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Landbird Inventory for North Cascades National Park Service Complex (2001-2002)
Final Report

Natural Resource Technical Report NPS/NCCN/NRTR—2009/152

ON THE COVER
Warbling vireo
Photograph courtesy of NPS files

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Final Report

Natural Resource Technical Report NPS/NCCN/NRTR—2009/152

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Executive Summary

In 2001 National Park Service, The Institute for Bird Populations, and Western Washington University initiated a two-year avian inventory of North Cascades National Park Service Complex (NOCA) to elucidate spatial patterns of abundance across the park for a large suite of species, and to produce information that will assist park managers and cooperators in developing the initial monitoring design for NOCA's long-term landbird monitoring program. The objectives of this inventory were as follows:

- Determine bird-habitat relationships across NOCA.
- Field test and evaluate a sampling method and survey design for inventory and monitoring avian populations in areas with diverse habitats and limited access.
- Gather data that will facilitate predicting avian responses to habitat changes due to land management practices and non-anthropogenic factors.

During our two field seasons (2001 and 2002), we recorded distances to 11,769 individual birds during 1,551 point counts conducted along 229 transects. Sixty-six of these transects (comprising 693 individual survey points) were conducted along park trails, while the remaining 163 transects (comprising 858 individual survey points) were conducted off-trail, generally within a 1 km buffer around roads or trails. We documented the presence of 116 species in the park during the study. One hundred and five of these were detected during at least one point count, while the remaining 11 were recorded only during our early season training session, or at other times during the season when observers were not conducting point counts. We also conducted detailed habitat assessments at each of the 1,551 survey points.

In this report we present lists of all species detected during point counts in each of the park's major habitats. We also indicate how many individuals of each species were detected at point counts in each habitat. For 58 species that were detected during at least ten point counts, we provide habitat-specific density estimates, corrected for species- and habit-differences in detectability. We also present park-wide maps of distribution and abundance for each of these species, and provide estimates of their park-wide abundance. These estimates range from just 190 Common Ravens to more than 300,000 Chestnut-backed Chickadees, which were found abundantly in most North Cascades habitats. Summed densities of all species range from 2.5 birds/ha in heather meadows to 11.1 birds/ha in mixed coniferous-deciduous forests. Park-wide estimates for all 58 common and intermediate species total to more than 2 million individuals.

Results from the 2001 field season also showed that a double-sampling method for estimating absolute population densities has limited utility in complex North Cascades forests. We created territory maps for 46 species detected in four intensively surveyed plots. Density estimates could be made with confidence for no species in low elevation plots with complex forests and for only two species in open subalpine plots. We provide several recommendations about appropriate use of double-sampling based on our results.

Finally, we are analyzing detection data to evaluate several hypotheses of scientific and management importance. We outline these analyses at the end of this report. Results will be submitted for publication in scientific journals.

In summary, our results document a successful field test of an avian population survey design that addressed challenges posed by regions characterized by habitat diversity, rugged terrain, and limited access. They provide an avian inventory of a remote and rugged landscape that remained poorly studied two centuries after the Lewis and Clark expedition. The inventory data also establish a baseline for detecting future changes due to fire management, recreational use, climate change, and other factors.

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Introduction

The National Park Service (NPS) is charged with the responsibility of managing park natural resources and preventing their loss or impairment. To meet this responsibility, NPS established the Natural Resource Inventory and Monitoring Program (I&M) to provide funding and technical support to approximately 269 national park units. The goals of this program are to help park units collect scientifically credible ecological resource information and to develop or improve field and analytical monitoring techniques to aid park managers in managing, planning, and protecting their natural resources. As a first step toward meeting I&M goals, NPS initiated its Natural Resource Inventories Program in 2001. This five-year program emphasizes gathering a core set of data describing park vascular plant and vertebrate resources. Furthermore, parks within the North Coast / Cascades Network, including North Cascades National Park Service Complex (NOCA), held "vital signs" workshops to identify and implement a core program of monitoring. The network monitoring program focuses on the most critical ecological parameters and stressors identified for the network as a whole. All seven parks in the North Coast / Cascades Network identified landbirds as a critical faunal resource to be monitored.

NOCA, encompassing a wide range of elevations and precipitation regimes, provides a variety of habitats that are important to resident and migrant bird populations. Birds are the most visible faunal component of the North Cascades ecosystem. Their high body temperature, rapid metabolism, and high ecological position in most food webs make them good indicators of the effects of local and regional changes in ecosystems (Furness et al. 1993). Their abundance and diversity in virtually all terrestrial habitats and their diurnal nature facilitate the monitoring of their populations. Birds also have tremendous public interest and support.

Reported declines of many birds breeding in North America have stimulated interest in avian population trends and mechanisms driving those trends (DeSante and George 1994). The North American Breeding Bird Survey suggests that landbird populations in Pacific Northwest late-seral forests appear to be in serious decline (Sauer et al. 2001). Though breeding landbird communities are well-documented in some habitats of the southern Washington - Oregon Cascades (Manuwal 1991, Gilbert and Allwine 1991, Hansen et al. 1995), breeding landbird communities and their habitat use in the North Cascades have received little coverage due to difficulty of access and limitations on research personnel. Some data are available, however. Information on species presence/absence and distribution in NOCA are provided in the Washington State Breeding Bird Atlas (Smith et al. 1997). Population trend data exist for two North American Breeding Bird Survey routes conducted annually for the past 17 years and for a third route surveyed almost annually for the past 37 years.

In September 2000, NOCA held a meeting of landbird monitoring experts to produce recommendations for a long-term monitoring plan for landbirds (Siegel and Kuntz 2009). The panel agreed that the combined goals of avian inventory and monitoring at NOCA should be two-fold. First, NOCA should initiate an inventory to elucidate spatial and temporal patterns of abundance across the park for a large suite of species. And, secondly, the park should study the demography of a smaller suite of species to elucidate the proximate causes of detected population trends.

In 2001 NPS, The Institute for Bird Populations (IBP), and Western Washington University (WWU) initiated a two-year inventory to address the first recommendation. The objectives of this inventory are as follows:

- Determine bird-habitat relationships across NOCA.
- Field test and evaluate a sampling method and survey design for inventory and monitoring avian populations in areas with diverse habitats and limited access.
- Gather data that will facilitate predicting avian responses to habitat changes due to land management practices and non-anthropogenic factors.

Data from this inventory effort will also aid park managers and cooperators in developing the initial monitoring design for NOCA's long-term landbird monitoring program.

Methods

Sampling Strategy

Based on the recommendations of our September 2000 workshop (Siegel and Kuntz 2009), we sought to design an inventory strategy that would provide unbiased samples of birds across the broad array of park habitats. To maintain maximum sampling efficiency while avoiding bias, we decided to stratify our survey effort by access strata, wherein areas of the park adjacent to trails and roads (our 'accessible' stratum) would be sampled at a greater intensity than areas more remote from trails or roads (our 'remote' stratum).

We used ArcView software to lay a grid of potential transect starting points, 1 km apart, over a map of the entire park. We then removed all grid points less than 2 km from the park boundary, because we expected transects to average about 2 km in length, and we wanted to insure that few if any survey points would accidentally be conducted outside the park. This initial effort yielded 2,105 potential transect starting points. We eliminated all points that fell in habitat cells classified as rock, snow, or water, and then, out of safety concerns, we removed all remaining starting points that fell on slopes greater than 40°.

We defined our 'accessible' stratum as including all areas of the park within a 2 km buffer of trails and roads. This buffer contained 730 of our remaining grid points. Our expectation was that transects defined by starting points within this stratum would extend away from the trails to a distance of up to 4 km. We therefore defined our 'remote' stratum as all areas of the park greater than 4 km from trails or roads. To sample this stratum, we restricted our attention to starting points at least 6 km from trails or roads, under the assumption that some of our 'remote' transects would run toward trails and roads, ending as close as 4 km away from them .

To select a tractable number of starting points, we then performed an iterative process of selecting for consideration every nth point within each stratum. We plotted the selected points on maps that indicated topography, streams and trails, and discarded points that:

1) were inaccessible from trails due to potentially dangerous stream crossings or areas with slope greater than 40°,

2) were accessible, but were severely hemmed in by uncrossable barriers, such that it would be impossible to conduct a transect of five or more points, and

3) were only 1 km from another selected starting point, unless the two points were separated by a river or other feature that would assure transects would not overlap one another.

Finally, once our point inspection process was complete, we augmented our starting point list with a small number of deliberately selected 'additional' points in habitats or areas of the park that have special management concerns, but that would likely be poorly sampled by our generalized strategy because of their very limited distribution. These habitats and areas included meadows, deciduous forest patches, and the Stehekin Valley.

Once the field season began, we made two important changes to our sampling scheme:

- We did not conduct any 'remote' stratum sampling points. Careful inspection of topographic maps had left us somewhat skeptical that we could indeed access these points. Once the field season began, it quickly became clear that logistic as well safety concerns made surveying these points unfeasible. They generally would require two or three days of off-trail travel to access, (and another two or three days to return) and more importantly, would necessitate crossing dangerous terrain. Sampling the remote areas would thus have compromised project objectives by 1) substantially reducing total sample size due to lengthy travel time required to access remote points, and 2) risking the safety of field crews.

- Our 2 km buffer around trails and roads proved to be too wide. During the first week of surveying, our crews routinely had to break camp and head for their survey points as early as 3:30 am to attempt to reach by sunrise points that were out toward the periphery of the buffer. After that first week, we therefore changed the locations of all intended survey points that were further than 1 km from a trail or road, by moving them along a perpendicular toward the trail, to a distance of 1 km from the trail.

Prior to the second year of the study, we made two additional changes to our sampling scheme:

- We changed our definition of accessible slope from <40° to <35°.

- Since observers can complete approximately twice as many individual points per morning working on trails compared to off trails, we decided to augment our sample sizes by conducting about half of our 2002 field season transects directly on park trails. Trail segments were selected at random, from among all possible trail segments in the park. Trail transects were conducted in a similar manner to off-trail transects, except that rather than following a cardinal or semi-cardinal compass bearing, observers walked along the trail in a predetermined direction, conducting point counts and vegetation sampling every 200 m.

Field Methods

We used five-minute variable circular plot (VCP) point counts (Fancy and Sauer 2000, Siegel 2009) coupled with detailed habitat descriptions of each point count location as our primary means of surveying birds. VCP point counts entailed recording the horizontal distance, estimated to the nearest meter, to every bird seen or heard during the point count.

Off-trail Transects

Each morning in the field, each two-person team conducted a transect of approximately 5-6 point counts spaced 200 m apart in a randomly chosen cardinal direction from the pre-selected starting point, which was located in the field with topographic maps and a hand-held GPS unit. Prior to starting a transect, one team member was designated the point count observer and the other was designated the vegetation observer. The point count observer flagged the trail from point to point as a transect was conducted; the vegetation observer then followed the trail of flagging, collecting vegetation data at the indicated point count locations. Vegetation observers were careful to remain at least 200 m behind the point count observer, to avoid influencing bird activity during the count. As a safety consideration, point count and vegetation observers remained in radio contact for the duration of a transect count period. Observers frequently encountered a river, cliff, or other barrier that prevented them from completing transects along the intended compass bearing. When this occurred in 2001 the observers returned to the last successfully completed point, and then turned 90° clockwise to continue a transect. If this bearing was obstructed as well, they turned 270° from the original bearing. In 2002, observers responded to impassable barriers by first considering adjusting their bearing by 45° in either direction; if both paths were still blocked, they then considered adjusting their bearing by 90° in each direction, etc. When either of these sets of instructions could be followed along an entire transect, that transect was recorded as having been completed according to the 'normal' protocol.

In many instances, however, the 'normal' protocol had to be modified, due to terrain that was unduly dangerous or even impossible to traverse. In such instances, the following transect protocol modifications were permitted at the discretion of the field observers:

1) When topographic features and/or streams prevented the crew's approaching within 250 m of the intended starting point, rather than sacrificing the morning's work, the crew was instructed to begin the transect from as close to the intended starting point as possible, but to record the transect as having been 'offset'. This situation rarely arose.

2) In many cases the crew successfully reached the intended starting point, but then at some point during a transect found that topographic features or streams prevented safe travel in *any* cardinal direction. In this instance crews were instructed to deliberately choose a non-cardinal bearing that would allow them to travel 200 m in a straight line to their next survey point. These transects were recorded as being 'deliberate'.

On-trail Transects

Pre-designated on-trail transects were begun at the intended starting points, and conducted along the trail in a pre-determined direction. Observers used pacing, topographic maps, and GPS units to place each point 200 m apart along the trail.

Point Counts: For all transects, point counts began within 10 minutes of local sunrise, and continued until 3.5 hours after local sunrise. Observers noted all birds heard or seen during five minutes of observation, and estimated the horizontal distance to each bird. 'Flyovers'— defined as birds that flew over the top of the vegetation canopy, never touched down in the observer's field of view, and did not appear to be foraging, displaying, or behaving in any other way that might suggest a link to the habitat below— were tallied separately from other bird detections. Birds thought to have been recorded previously at another point were marked accordingly on the data forms. Geographic coordinates based on GPS readings and topographic maps were recorded at each sampling point, generally by the vegetation observer (Appendix 1 – Field Forms).

Additionally, whenever crew members detected species thought to be rare or difficult to sample in the park, they completed "Rare Bird Report Forms", including descriptions of the birds' appearance and behavior and geographic coordinates (Appendix 1 – Field Forms). These reports covered not only birds detected during point counts, but also birds detected while sampling vegetation, hiking between transects, relaxing at camp in the evening, or at any other time during the field season.

In both 2001 and 2002, data collection began during the last week in May (with the exception of Rare Bird Report Forms, which were completed opportunistically during the training session which started May 7), and continued through the end of July.

Vegetation Sampling at Bird Survey Points

Vegetation descriptions entailed collecting data on vegetation structure and composition within a 50 m radius circular plot centered on each survey point, and then assigning a primary habitat classification to the plot. Habitat classifications were based on the 28 habitats mapped in the park's current GIS habitat coverage (Pacific Meridian Resources 1996), with two exceptions:

- We split the Pacific Meridian Resources (PMR) habitat 'Douglas-fir' into two separate habitats, Douglas-fir West and Douglas-fir East, based on whether individual habitat patches were east or west of the Cascades crest. This split was necessary because areas dominated by Douglas-fir exhibited substantially different stand structure and bird community composition on opposite sides of the crest (NPS, unpubl. data).

- We did not allow any points to be classified in the field with the catch-all classification 'Conifer Mix'.

Vegetation plots occasionally straddled more than one distinct habitat type. In these cases, observers classified the point as being dominated by the habitat that covered the larger portion of the plot, and then additionally recorded the 'secondary' habitat present in the plot. We also recorded cover, average height, and species composition of four vegetation layers (ground-cover,

understory, sub-canopy, and canopy), conducted point-centered quarters 50 m in each cardinal direction from the plot center, measured the canopy cover using a spherical densiometer, and recorded summary plot characteristics such as aspect, slope, and the presence of running or standing water. In 2002 only, we collected additional information, including trunk density and species composition, in two 20 m x 40 m subplots within the larger 50 m radius plot. A more detailed description of the habitat data we collected is provided in our Vegetation Sampling Field Protocol (Appendix 2).

Training and Testing

At the beginning of each field season, our field crew underwent an intensive two-week training program onsite in the park. Crew members, who generally had prior experience birding and conducting biological fieldwork, were trained in visual and aural bird identification, distance estimation, plant identification, orienteering, backcountry safety, and project protocols. Bird identification skills were honed by spending days in the field birding and practicing point counts with experienced trainers, and then reviewing at night with the aid of field guides, recorded songs and calls, and an instructional CD-ROM. At the end of the two-week training period, crew members underwent a rigorous exam involving the identification of approximately 100 recorded songs and calls (some of them grouped together in rapid succession to produce 'simulated point counts') as well as 20-30 photographic images. Crew members were not permitted to conduct point counts (they worked solely as vegetation observers instead) until they passed the exam, which required a near-perfect score.

Data Analysis

Density Estimates

All data were entered into DBASE databases, which were then checked for errors using an array of automated and manual data verification routines that ensured flagged invalid species codes, habitat codes, transect numbers, etc. Errors were corrected by referring back to the original datasheets. We have submitted copies of the verified databases along with this report.

The effective detection radius for birds during point counts has been shown to vary across habitats and between species (Burnham 1981, Barker and Sauer 1995). Because vegetative structure differs dramatically across park habitats, it is necessary to correct for inter-habitat variability in detectability before densities can be compared across habitats (Buckland et al. 2001). Additionally, some species vocalize much more frequently and/or loudly than others, so detectability corrections must be performed on a species by species basis. For frequently detected species in well-represented habitats, we used the computer program DISTANCE 4.0 (Thomas et al. 2002) to correct for inter-habitat differences in detectability and to produce estimates of absolute density.

Distance-sampling experts generally advise that at least 60-80 detections are necessary for reliably modeling the relationship between detection probability and distance from the observer (Buckland et al. 2001). We amassed 60 or more detections in a single habitat type for a relatively restricted number of species and habitats, so for the purpose of modeling detection

probability, we pooled habitats into two general groups, based on vegetation structure and, presumably, likelihood of detecting birds at moderate or large distances:

Sparsely vegetated habitats: high-elevation forests (including Subalpine Fir, Mountain Hemlock and Subalpine Larch) as well as unforested habitats (Meadow, Heather, and Rock).

Densely vegetated habitats: Low- and mid-elevation conifer and deciduous forests (including Bigleaf Maple, Conifer/Deciduous Mix, Douglas-fir (east and west of the crest), Engelmann Spruce, Hardwood Mix, Lodgepole Pine, Pacific Silver Fir, Ponderosa Pine, Red Alder, Shrub, Western Hemlock, and Western Redcedar).

Within each of these two habitat groups, we used DISTANCE 4.0 to fit detection functions for each species detected at least 60 times in the habitats that constituted that group. We set the data filter to truncate observations representing the largest 5% of recorded distances. We fit detection functions using the half normal key function with cosine as well as simple polynomial series expansions (Buckland et al. 2001), and used the Akaike Information Criterion (AIC) to select the best model (Akaike 1973, Burnham and Anderson 1998). We then used goodness of fit statistics to test the appropriateness of the selected models (Buckland et al. 2001). For each species in each habitat group, we applied the selected detection function to the data for each habitat within that habitat group, yielding species-specific density estimates for each habitat.

For species detected fewer than 60 times within either habitat group, but more than nine times, our dataset was inadequate for reliably fitting the detection function, but too large to discard altogether. We corrected point count results of these rarer species by using the detectability functions of 'surrogate species'—species with similar vocal characteristics and singing behaviors that were detected at least 60 times within a habitat group. To select surrogate species, we chose from among the pool of species with adequate numbers of detections within each habitat group, matching up pairs of species with similar song volume and pitch, singing frequency, and/or typical singing location (i.e. high in the canopy, or in dense underbrush). Following the guidelines of Thomas et al. (2002), we formatted Distance to model detectability of these rarer species by fitting a uniform detection function, with a multiplier that corresponded to the detection probability of the surrogate species.

Maps of Species Distribution and Abundance

We generated maps of the distribution and abundance of each species detected at 10 or more points. These maps combine habitat-specific density estimates with the NOCA habitat data layer (Map 1 on CD; Pacific Meridian Resources 1996). For each species, we assembled a list of mean density estimates for habitats in the PMR data layer (Tables 5-24). Then we transformed the PMR habitat map into density maps for each species. These density maps interpolate the habitat-specific density estimates across unsampled locations within sampled habitat types.

For Pine Siskins, we deviated from the mapping procedure described above because flocking behavior in this species required a different kind of analysis. Pine Siskin flocking resulted in severely clumped data, which violate the assumption that individuals were detected independently. For flocking species, it is more appropriate to determine the detection of flocks than detection of individuals. Consequently, we converted detection data into habitat-specific

rates of flock detection. Then we calculated mean flock size for each habitat (Table 25). Finally, we mapped Pine Siskin density as the product of habitat-specific flock detection rates with habitat-specific mean flock sizes. Following Welsh et al. (1988), we added covariance of flock size and detection rate to their product, because flock size and detection rate were strongly correlated. This yielded the following formula for habitat-specific mean density of Pine Siskins.

$$\mu_{d_i} = \mu(f_i p_i) = \mu(f_i)\mu(p_i) + \mathrm{cov}(f_i, p_i),$$

where d_i = density in habitat i

$\mu(x)$ = mean of quantity x

f_i = flock size in habitat i

p_i = detection rate in habitat i.

Similarly, estimates of variance in Pine Siskin density must consider non-independence of flock detection rates and flock sizes. The appropriate formula is from Goodman (1960):

$$\sigma(f_i p_i)^2 = \mu(p_i)^2\sigma(f_i)^2 + \mu(f_i)^2\sigma(p_i)^2 + 2\mu(p_i)\mu(f_i)\mathrm{Cov}(p_i, f) + 2\mu(p_i)\mathrm{Cov}(\Delta p, \Delta f^2) + 2\mu(f_i)\mathrm{Cov}(\Delta p^2, \Delta f) + \sigma(\Delta p \Delta f)^2$$

where $\Delta p = p - \mu(p)$ and $\Delta f = f - \mu(f)$

Park-wide Species Abundance Estimates

We estimated the total abundance of each species in NOCA by multiplying habitat-specific density estimates (μ_{d_i}) by the estimated areal extent of each habitat (μ_{a_i}), and summing over all habitats (*i*). Variances in park-wide abundance estimates $[\sigma(D)^2]$ were calculated following Welsh et al. (1988):

$$\sigma(D)^2 = \sum_i \sigma(d_i a_i)^2$$

$$\sigma(D)^2 = \sum_i [\mu(d_i)^2\sigma(a_i)^2 + \mu(a_i)^2\sigma(d_i)^2 + \sigma(d_i)^2\sigma(a_i)^2].$$

This formula assumes zero covariance between species densities and habitat areas. Variance in species densities were derived from values in Tables 5-18, 25. Variances in habitat areas were derived from the accuracy assessment error matrix in Pacific Meridian Resources (1996). Habitat-specific accuracy values were used as parameter values of a binomial distribution. Habitat variances then were calculated as $ap(1-p)$, where a is habitat area and p is identification accuracy for that habitat. For habitats inadequately sampled in the Pacific Meridian Resources (1996) accuracy assessment, we used the overall accuracy (0.49) as a surrogate for p.

Intensive Plot Survey Methods

Plot Selection

We conducted intensive surveys at four 10-hectare plots using territory mapping techniques (Bibby 2000). Potential plot locations were determined by stratifying NOCA into two categories based on perceived habitat complexity using ArcView GIS software version 3.2. The first stratum, representing the greatest habitat complexity, included all low elevation (< 305 m)

Douglas Fir (*Pseudotsuga menziesii*) and Western Hemlock (*Tsuga heterophylla)* dominated forests within NOCA. The second strata, representing the lowest complexity among forested habitats, included all high elevation (> 1676 m) Pacific Silver Fir (*Abies amabilis*) and Sub-alpine Fir (*Abies lasiocarpa*) dominated open parklands within NOCA. Final plot locations were determined by extracting all locations within the park that met the above criteria, could contain a 10 hectare plot, and lay within 0.8 km from a road or trail. After extracting the set of potential sites using GIS, we selected Big Beaver and Thunder Creek as low elevation sites, and McAlester and Stiletto as high elevation sites (Figure 1).

Plot Set-up

We used a square shape for our ten hectare plots to minimize edge to area ratio. We established a grid in each plot, which consisted of nine transect lines roughly parallel to the slope and nine transect lines roughly perpendicular to the slope. Adjacent lines were spaced 39.5 m apart. We marked each node on the plot grids with a numbered and brightly colored flag. We marked plot perimeters with flags of a different color. Setup time ranged from seven to 13 hours, depending on understory density.

Training

Field crew members attended the two-week point count training session conducted by The Institute for Bird Populations and NOCA biologist Bob Kuntz. While we did not formally test the field crew, we did not allow crew members to conduct surveys alone until they demonstrated competence in bird identification. Our criterion for competence was correct identification by sight and sound for nearly all birds encountered during training, plot set-up, and several group mapping sessions. All members of the intensive survey field crew achieved this level of competence before solitary surveys began.

Field Methods

Due to lingering snowpack at high elevation plots and safety concerns, we did not begin sampling high elevation sites until sampling at low elevation plots was completed.

Territory mapping at each site began at local sunrise and continued until all horizontal transect lines were walked. Time required to map an entire plot differed between the two habitat types in the intensive survey, with low and high elevation plots requiring roughly four hours and three hours to complete, respectively. Researchers recorded all bird vocalizations, visual observations, and kind of detection (visual, singing, territorial behavior, active nest, etc.), as described in Bibby (2000). Detection locations were recorded on a data grid corresponding to the grid of transect lines in each plot (Map 2 on CD).

After territory mapping in the morning, crew members returned to likely nest sites within study plots and attempted to locate nests precisely. We augmented territory maps with nests located during these nest searching periods. Low elevation plots were sampled three times per week for five weeks from late May until the end of June. High elevation plots were sampled four to five times per week for three weeks during July.

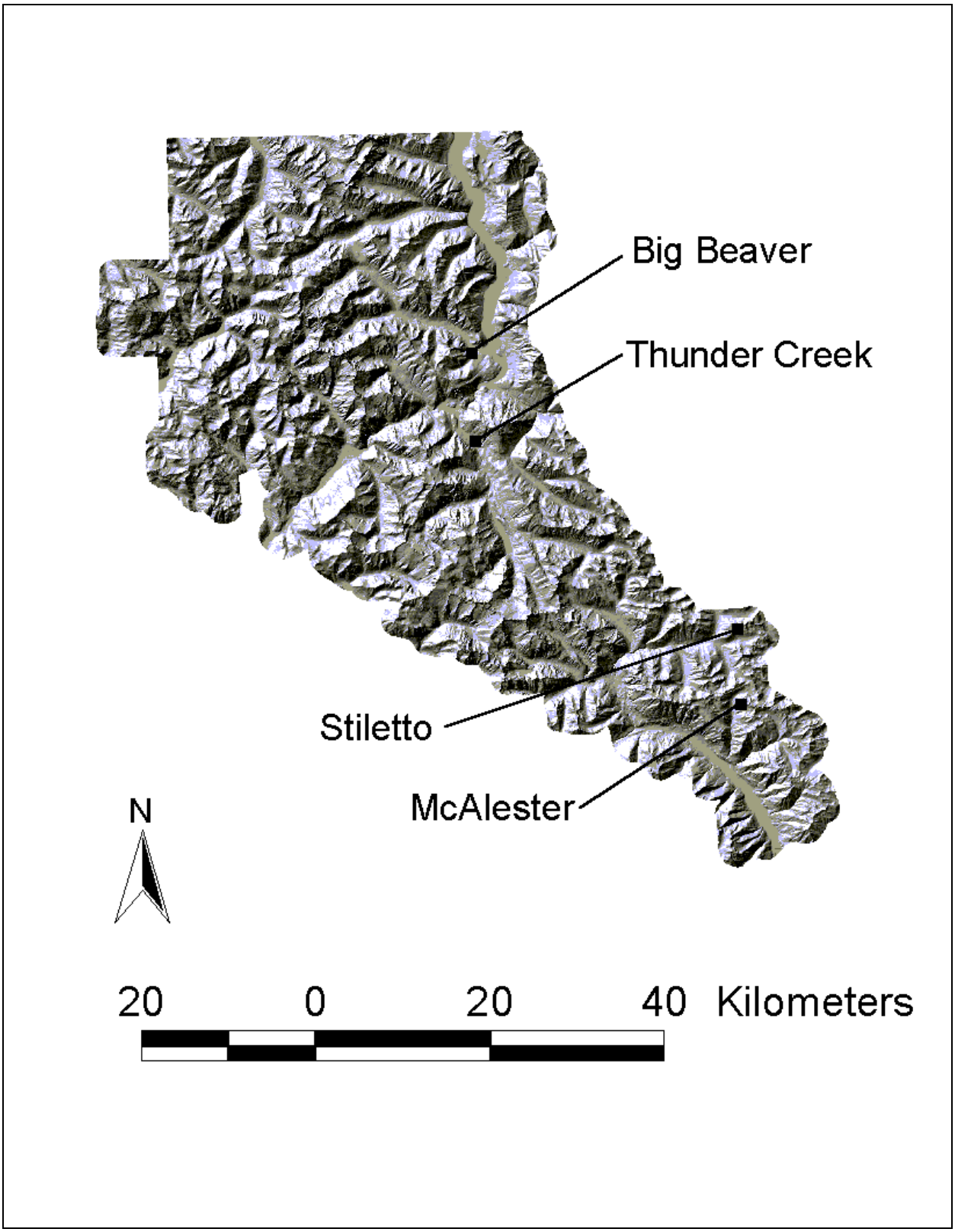


Figure 1. Locations of Intensive Survey Plots.

Results and Discussion

Scope of Fieldwork Accomplished

We recorded 11,769 individual birds during 1,551 point counts conducted along 229 transects (Maps 2, 4-61). We completed an average of 10.5 points per transect during on-trail transects, and 5.3 points per transect during off-trail transects, where difficult terrain and thick vegetation slowed our travel and reduced the number of points we could complete before the morning sampling hours ended. All the points on a particular transect were rarely classified as being dominated by the same habitat type; on average, on-trail transects included points dominated by 2.7 different habitats, and off-trail transect included points dominated by 2.2 different habitats.

The largest share of our sampling points were classified in the field as Douglas-fir West (318 points), Douglas-fir East (229 points) and Western Hemlock (208 points), but 11 other habitats were represented by at least 30 sampling points (Table 1). Habitats represented by fewer than 30 points were either deliberately avoided ('Water', because this was a landbird survey, 'Snow', because of accessibility issues, and 'Mixed Conifer' and 'Less than 25% Any Species' because these categories were poorly defined by Pacific Meridian Resources) or comprise well under 1% of the park.

Bird Species Detected in the Park

We documented the presence of 116 species in the park during the study (Table 2). One hundred and five of these were detected during at least one point count, while the remaining 11 were recorded only during our early season training session, or at other times during the season when observers were not conducting point counts (Table 2).

Density Estimates

Table 3 lists the 34 species for which we amassed at least 60 detections in densely vegetated habitats, sparsely vegetated habitats, or both.. Many more species met this threshold in densely vegetated habitats (33 species) than in sparsely vegetated habitats (9 species) because only 258 points, or 16.7% of the total, fell in sparsely vegetated habitats. We used the surrogate species method described above to estimate density in densely and/or sparsely vegetated habitats for 51 species. Table 4 indicates which surrogates species we paired with each of the rarer species.

The list of species detected during point counts in each habitat, along with the number of detections amassed for each species, and density estimates are presented in Tables 5-24. Tables 5-24 are presented in order according to how many points were sampled in each habitat.

Park-wide Abundance Estimates

Total park-wide abundance estimates ranged from incidentally detected species to more than 300,000 Chestnut-backed Chickadees (Table 26). These total abundance estimates form a lognormal distribution (Figure 2), a pattern commonly observed in species assemblages (Preston 1962a,b; 1975). Species-specific abundances sum to more than two million landbirds throughout

NOCA. Common species dominate this sum. The five most abundant species represent 49% of the total.

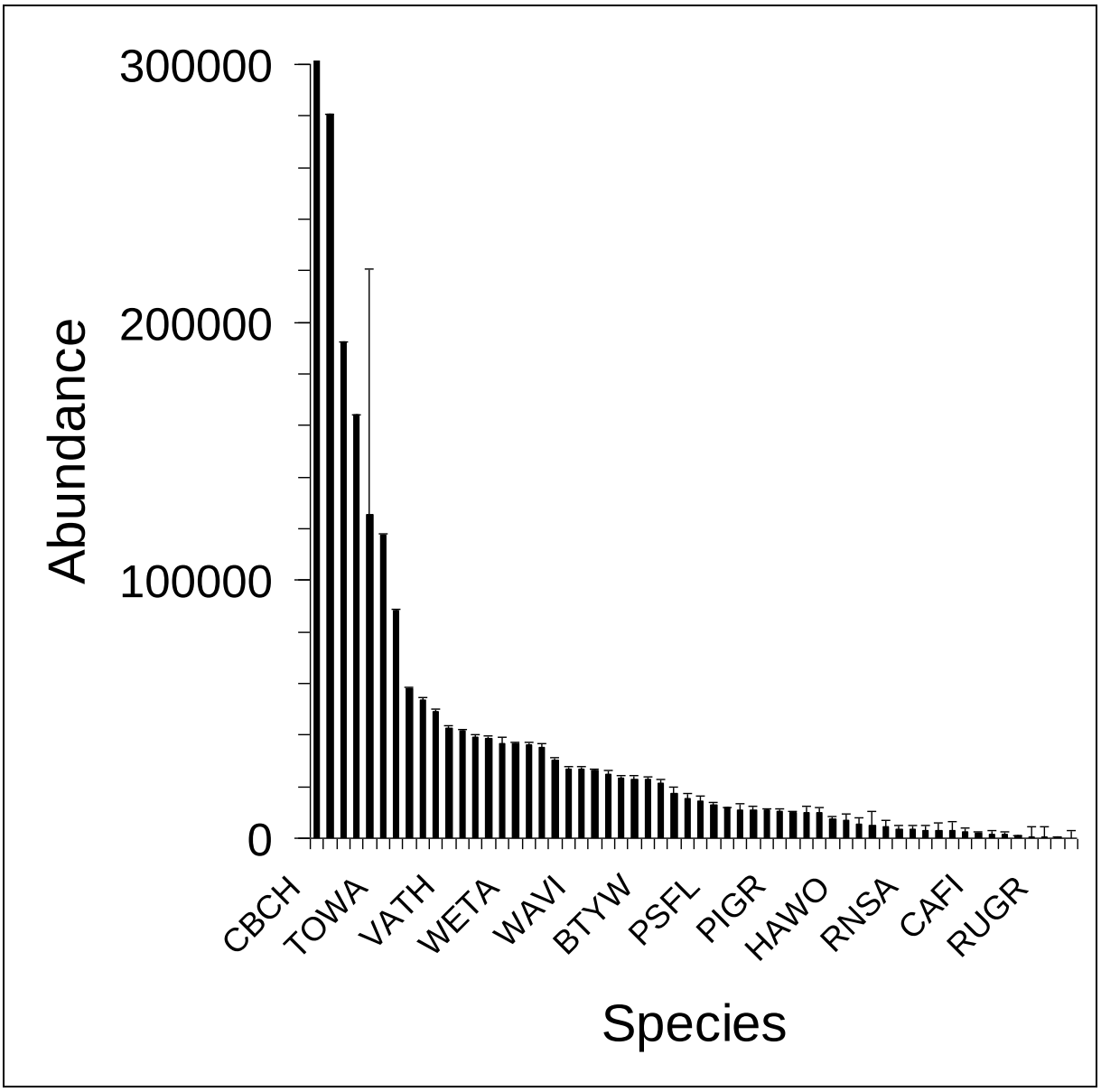


Figure 2. Park-wide abundance estimates (with SD added as error bars) for the 58 species detected in at least ten locations. Species are plotted from left to right in order of decreasing abundance, forming a lognormal distribution. The standard deviation in the abundance estimate for Pine Siskins, the 5th bar from the left, is unusually large due to the clumped distribution of this flocking species.

Species Maps

Maps 4-61 show (Appendix 4) estimated distributions and abundances of species detected at least 10 times during point counts. These maps also plot point count locations, which were well distributed across the park within most habitat types. The maps do not contain information about habitats not sampled ('Water', 'Snow', 'Mixed Conifer', and 'Less than 25% Any Species'), as discussed above.

Intensive Plot Surveys

We completed a total of 59 territory maps for 46 species in the four plots sampled in 2001. We recorded 32, 31, 26, and 22 species in plots at Thunder Creek, Big Beaver, Stiletto, and McAlester, respectively (Table 27).

Intensive survey results were not sufficient to estimate bias in VCP inventory data. Of the 36 species detected in or around the low elevation plots, rough estimates of absolute density are possible for only five species, and the number of territories can be determined with confidence for none (Table 27). Of the 28 species detected in high elevation plots, rough estimates of density are possible for three and the number of territories can be determined with confidence for two species, Chipping Sparrow and Dark-eyed Junco (Table 27). For these two species, the number of territories differed substantially between the two plots, resulting in large uncertainty in bias estimates for VCP inventory data using Bart's (2002) double sampling method.

Numerous factors hindered efforts to map songbird territories in NOCA. First, most detections at low elevations were aural. Dense forest understories and tall, multi-layered canopies reduced precision of detection locations. This uncertainty in location data resulted in exaggerated overlap in mapped territories. Second, delineating individual territories was difficult at both high and low elevation plots due to limited countersinging, which is essential for territory mapping. Third, temporal trends in detection rates hampered data collection. We checked for trends by having two observers survey a given plot starting simultaneously at opposite ends. We found trends of decreasing detection rates as a function of distance from the starting point in data from both observers. Similar trends were detected in data collected at a given plot throughout the season. At the low end of both kinds of temporal trends, individuals and territorial interactions were detected infrequently enough to compromise mapping effectiveness. Finally, 10 hectare plots were too small for some species. Many species had partial territories within the plots, complicating efforts to estimate density.

From its inception, we viewed this portion of the research project to be experimental. We hoped to determine whether or not the double-sampling that was used by Bart (2002) on ground nesting birds in Alaska could be applied to coniferous forests of the Pacific Northwest, one of the most structurally complex ecosystems in North America. Our results suggest that territory mapping in the North Cascades is impractical for use in structurally complex forests. Future attempts to study bias in VCP data in complex forests should consider using the nest search method (Siegel 2009) and focus on species that nest within 10-20 meters of the ground. Further, more plots per stratum are required to estimate bias and uncertainty with the double-sampling method. Our results from two sites within each strata were hampered two factors. First, not all species occurred in both plots, but the double-sampling method requires density estimates from at least

two plots. Second, many plots are required to reduce uncertainty in bias estimates, unless there is limited variability in density estimates between plots. Measures to address these factors would require larger field crews.

Analyses in Progress

We are analyzing point-specific detection data and habitat-specific density estimates to address several questions of scientific and management importance. Results will be submitted for publication in scientific journals. These questions and our analytic approaches are summarized below.

1. Detection rates for on- versus off-trails surveys. For several reasons, detectability of birds during point counts may differ between point counts conducted on and off trails. We tested whether trails affected bird detectability in forested habitats in NOCA. For 14 frequently detected species, we modeled the relationship between detection probability and distance from the observer a) with separate detection functions for on-trail and off-trail point counts, and b) with global detection functions based on all data pooled. Then, we used Akaike's Information Criterion to select the best kind of model. A manuscript has been completed and submitted to The American Ornithologist's Union for publication in *The Auk*.

2. Elevational gradients in species richness. Decreases in species richness with elevation are a common biogeographic pattern. We will determine the strength an elevational gradients in the NOCA avifauna, if one exists. Our approach will be to regress species richness on elevation, with due care to address potential statistical concerns, such as nonlinearities and non-normal distributions.

3. Relationship between total avian biomass and species richness. We will determine whether sites with more species also support greater avian biomass, or whether biomass depends more strongly on other factors such as species composition or habitat type. We will apply correlation and regression analyses to address this question.

4. Bird-habitat relationships. We will test bird-habitat models developed for other Pacific Northwest forested regions by Hansen et al. 1995. If those models perform poorly with our data from NOCA, we will develop NOCA-specific models using an Information Theoretic approach (Burnham and Anderson 1998). These models or those from Hansen et al. 1995 can be used to forecast effects of management decisions, such as snag removal or fire management in the Stehekin Valley.

5. Relationships between habitat structural complexity and species abundances. We will apply habitat models described above to determine whether or how avian-habitat relationships differ qualitatively among habitat types.

6. Effects of understory vegetation on aerial foragers. We will apply habitat models described above to determine whether or how management practices alter avian abundances. For example, we will test the hypothesis that fire suppression or other management increasing understory

vegetation reduces abundances of flycatchers and other species that forage in relatively open habitats.

7. Effects of human activity on species composition and abundances. We will test the linked hypotheses that human activity increases corvid densities, which then reduce densities of species vulnerable to corvid predation. We will test the first hypothesis using analysis of variance, after sorting point locations into levels of human activity. We will test the second by dividing remaining species into cavity and open-cup nesters, and then regressing abundances of each against corvid densities. If both hypotheses are accurate, open-cup nester abundance should decline more rapidly with corvid abundance.

Literature Cited

Akaike, H. 1973. Information theory as an extension of the maximum likelihood principle. Pages 267-281 in B. N. Petrov and F. Csaki, editors. Second International Symposium on Information Theory. Akademiai Kiado, Budapest.

Barker, R. J. and J. R. Sauer. 1995. Statistical aspects of point count sampling. Pages 125-130 in C.J. Ralph, J.R. Sauer and S. Droege, editors. Monitoring Bird Populations by Point Counts. USDA, Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-149.

Bart, J. and S. Earnst. 2002. Double-sampling to estimate density and population trends in birds. Auk 199:36-45.

Bibby, C.J., N.D. Burgess, D.A. Hill, and S.H. Mustoe. 2000. Bird census techniques. Second edition. Academic Press, London. 302 pp.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, Oxford.

Burnham, K. P. 1981. Summarizing remarks: environmental influences. Pages 324-325 in Ralph, C.J. and J.M. Scott, editors. Estimating Numbers of Terrestrial Birds. Studies in Avian Biology 6.

Burnham, K. P., and D. R. Anderson. 1998. Model selection and inference: a practical information-theoretic approach. Springer, New York.

DeSante, D. F. and L. George. 1994. Population trends in the landbirds of western North America. Pages 173-190 in Jehl, J.R. Jr. and N.K. Johnson, eds. A Century of Avifaunal change in western North America. Studies in Avian Biology No. 15.

Fancy, S. G. and J. R. Sauer. 2000. Recommended methods for inventory and monitoring of biological resources in national parks. National Park Service, Inventory and Monitoring Program. Fort Collins, CO. 11 pp.

Furness, R. W., J. J. D. Greenwood, and P.J. Jarvis. 1993. Can birds be used to monitor the environment? Pages 1-41 in Furness, R.W., and J.J.D. Greenwood, editors. Birds as Monitors of Environmental Change. Chapman and Hall, London.

Gilbert, F. F. and R. Allwine. 1991. Spring bird communities in the Oregon Cascade Range. Pages 144-158 in Ruggiero, L.F., K.B. Aubry, A.B. Carey, and M.H. Huff, editors. Wildlife and Vegetation of unmanaged Douglas-fir Forests. USDA, Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-285.

Goodman, L. A. 1960. On the exact variance of products. *J. Am. Stat. Assoc.* 50:708-713.

Hansen, A.J., W.C. McComb, R. Vega, M. G. Raphael, and M. Hunter. 1995. Bird habitat relationships in natural and managed forests in the west cascades of Oregon. Ecological Applications 5:555-569.

Manuel, D. A. 1991. Spring bird communities in the southern Washington Cascade Range. Pages 160-174 in Ruggiero, L.F., K.B. Aubry, A. B. Carey, and M. H. Huff, techical editors. Wildlife and Vegetation of unmanaged Douglas-fir Forests. USDA, Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-285.

Pacific Meridian Resources. 1996. Vegetation and landform database development—final report submitted to National Park Service, Pacific Northwest Region. Pacific Meridian Resources, Portland, OR. 37 pp + appendices.

Sauer, J. R., J. E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966-2000. Version 2001.2. USGS, Patuxent Wildlife Research Center, Laurel, MD.

Siegel, R. B. 2009. Methods for monitoring landbirds: a review commissioned by Seattle City Light's Wildlife Research Advisory Committee (2000). Natural Resource Report NPS/NCCN/NRR—2009/074. National Park Service, Fort Collins, Colorado.

Siegel, R. B., and R. C. Kuntz II. 2009. Designing a landbird monitoring program at North Cascades National Park Service Complex: summary recommendations from a September 2000 workshop. Natural Resource Report NPS/NCCN/NRR—2009/075. National Park Service, Fort Collins, Colorado.

Smith, M. R., P. W. Mattocks, Jr., and K. M. Cassidy. 1997. Breeding birds of Washington State. Volume 4 in Cassidy, K. M., C. E. Grue, M. R. Smith, and K. M. Dvornich, editors. Washington State Gap Analysis - Final Report. Seattle Audubon Society Publications in Zoology No. 1, Seattle. 538 pp.

Thomas, L., J. L. Laake, S. Strindberg, F. F. C. Marques, S. T. Buckland, D. L. Borchers, D. R. Anderson, K. P. Burnham, S. L. Hedley, and J. H. Pollard. 2002. Distance 4.0 Release 2. Research Unit for Wildlife Populations Assessment, University of St. Andrews, UK. <http://www.ruwpa.st-and.ac.uk/distance/>.

Welsh, A. H., A. T. Peterson, and S. A. Altmann. 1988. The fallacy of averages. American Naturalist 132:277-288.

Table 1. Number of points sampled in each habitat. 'Percent of Park' indicates the total park area each habitat comprises, as mapped by Pacific Meridian Resources (1996).

Habitat	Points Sampled	Percent of Park
Douglas-fir West	318	8.0[1]
Douglas-fir East	229	5.6[1]
Western Hemlock	208	10.0
Shrub	141	11.3
Pacific Silver Fir	110	11.0
Conifer-Deciduous Mix	104	0.1
Meadow	66	1.1
Engelmann Spruce	60	0.2
Western Redcedar	57	1.3
Subalpine Fir	55	1.9
Mountain Hemlock	53	5.1
Heather	50	5.2
Lodgepole Pine	37	0.9
Rock/Sparsely Vegetated	32	19.4
Red Alder	9	0.5
Hardwood Mix	8	<0.1
Ponderosa Pine	7	0.1
Bigleaf Maple	4	0.2
Subalpine Larch	1	<0.1
Less than 25% Any Species	1	4.5
Conifer Mix	0	6.4
Snow	0	5.3
Water	0	2.2
Black Cottonwood	0	0.1
Alaska Yellowcedar	0	<0.1
Quaking Aspen	0	<0.1
Total	1551	100

[1]Coverage estimate is approximate for Douglas-fir West/East split.

Table 2. All bird species detected by IBP staff in NOCA during the 2001 and 2002 field seasons. Asterisks indicate species that were never recorded during point counts.

1. Common Loon
2. Canada Goose
3. Mallard
4. Blue-winged Teal
5. Ring-necked Duck*
6. Harlequin Duck
7. Barrow's Goldeneye
8. Hooded Merganser*
9. Osprey
10. Bald Eagle
11. Cooper's Hawk
12. Northern Goshawk
13. Red-tailed Hawk*
14. Golden Eagle
15. Peregrine Falcon*
16. Ruffed Grouse
17. White-tailed Ptarmigan*
18. Blue Grouse
19. Killdeer
20. Spotted Sandpiper
21. Mourning Dove*
22. Western Screech-Owl
23. Northern Pygmy-Owl
24. Spotted Owl*
25. Barred Owl
26. Common Nighthawk
27. Black Swift
28. Vaux's Swift
29. Calliope Hummingbird
30. Rufous Hummingbird
31. Belted Kingfisher
32. Red-naped Sapsucker
33. Red-breasted Sapsucker
34. Downy Woodpecker
35. Hairy Woodpecker
36. Three-toed Woodpecker
37. Northern Flicker
38. Pileated Woodpecker
39. Olive-sided Flycatcher
40. Western Wood-Pewee
41. Willow Flycatcher
42. Least Flycatcher*
43. Hammond's Flycatcher
44. Dusky Flycatcher
45. Pacific-slope Flycatcher
46. Say's Phoebe*
47. Cassin's Vireo
48. Warbling Vireo
49. Red-eyed Vireo
50. Gray Jay
51. Steller's Jay
52. Clark's Nutcracker
53. American Crow
54. Common Raven
55. Cliff Swallow
56. Violet-green Swallow
57. N. Rough-winged Swallow
58. Cliff Swallow
59. Black-capped Chickadee
60. Mountain Chickadee
61. Chestnut-backed Chickadee
62. Red-breasted Nuthatch
63. White-breasted Nuthatch
64. Brown Creeper
65. Canyon Wren
66. House Wren
67. Winter Wren
68. American Dipper
69. Golden-crowned Kinglet
70. Ruby-crowned Kinglet
71. Mountain Bluebird
72. Townsend's Solitaire
73. Veery
74. Swainson's Thrush
75. Hermit Thrush
76. American Robin
77. Varied Thrush
78. Gray Catbird
79. European Starling
80. American Pipit
81. Cedar Waxwing
82. Orange-crowned Warbler
83. Nashville Warbler
84. Yellow Warbler
85. Audubon's Warbler
86. Blk.-throated Gray Warbler
87. Townsend's Warbler
88. American Redstart*
89. MacGillivray's Warbler
90. Common Yellowthroat
91. Wilson's Warbler
92. Western Tanager
93. Spotted Towhee
94. Chipping Sparrow
95. Vesper Sparrow
96. Savannah Sparrow
97. Fox Sparrow
98. Song Sparrow
99. Lincoln's Sparrow
100. White-crowned Sparrow
101. Oregon Junco
102. Black-headed Grosbeak
103. Lazuli Bunting
104. Red-winged Blackbird
105. Brown-headed Cowbird
106. Bullock's Oriole*
107. Gray-crowned Rosy-Finch
108. Pine Grosbeak
109. Purple Finch
110. Cassin's Finch
111. House Finch
112. Red Crossbill
113. White-winged Crossbill
114. Pine Siskin
115. American Goldfinch
116. Evening Grosbeak

Table 3. Species with adequate numbers of detections for modeling detectability across densely and/or sparsely vegetated habitats, without the use of 'surrogate' species.

Species	Densely vegetated	Sparsely vegetated
Blue Grouse	X	
Rufous Hummingbird	X	
Olive-sided Flycatcher	X	
Western Wood-Pewee	X	
Hammond's Flycatcher	X	
Pacific-slope Flycatcher	X	
Cassin's Vireo	X	
Warbling Vireo	X	
Gray Jay	X	
Steller's Jay	X	
Chestnut-backed Chickadee	X	
Red-breasted Nuthatch	X	
Brown Creeper	X	
Winter Wren	X	X
Golden-crowned Kinglet	X	
Swainson's Thrush	X	
Hermit Thrush	X	X
American Robin	X	
Varied Thrush	X	X
Nashville Warbler	X	
Yellow Warbler	X	
Audubon's Warbler	X	X
Black-throated Gray Warbler	X	
Townsend's Warbler	X	X
MacGillivray's Warbler	X	
Western Tanager	X	
Spotted Towhee	X	
Chipping Sparrow	X	X
Fox Sparrow		X
Song Sparrow	X	
Oregon Junco	X	X
Red Crossbill	X	
Pine Siskin	X	X
Evening Grosbeak	X	

Table 4. Surrogate species used for modeling the detection probability of less frequently detected species.

	Surrogate species used	
Species	'Closed' habitats	'Open' habitats
Ruffed Grouse	Blue Grouse	Varied Thrush
Blue Grouse		Hermit Thrush
Spotted Sandpiper	Dark-eyed Junco	Dark-eyed Junco
Calliope Hummingbird	Rufous Hummingbird	
Red-naped Sapsucker	Brown Creeper	Yellow-rumped Warbler
Red-breasted Sapsucker	Brown Creeper	Yellow-rumped Warbler
Hairy Woodpecker	Gray Jay	Varied Thrush
Northern Flicker	Olive-sided Flycatcher	Hermit Thrush
Pileated Woodpecker	Olive-sided Flycatcher	Varied Thrush
Olive-sided Flycatcher		Hermit Thrush
Western Wood-Pewee		Fox Sparrow
Willow Flycatcher	Western Wood-Pewee	Townsend's Warbler
Hammond's Flycatcher		Dark-eyed Junco
Pacific-slope Flycatcher		Dark-eyed Junco
Cassin's Vireo		Yellow-rumped Warbler
Red-eyed Vireo	Cassin's Vireo	Townsend's Warbler
Gray Jay		Townsend's Warbler
Steller's Jay		Hermit Thrush
Clark's Nutcracker	Gray Jay	Hermit Thrush
Common Raven	Olive-sided Flycatcher	Hermit Thrush
Black-capped Chickadee	Red-breasted Nuthatch	Hermit Thrush
Mountain Chickadee	Red-breasted Nuthatch	Hermit Thrush
Chestnut-backed Chickadee		Dark-eyed Junco
Red-breasted Nuthatch		Hermit Thrush
Brown Creeper		Townsend's Warbler
Golden-crowned Kinglet		Townsend's Warbler
Ruby-crowned Kinglet	Golden-crowned Kinglet	Townsend's Warbler
Townsend's Solitaire	Western Tanager	Hermit Thrush
Veery	Swainson's Thrush	Hermit Thrush
Swainson's Thrush		Hermit Thrush
American Robin		Hermit Thrush
American Pipit	Winter Wren	Winter Wren
Cedar Waxwing	Pine Siskin	Pine Siskin
Nashville Warbler		Yellow-rumped Warbler
Yellow Warbler		Yellow-rumped Warbler
Black-throated Gray Warbler		Townsend's Warbler
MacGillivray's Warbler		Townsend's Warbler
Wilson's Warbler	Yellow Warbler	Yellow-rumped Warbler
Western Tanager		Hermit Thrush
Spotted Towhee		Hermit Thrush
Chipping Sparrow		Dark-eyed Junco
Fox Sparrow	Song Sparrow	
Song Sparrow		Fox Sparrow
White-crowned Sparrow	Song Sparrow	Fox Sparrow
Black-headed Grosbeak	American Robin	Hermit Thrush
Lazuli Bunting	MacGillivray's Warbler	Dark-eyed Junco
Brown-headed Cowbird	Western Tanager	Hermit Thrush
Pine Grosbeak	Yellow-rumped Warbler	Yellow-rumped Warbler
Cassin's Finch	Western Tanager	Fox Sparrow
Red Crossbill		Pine Siskin
Evening Grosbeak		Yellow-rumped Warbler

Table 5. Point count results from 318 point counts at locations classified in the field as Douglas-fir West. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Common Loon	4	--				
Osprey	2	--				
Bald Eagle	1	--				
Northern Goshawk	1	--				
Ruffed Grouse	1	0.002	1.010	0.000	0.009	317
Blue Grouse	31	0.036	0.227	0.023	0.056	370
Killdeer	1	--				
Spotted Sandpiper	2	0.003	0.712	0.001	0.011	317
Western Screech-Owl	2	--				
Northern Pygmy-Owl	1	--				
Barred Owl	1	--				
Black Swift	1	--				
Vaux's Swift	3	--				
Rufous Hummingbird	27	--				
Red-naped Sapsucker	1	0.000	0.000	0.000	0.000	334
Red-breasted Sapsucker	13	0.023	0.319	0.013	0.043	317
Downy Woodpecker	1	--				
Hairy Woodpecker	6	0.037	0.443	0.016	0.086	317
Northern Flicker	14	0.018	0.452	0.008	0.042	317
Pileated Woodpecker	13	0.006	0.452	0.003	0.014	317
Olive-sided Flycatcher	8	0.012	0.514	0.004	0.030	270
Western Wood-Pewee	2	0.005	0.719	0.001	0.017	338
Hammond's Flycatcher	95	0.455	0.205	0.306	0.678	726
Pacific-slope Flycatcher	14	0.046	0.415	0.021	0.100	290
Cassin's Vireo	74	0.209	0.172	0.149	0.292	452
Warbling Vireo	50	0.130	0.188	0.090	0.187	466
Gray Jay	16	0.123	0.382	0.059	0.254	382
Steller's Jay	18	0.026	0.324	0.014	0.049	365
American Crow	3	--				
Common Raven	9	0.003	0.496	0.001	0.008	317
Tree Swallow	2	--				
Black-capped Chickadee	5	0.023	0.622	0.007	0.071	317
Chestnut-backed Chickadee	186	1.210	0.154	0.896	1.635	983
Red-breasted Nuthatch	103	0.175	0.200	0.119	0.258	611
Brown Creeper	26	0.140	0.256	0.085	0.229	420
Winter Wren	180	0.599	0.092	0.500	0.718	496
American Dipper	1	--				

Table 5. Point count results from 318 point counts at locations classified in the field as Douglas-fir West. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density (continued).

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Golden-crowned Kinglet	92	0.775	0.199	0.526	1.140	588
Townsend's Solitaire	5	0.010	0.596	0.004	0.031	317
Swainson's Thrush	81	0.182	0.146	0.137	0.243	435
Hermit Thrush	39	0.044	0.273	0.026	0.075	475
American Robin	106	0.367	0.166	0.266	0.508	627
Varied Thrush	181	0.151	0.150	0.112	0.202	942
Cedar Waxwing	8	0.290	1.004	0.056	1.501	317
Nashville Warbler	6	0.022	0.552	0.008	0.061	363
Yellow Warbler	7	0.030	0.417	0.013	0.065	353
Audubon's Warbler	83	0.198	0.223	0.128	0.305	607
Blk.-throated Gray Warbler	101	0.330	0.172	0.236	0.461	493
Townsend's Warbler	319	0.832	0.079	0.712	0.971	834
MacGillivray's Warbler	22	0.083	0.361	0.042	0.166	283
Western Tanager	82	0.190	0.204	0.128	0.282	694
Spotted Towhee	15	0.049	0.337	0.026	0.094	370
Chipping Sparrow	2	0.009	0.716	0.003	0.033	334
Song Sparrow	4	0.015	0.549	0.006	0.042	371
White-crowned Sparrow	2	0.005	1.026	0.001	0.026	317
Oregon Junco	135	0.662	0.142	0.502	0.873	720
Black-headed Grosbeak	10	0.021	0.360	0.010	0.041	317
Red-winged Blackbird	1	--				
Brown-headed Cowbird	4	0.015	0.596	0.005	0.045	317
Purple Finch	1	--				
Red Crossbill	15	0.086	0.710	0.024	0.301	344
White-winged Crossbill	1	--				
Pine Siskin	29	0.180	2.891	0.128	0.231	385
Evening Grosbeak	10	0.032	0.530	0.012	0.085	360

Table 6. Point count results from 229 point counts at locations classified in the field as Douglas-fir East. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Blue-winged Teal	4	--				
Barrow's Goldeneye	2	--				
Cooper's Hawk	2	--				
Ruffed Grouse	7	0.016	0.448	0.007	0.038	228
Blue Grouse	28	0.045	0.233	0.029	0.071	322
Spotted Sandpiper	1	0.002	1.004	0.000	0.011	228
Vaux's Swift	19	--				
Calliope Hummingbird	14	--				
Rufous Hummingbird	10	--				
Belted Kingfisher	3	--				
Red-naped Sapsucker	11	0.053	0.329	0.028	0.100	228
Downy Woodpecker	3	--				
Hairy Woodpecker	4	0.035	0.528	0.013	0.092	228
Northern Flicker	5	0.010	0.566	0.004	0.030	228
Pileated Woodpecker	12	0.008	0.466	0.003	0.020	228
Olive-sided Flycatcher	9	0.021	0.481	0.008	0.051	216
Western Wood-Pewee	27	0.092	0.255	0.056	0.151	270
Hammond's Flycatcher	99	0.721	0.192	0.496	1.046	624
Pacific-slope Flycatcher	7	0.029	0.475	0.012	0.071	281
Cassin's Vireo	39	0.164	0.221	0.107	0.251	339
Warbling Vireo	26	0.107	0.234	0.068	0.168	306
Red-eyed Vireo	9	0.039	0.405	0.018	0.084	228
Gray Jay	7	0.075	0.460	0.032	0.177	286
Steller's Jay	8	0.017	0.446	0.007	0.040	258
Clark's Nutcracker	10	0.051	0.488	0.021	0.128	228
American Crow	2	--				
Common Raven	3	0.002	0.674	0.001	0.006	228
N. Rough-winged Swallow	10	--				
Black-capped Chickadee	6	0.038	0.551	0.014	0.105	228
Mountain Chickadee	17	0.116	0.370	0.057	0.235	228
Chestnut-backed Chickadee	73	0.712	0.208	0.476	1.066	528
Red-breasted Nuthatch	115	0.283	0.197	0.193	0.415	567
White-breasted Nuthatch	2	--				
Brown Creeper	25	0.202	0.256	0.123	0.332	340
Canyon Wren	2	--				
Winter Wren	46	0.225	0.163	0.163	0.309	262
Golden-crowned Kinglet	65	0.759	0.215	0.500	1.153	584
Townsend's Solitaire	19	0.092	0.279	0.054	0.158	228

Table 6. Point count results from 229 point counts at locations classified in the field as Douglas-fir East. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density (continued).

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Veery	7	0.017	0.428	0.007	0.037	228
Swainson's Thrush	126	0.419	0.120	0.331	0.529	371
Hermit Thrush	31	0.054	0.290	0.031	0.095	426
American Robin	58	0.299	0.191	0.206	0.433	435
Varied Thrush	22	0.028	0.304	0.016	0.050	313
Cedar Waxwing	2	0.101	1.004	0.019	0.522	228
Nashville Warbler	40	0.239	0.233	0.152	0.377	199
Yellow Warbler	41	0.280	0.237	0.177	0.444	313
Audubon's Warbler	133	0.493	0.204	0.331	0.733	498
Blk.-throated Gray Warbler	6	0.029	0.478	0.012	0.071	248
Townsend's Warbler	265	1.044	0.090	0.874	1.246	486
MacGillivray's Warbler	40	0.205	0.336	0.108	0.391	224
Wilson's Warbler	10	0.093	0.325	0.050	0.175	228
Western Tanager	189	0.659	0.169	0.474	0.917	519
Spotted Towhee	17	0.077	0.311	0.043	0.141	278
Chipping Sparrow	33	0.212	0.242	0.132	0.339	298
Song Sparrow	5	0.026	0.575	0.009	0.076	282
Oregon Junco	155	1.132	0.133	0.874	1.467	620
Black-headed Grosbeak	4	0.011	0.509	0.004	0.029	228
Lazuli Bunting	2	0.037	1.043	0.007	0.202	228
Brown-headed Cowbird	3	0.021	0.760	0.006	0.079	228
Gray-crowned Rosy-Finch	1	--				
Pine Grosbeak	1	0.024	1.016	0.004	0.124	228
Purple Finch	2	--				
Cassin's Finch	4	0.021	0.760	0.006	0.079	228
Red Crossbill	6	0.048	0.639	0.015	0.151	252
Pine Siskin	153	0.757	2.074	0.605	0.908	407
American Goldfinch	4	--				
Evening Grosbeak	16	0.071	0.400	0.033	0.151	279

Table 7. Point count results from 208 point counts at locations classified in the field as Western Hemlock. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Golden Eagle	1	--				
Ruffed Grouse	1	0.003	1.010	0.000	0.013	208
Blue Grouse	13	0.021	0.315	0.012	0.039	290
Spotted Sandpiper	1	0.002	1.004	0.000	0.013	208
Black Swift	1	--				
Vaux's Swift	5	--				
Rufous Hummingbird	12	--				
Red-naped Sapsucker	2	0.011	0.720	0.003	0.038	208
Red-breasted Sapsucker	22	0.062	0.271	0.036	0.104	208
Hairy Woodpecker	8	0.076	0.391	0.036	0.159	208
Northern Flicker	5	0.011	0.566	0.004	0.032	208
Pileated Woodpecker	7	0.005	0.551	0.002	0.015	208
Olive-sided Flycatcher	17	0.043	0.430	0.019	0.097	160
Western Wood-Pewee	5	0.019	0.543	0.007	0.051	232
Hammond's Flycatcher	77	0.572	0.209	0.381	0.858	646
Pacific-slope Flycatcher	18	0.096	0.364	0.048	0.192	199
Cassin's Vireo	3	0.005	1.006	0.001	0.024	213
Warbling Vireo	17	0.072	0.287	0.041	0.125	255
Gray Jay	6	0.047	0.528	0.018	0.124	252
Steller's Jay	6	0.014	0.483	0.006	0.035	232
Common Raven	3	0.002	0.823	0.000	0.008	208
Black-capped Chickadee	5	0.028	0.634	0.009	0.088	208
Mountain Chickadee	1	0.008	1.015	0.002	0.044	208
Chestnut-backed Chickadee	191	1.993	0.152	1.482	2.680	864
Red-breasted Nuthatch	45	0.109	0.242	0.068	0.174	539
Brown Creeper	33	0.286	0.235	0.182	0.452	318
Winter Wren	204	1.085	0.086	0.917	1.284	357
American Dipper	2	--				
Golden-crowned Kinglet	42	0.527	0.230	0.337	0.823	544
Swainson's Thrush	62	0.215	0.168	0.154	0.298	264
Hermit Thrush	28	0.052	0.292	0.030	0.091	405
American Robin	29	0.158	0.267	0.094	0.265	293
Varied Thrush	203	0.277	0.138	0.211	0.362	842
Cedar Waxwing	1	0.055	1.004	0.011	0.286	208
Yellow Warbler	12	0.082	0.360	0.041	0.164	241
Audubon's Warbler	17	0.062	0.335	0.033	0.117	372
Blk.-throated Gray Warbler	13	0.069	0.343	0.036	0.132	244
Townsend's Warbler	89	0.357	0.129	0.277	0.460	294

Table 7. Point count results from 208 point counts at locations classified in the field as Western Hemlock. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density (continued).

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
MacGillivray's Warbler	9	0.04	0.517	0.015	0.105	341
Common Yellowthroat	2	--				
Wilson's Warbler	3	0.02	0.712	0.006	0.072	208
Western Tanager	15	0.059	0.322	0.032	0.109	333
Spotted Towhee	1	0.005	1.007	0.001	0.026	214
Fox Sparrow	1	0	0.000	0.000	0.000	235
Song Sparrow	10	0.052	0.430	0.023	0.117	255
Oregon Junco	23	0.175	0.237	0.110	0.277	286
Black-headed Grosbeak	1	0.003	1.006	0.001	0.016	208
Red-winged Blackbird	1	--				
Red Crossbill	21	0.182	0.706	0.052	0.638	226
Pine Siskin	18	0.175	2.950	0.109	0.240	235
Evening Grosbeak	12	0.058	0.606	0.019	0.175	233

Table 8. Point count results from 141 point counts at locations classified in the field as Shrub. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Mallard	2	--				
Blue Grouse	10	0.026	0.366	0.013	0.053	186
Common Nighthawk	1	--				
Black Swift	10	--				
Vaux's Swift	9	--				
Calliope Hummingbird	3	--				
Rufous Hummingbird	26	--				
Red-naped Sapsucker	1	0.008	1.011	0.001	0.041	140
Red-breasted Sapsucker	1	0.004	1.011	0.001	0.023	140
Downy Woodpecker	2	--				
Hairy Woodpecker	2	0.014	1.016	0.003	0.074	140
Northern Flicker	2	0.007	0.788	0.002	0.027	140
Olive-sided Flycatcher	26	0.094	0.420	0.042	0.207	144
Western Wood-Pewee	4	0.017	0.589	0.006	0.049	155
Willow Flycatcher	7	0.931	7.426	0.018	49.237	140
Hammond's Flycatcher	30	0.346	0.257	0.211	0.569	370
Dusky Flycatcher	2	--				
Pacific-slope Flycatcher	2	0.016	0.748	0.004	0.059	171
Cassin's Vireo	3	0.020	0.583	0.007	0.060	150
Warbling Vireo	49	0.320	0.193	0.219	0.466	220
Red-eyed Vireo	1	0.008	1.006	0.002	0.042	140
Gray Jay	3	0.017	1.016	0.003	0.092	149
Steller's Jay	4	0.010	0.586	0.004	0.030	152
Clark's Nutcracker	1	0.009	1.016	0.002	0.049	140
Violet-green Swallow	2	--				
Mountain Chickadee	5	0.063	0.473	0.026	0.153	140
Chestnut-backed Chickadee	42	0.674	0.256	0.411	1.107	244
Red-breasted Nuthatch	14	0.056	0.323	0.030	0.105	256
Brown Creeper	1	0.014	1.011	0.003	0.072	146
Winter Wren	51	0.406	0.167	0.293	0.564	160
Golden-crowned Kinglet	30	0.617	0.261	0.372	1.022	342
Mountain Bluebird	4	--				
Townsend's Solitaire	1	0.008	1.012	0.001	0.041	140
Swainson's Thrush	102	0.554	0.123	0.435	0.706	224
Hermit Thrush	34	0.097	0.281	0.056	0.167	327
American Robin	17	0.134	0.275	0.079	0.228	195
Varied Thrush	36	0.070	0.250	0.043	0.114	228

Table 8. Point count results from 141 point counts at locations classified in the field as Shrub. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density (continued).

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Cedar Waxwing	8	0.655	0.470	0.271	1.584	140
Orange-crowned Warbler	5	--				
Nashville Warbler	4	0.040	0.521	0.015	0.105	167
Yellow Warbler	52	0.544	0.233	0.346	0.856	199
Audubon's Warbler	40	0.238	0.256	0.145	0.391	390
Blk.-throated Gray Warbler	5	0.039	0.668	0.012	0.130	146
Townsend's Warbler	113	0.716	0.140	0.543	0.943	188
MacGillivray's Warbler	39	0.325	0.344	0.168	0.627	230
Common Yellowthroat	1	--				
Wilson's Warbler	17	0.243	0.359	0.122	0.483	140
Western Tanager	39	0.226	0.265	0.135	0.376	290
Spotted Towhee	2	0.015	0.714	0.004	0.053	148
Chipping Sparrow	20	0.209	0.313	0.114	0.381	181
Fox Sparrow	22	0.295	0.383	0.142	0.613	140
Song Sparrow	8	0.060	0.522	0.023	0.158	189
White-crowned Sparrow	5	0.055	0.573	0.019	0.159	140
Oregon Junco	73	0.888	0.167	0.641	1.231	278
Black-headed Grosbeak	8	0.033	0.436	0.014	0.074	140
Lazuli Bunting	11	0.303	0.550	0.110	0.837	140
Brown-headed Cowbird	1	0.011	1.012	0.002	0.060	140
Pine Grosbeak	3	0.115	1.016	0.022	0.606	140
Purple Finch	1	--				
Red Crossbill	23	0.296	0.772	0.077	1.143	150
Pine Siskin	56	0.486	2.425	0.304	0.667	166
Evening Grosbeak	9	0.050	0.605	0.017	0.151	158

Table 9. Point count results from 110 point counts at locations classified in the field as Pacific Silver Fir. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Blue Grouse	4	0.01	0.590	0.003	0.030	122
Northern Pygmy-Owl	1	--				
Rufous Hummingbird	5	--				
Red-breasted Sapsucker	4	0.022	0.514	0.009	0.058	109
Hairy Woodpecker	2	0.036	0.726	0.010	0.131	109
Three-toed Woodpecker	1	--				
Northern Flicker	2	0.009	0.787	0.002	0.034	109
Pileated Woodpecker	2	0.001	1.060	0.000	0.008	109
Olive-sided Flycatcher	12	0.058	0.446	0.025	0.133	159
Hammond's Flycatcher	12	0.184	0.363	0.092	0.368	175
Cassin's Vireo	2	0.017	1.006	0.003	0.092	112
Warbling Vireo	5	0.043	0.449	0.018	0.100	119
Gray Jay	31	0.689	0.298	0.387	1.225	177
Black-capped Chickadee	2	0.026	1.015	0.005	0.140	109
Mountain Chickadee	9	0.145	0.507	0.056	0.374	109
Chestnut-backed Chickadee	71	1.379	0.176	0.979	1.943	412
Red-breasted Nuthatch	46	0.233	0.231	0.148	0.364	375
Brown Creeper	18	0.316	0.284	0.182	0.547	178
Winter Wren	101	1.063	0.107	0.861	1.312	153
Golden-crowned Kinglet	50	1.317	0.241	0.826	2.101	327
Townsend's Solitaire	5	0.05	0.615	0.016	0.155	109
Swainson's Thrush	32	0.204	0.245	0.126	0.329	122
Hermit Thrush	37	0.12	0.275	0.071	0.205	287
American Robin	3	0.032	0.583	0.011	0.094	117
Varied Thrush	103	0.262	0.167	0.189	0.363	372
Yellow Warbler	2	0.028	0.711	0.008	0.101	113
Audubon's Warbler	8	0.063	0.386	0.030	0.131	173
Blk.-throated Gray Warbler	7	0.07	0.626	0.022	0.219	114
Townsend's Warbler	50	0.388	0.231	0.247	0.610	121
MacGillivray's Warbler	4	0.033	0.644	0.010	0.105	166
Western Tanager	6	0.037	0.545	0.014	0.102	128
Spotted Towhee	4	0.038	0.619	0.012	0.117	117
Fox Sparrow	2	0.034	0.741	0.009	0.128	109
Oregon Junco	40	0.617	0.210	0.410	0.929	166
Pine Grosbeak	1	0.049	1.016	0.009	0.260	109
Cassin's Finch	3	0	0.000	0.000	0.000	137
Pine Siskin	49	0.534	2.323	0.328	0.739	138
Evening Grosbeak	6	0.055	0.758	0.015	0.209	118

Table 10. Point count results from 104 point counts at locations classified in the field as Conifer-Deciduous Mix. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Canada Goose	11	--				
Harlequin Duck	2	--				
Ruffed Grouse	2	0.005	1.010	0.001	0.027	102
Blue Grouse	1	0.004	1.010	0.001	0.019	106
Killdeer	3	--				
Barred Owl	2	--				
Vaux's Swift	10	--				
Calliope Hummingbird	1	--				
Rufous Hummingbird	8	--				
Belted Kingfisher	1	--				
Red-naped Sapsucker	2	0.021	0.719	0.006	0.077	102
Red-breasted Sapsucker	3	0.018	0.590	0.006	0.053	102
Downy Woodpecker	1	--				
Hairy Woodpecker	2	0.038	0.726	0.011	0.140	102
Northern Flicker	4	0.019	0.605	0.006	0.056	102
Pileated Woodpecker	7	0.011	0.547	0.004	0.030	102
Olive-sided Flycatcher	3	0.005	1.060	0.001	0.029	126
Western Wood-Pewee	16	0.106	0.318	0.057	0.196	139
Willow Flycatcher	2	0.364	7.479	0.007	19.642	102
Hammond's Flycatcher	83	1.308	0.206	0.877	1.951	486
Pacific-slope Flycatcher	15	0.151	0.444	0.065	0.350	161
Cassin's Vireo	18	0.168	0.276	0.098	0.287	138
Warbling Vireo	15	0.137	0.274	0.080	0.233	128
Red-eyed Vireo	9	0.098	0.405	0.045	0.212	102
Gray Jay	4	0.095	1.016	0.018	0.504	108
Steller's Jay	10	0.043	0.540	0.016	0.116	112
Tree Swallow	1	--				
Violet-green Swallow	2	--				
Cliff Swallow	7	--				
Black-capped Chickadee	8	0.099	0.536	0.036	0.268	102
Mountain Chickadee	2	0.034	0.724	0.009	0.125	102
Chestnut-backed Chickadee	50	1.055	0.229	0.676	1.646	210
Red-breasted Nuthatch	37	0.177	0.266	0.106	0.296	262
Brown Creeper	2	0.037	0.719	0.010	0.135	111
Canyon Wren	1	--				
House Wren	1	--				
Winter Wren	42	0.454	0.190	0.312	0.660	113
Golden-crowned Kinglet	23	0.619	0.278	0.362	1.059	233

Table 10. Point count results from 104 point counts at locations classified in the field as Conifer-Deciduous Mix. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density (continued).

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Veery	33	0.164	0.217	0.107	0.250	102
Swainson's Thrush	64	0.405	0.146	0.304	0.540	142
Hermit Thrush	2	0.008	0.731	0.002	0.028	118
American Robin	67	0.733	0.193	0.503	1.069	208
Varied Thrush	34	0.090	0.244	0.056	0.145	172
European Starling	1	--				
Cedar Waxwing	5	0.560	0.827	0.134	2.347	102
Nashville Warbler	10	0.123	0.392	0.058	0.259	139
Yellow Warbler	20	0.304	0.275	0.178	0.519	132
Audubon's Warbler	32	0.259	0.264	0.156	0.432	288
Blk.-throated Gray Warbler	26	0.268	0.251	0.164	0.436	140
Townsend's Warbler	69	0.591	0.160	0.432	0.810	128
MacGillivray's Warbler	23	0.269	0.380	0.130	0.555	243
Common Yellowthroat	1	--				
Wilson's Warbler	2	0.042	0.711	0.012	0.148	102
Western Tanager	36	0.261	0.236	0.165	0.413	269
Spotted Towhee	13	0.101	0.382	0.049	0.210	122
Chipping Sparrow	16	0.186	0.360	0.093	0.371	126
Vesper Sparrow	2	--				
Song Sparrow	17	0.200	0.424	0.089	0.446	156
White-crowned Sparrow	8	0.121	0.483	0.049	0.301	102
Oregon Junco	34	0.574	0.230	0.367	0.900	144
Black-headed Grosbeak	14	0.083	0.322	0.044	0.154	102
Brown-headed Cowbird	19	0.279	0.308	0.154	0.507	102
Purple Finch	1	--				
Cassin's Finch	1	0.279	0.308	0.154	0.507	102
House Finch	1	--				
Red Crossbill	7	0.123	1.011	0.023	0.651	106
Pine Siskin	27	0.348	2.635	0.181	0.515	119
Evening Grosbeak	6	0.049	1.012	0.009	0.259	107

Table 11. Point count results from 66 point counts at locations classified in the field as Meadow. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Blue Grouse	4	0.039	0.496	0.015	0.098	65
Spotted Sandpiper	5	0.015	0.446	0.006	0.034	65
Calliope Hummingbird	1	--				
Rufous Hummingbird	2	--				
Northern Flicker	8	0.071	0.345	0.036	0.138	65
Olive-sided Flycatcher	19	0.118	0.256	0.072	0.196	65
Western Wood-Pewee	3	0.038	0.784	0.010	0.151	65
Hammond's Flycatcher	6	0.252	0.529	0.093	0.680	65
Pacific-slope Flycatcher	2	0.196	0.710	0.055	0.701	65
Cassin's Vireo	2	0.023	1.011	0.004	0.124	65
Warbling Vireo	3	0.060	0.784	0.015	0.239	65
Gray Jay	2	0.029	0.717	0.008	0.105	65
Clark's Nutcracker	20	0.107	0.352	0.054	0.212	65
Violet-green Swallow	3	--				
Mountain Chickadee	17	0.609	0.356	0.306	1.215	65
Chestnut-backed Chickadee	8	0.479	0.527	0.178	1.288	65
Red-breasted Nuthatch	10	0.171	0.394	0.080	0.365	65
House Wren	2	--				
Winter Wren	6	0.088	0.417	0.040	0.196	82
Golden-crowned Kinglet	3	0.166	0.717	0.046	0.600	65
Ruby-crowned Kinglet	7	0.361	0.525	0.135	0.966	65
Mountain Bluebird	4	--				
Townsend's Solitaire	1	0.026	1.004	0.005	0.138	65
Veery	3	0.015	0.746	0.004	0.058	65
Swainson's Thrush	13	0.188	0.345	0.096	0.367	65
Hermit Thrush	33	0.168	0.215	0.110	0.256	90
American Robin	31	0.906	0.236	0.569	1.444	65
Varied Thrush	12	0.097	0.408	0.044	0.211	84
European Starling	3	--				
Orange-crowned Warbler	1	--				
Yellow Warbler	4	0.336	0.622	0.107	1.053	65
Audubon's Warbler	28	0.356	0.288	0.203	0.623	104
Blk.-throated Gray Warbler	3	0.305	0.755	0.080	1.168	65
Townsend's Warbler	23	0.293	0.331	0.154	0.555	94
MacGillivray's Warbler	6	0.079	0.587	0.027	0.234	65
Wilson's Warbler	2	0.420	0.717	0.116	1.519	65
Western Tanager	9	0.207	0.394	0.097	0.442	65
Spotted Towhee	8	0.056	0.527	0.021	0.150	65

Table 11. Point count results from 66 point counts at locations classified in the field as Meadow. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density (continued).

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Chipping Sparrow	15	0.193	0.407	0.089	0.419	106
Vesper Sparrow	1	--				
Savannah Sparrow	4	--				
Fox Sparrow	22	0.193	0.407	0.089	0.419	106
Song Sparrow	2	0.037	1.032	0.007	0.203	65
Oregon Junco	84	2.588	0.158	1.900	3.525	184
Black-headed Grosbeak	5	0.031	0.526	0.012	0.084	65
Lazuli Bunting	1	0.050	1.006	0.009	0.268	65
Brown-headed Cowbird	2	0.071	0.707	0.020	0.252	65
Pine Grosbeak	1	0.060	1.011	0.011	0.320	65
Cassin's Finch	6	0.214	0.525	0.080	0.572	65
Red Crossbill	6	1.396	1.006	0.263	7.413	65
Pine Siskin	64	1.058	1.816	0.678	1.438	102
Evening Grosbeak	1	0.058	1.011	0.011	0.309	65

Table 12. Point count results from 60 point counts at locations classified in the field as Engelmann Spruce. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Blue Grouse	4	0.025	0.508	0.009	0.064	69
Rufous Hummingbird	2	--				
Red-naped Sapsucker	1	0.018	1.011	0.003	0.099	59
Northern Flicker	1	0.008	1.060	0.001	0.045	59
Olive-sided Flycatcher	3	0.026	0.820	0.006	0.110	85
Hammond's Flycatcher	10	0.253	0.418	0.114	0.561	84
Warbling Vireo	3	0.047	0.575	0.016	0.137	62
Gray Jay	8	0.326	0.519	0.123	0.862	75
Steller's Jay	1	0.008	1.007	0.002	0.043	61
Black-capped Chickadee	7	0.170	0.604	0.056	0.518	59
Mountain Chickadee	5	0.148	0.615	0.047	0.458	59
Chestnut-backed Chickadee	37	1.396	0.244	0.867	2.250	111
Red-breasted Nuthatch	20	0.180	0.288	0.103	0.314	135
Brown Creeper	3	0.097	0.586	0.033	0.286	67
Winter Wren	48	0.935	0.160	0.682	1.283	68
Golden-crowned Kinglet	47	2.270	0.227	1.459	3.530	235
Ruby-crowned Kinglet	3	0.175	0.759	0.045	0.674	59
Swainson's Thrush	45	0.580	0.193	0.396	0.848	71
Hermit Thrush	22	0.147	0.306	0.081	0.266	151
American Robin	5	0.098	0.529	0.036	0.265	64
Varied Thrush	22	0.097	0.280	0.056	0.167	87
Gray Catbird	4	--				
Cedar Waxwing	2	0.385	1.004	0.072	2.045	59
Nashville Warbler	1	0.023	1.013	0.004	0.126	62
Yellow Warbler	13	0.313	0.525	0.117	0.839	63
Audubon's Warbler	12	0.172	0.358	0.087	0.343	103
Blk.-throated Gray Warbler	4	0.055	0.747	0.015	0.209	61
Townsend's Warbler	65	0.985	0.155	0.724	1.339	75
MacGillivray's Warbler	4	0.060	0.640	0.019	0.193	93
Western Tanager	4	0.054	0.511	0.021	0.142	71
Chipping Sparrow	1	0.025	1.007	0.005	0.131	61
Fox Sparrow	3	0.095	0.613	0.031	0.293	59
Song Sparrow	1	0.020	1.026	0.004	0.110	65
Oregon Junco	35	1.015	0.189	0.700	1.471	101
Black-headed Grosbeak	2	0.022	1.006	0.004	0.116	59
Pine Grosbeak	1	0.090	1.016	0.017	0.484	59
Red Crossbill	11	0.333	0.848	0.076	1.449	63
Pine Siskin	43	0.817	2.014	0.442	1.192	76

Table 13. Point count results from 57 point counts at locations classified in the field as Western Redcedar. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Mallard	1	--				
Blue Grouse	7	0.032	0.454	0.014	0.077	68
Northern Pygmy-Owl	1	--				
Black Swift	1	--				
Vaux's Swift	3	--				
Rufous Hummingbird	7	--				
Red-breasted Sapsucker	5	0.054	0.455	0.023	0.128	56
Hairy Woodpecker	1	0.035	1.016	0.006	0.188	56
Northern Flicker	3	0.025	0.667	0.007	0.085	56
Pileated Woodpecker	1	0.003	1.060	0.000	0.016	56
Olive-sided Flycatcher	5	0.046	0.556	0.017	0.129	118
Western Wood-Pewee	3	0.041	0.752	0.011	0.157	60
Willow Flycatcher	1	0.329	7.479	0.006	18.465	56
Hammond's Flycatcher	31	0.886	0.255	0.540	1.455	166
Pacific-slope Flycatcher	10	0.195	0.409	0.090	0.426	108
Cassin's Vireo	4	0.067	0.498	0.026	0.173	62
Warbling Vireo	5	0.082	0.525	0.031	0.221	60
Steller's Jay	3	0.026	0.750	0.007	0.098	59
Black-capped Chickadee	5	0.128	0.615	0.041	0.397	56
Chestnut-backed Chickadee	33	1.271	0.257	0.769	2.101	98
Red-breasted Nuthatch	9	0.09	0.387	0.043	0.189	86
Brown Creeper	7	0.237	0.482	0.095	0.590	68
Winter Wren	57	1.128	0.112	0.903	1.409	76
Golden-crowned Kinglet	16	0.763	0.388	0.362	1.607	84
Swainson's Thrush	19	0.244	0.259	0.147	0.406	62
Hermit Thrush	6	0.042	0.437	0.018	0.097	87
American Robin	23	0.435	0.265	0.259	0.730	81
Varied Thrush	51	0.24	0.198	0.163	0.353	133
Yellow Warbler	4	0.11	0.496	0.043	0.281	61
Audubon's Warbler	6	0.076	0.467	0.031	0.183	77
Blk.-throated Gray Warbler	1	0.019	1.005	0.004	0.103	57
Townsend's Warbler	30	0.399	0.267	0.236	0.674	60
MacGillivray's Warbler	4	0.042	0.761	0.011	0.162	77
Common Yellowthroat	2	--				
Western Tanager	10	0.1	0.439	0.043	0.231	72
Song Sparrow	11	0.234	0.442	0.101	0.541	93
Oregon Junco	7	0.183	0.575	0.063	0.533	59
Red Crossbill	4	0.064	1.011	0.012	0.342	58
Pine Siskin	5	0.176	3.330	0.022	0.330	57

Table 14. Point count results from 55 point counts at locations classified in the field as Subalpine Fir. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Blue Grouse	9	0.093	0.385	0.044	0.195	54
Rufous Hummingbird	3	--				
Downy Woodpecker	1	--				
Hairy Woodpecker	7	0.047	0.523	0.018	0.127	54
Northern Flicker	8	0.085	0.554	0.030	0.239	54
Olive-sided Flycatcher	5	0.042	0.439	0.018	0.097	54
Western Wood-Pewee	1	0.015	1.032	0.003	0.084	54
Hammond's Flycatcher	5	0.303	0.443	0.129	0.707	54
Dusky Flycatcher	3	--				
Warbling Vireo	2	0.048	0.746	0.013	0.182	54
Gray Jay	2	0.017	1.011	0.003	0.094	54
Steller's Jay	2	0.128	1.004	0.024	0.684	54
Clark's Nutcracker	8	0.054	0.424	0.024	0.122	54
Mountain Chickadee	13	0.594	0.340	0.306	1.152	54
Chestnut-backed Chickadee	4	0.383	0.612	0.124	1.187	54
Red-breasted Nuthatch	13	0.274	0.319	0.147	0.511	54
Winter Wren	18	0.301	0.287	0.172	0.525	87
Golden-crowned Kinglet	20	1.891	0.300	1.049	3.409	54
Ruby-crowned Kinglet	3	0.124	0.716	0.034	0.449	54
Townsend's Solitaire	2	0.063	0.706	0.018	0.224	54
Swainson's Thrush	16	0.282	0.395	0.131	0.606	54
Hermit Thrush	44	0.282	0.178	0.199	0.400	88
American Robin	2	0.075	0.706	0.021	0.268	54
Varied Thrush	15	0.158	0.299	0.088	0.283	87
Nashville Warbler	4	0.067	0.800	0.016	0.275	54
Yellow Warbler	3	0.302	0.754	0.079	1.161	54
Audubon's Warbler	19	0.325	0.272	0.191	0.552	92
Townsend's Warbler	26	0.435	0.263	0.260	0.726	96
MacGillivray's Warbler	4	0.063	0.620	0.020	0.198	54
Western Tanager	6	0.138	0.439	0.060	0.321	54
Chipping Sparrow	26	0.370	0.331	0.195	0.701	100
Fox Sparrow	40	0.370	0.331	0.195	0.701	100
Lincoln's Sparrow	1	--				
Oregon Junco	58	2.147	0.180	1.508	3.057	120
Gray-crowned Rosy-Finch	1	--				
Pine Grosbeak	3	0.216	0.585	0.073	0.641	54
Cassin's Finch	2	0.085	0.746	0.023	0.324	54
Red Crossbill	3	0.838	1.006	0.157	4.477	54
Pine Siskin	67	2.334	1.282	1.698	2.970	86

Table 15. Point count results from 53 point counts at locations classified in the field as Mountain Hemlock. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Blue Grouse	7	0.072	0.397	0.033	0.155	52
Rufous Hummingbird	1	--				
Red-naped Sapsucker	1	0.124	1.011	0.023	0.668	52
Red-breasted Sapsucker	3	0.341	0.585	0.115	1.013	52
Hairy Woodpecker	1	0.007	1.011	0.001	0.038	52
Three-toed Woodpecker	1	--				
Northern Flicker	1	0.011	1.004	0.002	0.059	52
Pileated Woodpecker	3	0.268	0.585	0.090	0.797	52
Olive-sided Flycatcher	4	0.035	0.493	0.014	0.088	52
Hammond's Flycatcher	2	0.126	1.006	0.023	0.672	52
Pacific-slope Flycatcher	3	0.366	0.576	0.125	1.070	52
Warbling Vireo	1	0.025	1.032	0.005	0.138	52
Gray Jay	6	0.108	0.534	0.040	0.296	52
Mountain Chickadee	9	0.379	0.459	0.158	0.913	52
Chestnut-backed Chickadee	22	2.187	0.276	1.269	3.768	52
Red-breasted Nuthatch	19	0.426	0.252	0.259	0.701	52
Winter Wren	31	0.55	0.219	0.358	0.845	113
Golden-crowned Kinglet	10	1.033	0.353	0.520	2.053	52
Hermit Thrush	26	0.174	0.241	0.108	0.280	67
American Robin	1	0.039	1.004	0.007	0.208	52
Varied Thrush	32	0.34	0.260	0.204	0.564	96
Audubon's Warbler	2	0.035	0.716	0.010	0.129	57
Blk.-throated Gray Warbler	1	0.127	1.011	0.024	0.683	52
Townsend's Warbler	5	0.087	0.536	0.032	0.237	60
MacGillivray's Warbler	1	0.016	1.011	0.003	0.088	52
Spotted Towhee	2	0.017	0.706	0.005	0.062	52
Fox Sparrow	8	0	0.000	0.000	0.000	46
Oregon Junco	50	1.91	0.206	1.274	2.863	94
Gray-crowned Rosy-Finch	2	--				
Pine Grosbeak	2	0.149	0.716	0.041	0.543	52
Pine Siskin	28	0.617	2.416	0.260	0.973	72

Table 16. Point count results from 50 point counts at locations classified in the field as Heather. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Blue Grouse	9	0.115	0.419	0.051	0.257	49
Rufous Hummingbird	2	--				
Northern Flicker	3	0.023	0.705	0.006	0.083	49
Olive-sided Flycatcher	1	0.009	1.004	0.002	0.049	49
Hammond's Flycatcher	1	0.067	1.006	0.012	0.357	49
Gray Jay	1	0.019	1.011	0.004	0.103	49
Steller's Jay	1	0.071	1.004	0.013	0.378	49
Clark's Nutcracker	3	0.022	1.004	0.004	0.120	49
Red-breasted Nuthatch	7	0.176	0.619	0.056	0.551	49
Winter Wren	11	0.194	0.428	0.086	0.441	61
American Dipper	1	--				
Swainson's Thrush	2	0.041	0.705	0.012	0.148	49
Hermit Thrush	13	0.096	0.337	0.050	0.185	56
American Robin	4	0.165	0.492	0.065	0.421	49
Varied Thrush	1	0.012	1.011	0.002	0.063	51
American Pipit	8	0.136	0.558	0.048	0.388	49
Chipping Sparrow	1	0.017	1.025	0.003	0.093	54
Savannah Sparrow	1	--				
Fox Sparrow	6	0.017	1.025	0.003	0.093	54
Oregon Junco	34	1.307	0.231	0.830	2.060	78
Gray-crowned Rosy-Finch	4	--				
Pine Siskin	74	1.568	1.530	0.958	2.179	62

Table 17. Point count results from 37 point counts at locations classified in the field as Lodgepole Pine. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Common Loon	2	--				
Canada Goose	1	--				
Ruffed Grouse	1	0.014	1.010	0.003	0.079	36
Blue Grouse	9	0.090	0.364	0.044	0.182	50
Spotted Sandpiper	1	0.014	1.004	0.003	0.074	36
Rufous Hummingbird	5	--				
Hammond's Flycatcher	7	0.319	0.436	0.138	0.736	50
Cassin's Vireo	9	0.208	0.335	0.108	0.401	44
Warbling Vireo	9	0.203	0.330	0.106	0.389	42
Mountain Chickadee	3	0.144	0.757	0.037	0.562	36
Chestnut-backed Chickadee	13	0.673	0.429	0.294	1.542	43
Red-breasted Nuthatch	11	0.154	0.353	0.077	0.305	61
Brown Creeper	5	0.261	0.530	0.096	0.713	42
Winter Wren	12	0.348	0.319	0.185	0.652	37
Golden-crowned Kinglet	9	0.705	0.339	0.365	1.362	63
Townsend's Solitaire	1	0.030	1.012	0.005	0.165	36
Swainson's Thrush	9	0.188	0.300	0.104	0.340	39
Hermit Thrush	9	0.098	0.420	0.044	0.219	59
American Robin	7	0.191	0.519	0.071	0.514	39
Varied Thrush	4	0.031	0.493	0.012	0.081	40
Orange-crowned Warbler	1	--				
Yellow Warbler	1	0.042	1.005	0.008	0.230	37
Audubon's Warbler	19	0.419	0.272	0.247	0.712	106
Blk.-throated Gray Warbler	16	0.448	0.364	0.220	0.912	42
Townsend's Warbler	31	0.688	0.214	0.449	1.055	41
MacGillivray's Warbler	4	0.130	0.563	0.046	0.371	66
Western Tanager	8	0.154	0.430	0.067	0.353	47
Spotted Towhee	4	0.113	0.610	0.036	0.351	39
White-crowned Sparrow	1	0.042	1.026	0.008	0.236	36
Oregon Junco	28	1.270	0.223	0.815	1.977	52
Brown-headed Cowbird	2	0.086	1.012	0.016	0.474	36
Pine Siskin	12	0.413	2.538	0.080	0.745	39

Table 18. Point count results from 32 point counts at locations classified in the field as Rock or Sparsely Vegetated. An entry of '--' in the Density column indicates that we were unable to model detectability for the species (either directly, or through the use of a 'surrogate' species), and consequently cannot estimate absolute density.

Species	No. of detections	Density (birds/ha)	CV	Lower 95% C.I.	Upper 95% C.I.	df
Blue Grouse	6	0.119	0.452	0.050	0.288	31
Rufous Hummingbird	6	--				
Olive-sided Flycatcher	1	0.014	1.004	0.003	0.079	31
Western Wood-Pewee	1	0.026	1.032	0.005	0.148	31
Hammond's Flycatcher	2	0.208	0.704	0.057	0.758	31
Cassin's Vireo	4	0.095	0.614	0.030	0.302	31
Warbling Vireo	1	0.041	1.032	0.007	0.235	31
Gray Jay	1	0.030	1.011	0.005	0.166	31
Steller's Jay	1	0.110	1.004	0.020	0.605	31
Clark's Nutcracker	3	0.023	0.701	0.006	0.085	31
Cliff Swallow	5	--				
Mountain Chickadee	3	0.236	0.565	0.081	0.689	31
Chestnut-backed Chickadee	6	0.988	0.516	0.367	2.659	31
Red-breasted Nuthatch	1	0.039	1.004	0.007	0.215	31
Winter Wren	16	0.456	0.373	0.220	0.944	42
Golden-crowned Kinglet	3	0.513	0.577	0.172	1.532	31
Townsend's Solitaire	3	0.162	0.565	0.055	0.473	31
Swainson's Thrush	3	0.097	0.565	0.033	0.284	31
Hermit Thrush	10	0.115	0.401	0.053	0.253	34
American Robin	3	0.193	0.565	0.066	0.566	31
Varied Thrush	7	0.109	0.526	0.040	0.296	36
American Pipit	4	0.122	0.612	0.038	0.384	31
Nashville Warbler	1	0.029	1.011	0.005	0.160	31
Yellow Warbler	2	0.347	1.011	0.063	1.918	31
Audubon's Warbler	5	0.147	0.528	0.054	0.401	36
Townsend's Warbler	10	0.259	0.531	0.094	0.711	36
MacGillivray's Warbler	3	0.054	0.711	0.015	0.200	31
Common Yellowthroat	1	--				
Western Tanager	3	0.143	0.565	0.049	0.417	31
Chipping Sparrow	5	0.132	0.554	0.047	0.376	43
Fox Sparrow	8	0.132	0.554	0.047	0.376	43
Song Sparrow	2	0.076	1.032	0.013	0.434	31
Oregon Junco	29	1.713	0.215	1.119	2.624	54
Black-headed Grosbeak	1	0.013	1.004	0.002	0.071	31
Pine Siskin	4	0.213	2.859	0.003	0.423	33
Evening Grosbeak	2	0.239	1.011	0.043	1.323	31

Table 19. Point count results from 9 point counts at locations classified in the field as Red Alder. The low number of points sampled in this habitat prevented us from producing reliable habitat-specific density estimates.

Species	No. of detections
Canada Goose	2
Spotted Sandpiper	2
Rufous Hummingbird	2
Hairy Woodpecker	1
Hammond's Flycatcher	10
Warbling Vireo	2
Red-eyed Vireo	1
Chestnut-backed Chickadee	7
Winter Wren	4
Golden-crowned Kinglet	1
Swainson's Thrush	8
Hermit Thrush	1
American Robin	10
Varied Thrush	9
Cedar Waxwing	2
Yellow Warbler	2
Audubon's Warbler	2
Black-throated Gray Warbler	2
Townsend's Warbler	1
MacGillivray's Warbler	1
Western Tanager	1
Spotted Towhee	1
Song Sparrow	1
Oregon Junco	1

Table 20. Point count results from 8 point counts at locations classified in the field as Hardwood Mix. The low number of points sampled in this habitat prevented us from producing reliable habitat-specific density estimates.

Species	No. of detections
Downy Woodpecker	1
Hairy Woodpecker	2
Willow Flycatcher	2
Hammond's Flycatcher	6
Cassin's Vireo	2
Warbling Vireo	3
Red-eyed Vireo	3
Steller's Jay	1
Chestnut-backed Chickadee	1
Winter Wren	5
Swainson's Thrush	13
American Robin	8
Varied Thrush	4
Cedar Waxwing	1
Nashville Warbler	1
Audubon's Warbler	1
Black-throated Gray Warbler	5
Townsend's Warbler	2
Western Tanager	1
Song Sparrow	3
Oregon Junco	1
Black-headed Grosbeak	2
Brown-headed Cowbird	1

Table 21. Point count results from point counts at locations classified in the field as Ponderosa Pine. The low number of points sampled in this habitat prevented us from producing reliable habitat-specific density estimates.

Species	No. of detections
Blue Grouse	1
Vaux's Swift	4
Rufous Hummingbird	2
Pileated Woodpecker	1
Western Wood-Pewee	1
Hammond's Flycatcher	2
Cassin's Vireo	1
Red-eyed Vireo	1
Steller's Jay	1
Red-breasted Nuthatch	2
Brown Creeper	1
Golden-crowned Kinglet	1
Veery	1
Swainson's Thrush	3
American Robin	4
Nashville Warbler	2
Yellow Warbler	1
Audubon's Warbler	1
Black-throated Gray Warbler	1
Townsend's Warbler	4
MacGillivray's Warbler	1
Western Tanager	6
Spotted Towhee	1
Chipping Sparrow	2
Oregon Junco	5
Red Crossbill	2
Pine Siskin	2

Table 22. Point count results from 4 point counts at locations classified in the field as Bigleaf Maple. The low number of points sampled in this habitat prevented us from producing reliable habitat-specific density estimates.

Species	No. of detections
Olive-sided Flycatcher	1
Western Wood-Pewee	1
Hammond's Flycatcher	2
Warbling Vireo	3
Red-eyed Vireo	2
Winter Wren	3
Veery	1
Swainson's Thrush	3
American Robin	3
Varied Thrush	2
Nashville Warbler	1
Yellow Warbler	1
Audubon's Warbler	1
Black-throated Gray Warbler	2
Townsend's Warbler	1
MacGillivray's Warbler	1
Western Tanager	3
Song Sparrow	1
Oregon Junco	1

Table 23. Point count results from 2 point counts at locations classified in the field as Subalpine Larch. The low number of points sampled in this habitat prevented us from producing reliable habitat-specific density estimates.

Species	No. of detections
Rufous Hummingbird	1
Northern Flicker	1
Olive-sided Flycatcher	1
Pacific-slope Flycatcher	1
Mountain Chickadee	1
Winter Wren	1
American Robin	2
Nashville Warbler	1
Audubon's Warbler	3
Fox Sparrow	1
Oregon Junco	5
Pine Siskin	61

Table 24. Point count results from 1 point count at a location classified in the field as Mixed Conifer Forest With No Dominant Species. The low number of points sampled in this habitat prevented us from producing reliable habitat-specific density estimates.

Species	No. of detections
Blue Grouse	1
Clark's Nutcracker	2
Mountain Chickadee	4
Ruby-crowned Kinglet	1
Hermit Thrush	1
American Robin	5
Chipping Sparrow	2
Oregon Junco	2

Table 25. Habitat-specific detection results for Pine Siskin (PISI). Habitat-specific detection probabilities were calculated as the ratio of the number of points where Pine Siskin was detected to the number of points sampled in a given habitat type. Habitat-specific mean flock size was calculated as the average number of individuals detected per point, for all points in which at least one Pine Siskin was detected.

Habitat	P{detect}	Mean Flock Size
Douglas-fir West	0.063	1.4
Douglas-fir East	0.275	2.4
Western Hemlock	0.053	1.6
Shrub	0.149	2.7
Pacific Silver Fir	0.191	2.3
Conifer-Deciduous Mix	0.164	1.6
Meadow	0.364	2.7
Engelmann Spruce	0.305	2.4
Western Redcedar	0.035	2.5
Subalpine Fir	0.509	4.4
Mountain Hemlock	0.340	1.6
Heather	0.440	3.4
Lodgepole Pine	0.189	1.7
Rock/Sparsely Vegetated	0.094	1.3

Table 26. Park-wide abundance estimates and standard deviations (SD) for species detected in at least 10 locations.

Species	Total abundance	SD
Ruffed Grouse	366.3	146.6
Blue Grouse	15553.7	3624.3
Spotted Sandpiper	409.6	110.3
Red-naped Sapsucker	3285.4	2168.8
Red-breasted Sapsucker	9794.3	3465.5
Hairy Woodpecker	6859.2	1598.3
Northern Flicker	2932.8	661.9
Pileated Woodpecker	5050.2	2661.8
Olive-sided Flycatcher	9906.2	2102.3
Western Wood-Pewee	4439.4	1814.6
Willow Flycatcher	36177.2	257952.7
Hammond's Flycatcher	88142.6	11841.0
Pacific-slope Flycatcher	12774.3	3854.8
Cassin's Vireo	17522.1	4718.5
Warbling Vireo	26657.1	3833.3
Red-eyed Vireo	1311.3	336.5
Gray Jay	36727.1	8046.6
Steller's Jay	11093.5	7228.8
Clark's Nutcracker	3061.0	1184.0
Common Raven	190.2	76.2
Black-capped Chickadee	3685.1	1290.3
Mountain Chickadee	35041.6	9582.5
Chestnut-backed Chickadee	303055.4	37894.7
Red-breasted Nuthatch	38550.5	4503.1
Brown Creeper	30138.1	4008.6
Winter Wren	164073.9	12730.8
Golden-crowned Kinglet	192234.2	25076.5
Ruby-crowned Kinglet	1037.3	563.6
Townsend's Solitaire	14217.7	5985.7
Veery	314.6	70.7
Swainson's Thrush	57819.5	5039.7
Hermit Thrush	26166.7	3543.8
American Robin	48978.3	7787.1
Varied Thrush	42466.5	4587.3
American Pipit	10139.1	4951.2
Cedar Waxwing	41638.7	15521.0
Nashville Warbler	7196.4	2168.8
Yellow Warbler	53632.8	23027.0
Audubon's Warbler	39302.9	5919.9
Black-throated Gray Warbler	22769.1	3619.5
Townsend's Warbler	14217.7	10584.6
MacGillivray's Warbler	24780.4	5120.4

Table 26. Park-wide abundance estimates and standard deviations (SD) for species detected in at least 10 locations (continued).

Species	Total abundance	SD
Wilson's Warbler	10812.7	3301.4
Western Tanager	36493.3	5204.7
Spotted Towhee	5453.8	1182.2
Chipping Sparrow	21400.1	5366.9
Fox Sparrow	23415.8	6414.6
Song Sparrow	11037.4	5231.2
Dark-eyed Junco	280593.3	26477.9
White-crowned Sparrow	2380.3	1196.3
Black-headed Grosbeak	3051.5	1033.8
Lazuli Bunting	11676.0	6224.2
Brown-headed Cowbird	1497.4	605.0
Pine Grosbeak	10251.1	5119.8
Cassin's Finch	2091.6	426.5
Red Crossbill	26890.2	11084.1
Pine Siskin	125398.2	95035.2
Evening Grosbeak	22901.4	15630.5
TOTAL	**2,162,380**	**700,538**

Table 27. Species detected in intensive survey plots. * indicates that territorial boundaries could be determined. + indicates that determining territorial boundaries would have required substantially greater sampling. X indicates the species was detected, but territorial boundaries could not be established.

Species	Low Elevation		High Elevation	
	Thunder Creek	Big Beaver	Stilett	McAlester
Blue Grouse	X	X	X	X
Northern Pygmy-Owl	X			
Rufous Hummingbird	X	X	X	X
Red-breasted Sapsucker	X	+		
Downy Woodpecker	X	X		
Hairy Woodpecker	X	X	X	
Three-toed Woodpecker			X	X
Northern Flicker	X	X	X	X
Pileated Woodpecker	X	+		
Olive-sided Flycatcher	X	X	X	X
Western Wood-Pewee	X			
Hammond's Flycatcher	+	+		
Pacific-slope Flycatcher	X	X	X	
Cassin's Vireo	X	X		
Warbling Vireo	X	X		
Gray Jay		X	X	
Steller's Jay	X	X	X	X
Clark’s Nutcracker			X	X
Common Raven		X		X
Mountain Chickadee			+	X
Chestnut-backed Chickadee	+	+		
Red-breasted Nuthatch	X	+	+	+
Brown Creeper	+	+		
Winter Wren	+	*	X	X
Golden-crowned Kinglet	+	X	X	
Ruby-crowned Kinglet				X
Mountain Bluebird			X	X
Townsend's Solitaire			X	
Swainson's Thrush		X		
Hermit Thrush			+	X
American Robin	+	X	X	X
Varied Thrush	+	X	X	X
Orange-crowned Warbler	X			
Yellow Warbler	X			
Audubon's Warbler	X	X	+	+
Black-throated Gray Warbler	X	X		
Townsend's Warbler	+	+	X	
Western Tanager	+	X		
Chipping Sparrow			*	*
Fox Sparrow			+	+
Song Sparrow	X			
Oregon Junco	+	X	*	*
Cassin’s Finch			X	X

Table 27. Species detected in intensive survey plots. * indicates that territorial boundaries could be determined. + indicates that determining territorial boundaries would have required substantially greater sampling. X indicates the species was detected, but territorial boundaries could not be established (continued).

Species	Low Elevation		High Elevation	
	Thunder Creek	Big Beaver	Stilett	McAlester
Red Crossbill		X		
Pine Siskin	X	X	X	X
Evening Grosbeak	X	X		

Appendix 1. Field Forms

NOCA Point Count Densiometer Readings

Transect:_____ Date:_____ Observer:_____

NOTE: PLEASE RECORD THE NUMBER OF OPEN QUARTER-SQUARES!!!

Point 1	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 2	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 3	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 4	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 5	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 6	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 7	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 8	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 9	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 10	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 11	North: _____/96	East: _____/96	South: _____/96	West: _____/96
Point 12	North: _____/96	East: _____/96	South: _____/96	West: _____/96

NOCA VCP Point Count Form page____of_____

Transect_____ Date____/____/____ Observer_____ Weather_____

Starting Northing | | | | | | | |
Starting Easting | | | | | | |
Starting Direction:_____

Ending Northing | | | | | | | |
Ending Easting | | | | | | |
Protocol (**n**ormal, **o**ffset, **d**eliberate):_____

Notes:

TURNS Pt. #	New Direction

Point	Noise (1-5)*	Start Time	Species	Obs1	Obs2	Obs3	Obs4	Obs5	Obs6	Obs7	Obs8	Flyover (count)

*1=*no noise*; 2=*gentle babbling brook noise*, probably not missing birds; 3=*babbling creek noise*, might be missing some high-pitched songs/calls of distant birds; 4=*rushing creek noise*, detection radius is probably substantially reduced; 5=*roaring creek/river noise*, probably detecting only the closest/loudest birds.

North Cascades National Park Point Count Vegetation Sheet, Side 1

Point:_____ Hab:_____ Hab2 (optional):_____ Date:___/___/___ Elev:_____(ft) Quad:_____

Bird Obs:_____ Veg Obs:_____ Northing: __ __ __ __ __ __ __ Easting: __ __ __ __ __ __ GPS error:_____(m) **NAD 27 DATUM**

Plot 1 Habitat:_____	Avg. tree canopy ht.:_____m	Avg. shrub canopy ht.:_____m
Avg. herb canopy ht.:_____cm	Avg. tree sub-canopy ht.:_____m	Avg. shrub sub-canopy ht.:_____m

Tree Species	0-23 cm	24-53 cm	54-81 cm	82-122 cm	>122 cm	Cov > 20 m	Cov 5-20 m
						%	%
						%	%
						%	%
						%	%
						%	%
						%	%
						%	%
						%	%
						%	%
SNAGS (>1.5M TALL)							

LOGS > 20CM DBH	Decay =1	Decay=2	Decay=3	TOTAL COVER	%	%

Woody Vegetation between 0.1 m and 5.0 m

Total Cover:_____% Shrub Cover Only:_____%

Species	Cover	Avg. Ht. (m)
	%	
	%	
	%	
	%	
	%	
	%	
	%	
	%	

Ground cover (0.1 m or less)

Type	Cover	Type	Cover
snow	%	fern	%
water	%	shrub	%
rock	%	tree	%
bare dirt/mud	%	moss	%
litter	%	Other1:	%
downed wood	%	Other2:	%
grass	%	Other3:	%
sedge	%	Other4:	%
forb	%		%

Plot 2 Habitat:_____	Avg. tree canopy ht.:_____m	Avg. shrub canopy ht.:_____m
Avg. herb canopy ht.:_____cm	Avg. tree sub-canopy ht.:_____m	Avg. shrub sub-canopy ht.:_____m

Tree Species	0-23 cm	24-53 cm	54-81 cm	82-122 cm	>122 cm	Cov > 20 m	Cov 5-20 m
						%	%
						%	%
						%	%
						%	%
						%	%
						%	%
						%	%
						%	%
SNAGS (>1.5M TALL)							

LOGS > 20CM DBH	Decay =1	Decay=2	Decay=3	TOTAL COVER	%	%

Woody Vegetation between 0.1 m and 5.0 m

Total Cover:_____% Shrub Cover Only:_____%

Species	Cover	Avg. Ht. (m)
	%	
	%	
	%	
	%	
	%	
	%	
	%	
	%	

Ground cover (0.1 m or less)

Type	Cover	Type	Cover
snow	%	fern	%
water	%	shrub	%
rock	%	tree	%
bare dirt/mud	%	moss	%
litter	%	Other1:	%
downed wood	%	Other2:	%
grass	%	Other3:	%
sedge	%	Other4:	%
forb	%		%

North Cascades National Park Point Center Quarter Data Sheet

Point:___________ Transect:_____________ Page ___ of ___

ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m
ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m
ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m
ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m

Point:___________

ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m
ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m
ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m
ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m

Point:___________

ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m
ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m
ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m
ne	Species:	Distance:	m	DBH:	cm	Height:	m
nw	Species:	Distance:	m	DBH:	cm	Height:	m
sw	Species:	Distance:	m	DBH:	cm	Height:	m
se	Species:	Distance:	m	DBH:	cm	Height:	m

NOCA INVENTORY DAILY JOURNAL

Transect:_____ Quad:_____ Date:_____/____/_____ Bird Obs.:_____ Veg. Obs.:_____

TURNING POINTS

Point number:_____ New direction:_____

Explanation:_____

_____

Point number:_____ New direction:_____

Explanation:_____

_____

Point number:_____ New direction:_____

Explanation:_____

_____

Point number:_____ New direction:_____

Explanation:_____

_____

Point number:_____ New direction:_____

Explanation:_____

_____

Transect notes:

_____

_____

_____

_____

Weather:_____

_____

_____

Vegetation phenology and natural history observations (please record unusual bird sightings on the Rare Bird Report Form): _____

_____

_____

_____

Other:_____

_____

_____

NOCA Rare Bird Report Form

Please include rare birds detected during point counts **or at other times and places**. Use the back of this sheet if you need more space to describe the encounter.

Obs.:	Species:	Date: / /2001	Qty:	Northing: __ __ __ __ __ __ __	Easting: __ __ __ __ __ __	Quad:
Transect and point, if detected during a point count:						
Description:						

Obs.:	Species:	Date: / /2001	Qty:	Northing: __ __ __ __ __ __ __	Easting: __ __ __ __ __ __	Quad:
Transect and point, if detected during a point count:						
Description:						

Obs.:	Species:	Date: / /2001	Qty:	Northing: __ __ __ __ __ __ __	Easting: __ __ __ __ __ __	Quad:
Transect and point, if detected during a point count:						
Description:						

Obs.:	Species:	Date: / /2001	Qty:	Northing: __ __ __ __ __ __ __	Easting: __ __ __ __ __ __	Quad:
Transect and point, if detected during a point count:						
Description:						

Appendix 2. Field Protocol for the 2001-2002 North Cascades National Park Avian Inventory

Establishing a Transect

Each transect was named with a unique 4-digit code. The first character is either 'A' (indicating the starting point is within 1 km of a trail or road), 'X' (indicating a starting point that is within 1 km of a road or trail, but was not randomly generated; rather it marks a particular place and habitat we are interested in surveying), 'U' (indicating a starting point that was targeted in a rare or under-sampled habitat) and 'T' (indicating a transect run along a trail). The letter is followed by a unique 3-digit number. Examples of transect codes include A004, A092, R015, and X003.

Survey teams used topographic maps in conjunction with GPS units to locate transect starting points. Starting UTM's are based on the NAD27 datum, all GPS units were programmed accordingly. Point count surveys began within ten minutes of local sunrise. Due to various logistical problems, surveys were occasionally started slightly later in the morning. We considered it better to start the survey late than to skip it altogether.

Transects were only conducted in suitable weather— high winds that obscured birdsong or rainy conditions that suppressed bird activity prevented surveying. Definitions of acceptable/unacceptable weather conditions for conducting surveys were standardized during training.

We made every attempt to ensure that transect starting points were accessible without observers having to traverse dangerously steep slopes or attempt risky stream crossings. Evaluating these risks by looking at maps is an imprecise process, however, and we made some accessibility errors in point selection. Observers made every reasonable effort to reach starting points, but were instructed never to attempt crossing streams or steep slopes that seemed risky. If a barrier such as an un-crossable stream or a cliff prevented observers from reaching a starting point, but s/he could get to within 500 m of the point, the transect was run from that point. This was essentially the closest place to the intended point that the observers could safely reach. This situation was classified as an 'offset' transect-- a transect that was successfully conducted, but was spatially offset somewhat from the intended location. Furthermore, for all instances for which the transect started greater than 200 m away from the intended starting point, the transect was recorded as being 'offset'. In most instances if the observers were able to get within 200 m of the intended starting point, they were able to get to the exact starting point. Before splitting up to do their respective jobs, both members of the survey team made sure they had a topographic map of the area, a compass, and a GPS unit (among other necessary items). Additionally, in case of emergency, both team members carried a (turned-on) walkie-talkie, and a safety whistle, in case of walkie-talkie failure.

TRANSECT DIRECTION DETERMINATION

2001 Protocol

A randomly selected cardinal direction was selected and followed for the duration of the transect. All cardinal directions were based on true North. In instances when an un-crossable barrier, such as a dangerous slope or a stream that could not be safely forded, was encountered, a new compass bearing 90 degrees clockwise from the previous was followed to the next survey point. All transect direction changes were made at a sampled point such that in the instance that a barrier was encountered midway between two points, the observer retraced his/her steps back to the last successfully completed point and continued the transect in the new direction from that point. In some instances, the second cardinal direction also led to an un-crossable barrier. In these cases the transect was again retraced to the last successfully completed point, 180 degrees was added to the bearing (adding 90 degrees a second time would send the transect back in the same direction) and the transect was continued.

2002 Protocol

Each transect was designated as running either away from the trail or toward the trail (trail direction). The trail direction designation was determined based on the date, with the trail direction being away from the trail on even days and toward the trail on odd days. The transect was run along the semi-cardinal (for our purposes, this included all cardinal and semi-cardinal directions) direction that falls closest to the intended trail direction (away or toward the trail) at a perpendicular angle. When an obstacle was encountered, a change in direction was made at the last point sampled, not at the point at which the obstacle was encountered. In determining a new direction of travel, one of the two semi-cardinal directions closest to the previous direction of travel was randomly chosen and followed for the remainder of the transect unless another obstacle as encountered. To clarify this system: 1) The new direction of travel must adhere to the original trail direction if at all possible. 2) In cases where one out of the two closest semi-cardinal directions is blocked by the obstacle, the other, obstacle-free semi-cardinal direction was automatically used. In cases where both of the semi-cardinal directions closest to the current direction of travel were blocked, the two semi-cardinal directions at 90 degrees from the current direction of travel were chosen between, with the direction following the original trail direction chosen first if at all possible.

In instances where a transect was started from an offset starting point, the assigned trail direction was still followed. If the trail direction was away from trail, the semi-cardinal direction of travel that would run the transect closest to the original starting point was chosen. In the case of trail direction towards the trail, the nearest semi-cardinal direction of travel towards the trail was followed.

For randomly selected starting points that target the rarer vegetation types (transect code beginning letter U) the nearest semi-cardinal direction that would optimize the coverage of the rarer type was followed. Directional changes were made at each point, if necessary, to stay in the targeted habitat type for as long as possible was possible. Once the transect exited the rare habitat type, the direction of travel at the point of exit was followed for the remainder of the transect, provided there were no uncrossable barriers.

Transects assigned to be completed along a trail began on the trail and stayed on the trail for the duration of the transect. The direction of travel along the trail was predetermined. In instances where a transect was not originally assigned as a trail transect but portions of the transect were completed along the trail due to geographical constraints, these constraints were re-evaluated at each point along the transect and the transect was moved off trail as soon as possible.

Bird Observer's Responsibilities:

At the starting point, densiometer readings were taken and a five minute point count (see **Conducting Point Counts**, below) was conducted. After determining the proper direction of travel, each additional point was placed 200 m from the previous point. Distances were measured using standardized pacing and a GPS unit, bearings were followed using a compass. The designated vegetation observer stayed behind, and sampled the vegetation at Point 1 (see **Sampling Vegetation**, below). All bearings incorporated the declination-- transects were oriented on true north, NOT on magnetic north. A trail of orange flags was left by the bird observer; this allowed for the vegetation observer to easily follow the transect line. The appropriate distance between flags varied with the habitat (more flagging was needed in dense forest, less in clearings or rocky areas). Ideally, from each flag an observer could see to the next flag.

Two orange flags right next to each other were left 150 meters from the last point; this signaled to the vegetation observer that s/he was entering the next vegetation plot. Each point count center was marked with a blue flag. Upon arriving at each successive point count station, the point count observer stopped, and took a minute or so to quietly take densiometer readings. This provided a minute or two for birds that have been disturbed by the observer's approach to return to their normal activities before the count began. After each count was conducted, the observer paced another 200 m in the same direction s/he was heading before s/he stopped for the second point count. The entire morning's transect was conducted along this line, unless an un-crossable barrier, such as a dangerous slope or a stream that cannot be safely forded, was encountered. In instances where an un-crossable barrier was encountered, the directions above were followed to determine a new direction of travel away from the point. While conducting the transect, the bird observer decided on the traversability of the terrain, keeping in mind the athletic ability and agility of his/her partner.

In a few instances, it was not possible to run a portion of the transect along *any* semi-cardinal direction. Examples would be a stream that was only crossable along one reach, or that perhaps had a trail crossing with a bridge. In these instances, the transect was oriented so that it took the observer to the bridge, even though the bearing was not a cardinal or semi-cardinal direction. After each point along a 'deliberately' oriented section of the transect was sampled, the direction of travel was examined and if possible the standard protocol was implemented for traveling to the next point, (i.e., travel in a semi-cardinal direction). A deliberate transect direction was only utilized when the observer had no other choice of travel direction. To signal to the vegetation observer that a change of direction was made in the transect, two blue flags were tied at the point count survey point center and the initial part of the path away from the point was flagged extra heavily.

As many point counts as possible were sampled each morning, with the last point beginning no later than 3 hours and 25 minutes after local sunrise. A goal of at least 6 points off trail, or 12 points on trail, was set for each day.

After the bird observer completed his/her last point count on the transect, s/he then completed the vegetation survey at that last point and then proceeded to work his/her way back along the transect, sampling the vegetation and recording UTM coordinates at each point, until the vegetation observer was located. Flagging was collected by both observers as they worked toward each other.

Vegetation Observer's Responsibilities:
Vegetation sampling began at Point 1 after the point count observer completed the point count (this was not done *during* the point count, as any movement may disturb the birds and/or distract the bird observer). When completed with the sampling at Point 1, the transect flagging trail was followed toward the next point, and all flags were collected along the way. When the double-orange flag was reached (the signal that the next vegetation plot was being entered and was centered 50 m away, at the blue flag) the vegetation observer began to collect vegetation data. Vegetation was sampled and UTM coordinates were collected, and then the observer continued on to the next point. The amount of time and effort required to complete a vegetation sampling point varied greatly depending on habitat. The vegetation observer always maintained enough distance (> 200 m) from the point count observer to prevent disturbing the birds that were being counted.

COMPLETING THE DAILY JOURNAL FORM
Upon completing all vegetation sampling along the transect, the bird and vegetation observers completed the Daily Journal. The form was completed as follows:

Transect: The unique, 4-digit code for the transect (i.e. A027).

Quad: The name of the USGS 7.5 minute quad that contained all, or the majority, of the transect.

Date: Entered as mm/dd/yy.

Bird Obs.: First and last initials of the person who conducted the point counts.

Veg Obs.: First and last initials of the person who conducted the vegetation sampling.

Turning Points: Include all points at which changes in direction were made. Below is a sample entry:

Point number: *4* New direction: *45°*
Explanation: *Encountered a rushing stream (uncrossable) 200 m beyond point 4 @ 90°.*

Transect notes: Details of the transect recorded, including: if standard protocol was followed along the entire transect, if the transect was offset from the first point, or if compass bearings

were deliberately chosen anywhere along the transect. Explained why the transect was offset, or if any stretches of it used a 'deliberate' bearing. Irregularities that influenced how the transect was oriented were described (i.e. *'the only way to cross the river was to use the bridge between points 6 and 7'*, or *'because of the steep canyon walls, transect followed the trail between points 3 and 5'*).

Weather: The weather encountered during the transect was described, including notes on morning temperature, wind, or if any precipitation fell, and if so, whether any of these things influenced bird activity or the observer's ability to detect birds. If conditions differed at different points, this was explicitly described.

Vegetation phenology and natural history observations: General natural history observations were recorded including: whether shrubs were leafed out yet, whether large concentrations of flowers were blooming, whether many family groups of birds were seen, etc.

Other: Any other important details about the transect were recorded.

Upon completion of the Daily Journal form, all UTM point location coordinates were crosschecked and it was verified that the point count observer's and the vegetation observer's UTM coordinates agreed with regard to the location of each point on the transect.

Conducting Point Counts

Our survey utilized 5-minute, variable circular plot (VCP) point counts. Detections recorded in the first 3 minutes are recorded separately from those recorded in the last two minutes (2002 season only). VCP point counts require the observer to estimate the horizontal distance to each bird detected. The point count protocol is explained in detail below.

Each survey point was named with a unique 6-digit code. The first 4-digits were the transect code. The last two digits indicate the point number along that transect. For example, on transect A045, the first point is named A04501, the second point is A04502, and so on.

Upon arriving at a point, the bird observer's first task was to take densiometer readings. If done quietly, this allowed for a minute or two for birds disturbed by the observer's approach to settle back into their normal activities. From the counting point, a densiometer reading facing each of the four semi-cardinal directions was taken. The densiometer was held level and at 12'-18' in front of the observer, at elbow height. The number of open quarter squares was counted, and recorded on the densiometer Data Form. The number of open squares was not multiplied in the field by 1.04, as the instructions printed on the densiometer suggest; this was done later in the office. In instances where the survey point happened to fall right under low vegetation that would clearly skew results, the observer moved a couple of steps in the appropriate direction to get out from under the vegetation and collected a densiometer reading representative of the surrounding canopy cover.

After the completion of the densiometer data form, the observer set his/her watch and began the five-minute point count. The point count form was completed as follows:

Transect: The unique, 4-digit code for the transect (i.e. A027).

Date: Enter as mm/dd/yy.

Observer: First and last initials of the bird observer.

Weather: The weather was briefly described (e.g., '*clear; cool at first, but then became hot and sunny*', or '*cold, damp morning; overcast sky, slight drizzle at points 3 and 4*').

Starting Northing and Easting: Coordinates entered for the transect starting location (i.e. point one), these may differ from the assigned transect starting point.

Starting Direction: Initial compass bearing entered (e.g. 45°). Bearings based on true North, rather than magnetic north.

Ending Northing and Easting (entered after the completion of the transect): Coordinates of the last sampled point on the transect entered.

Protocol (entered after the completion the transect): For normal protocol usage in establishing all points, 'N' was entered. For instances in which the transect starting point was offset an 'O' was entered. In instances in which a deliberate direction was followed between any two points, along the transect a 'D' was entered. In instances where the starting point was offset and a deliberate direction (non-semi-cardinal) was followed 'O, D' was entered. For all transects assigned and completed along a trail a 'T' was entered. For transects not assigned to a trail but completed along the trail due to logistical concerns both 'D, T' were entered.

Turns (entered during the transect, as turns are made): The point number of each point at which a change of direction was made along with the new compass bearing was entered. For example, if the starting transect direction was at 45° and then the transect turned 45° due to an impassible obstacle past point 4, the first entry in this box would be "*4 90°*".

Point: The last two digits of the point number (e.g. 01, 02, etc.) entered. This was only recordded for the first record at each point.

Noise: Noise interference from streams or other noise at the survey point, as follows:

1 = *no noise*
2 = *gentle babbling brook noise*; probably not missing birds
3 = *babbling creek noise*; might be missing some high-pitched songs/calls of distant birds
4 = *rushing creek noise*; detection radius is probably substantially reduced
5 = *roaring creek or river noise*; probably detecting only the loudest/closest birds

Note that *noise* was scored based on the volume of the noise, rather than the actual size of the stream. A large rushing river may only produce the noise interference of a babbling brook if it is far away; in this case it was scored as a '2'.

Start Time: The four-digit starting time of the point count (i.e. 6:20 a.m. would be entered as '0620') entered.

Species: 4-letter species code entered for each species detected. Available space allowed for up to 8 individual birds of the same species on one line. If more than 8 individuals of the same species were detected, at the same point, the species code was entered again on another line. Occasionally it was only possible to identify what general group a bird belongs to (e.g. woodpeckers), and not possible to it to species. In these instances the following 'unidentified codes' were used.

UNDU— unidentified duck
UNHA— unidentified hawk
UNGU— unidentified gull
UNOW— unidentified owl
UNHU— unidentified hummingbird
UNSA— unidentified sapsucker
UNWO— unidentified woodpecker
UNFL— unidentified flycatcher
UNEM— unidentified *Empidonax* flycatcher
UNVI— unidentified vireo
UNSW— unidentified swallow
UNCH— unidentified chickadee
UNCA— unidentified *Catharus* thrush
UNWA— unidentified warbler
HETO— Hermit/Townsend's Warbler
UNSP— unidentified sparrow

Obs1-Obs8: The estimated horizontal distance to the first bird of each species detected under Obs1. The horizontal distance to the bird is the distance from the observer to directly under the bird above the observer (such as a bird singing high in the forest canopy). The distance to where the bird was when *first* detected it was recorded, regardless of whether it was perched or in motion; if it moved toward or away from the observer during the count, the distance was not changed. If a second bird of the same species during the same count was detected, the distance to it was entered under Obs2, and so on. Obs 1 – 5 were used for all birds detected in the first 3 minutes of the count, Obs 6-8 are used for birds detected in the last 2 minutes of the count (2002 only, no time differentiation used in 2001). In both time sub-sets, if more birds were detected than space on a single line allows, the species were recorded again on a lower line and the Observed distances were recorded respectively. All birds detected should be accounted for in Obs1- Obs8, except for birds that meet the criteria for 'flyovers' (which were entered in the 'Flyover' column-- see below) and birds that were clearly juveniles. Birds identified as juveniles were not recorded on the form, but it is often very difficult to age birds during point counts. In general a bird was counted unless bird unless it was confidently identified as a juvenile (i.e. juvenal plumage is evident, or you see the bird begging from its parents).

In instances where a single bird was recorded on two separate point counts, an "X" was placed above the distance estimation for that bird at either the current point or the previous point—

whichever distance was greater. For example, if a Clark's Nutcracker was recorded at 300 m at point 04, and then that same individual bird was recorded at 40 m at point 05, the "X" was placed above the distance estimation for point 04. Alternately, if the bird was recorded from 40 m at point 04 and then again from 300 m from point 05, the "X" was placed over the distance estimation for point 05. It was sometimes difficult to tell whether a far off bird is indeed an individual that has already counted— in general each detection was treated as a new individual, unless the observer is certain that it was not.

Flyover (count): Birds that fly above the top of the vegetation canopy, never touch down in field of view, and did not appear to be foraging, displaying, or behaving in any other way that suggested a link to the habitat below them were recorded as flyovers. These were birds that appeared to just be passing over, without actually utilizing the surveyed habitat. Distance was not estimated to these birds; only the number of birds detected was entered.

Sampling Vegetation

The vegetation sampling protocol was designed to produce a detailed, yet fairly rapid characterization of habitat structure and composition within a circular 50 m radius plot centered at the point count survey point. Protocols between the two years differed slightly, particularly relating to the process used to quantify percent coverage of vegetation within each plot. Specific data collected in both years is presented first followed by a description of the general method used in quantifying vegetation percent coverage followed by detailed descriptions for each year.

The following data were collected in both 2001 and 2002:
Point: Entered the full, 6-character point code, consisting of the 4-character transect code followed by the 2-digit point number (e.g. the second point on Transect A009 would be 'A00902').

Hab: The 4-character habitat code that best described the habitat within a 50 m radius of the survey point was entered. If the 50 m radius plot straddled two distinct habitat types, the habitat that accounts for the larger proportion of the plot was recorded. Habitat was assessed and recorded after all other vegetation data was collected in order to obtain an accurate classification.

Hab2: In instances where a 50 m radius plot straddled two distinct habitat types, the habitat that accounts for the smaller proportion of the plot was recorded.

Date: Entered as mm/dd/yy.

Elev: Elevation, in feet entered. A GPS unit along with a map were used to crosscheck each other in determining elevations.

Quad: The name of the USGS 7.5 minute quad that contained the point.

Bird Obs: First and last initials of the person who conducted the point count.

Veg. Obs: First and last initials of the person who conducted the vegetation sampling.

Northing and Easting: Coordinates that were as accurate as possible, using both a GPS unit and a topographic map entered. All GPS readings collected using the NAD27 datum.

GPS Error: GPS accuracy (in meters) reading indicated on the GPS screen entered (2002 only).

Point: The full, 6-character point code, consisting of the 4-character transect code followed by the 2-digit point number (e.g. the second point on Transect A009 would be 'A00902') was entered.

Aspect: A compass bearing for the general direction in which water would go if it flowed across the 50 m radius plot (e.g. '48°') was entered. *Bearing based on true north, rather than magnetic north.*

Slope: Clinometer used to estimate the average slope, in degrees, of the 50 m radius plot.

Rock: 'y' entered if rocks constituted a substantial portion of the vegetation plot and/or may provide necessary resources for rock-loving bird species. 'n' entered if they do not.

Moisture: '1' entered for dry, '2' for moist, and '3' for wet. Moisture assessment was standardized during training.

Standing H20: The number of square meters of the 50 m radius circle are covered by standing water was estimated.

Running H20: If the 50-m radius circle contained no running water a '1' was entered. If running water was present anywhere in the circle, the numeric code that best describes it was entered:

2=trickle
3=small stream
4=large stream
5=river

All codes were standardized during training.

Point Center Quarters: Fifty meters from the center of the vegetation plot along each of the four cardinal directions point-center-quarters were conducted. At the end of each 50 m cardinal directed arm the immediate space was divided into northeast, northwest, southwest, and southeast quadrants. For each quadrant, the distance was recorded from the observer to the nearest tree trunk more than half within that quadrant. For this metric, we defined a tree as a woody plant with a single stem (as opposed to a shrub, which has multiple stems) that is at least 10 m tall. All trees were within 100 m of where the observer was standing. If no trees were present within 100 m in a particular quadrant, '>100' was entered in the species blank. When a tree was present, the six-letter species code for the tree species, the DBH in centimeters, and the height in meters was recorded. This was done separately for each of the four quadrants. A

single tree occasionally ended up being the closest tree in more than one point-quarter in very sparsely forested habitats.

Determining Vegetative Cover

The following descriptions explain each data variable collected in the field. The goal was to determine percent cover for tree, shrub, and herbaceous vegetation layers. In 2001 data were collected based on a 50 m radius circle plot size. In 2002 data were collected within each of two 20 x 40-m subplots placed within each 50 m radius circle.

Avg. herb canopy height: Average height (cm) of the top of the top layer of the herb canopy entered.

Avg. tree canopy height: Average height (m) of the top of the top layer of the tree canopy entered. Note that this is generally not the same as the average tree height.

Avg. tree sub-canopy height: We described a tree subcanopy as being present if two distinct average heights of trees, generally comprised of different species with distinct growth forms, were present. There need not necessarily be a clear break between the tops of one set of trees and the lowest foliage of another set. *If no clear tree subcanopy existed, this space was left blank.*

Avg. shrub canopy height: The average height (m) of the top of the top layer of the shrub canopy entered. Note that this was not necessarily the same as the average shrub height.

Avg. shrub sub-canopy height: We described a shrub sub-canopy as being present if two distinct average heights of woody plants, generally comprised of different species with very distinct growth forms, were present. As with the tree subcanopy, there need not be a clear break between the tops of one set of shrubs and the lowest foliage of another set. *If no clear shrub sub-canopy exists, this space was left blank.*

Vegetation cover above 20 m: This category concerned only species-specific foliage in the vegetation layer that begins 20 m above the ground, and extends upward indefinitely. Species were recorded in the trunk count box. Note that if tree crowns overlap, it is possible that the sum of coverages by the individual species is much greater than the 'total cover'. Also estimated was percentage total vegetation cover above 20 m, recorded in the space marked 'Total Cover'.

Vegetation cover between 5.0 and 20.0 m: Vegetation between 5 and 20 m above ground considered. Species-specific percentage coverage values entered in the Cov 5-20 m space. Species recorded in the trunk count box, if not already present. Observers estimated how much area was covered by each individual species. A single tree could be counted in both the 20+ m layer, and the 5-20 m layer, provided that it had foliage in both layers. In the row marked **Total Cover**, total percent coverage for all species in Cov 5-20 m category was recorded using the same rules stated above.

Woody vegetation between 0.1 m and 5.0 m: Estimated the amount of ground shaded by all the woody vegetation between 0.1 and 5.0 m. Also estimated the amount of ground shaded by just the shrubs— this number was some fraction of the previous number. Listed 6-letter codes of the species that contributed to 'total cover', and estimated the amount of ground shaded by each, and the average height of the individuals of the species that were < 5.0 m tall.

Ground cover: Estimated the percentage plot accounted for by each ground cover category. All entries added to 100%. In 'other' categories, recorded both the item name and the percent cover.

2002 Sub-plot protocol

Within each 50-m radius vegetation plot, there are two 20 x 40-m sub-plots, running along the transect centerline of the plot. Within each sub-plot, various measurements were taken. Each is described below. Note that these field pertain only to data collected in 2002.

Each sub-plot is 20 m wide and 40 m long. **Plot 1** runs along the direction of travel the vegetation observer is traveling in as s/he enters the larger (50-m radius) vegetation plot. **Plot 2** runs along the plot centerline running out of the 50-m radius circle and starts 10 m out from the plot center.

Plot designation box: Each large subplot box has a small plot designation box in the upper left corner. The plot designation indicates the correct large box to use. Along with the plot designation is a habitat field; we recorded the habitat code that best characterized the sub-plot.

Tree and snag trunk count: In the large box titled **Tree Species**, we counted trunks from the sub-plot centerline out to 10 m on either side of the centerline. Each plot was sampled as the observer walked along the centerline. The observer stopped every 5 to 10 meters and counted each tree encountered that was inside of the plot (within 10 m of the plot center-line—including trunks that are $\geq$ 50 % inside the border of the 10 m plot boundary). Trees were identified to species. The code name of each species encountered was entered and then we tallied the number of trees or snags for each species encountered in each size category. Snags were recorded in the bottom row (labeled snags) by size category.

Logs: The number of logs in each decay class that crossed the centerline were tallied. The following table was used to determine decay class:

Characteristic	Decay Class 1	Decay Class 2	Decay Class 3
Bark	Mostly intact	Mostly sloughed/sloughing	Absent
3 cm twigs	Present to absent	Absent	Absent
Exposed wood texture	Intact, generally hard	Large pieces, partly soft	Small pieces, soft
Portion of log on ground	Log supporting itself	Log sagging on ground	Log entirely grounded
Exposed wood color	Original	Original to reddish	Reddish to brown
Epiphytes	None	Conifer seedlings	Moss and Conif. Sdlng
Invading roots	None	Shallow seedlings	Roots penetrating
Log x-sectional shape	Round	Round	Oval or collapsed

HABITAT DIFFERENTIATION

In some instances it was difficult to differentiate between habitats, particularly in mixed habitat classes, such as Conifer Deciduous Mix and those habitats in which several species co-dominate. The rules used by all field observers to classifying those habitats are below.

Conifer Deciduous Mixed Forests: In a deciduous forest in which a coniferous (mixed or single species, including hemlocks and cedars) component is present, if the coniferous component constitutes at least 20% of the total tree canopy present, the habitat was classified as CODM. The opposite is also true. In a coniferous forest in which a deciduous (mixed or single species) component is present, if the deciduous component constitutes at least 20% of the total tree canopy present, the habitat was classified as CODM.

Co-dominant Forests: In forests which several species are present in near equal numbers, it was necessary to classify that forest to one of the PMR GIS habitat classes. Examples of these forests included most low-elevation west-side forests in which several tree species are present in the forest and it is not readily apparent which species is dominant. In these cases, the habitat was typed by the biggest and tallest trees present even if they are slightly out-numbered by smaller, denser growing sub-canopy trees. An example of this type of forest is a Douglas-fir Forest in which Douglas-fir trees are noticeably the largest trees in the forest but are outnumbered by smaller and younger Western Hemlock trees. This would be a late-seral Douglas-fir Forest in which Western Hemlock may outgrow and replace Douglas-fir, but at this point in time has not; therefore the habitat was typed as Douglas-fir forest.

Forest/Open Matrix Habitats: In areas where forests and open habitats (such as Heather or Meadow and Subalpine Fir at higher elevations) intermingle; habitat that covers the largest percent of the area within the 50-m radius circle was recorded.

RARE BIRD DETECTIONS

Rare bird detections were recorded on the Rare Bird Detections Data Sheets. Refer to the list along the right margin of this sheet for a list of species that qualify as rare birds. Species on this list may not in fact be rare in the park, however, they were difficult to document using a point count survey technique. The this form was used to document both genuinely rare birds as well as species that are not typically documented well using point count surveys. For each individual documented, the encounter with the bird was described along with all pertinent identifying field marks. Also noted was the behavior of the bird, any behavior indicative of breeding including singing/territorial behaviors, copulation, nest building, brooding, or any other nesting-associated behaviors was also recorded.

Appendix 3. Metadata for the Avian Inventory of North Cascades National Park Service Complex

This report is accompanied by five dBase files prepared by The Institute for Bird Populations: ibp_pct.dbf, ibp_vega.dbf, ibp_vegb.dbf, ibp_pcq.dbf, and ibp_rare.dbf. This appendix serves as metadata for these files. Note that tables referenced in the field descriptions below are presented at the end of this appendix.

1. Point Count Data: ibp_pct.dbf

Field: UNIQPT
Description: Unique 6-character code for each point.

Field: NOISE
Description: Noise interference, scored from 1 to 5, where 1 = no noise; 2 = some noise, but probably not missing birds; 3 = might be missing some high-pitched vocalizations of distant birds; 4 = detection radius is probably substantially reduced; 5 = probably detecting only the closest/loudest birds.

Field: TIME
Description: 4-character field indicating the time of day the point count began.

Field: SPEC
Description: 4-character field indicating the bird species detected. A key to bird species codes is provided in Table A1.

Field: OBS
Description: Horizontal distance in meters to a bird when it was first detected (non-flyover birds only).

Field: Fly
Description: Number of birds detected together as flyovers.

2. Habitat Data I: ibp_vega.dbf

Field: TRANSECT
Description: 4-characater code identifies transect on which the point was conducted. Off-trail transects begin with 'A' and transects conducted along trails begin with 'T'. A small number of off-trail transects were selected non-randomly to sample areas of high interest; these begin with 'X'.

Field: POINT
Description: Identifies the point number along the transect.

Field: UNIQPT
Description: Combines transect and the point for each point conducted, providing a unique code for each point. **This field may be used to link data in each of the databases on this disk.**

Field: HAB
Description: 4-character code identifying the dominant PMR habitat type within a 50 m radius of the survey point. See Table A2 for list of habitat codes and their meanings.

Field: HAB2
Description: 4-character code identifying a secondary PMR habitat type (if present) within a 50 m radius of the survey point. See Table A2 for list of habitat codes and their meanings.

Field: DATE
Description: The date the point count was conducted (mm/dd/yyyy).

Field: ELEV
Description: Elevation in meters, as determined from the GIS database.

Field: BIRDOBS
Description: Initials of the point count observer.

Field: VEGOBS
Description: Initials of the habitat observer.

Field: NORTHING
Description: UTM northing (NAD27) of the survey point.

Field: EASTING
Description: UTM easting (NAD27) of the survey point.

Field: GPSERROR
Description: Error in meters of GPS reading, as provided by hand-held GPS unit.
Note: This information was collected in 2002 only.

Field: ASPECT
Description: Compass degrees indicating the dominant aspect of the 50 m radius point count circle.

Field: SLOPE
Description: Average slope (degrees) of the 50 m radius point count circle, measured with a clinometer. **'99' indicates no data were collected in the field.**

Field: ROCKPRES
Description: Y=exposed rock is a substantial enough feature of the habitat in the 50 m radius count circle to affect bird usage of the area, N=little or no exposed rock.

Field: MOIST
Description: Soil moisture in the 50 m circle. 1=dry, 2=moist, 3=wet.

Field: STANDH20
Description: Area (square meters) of the 50 m circle covered in standing water.

Field: RUNH20
Description: Index describing running water in the 50 m circle. 1=none, 2=trickle, 3=small stream, 4=large stream, 5=river.

The following fields, all of which begin with 'A' describe conditions in the first of two 20m x 40m subplots adjacent to the point count station (2002 methodology), or in a single 50m radius plot centered on the point count station (2001 methodology).

Field: APLOTHAB
Description: 4-character code identifying the dominant habitat type within the subplot. See Table A2 for list of habitat codes and their meanings.
Note: This information was collected in 2002 only.

Field: AHERBCAN
Description: Average height (cm) of the herbaceous canopy, if present.

Field: ATREECAN
Description: Average height (m) of the tree canopy, if present.

Field: ATREESCAN
Description: Average height (m) of the tree subcanopy, if present.

Field: ASHRUBCAN
Description: Average height (m) of the shrub canopy, if present.

Field: ASHRUBSCAN
Description: Average height (m) of the shrub subcanopy, if present.

Field: ATREE1ID
Description: 6-letter code (first 3 letters of genus followed by first 3 letters of species) of a plant species covering at least 1% of the subplot, at least 5m above ground. See Table A3 for list of tree codes and their meanings.

Field: ATREE123
Description: Count of stems 1-23cm dbh of the species indicated in Atree1id.
Note: This information was collected in 2002 only.

Field: ATREE153
Description: Description: Count of stems 24-53cm dbh of the species indicated in Atree1id.
Note: This information was collected in 2002 only.

Field: ATREE181
Description: Description: Count of stems 54-81cm dbh of the species indicated in Atree1id.
Note: This information was collected in 2002 only.

Field: ATREE1122
Description: Description: Count of stems 82-122cm dbh of the species indicated in Atree1id.
Note: This information was collected in 2002 only.

Field: ATREE1123
Description: Count of stems >122 cm dbh of the species listed in Atree1id.
Note: This information was collected in 2002 only.

Field: ATREE1HCOV
Description: Percent cover of the species indicated in Atree1id, considering only vegetation greater than 20m above ground.

Field: ATREE1MCOV
Description: Percent cover of the species indicated in Atree1id, considering only vegetation between 5 and 20 m above ground.

Field: ATREE2ID
Description: 6-letter code (first 3 letters of genus followed by first 3 letters of species) of another plant species covering at least 1% of the subplot, at least 5m above ground.

Fields: ATREE223… ATREE2MCOV
Description: Fields follow the same conventions as above, but applied to the species indicated in Atree2id, rather than Atree1id.

Fields following the same conventions are provided for seven additional plant species (Atree3id…Atree9id).

Field: SNAGS
Description: Indicates number of snags (>20 cm dbh) in the 50 m radius count circle.
A = none, B = 1-3, C = 4-8, D = 9+.
Note: This field was completed in 2001 only. In 2002 we described snags in more detail, using the following 5 fields.

Field: ASNAG23
Description: Number of snags (dead tree, any species, >1.5 m tall) 1-23 cm dbh.
Note: This information was collected in 2002 only.

Field: ASNAG53
Description: Number of snags 24-53 cm dbh.
Note: This information was collected in 2002 only.

Field: ASNAG81
Description: Number of snags 54-81 cm dbh.
Note: This information was collected in 2002 only.

Field: ASNAG122
Description: Number of snags 82-122 cm dbh.
Note: This information was collected in 2002 only.

Field: ASNAG123
Description: Number of snags >122 cm dbh.
Note: This information was collected in 2002 only.

Field: LOGS
Description: Indicates number of logs (>20 cm diameter) in the 50 m radius count circle.
A = none, B = 1-5, C = 6+.
Note: This field was completed in 2001 only. In 2002 we described logs in more detail, using the following 3 fields.

Field: ADECAY1
Description: Number of logs (>20 cm diameter) crossing the center of the plot, perpendicular to its long axis (such that the observer had to step or climb over them) of decay class 1.Decay classes were determined as follows:

Characteristic	Decay Class 1	Decay Class 2	Decay Class 3
Bark	Mostly intact	Mostly sloughed/sloughing	Absent
3 cm twigs	Present to absent	Absent	Absent
Exposed wood texture	Intact, hard	Large pieces, partly soft	Small pieces, soft
Portion of log on ground	Log supporting itself	Log sagging on ground	Log entirely grounded
Exposed wood color	Original	Original to reddish	Reddish to brown
Epiphytes	None	Conifer seedlings	Moss and Conif. Sdlng
Invading roots	None	Shallow seedlings	Roots penetrating
Log x-sectional shape	Round	Round	Oval or collapsed

Note: This information was collected in 2002 only.

Field: ADECAY2
Description: Number of logs (>20 cm diameter) crossing the center of the plot, perpendicular to its long axis (such that the observer had to step or climb over them) of decay class 2.
Note: This information was collected in 2002 only.

Field: ADECAY3
Description: Number of logs (>20 cm diameter) crossing the center of the plot, perpendicular to its long axis (such that the observer had to step or climb over them) of decay class 3.
Note: This information was collected in 2002 only.

Field: ATOTCOVH
Description: Percent cover of all contributing species, considering only vegetation greater than 20m above ground.

Field: ATOTCOVM
Description: Percent cover of all contributing species, considering only vegetation between 5 and 20 m above ground.

Field: AWVTOTCOV
Description: Percent cover of all contributing species (tree or shrub), considering only vegetation between 1 and 5 m above ground.

Field: ASHRUBONLY
Description: Percent cover of all shrub species, considering only vegetation between 1 and 5 m above ground.

Field: AWV1ID
Description: 6-letter code (first 3 letters of genus followed by first 3 letters of species) of a plant species covering at least 1% of the subplot, considering only vegetation between 1 and 5 m above ground. See Table A4 for shrub species list.

Field: AWV1COV
Description: Considering only vegetation between 1 and 5 m above ground, percent cover of species indicated in Awv1id.

Field: AWV1HT
Description: Avg. ht (m) of species indicated in Awv1id.

Fields following the same conventions are provided for 8 more plant species (AWV2ID-AWV2HT; AWV3ID-AWV3HT;…AWV9ID-AWV9HT).

The following fields all refer to ground cover below 0.1 m above ground.

Field: ASNOW
Description: Percent of ground covered by snow.

Field: AWATER
Description: Percent of ground covered by standing or running water.

Field: AROCK
Description: Percent of ground comprised of exposed rock.

Field: ABARE
Description: Percent of ground comprised of bare soil.

Field: ALITTER
Description: Percent of ground covered by organic litter.

Field: ADW
Description: Percent of ground covered by downed wood.

Field: AGRASS
Description: Percent of ground covered by grass.

Field: ASEDGE
Description: Percent of ground covered by sedge.

Field: AFORB
Description: Percent of ground covered by forbs.

Field: AFERN
Description: Percent of ground covered by ferns.

Field: ASHRUB
Description: Percent of ground covered by shrubs.

Field: ATREE
Description: Percent of ground covered by trees (trunks + foliage).

Field: AMOSS
Description: Percent of ground covered by moss.

Field: AOTHER1ID
Description: One-word description of any additional ground cover item.

Field: AOTHER1COV
Description: Percent of ground covered by item indicated in Aother1id.

Field: AOTHER2ID
Description: One-word description of any additional ground cover item.

Field: AOTHER2COV
Description: Percent of ground covered by item indicated in Aother2id.

Field: DENNORTH
Description: Number of open vertices (out of 96 possible) on the spherical densiometer face, when the observer was facing north. 999 signifies no data were collected in the field.

Field: DENEAST
Description: Number of open vertices (out of 96 possible) on the spherical densiometer face, when the observer was facing east. 999 signifies no data were collected in the field.

Field: DENSOUTH
Description: Number of open vertices (out of 96 possible) on the spherical densiometer face, when the observer was facing south. 999 signifies no data were collected in the field.

Field: DENWEST
Description: Number of open vertices (out of 96 possible) on the spherical densiometer face, when the observer was facing west. 999 signifies no data were collected in the field.

3. Habitat Data II: ibp_vegb.dbf

This file contains data pertaining to the second of the two vegetation subplots associated with each point count station. The first field, 'UNIQPT' serves as a link to each of the other databases. The remaining fields are identical to their counterparts in ibp_vega.dbf, except they all begin with 'B'. Note that only one vegetation plot was assessed in 2001, so the points visited that year are NOT represented at all in this database.

4. Habitat Data III (Point-Center Quarters): ibp_pcq.dbf

Field: UNIQPT
Description: Combines transect and the point for each point conducted, providing a unique code for each point. **This field may be used to link data in each of the databases on this disk.**

Field: DIRNESPEC
Description: Identifies the closest tree species present in the NE quadrant. See Appendix III for a list of tree species.

Field: DIRNEDIST
Description: Distance in meters to the tree identified in DIRNESPEC.

Field: DIRNEDBH
Description: Diameter at breast height (1.5 meters from the ground) for the tree recorded.

Field: DIRNEHT
Description: Height in meters of the tree recorded.

Field: DIRNWSPEC
Description: Identifies the closest tree species present in the NW quadrant. See Appendix III for a list of tree species.

Field: DIRNWDIST
Description: Distance in meters to the tree identified in DIRNWSPEC.

Field: DIRNWDBH
Description: Diameter at breast height (1.5 meters from the ground) for the tree recorded.

Field: DIRNWHT
Description: Height in meters of the tree recorded.

Field: DIRSESPEC
Description: Identifies the closest tree species present in the SE quadrant. See Appendix III for a list of tree species.

Field: DIRSEDIST
Description: Distance in meters to the tree identified in DIRSESPEC.

Field: DIRSEDBH
Description: Diameter at breast height (1.5 meters from the ground) for the tree recorded.

Field: DIRSEHT
Description: Height in meters of the tree recorded.

Field: DIRSWSPEC
Description: Identifies the closest tree species present in the SW quadrant. See Appendix III for a list of tree species.

Field: DIRSWDIST
Description: Distance in meters to the tree identified in DIRSWSPEC.

Field: DIRSWDBH
Description: Diameter at breast height (1.5 meters from the ground) for the tree recorded.

Field: DIRSWHT
Description: Height in meters of the tree recorded.

Fields following the same conventions are provided for 3 more point-center quarters. Whereas all fields pertaining to the first point-center quarter begin with 'DIR' (see above), all fields pertaining to the second point-center quarter begin with 'L', all fields pertaining to the third point-center quarter begin with 'R', and all fields pertaining to the fourth point-center quarter begin with 'END'.

5. Rare Bird Reports: ibp_rare.dbf

This database catalogs documented detections of species thought to be rare in the park and/or rarely detected during point counts. Some of the detections occurred during point counts, but many were gathered by crew members opportunistically while hiking, camping or engaged in other activities within park boundaries.

Field: SPEC
Description: 4-character field indicating the bird species detected. A key to bird species codes is provided in Table A1.

Field: OBSERVER
Description: Initials of the observer. When two or more observers detected the bird, initials are separated with '\'.

Field: DATE
Description: The date the bird was detected (mm/dd/yyyy).

Field: QUANTITY
Description: Number of individual birds detected.

Field: NORTHING
Description: UTM northing (NAD83) of the detection location.

Field: EASTING
Description: UTM easting (NAD83) of the detection location.

Field: QUAD
Description: Name of USGS 7.5 minute quadrangle.

Field: UNIQPT
Description: 6-character code for the survey point, if the detection occurred during a point count.

Field: DETAILS
Description: Additional information about the detection.

Table A1. Species codes used in the point count and rare bird databases.

SPEC Code	Common Name	SPEC Code	Common Name
AMCR	American Crow	HOME	Hooded Merganser
AMDI	American Dipper	HOWR	House Wren
AMGO	American Goldfinch	KILL	Killdeer
AMPI	American Pipit	LAZB	Lazuli Bunting
AMRE	American Redstart	LEFL	Least Flycatcher
AMRO	American Robin	LISP	Lincoln's Sparrow
AUWA	Audubon's Warbler	MALL	Mallard
BAEA	Bald Eagle	MGWA	MacGillivray's Warbler
BAGO	Barrow's Goldeneye	MOBL	Mountain Bluebird
BARS	Barn Swallow	MOCH	Mountain Chickadee
BCCH	Black-capped Chickadee	MODO	Mourning Dove
BDOW	Barred Owl	NAWA	Nashville Warbler
BEKI	Belted Kingfisher	NOFL	Northern Flicker
BHCO	Brown-headed Cowbird	NOGO	Northern Goshawk
BHGR	Black-headed Grosbeak	NONE	No birds detected at point
BLSW	Black Swift	NOPO	Northern Pygmy-Owl
BLUG	Blue Grouse	NRWS	Northern Rough-winged Swallow
BRCR	Brown Creeper	OCWA	Orange-crowned Warbler
BTYW	Black-throated Gray Warbler	ORJU	Oregon Junco
BUOR	Bullock's Oriole	OSFL	Olive-sided Flycatcher
BWTE	Blue-winged Teal	OSPR	Osprey
CAFI	Cassin's Finch	PEFA	Peregrine Falcon
CAGO	Canada Goose	PIGR	Pine Grosbeak
CAHU	Calliope Hummingbird	PISI	Pine Siskin
CANW	Canyon Wren	PIWO	Pileated Woodpecker
CAVI	Cassin's Vireo	PSFL	Pacific-slope Flycatcher
CBCH	Chestnut-backed Chickadee	PUFI	Purple Finch
CEDW	Cedar Waxwing	RBNU	Red-breasted Nuthatch
CHSP	Chipping Sparrow	RBSA	Red-breasted Sapsucker
CLNU	Clark's Nutcracker	RCKI	Ruby-crowned Kinglet
CLSW	Cliff Swallow	RECR	Red Crossbill
COHA	Cooper's Hawk	REVI	Red-eyed Vireo
COLO	Common Loon	RNDU	Ring-necked Duck
CONI	Common Nighthawk	RNSA	Red-naped Sapsucker
CORA	Common Raven	RTHA	Red-tailed Hawk
COYE	Common Yellowthroat	RUGR	Ruffed Grouse
DOWO	Downy Woodpecker	RUHU	Rufous Hummingbird
DUFL	Dusky Flycatcher	RWBL	Red-winged Blackbird
EUST	European Starling	SAPH	Say's Phoebe
EVGR	Evening Grosbeak	SAVS	Savannah Sparrow
FOSP	Fox Sparrow	SOSP	Song Sparrow
GCKI	Golden-crowned Kinglet	SPOW	Spotted Owl
GCRF	Gray-crowned Rosy-Finch	SPSA	Spotted Sandpiper
GOEA	Golden Eagle	SPTO	Spotted Towhee
GRAJ	Gray Jay	STJA	Steller's Jay
GRCA	Gray Catbird	SWTH	Swainson's Thrush
HAFL	Hammond's Flycatcher	TOSO	Townsend's Solitaire
HARD	Harlequin Duck	TOWA	Townsend's Warbler
HAWO	Hairy Woodpecker	TRES	Tree Swallow
HETH	Hermit Thrush	TTWO	Three-toed Woodpecker
HOFI	House Finch	UNAC	Unidentified Accipiter

Table A1. Species codes used in the point count and rare bird databases (continued).

SPEC Code	Common Name	SPEC Code	Common Name
UNGR	Unidentified Grouse	VGSW	Violet-green Swallow
UNHU	Unidentified Hummingbird	WAVI	Warbling Vireo
UNSA	Unidentified Sapsucker	WBNU	White-breasted Nuthatch
UNSP	Unidentified Sparrow	WCSP	White-crowned Sparrow
UNSW	Unidentified Swallow	WESO	Western Screech-Owl
UNTH	Unidentified Thrush	WETA	Western Tanager
UNWA	Unidentified Warbler	WEWP	Western Wood-Pewee
UNWO	Unidentified Woodpecker	WIFL	Willow Flycatcher
USWI	Unidentified Swift	WIWA	Wilson's Warbler
VASW	Vaux's Swift	WIWR	Winter Wren
VATH	Varied Thrush	WTPT	White-tailed Ptarmigan
VEER	Veery	WWCR	White-winged Crossbill
VESP	Vesper Sparrow	YWAR	Yellow Warbler

Table A2. Habitat codes used in the vegetation databases.

HAB Code	Habitat
BIGM	Bigleaf Maple
BLCO	Black Cottonwood
CODM	Conifer Deciduous Mix
DOFE	Douglas-fir East
DOFI	Douglas-fir Undifferentiated
DOFW	Douglas-fir West
ENGS	Engelmann Spruce
HAMI	Hardwood Mix
HEAT	Heather
LOPI	Lodgepole Pine
MEAD	Meadow
MOHE	Mountain Hemlock
PASF	Pacific Silver Fir
POPI	Ponderosa Pine
REAL	Red Alder
ROCK	Rock
SHRU	Shrub
SUBF	Subalpine Fir
SUBL	Subalpine Larch
WEHE	Western Hemlock
WERC	Western Redcedar
<25%	Less than 25% anything

Table A3. Tree species codes used in the vegetation databases.

Species Code	Common Name	Scientific Name
ABIAMA	Pacific Silver Fir	*Abies amabilis*
ABIGRA	Grand Fir	*Abies grandis*
ABILAS	Subalpine Fir	*Abies lasiocarpa*
ABIPRO	Noble Fir	***Abies procera***
ACEMAC	Big-leaf Maple	***Acer macrophyllum***
ALNRUB	Red Alder	*Alnus rubra*
BEGGLA	Bog Birch	*Betula glandulosa*
BETPAP	Paper Birch	*Betula papyrifera*
CHANOO	Alaska Yellowcedar	***Chamaecyparis nootkatensis***
LARLYA	Subalpine Larch	*Larix lyallii*
PICENG	Engelmann Spruce	*Picea engelmannii*
PICGLA	White Spruce	*Picea glauca*
PINALE	Whitebark Pine	*Pinus albicaulis*
PINCON	Lodgepole Pine	*Pinus contorta*
PINMON	Western White Pine	*Pinus monticola*
PINPON	Ponderosa Pine	*Pinus ponderosa*
POPBAL	Black Cottonwood	*Populus balsamifera*
POPTRE	Quaking Aspen	*Populus tremuloides*
PSEMEN	Douglas Fir	*Pseudotsuga menziesii*
TAXBRE	Western Yew	*Taxus brevifolia*
THUPLI	Western Redcedar	*Thuja Plicata*
TSUHET	Western Hemlock	*Tsuga heterophylla*
TSUMER	Mountain Hemlock	*Tsuga mertensiana*

Table A4. Additional plant codes used in the vegetation databases.

Species Code	Common Name	Scientific Name
ACECIR	Vine Maple	*Acer circinatum*
ACEGLA	Dwarf Maple	*Acer glabrum*
ALNSIN	Sitka Alder	*Alnus sinuata*
AMEALN	Serviceberry	*Amelanchier alnifolia*
ARCUVA	Kinnikinnick	*Arctostaphylos uva-ursi*
BEBAQU	Tall Oregon Grape	*Beberis aquifolium*
BEBNER	Cascade Oregon Grape	*Beberis nervosa*
BEBRIP	Creeping Oregon Grape	*Beberis ripens*
CASMER	White Mountain Heather	*Cassiope mertensiana*
CASSTE	Alaskan Mountain Heather	*Cassiope stelleriana*
CEAVEL	Mountain Balm	*Ceanothus velutinus*
CORCAN	Bunchberry	*Cornus canadensis*
CORCOR	Hazelnut	*Corylus cornuta*
GAUOVA	Slender Wintergreen	*Gaultheria ovatifolia*
BAUSHA	Salal	*Gaultheria shallon*
HOLDIS	Ocean Spray	*Holodiscus discolor*
JUNCOM	Juniper	*Juniperus communis*
KALMIC	Bog Laurel	*Kalmia microphylla*
LEDGLA	Trapper's Tea	*Ledum glandulosum*
LEDGRO	Labrador Tea	*Ledum groenlandicum*
LINBOR	Twinflower	*Linnaea borealis*
LONINV	Twinberry	*Lonicera involucrata*
LUPSP	Lupine	*Lupinus sp.*
MENFER	False Azalea	*Menziesia ferruginea*
MYRGAL	Sweet Gale	*Myrica gale*
OEMCER	Indian Plum	*Oemleria cerasiformis*
OPLHOR	Devil's Club	*Oplopanax horridum*
PACMYR	Mountain Box	*Pachistima myrsinites*
PHYEMP	Pink Mountain Heather	*Phyllodoce empetriformis*
PHYGLA	Yellow Mountain Heather	*Phyllodoce glanduliflora*
PRUEMA	Bitter Cherry	*Prunus emarginata*
RHAPUR	Cascara	*Rhamnus purshiana*
RHOALB	White Rhododendron	*Rhododendron albiflorum*
RHOMAC	Pacific Rhododendron	*Rhododendron macrophyllum*
RIBSP	Currant	*Ribes sp.*
RUBSP	Rubus	*Rubus sp.*
SALSP	Willow	*Salix Sp.*
SAMCER	Blue Elderberry	*Sambucus cerulea*
SAMRAC	Red Elderberry	*Sambucus racemosa*
SORSCO	Western Mountain Ash	*Sorbus scopulina*
SPIBET	Birch-leaved Spirea	*Spirea betulifolia*

Table A4. Additional plant codes used in the vegetation databases (continued).

Species Code	Common Name	Scientific Name
SPIDEN	Subalpine Spirea	*Spirea densiflora*
SYMSP	Snowberry	*Symphoricarpos sp.*
VACSP	Blueberry/Huckleberry	*Vaccinium sp.*

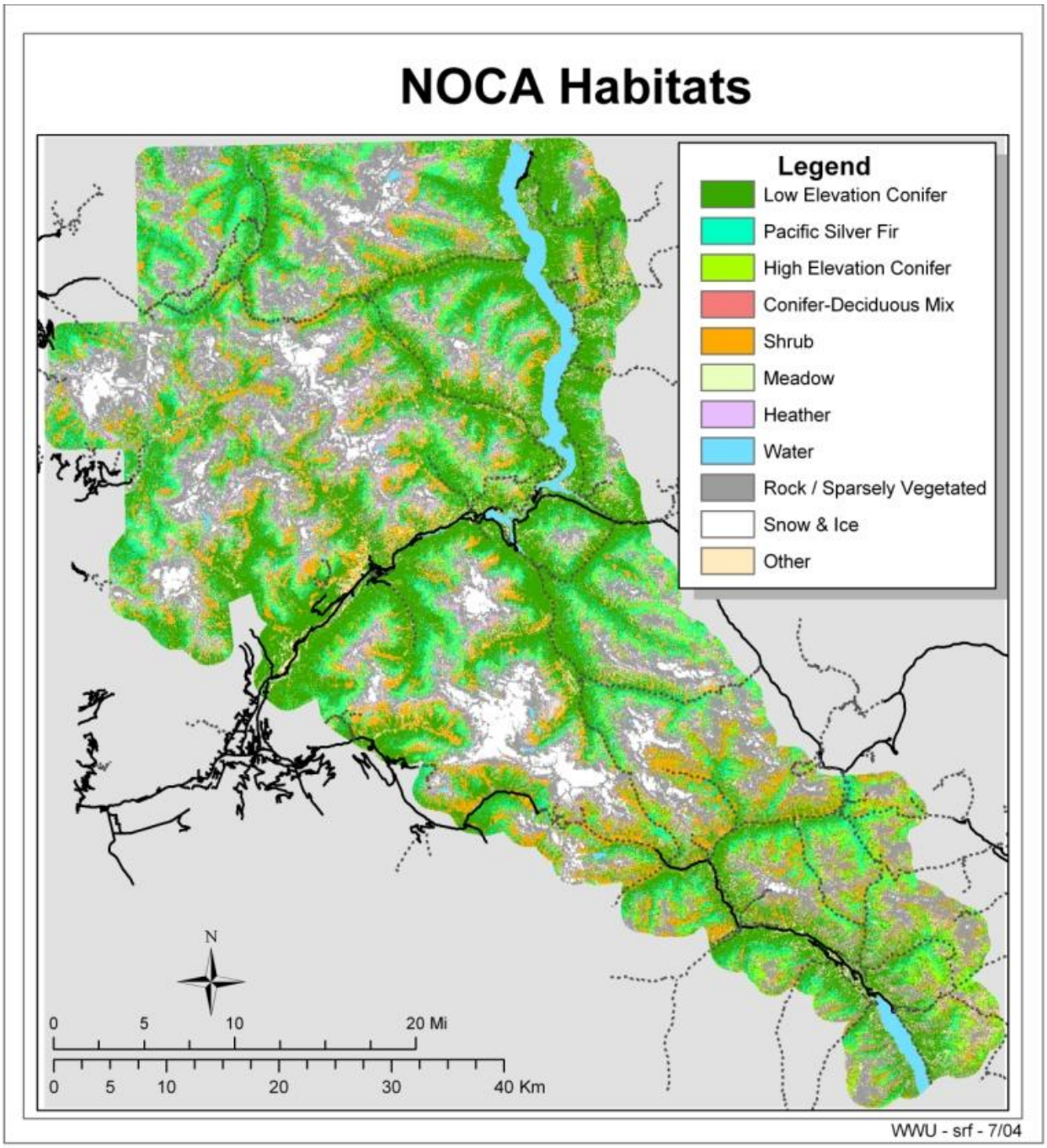
Appendix 4. Maps

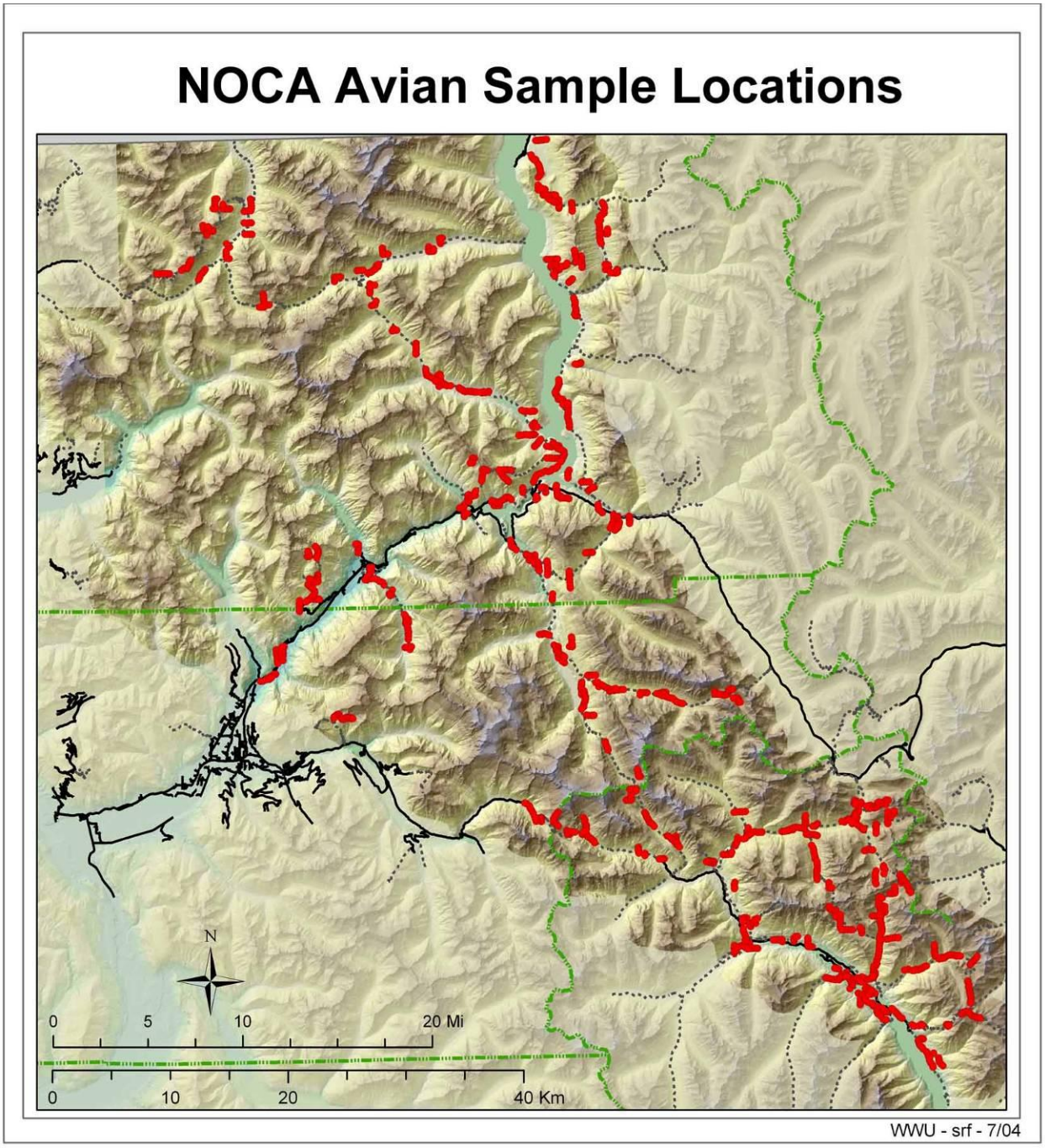
Map 1. General habitats within NOCA derived from data layers in Pacific Meridian Resources (1996). Several habitat categories shown here contain multiple habitat types, which were considered individually in our analyses. For example, "Low Elevation Conifer" displayed in this map contains Douglas fir-west, Douglas fir-east, western hemlock, and western redcedar habitat types. Roads and trails are mapped as in solid and dashed lines, respectively.

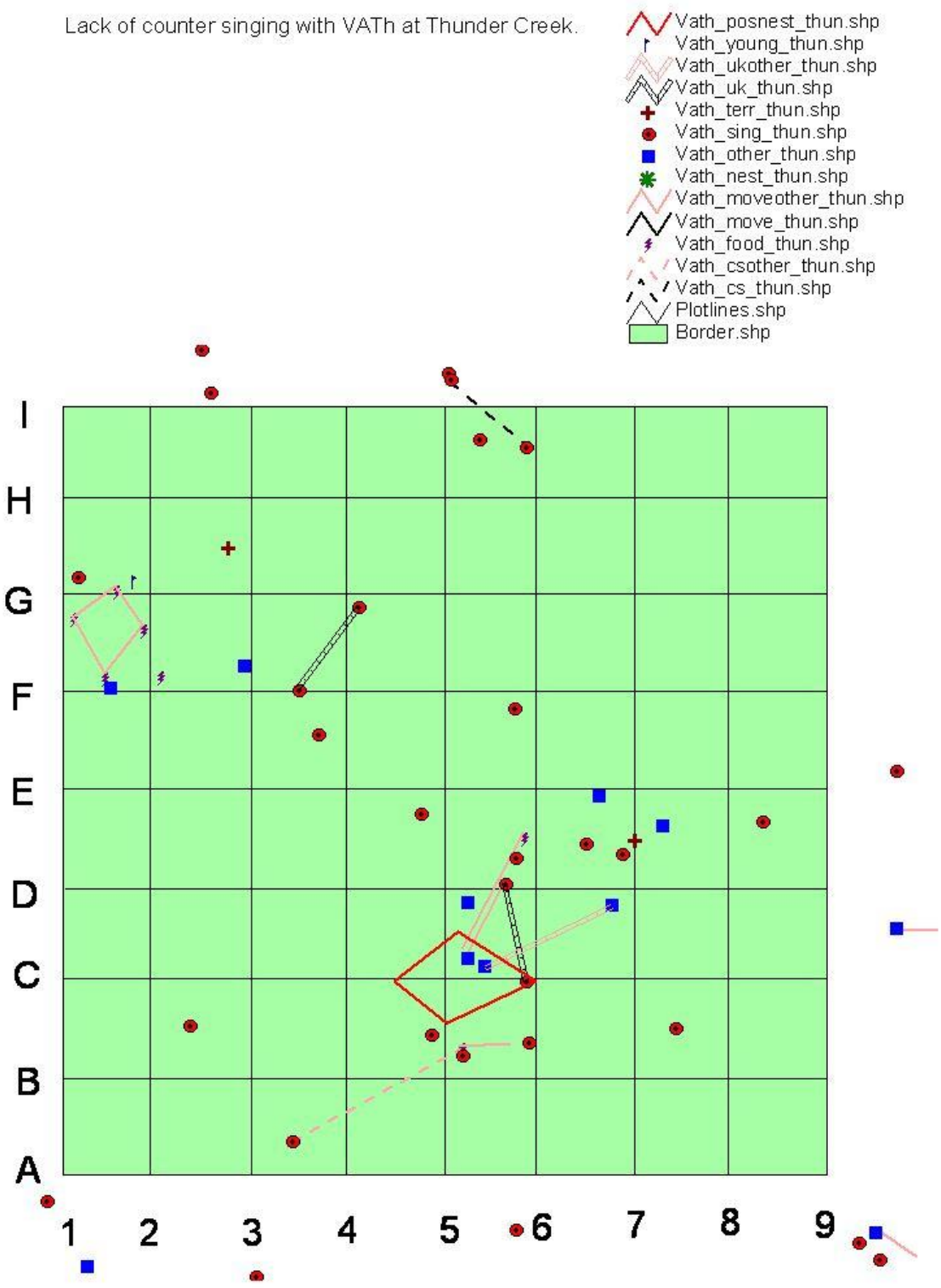
Map 2. Locations of NOCA's avian sampling points.

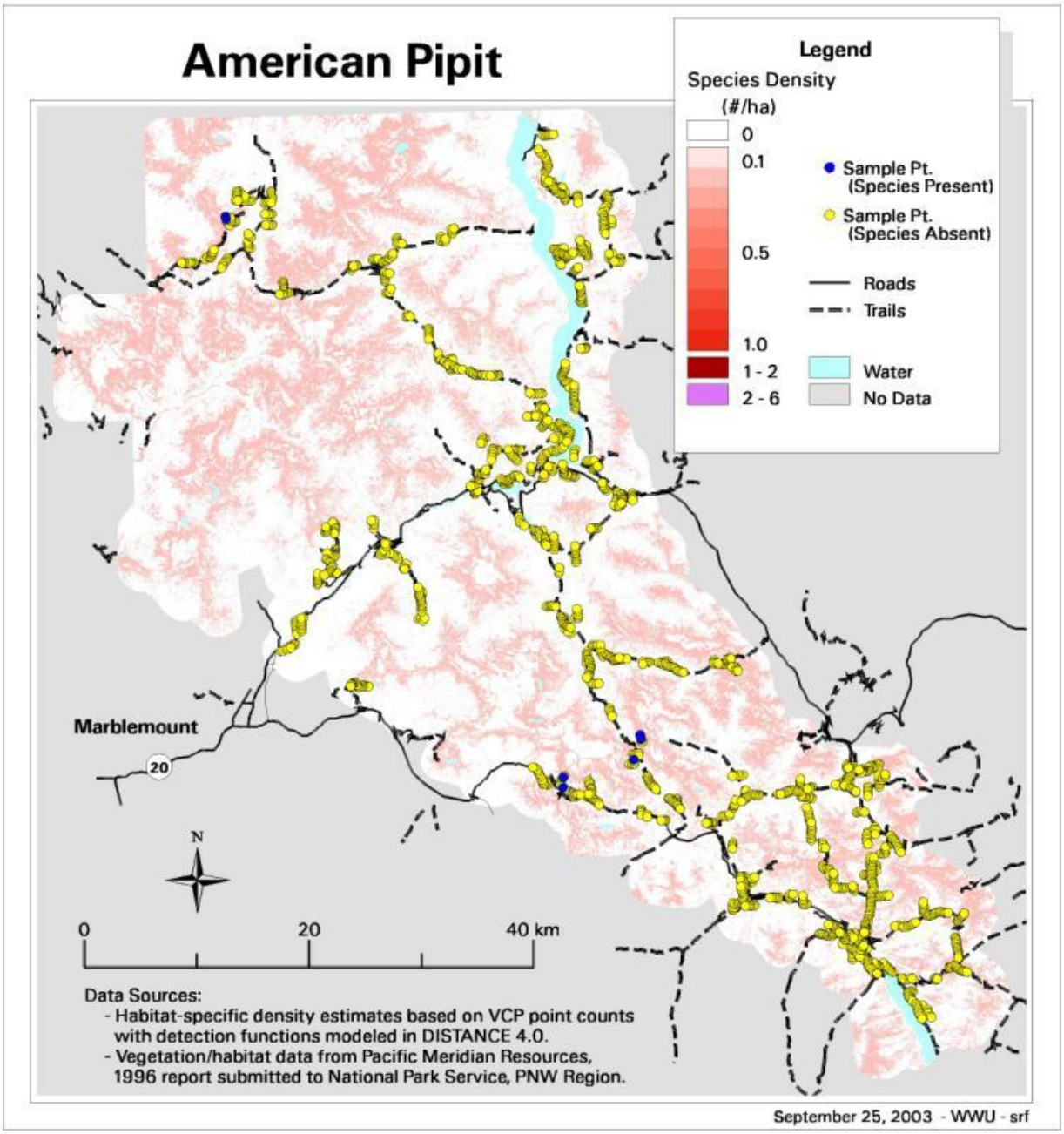
Map 3. Example of data collected at the four territory mapping plots.

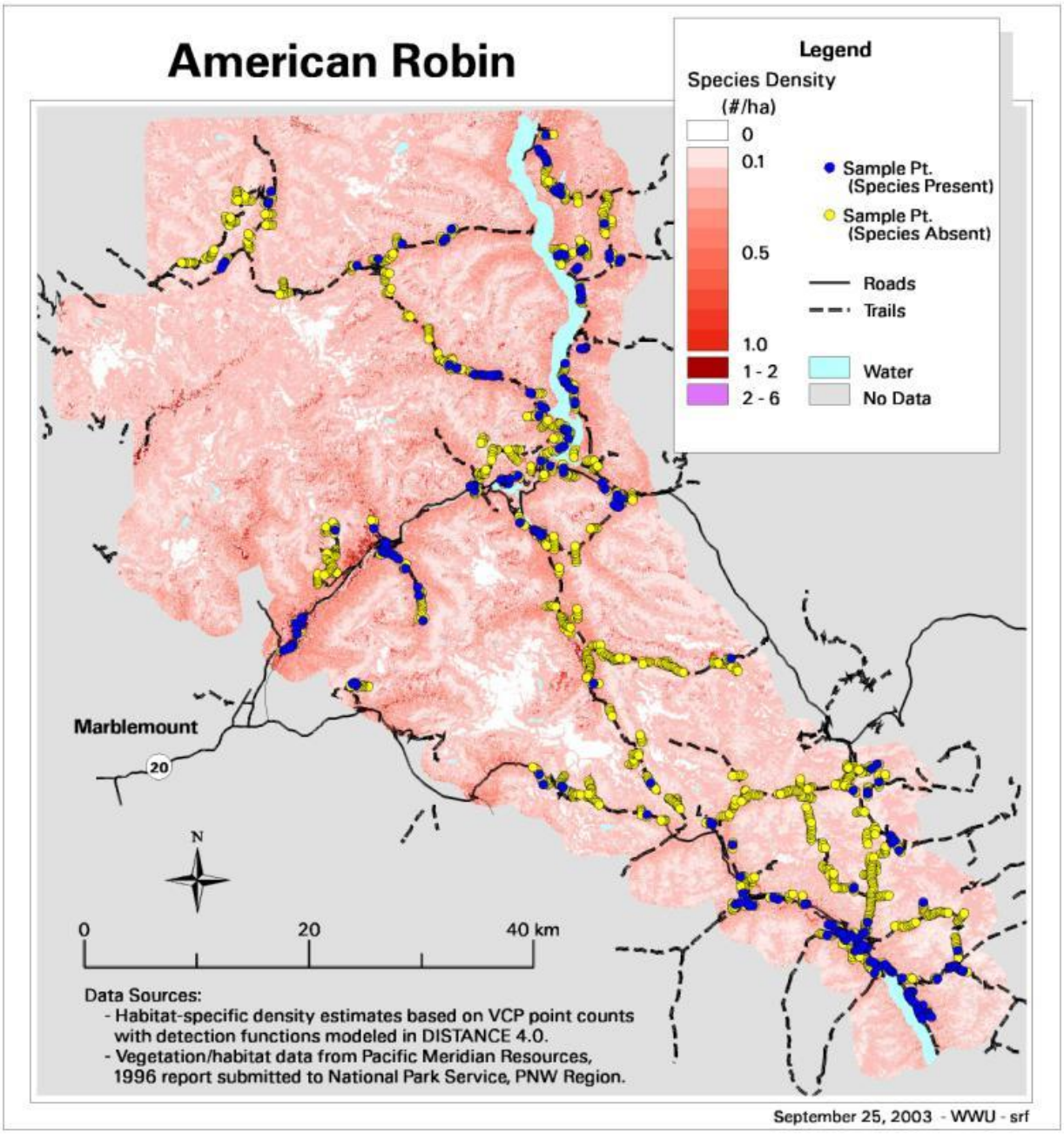
Maps 4-61. Distribution and abundance maps for common and intermediate species.

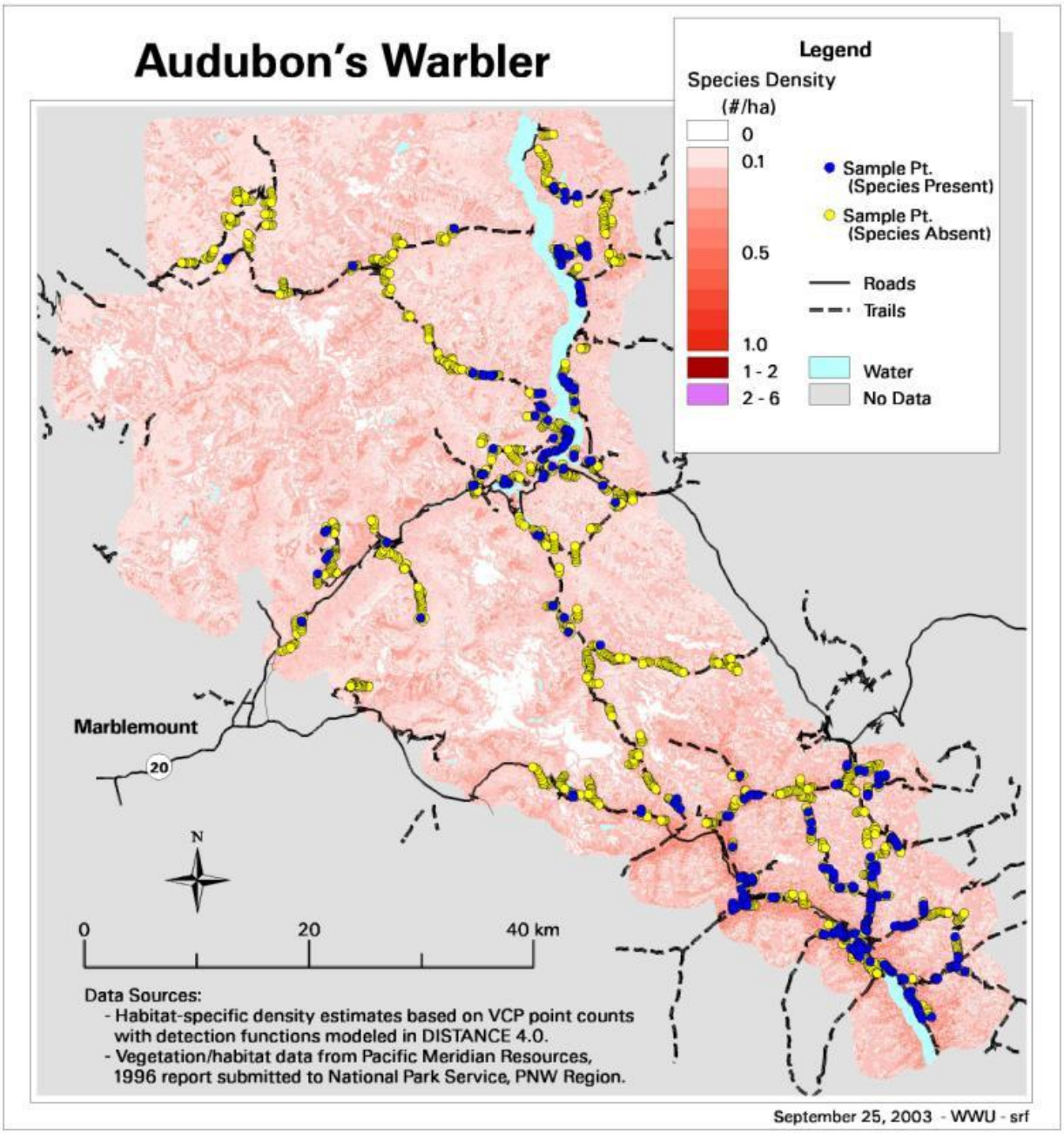

NOCA Habitats
Legend
Low Elevation Conifer
Pacific Silver Fir
High Elevation Conifer
Conifer-Deciduous Mix
Shrub
Meadow
Heather
Water
Rock / Sparsely Vegetated
Snow & Ice
Other
N
0 5 10 20 Mi
0 5 10 20 30 40 Km
WWU - srf - 7/04

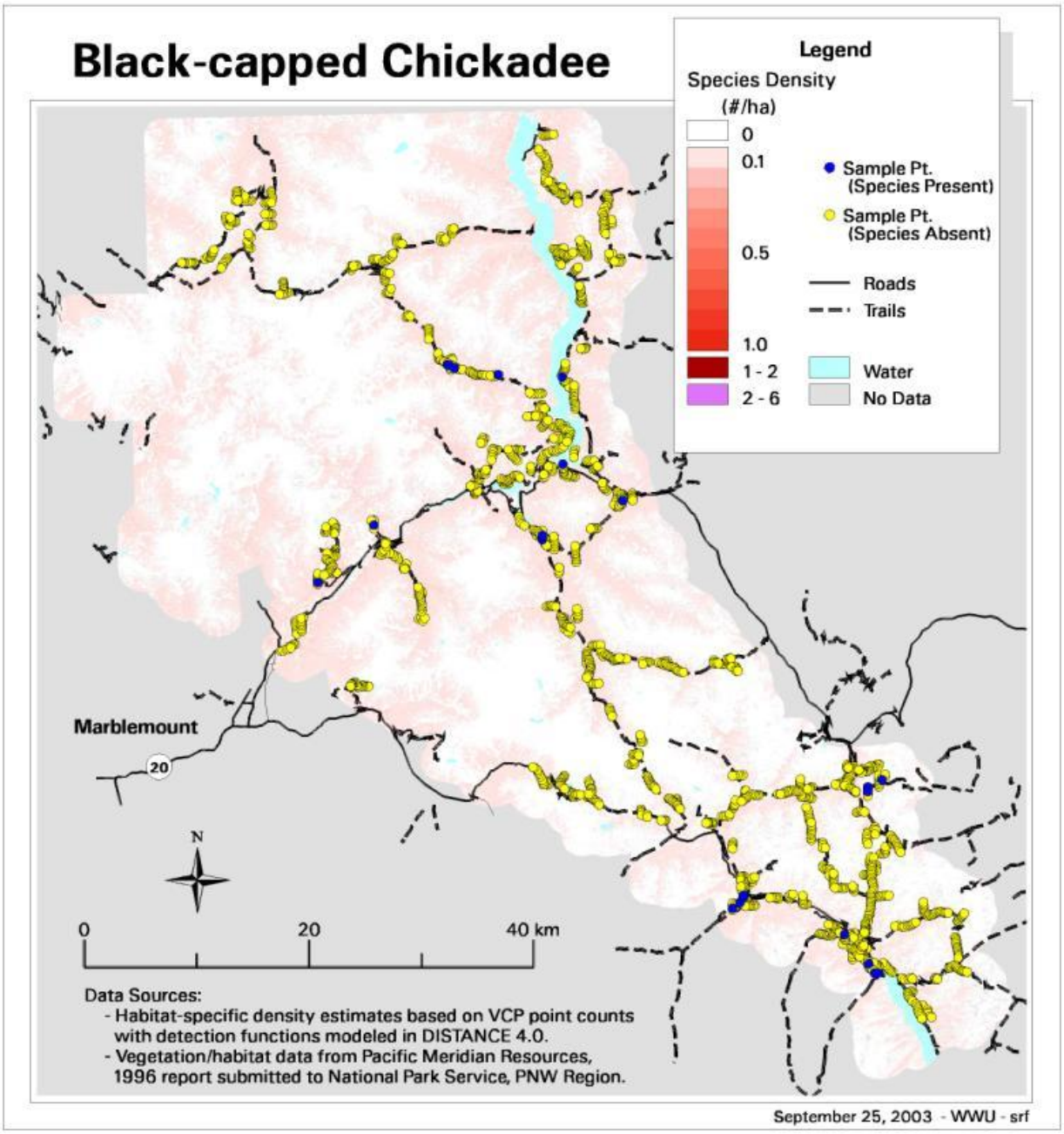

NOCA Avian Sample Locations
N
0 5 10 20 Mi
0 10 20 40 Km
WWU - srf - 7/04

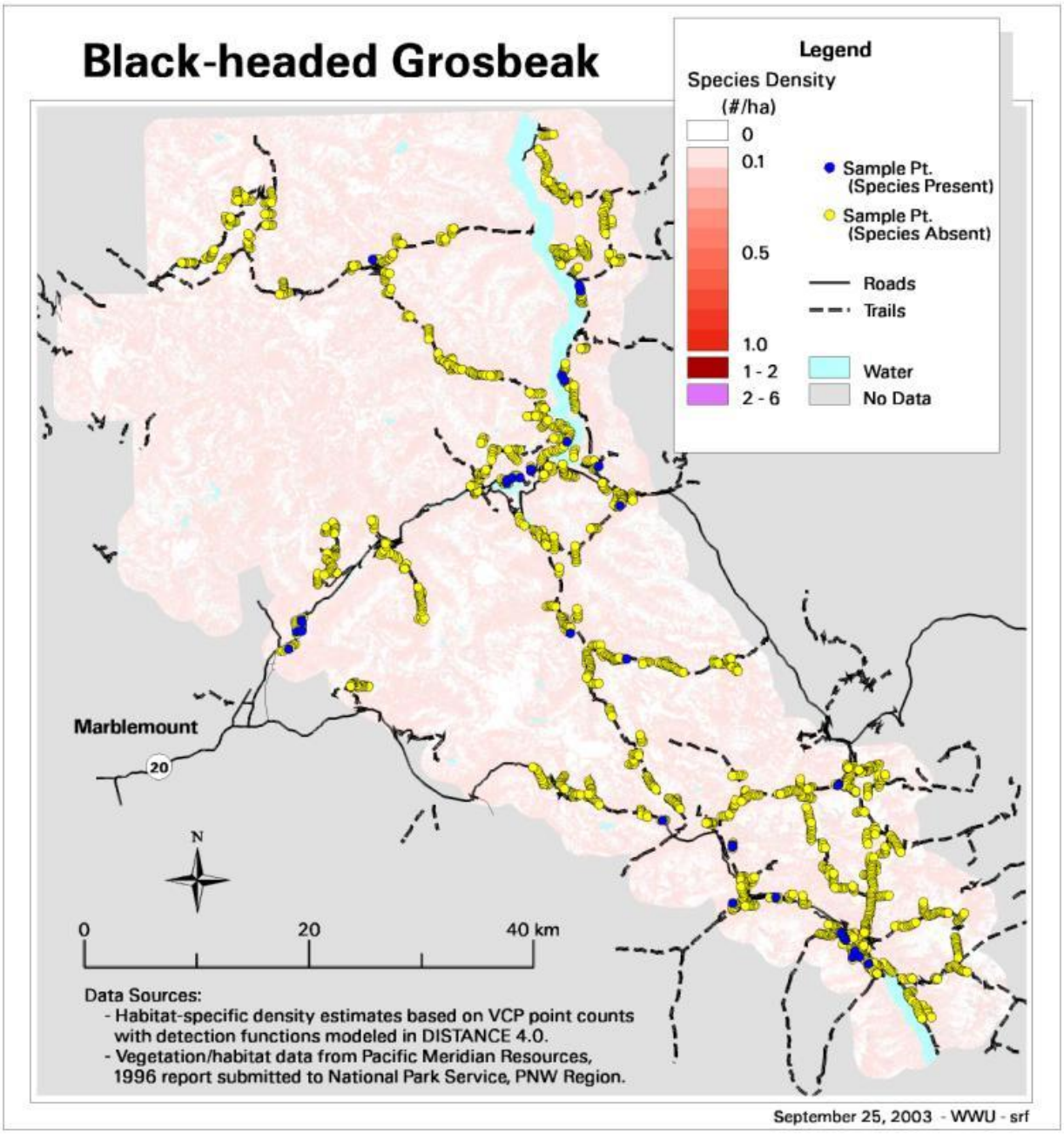

Lack of counter singing with VATh at Thunder Creek.
Vath_posnest_thun.shp
Vath_young_thun.shp
Vath_ukother_thun.shp
Vath_uk_thun.shp
Vath_terr_thun.shp
Vath_sing_thun.shp
Vath_other_thun.shp
Vath_nest_thun.shp
Vath_moveother_thun.shp
Vath_move_thun.shp
Vath_food_thun.shp
Vath_csother_thun.shp
Vath_cs_thun.shp
Plotlines.shp
Border.shp
I
H
G
F
E
D
C
B
A
1
2
3
4
5
6
7
8
9

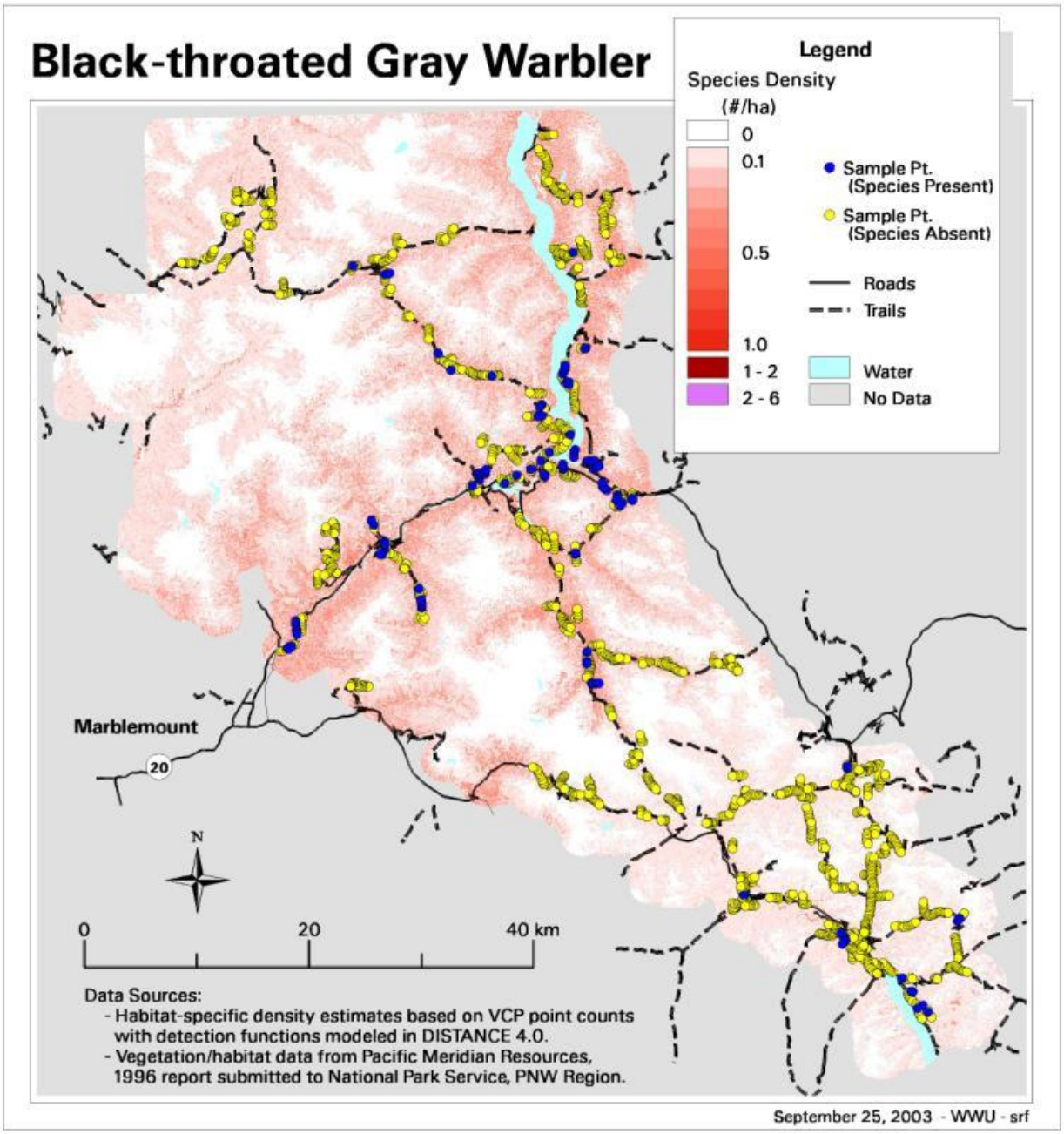

American Pipit
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

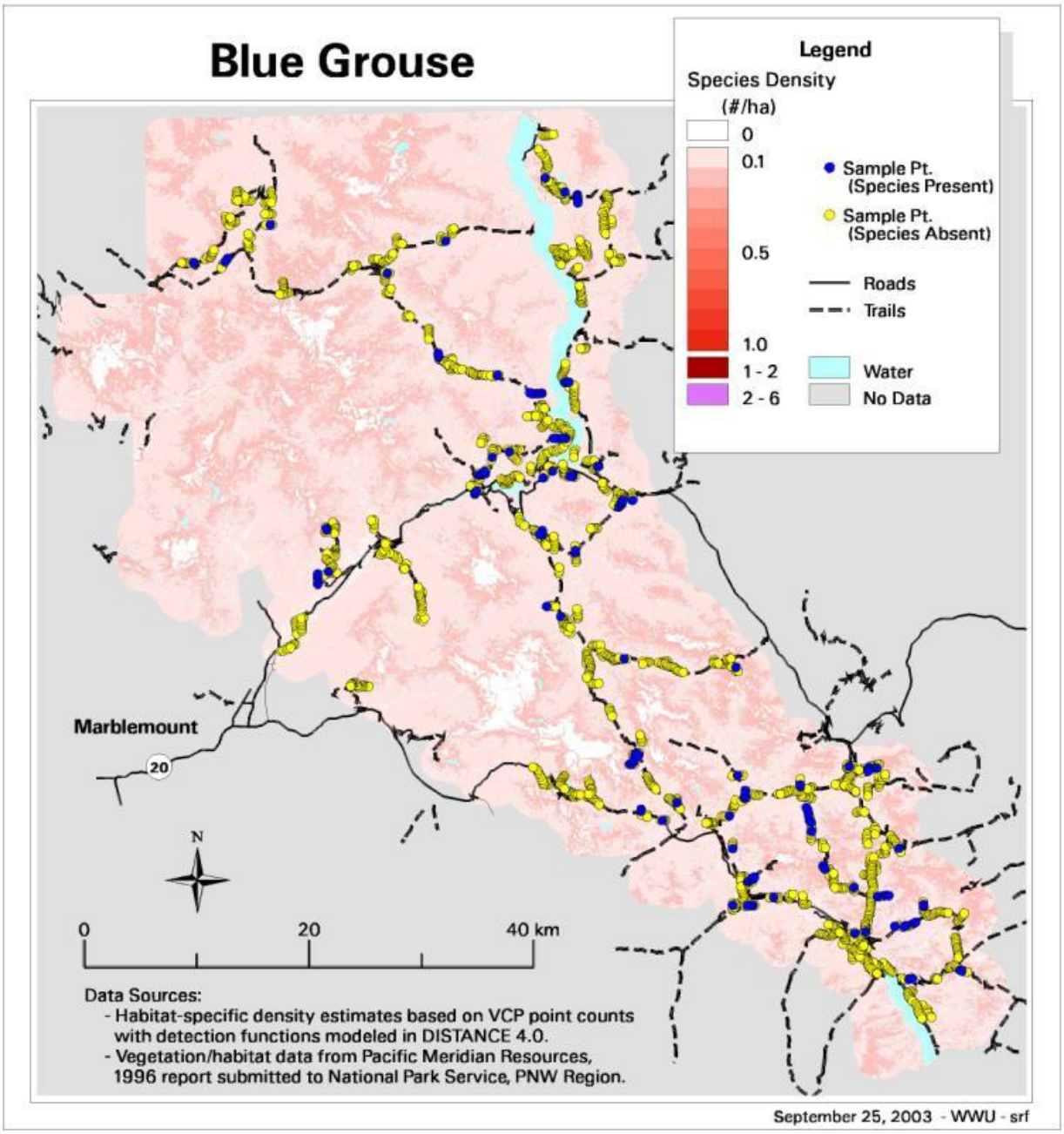

American Robin
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

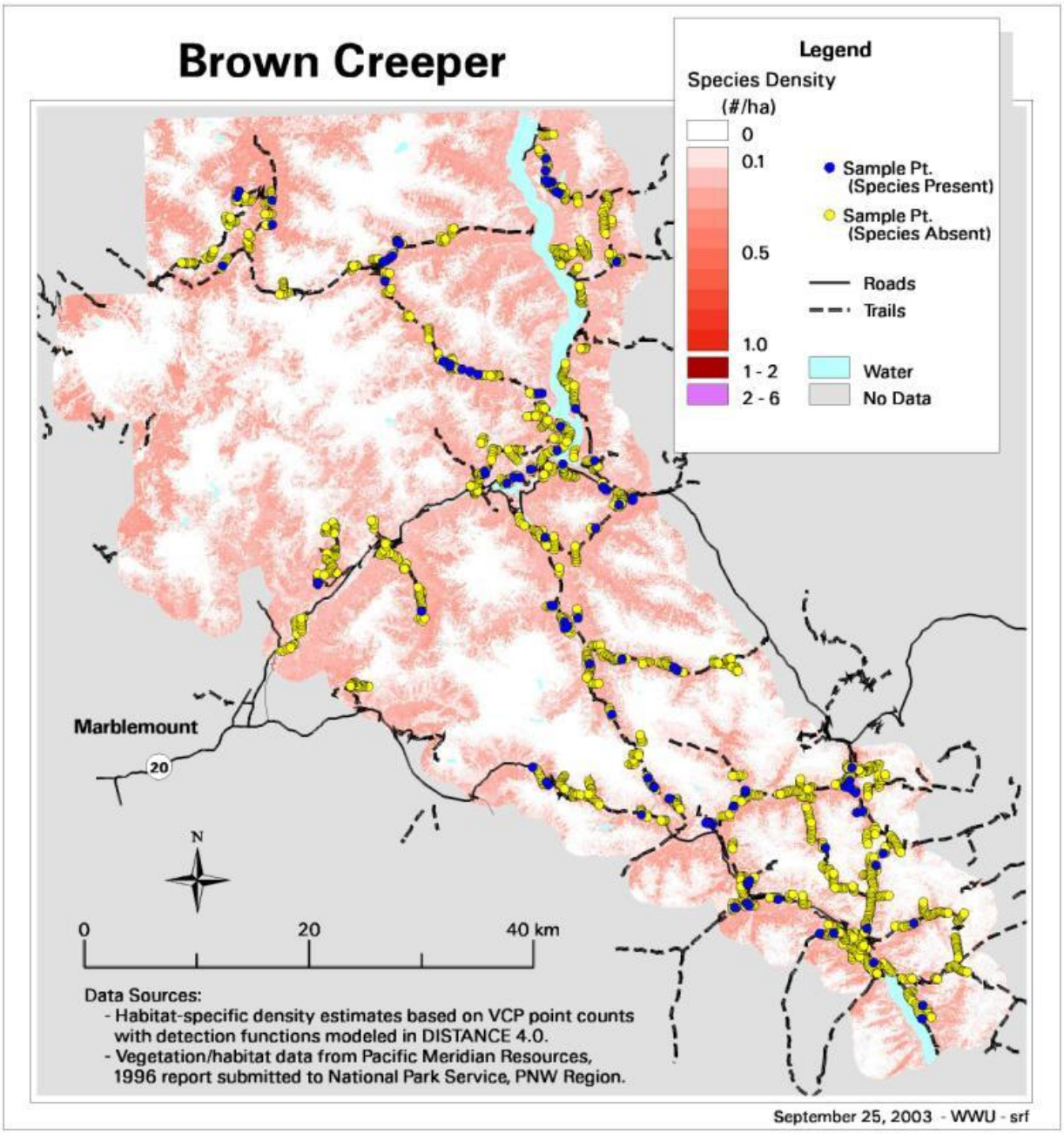

Audubon's Warbler
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

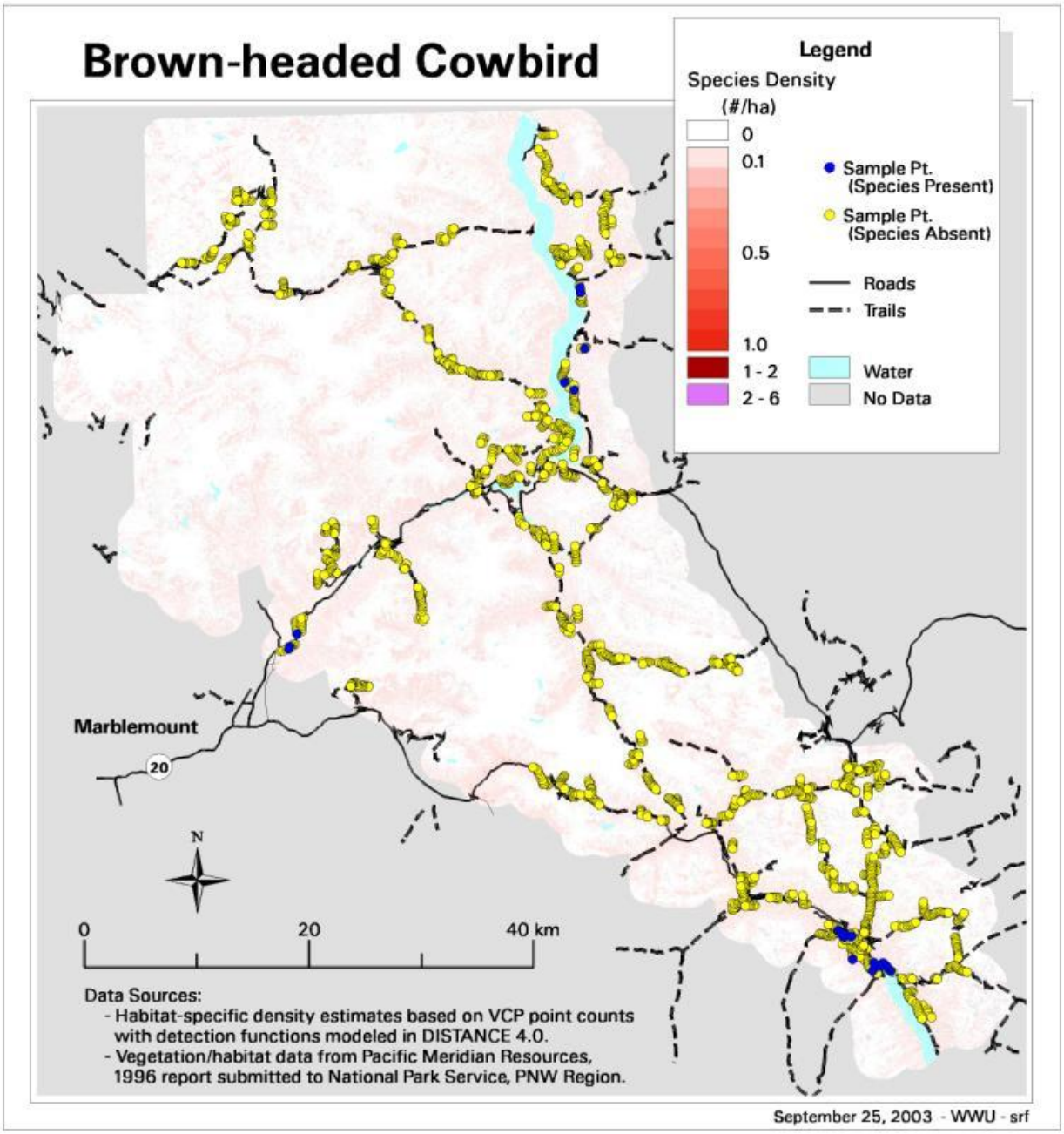

Black-capped Chickadee
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

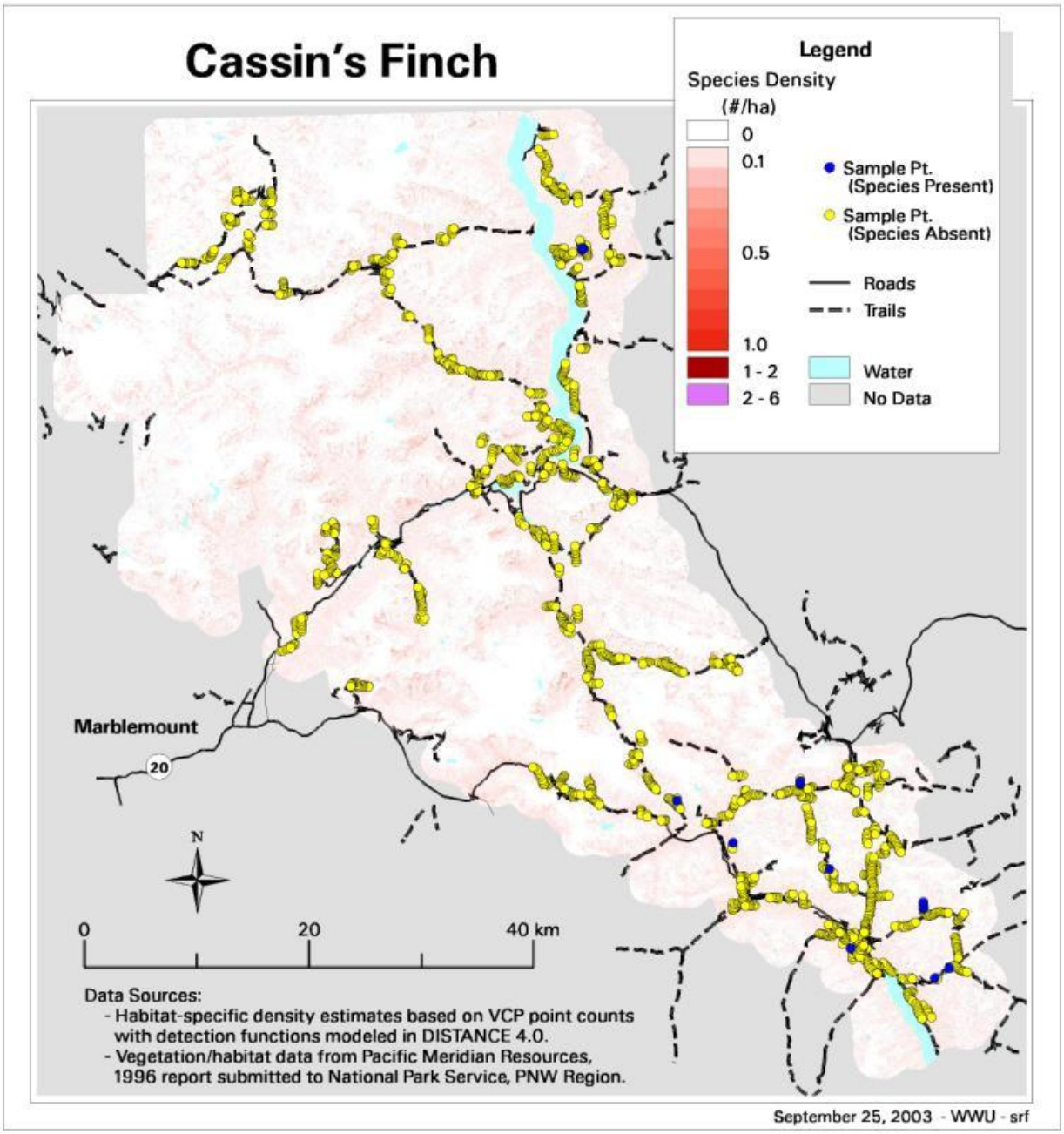

Black-headed Grosbeak
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

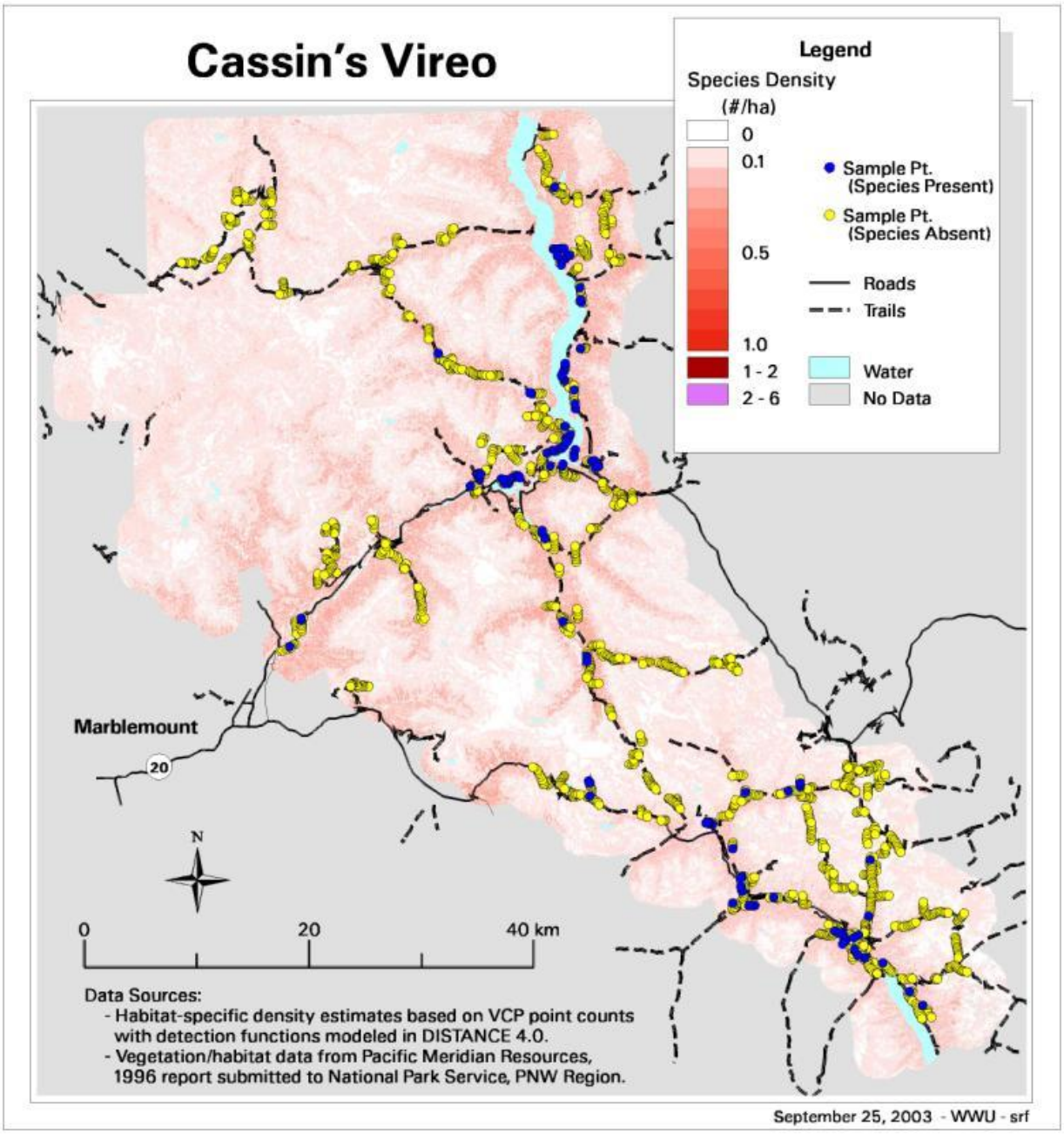

Black-throated Gray Warbler
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

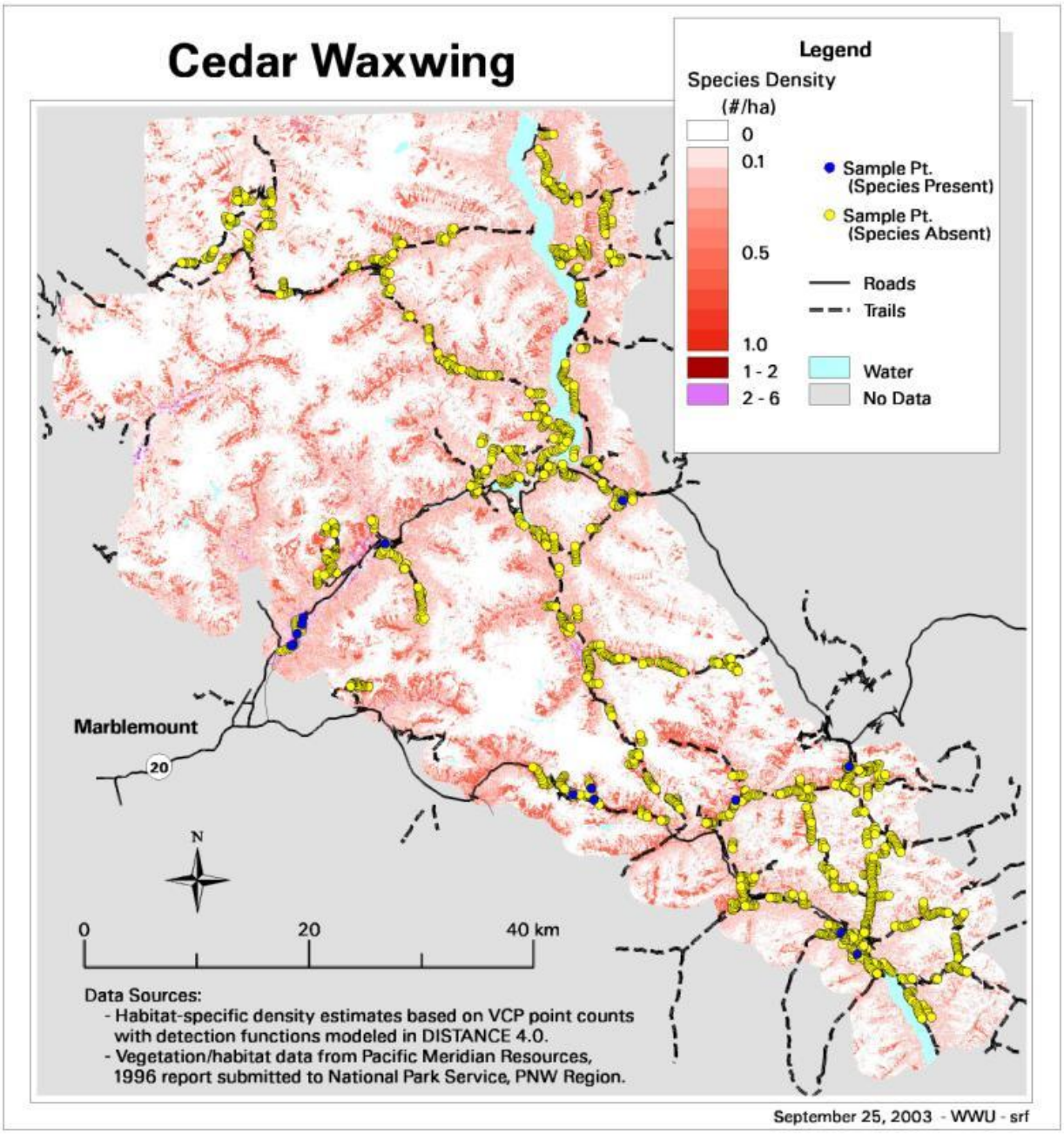

Blue Grouse
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

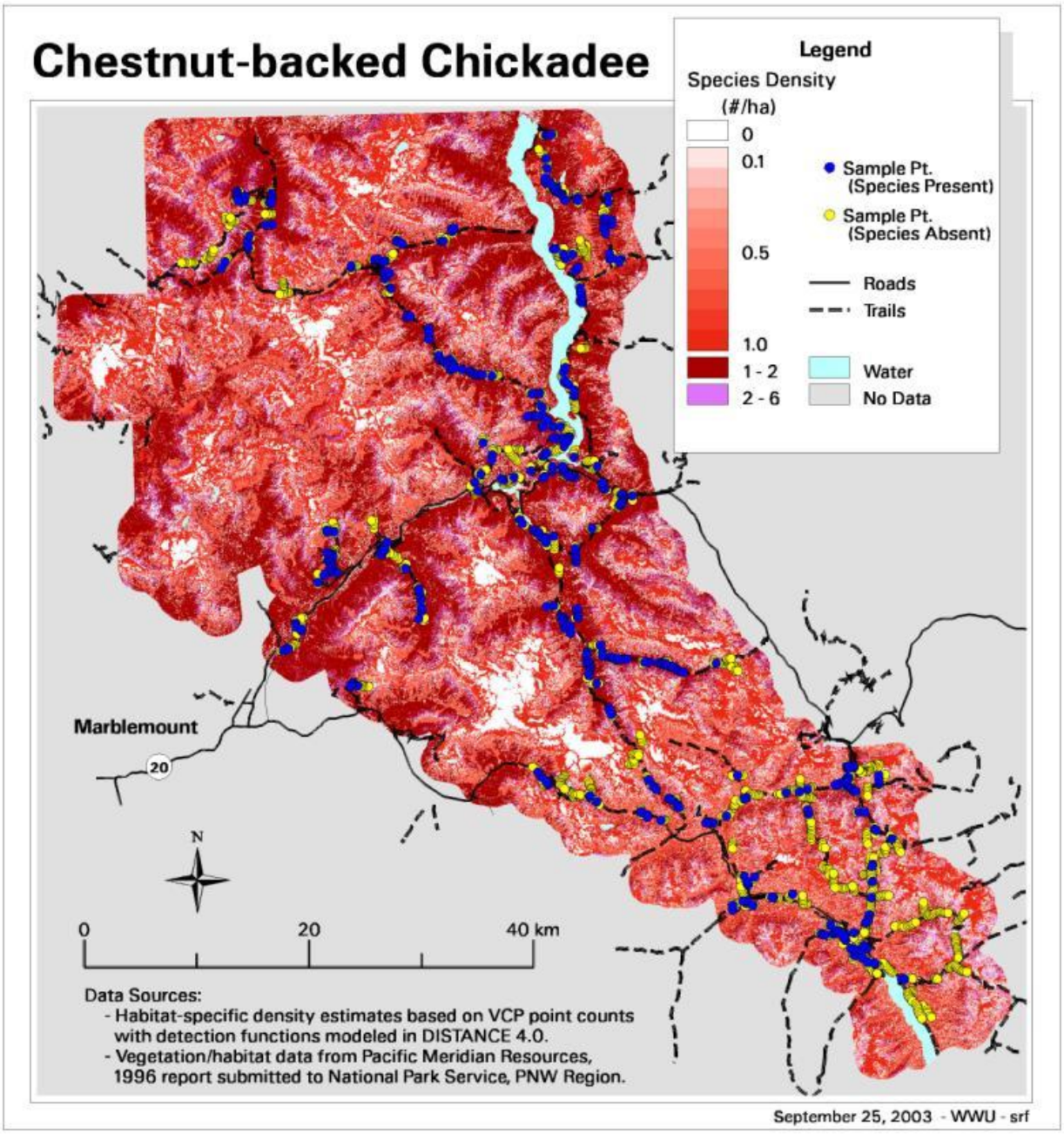

Brown Creeper
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

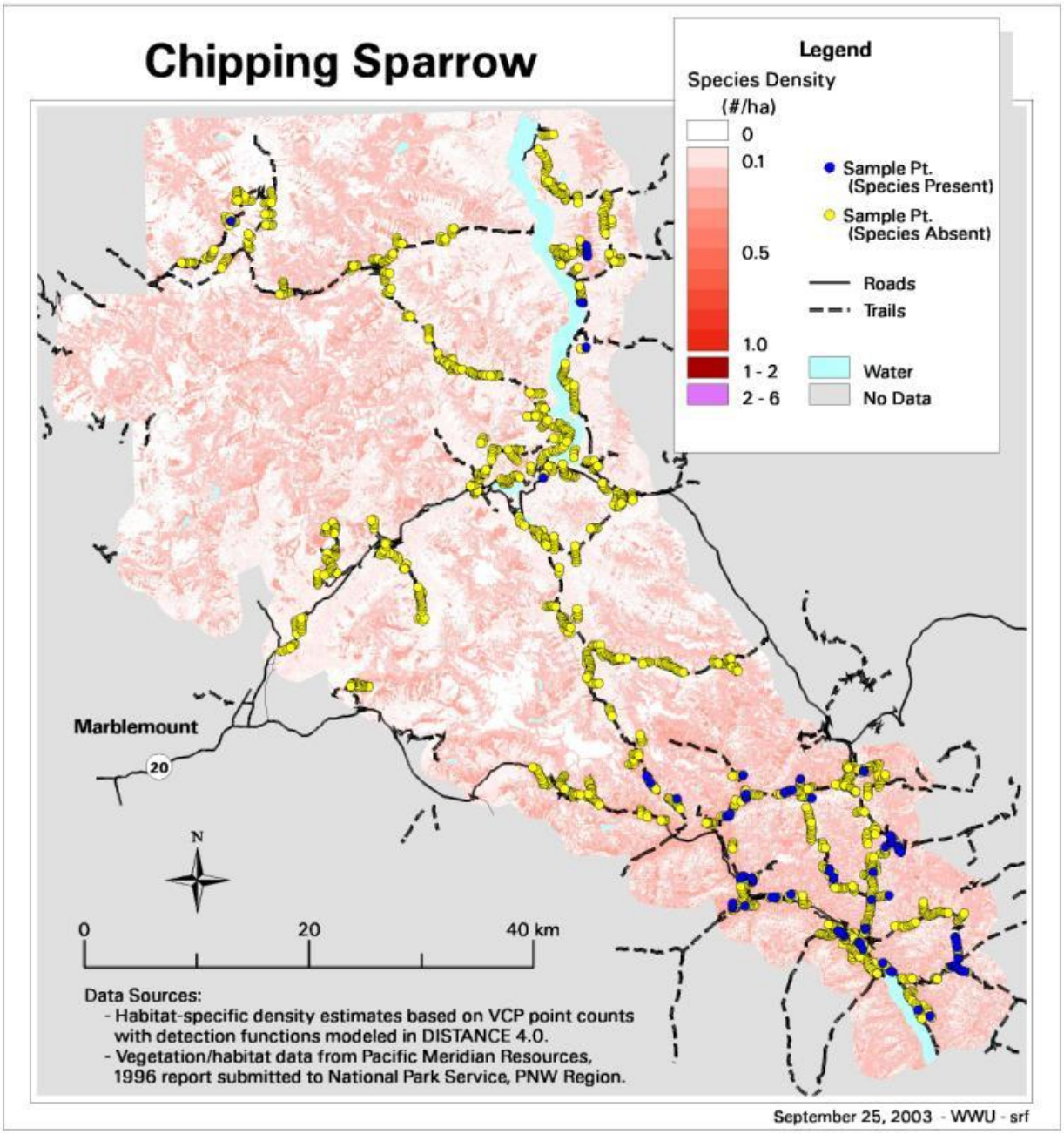

Brown-headed Cowbird
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

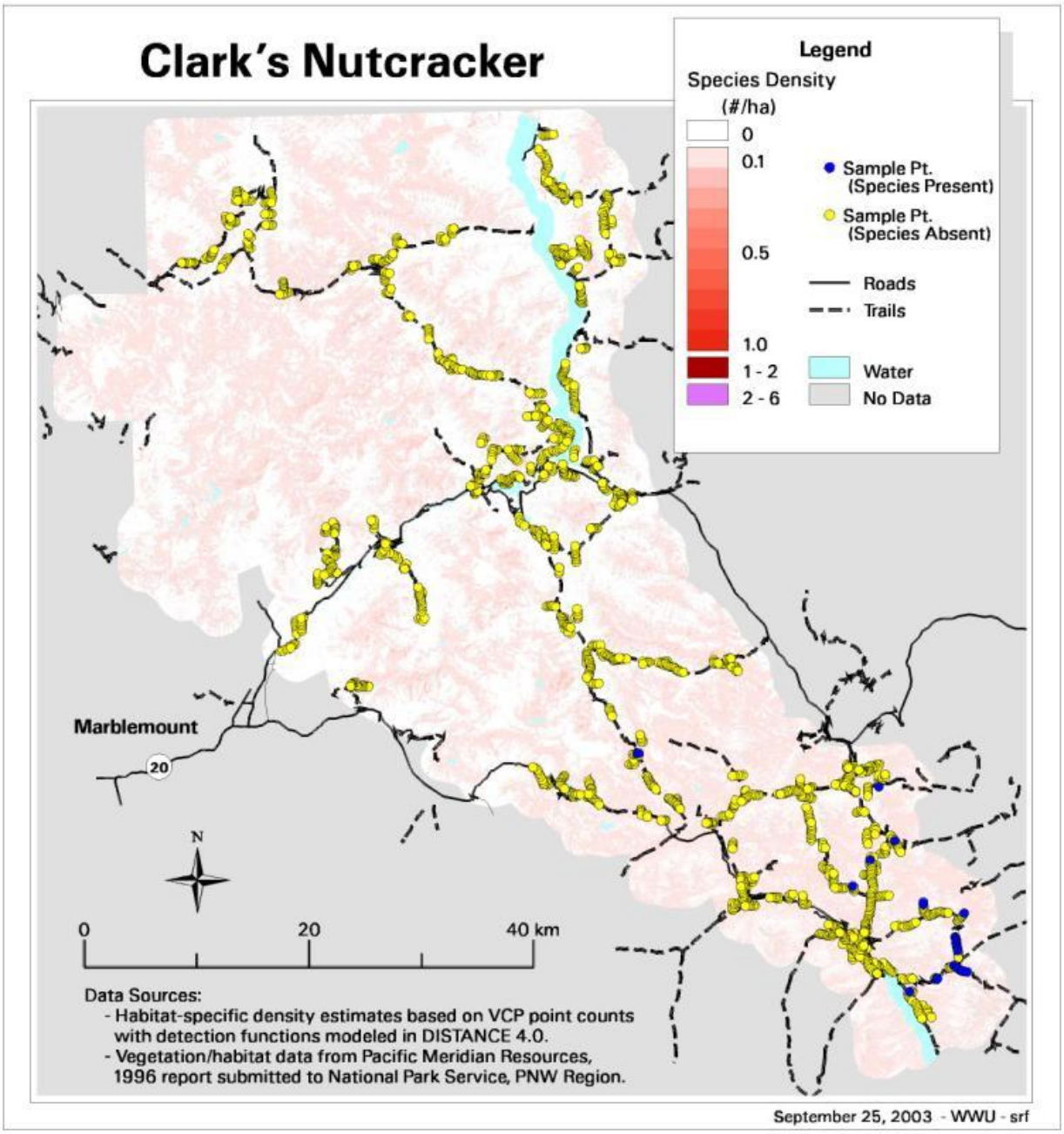

Cassin's Finch
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

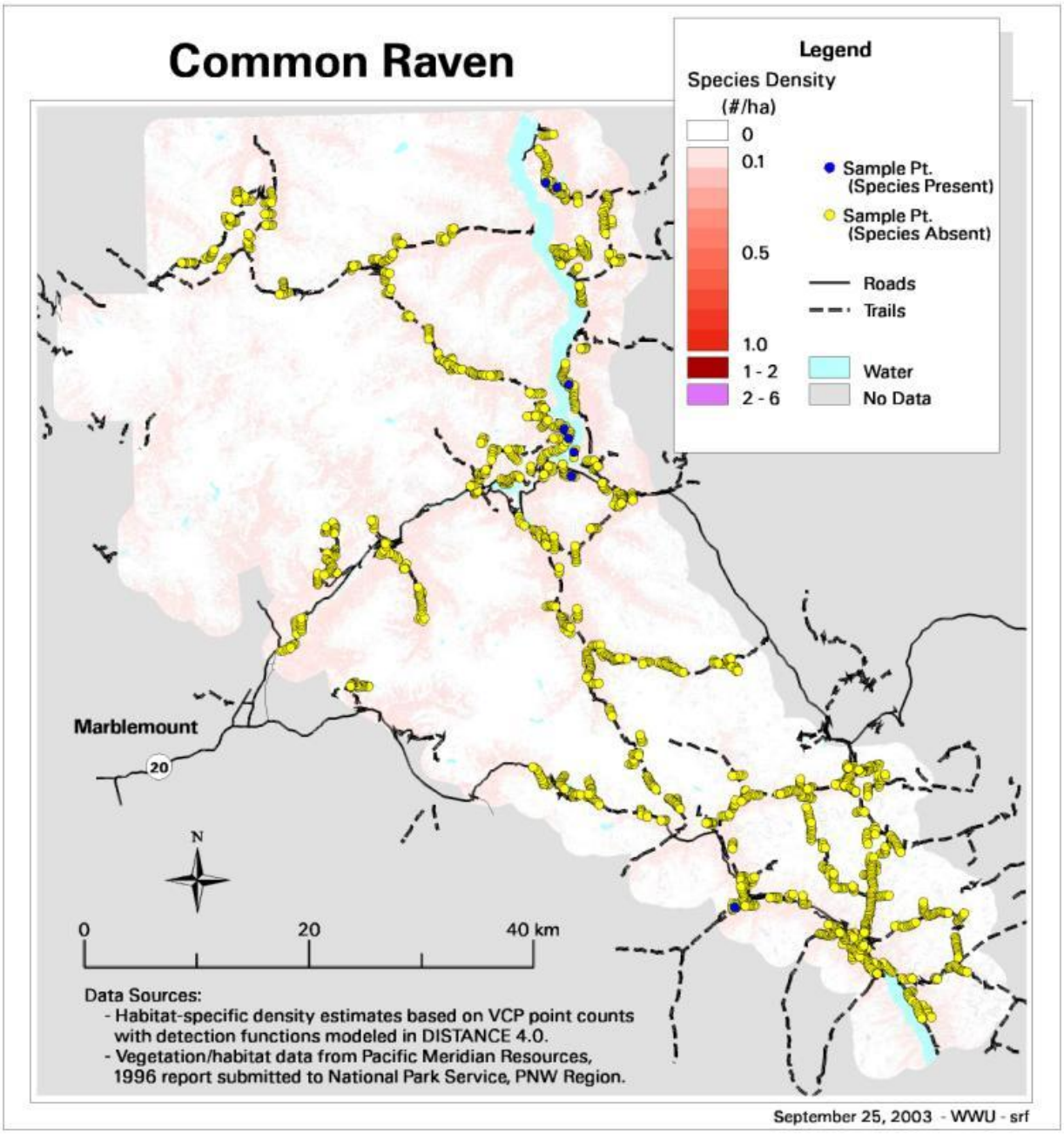

Cassin's Vireo
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

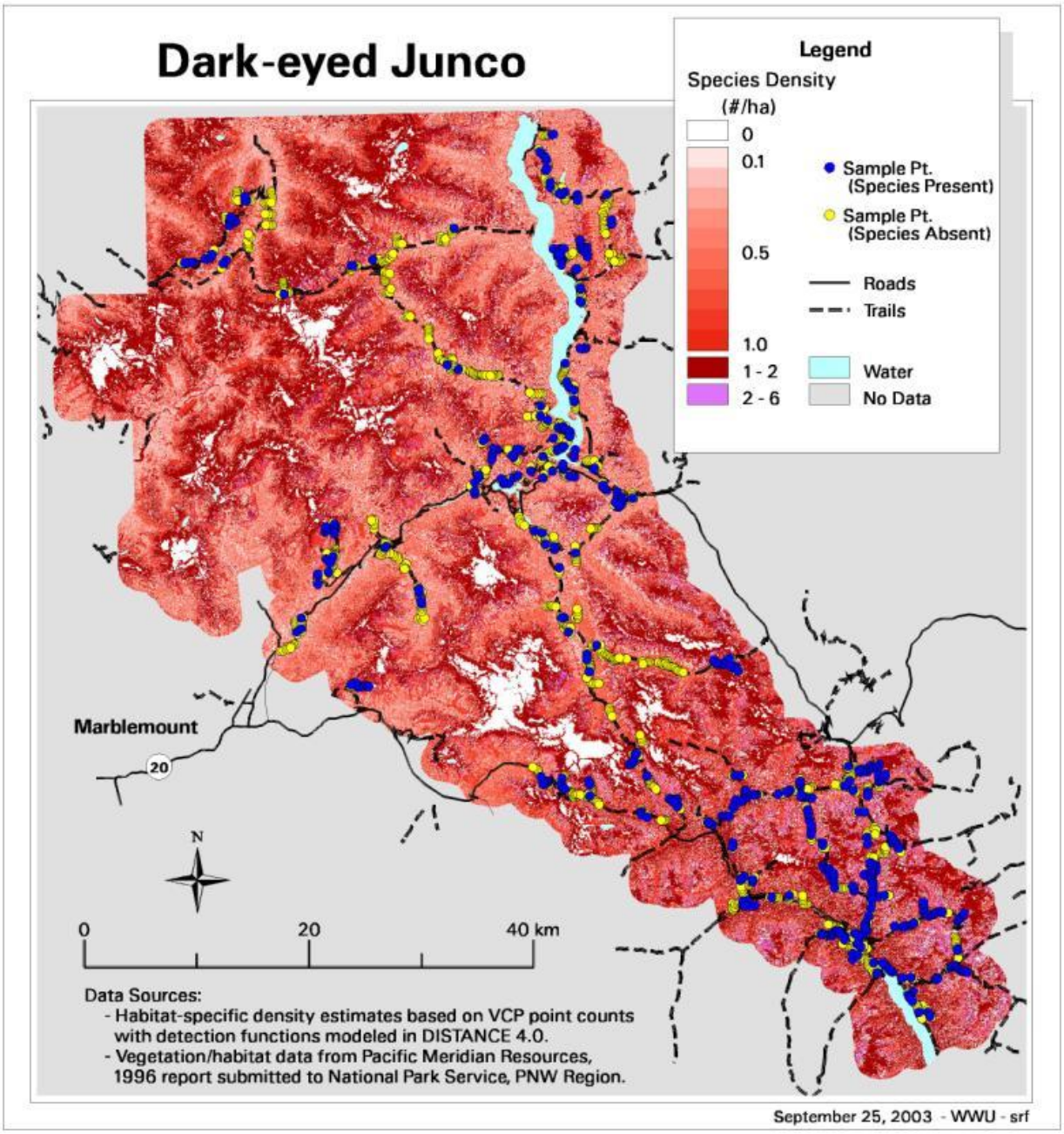

Cedar Waxwing
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

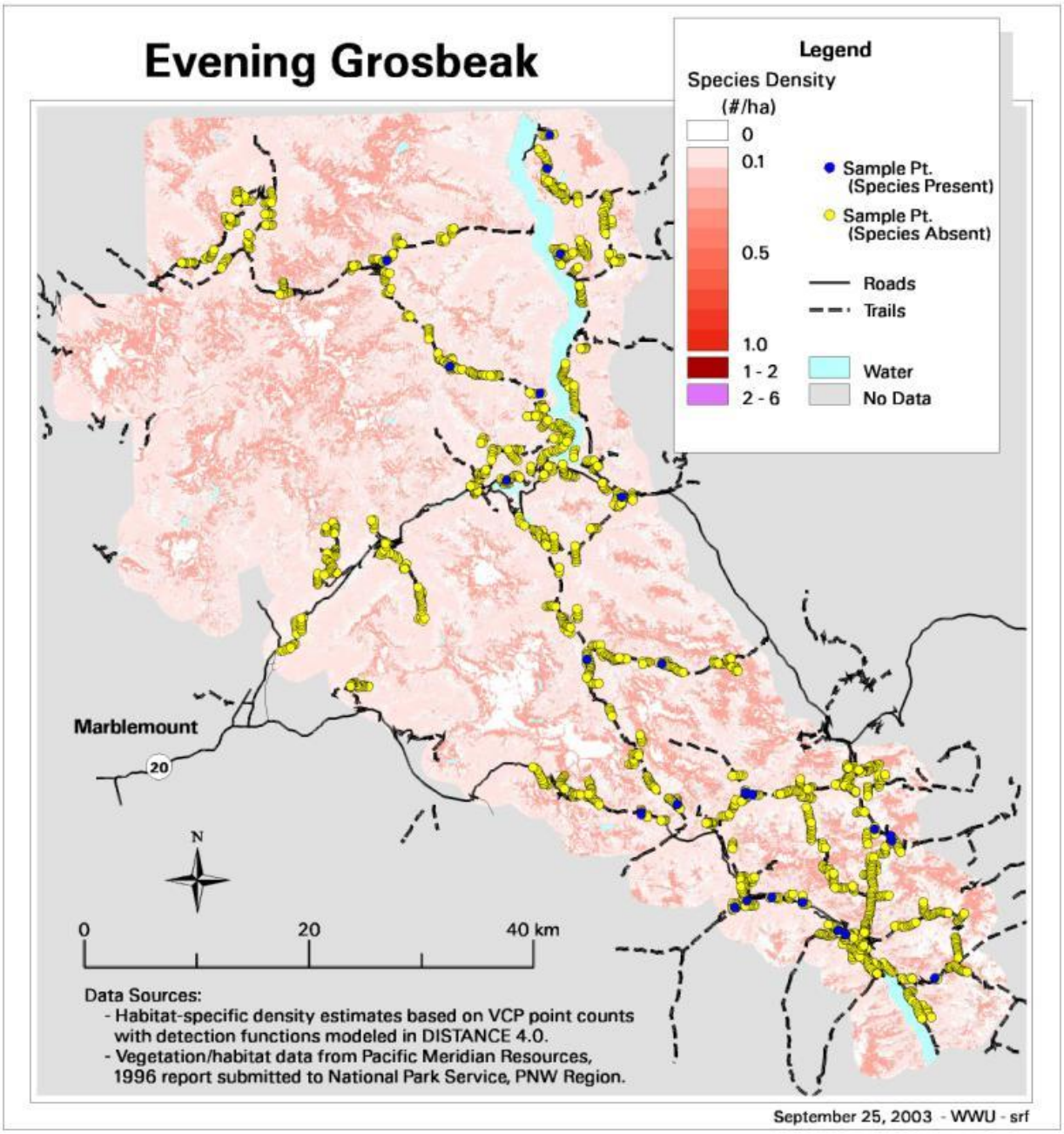

Chestnut-backed Chickadee
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt. (Species Present)
Sample Pt. (Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

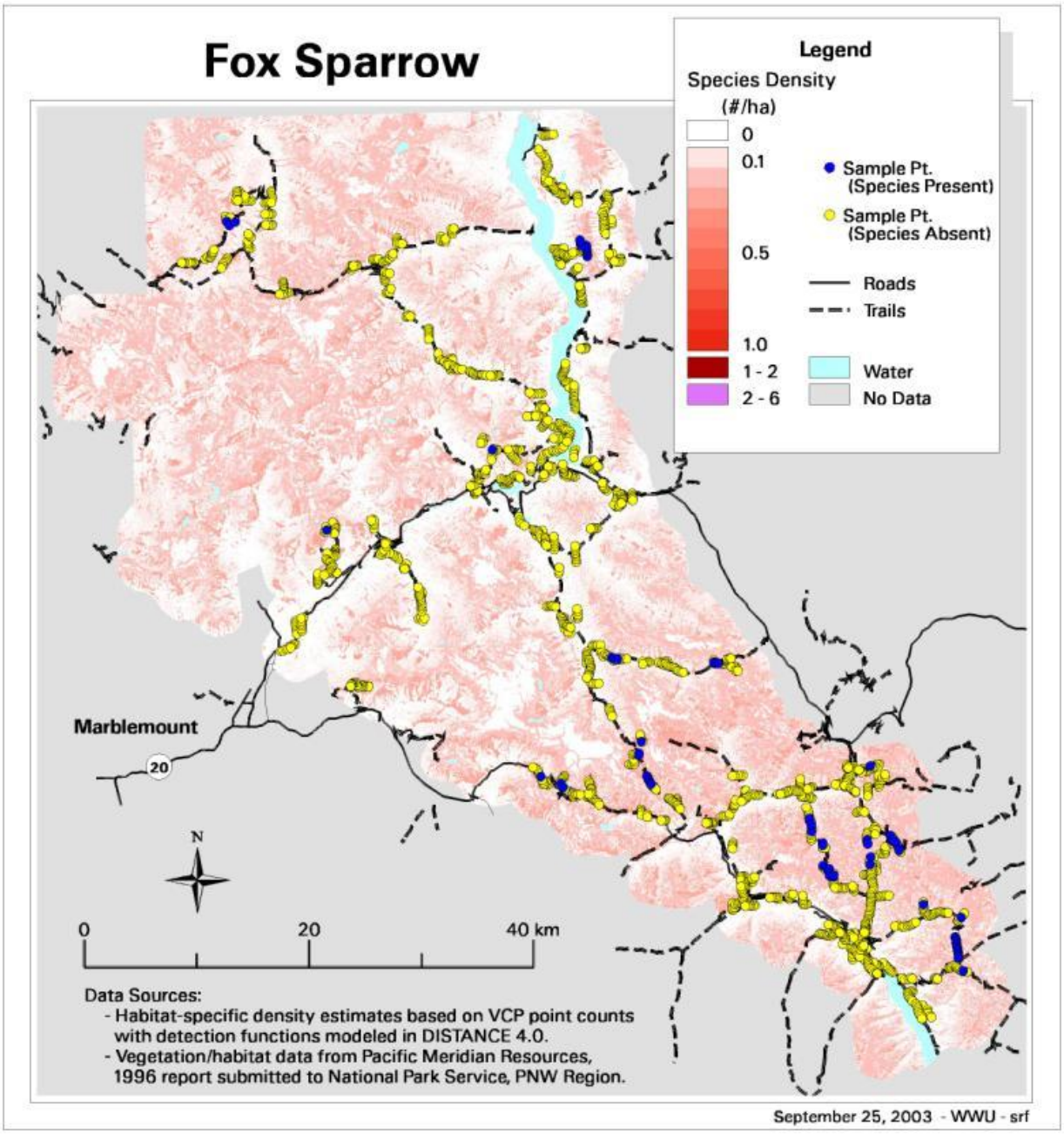

Chipping Sparrow
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

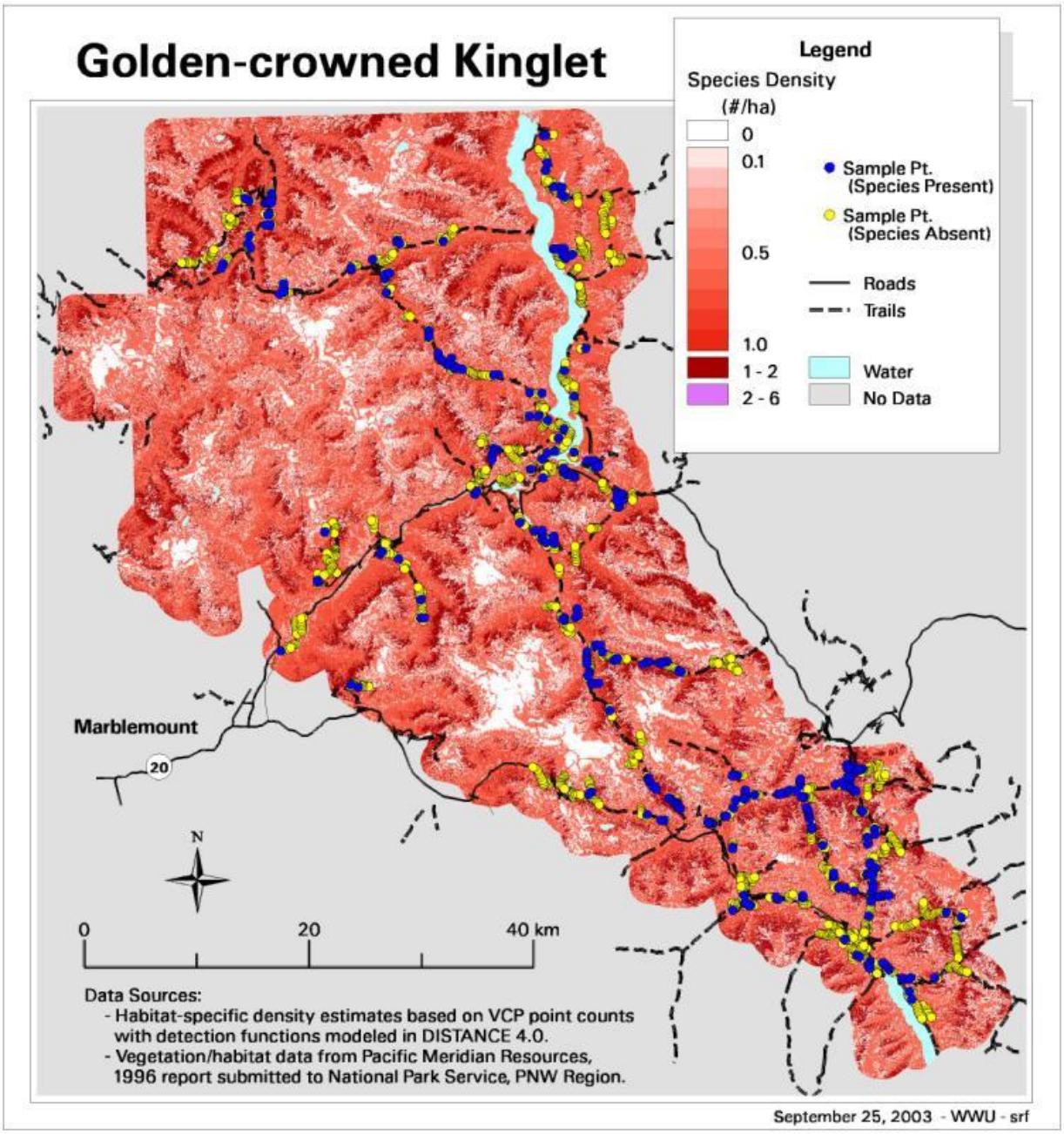

Clark's Nutcracker
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

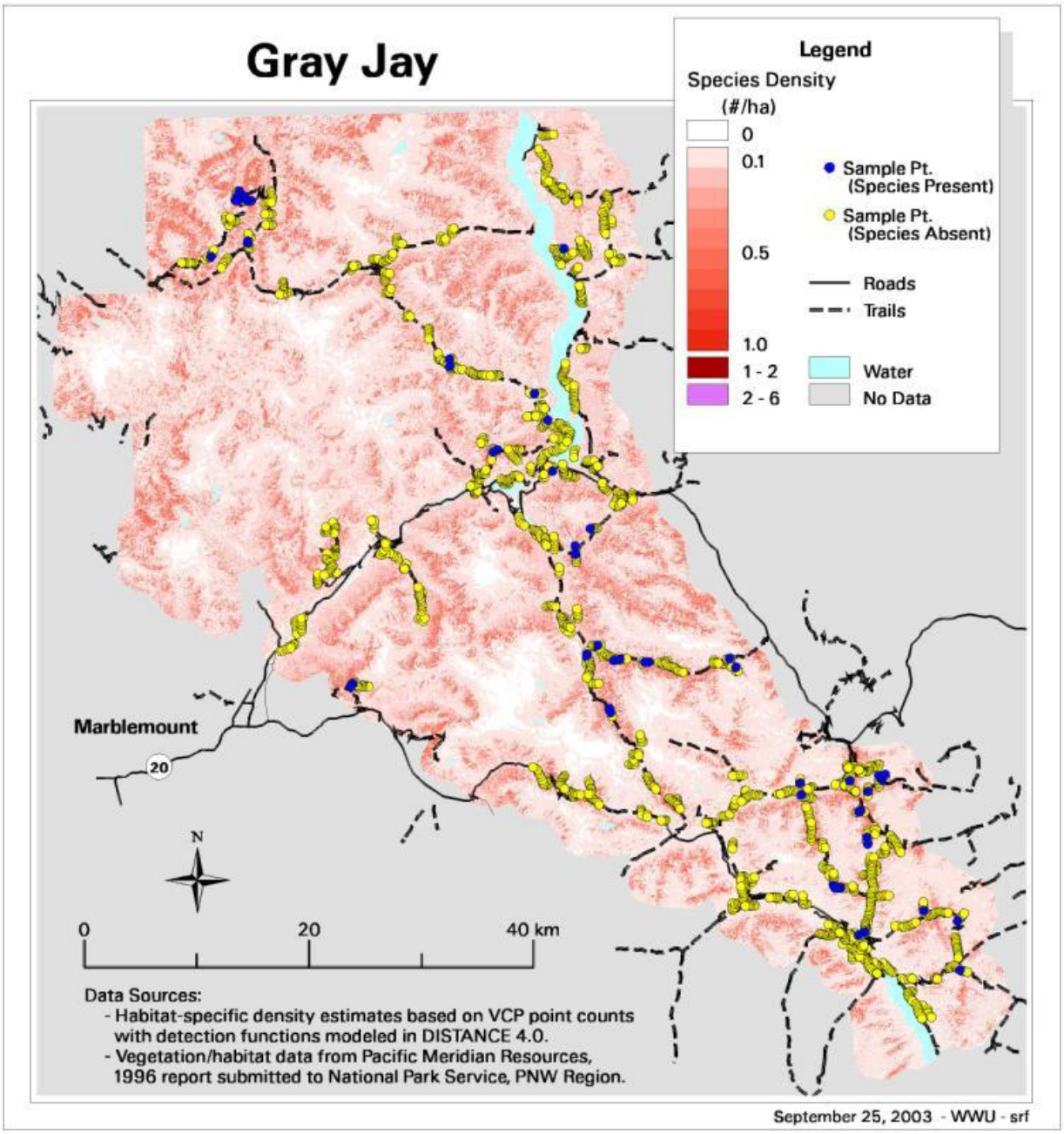

Common Raven
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

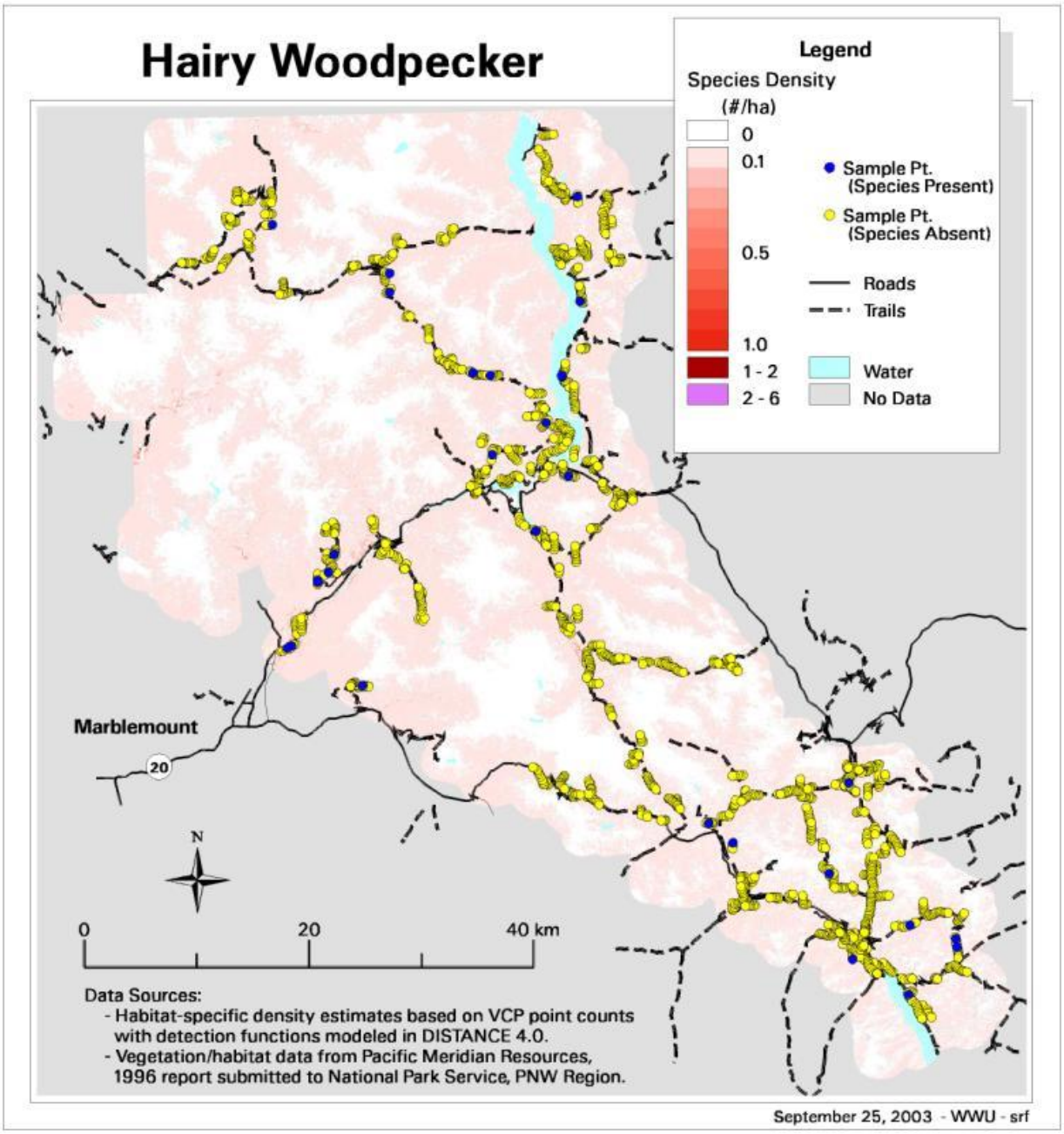

Dark-eyed Junco
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

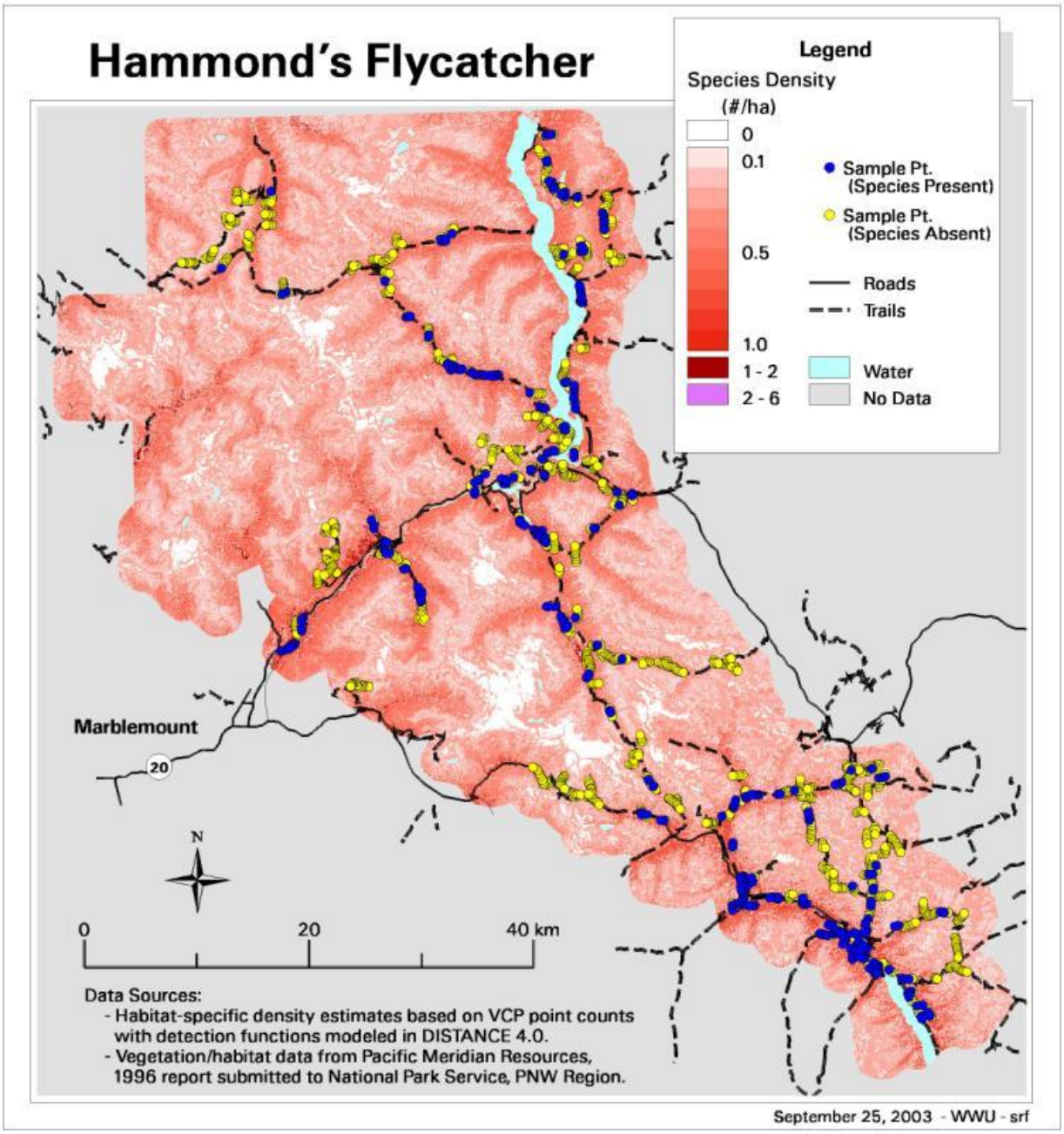

Evening Grosbeak
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

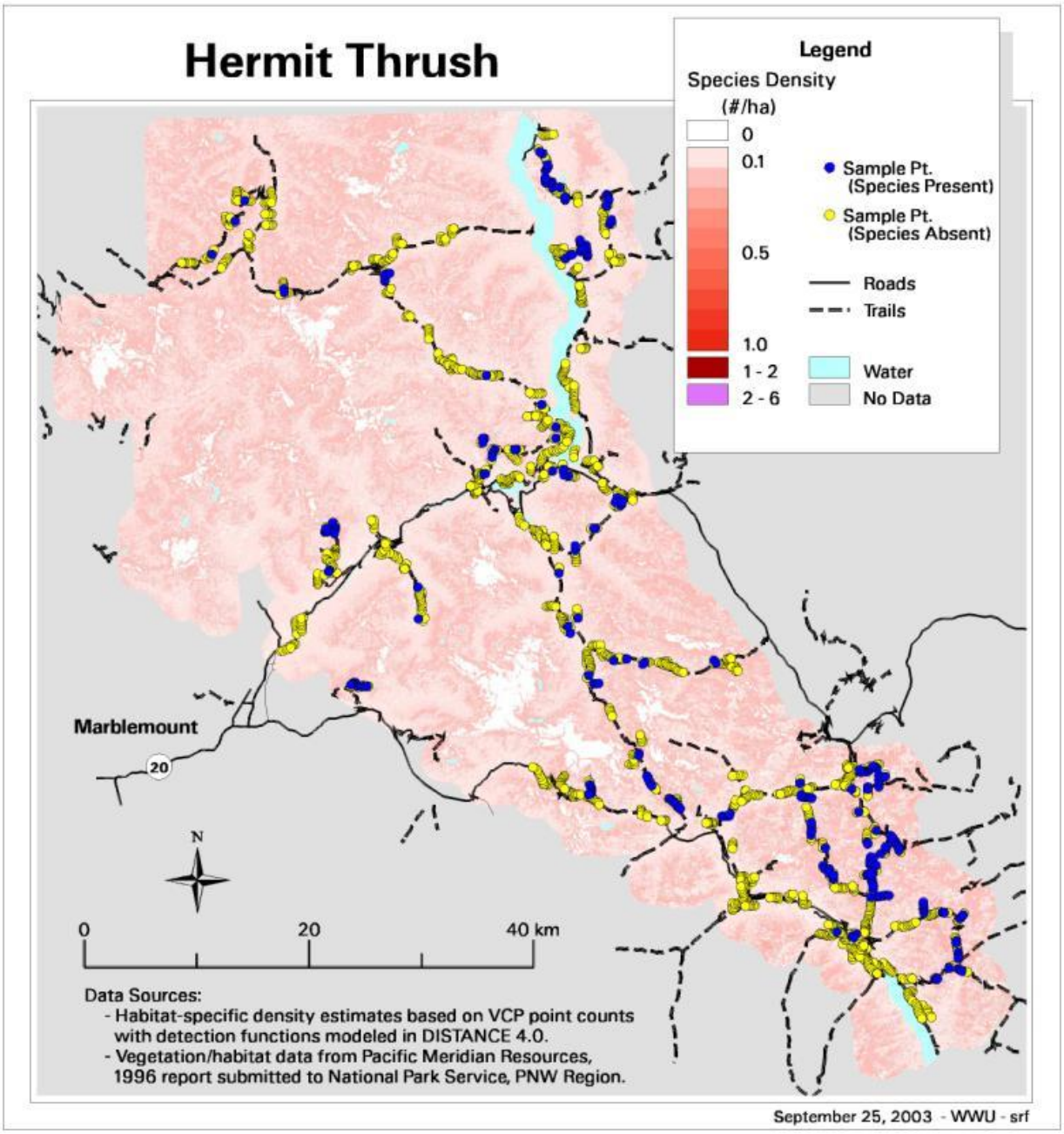

Fox Sparrow
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

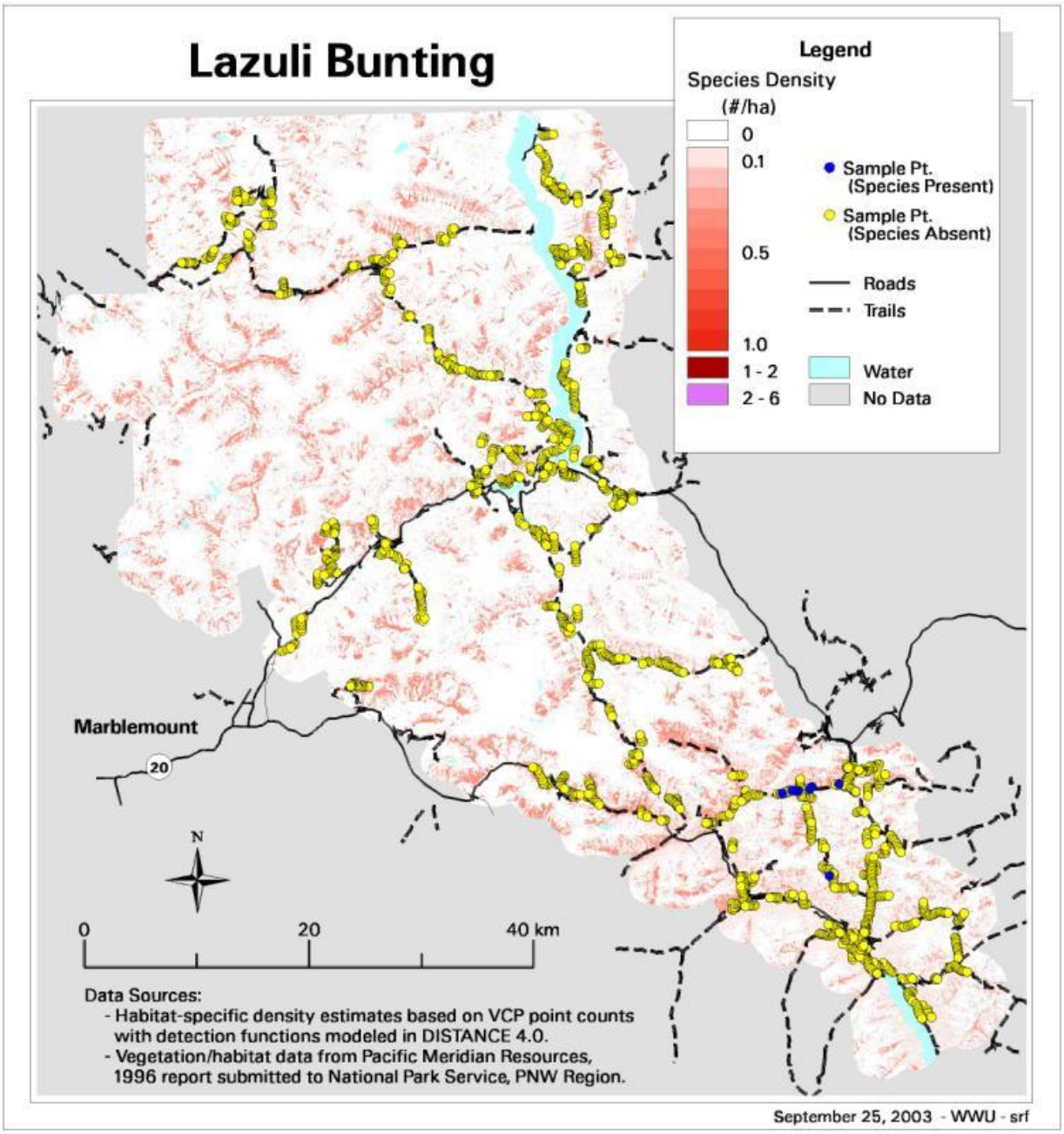

Golden-crowned Kinglet
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

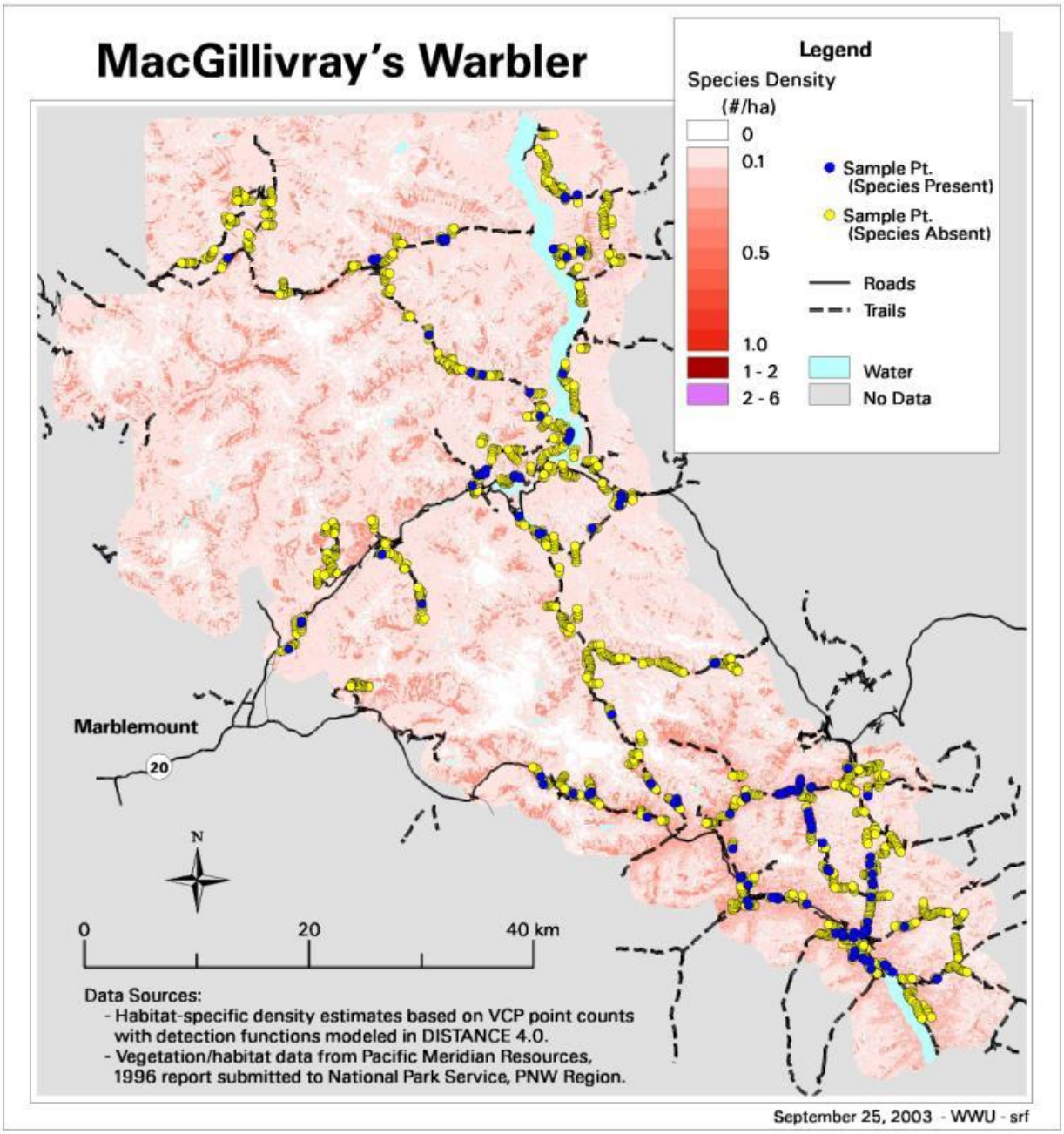

Gray Jay
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

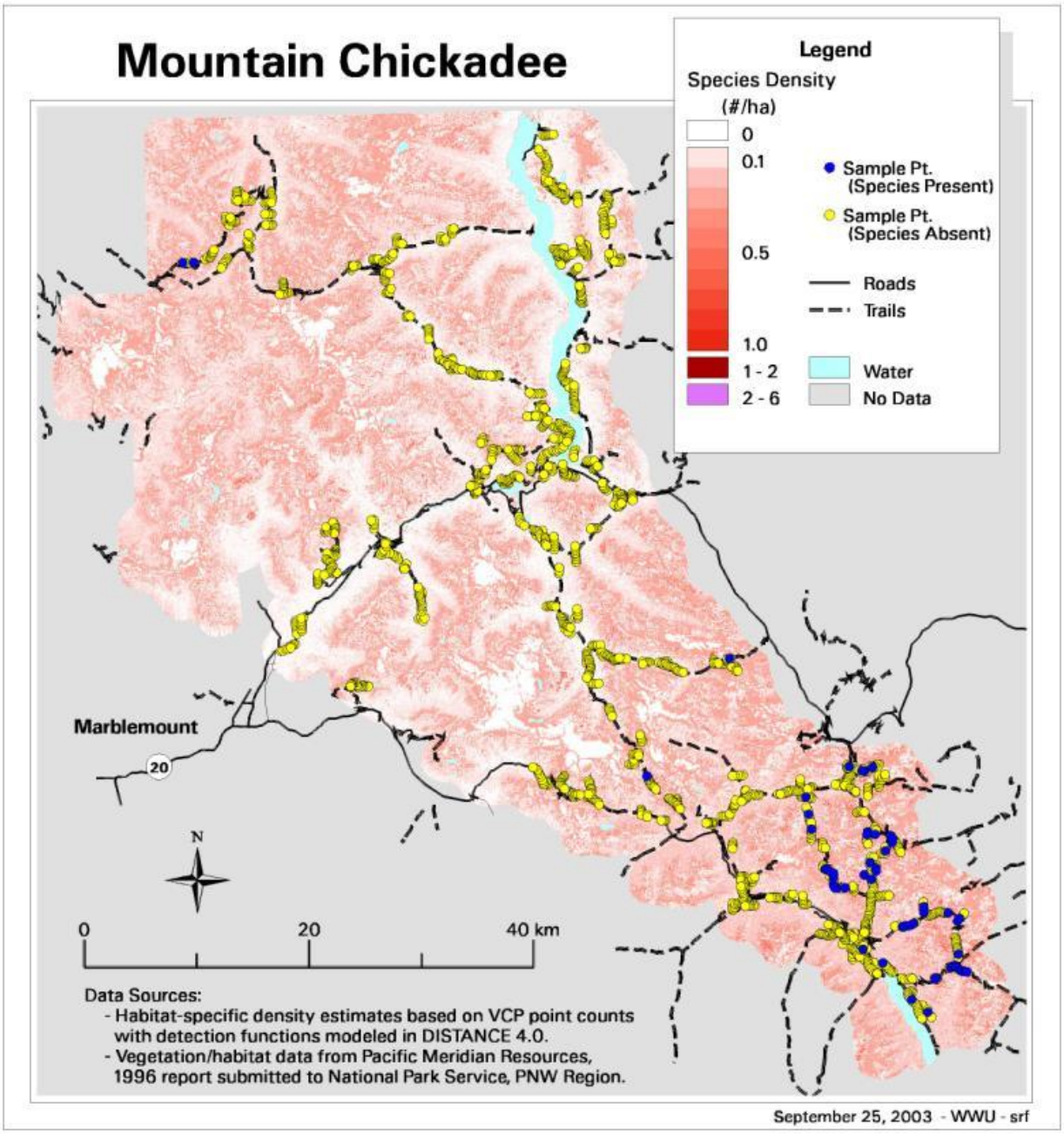

Hairy Woodpecker
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

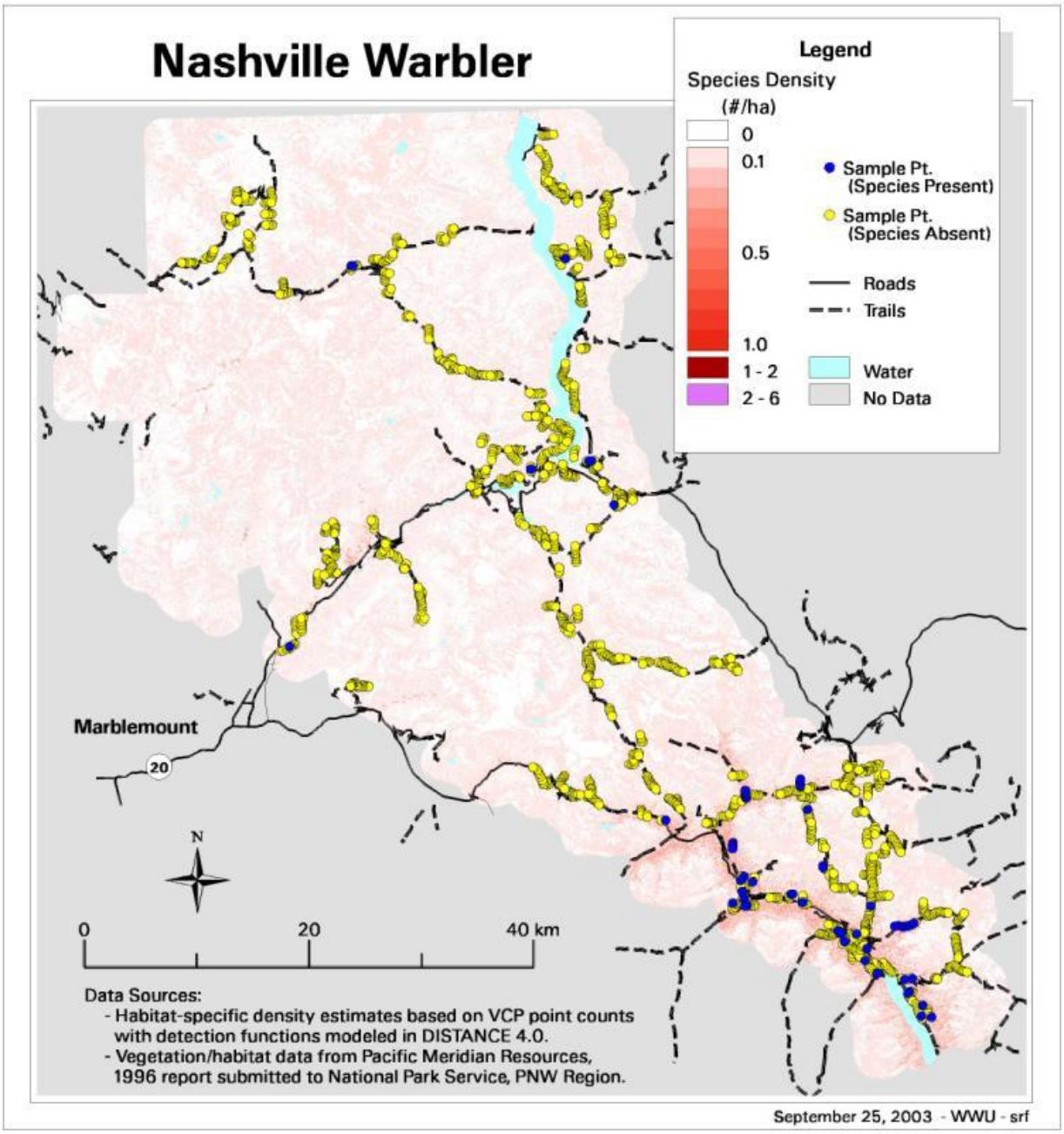

Hammond's Flycatcher
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt. (Species Present)
Sample Pt. (Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

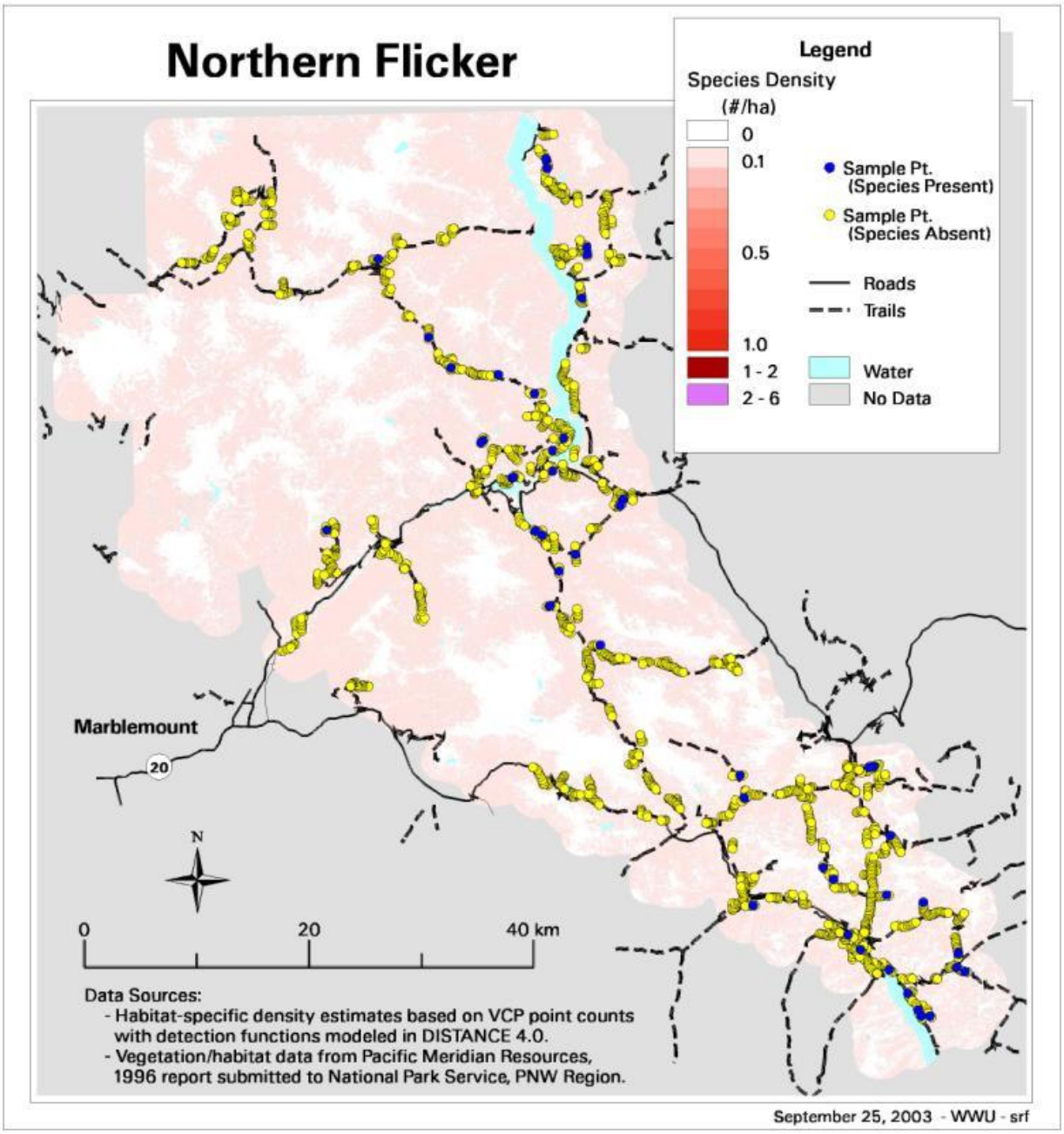

Hermit Thrush
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

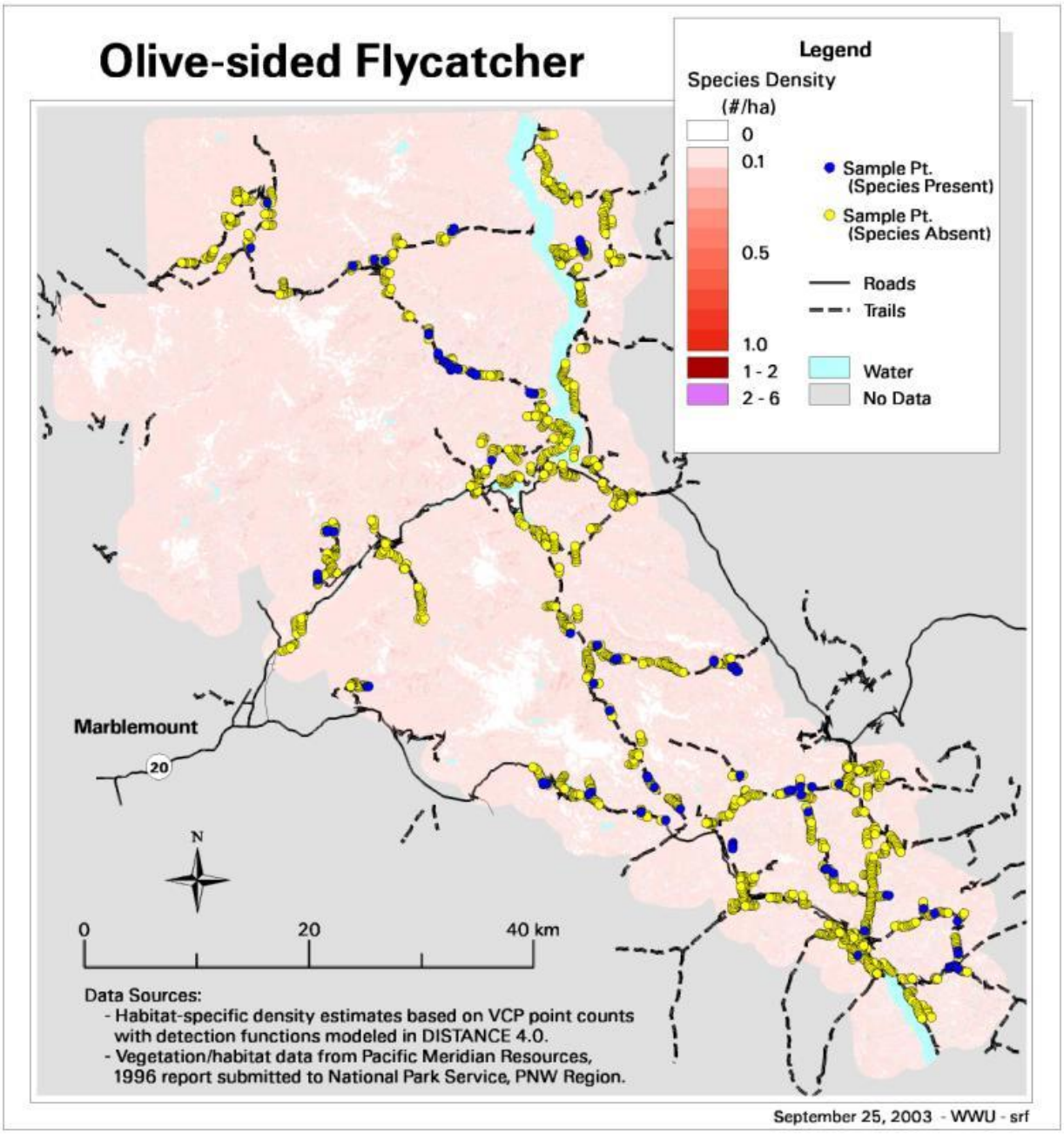

Lazuli Bunting
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


MacGillivray's Warbler
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Mountain Chickadee
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Nashville Warbler
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Northern Flicker
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Olive-sided Flycatcher
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
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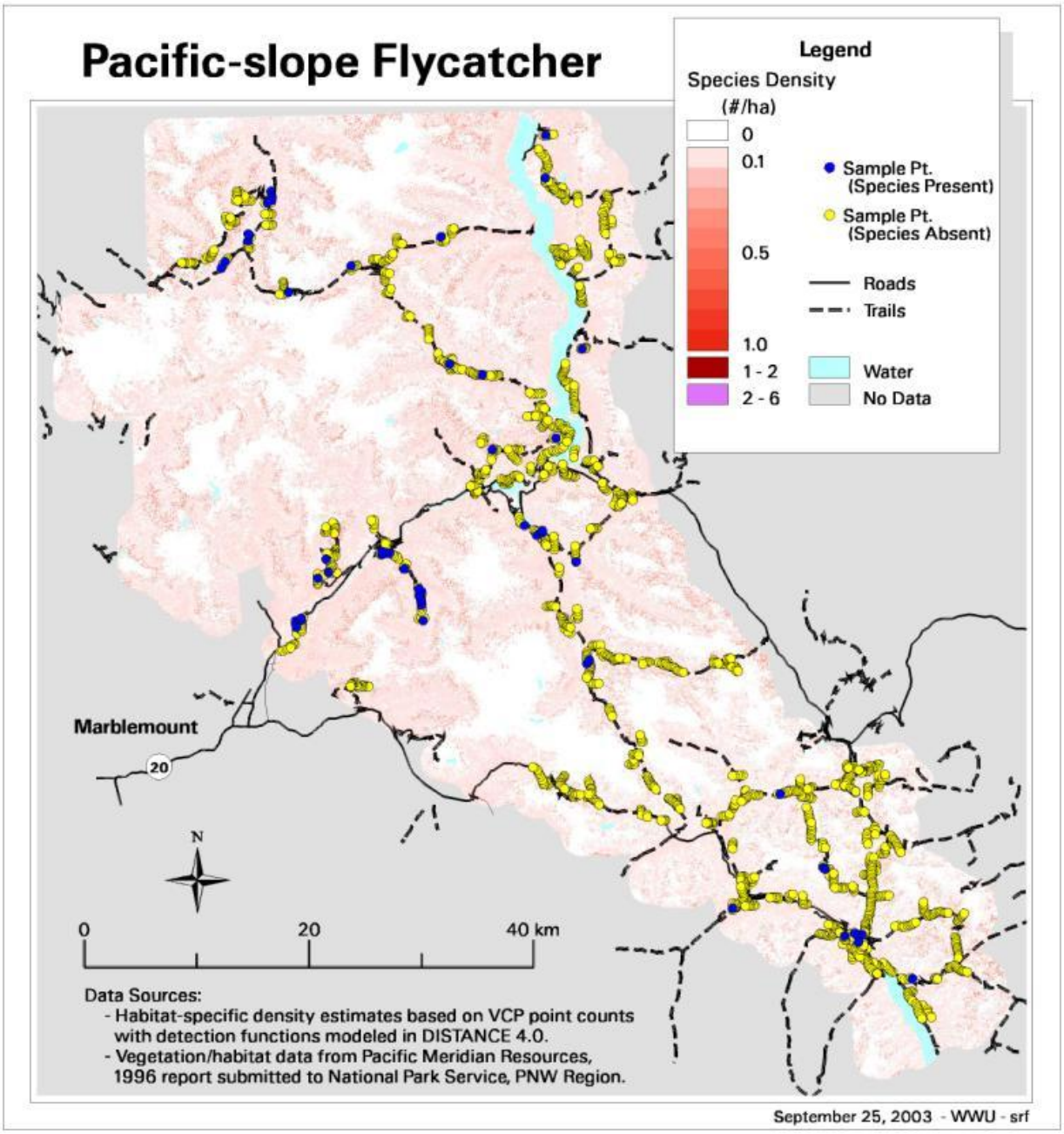
Pacific-slope Flycatcher
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
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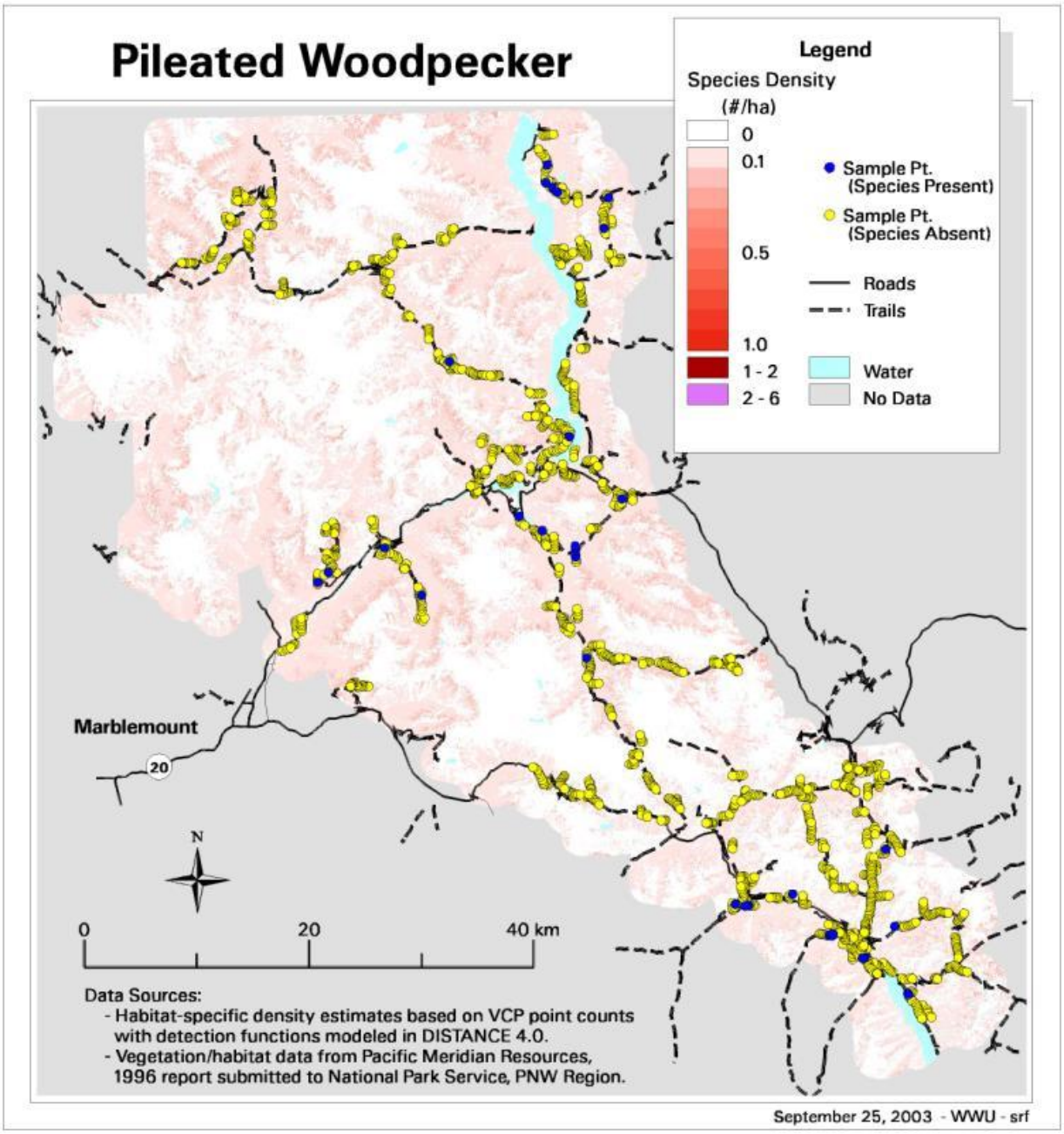
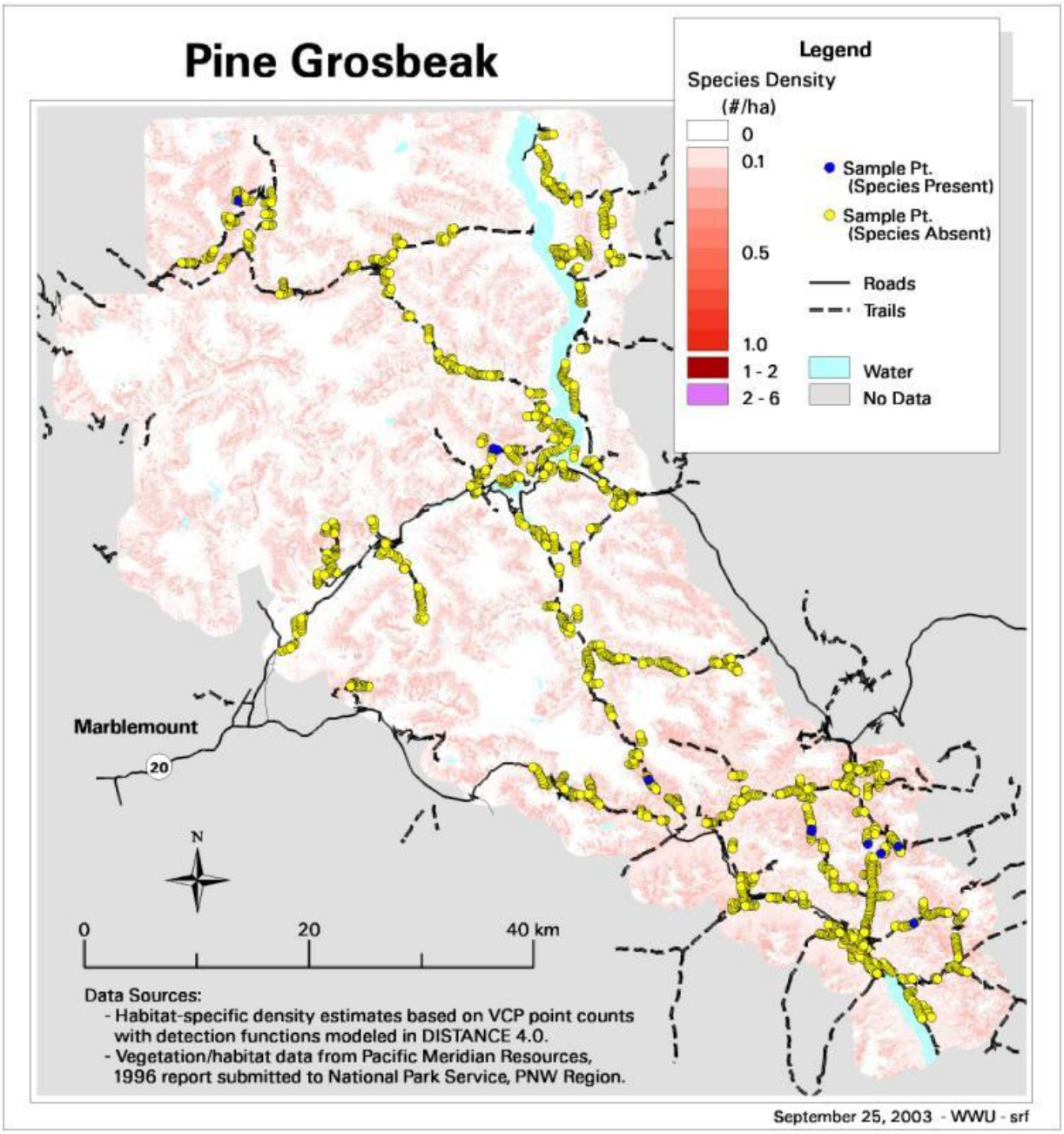
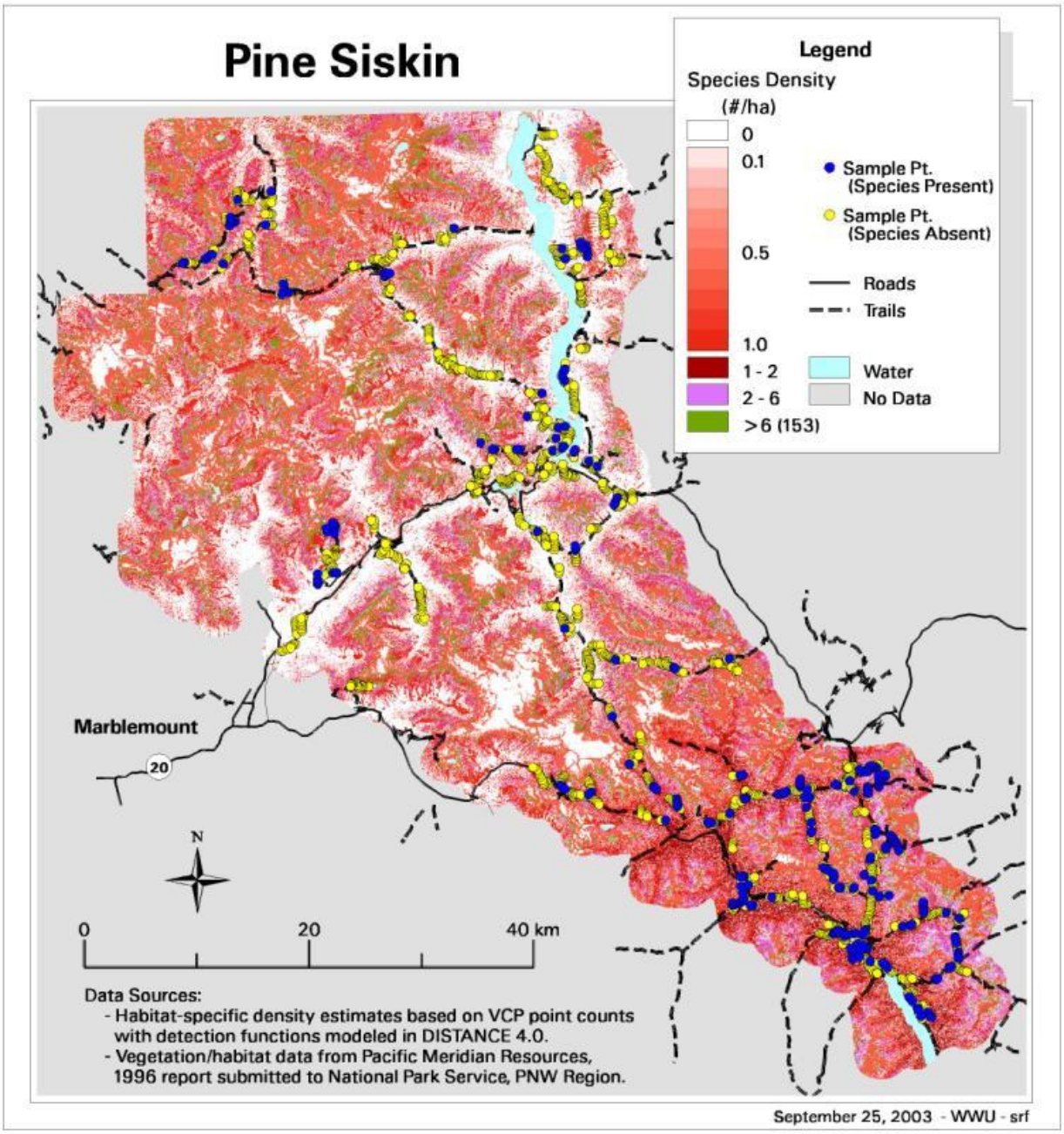

Pileated Woodpecker
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Pine Grosbeak
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Pine Siskin
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
>6 (153)
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
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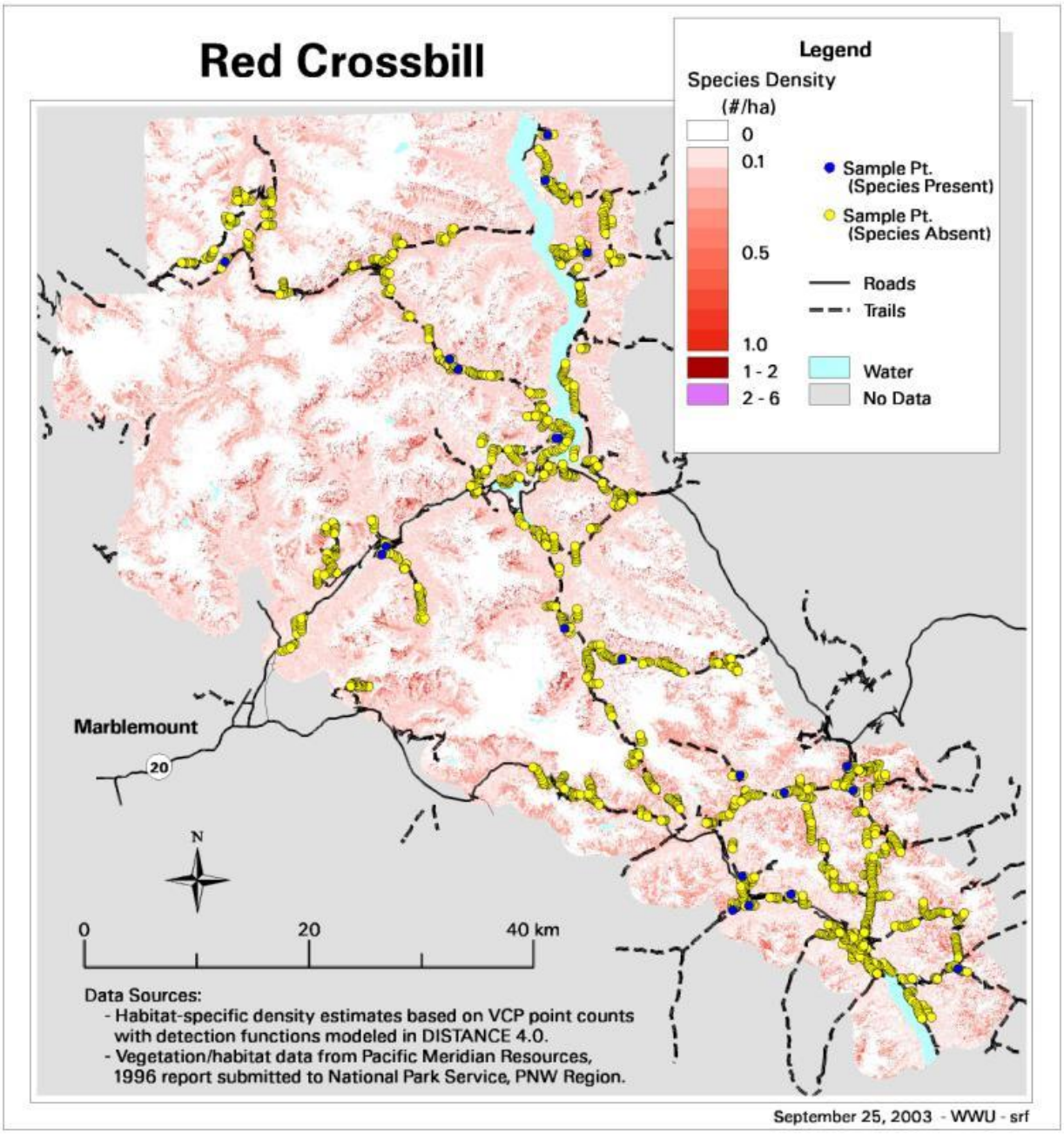
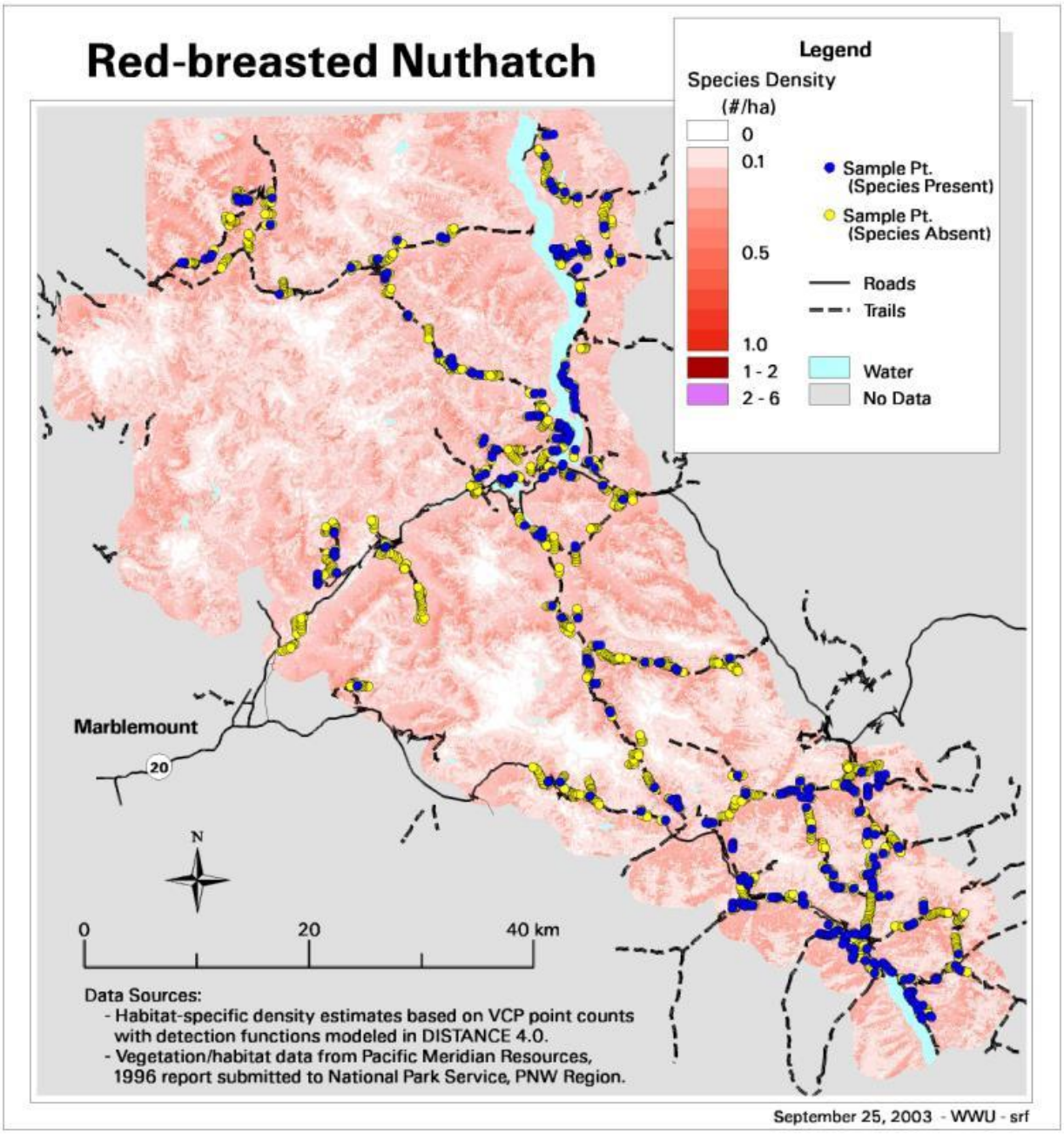
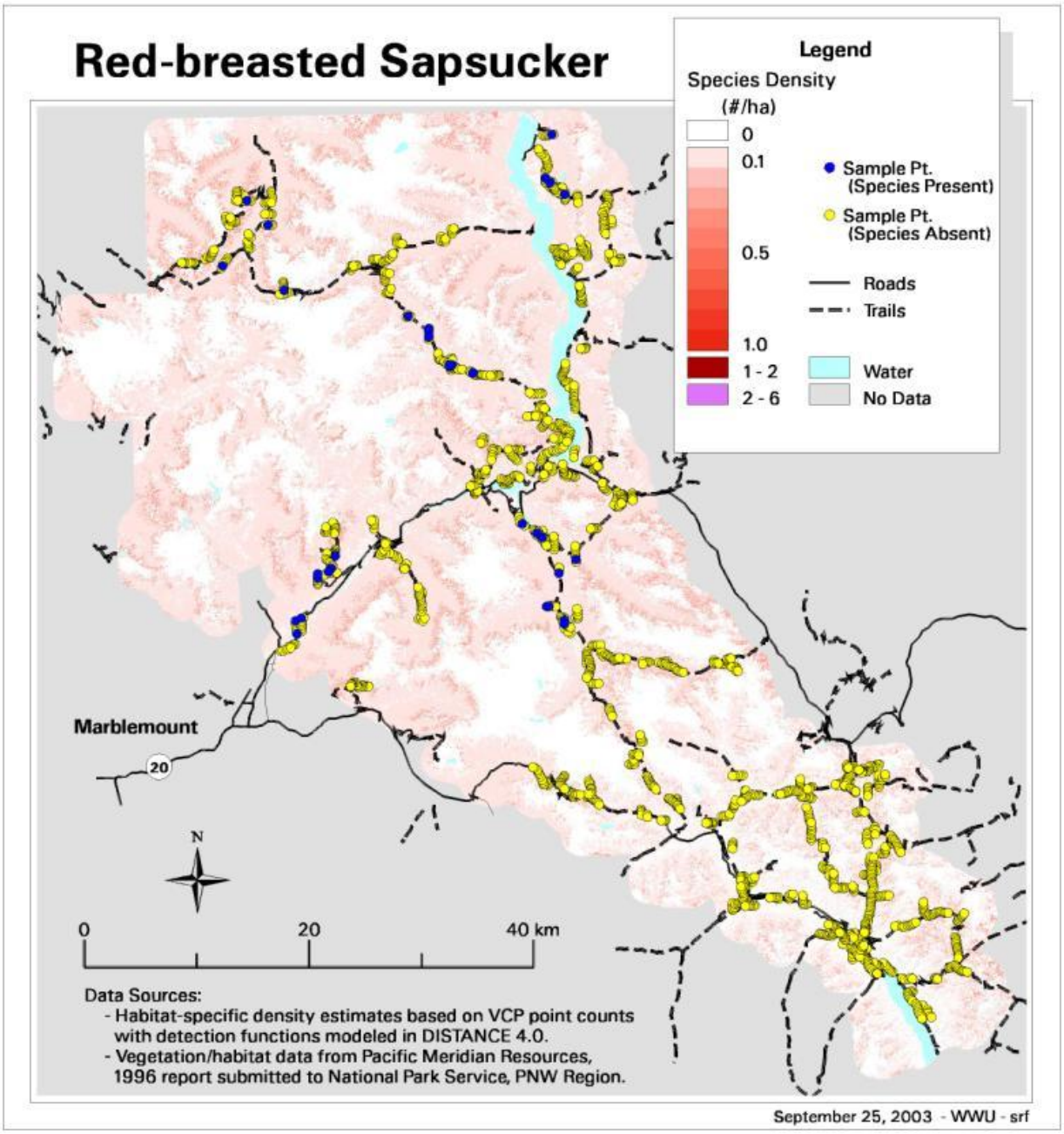
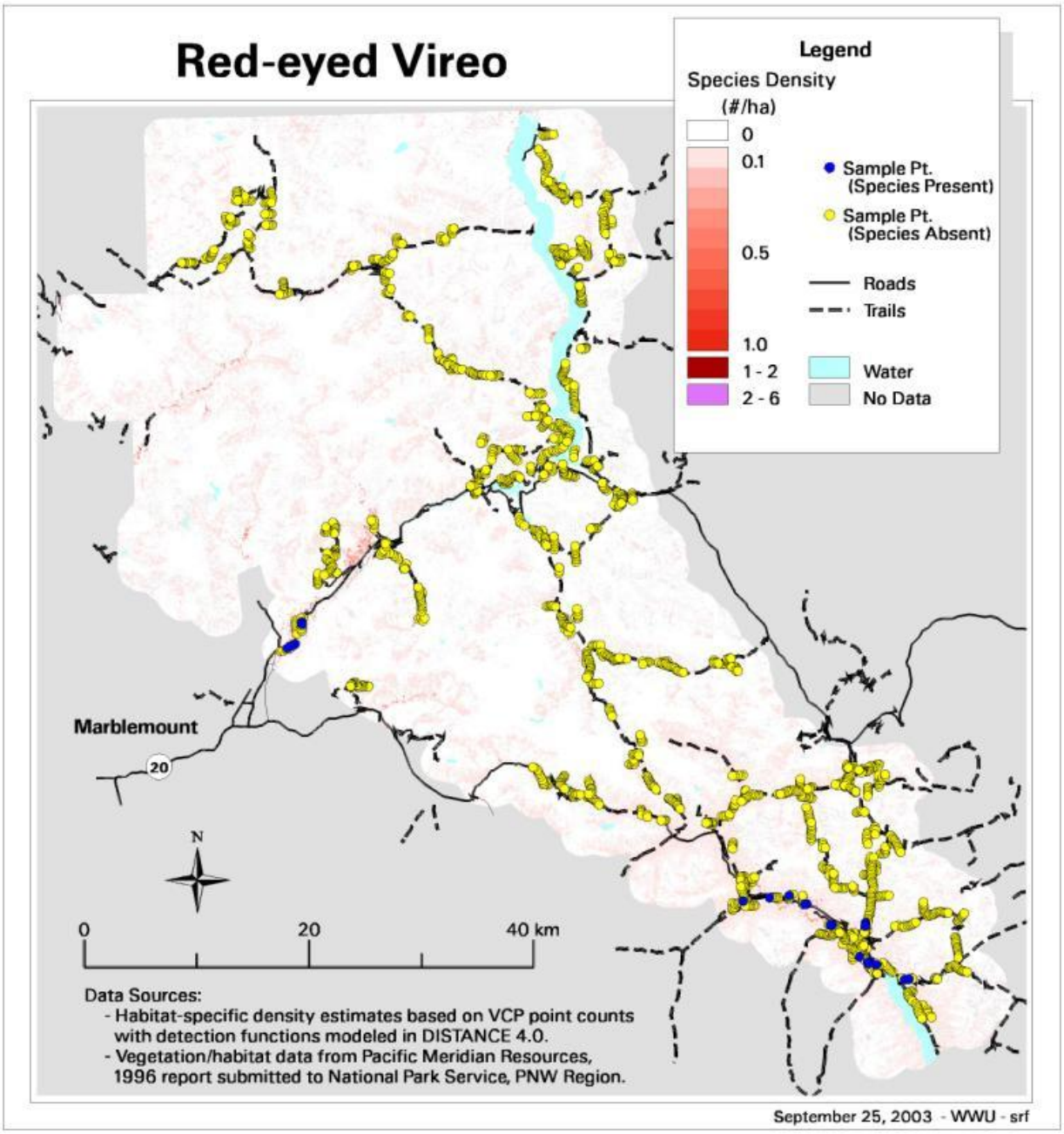
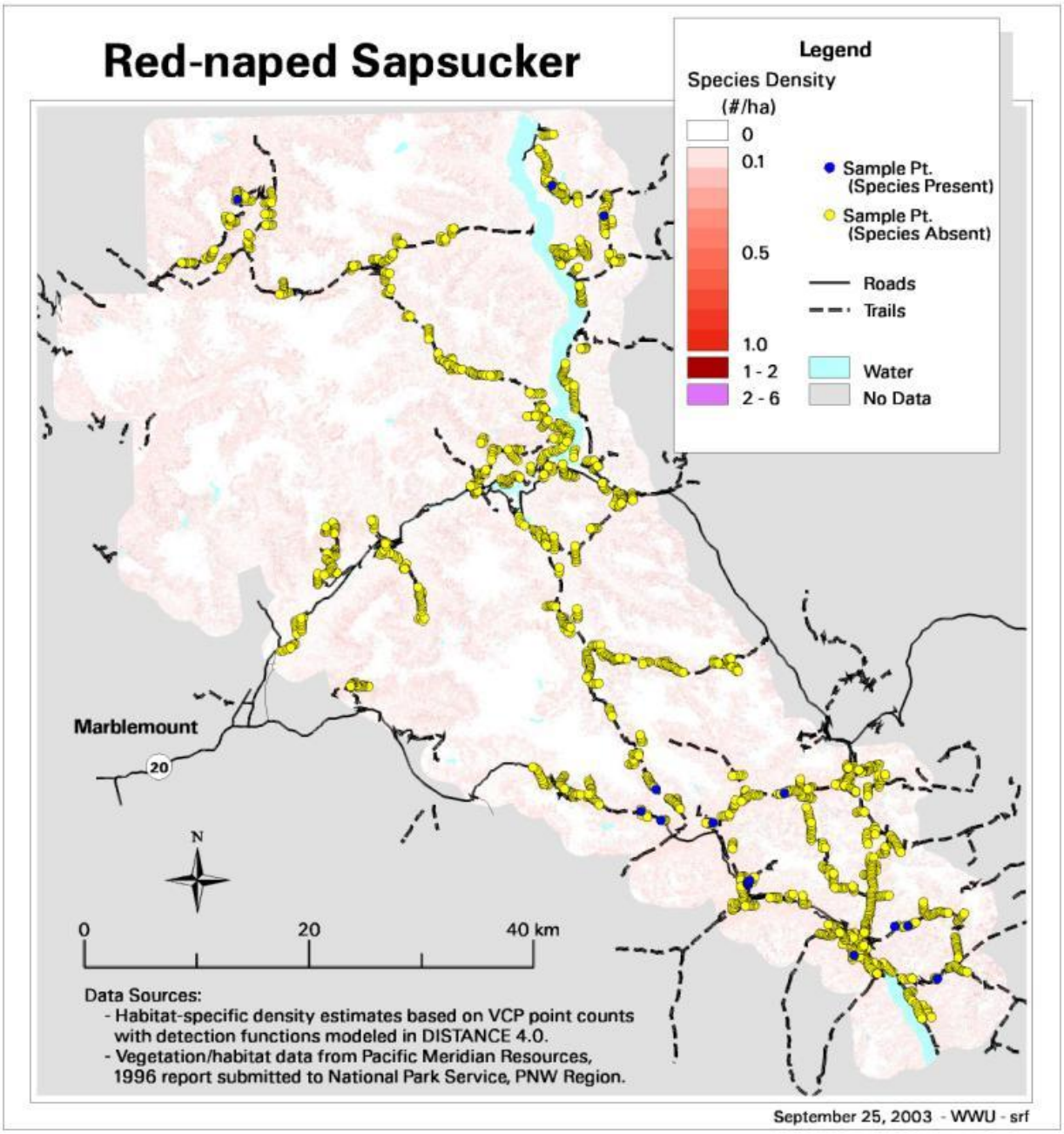
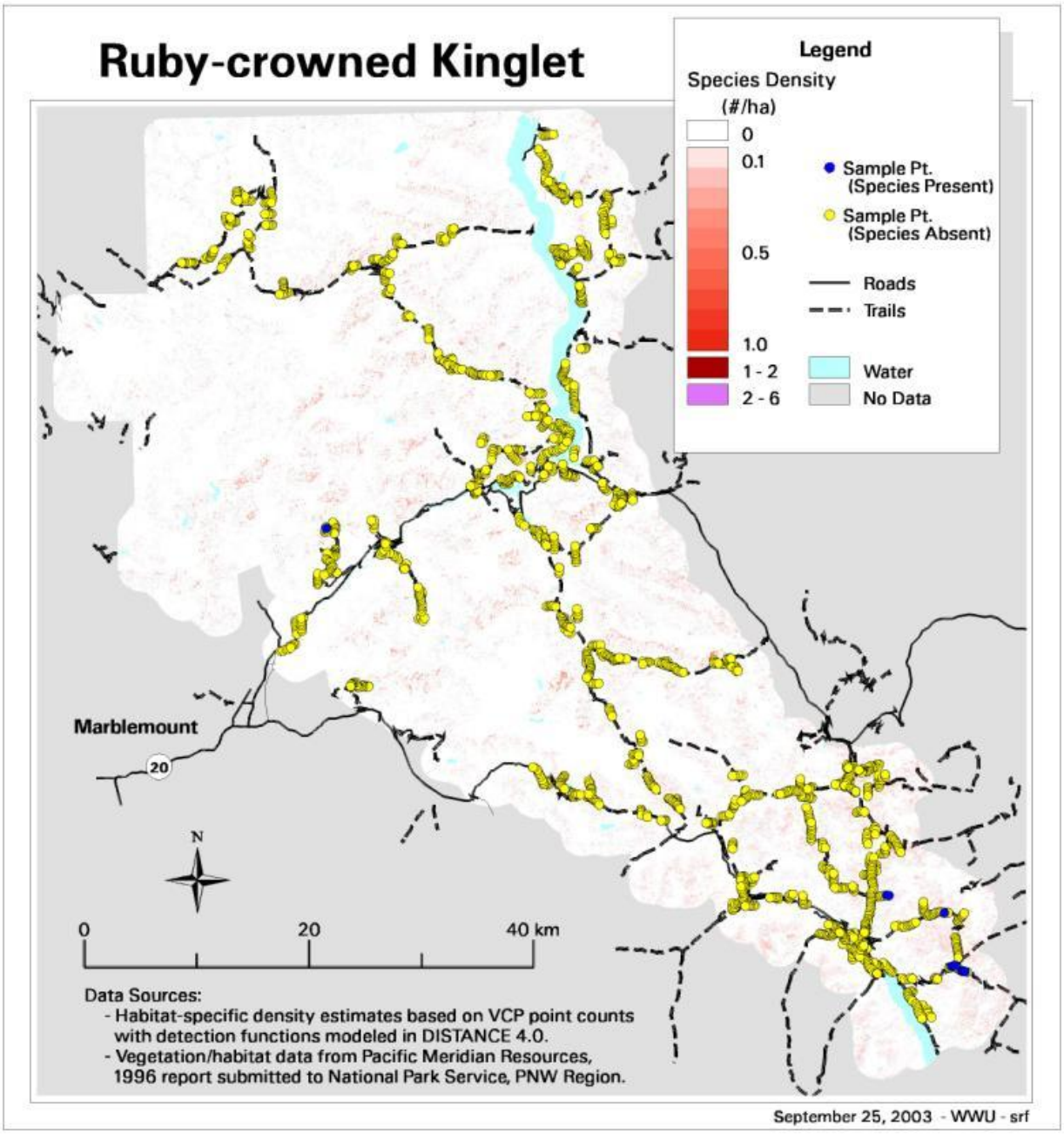

Red Crossbill
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

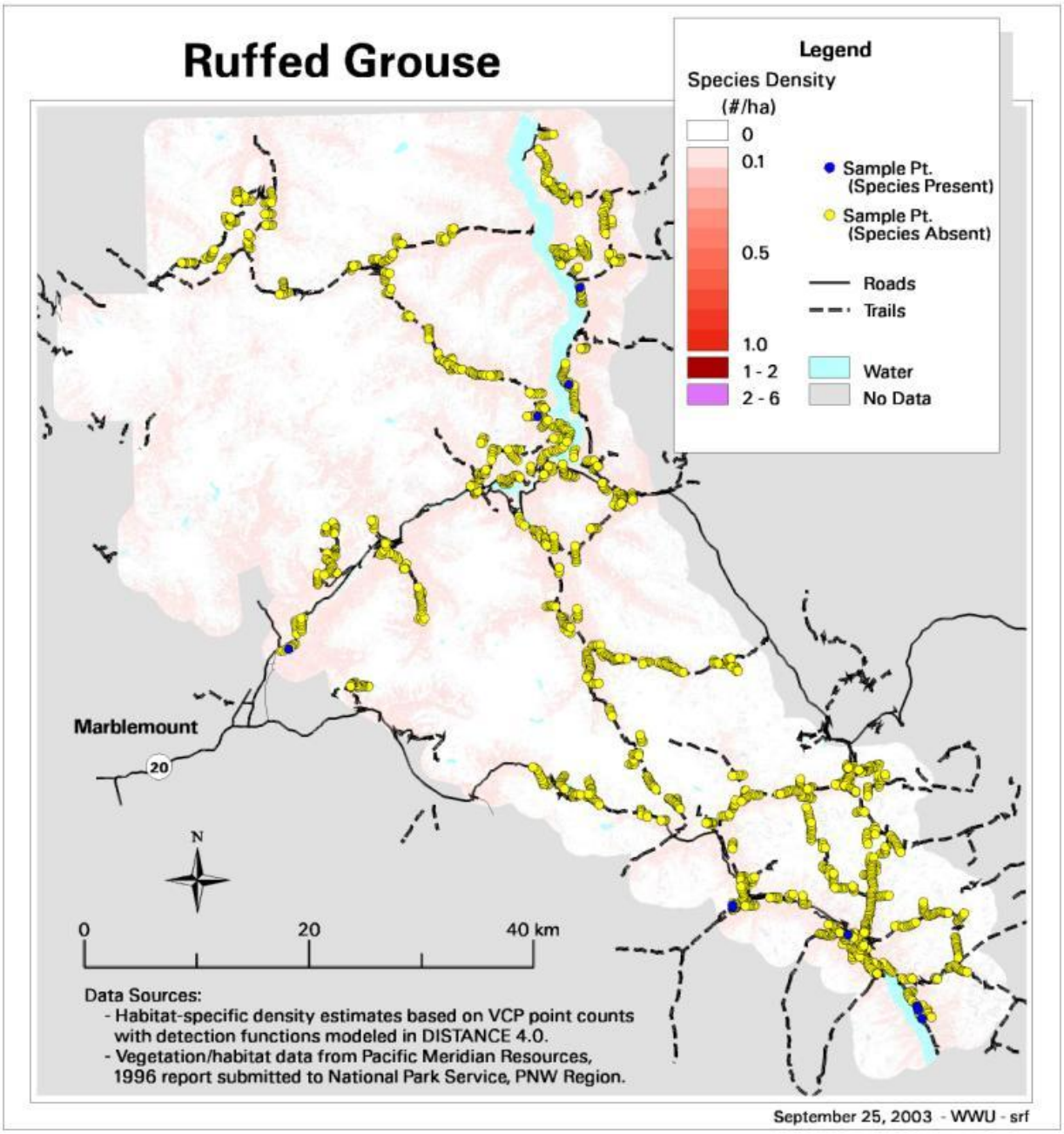

Red-breasted Nuthatch
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

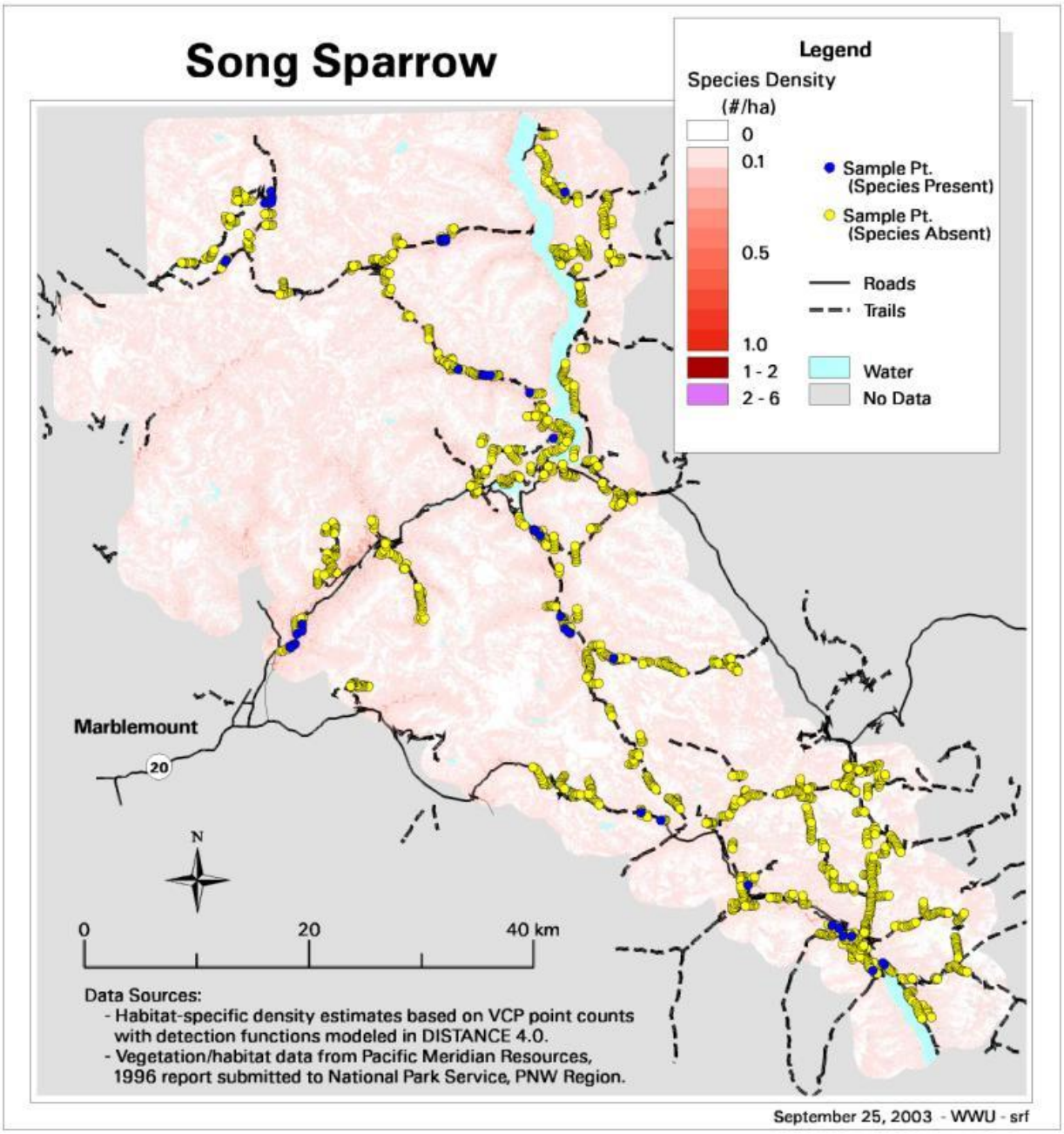

Red-breasted Sapsucker
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

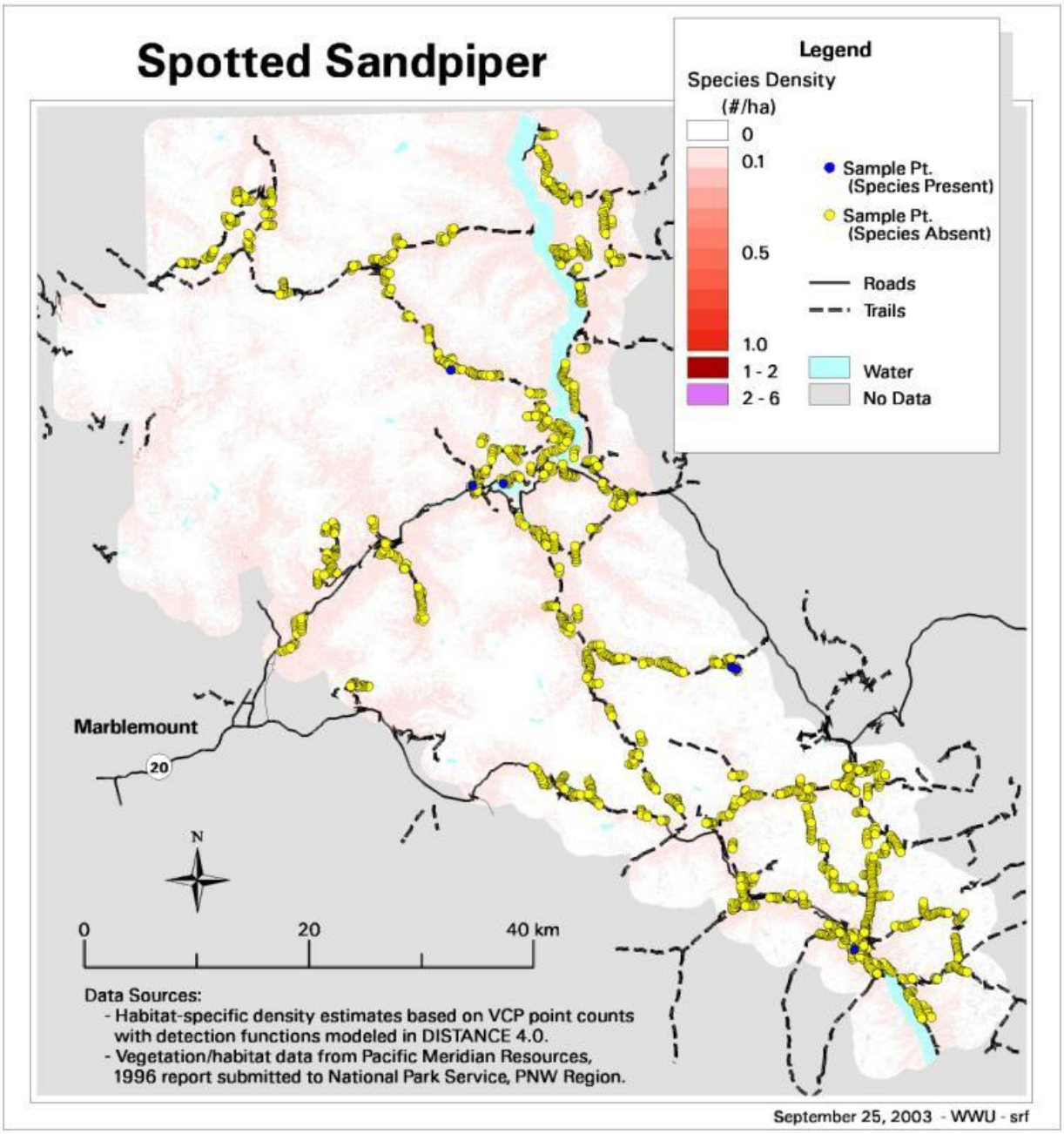

Red-eyed Vireo
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

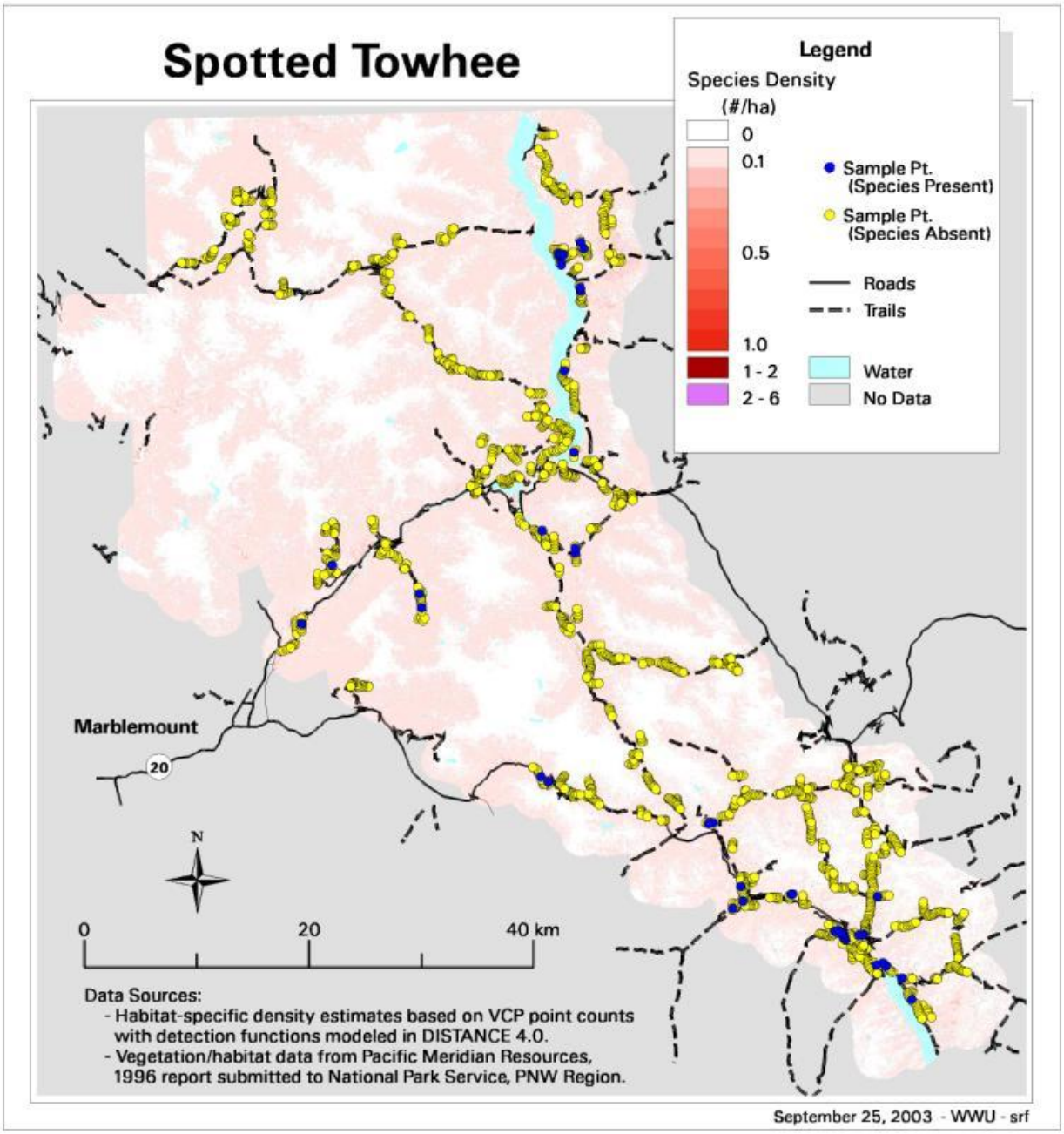

Red-naped Sapsucker
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

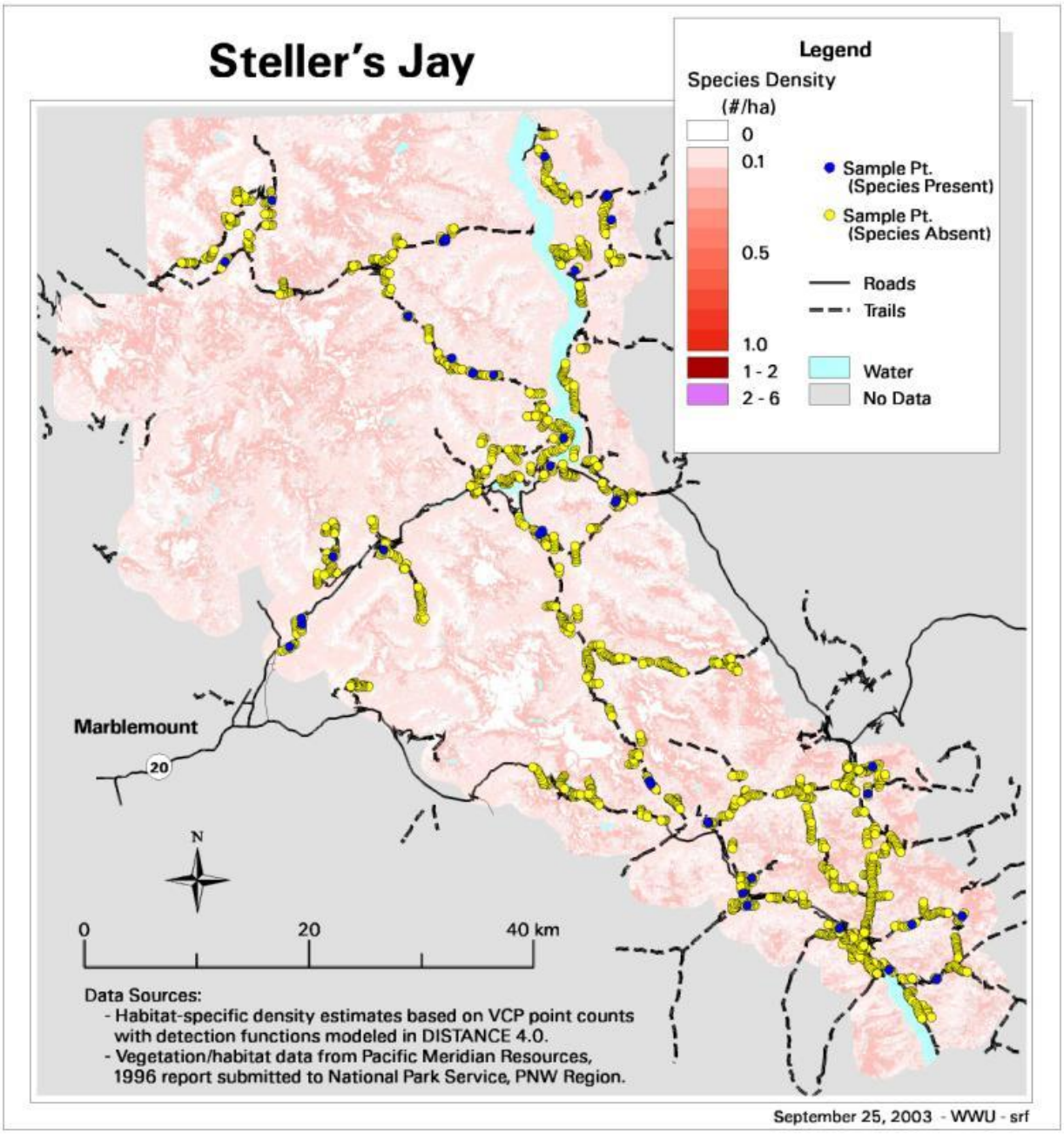

Ruby-crowned Kinglet
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

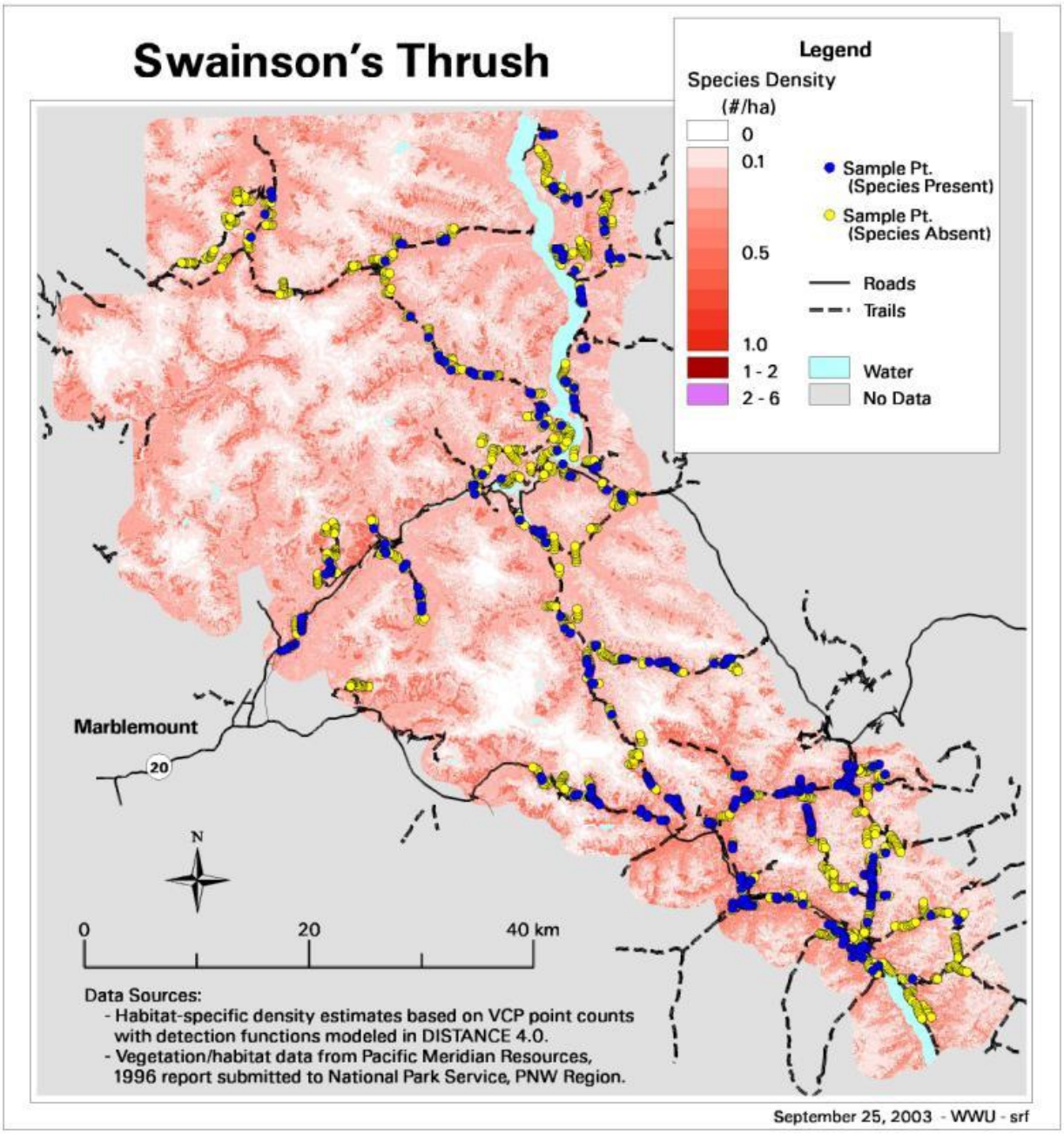

Ruffed Grouse
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

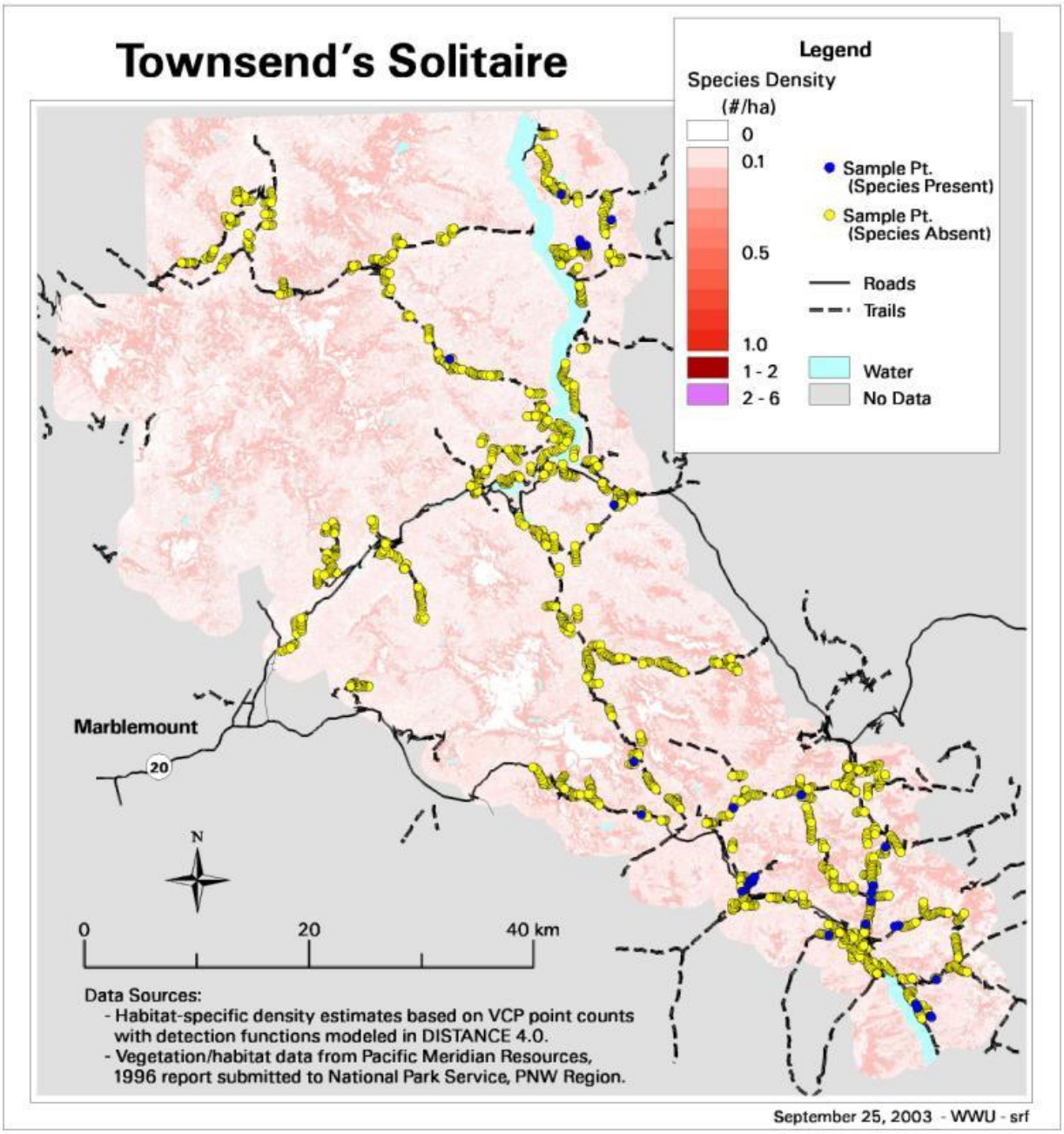

Song Sparrow
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

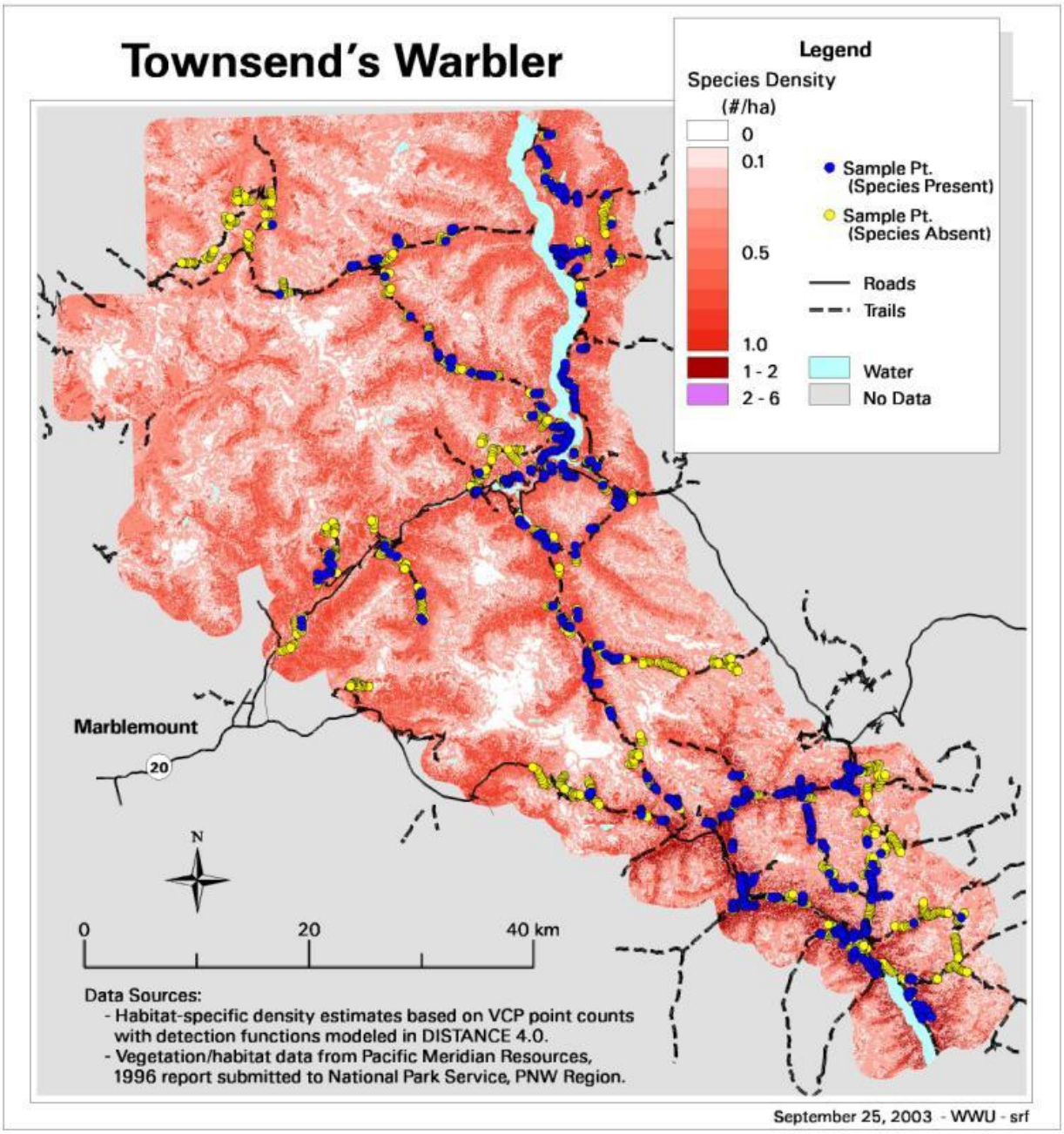

Spotted Sandpiper
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

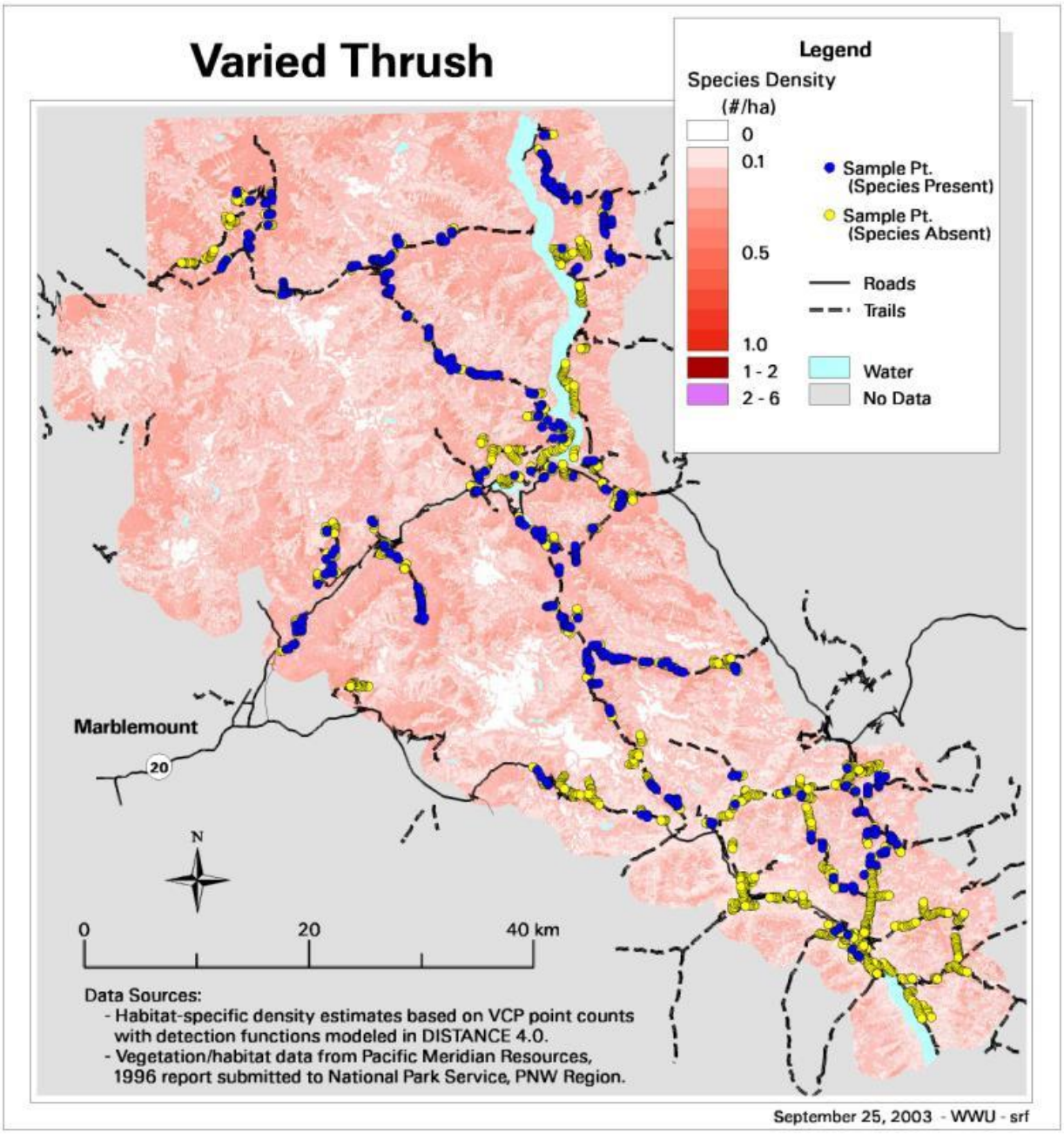

Spotted Towhee
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

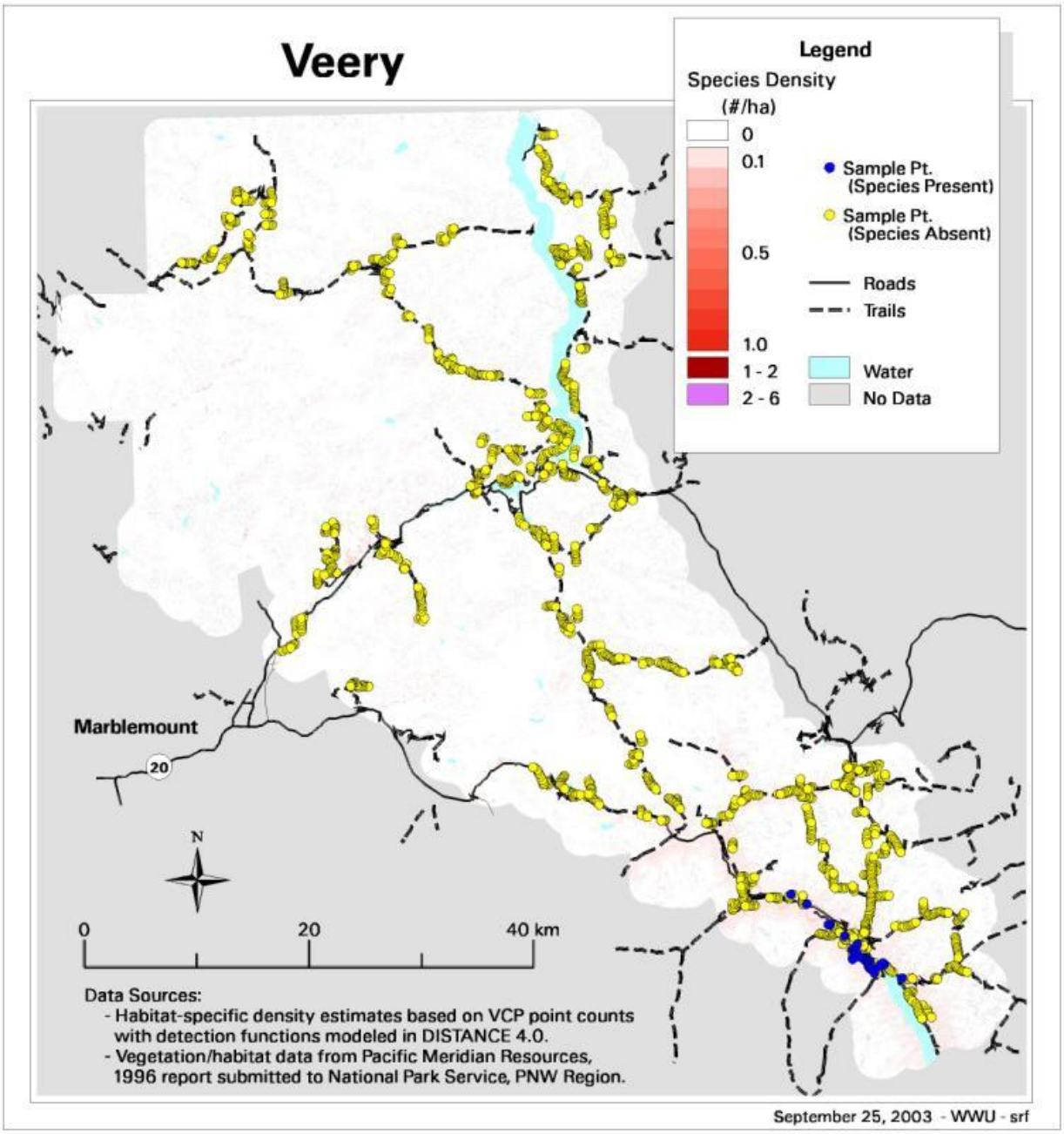

Steller's Jay
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

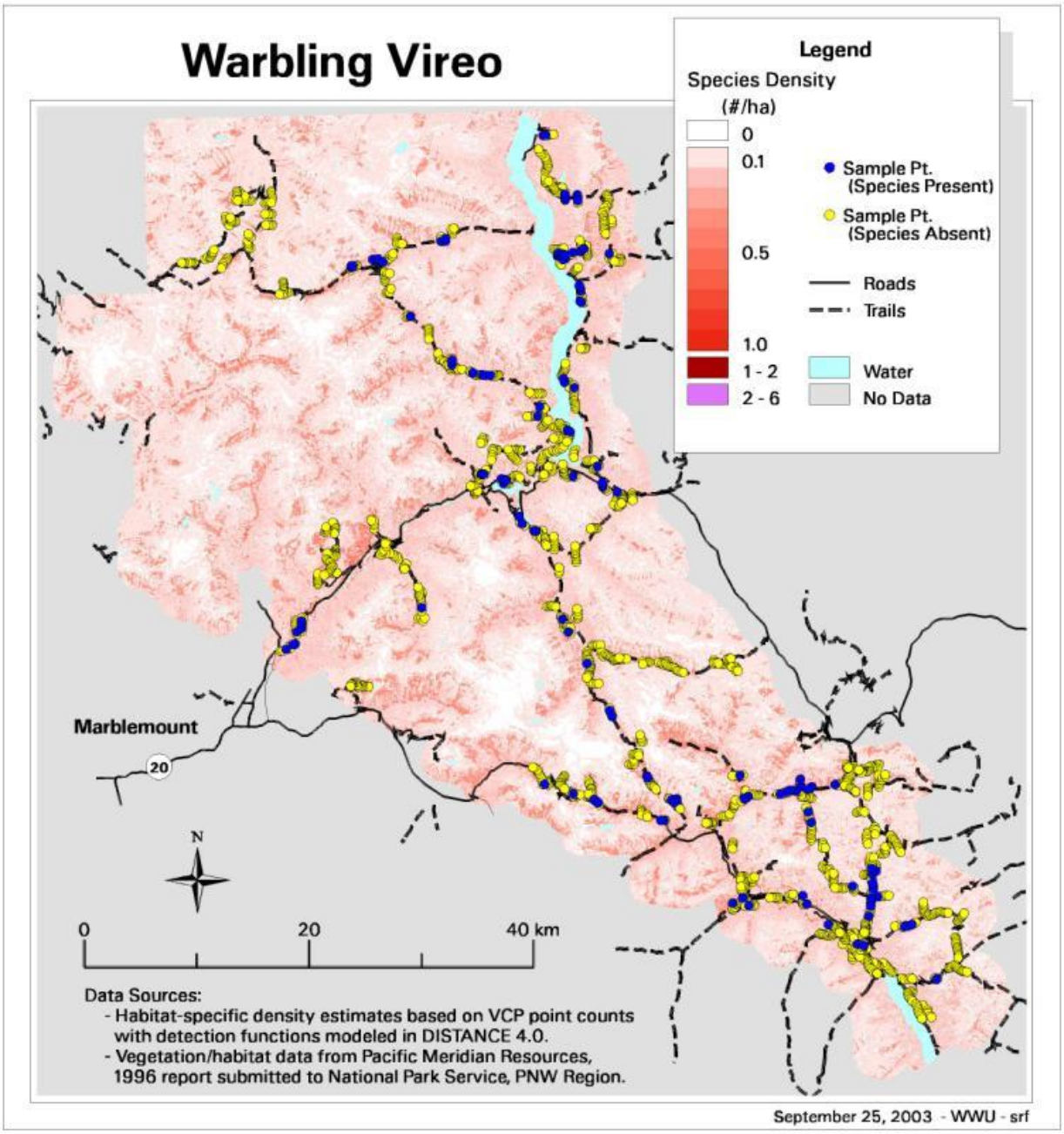

Swainson's Thrush
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

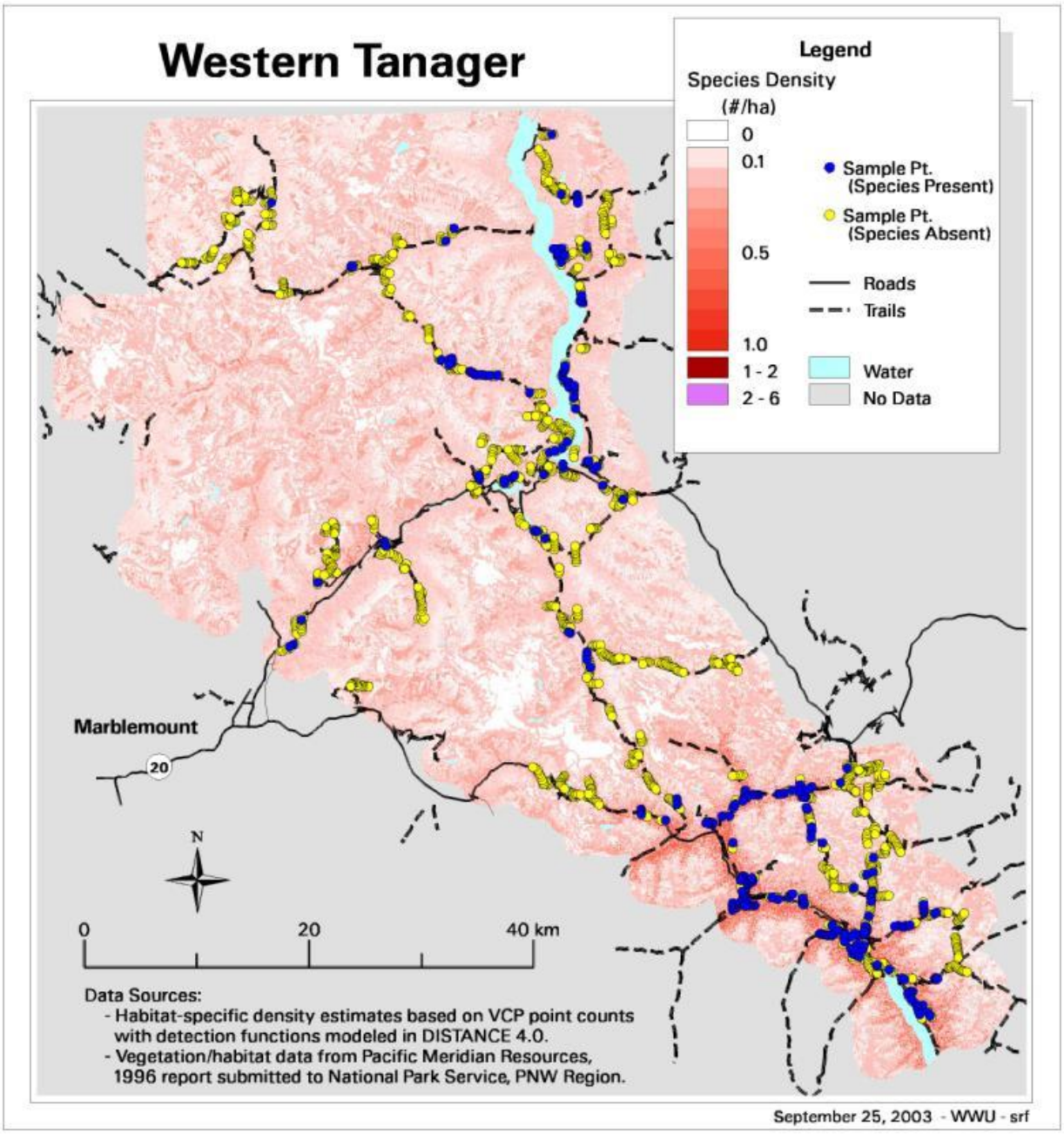

Townsend's Solitaire
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

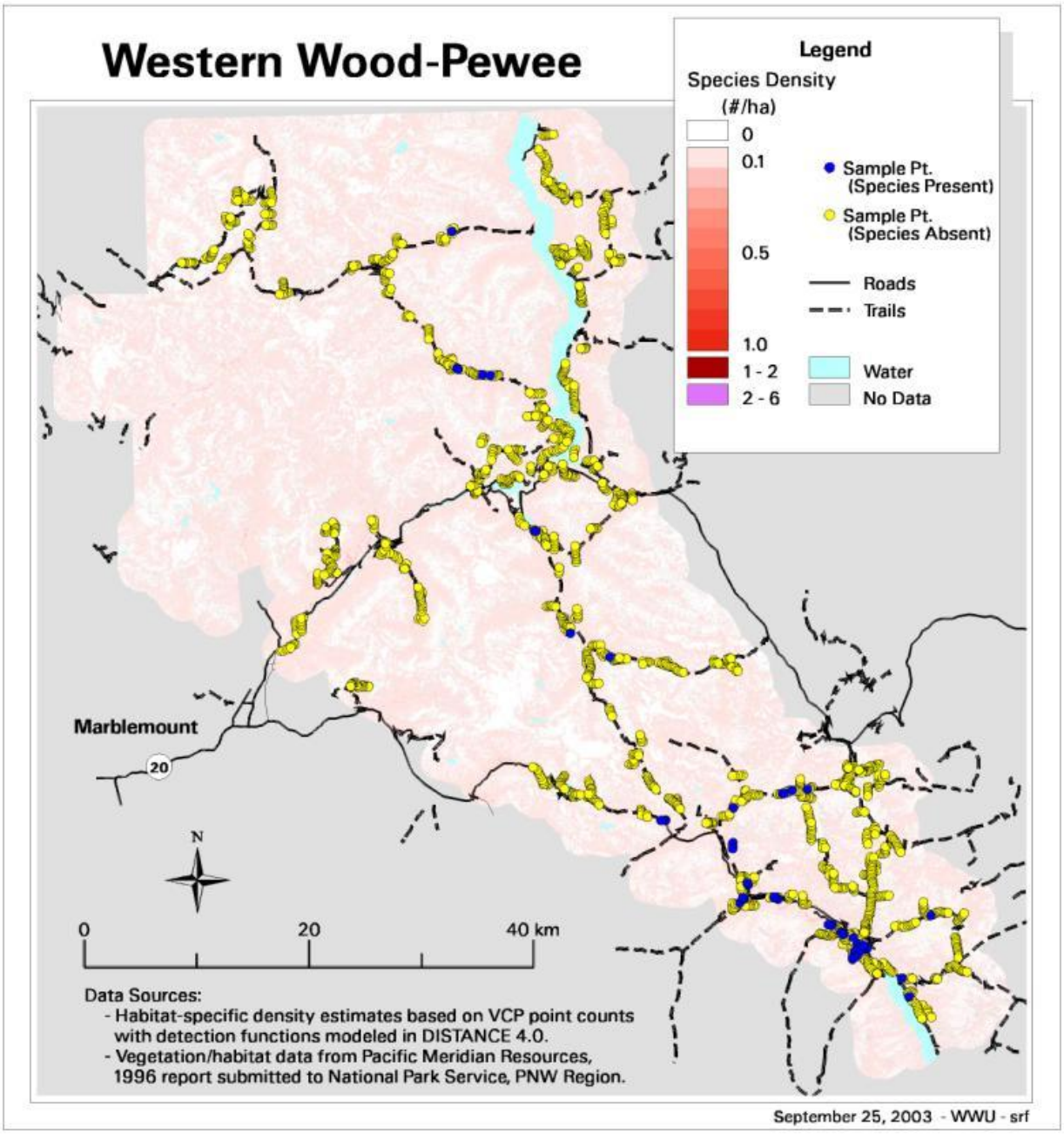

Townsend's Warbler
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

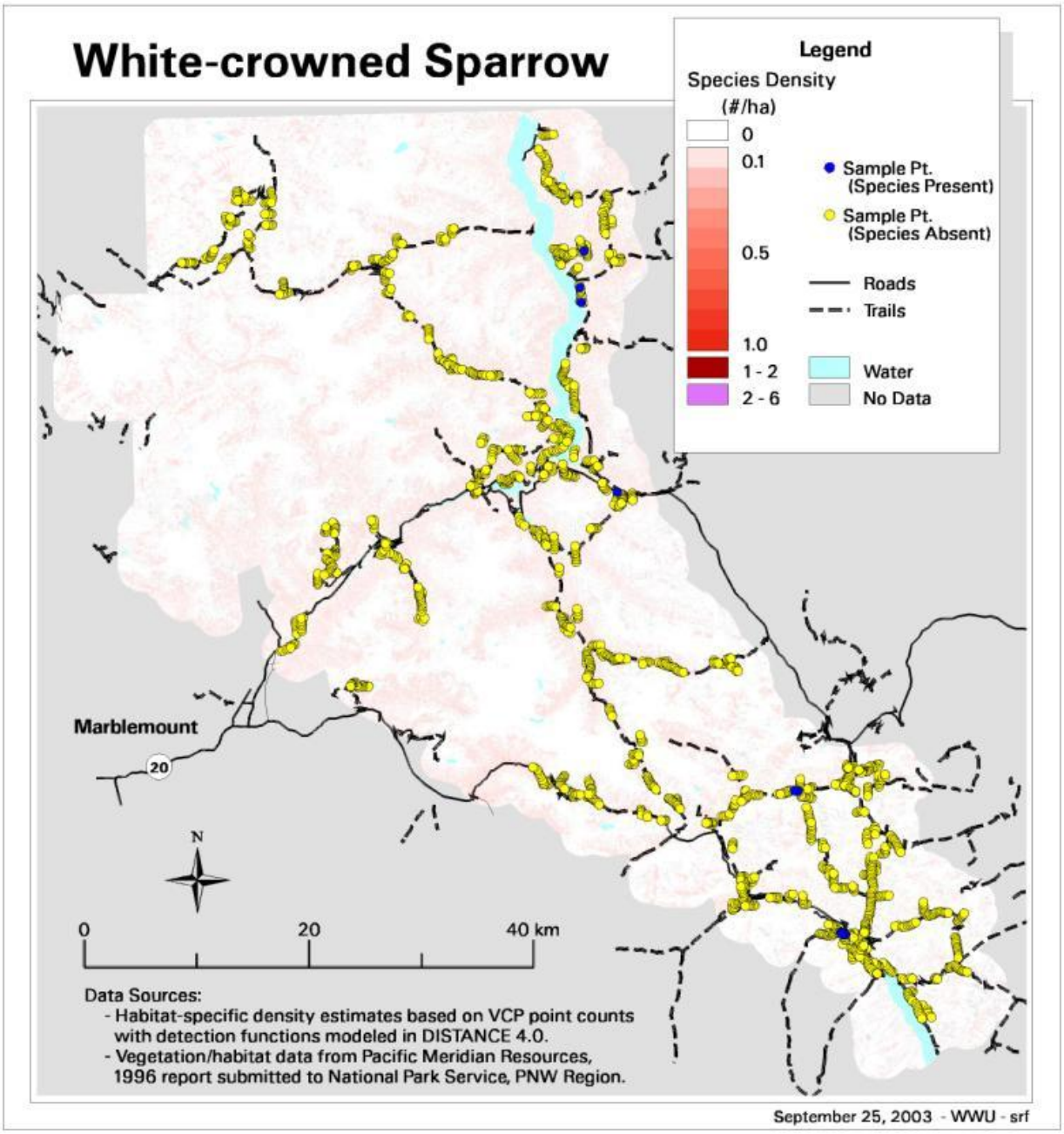

Varied Thrush
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

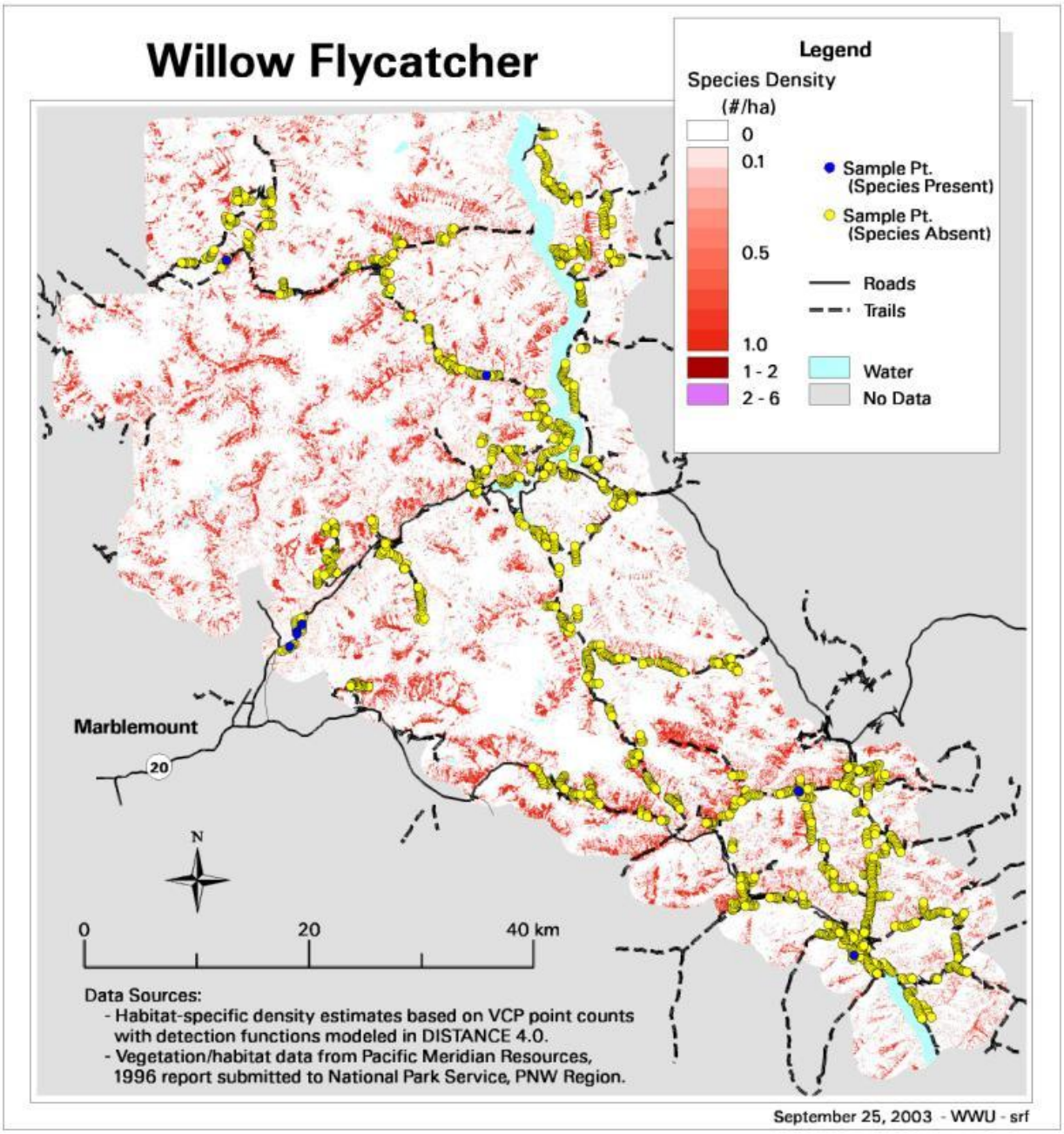

Veery
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf

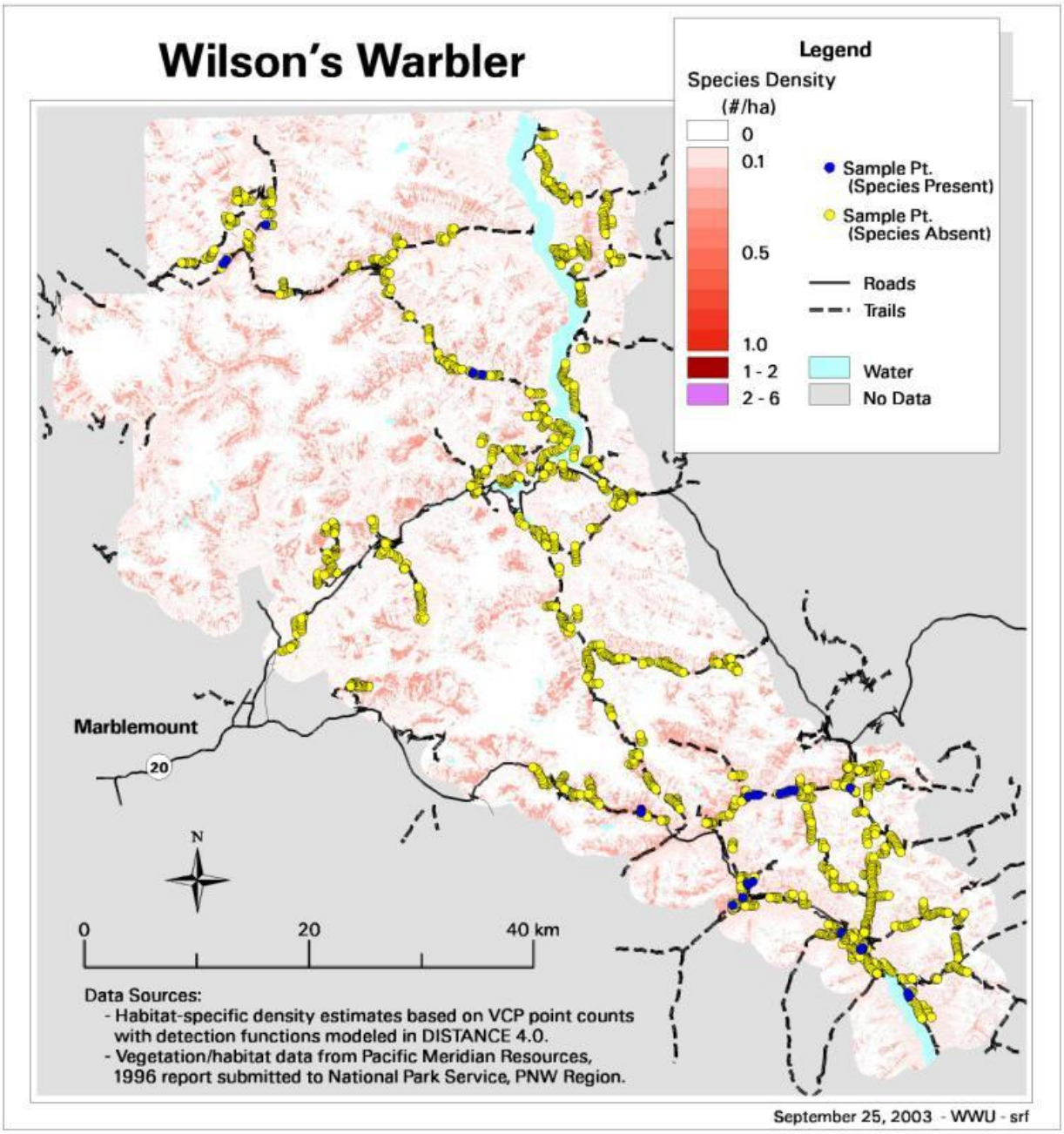

Warbling Vireo
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Western Tanager
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Western Wood-Pewee
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


White-crowned Sparrow
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Willow Flycatcher
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
September 25, 2003 - WWU - srf


Wilson's Warbler
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
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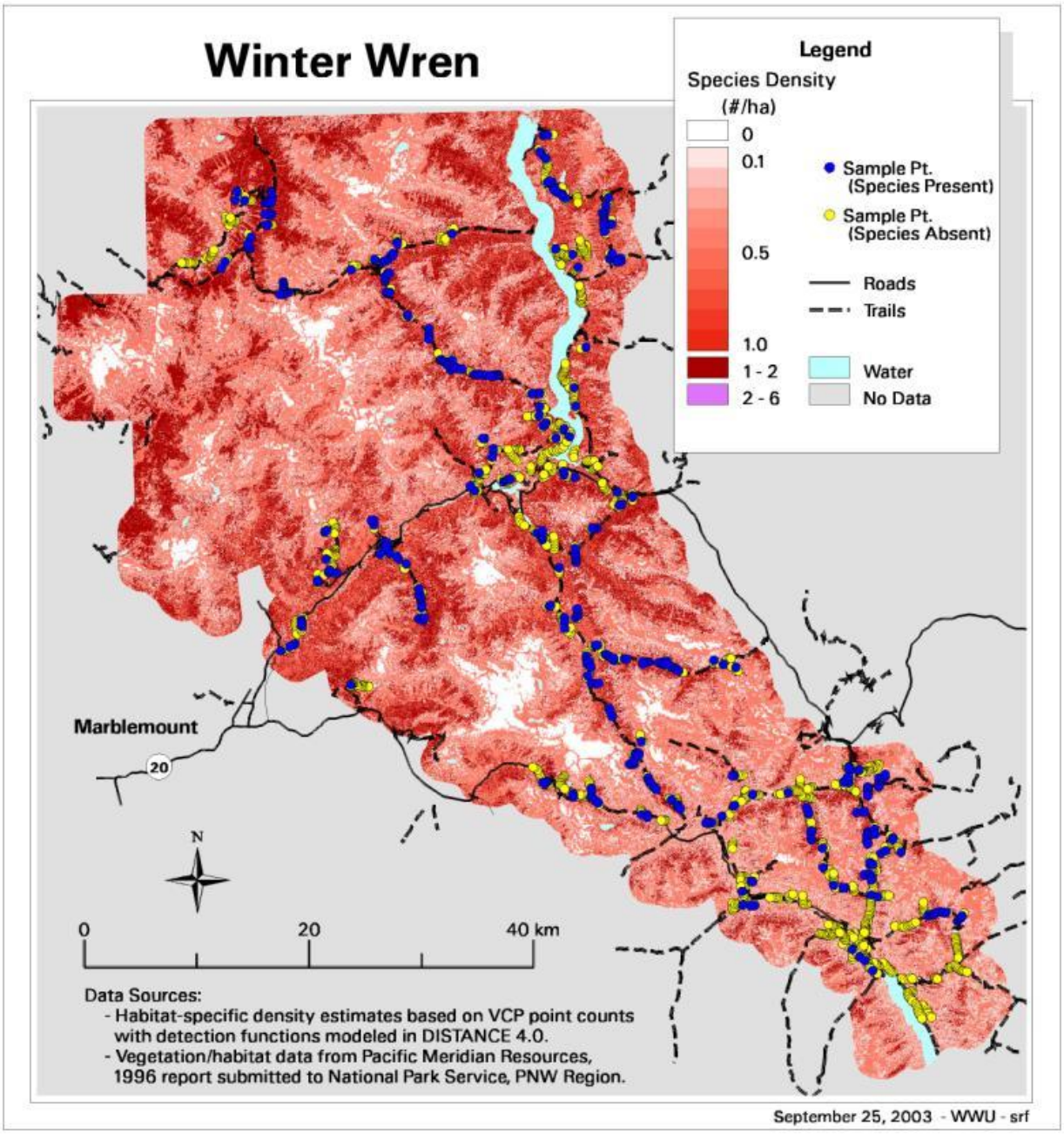
Winter Wren
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
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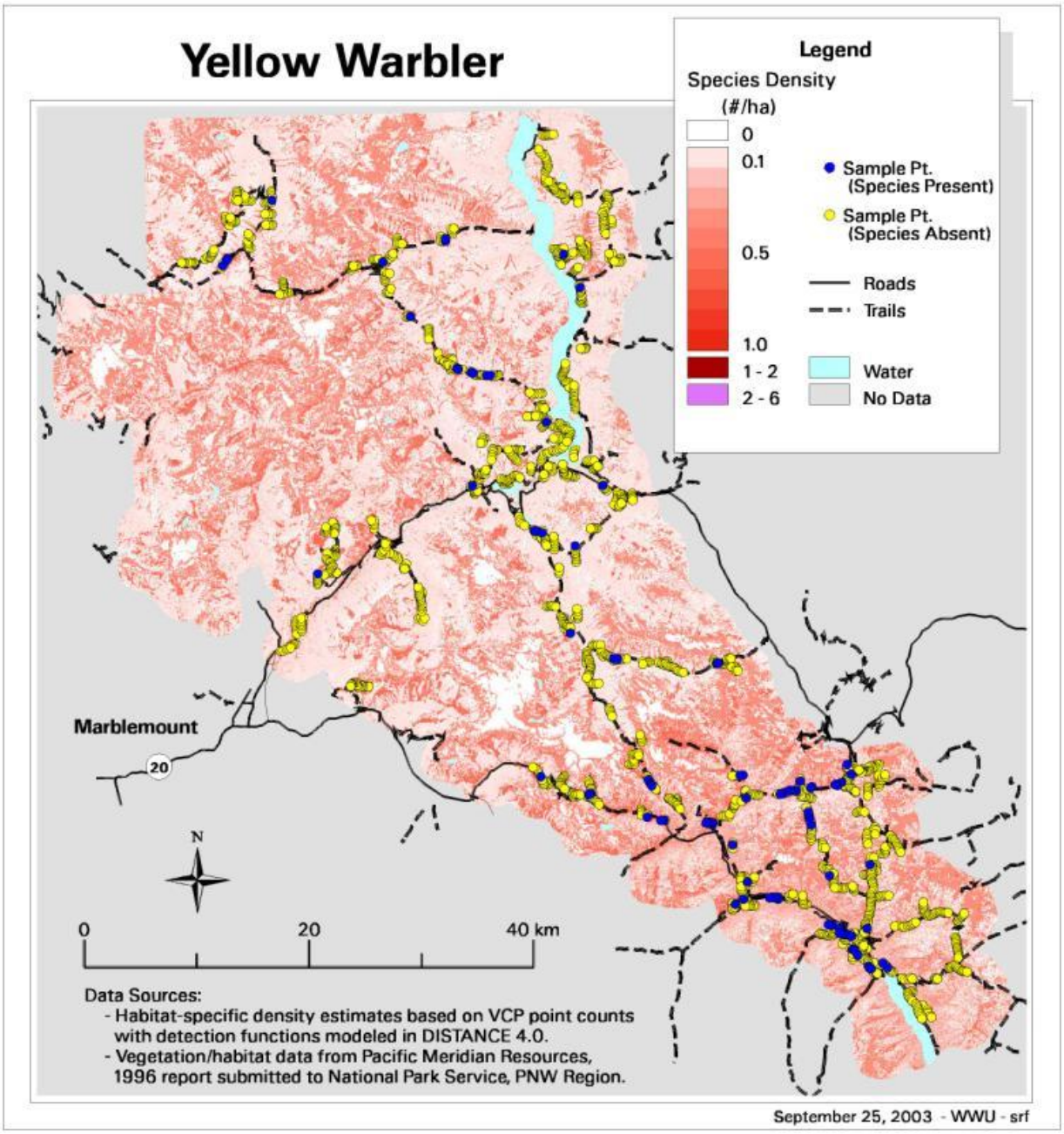
Yellow Warbler
Legend
Species Density
(#/ha)
0
0.1
0.5
1.0
1 - 2
2 - 6
Sample Pt.
(Species Present)
Sample Pt.
(Species Absent)
Roads
Trails
Water
No Data
Marblemount
20
N
0
20
40 km
Data Sources:
- Habitat-specific density estimates based on VCP point counts with detection functions modeled in DISTANCE 4.0.
- Vegetation/habitat data from Pacific Meridian Resources, 1996 report submitted to National Park Service, PNW Region.
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The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior

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