Monitoring Songbird Populations at the Pioneer Butte Meadow Restoration Project, Siuslaw National Forest

Survey Methods & 2011-2012 Pre-Treatment Results

Prepared by David Vesely,
Oregon Wildlife Institute
August 2012

Contents

Introduction

The Siuslaw National Forest (SNF) is planning to conduct habitat restoration activities at a site known as Pioneer Butte on Mary's Peak, Benton County, Oregon (Fig. 1). The site includes an abandoned homestead with small scattered openings that probably are remnants of what were once more extensive livestock pastures. However the site has largely become reforested because of the encroachment of surrounding Douglas-fir forests under SNF management. The SNF is planning to remove most conifers on the old homestead site and enlarge the existing openings to benefit wildlife that use early successional habitat. Such habitat has become rare on the SNF since the adoption of the Northwest Forest Plan. Conifer removal will result in an expanded opening of approximately 9 ac (3.6 ha) on the site (Cindy McCain, pers. comm).

The City of Corvallis conducted a overstory thinning and meadow restoration on City-owned forestlands near Pioneer Butte, enlarging an existing opening to 1.2 ha. This presented an opportunity to collect and examine short-term post-treatment avian population and community data on a meadow site similar to the intended future habitat condition for Pioneer Butte.

At least 91 passerine and woodpecker species are known to inhabit Douglas-fir forests of the Oregon Coast range (Carey et al. 1991). The diversity of avian communities in the region, their well-studied species-habitat relationships, and the relatively low cost of breeding bird surveys (as compared to herpetofauna or mammal surveys), make songbirds excellent subjects of wildlife management monitoring studies.

Avian territory mapping (also called "spot mapping") is a survey technique that utilizes behavioral observations and recorded positions of birds collected over repeated visits to construct maps of habitats occupied and defended by breeding males. Territory mapping is generally regarded as one of the least biased methods for estimating population density of songbirds and is often the standard by which other density estimates are measured (Christman 1984, Verner and Ritter 1988, Toms et al. 2006). The method also permits greater specificity in habitat use analyses because data are recorded at the position of the subject rather than the position of the surveyor, who can be more than 100 m away from the bird.

I selected three indicator species for pre- and post-restoration treatment comparisons at the SNF site, and between the SNF and City of Corvallis sites to examine to response of songbirds to meadow restoration: Pacific wren, hermit warbler, and dark-eyed junco. All three species are widely distributed in the Oregon Coast Range; establish territories that are typically much smaller than the Pioneer Butte restoration area, and whose reported species-habitat relationships (Table 1) suggest that each would display different responses to restoration treatments. I hypothesized that dark-eyed junco populations could be expected to expand as the meadow area at Pioneer Butte increases, hermit warblers would be excluded as canopy cover decreases but may possibly respond to edge effects, and Pacific wrens are likely to be particularly sensitive to coarse woody debris retention and soil disturbance on the site.

Table 1. *Synopsis of habitat relationships for the Pacific wren, hermit warbler, and dark-eyed junco. Seral stand associations, edge response, and CWD response based on Bunnell, et al. 1997, Appendix II. Seasonal movements, forest strata used, and territory size are based on Weikel 2003 (Pacific wren), Janes 2003 (hermit warbler), Nehls 2003 and Brown 1985 (dark-eyed junco).*

	Pacific Wren	Hermit Warbler	Dark-eyed Junco
Seasonal movement	Winter resident	Neo-tropical migrant	Short-distance migrant
Seral stage associations	(+) association w/ advancing stages	Generally associated w/ stand age >40 years	(-) association w/ advancing stages
Forest strata used	Ground; grass/forb layer	Mid-canopy	Ground; grass/forb layer
Response to edges	(-)	?	(+)
Response to coarse woody debris	(+)	---	---
Territory size	range 0.37-2.38 ha	mean 0.65 ha	range 0.8-1.2 ha

Methods

Site Layout

I conducted bird surveys on the same 200 X 200 m sampling plots (total area = 4 ha) used during the 2011 breeding season. The plot at the SNF Pioneer Butte site ("SNF plot") was placed over the location of the future meadow restoration according to a map and guidance provided by Cindy McCain, SNF ecologist. The plot at the City of Corvallis site ("City plot") was positioned so that the meadow created in 2010 and edge of the adjacent forest were included. The stand lying along the E and S portions of the City plot were thinned during the same operation that expanded the meadow. Each plot was divided into sixteen 50 X 50 m subplots to aid in navigation during surveys and facilitate mapping.

I created maps of both plots in a geographic information system (GIS) using 2009 color imagery, Benton county tax lot boundaries, and a U. S. Forest Service roads layers. Using the GIS, I created a vector-format sampling grid for each plot and uploaded the UTM coordinates of the subplot corners into a geographic positioning system (GPS). The GPS was then used to locate subplot corners at each site. Where the forest canopy or topography prevented reception of the GPS signal, I used a compass and laser range finder to locate corners from measurements to known positions. All of the corners should be within a 4 m of their true UTM coordinates based on precision estimates recorded by the GPS. Each corner was marked with a wood stake and pink/black flagging ribbon.

Bird Surveys

I performed bird surveys during 8 visits to the SNF plot and 7 visits to the City plot between June 6 and July 5, 2012. Surveys were conducted on the same morning at both plots except on June 6. Surveys were conducted between dawn and 11:00 am. The survey effort this year represents an increase in sampling intensity from 2011. Last year the SNF plot was visited 6 times and the City plot 5 times between June 2 and June 23, 2011. The order of surveys on the SNF and City plots were alternated between visits and the pattern of surveyor movement across the plot was varied to minimize the effect of time of day on observations.

Bird observations were made as I walked through each of the subplots at a slow pace while listening for bird songs, calls, and drumming by woodpeckers. Visual observations were made with 8 X 30 binoculars. I remained in each of the subplots long enough to be reasonably certain that all of the birds that were detectable that morning had been observed. Subplots with dense vegetation and/or a relatively high number of birds could take as long as 15 minutes while subplots that were mostly open might only take 2 minutes.

I carried a paper map of the plot and marked positions (called "registrations"; Bibby et al. 1992) where the three indicator species were observed. Mapped registrations were focused on the types of detections that were most valuable for distinguishing between adjacent territories (e.g., counter singing) and confirming nesting or rearing (e.g. adults carrying food). I recorded only one registration per potential territory each day to avoid mapping extra-territory movements, which can lead to over-estimates of territory size (Bibby et al. 1992). I sighted subplot corner markers to estimate my position (and those of birds) within the whole plot. Behavioral observations and position changes were recorded according to methods described by Bibby et al. (1992). I mapped bird positions as far as 100 m beyond the edge of the plot so as delineate clusters of registrations as fully as practical.

During the 2011 survey, the UTM coordinates were recorded for each registration of an indicator species. However, the dense canopy cover and terrain often prevented reception of the GPS satellite signal across much of both plots. Therefore, the coordinates had to be derived by measuring the distance and azimuth to the bird location from a control point on the plot and using trigonometry to calculate the coordinate. The method entailed intensive fieldwork, causing me to revise the protocol in 2012.

Territory Mapping

The 2012 locations of indicator species mapped in the field were transferred to ESRI shapefiles by the following procedure. Using a GIS, I displayed recent satellite imagery and subplot corners could while creating a point representing each bird location in the shapefile. These location points were spatially referenced to the survey plot by manually editing their positions relative to the subplot corners represented in the GIS. Since I conducted both the bird survey and cartography, I could use my knowledge of natural landmarks (e.g., canopy gaps, dominant trees) on each plot to further refine bird positions by referring to the satellite imagery viewed in the GIS. The shapefile also has an attribute table containing the date, species, sex (if known) and a behavior code for each record.

Delineating territory boundaries was performed by methods described in Bibby et al. (1992). Several of the most important assumptions and rules are as follows:

- The territory mapping method assumes that the species under investigation lives during the breeding season in discrete, non-overlapping ranges and territory boundaries fall between clusters of registrations.
- Territories must include at least two registrations at least 10-days apart to avoid classifying stop-over migrants as individuals breeding on the plot.
- Carefully mapped positions of counter-singing males are crucial to separate clusters of registrations into territories held by different birds.
- Territories were counted as in the plot if at least half the registrations fell inside the plot boundary.

A territory map for each of the three indicator species was created in the GIS by manually drawing boundaries using the mapping rules described above and further guidance by Bibby et al. (1992). In cases where field observations suggested that territory boundaries extended further than 100 m beyond the plot, I truncated the territory boundary with a straight line.

Species Inventory and Species Accumulation Curves

I recorded a list of all avian species detected on each plot during each visit. From these lists, an avian species inventory was compiled and detection frequencies (i.e., total number of visits to plot/number of visits species was observed) were calculated for each plot. Other avian species detected outside the plot boundaries were recorded separately.

Using raw, tabulated counts of species detected per visit is invariably a biased, underestimate of total species richness because not all species are detected. Using simple ratios of species per unit of sampling effort does not address the underlying problem and should be avoided (Chazdon et al. 1999). Instead, estimates of species richness should be based on an explicit statistical sampling model (Colwell et al 2012).

I used the program *EstimateS* (Colwell 2009) to compute expected species accumulation curves (ACs) for the SNF and City plots. The ACs represent the predicted numbers of species present on the plot by number of survey visits. Program *EstimateS* uses a sample-based rarefaction function, called *Mao Tau* (Colwell 2009), to compute the ACs based on the frequencies of occurrence for each species among the pooled samples. *Mao Tau* predicts the number of species detected for a sub-sample of the pooled species actually discovered on the plot (without accounting for undetected species), therefore the ACs represent species density (i.e., number of species per unit of area) and are not strictly estimates of total species richness (Colwell 2009).

Results and Discussion

Territory Mapping

Results of territory mapping indicate that all three indicator species were breeding on the SNF and City plots in 2012. The convention is to report the results of territory mapping as population densities in terms of territorial males per 10 ha or km^2 (IBCC 1970). However the small size of the monitoring plots used in this study has resulted in a high proportion of territories overlapping plot boundaries. In such cases, population densities tend to be overestimated (Tomiakojc and Verner 1990). The spatial extent of the survey also prevented replication or randomization of sampling units. Therefore the design of this study cannot support formal hypothesis testing or inferences beyond the SNF and City plots.

Pacific Wren

SNF Plot--There were nine registrations of Pacific wrens on or near the SNF plot in 2012, compared to only two registrations during the previous breeding season (Fig. 2). The 2012 registrations were clustered into two territories. A territory near the SE corner of the plot was partially delineated based on a cluster of three registrations along a seasonal stream. The forest canopy above the cluster is dominated by Douglas-fir with hardwoods present in the lower canopy. Immediately E of the cluster is a much younger stand, but it is not known how far this territory extended beyond the plot boundary. Two 2011 registrations were in close proximity to the 2012 cluster which suggests the area has been occupied by a territorial male for at least a year. Observations did not reveal if there was a female present in the territory.

The second 2012 territory lies on the W side of the SNF plot under some of the largest trees on the plot. There are many large diameter branches on the ground, evidently fallen from the old Douglas-firs above. There were no Pacific wrens detected in these subplots last year, indicating that territory was established after the last breeding season.

City Plot--There were four Pacific wren territories in or overlapping the boundary of the City plot in 2012 (Fig. 3). A territory south of the meadow was associated with a shrubby riparian area. This territory included multiple sightings of mated pair.

A territory in the SW corner of the plot was delineated from three registrations; two of them were observations of a male counter-singing with the male in the territory to the immediate N. The understory was dominated by sword fern with scattered, small logs.

There were ten 2011 registrations in the vicinity of the 2012 territories described above, including an observation of two males counter-singing at the stream. The pattern of 2011 and 2012 registrations suggest that territorial boundaries have shifted during the last year.

Two 2012 territories overlap the E boundary of the plot. This portion of the stand had been thinned during the same year that the meadow was expanded on the City plot. This area of the plot contains abundant, scattered slash and small logs on the ground. All of the 2012 registrations were of birds displaying from or moving among slash piles. There was considerable Pacific wren activity in this area during 2011.

Hermit Warbler

***SNF Plot*—**There were three hermit warbler territories within or overlapping the plot boundaries in 2012 (Fig. 4). Most detections were of singing males among the tallest conifers on the plot. A mated pair was observed on one visit. Two territories that were mapped in the NE corner of the plot this year correspond closely to clusters of hermit warbler registrations in 2011.

The third territory was in the SE corner of the plot and also overlapped four registrations mapped in 2011.

City Plot—Three territories were mapped on the City plot in 2012. The clusters of registrations near the N boundary indicate that these individuals were using the dominant Douglas-firs near the meadow, as well as the younger and denser stand to the N (Fig. 5). There were 11 hermit warbler registrations in 2011 from this same area of the plot.

A third territory was mapped near the SE corner of the plot from 6 registrations. This territory was located on the slope immediately beyond the south plot boundary. All detections were within the canopy of the large Douglas-firs retained after the recent thinning. There were no hermit warbler detections from this area in 2011.

Dark-eyed Junco

SNF Plot—There were 25 registrations in 2012 compared to 13 in 2011. The distribution of registrations indicates that most of the plot was used by at least three breeding pairs of juncos (Fig. 6). Two territories incorporated a high proportion of forest edge, although there were only two detections of juncos in forest openings. There were five registrations from this area in 2011. There was also a tight cluster of registrations near the edge of meadow in the SE corner. A mated pair used the SW corner of the plot in 2012 where tall shrubs were so dense that walking was challenging. The pattern of 2011 and 2012 registrations suggest that there were probably the same number of breeding pairs on or near the plot during both seasons, but territory boundaries have shifted.

City Plot— There were 27 registrations in 2012, resulting in five mapped territories (Fig. 7). There were 16 registrations during the 2011 season. Vegetation structure varied widely within the five dark-eyed junco territories—from open forest understories in the S and central portions of the plot, to the dense, young stand in the N, and patches of tall shrubs on the W side of the plot. All of the territories had an abundance of ground-level hiding cover (e.g., low shrubs, sword fern, woody debris) that juncos prefer for nesting. Even though juncos are usually considered an early-seral associate, they have avoided the meadow in the City plot in 2011 and 2012.

Species Accumulation Curves and Species Inventory

The ACs serve two purposes in this study. The first is to determine whether there were a sufficient number of survey visits to detect all species using the plot. A visual examination of ACs should demonstrate a clear asymptotic curve when an increasing number of visits no longer result in additional species detected (Colwell et al. 2012). The ACs for the 2011 and 2012 surveys indicate that new species still continued to accumulate during the last visits to both plots (Fig. 8). These results suggest that increasing the survey effort is likely to lead to higher estimates of species density. However, ACs are sensitive to single occurrences of a species, including migrants briefly stopping over and dispersing juveniles. Avian surveys generally are designed to exclude non-territorial birds from analysis because their inclusion is likely to lead to spurious species-habitat associations (Bibby et al. 1992). Passerine and woodpecker species that are stable members of a particular avian community are likely to be encountered early and frequently during a survey, at least during the breeding season when males are displaying and defending territories.

The second purpose of the ACs is to permit comparisons of species density between plots and time periods. A cursory examination of the 2012 ACs shows a greater species density at the SNF plot than the City plot across all levels of survey effort (Fig. 8). However, the overlapping confidence intervals indicate the difference is not statistically significant. There was markedly stronger contrast between the two plots during the 2011 breeding season. Explaining the difference in 2011 species density between plots is challenging. The most obvious factor is that the 1.2 ha meadow in the City plot seems to be avoided by the entire avian community during the breeding season. Given the reduced habitat area for forest birds on the City plot, it would not be surprising to find less species density. However, the meadow remained relatively unchanged in structure or size during the 2011-2012 survey period. The difference should have also been more apparent during this year's survey if the meadow was causing the effect. It seems more probable that the difference observed one year and not the next is due to the natural, annual variation within the bird community.

The six most frequently detected species on the SNF plot during the 2011-2012 pre-treatment period were the golden-crowned kinglet, chestnut-backed chickadee, dark-eyed junco, Pacific-slope flycatcher, hermit warbler, and Wilson's warbler (Table 2). Of the 13 species detected during at least 50% of the visits to the SNF plot in 2011, 10 of those species were detected at least as frequently in 2012 (Table 2). This suggests the avian community on the SNF plot was mostly stable during the 2011-2012 pre-restoration period. The variation in species density between years is largely a result of those species that appeared only once or twice during the survey and were less likely to be breeding on the plot.

Conclusions and Recommendations

The avian community on the SNF plot at Pioneer Butte is presently dominated by species typically associated with mid- to late-seral Douglas-fir forests. Examples include the golden-crowned kinglet, Pacific-slope flycatcher, and black-throated gray warbler. However, the occurrence of other species (e.g., Hutton's vireo, cedar waxwing) is certainly linked with big-leaf maples (*Acer macrophylum*), chinquapin (*Castanopsis chrysophylla*), and other hardwoods on the plot (Bunnell et al. 1997). It is unlikely that the Wilson's warbler or Swainson's thrush would be so common without widespread patches of tall shrubs on the plot (Hagar 2003). The incidence and abundance of all these species is likely to shift in the future, depending upon the response of each species to restoration treatments and stand maintenance.

One of the primary purposes of the Pioneer Butte restoration project is to expand the small, existing meadows and early seral plant community, habitat types that are increasingly uncommon on the SNF (Cindy McCain, pers comm.). The City plot was included in this study to provide an opportunity to collect avian data at a site similar to the meadow being planned on the nearby SNF lands. Territory mapping clearly demonstrated that dark-eyed juncos avoided the meadow, which is unexpected based on its reported habitat relationships and my professional survey experience. Furthermore, none of the other species present on the plot used the meadow, even species that were present are typically associated with this habitat type (i.e., American robin and rufous hummingbird). The City meadow has a very simple plant species composition, is homogenous in vegetation structure, and is dominated by relatively tall grasses (stand height >1 m in early summer). The City meadow doesn't possess the habitat complexity of grass balds in the Oregon Coast Range (Franklin and Dryness 1988), nor does it have the diversity of forbs that characterize foothill prairies (USFWS 2010). Species that typically forage on the ground (e.g., dark-eyed juncos, American robins) are likely excluded by the density and height of the grass in the City meadow.

The forest opening created by the meadow has created a high-contrast edge and promoted a layer of tall shrubs in the forest understory. Territory mapping revealed that much of the forest/meadow edge on both the City and SNF plots were used during the breeding season by two of the indicator species, hermit warblers and dark-eyed junco. I also observed evidence of black-tailed deer regularly bedding in the City meadow and the site likely provides benefits to wildlife that were not subjects of this study.

I did not detect any early-seral or meadow-associated species having special status that should clearly receive management priority during meadow restoration at Pioneer Butte. However, I did detect three species associated with closed-canopy forests that are Oregon strategy species (pp. 324-335, ODFW 2006). Band-tailed pigeons were regularly observed during 2011-2012. The species feeds on large fruits such as those produced by cascara (*Rhamnus purshiana*) and elderberry (*Sambucus* spp.) and therefore the creation of forest openings that foster the development of understory shrubs may improve its foraging habitat. Purple martins were detected during one visit in 2012 and pileated woodpeckers were sporadically observed near the plot during 2011-2012. State populations of both species are reported to be limited by the availability of large snags (ODFW 2006). Neither species is likely to benefit from meadow restoration, unless snags are retained or created during the project.

Two other Oregon strategy species, the little willow flycatcher (*Empidonax traillii brewsteri*) and olive-sided flycatcher (*Contopus cooperi*) were not detected at Pioneer Butte during pre-restoration surveys, but probably are the special status avian species most likely to discover and inhabit the site. In Benton County, the little willow flycatcher is common in dense patches of shrubs, in both riparian and upland settings (Altman 2003a). Using a hierarchical wildlife community classification by Bunnell et al. (Appendix II, 1997), the species already occurring at Pioneer Butte and with the most similar habitat associations to the little willow flycatcher are the MacGillivray's warbler and spotted towhee. Monitoring the response of these two species to the restoration treatments provides a strategy for assessing whether the little willow flycatcher is more or less likely to occur at Pioneer Butte in the future.

The olive-side flycatcher is widespread in Coast range forests, but typically occurs at low population densities (Altman 2003b). High-contrast edges, such as those between closed-canopy forest and meadows are among the species' preferred habitats (Altman 2003b). Using the same analysis by Bunnell et al. (Appendix II, 2003), the common raven, Pacific-slope flycatcher, and golden-crowned kinglet, are the closest community associates to the olive-side flycatcher and are probably the best indicators to forecast its future occurrence on the site.

Based on the results of the pre-restoration surveys, I offer the following recommendations to the SNF managers planning the Pioneer Butte restoration:

- Maintain a range of native forbs in the meadow community to ensure a diversity invertebrate community, and consequently, abundant prey for insectivorous birds.
- Create habitat complexity within the meadow by maintaining patches of various vegetation heights, space between plants for ground-foraging birds, and singing perches (e.g. tall shrubs, snags).
- Create meadows with complex edges and having high ratios of edge-to-interior space. Increasing the amount of meadow/forest edge will maximize light penetration into the forest understory and promote the growth of shrubs, a habitat component that was greatly used by the avian community during pre-restoration surveys at Pioneer Butte. Furthermore, I posit that songbirds may have also avoided the interior of the meadow because of the almost certain (but admittedly unobserved) presence of forest hawks (*Accipiter* spp.) to which passerines would be vulnerable in openings.
- Maintain or create large-diameter snags during restoration treatments. Snags are common on meadows created by wildfire and are a crucial habitat element for woodpeckers and secondary cavity-nesters.

While the small size of monitoring plots on which bird territories were mapped precluded population density estimation, the territory maps did provide an excellent resource for a qualitative assessment of habitat use by Pacific wrens, hermit warblers, and dark-eyed juncos. The method also lends itself very well to statistical comparisons of used and unused habitats when model-based habitat sampling is conducted on the territory mapping plots. Hopefully this will be considered for post-restoration monitoring.

Table 2. *Avian species detection frequencies (total number visits/visits spp. detected) for the SNF and City plots. Data are sorted on the SNF MN_Freq. Indicator species indicated in **bold**. Pioneer Butte Meadow Restoration Project.*

		SNF			CITY		
Common Name	Scientific Name	2012	2011	MN_Freq [1]	2012	2011	MN_Freq [2]
Golden-crowned kinglet	*Regulus satrapa*	1.00	1.00	1.00	1.00	0.60	0.92
Chestnut-backed chickadee	*Poecile rufescens*	0.88	1.00	0.94	0.71	0.20	0.75
Dark-eyed junco	***Junco hyemalis***	**0.88**	**1.00**	**0.94**	**0.86**	**0.80**	**0.89**
Pacific-slope flycatcher	*Empidonax difficilis*	0.75	1.00	0.88	1.00	1.00	0.93
Hermit warbler	***Dendroica occidentalis***	**0.88**	**0.83**	**0.85**	**0.43**	**0.80**	**0.76**
Wilson's warbler	*Wilsonia pusilla*	0.88	0.67	0.77	0.29	1.00	0.72
Swainson's thrush	*Catharus ustulatus*	1.00	0.50	0.75	0.86	0.40	0.70
Western wood-pewee	*Contopus sordidulus*	0.50	1.00	0.75	0.57	0.20	0.60
Hermit thrush	*Catharus guttatus*	0.63	0.83	0.73	0.29	0.20	0.53
Black-throated gray warbler	*Dendroica nigrescens*	0.88	0.50	0.69	0.86	0.20	0.62
Black-headed grosbeak	*Pheucticus melanocephalus*	0.88	0.33	0.60	1.00	0.20	0.60
Gray jay	*Perisoreus canadensis*	0.75	0.33	0.54	0.29	0.20	0.42
Western tanager	*Piranga ludoviciana*	0.75	0.33	0.54	0.29	0.60	0.50
Red-breasted nuthatch	*Sitta canadensis*	1.00	0.00	0.50	0.29	0.40	0.44
Pacific wren	***Troglodytes pacificus***	**0.63**	**0.33**	**0.48**	**1.00**	**0.60**	**0.61**
Brown creeper	*Certhia americana*	0.50	0.33	0.42	0.14	0.40	0.36
Band-tailed pigeon	*Columba fasciata*	0.63	0.17	0.40	0.43	0.20	0.36
Hutton's vireo	*Vireo huttoni*	0.25	0.50	0.38	0.43	0.00	0.31
Steller's jay	*Cyanocitta stelleri*	0.25	0.50	0.38	0.14	0.20	0.29
Orange-crowned warbler	*Vermivora celata*	0.50	0.17	0.34	0.29	0.20	0.30
American robin	*Turdus migratorius*	0.13	0.50	0.31	0.43	0.40	0.35
Rufous hummingbird	*Selasphorus rufus*	0.38	0.17	0.27	0.14	0.00	0.19
Cedar waxwing	*Bombycilla cedrorum*	0.00	0.33	0.17	0.14	0.00	0.13
Common raven	*Corvus corax*	0.13	0.17	0.15	0.00	0.00	0.09
Red-breasted sapsucker	*Sphyrapicus ruber*	0.25	0.00	0.13	0.43	0.00	0.16
Ruby-crowned kinglet	*Regulus calendula*	0.25	0.00	0.13	0.14	0.00	0.10
Barred owl	*Strix varia*	0.13	0.00	0.06	0.00	0.00	0.04
Hairy woodpecker	*Picoides villosus*	0.13	0.00	0.06	0.14	0.40	0.15
MacGillivray's warbler	*Oporornis tolmiei*	0.13	0.00	0.06	0.00	0.00	0.04
Northern pygmy-owl	*Glaucidium gnoma*	0.13	0.00	0.06	0.00	0.00	0.04
Spotted towhee	*Pipilo maculatus*	0.13	0.00	0.06	0.00	0.00	0.04
Purple finch	*Carpodacus purpureus*	0.00	0.00	0.00	0.14	0.00	0.03
Red-tailed hawk	*Buteo jamaicensis*	0.00	0.00	0.00	0.14	0.00	0.03

[1] Mean detection frequency for 2011 and 2012.

Literature Cited

Altman, B. 2003a. Willow flycatcher (*Empidonax traillii*). Pp 378-381, *In*, Marshall, D. B., M. G. Hunter, and A. L. Contreras. 2003. Birds of Oregon: a general reference. Oregon State University Press, Corvallis, OR.

Altman, B. 2003b. Olive-sided flycatcher (*Contopus cooperi*). Pp. 374-376, *In*, Marshall, D. B., M. G. Hunter, and A. L. Contreras. 2003. Birds of Oregon: a general reference. Oregon State University Press, Corvallis, OR.

Brown, E.R. [tech ed.]. 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Part 2-Appendices. Publication no. R6-F&WL-192-1985. USDA Forest Service, Portland, OR.

Bunnell, F. L., L. L. Kremsater, and R. W. Wells. 1997. Likely consequences of forest management on terrestrial, forest-dwelling vertebrates in Oregon. Report M-7. Centre for Applied Conservation Biology, University of British Columbia, Vancouver, BC.

Carey, A.B., M.M. Hardt, S.P. Horton, and B.L. Biswell. 1991. Spring bird communities in the Oregon Coast Range. Pp. 123-137, *In*, L.F. Ruggiero, K.B. Aubry, A.B. Carey, and M.H. Huff (tech. eds.), Wildlife and vegetation of unmanaged Douglas-fir forests. PNW-GTR-285. Pacific Northwest Research Station, USDA Forest Service, Portland, OR.

Chazdon, R. L., R. K. Colwell, J. S. Denslow, & M. R. Guariguata. 1998. Statistical methods for estimating species richness of woody regeneration in primary and secondary rain forests of NE Costa Rica. Pp. 285-309 in F. Dallmeier and J. A. Comiskey, eds. *Forest biodiversity research, monitoring and modeling: Conceptual background and Old World case studies.* Parthenon Publishing, Paris

Christman, S.P. 1984. Plot mapping: estimating densities of breeding bird territories by combining spot mapping and transect techniques. The Condor 86:237-241.

Colwell, R. K., A. Chao, N. J. Gotelli, S.-Y. Lin, C. X. Mao, R. L. Chazdon, and J. T. Longino. 2012. Models and estimators linking individual-based and sample-based rarefaction, extrapolation, and comparison of assemblages. Journal of Plant Ecology 5:3-21.

Colwell, R. K. 2009. EstimateS 8.2 user's guide. Available online at http://viceroy.eeb.uconn.edu/estimates

Hagar, J. 2003. Functional relationships among songbirds, arthopods, and understory vegetation in Douglas-fir forests, western Oregon. PhD Dissertation. Oregon State University, Corvallis, OR.

IBCC [International Bird Census Committee]. 1970. An international standard for mapping method in bird census work. Audubon Field Notes 24:722-726.

Janes, S.W. 2003. Hermit warbler (*Dendroica occidentalis*). Pp 515-517, *In*, , Marshall, D. B., M. G. Hunter, and A. L. Contreras [eds.]. 2003. Birds of Oregon: a general reference. Oregon State University Press, Corvallis, OR.

Johnson, D.H. and T.A O'Neil (eds.). 2001. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Kissling, M. L. and E. O. Garton. 2006. Estimating detection probablility and density from point-count surveys: a combination of distance and double-observer sampling. The Auk 123:735-752.

Nehls, B. 2003. Dark-eyed Junco (*Junco hyemalis*). Pp. 566-567, *In*, Marshall, D. B., M. G. Hunter, and A. L. Contreras [eds.]. 2003. Birds of Oregon: a general reference. Oregon State University Press, Corvallis, OR.

ODFW [Oregon Department of Fish and Wildlife]. 2006. The Oregon conservation strategy. February 2006. Oregon Department of Fish and Wildlife, Salem, OR.

Ralph, C.J., S. Droege, and J.R. Sauer. 1995. Managing and monitoring birds using point counts: standards and applications. PSW-GTR-149. USDA Forest Service, Pacific Southwest Research Station, Albany, CA.

Tomiakojc, L. and J. Verner. 1990. Do point counting and spot mapping produce equivalent estimates of bird densities? The Auk 107:447-450.

Toms, J. D., F. K. A. Schmiegelow, S. J. Hannon, and M. Villard. 2006. Are point-counts of boreal birds reliable proxies for more intensive abundance estimators? The Auk 123:438-454.

USFWS [U.S. Fish and Wildlife Service] 2010. Recovery plan for the prairie species of western Oregon and southwestern Washington. U.S. Fish and Wildlife Service, Portland, OR.

Verner, J. and L. V. Ritter. 1988. A comparison of transects and spot mapping in oak-pine woodlands of California. The Condor 90:401-419.

Weikel, J.M. 2003. Winter wren (*Troglodytes troglodytes*). Pp 462-464, *In*, Marshall, D. B., M. G. Hunter, and A. L. Contreras [eds.]. 2003. Birds of Oregon: a general reference. Oregon State University Press, Corvallis, OR.

Figures

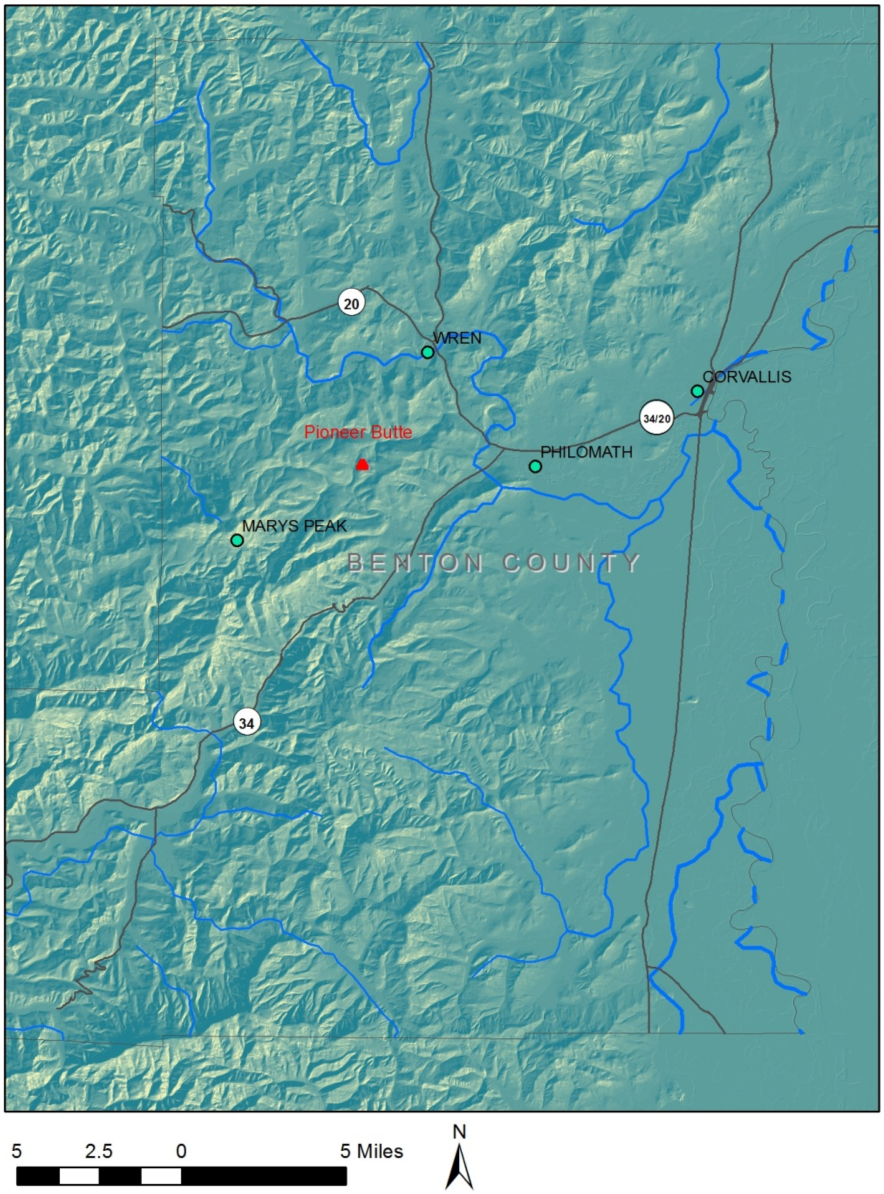


Figure 1. Location of the Siuslaw National Forest Pioneer Butte meadow restoration project, Benton County, OR.

.

Pacific Wren/SNF Plot

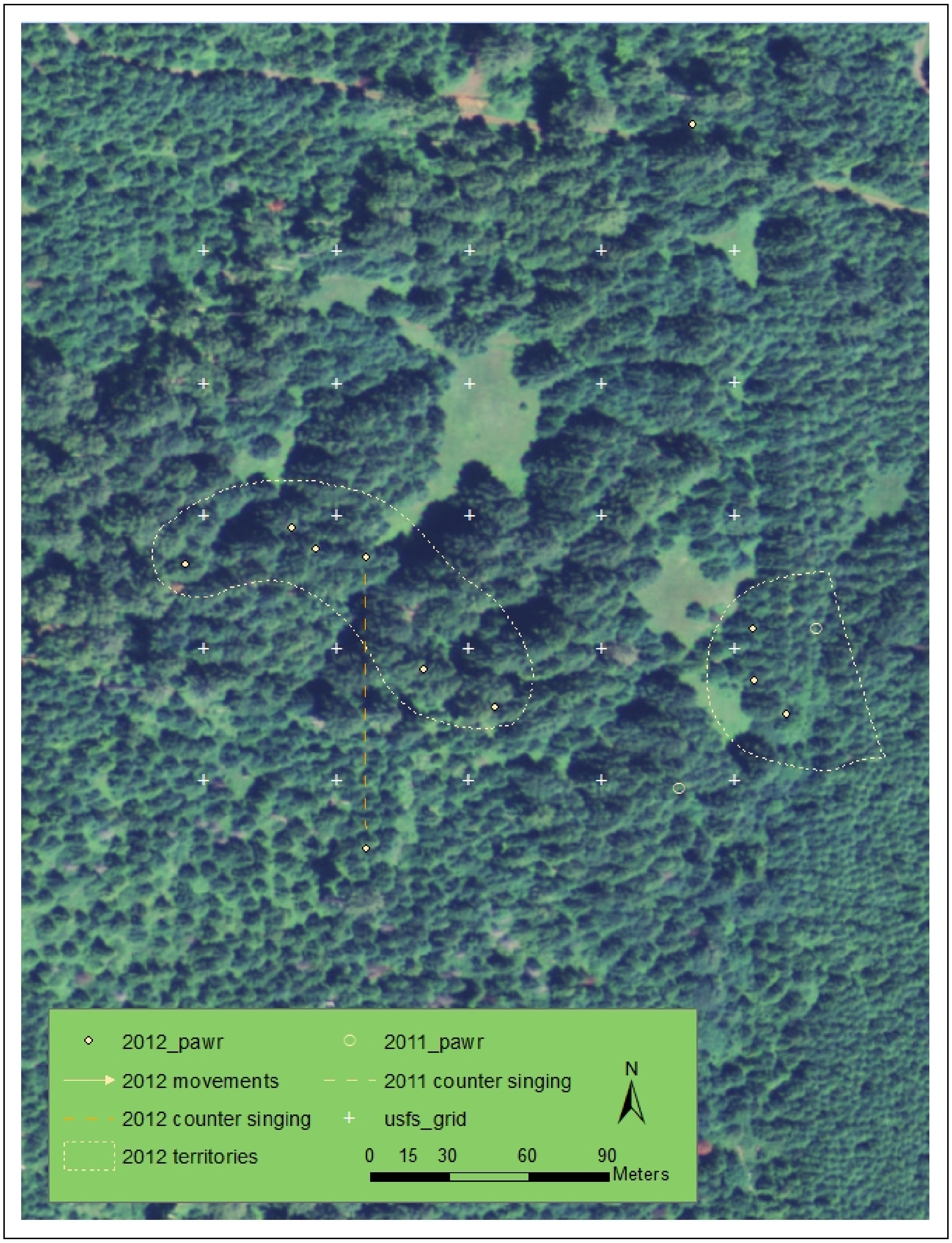


Figure 2. 2011-2012 Pacific wren registrations on SNF plot

Pacific Wren/City Plot

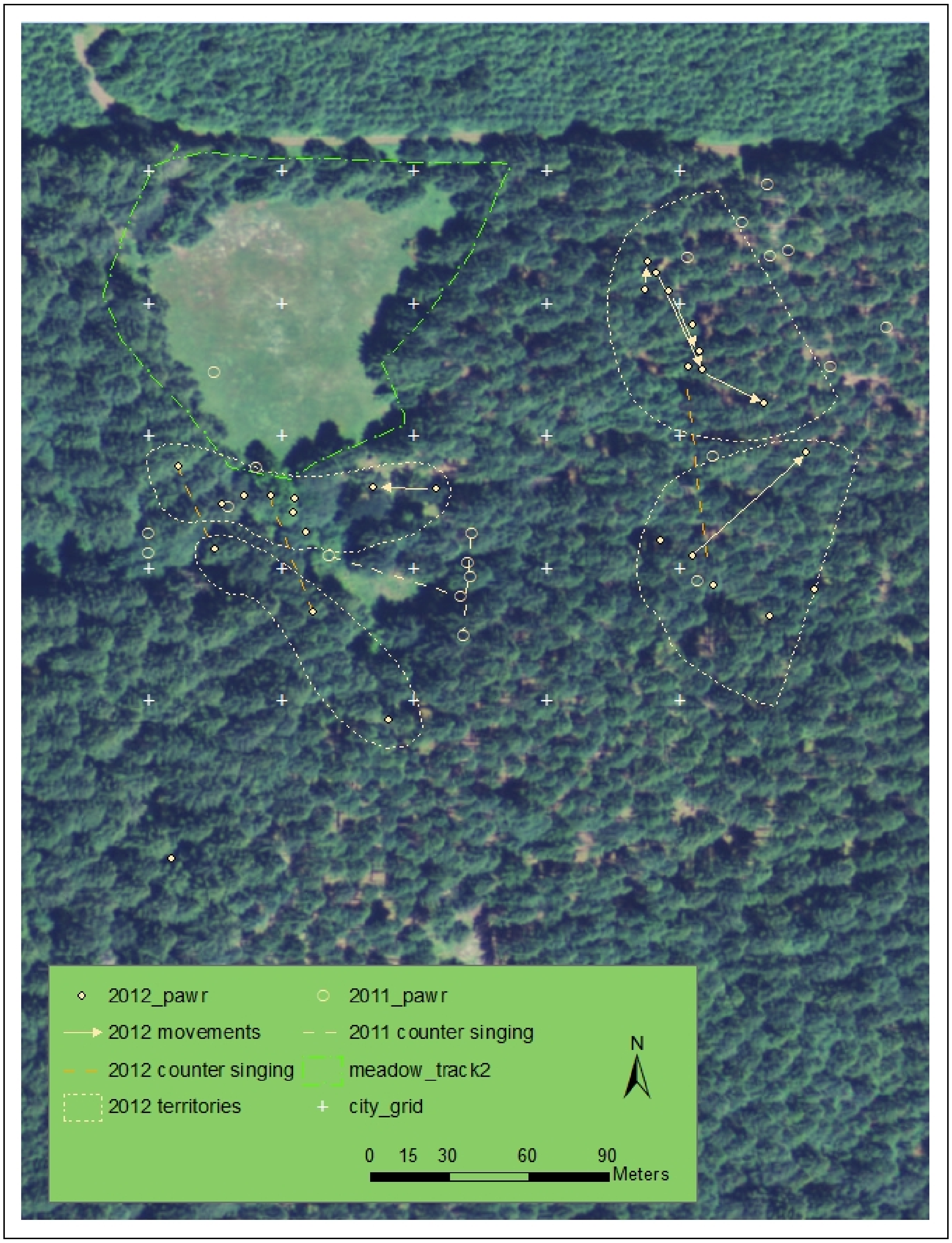


Figure 3. 2011-2012 Pacific wren registrations on the City plot.

Hermit Warbler/SNF Plot

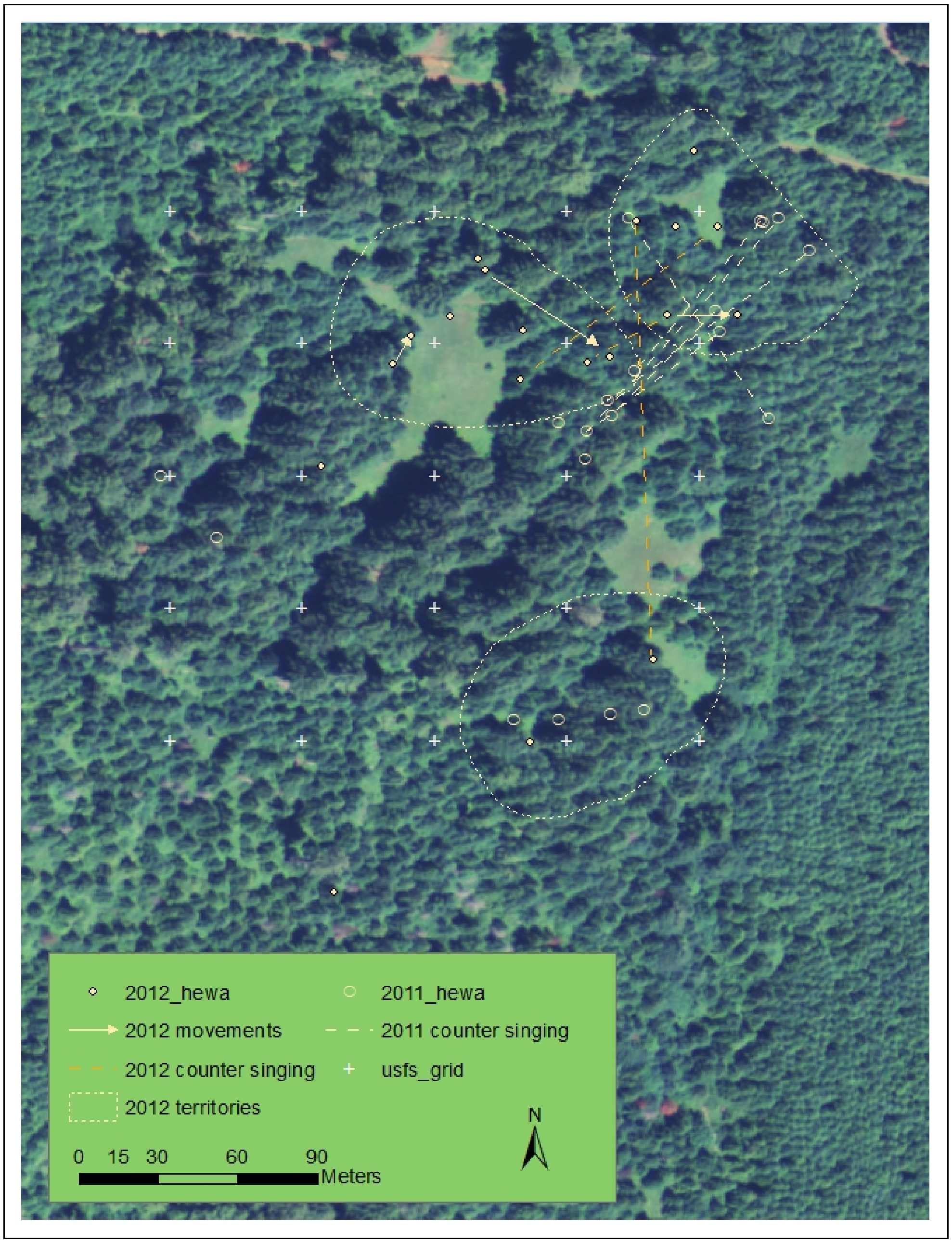


Figure 4. 2011-2012 hermit warbler registrations on SNF plot.

Hermit Warbler/City Plot

Figure 5. 2011-2012 hermit warbler registrations on the City plot.

Dark-eyed Junco/SNF Plot

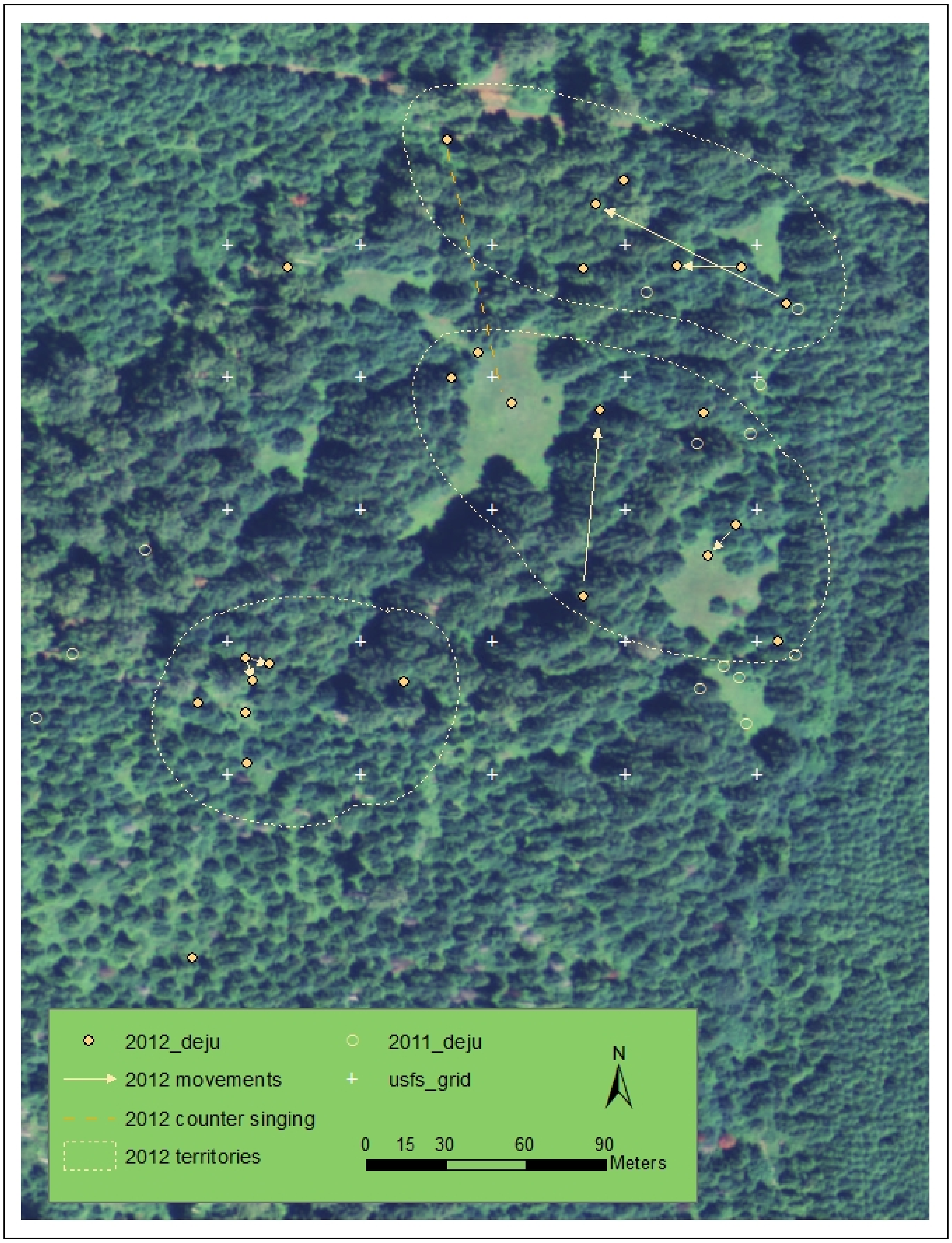


Figure 6. 2011-2012 dark-eyed junco registrations on the SNF plot.

Dark-eyed Junco/City Plot

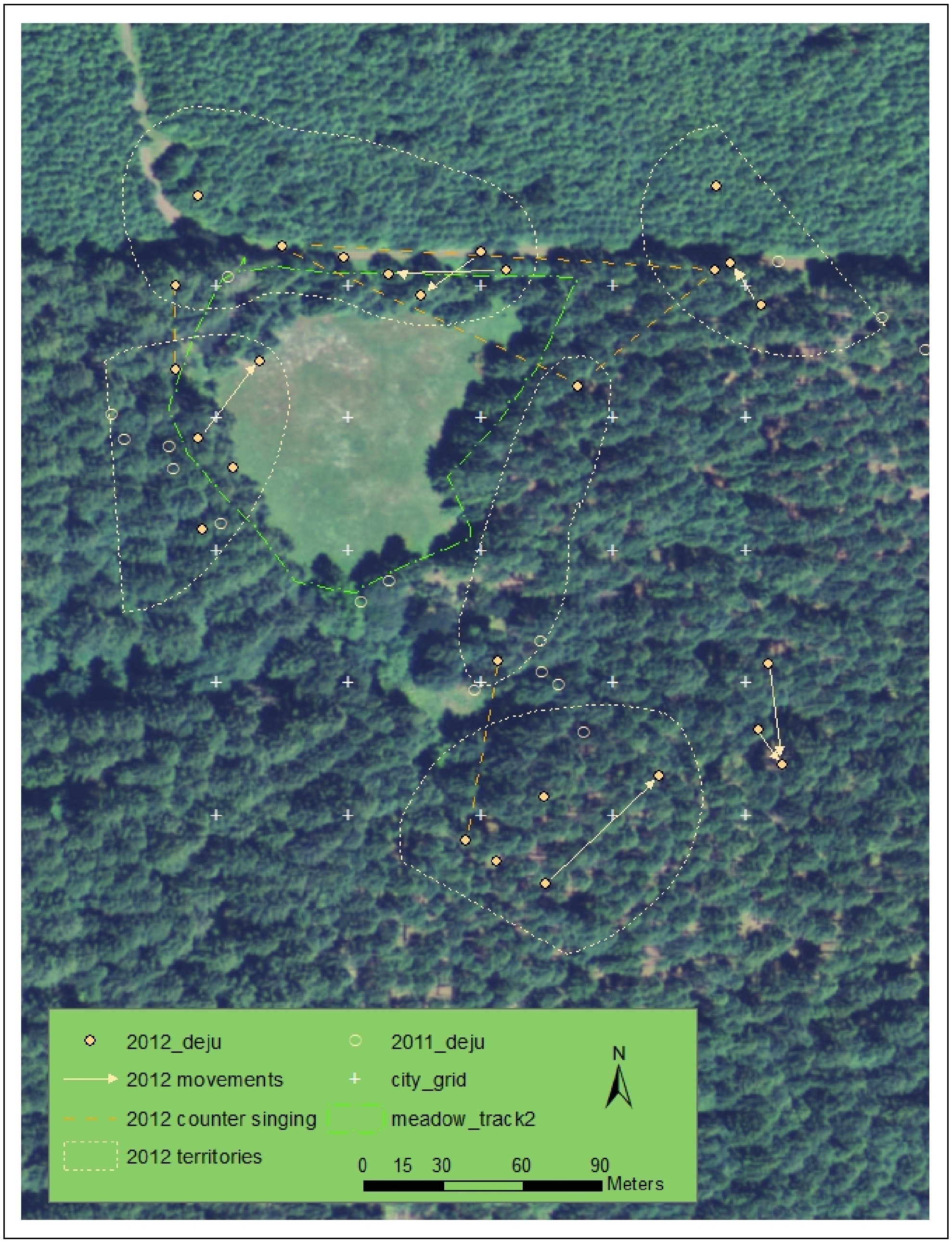
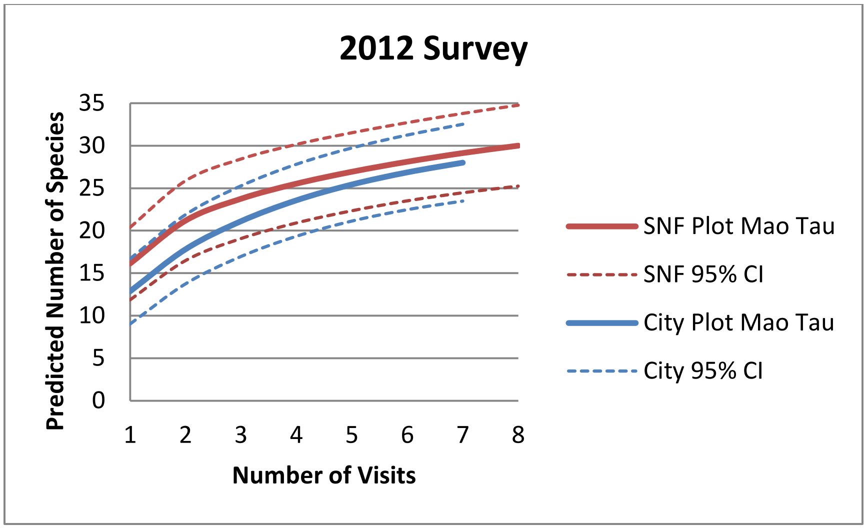


Figure 7. 2011-2012 dark-eyed junco registrations on City plot.



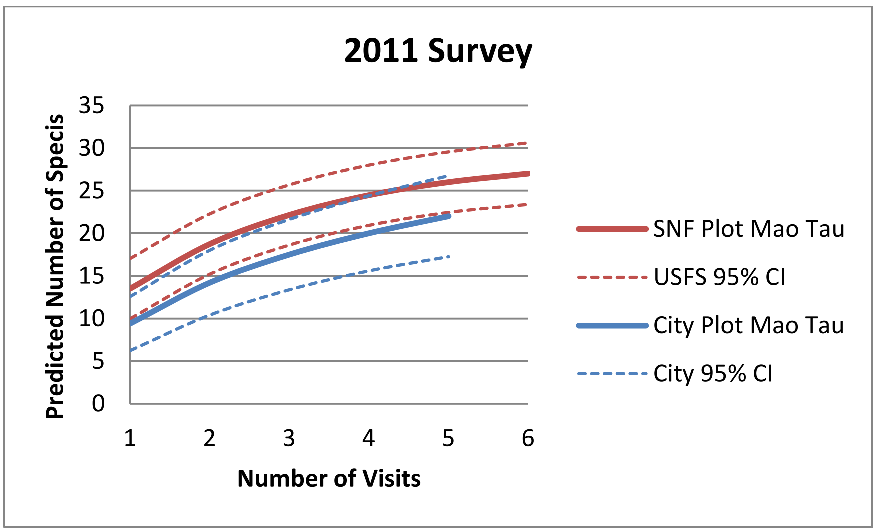


Figure 8. 2011 and 2012 species accumulation curves (ACs) and their 95% confidence intervals for the USFS and City avian monitoring plots based on sample-based rarefaction. *Mao Tau* is number of species predicted in the accumulated samples based on the empirical data. Pioneer Butte Meadow Restoration Project.