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UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

LANDSCAPE HETEROGENEITY AND THE ROLE OF CORRIDORS IN
DETERMINING THE SPATIAL STRUCTURE OF
INSULAR MAMMAL POPULATIONS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

By

DAVID R. PERAULT
Norman, Oklahoma
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LANDSCAPE HETEROGENEITY AND THE ROLE OF CORRIDORS IN
DETERMINING THE SPATIAL STRUCTURE OF
INSULAR MAMMAL POPULATIONS

A Dissertation APPROVED FOR THE
DEPARTMENT OF ZOOLOGY

BY


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TABLE OF CONTENTS

	Page
List of Tables	vii
List of Illustrations	x
Abstract	xiii
Chapter 1	
Abstract	2
Introduction	4
Materials and Methods	8
Results and Discussion	13
Conclusions	23
Acknowledgments	25
References	26
Appendix 1	65
Appendix 2	70
Appendix 3	75
Chapter 2	
Abstract	97
Introduction	99
Methods	111
Results	120
Discussion	126

Conclusions	129
Acknowledgments	130
Literature Cited	131
Appendix 1	190
Appendix 2	217
Appendix 3	228

LIST OF TABLES

	Page
CHAPTER 1	
1. Areal coverage of macrohabitats	32
2. Hierarchical design for analyses of isolation indices.	33
3. Means and variances for geographic isolation measures.	34
4. Means and variances for habitat isolation measures.	35
5. Means and variance for measures of neighborhood isolation	36
CHAPTER 2	
1. Areal coverage of macrohabitats	140
2. Habitat variables measured at each station	141
3. Canonical variate scores for site habitat variables	142
4. Results of trapping, infra-red triggered cameras, and sign surveys conducted at each corridor and paired site	143
5. Comparison of community and demographic indices between mainland and corridor treatments	151
6. Classification matrices across corridor sites based on mammal communities and local habitat conditions	152
7. Correlation matrix of Pearson product-moment correlations	153
8. Summary of correlations for isolation vs. site descriptors	154
9. Summary of correlations for forest species richness vs. site descriptors	155

10. Summary of correlations for relative density of <u>Peromyscus</u> <u>oreas</u> vs. site descriptors	156
11. Summary of correlations for relative density of <u>Clethrionomys</u> <u>gapperi</u> vs. site descriptors	157
12. Summary of correlations for relative density of <u>Sorex monticolus</u> vs. site descriptors	158
13. Summary of correlations for relative density of <u>Sorex trowbridgii</u> vs. site descriptors	159
14. Summary of correlations for incidence of <u>Glaucomys sabrinus</u> vs. site descriptors	160
15. Summary of correlations for incidence of <u>Tamiasciurus douglasii</u> vs. site descriptors	161
16. Summary of correlations for proportion breeding individuals of <u>Peromyscus oreas</u> vs. site descriptors	162
17. Summary of correlations for proportion juveniles of <u>Peromyscus</u> <u>oreas</u> vs. site descriptors	163
18. Summary of correlations for proportion females of <u>Peromyscus</u> <u>oreas</u> vs. site descriptors	164
19. Summary of correlations for proportion breeding individuals of <u>Clethrionomys gapperi</u> vs. site descriptors	165
20. Summary of correlations for proportion juveniles of <u>Clethrionomys</u> <u>gapperi</u> vs. site descriptors	166

21. Summary of correlations for proportion females of Clethrionomys
gapperi vs. site descriptors 167

22. Comparison of community and demographic indices between
corridors and surrounding matrix 168

LIST OF ILLUSTRATIONS

	Page
CHAPTER 1	
1. Alternative measures of isolation for a sample community.	42
2. Deforestation and fragmentation of old-growth forests across the Hood Canal District, Olympic National Forest	43
3. Distribution of land cover types across the Hood Canal District, Olympic National Forest	44
4. Isolation indices for a sample fragment site	45
5. Isolation indices for a sample corridor site	46
6. Isolation indices for a sample continuous forest site	47
7. Spearman correlations of area vs. measures of isolation for fragment sites.	48
8. Spearman correlations among measures of geographic isolation of fragment sites	51
9. Spearman correlations among measures of geographic isolation of corridor sites	52
10. Spearman correlations among measures of habitat isolation of fragment sites	53
11. Spearman correlations among measures of habitat isolation of corridor sites	54
12. Spearman correlations among measures of neighborhood isolation	

of fragment sites	55
13. Spearman correlations among measures of neighborhood isolation of corridor sites	56
14. Spearman correlations among measures of neighborhood isolation of continuous forest sites	57
15. Spearman correlations comparing isolation measures across fragment sites	58
16. Spearman correlations comparing isolation measures across corridor sites	61

CHAPTER 2

1. Theoretical isolation effect	174
2. Deforestation and fragmentation of old-growth forests across the Hood Canal District, Olympic National Forest	175
3. Corridors studied and the distribution of forest age-classes across the Hood Canal District, Olympic National Forest	176
4. Mean species richness for forest dependent mammals and all mammals across corridors	177
5. Relative densities of rodents across corridors	178
6. Relative densities of insectivores across corridors	179
7. Richness of sciurids across corridors	180
8. Richness of carnivores across corridors	181
9. Richness of miscellaneous species across corridors	182

10. Discriminant analysis among corridor sites based on species composition	183
11. Discriminant analysis among corridor sites based on local habitat characteristics	184
12. Pearson product-moment correlations between discriminant analysis of species composition and habitat data	185
13. Width of corridor at each site as a function of isolation	186
14. Percent old-growth forest within 1000 m of a site as a function of isolation	187
15. Species richness per site for old-growth dependent mammals as a function of isolation	188
16. Differences in species richness of old-growth forest mammals in corridors and in adjacent paired sites	189

ABSTRACT

Ecological landscapes are often viewed as heterogeneous mosaics of suitable habitat interspersed within a suboptimal matrix. Fragmentation of such landscapes has altered the natural patterns of these mosaics. As a result, processes such as immigration have also been altered, with dire consequences on biodiversity. I investigated how anthropogenic influences on the Olympic National Forest, Washington, have affected landscape measures of isolation and resulting species diversity. I assessed alternative indices of isolation for sites located in three types of old-growth forest: fragments, corridors, and continuous forest. These isolation indices vary in how they identify sources of colonizers and in their characterization of the landscape matrix. Geographic isolation measures the straight line distance from a potential source. Habitat isolation represents the length of the shortest route from a source across most optimal habitat. Neighborhood isolation describes the habitat quality of the surrounding landscape matrix at varying spatial scales. I compared levels of variance and redundancy among these measures to ascertain the most relevant index for assessing isolation. I then focused on the role of corridors in ameliorating the effects of fragmentation by decreasing isolation. To assess such corridor utility, I quantified among- and within-corridor variability in community structure, landscape indices, and habitat descriptors. I also compared corridor use by forest species with that of continuous mainland forest and the surrounding habitat matrix (successional forest and clearcut).

Although highly correlated, optimal measures of isolation varied among types of sites. For fragment sites, the best measure consisted of habitat isolation and neighborhood isolation at large scales (1000 m). For corridor and continuous forest sites, it consisted of habitat isolation and neighborhood isolation at small scales (500 m). The high correlation among measures was largely due to two prominent features of the Olympic National Forest landscape: (1) the orientation and magnitude of the fragmentation gradient and (2) the orientation of corridors in relation to this gradient and to one another. In the Olympic National Forest, the fragmentation gradient runs from the relatively intact mainland of continuous forest in the north to the highly impacted matrix of clearcuts and successional forest in the south. The corridors in this system extend along this gradient, crossing the entire study district. They also have few breaks, are fairly straight, and are parallel with one another.

The influence of corridors on species responses to isolation was shown to be very strong. While variability in species assemblages and habitat was very high among the four corridors studied, such variability was low along individual corridors. In addition, changes in demographic measures along corridors were minimal. This suggests that although these corridors appeared to be effective through their entirety, possibly acting as demographic sources of individuals, they should not be considered equivalent to one another. Use of corridors by forest species was also higher than in the surrounding habitat matrix, re-enforcing the importance of these corridors in maintaining connectivity. Our work further

implies that only by considering biological relationships on a per corridor basis can the respective value of individual corridors be determined. For the Olympic National Forest, this value is significant, with its corridors acting as important connectors across this system's fragmented landscape.

Characterizing the influence of landscape features on assessments of isolation is critical to understanding dispersal, and, ultimately, the structure of native communities in fragmented ecosystems. At the same time, a comprehensive understanding of such landscape features, especially corridors, requires assessing corridors individually and incorporating the habitat needs of relevant species. By considering biologic responses to fragmentation at appropriate scales, we can work to maintain natural processes and preserve natural levels of biodiversity.

Isolation of Old-growth Forest Communities in a Fragmented
Landscape, Olympic National Forest

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Isolation of Old-growth Forest Communities in a Fragmented Landscape, Olympic National Forest

Abstract

Assessing how landscape features influence immigration rates and resulting local community structure is an important component of landscape ecology. Landscape features are tied to immigration by landscape impedance, a concept that incorporates distances among the features and the nature of the intervening habitat matrix. Here, impedance was studied across a real world landscape, the Olympic National Forest, Washington, fragmented by logging practices. Prominent landscape features in this system include (1) a fragmentation gradient having both an orientation and a gradient and (2) highly connected corridors that both parallel one another and are orientated along the fragmentation gradient. Landscape impedance was assessed by measuring alternative indices of isolation for sites located in three types of old-growth forest: fragments, corridors, and continuous forest. These isolation indices vary in how they identify sources of colonizers and in their characterization of the landscape matrix. Geographic isolation measures the straight line distance from a potential source. Habitat isolation represents the length of the shortest route from a source across most optimal habitat. Neighborhood isolation describes the habitat quality of the surrounding landscape matrix at varying spatial scales. The importance of source type varied by isolation category and type of site. Spatial scale played an important role in neighborhood isolation, with measures dependent on both type

of site and buffer radius. In comparing measures across categories, geographic and habitat isolation were similar, with both inversely correlated with neighborhood isolation. Together, these isolation measures assess landscape impedance across Olympic National Forest as a function of its prominent landscape features, which may differ among systems.

Key words: landscape ecology, matrix, heterogeneity, dispersal, isolation.

Olympic Peninsula

Running Head: Perault and Lomolino - Alternative Isolation Measures

Isolation of Old-growth Forest Communities in a Fragmented
Landscape, Olympic National Forest

1. Introduction

Ecological landscapes are often viewed as heterogeneous mosaics of suitable habitat interspersed within a suboptimal matrix (Wilcove et al. 1986). Quantifying this spatial heterogeneity and its influence on ecological processes are major challenges of landscape ecology (Turner 1989). Such heterogeneity affects landscape impedance, a concept that incorporates distances among features and the nature of the intervening habitat matrix. Measures of landscape impedance should be inversely related to immigration potential and should be specific to the characteristics of the focal species. Dispersal and persistence vary according to these species-specific responses to impedance (Gilpin 1987). By altering natural levels of impedance, anthropogenic modifications (e.g., forest fragmentation) have affected normal movements and decreased the persistence of many species (Kozakiewicz 1993, Schippers et al. 1996). Such changes have renewed interest in studying how regional landscape features (e.g., corridors and barriers) may influence local community structure (Holt 1993, Schumaker 1996). As a result, developing straightforward indices that assess these features and their influences on native communities has become an important theme in landscape-level research (e.g., Szacki et al. 1993, Vos and Stumpel 1995, With et al. 1997).

1.1 Background

Traditional studies of landscape-level influences were typically made with

respect to linear isolation, measuring the straight-line distance between a feature and the nearest source of potential immigrants. In 1963, MacArthur and Wilson formalized this approach by suggesting that communities on oceanic islands are structured by an ongoing interaction between immigration and extinction (MacArthur and Wilson 1963, 1967). As MacArthur and Wilson's equilibrium theory was applied to terrestrial isolates in "seas" of less hospitable terrain, additional factors became important (e.g., Brown 1971, 1978, Simberloff 1974). Immigrant sources, for example, ranged from a single, large patch in the classic mainland-island model (MacArthur and Wilson 1967) to all occupied patches of suitable habitat in metapopulation models (Levins 1969, Harrison 1991). Another expansion on the original equilibrium theory looked beyond the source itself to consider the character of intervening matrix (Wiens 1989, Szacki et al. 1993, Adersen 1995). Measuring simple linear distance alone overlooked how the structure and quality of the landscape influence an individual's ability and propensity for dispersal (Harris 1984, Shafer 1990). This influence may vary both with the nature of the intervening habitat matrix and with the characteristics of the focal species. Addressing these factors includes identifying optimal dispersal routes across preferred habitat types (e.g., Davis et al. 1988, Knappen et al. 1992, Gustafson and Gardner 1996), quantifying the surrounding landscape matrix (e.g., Aberg et al. 1995, Vos and Stumpel 1995, Malcolm 1997), and incorporating species-specific responses (e.g., Hansson 1988, Lomolino and Davis 1997, Lomolino 1998).

1.2 Isolation Indices

Accurately assessing landscape-level influences on dispersal and resulting community structure requires a thorough consideration of appropriate measures of isolation. There are four relevant criteria that consider both the best single measure and the best combination of measures. Individual measures should, first, vary substantially among local communities. That is, they should encompass a wide range in degree of isolation, allowing communities to be easily ranked and compared. Second, if more than one measure is used, they should complement another, with each reflecting different factors that affect dispersal. Third, each measure, or group of measures, should also be made at a scale appropriate to the species of interest. This produces indices that are biologically relevant to actual movements of the focal species. Finally, the study itself should be designed (i.e., study sites selected), such that indices are not correlated with other, independent variables such as area. This eliminates confounding effects of mechanisms not under investigation. An ideal assessment of isolation would address all four of these criteria, consisting of a combination of non-redundant measures, each capturing maximal variance in unique, ecologically relevant features (i.e., those strongly limiting the dispersal of the focal species).

The simplest, most straightforward measure of isolation is one we refer to as geographic isolation. This measure ignores intervening habitat type and simply delineates the shortest, straight line distance between features. Geographic isolation is the classical, island biogeography measure and has most often been

used in research (e.g., Simberloff and Wilson, 1969, Crowell 1973, Diamond 1975, Lomolino 1982, Forman and Godron 1986, Lomolino et al. 1989, Opdam 1991). The black line in Figure 1 displays a measure of geographic isolation for an old-growth forest fragment of the Olympic National Forest, Washington. It represents the shortest distance between a source (continuous forest) and the fragment.

In contrast to geographic isolation, measures of what we term habitat isolation describe the optimal path between features of interest by explicitly considering both the characteristics of the intervening habitat and the preferences of the focal species (e.g., Davis et al. 1988, Knappen et al. 1992, Gustafson and Gardner 1996). This assumes that species movements are not random, but biased towards the use of optimal habitats. The resulting route of “least resistance” offers the lowest impedance to species movements. The red line in Figure 1 shows such a path for an old-growth forest dependent species moving between continuous forest and a fragment of old-growth forest.

Perhaps the most thorough assessment of landscape impedance is one measured by what we call neighborhood isolation. This index examines the quality of the habitat matrix by quantifying the composition of landscape features within a given radius around the focal site (e.g., Mwalyosi 1991, Aberg et al. 1995, Grashof-Bokdam 1997, Malcolm 1997). Figure 1 shows samples of neighborhood isolation at 500 m, 1000 m, and 3000 m with landscape composition shown by a different color for each habitat type. By measuring

neighborhood isolation across buffers of varying radii, each representing a unique spatial extent, a comparison of results should reveal scale effects (e.g., Vos and Stumpel 1995). For example, the neighborhood within a 500 m radius of the focal fragment in Figure 1 is dominated by old-successional forest (31-159 years in age), covering 82% of the landscape. Such forest, meanwhile, comprises only 61% and 32% of the landscape within 1000 m and 3000 m of this fragment, respectively. Thus, species with different dispersal ranges -- even those having identical habitat affinities -- would respond differently to landscapes represented by measures made at each radius.

1.3 Purpose of Study

The goal of this study is to investigate the potential influence of landscape features on the immigration potential of mammals dependent on old-growth forest by assessing alternative measures of isolation. Specifically, we address how the heterogeneous landscape of the Olympic National Forest influences such measures, and, based on the four criteria listed above, we test which measures best characterize landscape impedance. Because we measure isolation indices across a real landscape disrupted by anthropogenic disturbance, our findings should have strong relevance to both landscape ecologists and conservation biologists studying fragmented ecosystems.

2. Material and Methods

2.1 Study area and data

We conducted analyses across the Hood Canal District (approximately

60,000 ha) of the Olympic National Forest in northwest Washington. Old-growth forest in this region consists of stands having the following characteristics: eight trees per acre older than 200 years or more than 32 inches diameter-at-breast-height (dbh), deep multi-layered canopy with at least four conifer snags of at least 20 inches dbh, and at least 20 tons of logs per acre greater than 23 inches dbh and at least 15 m long (Old-growth Definition Task Group 1986). Fragmentation of the once dominant old-growth forest has steadily increased from 1900 to 1990 (Figure 2). Particularly since the 1950s, over half of the mature forests in this district have been logged, transforming the landscape from continuous forest to its current mosaic of habitat patches (Rosenberg and Raphael 1990, Peterson et al. 1997) (Table 1, Figure 3). The pattern of this logging has resulted in a distinct fragmentation gradient. This gradient follows a shift, from the large, relatively intact region of continuous forest in the north, to increasingly disturbed forest matrix of clearcuts and successional forest in the south. In addition, the forest corridors run generally north-south and parallel to one another.

We obtained data in Geographic Information Systems (GIS) formats, describing the forest structure from the Olympic National Forest. This data set was created in 1990 by manually digitizing polygons of different-age forest stands from 1:24,000 hardboard photo-mosaics (unpublished Olympic National Forest Data Dictionary). Resulting coverages were then imported into ARC/INFO (Environmental Systems Research Institute 1997) where all analyses were conducted. From these coverages, we selected 93 sites that were distributed

across old-growth forest, successional forest, and clear-cut macrohabitat treatments. Within old-growth forest, 15 sites were located in continuous forest, 30 in forest corridors, and 20 in forest patches or fragments.

2.2 Calculation of Isolation indices

We calculated three sets of isolation indices (Figure 1): straight line distance from source (geographic isolation), length along suitable habitat (habitat isolation), and habitat quality of the landscape surrounding a community (neighborhood isolation). For each set, we used the Arc Macro Language (AML) in ARC/INFO to calculate specific isolation measures for the study sites (Appendices). For the remainder of this paper, we will use the term “site” to refer to immigration/dispersal targets, and “source” to refer to immigration/dispersal origins. We used a hierarchical approach in which, for each set of sites within an isolation category, measures were made from each potential source, or combinations of sources (continuous forest, corridor, or fragment; Table 2). We define continuous forest as areas of old-growth forest greater than 50 km². We define corridors as linear bands of old-growth forest, less than 1 km across at their widest, connected to continuous forest. We define fragments as insular patches of old-growth ranging from 0.1 to 1 km² in size.

We measured geographic isolation of fragment sites as the shortest straight line distance from the edge of a site to three sources: continuous forest, forest corridor, and forest fragment (Figure 4). Unlike fragment sites, for sites within corridors, we were not able to discern site edge. While sites in insular fragments

had edges corresponding with the fragment boundary, corridor sites showed no such delineation. Therefore, for sites in corridors, we measured geographic isolation as the shortest straight line distance from the center of a site to two sources: continuous forest and fragment (Figure 5). For sites within continuous forest, we did not measure geographic isolation because there was no separation between a site and any potential sources (i.e., the target, continuous forest, is also the source).

We measured habitat isolation of fragment sites as the shortest distance through preferred habitat to both the closest forest corridor and the closest continuous forest (Figure 4). For corridor sites, we measured habitat isolation as the shortest distance along the corridor to continuous forest (Figure 5). Because of the potential importance of corridor habitat, we broke this measure into two components. The first did not include any breaks in a corridor; the second calculated the entire distance along the corridor, including breaks. We defined a break as any gap completely across a corridor and consisting of non old-growth forest. Again, because of a lack of separation between sites and sources, we did not measure habitat isolation for continuous forest sites.

We used neighborhood isolation to assess landscape impedance for old-growth forest dependent species by quantifying sub-optimal habitat around each site. We chose our buffer distances – 50 m, 500 m, 1000 m, and 3000 m – to encompass a broad range in dispersal ability of old-growth forest mammals. Our smallest radius, 50 m, approximates the home ranges of small mammals such as

shrews (Sorex spp.), voles (Cletheronomys spp.), and mice (Peromyscus spp.) (0.049-0.44 ha). Our largest, 3000 m, encompasses an area equivalent to the home range of our largest terrestrial mammal, the black bear (Ursus americanus) (1760 ha). (See Table 6.3 in Harris 1984:85-86 for home ranges for 60 non-volant mammals of the Pacific northwest). If our community studies were restricted to small mammals, we predict that measures of community structure would be more strongly correlated with neighborhood isolation measured at 500 m or less. If, on the other hand, our studies assessed only large mammals, we predict that measures of community structure would be more strongly correlated with neighborhood isolation measured at 1000 m or more.

For fragment sites, we calculated neighborhood isolation as 100 minus the percent cover of source habitat (old-growth corridor and continuous forest) within the four buffer radii: 50 m, 500 m, 1000 m, and 3000 m (Figure 4). Because fragment sites were discrete features with obvious boundaries, we measured radii as buffer widths from the fragment edges. For both corridor and continuous forest sites, we measured neighborhood isolation as 100 minus the percent cover of source habitat (again, old-growth corridor and continuous forest) within three buffer radii: 500 m, 1000 m, and 3000 m. Due to the difficulty in delineating the edge of corridor and continuous forest sites, we measured radii from the center of each site (Figures 5 and 6). Because these centers were always at least 75 m from the forest edge, we did not use 50 m as a buffering radius.

We assessed all of these measures with respect to the four criteria

previously discussed. For criterion 1, emphasizing the importance of a measure varying among sample sites, we calculated and compared variances (s^2) for each isolation measure. For criterion 2, stressing the importance of complementarity of measures, we used rank correlation analysis to address redundancy among measures, with a low correlation indicating high complementarity. As noted above, we addressed criterion 3, appropriate spatial scale, by designing our study to include a range of isolation metrics appropriate to the scale at which our focal species, non-volant mammals, perceive and use their environment. Finally, for criterion 4, independence of variables, we designed our study such that none of our measures of fragment isolation was correlated with fragment area (Figure 7).

3. Results and Discussion

In the following sections we first consider measures of isolation within each category, focusing on the variance each explained. Because we did not measure them, geographic and habitat isolation for continuous forest sites are not discussed. We then examine correlations among alternate measures across categories to identify complementary, or non-redundant, sets of indices that best express landscape impedance. Finally, we discuss landscape impedance as a function of the prominent landscape features of the Olympic National Forest and the implications of these features differing across other fragmented systems.

3.1 Geographic Isolation

3.1.1 Fragments

For fragment sites, the shortest distance from continuous forest captured

the greatest amount of variance (criterion 1; Table 3). Its high variability is a reflection of the fragmentation pattern across the study district, i.e., the wide dispersion of fragment sites south of the continuous forest mainland (Figure 3). Inter-fragment distance, meanwhile, captured the lowest amount of variance, largely because fragments are ubiquitous south of the mainland and are fairly equidistant from one another. Relative to these two measures, the amount of variance captured by distance from corridor was moderate. While not as common as fragments, corridors are still found across the entire district, as segregated, parallel lines of old-growth forest. Thus, distances among fragments are most similar, distances between fragments and corridors are less similar, and distances between fragments and continuous forest are least similar.

Complementarity among measures (criterion 2) of geographic isolation for fragments varied by source. Geographic isolation from corridor and continuous forest were positively correlated ($r_s = 0.58$, $p < 0.05$; Figure 8). This suggests that, because corridors fan out from the main forest, fragment sites close to continuous forest also tend to be close to corridors. Most points fall above the line of equality in Figure 8, showing that geographic isolation from continuous forest (y-axis) is greater than geographic isolation from corridor (x-axis). In contrast, geographic isolation from other fragments was inversely correlated with geographic isolation from both corridor ($r_s = -0.57$, $p < 0.05$) and continuous forest ($r_s = -0.55$, $p < 0.05$). This suggests that fragment sites close to other fragments tend to be isolated from both corridors and continuous forest. For both of these negative

correlations, most points fall below the line of equality in Figure 8, showing that geographic isolation from another fragment is nearly always shorter than geographic isolation from any other source.

These correlations all reflect the fragmentation gradient across the study area. As one moves southward and away from the continuous forest mainland, or moves further away from corridors, the number of fragments increases, reducing inter-fragment distances (Figure 3). Because the correlations among these measures were significant, the measures themselves are complementary (criterion 2). Of these similar measures, distance from continuous forest, by capturing the most variance (criterion 1), should be the most useful single measure for assessing geographic isolation for fragment sites.

3.1.2 Corridors

For corridor sites, the variance in geographic isolation from continuous forest was more than an order of magnitude greater than geographic isolation from fragments (Table 3). Again, this reflects the fragmentation gradient of the study system. Because corridors extend across the entire length of the study area (Figure 3), their measures of geographic isolation from continuous forest vary considerably. On the other hand, regardless of location along a corridor, a fragment is likely to be nearby. Accordingly, most points in Figure 9 fall below the line of equality, indicating that corridor sites are usually farther from continuous forest than from fragments.

Complementarity between the two measures of geographic isolation for

corridor sites was very high, i.e., their correlation was low ($r_s = -0.14$, $p = 0.48$; Figure 9). Such a low correlation demonstrates that geographic isolation of corridor sites from continuous forest cannot be used to predict geographic isolation from fragments. Thus, both provide independent measures of isolation, again indicating the importance of selecting appropriate source type. Because the measure from continuous forest captures greater variance (criterion 1), however, it is the more informative single metric of geographic isolation of corridor sites in the Olympic National Forest.

3.2 Habitat Isolation

3.2.1 Fragments

For fragment sites, habitat isolation was measured as the shortest distance along a path, both from corridor and from continuous forest, across oldest available forest. This delineates the optimal route (lowest impedance) across the landscape matrix for old-growth forest dependent species. As with geographic isolation, the variance in habitat isolation measured from continuous forest was more than twice of that from corridor (Table 4). Again, while continuous forest is nearly completely restricted to the northern portion of the study district, corridors extend throughout most of the district. Although paths from continuous forest may vary in length, regardless of a fragment's location, a corridor is likely to be nearby.

The correlation between length of optimal path from continuous forest and from corridor was significantly positive ($r_s = 0.61$, $p < 0.01$; Figure 10). Nearly all

points fell above the line of equality, indicating that, although the two routes are similar in length, shortest optimal path from continuous forest is typically longer than that from corridors. Thus, of these two redundant measures, habitat isolation, with its higher variance, would be the more useful measure for fragment sites (criteria 1 and 2).

3.2.2 Corridors

For corridor sites, habitat isolation was measured as distance along corridors from continuous forest to the site, both including and excluding breaks in corridors. These two measures each captured a similar amount of variance (Table 4). The nearly perfect correlation between the two ($r_s = 0.99$, $p < 0.001$; Figure 11), indicates only a small influence from corridor breaks. In fact, actual breaks are few in number and small in size, not affecting overall measures. Thus, for this system, either of these two redundant measures, having similar variance, could be used to assess habitat isolation of corridor sites (criteria 1 and 2).

3.3 Neighborhood Isolation

3.3.1 Fragments

For fragment sites, larger scales captured a smaller percentage of non-source habitat (Table 5). That is, as scale increased, the percentage of old-growth forest corridor and continuous forest captured also increased. The correlations support this, with more points falling below the line of equality and closer to the x-axis, the axis of smaller scale (Figure 12). Fragments in this system (by definition or design) are insular, immediately surrounded by a matrix of non old-

growth forest. As distance from a fragment increases, so does the probability of encountering old-growth forest corridor or continuous forest.

The variance in neighborhood isolation of fragments increased with increasing spatial scale (Table 5). Thus, larger spatial scales not only captured a greater percentage of old-growth corridor and continuous forest, but also a greater variability in cover types and therefore landscape impedance. The extremely low variance (0.04) at the 50 m buffer provides so little descriptive data that its usefulness is negligible. Only at large spatial scales is enough habitat heterogeneity captured to provide meaningful measures of variability in landscape impedance. Because of the very low variance captured at 50 m (criterion 1), we dropped this measure from further analyses.

Correlations were lowest between widely separated scales (500 m - 3000 m, $r_s = 0.73$, $p < 0.005$). As scales converged, correlations increased, with both pairs of adjacent scales having the highest correlations (500 m - 1000 m, $r_s = 0.84$, $p < 0.005$; 1000 m - 3000 m, $r_s = 0.87$, $p < 0.005$). Given the low degree of complementarity among these three scales, a 3000 m buffer radius, offering the highest level of variance, should be the most useful scale for depicting neighborhood isolation of fragment sites (criteria 1 and 2).

3.3.2 Corridors

Unlike fragment sites, larger scales captured a greater percentage of non-source habitat for corridor sites and variance decreased with increasing scale (Table 5), with more points now falling closer to the y-axis, the axis of larger

scale (Figure 13). That is, as scale increased, the percentage of old-growth forest corridor and continuous forest captured decreased. This reflects a shift in landscape composition from one at small scales, dominated by the corridor itself, to one at large scales, dominated by the heterogeneous landscape matrix.

Measures of neighborhood isolation at small, adjacent scales were strongly correlated (500 m - 1000 m, $r_s = 0.86$, $p < 0.001$), reflecting the dominant influence of the corridor on measures of neighborhood isolation up to 1000 m. The correlation between large, adjacent scales was lower (1000 m - 3000 m, $r_s = 0.62$, $p < 0.005$), reflecting a smaller influence of corridor habitat and an increasing influence of matrix habitat. Not surprisingly, the widest comparison across scales had the weakest correlation (500 m - 3000 m, $r_s = 0.39$, $p = 0.11$). Therefore, while the 500 m buffer is the most useful single measure because it has the highest variance (criterion 1), the 3000 m buffer provides a complementary measure of neighborhood isolation of corridor sites (criterion 2).

3.3.3 Continuous Forest

As with corridor sites, larger scales captured a greater percentage of non-source habitat for continuous forest sites and variance decreased with increasing scale (although variance did increase slightly from 1000 m to 3000 m) (Table 5), with more points again falling closer to the y-axis, the axis of larger scale (Figure 13). That is, as scale increased, the percentage of old-growth forest corridor and continuous forest captured decreased. This reflects a shift in landscape composition from one at small scales, dominated by continuous forest, to one at

large scales, dominated by the heterogeneous landscape matrix.

Neighborhood isolation measures at adjacent and small scales were strongly correlated (500 m - 1000 m, $r_s = 0.89$, $p < 0.005$), here because both measures assess forest continuity. The influence of continuous forest extends farther than did the influence of the corridor with neither the 500 m nor the 1000 m buffer being correlated with the 3000 m buffer (500 m - 3000 m, $r_s = 0.41$, $p = 0.38$; 1000 m - 3000 m, $r_s = 0.41$, $p = 0.38$). Only after extending beyond 1000 m from continuous forest sites does the measure assess adjacent habitat matrix. Therefore, as with corridor sites, while the 500 m buffer is the most useful single measure because it has the highest variance (criterion 1), the 3000 m buffer provides an additional complementary measure of neighborhood isolation for continuous forest sites (criterion 2).

3.4 Comparisons across Categories

The previous sections examined differences in isolation measures within categories (geographic, habitat, and neighborhood) based on both source pool (old-growth continuous forest, corridor, and fragment) and spatial scale. We now assess the complementarity of these measures across categories. Since we did not calculate geographic and habitat isolation for continuous forest sites, comparisons were only made across the three categories of isolation measures for fragment and corridor sites.

3.4.1 Fragments

For fragment sites, measures of geographic isolation were strongly

correlated ($r_s = 0.88$, $p < 0.001$) with those of habitat isolation (Figure 15a). Fragment sites located close to corridors or continuous forest via straight lines were also close via optimal paths. This is because the fragmentation gradient and corridors are aligned, i.e., both run from the mainland in the north to the district boundary in the south. Most optimal paths to a fragment consist of traveling along a corridor to a point near the fragment and then traversing across the matrix to the fragment itself. The distribution of points above the line of equality in Figure 15a shows that these optimal paths are nearly always longer than those of geographic isolation. Because these two measures are not complementary (criterion 2) and habitat isolation captures more variance than geographic isolation (Tables 3 and 4), habitat isolation should be the more useful measure of the two (criterion 1).

Geographic and habitat isolation measures were again strongly correlated with each other and exhibited similar patterns of variation across the spatial scales delineated by neighborhood isolation (Figures 15b and 15c). That is, the measures were all positively correlated and the strength of these correlations increased with increasing spatial scale. Although measures of neighborhood isolation at 500 m were complementary with respect to those of geographic and habitat isolation, they were essentially invariable (Table 5), showing little differences among fragment sites. A buffer of 1000 m, providing both moderate amounts of variability and more complementarity than one of 3000 m, may therefore be the preferred neighborhood measure. Thus, based on our criteria 1

and 2, the best combination of isolation measures for fragment sites is habitat isolation (with its higher variance than geographic isolation) and neighborhood isolation at a 1000 m buffer distance.

3.4.2 Corridors

As with fragment sites, corridor sites showed measures of geographic isolation that were strongly correlated ($r_s = 0.88$, $p < 0.001$) with those of habitat isolation (Figure 16a). Again, travel routes along corridors often parallel those along shortest, straight line distances (Figure 3). As shown by the distribution of points above the line of equality, these travel routes are also almost always longer than straight line distances. Because these two measures are not complementary (criterion 2) and habitat isolation captures more variance than geographic isolation (Tables 3 and 4), habitat isolation should be a better measure of isolation for corridor sites, as it is with fragment sites.

All correlations among neighborhood, geographic, and habitat isolation of corridor sites were positive (Figures 16b and 16c). As with fragment sites, the strength of these correlations increased with increasing spatial scale. The greater the distance between a corridor site and old-growth forest source pools, the less old-growth forest found within the buffer radius. The correlations at 500 m, however, were weaker for corridor sites than for fragment sites. Because the neighborhood measured at this scale also captured the highest variance, it, together with habitat isolation (having higher variance than geographic isolation), yields an optimal measure of isolation for corridor sites.

4. Conclusions

Based on our criteria for optimally measuring isolation, the best set of isolation measures describing landscape impedance across the Olympic National Forest varied by site type (fragment, corridor, and continuous forest). While all isolation categories (geographic, habitat, and neighborhood) produced measures strongly correlated with one another, the amount of variance captured by neighborhood isolation measures differed between insular (fragment) and non-insular (corridor and continuous forest) communities. These differences in variance resulted in different optimal combinations of isolation measures. For fragment sites, the best assessment of landscape impedance consisted of habitat isolation and neighborhood isolation at large scales (1000 m). For corridor and continuous forest sites, it consisted of habitat isolation and neighborhood isolation at small scales (500 m).

The strong correlation among all isolation measures was largely due to two prominent features of the Olympic National Forest landscape: (1) the orientation and magnitude of the fragmentation gradient and (2) the orientation of corridors in relation to this gradient and to one another. In the Olympic National Forest, the fragmentation gradient runs from the relatively intact mainland of continuous forest in the north to the highly impacted matrix of clearcuts and successional forest in the south (Figure 3). The corridors in this system extend along this gradient, crossing the entire study district. They also have few breaks, are fairly straight, and are parallel with one another. The general effect of these two

features is that our isolation measures displayed a high degree of correlation. Optimal paths primarily using corridors as conduits (habitat isolation) were similar in length to straight line paths (geographic isolation). Both of these measures were similar to assessments of adjacent habitat matrix (neighborhood isolation) in which target sites far from dispersal sources were also surrounded primarily by nonoptimal habitat.

While the alignment between the fragmentation gradient and corridors may be a general feature of fragmented landscapes, the pattern is not likely to be universal. Any distinctions among systems would strongly influence both how isolation indices are measured and relationships among measures. For example, systems without a well defined fragmentation gradient may have more than a single, large mainland acting as a primary source of individuals; instead, all optimal habitat patches may serve as equivalent sources (a classic metapopulation structure). Such an arrangement would most likely reduce correlations within and among isolation categories. Likewise, greater differences among measures might be found in systems without corridors, or with corridors that are curvilinear or not aligned with either the fragmentation gradient or one another. In such cases, geographic isolation may not be positively correlated with habitat isolation; in fact, the two may even be inversely correlated.

Characterizing the influence of landscape features on assessments of landscape impedance is critical to understanding dispersal, and, ultimately, the structure of native communities in fragmented ecosystems. The strong directional

component of the fragmentation gradient of the Olympic National Forest and the layout of its corridors, matching both this gradient and each other, resulted in strong correlations among landscape impedance measures. Other systems may show different patterns, leading to different results. As fragmentation continues to alter natural landscape patterns, recognizing the implications of these differences among fragmented landscapes will be a key component of studying insular communities.

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Table 1. - Areal coverage of macrohabitats across the Hood Canal District, Olympic National Forest, Washington. Classifications were based on 1990 data from the unpublished Olympic National Forest Data Dictionary.

Macrohabitat	Stand Age (years)	Area in ha (percent total)
Continuous Forest	> 160	14932.86 (24.9)
Corridor	> 160	6205.86 (10.4)
Fragment	> 160	3963.77 (6.6)
Old-successional	41-159	14334.38 (23.9)
Young-successional	26 -40	14109.06 (23.5)
Clearcut	< 26	5161.98 (8.6)
Water	na	1245.41 (2.1)

Table 2. - Hierarchical design for analyses and comparison of isolation indices. Sources are listed in decreasing order of presumed importance with respect to potential dispersers. Because there was no separation between a target and any potential source (i.e., the target, continuous forest, is also the source), geographic and habitat isolation were not calculated for continuous forest sites. For fragment sites, which have a discrete edge, neighborhood isolation was calculated at 50, 500, 1000, and 3000 m from fragment boundaries. For corridor and continuous forest sites, which lack a discrete boundary, radii were measured from the center of each site. Since these centers were always at least 75 m from the forest edge, neighborhood isolation was only calculated at 500, 1000, and 3000 m.

Isolation Measure	Target	Source (s)
Geographic	Fragment	1. Corridor 2. Continuous forest 3. Fragment
	Corridor	1. Continuous forest 2. Fragment
Habitat	Fragment	1. Corridor 2. Continuous forest
	Corridor	1. Continuous forest (including breaks) 2. Continuous forest (excluding breaks)
Neighborhood	Fragment	Continuous forest and corridor ^a
	Corridor	Continuous forest and corridor ^a
	Continuous Forest	Continuous forest and corridor ^b

^a For both fragment and corridor sites, the amount of surrounding continuous forest was very small, even at a 3000 m buffer radius. This forfeited measuring continuous forest habitat alone. To include any contribution from continuous forest, however, it was measured with corridor habitat as a potential source.

^b For continuous forest sites, the amount of surrounding corridor habitat was small. Continuous forest and corridor habitat were again measured together to include any contribution from corridor as a potential source.

Table 3. - Means and variances for geographic isolation measures. Geographic isolation was measured as the shortest straight line distance between source and target. Because there was no separation between a target and any potential source (i.e., the target, continuous forest, is also the source), geographic and habitat isolation were not calculated for continuous forest sites.

Target Site	Sources	\bar{X}	s^2
Fragment (n=20)	1. Corridor	2142.87	2,541,558
	2. Continuous Forest	6692.30	10,019,200
	3. Fragment	563.84	62,454
Corridor (n=30)	1. Continuous Forest	4,390.49	9,946,322
	2. Fragment	1,137.56	780,800

Table 4. - Means and variances for habitat isolation measures. Habitat isolation was measured as the shortest optimal route between source and target. Because there was no separation between a target and any potential source (i.e., the target, continuous forest, is also the source), geographic and habitat isolation were not calculated for continuous forest sites.

Target Site	Sources	\bar{X}	s^2
Fragment (n=20)	1. Corridor	3,973.75	11,620,432
	2. Continuous forest	11,773.18	28,930,276
Corridor (n=30)	1. Continuous forest (including breaks)	7,020.36	16,940,500
	2. Continuous forest (excluding breaks)	6,641.79	15,460,444

Table 5. - Means and variance in percent of non-source habitat for measures of neighborhood isolation across buffer radii. These were calculated as 100 minus (% old-growth corridor and continuous forest). For fragment sites, which have a discrete edge, calculations were made at 50, 500, 1000, and 3000 m from fragment boundaries. For corridor and continuous forest sites, which lack a discrete boundary, radii were measured from the center of each site. Since these centers were always at least 75 m from the forest edge, calculations were only made at 500, 1000, and 3000 m.

Target Site	$\bar{X} (s^2)$			
	50 m	500 m	1000 m	3000 m
Fragment (n=20)	99.96 (0.04)	99.23 (2.34)	96.59 (47.28)	88.97 (167.94)
Corridor (n=30)	–	60.25 (456.22)	75.07 (334.04)	80.46 (242.83)
Continuous Forest (n=15)	–	21.09 (248.52)	28.35 (147.86)	41.29 (166.49)

FIGURE LEGENDS

Figure 1. - Alternative measures of isolation for a sample community, here a forest fragment. Geographic isolation (black line) delineates the shortest straight line path from a dispersal source, here continuous forest. Habitat isolation (red line), represents the optimal route from the source. Neighborhood isolation characterizes the landscape matrix surrounding a community, here for 3000 m, with a different color for each habitat type. Additional buffer radii of 500 m and 1000 m are shown in purple.

Figure 2. - Deforestation and fragmentation of old-growth forests across the Hood Canal District of the Olympic National Forest, Washington.

Figure 3. - Distribution of land cover types across the Hood Canal District of the Olympic National Forest, Washington.

Figure 4. - Isolation indices for a sample fragment site, measured from the edge of the fragment. These are geographic isolation from continuous forest, corridor, and fragment (black lines), habitat isolation from continuous forest and corridor (red lines), and neighborhood isolation within four buffer radii: 50, 500, 1000, and 3000 m (50 m buffer not shown).

Figure 5. - Isolation indices for a sample corridor site, measured from the center of the site. These are geographic isolation from continuous forest and fragment (black lines), habitat isolation from continuous forest, both including and excluding corridor breaks (red line), and neighborhood isolation within three buffer radii: 500, 1000, and 3000 m.

Figure 6. - Isolation indices for a sample continuous forest site, measured from the center of the site. These are neighborhood isolation within three buffer radii: 500, 1000, and 3000 m.

Figure 7. - Spearman correlations and Spearman's Rho (r_s) of area vs. geographic isolation (a), habitat isolation (b), and neighborhood isolation (c) measures for fragment sites ($n = 20$). To maintain an experimentwise Type I error of $\alpha = 0.05$, a Bonferroni adjustment for multiple comparisons was used. The p -values shown reflect this adjustment. None of the 9 correlations was significant.

Figure 8. - Spearman correlations and Spearman's Rho (r_s) for measures of geographic isolation of fragment sites ($n = 20$). A line of equality (c) represents equal values for both the x-axis and y-axis variables. Points falling to the left and above the line (a) have larger values for y-axis variables than for x-axis variables. Points falling to the right and below the line (b) have larger values for x-axis variables than for y-axis variables. The p -values shown reflect a Bonferroni adjustment for multiple comparisons to maintain an experimentwise $\alpha = 0.05$.

Figure 9. - Spearman correlations for measures of geographic isolation of corridor sites ($n = 30$). The dotted line of equality represents equal values for both the x-axis and y-axis variables. Points falling to the left and above the line have larger values for y-axis variables than for x-axis variables, and vice versa.

Figure 10. - Spearman correlation matrix for measures of habitat isolation of fragment sites ($n = 20$). The dotted line of equality represents equal values for both the x-axis and y-axis variables. Points falling to the left and above the line have larger values for y-axis variables than for x-axis variables. Points falling to the right and below the line have larger values for x-axis variables than for y-axis variables.

Figure 11. - Spearman correlation matrix for measures of habitat isolation of corridor sites ($n = 30$). The dotted line of equality represents equal values for both the x-axis and y-axis variables. Points falling to the left and above the line have larger values for y-axis variables than for x-axis variables. Points falling to the right and below the line have larger values for x-axis variables than for y-axis variables.

Figure 12. - Spearman correlation matrices for measures of neighborhood isolation of fragment sites ($n = 20$). The dotted lines of equality represent equal values for both the x-axis and y-axis variables. Points falling to the left and above the line have larger values for y-axis variables than for x-axis variables. Points falling to the right and below the line have larger values for x-axis variables than for y-axis variables. The p-values shown reflect a Bonferroni adjustment for multiple comparisons to maintain an experimentwise $\alpha = 0.05$.

Figure 13. - Spearman correlation matrices for measures of neighborhood isolation of corridor sites ($n = 30$). The dotted lines of equality represent

equal values for both the x-axis and y-axis variables. Points falling to the left and above the line have larger values for y-axis variables than for x-axis variables. Points falling to the right and below the line have larger values for x-axis variables than for y-axis variables. The p-values shown reflect a Bonferroni adjustment for multiple comparisons to maintain an experimentwise $\alpha = 0.05$.

Figure 14. - Spearman correlation matrices for measures of neighborhood

isolation for continuous forest sites ($n = 15$). The dotted lines of equality represent equal values for both the x-axis and y-axis variables. Points falling to the left and above the line have larger values for y-axis variables than for x-axis variables. Points falling to the right and below the line have larger values for x-axis variables than for y-axis variables. The p-values shown reflect a Bonferroni adjustment for multiple comparisons to maintain an experimentwise $\alpha = 0.05$.

Figure 15. - Spearman correlation matrices comparing isolation measures across

fragment sites ($n = 30$): geographic vs. habitat (a), geographic vs. neighborhood (b), and habitat vs. neighborhood (c). The dotted line of equality in (a) represents equal values for both the x-axis and y-axis variables. Points falling to the left and above the line have larger values for y-axis variables than for x-axis variables. Points falling to the right and below the line have larger values for x-axis variables than for y-axis variables. The p-values shown reflect a Bonferroni adjustment for multiple

comparisons to maintain an experimentwise $\alpha = 0.05$.

Figure 16. - Spearman correlation matrices comparing isolation measures across corridor sites ($n = 20$): geographic vs. habitat (a), geographic vs. neighborhood (b), and habitat vs. neighborhood (c). The dotted line of equality in (a) represents equal values for both the x-axis and y-axis variables. Points falling to the left and above the line have larger values for y-axis variables than for x-axis variables. Points falling to the right and below the line have larger values for x-axis variables than for y-axis variables. The p-values shown reflect a Bonferroni adjustment for multiple comparisons to maintain an experimentwise $\alpha = 0.05$.

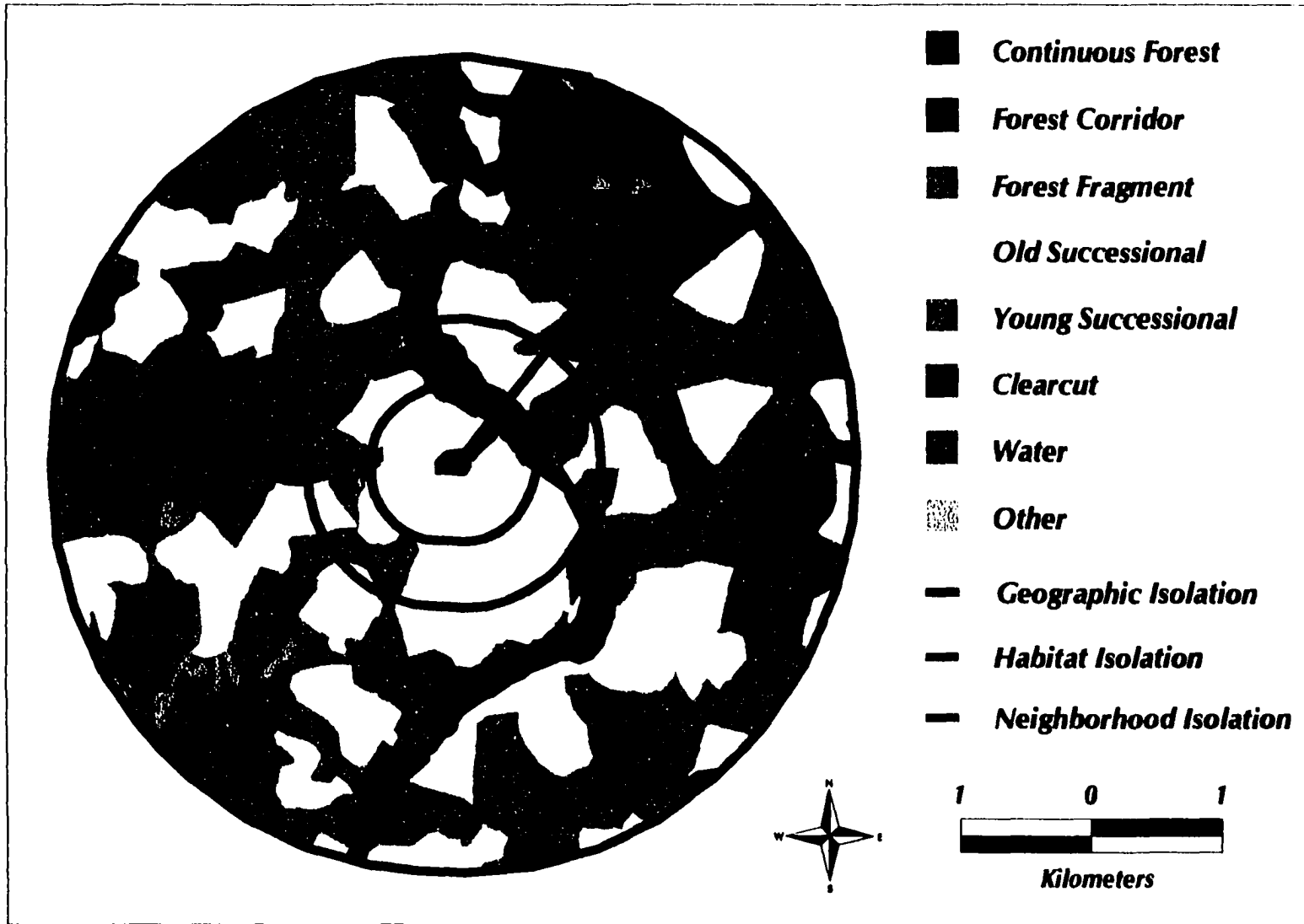


Fig. 1

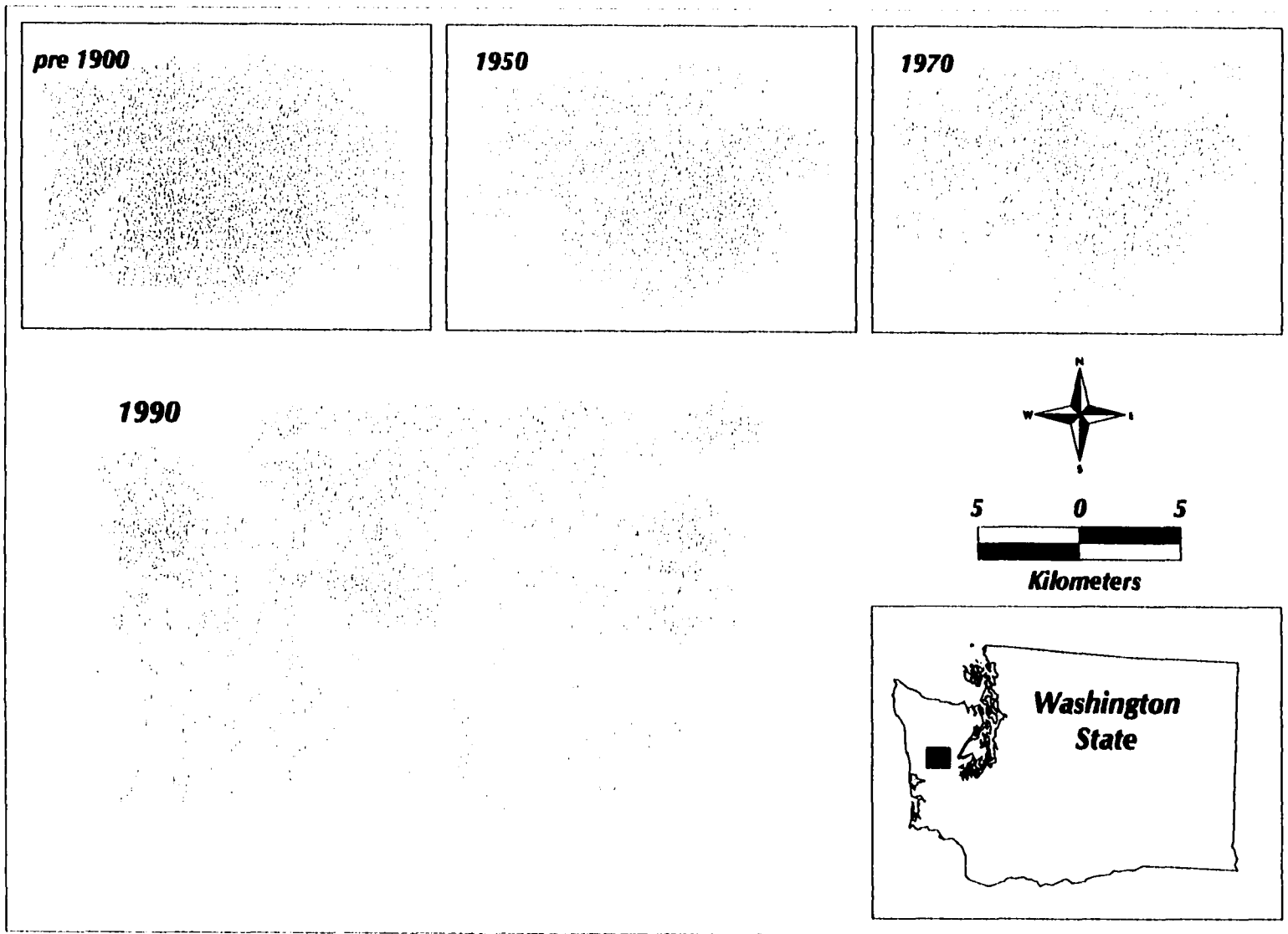


Fig. 2

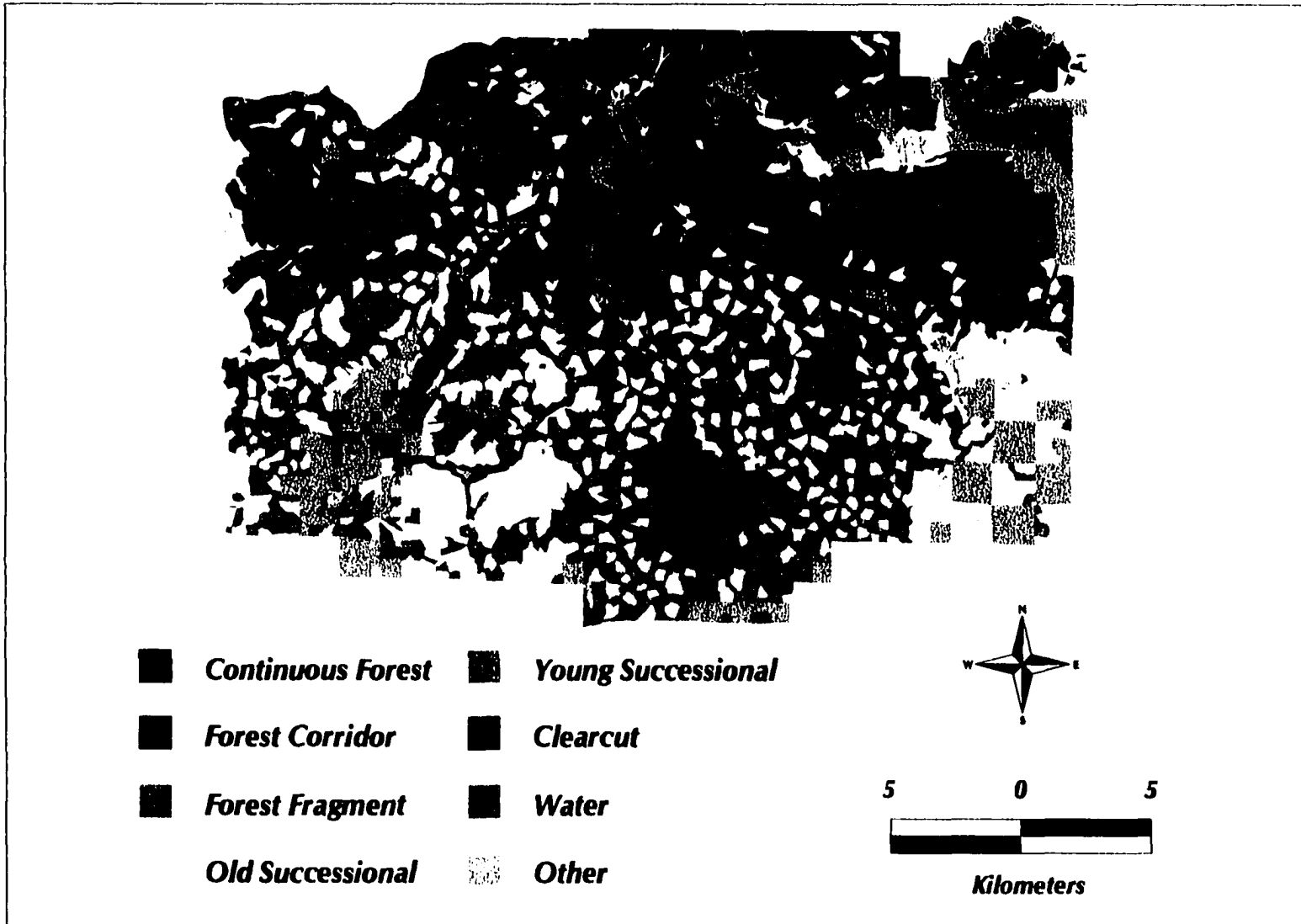


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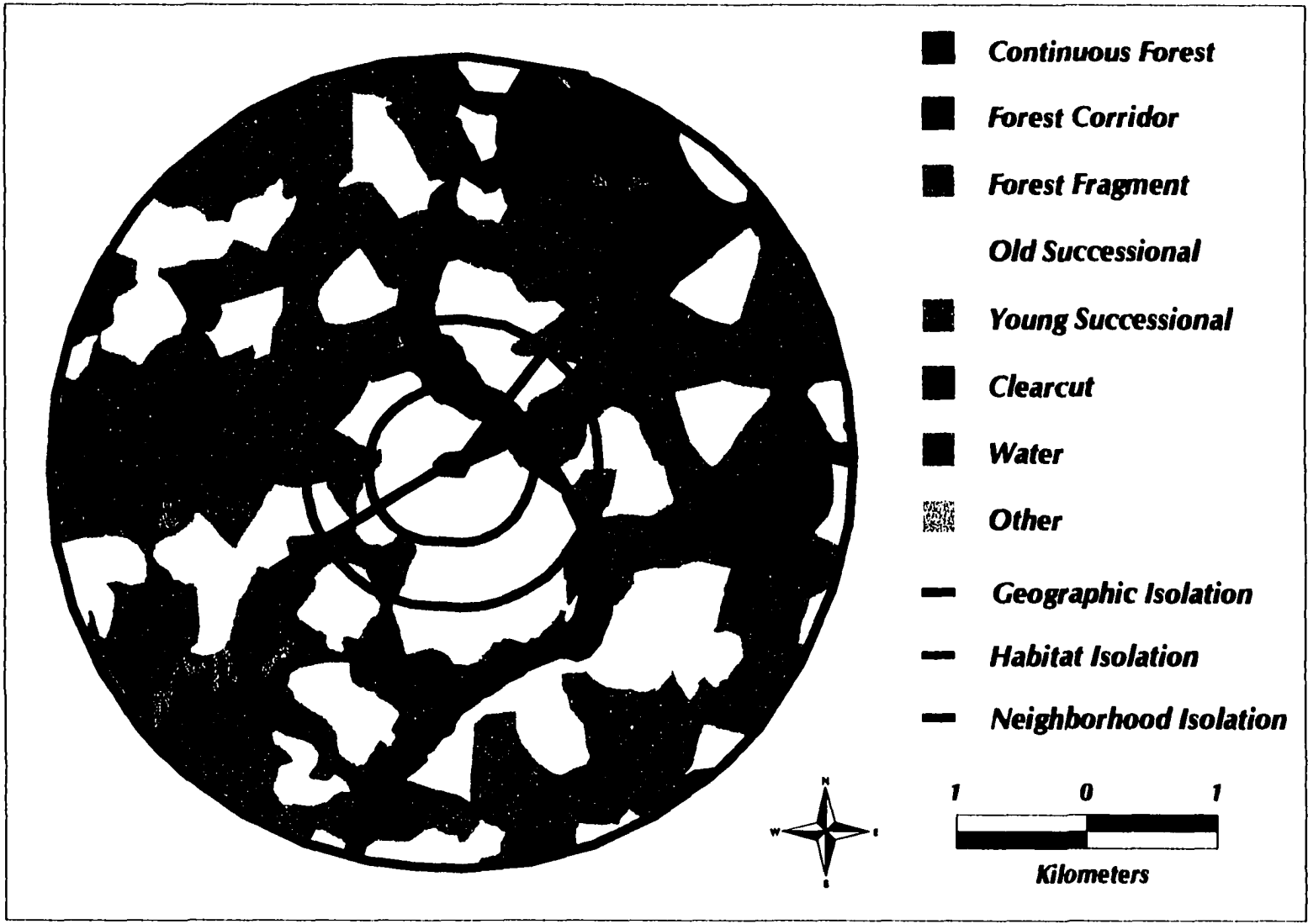


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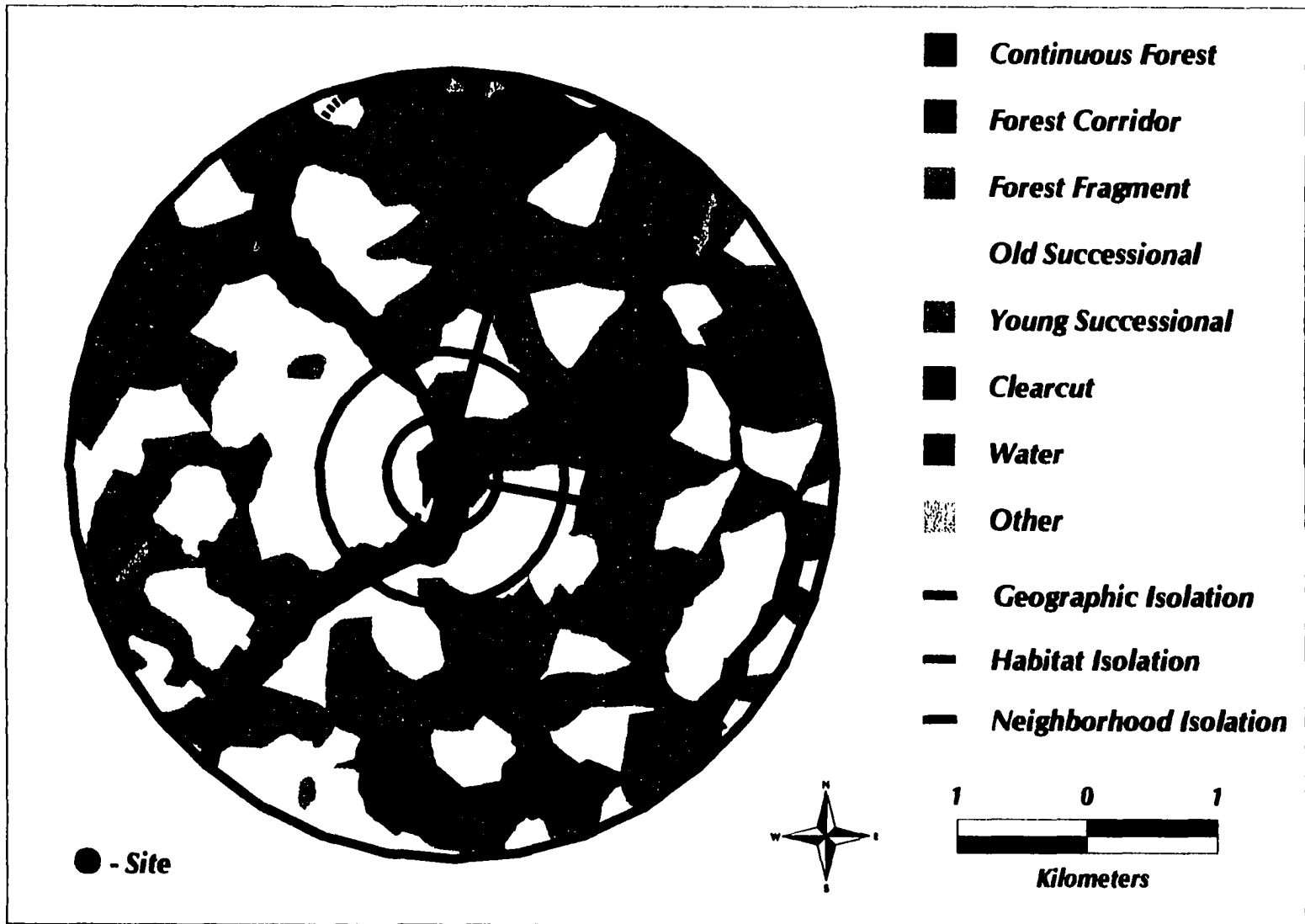


Fig. 5

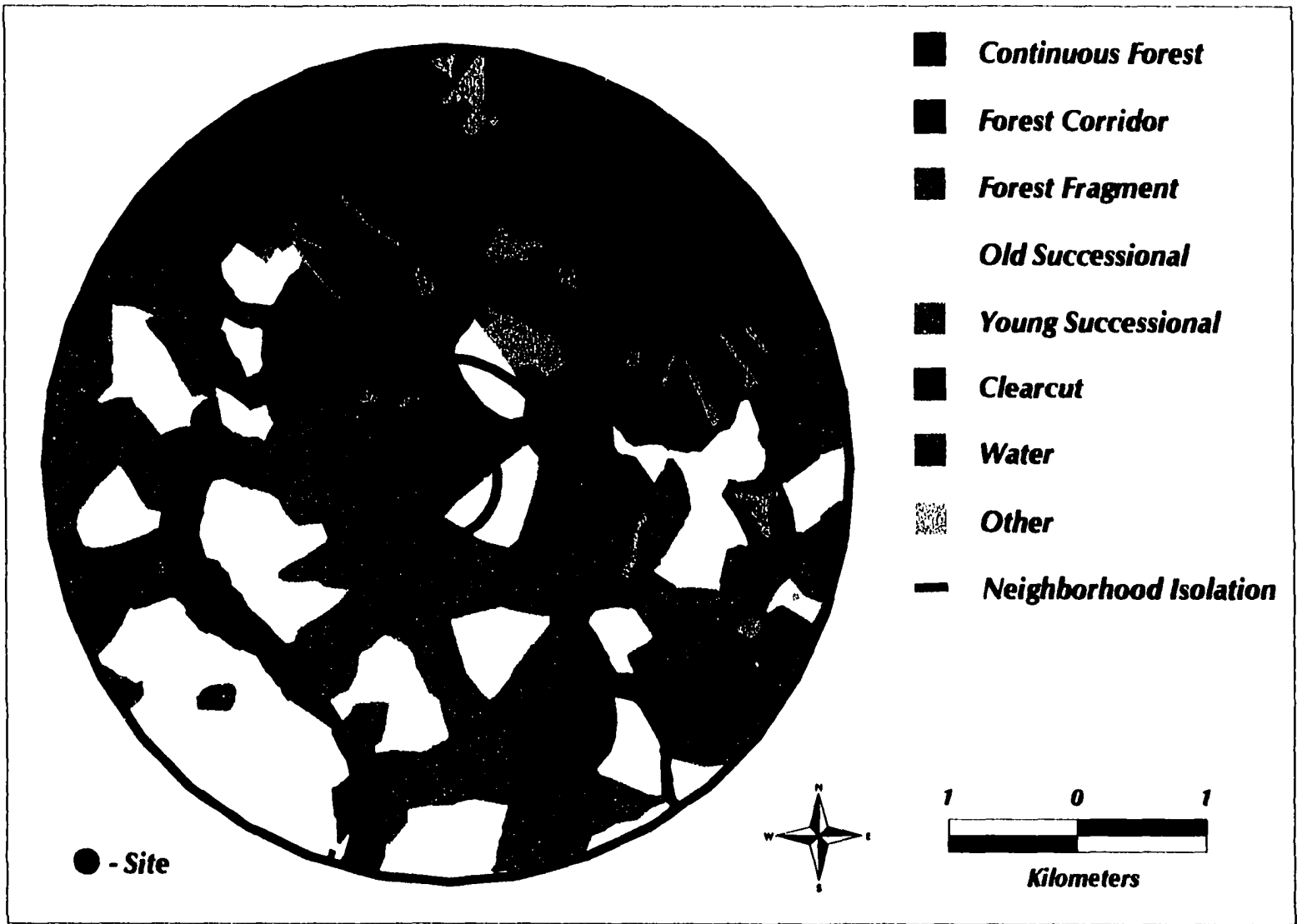


Fig. 6

Fig. 7a

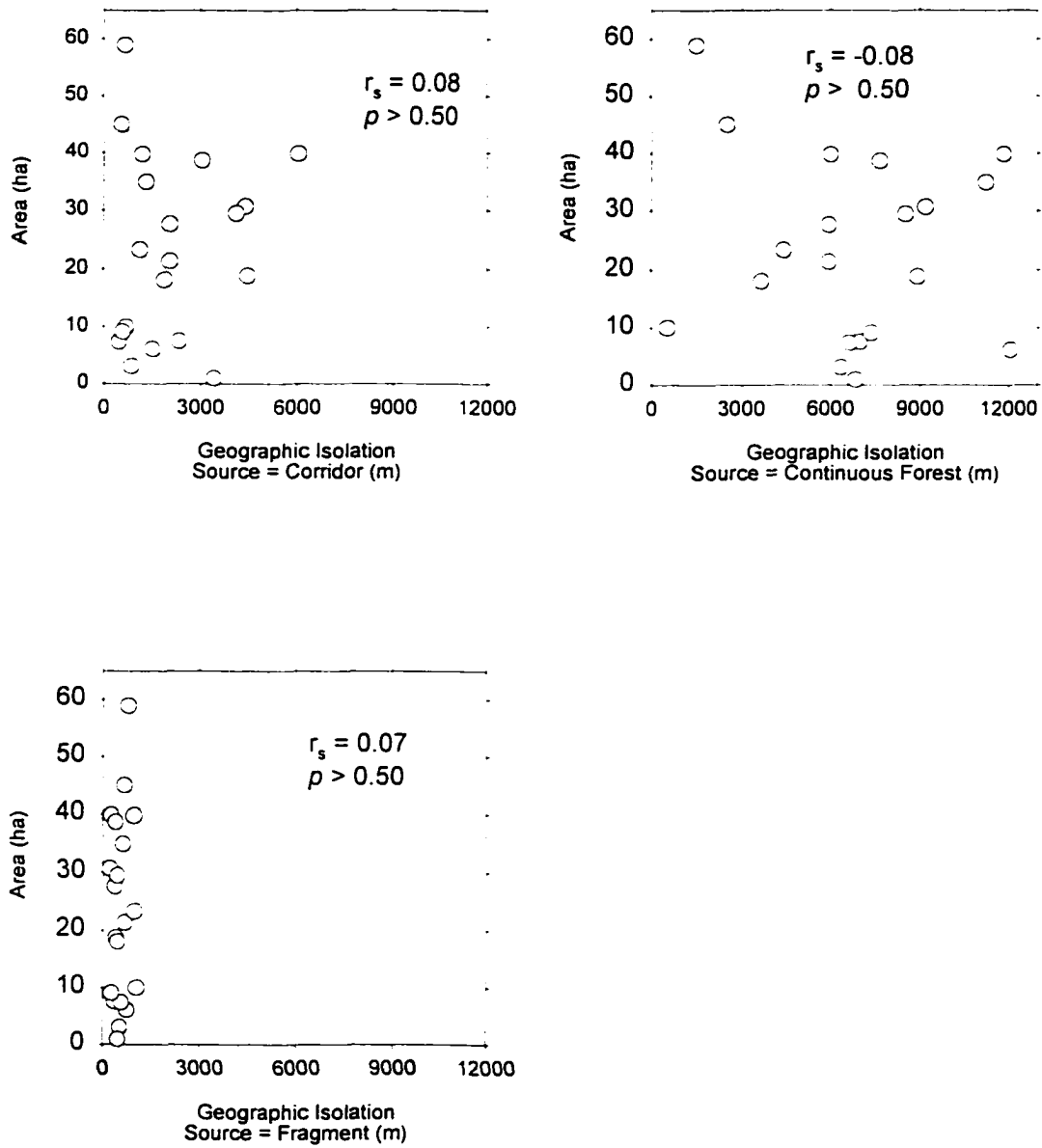


Fig. 7b

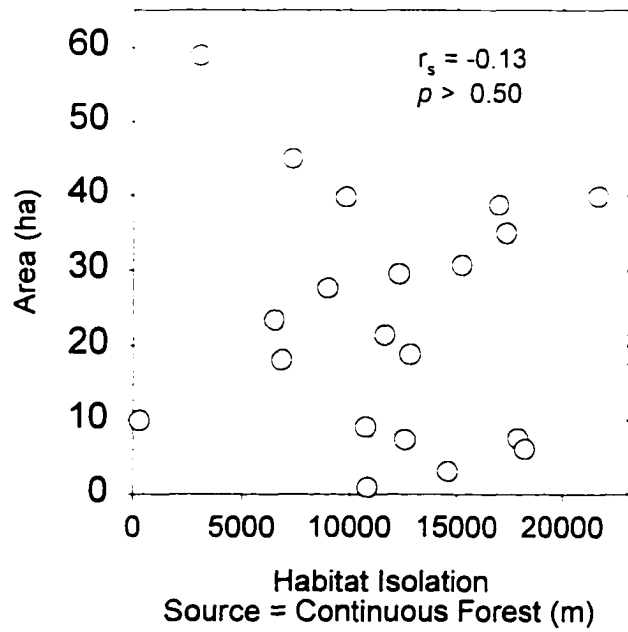
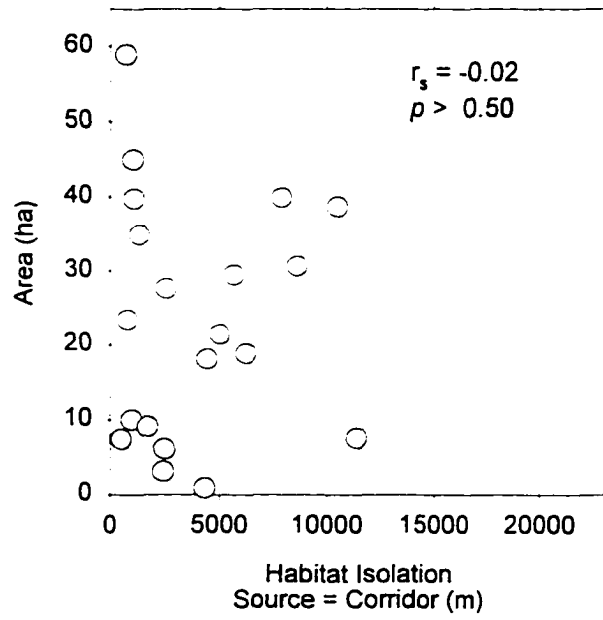


Fig. 7c

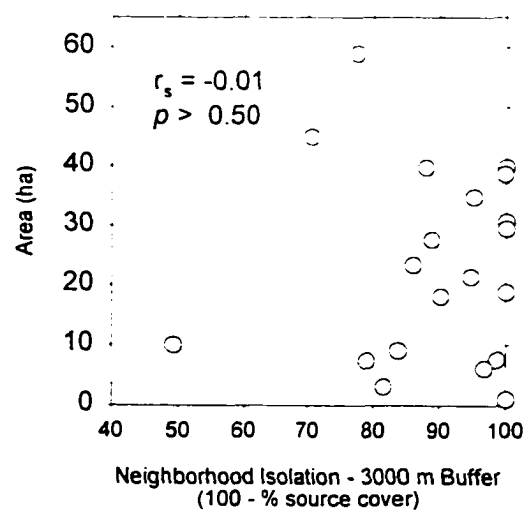
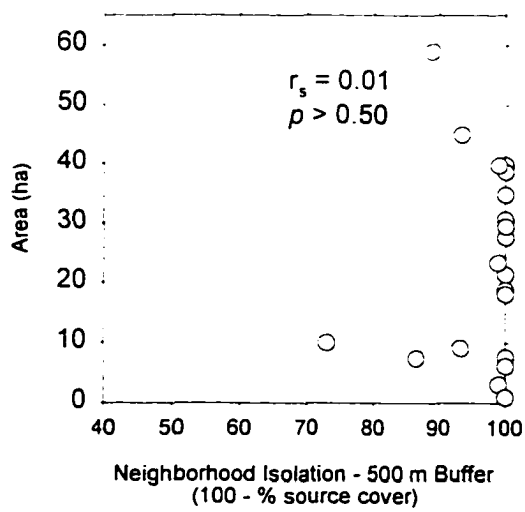
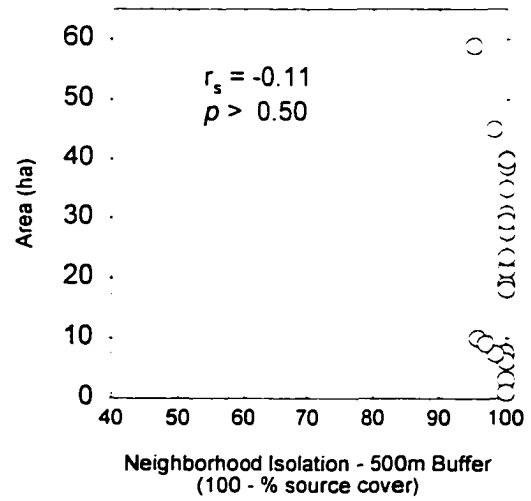
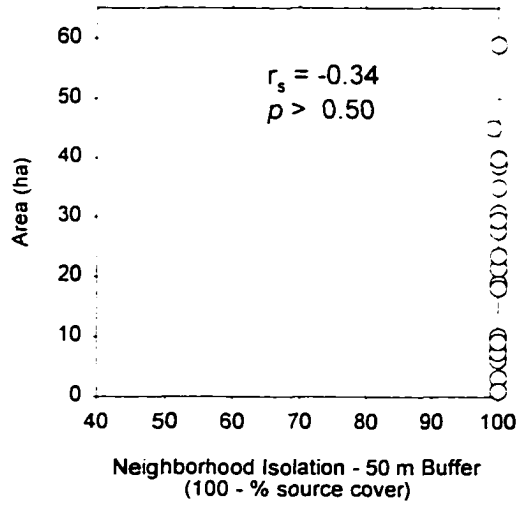


Fig. 8

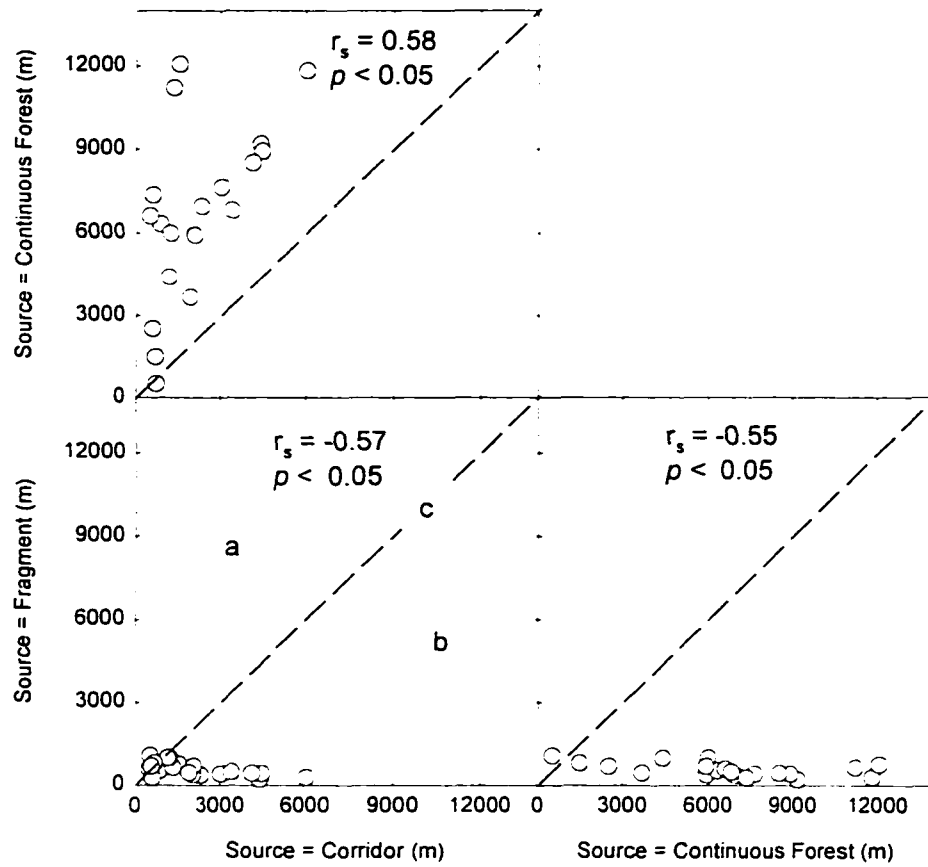


Fig. 9

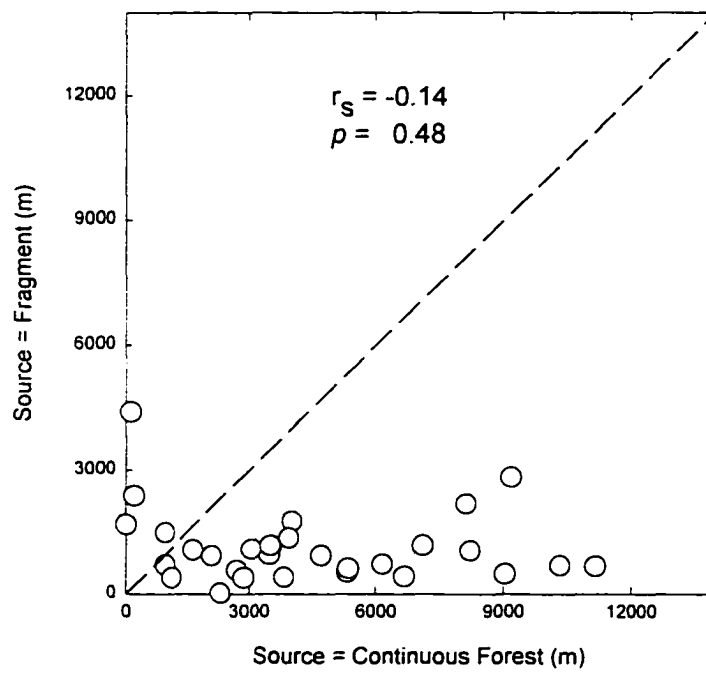


Fig. 10

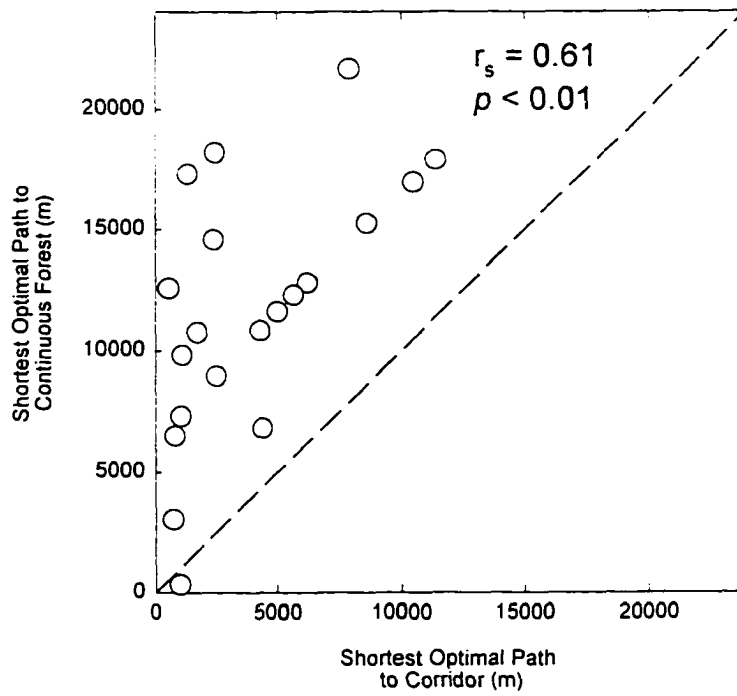


Fig. 11

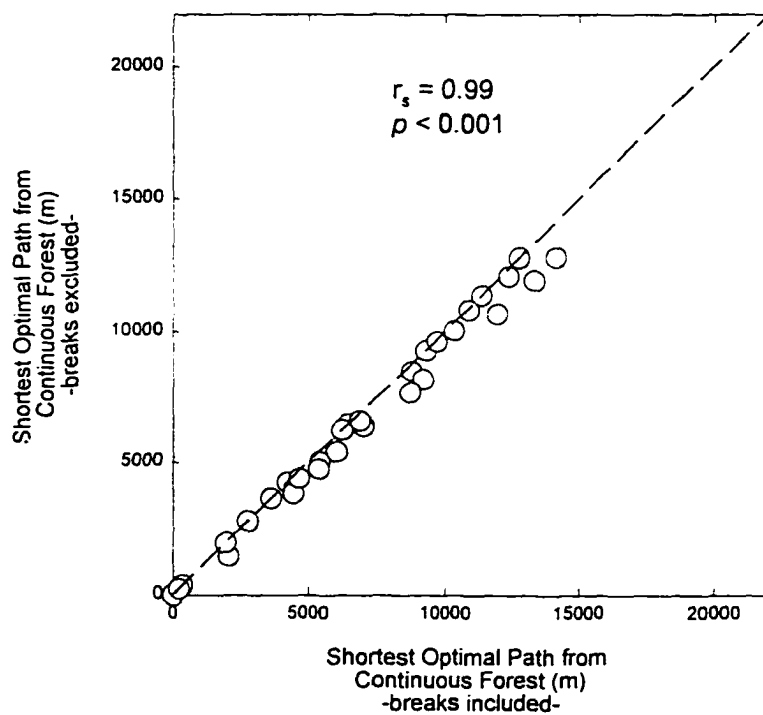


Fig. 12

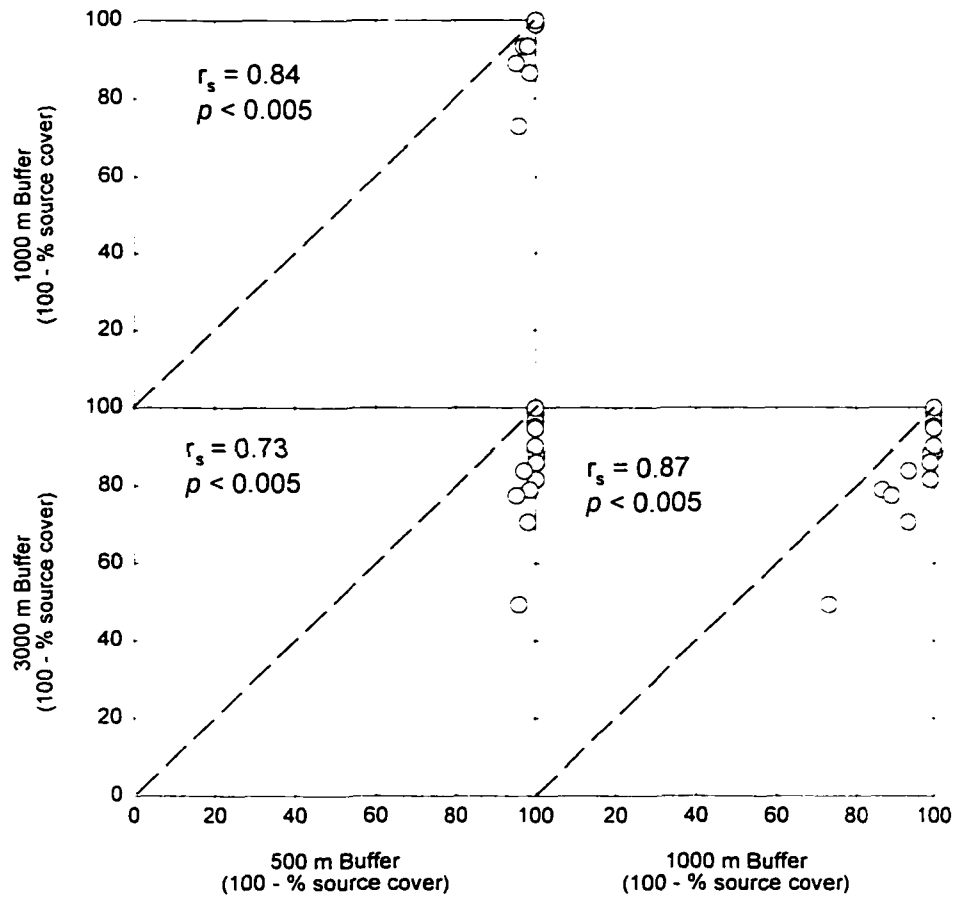


Fig. 13

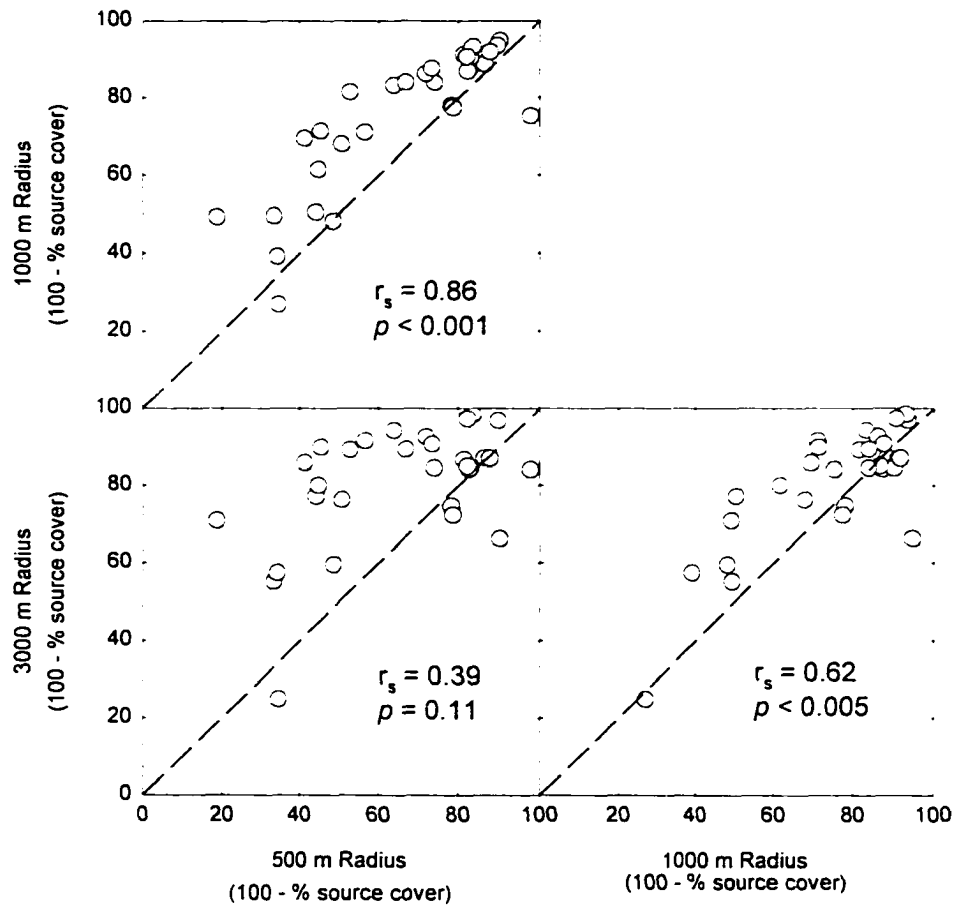


Fig. 14

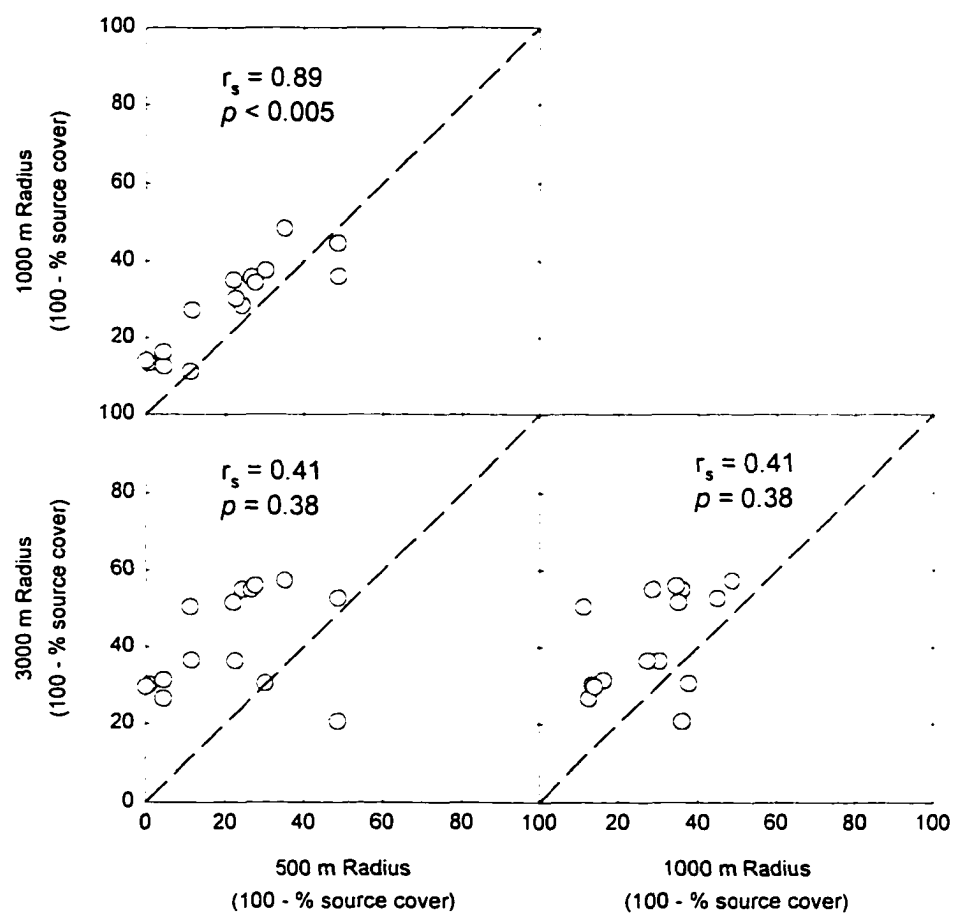


Fig. 15a

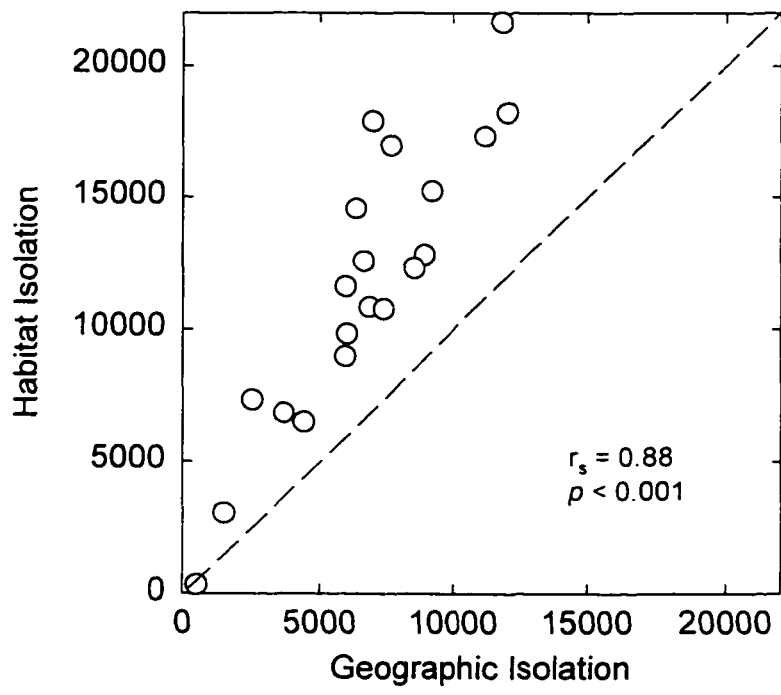


Fig. 15b

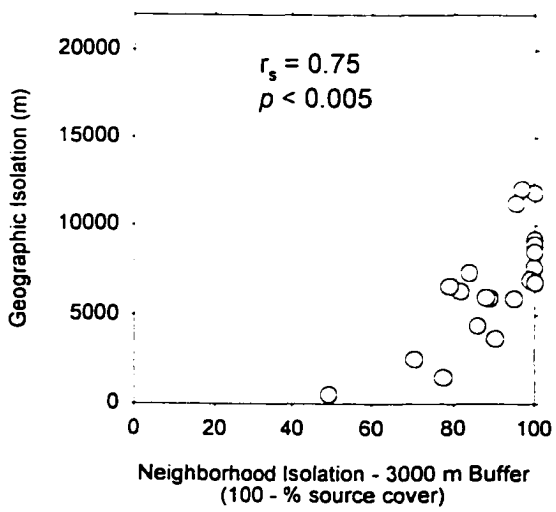
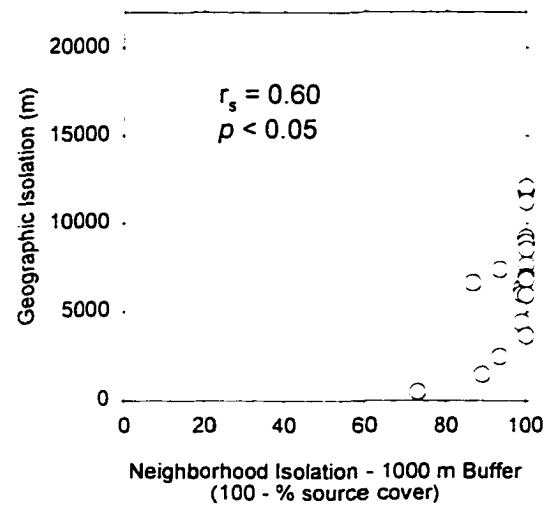
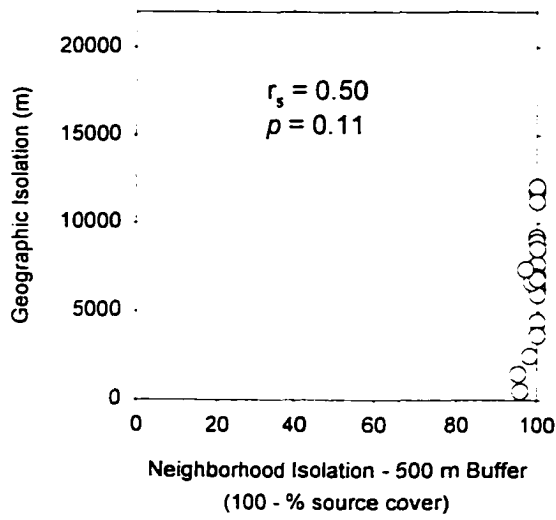


Fig. 15c

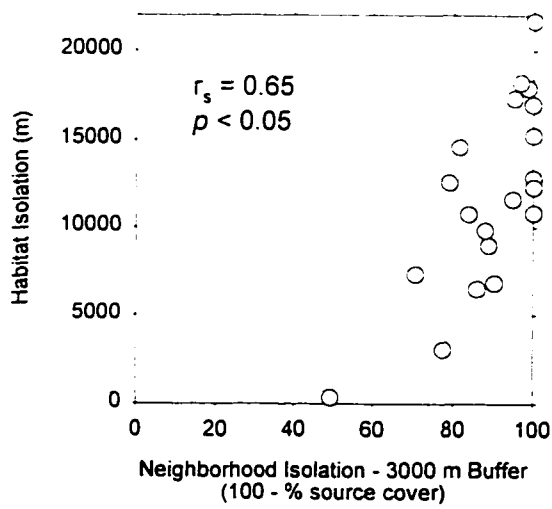
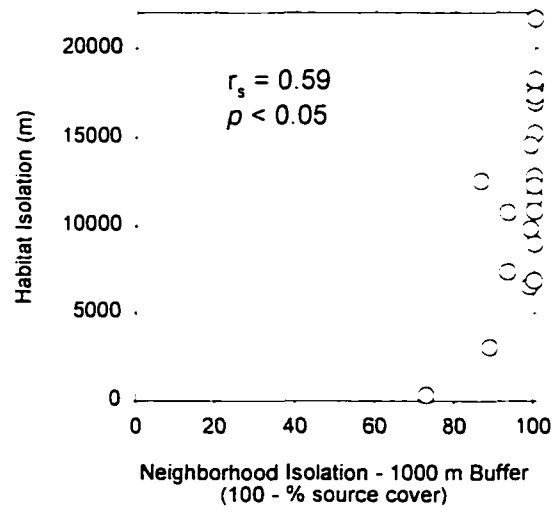
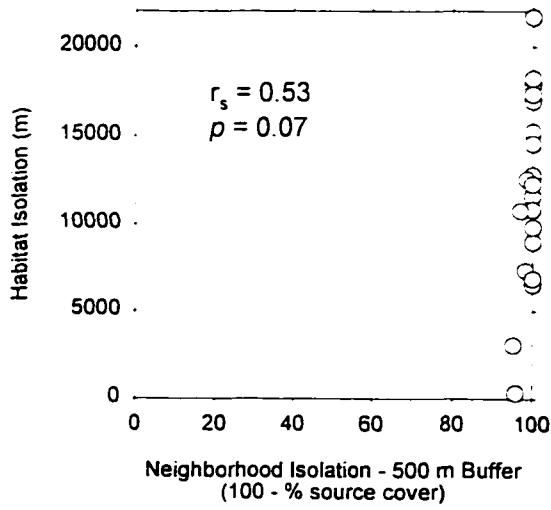


Fig. 16a

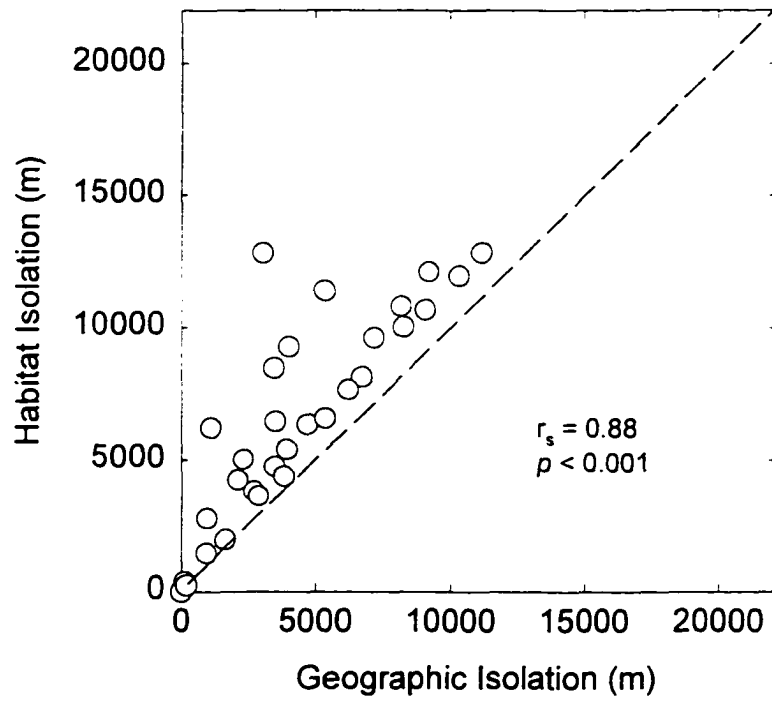


Fig. 16b

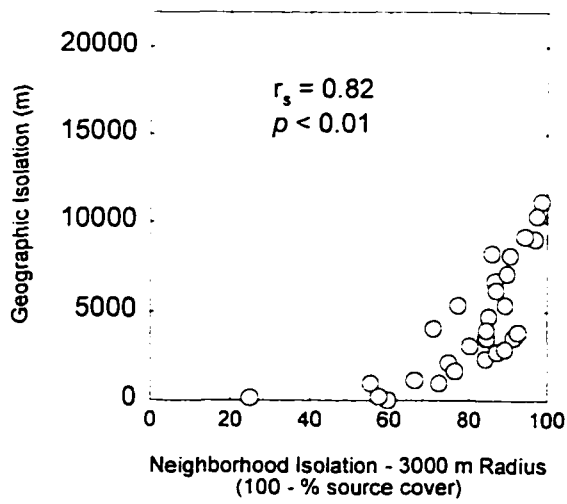
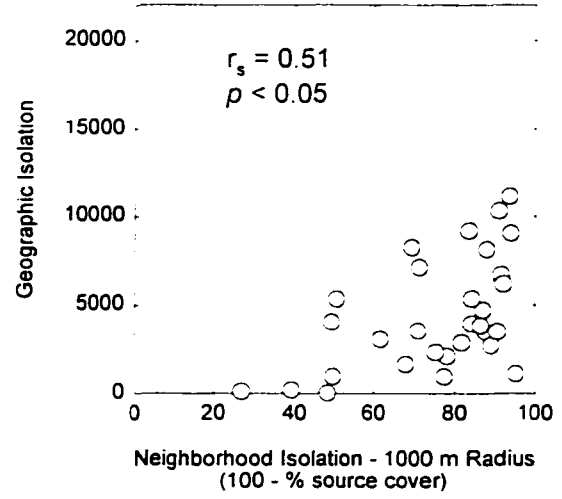
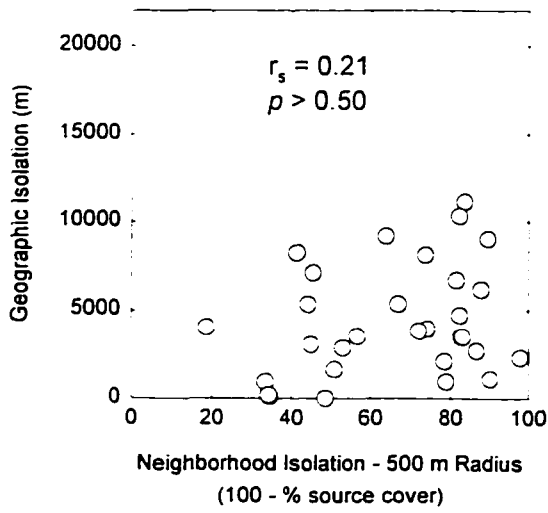
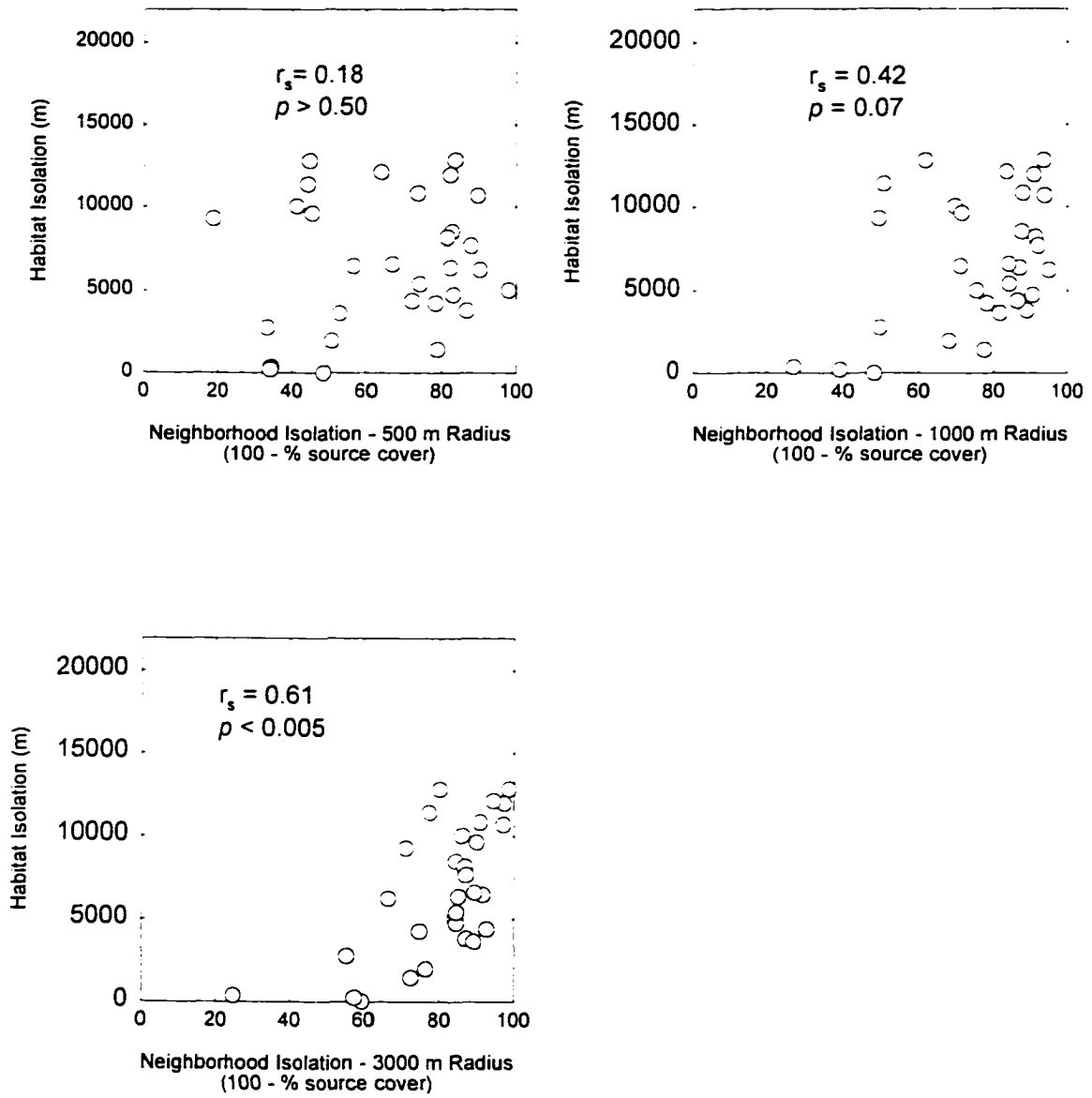


Fig. 16c



APPENDICES

Appendix 1: Geographic Isolation AML

Appendix 2: Habitat Isolation AML

Appendix 3: Neighborhood Isolation AML

3a. Fragment Sites

3b. Corridor Sites

3c. Continuous Forest Sites

Appendix 1: Geographic Isolation AML

```
/* neighborhood.aml
/* calculates straightline distances to cf, corrs, and frags

/* Dave Perault September 1997

/* called by circles.menu

/* names of coverages no longer than 13 characters

&do cursor_name &list [show cursors]
  cursor %cursor_name% remove
&end

&dv .*
&dv A*
&messages &off
&messages &on

&if [exists sites_hood -cov] &then
  ARC KILL sites_hood ALL
  ARC COPY hood_sites sites_hood

UNITS map
&type \Please select a site.\
SHADESYMBOL 38
&getpoint &map &current /* xy coordinates
&sv x = %pnt$x%
&sv y = %pnt$y%
cursor cur_poly declare sites_hood poly
cursor cur_corr declare sites_hood poly
cursor cur_frag declare sites_hood poly
RESEL sites_hood POLY ONE %x% %y% /* reselects polygon with &getpoint coords
cursor cur_poly open
cursor cur_corr open
cursor cur_frag open
&sv poly_id = %:cur_poly.sites_hood-id%
&sv corr = %:cur_corr.corridor%
&sv frag = %:cur_frag.fragment%
cursor cur_poly close
cursor cur_corr close
cursor cur_frag close
cursor cur_poly remove
cursor cur_corr remove
cursor cur_frag remove
&type \You have selected polygon #%poly_id%.
&if %frag% = YES &then
  POLYGONSH sites_hood 38
&else &if %corr% = YES &then
  SPOT %pnt$x% %pnt$y% 150
```

```

&type Is this a fragment site?: %frag%
&type Is this a corridor site?: %corr%

&do &until %continue% = Y OR %continue% = EXIT

  &type \
  &sv site_name = [response 'Please enter site name']
  &sv site_name = [translate %site_name%]
  &type \You have selected site %site_name%.
  &type a fragment (%frag%) or corridor (%corr%) site, located in polygon #%%poly_id%.
  &sv continue = [response ' Do you wish to continue? (y, n, or exit)']
  &sv continue = [translate %continue%]
  &if %continue% = EXIT &then
    &do
      ARC KILL sites_hood ALL
      &type \Please select quit from program menu.\
      &return
    &end /* do if exit

&end /* do until continue = Y or EXIT

MEND
MAP END

&if %frag% = YES &then
  &call &nn_frag
&else &if %corr% = YES &then
  &call &nn_corr
&else &if %frag% = NO AND %corr% = NO &then
  &do
    &call &nn_frag /* remove later
    &type \Neither a corridor nor a fragment site. Try again.\
  &end /* do if no and no

ARC KILL sites_hood ALL

&type \Analysis for site %site_name% completed.
&type \Please continue.\

&return

&routine &nn_frag /* gets nearest neighbor distance

&if [exists site.sel -file] &then
  &sv del = [delete site.sel -file]
&if [exists site.sex -file] &then
  &sv del = [delete site.sex -file]
&if [exists site -cov] &then
  ARC KILL site ALL

```

```

CALCULATE sites_hood POLY class = '**'
WRITESEL site.sel
ARC RESELECT sites_hood site POLY site.sel

&do age &list CF CO FR

&sv class = [quote "[unquote %age%]"]
&sv class = [substr %class% 2 4]

&if [exists class.sel -file] &then
  &sv del = [delete class.sel -file]
&if [exists class.sex -file] &then
  &sv del = [delete class.sex -file]
&if [exists neighbors -cov] &then
  ARC KILL neighbors ALL
&if [exists site_point -cov] &then
  ARC KILL site_point ALL

&type \Now working on habitat cover_%class%...\
ASEL sites_hood POLY
RESEL sites_hood POLY class = %class% /* site class = **
WRITESEL class.sel
ARC RESELECT sites_hood neighbors POLY class.sel
CLEAR
POLYGONSH site 38
POLYGONSH neighbors 67

ARC CREATE site_point sites_hood
&data ARC ARCCREDIT
  EDITCOVERAGE site_point
  EDITFEATURE label
  GET site
  SAVE
  Q
&end
ARC BUILD site_point POINT

ARC BUILD neighbors LINES
ARC NEAR site_point neighbors LINE 1000000
cursor cur_dist declare site_point point
cursor cur_dist open
&sv distance = %:cur_dist.distance%
cursor cur_dist close
cursor cur_dist remove

&data ARC INFO
  ARC
  OUTPUT /DATA4/OKLAHOMA/CIRCLES/NN.TXT
  PRINT 1X,[QUOTE %SITE_NAME%],5X,[QUOTE HABITAT: %CLASS%],5X,[QUOTE
  DISTANCE (M): %distance%]
  Q STOP

```

```

&end

&type \Distance to %class% is %distance% meters.\

&sv del = [delete class.sel -file]
&sv del = [delete class.sex -file]
ARC KILL neighbors ALL
ARC KILL site_point ALL

&end /* do list age

&sv del = [delete site.sel -file]
&sv del = [delete site.sex -file]
ARC KILL site ALL

&return /* ends nn_frag routine

&routine &nn_corr /* gets nearest neighbor distance

&if [exists site -cov] &then
  ARC KILL site ALL

ARC GENERATE site
POINTS
  1,%x%,%y%
end
Q
ARC BUILD site points

&do age &list CF FR

&sv class = [quote "[unquote %age%]"]
&sv class = [substr %class% 2 4]

&if [exists class.sel -file] &then
  &sv del = [delete class.sel -file]
&if [exists class.sex -file] &then
  &sv del = [delete class.sex -file]
&if [exists neighbors -cov] &then
  ARC KILL neighbors ALL
&if [exists site_point -cov] &then
  ARC KILL site_point ALL

&type \Now working on habitat cover_%class%...\
ASEL sites_hood POLY
RESEL sites_hood POLY class = %class% /* site class = **
WRITESEL class.sel
ARC RESELECT sites_hood neighbors POLY class.sel
CLEAR
SPOT %x% %y% 200

```

POLYGONSH neighbors 67

ARC COPY site site_point

ARC BUILD neighbors LINES

ARC NEAR site_point neighbors LINE 1000000

cursor cur_dist declare site_point point

cursor cur_dist open

&sv distance = %:cur_dist.distance%

cursor cur_dist close

cursor cur_dist remove

&data ARC INFO

ARC

OUTPUT /DATA4/OKLAHOMA/CIRCLES/NN.TXT

PRINT 1X,[QUOTE %SITE_NAME%],5X,[QUOTE HABITAT: %CLASS%],5X,[QUOTE
DISTANCE (M): %distance%]

Q STOP

&end

&type \Distance to %class% is %distance% meters.\

&sv del = [delete class.sel -file]

&sv del = [delete class.sex -file]

ARC KILL neighbors ALL

ARC KILL site_point ALL

&end /* do list age

&sv del = [delete site.sel -file]

&sv del = [delete site.sex -file]

ARC KILL site ALL

&return /* ends nn_corr routine

Appendix 2: Habitat Isolation AML

```
/* habitat.aml
/* measures optimal path

/* Dave Perault September 1997

/* called by circles.menu

&do cursor_name &list [show cursors]
  cursor %cursor_name% remove
&end

&dv .*
&dv A*
&messages &off
&messages &on

&if [exists sites_hood -cov] &then
  ARC KILL sites_hood ALL
  ARC COPY hood_sites sites_hood

UNITS map
SHADES YMBOL 38
&type \Please select site.\
&getpoint &map &current /* xy coordinates
&sv x = %pnt$x%
&sv y = %pnt$y%
cursor cur_poly declare sites_hood poly
cursor cur_corr declare sites_hood poly
cursor cur_frag declare sites_hood poly
RESEL sites_hood POLY ONE %x% %y% /* reselects polygon with &getpoint coords
cursor cur_poly open
cursor cur_corr open
cursor cur_frag open
&sv poly_id = %:cur_poly.sites_hood-id%
&sv corr = %:cur_corr.corridor%
&sv frag = %:cur_frag.fragment%
cursor cur_poly close
cursor cur_corr close
cursor cur_frag close
cursor cur_poly remove
cursor cur_corr remove
cursor cur_frag remove
&type \You have selected polygon #%poly_id%.
&if %frag% = YES &then
  POLYGONSH sites_hood 38
&else &if %corr% = YES &then
  SPOT %pnt$x% %pnt$y% 150
&type Is this a fragment site?: %frag%
&type Is this a corridor site?: %corr%
```



```

&do &until %continue% = Y OR %continue% = EXIT

  &type \
  &sv site_name = [response 'Please enter site name']
  &sv site_name = [translate %site_name%]
  &type \You have selected site %site_name%,
  &type a fragment (%frag%) or corridor (%corr%) site, located in polygon #%%poly_id%.
  &sv continue = [response ' Do you wish to continue? (y, n, or exit)']
  &sv continue = [translate %continue%]
  &if %continue% = EXIT &then
    &do
      ARC KILL sites_hood ALL
      &type \Please select quit from program menu.\
      &return
    &end /* do if exit

&end /* do until continue = Y or EXIT

&if [exists %site_name%_path.txt -file] &then
  &sv del = [delete %site_name%_path.txt -file]
&if [exists path.txt -file] &then
  &sv del = [delete path.txt -file]
&if [exists path.dat -info] &then
  &sv del = [delete path.dat -info]
&if [exists path.tab -info] &then
  &sv del = [delete path.tab -info]
&if [exists distance.dat -info] &then
  &sv del = [delete distance.dat -info]

/* Select path

MSEL 2
MDEL
ASEL sites_hood POLY
POLYGONSH sites_hood class class.lut
&type \Please select optimal path, starting just outside of patch.\
&if %frag% = YES &then
  &do
    RESEL sites_hood POLY ONE %x% %y%
    POLYGONSH sites_hood 38
    ASEL sites_hood POLY
  &end
&else &if %corr% = YES &then
  SPOT %pnt$x% %pnt$y% 25

&do &until %opt2_hab% = CF

&if [exists line.txt -file] &then
  &sv del = [delete line.txt -file]
&if [exists path -cov] &then
  ARC KILL path ALL

```

```

&data ARC INFO
  ARC
  OUTPUT /DATA4/OKLAHOMA/CIRCLES/LINE.TXT
  PRINT [QUOTE 1]
  Q STOP
&end

```

```

ASEL sites_hood POLY
cursor cur_pt1_hab declare sites_hood poly
&type \Enter first point, overlapping with previous second point.
&getpoint &map &current
&sv x1 = %pnt$x%
&sv y1 = %pnt$y%
markerset plotter.mrk
markersymbol 53
markercolor black
marker %x1% %y1%
RESEL sites_hood POLY ONE %x1% %y1%
cursor cur_pt1_hab open
&sv pt1_hab = %:cur_pt1_hab.class%
cursor cur_pt1_hab close
cursor cur_pt1_hab remove

```

```

ASEL sites_hood POLY
cursor cur_pt2_hab declare sites_hood poly
&type \Enter second point, just inside next habitat polygon.
&getpoint &map &current
&sv x2 = %pnt$x%
&sv y2 = %pnt$y%
marker %x2% %y2%
RESEL sites_hood POLY ONE %x2% %y2%
cursor cur_pt2_hab open
&sv pt2_hab = %:cur_pt2_hab.class%
cursor cur_pt2_hab close
cursor cur_pt2_hab remove

```

```

&type \ %pt1_hab% %pt2_hab%\

```

```

&data ARC INFO
  ARC
  OUTPUT /DATA4/OKLAHOMA/CIRCLES/LINE.TXT
  PRINT [QUOTE %X1%],[QUOTE .],[QUOTE %Y1%]
  PRINT [QUOTE %X2%],[QUOTE .],[QUOTE %Y2%]
  Q STOP
&end

```

```

&data ARC INFO
  ARC
  OUTPUT /DATA4/OKLAHOMA/CIRCLES/LINE.TXT
  PRINT [QUOTE END]
  PRINT [QUOTE END]

```

```

PRINT [QUOTE ]
Q STOP
&end

ARC GENERATE path
INPUT line.txt
LINES
Q
ARC BUILD PATH LINES
ARCLINES path 2

cur cur_length declare path arc
cur cur_length open
&sv length = %:cur_length.length%
cur cur_length close
cur cur_length remove

&data ARC INFO
ARC
OUTPUT /DATA4/OKLAHOMA/CIRCLES/PATH.TXT
PRINT [QUOTE %PT1_HAB%],[QUOTE .],[QUOTE %LENGTH%]
Q STOP
&end

&type \
&sv del = [delete line.txt -file]
ARC KILL path ALL
&type \ %pt1_hab% %pt2_hab%\

&end /* do until pt1_hab = CF

&data ARC INFO
ARC
DEFINE PATH.DAT
HABITAT,4,4,C
LENGTH,4,12,F,3
/* need <cr> here to end define
SEL PATH.DAT
ADD FROM /DATA4/OKLAHOMA/CIRCLES/PATH.TXT
Q STOP
&end

ARC FREQUENCY path.dat path.tab
habitat
END
length
END

ARC STATISTICS path.dat distance.dat
SUM length
END

```

```
cursor cur_dist declare distance.dat info
cursor cur_dist open
&sv total_distance = %:cur_dist.sum-length%
cursor cur_dist close
cursor cur_dist remove
```

```
ARC ADDITEM path.tab path.tab percentage 8 18 f 6
CALCULATE path.tab INFO percentage = length / %total_distance% * 100
```

```
&data ARC INFO
ARC
OUTPUT /DATA4/OKLAHOMA/CIRCLES/%SITE_NAME%_PATH.TXT
PRINT [QUOTE ]
PRINT [QUOTE ]
PRINT [QUOTE OPTIMAL ROUTE FROM SITE %SITE_NAME% TO CONTIGUOUS
FOREST]
PRINT [QUOTE ]
PRINT 6X,[QUOTE CF: CONTIGUOUS FOREST]
PRINT 6X,[QUOTE CO: CORRIDOR]
PRINT 6X,[QUOTE FR: FRAGMENT]
PRINT 6X,[QUOTE OS: OLD SUCCESSIONAL]
PRINT 6X,[QUOTE YS: YOUNG SUCCESSIONAL]
PRINT 6X,[QUOTE CC: CLEARCUT]
PRINT 6X,[QUOTE WA: WATER]
PRINT 6X,[QUOTE OT: OTHER]
PRINT [QUOTE ]
PRINT 5X,[QUOTE HABITAT],18X,[QUOTE DISTANCE],21X,[QUOTE PERCENT]
SEL PATH.TAB
LI 7X,HABITAT,12X,LENGTH,8X,PERCENTAGE PRINT
PRINT [QUOTE ]
PRINT 11X,[QUOTE TOTAL DISTANCE (METERS):]
SEL DISTANCE.DAT
LI 9X,SUM-LENGTH PRINT
PRINT [QUOTE ]
Q STOP
&end
```

```
&type \\Distance (meters) across each habitat:\
ARC LIST path.tab habitat length percentage
&type \Total distance: %total_distance% meters.\
```

```
ARC KILL sites_hood ALL
&sv del = [delete path.txt -file]
&sv del = [delete path.dat -info]
&sv del = [delete path.tab -info]
&sv del = [delete distance.dat -info]
&type \Analysis for site %site_name% completed.
&type \Please continue.\
```

```
&return
```

Appendix 3: Neighborhood Isolation AML

3a. Fragment Sites

```
/* neigh_frag.aml

/* Dave Perault September 1997

/* called by circles.menu

/* names of coverages no longer than 13 characters

&do cursor_name &list [show cursors]
  cursor %cursor_name% remove
&end

&dv .*
&dv A*
&messages &off
&messages &on

&if [exists sites_hood -cov] &then
  ARC KILL sites_hood ALL
  ARC COPY hood_sites sites_hood

UNITS map
&type \Please select a site.\
&getpoint &map &current /* xy coordinates
&sv x = %pnt$x%
&sv y = %pnt$y%
cursor cur_poly declare sites_hood poly
cursor cur_corr declare sites_hood poly
cursor cur_frag declare sites_hood poly
RESEL sites_hood POLY ONE %x% %y% /* reselects polygon with &getpoint coords.
POLYGONSH sites_hood 38
cursor cur_poly open
cursor cur_corr open
cursor cur_frag open
&sv poly_id = %:cur_poly.sites_hood-id%
&sv corr = %:cur_corr.corridor%
&sv frag = %:cur_frag.fragment%
cursor cur_poly close
cursor cur_corr close
cursor cur_frag close
cursor cur_poly remove
cursor cur_corr remove
cursor cur_frag remove
&type \You have selected polygon #%poly_id%.
&type Is this a fragment site?: %frag%\

&do &until %continue% = Y OR %continue% = EXIT
```

```

&type \
&sv site_name = [response 'Please enter site name']
&sv site_name = [translate %site_name%]
&type \
/* &sv dist_1 = [response 'Please enter buffer distance 1 in km']
&sv dist_1 = 0.05
/* &sv dist_2 = [response 'Please enter buffer distance 2 in km']
&sv dist_2 = 0.5
/* &sv dist_3 = [response 'Please enter buffer distance 3 in km']
&sv dist_3 = 1
/* &sv dist_4 = [response 'Please enter buffer distance 4 in km']
&sv dist_4 = 3

&type \You have selected site %site_name%,
&type a fragment site (%frag%), located in polygon #%%poly_id%.
&type %dist_1% km, %dist_2% km, %dist_3% km and %dist_4% are your distances.
&sv continue = [response ' Do you wish to continue? (y, n, or exit)']
&sv continue = [translate %continue%]
&if %continue% = EXIT &then
&do
ARC KILL sites_hood ALL
&type \Please select quit from program menu.\
&return
&end /* do if exit

&end /* do until continue = Y or EXIT

&type \

&if [exists %site_name%.txt -file] &then
&sv del = [delete %site_name%.txt -file]
&if [exists site.sel -file] &then
&sv del = [delete site.sel -file]
&if [exists site.sex -file] &then
&sv del = [delete site.sex -file]
&if [exists s_%%poly_id% -cov] &then
ARC KILL s_%%poly_id% ALL

&sv dist_1 = %dist_1% * 1000
&sv dist_2 = %dist_2% * 1000
&sv dist_3 = %dist_3% * 1000
&sv dist_4 = %dist_4% * 1000

/* set site polygon(s) apart from others
CALCULATE sites_hood POLY class = '**'
WRITESEL site.sel
ARC RESELECT sites_hood s_%%poly_id% POLY site.sel

&do n &list %dist_1% %dist_2% %dist_3% %dist_4%

```

```

&if [exists s_%poly_id%_%n% -cov] &then      /* s_ >> site_
  ARC KILL s_%poly_id%_%n% ALL
&if [exists f_%poly_id%_%n% -cov] &then      /* f_ >> final_
  ARC KILL f_%poly_id%_%n% ALL
&if [exists fr_%poly_id%_%n% -cov] &then     /* fr_ >> finalreselect_
  ARC KILL fr_%poly_id%_%n% ALL
&if [exists diss.sel -file] &then
  &sv del = [delete diss.sel -file]
&if [exists diss.sex -file] &then
  &sv del = [delete diss.sex -file]
&if [exists fd_%poly_id%_%n% -cov] &then     /* fd_ >> final_dissolve_
  ARC KILL fd_%poly_id%_%n% ALL
&if [exists pfd_%poly_id%_%n%.pat -info] &then /* pfd_ >> pos_final_dissolve_
  &sv del = [delete pfd_%poly_id%_%n%.pat -info]
&if [exists pfd_%poly_id%_%n%.tab -info] &then
  &sv del = [delete pfd_%poly_id%_%n%.tab -info]
&if [exists t_%poly_id%_%n%.dat -info] &then /* t_ >> sum_total_
  &sv del = [delete t_%poly_id%_%n%.dat -info]

&type \Now working on a buffer distance of %n% m...\
ARC BUFFER s_%poly_id%_%n% s_%poly_id%_%n% # # %n%
ARC UNION s_%poly_id%_%n% sites_hood f_%poly_id%_%n%
RESEL f_%poly_id%_%n% POLY inside = 100
WRITESEL diss.sel
ARC RESELECT f_%poly_id%_%n% fr_%poly_id%_%n% POLY diss.sel
RESEL fr_%poly_id%_%n% POLY sites_hood-id = 0 AND area > 0 AND ( fragment NE 'YES' OR corridor
NE 'YES' )
CALCULATE fr_%poly_id%_%n% POLY age_class = 'OTHER'
CALCULATE fr_%poly_id%_%n% POLY class = 'OT'
ASEL fr_%poly_id%_%n% POLY
CLEAR
MAPE s_%poly_id%_%n%
ARC DISSOLVE fr_%poly_id%_%n% fd_%poly_id%_%n% class
POLYGONSH fd_%poly_id%_%n% class class.lut
ARCS fd_%poly_id%_%n%
POLYGONSH sites_hood 38
KEYAREA 13.5 2 16 9
KEYSHADE class.key NOBOX

ARC COPYINFO fd_%poly_id%_%n%.pat pfd_%poly_id%_%n%.pat

CALCULATE pfd_%poly_id%_%n%.pat INFO area = area / 10000 /* converts sq. m to ha

&data ARC INFO
  ARC
  SEL PFD_%POLY_ID%_%N%.PAT
  RESEL FOR AREA LE 0 OR CLASS = '***' /* removes background and site polygons
  PURGE
  Y
  Q STOP
&end

```

```

ARC FREQUENCY pfd_%poly_id%_%n%.pat pfd_%poly_id%_%n%.tab
  class
  END
  area
END

```

```

ARC STATISTICS pfd_%poly_id%_%n%.pat t_%poly_id%_%n%.dat
  SUM area
END

```

```

cursor cur_area declare t_%poly_id%_%n%.dat info
cursor cur_area open
&sv total_area = %:cur_area.sum-area%
cursor cur_area close
cursor cur_area remove

```

```

&data ARC INFO
  ARC
  OUTPUT /DATA4/OKLAHOMA/CIRCLES/%SITE_NAME%.TXT
  PRINT [QUOTE ]
  PRINT [QUOTE ]
  PRINT [QUOTE AREA (HA) MEASUREMENTS FOR SITE %SITE_NAME% LOCATED
IN POLYGON #%%POLY_ID%]
  PRINT [QUOTE ]
  PRINT 12X,[QUOTE BUFFER DISTANCE: %N% METERS]
  PRINT [QUOTE ]
  PRINT 6X,[QUOTE CF: CONTIGUOUS FOREST]
  PRINT 6X,[QUOTE CO: CORRIDOR]
  PRINT 6X,[QUOTE FR: FRAGMENT]
  PRINT 6X,[QUOTE OS: OLD SUCCESSIONAL]
  PRINT 6X,[QUOTE YS: YOUNG SUCCESSIONAL]
  PRINT 6X,[QUOTE CC: CLEARCUT]
  PRINT 6X,[QUOTE WA: WATER]
  PRINT 6X,[QUOTE OT: OTHER]
  PRINT [QUOTE ]
  PRINT 2X,[QUOTE HABITAT],6X,[QUOTE FREQUENCY],8X,[QUOTE AREA]
  SEL PFD_%POLY_ID%_%N%.TAB
  LI 5X,CLASS,5X,FREQUENCY,5X,AREA PRINT
  PRINT 3X,[QUOTE TOTAL AREA (HA):]
  SEL T_%POLY_ID%_%N%.DAT
  LI 5X,SUM-AREA PRINT
  PRINT [QUOTE ]
  Q STOP
&end

```

```

/* values of age classes for buffer distance n

```

```

&do age &list CF CO FR OS YS CC WA OT

```

```

&sv class = [quote "[unquote %age%]" ]

```

```

&sv class = [substr %class% 2 4]

```



```

&if [exists class.sel -file] &then
  &sv del = [delete class.sel -file]
&if [exists class.sex -file] &then
  &sv del = [delete class.sex -file]
&if [exists c_%poly_id%_%n% -cov] &then      /* c_ >> class_
  ARC KILL c_%poly_id%_%n% ALL
&if [exists p_c_%poly_id%_%n%.pat -info] &then /* p_c_ >> pos_c_
  &sv del = [delete p_c_%poly_id%_%n%.pat -info]
&if [exists %poly_id%_%age%_%n%.dat -info] &then
  &sv del = [delete %poly_id%_%age%_%n%.dat -info]

&type \Now working on habitat %class%...\
ASEL fd_%poly_id%_%n% POLY
RESEL fd_%poly_id%_%n% POLY class = %class% /* site class = **
WRITESEL class.sel
ARC RESELECT fd_%poly_id%_%n% c_%poly_id%_%n% POLY class.sel
RESEL c_%poly_id%_%n% POLY class NE %class%
CALCULATE c_%poly_id%_%n% POLY class = '**'
ASEL c_%poly_id%_%n% POLY

ARC COPYINFO c_%poly_id%_%n%.pat p_c_%poly_id%_%n%.pat

CALCULATE p_c_%poly_id%_%n%.pat INFO area = area / 10000 /* converts sq. m to ha

&data ARC INFO
  ARC
  SEL P_C_%POLY_ID%_%N%.PAT
  RESEL FOR AREA LE 0 OR CLASS = '**' /* removes background and site polygons
  PURGE
  Y
  Q STOP
&end

ARC STATISTICS p_c_%poly_id%_%n%.pat %poly_id%_%age%_%n%.dat
  MIN area
  MAX area
  MEAN area
  STD area
  SUM area
END

ARC ADDITEM %poly_id%_%age%_%n%.dat %poly_id%_%age%_%n%.dat variance 8 18 f 6
ARC ADDITEM %poly_id%_%age%_%n%.dat %poly_id%_%age%_%n%.dat se-area 8 18 f 6
ARC ADDITEM %poly_id%_%age%_%n%.dat %poly_id%_%age%_%n%.dat percentage 8 18 f
6
cursor cur_freq declare %poly_id%_%age%_%n%.dat info
cursor cur_freq open
&sv freq = %:cur_freq.frequency%
&type Number of polygons of habitat type %class% = %freq%.
cursor cur_freq close
cursor cur_freq remove

```

```

&if %freq% > 0 &then
&do
  CALCULATE %poly_id%_%age%_%n%.dat INFO variance = std-area * std-area
  CALCULATE %poly_id%_%age%_%n%.dat INFO se-area = std-area / ( frequency ** ( 1 / 2 )
)
  CALCULATE %poly_id%_%age%_%n%.dat INFO percentage = sum-area / %total_area% *
100
&end /* if freq > 0
&else
&do
  CALCULATE %poly_id%_%age%_%n%.dat INFO variance = 0
  CALCULATE %poly_id%_%age%_%n%.dat INFO se-area = 0
  CALCULATE %poly_id%_%age%_%n%.dat INFO percentage = 0
&end /* if freq NE 0

&type \Sum of area (sq. m) for %age%:\
ARC LIST %poly_id%_%age%_%n%.dat
&type \

&data ARC INFO
ARC
OUTPUT /DATA4/OKLAHOMA/CIRCLES/%SITE_NAME%.TXT
PRINT IX,[QUOTE HABITAT: %AGE%]
SEL %POLY_ID%_%AGE%_%N%.DAT
LI
FREQUENCY,MIN-AREA,MAX-AREA,MEAN-AREA,SE-AREA,SUM-AREA,PERCENTAG
E PRINT
PRINT [QUOTE ]
Q STOP
&end

ASEL fd_%poly_id%_%n% POLY

&sv del = [delete class.sel -file]
&sv del = [delete class.sex -file]
ARC KILL c_%poly_id%_%n% ALL
&sv del = [delete p_c_%poly_id%_%n%.pat -info]
&sv del = [delete %poly_id%_%age%_%n%.dat -info]

&end /* do list age

&type \Data Summary:\
ARC LIST pfd_%poly_id%_%n%.tab
&type \Total area (ha) across all age-classes:\
ARC LIST t_%poly_id%_%n%.dat
&type \

ARC KILL s_%poly_id%_%n% ALL
ARC KILL f_%poly_id%_%n% ALL
ARC KILL fr_%poly_id%_%n% ALL
&sv del = [delete diss.sel -file]

```

```
&sv del = [delete diss.sex -file]
ARC KILL fd_%poly_id%_%n% ALL
&sv del = [delete pfd_%poly_id%_%n%.pat -info]
&sv del = [delete pfd_%poly_id%_%n%.tab -info]
&sv del = [delete t_%poly_id%_%n%.dat -info]

&end /* do i = 1 to 4

&sv del = [delete site.sel -file]
&sv del = [delete site.sex -file]
ARC KILL s_%poly_id% ALL
ARC KILL sites_hood ALL

&dv .*
&dv A*

&type \Analysis for site %site_name% completed.
&type \Please continue.\

&return
```

Appendix 3: Neighborhood Isolation AML

3b. Corridor Sites

```
/* neigh_corr.aml

/* Dave Perault September 1997

/* called by circles.menu

/* names of coverages no longer than 13 characters

&do cursor_name &list [show cursors]
  cursor %cursor_name% remove
&end

&dv .*
&dv A*
&messages &off
&messages &on

&if [exists sites_hood -cov] &then
  ARC KILL sites_hood ALL
  ARC COPY hood_sites sites_hood

UNITS map
&type \Please select a site.\
&getpoint &map &current /* xy coordinates
&sv x = %pnt$x%
&sv y = %pnt$y%
SHADESYMBOL 38
SPOT %pnt$x% %pnt$y% 100
cursor cur_poly declare sites_hood poly
cursor cur_corr declare sites_hood poly
cursor cur_frag declare sites_hood poly
RESEL sites_hood POLY ONE %x% %y% /* reselects polygon with &getpoint coords.
cursor cur_poly open
cursor cur_corr open
cursor cur_frag open
&sv poly_id = %:cur_poly.sites_hood-id%
&sv corr = %:cur_corr.corridor%
&sv frag = %:cur_frag.fragment%
cursor cur_poly close
cursor cur_corr close
cursor cur_frag close
cursor cur_poly remove
cursor cur_corr remove
cursor cur_frag remove
&type \You have selected polygon #%%poly_id%.
&type \Is this a corridor site?: %%corr%
```

```
&do &until %continue% = Y OR %continue% = EXIT
```

```
&type \  
&sv site_name = [response 'Please enter site name']  
&sv site_name = [translate %site_name%]  
&type \  
/* &sv dist_1 = [response 'Please enter buffer distance 1 in km']  
&sv dist_1 = 0.5  
/* &sv dist_2 = [response 'Please enter buffer distance 2 in km']  
&sv dist_2 = 1  
/* &sv dist_3 = [response 'Please enter buffer distance 3 in km']  
&sv dist_3 = 3
```

```
&type \You have selected site %site_name%,  
&type a corridor site (%corr%) located in polygon #%%poly_id%.  
&type %dist_1% km, %dist_2% km, and %dist_3% km are your distances.  
&sv continue = [response ' Do you wish to continue? (y, n, or exit)']  
&sv continue = [translate %continue%]  
&if %continue% = EXIT &then  
&do  
  ARC KILL sites_hood ALL  
  &type \Please select quit from program menu\  
  &return  
&end /* do if exit
```

```
&end /* do until continue = Y or EXIT
```

```
&type \  

```

```
&if [exists %site_name%.txt -file] &then  
  &sv del = [delete %site_name%.txt -file]
```

```
&sv dist_1 = %dist_1% * 1000  
&sv dist_2 = %dist_2% * 1000  
&sv dist_3 = %dist_3% * 1000
```

```
&do n &list %dist_1% %dist_2% %dist_3%
```

```
&if [exists circle_%n% -cov] &then  
  ARC KILL circle_%n% ALL  
&if [exists f_%poly_id%_%n% -cov] &then /* f_ >> final_  
  ARC KILL f_%poly_id%_%n% ALL  
&if [exists fr_%poly_id%_%n% -cov] &then /* fr_ >> finalreselect_  
  ARC KILL fr_%poly_id%_%n% ALL  
&if [exists diss.sel -file] &then  
  &sv del = [delete diss.sel -file]  
&if [exists diss.sex -file] &then  
  &sv del = [delete diss.sex -file]  
&if [exists rc_%poly_id%_%n% -cov] &then /* rc_ >> finalreselectclip_  
  ARC KILL rc_%poly_id%_%n% ALL  
&if [exists fd_%poly_id%_%n% -cov] &then /* fd_ >> final_dissolve_
```

```

ARC KILL fd_%poly_id%_%n% ALL
&if [exists pfd_%poly_id%_%n%.pat -info] &then /* pfd_ >> pos_final_dissolve_
  &sv del = [delete pfd_%poly_id%_%n%.pat -info]
&if [exists pfd_%poly_id%_%n%.tab -info] &then
  &sv del = [delete pfd_%poly_id%_%n%.tab -info]
&if [exists t_%poly_id%_%n%.dat -info] &then /* t_ >> sum_total_
  &sv del = [delete t_%poly_id%_%n%.dat -info]

&type \Now working on a buffer distance of %n% m...\
ARC GENERATE circle_%n%
  CIRCLE
  %n%,%x%,%y%,%n%
  END
  Q
ARC CLEAN circle_%n%
ARCLINES circle_%n% 2
ARC UNION sites_hood circle_%n% f_%poly_id%_%n%
RESEL f_%poly_id%_%n% POLY circle_%n%-id NE 0
WRITESEL diss.sel
ARC RESELECT f_%poly_id%_%n% fr_%poly_id%_%n% POLY diss.sel
RESEL fr_%poly_id%_%n% POLY sites_hood-id = 0 AND area > 0
CALCULATE fr_%poly_id%_%n% POLY age_class = 'OTHER'
CALCULATE fr_%poly_id%_%n% POLY class = 'OT'
ASEL fr_%poly_id%_%n% POLY
ARC CLIP fr_%poly_id%_%n% circle_%n% rc_%poly_id%_%n% POLY
CLEAR
MAPE rc_%poly_id%_%n%
ARC DISSOLVE rc_%poly_id%_%n% fd_%poly_id%_%n% class
POLYGONSH fd_%poly_id%_%n% class class.lut
ARCS fd_%poly_id%_%n%
SPOT %pnt$x% %pnt$y% 100
KEYAREA 13.5 2 16 9
KEYSHADE class.key NOBOX

ARC COPYINFO fd_%poly_id%_%n%.pat pfd_%poly_id%_%n%.pat
CALCULATE pfd_%poly_id%_%n%.pat INFO area = area / 10000 /* converts sq. m to ha

&data ARC INFO
  ARC
  SEL PFD_%POLY_ID%_%N%.PAT
  RESEL FOR AREA LE 0 OR CLASS = '***' /* removes background and site polygons
  PURGE
  Y
  Q STOP
&end

ARC FREQUENCY pfd_%poly_id%_%n%.pat pfd_%poly_id%_%n%.tab
  class
  END
  area
  END

```

```

ARC STATISTICS pfd_%poly_id%_%n%.pat t_%poly_id%_%n%.dat
SUM area
END

```

```

cursor cur_area declare t_%poly_id%_%n%.dat info
cursor cur_area open
&sv total_area = %:cur_area.sum-area%
cursor cur_area close
cursor cur_area remove

```

```

&data ARC INFO
ARC
OUTPUT /DATA4/OKLAHOMA/CIRCLES/%SITE_NAME%.TXT
PRINT [QUOTE ]
PRINT [QUOTE ]
PRINT [QUOTE AREA (HA) MEASUREMENTS FOR SITE %SITE_NAME% LOCATED IN POLYGON
#%POLY_ID%]
PRINT [QUOTE ]
PRINT 12X,[QUOTE BUFFER DISTANCE: %N% METERS]
PRINT [QUOTE ]
PRINT 6X,[QUOTE CF: CONTIGUOUS FOREST]
PRINT 6X,[QUOTE CO: CORRIDOR]
PRINT 6X,[QUOTE FR: FRAGMENT]
PRINT 6X,[QUOTE OS: OLD SUCCESSIONAL]
PRINT 6X,[QUOTE YS: YOUNG SUCCESSIONAL]
PRINT 6X,[QUOTE CC: CLEARCUT]
PRINT 6X,[QUOTE WA: WATER]
PRINT 6X,[QUOTE OT: OTHER]
PRINT [QUOTE ]
PRINT 2X,[QUOTE HABITAT],6X,[QUOTE FREQUENCY],8X,[QUOTE AREA]
SEL PFD_%POLY_ID%_%N%.TAB
LI 5X,CLASS,5X,FREQUENCY,5X,AREA PRINT
PRINT 3X,[QUOTE TOTAL AREA (HA):]
SEL T_%POLY_ID%_%N%.DAT
LI 5X,SUM-AREA PRINT
PRINT [QUOTE ]
Q STOP
&end

```

```

/* values of age classes for buffer distance n
&do age &list CF CO FR OS YS CC WA OT

```

```

&sv class = [quote "[unquote %age%]" ]
&sv class = [substr %class% 2 4]

```

```

&if [exists class.sel -file] &then
&sv del = [delete class.sel -file]
&if [exists class.sex -file] &then
&sv del = [delete class.sex -file]
&if [exists c_%poly_id%_%n% -cov] &then /* c_ >> class_
ARC KILL c_%poly_id%_%n% ALL

```

```

&if [exists p_c_%poly_id%_%n%.pat -info] &then /* p_c_ >> pos_c_
  &sv del = [delete p_c_%poly_id%_%n%.pat -info]
&if [exists %poly_id%_%age%_%n%.dat -info] &then
  &sv del = [delete %poly_id%_%age%_%n%.dat -info]

&type \Now working on habitat %class%...\
ASEL fd_%poly_id%_%n% POLY
RESEL fd_%poly_id%_%n% POLY class = %class% /* site class = **
WRITESEL class.sel
ARC RESELECT fd_%poly_id%_%n% c_%poly_id%_%n% POLY class.sel
RESEL c_%poly_id%_%n% POLY class NE %class%
CALCULATE c_%poly_id%_%n% POLY class = '**'
ASEL c_%poly_id%_%n% POLY

ARC COPYINFO c_%poly_id%_%n%.pat p_c_%poly_id%_%n%.pat
CALCULATE p_c_%poly_id%_%n%.pat INFO area = area / 10000 /* converts sq. m to ha

&data ARC INFO
  ARC
  SEL P_C_%POLY_ID%_%N%.PAT
  RESEL FOR AREA LE 0 OR CLASS = '**' /* removes background and site polygons
  PURGE
  Y
  Q STOP
&end

ARC STATISTICS p_c_%poly_id%_%n%.pat %poly_id%_%age%_%n%.dat
  MIN area
  MAX area
  MEAN area
  STD area
  SUM area
END

ARC ADDITEM %poly_id%_%age%_%n%.dat %poly_id%_%age%_%n%.dat variance 8 18 f 6
ARC ADDITEM %poly_id%_%age%_%n%.dat %poly_id%_%age%_%n%.dat se-area 8 18 f 6
ARC ADDITEM %poly_id%_%age%_%n%.dat %poly_id%_%age%_%n%.dat percentage 8 18 f
6
cursor cur_freq declare %poly_id%_%age%_%n%.dat info
cursor cur_freq open
&sv freq = %:cur_freq.frequency%
&type Number of polygons of habitat type %class% = %freq%.
cursor cur_freq close
cursor cur_freq remove
&if %freq% > 0 &then
  &do
    CALCULATE %poly_id%_%age%_%n%.dat INFO variance = std-area * std-area
    CALCULATE %poly_id%_%age%_%n%.dat INFO se-area = std-area / ( frequency ** ( 1 / 2 )
  )
  CALCULATE %poly_id%_%age%_%n%.dat INFO percentage = sum-area / %total_area% *
100

```



```

&end /* if freq > 0
&else
&do
CALCULATE %poly_id%_%age%_%n%.dat INFO variance = 0
CALCULATE %poly_id%_%age%_%n%.dat INFO se-area = 0
CALCULATE %poly_id%_%age%_%n%.dat INFO percentage = 0
&end /* if freq NE 0

&type \Sum of area (sq. m) for %age%:\
ARC LIST %poly_id%_%age%_%n%.dat
&type \

&data ARC INFO
ARC
OUTPUT /DATA4/OKLAHOMA/CIRCLES/%SITE_NAME%.TXT
PRINT IX,[QUOTE HABITAT: %AGE%]
SEL %POLY_ID%_%AGE%_%N%.DAT
LI
FREQUENCY,MIN-AREA,MAX-AREA,MEAN-AREA,SE-AREA,SUM-AREA,PERCENTAG
E PRINT
PRINT [QUOTE ]
Q STOP
&end

ASEL fd_%poly_id%_%n% POLY
&sv del = [delete class.sel -file]
&sv del = [delete class.sex -file]
ARC KILL c_%poly_id%_%n% ALL
&sv del = [delete p_c_%poly_id%_%n%.pat -info]
&sv del = [delete %poly_id%_%age%_%n%.dat -info]

&end /* do list age

&type \Data Summary:\
ARC LIST pfd_%poly_id%_%n%.tab
&type \Total area (ha) across all age-classes:\
ARC LIST t_%poly_id%_%n%.dat
&type \

ARC KILL circle_%n% ALL
ARC KILL f_%poly_id%_%n% ALL
ARC KILL fr_%poly_id%_%n% ALL
&sv del = [delete diss.sel -file]
&sv del = [delete diss.sex -file]
ARC KILL rc_%poly_id%_%n% ALL
ARC KILL fd_%poly_id%_%n% ALL
&sv del = [delete pfd_%poly_id%_%n%.pat -info]
&sv del = [delete pfd_%poly_id%_%n%.tab -info]
&sv del = [delete t_%poly_id%_%n%.dat -info]

&end /* do i = 1 to 4

```

ARC KILL sites_hood ALL

&dv .*
&dv A*

&type \Analysis for site %site_name% completed.
&type \Please continue\
&return

Appendix 3: Neighborhood Isolation AML

3c. Continuous Forest Sites

```
/* neigh_cf.aml

/* Dave Perault September 1997

/* called by circles.menu

&do cursor_name &list [show cursors]
  cursor %cursor_name% remove
&end

&dv .*
&dv A*
&messages &off
&messages &on

&if [exists sites_hood -cov] &then
  ARC KILL sites_hood ALL
  ARC COPY hood_sites sites_hood

UNITS map
&type \Please select a site.\
&getpoint &map &current /* xy coordinates
&sv x = %pnt$x%
&sv y = %pnt$y%
SHADESYMBOL 38
SPOT %pnt$x% %pnt$y% 100
cursor cur_poly declare sites_hood poly
cursor cur_corr declare sites_hood poly
cursor cur_frag declare sites_hood poly
cursor cur_mf declare sites_hood poly
RESEL sites_hood POLY ONE %x% %y% /* reselects polygon with &getpoint coords.
cursor cur_poly open
cursor cur_corr open
cursor cur_frag open
cursor cur_mf open
&sv poly_id = %:cur_poly.sites_hood-id%
&sv corr = %:cur_corr.corridor%
&sv frag = %:cur_frag.fragment%
&sv mf = %:cur_mf.class%
cursor cur_poly close
cursor cur_corr close
cursor cur_frag close
cursor cur_mf close
cursor cur_poly remove
cursor cur_corr remove
cursor cur_frag remove
cursor cur_mf remove
```

```

&type \You have selected polygon #%%poly_id%.
&type \Is this a contiguous forest (MF) site?: %%mf%

&do &until %%continue% = Y OR %%continue% = EXIT

    &type \
    &sv site_name = [response 'Please enter site name']
    &sv site_name = [translate %%site_name%]
    &type \
    /* &sv dist_1 = [response 'Please enter buffer distance 1 in km']
    &sv dist_1 = 0.5
    /* &sv dist_2 = [response 'Please enter buffer distance 2 in km']
    &sv dist_2 = 1
    /* &sv dist_3 = [response 'Please enter buffer distance 3 in km']
    &sv dist_3 = 3

    &type \You have selected site %%site_name%,
    &type a %%mf% site located in polygon #%%poly_id%.
    &type %%dist_1% km, %%dist_2% km and %%dist_3% are your distances.
    &sv continue = [response ' Do you wish to continue? (y, n, or exit)']
    &sv continue = [translate %%continue%]
    &if %%continue% = EXIT &then
    &do
        ARC KILL sites_hood ALL
        &type \Please select quit from program menu.\
        &return
    &end /* do if exit

&end /* do until continue = Y or EXIT

&type \
&if [exists %%site_name%.txt -file] &then
    &sv del = [delete %%site_name%.txt -file]

&sv dist_1 = %%dist_1% * 1000
&sv dist_2 = %%dist_2% * 1000
&sv dist_3 = %%dist_3% * 1000

&do n &list %%dist_1% %%dist_2% %%dist_3%

&if [exists circle_%%n% -cov] &then
    ARC KILL circle_%%n% ALL
&if [exists f_%%poly_id%_%%n% -cov] &then /* f_ >> final_
    ARC KILL f_%%poly_id%_%%n% ALL
&if [exists fr_%%poly_id%_%%n% -cov] &then /* fr_ >> finalreselect_
    ARC KILL fr_%%poly_id%_%%n% ALL
&if [exists diss.sel -file] &then
    &sv del = [delete diss.sel -file]
&if [exists diss.sex -file] &then
    &sv del = [delete diss.sex -file]
&if [exists rc_%%poly_id%_%%n% -cov] &then /* rc_ >> finalreselectclip_

```

```

ARC KILL rc_%poly_id%_%n% ALL
&if [exists fd_%poly_id%_%n% -cov] &then /* fd_ >> final_dissolve_
  ARC KILL fd_%poly_id%_%n% ALL
&if [exists pfd_%poly_id%_%n%.pat -info] &then /* pfd_ >> pos_final_dissolve_
  &sv del = [delete pfd_%poly_id%_%n%.pat -info]
&if [exists pfd_%poly_id%_%n%.tab -info] &then
  &sv del = [delete pfd_%poly_id%_%n%.tab -info]
&if [exists t_%poly_id%_%n%.dat -info] &then /* t_ >> sum_total_
  &sv del = [delete t_%poly_id%_%n%.dat -info]

&type \Now working on a buffer distance of %n% m...\
ARC GENERATE circle_%n%
  CIRCLE
  %n%,%x%,%y%,%n%
  END
  Q
ARC CLEAN circle_%n%
ARCLINES circle_%n% 2
ARC UNION sites_hood circle_%n% f_%poly_id%_%n%
RESEL f_%poly_id%_%n% POLY circle_%n%-id NE 0
WRITESEL diss.sel
ARC RESELECT f_%poly_id%_%n% fr_%poly_id%_%n% POLY diss.sel
RESEL fr_%poly_id%_%n% POLY sites_hood-id = 0 AND area > 0
CALCULATE fr_%poly_id%_%n% POLY age_class = 'OTHER'
CALCULATE fr_%poly_id%_%n% POLY class = 'OT'
ASEL fr_%poly_id%_%n% POLY
ARC CLIP fr_%poly_id%_%n% circle_%n% rc_%poly_id%_%n% POLY
CLEAR
MAPE rc_%poly_id%_%n%
ARC DISSOLVE rc_%poly_id%_%n% fd_%poly_id%_%n% class
POLYGONSH fd_%poly_id%_%n% class class.lut
ARCS fd_%poly_id%_%n%
SPOT %pnt$x% %pnt$y% 100
KEYAREA 13.5 2 16 9
KEYSHADE class.key NOBOX

ARC COPYINFO fd_%poly_id%_%n%.pat pfd_%poly_id%_%n%.pat
CALCULATE pfd_%poly_id%_%n%.pat INFO area = area / 10000 /* converts sq. m to ha

&data ARC INFO
  ARC
  SEL PFD_%POLY_ID%_%N%.PAT
  RESEL FOR AREA LE 0 OR CLASS = '**' /* removes background and site polygons
  PURGE
  Y
  Q STOP
&end

ARC FREQUENCY pfd_%poly_id%_%n%.pat pfd_%poly_id%_%n%.tab
  class
  END

```

```

    area
END

ARC STATISTICS pfd_%poly_id%_%n%.pat t_%poly_id%_%n%.dat
    SUM area
END

cursor cur_area declare t_%poly_id%_%n%.dat info
cursor cur_area open
&sv total_area = %:cur_area.sum-area%
cursor cur_area close
cursor cur_area remove

&data ARC INFO
    ARC
    OUTPUT /DATA4/OKLAHOMA/CIRCLES/%SITE_NAME%.TXT
    PRINT [QUOTE ]
    PRINT [QUOTE ]
    PRINT [QUOTE AREA (HA) MEASUREMENTS FOR SITE %SITE_NAME% LOCATED IN POLYGON
#%POLY_ID%]
    PRINT [QUOTE ]
    PRINT 12X,[QUOTE BUFFER DISTANCE: %N% METERS]
    PRINT [QUOTE ]
    PRINT 6X,[QUOTE CF: CONTIGUOUS FOREST]
    PRINT 6X,[QUOTE CO: CORRIDOR]
    PRINT 6X,[QUOTE FR: FRAGMENT]
    PRINT 6X,[QUOTE OS: OLD SUCCESSIONAL]
    PRINT 6X,[QUOTE YS: YOUNG SUCCESSIONAL]
    PRINT 6X,[QUOTE CC: CLEARCUT]
    PRINT 6X,[QUOTE WA: WATER]
    PRINT 6X,[QUOTE OT: OTHER]
    PRINT [QUOTE ]
    PRINT 2X,[QUOTE HABITAT],6X,[QUOTE FREQUENCY],8X,[QUOTE AREA]
    SEL PFD_%POLY_ID%_%N%.TAB
    LI 5X,CLASS,5X,FREQUENCY,5X,AREA PRINT
    PRINT 3X,[QUOTE TOTAL AREA (HA):]
    SEL T_%POLY_ID%_%N%.DAT
    LI 5X,SUM-AREA PRINT
    PRINT [QUOTE ]
    Q STOP
&end

/* values of age classes for buffer distance n

&do age &list CF CO FR OS YS CC WA OT

&sv class = [quote "[unquote %age%]" ]
&sv class = [substr %class% 2 4]

&if [exists class.sel -file] &then
    &sv del = [delete class.sel -file]

```

```

&if [exists class.sex -file] &then
  &sv del = [delete class.sex -file]
&if [exists c_%poly_id%_%n% -cov] &then          /* c_ >> class_
  ARC KILL c_%poly_id%_%n% ALL
&if [exists p_c_%poly_id%_%n%.pat -info] &then    /* p_c_ >> pos_c_
  &sv del = [delete p_c_%poly_id%_%n%.pat -info]
&if [exists %poly_id%_%age%_%n%.dat -info] &then
  &sv del = [delete %poly_id%_%age%_%n%.dat -info]

&type \Now working on habitat %class%\
ASEL fd_%poly_id%_%n% POLY
RESEL fd_%poly_id%_%n% POLY class = %class% /* site class = **
WRITESEL class.sel
ARC RESELECT fd_%poly_id%_%n% c_%poly_id%_%n% POLY class.sel
RESEL c_%poly_id%_%n% POLY class NE %class%
CALCULATE c_%poly_id%_%n% POLY class = '**'
ASEL c_%poly_id%_%n% POLY

ARC COPYINFO c_%poly_id%_%n%.pat p_c_%poly_id%_%n%.pat
CALCULATE p_c_%poly_id%_%n%.pat INFO area = area / 10000 /* converts sq. m to ha

&data ARC INFO
  ARC
  SEL P_C_%POLY_ID%_%N%.PAT
  RESEL FOR AREA LE 0 OR CLASS = '**' /* removes background and site polygons
  PURGE
  Y
  Q STOP
&end

ARC STATISTICS p_c_%poly_id%_%n%.pat %poly_id%_%age%_%n%.dat
  MIN area
  MAX area
  MEAN area
  STD area
  SUM area
END

ARC ADDITEM %poly_id%_%age%_%n%.dat %poly_id%_%age%_%n%.dat variance 8 18 f 6
ARC ADDITEM %poly_id%_%age%_%n%.dat %poly_id%_%age%_%n%.dat se-area 8 18 f 6
ARC ADDITEM %poly_id%_%age%_%n%.dat %poly_id%_%age%_%n%.dat percentage 8 18 f
6
cursor cur_freq declare %poly_id%_%age%_%n%.dat info
cursor cur_freq open
&sv freq = %:cur_freq.frequency%
&type Number of polygons of habitat type %class% = %freq%.
cursor cur_freq close
cursor cur_freq remove

&if %freq% > 0 &then
  &do

```

```

    CALCULATE %poly_id%_%age%_%n%.dat INFO variance = std-area * std-area
    CALCULATE %poly_id%_%age%_%n%.dat INFO se-area = std-area / ( frequency ** ( 1 / 2 )
)
    CALCULATE %poly_id%_%age%_%n%.dat INFO percentage = sum-area / %total_area% *
100
&end /* if freq > 0
&else
&do
    CALCULATE %poly_id%_%age%_%n%.dat INFO variance = 0
    CALCULATE %poly_id%_%age%_%n%.dat INFO se-area = 0
    CALCULATE %poly_id%_%age%_%n%.dat INFO percentage = 0
&end /* if freq NE 0

&type \Sum of area (sq. m) for %age%:\
ARC LIST %poly_id%_%age%_%n%.dat
&type \

&data ARC INFO
ARC
OUTPUT /DATA4/OKLAHOMA/CIRCLES/%SITE_NAME%.TXT
PRINT IX,[QUOTE HABITAT: %AGE%]
SEL %POLY_ID%_%AGE%_%N%.DAT
LI
FREQUENCY,MIN-AREA,MAX-AREA,MEAN-AREA,SE-AREA,SUM-AREA,PERCENTAG
E PRINT
PRINT [QUOTE ]
Q STOP
&end

ASEL fd_%poly_id%_%n% POLY

&sv del = [delete class.sel -file]
&sv del = [delete class.sex -file]
ARC KILL c_%poly_id%_%n% ALL
&sv del = [delete p_c_%poly_id%_%n%.pat -info]
&sv del = [delete %poly_id%_%age%_%n%.dat -info]

&end /* do list age

&type \Data Summary:\
ARC LIST pfd_%poly_id%_%n%.tab
&type \Total area (ha) across all age-classes:\
ARC LIST t_%poly_id%_%n%.dat
&type \

ARC KILL circle_%n% ALL
ARC KILL f_%poly_id%_%n% ALL
ARC KILL fr_%poly_id%_%n% ALL
&sv del = [delete diss.sel -file]
&sv del = [delete diss.sex -file]
ARC KILL rc_%poly_id%_%n% ALL

```



```
ARC KILL fd_%poly_id%_%n% ALL
&sv del = [delete pfd_%poly_id%_%n%.pat -info]
&sv del = [delete pfd_%poly_id%_%n%.tab -info]
&sv del = [delete t_%poly_id%_%n%.dat -info]

&end /* do i = 1 to 4

ARC KILL sites_hood ALL

&dv .*
&dv A*

&type \Analysis for site %site_name% completed.
&type \Please continue.\

&return
```

Corridors and Mammal Community Structure across a
Fragmented, Old-growth Forest Landscape

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Corridors and Mammal Community Structure across a
Fragmented, Old-growth Forest Landscape

ABSTRACT

We studied the influence of corridors on the community structure of old-growth forest mammals across a fragmented ecosystem, the Olympic National Forest, Washington. This region of once contiguous forest has been transformed by logging into a mosaic of landscape features including clearcuts, successional forest, and old-growth forest patches and corridors. To assess corridor utility, we quantified among- and within-corridor variability in community structure, landscape indices, and habitat descriptors. Discriminant analyses showed the four corridors studied differing significantly both in species assemblages ($p < 0.05$) and in habitat characteristics ($p < 0.005$). Changes along individual corridors, however, were minimal, and were primarily associated with adjacent habitat. The proportion of adjacent old-growth forest significantly decreased along three of the four corridors, reflecting the fragmentation gradient across this system. At the species level, relative density was significantly correlated with isolation along individual corridors in four (three positive and one negative) of 23 cases. No demographic measure (proportion breeding individuals, proportion juveniles, or proportion females) attenuated with isolation along any single corridor. Finally, both forest species richness and occurrence of specific forest species were consistently higher in corridors than in the surrounding matrix of young forest and clearcut. These results suggest that, although these corridors appear to be

effective throughout their entirety and possibly serve as demographic sources of individuals, they should not be considered equivalent to one another. Only by considering biological relationships on a per corridor basis can the respective value of individual corridors be determined. For the Olympic National Forest, this value is significant, with its corridors both maintaining connectivity and providing dispersers across this system's fragmented landscape.

Key words: corridors, dispersal, fragmentation, landscape ecology, matrix, mammals, community structure, Olympic Peninsula

Running Head: Perault and Lomolino - Corridors and Community Structure

INTRODUCTION

The role corridors play in ameliorating the effects of fragmentation is a heavily debated topic in landscape ecology and conservation biology (Noss 1987, Saunders and Hobbs 1991, Hobbs 1992, Simberloff et al. 1992, Forman 1995, Mann and Plummer 1995). The idea that corridors, by allowing species movements, might serve to maintain natural levels of connectivity among populations, is an appealing one. This potential for maintaining connectivity, however, is one that has neither been fully accepted nor rigorously tested. Because such rigorous investigations conducted at landscape-level scales are lacking, many of the conservation practices related to corridor design and maintenance have been based on theory alone.

Corridor Function

Corridors were originally defined by Simpson (1936, 1940) as routes permitting the relative rapid and unselective spread of biota between regions (Brown and Lomolino 1998). Most current definitions of corridors, particularly in landscape ecology, discuss their functions as dispersal conduits. For example, Newmark (1993:500) defines a corridor simply as "habitat that permits the movement of organisms between ecological isolates." Such movements may be short, as with daily excursions for food (Beier 1993, Bennett et al. 1994), or they may involve relocations such as seasonal migrations (Thomas and Irby 1990, Kahurananga and Silkiluwasha 1997) or natal dispersal (Harrison 1992, Beier 1995). Movements may even encompass biogeographic spatial and temporal

scales, resulting in shifts in species ranges (Graham 1988, Lepage and Basinger 1995). Corridors accommodating this broad range of movements vary in size from short, linear bands less than 1 m wide (Andreassen et al. 1996) to regional swaths many kilometers wide and thousands of kilometers in length (Hunter et al. 1988).

In addition to acting as travel conduits, corridors may serve another important role by providing basic requirements for foraging, breeding, and refugia (Johnson 1989, Andreassen et al. 1996). In doing this, corridors may serve as secondary sources of immigrants, increasing dispersal to otherwise isolated populations. Thus, corridors may represent important, independent landscape features as well as dispersal conduits (Forman 1995).

Corridor Theory

As with their original definition, the roots of corridor theory can be traced to Simpson's (1940) work on movements between North and South America during the great faunal interchange. Corridor theory later drew from MacArthur and Wilson's (1963, 1967) equilibrium theory of island biogeography which, states that species richness results from an ongoing interaction between immigration and extinction. By permitting movements, corridors should increase immigration rates among isolates, enabling higher abundance as well as greater species richness. They accomplish this by reducing the probability of local extinction (rescue effect; Brown and Kodric-Brown 1977), by allowing those species that have undergone extinction to recolonize, and by providing secondary

breeding and feeding sites (Newmark 1993). By increasing immigration, corridors may also reduce inbreeding and random genetic drift in local populations.

Increases in movements, however, may be detrimental. Movements along corridors may facilitate the spread of negative factors such as diseases, pests, and exotic species. For example, Kitron and Kazmierczak (1997) found an increase in the spread of Lyme disease carried by white-tailed deer (Odocoileus virginianus) dispersing along corridors. Increased movements may also cause corridors to act as population sinks, drawing individuals from high quality habitat into edge-dominated, higher mortality areas. Genetically, such movements may adversely serve to offset local adaptive processes and homogenize local populations (Noss 1987, Simberloff et al. 1992, Fahrig and Merriam 1994, Forman 1995). Corridor advocates respond that any negative aspects, such as increases in pests and exotic species, would be likely regardless of corridor presence and that, until better data are collected, it is better to be “conservative” and maintain connections whenever possible (Forman 1995, Mann and Plummer 1995). Given, the great costs and potential deleterious effects of maintaining or re-establishing corridors, however, it seems imperative that we test assumptions of both sides of this debate.

Corridor Research

The notion that connected populations are more viable than unconnected ones was championed by Levins in the 1960s and 1970s (Levins 1969). His metapopulation theory described transitory populations that, although

autonomous, were linked to one another as a “metapopulation” via dispersal (see also Gilpin and Hanski 1997). The strength of this link should vary according to the connectivity, or ease of movement among local populations, of the metapopulation (Merriam 1984). Thus, corridors were suggested to be key tools for maintaining high levels of connectivity and viability, particularly across terrestrial ecosystems (Harris 1984). Work to verify this claim has generally fallen into four categories: theoretical models and simulations, experimental manipulations, natural experiments, and direct monitoring of movements.

Theoretical models and simulations

Researchers have explored the dynamics of connectivity by modeling demographic parameters (e.g., birth rates, mortality, habitat preferences, and movement rates) to simulate movements across theoretical landscapes (Merriam 1984, Fahrig and Merriam 1985, Taylor et al. 1993, With et al. 1997). Although corridors were not originally delineated from the overall matrix, they have since become an explicit component of such studies (Henein and Merriam 1990, Merriam 1991, Beier 1993, Tiebout and Anderson 1997, Tischendorf and Wissel 1997). Survival of local populations and metapopulations was originally assessed with and without corridors. Eventually, simulations began to explore how changing the characteristics of corridors affected their usefulness (Soule and Gilpin 1991, Baur and Baur 1992, Anderson and Danielson 1997, Tischendorf and Wissel 1997, Van Drop et al. 1997). Width, for example, has often been proposed as a key component to dispersal success (Soule and Gilpin 1991, Tischendorf and

Wissel 1997).

Simulations are advantageous in that they can generate large amounts of data based on multiple criteria. They have been criticized, however, for their vague results and questionable relevance to actual scenarios. Extending the example for width, an ambiguous distance between a minimum width to offset edge effects, and a maximum width to reduce cross-directional movements, has been suggested to be optimal (Soule and Gilpin 1991, Tischendorf and Wissel 1997). In essence, this theoretical approach to corridor research fails to satisfy the need for rigorous, real-world empirical data collected from actual disruptions to a natural system.

Experimental manipulations

Another common approach to corridor research has been to experimentally manipulate a controlled system. Experimental manipulations have been typically conducted across areas of less than 1 ha and involve comparing community structure of connected patches against those of unconnected ones (Lorenz and Barrett 1990, La Polla and Barrett 1993, Andreassen et al. 1996, Ruefenacht and Knight 1997). In addition to assessing the patches themselves, such studies have measured movements of individuals between patches (Lorenz and Barrett 1990).

As with models and simulations, results from experimental manipulations have varied. La Polla and Barrett (1993), for example, demonstrated that corridors are important for movements of meadow voles (Microtus pennsylvanicus), but that this importance differed between males and females.

Lorenz and Barrett (1990) showed seasonal as well as sex biases in dispersal along corridors by house mice (*Mus musculus*). In terms of width, Andreassen et al. (1997) found that, as in the theoretical approach, a compromise in width proved optimal for movements of root voles (*Microtus oeconomus*) along corridors. Too narrow, and individuals are restricted in their movements; too wide, and individuals meander, making little forward progress along the corridor (Andreassen et al. 1997).

Experimental manipulations have provided opportunities to conduct highly controlled, replicated studies on corridor use. The short-term and spatially limited scales of such studies (typically less than the life spans and smaller than the home ranges of the target species), and their focus on species generally of little relevance to conserving biodiversity, however, make it difficult to generalize their results to real-world landscapes. Because most interest in corridor application focuses on their use to ameliorate large-scale fragmentation, the utility of small-scale, experimental manipulations may be limited.

Natural experiments

Diamond (1986:12) describes a natural experiment as one in which “. . . the experimenter chooses sites where the perturbation is already running or has run.” In such experiments, the researcher does not establish or manipulate treatments, but capitalizes on existing treatments occurring across ecologically appropriate spatial and temporal scales. As with experimental manipulations, researchers have compared isolates with and without corridor connections

(Saunders and Rebeira 1991, Dunning et al. 1995). An additional strategy of natural experiments has been to sample species directly from corridors (but often without comparable sampling from the surrounding matrix of habitats) (Bennett 1990, Bennett et al. 1994, Lindenmayer et al. 1994, Bentley and Catterall 1997, Downes et al. 1997a, 1997b).

Results from natural experiments have shown that many species, including those directly threatened by fragmentation, respond positively to corridors. Several small mammals, including the southern brown bandicoot (Isoodon obesulus), the long-nosed bandicoot (Perameles nasuta), the long-nosed potoroo (Potorous tridactylus), the brown antechinus (Antechinus stuarti), the swamp rat (Rattus lutreolus), and the house mouse (Mus musculus), were shown to travel between isolates along forested corridors in Victoria, Australia (Bennett 1990). Similarly, eastern chipmunks (Tamias striatus) of deciduous forests in eastern North America used fencerows both for travel conduits and for breeding habitat (Bennett et al. 1994).

Natural experiments have also revealed species-specific responses to corridors (Lindenmayer et al. 1994, Downes et al. 1997b). Differences in corridor use in southeastern Australia were found between native and introduced rodents (Downes et al. 1997a), and among different forms of bird migrants (Bentley and Catterall 1997). At the taxon level, studies in eastern North America have demonstrated differences among taxonomic groups including birds, both large and small mammals, and vascular plants (Spackman and Hughes 1995).

Natural experiments offer researchers the opportunity to study corridors at spatial and temporal scales appropriate to disturbed and managed landscapes.

What natural experiments gain in realism, however, they often give up in replication and control. In spite of such difficulties, this comparative approach has allowed researchers to take advantage of anthropogenic fragmentation and directly assess how species respond to changes in connectivity and in their use of corridors at ecologically relevant scales.

Direct monitoring of movements

Although directly monitoring the movement of individuals through corridors has been considered to be an important addendum to sampling (Merriam 1991), studies using large numbers of such observations have been lacking due to obvious financial and logistical constraints. Those studies that have been conducted, usually with radiotelemetry, have all shown a preference by the target species for corridors. White-footed mice (*Peromyscus leucopus*) (Merriam and Lanoue 1991), root voles (*Microtus oeconomus*) (Andreassen et al. 1996), cougars (*Felis concolor*) (Beier 1995), mule deer (*Odocoileus hemionus*) (Thomas and Irby 1990), and euros, or common wallaroos (*Macropus robustus*) (Arnold et al. 1993) were all observed making use of available corridors. While this approach can provide direct data on actual corridor use by individuals, it does require that movements occur and can be detected within the time frame of the study, overlooking long-term dispersal patterns. Until logistical difficulties can be overcome, much of the data collected by this approach will remain anecdotal.

A Different Approach

Despite the growing number of studies that support the utility of corridors, there is still an alarming lack of a consensus as to what makes a corridor “good.” Much of the work on corridor effectiveness -- regardless of the approach used -- has focused on their landscape characteristics. These include length (Soule and Gilpin 1991), continuity or lack of gaps (Merriam 1991, Croonquist and Brooks 1993, Ruefenacht and Knight 1995), curvilinearity (Soule and Gilpin 1991), and especially width (Baur and Baur 1992, La Polla and Barrett 1993, Ruefenacht and Knight 1995, Spackman and Hughes 1995, Andreassen et al. 1996, Tischendorf and Wissel 1997). Inherent in these studies is the assumption that a corridor that meets certain geometric requirements will also satisfy the habitat needs of the species in question. Less effort has been addressed towards assessing whether corridor use is simply a reflection of local habitat conditions (but see Bennett et al. 1994). This alternative approach, focusing on habitat quality and species biology, assumes that in meeting habitat requirements, design or geometric considerations are indirectly taken into account (Newmark 1993). It also addresses a common criticism in corridor work: the inability of researchers to prove that species using corridors cannot move without them (Hobbs 1992). By linking species to corridor habitat, and showing differences between such habitat and the surrounding matrix, it may be possible to better demonstrate the utility of corridors at appropriate spatial and temporal scales.

The common approach of focusing exclusively on corridor geometry also

suggests that corridors in a system can be ranked solely on physiographic characteristics such as width and length. This suggestion is based on the premise that the corridors themselves are equivalent -- that there are no differences in habitat among or within corridors in a system. That is, regardless of the length, width, or overall size, corridor habitat is assumed to be optimal and invariable.

By ignoring habitat quality, many researchers also overlook potential differences based on location along the corridor. Because the number of dispersers is expected to decrease with increasing distance from their source (MacArthur and Wilson 1963, 1967, Buechner 1987, Miller and Carroll 1989), an isolation effect can exist along corridors as their effectiveness attenuates. Alternatively, if corridors are short relative to dispersal abilities, or if species reproduce within corridors, then densities may fail to show an isolation effect. Conventional corridor theory also assumes that, as distance increases, similarities between local communities and the source region should decrease. The exact form of this divergence may vary both by corridor and by the species in question (Figure 1). The greater the distance at which similarities diverge, the better the corridor, with the most effective corridors showing little or no isolation effect. One key objective in corridor research is delineating the distance at which community similarity begins to diverge, and the distance at which the similarity in demographic parameters and dispersal rates of a species begin to decline. A second key objective is predicting how curves describing corridor effectiveness vary among species or among landscapes (e.g., tropical vs. temperate rainforests).

Compounding the isolation effect is the fact that habitat quality, as well as dispersal success, also may decrease with isolation along a corridor (Harris 1984). Local habitat conditions at the end of a corridor may not be identical to those found at its beginning, where it adjoins the source region. These changes can apply to the characteristics of the landscape matrix adjacent to a corridor, as well as to its internal habitat.

By de-emphasizing species-habitat relationships, the more common practice of focusing solely on geometric criteria may produce generic, and possibly dangerous, prescriptions for corridor implementation and management. A more insightful approach to assessing corridor utility calls for the use of strategically designed, biologically relevant field studies: studies conducted at a scale at which corridors are often used to offset anthropogenic fragmentation. This is not to dismiss potentially important geometric influences on corridor use, but to reassess them as part of species-habitat relationships. To accomplish this, we took advantage of a natural experiment in the Olympic National Forest, Washington, a region heavily fragmented by deforestation (Figures 2 and 3). By placing a rigorous, replicated approach within the context of the generality and realism of a natural experiment, we hope to collect empirical data essential for assessing the mechanisms underlying corridor utility.

Our initial studies in the Olympic National Forest have demonstrated a clear relationship between mammal species assembly and macrohabitats (continuous old-growth forest, corridors, fragments, successional forest, and

clearcuts). Corridors were shown to differ significantly in both species assemblages and habitat from successional forest and clearcuts. However, the species assemblages and habitat found in corridors overlapped broadly with those found in the two other old-growth forest macrohabitats: mainland and fragments (Lomolino and Perault in prep).

The goal of the present study is to focus solely on the corridors of the Olympic National Forest and address their utility by assessing variability in mammalian community structure, demographic parameters, and habitat quality among and within the corridors themselves. To first address the assumption of corridor equivalency, we compare differences in community structure and local habitat among the four corridors in this system. Then, to test the assumption of within-corridor site equivalency, we look at changes along each corridor. We consider isolation effects by examining how habitat quality -- both within and around corridors -- and community structure vary along individual corridors. To investigate how corridors might function beyond simple travel conduits and serve as supplemental sources of individuals, we also assess how various demographic measures for old-growth forest species vary with isolation. Finally, because the use of corridors does not necessarily preclude the use of intervening matrix, we also compare corridor sites against paired sites in the adjacent landscape matrix. We conclude by discussing the conservation and managerial implications of this work.

METHODS

Study Area

We conducted analyses across the Hood Canal District (approximately 60,000 ha) of the Olympic National Forest (ONF) in northwest Washington. Trees in this temperate rainforest often exceed 70 m in height and may exceed 400 years in age. Dominant species include Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), mountain hemlock (*Tsuga mertensiana*), western red cedar (*Thuja plicata*), and Pacific silver fir (*Abies amabilis*) (Henderson et al. 1989). Old-growth forest in this region consists of stands having the following characteristics: eight trees per acre older than 160 years or more than 32 inches diameter-at-breast-height (dbh), deep multi-layered canopy with at least four conifer snags of at least 20 inches dbh, and at least 20 tons of logs per acre greater than 23 inches dbh and at least 15 m long (Old-growth Definition Task Group 1986). Fragmentation of the once dominant old-growth forest has steadily increased from 1900 to 1990 (Figure 2). Particularly since the 1950s, over half of the mature forests in this district have been logged (Peterson et al. 1997).

Deforestation in the ONF has transformed the landscape from continuous forest to its current mosaic (Rosenberg and Raphael 1990) (Figure 3). This configuration contains the following vegetative landscape features (Table 1):

- 1) old-growth forest (age-class > 160 years), further broken down into:
 - a. continuous forest: areas of old-growth forest > 50 km²;

- b. fragments: insular patches of old-growth forest; and
 - c. corridors: linear bands of old-growth forest less than 1 km across at their widest, at least 8 km long, and connected to continuous forest;
- 2) successional forest: mono-specific, even-aged stands, mostly 26-80 years old following harvesting; and
 - 3) clearcut: age class < 26 years following harvesting, lacking trees > 3 m in height and 3 cm dbh.

The pattern of deforestation in this region has led to a distinct fragmentation gradient. This gradient shifts from a large, relatively intact region of continuous forest in the northern part of the district, to an increasingly disturbed matrix of clearcuts and successional forest in the south. In addition, the corridors in the ONF have two important, general characteristics: first, they extend along the fragmentation gradient, running from the relatively intact mainland in the north to the highly impacted matrix in the south; and, second, they are fairly straight and are parallel to one another (Perault and Lomolino in prep).

Field Work

We conducted field studies during June - August, 1994-1997. Four major corridors were sampled: Wynoochee, Satsop, Bingam, and Skokomish (Figure 3). Along each corridor, sites were established at increasing distances from the mainland of continuous old-growth forest. Each of these corridor sites contained two stations and were paired with an additional two stations in the adjacent habitat, either successional forest or clearcut. Stations were spaced 75 m apart

and were situated at least 75 m from the nearest treatment edge. Three to four sampling sessions were conducted each year. During each session, sampling was also conducted at five continuous old-growth forest stations to serve as a control.

At each station, live-traps (pitfalls, Shermans, and Tomahawks), infra-red triggered cameras, and sign surveys were used to sample local mammals.

Sampling took place over a five-day prebait period followed by seven days of trapping. Live-traps were set within a 6 m radius of the station center and in a variety of available microhabitats. Five two-liter pitfall traps, three 3" x 3" x 9" and one 4" x 4.5" x 15" Sherman live-traps baited with peanut butter and oats, and one 5" x 5" x 16" and one 6" x 6" x 24" Tomahawk live-traps baited with raw chicken, apples, carrots, peanut butter and oats, and cracked corn were used. The pitfalls were placed linearly at 1 m intervals near the periphery of each station, the Shermans within 6 m of the station center and at the four cardinal directions, and the Tomahawks in appropriate locations near or on stumps, logs, and trees and within 6 m of the station center.

All traps were locked open for a five day prebait session, then unlocked, rebaited, and checked daily for the next seven days. All small mammals captured were weighed, measured, sexed, aged, marked by toe clipping, and released. Relative densities for each trapped species were determined by dividing the number of individuals captured (excluding recaptures) by the number of functional trapnights. Functional trapnights were calculated by subtracting from the total potential number of trapnights, 1.0 for traps that were not functional, and

0.5 for traps that were disturbed, missing bait, or containing a recaptured individual.

In addition to live-trapping, infra-red triggered cameras and sign surveys were used to detect the presence of larger or more secretive animals. One camera station was established between every two trapping stations and no closer than 75 m from the nearest station. These were baited with raw chicken, peanut butter and oats, and cracked corn. Camera stations ran for the duration of each twelve day trapping session. Sign surveys were also conducted throughout each session by searching for scats, tracks, feeding signs, and dens.

At each station, 22 habitat characteristics were recorded (Table 2, Appendix 1). Two 10 m ropes, knotted at 1 m intervals, were placed along the cardinal directions, crossing at 90-degree angles at the center of the site. Under each knot, we noted the presence of litter, rock, fern, moss, herbaceous plant, shrub, stump, log, or tree. Also, the number of snags and size of trees, logs, and stumps were counted and measured within a 10 m radius of the plot center. Categories included trees, stumps, and logs that were <20 cm dbh, between 20-40 cm dbh, and >40 cm dbh. Canopy closure was measured by use of a spherical densiometer. A clinometer was used to estimate slope and canopy height. The distance from the site to the nearest edge of the macrohabitat was also recorded.

Statistical Analysis

Before assessing among- and within-corridor variation, we compared community indices of all corridor sites against those of the mainland. We used

the six most common corridor species: forest deer mouse (Peromyscus oreas), red-backed vole (Clethrionomys gapperi), dusky shrew (Sorex monticolus), Trowbridge's shrew (Sorex trowbridgii), Douglas squirrel (Tamiasciurus douglasii), and northern flying squirrel (Glaucomys sabrinus). We first compared mean incidence of occurrence (proportion of stations in a site with the species) between the two treatments. For the two species for which we had demographic data, Peromyscus oreas and Clethrionomys gapperi, we also compared proportion of individuals by breeding status (pregnant, lactating, scrotal, or none), age-class (juvenile or adult), and sex (male or female). To reduce the likelihood of Type II errors, for all analyses, we considered a p-value of less than 0.10 to be significant.

Comparisons among corridors

We wrote a randomization program to test for statistical significance of differences in species richness among corridors. The program was written in RESAMPLING STATS (Simon 1995) and is available on request. For each pairwise combination of corridors (i.e., Wynoochee vs. Satsop, Wynoochee vs. Bingam, etc.), we randomly selected two stations from each corridor and then compared overall species richness of these random samples between the two corridors. We repeated this resampling procedure 1000 times and counted the number of times richness of samples from one corridor (C1) exceeded that of the other (C2). We then calculated the mean richness (species density) for each corridor (1000 random samples of two stations) and expressed the significance of differences among these means as $(\text{minimum of either } C1 \text{ or } C2)/(C1+C2)$. After

completing these procedures comparing species richness of all mammal species, we repeated them for forest species considered separately (species list in Appendix 2).

We used the multiple discriminant analysis procedure in SYSTAT (1997) to test whether mammalian community structure differed significantly among corridors. We first calculated the proportion of stations in each corridor site that was occupied by each of the six most common species (Peromyscus oreas, Clethrionomys gapperi, Sorex monticolus, Sorex trowbridgii, Tamiasciurus douglasii, and Glaucomys sabrinus). We then used these data as independent variables in the discriminant analysis. In addition to noting the statistical significance of discrimination among sites across the four corridors and their classification success, we saved the canonical variate scores to illustrate differences among corridor sites based on species composition of mammals.

We performed a similar discriminant analysis on habitat variables (Table 2). For each site, we first calculated the means for the 22 environmental variables recorded at each station (Appendix 1). We then repeated the multiple discriminant analysis procedure provided by SYSTAT (1997) to test whether habitat conditions varied significantly among corridors. We recorded the statistical significance and classification success of the discriminant function and saved the canonical variate scores to illustrate differences among corridors based on the environmental characteristics of their sites.

Finally, we used the canonical variate scores generated by the above

discriminant analysis procedures to investigate the association between mammalian community structure and environmental characteristics. We used the correlation procedure in SYSTAT (1997) to estimate the Pearson product-moment correlation between canonical variate scores derived from the discriminant analysis of species composition and those derived from discriminant analysis of habitat data.

Comparisons within corridors

To assess change along corridors, we first calculated isolation as the distance along a corridor, including breaks, from the main forest to a site. This measure best represents the path that individuals using the corridor, either as a conduit or as habitat, are most likely to follow (Perault and Lomolino in prep).

After measuring the isolation of each corridor site, we analyzed its relationships with width, adjacent habitat matrix, and local habitat. We measured width as the cross-sectional distance across the corridor at each site. We measured the habitat matrix adjacent to each corridor site by quantifying the percent of adjacent old-growth forest within 1000 m of a site against distance from main forest (Perault and Lomolino in prep).

We measured local habitat at each site using the means of the environmental variables (Table 2) measured at each station (2 stations per site). We also used the multiple discriminant analysis from the among-corridor assessment of local habitat to provide canonical variate scores summarizing overall habitat variation. For this standardized output, canonical variate score 1

loaded strongly on canopy height, canopy cover, small logs, and medium-sized stumps. Canonical score 2 loaded strongly on slope, large trees, litter, and herb. Canonical score 3 loaded strongly on rock, litter, herb, and moss (Table 3).

After compiling all of the above descriptive data, we then analyzed the relationships between each component and isolation along individual corridors. For each corridor, we used the Spearman rank correlation (SYSTAT 1997) to assess how width, adjacent habitat, individual environmental variables, and variate scores from the discriminant function analysis varied with isolation.

After completing our corridor descriptions, we addressed how mammal community structure varied according to the above descriptive variables. Beginning with forest species richness, we again used Spearman rank correlations to assess how the number of forest species varied with isolation across all corridors sites combined. We then focused on individual corridors, assessing how the richness of forest species varied with distance along each corridor, again using Spearman rank correlations. We then correlated forest species richness against corridor width, adjacent matrix, and local habitat (as described by individual environmental variables, and variate scores from the discriminant analysis).

To assess species-level corridor effects, we looked at how Peromyscus oreas, Clethrionomys gapperi, Sorex monticolus, Sorex trowbridgii, Tamiasciurus douglasii, and Glaucomys sabrinus responded to the above physiographic and environmental factors. For each of these species, we used Spearman rank correlations to show how their relative densities varied by each variable. Finally,

to address how species might be using these corridors, we focused on the two species for which we had demographic data, Peromyscus oreas and Clethrionomys gapperi. Again, these data were breeding status (pregnant, lactating, scrotal, or none), age (juvenile or adult), and sex (male or female). Repeating our previous analyses, we assessed how proportion of individuals breeding, proportion of juveniles, and proportion of females for Peromyscus oreas and Clethrionomys gapperi varied according to the above landscape and environmental variables.

Corridors and the matrix

To assess use of the landscape matrix, we used a binomial test to compare forest species richness between sites (2 stations) in the corridor paired with sites in the adjacent habitat matrix (either successional or clearcut). After conducting the binomial test on pairings from all four corridors combined, we repeated it on individual corridors. In all tests, pairings containing equal numbers of forest species from the corridor and adjacent sites were excluded from the binomial analyses. The two unpaired sites from the Satsop Corridor were also excluded from consideration.

After investigating differences in richness of forest species between corridors and the matrix, we assessed species-level differences. We compared incidence of occurrence (proportion of stations in a site with the species) between the two treatments for Peromyscus oreas, Clethrionomys gapperi, Sorex monticolus, Sorex trowbridgii, Tamiasciurus douglasii, and Glaucomys sabrinus. Because we caught so few Peromyscus oreas and Clethrionomys gapperi in the

matrix habitat (successional forest and clearcut), we were unable to make use of their demographic data.

RESULTS

A total of 58 sites was sampled: 30 in corridors and 28 in adjacent habitat pairings, either successional forest (19) or clearcut (9). Eighteen of the 24 species detected across the study area were found in corridors (Appendix 2). Sixteen of these 18 corridor species were shared by both mainland and fragments sites, typifying the broad overlap in species assemblages between corridors and the two additional old-growth forest macrohabitats, continuous old-growth and old-growth fragments (Lomolino and Perault, in prep).

More than 1100 animals (including recaptures) from the 18 species found in corridors were detected using traps, cameras, and sign surveys. Of these 18 species, 14 were trapped, with over 4,000 functional trapnights producing 491 unique individuals. Sixty-five percent of the individuals were Peromyscus oreas, followed by individuals of Clethrionomys gapperi at 11%. Sorex monticolus, Sorex trowbridgii, Glacomys sabrinus, Spilogale putorius, Peromyscus maniculatus, and Sorex vagrans together made up 22%. The remaining six species combined made up 2% of the new captures, with no single species accounting for more than 1% of the total (Table 4; Appendix 3).

Use of corridors relative to mainland forest varied among the six most common corridor species (Table 5). Four of these six species (Clethrionomys gapperi, Sorex monticolus, Tamiasciurus douglasii, and Sorex trowbridgii) were

found significantly more often in the mainland ($p < 0.005$; goodness of fit tests), while one (*Glacomys sabrinus*) was found significantly more often in corridors ($p < 0.10$; goodness of fit test). Only *Peromyscus oreas* showed no significant difference in incidence of occurrence between forest mainland and corridors.

The demographic data for *Peromyscus oreas* and *Clethrionomys gapperi* showed little difference in function between corridors and the mainland (Table 5). For both of these species, goodness-of-fit tests showed no significant differences between the two treatments in any of the three demographic measures: proportion breeding individuals, proportion juveniles, or proportion females.

Patterns among Corridors

Neither forest species richness nor richness for all mammals, combined, varied significantly among the four corridors ($p > 0.20$; randomization program test; Figure 4). Individual species, however, differed in their incidence and relative densities among each corridor (Figures 5-9). For example, *Aplodontia rufa* was detected in only three of the four corridors and its incidence was highest in the Satsop Corridor (Figure 9). In addition, while *Glaucomys sabrinus* also was detected across three of the four corridors (Figure 7a), its relative density (trapping data only) was by far highest in the Wynoochee Corridor (Figure 7b).

These differences among corridors also were evident from the discriminant analysis of species composition at sites in each of the four corridors (Figure 10). Overall classification success of sites to one of the four corridors based on mammal species composition was 47% (Table 6). The Satsop Corridor was set

apart from the other three by its nearly complete lack of Clethrionomys gapperi. In fact, only one (9%) of its eleven sites contained any of these voles, while 15 (79%) of the 19 sites from the remaining three corridors had Clethrionomys gapperi. In addition, the communities along the Satsop Corridor showed the greatest incidence of Sorex trowbridgii. Conversely, the communities along the Skokomish Corridor were characterized by a relatively high incidence of Clethrionomys gapperi while they lacked Sorex trowbridgii (Figure 10). The mammal assemblages of the Wynoochee and Bingam corridors were distinguished from other corridors and each other by their relatively high incidences of Sorex monticolus and of Tamiasciurus douglasii, respectively.

Ordination of corridor sites based on habitat characteristics were similar to, and even more pronounced than, that based on species composition (Figure 11). In fact, classification success of corridor sites based on local habitat conditions was 100% (Table 6). The Bingam Corridor was distinguished from the others by having a more open but taller canopy, fewer medium-sized stumps, and a greater number of small logs. The Skokomish Corridor was distinguished by a preponderance of litter, and the Satsop Corridor by steep slopes. Finally, the Wynoochee Corridor was characterized by a slightly greater canopy closure and a relatively high incidence of medium-sized stumps.

Relationships between environmental features and species assemblages across corridors was directly evidenced by the correlations between canonical variate scores based on species composition with those based on habitat variables

(Table 7, Figure 12). For example, a shift in a species assemblage dominated by Clethrionomys gapperi to one dominated by Sorex trowbridgii (i.e., Species Canonical Variate Score 1) parallels a corresponding shift from sites with steep slopes to those with heavy ground litter cover (Habitat Canonical Variate Score 2) (Figure 12a). Also, a shift in species assemblages dominated by Sorex monticolus to one dominated by Tamiasciurus douglasii (Species Canonical Variate Score 2) parallels a corresponding shift from sites with high canopy closure, many medium sized stumps, and high amounts of litter and herbs to those with many small logs, tall canopy, and many medium-sized logs (Habitat Canonical Variate Scores 1 and 3) (Figures 12b and 12c).

Patterns within Corridors

Corridor width did not significantly vary with isolation along all corridors combined, nor, with the exception of the Bingam Corridor, did it significantly vary with distance along individual corridors (Figure 13, Table 8). The increase in width as a function of increasing isolation along the Bingam Corridor is largely due to it widening far south of the mainland source (Figure 3). This widening also explains why the matrix surrounding sites along the Bingam Corridor did not decrease in old-growth forest composition as isolation increases. By becoming wider, the Bingam Corridor offsets the more general fragmentation gradient (low to high fragmentation) running north to south across this system and exhibited around the other three corridor sites. Overall, the proportion of old-growth forest adjacent to a corridor site was negatively correlated with distance from source

(Figure 14, Table 8). Adjacent old-growth forest composition also decreased along the Wynoochee, Satsop, and Skokomish Corridor sites, reflecting the increasingly young matrix found moving south from the continuous forest mainland (Figure 3).

Habitat variables changed significantly with isolation along the Satsop and Skokomish corridors (Table 8). Along the Satsop Corridor, the incidence of fern increased with increasing distance from main forest. Along the Skokomish Corridor, the number of snags decreased with increasing isolation. For summary habitat data based on the discriminant analysis of environmental characteristics, only the Skokomish Corridor showed a canonical score significantly related to isolation. Canonical score 3 (loading strongly on rock, litter, herb, and moss) decreased as distance from main forest increased. No single environmental factor, either an independent habitat variable or a canonical score, was significantly related to isolation in more than one corridor.

As with much of the habitat data, forest species richness was not significantly related to isolation, either when the four corridors were considered together or individually (Figure 15, Table 9). Forest species richness also was not related to corridor width along any of the four corridors, but was positively correlated with adjacent habitat matrix along the Wynoochee Corridor. Only a few independent measures of habitat characteristics were significantly related to forest species richness -- and of these, only one (rock) was significantly correlated with isolation in more than one corridor. None of the canonical scores was

correlated with isolation in any of the four corridors, either combined or separate (Table 9).

Focusing just on species-level relationships changed the within-corridor patterns little (Tables 10-15). For Peromyscus oreas, relative density was negatively correlated with isolation along the Skokomish Corridor ($r_s = -1.00$, $p < 0.10$), positively correlated with adjacent matrix in both the Wynoochee ($r_s = 0.62$, $p < 0.10$) and Skokomish corridors ($r_s = 1.00$, $p < 0.10$), and showed significant relationships with several habitat variables along the Wynoochee corridor (Table 10). With the exception of adjacent matrix, no factor, either physiographic or environmental, showed a significant relationship with relative density of Peromyscus oreas in more than one corridor (Table 10).

Similar patterns were shown by the remaining five species (Clethrionomys gapperi, Table 11; Sorex monticolus, Table 12; Sorex trowbridgii, Table 13; Glaucomys sabrinus, Table 14; Tamiasciurus douglasii, Table 15). For example, the relative density of Clethrionomys gapperi was positively related to isolation ($r_s = 0.85$, $p < 0.10$) along the Bingam corridor and exhibited several significant relationships with habitat variables along the Wynoochee and Satsop corridors (Table 11). Only one factor was significantly related to relative density in more than one corridor: relative density of Tamiasciurus douglasii was negatively correlated with rock in the Wynoochee Corridor ($r_s = -0.66$, $p < 0.10$), and positively correlated with rock in the Skokomish Corridor ($r_s = 1.00$, $p < 0.10$) (Table 15).

The same general patterns were found for demographic measures for both Peromyscus oreas and Clethrionomys gapperi. The importance of specific habitat variables varied both across corridors and by demographic measure: proportion of individuals breeding (Tables 16 and 19), proportion of juveniles (Tables 17 and 20) and proportion of female individuals (Tables 18 and 21). For Peromyscus oreas, only one physiographic factor along any corridor was significantly related to a demographic measure: adjacent habitat matrix along the Satsop Corridor was positively correlated with proportion of juveniles ($r_s = 0.67$, $p < 0.05$) (Table 17). For Clethrionomys gapperi, no physiographic factors were significantly related to a demographic measure along any single corridor.

Corridors and the matrix

When all corridor pairings were considered together, corridor sites contained more forest species than adjacent, paired sites in 22 of 25 cases ($p < 0.001$; binomial test). In fact, although the pattern varied somewhat among corridors, richness of forest species was consistently higher in each corridor than in the adjacent matrix (Figure 16). At the species level, however, only one (Peromyscus oreas; $p < 0.005$; goodness-of-fit test) of the six forest species assessed were found significantly more often in corridors than in surrounding matrix (Table 22).

DISCUSSION

The results presented here suggest that corridors serve as important landscape features for old-growth forest mammals in the Olympic National Forest.

While fragments in this system differ somewhat from continuous old-growth forest, the characteristics of its corridors encompass those of both continuous old-growth and forest fragments (Lomolino and Perault, *in prep*). This suggests that corridors offer promising opportunities for helping to maintain diverse assemblages of old-growth forest species in this fragmented landscape. In fact, while occurrences of forest mammals relative to mainland varied by species, corridors supported actively breeding individuals of forest species at levels similar to those found in the mainland (Table 5).

The broad overlap between corridors and the two additional old-growth forest macrohabitats, continuous forest and fragments, can be attributed to one of two hypothetical patterns. Either habitat and mammalian assemblages vary substantially among sites within corridors, or each corridor is comprised of a distinct habitat and assemblage of mammals. Our results are consistent with the latter hypothesis. Together, the four corridors contain habitat and species assemblages diverse enough to encompass those of both continuous forest and fragments. Singly, however, individual corridors are sharply different in terms of habitat (Figure 14), with their species composition reflecting these differences (Figure 13). Thus, contrary to the prevailing assumption, even within the same fragmented landscape, corridors are not necessarily equivalent, suggesting that any single corridor would not offer the comprehensive resources and protection that all four here provide.

While the four corridors we studied differed from one another, changes

along individual corridors were mostly insignificant and difficult to attribute to a single mechanism. Yet, regardless of the particular corridor or position along the corridor, habitat and species composition remained significantly different from the adjacent habitat matrix. While some researchers suggest that connectivity can be maintained across a mosaic of habitat types of varying suitability (Merriam 1991, Knappen et al. 1992, Gustafson and Gardner 1996, Schumaker 1996), these results imply a need for well-delineated corridors of optimal habitat.

Again, the most effective corridors should not demonstrate isolation effects. Along the corridors in the Olympic National Forest, measures of both forest species richness and densities of individual forest species failed to attenuate. This suggests that these corridors are effective throughout their entirety, from their beginnings at uncut forest in the north to their terminations, some ten to fifteen kilometers distant, at the forest boundary in the south. The lack of a significant isolation effect was made more apparent, and more important, by the fact that no demographic measure attenuated with isolation along any single corridor. Because individuals are breeding and reproducing throughout these corridors, the corridors themselves may be serving as supplemental sources of individuals. These individuals are then able to emigrate into more distant sites where further reproduction can occur. This assessment of demographics reinforces the utility of these corridors as more than simple conduits. By assessing not just if, but how, individuals use corridors, these results add an important component to previous corridor research (Hobbs 1992, Simberloff et al.

1992, Mann and Plummer 1995).

CONCLUSIONS

Fragmentation in the Olympic National Forest is directly altering local habitat conditions and affecting mammalian community structures. For this system, corridors appear to be an effective tool for ameliorating the effects of such fragmentation. Although complex with many interacting influences, use of these corridors appears to be a direct consequence of habitat. This poses a serious challenge to the use of corridors as generic management tools with disregard for species biology. Instead, understanding corridor effectiveness requires assessing corridors individually and incorporating the habitat needs of relevant species into any successful conservation strategy. This approach goes beyond the common view of corridors as simple conduits for dispersal and considers them to be important landscape features, serving as potential population sources, in their own right.

The results of this work also demonstrate the importance of conducting fragmentation and corridor research at landscape-level scales. It is doubtful that the detailed, yet generally applicable, information yielded here could be drawn from models or simulations, experimental manipulations, or even direct observations of movements by individuals within limited spatial or temporal scales. By conducting this study across a typical management unit (a district in a national forest), we have shown how this approach can be directly applicable to many fragmented ecosystems. Finally, our results demonstrate how landscape-

scale, anthropogenic experiments can extract important information on the appropriateness of corridors as conservation tools for maintaining natural levels of connectivity.

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Table 1. - Areal coverage of macrohabitats across the Hood Canal District,
 Olympic National Forest, Washington. Classifications were based on 1990
 data from the unpublished Olympic National Forest Data Dictionary.

Macrohabitat	Stand Age (years)	Area in ha (percent total)
Continuous Forest	> 160	14932.86 (24.9)
Corridor	> 160	6205.86 (10.4)
Fragment	> 160	3963.77 (6.6)
Successional	26 -159	28443.44 (47.4)
Clearcut	< 26	5161.98 (8.6)
Water	na	1245.41 (2.1)

Table 2. - Habitat variables measured at each station, Hood Canal District,
Olympic National Forest, Washington.

Abbreviation	Description
DTOP	Canopy height (measured with a clinometer)
CANC	Canopy closure (measured with a spherical densiometer)
EDGE	Distance to nearest edge (forest or clearcut)
SLOPE	Percentage of slope (measured with a clinometer)
SNAG	Number of snags present in a 10 m radius
T20,T20-40,T40	Number of trees with a dbh of <20 cm, 20-40 cm, and >40 cm, respectively, in a 10 m radius
L20,L20-40,L40	Number of logs with a dbh of <20 cm, 20-40 cm, and >40 cm, respectively, in a 10 m radius
S20,S20-40,S40	Number of stumps with a dbh of <20 cm, 20-40 cm, and >40 cm, respectively, in a 10 m radius
MOSS	Frequency of moss at 22 points in plot
FERN	Frequency of ferns at 22 points in plot
GRASS	Frequency of grass at 22 points in plot
ROCK	Frequency of rock at 22 points in plot
SHRUB	Frequency of shrub at 22 points in plot
HERB	Frequency of herb at 22 points in plot
LITTER	Frequency of litter at 22 points in plot
WOOD	Frequency of a stump, log, or tree at 22 points in plot
SOIL	Frequency of exposed soil at 22 points in plot

Table 3. - Canonical variate scores from multiple discriminant analysis on habitat variables recorded at each site. See Table 2 for description of habitat variables.

Variable	Score 1	Score 2	Score 3
EDGE	0.500	0.544	0.485
DTOP	-2.611	-0.676	-0.712
CAN	2.137	0.058	0.214
SLOPE	-1.354	1.680	0.051
TREE20	-2.267	-0.873	-0.898
TREE2040	-0.957	0.459	-0.185
TREE40	0.580	-1.612	0.681
LOG20	-2.809	-0.526	-0.287
LOG2040	-1.388	-0.120	0.737
LOG40	-0.372	1.034	-0.203
SNAG	0.759	-0.544	0.331
STUM20	1.453	0.246	0.691
STUM2040	2.031	-0.397	0.363
STUM40	-0.921	0.875	0.185
SOILS	0.196	-0.683	-0.217
ROCK	0.076	-0.388	-1.760
LITTER	0.597	-2.942	-2.106
HERB	-0.335	-1.854	-1.980
GRASS	0.051	-0.825	0.681
FERN	0.271	-0.721	-0.159
MOSS	-1.173	0.006	-1.556
SHRUB	-1.039	-1.167	-1.117

Table 4. - Results of trapping, infra-red triggered cameras, and sign surveys conducted at each corridor and paired site across Hood Canal District, Olympic National Forest, Washington. Each site consists of two stations. All paired sites for the Wynoochee Corridor are in successional forest; all paired sites for the Satsop, Bingam, and Skokomish Corridors are in clearcut. For trapped species, relative densities are shown. For species best detected by cameras or sign surveys, "P" indicates present and "A" indicates absent. See Appendix 1 for more detailed sampling data by site across all macrohabitats.

Corridor	Site	Site-id	Forest Species (in bold, n = 8) ^a							
			CLGA	GLSA	NEGI	PEOR	SOBE	SOMO	SOTR	TADO
Wynoochee	Site 1	CO23	0.057	P	0.000	0.171	0.000	0.000	0.000	A
	Pair 1	S23	0.025	A	0.000	0.200	0.000	0.000	0.000	A
	Site 2	CO24	0.076	P	0.000	0.354	0.000	0.000	0.014	P
	Pair 2	S24	0.000	A	0.000	0.317	0.000	0.000	0.043	A
	Site 3	CO25	0.098	A	0.000	0.098	0.000	0.000	0.029	A
	Pair 3	S25	0.023	A	0.000	0.045	0.000	0.014	0.014	P
	Site 4	CO26	0.000	P	0.000	0.324	0.000	0.000	0.014	P
	Pair 4	S26	0.000	A	0.014	0.122	0.000	0.000	0.029	P
	Site 5	CO27	0.023	A	0.014	0.159	0.000	0.000	0.000	P
	Pair 5	S27	0.000	P	0.000	0.067	0.000	0.000	0.043	A
	Site 6	CO28	0.000	A	0.000	0.080	0.000	0.000	0.000	P
	Pair 6	S28	0.023	A	0.000	0.230	0.000	0.000	0.000	P
	Site 7	CO29	0.000	P	0.000	0.165	0.000	0.086	0.000	P
	Pair 7	S29	0.000	A	0.000	0.080	0.000	0.029	0.014	P
	Site 8	CO30	0.022	A	0.000	0.065	0.000	0.014	0.000	A
	Pair 8	S30	0.000	A	0.000	0.019	0.000	0.000	0.000	A
	Site 9	CO31	0.000	A	0.000	0.253	0.000	0.014	0.000	A
	Pair 9	S31	0.000	A	0.000	0.087	0.000	0.000	0.000	A
Satsop	Site 1	CO12	0.000	A	0.000	0.736	0.000	0.029	0.071	P
	Pair 1	CC12	0.000	A	0.000	0.000	0.000	0.000	0.000	A
	Site 2	CO13	0.211	A	0.000	0.337	0.000	0.000	0.014	P
	Pair 2	CC13	0.000	A	0.000	0.100	0.000	0.000	0.000	A

	Site 3	CO14	0.000	A	0.000	0.063	0.014	0.000	0.029	P
	Pair 3	CC14	0.000	A	0.000	0.022	0.000	0.000	0.000	A
	Site 4	CO15	0.000	A	0.000	0.150	0.000	0.000	0.000	A
	Pair 4	CC15	0.000	A	0.000	0.206	0.000	0.000	0.000	A
	Site 5	CO16	0.000	A	0.000	0.372	0.000	0.000	0.000	A
	Pair 5	CC16	0.000	A	0.000	0.048	0.000	0.000	0.000	A
	Site 6	CO17	0.000	A	0.000	0.545	0.000	0.000	0.086	A
	Pair 6	CC17	0.000	A	0.000	0.000	0.000	0.000	0.000	A
	Site 7	CO18	0.000	A	0.000	0.371	0.000	0.000	0.000	A
	Pair 7	-	-	-	-	-	-	-	-	-
	Site 8	CO19	0.000	A	0.000	0.436	0.000	0.132	0.000	P
	Pair 8	CC19	0.000	A	0.000	0.072	0.000	0.000	0.000	A
	Site 9	CO20	0.000	A	0.000	0.370	0.000	0.057	0.057	A
	Pair 9	CC20	0.000	A	0.000	0.072	0.000	0.000	0.000	A
	Site 10	CO21	0.000	A	0.000	0.282	0.000	0.014	0.114	P
	Pair 10	CC21	0.000	A	0.000	0.000	0.000	0.000	0.000	A
	Site 11	CO22	0.000	A	0.000	0.000	0.000	0.000	0.000	A
	Pair 11	-	-	-	-	-	-	-	-	-
Bingam	Site 1	CO1	0.000	A	0.000	0.286	0.014	0.014	0.000	A
	Pair 1	CC1	0.094	A	0.000	0.165	0.000	0.014	0.014	P
	Site 2	CO2	0.019	P	0.000	0.212	0.000	0.014	0.000	A
	Pair 2	CC2	0.000	A	0.000	0.225	0.000	0.000	0.000	A
	Site 3	CO3	0.100	A	0.000	0.240	0.000	0.014	0.000	A
	Pair 3	CC3	0.000	A	0.000	0.168	0.000	0.000	0.000	A
	Site 4	CO4	0.126	A	0.000	0.211	0.000	0.000	0.043	A
	Pair 4	CC4	0.000	A	0.000	0.041	0.000	0.000	0.000	A
	Site 5	CO10	0.019	A	0.000	0.214	0.000	0.014	0.000	A
	Pair 5	CC10	0.000	A	0.000	0.036	0.000	0.000	0.014	A
	Site 6	CO11	0.000	A	0.000	0.191	0.000	0.014	0.000	P
	Pair 6	CC11	0.000	A	0.000	0.022	0.000	0.000	0.000	A

Skokomish	Site 1	CO6	0.063	A	0.000	0.295	0.000	0.029	0.000	A
	Pair 1	CC6	0.000	A	0.000	0.018	0.000	0.000	0.000	P
	Site 2	CO7	0.022	P	0.000	0.258	0.000	0.000	0.000	A
	Pair 2	CC7	0.000	A	0.000	0.000	0.000	0.000	0.000	A
	Site 3	CO8	0.154	A	0.000	0.154	0.000	0.029	0.000	A
	Pair 3	CC8	0.036	A	0.000	0.000	0.000	0.000	0.000	A
	Site 4	CO9	0.190	P	0.000	0.000	0.000	0.014	0.000	A
	Pair 4	CC9	0.000	A	0.000	0.000	0.000	0.000	0.000	A

Non-forest species (n=16)										
Site	Site-id	APRU	CALA	CEEL	EUTO	LEAM	LYRU	MUER	MUFR	MILO
Site 1	CO23	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 1	S23	A	A	A	0.040	A	A	0.000	0.000	0.000
Site 2	CO24	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 2	S24	A	A	A	0.041	A	A	0.000	0.000	0.000
Site 3	CO25	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 3	S25	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 4	CO26	P	A	A	0.000	A	A	0.000	0.000	0.000
Pair 4	S26	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 5	CO27	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 5	S27	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 6	CO28	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 6	S28	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 7	CO29	P	A	A	0.000	A	A	0.000	0.000	0.000
Pair 7	S29	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 8	CO30	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 8	S30	A	A	A	0.000	A	A	0.000	0.015	0.000
Site 9	CO31	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 9	S31	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 1	CO12	P	A	P	0.000	A	A	0.000	0.000	0.000
Pair 1	CC12	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 2	CO13	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 2	CC13	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 3	CO14	P	A	A	0.017	A	A	0.000	0.000	0.000
Pair 3	CC14	A	A	A	0.291	A	A	0.000	0.000	0.000
Site 4	CO15	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 4	CC15	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 5	CO16	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 5	CC16	P	A	A	0.118	A	A	0.000	0.000	0.000
Site 6	CO17	A	A	A	0.000	A	A	0.000	0.000	0.000

Pair 6	CC17	A	A	A	0.109	A	A	0.000	0.000	0.000
Site 7	CO18	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 7	-	-	-	-	-	-	-	-	-	-
Site 8	CO19	P	A	A	0.000	A	A	0.000	0.000	0.000
Pair 8	CC19	A	A	A	0.000	A	A	0.024	0.000	0.000
Site 9	CO20	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 9	CC20	P	A	A	0.000	A	A	0.000	0.000	0.000
Site 10	CO21	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 10	CC21	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 11	CO22	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 11	-	-	-	-	-	-	-	-	-	-
Site 1	CO1	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 1	CC1	A	A	A	0.000	P	A	0.000	0.040	0.000
Site 2	CO2	A	A	A	0.000	A	A	0.000	0.016	0.000
Pair 2	CC2	A	A	P	0.000	P	P	0.000	0.000	0.000
Site 3	CO3	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 3	CC3	A	A	A	0.015	A	A	0.000	0.000	0.000
Site 4	CO4	A	A	A	0.000	A	A	0.000	0.017	0.000
Pair 4	CC4	A	A	A	0.000	A	A	0.000	0.000	0.000
Site 5	CO10	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 5	CC10	A	A	A	0.000	A	A	0.000	0.000	0.012
Site 6	CO11	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 6	CC11	P	A	A	0.034	A	A	0.000	0.000	0.000
Site 1	CO6	A	A	A	0.016	A	A	0.000	0.000	0.000
Pair 1	CC6	A	A	P	0.014	A	A	0.000	0.000	0.000
Site 2	CO7	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 2	CC7	A	A	A	0.015	A	A	0.000	0.000	0.000
Site 3	CO8	A	A	P	0.000	A	A	0.000	0.000	0.000
Pair 3	CC8	A	A	A	0.000	A	A	0.000	0.014	0.000
Site 4	CO9	A	A	A	0.000	A	A	0.000	0.000	0.000
Pair 4	CC9	A	A	A	0.000	A	A	0.000	0.000	0.000

Site	Site-id	NECI	ODHE	PEMA	SOVA	SPPU	URAM	ZATR
Site 1	CO23	0.000	A	0.000	0.000	0.051	A	0.000
Pair 1	S23	0.000	P	0.000	0.000	0.000	A	0.000
Site 2	CO24	0.000	A	0.000	0.000	0.047	A	0.000
Pair 2	S24	0.000	P	0.000	0.000	0.103	A	0.000
Site 3	CO25	0.000	A	0.000	0.000	0.085	A	0.000
Pair 3	S25	0.000	A	0.000	0.000	0.040	A	0.000
Site 4	CO26	0.000	A	0.000	0.000	0.000	A	0.000
Pair 4	S26	0.000	A	0.000	0.000	0.077	A	0.000
Site 5	CO27	0.000	A	0.000	0.000	0.000	A	0.000
Pair 5	S27	0.000	A	0.000	0.000	0.000	P	0.000
Site 6	CO28	0.000	A	0.000	0.000	0.000	A	0.020
Pair 6	S28	0.000	A	0.000	0.000	0.039	A	0.000
Site 7	CO29	0.000	A	0.000	0.000	0.000	A	0.024
Pair 7	S29	0.000	A	0.000	0.000	0.000	A	0.000
Site 8	CO30	0.000	A	0.000	0.014	0.043	A	0.000
Pair 8	S30	0.000	A	0.000	0.000	0.000	A	0.000
Site 9	CO31	0.000	A	0.000	0.000	0.000	A	0.000
Pair 9	S31	0.000	A	0.000	0.000	0.000	A	0.000
Site 1	CO12	0.000	A	0.000	0.000	0.000	P	0.000
Pair 1	CC12	0.000	P	0.338	0.000	0.000	A	0.000
Site 2	CO13	0.000	P	0.000	0.000	0.000	P	0.000
Pair 2	CC13	0.000	P	0.100	0.000	0.000	A	0.000
Site 3	CO14	0.000	A	0.021	0.000	0.000	P	0.000
Pair 3	CC14	0.000	A	0.157	0.000	0.000	A	0.000
Site 4	CO15	0.000	A	0.000	0.000	0.043	A	0.000
Pair 4	CC15	0.000	A	0.144	0.000	0.000	A	0.000
Site 5	CO16	0.000	A	0.023	0.000	0.000	A	0.000
Pair 5	CC16	0.000	A	0.143	0.000	0.000	A	0.000
Site 6	CO17	0.000	A	0.000	0.000	0.000	A	0.000

Pair 6	CC17	0.000	A	0.110	0.000	0.000	A	0.000
Site 7	CO18	0.000	A	0.000	0.000	0.000	A	0.000
Pair 7	-	-	-	-	-	-	-	-
Site 8	CO19	0.000	A	0.000	0.015	0.000	P	0.000
Pair 8	CC19	0.000	A	0.145	0.014	0.000	A	0.000
Site 9	CO20	0.000	A	0.000	0.000	0.000	A	0.000
Pair 9	CC20	0.000	A	0.217	0.000	0.056	A	0.000
Site 10	CO21	0.000	A	0.028	0.000	0.000	A	0.000
Pair 10	CC21	0.000	A	0.055	0.000	0.000	A	0.000
Site 11	CO22	0.000	P	0.000	0.000	0.000	A	0.000
Pair 11	-	-	-	-	-	-	-	-
Site 1	CO1	0.000	A	0.000	0.029	0.103	P	0.000
Pair 1	CC1	0.000	P	0.071	0.014	0.176	A	0.000
Site 2	CO2	0.000	A	0.000	0.000	0.089	P	0.000
Pair 2	CC2	0.000	P	0.090	0.000	0.000	A	0.000
Site 3	CO3	0.000	A	0.020	0.000	0.000	A	0.000
Pair 3	CC3	0.000	P	0.000	0.000	0.000	A	0.000
Site 4	CO4	0.000	A	0.021	0.000	0.000	A	0.000
Pair 4	CC4	0.000	P	0.122	0.000	0.000	A	0.000
Site 5	CO10	0.000	A	0.000	0.000	0.000	P	0.000
Pair 5	CC10	0.000	A	0.073	0.000	0.000	A	0.000
Site 6	CO11	0.000	A	0.000	0.000	0.089	A	0.000
Pair 6	CC11	0.000	A	0.043	0.000	0.000	A	0.000
Site 1	CO6	0.000	A	0.000	0.014	0.000	A	0.000
Pair 1	CC6	0.000	P	0.000	0.000	0.000	P	0.162
Site 2	CO7	0.000	P	0.000	0.000	0.048	A	0.000
Pair 2	CC7	0.000	A	0.115	0.014	0.000	P	0.000
Site 3	CO8	0.000	P	0.000	0.000	0.000	A	0.000
Pair 3	CC8	0.000	A	0.018	0.000	0.000	A	0.000
Site 4	CO9	0.000	A	0.000	0.000	0.000	A	0.000
Pair 4	CC9	0.000	A	0.018	0.000	0.000	A	0.000

Species codes (methods of detection; T = live trapping, C = infrared triggered camera, and S = survey for animal signs):

CLGA = Clethrionomys gapperi (TC)
GLSA = Glaucomys sabrinus (TC)
NEGI = Neurotrichus gibbsii (T)
PEOR = Peromyscus oreas (TC)
SOBE = Sorex bendirii (T)
SOMO = Sorex monticolus (T)
SOTR = Sorex trowbridgii (T)
TADO = Tamiasciurus douglasii (TCS)

APRU = Aplodontia rufa (CS)
 LYRU = Lynx rufus (CS)
 MILO = Microtus longicaudus (T)
 SOVA = Sorex vagrans (T)
 CALA = Canis latrans (CS)
 CEEL = Cervus elaphus (CS)
 EUTO = Tamias (Eutamias) townsendii (TC)
 LEAM = Lepus americanus (CS)

MUER = Mustela erminea (TC)
 MUFR = Mustela frenata (TC)
 NECI = Neotoma cinerea
 ODHE = Odocoileus hemionus (CS)
 PEMA = Peromyscus maniculatus (TC)
 SPPU = Spilogale putorius (TC)
 URAM = Ursus americanus (CS)
 ZATR = Zapus trinotatus (T)

^a - List of forest species was determined a priori based on habitat associations described in the literature (primarily Larrison and Fisher 1976, Carey and Johnson 1995, Norse 1990).

Table 5. - Comparison of community and demographic indices between mainland and corridor treatments. Presence data for each species represents their mean incidence of occurrence (proportion of stations in a site with the species). Demographic data are all reported as mean proportion of individuals within a site. To maintain an experimentwise Type 1 error of $\alpha = 0.10$, a Dunn-Sidak adjustment for multiple comparisons was used. The significance levels shown reflect this adjustment with significant relationships in bold.

	Mainland (n = 15)	Corridor (n = 30)	χ^2 Goodness-of-Fit
Presence Data			
<u>Peromyscus oreas</u>	0.95	0.95	7.20
<u>Clethrionomys gapperi</u>	0.63	0.40	28.32**
<u>Sorex monticolus</u>	0.41	0.32	27.75**
<u>Tamiasciurus douglasii</u>	0.35	0.32	29.67**
<u>Sorex trowbridgii</u>	0.32	0.25	23.25**
<u>Glaucomys sabrinus</u>	0.11	0.18	13.64*
Demographic Data			
<u>P. oreas</u> Breeding	0.14	0.12	23.12
<u>P. oreas</u> Juvenile	0.09	0.05	23.62
<u>P. oreas</u> Female	0.55	0.47	30.22
<u>C. gapperi</u> Breeding	0.16	0.11	13.08
<u>C. gapperi</u> Juvenile	0.09	0.08	12.25
<u>C. gapperi</u> Female	0.68	0.82	21.45

* p < 0.10

** p < 0.005

Table 6. - Classification matrices across corridor sites based on mammal communities (above diagonal) and local environmental characteristics (below diagonal). Results reported are between group pairwise F-values and classification success from multiple discriminant analysis (SYSTAT 1997). Significant F-values ($p < 0.05$) are listed in bold. Overall classification success based on species composition was 47%; based on habitat, 100%.

	Wynoochee	Satsop	Bingam	Skokomish	Classification Success
Wynoochee (n = 9)	—	2.60	1.70	1.70	56%
Satsop (n = 11)	3.19	—	1.66	3.65	73%
Bingam (n = 6)	9.15	8.06	—	1.02	67%
Skokomish (n = 4)	2.67	5.79	6.20	—	50%
Classification Success	100%	100%	100%	100%	

Table 7. - Matrix for corridors showing Pearson product-moment correlations between canonical variate scores based on species composition at each site with scores based on habitat variables. Canonical variate scores were generated by the multiple discriminant analysis procedure in SYSTAT (1997). Significant relationships are in bold.

Habitat	Species		
	Score 1	Score 2	Score 3
Score 1	-0.063	-0.450*	-0.176
Score 2	-0.710**	-0.012	-0.050
Score 3	-0.093	0.449*	-0.127

* $p < 0.05$

** $p < 0.005$

Table 8. - Summary of Spearman rank correlations for isolation vs. site descriptors along the corridors in Hood Canal District, Olympic National Forest, Washington. Significant relationships are in bold. See Table 2 for description of habitat variables.

Variable	Individual Corridors				
	All Corridors (n = 30)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)	Skokomish (n = 4)
	r_s	r_s	r_s	r_s	r_s
Width	-0.03	-0.48	-0.09	0.77*	0.20
Matrix	-0.43**	-0.87***	-0.55**	0.49	-1.00*
EDGE	-0.11	0.03	-0.30	0.06	0.40
DTOP	0.07	-0.38	0.38	0.41	0.60
CANC	0.22	0.37	0.23	-0.77	0.40
SLOPE	0.01	0.17	-0.35	0.71	0.80
T20	-0.15	0.27	-0.49	-0.75	0.00
T20-40	-0.04	-0.14	0.06	0.25	-0.40
T40	0.04	-0.03	0.06	-0.09	0.74
L20	0.03	0.37	-0.06	0.77	-0.63
L20-40	-0.16	0.28	-0.09	-0.44	-0.74
L40	-0.01	-0.27	0.27	-0.09	-0.63
SNAG	-0.22	-0.27	-0.10	-0.44	-1.00*
S20	0.02	-0.27	-0.04	0.62	-0.40
S20-40	-0.07	0.18	-0.12	0.68	-0.63
S40	0.03	-0.14	-0.10	-0.52	0.89
SOIL	0.18	0.56	0.13	-0.20	0.21
ROCK	0.11	0.72	-0.50	0.65	-0.26
LITTER	-0.05	0.15	-0.37	-0.09	0.60
HERB	0.13	-0.34	0.31	-0.03	0.80
FERN	0.06	-0.60	0.76**	-0.38	0.40
GRASS	0.18	0.41	--- [†]	---	---
MOSS	0.10	-0.24	0.26	0.44	-0.32
SHRUB	-0.20	-0.05	-0.45	0.31	0.00
Habitat Score 1 [‡]	0.01	-0.05	0.10	-0.09	0.80
Habitat Score 2	0.08	0.02	0.07	0.60	0.20
Habitat Score 3	0.00	0.05	0.20	-0.49	-1.00*

* - $p < 0.10$

** - $p < 0.05$

*** - $p < 0.005$

[†] - Not present at any site.

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 9. - Summary of Spearman rank correlations for forest species richness vs. site descriptors along each of four corridors in Hood Canal District, Olympic National Forest, Washington. Significant relationships are in bold. See Table 2 for description of habitat variables.

Variable	Individual Corridors				
	All Corridors (n = 30)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)	Skokomish (n = 4)
	r_s	r_s	r_s	r_s	r_s
Isolation	-0.29	0.47	-0.14	0.13	-0.26
Width	0.18	0.55	-0.46	0.39	0.77
Matrix	0.32*	0.70**	0.04	0.13	0.26
EDGE	-0.02	-0.51	-0.16	-0.13	0.26
DTOP	0.29	0.70**	-0.15	0.66	-0.77
CANC	-0.16	-0.80**	-0.09	-0.39	0.26
SLOPE	-0.13	-0.40	-0.02	-0.13	0.26
T20	-0.04	-0.05	-0.09	-0.13	0.77
T20-40	-0.17	-0.38	0.10	-0.42	-0.26
T40	-0.24	-0.03	-0.42	-0.67	-0.82
L20	-0.19	-0.61	0.09	-0.42	-0.27
L20-40	0.04	-0.46	0.26	0.27	0.82
L40	-0.30	0.00	-0.78**	-0.09	-0.54
SNAG	-0.07	-0.31	0.00	0.13	0.26
S20	0.08	-0.34	0.42	0.63	-0.77
S20-40	0.00	-0.34	0.09	0.00	0.82
S40	-0.37**	-0.32	-0.36	-0.42	-0.58
SOIL	-0.05	-0.69**	0.04	0.13	0.82
ROCK	-0.17	-0.82**	0.05	-0.20	1.00*
LITTER	0.02	0.43	-0.40	0.13	-0.77
HERB	0.28	-0.07	0.49	0.65	-0.26
FERN	-0.22	-0.14	0.08	0.66	0.77
GRASS	0.16	-0.51	---	---	---
MOSS	-0.08	-0.54	0.15	-0.54	-0.82
SHRUB	0.19	0.34	0.26	0.65	0.58
Habitat Score 1 [‡]	0.08	-0.05	-0.21	-0.65	-0.26
Habitat Score 2	-0.28	-0.26	-0.32	-0.65	-0.26
Habitat Score 3	-0.24	-0.41	0.07	-0.65	0.26

* - $p < 0.10$

** - $p < 0.05$

† - Not present at any site.

‡ - Canonical variate scores from discriminant analysis of habitat variables.

Table 10. - Summary of Spearman rank correlations for relative density of *Peromyscus oreas* vs. site descriptors along each of four corridors in Hood Canal District, Olympic National Forest, Washington. Significant relationships are in bold. See Table 2 for description of habitat variables.

Variable	Corridor				
	All Corridors (n = 30)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)	Skokomish (n = 4)
	r_s	r_s	r_s	r_s	r_s
Isolation	-0.36*	-0.33	-0.48	-0.43	-1.00*
Width	-0.20	0.37	0.32	-0.14	-0.20
Matrix	-0.05	0.62*	0.04	-0.08	1.00*
EDGE	-0.17	-0.26	0.03	0.70	-0.40
DTOP	-0.16	0.60	-0.12	0.38	-0.60
CANC	-0.11	-0.63*	0.28	-0.65	-0.40
SLOPE	-0.42**	-0.60	-0.27	0.41	-0.80
T20	-0.05	0.25	-0.05	-0.75	0.00
T20-40	0.09	-0.44	0.10	0.11	0.40
T40	-0.25	0.16	-0.52	0.09	-0.74
L20	0.14	-0.40	0.42	0.56	0.63
L20-40	0.19	-0.18	0.17	-0.38	0.74
L40	0.16	0.64*	0.07	-0.03	0.63
SNAG	0.07	0.19	0.48	-0.50	1.00
S20	0.20	0.09	0.45	0.53	0.40
S20-40	-0.14	0.00	-0.42	0.44	0.63
S40	-0.06	0.19	-0.02	-0.28	-0.89
SOIL	-0.16	-0.62*	0.07	-0.01	-0.21
ROCK	-0.07	-0.33	0.30	-0.39	0.26
LITTER	0.00	0.21	0.46	0.46	-0.60
HERB	-0.27	0.03	-0.40	-0.37	-0.80
FERN	-0.27	-0.21	-0.27	0.41	-0.40
GRASS	-0.22	-0.41	---	---	---
MOSS	0.20	-0.12	0.01	-0.62	0.32
SHRUB	0.14	0.40	-0.10	-0.71	0.00
Habitat Score 1 [‡]	-0.14	-0.50	0.12	-0.59	-0.80
Habitat Score 2	0.35	-0.63*	0.18	-0.14	-0.20
Habitat Score 3	0.13	-0.18	-0.68	0.66	1.00*

* - $p < 0.10$

** - $p < 0.05$

† - Not present at any site.

‡ - Canonical variate scores from discriminant analysis of habitat variables.

Table 11. - Summary of Spearman rank correlations for relative density of Clethrionomys gapperi vs. site descriptors along each of four corridors in Hood Canal District, Olympic National Forest, Washington. Significant relationships are in bold. See Table 2 for description of habitat variables.

Variable	Individual Corridors				
	All Corridors (n = 30)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)	Skokomish (n = 4)
	r_s	r_s	r_s	r_s	r_s
Isolation	0.24	0.43	0.20	0.85*	0.80
Width	0.48**	0.03	-0.06	0.65	-0.40
Matrix	0.51***	-0.07	0.30	0.79	-0.80
EDGE	0.43**	-0.27	0.41	0.24	0.00
DTOP	0.72***	0.29	0.50	0.43	0.80
CANC	-0.13	-0.47	-0.15	-0.65	0.00
SLOPE	-0.13	0.21	-0.50	0.41	0.40
T20	-0.06	-0.14	-0.30	-0.75	-0.40
T20-40	0.04	-0.71**	0.30	0.11	-0.20
T40	0.00	-0.77**	-0.20	0.09	0.95
L20	0.05	0.06	-0.41	0.56	-0.32
L20-40	-0.05	-0.14	0.05	-0.38	-0.95
L40	-0.22	-0.62*	-0.05	-0.03	-0.11
SNAG	0.00	-0.34	-0.21	-0.50	-0.80
S20	0.37	-0.48	0.64**	0.53	0.20
S20-40	0.14	-0.10	-0.24	0.44	-0.95
S40	-0.46**	-0.79**	-0.51	-0.28	0.89
SOIL	0.00	-0.12	-0.19	-0.02	-0.32
ROCK	0.02	-0.16	-0.10	0.67	-0.77
LITTER	0.18	0.74**	-0.40	0.09	0.80
HERB	0.06	-0.70**	0.41	-0.44	0.60
FERN	-0.01	-0.45	-0.05	-0.19	-0.20
GRASS	-0.16	-0.36	---	---	---
MOSS	-0.30	-0.69*	0.05	0.45	0.32
SHRUB	0.04	0.53	0.41	0.12	-0.45
Habitat Score 1 [‡]	0.03	0.30	0.50	-0.26	0.60
Habitat Score 2	-0.44**	0.14	0.10	0.56	0.40
Habitat Score 3	0.00	0.06	0.10	-0.03	-0.80

* - $p < 0.10$

** - $p < 0.05$

*** - $p < 0.005$

† - Not present at any site.

‡ - Canonical variate scores from discriminant analysis of habitat variables.

Table 12. - Summary of Spearman rank correlations for relative density of *Sorex monticolus* vs. site descriptors along each of four corridors in Hood Canal District, Olympic National Forest, Washington. Significant relationships are in bold. See Table 2 for description of habitat variables.

Variable	Individual Corridors				
	All Corridors (n = 30)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)	Skokomish (n = 4)
	r_s	r_s	r_s	r_s	r_s
Isolation	-0.34*	-0.25	-0.55*	-0.65	-0.21
Width	-0.09	-0.26	-0.31	-0.65	-0.63
Matrix	0.19	-0.13	0.36	-0.65	0.21
EDGE	-0.13	0.04	-0.29	-0.27	-0.11
DTOP	0.11	-0.08	-0.12	0.00	0.63
CANC	-0.07	0.51	-0.30	0.65	-0.11
SLOPE	0.05	0.00	0.38	-0.13	-0.74
T20	0.17	0.52	-0.04	0.40	-0.95
T20-40	0.07	0.18	-0.08	-0.57	0.74
T40	0.04	0.26	-0.27	0.27	0.50
L20	0.19	0.47	-0.11	-0.71	0.78
L20-40	0.34*	0.06	0.56*	0.27	-0.50
L40	-0.19	0.06	-0.59*	0.39	0.89
SNAG	0.18	-0.08	0.42	0.27	0.21
S20	0.21	0.38	-0.07	-0.63	0.95
S20-40	0.12	0.55	-0.28	-0.77	-0.33
S40	0.10	0.22	-0.12	-0.14	0.24
SOIL	0.07	0.31	0.33	-0.40	-1.00*
ROCK	-0.14	-0.10	0.58*	-1.00	-0.82
LITTER	0.08	-0.40	0.24	0.66	0.63
HERB	0.13	0.48	-0.04	0.13	0.11
FERN	0.01	0.58	-0.29	0.66	-0.95
GRASS	-0.17	-0.25	--- [†]	---	---
MOSS	-0.22	-0.04	0.07	-0.67	0.83
SHRUB	-0.31*	-0.80**	-0.02	-0.39	-0.24
Habitat Score 1 [‡]	-0.25	-0.32	-0.03	-0.39	0.11
Habitat Score 2	-0.21	-0.25	-0.40	-0.39	-0.21
Habitat Score 3	0.13	0.04	-0.11	0.13	0.21

* - $p < 0.10$

** - $p < 0.05$

[†] - Not present at any site.

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 13. - Summary of Spearman rank correlations for relative density of *Sorex trowbridgii* vs. site descriptors along each of three corridors in Hood Canal District, Olympic National Forest, Washington. Because individuals of *Sorex trowbridgii* were not found at any sites along the Skokomish Corridor, it was excluded from statistical analysis. Significant relationships are in bold. See Table 2 for description of habitat variables.

Variable	Individual Corridors			
	All Corridors (n = 26)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)
	r_s	r_s	r_s	r_s
Isolation	0.21	0.22	0.03	0.65
Width	-0.17	0.23	-0.44	0.65
Matrix	-0.20	0.03	-0.22	0.65
EDGE	-0.20	0.10	-0.30	0.27
DTOP	-0.09	0.44	0.02	0.00
CANC	-0.01	-0.67*	-0.08	-0.65
SLOPE	-0.11	0.07	-0.29	0.13
T20	-0.17	0.08	-0.08	-0.40
T20-40	0.35*	-0.23	0.47	0.57
T40	-0.11	-0.45	-0.30	-0.27
L20	0.08	-0.02	0.14	0.71
L20-40	0.08	0.03	0.26	-0.27
L40	-0.13	-0.03	-0.28	-0.39
SNAG	0.03	0.07	0.17	-0.27
S20	0.34*	0.00	0.42	0.63
S20-40	-0.01	0.11	0.00	0.77
S40	-0.25	-0.45	-0.44	0.14
SOIL	-0.08	0.04	0.03	0.40
ROCK	-0.01	0.04	-0.32	1.00
LITTER	-0.10	0.39	-0.26	-0.66
HERB	-0.25	-0.49	0.01	-0.13
FERN	-0.24	-0.59	0.37	-0.66
GRASS	-0.15	-0.24	--- [†]	---
MOSS	0.40**	-0.19	0.55*	0.67
SHRUB	0.17	0.54	0.01	0.39
Habitat Score 1 [‡]	-0.08	-0.24	-0.44	0.39
Habitat Score 2	0.23	0.03	-0.19	0.39
Habitat Score 3	0.23	-0.30	-0.18	-0.13

* - $p < 0.10$

** - $p < 0.05$

[†] - Not present at any site.

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 14. - Summary of Spearman rank correlations for incidence of Glaucomys sabrinus vs. site descriptors along each of four corridors in Hood Canal District, Olympic National Forest, Washington. Because individuals of Glaucomys sabrinus were not found at any sites along the Satsop Corridor, it was excluded from statistical analysis.

Variable	Individual Corridors			
	All Corridors (n = 19)	Wynoochee (n = 9)	Bingam (n = 6)	Skokomish (n = 4)
	r_s	r_s	r_s	r_s
Isolation	-0.33	-0.61*	0.13	0.45
Width	0.62**	0.87***	0.39	0.45
Matrix	0.53**	0.69*	0.13	-0.45
EDGE	0.01	-0.53	-0.13	0.00
DTOP	0.58**	0.78**	0.66	-0.45
CANC	-0.26	-0.69	-0.39	0.00
SLOPE	-0.11	-0.17	-0.13	0.89
T20	-0.06	0.00	-0.13	0.89
T20-40	-0.34	-0.31	-0.42	-0.89
T40	0.04	-0.04	-0.67	0.24
L20	-0.45*	-0.62*	-0.42	-0.94
L20-40	-0.36	-0.59	0.27	0.24
L40	0.18	0.18	0.39	-0.94
SNAG	0.07	0.17	0.13	-0.45
S20	0.04	-0.16	0.63	-0.89
S20-40	-0.10	-0.16	0.00	0.00
S40	-0.17	-0.04	-0.42	0.00
SOIL	-0.06	-0.50	0.13	0.94
ROCK	-0.24	-0.62	-0.20	0.58
LITTER	0.24	0.22	0.13	-0.45
HERB	0.10	-0.09	0.65	0.00
FERN	0.28	0.17	0.66	0.89
GRASS	-0.10	-0.32	--- [†]	---
MOSS	-0.06	-0.22	-0.54	-0.71
SHRUB	0.12	0.31	0.65	0.00
Habitat Score 1 [‡]	0.28	-0.17	-0.65	0.00
Habitat Score 2	-0.60**	-0.61	-0.65	0.45
Habitat Score 3	-0.62	-0.61	-0.65	-0.45

* - $p < 0.10$

** - $p < 0.05$

*** - $p < 0.005$

[†] - Not present at any site.

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 15. - Summary of Spearman rank correlations for incidence of Tamiasciurus douglasii vs. site descriptors along each of four corridors in Hood Canal District, Olympic National Forest, Washington. Significant relationships are in bold. See Table 2 for description of habitat variables.

Variable	Individual Corridors				
	All Corridors (n = 30)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)	Skokomish (n = 4)
	r_s	r_s	r_s	r_s	r_s
Isolation	-0.35*	-0.63*	-0.18	-0.13	-0.26
Width	0.12	0.65*	-0.31	0.39	0.77
Matrix	0.11	0.78**	-0.03	-0.65	0.26
EDGE	-0.19	-0.57	-0.23	-0.66	0.26
DTOP	-0.15	0.41	-0.36	-0.66	-0.77
CANC	0.07	-0.60	0.15	-0.39	0.26
SLOPE	0.00	-0.43	0.13	0.39	0.26
T20	-0.20	-0.32	0.08	0.53	0.77
T20-40	-0.18	-0.13	-0.28	0.57	-0.26
T40	-0.08	0.10	-0.70*	0.13	-0.82
L20	-0.36*	-0.90**	0.29	0.28	-0.27
L20-40	-0.08	-0.32	0.45	0.27	0.82
L40	-0.11	0.26	-0.81**	0.13	-0.54
SNAG	-0.02	-0.17	0.00	0.54	0.26
S20	-0.16	-0.41	0.42	-0.32	-0.77
S20-40	-0.28	-0.41	0.00	0.00	0.82
S40	-0.09	0.13	-0.25	0.14	-0.58
SOIL	-0.21	-0.66*	0.18	-0.53	0.82
ROCK	-0.01	-0.66*	0.28	-0.20	1.00*
LITTER	0.02	0.03	-0.10	-0.27	-0.77
HERB	0.17	0.23	0.36	0.39	-0.26
FERN	-0.14	-0.04	-0.14	-0.40	0.77
GRASS	0.13	-0.15	---	---	---
MOSS	0.20	-0.22	-0.13	0.27	-0.82
SHRUB	0.12	0.32	0.08	0.13	0.58
Habitat Score 1 [‡]	0.40**	0.13	-0.18	0.65	-0.26
Habitat Score 2	-0.09	-0.28	-0.18	0.13	-0.26
Habitat Score 3	-0.35*	-0.45	-0.18	-0.39	0.26

* - $p < 0.10$

** - $p < 0.05$

[†] - Not present at any site.

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 16. - Summary of Spearman rank correlations for proportion breeding individuals (pregnant, lactating, or scrotal) of Peromyscus oreas vs. site descriptors along each of four corridors in Hood Canal District, Olympic National Forest, Washington. Significant relationships are in bold.

Variable	Individual Corridors				
	All Corridors (n = 29)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)	Skokomish (n = 3) [/]
	r _s	r _s	r _s	r _s	r _s
Isolation	-0.02	-0.25	0.28	-0.43	-0.50
Width	-0.08	-0.09	-0.13	-0.37	0.50
Matrix	0.12	0.12	0.22	-0.37	0.50
EDGE	0.13	0.75**	-0.15	-0.63	-0.50
DTOP	0.21	-0.08	0.58*	-0.03	-1.00
CANC	-0.53***	0.12	0.67**	0.37	-0.50
SLOPE	-0.03	-0.14	0.10	-0.20	0.50
T20	0.39**	-0.14	0.12	0.58	1.00
T20-40	0.07	0.73**	0.36	-0.15	-1.00
T40	-0.35*	0.23	0.18	-0.26	-1.00
L20	-0.07	0.03	-0.75**	-0.62	-0.87
L20-40	0.22	-0.18	0.31	0.71	1.00
L40	-0.22	0.24	-0.09	0.66	-0.50
SNAG	-0.09	0.49	-0.22	0.71	0.50
S20	-0.03	0.60	-0.18	0.00	-0.50
S20-40	0.00	-0.64*	-0.03	-0.51	0.87
S40	-0.03	0.21	-0.22	0.03	-0.87
SOIL	0.23	-0.30	0.16	-0.23	0.87
ROCK	-0.02	-0.01	-0.36	-0.65	0.87
LITTER	-0.20	-0.04	-0.25	0.20	-1.00
HERB	0.33*	0.11	0.01	0.60	-0.50
FERN	0.38**	0.28	0.01	0.64	0.50
GRASS	0.15	0.35	--- [†]	---	---
MOSS	-0.22	0.85**	0.07	-0.44	-0.50
SHRUB	0.15	-0.06	0.00	0.43	0.00
Habitat Score 1 [‡]	-0.39**	-0.13	-0.22	-0.26	-0.50
Habitat Score 2	-0.11	0.47	-0.02	-0.71	0.50
Habitat Score 3	-0.17	0.30	0.59	-0.43	0.50

* - p < 0.10

** - p < 0.05

*** - p < 0.005

/ - Proportion of breeding individuals could not be calculated for a site lacking P. oreas.

† - Not present at any site.

‡ - Canonical variate scores from discriminant analysis of habitat variables.

Table 17. - Summary of Spearman rank correlations for proportion juveniles of Peromyscus oreas vs. site descriptors along each of four corridors in Hood Canal District, Olympic National Forest, Washington. Significant relationships are in bold. See Table 2 for description of habitat variables.

Variable	Individual Corridors				
	All Corridors (n = 29)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)	Skokomish (n = 3) ^f
	r _s	r _s	r _s	r _s	r _s
Isolation	-0.18	0.20	-0.41	-0.52	-0.50
Width	0.05	-0.51	0.37	-0.28	-1.00
Matrix	0.41	0.00	0.67**	0.25	0.50
EDGE	0.23	0.32	0.38	-0.13	-0.50
DTOP	0.26	-0.37	-0.09	0.22	0.50
CANC	-0.13	-0.11	-0.40	0.28	0.50
SLOPE	-0.05	-0.04	0.77**	-0.74	-1.00
T20	0.18	-0.22	0.50	0.39	-0.50
T20-40	-0.12	-0.17	-0.28	-0.43	0.50
T40	0.09	-0.22	0.32	-0.24	0.50
L20	-0.05	0.26	-0.33	-0.90**	0.87
L20-40	0.30	0.80	0.02	0.65	-0.50
L40	0.24	0.18	-0.17	0.56	1.00
SNAG	0.11	-0.11	-0.13	0.43	0.50
S20	0.14	0.10	-0.36	0.11	1.00
S20-40	0.16	0.40	0.04	-0.64	-0.87
S40	0.08	-0.06	0.04	0.30	0.00
SOIL	0.11	0.11	0.00	0.31	-0.87
ROCK	0.07	0.28	0.51	-0.42	-0.87
LITTER	0.22	-0.13	0.26	0.31	0.50
HERB	0.01	0.04	-0.18	0.06	-0.50
FERN	-0.24	-0.51	-0.53	0.88*	-1.00
GRASS	-0.15	-0.30	--- [†]	---	---
MOSS	-0.34*	0.00	-0.67**	-0.48	1.00
SHRUB	0.18	0.35	0.33	0.25	-0.87
Habitat Score 1 [‡]	-0.07	0.16	-0.17	-0.59	-0.50
Habitat Score 2	-0.23	0.49	-0.13	-0.83*	0.50
Habitat Score 3	0.08	0.51	0.34	0.19	0.50

* - $p < 0.10$

** - $p < 0.05$

^f - Proportion of juveniles could not be calculated for a site lacking P. oreas.

[†] - Not present at any site.

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 18. - Summary of Spearman rank correlations for proportion females of Peromyscus oreas vs. site descriptors along each of four corridors in Hood Canal District, Olympic National Forest, Washington. Significant relationships are in bold. See Table 2 for description of habitat variables.

Variable	Individual Corridors				
	All Corridors (n = 29)	Wynoochee (n = 9)	Satsop (n = 11)	Bingam (n = 6)	Skokomish (n = 3) ^f
	r _s	r _s	r _s	r _s	r _s
Isolation	-0.06	0.20	-0.10	-0.43	-1.00
Width	-0.19	-0.27	0.16	-0.37	-0.50
Matrix	-0.07	-0.27	-0.07	-0.37	1.00
EDGE	-0.16	-0.09	-0.05	-0.64	-1.00
DTOP	0.07	0.15	0.07	-0.03	-0.50
CANC	-0.11	-0.03	-0.08	0.37	-1.00
SLOPE	-0.06	0.13	-0.28	-0.20	-0.50
T20	0.44**	0.47	0.53	0.58	0.50
T20-40	-0.26	-0.26	0.15	-0.15	-0.50
T40	-0.26	-0.40	-0.35	-0.26	-0.50
L20	-0.21	0.50	-0.10	-0.62	0.00
L20-40	0.15	0.18	-0.20	0.71	0.50
L40	0.09	-0.36	0.00	0.66	0.50
SNAG	-0.25	-0.47	-0.49	0.71	1.00
S20	0.01	0.00	0.33	0.00	0.50
S20-40	0.02	0.64*	0.25	-0.51	0.00
S40	-0.16	-0.47	0.08	0.03	-0.87
SOIL	0.15	0.41	-0.14	-0.23	0.00
ROCK	-0.18	-0.12	-0.51	-0.65	0.00
LITTER	0.10	0.11	0.01	0.20	-0.50
HERB	0.11	-0.05	-0.17	0.60	1.00
FERN	0.00	-0.13	-0.48	0.64	-0.50
GRASS	-0.31	0.55	---	---	---
MOSS	-0.23	-0.13	-0.16	-0.44	0.50
SHRUB	-0.01	-0.31	0.05	0.43	-0.87
Habitat Score 1 [‡]	0.05	-0.22	-0.20	-0.26	-1.00
Habitat Score 2	-0.10	-0.03	0.46	-0.71	1.00
Habitat Score 3	-0.36*	-0.12	0.06	-0.43	1.00

* - $p < 0.10$

^f - Proportion of female individuals could not be calculated for a site lacking P. oreas.

[†] - Not present at any site.

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 19. - Summary of Spearman rank correlations for proportion breeding individuals (pregnant, lactating, or scrotal) of *Clethrionomys gapperi* vs. site descriptors along each of three corridors in Hood Canal District.

Variable	Individual Corridors			
	All Corridors (n = 13)	Wynoochee (n = 5) ^f	Bingam (n = 4) ^f	Skokomish (n = 4)
	r _s	r _s	r _s	r _s
Isolation	0.22	0.71	0.21	-0.40
Width	0.27	0.00	0.73	-0.80
Matrix	0.16	0.19	0.21	0.40
EDGE	-0.12	0.19	0.06	-0.40
DTOP	0.39	-0.35	0.63	0.40
CANC	-0.35	0.00	-0.74	-0.40
SLOPE	-0.04	0.71	-0.10	-0.80
T20	0.06	0.00	0.10	-0.80
T20-40	0.21	-0.18	-0.06	0.60
T40	-0.19	-0.74	-1.00*	0.32
L20	0.36	0.39	-0.06	0.74
L20-40	0.33	0.61	0.10	-0.32
L40	0.12	-0.36	-0.21	0.95
SNAG	0.20	0.00	0.10	0.40
S20	0.66**	-0.25	0.94	1.00*
S20-40	0.53*	1.00*	0.50	-0.32
S40	0.12	-0.56	-0.10	0.00
SOIL	0.42	0.79	0.74	-0.95
ROCK	0.16	1.00*	0.27	-0.77
LITTER	-0.28	-0.36	-0.74	0.40
HERB	0.08	-0.56	0.95	-0.20
FERN	-0.33	-0.54	0.31	-1.00*
GRASS	--- [†]	---	---	---
MOSS	-0.15	-0.35	-0.32	0.95
SHRUB	0.26	0.36	0.95	-0.45
Habitat Score 1 [‡]	-0.33	0.00	-0.32	-0.20
Habitat Score 2	-0.19	0.00	-0.63	0.00
Habitat Score 3	0.05	-0.35	-0.95	0.40

* - $p < 0.10$

^f - Proportion of breeding individuals could not be calculated for sites lacking *Clethrionomys gapperi*.

[†] - Not present at any site containing *Clethrionomys gapperi*.

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 20. - Summary of Spearman rank correlations for proportion juveniles of Clethrionomys gapperi vs. site descriptors along each of three corridors in Hood Canal District, Olympic National Forest, Washington.

Variable	Individual Corridors			
	All Corridors (n = 13)	Wynoochee (n = 5) ^f	Bingam (n = 4) ^f	Skokomish (n = 4)
	r _s	r _s	r _s	r _s
Isolation	0.64**	0.71	0.26	0.95
Width	0.13	0.00	-0.26	-0.11
Matrix	-0.12	-0.71	-0.77	-0.95
EDGE	0.48*	0.19	0.54	0.21
DTOP	0.48	-0.35	0.26	0.74
CANC	0.35	0.00	0.26	0.21
SLOPE	0.37	0.71	0.77	0.63
T20	-0.14	0.00	-0.77	-0.21
T20-40	0.00	-0.18	-0.54	-0.32
T40	0.36	-0.75	0.54	0.89
L20	0.03	0.40	0.27	-0.50
L20-40	-0.24	0.61	-0.77	-0.89
L40	-0.35	-0.36	-0.26	-0.39
SNAG	0.06	0.00	-0.77	-0.95
S20	0.16	-0.25	-0.58	-0.11
S20-40	0.05	1.00*	0.00	-0.83
S40	0.08	-0.56	-0.77	0.94
SOIL	-0.02	0.79	-0.77	-0.06
ROCK	-0.05	1.00*	-0.33	-0.54
LITTER	0.30	-0.36	0.77	0.74
HERB	0.14	-0.56	-0.26	0.74
FERN	-0.20	-0.54	-0.26	0.11
GRASS	--- [†]	---	---	---
MOSS	-0.30	-0.35	-0.26	0.00
SHRUB	-0.37	0.36	-0.77	-0.24
Habitat Score 1 [‡]	0.01	0.00	-0.26	0.74
Habitat Score 2	-0.26	0.00	0.77	0.32
Habitat Score 3	0.20	-0.35	0.26	-0.95

* - $p < 0.10$

** - $p < 0.05$

^f - Proportion of breeding individuals could not be calculated for sites lacking Clethrionomys gapperi

[†] - Not present at any site containing Clethrionomys gapperi.

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 21. - Summary of Spearman rank correlations for proportion females of Clethrionomys gapperi vs. site descriptors along each of two corridors in Hood Canal District, Olympic National Forest, Washington.

Variable	Individual Corridors		
	All Corridors (n = 9)	Wynoochee (n = 5) [/]	Skokomish (n = 4)
	r _s	r _s	r _s
Isolation	-0.15	0.71	-0.74
Width	-0.51	-0.71	-0.11
Matrix	-0.25	-0.71	0.74
EDGE	-0.15	0.56	-0.63
DTOP	-0.56	-0.35	-0.95
CANC	-0.28	0.35	-0.63
SLOPE	-0.31	-0.35	-0.21
T20	0.41	0.71	0.63
T20-40	0.11	0.73	-0.32
T40	-0.29	0.19	-0.89
L20	0.15	0.40	-0.06
L20-40	0.42	0.41	0.89
L40	0.04	0.00	0.06
SNAG	-0.27	-0.71	0.74
S20	-0.17	0.25	-0.11
S20-40	0.15	0.25	0.50
S40	-0.40	-0.19	-0.94
SOIL	0.32	0.40	0.39
ROCK	0.37	0.25	0.54
LITTER	-0.33	-0.18	-0.95
HERB	-0.08	0.56	-0.95
FERN	-0.30	-0.36	0.10
GRASS	--- [†]	---	---
MOSS	0.07	-0.35	0.00
SHRUB	-0.19	-0.73	-0.24
Habitat Score 1 [‡]	-0.21	-0.71	-0.95
Habitat Score 2	0.32	0.35	0.32
Habitat Score 3	-0.03	0.00	0.74

[/] - Proportion of female individuals could not be calculated for sites lacking Clethrionomys gapperi

[†] - Not present at any site containing Clethrionomys gapperi .

[‡] - Canonical variate scores from discriminant analysis of habitat variables.

Table 22. - Comparison of community and demographic indices between corridors and surrounding matrix. Presence data for each species represents their mean incidence of occurrence (proportion of stations in a site with the species). To maintain an experimentwise Type 1 error of $\alpha = 0.10$, a Dunn-Sidak adjustment for multiple comparisons was used. The significance levels shown reflect this adjustment with significant relationships in bold.

	Corridor (n = 30)	Matrix (n = 28)	χ^2 Goodness-of-Fit
Presence Data			
<u>Peromyscus oreas</u>	0.95	0.69	11.95*
<u>Clethrionomys gapperi</u>	0.40	0.12	7.76
<u>Tamiasciurus douglasii</u>	0.32	0.11	5.23
<u>Sorex monticolus</u>	0.32	0.11	6.73
<u>Sorex trowbridgii</u>	0.25	0.27	2.93
<u>Glaucomys sabrinus</u>	0.18	0.02	5.26

* $p < 0.005$

LIST OF FIGURES

Figure 1. - Theoretical isolation effect for two hypothetical corridors, or, alternatively, two species, A and B. For both the two corridors and the two species, similarities with the source decrease with increasing distance. For corridors, the distance at which corridor communities diverge from those of the source (a' and b'), however, is lower for corridor A than for corridor B, making B the more effective corridor. For species, the distance at which population or demographic parameters begin to decline with isolation (e.g., densities or reproductive measures) is greater for species B than for species A, suggesting that species B is better adapted to conditions along the corridor.

Figure 2. - Deforestation and fragmentation of old-growth forests across the Hood Canal District of the Olympic National Forest, Washington (based on GIS data provided by the Olympic National Forest).

Figure 3. - The four corridors studied and the distribution of forest age-classes across the Hood Canal District of the Olympic National Forest, Washington (based on GIS data provided by the Olympic National Forest). Sampling sites for corridors and their pairings in adjacent habitat are also shown.

Figure 4. - Mean species richness (number per two randomly selected stations from 1000 simulations) for all mammals and forest mammals across the four corridors studied in the Hood Canal District, Olympic National

Forest, Washington (n = 30). Forest species are listed in Table 4. Neither forest species richness nor richness for all mammals varied significantly among the four corridors ($p > 0.20$ for both all mammals and forest mammals; randomization program).

Figure 5. - Relative densities (number of individuals per functional trapnight) of rodents at sites from the four corridors studied in the Hood Canal District, Olympic National Forest, Washington (n = 30).

Figure 6. - Relative densities (number of individuals per functional trapnight) of insectivores at sites from the four corridors studied in the Hood Canal District, Olympic National Forest, Washington (n = 30).

Figure 7. - Incidence (proportion of sites occupied) from all methods of detection (a) and relative densities (number of individuals per functional trapnight) from trapping data only (b) of sciurids at sites from the four corridors studied in the Hood Canal District, Olympic National Forest, Washington (n = 30).

Figure 8. - Incidence (proportion of sites occupied) of carnivores at sites from the four corridors studied in the Hood Canal District, Olympic National Forest, Washington (n = 30).

Figure 9. - Incidence (proportion of sites occupied) of miscellaneous species at sites from the four corridors studied in the Hood Canal District, Olympic National Forest, Washington (n = 30).

Figure 10. - Ordination of corridor communities in the Hood Canal District,

Olympic National Forest, Washington, based on mammal species composition. Canonical variate scores used for axes were generated using multiple discriminant analysis (SYSTAT 1997). Discrimination of sites among corridors was significant ($F = 1.94$, $p < 0.05$), with an overall classification success of 47%. ● - Wynoochee Corridor; ▲ - Satsop Corridor; □ - Bingam Corridor; ▽ - Skokomish Corridor.

Figure 11. - Ordination of corridor communities in the Hood Canal District, Olympic National Forest, Washington, based on environmental characteristics. Canonical variate scores used for axes were generated using multiple discriminant analysis (SYSTAT 1997). Discrimination of sites among corridors was highly significant ($F = 4.42$, $p < 0.005$), with an overall classification success of 100%. ● - Wynoochee Corridor; ▲ - Satsop Corridor; □ - Bingam Corridor; ▽ - Skokomish Corridor.

Figure 12. - Relationships between canonical variate scores derived from the discriminant analysis of species composition and those derived from discriminant analysis of habitat data at sites in each of the four corridors studied in the Hood Canal District, Olympic National Forest, Washington. Only significant Pearson product moment correlations are shown.

Figure 13. - Width of corridor at each site as a function of isolation for all four corridors in the Hood Canal District, Olympic National Forest,

Washington ($n = 30$, Spearman $r = -0.03$, $p = 0.92$). Isolation was measured as distance along corridor from the mainland of continuous forest. ● - Wynoochee Corridor; ▲ - Satsop Corridor; □ - Bingam Corridor; ▽ - Skokomish Corridor.

Figure 14. - Percent old-growth forest within 1000 m of a site as a function of isolation along all four corridors in the Hood Canal District, Olympic National Forest, Washington ($n = 30$, Spearman $r = -0.43$, $p < 0.05$). Isolation was measured as distance along corridor from the mainland of continuous forest. ● - Wynoochee Corridor; ▲ - Satsop Corridor; □ - Bingam Corridor; ▽ - Skokomish Corridor.

Figure 15. - Species richness per site for old-growth dependent mammals as a function of isolation for all four corridors in the Hood Canal District, Olympic National Forest, Washington ($n = 30$, Spearman $r = -0.29$, $p = 0.12$). Isolation was measured as distance along corridor from the mainland of continuous forest. ● - Wynoochee Corridor; ▲ - Satsop Corridor; □ - Bingam Corridor; ▽ - Skokomish Corridor.

Figure 16. - Differences in species richness of old-growth forest mammals in corridors and in adjacent paired sites across Hood Canal District, Olympic National Forest, Washington. P -values were based on binomial tests of differences within each corridor. Overall, 22 of 25 cases showed greater

richness in corridors than in adjacent paired sites ($p < 0.001$). Paired sites were successional forest for the Wynoochee corridor (a), and clearcut for the Satsop (b), Bingam (c), and Skokomish (d) corridors. Isolation was measured as distance along corridor from the mainland of continuous forest.

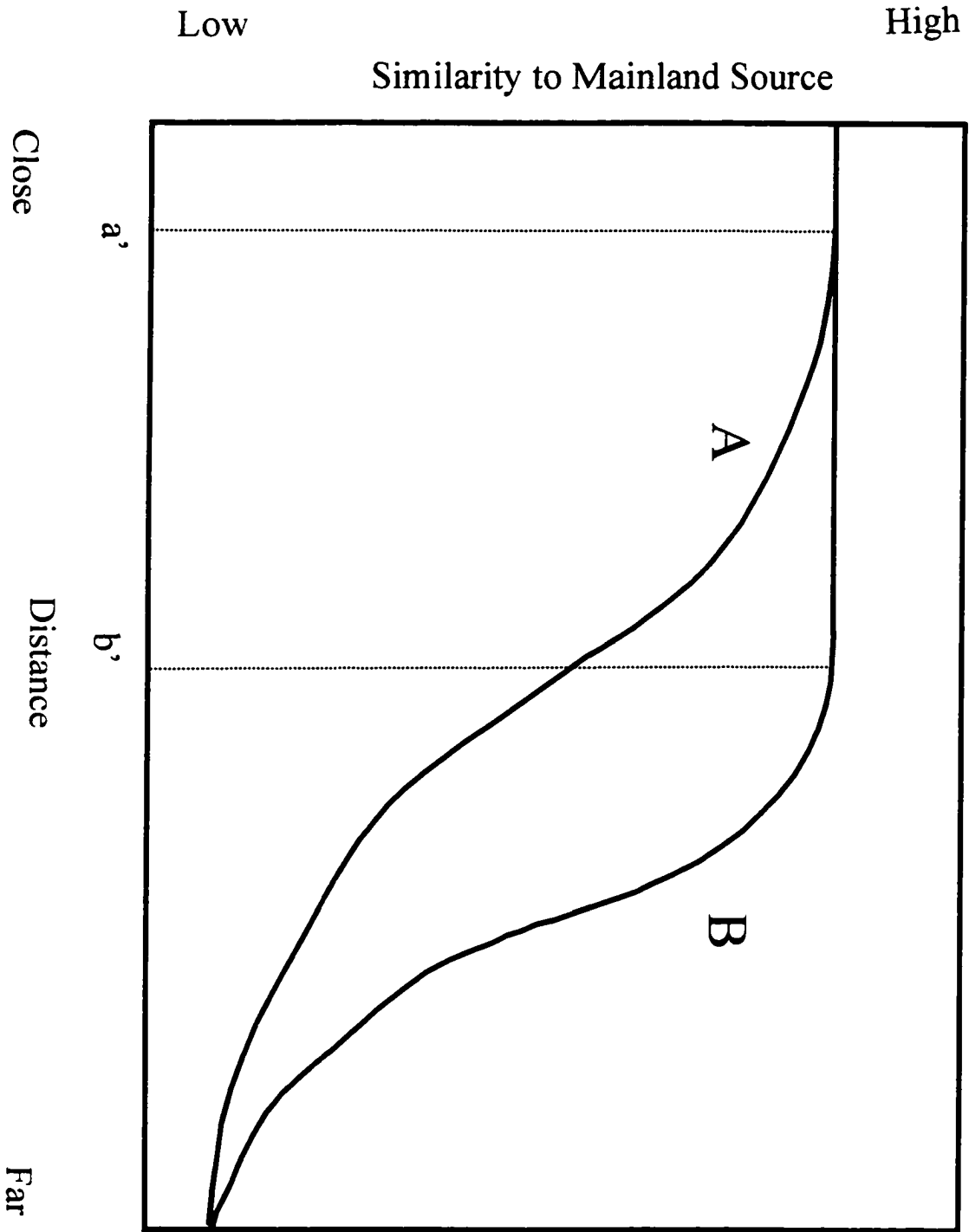


Fig. 1

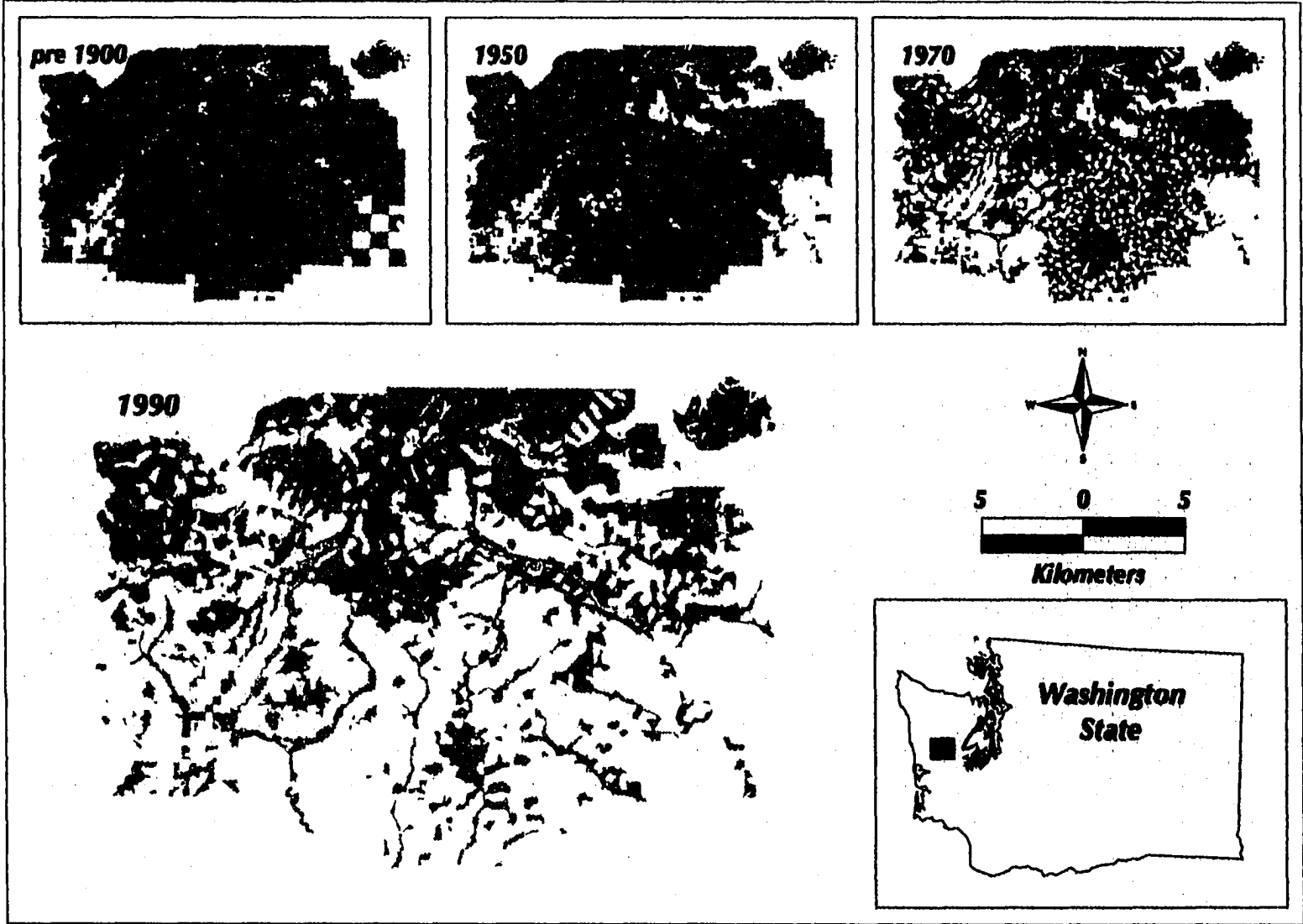


Fig. 2

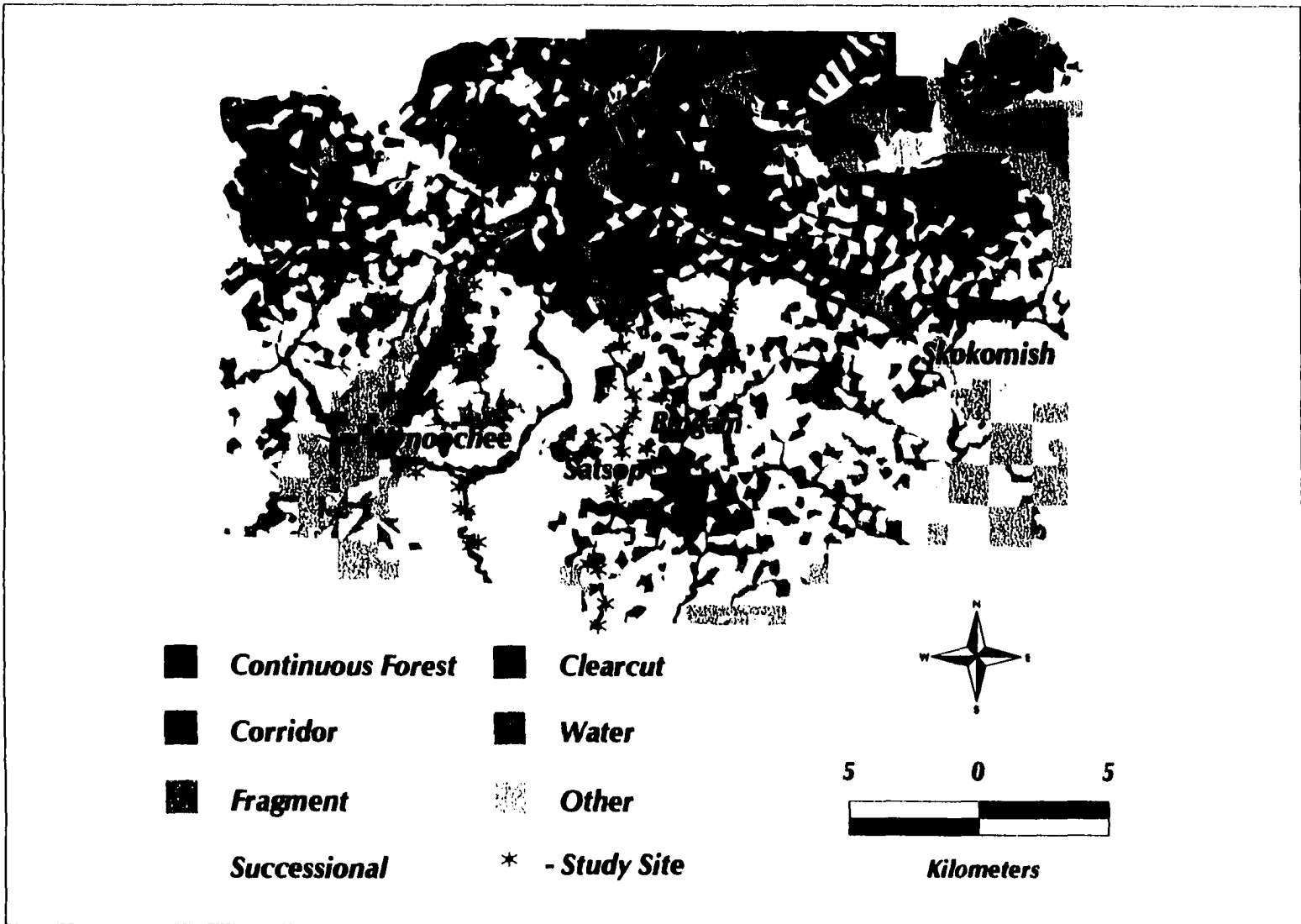


Fig. 3

Fig. 4

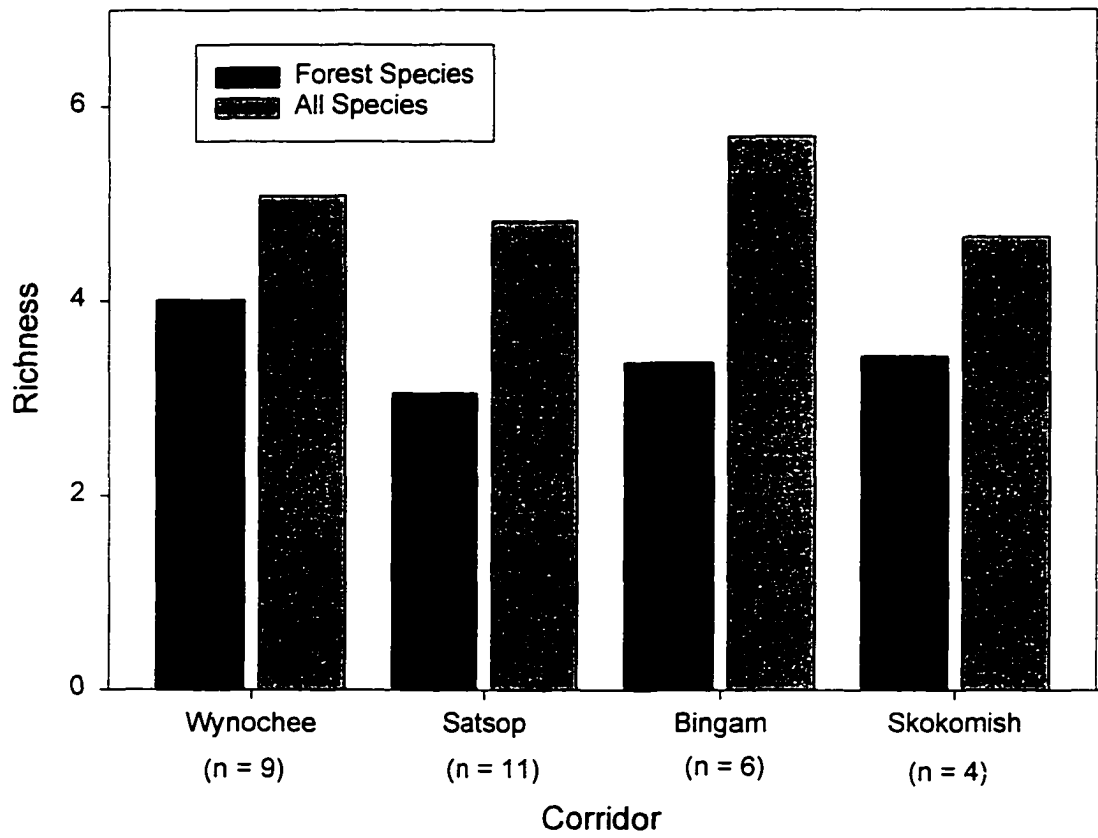


Fig. 5

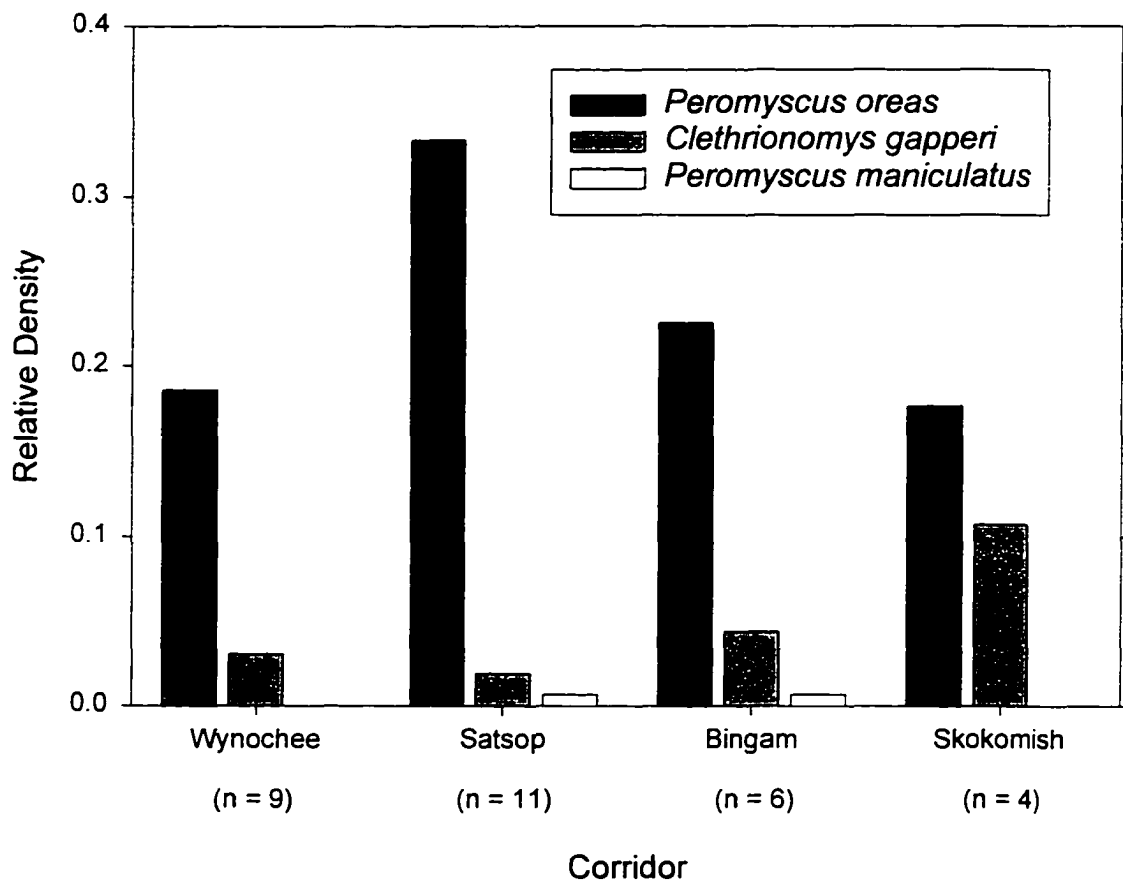


Fig. 6

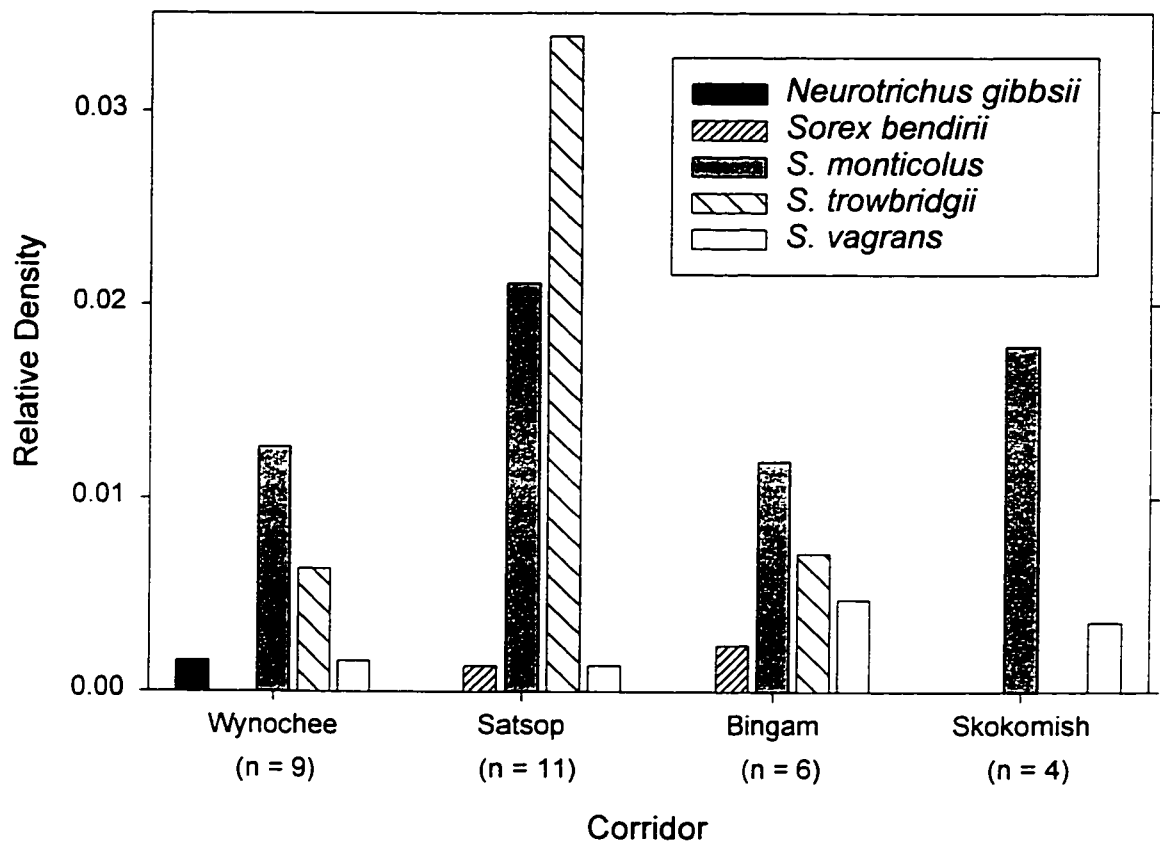


Fig. 7

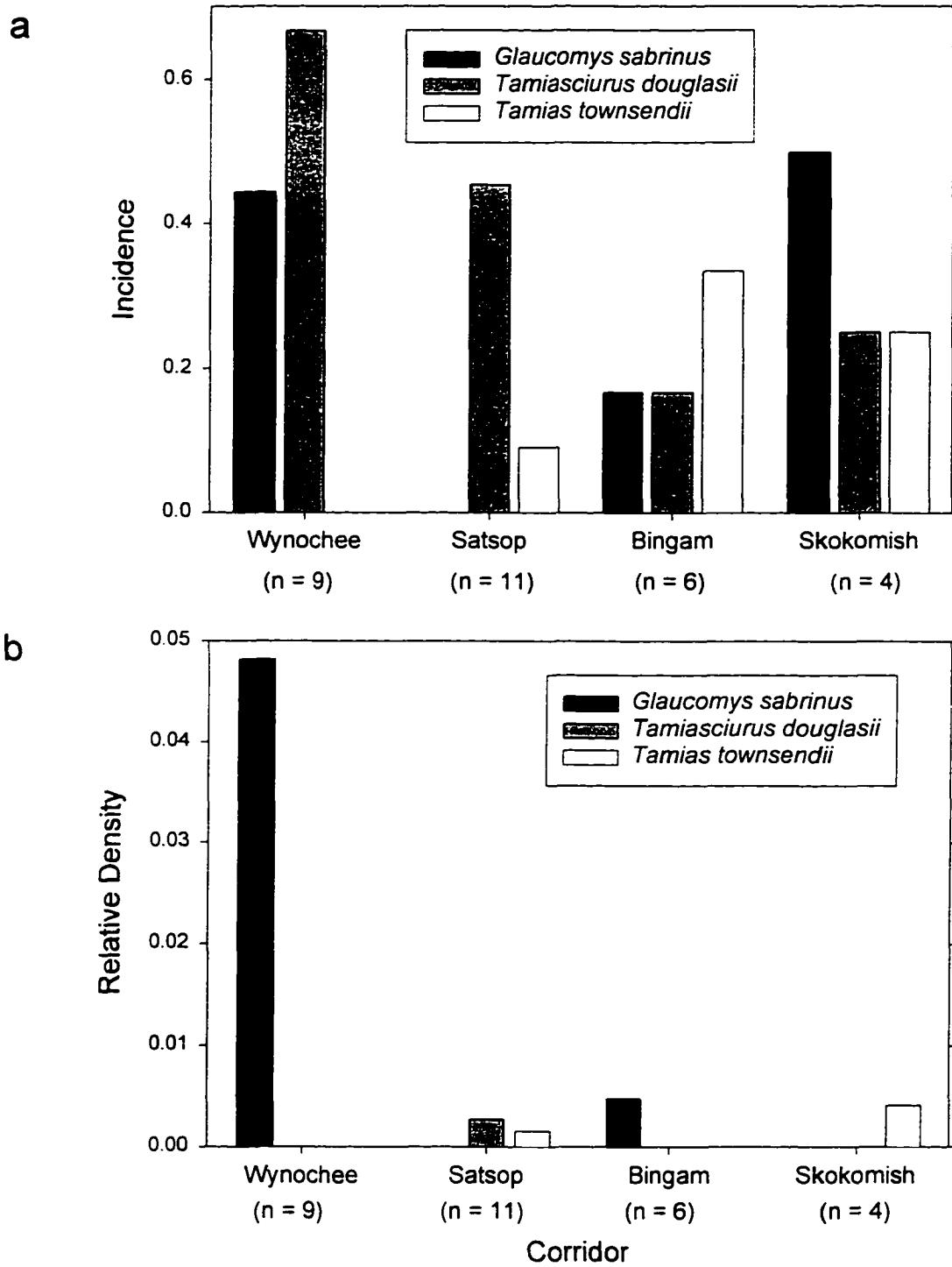


Fig. 8

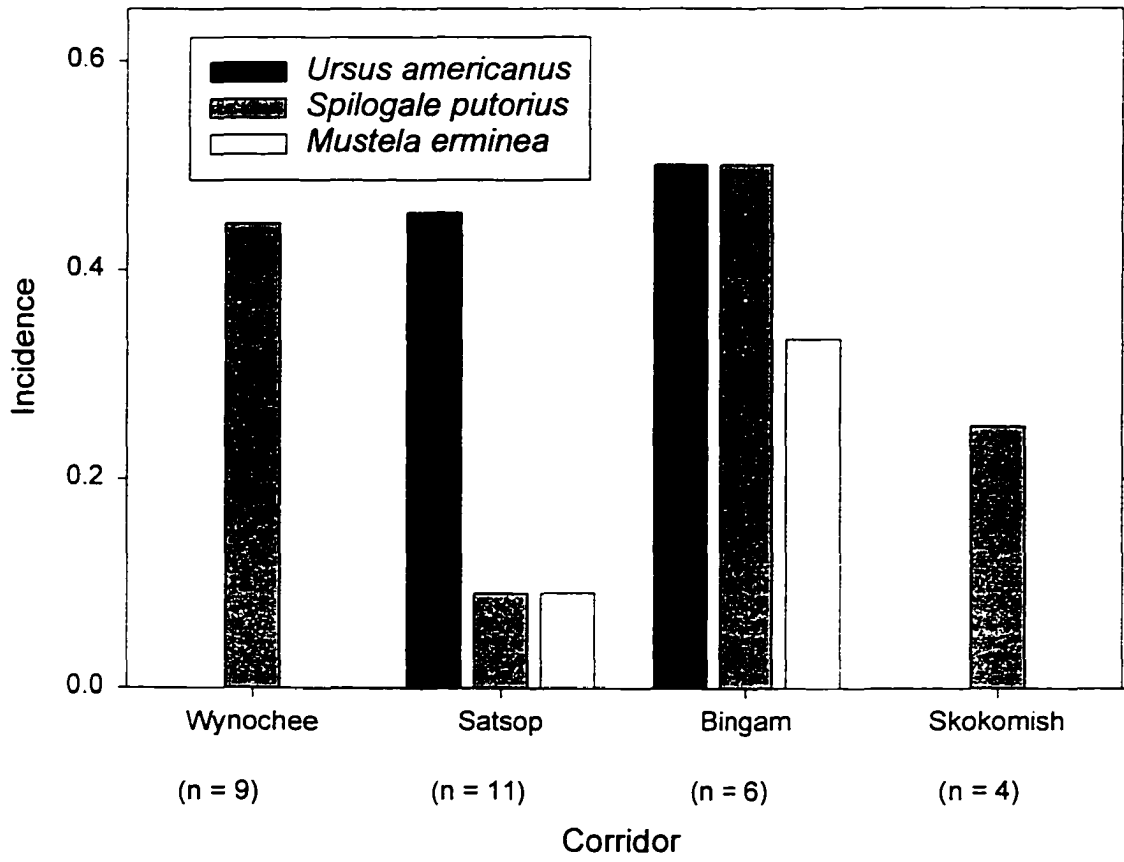
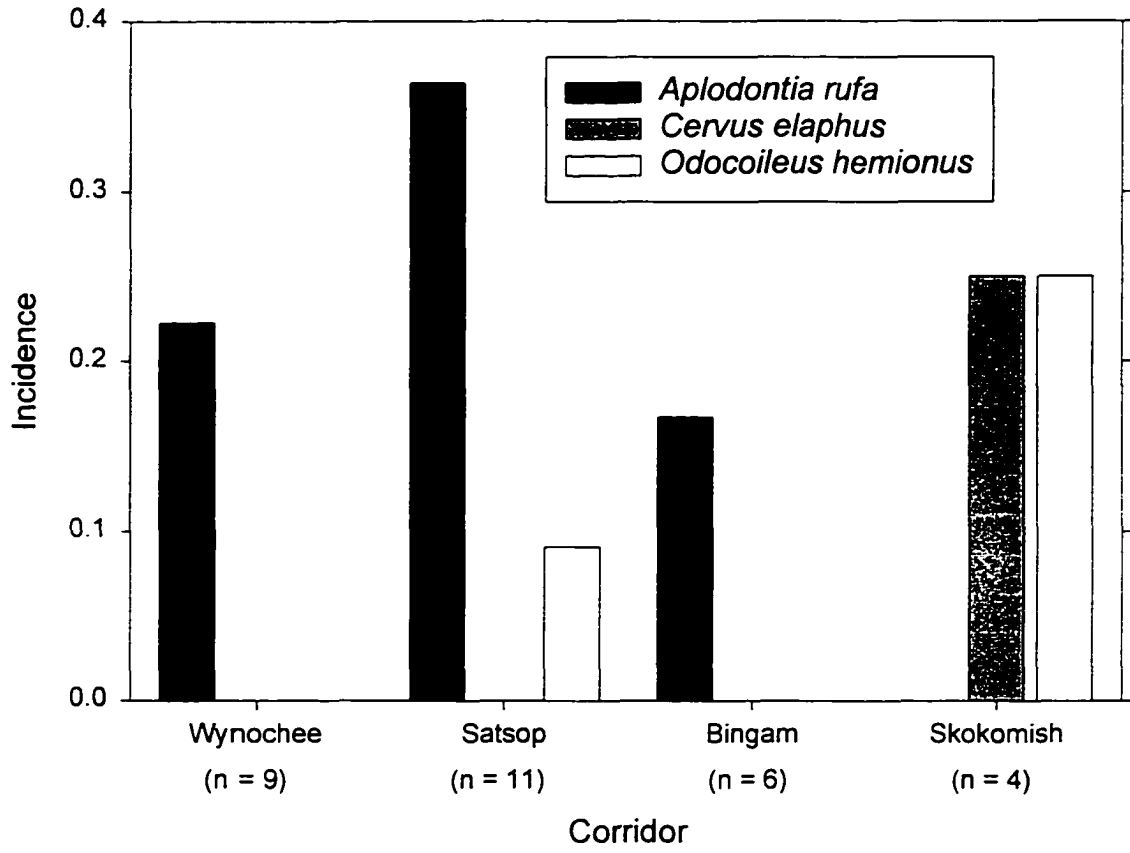


Fig. 9



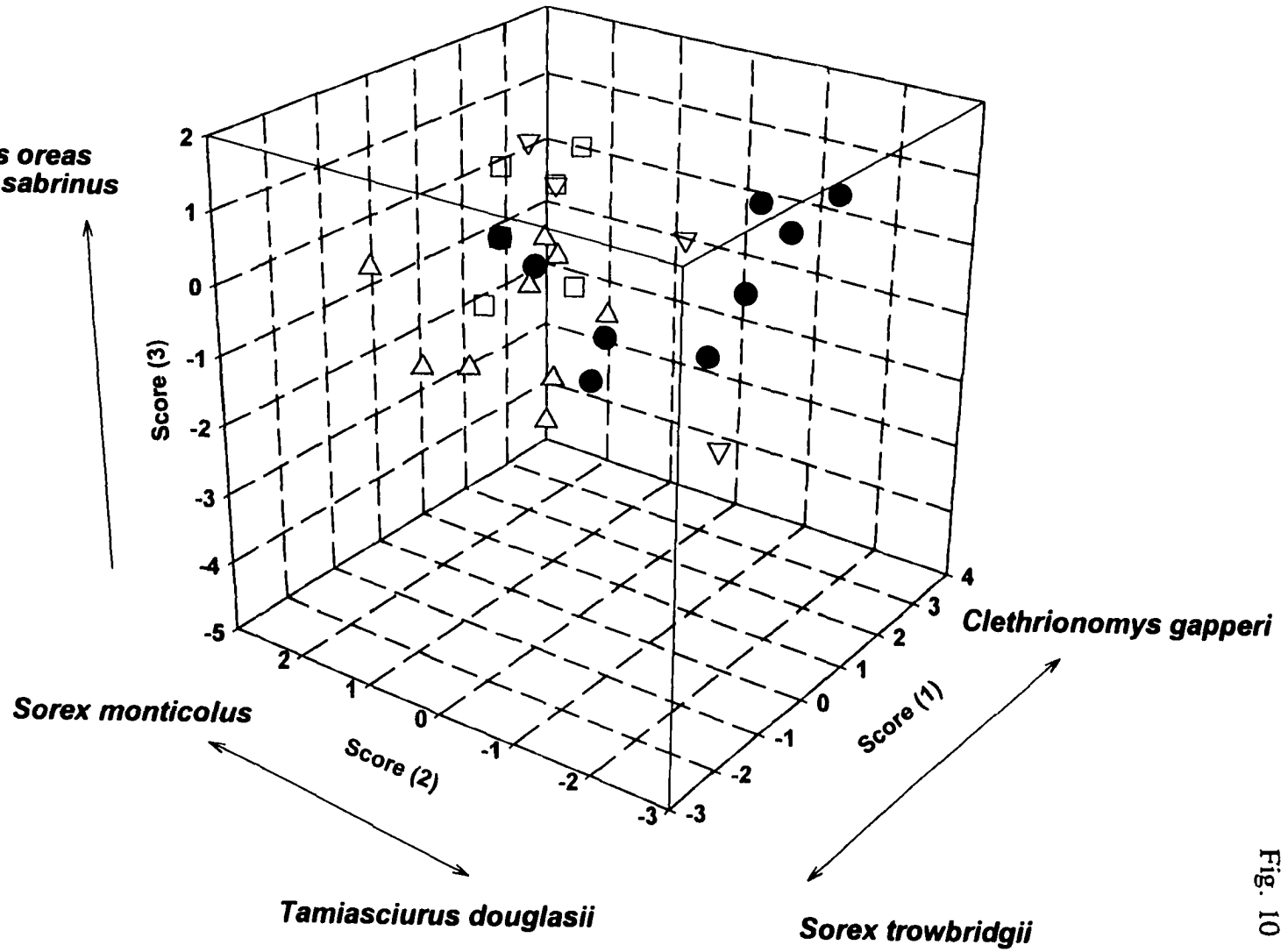


Fig. 10

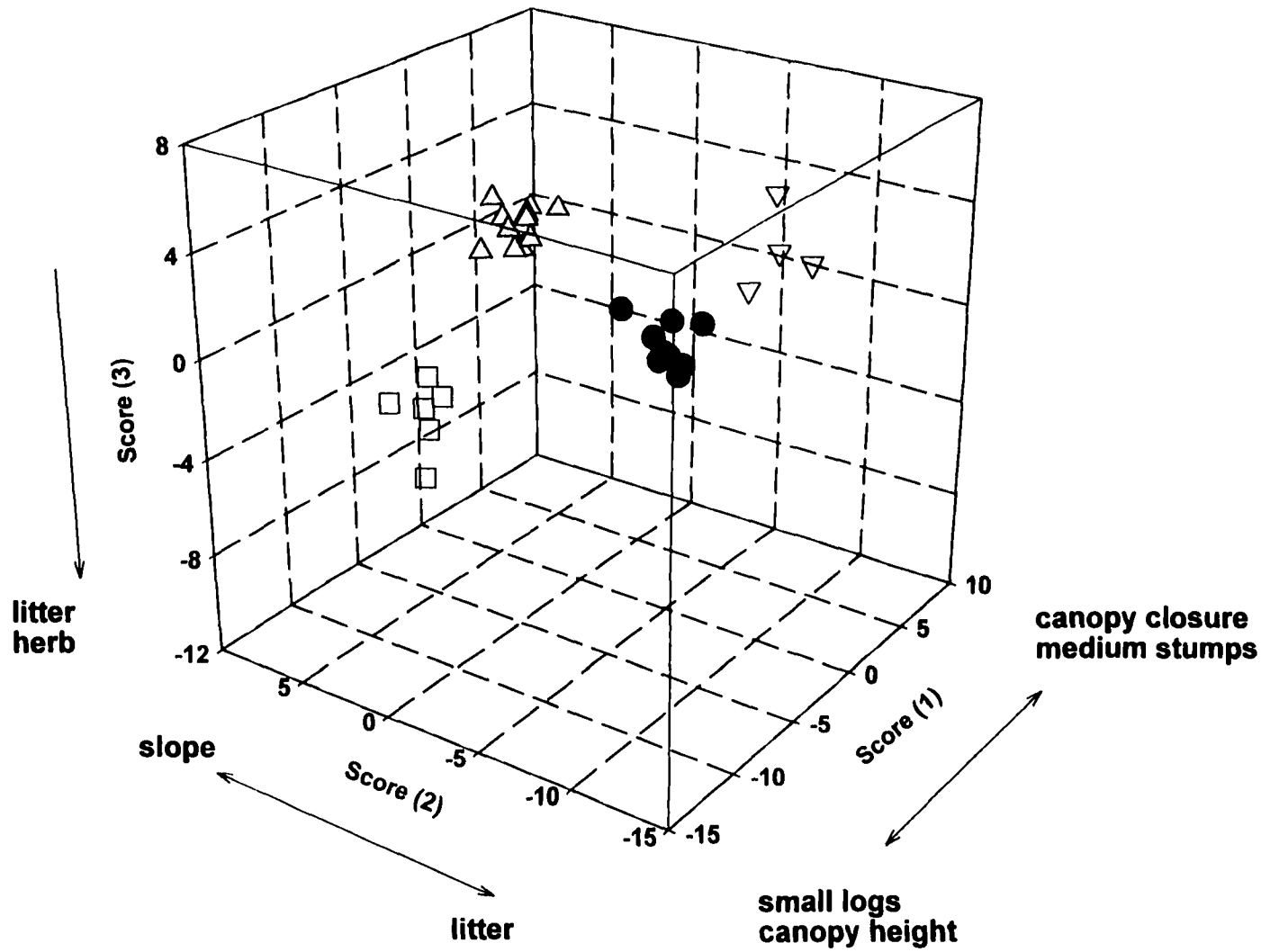


Fig. 11

Fig. 12

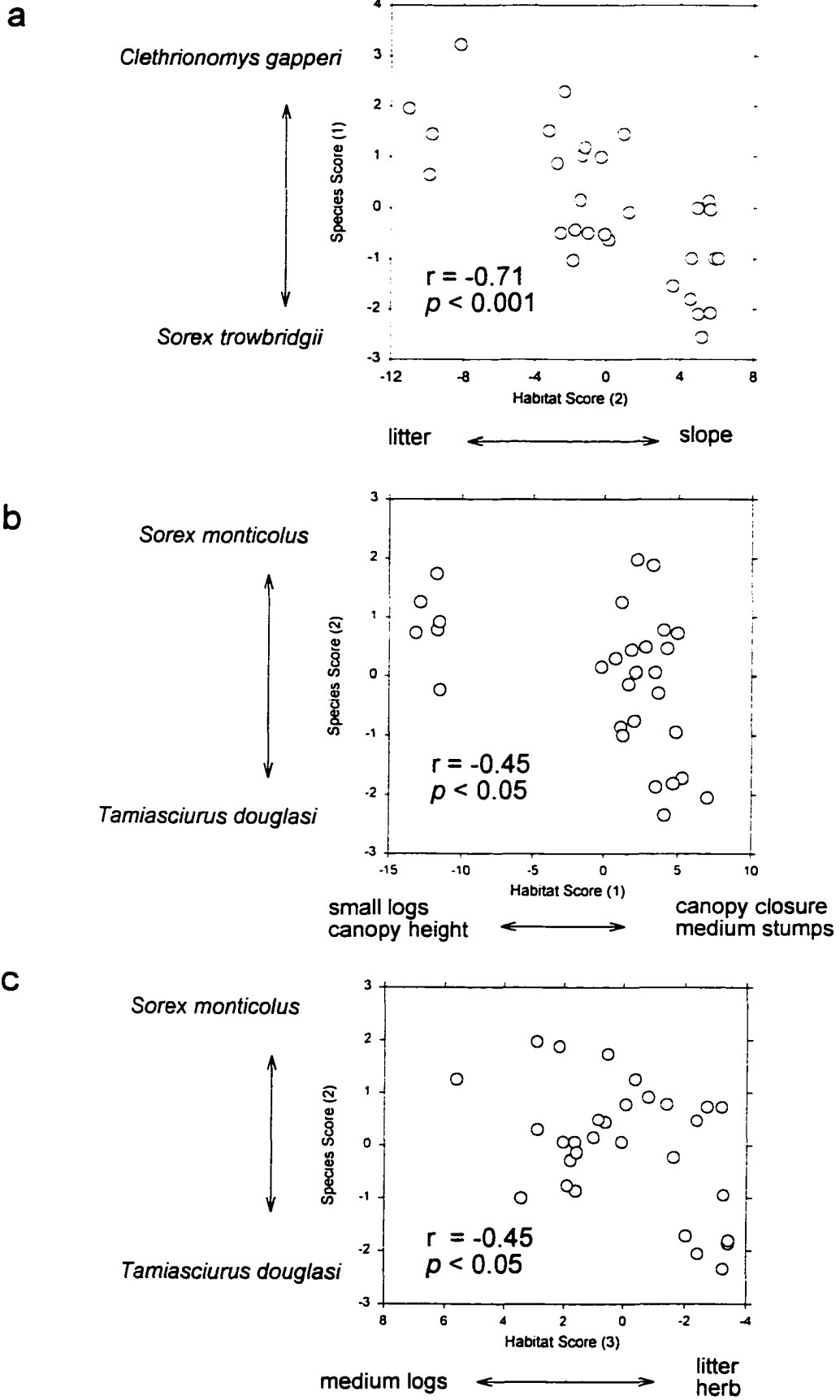


Fig. 13

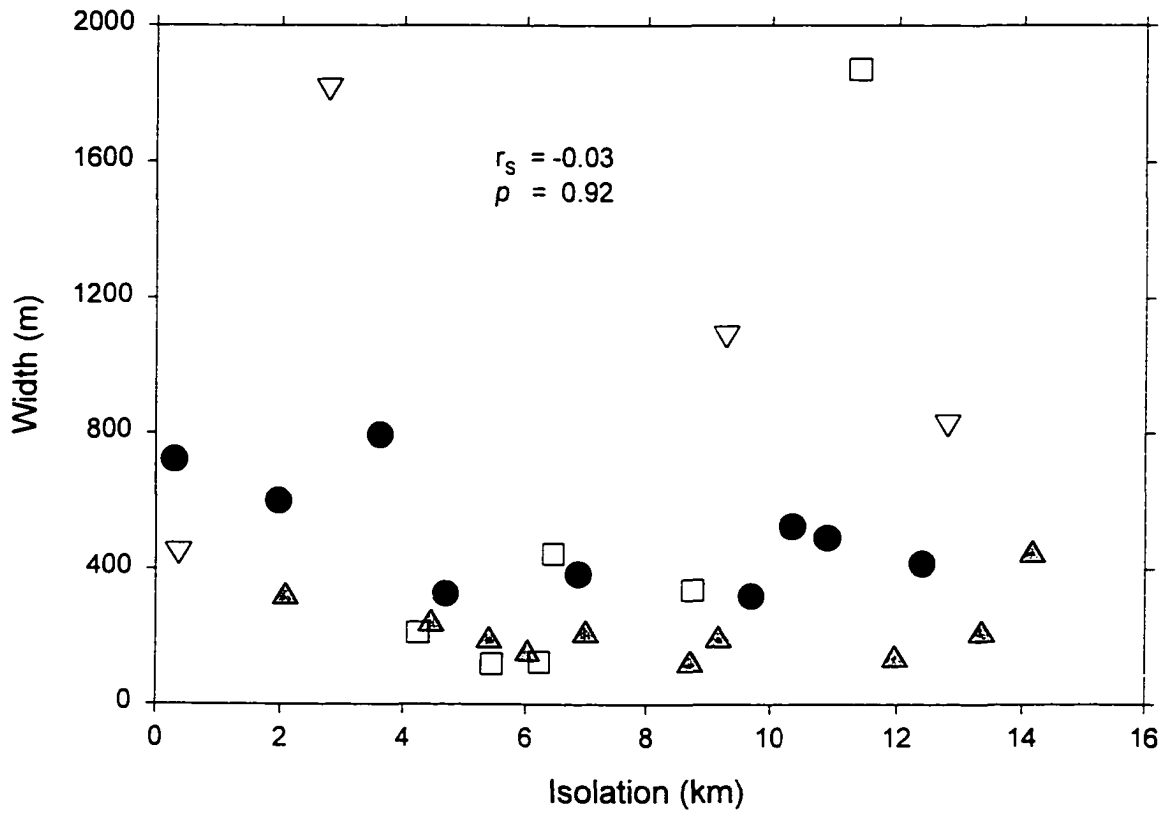


Fig. 14

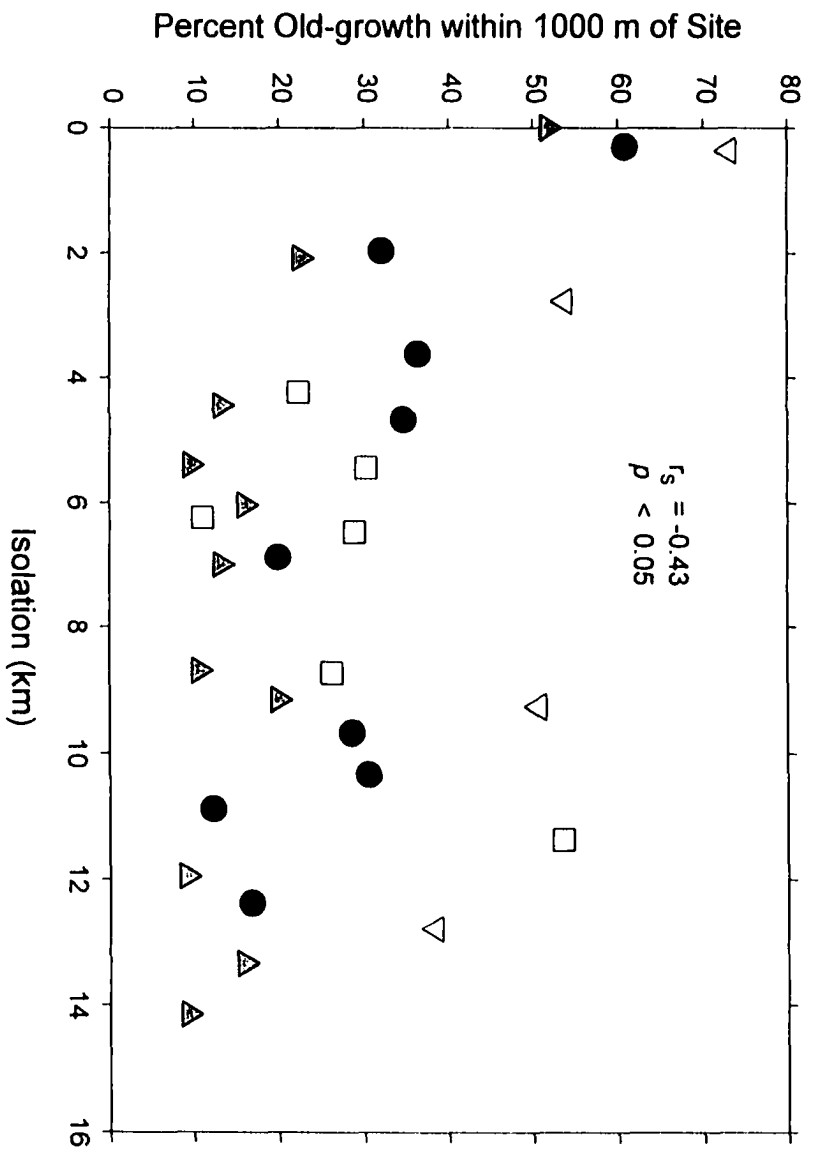
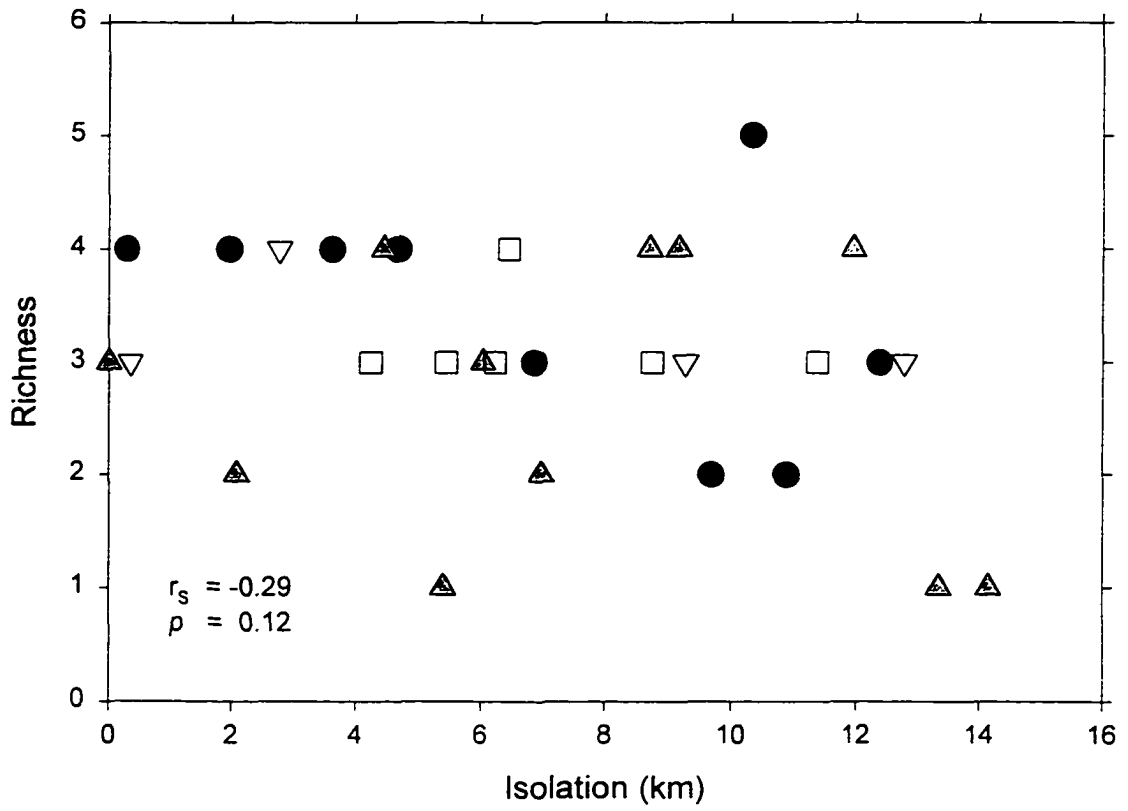


Fig. 15



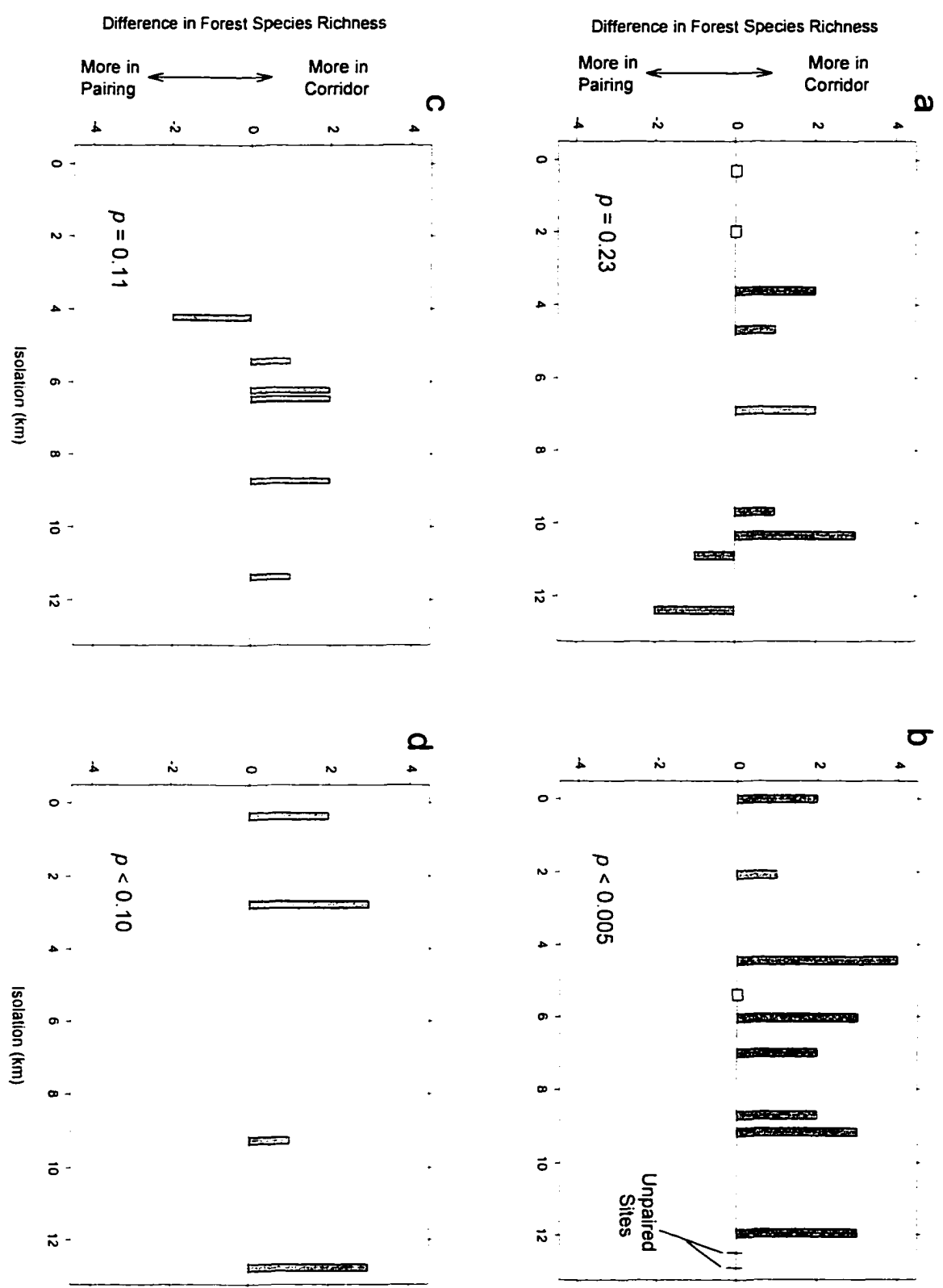


Fig. 16

Appendix 1. Habitat data collected at each station during field studies in the Hood Canal of the Olympic National Forest during the summers of 1994 to 1997. Except where noted, all measures are in meters.

Macrohabitat Category	Site-id	Station	Distance to Edge	Distance to Water	Canopy Height	Canopy Cover (%)	Slope	Aspect	Trees <20 cm dbh
Old-growth Mainland (n = 15)	OG4	1	100	50	75	32	64	NE	9
	OG4	2	150	40	75	31	45	NE	9
	OG4	3	230	50	75	32	65	N	5
	OG4	4	320	120	75	34	70	N	2
	OG4	5	350	200	75	33	80	N	2
	OG5	1	100	150	65	32	5	NW	5
	OG5	2	200	200	65	34	10	E	10
	OG5	3	275	250	65	18	10	N	4
	OG5	4	350	300	65	35	10	NW	9
	OG5	5	400	300	65	31	30	SE	5
	OG6	1	50	NA	65	28	5	SW	15
	OG6	2	125	NA	65	34	20	NE	10
	OG6	3	200	NA	65	28	90	W	4
	OG6	4	300	NA	65	29	0	NA	5
	OG6	5	200	NA	65	31	0	NA	8
	OG7	1	125	20	60.57	90	45	N	23
	OG7	2	200	30	56	94	22	N	33
	OG7	3	300	2	39.95	80	12	N	12
	OG7	4	375	20	50.74	78	50	N	19
	OG7	5	450	30	74.02	93	30	N	16
	OG8	1	275	325	39.97	96	14	S	10
	OG8	2	200	300	37.13	95	40	W	4
	OG8	3	100	50	58.54	96	7	W	8
	OG8	4	150	50	84.96	94	20	N	7
	OG8	5	200	75	47.94	94	20	W	18
	OG9	1	200	NA	27.78	95	25	N	15
	OG9	2	200	NA	47.09	89	55	N	5
	OG9	3	200	NA	22.87	89	25	N	12
	OG9	4	150	NA	33.4	92	48	N	3

OG9	5	150	NA	35.35	51	30	N	6
OG10	1	100	NA	35.75	39	30	N	18
OG10	2	200	NA	49.85	91	65	N	15
OG10	3	200	NA	45.17	77	35	N	6
OG10	4	220	NA	46.04	96	50	N	19
OG10	5	250	NA	36.85	90	5	N	4
OG11	1	75	200	39.3	93.86	55	SE	6
OG11	2	100	200	41.57	92.82	52	E	9
OG11	3	250	100	34.79	94.38	58	E	1
OG11	4	350	5	42.53	93.6	35	NE	7
OG11	5	200	NA	38.62	88.4	30	E	3
OG12	1	400	3	42.73	94.38	30	NW	10
OG12	2	475	0	40.17	96.46	15	NW	6
OG12	3	550	75	29.81	91.78	50	NW	5
OG12	4	560	150	39.83	96.72	70	W	4
OG12	5	555	175	40.5	92.3	52	W	0
OG13	1	300	NA	60.45	94.9	16	NE	9
OG13	2	300	NA	75.11	96.98	30	NE	7
OG13	3	350	NA	61.09	93.6	20	E	4
OG13	4	325	NA	56.52	96.2	38	NE	4
OG13	5	150	NA	81.88	93.86	55	NE	6
OG14	1	125	NA	28.09	93.08	55	E	4
OG14	2	100	NA	69.18	90.48	68	SE	3
OG14	3	100	NA	29.71	94.38	64	E	3
OG14	4	150	NA	33.62	95.42	56	W	2
OG14	5	175	NA	31.42	91	70	S	3
OG15	1	75	10	67.25	85.28	19	SW	5
OG15	2	150	8	28.81	94.64	25	SE	5
OG15	3	250	7	52.82	94.64	52	E	2
OG15	4	300	82	44.45	89.18	42	SE	2
OG15	5	250	100	63.47	95.16	60	S	0
OG16	1	200	175	54.48	94.64	52	S	1
OG16	2	250	250	44.52	95.94	43	SW	5
OG16	3	350	275	48.22	92.3	30	S	0

Old-growth Corridor
(n = 30)

OG16	4	400	40	63.58	93.86	75	S	2
OG16	5	500	5	49.98	96.2	50	SE	1
OG17	1	100	150	75.58	93.34	45	W	1
OG17	2	150	150	46.07	97.76	51	W	1
OG17	3	160	75	56.86	93.6	65	N	4
OG17	4	150	150	59.68	97.24	53	W	1
OG17	5	150	175	40.16	91.26	58	SW	1
OG18	1	100	15	112.14	93.86	65	E	1
OG18	2	175	0	47.91	92.04	65	NE	4
OG18	3	250	35	45.34	92.82	83	SW	12
OG18	4	200	50	69.48	96.46	74	NW	6
OG18	5	150	75	65.38	92.82	37	SE	0
CO1	1	300	30	60	34	5	E	30
CO1	2	300	30	60	36	0	NA	2
CO2	1	100	15	70	33	25	W	5
CO2	2	100	100	70	31	15	SW	10
CO3	1	200	15	65	32	50	N	6
CO3	2	100	20	65	35	70	N	2
CO4	1	100	500	60	33	0	NA	4
CO4	2	200	500	60	26	45	E	6
CO6	1	80	60	51.01	94	5	SW	6
CO6	2	100	100	80.29	82	10	SW	5
CO7	1	500	500	50.57	97	23	S	14
CO7	2	200	600	52.45	95	24	S	15
CO8	1	500	250	74.9	96	22	NW	0
CO8	2	500	250	82.29	97	0	X	5
CO9	1	175	300	72.87	95	30	NW	1
CO9	2	200	350	79.68	96	25	NW	20
CO10	1	100	10	42.52	94	15	N	26
CO10	2	75	30	61.21	96	20	NW	15
CO11	1	50	500	30.56	98	45	N	21
CO11	2	50	500	25.18	57	45	N	20
CO12	1	20	20	31.9	96.72	43	E	6

CO12	2	25	25	41.28	96.2	33	SE	8
CO13	1	150	150	66.19	93.08	0	NA	3
CO13	2	300	0	53.79	93.86	10	SE	1
CO14	1	75	5(0 to spring)	36.94	98.02	30	NE	1
CO14	2	50	50	20.85	95.16	62	N	4
CO15	1	300	NA	41.56	91.26	75	W	14
CO15	2	300	NA	38.5	92.04	80	S	2
CO16	1	50	100	28.65	93.6	30	E	6
CO16	2	110	40	33.32	97.5	0	NA	5
CO17	1	75	100	50.18	94.64	20	S	3
CO17	2	150	10	34.66	94.64	12	S	3
CO18	1	75	150	29.52	95.42	17	SW	2
CO18	2	75	200	62.78	94.9	16	SE	0
CO19	1	75	500	39.14	91	80	N	3
CO19	2	150	450	30.58	95.94	110	N	3
CO20	1	75	30	36.58	91.26	20	SW	3
CO20	2	50	30	58.35	94.9	24	SW	0
CO21	1	50	25	21.81	78.78	35	E	4
CO21	2	100	40	55.06	92.3	0	NA	6
CO22	1	75	125	34.65	93.86	70	S	2
CO22	2	50	150	57.34	94.64	40	NW	10
CO23	1	100	300	71.34	92.56	49	NW	0
CO23	2	100	300	49.07	93.08	55	W	2
CO24	1	75	300	38.44	92.56	0	NA	10
CO24	2	125	250	103.66	92.04	0	NA	3
CO25	1	75	300	29.33	93.08	70	W	5
CO25	2	150	225	78.35	94.12	60	W	1
CO26	1	200	30	73.76	89.18	23	W	0
CO26	2	250	105	46.94	94.38	12	N	6
CO27	1	75	200	55.87	93.08	7	W	2
CO27	2	150	100	42.45	95.42	0	NA	1
CO28	1	100	35	39.08	95.68	30	SW	4
CO28	2	125	110	42.36	95.94	23	SW	2
CO29	1	100	400	59.24	94.64	30	S	4

	CO29	2	75	400	49.66	94.12	18	SE	3
	CO30	1	200	15	62.02	93.86	28	W	2
	CO30	2	275	15	49.57	95.16	63	E	6
	CO31	1	200	10	50.69	94.9	20	S	5
	CO31	2	200	35	56.84	95.94	7	SW	4
Old-growth Fragment (n = 20)	F4	1	75	200	70	33	10	SW	0
	F4	2	150	150	70	28	25	SW	2
	F4	3	200	100	70	31	45	SW	0
	F4	4	200	100	70	32	30	SW	1
	F4	5	150	70	70	31	35	S	3
	F5	1	75	170	75	33	40	N	4
	F5	2	100	200	75	30	20	N	5
	F5	3	75	200	75	31	20	NE	3
	F5	4	75	250	75	33	40	NE	20
	F5	5	100	300	75	32	35	NE	21
	F6	1	100	250	70	28	40	S	2
	F6	2	150	220	70	33	50	SE	3
	F6	3	150	200	70	32	45	SE	3
	F6	4	160	200	70	31	40	SE	0
	F6	5	200	300	70	31	45	E	8
	F7	1	75	50	60	35	55	N	3
	F7	2	150	10	60	34	20	NE	6
	F7	3	230	50	60	35	25	NE	3
	F7	4	300	120	60	32	25	E	3
	F8	1	100	NA	70	35	90	S	10
F8	2	200	NA	70	35	50	SE	2	
F8	3	200	NA	70	34	55	S	28	
F8	4	250	NA	70	33	75	S	6	
F8	5	200	NA	70	32	75	SW	5	
F9	1	50	NA	60	31	130	NE	6	
F9	2	60	NA	60	35	95	E	16	
F9	3	60	NA	60	33	85	NE	6	
F9	4	70	NA	60	34	90	NE	2	

F10	1	50	100	60	34	65	SE	2
F10	2	60	100	60	35	45	S	25
F10	3	60	50	60	32	30	SW	10
F10	4	50	40	60	36	40	E	13
F11	1	150	150	70	36	0	NA	10
F11	2	200	200	70	34	0	NA	0
F11	3	150	150	70	35	15	SE	14
F11	4	150	100	70	34	10	S	12
F11	5	75	120	70	32	65	E	10
F12	1	75	NA	32.94	96	32	S	12
F12	2	50	NA	39.36	95	32	S	16
F12	3	75	NA	42	57	31	S	6
F12	4	30	NA	35.98	87	38	S	7
F12	5	75	NA	39.08	95	35	S	3
F13	1	150	NA	37.63	99	40	E	10
F13	2	170	NA	50.3	89	68	E	4
F13	3	300	NA	45.81	95	45	E	5
F13	4	350	NA	51.04	96	65	E	9
F13	5	175	NA	48.47	81	55	E	9
F14	1	75	NA	27.33	93	60	W	10
F14	2	100	NA	39.72	93	38	S	2
F14	3	150	NA	57.35	92	45	S	4
F14	4	200	NA	42.93	96	45	E	5
F14	5	200	NA	58.24	95	50	E	1
F15	1	75	NA	25.24	92	39	S	6
F15	2	100	NA	75.87	88	60	S	18
F15	3	100	NA	77.25	96	58	S	12
F15	4	125	NA	29.02	95	60	S	8
F15	5	75	NA	60.77	92	46	S	5
F16	1	40	NA	40.93	95	75	E	9
F16	2	75	NA	37.97	84	58	E	5
F16	3	100	NA	25.98	55	65	E	10
F17	1	75	25	30.26	93	70	E	11
F17	2	150	25	49.65	94	65	E	2

	F17	3	200	0	48.35	92	1	S	12
	F17	4	250	25	29.18	94	45	W	5
	F17	5	300	15	30.72	95	50	E	3
	F18	1	75	25	29.14	92	90	S	10
	F18	2	75	40	25.73	92	35	SW	14
	F18	3	75	60	39.84	92	33	SW	6
	F18	4	75	100	43.87	90	40	W	12
	F18	5	75	150	40.3	91	42	NW	3
	F19	1	25	NA	26.13	92	100	W	5
	F19	2	25	NA	36.07	53	100	W	2
	F20	1	75	NA	21.85	42.12	67	NW	16
	F20	2	75	NA	111.16	94.64	55	NW	8
	F20	3	75	NA	22.02	91.26	55	N	4
	F20	4	150	NA	31.3	86.06	50	N	4
	F20	5	75	NA	31.57	90.48	77	W	18
	F21	1	125	NA	59.7	90.48	65	N	11
	F21	2	75	NA	47.12	95.68	70	W	3
	F21	3	75	125	29.01	94.12	55	NW	5
	F21	4	50	50	57.2	94.09	75	W	7
	F22	1	75	250	36.79	91.78	23	SW	3
	F22	2	150	125	46.52	95.16	3	SE	6
	F22	3	200	100	44.1	89.7	5	S	2
	F22	4	250	75	22.31	96.46	0	NA	4
	F22	5	300	100	53.15	92.04	0	NA	8
	F23	1	75	NA	31.27	96.2	80	N	4
	F23	2	75	NA	33.81	81.12	80	NE	0
	F23	3	150	NA	72.73	94.64	73	NE	3
	F23	4	200	NA	59	87.8	75	NE	3
Successional Forest (n = 9)	S23	1	75	200	25.21	95.68	0	NA	1
	S23	2	150	150	21.32	93.08	0	NA	1
	S24	1	200	300	26.51	92.56	45	NW	9
	S24	2	250	300	28.12	90.22	45	NW	13
	S25	1	100	500	17.09	84.5	50	W	10

Clearcut
(n = 19)

S25	2	100	500	29.44	93.6	50	W	1
S26	1	75	200	28.62	93.6	57	W	3
S26	2	150	275	39.5	93.08	65	NW	9
S27	1	75	300	42.73	90.48	12	W	1
S27	2	125	350	36.77	94.12	30	SW	7
S28	1	75	150	31.45	93.34	26	NE	16
S28	2	150	225	25.51	92.82	55	SE	15
S29	1	100	NA	31.53	93.6	0	NA	13
S29	2	100	NA	23.12	95.16	8	W	12
S30	1	75	100	32.98	94.38	47	W	14
S30	2	125	175	29.22	93.86	45	SW	15
S31	1	175	175	32.92	93.86	45	E	4
S31	2	200	250	33.08	92.3	50	NE	9
CC1	1	100	100	5	3	80	W	8
CC1	2	200	30	5	0	0	NA	15
CC2	1	100	500	5	0	50	SW	16
CC2	2	75	500	5	0	50	SW	12
CC3	1	75	50	3	0	90	N	8
CC3	2	200	100	3	0	40	NE	9
CC4	1	100	NA	0	0	85	SE	0
CC4	2	100	NA	0	0	85	SE	0
CC5	1	50	NA	5	0	60	SW	6
CC5	2	70	NA	5	0	65	W	10
CC6	1	150	300	3	0	45	W	25
CC6	2	150	300	3	0	45	W	20
CC7	1	250	750	0.2	0	53	S	6
CC7	2	300	800	0.3	0	55	S	7
CC8	1	200	300	1	0	25	NE	33
CC8	2	100	250	1	0	15	NE	29
CC9	1	125	300	2.5	2	0	X	23
CC9	2	125	300	2.5	0	0	X	24
CC10	1	400	200	2	0	90	NW	3
CC10	2	350	200	2	0	70	NW	6

CC11	1	100	40	0.2	0	55	E	4
CC11	2	125	65	0.2	0	47	E	5
CC12	1	250	NA	1	0	20	E	1
CC12	2	150	NA	0	0	73	E	2
CC13	1	300	NA	1	41.6	60	W	1
CC13	2	500	NA	1	2.08	78	S	2
CC14	1	500	550	2.5	3.38	70	NE	3
CC14	2	600	650	3	16.12	75	E	1
CC15	1	400(1 km to	NA	0.5	2.6	80	SE	1
CC15	2	400(1 km to	NA	1	0	45	S	1
CC16	1	400	NA	0	0	36	S	0
CC16	2	300	NA	0.5	0	60	S	0
CC17	1	75(1 km to	NA	0	0	80	W	0
CC17	2	100(1 km to	NA	2	6.5	80	NE	1
CC19	1	100	NA	4	0.52	7	SE	0
CC19	2	75	NA	0.5	0	22	SE	1
CC20	1	150	150	0.5	0	70	E	0

Site-id	Station	Trees		Logs		Logs		Snags	Stumps	
		20-40 cm dbh	>40 cm dbh	<20 cm dbh	20-40 cm dbh	>40 cm dbh	<20 cm dbh			
OG4	1	1	4	0	1	1	1	1	0	
OG4	2	3	5	3	2	0	2	2	0	
OG4	3	2	4	3	0	1	1	1	2	
OG4	4	1	2	1	3	0	1	1	0	
OG4	5	1	4	3	1	1	1	1	0	
OG5	1	1	3	0	2	2	0	1	1	
OG5	2	0	3	1	0	5	0	0	0	
OG5	3	0	1	3	0	6	3	0	0	
OG5	4	2	0	3	1	5	3	1	1	
OG5	5	1	1	4	4	2	2	1	1	
OG6	1	1	2	5	2	1	1	2	2	
OG6	2	3	4	4	1	1	2	1	1	
OG6	3	1	1	1	4	1	0	2	2	
OG6	4	6	1	3	2	2	2	1	1	
OG6	5	3	2	4	1	1	3	1	1	
OG7	1	6	9	4	5	3	4	2	2	
OG7	2	4	8	3	2	5	6	0	0	
OG7	3	8	4	3	2	2	4	1	1	
OG7	4	5	4	8	6	6	3	0	0	
OG7	5	4	4	15	4	8	1	2	2	
OG8	1	5	6	5	4	6	6	2	2	
OG8	2	6	8	4	4	4	1	0	0	
OG8	3	4	8	3	0	1	1	0	0	
OG8	4	2	9	2	1	4	2	0	0	
OG8	5	3	6	5	0	2	0	1	1	
OG9	1	3	4	0	1	0	1	0	0	
OG9	2	5	6	1	1	7	2	0	0	
OG9	3	5	2	2	1	0	3	0	0	
OG9	4	2	2	3	1	1	3	0	0	
OG9	5	2	3	3	1	5	1	0	0	
OG10	1	0	2	0	0	2	2	0	0	
OG10	2	3	1	5	0	1	0	1	1	

OG10	3	4	3	0	1	5	1	0
OG10	4	1	5	3	2	1	1	0
OG10	5	5	2	0	3	4	1	0
OG11	1	5	2	1	1	1	1	1
OG11	2	1	12	5	1	2	1	0
OG11	3	4	6	0	1	2	0	0
OG11	4	3	8	0	1	6	0	0
OG11	4	4	7	1	2	2	1	1
OG11	5	4	4	0	1	8	2	0
OG12	1	2	6	0	1	2	0	1
OG12	2	2	3	0	2	2	0	1
OG12	3	1	3	1	2	6	1	0
OG12	4	8	1	0	3	4	2	0
OG12	5	5	5	4	3	4	4	0
OG13	1	2	4	1	2	3	4	0
OG13	2	3	3	1	2	5	4	0
OG13	3	1	4	2	1	5	4	0
OG13	4	4	3	2	3	5	4	0
OG13	5	5	4	4	2	5	4	0
OG13	1	6	4	1	3	2	4	1
OG13	2	2	6	2	0	3	4	1
OG13	3	1	4	2	1	3	2	0
OG13	4	2	4	3	3	4	2	0
OG13	5	3	3	1	0	2	4	1
OG14	1	3	6	1	4	3	1	0
OG14	2	6	4	1	3	4	2	0
OG14	3	4	1	0	2	0	1	0
OG14	4	5	8	2	1	2	6	0
OG14	5	2	3	0	2	2	1	0
OG15	1	2	3	1	2	3	0	0
OG15	2	4	2	3	3	3	0	0
OG15	3	2	4	0	1	6	0	0
OG15	4	2	3	0	2	3	1	0
OG15	5	4	2	0	3	5	3	0
OG16	1	2	3	2	1	6	4	0
OG16	2	3	3	3	1	5	3	0
OG16	3	2	3	0	1	4	3	0
OG16	4	5	5	0	1	3	2	0
OG16	5	2	2	0	1	3	0	1
OG17	1	0	4	0	0	5	2	1

OG17	2	2	6	0	1	4	2	0
OG17	3	0	3	1	1	4	1	0
OG17	4	2	3	0	1	4	5	0
OG17	5	2	4	0	1	3	4	1
OG18	1	3	4	1	0	2	3	1
OG18	2	0	3	0	2	5	1	0
OG18	3	2	6	1	2	3	1	0
OG18	4	3	2	1	1	7	2	0
OG18	5	2	5	1	1	1	3	1
CO1	1	0	1	0	2	0	0	0
CO1	2	3	1	2	1	0	1	0
CO2	1	1	0	1	3	4	2	1
CO2	2	2	1	1	1	4	0	0
CO3	1	2	3	5	1	1	0	0
CO3	2	1	3	0	1	3	0	0
CO4	1	5	1	6	1	2	1	1
CO4	2	2	1	0	2	1	0	0
CO6	1	5	7	1	2	7	5	1
CO6	2	3	4	5	3	10	9	2
CO7	1	4	5	0	7	4	3	0
CO7	2	3	4	3	2	2	5	0
CO8	1	5	7	1	2	3	4	0
CO8	2	4	6	5	0	4	3	2
CO9	1	2	10	0	0	2	2	0
CO9	2	2	3	0	2	4	4	1
CO10	1	2	4	1	5	4	3	0
CO10	2	3	2	1	2	6	2	0
CO11	1	5	4	0	2	4	3	0
CO11	2	2	0	5	2	1	2	0
CO12	1	2	1	2	3	4	1	1
CO12	2	3	2	2	2	2	1	1
CO13	1	4	2	0	0	4	0	1
CO13	2	3	4	0	3	3	2	2

CO31	1	2	4	1	2	6	3	1
CO31	2	1	6	1	1	4	1	0
F4	1	2	2	6	0	0	0	0
F4	2	0	1	2	1	0	0	0
F4	3	1	7	5	1	0	0	0
F4	4	1	2	3	1	3	1	0
F4	5	0	3	3	1	0	0	0
F5	1	2	0	0	0	3	1	0
F5	2	2	2	0	0	5	1	0
F5	3	0	3	0	0	0	0	0
F5	4	1	2	0	1	5	2	0
F5	5	0	0	0	1	3	0	0
F6	1	1	0	1	0	1	3	0
F6	2	1	1	0	0	1	0	0
F6	3	1	0	0	1	0	0	1
F6	4	3	1	1	2	0	0	0
F6	5	0	4	0	1	0	2	0
F7	1	1	1	1	0	1	0	0
F7	2	1	0	1	4	5	0	0
F7	3	2	3	3	0	1	1	0
F7	4	0	3	2	1	1	0	1
F8	1	1	2	3	1	0	1	1
F8	2	2	2	3	2	0	1	1
F8	3	5	0	18	0	0	1	2
F8	4	4	1	12	1	0	2	4
F8	5	2	1	3	2	0	1	1
F9	1	2	0	1	0	1	4	1
F9	2	2	0	2	1	0	0	2
F9	3	4	1	6	1	0	1	1
F9	4	6	1	7	12	0	3	3
F10	1	1	1	6	2	4	0	0
F10	2	6	0	3	4	4	0	0
F10	3	1	2	1	3	1	0	0

F10	4	1	1	5	4	2	2	1
F11	1	1	1	2	2	5	1	2
F11	2	1	1	0	1	1	1	1
F11	3	1	3	2	3	3	0	0
F11	4	2	0	1	2	3	3	1
F11	5	2	1	2	3	3	2	0
F12	1	2	8	0	1	4	5	0
F12	2	0	7	0	1	5	2	0
F12	3	3	9	11	3	4	2	4
F12	4	3	3	1	0	3	3	0
F12	5	1	3	5	3	5	3	2
F13	1	2	7	8	3	4	1	0
F13	2	1	7	0	1	3	3	0
F13	3	3	2	1	3	8	3	3
F13	4	3	3	1	0	2	1	0
F13	5	2	9	0	4	1	1	1
F14	1	5	3	8	2	5	1	2
F14	2	2	12	6	2	2	2	0
F14	3	4	11	4	3	2	4	2
F14	4	5	10	1	1	4	4	1
F14	5	3	5	3	4	1	6	0
F15	1	4	0	1	1	8	4	0
F15	2	3	3	3	1	4	1	0
F15	3	2	3	5	1	2	0	0
F15	4	2	4	2	2	4	1	0
F15	5	2	3	0	0	6	0	0
F16	1	3	7	0	1	2	0	0
F16	2	2	2	4	2	8	3	1
F16	3	0	3	3	2	8	3	0
F17	1	3	0	6	2	8	2	0
F17	2	5	3	2	2	4	1	1
F17	3	5	1	8	3	7	1	0
F17	4	6	2	0	0	9	3	0
F17	5	3	2	9	2	6	2	0

F18	1	2	4	5	1	0	3	1
F18	2	1	7	0	0	4	3	0
F18	3	4	6	6	1	0	1	0
F18	4	3	3	1	3	1	3	0
F18	5	1	1	5	2	0	2	0
F19	1	2	2	1	1	0	2	0
F19	2	5	2	3	3	1	13	2
F20	1	3	1	1	2	3	4	0
F20	2	6	4	3	3	2	1	0
F20	3	4	4	1	8	5	0	0
F20	4	4	3	0	1	6	2	0
F20	5	1	5	3	1	2	1	0
F21	1	2	5	0	1	5	1	0
F21	2	5	4	0	3	2	1	0
F21	3	0	3	0	0	3	1	0
F21	4	2	2	0	0	4	2	1
F22	1	3	2	1	0	2	0	0
F22	2	3	2	2	3	3	0	0
F22	3	2	3	0	1	4	0	0
F22	4	5	1	0	1	4	0	0
F22	5	2	4	1	0	4	0	0
F23	1	1	3	1	2	2	0	0
F23	2	1	3	0	2	7	1	0
F23	3	4	3	2	1	1	1	0
F23	4	2	1	1	2	2	1	0
S23	1	11	0	22	0	0	0	6
S23	2	9	1	7	0	1	1	7
S24	1	5	0	2	0	3	0	0
S24	2	7	0	0	3	6	0	0
S25	1	1	0	1	0	0	0	0
S25	2	6	1	1	0	1	0	2
S26	1	3	2	6	1	3	2	1
S26	2	5	1	5	1	4	0	1

S27	1	13	1	5	1	2	1	7
S27	2	5	2	4	1	4	0	5
S28	1	5	0	7	0	1	0	1
S28	2	1	0	2	1	6	0	0
S29	1	3	1	4	0	1	0	2
S29	2	17	0	2	0	4	0	0
S30	1	4	0	6	0	2	0	1
S30	2	7	0	11	2	0	0	2
S31	1	8	0	9	0	6	2	3
S31	2	4	2	4	1	3	0	4
CC1	1	0	0	1	0	1	1	0
CC1	2	0	0	4	2	0	0	0
CC2	1	0	0	1	3	2	0	0
CC2	2	0	0	2	3	1	1	0
CC3	1	0	0	2	1	0	0	1
CC3	2	0	0	1	4	2	0	0
CC4	1	0	0	0	1	2	0	0
CC4	2	0	0	0	1	4	0	0
CC5	1	0	0	2	0	0	0	1
CC5	2	0	0	2	1	0	0	1
CC6	1	0	0	10	2	2	0	0
CC6	2	0	0	8	3	3	0	0
CC7	1	0	0	6	10	2	0	0
CC7	2	0	0	3	5	0	0	0
CC8	1	0	0	2	3	5	0	0
CC8	2	0	0	4	4	6	0	1
CC9	1	0	0	1	1	0	0	0
CC9	2	0	0	3	5	6	0	0
CC10	1	0	0	5	6	1	0	0
CC10	2	0	0	3	7	5	0	0
CC11	1	0	0	0	1	2	2	1
CC11	2	0	0	4	2	2	1	0
CC12	1	0	0	1	1	0	0	0

CC12	2	0	0	0	0	2	0	0	0
CC13	1	0	0	0	0	0	1	0	3
CC13	2	0	0	0	0	1	0	0	0
CC14	1	0	0	0	0	1	0	0	0
CC14	2	0	0	0	0	2	0	0	2
CC15	1	0	0	0	0	2	0	0	0
CC15	2	0	0	0	0	0	0	0	0
CC16	1	0	0	0	0	0	0	0	1
CC16	2	0	0	0	0	2	0	0	1
CC17	1	0	0	0	0	1	0	0	0
CC17	2	0	0	0	0	0	1	0	0
CC19	1	0	0	0	0	0	0	0	0
CC19	2	0	0	0	0	1	0	0	0
CC20	1	0	0	0	0	3	0	1	0
CC20	2	0	0	0	0	0	2	0	0
CC21	1	0	0	0	0	3	0	0	0
CC21	2	0	0	0	0	0	0	0	3

Site-id	Station	Stumps		Soil	Rock	Litter	Herbs	Grass	Fern	Moss	Shrub	Log/Stump
		20-40 cm dbh	>40 cm dbh									
OG4	1	1	1	0	0	11	2	0	0	2	0	7
OG4	2	0	2	0	2	18	0	0	0	2	0	0
OG4	3	0	0	0	0	16	0	0	0	3	2	1
OG4	4	0	2	0	1	6	7	0	0	6	0	2
OG4	5	1	1	0	1	18	0	0	0	2	0	1
OG5	1	1	0	5	0	4	0	0	0	0	10	3
OG5	2	0	0	0	0	6	0	0	0	0	2	14
OG5	3	2	3	0	0	11	0	0	1	0	7	4
OG5	4	1	1	2	0	7	0	0	0	2	5	8
OG5	5	0	2	2	0	6	0	0	0	5	4	8
OG6	1	2	2	0	0	3	2	0	0	1	3	11
OG6	2	1	4	0	0	5	5	0	0	9	4	0
OG6	3	2	0	0	0	3	1	0	0	12	3	4
OG6	4	1	0	0	0	8	5	0	0	1	4	5
OG6	5	1	0	0	0	2	5	0	0	6	7	2
OG7	1	2	1	0	0	13	0	0	0	5	0	4
OG7	2	2	5	0	0	10	3	0	0	7	0	2
OG7	3	2	5	0	4	0	6	0	0	7	2	5
OG7	4	2	3	0	0	4	0	0	0	4	0	11
OG7	5	0	3	0	0	2	0	0	0	9	6	4
OG8	1	2	1	0	0	1	0	0	0	15	1	5
OG8	2	2	3	0	3	8	0	0	0	13	0	0
OG8	3	0	2	0	0	5	1	0	0	17	0	2
OG8	4	0	3	0	0	3	5	0	1	18	3	0
OG8	5	0	2	0	0	10	1	0	1	9	1	1
OG9	1	0	2	0	0	5	0	0	0	11	7	1
OG9	2	0	1	1	0	13	3	0	0	2	1	1
OG9	3	0	2	1	0	10	2	0	0	3	3	5
OG9	4	0	0	0	1	8	0	0	0	4	5	3
OG9	5	0	1	1	0	5	9	2	0	0	2	3
OG10	1	0	1	2	4	5	0	1	0	2	5	1
OG10	2	0	0	0	4	9	1	0	0	6	5	1

OG10	3	0	0	1	0	4	11	0	1	4	5	2
OG10	4	1	1	0	1	5	0	0	0	10	2	3
OG10	5	0	1	0	1	10	1	0	0	0	3	8
OG11	1	0	0	0	0	13	1	0	0	5	2	2
OG11	2	0	0	0	1	16	3	0	0	0	0	4
OG11	3	0	0	0	0	16	0	0	0	4	3	2
OG11	4	0	1	0	3	11	0	0	0	0	3	8
OG11	5	0	2	0	0	12	6	0	0	2	2	3
OG12	1	1	1	0	0	4	2	0	0	7	1	2
OG12	2	0	1	0	0	5	0	0	0	17	3	1
OG12	3	0	1	0	0	3	0	0	0	7	12	4
OG12	4	2	1	0	0	9	0	0	2	5	0	10
OG12	5	1	0	0	1	6	0	0	3	8	0	8
OG13	1	0	1	0	0	6	0	0	0	12	1	9
OG13	2	0	3	0	0	11	0	0	0	10	0	3
OG13	3	0	3	0	0	10	0	0	3	6	1	8
OG13	4	0	1	0	0	10	1	0	0	4	1	9
OG13	5	0	3	1	4	13	0	0	0	5	2	1
OG14	1	0	1	0	0	16	0	0	0	2	0	4
OG14	2	0	0	1	2	10	1	0	0	1	2	6
OG14	3	0	2	0	1	11	0	0	0	5	1	6
OG14	4	1	0	0	1	20	0	0	0	0	0	1
OG14	5	0	2	0	0	14	1	0	0	6	0	1
OG15	1	1	3	0	0	5	1	0	1	15	0	4
OG15	2	0	2	0	0	7	7	0	0	13	0	4
OG15	3	0	0	0	1	7	0	0	1	15	0	1
OG15	4	0	2	0	0	11	3	0	7	8	0	4
OG15	5	2	5	0	0	7	4	0	0	12	1	6
OG16	1	0	2	1	0	16	3	0	0	5	0	4
OG16	2	0	1	0	0	14	0	0	0	6	1	5
OG16	3	0	1	0	0	18	2	0	0	5	2	2
OG16	4	0	1	1	0	15	1	0	1	7	1	3
OG16	5	0	3	1	4	19	5	0	0	2	0	1
OG17	1	0	0	0	0	14	0	0	0	6	7	5

OG17	2	0	0	0	0	14	0	0	0	9	1	2
OG17	3	0	2	0	0	17	0	0	1	9	1	7
OG17	4	1	0	0	0	9	2	0	0	6	1	6
OG17	5	1	1	0	0	9	2	0	7	5	5	6
OG18	1	0	0	0	0	3	0	0	0	19	1	3
OG18	2	0	3	0	1	5	12	0	7	4	1	2
OG18	3	0	3	0	0	20	0	0	0	1	0	2
OG18	4	0	0	0	1	17	0	0	0	5	0	4
OG18	5	1	2	0	0	8	0	0	0	12	3	6
CO1	1	0	2	6	0	6	2	0	1	2	0	3
CO1	2	1	2	3	0	6	8	0	2	1	2	1
CO2	1	1	3	0	0	7	0	0	7	2	3	4
CO2	2	0	0	4	0	6	14	0	1	1	5	1
CO3	1	1	1	0	0	7	5	0	0	7	0	0
CO3	2	0	0	0	0	14	1	0	3	1	0	2
CO4	1	4	3	1	0	1	3	0	0	11	7	1
CO4	2	1	1	4	1	2	6	0	1	3	0	3
CO6	1	1	3	0	0	11	1	0	0	10	0	3
CO6	2	1	0	0	0	10	0	0	0	6	0	10
CO7	1	2	2	2	1	12	0	0	1	3	0	4
CO7	2	1	1	0	1	4	4	0	7	4	1	1
CO8	1	0	2	0	0	12	3	0	0	7	1	2
CO8	2	2	3	0	0	14	7	0	1	4	0	1
CO9	1	0	2	1	0	10	3	0	4	3	0	2
CO9	2	0	3	0	0	13	3	0	1	8	0	2
CO10	1	0	4	0	0	8	5	0	2	5	2	1
CO10	2	0	3	1	0	7	0	0	3	6	1	7
CO11	1	1	3	0	0	11	3	0	1	6	2	4
CO11	2	0	1	0	0	1	9	0	1	5	2	5
CO12	1	0	4	0	0	10	0	0	0	9	0	11
CO12	2	0	0	0	0	18	0	0	0	4	0	2
CO13	1	0	0	0	0	1	4	0	0	7	11	4
CO13	2	0	1	0	0	1	8	0	1	13	0	2

CO31	1	2	1	1	1	0	1	0	1	6	13	0	3	12	1	1	8
CO31	1	2	3	4	5	1	2	3	4	5	1	2	3	8	0	3	3
F4	1	2	1	0	1	1	1	1	1	1	0	0	0	0	0	0	3
F4	2	3	0	1	0	1	2	0	2	11	0	0	0	0	0	0	0
F4	3	4	0	1	0	0	1	0	4	4	0	0	1	0	6	6	1
F4	4	5	1	4	0	0	2	0	10	10	0	0	0	4	7	6	0
F5	5	1	1	3	1	0	1	0	16	16	0	0	0	5	1	4	4
F5	2	2	0	0	1	3	1	0	8	8	0	0	0	2	2	1	1
F5	3	3	5	0	5	0	5	0	10	10	0	0	0	1	2	0	0
F5	4	4	3	0	3	2	3	0	9	9	0	0	0	6	8	2	0
F5	5	5	0	0	1	1	0	0	10	10	0	0	0	5	1	0	2
F6	1	1	1	1	1	0	1	0	4	4	0	0	0	0	0	2	1
F6	2	2	1	1	1	0	1	0	8	8	0	0	0	0	10	10	2
F6	3	3	4	5	0	0	5	0	8	8	0	0	0	0	4	7	0
F6	4	4	1	0	0	1	0	0	5	5	0	0	0	0	4	7	0
F6	5	5	0	0	0	0	0	0	3	3	0	0	0	0	12	0	0
F7	1	1	0	1	0	0	0	0	16	16	0	0	0	0	0	1	0
F7	2	2	1	1	1	0	1	0	11	11	0	0	0	0	2	2	0
F7	3	3	0	0	0	0	0	0	1	1	0	0	0	0	9	1	0
F7	4	4	0	0	0	0	0	0	12	12	0	0	1	0	0	1	2
F8	1	1	6	0	0	0	0	0	3	3	0	0	0	0	0	2	2
F8	2	2	0	2	2	0	0	0	15	15	0	0	0	0	2	2	2
F8	3	3	2	3	0	0	0	0	2	2	0	0	0	0	0	0	0
F8	4	4	3	0	1	1	1	1	9	9	0	0	0	4	4	2	2
F8	5	5	1	3	3	0	3	3	12	12	0	0	0	4	4	0	0
F9	1	1	2	0	0	0	0	0	10	10	0	0	1	1	0	1	1
F9	2	2	5	2	5	0	2	2	2	2	0	0	6	0	0	0	0
F9	3	3	2	3	2	7	3	3	3	3	0	0	0	1	3	0	7
F9	4	4	6	0	6	1	1	1	1	1	7	6	0	2	1	1	2
F10	1	1	4	2	4	1	4	4	7	7	0	0	0	1	0	0	1
F10	2	2	2	0	2	0	2	2	11	11	0	0	0	5	4	2	2
F10	3	3	1	1	1	0	1	1	7	7	0	0	0	8	0	0	2

F10	4	1	3	1	0	11	1	0	0	4	0	6
F11	1	1	2	1	0	0	0	0	4	5	9	3
F11	2	0	0	1	0	3	2	0	3	6	8	0
F11	3	1	1	0	0	3	0	0	1	8	2	7
F11	4	2	1	1	0	10	0	0	0	5	3	4
F11	5	1	2	0	0	0	3	0	0	4	7	6
F12	1	1	0	0	0	7	0	2	0	2	5	5
F12	2	0	3	0	0	8	0	5	0	2	6	1
F12	3	1	2	0	0	8	5	0	2	0	3	4
F12	4	0	2	0	0	13	1	0	0	2	1	5
F12	5	0	2	0	0	11	1	0	0	3	1	3
F13	1	2	1	0	0	12	0	0	0	4	2	3
F13	2	0	2	0	0	11	1	0	1	1	8	1
F13	3	1	3	0	3	5	4	0	4	0	0	5
F13	4	1	1	0	1	7	3	0	3	2	2	4
F13	5	0	1	0	0	8	1	0	1	0	9	4
F14	1	1	2	0	2	11	2	0	0	2	1	4
F14	2	0	1	1	0	14	1	0	0	4	0	3
F14	3	3	2	0	0	8	4	1	0	8	0	0
F14	4	0	3	0	0	19	0	0	0	0	0	3
F14	5	2	1	0	0	16	0	0	0	1	0	4
F15	1	0	3	0	0	6	0	0	2	5	0	8
F15	2	0	2	0	0	12	0	0	2	4	2	2
F15	3	0	1	0	0	10	1	0	1	8	0	4
F15	4	0	1	1	0	16	1	0	1	0	2	3
F15	5	0	3	0	0	10	1	0	0	7	0	4
F16	1	1	4	0	13	8	0	0	0	1	4	1
F16	2	1	1	0	4	2	4	0	0	5	4	4
F16	3	0	1	0	0	12	0	0	0	0	4	6
F17	1	1	1	0	0	14	0	0	0	1	0	6
F17	2	0	2	1	0	14	1	1	1	1	0	3
F17	3	0	2	0	15	1	0	0	0	0	0	4
F17	4	0	3	0	0	12	4	0	0	3	0	3
F17	5	0	2	0	1	14	0	0	0	1	0	6

F18	1	1	1	0	0	8	2	0	0	11	2	0
F18	2	0	2	0	0	5	0	0	0	13	1	3
F18	3	1	0	0	0	12	2	0	0	4	5	0
F18	4	0	2	1	0	3	1	0	0	9	10	2
F18	5	0	0	0	0	2	1	1	1	13	6	3
F19	1	0	0	2	3	1	1	0	0	6	9	4
F19	2	2	0	0	0	8	0	1	0	0	10	3
F20	1	2	6	1	0	13	2	0	0	3	8	4
F20	2	1	1	0	0	17	3	0	0	6	1	11
F20	3	0	1	0	0	9	0	0	1	5	2	10
F20	4	1	2	1	0	11	4	0	0	6	4	6
F20	5	1	1	0	0	16	0	0	0	7	1	3
F21	1	0	2	0	0	15	0	0	5	0	0	2
F21	2	1	2	1	0	11	2	0	6	0	3	1
F21	3	0	2	0	0	13	0	0	1	6	0	2
F21	4	1	0	0	0	13	1	0	2	4	0	3
F22	1	1	2	0	0	13	1	0	0	9	3	6
F22	2	0	2	0	0	7	0	0	0	14	2	5
F22	3	0	1	0	0	8	1	0	3	0	0	8
F22	4	1	1	0	1	6	1	0	0	12	3	5
F22	5	0	1	0	0	7	4	0	2	9	5	4
F23	1	0	1	0	0	14	0	0	0	11	0	3
F23	2	1	3	0	5	3	0	0	1	4	1	11
F23	3	0	0	0	2	15	1	0	7	5	0	2
F23	4	0	1	0	0	14	0	0	2	4	1	6
S23	1	2	3	1	0	5	3	0	1	15	1	2
S23	2	0	3	0	0	16	0	0	0	12	1	7
S24	1	0	2	0	0	15	2	0	1	5	0	4
S24	2	0	2	0	0	14	3	0	1	3	0	7
S25	1	2	2	0	0	5	0	0	0	14	14	6
S25	2	0	0	1	1	14	0	0	3	6	7	3
S26	1	1	1	0	1	6	7	0	2	12	0	1
S26	2	0	1	0	2	12	1	0	6	9	0	3

S27	1	1	1	0	0	8	15	0	1	15	0	1
S27	2	0	3	0	0	11	0	0	1	14	0	0
S28	1	0	2	0	0	15	0	0	0	8	0	1
S28	2	1	4	1	0	16	0	0	0	5	0	5
S29	1	0	1	0	0	13	1	0	0	11	0	1
S29	2	0	2	1	0	13	3	0	0	9	0	1
S30	1	0	2	0	0	15	0	0	0	0	0	5
S30	2	0	1	3	0	21	1	0	0	5	0	0
S31	1	0	1	0	0	20	0	0	0	0	0	2
S31	2	0	3	0	0	16	0	0	0	2	0	6
CC1	1	1	1	3	0	0	3	0	0	0	9	4
CC1	2	1	1	0	0	1	11	0	0	0	7	3
CC2	1	3	0	3	0	3	11	0	0	0	1	4
CC2	2	1	1	0	0	8	2	0	0	0	1	0
CC3	1	1	1	0	5	9	6	0	0	0	0	1
CC3	2	0	1	3	0	0	4	0	6	0	3	5
CC4	1	0	0	0	8	3	6	0	0	0	0	4
CC4	2	0	0	0	8	6	3	0	0	0	0	5
CC5	1	4	1	1	17	3	4	0	0	0	5	1
CC5	2	1	3	1	9	2	3	0	0	0	5	1
CC6	1	4	4	3	2	0	8	0	1	0	2	7
CC6	2	3	4	7	2	1	10	0	0	0	0	6
CC7	1	5	3	6	3	2	2	5	0	0	0	5
CC7	2	2	1	4	4	2	1	10	0	0	0	3
CC8	1	1	4	0	0	13	0	0	0	0	7	4
CC8	2	0	1	1	0	5	10	0	1	0	3	4
CC9	1	1	3	0	0	6	5	11	0	0	1	1
CC9	2	0	3	0	0	16	3	0	2	0	0	2
CC10	1	0	5	4	4	2	8	0	1	0	1	3
CC10	2	1	3	1	1	1	11	0	0	0	0	7
CC11	1	0	2	3	1	4	8	0	1	0	3	4
CC11	2	3	2	3	0	7	6	0	0	0	3	2
CC12	1	0	2	0	4	4	1	7	0	0	7	2

CC12	2	1	2	9	4	4	0	4	0	0	1	0
CC13	1	1	8	2	8	3	6	3	0	0	1	0
CC13	2	1	3	9	8	0	1	2	0	0	0	1
CC14	1	1	5	1	11	0	6	0	3	0	2	0
CC14	2	2	0	8	2	5	3	0	0	0	3	1
CC15	1	0	7	1	3	4	0	6	0	0	2	5
CC15	2	1	5	2	0	6	0	6	0	0	7	1
CC16	1	0	4	0	0	2	3	6	1	0	3	7
CC16	2	0	4	6	1	5	0	6	0	0	0	4
CC17	1	1	2	10	4	2	1	2	1	0	1	1
CC17	2	0	3	0	2	2	7	1	1	0	5	4
CC19	1	1	0	1	0	0	11	2	4	0	0	1
CC19	2	2	5	3	1	1	6	3	0	0	3	5
CC20	1	0	2	4	0	3	9	0	0	0	0	6
CC20	2	1	1	1	1	6	11	0	0	0	1	2
CC21	1	1	2	6	1	3	8	1	2	0	3	0
CC21	2	1	2	6	0	4	3	0	0	0	2	9

Appendix 2. Results of trapping, infra-red triggered cameras and sign surveys conducted at each site during field studies in the Hood Canal District of the Olympic National Forest during the summers of 1994 to 1997. Values reported for species are the proportion of stations within this site where this species was detected.

Macrohabitat Category	Site-id	Number of Stations	Forest Species (in bold, n = 8)							
			CLGA	GLSA	NEGI	PEOR	SOBE	SOMO	SOTR	TADO
Old-growth Mainland (n = 15)	OG4	5	0.60	0.00	0.00	1.00	0.20	0.20	0.40	0.40
	OG5	5	0.20	0.00	0.00	1.00	0.00	0.80	0.40	0.40
	OG6	5	1.00	0.00	0.00	1.00	0.00	0.20	0.00	0.20
	OG7	5	0.80	0.00	0.00	1.00	0.00	0.00	0.20	0.00
	OG8	5	0.80	0.20	0.00	1.00	0.00	0.40	0.40	0.20
	OG9	5	0.20	0.00	0.00	1.00	0.00	0.60	0.00	0.00
	OG10	5	0.60	0.00	0.20	0.80	0.00	0.20	0.00	0.20
	OG11	5	0.40	0.20	0.00	1.00	0.00	0.40	0.60	0.00
	OG12	5	1.00	0.80	0.00	1.00	0.00	0.80	0.40	0.80
	OG13	5	1.00	0.00	0.00	0.80	0.00	0.00	0.00	1.00
	OG14	5	1.00	0.20	0.00	1.00	0.00	0.40	0.60	0.20
	OG15	5	0.00	0.00	0.20	1.00	0.00	1.00	1.00	0.60
	OG16	5	0.60	0.20	0.20	1.00	0.00	1.00	0.40	0.20
	OG17	5	0.80	0.00	0.00	1.00	0.00	0.20	0.00	0.60
	OG18	5	0.40	0.00	0.00	0.60	0.00	0.00	0.40	0.40
Old-growth Corridor (n = 30)	CO1	2	0.00	0.00	0.00	1.00	0.50	0.50	0.00	0.00
	CO2	2	0.50	0.50	0.00	1.00	0.00	0.50	0.00	0.00
	CO3	2	1.00	0.00	0.00	1.00	0.00	0.50	0.00	0.00
	CO4	2	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
	CO6	2	1.00	0.00	0.00	1.00	0.00	0.50	0.00	0.00
	CO7	2	0.50	0.50	0.00	1.00	0.00	0.00	0.00	0.50
	CO8	2	1.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00
	CO9	2	1.00	0.50	0.00	0.00	0.00	0.50	0.00	0.00
	CO10	2	0.50	0.00	0.00	1.00	0.00	1.00	0.00	0.00
	CO11	2	0.00	0.00	0.00	1.00	0.00	0.50	0.00	0.50
	CO12	2	0.00	0.00	0.00	1.00	0.00	0.50	1.00	1.00

CO13	2	1.00	0.00	0.00	1.00	0.00	0.00	0.50	0.50
CO14	2	0.00	0.00	0.00	1.00	0.50	0.00	0.50	0.50
CO15	2	0.50	0.00	0.00	1.00	0.00	0.00	0.00	0.00
CO16	2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
CO17	2	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
CO18	2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
CO19	2	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.50
CO20	2	0.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00
CO21	2	0.00	0.00	0.00	1.00	0.00	0.50	1.00	0.50
CO22	2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
CO23	2	1.00	1.00	0.00	1.00	0.00	0.00	0.00	1.00
CO24	2	1.00	1.00	0.00	1.00	0.00	0.00	0.50	1.00
CO25	2	1.00	0.00	0.00	1.00	0.00	0.00	0.50	0.00
CO26	2	0.00	1.00	0.00	1.00	0.00	0.00	0.50	1.00
CO27	2	0.50	0.00	0.50	1.00	0.00	0.00	0.00	1.00
CO28	2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.50
CO29	2	0.00	1.00	0.00	1.00	0.00	0.50	0.00	1.00
CO30	2	0.50	0.00	0.00	0.50	0.00	0.50	0.00	0.00
CO31	2	0.00	0.00	0.00	1.00	0.00	0.50	0.00	0.00
Old-growth Fragment (n = 20)									
F4	5	0.80	0.00	0.20	1.00	0.00	0.80	0.80	0.00
F5	5	0.80	0.00	0.20	1.00	0.00	0.40	0.40	0.20
F6	5	1.00	0.00	0.20	1.00	0.00	0.80	0.80	0.00
F7	4	1.00	0.50	0.25	1.00	0.25	0.75	1.00	0.25
F8	5	0.60	0.20	0.00	0.20	0.00	0.20	0.20	0.60
F9	4	1.00	0.00	0.00	0.25	0.00	0.25	0.25	0.25
F10	4	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
F11	5	0.40	0.00	0.00	1.00	0.00	0.00	0.00	0.20
F12	5	0.00	0.00	0.00	0.40	0.00	0.80	0.40	0.00
F13	5	1.00	0.40	0.00	0.20	0.00	0.80	0.60	0.00
F14	5	0.80	0.00	0.00	0.20	0.00	0.20	0.00	0.20
F15	5	0.80	0.00	0.00	0.40	0.00	0.80	0.00	0.00
F16	3	1.00	0.00	0.00	0.67	0.00	0.33	0.00	0.00

	F17	5	0.60	0.00	0.00	0.80	0.00	0.40	0.00	0.00
	F18	5	0.80	0.00	0.00	1.00	0.00	0.60	0.00	0.20
	F19	2	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.50
	F20	5	1.00	0.00	0.00	1.00	0.00	0.20	0.60	0.60
	F21	4	1.00	0.00	0.00	1.00	0.00	0.00	0.25	0.00
	F22	5	0.00	0.00	0.20	1.00	0.00	0.40	0.20	0.20
	F23	4	1.00	0.00	0.00	1.00	0.00	0.50	0.50	0.50
Successional Forest (n = 9)	S1	2	0.50	0.00	0.00	1.00	0.00	0.00	0.00	0.00
	S2	2	0.00	0.00	0.00	1.00	0.00	0.00	0.50	0.00
	S3	2	0.50	0.00	0.00	1.00	0.00	0.50	0.50	0.50
	S4	2	0.00	0.00	0.50	1.00	0.00	0.00	0.50	0.50
	S5	2	0.00	0.50	0.00	1.00	0.00	0.00	1.00	0.00
	S6	2	0.50	0.00	0.00	1.00	0.00	0.00	0.00	1.00
	S7	2	0.00	0.00	0.00	1.00	0.00	0.50	0.50	0.50
	S8	2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
	S9	2	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
Clearcut (n = 19)	CC1	2	1.00	0.00	0.00	1.00	0.00	0.50	0.50	0.50
	CC2	2	0.00	0.00	0.00	1.00	0.00	0.50	0.00	0.00
	CC3	2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
	CC4	2	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.00
	CC6	2	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
	CC7	2	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
	CC8	2	0.50	0.00	0.00	0.00	0.00	0.50	0.00	0.00
	CC9	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CC10	2	0.00	0.00	0.00	1.00	0.00	0.00	0.50	0.00
	CC11	2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
	CC12	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CC13	2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
	CC14	2	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
	CC15	2	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
	CC16	2	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00

CC17	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC19	2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
CC20	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC21	2	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00

Non-forest species (n=16)												
Site-id	APRU	CALA	CEEL	EUTO	LEAM	LYRU	MILO	MUER	MUFR	NECI	ODHE	
OG1	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OG2	0.20	0.00	0.00	1.00	0.20	0.00	0.00	0.00	0.00	0.20	0.00	
OG3	0.00	0.00	0.00	0.20	0.20	0.00	0.00	0.40	0.00	1.00	0.00	
OG4	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OG5	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	
OG6	0.40	0.20	0.20	0.40	0.40	0.00	0.00	0.00	0.00	0.00	0.00	
OG7	0.60	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OG8	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OG9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	
OG10	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OG11	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OG12	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OG13	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OG14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OG15	0.20	0.00	0.00	0.60	0.00	0.00	0.20	0.00	0.00	0.00	0.00	
CO1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	
CO3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CO4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	
CO6	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CO7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	
CO8	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CO9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CO10	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CO11	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CO12	1.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CO13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	
CO14	1.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CO15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	
CO16	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Site-id	PEMA	SOVA	SPPU	URAM	ZATR
OG4	1.00	0.20	0.00	0.00	0.00
OG5	0.20	0.20	0.00	0.00	0.20
OG6	0.00	0.00	0.00	0.00	0.00
OG7	0.00	0.00	0.00	0.20	0.00
OG8	0.00	0.00	0.20	0.00	0.00
OG9	0.20	0.00	0.00	0.60	0.00
OG10	0.00	0.00	0.00	0.20	0.20
OG11	0.00	0.00	0.00	0.60	0.00
OG12	0.40	0.00	0.20	0.00	0.00
OG13	0.00	0.00	0.00	0.20	0.00
OG14	0.00	0.00	0.00	0.00	0.00
OG15	0.20	0.00	0.20	0.00	0.00
OG16	0.00	0.20	0.60	0.00	0.00
OG17	0.00	0.00	0.00	0.00	0.00
OG18	0.00	0.00	0.80	0.00	0.00
CO1	0.00	0.00	0.50	0.50	0.00
CO2	0.00	0.00	1.00	0.50	0.00
CO3	0.50	0.00	0.00	0.00	0.00
CO4	0.50	0.00	0.00	0.00	0.00
CO6	0.00	0.00	0.00	0.00	0.00
CO7	0.00	0.00	0.50	0.00	0.00
CO8	0.00	0.00	0.00	0.00	0.00
CO9	0.00	0.00	0.00	0.00	0.00
CO10	0.00	0.00	0.00	0.50	0.00
CO11	0.00	0.00	1.00	0.00	0.00
CO12	0.00	0.00	0.00	0.50	0.00
CO13	0.00	0.00	0.00	0.50	0.00
CO14	0.50	0.00	0.00	0.50	0.00
CO15	0.00	0.00	0.50	0.00	0.00
CO16	0.50	0.00	0.00	1.00	0.00

CO17	0.00	0.00	0.00	0.00	0.00
CO18	0.00	0.00	0.00	0.00	0.00
CO19	0.00	0.50	0.00	0.50	0.00
CO20	0.00	0.00	0.00	0.00	0.00
CO21	0.50	0.00	0.00	0.00	0.00
CO22	0.00	0.00	0.00	0.00	0.00
CO23	0.00	0.00	0.50	0.00	0.00
CO24	0.00	0.00	1.00	0.00	0.00
CO25	0.00	0.00	1.00	0.00	0.00
CO26	0.00	0.00	0.00	0.00	0.00
CO27	0.00	0.00	0.00	0.00	0.00
CO28	0.00	0.00	0.00	0.00	0.50
CO29	0.00	0.00	0.00	0.00	0.50
CO30	0.00	0.50	0.50	0.00	0.00
CO31	0.00	0.00	0.00	0.00	0.00
F4	0.40	0.00	0.40	0.00	0.00
F5	0.20	0.20	0.00	0.20	0.00
F6	0.60	0.20	0.40	0.00	0.00
F7	0.50	0.00	0.00	0.00	0.00
F8	0.20	0.00	0.00	0.60	0.00
F9	0.00	0.00	0.00	0.00	0.00
F10	0.50	0.00	0.50	0.00	0.00
F11	0.40	0.00	0.40	0.00	0.00
F12	0.00	0.00	0.00	0.20	0.00
F13	0.00	0.00	0.40	0.00	0.00
F14	0.00	0.00	0.00	0.00	0.00
F15	0.00	0.00	0.00	0.00	0.00
F16	0.00	0.00	0.00	0.00	0.00
F17	0.00	0.00	0.00	0.00	0.00
F18	0.00	0.00	0.00	0.00	0.00
F19	1.00	0.00	0.00	0.00	0.00
F20	0.20	0.00	0.00	0.20	0.00

F21	0.50	0.00	0.75	0.00	0.00
F22	0.20	0.40	0.00	0.60	0.00
F23	0.25	0.00	0.00	0.25	0.00
S1	0.00	0.00	0.00	0.00	0.00
S2	0.00	0.00	1.00	0.00	0.00
S3	0.00	0.00	1.00	0.00	0.00
S4	0.00	0.00	1.00	0.00	0.00
S5	0.00	0.00	0.00	0.50	0.00
S6	0.00	0.00	0.50	0.00	0.00
S7	0.00	0.00	0.00	0.00	0.00
S8	0.00	0.00	0.00	0.00	0.00
S9	0.00	0.00	0.00	0.00	0.00
CC1	0.50	0.00	1.00	0.00	0.00
CC2	1.00	0.00	0.00	0.00	0.50
CC3	1.00	0.00	0.00	0.00	0.00
CC4	1.00	0.00	0.00	0.00	0.00
CC6	0.00	0.00	0.00	0.50	0.50
CC7	1.00	0.00	0.00	0.50	0.00
CC8	0.50	0.00	0.00	0.00	0.00
CC9	0.50	0.00	0.00	0.00	0.00
CC10	1.00	0.00	0.00	0.00	0.00
CC11	1.00	0.00	0.00	0.00	0.00
CC12	1.00	0.00	0.00	0.00	0.00
CC13	1.00	0.00	0.00	0.00	0.00
CC14	1.00	0.00	0.00	0.00	0.00
CC15	1.00	0.00	0.00	0.00	0.00
CC16	1.00	0.00	0.00	0.00	0.00
CC17	1.00	0.00	0.00	0.00	0.00
CC19	1.00	0.50	0.00	0.00	0.00
CC20	1.00	0.00	0.50	0.00	0.00
CC21	1.00	0.00	0.00	0.00	0.00

Species codes (methods of detection; T = live trapping, C = infrared triggered camera, and S = survey for animal signs):

CLGA = Clethrionomys gapperi (TC)
GLSA = Glaucomys sabrinus (TC)
NEGI = Neurotrichus gibbsii (T)
PEOR = Peromyscus oreas (TC)
SOBE = Sorex bendirii (T)
SOMO = Sorex monticolus (T)
SOTR = Sorex trowbridgii (T)
TADO = Tamiasciurus douglasii (TCS)

APRU = Aplodontia rufa (CS)
LYRU = Lynx rufus (CS)
MILO = Microtus longicaudus (T)
SOVA = Sorex vagrans (T)
CALA = Canis latrans (CS)
CEEL = Cervus elaphus (CS)
EUTO = Tamias (Eutamias) townsendii (TC)
LEAM = Lepus americanus (CS)
MUER = Mustela erminea (TC)
MUFR = Mustela frenata (TC)
NECI = Neotoma cinerea
ODHE = Odocoileus hemionus (CS)
PEMA = Peromyscus maniculatus (TC)
SPPU = Spilogale putorius (TC)
URAM = Ursus americanus (CS)
ZATR = Zapus trinotatus (T)

Appendix 3. Results of live-trapping at each site in the Hood Canal District of the Olympic National Forest during the summers of 1994 to 1997. Functional trapnights (FT) for each species are based on appropriate trap types, corrected for trap malfunctions and closures. Relative densities (RD) are equal to the number of unique individuals caught at a site divided by functional trapnight.

Macrohabitat Category	Site-id	Number of Stations		Trapped Forest Species (in bold, n = 8)							
				CLGA	GLSA	NEGI	PEOR	SOBE	SOMO	SOTR	TADO
Old-growth	OG4	5	FT	110.5	147.0	175.0	110.5	175.0	175.0	175.0	69.0
			RD	0.027	0.000	0.000	0.425	0.006	0.023	0.017	0.000
Mainland (n = 15)	OG5	5	FT	118.5	73.0	175.0	118.5	175.0	175.0	175.0	73.0
			RD	0.008	0.000	0.000	0.194	0.000	0.086	0.017	0.000
	OG6	5	FT	129.0	129.0	175.0	129.0	175.0	175.0	175.0	80.0
			RD	0.140	0.000	0.000	0.178	0.000	0.006	0.000	0.000
	OG7	5	FT	132.0	100.5	175.0	132.0	175.0	175.0	175.0	100.5
			RD	0.091	0.000	0.000	0.098	0.000	0.000	0.011	0.000
	OG8	5	FT	117.0	75.0	175.0	117.0	175.0	175.0	175.0	89.5
			RD	0.094	0.000	0.000	0.197	0.000	0.017	0.006	0.000
	OG9	5	FT	126.0	89.0	175.0	126.0	175.0	175.0	175.0	99.5
			RD	0.008	0.000	0.000	0.135	0.000	0.017	0.000	0.000
	OG10	5	FT	130.5	102.5	175.0	130.5	175.0	175.0	175.0	102.5
			RD	0.038	0.000	0.006	0.138	0.000	0.000	0.000	0.000
	OG11	5	FT	122.0	91.0	173.5	122.0	173.5	173.5	173.5	91.0
			RD	0.016	0.000	0.000	0.336	0.000	0.023	0.040	0.000
	OG12	5	FT	104.0	132.5	173.0	104.0	173.0	173.0	173.0	77.5
			RD	0.250	0.023	0.000	0.577	0.000	0.035	0.012	0.013
	OG13	5	FT	93.5	80.0	174.0	93.5	174.0	174.0	174.0	80.0
			RD	0.289	0.000	0.000	0.096	0.000	0.000	0.000	0.000
	OG14	5	FT	98.0	83.5	164.0	98.0	164.0	164.0	164.0	83.5
			RD	0.204	0.000	0.000	0.112	0.000	0.024	0.049	0.000
	OG15	5	FT	106.0	86.0	175.0	106.0	175.0	175.0	175.0	86.0
			RD	0.000	0.000	0.006	0.160	0.000	0.097	0.057	0.000
	OG16	5	FT	108.5	88.0	175.0	108.5	175.0	175.0	175.0	88.0
			RD	0.046	0.000	0.006	0.120	0.000	0.046	0.029	0.000
	OG17	5	FT	111.0	93.0	171.5	111.0	171.5	171.5	171.5	93.0
			RD	0.072	0.000	0.000	0.162	0.000	0.017	0.000	0.000

	OG18	5	FT	117.5	94.0	175.0	117.5	175.0	175.0	175.0	94.0
			RD	0.026	0.000	0.000	0.026	0.000	0.000	0.011	0.000
Old-growth Corridor (n = 30)	CO1	2	FT	52.5	33	70	52.5	70	70	70	33
			RD	0.000	0.000	0.000	0.286	0.014	0.014	0.000	0.000
	CO2	2	FT	52.0	35.5	70.0	52.0	70.0	70.0	70.0	35.5
			RD	0.019	0.028	0.000	0.212	0.000	0.014	0.000	0.000
	CO3	2	FT	50.0	30.0	70.0	50.0	70.0	70.0	70.0	30.0
			RD	0.100	0.000	0.000	0.240	0.000	0.014	0.000	0.000
	CO4	2	FT	47.5	35.0	70.0	47.5	70.0	70.0	70.0	35.0
			RD	0.126	0.000	0.000	0.211	0.000	0.000	0.043	0.000
	CO6	2	FT	47.5	37.0	70.0	47.5	70.0	70.0	70.0	37.0
			RD	0.063	0.000	0.000	0.295	0.000	0.029	0.000	0.000
	CO7	2	FT	46.5	32.5	70.0	46.5	70.0	70.0	70.0	32.5
			RD	0.022	0.000	0.000	0.258	0.000	0.000	0.000	0.000
	CO8	2	FT	52.0	39.5	70.0	52.0	70.0	70.0	70.0	39.5
			RD	0.154	0.000	0.000	0.154	0.000	0.029	0.000	0.000
	CO9	2	FT	52.5	38.0	70.0	52.5	70.0	70.0	70.0	38.0
			RD	0.190	0.000	0.000	0.000	0.000	0.014	0.000	0.000
	CO10	2	FT	51.5	39.5	70.0	51.5	70.0	70.0	70.0	39.5
			RD	0.019	0.000	0.000	0.214	0.000	0.014	0.000	0.000
	CO11	2	FT	47.0	33.0	70.0	47.0	70.0	70.0	70.0	33.0
			RD	0.000	0.000	0.000	0.191	0.000	0.014	0.000	0.000
	CO12	2	FT	43.5	32.0	70.0	43.5	70.0	70.0	70.0	32.0
			RD	0.000	0.000	0.000	0.736	0.000	0.029	0.071	0.000
	CO13	2	FT	47.5	34.0	70.0	47.5	70.0	70.0	70.0	34.0
			RD	0.211	0.000	0.000	0.337	0.000	0.000	0.014	0.000
	CO14	2	FT	47.5	34.0	69.0	47.5	69.0	69.0	69.0	34.0
			RD	0.000	0.000	0.000	0.063	0.014	0.000	0.029	0.029
	CO15	2	FT	53.5	37.0	69.5	53.5	69.5	69.5	69.5	37.0
			RD	0.000	0.000	0.000	0.150	0.000	0.000	0.000	0.000
	CO16	2	FT	43.0	31.0	70.0	43.0	70.0	70.0	70.0	31.0
			RD	0.000	0.000	0.000	0.372	0.000	0.000	0.000	0.000
	CO17	2	FT	44.0	32.5	70.0	44.0	70.0	70.0	70.0	32.5

			RD	0.000	0.000	0.000	0.545	0.000	0.000	0.086	0.000
	CO18	2	FT	48.5	35.5	70.0	48.5	70.0	70.0	70.0	35.5
			RD	0.000	0.000	0.000	0.371	0.000	0.000	0.000	0.000
	CO19	2	FT	39.0	32.0	68.0	39.0	68.0	68.0	68.0	32.0
			RD	0.000	0.000	0.000	0.436	0.000	0.132	0.000	0.000
	CO20	2	FT	46.0	29.5	70.0	46.0	70.0	70.0	70.0	29.5
			RD	0.000	0.000	0.000	0.370	0.000	0.057	0.057	0.000
	CO21	2	FT	35.5	26.0	70.0	35.5	70.0	70.0	70.0	26.0
			RD	0.000	0.000	0.000	0.282	0.000	0.014	0.114	0.000
	CO22	2	FT	46.0	32.0	70.0	46.0	70.0	70.0	70.0	32.0
			RD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	CO23	2	FT	35.0	28.5	70.0	35.0	70.0	70.0	70.0	28.5
			RD	0.057	0.035	0.000	0.171	0.000	0.000	0.000	0.000
	CO24	2	FT	39.5	31.5	70.0	39.5	70.0	70.0	70.0	31.5
			RD	0.076	0.190	0.000	0.354	0.000	0.000	0.014	0.000
	CO25	2	FT	41.0	35.0	70.0	41.0	70.0	70.0	70.0	35.0
			RD	0.098	0.000	0.000	0.098	0.000	0.000	0.029	0.000
	CO26	2	FT	37.0	28.5	69.5	37.0	69.5	69.5	69.5	28.5
			RD	0.000	0.140	0.000	0.324	0.000	0.000	0.014	0.000
	CO27	2	FT	44.0	34.0	70.0	44.0	70.0	70.0	70.0	34.0
			RD	0.023	0.000	0.014	0.159	0.000	0.000	0.000	0.000
	CO28	2	FT	50.0	38.5	70.0	50.0	70.0	70.0	70.0	38.5
			RD	0.000	0.000	0.000	0.080	0.000	0.000	0.000	0.000
	CO29	2	FT	42.5	29.5	70.0	42.5	56.5	70.0	70.0	29.5
			RD	0.000	0.068	0.000	0.165	0.000	0.086	0.000	0.000
	CO30	2	FT	46.0	34.5	70.0	46.0	70.0	70.0	70.0	34.5
			RD	0.022	0.000	0.000	0.065	0.000	0.014	0.000	0.000
	CO31	2	FT	43.5	37.0	70.0	43.5	70.0	70.0	70.0	37.0
			RD	0.000	0.000	0.000	0.253	0.000	0.014	0.000	0.000
Old-growth Fragment (n = 20)	F4	5	FT	127.0	90.5	175.0	127.0	175.0	175.0	175.0	90.5
			RD	0.071	0.000	0.006	0.339	0.000	0.074	0.034	0.000
	F5	5	FT	120.0	77.0	175.0	120.0	175.0	175.0	175.0	77.0
			RD	0.100	0.000	0.006	0.358	0.000	0.011	0.017	0.000

F6	5	FT	126.5	87.5	175.0	126.5	175.0	175.0	175.0	175.0	175.0	175.0	87.5
		RD	0.095	0.000	0.006	0.206	0.000	0.046	0.034	0.000	0.000	0.000	0.000
F7	4	FT	101.5	66.0	140.0	101.5	140.0	140.0	140.0	140.0	140.0	140.0	66.0
		RD	0.108	0.045	0.007	0.256	0.007	0.036	0.071	0.000	0.000	0.000	0.000
F8	5	FT	135.5	96.5	175.0	135.5	175.0	175.0	175.0	175.0	175.0	175.0	96.5
		RD	0.059	0.010	0.000	0.007	0.000	0.006	0.000	0.000	0.000	0.000	0.031
F9	4	FT	108.5	80.5	140.0	108.5	140.0	140.0	140.0	140.0	140.0	140.0	81.0
		RD	0.037	0.000	0.000	0.009	0.000	0.007	0.007	0.000	0.000	0.000	0.000
F10	4	FT	104.0	76.0	140.0	104.0	140.0	140.0	140.0	140.0	140.0	140.0	76.0
		RD	0.000	0.000	0.000	0.087	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F11	5	FT	131.0	95.0	175.0	131.0	175.0	175.0	175.0	175.0	175.0	175.0	95.0
		RD	0.015	0.000	0.000	0.160	0.000	0.000	0.000	0.000	0.000	0.000	0.011
F12	5	FT	134.0	104.0	175.0	134.0	175.0	175.0	175.0	175.0	175.0	175.0	104.0
		RD	0.000	0.000	0.000	0.022	0.000	0.023	0.017	0.000	0.000	0.000	0.000
F13	5	FT	133.5	97.5	175.0	133.5	175.0	175.0	175.0	175.0	175.0	175.0	97.5
		RD	0.210	0.010	0.000	0.007	0.000	0.029	0.023	0.000	0.000	0.000	0.000
F14	5	FT	135.0	103.5	175.0	135.0	175.0	175.0	175.0	175.0	175.0	175.0	103.5
		RD	0.089	0.000	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F15	5	FT	134.0	103.0	175.0	134.0	175.0	175.0	175.0	175.0	175.0	175.0	103.0
		RD	0.104	0.000	0.000	0.022	0.000	0.034	0.000	0.000	0.000	0.000	0.000
F16	3	FT	79.0	59.0	105.0	79.0	105.0	105.0	105.0	105.0	105.0	105.0	59.0
		RD	0.127	0.000	0.000	0.051	0.000	0.010	0.000	0.000	0.000	0.000	0.000
F17	5	FT	135.0	102.0	175.0	135.0	175.0	175.0	175.0	175.0	175.0	175.0	102.0
		RD	0.074	0.000	0.000	0.074	0.000	0.023	0.000	0.000	0.000	0.000	0.000
F18	5	FT	125.0	95.5	175.0	125.0	175.0	175.0	175.0	175.0	175.0	175.0	95.5
		RD	0.120	0.000	0.000	0.104	0.000	0.034	0.000	0.000	0.000	0.000	0.000
F19	2	FT	55.5	41.5	70.0	55.5	70.0	70.0	70.0	70.0	70.0	70.0	41.5
		RD	0.000	0.000	0.000	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F20	5	FT	118.5	89.5	172.0	118.5	172.0	172.0	172.0	172.0	172.0	172.0	89.5
		RD	0.084	0.000	0.000	0.194	0.000	0.006	0.017	0.000	0.000	0.000	0.000
F21	4	FT	100.0	74.0	139.0	100.0	139.0	139.0	139.0	139.0	139.0	139.0	74.0
		RD	0.180	0.000	0.000	0.260	0.000	0.000	0.022	0.000	0.000	0.000	0.000
F22	5	FT	124.5	92.5	174.0	124.5	174.0	174.0	174.0	174.0	174.0	174.0	92.5
		RD	0.000	0.000	0.006	0.129	0.000	0.011	0.023	0.000	0.000	0.000	0.000

CC8	2	FT	56.0	40.0	70.0	56.0	70.0	70.0	70.0	40.0
		RD	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CC9	2	FT	55.5	41.5	70.0	55.5	70.0	70.0	70.0	41.5
		RD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CC10	2	FT	55.0	41.5	70.0	55.0	70.0	70.0	70.0	41.5
		RD	0.000	0.000	0.000	0.036	0.000	0.000	0.014	0.000
CC11	2	FT	46.5	37.5	70.0	46.5	60.5	70.0	70.0	37.5
		RD	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.000
CC12	2	FT	35.5	26.5	70.0	35.5	70.0	70.0	70.0	26.5
		RD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CC13	2	FT	50.0	35.0	69.0	50.0	69.0	69.0	69.0	35.0
		RD	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000
CC14	2	FT	44.5	36.5	70.0	44.5	70.0	70.0	70.0	36.5
		RD	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.080
CC15	2	FT	48.5	35.5	70.0	48.5	70.0	70.0	70.0	35.5
		RD	0.000	0.000	0.000	0.206	0.000	0.000	0.000	0.000
CC16	2	FT	42.0	26.5	70.0	42.0	70.0	70.0	70.0	26.5
		RD	0.000	0.000	0.000	0.048	0.000	0.000	0.000	0.000
CC17	2	FT	45.5	31.5	70.0	45.5	70.0	70.0	70.0	31.5
		RD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CC19	2	FT	41.5	30.5	70.0	41.5	70.0	70.0	70.0	30.5
		RD	0.000	0.000	0.000	0.072	0.000	0.000	0.000	0.000
CC20	2	FT	41.5	29.5	70.0	41.5	70.0	70.0	70.0	29.5
		RD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CC21	2	FT	54.5	41.0	70.0	54.5	70.0	70.0	70.0	41.0
		RD	0.000	0.000	0.000	0.000	0.029	0.043	0.000	0.000

Site-id	EUTO	MILO	MUER	MUFR	NECI	PEMA	SOVA	SPPU	ZATR
OG4	133.0	110.5	133.0	156.5	110.5	110.5	175.0	46.0	110.5
	0.075	0.000	0.000	0.000	0.000	0.063	0.006	0.000	0.000
OG5	140.5	118.5	140.5	160.5	118.5	118.5	175.0	42.0	118.5
	0.164	0.000	0.000	0.000	0.008	0.000	0.011	0.000	0.008
OG6	153.5	129.0	153.5	177.0	129.0	129.0	175.0	48.0	129.0
	0.007	0.000	0.013	0.000	0.016	0.000	0.000	0.000	0.000
OG7	165.0	132.0	167.0	200.0	132.0	132.0	175.0	68.0	132.0
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OG8	147.5	117.0	147.5	175.5	117.0	117.0	175.0	58.5	117.0
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.000
OG9	160.5	126.0	160.5	193.5	126.0	126.0	175.0	67.5	126.0
	0.000	0.000	0.000	0.000	0.000	0.016	0.000	0.000	0.000
OG10	165.5	130.5	165.5	200.0	130.5	130.5	175.0	69.5	130.5
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008
OG11	151.5	122.0	151.5	182.5	122.0	122.0	173.5	60.5	122.0
	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OG12	126.0	104.0	126.0	154.5	104.0	104.0	173.0	50.5	104.0
	0.000	0.000	0.000	0.000	0.000	0.019	0.000	0.000	0.000
OG13	124.0	93.5	124.0	149.5	93.5	93.5	174.0	56.0	93.5
	0.266	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OG14	127.5	98.0	127.5	157.5	98.0	98.0	164.0	59.5	98.0
	0.212	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OG15	134.5	106.0	134.5	164.5	106.0	106.0	175.0	58.5	106.0
	0.000	0.000	0.000	0.000	0.000	0.009	0.006	0.017	0.000
OG16	140.0	108.5	140.0	167.0	108.5	108.5	175.0	58.5	108.5
	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.034	0.000
OG17	145.0	111.0	145.0	176.5	111.0	111.0	171.5	65.5	111.0
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OG18	149.5	117.5	149.5	182.0	117.5	117.5	175.0	64.5	117.5
	0.033	0.009	0.000	0.000	0.000	0.000	0.000	0.031	0.000
CO1	62.5	52.5	62.5	72.0	52.5	52.5	70.0	19.5	52.5

CO2	0.000	63.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.103	0.000
	63.0	52.0	63.0	74.5	0.000	52.0	52.0	52.0	70.0	70.0	22.5	52.0
CO3	0.000	0.000	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.089	0.000
	59.0	50.0	59.0	67.5	50.0	50.0	50.0	50.0	70.0	70.0	17.5	50.0
CO4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.000
	58.0	47.5	58.0	71.5	47.5	47.5	47.5	47.5	70.0	70.0	24.0	47.5
CO6	0.000	0.000	0.017	0.000	0.000	0.000	0.021	0.021	0.000	0.000	0.000	0.000
	61.5	47.5	61.5	73.5	47.5	47.5	47.5	47.5	70.0	70.0	26.0	47.5
CO7	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000	0.000
	57.5	46.5	57.5	67.5	46.5	46.5	46.5	46.5	70.0	70.0	21.0	46.5
CO8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.000
	65.0	52.0	65.0	79.0	52.0	52.0	52.0	52.0	70.0	70.0	27.0	52.0
CO9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	65.0	52.5	65.0	76.5	52.5	52.5	52.5	52.5	70.0	70.0	24.0	52.5
CO10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	64.5	51.5	64.5	77.5	51.5	51.5	51.5	51.5	70.0	70.0	26.0	51.5
CO11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	57.5	47.0	57.5	69.5	47.0	47.0	47.0	47.0	70.0	70.0	22.5	47.0
CO12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.089	0.000
	54.5	43.5	54.5	64.5	43.5	43.5	43.5	43.5	70.0	70.0	21.0	43.5
CO13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	58.5	47.5	58.5	68.5	47.5	47.5	47.5	47.5	70.0	70.0	21.0	47.5
CO14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	59.5	47.5	59.5	69.5	47.5	47.5	47.5	47.5	69.0	69.0	23.0	47.5
CO15	0.017	0.000	0.000	0.000	0.000	0.000	0.021	0.021	0.000	0.000	0.000	0.000
	64.5	53.5	64.5	91.5	53.5	53.5	53.5	53.5	69.5	69.5	23.0	53.5
CO16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.043	0.000
	56.0	43.0	56.0	64.0	43.0	43.0	43.0	43.0	70.0	70.0	21.0	43.0
CO17	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.023	0.000	0.000	0.000	0.000
	54.0	44.0	54.0	65.0	44.0	44.0	44.0	44.0	70.0	70.0	21.0	44.0
CO18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	59.5	48.5	59.5	72.0	48.5	48.5	48.5	48.5	70.0	70.0	23.5	48.5
CO19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	50.0	39.0	50.0	61.0	39.0	39.0	39.0	39.0	68.0	68.0	22.0	39.0

F8	168.0	135.5	168.0	198.5	135.5	135.5	175.0	63.0	135.5
	0.089	0.000	0.000	0.000	0.000	0.007	0.006	0.000	0.000
F9	136.0	108.5	136.0	163.0	108.5	108.5	140.0	54.5	108.5
	0.081	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.000
F10	129.5	104.0	129.5	156.0	104.0	104.0	140.0	52.0	104.0
	0.000	0.000	0.023	0.000	0.000	0.010	0.000	0.019	0.000
F11	162.0	131.0	162.0	194.0	131.0	131.0	175.0	63.0	131.0
	0.000	0.000	0.000	0.000	0.000	0.023	0.000	0.032	0.000
F12	168.5	134.0	168.5	203.0	134.0	134.0	175.0	69.0	134.0
	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F13	167.0	133.5	167.0	198.5	133.5	133.5	175.0	65.0	133.5
	0.054	0.000	0.000	0.000	0.000	0.000	0.006	0.031	0.000
F14	170.0	135.0	170.0	205.0	135.0	135.0	175.0	70.0	135.0
	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.000	0.000
F15	169.0	134.0	169.0	204.0	134.0	134.0	175.0	70.0	134.0
	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.000
F16	98.5	79.0	98.5	119.0	79.0	79.0	105.0	40.0	79.0
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F17	169.5	135.0	169.5	203.5	135.0	135.0	175.0	68.5	135.0
	0.000	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F18	159.5	125.0	159.5	193.5	125.0	125.0	175.0	68.5	125.0
	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.000
F19	69.0	55.5	69.0	83.0	55.5	55.5	70.0	27.5	55.5
	0.000	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.000
F20	151.5	118.5	151.5	178.5	118.5	118.5	172.0	60.0	118.5
	0.211	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000
F21	123.5	100.0	123.5	150.5	100.0	100.0	139.0	50.5	100.0
	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.059	0.000
F22	155.5	124.5	155.5	185.0	124.5	124.5	174.0	60.5	124.5
	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.000	0.000
F23	121.5	100.5	121.5	146.0	100.5	100.5	140.0	44.5	100.5
	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000
S1	50.5	40.0	50.5	64.5	40.0	40.0	70.0	28.0	40.0

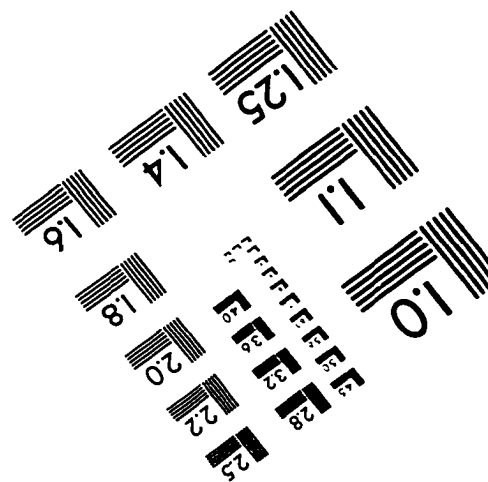
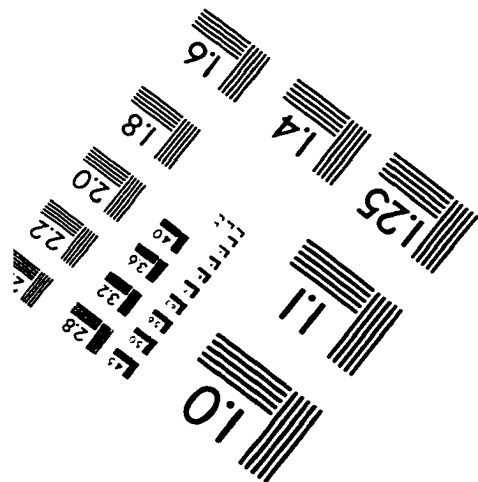
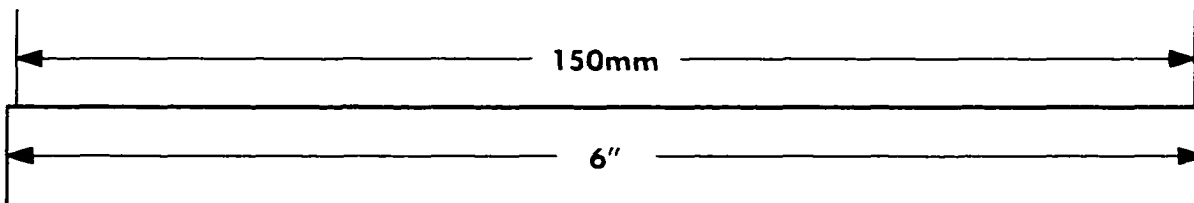
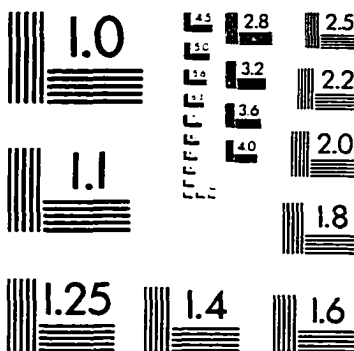
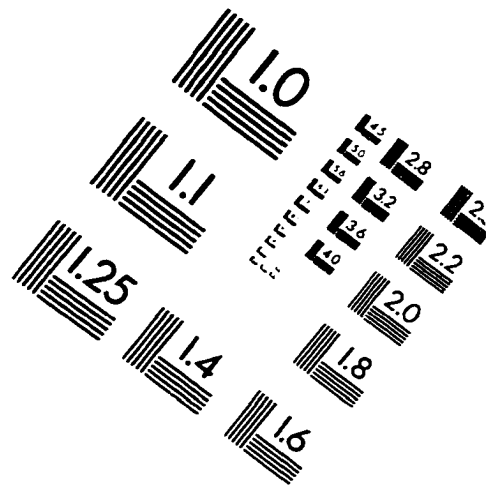
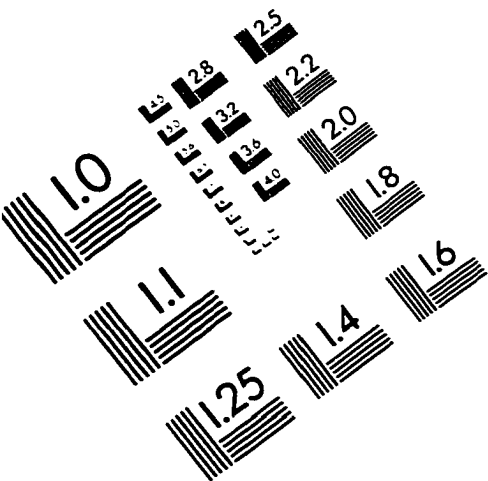
CC10	69.0	55.0	69.0	82.5	55.0	55.0	70.0	27.5	55.0
	0.000	0.000	0.000	0.012	0.000	0.073	0.000	0.000	0.000
CC11	59.5	46.5	59.5	72.5	46.5	46.5	70.0	26.0	46.5
	0.034	0.000	0.000	0.000	0.000	0.043	0.000	0.000	0.000
CC12	44.0	35.5	44.0	52.0	35.5	35.5	70.0	16.5	35.5
	0.000	0.000	0.000	0.000	0.000	0.338	0.000	0.000	0.000
CC13	62.5	50.0	62.5	73.0	50.0	50.0	69.0	23.0	50.0
	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000
CC14	58.5	44.5	58.5	68.5	44.5	44.5	70.0	24.0	44.5
	0.291	0.000	0.000	0.000	0.000	0.157	0.000	0.000	0.000
CC15	60.0	48.5	60.0	72.0	48.5	48.5	70.0	23.5	48.5
	0.000	0.000	0.000	0.000	0.000	0.144	0.000	0.000	0.000
CC16	51.0	42.0	51.0	58.5	42.0	42.0	70.0	16.5	42.0
	0.118	0.000	0.000	0.000	0.000	0.143	0.000	0.000	0.000
CC17	55.0	45.5	55.0	65.5	45.5	45.5	70.0	20.0	45.5
	0.109	0.000	0.000	0.000	0.000	0.110	0.000	0.000	0.000
CC19	52.0	41.5	52.0	61.0	41.5	41.5	70.0	19.5	41.5
	0.000	0.024	0.000	0.000	0.000	0.145	0.014	0.000	0.000
CC20	51.0	41.5	51.0	59.5	41.5	41.5	70.0	18.0	41.5
	0.000	0.000	0.000	0.000	0.000	0.217	0.000	0.056	0.000
CC21	68.0	54.5	68.0	82.0	54.5	54.5	70.0	27.5	54.5
	0.000	0.000	0.000	0.000	0.000	0.055	0.000	0.000	0.000

Species codes (methods of detection; T = live trapping, C = infrared triggered camera, and S = survey for animal signs):

CLGA = *Clethrionomys gapperi* (TC)
GLSA = *Glaucomys sabrinus* (TC)
NEGI = *Neurotrichus gibbsii* (T)
PEOR = *Peromyscus oreas* (TC)
SOBE = *Sorex bendirii* (T)
SOMO = *Sorex monticolus* (T)
SOTR = *Sorex trowbridgii* (T)
TADO = *Tamiasciurus douglasii* (TCS)

APRU = *Aplodontia rufa* (CS)
LYRU = *Lynx rufus* (CS)
MILO = *Microtus longicaudus* (T)
SOVA = *Sorex vagrans* (T)
CALA = *Canis latrans* (CS)
CEEL = *Cervus elaphus* (CS)
EUTO = *Tamias (Eutamias) townsendii* (TC)
LEAM = *Lepus americanus* (CS)
MUER = *Mustela erminea* (TC)
MUFR = *Mustela frenata* (TC)
NECI = *Neotoma cinerea*
ODHE = *Odocoileus hemionus* (CS)
PEMA = *Peromyscus maniculatus* (TC)
SPPU = *Spilogale putorius* (TC)
URAM = *Ursus americanus* (CS)
ZATR = *Zapus trinotatus* (T)

IMAGE EVALUATION TEST TARGET (QA-3)



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