations

Beavers will live in close proximity to man if its habitat requirements are satisfied (Henderson 1960). Berghofer (1961) stated that beaver were excellent developers of waterfowl habitat. Neff (1957) reported that waterfowl and muskrat were significantly more common on beaver occupied streams. Beaver ponds provided interspersion of food and cover plants, loafing sites for waterfowl, and shallow water for waterfowl foraging (Beard 1953). Gard (1961) found that beaver ponds produced a high standing crop of bottom fauna and a unique physical habitat which resulted in greater trout production.

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Osprey

(Pandion haliaetus)

General

- The osprey (Pandion haliaetus) is a migratory raptor common April through September in western Washington.

Food Requirements

- Feed almost exclusively on fish, both fresh and salt water, usually in the 6 to 10 in. size class, although four to six pound fish are not uncommon prey (Bend 1937, Hughes 1983).
- No particular fish species seem to be preferred, almost any fish found at or near surface will be taken.

Water/Cover Requirements

- Regularly use land adjacent to lakes, ponds and streams that are ice-free by mid-April for nesting. Land adjacent to reservoirs is associated with higher nesting densities than land adjacent to free flowing rivers (Van Daele and Van Daele 1982, Grover 1984).
- Utilization of water bodies appears to be related to available surface area and fish production (Van Daele and Van Daele 1982).

Reproductive Requirements

- Nest sites are nearly always located in the open, at the top of the nesting structure (Bent 1937).
- Both artificial and natural nest sites are used. Snags, live conifers, and broken-top trees are common natural nest sites (Bent 1937, Garber 1972).
- Pilings and telephone poles are common artificial nest sites (Bent 1937).
- Nest sites with broad, flat, tops seem to be preferred. Nest sites average 3 to 3.5 ft. in diameter and 1 to 2 ft. in depth (Garber 1972).
- Nest sites in trees or snags are 60 to 160 ft. above ground and usually extend above the surrounding canopy (Garber 1972).
- Nests located on pilings may be as little as a few inches above the water (Bent 1937).
- Nest sites are usually located within 250 ft. of a body of water, although some ospreys under normal circumstances select nesting sites 2.5 to 4 mi. from water (Garber 1972, Henny 1977, Seymour and Bancroft 1983).

- Individual nest sites are used year after year by the same breeding pair (Bent 1937).

- Will tolerate adjacent (approximately 150 ft.) osprey nests (Kushlan and Bass 1983).

Special Considerations

- Ospreys nesting in areas of heavy recreational use have experienced significant population declines through reproductive failure (Swenson 1979, Levenson and Koplin 1984).

- Increased disturbances (logging, boating, etc.) occuring from mid-May through August appear to have greater impacts to nesting success than relatively constant disturbances occuring prior to and throughout the nesting period (Levenson and Koplin 1984).

- Human activity in the immediate vicinity of the nest tree can cause nest abandonment during egg laying and incubation periods (Levenson and Koplin 1984).

- Specially designed artificial nesting sites may increase nest productivity (# young/nest site) (Westall 1983).

- Re-establishment of bald eagle nests near an osprey nest can be potentially disruptive, resulting in reduced osprey breeding success, nest failure, or abandonment of the area (Garber 1972, Kushlan and Bass 1983).

- Populations are limited by dispersal distances. The potential for osprey to pioneer suitable habitat greater than 60 miles from nesting concentrations is low (Henny 1983).

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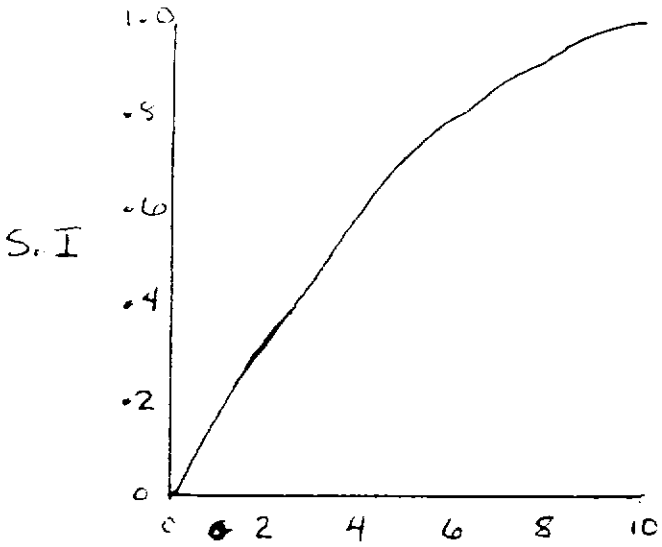
APPENDIX A

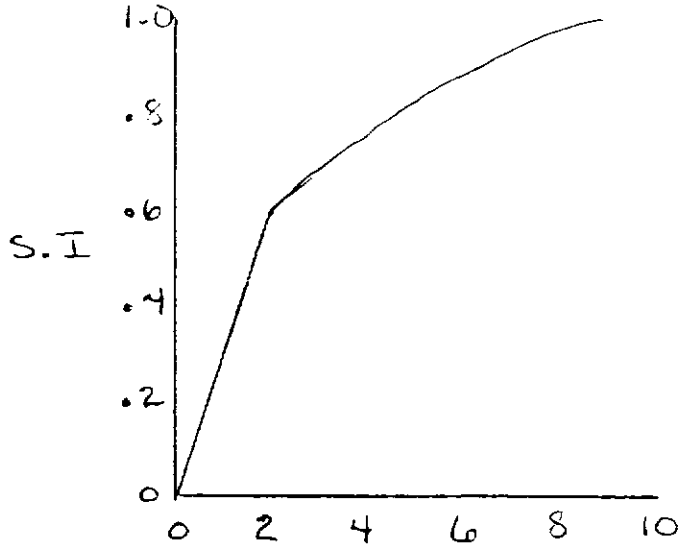
Suitability indices obtained from the USFWS draft Habitat Suitability Index Models - osprey (USFWS 1984).

V2) Availability of Perch Sites



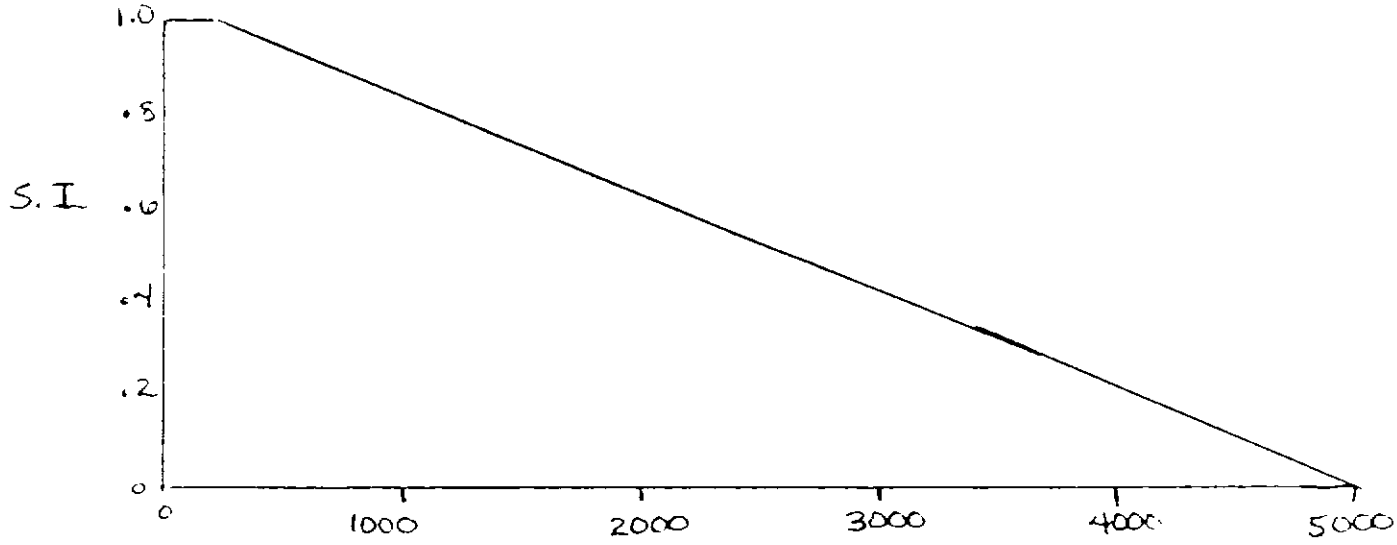
# of Available Perch Sites / 5 acres

V3) Nest TREE Availability



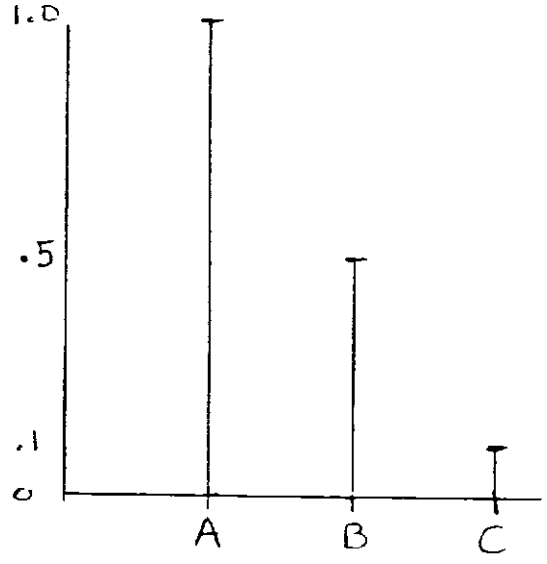
# of West TREES / 100 ACRES

V4) The Distance between potential nesting habitat and fishing waters.



Distance to water (feet)

V1) Water clarity (measured in Summer)



A = Clear to 1 m
B = Partly Cloudy to 1 m
C = Cloudy to 1 m