

Band-tailed Pigeon Distribution and Habitat Component Availability in Western Oregon

Abstract

Abundance of Pacific coast band-tailed pigeons has declined; this decline is thought to be due, in part, to habitat alteration associated with current forestry practices. We examined distribution of Pacific coast band-tailed pigeons and availability of habitat components (known mineral sites and potential nesting and feeding areas) in the central Coast Range of Oregon. Also, we evaluated associations of relative pigeon abundance at 323 randomly selected sample points and 97 known nest sites with adjacent habitat component availability. We detected 1–8 pigeons during a 1-hr point count at 83% of sample points from mid-June to July. Eighty-four percent of the study area was classified as potential nesting (66%) and feeding (18%) areas. The maximum distance to the closest known mineral site was 37 km, but 91% of the study area was within 25 km of the nearest known mineral site. Availability of habitat components around known nest sites was similar to that at sample points and reflected availability within the study area. Relative pigeon abundance was not associated with availability of known mineral sites, or potential nesting and feeding areas. Pigeons were 62% more abundant along the western one-third of the Coast Range than along the eastern one-third, however, and this pattern was correlated with the apparent availability of red elder and cascara. Possibly the availability of red elder and cascara imposed a constraint on band-tailed pigeon distribution and abundance.

Introduction

The abundance of Pacific coast band-tailed pigeons (*Columba fuscata monilis*), which nest mostly in coastal areas of British Columbia, Washington, Oregon, and California, decreased by 2.8% annually between 1966 and 2000 and by 1.5% annually between 1991 and 2000 as indicated by the Breeding Bird Survey (analysis provided by J.R. Sauer, U.S. Geological Survey, Laurel, Maryland). This decline has been corroborated by visual counts conducted during August at mineral sites in Oregon and audio counts conducted during June in Washington (Western Migratory Upland Game Bird Technical Committee 1994). Increasingly restrictive hunting regulations have been implemented since the late 1980s, but population trends apparently have not been reversed (Western Migratory Upland Game Bird Technical Committee 1994). The decline is suspected to be related, in part, to extensive timber harvest and intensive reforestation replacing diverse forest stands with even-age conifer monocultures that reduce availability of food producing trees and shrubs (Hansen et al. 1991, Braun 1994, Western

Migratory Upland Game Bird Technical Committee 1994).

Effective management of an animal population requires knowledge of its size and composition, and how the population relates to habitat and other limiting factors (Verner 1981, Wiens and Rotenberry 1981, Hansen et al. 1993). Little is known about the distribution of band-tailed pigeons and availability of habitat in the Pacific Northwest. Leonard (1998) radio-marked 127 adult band-tailed pigeons in the central Oregon Coast Range and measured breeding season home range size ($\bar{x} = 11,121$ ha) and described 137 nest, feeding, and mineral sites. He suggested that pigeons select nest sites based on availability of mineral sites and potential nesting and feeding areas.

Band-tailed pigeons in Oregon nest primarily in Douglas-fir (*Pseudotsuga menziesii*) trees within closed-canopy (>70%), conifer or mixed conifer-broadleaf forests (Leonard 1998). Pigeons feed almost exclusively on berries of red elder (*Sambucus racemosa*), blue elder (*S. cerulea*), and cascara (*Rhamnus purshiana*) during the breeding season (Jarvis and Passmore 1992). Pigeons also congregate at and use mineral sites (March and Sadleir 1972, Jarvis and Passmore 1992, Sanders and Jarvis 2000). In Oregon, mineral sites are typically mineralized springs, abandoned artesian salt wells, and saltwater bays and estuaries, but also may be exposed mineral deposits and

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mineralized wastewater from pulp mills (Sanders and Jarvis 2000).

Food plays a major role in band-tailed pigeon ecology, influencing distribution (Neff 1947), initiation and duration of the nesting season (Gutiérrez et al. 1975, Jarvis and Passmore 1992), and use of mineral sites (Sanders and Jarvis 2000). In the Coast Range, elder and cascara shrubs are naturally prevalent in disturbed, open-canopy forests of early to intermediate successional stages and some riparian areas (Franklin and Dyrness 1988, Kozloff 1976, Klinka et al. 1989, Leonard 1998, Pabst and Spies 1998). Berries of red elder and cascara provide a dependable and nutrient-rich food supply during the nesting season (Sanders 1999). Red elder berries are consumed from late June to mid-August and cascara berries from late August to early September, consistent with the fruiting phenology of these shrubs (Jarvis and Passmore 1992). Berries of blue elder become available in early September and are consumed in September and October.

In western Washington, Oregon, and northern California, forests have been harvested extensively for >100 yr (Tappeiner et al. 1997). These are among the most productive coniferous forests in the world and forestry practices are intense (Franklin and Dyrness 1988, Harris 1984). Since the mid-1940s, silvicultural systems have typically included clear-cutting, broadcast burning of logging slash, hand planting of selected species, pre-commercial and commercial thinning, application of herbicides to suppress competing species, and harvesting at 40–100 yr intervals, although 40–60 yr intervals are more common (Hansen et al. 1991, Spies et al. 1991, Tappeiner et al. 1997). Intensive reforestation practices suppress the growth of red elder, blue elder, and cascara, primarily through application of herbicides and overstory shading (Hansen et al. 1991). Such forestry practices also produce a greatly altered forest environment, resulting in a mosaic of patches of forest stands across the landscape (Hansen et al. 1991). The spatial pattern of vegetation exerts strong influence on the abundance, distribution, and dynamics of populations inhabiting those landscapes (Harris 1984, Wiens 1989). The extent to which forestry practices impact band-tailed pigeon demographics is unknown, but the potential is substantial.

We examined the distribution of band-tailed pigeons and availability of habitat components

(known mineral sites and potential nesting and feeding areas) to test the hypotheses that availability of habitat components explains relative abundance of nesting band-tailed pigeons and known nest site locations in the central Coast Range of Oregon.

Methods

Study Area

We conducted the study in the central Coast Range province (Franklin and Dyrness 1988) of Oregon. The study area extended approximately from Lincoln City south to Reedsport along the Pacific Coast and east to the western edge of the Willamette Valley (50 × 139 km) (Figure 1). Climate is maritime (Loy et al. 1976) and elevation varies from sea level to 1,249 m.

The Coast Range province is dominated by dense, potentially long-lived (>500 yr), coniferous forests. Two natural forest communities or distinctive vegetation zones are present: coastal sitka spruce (*Picea sitchensis*) along the western one-third of the province, and western hemlock (*Tsuga heterophylla*) along the eastern two-thirds (Franklin and Dyrness 1988). Most natural forested areas have an overstory dominated by western hemlock, western redcedar (*Thuja plicata*), Douglas-fir, sitka spruce, and red alder (*Alnus rubra*). In areas managed for timber production, which is most of the study area, the dominant tree is Douglas-fir.

The Coast Range province comprises mostly privately owned lands and public lands administered by the USDA Forest Service and the USDI Bureau of Land Management. The majority of the study area (56%) was privately owned. Land use was primarily intensive timber production on both public- and private-owned lands. An extensive network of primitive roads permeates the study area and are used primarily for timber harvest. Landscape patterns have been largely shaped by human induced disturbances (timber harvest and reforestation) (Hansen et al. 1991).

Point Counts

We used point counts to index the abundance of band-tailed pigeons at 323 sample points (Figure 2) between 16 June and 16 August annually during 1996–1998. We considered counts of calling pigeons at sample points to estimate relative

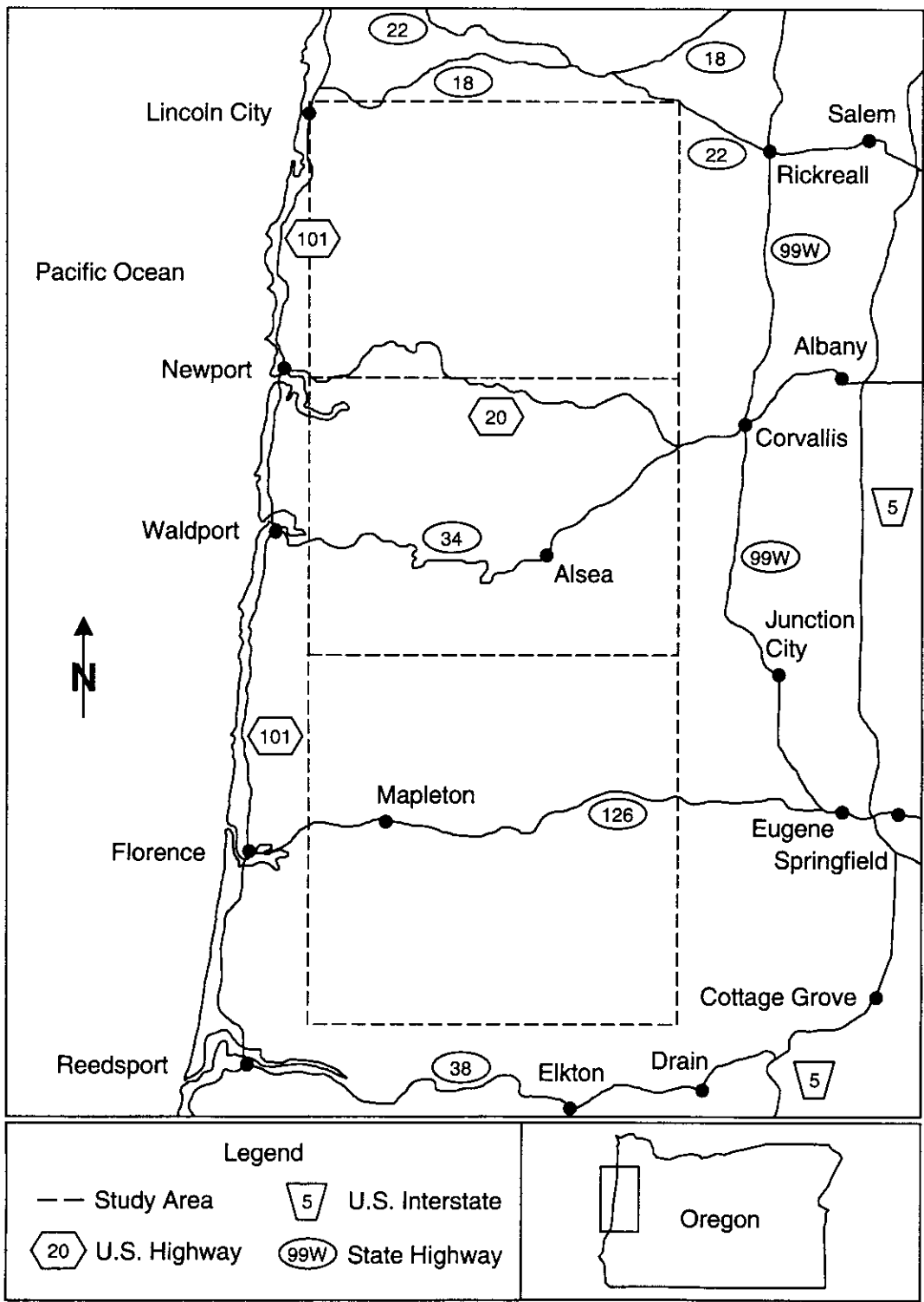


Figure 1. Location of the study area (50 × 139 km) and subareas (north, central, and south) in Oregon.

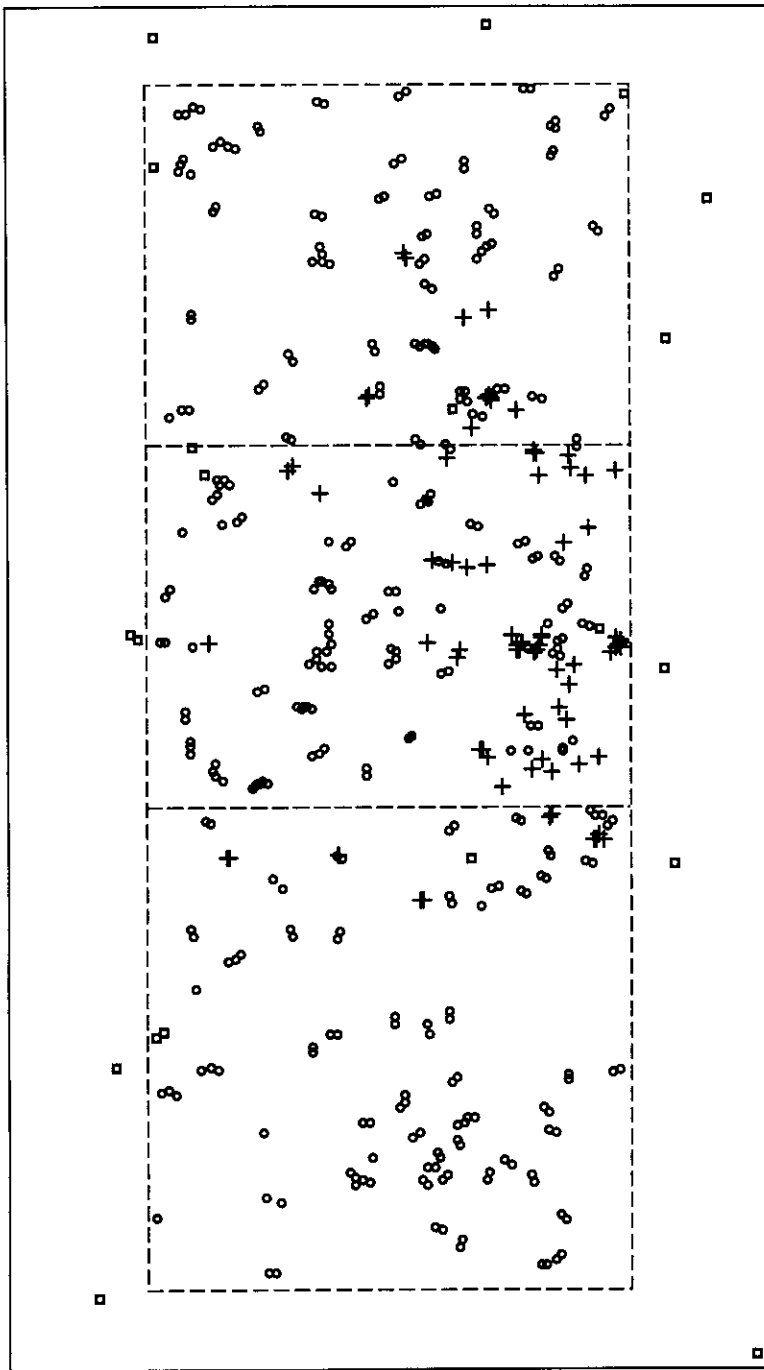


Figure 2. Distribution of 323 sample points (O), 20 known mineral sites (□), and 97 known nest sites (+) within the study area, or in the case on mineral sites, were the closest mineral source to part of the study area.

abundance of breeding males (Keppie et al. 1970, Bull 1981). Point counts were conducted beginning 10 min before official local sunrise and lasted 1 hr during mornings with <11 km per hr wind and little or no precipitation. We did not knowingly count the same pigeon more than once. We recorded the azimuth to each call to distinguish individual pigeons. Calls were considered to be of different birds when the audibility or azimuth were evidently unique, although a pigeon that obviously called from multiple locations was recorded as one.

We trained observers for 1 wk prior to surveying to increase accuracy of detections and minimize observer variability (Kepler and Scott 1981). We distributed each observer's effort equally among sample points to avoid systematic observer bias. Sample points were distributed among equal-sized subareas (north, central, and south) of the study area. Subareas were surveyed on a 1-wk rotational schedule; surveys were restricted to one subarea during a week.

We paired sample points 800 m apart for logistic reasons, and located them using a systematic, random procedure. The distance between sample points was determined so that it maximized sample size, transportation efficiency, and observer safety, while maintaining sample independence. The maximum audible range of the band-tailed pigeon coo-call for the study area was determined to be <400 m in most all forest environments (Sisson 1968, Keppie et al. 1970). We located paired sample points by generating a random location within the study area with the constraint that the site was on forested land. The location was temporarily marked on a USGS 7.5 Minute Quadrangle map (scale 1:24,000) and a second location, the first sample point, was marked at the closest point on an accessible road. A third location, the second sample point, was marked 800 m from the first sample point on an accessible road. A clear plastic overlay with concentric rings at 100-m intervals was used to find sample point locations on the nearest accessible road; either the closest point from the initial random point or 800 m from the first sample point. In cases where multiple locations were possible for the second sample point, either on the same or a different road, we systematically selected the point farther along the road of initial access and that provided the shortest driving distance between the two sample points.

Geographic Information

We used ARC/INFO version 7.2 (Environmental Systems Research Institute, Redlands, California) to generate four themes, one raster based grid (potential nesting and feeding areas) and three vector based coverages (mineral site, sample point, and nest site), and to estimate spatial measures. The potential nesting and feeding areas theme was produced from 1988 and 1995 Thematic Mapper Imagery processed by the Coastal Landscape Analysis and Modeling Study at the Forestry Sciences Laboratory at Oregon State University to include 12 land cover types (open, water, semi-closed, broadleaf, and four tree sizes each for conifer and mixed conifer-broadleaf forest types) and was digitally referenced in 25-m pixels. The map had 98% accuracy within one land cover type and 80% accuracy overall.

The potential nesting and feeding areas theme included an area 5,000 m beyond the study area boundaries. We reclassified land cover data to represent potential nesting and feeding areas. Potential nesting area included conifer and mixed conifer-broadleaf forest with >70% canopy cover (Leonard 1998). Potential feeding area included cover types with $\leq 70\%$ canopy cover (Leonard 1998). The two habitat components were mutually exclusive, and excluded only broadleaf forest with >70% canopy cover and open water cover types. Data were filtered using a majority procedure to increase the minimum mapping unit to 32 pixels (2 ha) so that there were no patches <2 ha. This procedure reduced polygon numbers and processing time in later analyses. Overall map accuracy was 97% based on visits to 154 randomly selected sites. We produced the mineral site theme from location coordinates of mineral sites known to be used by band-tailed pigeons in western Oregon during 1996–1998 (Sanders and Jarvis 2000). We produced the sample point theme from coordinates of sample points. The nest site theme was produced from coordinates of nest sites collected during a previous study (1994–1996) (Leonard 1998) that occurred within a portion of our study area.

We calculated the availability of potential nesting and feeding area, and mineral sites for the entire study area, at the sample points used to index pigeon abundance, and at known nest sites from the geographic information themes. To estimate habitat component availability at point

locations, we calculated the percentage of potential nesting area in 0.5-km radius (79 ha) plots and potential feeding area in 5-km radius (7,854 ha) plots centered on the same sample points and known nest sites using an automated macro language program. We selected plot sizes *a priori* given home range size and average travel distance of 5 km between nesting and feeding sites (Leonard 1998). The procedure consisted of (1) converting the potential nesting and feeding areas theme from a grid to a polygon coverage, (2) generating a circular plot around sample points or nests, (3) overlaying plots on the potential nesting and feeding areas coverage (having the effect of a cookie cutter; dissecting habitat polygons along plot edges, where habitat polygons outside buffers are eliminated), and (4) calculating total area of potential nesting and feeding areas. Area estimates were converted to percentage of the circular plot. We ran the procedure for each plot size. Also, we determined the straight line distance to the nearest mineral site for each sample point and nest.

To verify that areas classified as potential feeding areas had a high probability of containing food items, we visited 126 randomly selected forest areas with $\leq 70\%$ canopy cover between 8 July and 5 August 1997 to determine the presence or absence of red elder, blue elder, and cascara. These shrubs rarely occur in closed-canopy forests, and produce few or no berries in such environments (Klinka et al. 1989, Randall et al. 1990).

Statistical Analyses

We used a multiple regression model to assess the relationship between relative pigeon abundance and availability of habitat components at sample points. The response variable, pigeon abundance, tended to be skewed to the right and more uniform than predicted by normal and Poisson distributions. Fitted regression and Poisson regression models had either 8% of the residuals ≥ 3 units in magnitude or extra Poisson variation. However, coefficients and their standard errors are robust to non-normal distributions while deviance chi-square tests for extra Poisson variation are unreliable given means < 5 (Ramsey and Schafer 1997). Consequently, we also fit a Poisson log-linear multiple regression model. The standard and Poisson log-linear regression models produced similar parameter estimates and associated *P*-values; therefore, we present statistics

from the standard regression model. Similarly, a multiple linear regression model was used to assess relative pigeon abundance among 3 equal-sized subareas (west, central, and east) of the study area. We included an indicator variable in all regression models to account for seasonal differences in pigeon detections for point counts conducted during 16 June–24 July and 25 July–16 August (Sanders 1999). We used $P = 0.05$ and interaction and quadratic terms were included in models initially, then were removed when *P*-values exceeded 0.05.

We used two-sample *t*-tests (two-tailed) and $P = 0.05$ to compare differences in availability of habitat components between 70 successful and 27 unsuccessful band-tailed pigeon nests observed by Leonard (1998). Nests were considered successful if at least one young fledged from the nest.

Results

The mean number of band-tailed pigeons (2.52 ± 0.13) detected during 106 point counts during 16 June–24 July was 1.5 times higher than during 25 July–16 August (1.69 ± 0.17) ($n = 217$). The probability of detecting at least one band-tailed pigeon during a 1 hr point count at sample points was 0.83 for the first survey period and 0.65 for the second survey period. Pigeon abundance varied from west-to-east, however, decreasing by 62% from the west-to-east one-third of the study area during both survey periods combined. The probability of detecting at least one pigeon during a 1 hr point count at sample points within each one-third of the study area from west-to-east was 0.88, 0.82, and 0.79 during the first survey period and 0.75, 0.76, and 0.50 during the second survey period.

We located 20 mineral sites currently used by band-tailed pigeons that were either within the study area or were the closest mineral source to part of the study area (Figure 2). The maximum distance to the closest known mineral site from any part of the study area was 37 km, but 91% of the study area was within 25 km of the nearest known mineral site. Potential nesting and feeding areas comprised 66 and 18% of the study area.

Availability of habitat components (known mineral sites and potential nesting and feedings areas) around sample points reflected availability within the study area (Figure 3). Mean potential nesting area within 0.5 km of sample points

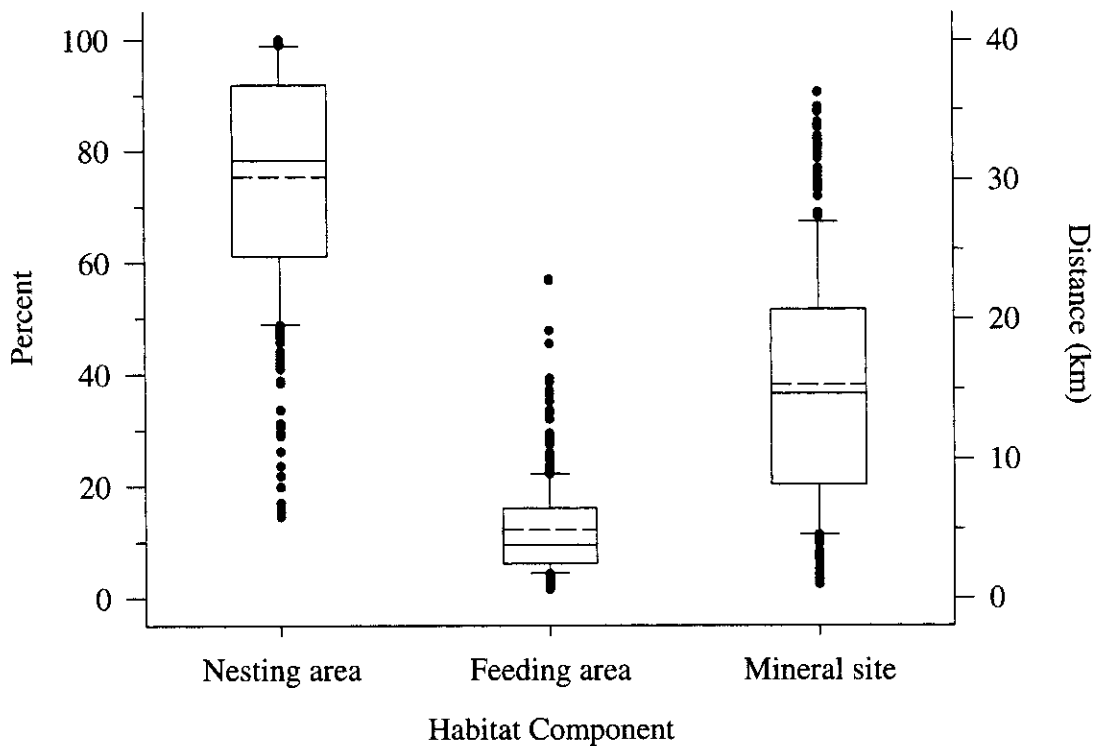


Figure 3. Distribution of 323 sample points by percent of potential band-tailed pigeon nesting and feeding areas (in 0.5-km and 5-km radius plots, respectively) and distance to nearest known mineral site in the central Coast Range of Oregon, 1995. Boxes represent the 25th and 75th percentiles, solid horizontal lines mark the value of the 50th percentile, broken horizontal lines indicate the mean, capped bars signify the 10th and 90th percentiles, and symbols mark all data outside the 10th and 90th percentiles.

was $75 \pm 1.1\%$, mean potential feeding area within 5 km of sample points was $12 \pm 0.5\%$, and mean distance to nearest known mineral site was 15.3 ± 0.5 km. Most (80%) of the sample points ranged from 49 to 99% (393 to 1,728 ha) potential nesting area within 0.5 km and from 5 to 22% (38 to 78 ha) potential feeding area within 5 km, and were 5–27 km of the nearest known mineral site.

Relative abundance of band-tailed pigeons at sample points was weakly related to the availability of habitat components ($P < 0.01$, $r^2 = 0.07$). Pigeon abundance decreased with increasing feeding area at sample points ($b_2 = -0.04 \pm 0.01$, 95% CI = -0.07 to -0.01 , $P < 0.01$), but did not change significantly with increasing potential nest area and distance to nearest known mineral site.

Mean availability of habitat components at known nest sites did not differ significantly by nest fate; therefore, we pooled data for successful and unsuccessful nests. The availability of

habitat components around known nest sites (Figure 4) resembled availability of habitat components around sample points (Figure 3), except that known nest sites tended to be closer to known mineral sites. Average nesting area within 0.5 km of nest sites was $81 \pm 2.0\%$, average feeding area within 5 km of sample points was $16 \pm 1.1\%$, and mean distance to nearest known mineral site was 9.6 ± 0.5 km. Most (80%) of the known nest sites had from 51 to 100% (40 to 80 ha) potential nesting area within 0.5 km, from 3 to 36% (236 to 2,827 ha) potential feeding area within 5 km, and were within 5–16 km of the nearest known mineral site.

Forested areas with $\leq 70\%$ canopy cover, classified as potential feeding area, had high probability (0.80) of containing food items (berries of red elder, blue elder, or cascara) (Figure 5). Occurrence of each species, however, depended on geographic location. Red elder was most abundant along the western one-third of the Coast

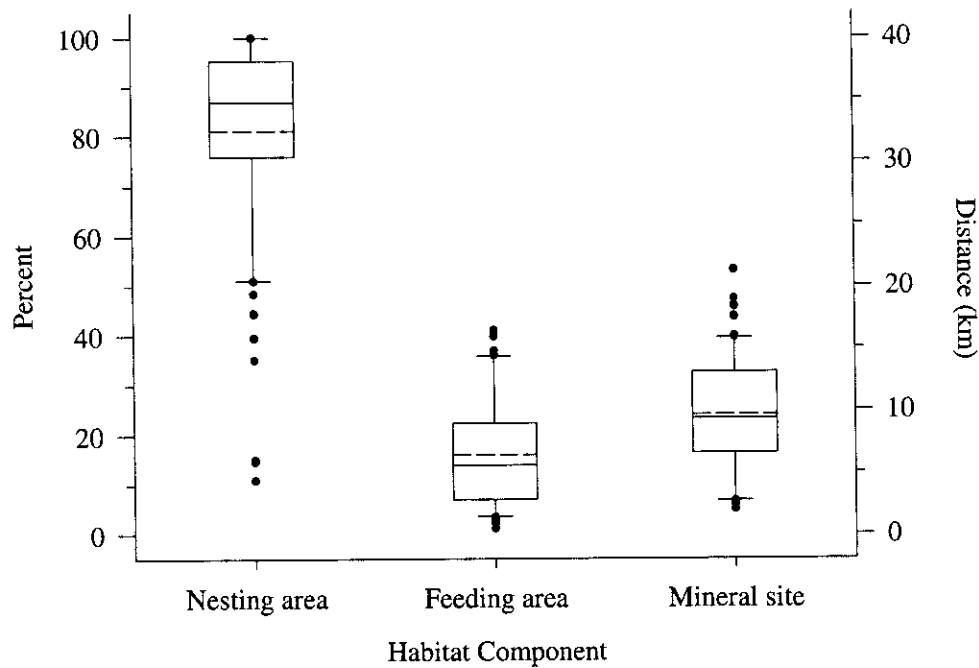


Figure 4. Distribution of 97 known nest sites by percent of potential band-tailed pigeon nesting and feeding areas (in 0.5-km and 5-km radius plots, respectively) and distance to nearest known mineral site in the central Coast Range of Oregon, 1995. Boxes represent the 25th and 75th percentiles, solid horizontal lines mark the value of the 50th percentile, broken horizontal lines indicate the mean, capped bars signify the 10th and 90th percentiles, and symbols mark all data outside the 10th and 90th percentiles.

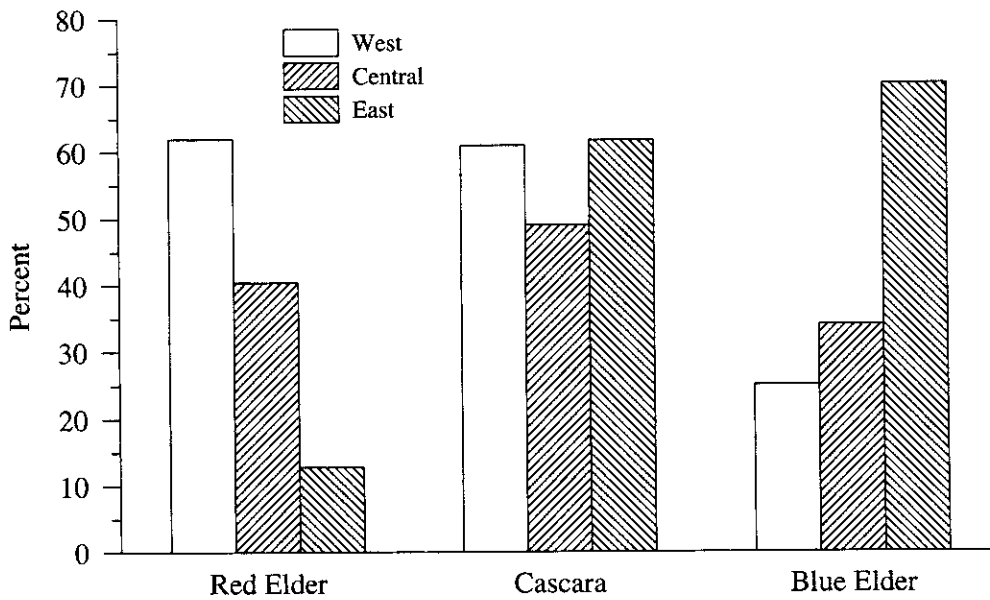


Figure 5. Percent of 126 randomly selected forested areas with $\leq 70\%$ canopy cover by that contained red elder, cascara, and blue elder within equal-sized subareas (west, central, and east, $n = 42$ each) of the study area in the central Coast Range of Oregon, 1997.

Range, blue elder was most abundant along the eastern one-third, and cascara was most abundant along the western and eastern one-third of the study area (Figure 5).

Discussion

Band-tailed pigeons were ubiquitous within the study area, and were detected at 83% of sample points between mid-June and late July. This result may be attributed to the prevalence and interspersed of habitat components across the central Coast Range of Oregon (Figures 3 and 4) and high mobility of pigeons. Leonard (1998) reported band-tailed pigeons in the same area had a mean breeding home range of 11,121 ha (range = 314–180,000), and traveled a mean distance of 5.0 km (range = 0.3–51.6) to feeding sites and 8.4 km (range = 3.5–14.0) to mineral sites from nest locations. Pigeons visit mineral sites about once per week (Jarvis and Passmore 1992), and are apparently capable of making flights >27 km while nesting.

We found no biologically meaningful relationship between relative band-tailed pigeon abundance and availability of habitat components (known mineral sites and potential nesting and feeding areas) within the central Coast Range of Oregon. Pigeon abundance decreased significantly with increasing potential forage area, however, this relationship was weak and did not appear biologically meaningful. Explanatory variables in the fitted model explained only 7% of the variation in relative pigeon abundance at sample points, and the estimated change in pigeon abundance was inverse to what we hypothesized. Also, potential nesting and feeding areas were mutually exclusive categories and together accounted for 84% of the study area. If band-tailed pigeon abundance increased with decreasing forage area, this implies that band-tailed pigeon abundance should have increased with increasing nest area, and there was no evidence to support that relationship.

Our results of no relationship between relative pigeon abundance and habitat component availability at sample points are seemingly conclusive. The distributions of habitat components around known nest sites were similar to the distribution of habitat components around randomly selected sample points. Nest sites were closer to known mineral sites than sample points, but this

resulted from differences in study areas. Leonard's (1998) study area occurred in a portion of our study area where the maximum distance to a known mineral site was <25 km, as compared to 37 km for our study area. Thus, known nest sites did not differ from random locations based on the spatial scales and parameters we examined.

Forest areas with $\leq 70\%$ canopy cover had high probability (0.80) of containing red elder, blue elder, or cascara berries, however, occurrence of each species depended on longitudinal position within the Coast Range (Figure 5). Kozloff (1976) noted the two kinds of elder did not often mix; red elder grows best near the coast in wet habitats, whereas blue elder inhabits dryer areas and is a more common species along the eastern edge of the Coast Range. Although open-canopied forest areas represent potential feeding areas for band-tailed pigeons, longitudinal position within the study area and plant species phenology influence actual food availability.

West-to-east variation in band-tailed pigeon abundance was correlated with the apparent availability of red elder and cascara within potential feeding sites, but also coincided with a number of confounding natural and induced landscape patterns. The study area naturally varied from west to east in climate and vegetation (Franklin and Dymess 1988, Loy et al. 1976). Gabrielson and Jewett (1940) reported band-tailed pigeons in Oregon reach greatest abundance along the coast. Food for nesting pigeons is most available along the coastal side of the Coast Range and least available along the inland side, especially when we conducted our study.

The extent to which the distribution and berry production of elder and cascara has changed over time and the effect on band-tailed pigeon populations is unknown. Elder and cascara shrubs are prevalent in early to intermediate forest successional stages, are prolific producers of berries, and appear to be abundant. However, little is known about the autecology of these species. Factors that can affect the availability of these food resources include: 1) herbicide application following intensive harvest (Hansen et al. 1991); 2) harvest for medicinal use (Starker and Wilcox 1931); and 3) clearing for agricultural practices (Starker and Wilcox 1931). Although the overall distribution of elder and cascara has not likely changed, the

volume of berry production most likely has changed in relation to shrub number, size, form, and over-story shading.

Band-tailed pigeons are widely distributed across the central Coast Range of Oregon, with abundance decreasing from west to east; however, the cues by, and scales at which these birds select breeding habitat is unknown. Decreasing abundance of breeding Pacific Coast band-tailed pigeons over two to three decades does not appear related to availability of potential nesting and feeding areas and known mineral sites, but may be related to actual food availability. Further study is needed to understand the relationship between food availability and pigeon abundance in western Oregon.

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