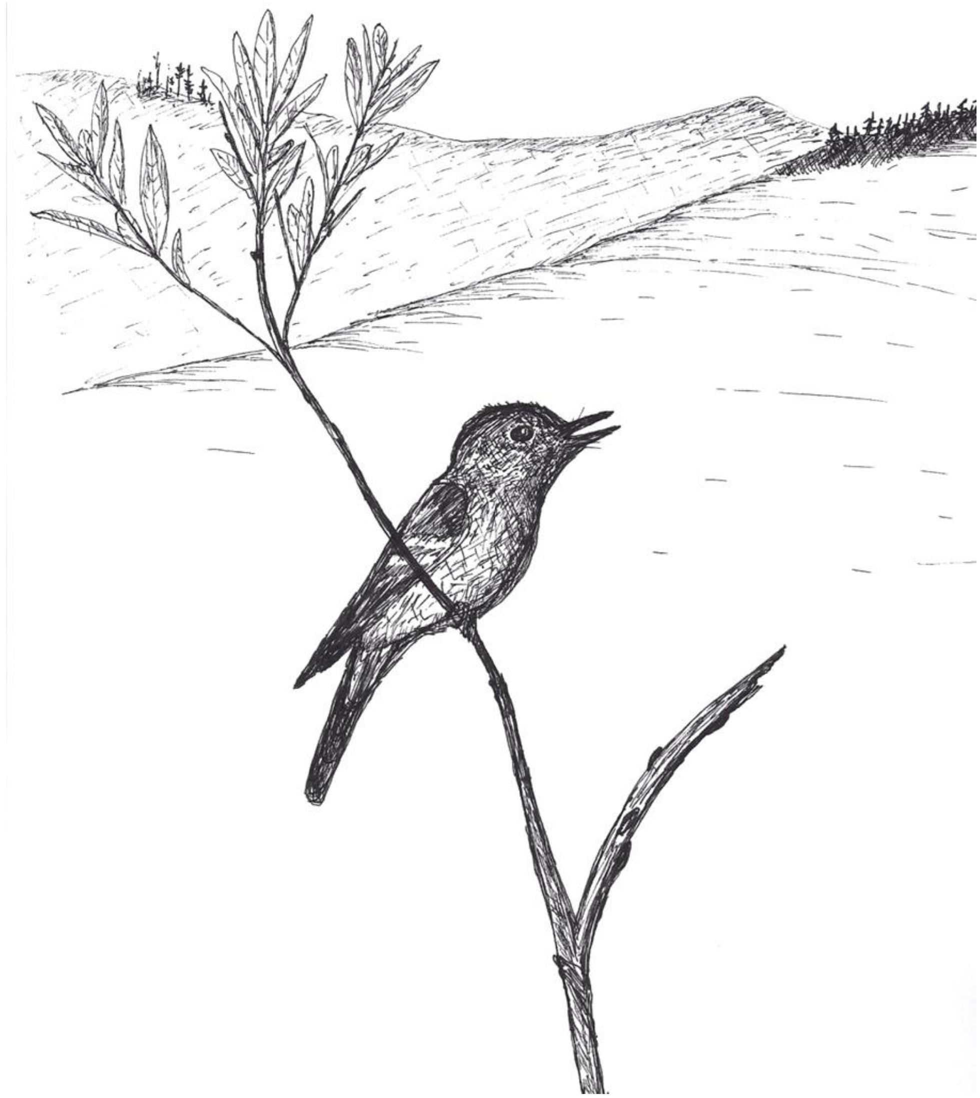
WILLOW FLYCATCHER MONITORING AT KILLIN WETLANDS



Final Report

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for the Oregon Watershed Enhancement Board
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A. PROJECT BACKGROUND

The acreage of emergent wetlands has declined during the last century in much of the United States, with most losses resulting from conversion to agriculture (Dahl 2006, Hansen 2006). These declines have reduced the amount of habitat available for sensitive wildlife species, including Neotropical migratory birds (Faaborg et al. 2010). To maintain wetland-breeding bird populations, managers must identify their habitat associations across a range of existing conditions. Restoration of wetland habitats, a high priority in the Portland Metropolitan region (Jenkins et al. 2008), has created natural areas in various stages of recovery. Studies of migratory birds in these wetland sites can provide opportunities to evaluate the effects of habitat restoration on their populations.

The quality of nesting habitat for migratory birds is generally measured by availability of food, nest sites, and other features offering protection from weather, predation, and parasitism (Sherry and Holmes 1995). Habitat selection patterns of territorial males can be used as an indirect measurement of the availability of these resources (Pulliam and Danielson 1991, Aherling et al. 2009). Territorial males likely respond to variation in habitat quality by selecting and defending locations that will result in higher rates of nesting success than others (Pulliam and Danielson 1991). Identification of areas selected by males for territories can therefore be used to determine the quality of habitat under restoration. If features in selected habitats can be propagated by restoration, managers can increase the population sizes of birds using the habitat.

Killin Wetlands, managed by Metro Regional Natural Areas, consists of emergent vegetation, shrub-swamps, and bottomland forest. At least 60% of these habitats have been lost in the Willamette Valley, concurrent with declines of Neotropical migratory birds (Titus et al. 1996). Annual surveys suggest that the number of Neotropical migrants using the Killin Wetlands has increased in recent years (D.M. Smith, unpublished data), but the proximate causes of these increase are unknown.

In 2009, I initiated a study of Willow Flycatcher (*Empidonax trailii*) habitat use at Killin Wetlands (Smith 2009). The objectives of this work were to identify areas of the wetland complex that were selected for territories, estimate number of flycatchers territories in survey plots, and identify habitat characteristics associated with territory selection. This work is funded by an Oregon Watershed Enhancement Board grant administered by the Metro Sustainability Center Natural Areas Program. I conducted field work during the nesting seasons of 2009 and 2010.

The Willow Flycatcher is an Oregon State Sensitive Species and a Neotropical migrant whose numbers have declined in the northwestern United States (Altman 2001). Western populations of this species nest in areas with high densities of woody vegetation, usually near streams or other bodies of water (Sedgwick 2000, Altman et al. 2003). Adults forage for a variety of insects, which are captured in flight or gleaned from vegetation (Sedgwick 2000). Open-cup nests of Willow Flycatchers are constructed in a variety of plant species across a range of heights (Altman et al. 2003, Stoleson and Finch 2003). Work in the southwestern United States has shown that Willow Flycatchers respond well to habitat restoration (Boucher et al. 2003), but such studies are lacking in the Northwest.

B. WORK CONDUCTED

Avian Point Counts

In 2009 and 2010, I counted birds at point count stations previously established by Metro biologists. These stations were located in two restoration units to the north and south of Cedar Canyon Road (Figure 1). These plots were approximately 11 ha in area and were in the active/annual floodplain of creeks in the Dairy Creek drainage. Restoration unites were partially or fully inundated during periods of high precipitation. Five stations were located in each plot (Figure 2). I visited each station on three occasions each year between May 21st and June 17th. I performed point counts in the morning between 06:30 and 10:00 and recorded all bird species detected by sight or sound within a five-minute period at each station (Huff et al. 2000). When I detected Willow Flycatchers during point counts, I used a gridded map of the study area to record their approximate location.

Area Searches

I supplemented point counts with area searches to expand the amount of area and time surveyed for Willow Flycatchers. In addition to the restoration units, I searched the forest plot, which is part of the active/annual floodplain, and the west swamp, which includes active/annual floodplain, valley wall, and toeslope surfaces. I conducted area searches with assistance from volunteers recruited through the Audubon Society of Portland Important Bird Area Citizen Science Program. In 2009 and 2010 we conducted area searches from June 5th to July 20th, accumulating a total of 166 volunteer hours. We searched plots by foot at least once per week. Following guidelines by Robbins (1970), we used gridded maps to record locations of singing Willow Flycatcher and other birds. When possible, we marked song perches of males with flagging tape and recorded the perch type. We observed adults each week to look for behaviors that would indicate nesting taking place in their territories. Such behaviors would include courtship displays, copulations, nest construction, and carrying food to young.

Figure 1. Killin Wetlands survey plots.

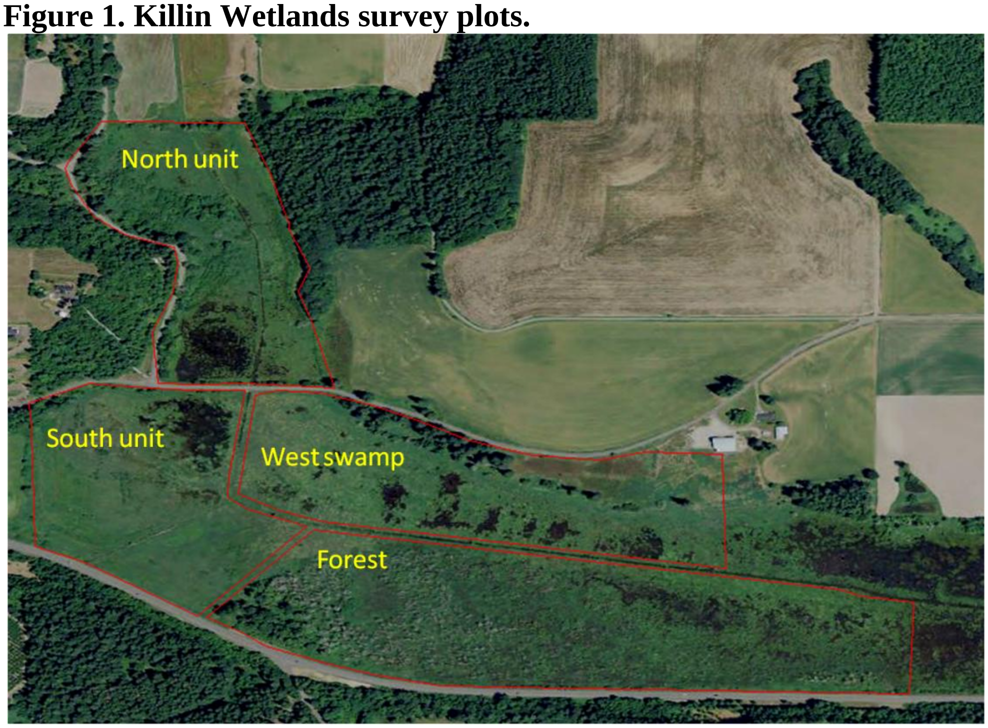
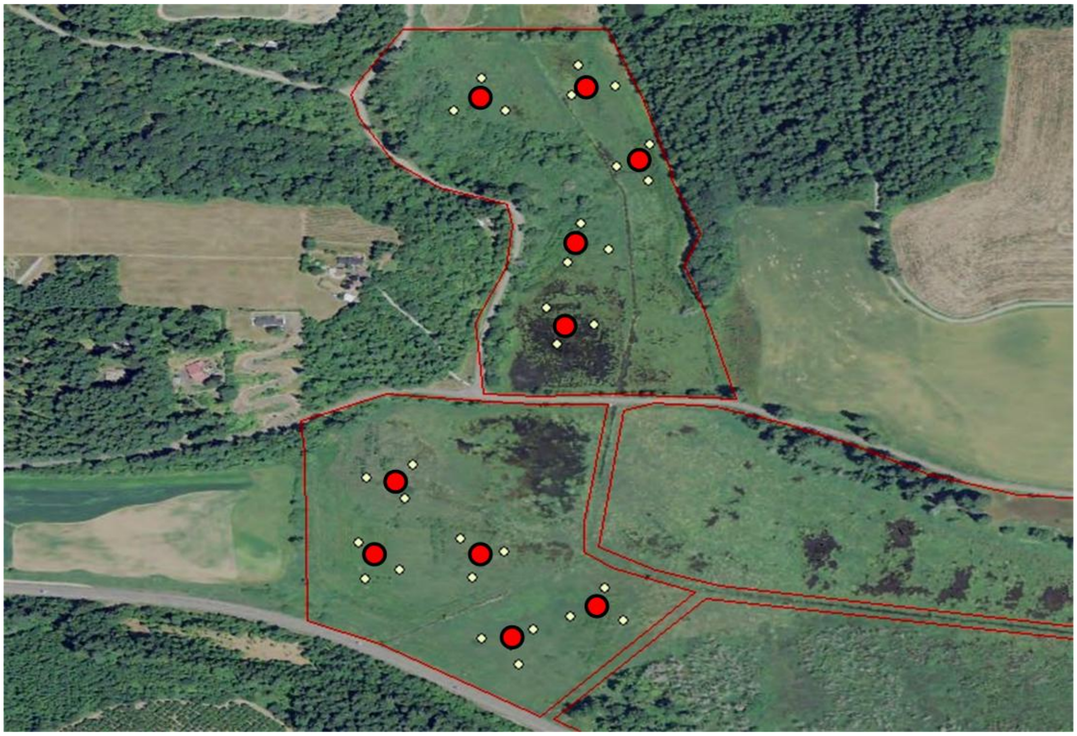


Figure 2. Point count stations (red circles) and vegetation measurement plots (yellow dots) at north and south restoration units.



Territory Mapping

Throughout each breeding season, I transferred detections from point counts and area searches onto territory maps of each plot. I considered areas where males were observed singing for at least three consecutive weeks to be territories (Kirsch et al. 2007). Each week, I counted the number of flycatcher territories on each plot to calculate territory density and timing of settlement in the restoration units. After territories were established, I used a handheld GPS receiver to record positions of song perches. I entered these locations into a data layer in Metro's ARC GIS database. I created polygons using song perches and projected them onto overhead photos of each plot.

Vegetation Measurement

In 2009, I established sampling plots in the restoration units to measure vegetation and hydrologic variables. I placed one sampling plot at the center of each point count station and three additional plots within 50 m of the center (Figure 2, Martin et al. 1997). In 2009, I compared variables between the north and south units by measuring vegetation and hydrology at all sampling plots in both areas.

I measured structure and composition of vegetation using BBIRD protocol recommendations for point count studies (Martin et al. 1997). Each sampling plot was 11.3 m in diameter and divided into four quadrants. I measured canopy height, canopy coverage, and water depth at the center of each sampling plot and at one location in each quadrant. In each of these locations, I used a 3 m pole marked in centimeters to record maximum vegetation height and water depth. I also used a vertical densiometer to determine whether canopy vegetation covered the area directly above each location. I then calculated the percent of locations covered as an index of canopy coverage. In each sampling plot quadrant, I identified and counted the number of shrub and tree stems greater than 50 cm tall that were within 5 m of the center of the sampling plot (Martin et al. 1997). Because Piper willow (*Salix piperi*) and Sitka willow (*Salix sitchensis*) were at times difficult to separate, I combined individuals into a single species, Piper/Sitka willow. In addition, I did not count the number of Douglas spirea (*Spirea douglasii*) stems due to their high density. Instead, I visually estimated percent of ground in each quadrant covered by this species. I also estimated percent of ground in each quadrant covered by water, reed canary grass (*Phalaris arundinacea*), and other shrubs.

C.CHANGES TO ORIGINAL PROPOSAL

I originally proposed to monitor nesting activity of Willow Flycatchers in response to restoration of Killin Wetlands and to estimate population size and determine location of nesting territories. I planned to measure composition and structure of native and exotic vegetation in nesting territories and non-use sites to determine habitat preferences. Surveys were to be conducted during the nesting seasons prior to and after removal of canary grass to determine effects of removal on population size and nest site selection of willow flycatchers.

Metro technicians mowed reed canary grass in a relatively small area (about one quarter of the area of South Array) prior to the start of the 2009 season, but they did not mow prior to the 2010 season due to high water levels that resulted from a wet spring. I was therefore unable to examine effects of reed canary grass removal on Willow Flycatchers. The canary grass mowing did, however, allow me to access areas of the south unit to measure woody plant composition in 2009.

I initially measured vegetation at one sampling point in the center of each territory. I later realized that this was not a complete representation of vegetative structure and composition within the entire territory. I corrected this oversight by revisiting territories to measure vegetation at song perches that were marked during the 2009 and 2010 nesting season.

In addition to flycatchers, I recorded detections of other bird species during both years of the study. I summarized this information to list the number of species detected in each survey plot. I also classified species by nesting habitat, migratory status, and conservation status. I will use this information to provide baseline data for future surveys and help Metro plan birding access at the wetlands.

E. PUBLIC AWARENESS AND EDUCATIONAL ACTIVITIES

Several members of the public gained education and research experience through this project. In conducting this research, I introduced monitoring volunteers to current avian survey methods and monitoring protocols. In addition, volunteers improved their wetland bird identification skills. On one occasion, I received assistance in vegetation measurement from high school volunteers provided by the Oregon Zoo. During this time, they learned principles of vegetation measurement and plant identification. On another occasion, I introduced grade-schoolers from an Audubon summer camp to methods of insect collection, arthropod identification, and nest monitoring. I increased public awareness of Metro's restoration practices and wildlife monitoring program by sharing results from my project at two Urban Ecological Research Consortium symposia and the Oregon Chapter of the Wildlife Society's annual meeting in Bend.

F. LESSONS LEARNED FROM PROJECT

While conducting this research, I learned several lessons about volunteer field assistance, Willow Flycatcher biology, and field conditions at Killin Wetlands. I had no trouble recruiting eager field assistants through the Audubon Society of Portland volunteer program. I now know that volunteers are a valuable resource for wildlife monitoring in the Portland metropolitan area. Because volunteers had wide range of fieldwork experience, however, I found that volunteers should spend as much time as possible practicing bird identification and learning about survey protocol.

While monitoring Willow Flycatchers in restoration sites, I easily located males but was unable to confirm the presence of females. I therefore learned that the presence alone of any species during the nesting season is inadequate evidence that they are nesting in the habitat of interest.

While trying to access as much of Killin Wetlands as possible on foot (while wearing chest waders), I learned that boats, such as canoes or kayaks, are needed to fully survey large portions of the swamps and flooded forests at east side of the site. I found, however, that dense growth of reed canary grass makes travel by kayak difficult during later part of the growing season.

G. RECOMMENDATIONS FOR SIMILAR PROJECTS

Researchers planning future surveys of Willow Flycatchers or other nesting species at Killin Wetlands should allocate adequate funding and time to ensure that areas are fully searched and territories are intensively monitored. I had four volunteers each season, but I was only able to completely survey two of four plots. Additional volunteers or paid assistants would have increased my survey area. Though I am confident that we did not miss any nesting activity, additional visits to territories (more than two per week) would provide more detailed information about flycatcher behavior. Prior to the nesting season, at least three days should be spent in the field to introduce assistants to the calls and songs of the birds being monitored. This would increase confidence in their abilities to detect birds while not under supervision.

Future surveys of Willow Flycatchers at Killin Wetlands should include areas to the east of my survey plots that were inaccessible by foot. I aurally detected singing males in these areas, but was unable to look for nesting behavior. Areas with dense reed canary grass or woody debris should be treated during winter or early spring by Metro staff to allow passage by canoes or kayaks during the nesting season.

H. ACKOWLEDGMENTS

Field work and project management were funded by a monitoring grant from the Oregon Watershed Enhancement Board. Administration of funds and logistical support were provided by Metro Science and Sustainability center staff including Curt Zonick, Katy Weil, Rick Scrivens, Melissa Bergstrom, Marcelle Caturia, and Linda Martin. I thank Mary Coolidge and the Audubon Society of Portland Important Bird Area volunteers Cameron Ames, Chris Grant, Marlene Huntsinger, Wendy Lee, Linda Magnuson, and Maureen Smith for their assistance with area searches. Bonnie Shoffner and the Oregon Zoo Animal Presenters assisted vegetation measurement.

I. LITERATURE CITED

Aherling, M.A., D.H. Johnson, and J. Faaborg. 2009. Factors associated with arrival densities of Grasshopper Sparrow (*Ammodramus savannarum*) and Baird's Sparrow (*A. bairdii*) in the upper Great Plains. Auk 126: 799-808.

Altman, B. 2001. Willow Flycatcher and Yellow-breasted Chat in the Willamette Basin: nest success, habitat relationships, and population status. American Bird Observatory, Boring, Oregon.

Altman, B., M. Boulay, S. Dowlan, D. Crannell, K. Russell, K. Beal, and J. Dillon. 2003. Willow flycatcher nesting ecology and habitat relationships in the Willamette Basin, Oregon. Studies in Avian Biology 26: 73-80.

Boucher, P.F., S.H. Stoleson, R.S. Shook, R.D. Pope, and J. Monzingo. 2003. Riparian restoration on the Gila River, New Mexico, creates breeding habitat for southwestern Willow Flycatchers. Studies in Avian Biology 26: 135-142.

Dahl, T.E. 2006. Status and trends of wetlands in the conterminous United States 1998 to 2004. U.S. Department of the Interior, Fish and Wildlife Service, Washington.

Faaborg, J., R.T. Holmes, A.D. Anders, K.L. Bildstein, K.M. Dugger, S.A. Gauthreaux Jr., P. Heglund, K.A. Hobson, A.E. Jahn, D.H. Johnson, S.C. Latta, D.J. Levey, P.P. Marra, C.L. Merkord, E. Nol, S.I. Rothstein, T.W. Sherry, T.S. Sillett, F.R. Thompson III, and N. Warnock. 2010. Conserving migratory landbirds in the New World: do we know enough? Ecological Applications 20: 398-418.

Hansen, L. 2006. Wetland status and trends. In: Agricultural Resources and Environmental Indicators. EIB-16, US Department of Agriculture.

Huff, M.H., K.A. Bettinger, H.L. Ferguson, M.J. Brown, and B. Altman. 2000. A habitat based point-count protocol for terrestrial birds, emphasizing Washington and Oregon. U.S Department of Agriculture/Forest Service Gen. Tech. Rep. PNW GTR-501.

Jenkins, N.J., J.A. Yeakley, and E.M. Stewart. 2008. First-year flooding responses to managed flooding of Lower Columbia River bottomland vegetation dominated by *Phalaris arundinacea*. Wetlands 28: 1018-1027.

Kirsch, E.M., B.R. Gray, T.J. Fox, W.E. Thogmartin. 2007. Breeding bird territory placement in riparian wet meadows in relation to invasive reed canary grass, *Phalaris arundinacea*. Wetlands 27: 644-655.

Martin, T.E., C. Paine, C.J. Conway, W.M. Hochachka, P. Allen, and W. Jenkins. 1997. BBIRD field protocol. Biological Resources Division, Montana Cooperative Fish and Wildlife Research Unit. Missoula, Montana, USA.

Pulliam, H. R., and B. J. Danielson. 1991. Sources, sinks, and habitat selection: A landscape perspective on population dynamics. American Naturalist 137 (Supplement): S50–S66.

Robbins, C.S. 1970. Recommendations for an international standard for mapping method in bird census work. Aud. Field Notes 24: 723-726.

Sedgwick, J. A. 2000. Willow Flycatcher (*Empidonax traillii*). *In* The Birds of North America, No. 533 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Sherry, T.W. and R.T. Holmes. 1995. Summer versus winter limitations of populations: what are the issues and what is the evidence? In T.E. Martin and D. M. Finch, editors. Ecology and Management of Neotropical Migratory Birds. Oxford University Press, New York.

Smith, D.M. 2009. Willow flycatcher monitoring at Killin Wetlands. Interim report for Metro Sustainability Center Natural Areas Program.

Stoleson, S.H., and D.H. Finch. 2003.Microhabitat use by breeding southwestern Willow Flycatchers on the Gila River, New Mexico. Studies in Avian Biology 26: 91-95.

Titus, J.H., J.A. Christy, D. VanderSchaaf, J.S. Kagan, and E.R. Alverson. 1996. Native wetland, riparian, and upland plant communities and their biota in the Willamette Valley, Oregon.

J. ATTACHMENTS

The following attachments are manuscripts that will be submitted to peer-reviewed journals. They are included in this report as summaries of monitoring data and analyses used. Data will be stored by the principle investigator and submitted to the ODFW National Resource Information Management Program.

TERRITORY DYNAMICS OF WILLOW FLYCATCHERS AT A RESTORED WETLAND IN NORTHWESTERN OREGON

D. MAX SMITH

ABSTRACT.- I monitored territories of the Little Willow Flycatcher (*Empidonax trailii brewsteri*) in two riparian shrub-swamp restoration units at Killin Wetlands in northwestern Oregon. I located 10 flycatcher territories from 2009 to 2010, seven of which were established in the northern unit, which had greater shrub cover, willow density, tree density, and canopy height were greater than the southern unit. Territories were established earlier in the northern unit as well, indicating that its features were more attractive to males. Woody stems of Sitka willow (*Salix sitchensis*), Piper willow (*Salix piperi*), Oregon ash (*Fraxinus latifolia*), and redstem dogwood (*Cornus stolonifera*) were more abundant in vegetation sampling plots located within flycatcher territories than those located in unused sites, while cover of Douglas spirea (*Spirea douglasii*) was greater in unused site sampling plots. Despite these differences, logistic regression analysis showed that no single plant species had a large influence on territorial establishment. Estimates of territory success were extremely low (Vickery index ≤ 1) in both units because my assistants and I observed territorial males but no females. This result suggests that habitat features in the restoration units were attractive to males but not females during the study period. Although restoration has increased the number of singing males at Killin Wetlands, additional monitoring of Willamette Valley breeding populations is needed to identify practices that will increase reproductive success of this sensitive species.

Loss of breeding habitat has been implicated in declines of Neotropical migratory birds in North America (Rich et al. 2004, Faaborg et al. 2010). In Willamette Valley lowlands of western

Oregon, numerous migrant landbird species are associated with riparian shrub and woodland vegetation communities (Altman 2000), which were a historically large component of the lowland plant cover (Christy et al. 1999, Franklin and Dyrness 1973). Acreage of these habitats declined during the last century as the human population increased along with intensive agriculture, modification or stream hydrology, and drainage of wetlands (Titus et al. 1996). Conservation activities, such as protection of existing shrub and woodland habitats and restoration of former habitat, have been given high priority by Partners in Flight and other management agencies in an effort to recover lost breeding species or slow declines of existing species in the Willamette Valley (Altman 2000). Much research is needed, however, to help managers focus restoration activities on species in need.

The Willow Flycatcher *(Empidonax traili)i* is indicative of many Neotropical migrants whose breeding populations have declined following reductions in nesting habitat (Altman 2001, Sedgwick 2000, U.S. Fish and Wildlife Service 2002). The Little Willow Flycatcher subspecies (*Empidonax trailii brewsteri*) was listed as vulnerable by the state of Oregon in 1997 and was a federal candidate species for protection under the Endangered Species Act due to population declines in northwestern U.S. and a lack of information about its biology (Altman 2001). The Willow Flycatcher is also a focal species for conservation by Oregon-Washington chapter of Partners-in flight and is one of two bird species listed as rare riparian/wetland-associates by the Oregon Nature Conservancy (Titus et al. 1996, Altman 2000). The other species, Yellow-billed Cuckoo (*Coccyzus americanus*), has been extirpated from the area, highlighting the vulnerability of riparian/wetland habitat (Titus et al. 1996). Certain structural habitat requirements have been identified for the Little Willow Flycatcher (hereafter, “flycatcher”), such as 30-80% cover of dense shrub stands ≤ 4 m tall and ≤ 20% cover of canopy trees > 4 m tall. Less information is available on riparian plant composition necessary to provide adequate breeding habitat for this species in lowland wetland habitats (Altman 2000). Flycatchers nest in upland and riparian habitats, but Altman et al. (2003) found evidence that productivity is higher in riparian sites associated with water. Priorities for the conservation of this subspecies therefore include protection and restoration of nesting habitat at rivers and wetlands in western Oregon.

The Portland, Oregon metropolitan region has an elected regional government, known as Metro, which has acquired private land for restoration activities, such as native species planting and exotic control (Jenkins et al. 2008). By monitoring birds in a wetland under restoration by Metro, I had the opportunity to examine territory establishment patterns of males in response to vegetation structure and composition. Males likely respond to variation in habitat quality by selecting territory locations that will result in higher rates of reproductive success than others (Pulliam and Danielson 1991). Identification of areas selected by male flycatchers can therefore be used to evaluate habitat quality. In addition, features associated with habitat quality should differ from areas not selected for territories. If such features can be manipulated by restoration, managers can increase habitat quality and occupation of a site by flycatchers or other species. I monitored territorial flycatchers in restored wetlands during the nesting seasons of 2009 and 2010. The objectives of this work were to 1) describe structure and composition of restored wetland plots, 2) identify spatial and temporal patterns of territory settlement within these plots, 3) describe vegetation composition of territories and unused sites, and 4) estimate territory success.

METHODS

Study Area.- Killin Wetlands, located in Washington County, Oregon, occupies a basin filled by several creeks in the Dairy Creek drainage. These streams have been channelized to provide drainage for agriculture (Titus et al. 1996), but certain parts of the wetland have remained inundated from year to year. Depth and extent of water fluctuate within and among years due to beaver (*Castor canadensis*) activity and variation in precipitation (Smith, personal observation). The wetlands consist of emergent vegetation, riparian shrub-swamp, and riparian bottomland forest vegetation communities, along with expanses dominated by invasive reed canary grass (*Phalaris arundinacea*). Riparian shrub species include Sitka willow (*Salix sitchensis*), Piper willow (*Salix piperi*), Geyer willow (*Salix geyeriana*), and Pacific willow (*Salix lucida*). Dense patches of Douglas spirea (*Spirea douglasii*) are also present. Other woody species include Pacific ninebark (*Physocarpus capitatus*), redstem dogwood (*Cornus stolonifera*), and wild rose (*Rosa spp*). Oregon Ash (*Fraxinus latifolia*) trees are present throughout the wetlands in a variety of sizes. Reed canary grass is the dominant herbaceous species. The wetlands are bordered in some areas by large Scouler willow (*Salix scouleriana*) trees and upland forests largely composed of Douglas fir (*Pseudotsuga menziesii*), western red-cedar (*Thuja plicata*), and big-leaf maple (*Acer macrophyllum*).

I conducted surveys in two wetland units that were approximately 11 ha in size and located to the north and south of Cedar Canyon Road (Fig. 1). These units were drained for production of crops, such as corn and onions prior to Metro's acquisition in 1996. Metro biologists have since worked to restore native shrub-swamp communities, which had decreased from 3,900 ha to 60 ha in the Willamette Valley between 1850 and 1995 (Titus et al. 1996). Restoration activities include de-channelization of drainage canals where possible to increase extent of water cover, and pole planting of native woody plants. To monitor effects of restoration on bird communities, five point count stations were established by Metro biologists in each unit

(Roon et al. 2006). Birds have been surveyed at each station several times each breeding season since 2004.

Willow Flycatcher surveys.- I visited the north and south units at least once per week to determine the number and location of singing males. I conducted surveys between 10 May and 20 July during 2009 and 2010. I employed two avian survey methods, point counts (Huff et al. 2000) and area searches (Robins 1970), to ensure that the entire area of each unit was covered and all territorial males were detected. During each point count survey, I recorded all species detected within a five-minute period at each station and I used a gridded map of the study area to record locations of flycatchers. During area searches, I spent two to three hours walking the perimeter of each plot listening for singing males, recording their locations on the same gridded maps used in point counts. When necessary, I walked through the interior of a unit to obtain a precise location, but I minimized travel through wetland vegetation to avoid disturbing sensitive marsh birds.

Territory Mapping/monitoring.- Throughout the breeding season, I transferred detections from point counts and area searches onto territory maps of each plot. I classified areas as territories Willow Flycatchers were observed singing in the same location for at least three weeks (Kirsch et al. 2007). I visited each territory at least once per week to look for changes in adult behavior that are indicative of reproductive success (Vickery et al. 1992). Each week, I counted the number of mapped territories to calculate density in each unit. In August, the end of the breeding season for most species, I used a Trimble© Handheld GPS receiver to record positions song perches at the perimeter of territories. I entered these locations into a data layer in ARCGIS to create polygon representations of each territory, which I overlaid onto an overhead photo of the study area.

Vegetation measurement.- To measure composition and structure of vegetation in the restoration units, I established four sampling plots at each point count station. I centered one sampling plot at the each station and added three additional plots within 50m of the station 120^{o} apart from one another (Martin et al. 1997). Following BBIRD protocol recommendations for point count studies (Martin et al. 1997), each sampling plot was 11.3 m in diameter and divided into four quadrants. I measured canopy height, water depth, and canopy coverage at seventeen locations in each sampling plot. In each of these locations, I determined whether canopy vegetation covered the area directly above a vertical densiometer. I then calculated the percent of locations covered as an index of canopy coverage. In each sampling plot quadrant, I identified and counted the number of shrub stems greater than 50 cm tall that were within 5 m of the center of the plot (Martin et al. 1997). I visually estimated percent of ground covered by water, reed canary grass, other grass species, forbs, and shrubs in each quadrant. Douglas spirea stems were often too numerous to count, so I estimated the percent of ground covered by this species as well.

To compare composition of vegetation between areas used by flycatchers versus unused sites, I established sampling plots at each territory. After the nesting seasons, I centered sampling plots at centroids and song perches in each territory in 2009 and 2010. At each of these sampling plots, I recorded stem composition variables and ground cover to compare with variables measured at point count sampling plots that were not in or adjacent to territories (hereafter, "unused sites"). I did not record structure variables such as canopy height and canopy cover in territories because these likely changed between years and were only measured in 2009 at point count sampling plots, making comparison between territories and unused sites difficult.

Data Analyses.- Because study plots were not selected randomly and this study was exploratory in nature, I did not use statistical methods associated with null hypothesis tests

(Johnson 1999). Instead, I calculated means and effect sizes to compare canopy height, canopy cover, water depth, water cover, stem densities, spirea cover, and reed canary grass dominance between study plots. I combined Sitka and Piper willow into one species because growth forms were very similar and at times difficult to tell apart. To calculate reed canary grass dominance, I divided the percent of ground covered by reed canary grass by the percent of ground covered by all vegetation, with a resulting value of zero indicating no reed canary grass and a value of one indicating complete dominance by reed canary grass (Kirsch et al. 2007). I calculated effect sizes using Cohen's *d* and interpreted values 0 to 0.2 as no effect, 02 to 0.5 as small, 0.5 to 0.8 as moderate, and > 0.8 as large (Cohen 1988).

I used a modification the index developed by Vickery et al. (1992) to compare territory success among years and restoration units. I gave each territory a score based on the observations recorded throughout each season, with 0 = a male holding a territory for less than four weeks, 1 = a male holding a territory for four weeks or longer, 2 = a pair observed for four weeks or longer, and 3 = signs of nest building or care for young.

I conducted an exploratory analysis to determine which, if any woody plant species influenced territory selection. In the first stage, I compared density of common woody species, and well as spirea cover and reed canary grass dominance in territories and unused plots with means and effect sizes. In the second stage, I constructed logistic regression models to determine which composition variables with moderate to large differences between territories and unused sites best explained use by flycatchers. I used SAS PPROC LOGISTIC (SAS Institute 2004) to calculate Akaike's Information Criteria adjusted for sample size (AIC_c), to select the model that best explained variation between sampling plots in territories and unused sites (Burnham and Anderson 2002). I calculated ΔAIC and Akaike weights (w_i) to rank all models and estimate support for each model in the set (Burnham and Anderson 2002). Finally, I used maximum likelihood parameter estimates to determine the effect of vegetation variables on flycatcher use.

RESULTS

Characteristics of restoration units.-The woody plant community of the restoration units was largely composed of willows, scattered ashes, dense stands of spirea, and reed canary grass. Willows composed 90% of woody stems in sampling plots, with Sitka/Piper willow the most abundant species (57%). Oregon ash (9% of all stems) was the most abundant non-willow species. Reed canary grass was present in every sampling plot and spirea was present in 50% of sampling plots.

Vegetation and hydrologic variables differed considerably between the two restoration units. Among vegetation structure variables, mean canopy height, shrub cover, and number of shrub and sapling stems were greatest in the north unit and their effect sizes were large (Table 1). Canopy cover was also greater in the north unit and its effect size was moderate. Among vegetation composition variables, reed canary grass dominance was greater in the northern than southern unit and mean number of ash stems was greater in the north as well. Effect sizes of these differences were large. Number of Sitka/Piper willow stems, total willow stems, and spirea cover were greater in the north unit with moderate effect sizes. Number of dogwood stems was greater in the north unit and number of Geyer willow stems was greater in the south unit, but their effect sizes were low. Water depth and water cover were greater in the north unit with large and moderate effect sizes, respectively.

Spatial and Temporal Patterns of Territory Establishment.- I located five flycatcher territories each year, with four in the north unit and one in the south unit in 2009 and three in the north and two in the south in 2010 (Fig. 2). The mean distance from song perches to the nearest edge of the north restoration unit was 39.9 and the mean distance to edge of the south unit was 62.5. Visual examination of territory locations revealed that three territories in the north unit overlapped county roads and two territories overlapped drainage canals in each unit. Flycatchers avoided areas of open water and emergent vegetation located in the southwest corner of the north unit and the northeast corner of the south unit (Fig. 2). In the north unit, they avoided the eastern boundary that bordered a mixed conifer/deciduous forest. A patch of deciduous bottomland forest in the central part of the north unit was avoided as well (Fig. 2).

The earliest date I detected territorial flycatchers was May 18th in 2009 and the latest date was July 20th in 2010. In the northern unit, the number of singing males changed throughout each season and peaked during the second half of June (Fig. 3). Territory establishment occurred later in the south in 2009 and 2010 and number of males was constant throughout each season (Figure 4). The number of weeks I detected singing males at each territory ranged from three to nine, with a mean of 5.2 in 2009 and 2010.

Vegetative features of territories.- The most abundant woody plant species in territories were Sitka/Piper willow (48% of woody stems) followed by redstem dogwood (20% of stems) and Oregon ash (8% of stems) Overall, willows composed only 56% of the woody stems in territories. Reed canary grass was present in every sampling plot in territories and spirea was present in 80% of the sampling plots.

Several variables varied between sampling plots in territories and unused sites (Table 2). Mean number of shrub and sapling stems was greater in territories and the effect size was large. Spirea cover was greater in unused areas, while ash stems, Sitka/Piper willow stems, and total willow stems, were greater in territories; the effect size for these variables was moderate.

Number of Geyer willow stems was greater in unused sites, and number of dogwood stems was greater in territories, but the effect sizes were small. Reed canary grass dominance did not differ between territories and unused sites (Table 2). The global logistic regression model, which contained all variables with high or moderate effect sizes, received the most support from the data (w_i = 0.998), followed by the model containing number of shrub and sapling stems and spirea cover (*ΔAIC = 13.6,* w_i = 0.001). Because the global model received nearly all of the support, I did not use model averaging to obtain parameter estimates; instead I used estimates from the global model. Confidence intervals overlapped zero for each variable which, along with high support for the global model, indicated that no single variable explained variation between territories and unused sites.

Territory success.- Because I did not observe pairs at any territory, the Vickery index scores were zero or one for each territory, resulting in low means for each restoration unit. Mean Vickery index was greater at the south unit (1.0) than the north unit (0.57) because all males in the south unit sang on their territories for > 3 weeks, while three territories in the north unit were occupied for only three weeks. Overall Vickery index was slightly higher in 2010 (0.8) than in 2009 (0.6).

DISCUSSION

In 2009 and 2010, I found flycatchers establishing territories in restoration units where they were not detected during the years prior to this study (D.M. Smith, unpublished data, Roon et al. 2006). Males are therefore responding positively to restoration of shrub-swamp riparian plant communities at this site. Similarly, Boucher et al. (2003) found that male flycatchers rapidly responded to restoration of riparian vegetation along the Gila River in southwestern New

Mexico. Song perches may be the habitat feature most important in habitat selection by male flycatchers (Sedgwick and Knopf 1992) Sitka/Piper willow and Oregon ash were the species most frequently used as song perches inside the restoration units. These two species are therefore an important component of willow shrub-swamp plant communities in terms of territory establishment by flycatchers.

Measurements of territory locations indicated spatial patterns of establishment in the restoration units. Males appeared attracted to the wetland boundaries, especially in the north unit and drainage canals in both units. Wetland boundaries were probably preferred because they offered tall perches such as transmission lines, Douglas fir trees, and dying Oregon ash trees, which were used by to territorial males. Drainage canals and wetland boundaries also provided vegetation gaps, which flycatchers use to capture flying insects on the wing (Sedgwick 2000 Brodhead 2005). Flycatchers appeared to avoid certain components of the restoration units, such as emergent wetland vegetation and closed canopy forest. Emergent wetlands did not contain perches tall or study enough for singing and lacked dense shrub patches preferred for nest sites by females (Sedgwick and Knopf 1992). Closed-canopy deciduous and mixed-conifer-deciduous forests were also avoided. These vegetation types were occupied by other flycatcher species, such as Pacific slope Flycatcher (*Empidonax difficilis*) and Western Wood-pewee (*Contopus cooperi*). The latter is larger than Willow Flycatchers and may exclude them from woodland sites. The song perches nearest closed canopy forests were at least 30m away (D.M. Smith unpublished data), therefore, to maximize the number of flycatchers in a restoration site, vegetation providing song perches should be established at this or greater distances from forest.

Because flycatchers are prefer to nest in early-successional vegetation patches (Altman et al. 2003), wetland succession should be accounted for in management of shrub-swamp communities. As species such as Oregon ash or Scouler willow grow to canopy trees, sites may become unsuitable for flycatchers. This may have occurred in the northwest corner of the north restoration unit, where willows have exceeded 4 m in height and a territory was established in 2009, but not in 2010. Disturbances, such as seasonal flooding, drought, and beaver herbivory, however, result in mortality or slowed growth of trees (Franklin and Dyrness 1973). Natural disturbance regimes maintain the vegetation structure preferred by flycatchers and, when possible, could be encouraged by managers to control exotic species, create a dynamic wetland mosaic, and provide early and late successional habitat for a variety of landbird species (Jenkins et al. 2008).

Because I located a greater number of territories in the north unit and territories were established there earliest, the habitat in this area appears to be more attractive to territorial males than the habitat provided by the south unit. Sampling plots in the north unit had greater shrub cover, greater canopy height of shrubs and saplings, and greater number of shrubs and saplings, including Sitka/Piper willow and Oregon ash. These variables have all been shown to be important habitat components of flycatcher territories by this study or others (Sedgwick and Knopf 1992, Kulba and McGillivray 2003). Reed canary grass was more dominant in the north unit than in the south, but this difference does not explain flycatcher preference for the north unit because canary grass dominance did not differ between territories and unused sites. Temporal patterns of establishment suggest that the earliest arriving males occupied in the north unit and selected the most attractive areas, forcing later-arriving males to settle for the south unit. This pattern fits the concept of the ideal preemptive distribution, suggested by Pulliam and Danielson (1991), where individuals always select the best unoccupied site. If two habitat types differ in quality, the less attractive one will not be settled until all sites are filled in the more attractive habitat. Vegetation measurements from the north unit are therefore more indicative of ideal flycatcher habitat in the Willamette Valley than those from the south unit.

Pair-wise comparisons and logistic regression analysis showed that a combination of plant species influenced territory selection by males in both units. Number of woody stems differed considerably between territories and unused sites. Numbers of Oregon ash and Sitka/Piper willow stems were also greater in territories, reflecting the importance of song perches in territory selection. Mean reed canary grass dominance was the same in territory and unused site sampling plots, showing that males were not responding to variation in its cover. In the upper Midwest, territory establishment of several landbird species was unaffected by reed canary grass as well (Kirsch et al. 2007). These results suggest that eradication of reed canary grass is not necessary to attract territorial flycatchers to a site. However, reed canary grass's effects on breeding biology of flycatchers and other birds require further investigation. An ecological trap could occur if birds nesting in invaded sites have lower reproductive success than in areas with no reed canary grass (Kirsch et al. 2007).

Female flycatchers have different habitat preferences than males (Sedgwick and Knopf 1992) and these differences may explain why I did not find females paired with territorial males at the restoration units. In northwest Oregon, female flycatchers select nest sites at low heights in a variety of substrate species (Altman et al. 2003). Nest sites, selected by female flycatchers in Colorado contained higher shrub densities and more evenly-spaced, uniform-sized bushes than song perch sites or unused sites (Sedgwick and Knopf 1992). The low Vickery index values of territory success that I calculated could have resulted from two scenarios: 1) the habitat was not attractive to females, so males had no success in attracting mates, and 2) females paired with males, but constructed nests outside of male territories. Under either scenario, the habitat in territories was suitable for males, but not for females. A more extensive shrub area, with greater spacing of bushes may be needed for females to select nest sites in the restoration plots.

CONCLUSIONS

I found that vegetation structure and composition varied between the restoration units and between territories and unused sites. A greater number of males established territories in the north than the south and establishing earlier in the north. These differences were likely explained by the greater number of woody stems, especially Sitka/Piper willow and Oregon ash, found in northern sampling plots than southern sampling plots. While flycatchers clearly responded positively to restoration, I did not find any evidence of reproductive success, suggesting that the habitat is not yet suitable to attract females. Additional measurements of vegetation features selected by males and females at Killin Wetlands are needed to help managers restore riparian nesting habitat throughout the Willamette Valley. In addition, effects of vegetation on nest survival, Brown-headed Cowbird (*Molothrus ater*) parasitism, and fledgling survival are needed to manage populations of this flycatcher amidst a changing Willamette Valley landscape.

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LITERATURE CITED

Altman, B. 2000. Conservation strategy for landbirds in lowlands and valleys of western Oregon and Washington. Report by the American Bird Conservancy for Oregon-Washington Partners in Flight.

Altman, B. 2001. Willow Flycatcher and Yellow-breasted Chat in the Willamette Basin: nest success, habitat relationships, and population status. American Bird Observatory, Boring, Oregon.

Altman, B., M. Boulay, S. Dowlan, D. Crannell, K. Russell, K. Beal, and J. Dillon. 2003. Willow flycatcher nesting ecology and habitat relationships in the Willamette Basin, Oregon. Studies in Avian Biology 26: 73-80.

Boucher, P.F., S.H. Stoleson, R.S. Shook, R.D. Pope, and J. Monzingo. 2003. Riparian restoration on the Gila River, New Mexico, creates breeding habitat for southwestern Willow Flycatchers. Studies in Avian Biology 26: 135-142.

Burnham, K.P., and D.R. Anderson. 2002. Model Selection and Multimodel Inference: a Practical Information-theoretic Approach. Springer-Verlag Press, New York.

Brodhead, K.M., 2005. The influence of riparian-canopy structure and coverage on the breeding distribution of the southwestern willow flycatcher. Master’s Thesis, Montana State Univeristy, Bozeman, Montana.

Cohen, J. 1988. Statistical power analysis for the behavioral sciences, 2nd edn. Erlbaum Associates, Hillsdale.

Christy, J., E. Alverson, M. Dougherty, S. Kolar, L. Ashkenas, and P. Minnear. 1999. Pre-settlement vegetation map for the Willamette Valley, Oregon, compiled from records of the General Land Office Surveyors (c. 1850). Oregon Natural Heritage Program, Portland, OR.

Faaborg, J., R.T. Holmes, A.D. Anders, K.L. Bildstein, K.M. Dugger, S.A. Gauthreaux Jr., P. Heglund, K.A. Hobson, A.E. Jahn, D.H. Johnson, S.C. Latta, D.J. Levey, P.P. Marra, C.L. Merkord, E. Nol, S.I. Rothstein, T.W. Sherry, T.S. Sillett, F.R. Thompson III, and N. Warnock. 2010. Recent advances in understanding migration systems of New World land birds. Ecological Monographs 80: 3-48.

Franklin, J.F. and C.T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Huff, M.H., K.A. Bettinger, H.L. Ferguson, M.J. Brown, and B. Altman. 2000. A habitat based point-count protocol for terrestrial birds, emphasizing Washington and Oregon. U.S Department of Agriculture/Forest Service Gen. Tech. Rep. PNW GTR-501.

Jenkins, N.J., J.A. Yeakley, and E.M. Stewart. 2008. First-year flooding responses to managed flooding of Lower Columbia River bottomland vegetation dominated by *Phalaris arundinacea*. Wetlands 28: 1018-1027.

Johnson, D.H. 1999. The insignificance of statistical significance testing. Journal of Wildlife Management. 63: 763-772.

Kirsch, E.M., B.R. Gray, T.J. Fox, and W.E. Thogmartin. 2007. Breeding bird territory placement in riparian wet meadows in relation to invasive reed canary grass, *Phalaris arundinacea*. Wetlands 27: 644-655.

Kulba, B. and W.B. McGillivray. 2003. Distribution and habitat characteristics of the Willow Flycatcher (Empidonax trailii) in Alberta. Studies in Avian Biology 26: 36-40.

Martin, T.E., C. Paine, C.J. Conway, W.M. Hochachka, P. Allen, and W. Jenkins. 1997. BBIRD field protocol. Biological Resources Division, Montana Cooperative Fish and Wildlife Research Unit. Missoula, Montana, USA.

Pulliam, H.R., and B.J. Danielson. 1991. Sources, sinks, and habitat selection: A landscape perspective on population dynamics. American Naturalist 137 (Supplement): S50–S66.

Rich, T. D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E. Iñigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY.

Robbins, C.S. 1970. Recommendations for an international standard for mapping method in bird census work. Aud. Field Notes 24: 723-726.

Roon, D., M. Boisvert, G. Padilla, K. Peyrollaz, and C. Zonick. 2006. A volunteer-mediated monitoring program tracking the effects of habitat restoration on selected bird populations at Metro Natural Areas. Metro Science and Sustainability Center report. http://library.oregonmetro.gov/files/2006breedingbirdmonitoringreport.pdf

SAS Institute. 2004. SAS Online Doc. 91.2. SAS Institute, Cary, NC.

Sedgwick, J.A. 2000. Willow Flycatcher (*Empidonax traillii*). *In* The Birds of North America, No. 533 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Sedgwick, J.A. and F.L. Knopf. 1992. Describing Willow Flycatcher habitats: scale perspectives and gender differences. Condor 94: 720-733.

Titus, J.H., J.A. Christy, D. VanderSchaaf, J.S. Kagan, and E.R. Alverson. 1996. Native wetland, riparian, and upland plant communities and their biota in the Willamette Valley, Oregon. Phase I project: inventory and assessment report to environmental protection agency, Region X, Seattle, Washington. Willamette Basin Geographic Initiative Program. Oregon Natural Heritage Program, the Nature Conservancy, Portland, Oregon.

Vickery, P.D., M.L. Hunter, Jr., and J.V. Wells. 1992. Use of a new reproductive index to evaluate relationship between habitat quality and reproductive success. Auk 109: 697-705.

U.S. Fish and Wildlife service. 2002. Southwestern Willow Flycatcher recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Table 1. Vegetation and hydrologic variables measured in the north and south restoration units at Killin Wetlands during the 2009 field season.

Variable	North unit	South unit	*d*
Shrub cover	36.4%	6.6%	1.37
Shrub and sapling stems (# per sampling plot)	26.6	6.0	0.86
Canopy Height (cm)	116.7	39.2	0.83
Canopy cover	13.8%	1.9%	0.79
Reed canary grass dominance	0.55	0.92	1.97
Oregon ash stems	3.1	0	1.02
Sitka/Piper willow stems	18.3	2.4	0.76
Willow stems	29.8	14.7	0.62
Douglas spirea cover (%)	21.5	3.3	0.55
Redstem dogwood stems	0	0.2	0.32
Geyer willow stems	6.3	3.5	0.22
Water depth (cm)	6.6	0.1	0.83
Water cover	12.1%	0	0.63

Table 2. Means and effect size for variables measured at sampling plots within Willow Flycatcher territories and in unused sites in 2009 and 2010.

Variable	Mean territory	Mean unused	d
Reed Canary grass dominance	0.74	0.74	0.03
Oregon ash stems	3.2	1.1	0.52
Willow stems	23.6	10.8	0.53
Sitka/Piper willow stems	20.1	6.5	0.60
Geyer willow stems	1.2	3.2	0.30
Redstem dogwood stems	8.5	0.1	0.40
Spirea cover	5.5	14.8	0.47
Shrub and sapling stems	42.0	12.2	1.0

FIGURE CAPTIONS

FIGURE 1. North and south restoration units at Killin Wetlands in northwestern Oregon.

FIGURE 2. Willow Flycatcher territories mapped in 2009 and 2010 in Killin Wetlands restoration units.

FIGURE 3. Number of singing males observed each week in the north restoration unit of Killin Wetlands in 2009 and 2010.

FIGURE 4. Number of singing males observed each week in the south restoration unit of Killin Wetlands in 2009 and 2010.

FIGURE 1.

FIGURE 2.

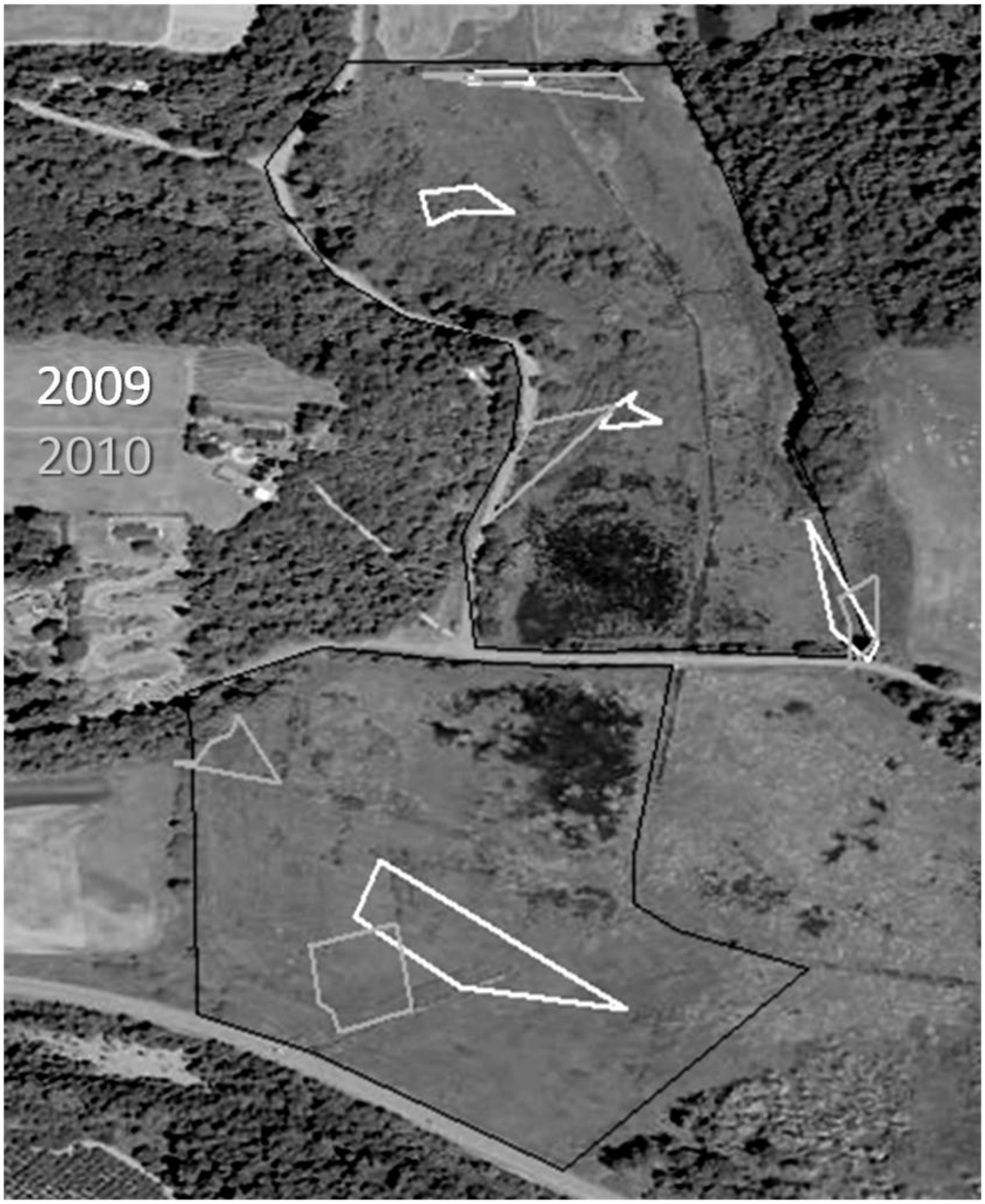


FIGURE 3.

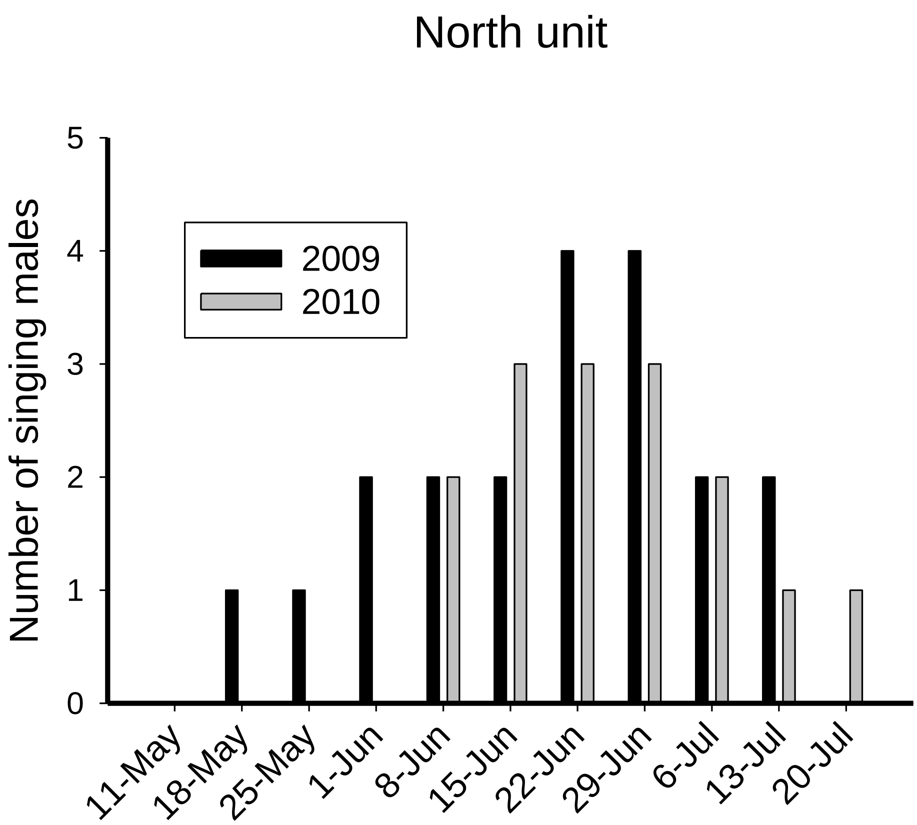
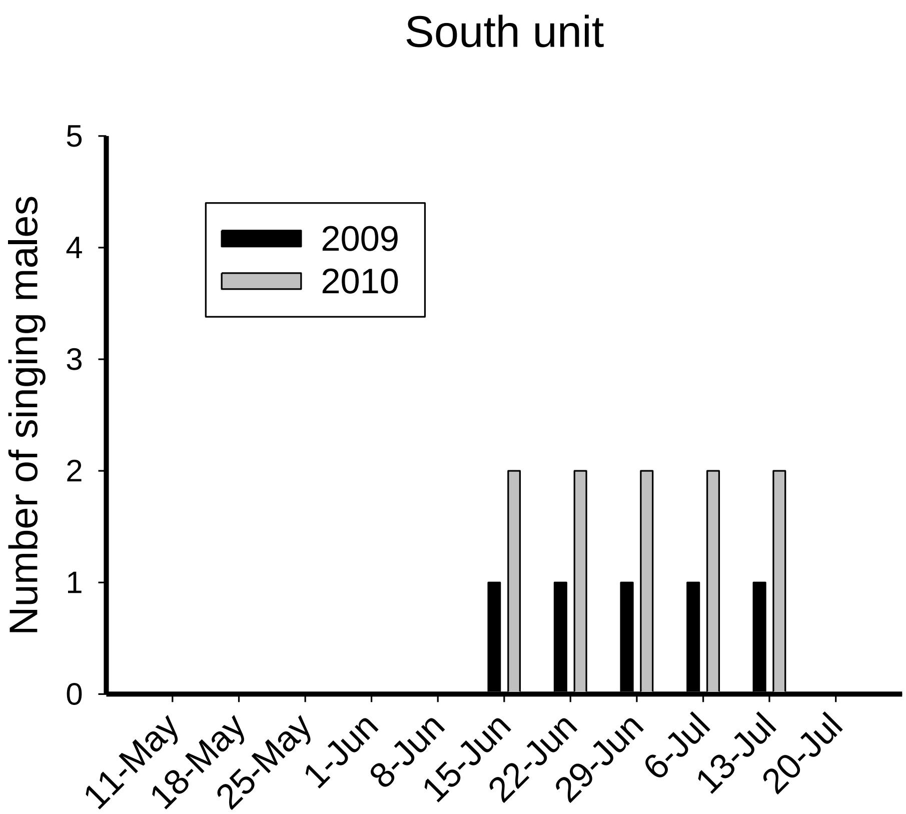

North unit
Number of singing males
2009
2010
0
1
2
3
4
5
11-May
18-May
25-May
1-Jun
8-Jun
15-Jun
22-Jun
29-Jun
6-Jul
13-Jul
20-Jul

FIGURE 4.


South unit
Number of singing males
0
1
2
3
4
5
2009
2010
11-May
18-May
25-May
1-Jun
8-Jun
15-Jun
22-Jun
29-Jun
6-Jul
13-Jul
20-Jul

A SUMMARY OF BIRDS DETECTED DURING THE BREEDING SEASON AT KILLIN WETLANDS, NORTHWESTERN OREGON

D. MAX SMITH

ABSTRACT - To evaluate response to restoration activities and provide baseline data, I recorded presence, areas of use, and evidence for nesting of birds in Killin Wetlands, western Oregon during two nesting seasons. The site consisted of emergent vegetation, restored shrub-swamp wetlands, and bottomland riparian forest, and upland forest. During the nesting seasons of 2009 and 2010, I observed 71 species while conducting point counts and areas searches. I confirmed nesting activity of 18 species, while another 18 species were probable nesters within the wetland boundary. At least 12 species likely nested in adjacent habitats and another 23 were detected too infrequently to determine their status. Species listed as vulnerable by ODFW were Pileated Woodpecker (*Dryocopus pileatus),* Willow Flycatcher (*Empidonax trailii*), Olive-sided Flycatcher (*Contopus cooperi*), and White-breasted Nuthatch (*Sitta carolinensis*). Yellow-breasted Chat (*Icteria virens),* which I detected in 2010, was the only species listed as critical. These results show that diverse bird communities, including sensitive landbird species, can benefit from restoration of wetlands in western Oregon.

Key words: Killin Wetlands, breeding birds, Neotropical migrants, marsh birds, restoration

Lowland wetlands of western Oregon historically supported diverse plant communities including emergent vegetation, shrub-swamp riparian vegetation, and bottomland forest (Johannessen et al. 1971, Taft and Haig 2003). In the mid to late 19th century, these vegetation types provided habitat for unique assemblages of waterbird and landbird species (Johnson 1880, Anthony 1886). Beginning with European settlement in the 1840s and lasting through the late 20th century, the extent of agriculture was expanded through construction of dams, drainage of wetlands, and clearing of riparian woodlands. These alterations reduced acreage of wetlands by at least 67% in the Willamette Valley and have altered the composition of avian communities (Titus et al. 1996, Altman 2000, Taft and Haig 2003). Despite intensive agriculture and increasing population growth, relict patches of emergent wetland and riparian plant communities remain in western Oregon (Franklin and Dyrness 1973). Protection and restoration of these habitats are priorities for management of declining landbird and waterbird species in the region (Altman 2000 Taft and Haig 2003).

Killin Wetlands is one of several natural areas under restoration in the Portland, Oregon metropolitan area. This site is owned and managed by the Metro regional government and contains habitats such as emergent vegetation and bottomland forest/shrub swamp, which have been reduced in the Willamette Valley by 57.6%, 71.8%, respectively (Titus et al. 1996). To help managers assess the progress of restoration and provide baseline data for future surveys, I conducted point counts and area searches of areas accessible by foot within Killin Wetlands. In this paper, I summarize data from the 2009 and 2010 breeding season to compare relative frequencies birds detected in restoration units and other plots, grouped by their nesting habitat associations and migratory status. I also document species that are nesting within the site, as well as use of the wetlands by sensitive species. Results can be used to target specific groups of bird for research and management.

METHODS

Study Area

Killin Wetlands, located in Washington County, occupies a basin filled by several creeks that are part of the Dairy Creek drainage. These streams have been channelized to reduce seasonal inundation and provide drainage for agriculture. Despite channelization, certain parts of the wetland have remained inundated from year to year. Depth and extent of water fluctuate within and among years due to beaver (*Castor canadensis*) activity and variation in precipitation (Smith, personal observation).

Vegetation typical of emergent shrub-swamp communities naturally occurs or has been planted as part of restoration efforts in the wetlands (Titus et al. 1996). Shrub species include Sitka willow (*Salix sitchensis*), Piper willow (*Salix piperi*), Geyer willow (*Salix geyeriana*), and Pacific willow (*Salix lucida*). Dense patches of Douglas spirea (*Spirea douglasii*) are also present. Other woody species include Pacific ninebark (*Physocarpus capitatus*), redstem dogwood (*Cornus stolonifera*), and wild rose (*Rosa spp*). Oregon ash (*Fraxinus latifolia*) trees in a variety of sizes are common throughout the wetlands. Reed canary grass (*Phalaris arundinacea*) is the dominant herbaceous species. The wetlands are bordered in some areas by large Scouler willow (*Salix scouleriana*) trees and upland forests largely composed of Douglas fir (*Pseudotsuga menziesii*), western red-cedar (*Thuja plicata*), and big leaf maple (*Acer macrophyllum*).

In 2009, I delineated four survey plots within the wetland complex (Fig. 1). Two plots are restoration units located north and south of Cedar Canyon Road. The north unit contained dense patches of willows, a small section of bottomland forest, and scattered plantings of Oregon ash saplings (Fig. 2). The south unit had fewer woody plants than the north unit and had large expanses dominated by reed canary grass (Fig. 3). The perimeters of both plots were accessible by foot, as were much of their interiors, allowing complete survey coverage. A third plot, the west swamp, was accessible by foot only along its north edge, which contained large Douglas fir trees and smaller deciduous trees and shrubs. The rest of the west swamp was covered by reed canary grass, open water, and emergent vegetation (Fig. 4).The forest plot was the southernmost plot and was a flooded bottomland forest with many Oregon ash snags, scattered black cottonwoods, some western red-cedars, and an understory dominated by reed canary grass (Fig. 5). This plot is accessible by foot only at its west end due to high water levels, so I did not attempt to survey the entire plot. In 2009, I surveyed all of the north and south restoration units, the west end of the forest plot and the north edge of the west swap. In 2010, I surveyed the restoration units and the north edge of the west swamp. I did not survey the forest plot in 2010 because it was inaccessible due to high water levels.

Surveys

In 2009 and 2010, I counted birds at point count stations established in the north and south restoration units. Five stations were located in each plot. I visited each station on three occasions each year between May 21st and June 17th. I performed point counts in the morning between 06:30 and 10:00 and recorded all bird species detected by sight or sound within a five-minute period at each station (Huff et al. 2000).

I conducted area searches in 2009 and 2010 from June 5th to July 20th. I searched plots by foot at least once per week. Following guidelines by Robbins (1970), I used a gridded map to determine locations all birds detected by sight or sound. I recorded these locations on a datasheet and recorded any behaviors that indicated nesting was taking place. Such behaviors would include courtship displays, copulations, nest construction, and adults carrying food to young.

Data Preparation

After collecting survey data, I assigned designations about breeding status, migratory status, conservation status, and general nesting habitat for each bird species. Nesting status designations were: confirmed = nests observed, adults observed constructing nests, carrying food, or feeding fledglings, or fledglings observed within boundaries of site; Probable nester = adults or pairs observed within wetland boundaries throughout one or two nesting seasons, but no actual nesting activity observed; Probably nesting nearby = nests likely constructed in upland habitats adjacent the wetland site, adults either detected from the wetland while singing in nesting habitat throughout one or more seasons, or adults traveling to wetland to forage, but nesting in another vegetation type; Unknown = too few observations of a species during either breeding season (≤ 3) to determine if it was nesting within the wetland boundaries or in adjacent habitat.

I used Marshall et al. (2003) as a reference to designate breeding habitat of each species in northwestern Oregon. Breeding habitat designations were: Forest = species dependent on large trees or other features found in conifer, deciduous, or mixed conifer/deciduous forest; Woodland/shrub = species nesting in open, patchy forest stands or shrub-dominated areas; Generalist = species that nest in open, forested, or human-altered areas; Marsh = species that primarily nest in emergent wetlands; Open = species that nest and forage in upland areas that are not dominated by trees or shrubs; Water obligate = species that nest near bodies of water, where they forage for fish or other aquatic animals.

I used information from Marshall et al. (2003) and range maps from Birds of North America (Pool and Gill 2001) to determine the migratory status of northwestern populations of birds detected at the wetlands sites. The categories were: Neotropical migrants = species that leave the northwest after the breeding season and whose winter range is mostly south of the Tropic of Cancer; Resident = species regularly found throughout the year in the Willamette Valley region of northwestern Oregon; Short-distance migrants = migratory species that breed in northwestern Oregon and winter in the southern U.S. I classified conservation status of bird species using the Oregon Department of Fish and Wildlife's state sensitive species list (ODFW 2008).

This study is exploratory in nature and intended to help focus future surveys. I therefore did not design surveys that incorporated detection probability, which is needed to compare abundance or density of among species or plots (Thompson and La Sorte 2008). Instead, I report species richness (number of species observed) and relative frequency of detection. For each bird species, I calculated the percentage of all surveys in which it was detected. I calculated frequency in 2009, 2010, and both years combined. To compare characteristics of birds in each survey plot, I calculated percentages of species in each nesting habitat association and migratory status.

RESULTS

I conducted 16 area searches and 12 point counts in 2009 and 2010 for a total of 66 survey hours. I observed 61 species of birds in 2009, 59 species in 2010 and a total of 71 species for both years (Table 1). I confirmed nesting activity within the wetland boundaries for 18 species and another 18 were probably nesting in the wetlands as well. Twelve species were likely nesting in adjacent habitats, and another 23 species were observed too infrequently to determine breeding status. The five most frequently detected species were Black-headed grosbeak (detection frequency = 100%), Marsh Wren (96.4%), Song Sparrow (89.3%), Common Yellowthroat (89.3%, scientific names are listed in Table 1), and American Goldfinch (85.7%).

In 2009 the five most frequently detected species were Black-headed Grosbeak (100%), Song Sparrow (92.9%), Marsh Wren (92.8%), American Goldfinch (85.7%), and American Robin (85.7%). In 2010, the five most frequently detected species were Black-headed Grosbeak (100%), Marsh Wren (100%), Common Yellowthroat (100%), and six species with detection frequency of 85.7% (Table 1). I detected Black-headed Grosbeak, Marsh Wren, Song Sparrow, Red-winged Blackbird, and American Robin during every survey in the north restoration unit, and Black-headed Grosbeak, Marsh Wren, and Common Yellowthroat during every survey in the south restoration unit and west swamp. Of the bird species I detected, five (Pileated Woodpecker, Olive-sided Flycatcher, Willow Flycatcher, White-breasted Nuthatch, and Yellow-breasted Chat) were listed as vulnerable or critical by the Oregon Department of Fish and Wildlife (Table 1).

Relative detection frequency varied among years for some species. Species for which detection frequency was ≥ 20% greater in 2009 than in 2010 were American Bittern, Cliff Swallow and Wilson's Warbler. Species whose frequencies were ≥ 20% greater in 2010 than in 2009 were Wood Duck, Hooded Merganser, Virginia Rail, Willow Flycatcher, Western wood-pewee, Cedar Waxwing, European Starling, Common Yellowthroat, and Yellow-breasted Chat.

In terms of migration status, most species were residents (57.7%), followed by Neotropical migrants (25.4%) and short-distance migrants (16.9%). Among general breeding habitats, the greatest percentages of birds were forest (35.2%) and woodland/shrub (26.8%) nesters. Intermediate percentages of birds were open area birds (14.1%) and marsh birds (12.7%). Low percentages were water obligates and generalists (7.0% and 4.2%, respectively).

Among survey plots, species richness was greater in the restoration units (54 species in the north and 53 in the south) than in the west swamp (50) and the forest (21). Percentages of residents, Neotropical migrants, and short distance migrants were similar among the north unit, south unit, and west swamp (Fig. 6). I detected a greater percentage of forest-nesting species in the north and south restoration units than in the west swamp, while I detected the greatest percentage of woodland/shrubland species in the west swamp. I detected low percentages of generalists in all plots, and greater percentages of marsh birds, open area birds, and water obligates in the north unit and west swamp than in the south unit (Fig. 7). I did not compare percentages of species detected in the forest with the other plots because of lower survey effort in the forest.

Discussion

I found several marsh and water bird species and dozens of landbird species using Killin Wetlands during the nesting season. I observed nesting by resident and migratory species within the wetland boundaries, as well as upland forest species using the wetland vegetation for foraging or display sites. These results indicate that restoration of wetlands in western Oregon can benefit a diverse community of breeding birds.

Most of the species I detected were landbirds that are dependent on woody vegetation for nesting and foraging. Black-headed Grosbeak was the only species I detected in every survey. However, this forest-nesting species was probably not the most abundant species, but the most easily detected species due to frequent, high-volume singing by males. Marsh Wren, Common Yellowthroat, Song Sparrow, and Red-winged Blackbird were likely more abundant than Black-headed Grosbeaks in the wetlands plots because their emergent wetland and shrub nesting habitat composed a larger percentage of the vegetation than the mixed forest habitat of grosbeaks. To estimate actual densities of these species, future surveys should incorporate detectability into study designs.

Marsh birds and water-obligates formed a smaller percentages of the bird community than landbirds. Populations of marsh birds, which can be difficult to detect, are of concern to wildlife managers (Conway and Gibbs 2011). I found nests or broods of six of the eight marsh bird species in areas of emergent vegetation. Frequent detection of the two additional species marsh bird species (American Bittern and Wilson’s Snipe) indicate that they were nesting as well. Abundant reed canary grass is likely an important component of the habitat for marsh birds that are dependent on emergent vegetation at this site. Previous studies have shown that species, such as Common Yellowthroat, are often abundant in areas invaded by reed canary grass (Kirsch et al. 2007). Removal of this invasive species is priority in the region (Jenkins et al. 2008), and should be followed by restoration of native emergent plant to maintain breeding populations of marsh birds at this site. Water-obligate species, such as Great Blue Herons and Common Mergansers, used standing water and drainage canals to forage for aquatic animals during this study. Managers seeking to maintain use of the wetlands by these birds should monitor water quality and prey populations, ensuring that management activities do not negatively affect these resources.

Most of the species detected were residents that winter and breed in western Oregon. Populations of these birds therefore have the greatest potential to be positively affected by wetland restoration. Neotropical migrants have declined throughout much of the U.S. and breeding habitat loss has been implicated in some of the declines (Rich 2004, Faaborg et al. 2010). During 2009 and 2010, I detected 17 Neotropical migrant species and at least 10 of these species were likely breeding within the wetland boundaries. Short distance migrants made up the smallest percentage of migrant types. Of the twelve short distance migrant species detected, five were likely nesting within the wetlands. Restoration practices that increase numbers or reproductive success of migrant birds at Killin Wetlands should be identified and implemented at other sites to help reverse continental declines.

Detection frequencies were substantially different among years for certain species of birds. I had conducted surveys at this site for several years prior to 2009, so I do not believe that my ability to detect species varied between 2009 and 2010. For some species, such as Common Yellowthroat, differences between years can be explained by the fact that I surveyed the forest plot, where they were absent, in 2009, but not in 2010. For others, differences could be explained by favorable conditions during one year that resulted in greater numbers using the wetlands. Alternately, differences between years could be indicative of long-term increases or declines in population size. The species with greatest difference in detection frequency was for Virginia rails, which were detected during 7% of surveys in 2009 and in 80% in 2010. Precipitation was greater in early 2010 than in early 2009 (WRCC 2011), and mean water depth and cover were greater in the restoration units in 2009 than 2010 (Smith 2010). Wetter conditions in 2010 likely increased the suitability of the wetlands for this Virginia Rails and Common Mergansers, which were also detected more frequently in 2010. The percentage of surveys I detected Willow Flycatchers increased from 50% in 2009 to 86% in 2010. This change reflects increasing use of the plots by this species, which I documented in a companion study (Smith in review). I detected American Bitterns less frequently in 2010 than in 2009, reflecting local concerns that numbers of this species are declining at the site (Smith, personal observation). Longer-term monitoring is needed to determine if bitterns and additional species, such as Wilson's Warblers and Cliff Swallows, are declining or if rails, mergansers, Cedar Waxwing, European Starling, Yellow-breasted Chat, Hooded Merganser, Common Yellowthroat, and Western Wood-pewee are indeed increasing in abundance at this site and other areas in western Oregon.

The four plots I examined differed in their vegetation structure and composition, which resulted in some differences in birds present. The species I observed in three of the wetland plots did not differ in migratory status, but did differ in their general breeding habitat. The north restoration unit and the west swamp had greater water depth and cover than the south unit (D.M. Smith, unpublished data). As a result, I detected fewer marsh birds and water obligate species in the south unit. At least 25% of the birds detected in each plot were forest birds, which is likely a result of the coniferous or deciduous forests bordering each plot. A high percentage of species in each plot were woodland/shrubland birds, which nested and foraged in shrubs and small trees present throughout the wetlands. Though I spent less time surveying the forest plot, I observed two species, bushtit and brown creeper, which I did not observe in other areas of the wetland. These observations suggest that the forest plot bird community is unique among wetland plots.

Of the vulnerable species I detected, Pileated Woodpecker is a mature forest specialist, Olive-sided Flycatcher is a post-disturbance coniferous forest specialist, Willow Flycatcher is an early succession shrub and open-woodland specialist, and White-breasted Nuthatch is a mature deciduous forest specialist (Marshall et al. 2003). My observations of Pileated Woodpeckers were typically aural detections of adults calling from Douglas fir trees outside of the wetland boundaries. Scattered Douglas fir and western red-cedar at the edges of the wetland plots could have been used by these species as well. Retention of large trees at the wetland edges will help to maintain suitable habitat for this species. I observed one Olive-sided Flycatcher singing in the north edge of the south unit in 2010, but I expect that this individual was outside of its territory or was a non-breeder, because it was not detected in subsequent visits. Because Olive-sided Flycatchers rely on opening in upland coniferous forests created by disturbances such as fire or logging, (Robertson and Hutto 2007), restoration of Killin Wetlands has likely had little effect on reproduction of the local population. These flycatchers will use lowland areas during migration, however, so they can benefit from restoration during the non-breeding season (Marshall et al. 2003). Willow flycatchers are the sensitive species that benefited the most from restoration in the north and south units, as evidenced by increasing numbers detected at these plots since 2004 (Smith in review). I observed males singing in each plot in 2010 and though I did not observe nesting behavior in the north or south units (Smith in review), there are many inaccessible areas of the west swamp and forest plots where successful nesting may have occurred. Populations of White-breasted Nuthatch have declined with loss of large deciduous trees such as Oregon white oak (*Quercus garryana*) and black cottonwood (Hagar and Stern 2001). Though large oaks were not present at the wetland plots, a few large cottonwood and Oregon ash trees remain, which may provide foraging and nesting substrates for this nuthatch species. I only observed White–breasted Nuthatches on two occasions, but retention of large deciduous trees and planting of others, including oaks, in drier areas of the property could increase their use of the site.

The only species I detected that is listed as critical by ODFW was the Yellow-breasted Chat. I observed one male singing in the upland border of west swamp on three occasions, which suggests that he was attempting to establish a territory. The area he occupied consisted of dense shrubs, Himalayan blackberry (*Rubus discolor*), and widely spaced Douglas fir trees. In the Willamette Valley, Yellow-breasted Chats occupy upland sites with heavy shrub cover, such as clear-cuts, but breeding densities are low in western Oregon (Altman 2001). If heavy shrub cover is maintained on the slopes bordering the wetlands, Yellow-breasted Chats may establish territories in the future.

I detected numerous species at the site, but it is difficult to judge habitat quality based on short-term estimates of species richness (Knopf 2010). Focused surveys should therefore be conducted in the future to evaluate restoration success, as well as the importance of the wetlands as breeding bird habitat. Such surveys should use floating watercraft to cover the larger percentage of the wetland that was inaccessible by foot. In addition, density and detectability of birds should be estimated using distance sampling, mixed models, or removal models (Thompson and La Sorte 2008). Because secretive marsh birds are difficult to detect without the use of broadcast calls (Conway and Gibbs 2010), standardized broadcast surveys could be used to better estimate numbers of breeding birds such as Virginia Rail, which may be increasing, and American Bittern, which may be decreasing. Long-term data, collected using the above methods, are needed to identify population changes for marsh birds and landbirds nesting at this site.

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LITERATURE CITED

Altman B. 2000. Conservation strategy for landbirds in lowlands and valleys of western Oregon and Washington. Report by the American Bird Conservancy for Oregon-Washington Partners in Flight.

Altman B. 2001. Willow Flycatcher and Yellow-breasted Chat in the Willamette Basin: nest success, habitat relationships, and population status. Boring, Oregon: American Bird Conservancy. 53 p.

Anthony AW. 1886. Field notes on the birds of Washington County, Oregon. Auk 3: 161-172.

Conway CJ, and JP Gibbs. 2011. Summary of intrinsic and extrinsic factors affecting detection probability of marsh birds. Wetlands 31: 403-411.

Faaborg J, RT Holmes, AD Anders, KL Bildstein, KM Dugger, SA Gauthreaux Jr., P Heglund, KA Hobson, AE Jahn, DH Johnson, SC Latta, DJ Levey, PP Marra, CL Merkord, E Nol, SI Rothstein, TW Sherry, TS Sillett, FR Thompson III, N Warnock. 2010. Recent advances in understanding migration systems of New World land birds. Ecological Monographs 80: 3-48.

Franklin JF, CT Dyrness. 1973. Natural Vegetation of Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Hagar JC, MA Stern. 2001. Avifauna in oak woodlands of the Willamette Valley, Oregon, Northwestern Naturalist 82: 12-25.

Huff MH, KA Bettinger, HL Ferguson, MJ Brown, B Altman. 2000. A habitat based point-count protocol for terrestrial birds, emphasizing Washington and Oregon. U.S Department of Agriculture/Forest Service Gen. Tech. Rep. PNW GTR-501.

Jenkins, N.J., J.A. Yeakley, and E.M. Stewart. 2008. First-year flooding responses to managed flooding of Lower Columbia River bottomland vegetation dominated by *Phalaris arundinacea*. Wetlands 28: 1018-1027.

Johannessen CL, WA Davenport, A Millet, S McWilliams. 1971. The vegetation of the Willamette Valley. Annals of the Association of American Geographers 61: 286-302.

Johnson OB. 1880. List of the birds of the Willamette Valley, Oregon. American Naturalist 14: 485-491.

Knopf FL. 2010. Composition dynamics of an avian assemblage. Wilson Journal of Ornithology 122: 767-771.

Marshall DB, MG Hunter, AL Contreras. 2003. Birds of Oregon: A General Reference. Oregon State University Press, Corvallis, OR.

Oregon Department of Fish and Wildlife. 2008. Frequently asked questions and sensitive species list. Salem, Oregon.

Poole A, F Gill. 2001. The Birds of North America. The Birds of North America, Inc. Philadelphia, Pennsylvania, U.S.A.

Rich TD, CJ Beardmore, H Berlanga, P J Blancher, MSW Bradstreet, GS Butcher, DW Demarest, EH Dunn, WC Hunter, EE Iñigo-Elias, JA Kennedy, AM Martell, AO Panjabi, DN Pashley, KV Rosenberg, CM Rustay, JS Wendt, TC Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY.

Robbins CS. 1970. Recommendations for an international standard for mapping method in bird census work. Aud. Field Notes 24: 723-726.

Robertson BA, RL Hutto. 2007. Is selectively harvested forest an ecological trap for Olive-sided Flycatchers? Condor 109: 109-121.

Smith DM. 2010. Willow flycatcher monitoring at Killin Wetlands. Interim report for Metro Sustainability Center Natural Areas Program.

Smith DM. In review. Territory dynamics of Willow Flycatchers a restored Willamette Valley wetland in northwestern Oregon. Wilson Journal of Ornithology.

Taft OW, SM Haig. 2003. Historical wetlands in Oregon's Willamette Valley: implications for restoration of winter waterbird habitat. Wetlands 23: 51-64.

Thompson FR III, FR La Sorte. 2008. Comparison of methods for estimating bird abundance and trends from historical count data. Journal of Wildlife Management 72: 1674-1682.

Titus JH, JA Christy, D VanderSchaaf, JS Kagan, ER Alverson. 1996. Native wetland, riparian, and upland plant communities and their biota in the Willamette Valley, Oregon. Phase I project: inventory and assessment report to environmental protection agency, Region X, Seattle, WashingtonWillamette Basin Geographic Initiative Program. Oregon Natural Heritage Program, The Nature Conservancy, Portland, Oregon.

Western Regional Climate Center (WRCC) http://www.wrcc.dri.edu/summary/Climsmor.html. Site accessed 4/15/2011.

TABLE 1. Species detected in Killin Wetlands; detection frequency in 2009 and 2010; breeding, migration, and conservation status; general nesting habitat of each species; and ODFW conservation status.

Species	Det. freq. 2009	Det. freq 2010	Breeding status[a]	Migrant type[b]	Breeding habitat[c]	Conservation code[d]
Black-headed Grosbeak *Pheucticus melanocephalus*	100	100	Conf.	Neo.	Forest	NL
Marsh Wren *Cistothorus palustris*	92.8	100	Conf.	Res.	Marsh	NL
Common Yellowthroat *Geothlypis trichas*	78.6	100	Conf.	SD Mig.	Marsh	NL
American Goldfinch *Spinus tristis*	78.6	85.7	Prob.	Res.	W/S	NL
Song Sparrow *Melospiza melodia*	92.9	85.7	Conf	Res.	W/S	NL
American Robin *Turdus migratorius*	85.7	78.6	Conf.	Res.	W/S	NL
Red-winged Blackbird *Agelaius phoeniceus*	78.6	85.7	Conf.	Res.	Marsh	NL
Western wood-pewee *Contopus sordidulus*	57.1	85.7	Prob.	Neo.	Forest	NL
Willow Flycatcher *Empidonax traillii*	50	85.7	Prob.	Neo.	W/S	Vulnerable

Swainson's Thrush	64.3	64.3	Prob.	Neo.	Forest	NL
Catharus ustulatus						
Brown-headed cowbird	71.4	57.1	Prob.	Res.	W/S	NL
Molothrus ater						
Orange-crowned Warbler	64.3	64.3	Prob.	SD Mig.	W/S	NL
Oreothlypis celata						
Cedar Waxwing	35.7	85.7	Conf.	Res.	W/S	NL
Bombycilla cedrorum						
American Crow	50	64.3	PN	Res.	W/S	NL
Corvus brachyrhynchos						
Mallard	50	64.3	Conf.	Res.	Marsh	NL
Anas platyrhynchos						
Spotted Towhee	57.1	57.1	PN	Res.	W/S	NL
Pipilo maculatus						
Steller's Jay	50	64.3	PN	Res.	Forest	NL
Cyanocitta stelleri						
Tree Swallow	57.1	57.1	Conf.	SD Mig.	Open	NL
Tachycineta bicolor						
Wilson's Warbler	64.3	35.7	Prob.	Neo.	Forest	NL
Wilsonia pusilla						
Black-capped Chickadee	57.1	42.9	Conf.	Res.	Forest	NL
Poecile atricapillus						
Great Blue Heron	42.9	57.1	PN	Res.	Water	NL
Ardea herodias						

Pacific Slope Flycatcher	50	42.9	PN	Neo.	Forest	NL
Empidonax difficilis						
Rufous Hummingbird	42.9	50	Prob.	Neo.	Forest	NL
Selasphorus rufus						
Western Tanager	42.9	42.9	PN	Neo.	Forest	NL
Piranga ludoviciana						
Virginia Rail	7.1	78.6	Conf.	Res.	Marsh	NL
Rallus limicola						
Barn Swallow	42.9	35.7	Prob.	Neo.	Open	NL
Hirundo rustica						
Bewick's Wren	42.9	35.7	PN	Res.	W/S	NL
Thryomanes bewickii						
Warbling Vireo	35.7	35.7	Prob.	Neo.	Forest	NL
Vireo gilvus						
Yellow Warbler	35.7	35.7	Prob.	Neo.	W/S	NL
Dendroica petechia						
American Bittern	50	21.4	Prob.	Res.	Marsh	NL
Botaurus lentiginosus						
Purple Finch	28.6	42.9	PN	SD Mig.	Forest	NL
Carpodacus purpureus						
Black-throated Gray Warbler	28.6	28.6	PN	Neo.	Forest	NL
Dendroica nigrescens						
Lazuli Bunting	21.4	35.7	Prob.	Neo.	W/S	NL
Passerina amoena						

Red-breasted Nuthatch	28.6	28.6	PN	Res.	Forest	NL
Sitta canadensis						
Red-tailed Hawk	21.4	35.7	Conf.	Res.	Gen.	NL
Buteo jamaicensis						
Cinnamon Teal	35.7	21.4	Conf.	SD Mig.	Marsh	NL
Anas cyanoptera						
Wood Duck	7.1	42.8	Conf.	Res.	Forest	NL
Aix sponsa						
Band-tailed Pigeon	21.4	28.6	PN	SD Mig.	Forest	NL
Patagioenas fasciata						
European Starling	7.1	35.7	Prob.	Res.	Gen.	NL
Sturnus vulgaris						
Killdeer	14.3	28.6	Prob.	Res.	Open	NL
Charadrius vociferus						
Western Scrub Jay	14.3	28.6	PN	Res.	W/S	NL
Aphelocoma californica						
Wilson’s Snipe	14.3	28.6	Prob.	Res.	Marsh	NL
Gallinago delicata						
Downy Woodpecker	14.3	21.4	Prob.	Res.	Forest	NL
Picoides pubescens						
Mourning Dove	21.4	14.3	Conf.	Res.	W/S	NL
Zenaida macroura						
Northern Flicker	21.4	14.3	Conf.	Res.	W/S	NL
Colaptes auratus						

Yellow-breasted Chat *Icteria virens*	0	21.4	Unk.	Neo.	W/S	Critical
Cliff Swallow *Petrochelidon pyrrhonota*	21.4	0	Unk.	Neo.	Open	NL
Vaux's Swift *Chaetura vauxi*	14.3	7.1	Unk.	Neo.	Forest	NL
Hooded Merganser *Lophodytes cucullatus*	0	21.4	Prob.	Res.	Water	NL
Red-breasted Sapsucker *Sphyrapicus ruber*	7.1	14.3	Unk.	Res.	Forest	NL
Evening Grosbeak *Coccothraustes vespertinus*	14.3	7.1	Unk.	SD Mig.	Forest	NL
Belted Kingfisher *Megaceryle alcyon*	7.1	7.1	Unk.	Res.	Water	NL
Common Raven *Corvus corax*	14.3	0	Unk.	Res.	Gen.	NL
Hairy Woodpecker *Picoides villosus*	0	14.3	Unk.	Res.	Forest	NL
Northern Harrier *Circus cyaneus*	14.3	0	Unk.	Res.	Open	NL
White-crowned Sparrow *Zonotrichia leucophrys*	0	14.3	Unk.	Res.	W/S	NL
Osprey *Pandion haliaetus*	0	14.3	Unk.	SD Mig.	Water	NL

Violet Green Swallow	14.3	0	Unk.	SD Mig.	Open	NL
Tachycineta thalassina						
Pileated Woodpecker	14.3	0	Unk.	Res.	Forest	Vulnerable
Dryocopus pileatus						
MacGillivray's Warbler	7.1	0	Unk.	Neo.	W/S	NL
Oporornis tolmiei						
Brown Creeper	7.1	0	Conf.	Res.	Forest	NL
Certhia americana						
Bushtit	7.1	0	Unk.	Res.	W/S	NL
Psaltriparus minimus						
Canada Goose	0	7.1	Unk.	Res.	Open	NL
Branta canadensis						
Dark-eyed Junco	7.1	0	Unk.	Res.	Forest	NL
Junco hyemalis						
Northern Pintail	0	7.1	Unk.	Res.	Open	NL
Anas acuta						
Savannah Sparrow	7.1	0	Unk.	Res.	Open	NL
Passerculus sandwichensis						
Green Heron	0	7.1	Conf.	SD Mig.	Water	NL
Butorides virescens						
Sora	0	7.1	Unk.	SD Mig.	Marsh	NL
Porzana carolina						
Turkey Vulture	7.1	0	Unk.	SD Mig.	Open	NL
Cathartes aura						

Olive-sided Flycatcher	0	7.1	Unk.	Neo.	Forest	Vulnerable
Contopus cooperi						
White-breasted nuthatch	7.1	0	Unk.	Res.	Forest	Vulnerable
Sitta carolinensis						

a Conf. = nests or nesting activity observed within wetlands, PN = probably nesting in nearby areas; Prob. = probably nesting within wetlands, Unk = too few observations to determine if nesting in or near wetlands.

b Neo. = Neotropical migrant, Res. = year-round resident, SD Mig. = short-distance migrant.

c Forest = closed canopy forest nester, Gen. = nests in multiple vegetation types, Marsh = nests in emergent wetlands, Open = nests in open areas, Water = dependent on open water and fish for nesting, W/S = open-canopy woodland and shrubland nester.

d Critical = listed as critically sensitive species by ODFW, Vulnerable = listed as a vulnerable sensitive species by ODFW, NL = not listed as sensitive by ODFW.

FIGURE 1. Study plots at Killin Wetlands in Washington County, OR.

FIGURE 2. North restoration unit consisting of emergent vegetation, shrubs, and broadleaf trees in Killin Wetlands, Washington County, OR.

FIGURE 3. South restoration unit with expanses of reed canary grass and scattered willow plantings.

FIGURE 4. West swamp plot with woody vegetation confined to the north edge (left side of photograph).

FIGURE 5. Forest plot with ash trees, snags, live willows, and reed canary grass.

FIGURE 6. Percentages of birds detected at survey plots that were residents, short distance migrants, and Neotropical migrants.

FIGURE 7. Percentages of birds in each nesting habitat designation detected at survey plots.

FIGURE 1.

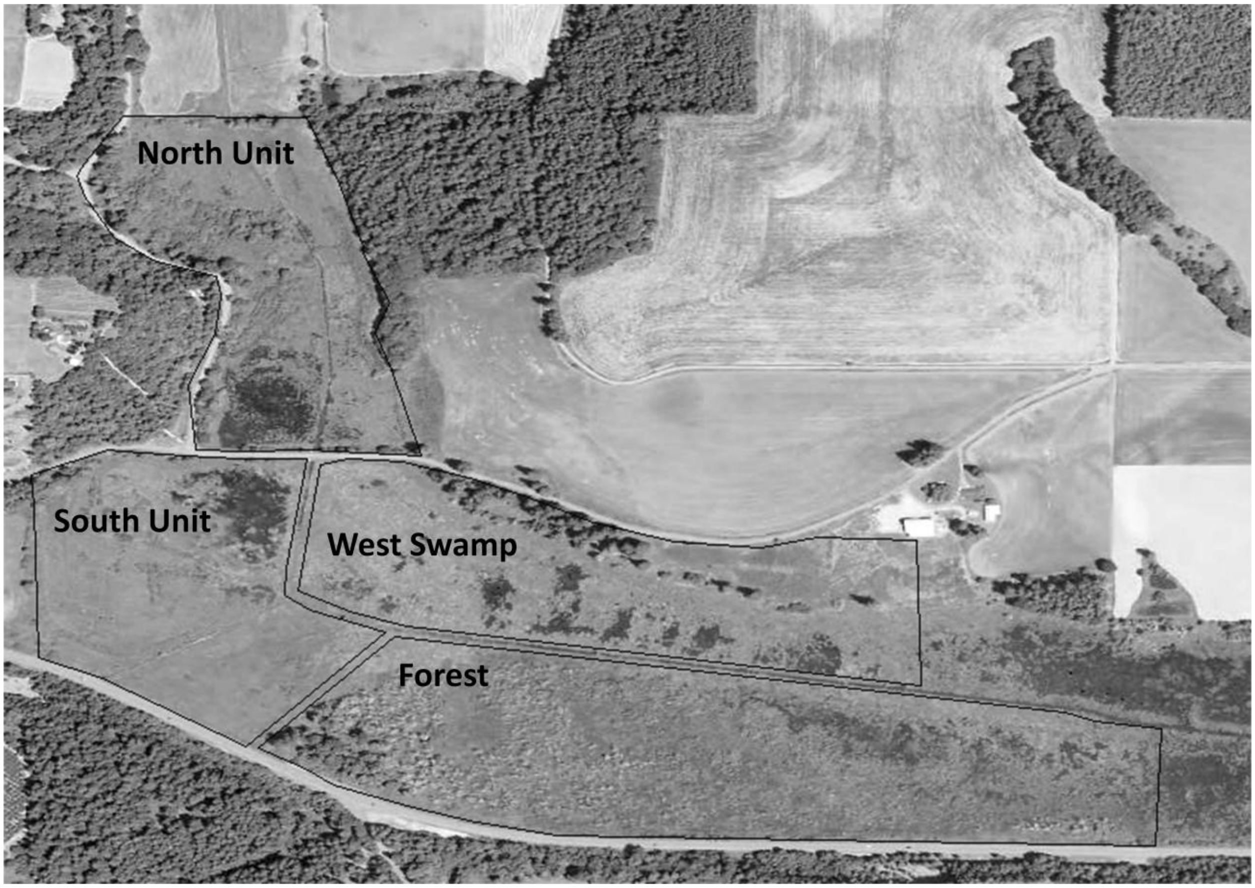


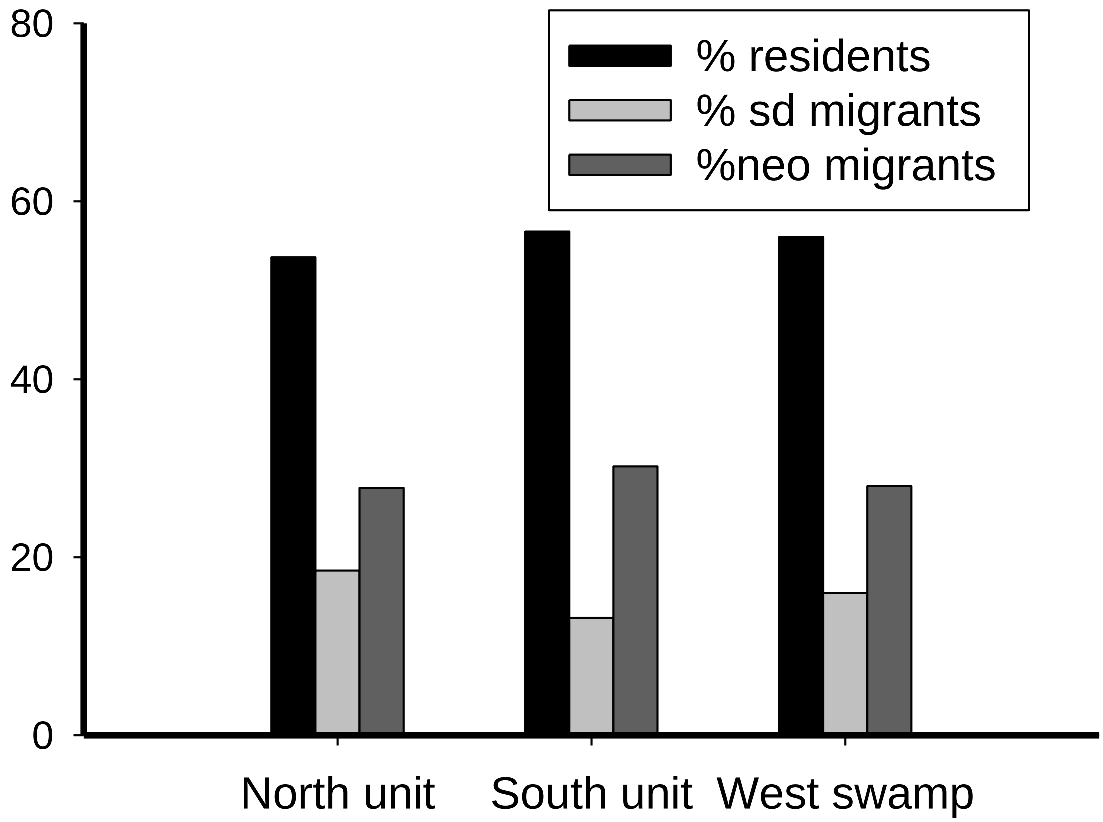
FIGURE 2.

FIGURE 3.

FIGURE 4.

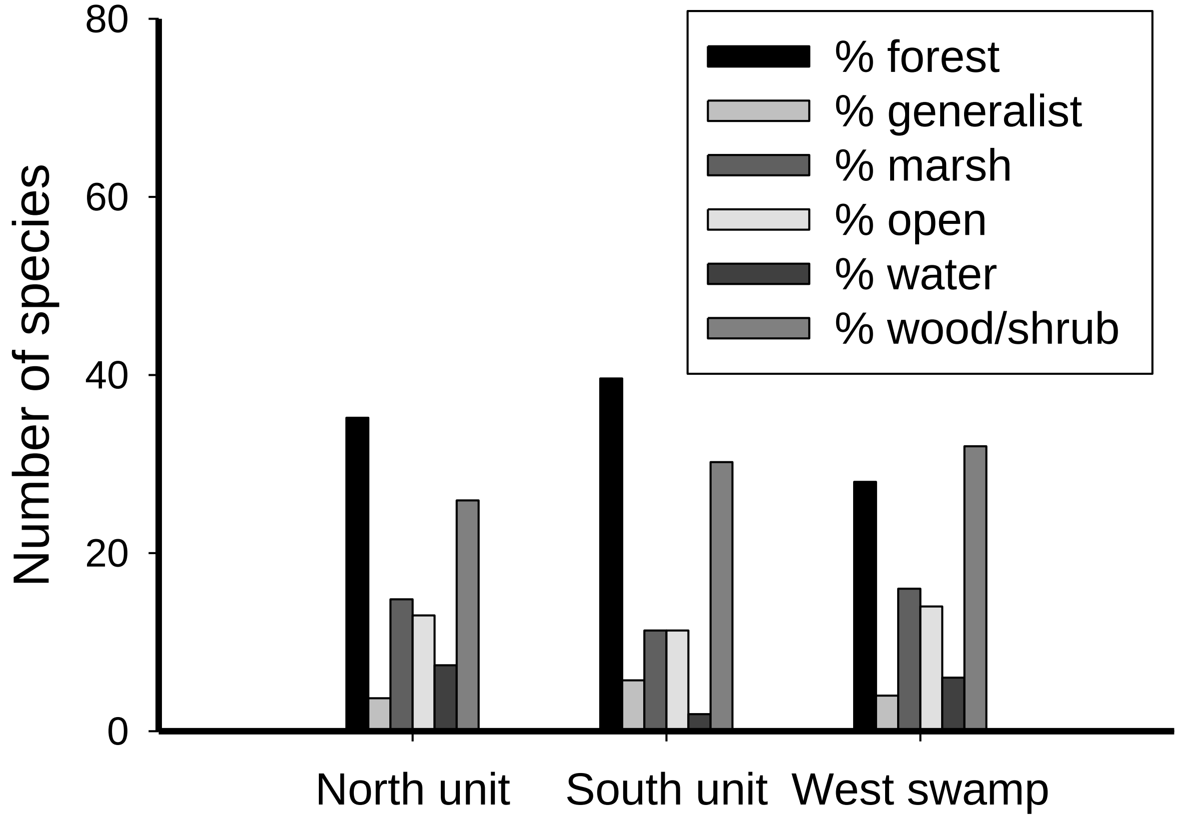
FIGURE 5.

FIGURE 6.



80
60
40
20
0
% residents
% sd migrants
%neo migrants
North unit
South unit
West swamp

FIGURE 7.



80
60
40
20
0
Number of species
% forest
% generalist
% marsh
% open
% water
% wood/shrub
North unit
South unit
West swamp