FOREST PARKLAND RESTORATION PLANNING RELATED TO BREEDING BIRDS IN SEATTLE, WA

September 2014

By

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Suggested citation: Syrowitz, J. 2014. Forest parkland restoration planning related to breeding birds in Seattle, WA. Prepared for City of Seattle Parks and Recreation. Audubon Washington. Seattle, WA. 55pp.

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EXECUTIVE SUMMARY

The Green Seattle Partnership (GSP) Strategic Plan proposes to renew and maintain Seattle's urban forested parkland through the restoration work of an informed and engaged community (Green Seattle Partnership 2005). The health of Seattle's forests has declined due to old age, invasive plant suffocation, and unsolicited tree removal for over thirty years. Forest restoration involves the removal of invasive plant species and other impeding structures, the establishment of native trees and understory vegetation, and site maintenance both through weed control and community education. Taking place over 20 years, this process will gradually convert Seattle's urban forests from declining ecological dead zones, to healthy, sustainable target forest ecosystems with improved species and age diversity (Society for Ecological Restoration 2004, Green Seattle Partnership 2011).

Benefit to birds. The practice of forest stewardship extends beyond plant health to include the habitat and welfare of local wildlife, including birds which provide important ecosystem services such as insect and rodent predation, plant pollination, and seed dispersal (Burke et al. 2011), as well as being aesthetically pleasing. Birds thrive in forests with diverse vegetation communities and structures (Burke et al. 2011, Bakermans et al. 2012, Twedt et al. 2010, Marzluff and Ewing 2001, Altman and Hagar 2007, Sanesi et al. 2009, Miller 1994, Tilghman 1987, Lancaster and Rees 1979, Gavareski 1976). The GSP target forest types will provide a multidimensional habitat capable of sustaining a greater number and diversity of bird species than are currently present. Over time, these forest remnants may help improve the City of Seattle's resident and migratory bird populations.

Mitigate temporary impacts. Actions around forest stewardship such as invasive species removal, re-vegetation, and structural maintenance may negatively impact breeding bird habitat and chick survival. Prior evaluation of bird use in project areas, planning restoration activities outside of primary nesting season, and/or mitigating the on-site impacts of treatment through buffers, barriers or interim avoidance is the best way to prevent disturbance and potential breeding bird mortality.

Build for birds. Understanding ecosystem processes, focusing on future forest health, and cultivating bird knowledge and relationships will enable forest stewards to incorporate key habitat components in their restoration efforts such as canopy openings and compost piles that will improve forest health and breeding bird productivity. With knowledge and appropriate technique, forest parkland restoration can work both for and in harmony with birds and the natural environment.

INTRODUCTION

Purpose

The purpose of this guide is to promote urban forest health and bird conservation by providing information about breeding bird species in Seattle, examining the impact of threats facing breeding birds in urban areas, and offering best management practices with the intent of reducing nest disturbance and breeding bird mortality related to the restoration of forested parklands in Seattle, while maximizing the ecosystem services provided by the forest resource.

Status of Breeding Birds in Seattle

More than 500 bird species have been observed in Washington State (Washington Ornithological Society 2013), and over 200 of these species are known to breed in Washington (Washington Department of Fish and Wildlife 1997, Sauer et al. 2014). The City of Seattle is home to at least 75 species of breeding birds, and an additional 34 likely breed within city limits (Opperman et al. 2006, Wheeler 2014). Therefore, there are as many as 109 bird species in the City of Seattle whose breeding success may be impacted by the activities of park restoration efforts during nesting season (Appendix A). More species of birds use conifer, deciduous, and riparian forest types than any other habitat type available in Puget Sound (Raedeke and Raedeke 1995).

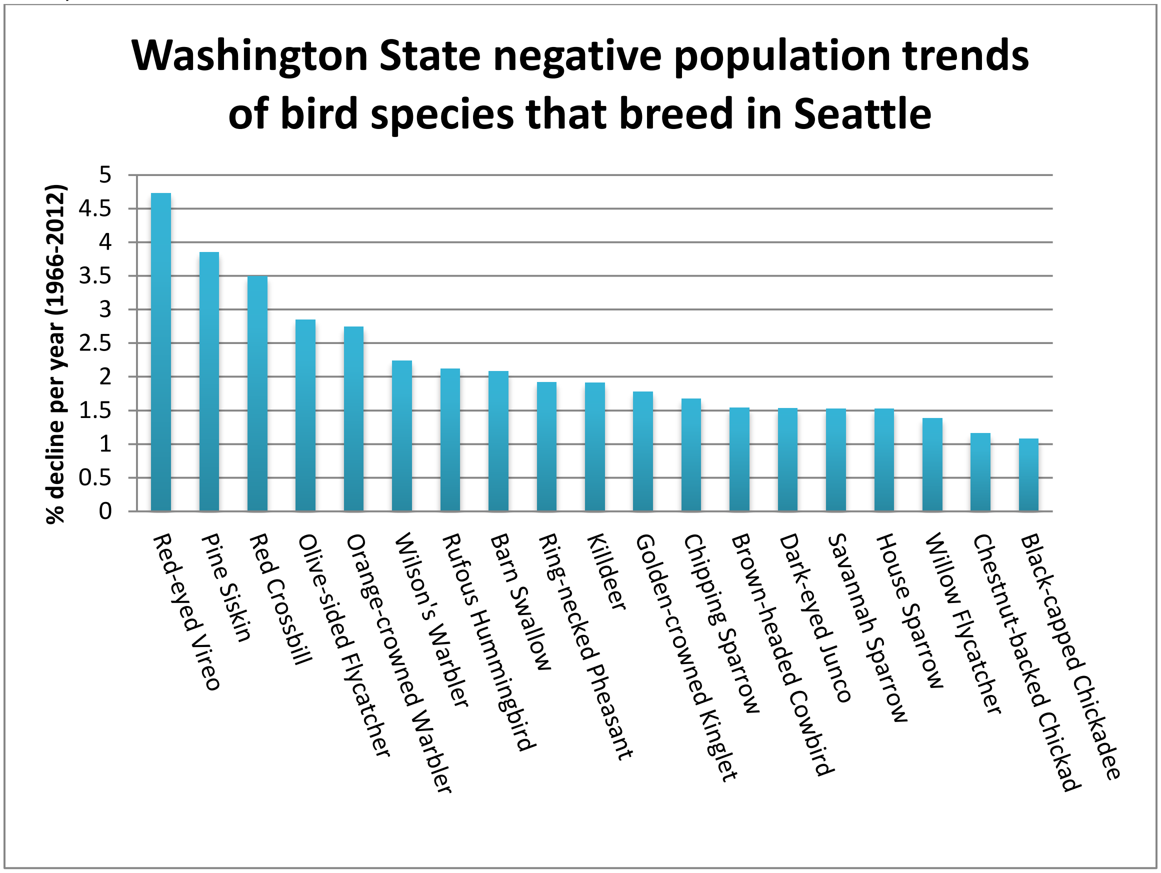
Nearly all of Seattle's breeding bird species are protected by the United States Fish and Wildlife Service Migratory Bird Treaty Act; non-protected species include the California Quail, European Starling, House Sparrow, Ring-necked Pheasant, and Rock Pigeon. It is illegal to take (kill), possess, import, export, transport, sell, purchase, barter, or offer for sale, a bird, nest, eggs, or nestlings of a protected migratory species without a federal permit. Eighteen of the 109 Seattle breeding bird species are currently listed as threatened, sensitive, or species of concern by various agencies and organizations, including the United States Fish and Wildlife Service, Washington Department of Fish and Wildlife, American Bird Conservancy, National Audubon Society, and Audubon Washington (Bird Web*a*). The USGS Breeding Bird Survey has documented the population decline of three of these state listed species – the Chipping Sparrow, Rufous Hummingbird, and the Willow Flycatcher – as well as 16 other confirmed or likely breeding species in Seattle (Sauer et al. 2014)(Figure 1).


Rufous Hummingbird, Rick Leche, FlickrCC


Chipping Sparrow, Elaine R. Wilson


Willow Flycatcher, Kelly Azar, FlickrCC

Figure 1. Negative state population trends of bird species that breed in Seattle (Sauer et al. 2014)



Literature Review

Knowledge Gaps

There is a great deal of research on large scale forest management practices in North America and their impact on forest bird communities. There is also a significant amount of information on birds in urban parklands, specifically regarding the preservation of natural space in urban areas and the impacts of recreational use on birds and other wildlife. However, there remains a dearth of knowledge around less conspicuous urban park activities such as vegetation restoration and associated species protection zones, and their potential influence on birds. Therefore, urban forest parkland planners must marry the data on forest management, urban park development, and other metropolitan guidelines, as well as incorporate local expertise and experience into their urban forest management plans. Certainly, more studies are needed regarding urban forest ecosystem management and human-influenced issues that will measure the effects of human activity, including restoration practices, on urban bird reproductive success and survival (Wolf 2007, Donnelly and Marzluff 2004*b*).

Focal Area

The City of Seattle and the greater metropolitan area are located within the Puget Trough Ecoregion, a lowland and marine environment located longitudinally between Washington's Cascade and Olympic mountain ranges. Predominate tree species include Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), big leaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), and Pacific madrone (*Arbutus menziesii*). Common understory vegetation includes sword fern (*Polystichum munitum*), salal (*Gaultheria shallon*), salmonberry (*Rubus spectabilis*), Oregon grape (*Mahonia aquifolium*), snowberry (*Symphoricarpos*), evergreen huckleberry (*Vaccinium ovatum*), red elderberry (*Sambucus racemosa*), ocean spray (*Holodiscus discolor*), vine maple (*Acer circinatum*), and rhododendron (*Rhododendron macrophyllum*), the Washington State flower. Landscape geography has been altered, and native vegetation has been highly fragmented in this region by human development. Natural forest succession is hampered by fire suppression, snag removal, and clear cut harvest practices, leaving only small old-growth fragments (Bird Web*b*); Seattle parks and green spaces act as some of these refuges (Figure 2).


Western Red Cedar, Walter Siegmund


Salal, Peter Steinberg


Salmonberry, Leslie Seaton

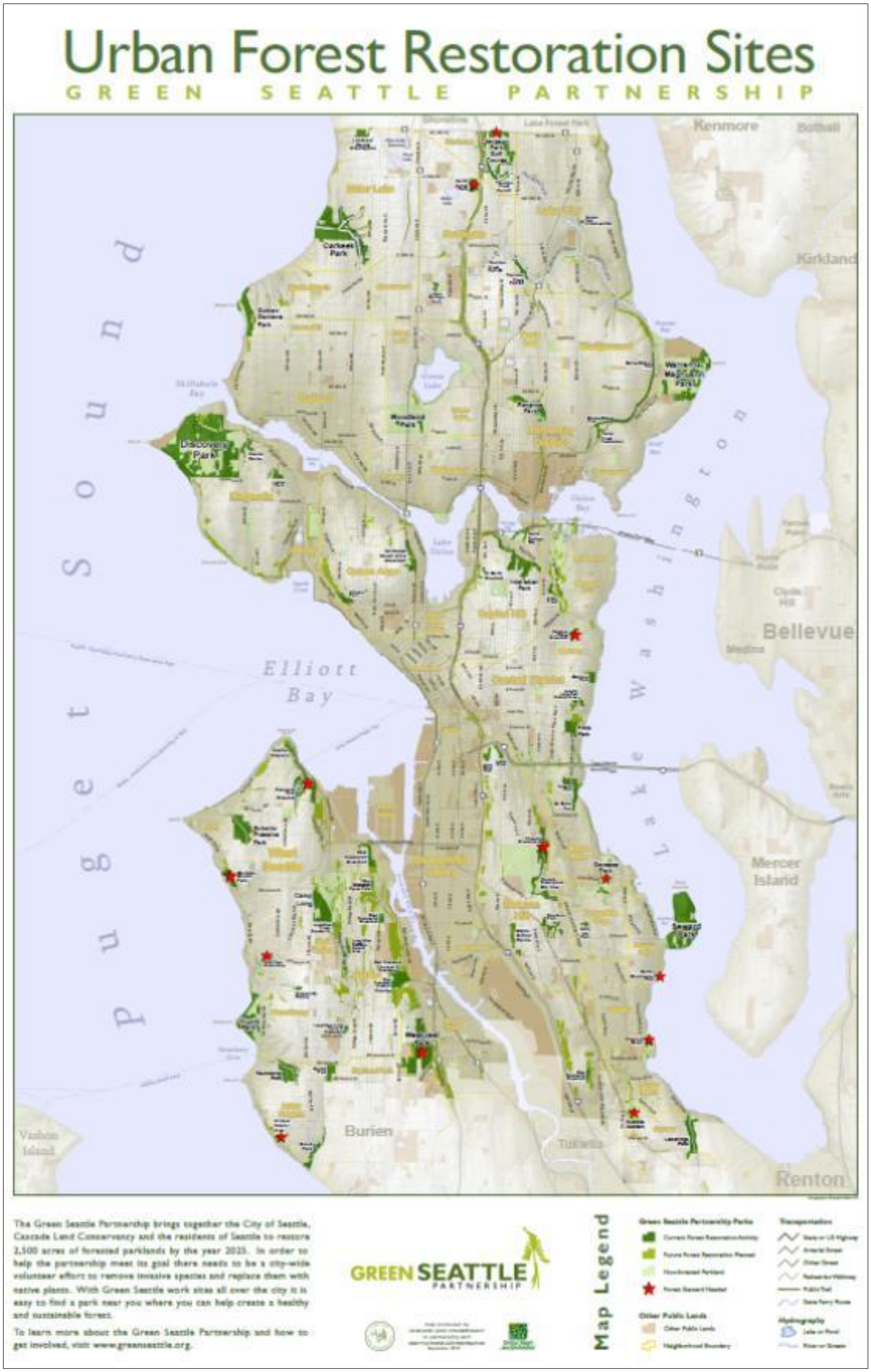


Figure 2. Green Seattle Partnership restoration sites and habitat phase map

Local Bird Monitoring

Seattle Audubon Society has been monitoring bird populations in Seattle and the Puget Sound Region for over 85 years. They began with the Christmas Bird Count, the longest running avian citizen science survey in the world. In the late 1980s, the chapter collaborated with other local Audubon chapters on the Sound to Sage Breeding Bird Atlas – a 15 year study to count breeding bird populations in four Washington counties, including King County. In 1994, Seattle Audubon Society coordinated the Neighborhood Bird Project to monitor species diversity in eight Seattle parks: Magnuson Park, Discovery Park, Golden Gardens, Carkeek Park, Seward Park, Genesee Park, the Arboretum, and Lake Forest Park Civic Club at the north end of Lake Washington. The Puget Sound Bird Observatory (PRBO) also monitors regional bird populations through their Summer Banding Camp, and Birds Wintering in Urban Landscapes project. Through these and other studies, approximately 265 bird species have been observed within the Puget Trough Ecoregion (Bird Web*b*).

Avian Adaptation to Urban Environments

Urban spaces provide habitat for both resident and long distance migratory bird species (Evans et al. 2011). 72% of Seattle's breeding bird population is resident species, and 28% is migratory (Appendix A). Regardless of their permanent or visitor status, there are a number of general qualities that help to characterize urban birds (Evans et al. 2011, Moller 2009)(Table 1).

Table 1. General characteristics of urban bird species (Evans et al. 2011, Moller 2009)
Large breeding range
Increased dispersal pattern
Generalist consumer, good at exploiting food resources
Canopy nester (versus ground nester)
High reproduction rate and increased adult survival
Shorter flight initiation distance (flushes quickly when approached)
Increased parasite resistance and predation avoidance
Large range size, population size, and population density

Over time, species may show adaptive responses to changing ecosystems. Urban environments feature high levels of direct and indirect disturbance potentially impacting avian movement and activity, diet and nutrition, disease, reproduction, and overall survival (Ditchkoff et al. 2006, Environment Canada 2006). Behavioral flexibility allows some bird species to adapt more readily to novel environments, including the disturbed habitats common to urban areas (Moller 2010, Bonier et al. 2007, Marzluff 1997). Species capable of adapting to human pressures within the course of generations may have a competitive advantage, improving their survival rates and fitness levels more quickly than less tolerant species (Ditchkoff et al. 2006, Diamond 1986). There is growing evidence that birds living in urban environments are not only becoming increasingly habituated to human activity, but are capable of exploiting urban resources to decrease energy expenditure (Cooke 1980, Moller 2010, Fernandez-Juricic et al. 2001*a*, Burger and Gochfeld 1991, Whittaker and Knight 1998, Marzluff 1997), sometimes to the point of dependence.

Urban areas are considered young ecosystems in an evolutionary context (Jokimaki 1999). While some species such as the American crow have quickly adjusted to human settlement and developed a symbiotic relationship with the urban world, many species are still adapting (or failing to adapt) to the rate of change brought about by human action. Avian response to urban impacts is species-specific and their tolerance to disturbance is dependent on the bird's experience, and the species' natural history (Reale and Blair 2005, Jokimaki 1999, Tilghman 1987, Blumstein et al. 2005, Blumstein 2006, Blumstein et al. 2003). Birds that fare well in urban areas can be called "urban exploiters" or synanthropic species, and birds that are challenged by urban stressors may be termed "urban avoiders" (Reale and Blair 2005). Specialized species with specific food and habitat requirements are generally more vulnerable to disturbance due to their inability to modify their habits according to environmental change (Marzluff 1997, Bonier et al. 2007). Permanent resident species subject to urban stressors year-round are likely to be more tolerant to disturbance than migrant birds that may only experience human activity during nesting season (Marzluff 1997, Burger and Gochfeld 1991). Large animals are reported to have lower disturbance thresholds than smaller animals, and the majority of studies report that songbirds show greater tolerance to disturbance than larger birds, such as corvids or raptors (Marzluff 1997, Fernandez-Juricic et al. 2001*a*, Fernandez-Juricic et al. 2001*b*, Cooke 1980).

Avian-Urban Habitat Relationships

Species diversity and density depend on habitat quantity and quality and, in particular, the availability of appropriate nesting habitat (Reale and Blair 2005). Habitat factors influencing breeding birds can be broadly categorized as patch size and shape, vegetation structure, and landscape design or the location of habitat features within the area. Forest bird occurrence is determined primarily by woodland size (Tilghman 1987, Donnelly and Marzluff 2004*a*, Dawson and Hostetler 2013), and the amount of forest cover within a patch is more important than the spatial distribution of woodlot fragments within the landscape (Trzcinski et al. 1999, Tilghman 1987, Guenette and Villard 2005). Bird diversity and abundance is higher in large, contiguous forested areas with high interior to exterior ratios (Donnelly and Marzluff 2004*a*, Dawson and Hostetler 2013, Mortberg 2001, Mortberg and Wallentinus 2000, Jokimaki 1999, Tilghman 1987, Gavareski 1976). Nest predation, especially of ground nesting species, has been shown to increase as forest size decreases (Wilcove 1985). Large scale, landscape level habitat changes have been shown to decrease the number of native species, and increase the number of synanthropic species like the American Crow (Hepinstall et al. 2008).

Diverse vegetation communities attract diverse bird communities. Urban bird conservation is best achieved by increasing the amount, composition, and structural complexity of vegetation within the habitat area (Bakermans et al. 2012, Burke et al. 2011, Twedt et al. 2010, Donnelly and Marzluff 2006, Shochat et al. 2010, Sanesi et al. 2009, Miller 1994, Lancaster and Rees 1979, Gavareski 1976). Vertical structure, the arrangement of vegetation layers within the habitat, is determined by the species of plants present. The greater the assortment and distribution of trees (canopy and subcanopy layers), vines and shrubs (understory layer), and herbaceous material (ground layer) in a forest, the greater the occurrence and diversity of various bird species (Burke et al. 2011, Bakermans et al. 2012, Twedt et al. 2010, Marzluff and Ewing 2001, Altman and Hagar 2007, Sanesi et al. 2009, Miller 1994, Tilghman 1987, Lancaster and Rees 1979, Gavareski 1976). Vegetation structure and plant species presence also affects invertebrate abundance and composition, a critical food resource for nestlings and fledglings (Burke et al. 2011, Altman and Hagar 2007). Early successional forests dominated by shrubs, saplings, and young trees, can promote avian species diversity, particularly that of insectivorous birds (Altman and Hagar 2007). Mid-successional forests dominated by pioneer trees can be the least productive for songbirds as they lack the dense herbaceous cover of early stands, and the structural complexity of late successional forests (Altman and Hagar 2007, Rodewald 2001). Structural vegetative diversity is typically highest in mature or late successional forests hosting dense herbaceous ground cover, several layers of various saplings and mid-story vegetation, and lower and upper tree canopies (Burke et al. 2011). Certain vegetation components such as large, mature trees or decaying trees, often act as an important nesting and foraging resource for multiple bird species, increasing site diversity (Stagoll et al. 2012, Mortberg and Wallentinus 2000, Kalies and Rosenstock 2013, Burke et al. 2011). Conversely, exotic invasive plant species have been shown to decrease native forest birds (Donnelly and Marzluff 2004*a*, Donnelly 2002, Marzluff and Rodewald 2008, Cleeton 2012), possibly due to poorer coverage and increased predation rates (Donnelly 2002, Schmidt and Whelan 1999).

Landscape design, the location and placement of habitat components within the area, can also affect bird abundance in urban forests. Species sensitive to disturbance have been shown to decrease as recreation trails and associated mowed and landscaped areas increase (Mason et al. 2007, Hull 2003). Generally, woodland bird abundance, especially that of edge-sensitive species, decreases closer to the forest edge, perhaps due to higher predation rates (Brand and George 2001, Mason et al. 2007, Cleeton 2012, Tilghman 1987, Rodewald 2001, Marzluff and Ewing 2001). Birds must also consider the distance to the nearest source of water; bird diversity has been shown to decrease as distance to water increases (Tilghman 1987). For certain birds, in particular cavity nesters, anthropogenic structures such as buildings can create habitat in urban areas (Gavareski 1976). However, other studies have shown that bird diversity and abundance decrease as building proximity and urban development increases (Jokimaki 1999, Tilghman 1987, Butcher et al. 1981, Lancaster and Rees 1979).

Avian Response to Forest Restoration and Habitat Succession

Biodiversity of birds and other wildlife is best maintained in habitats that are similar to those they evolved in, and human intervention in the form of habitat restoration is likely to be most successful when emulating the evolutionary environment (Kalies and Rosenstock 2013, Schmiegelow et al. 1997). As an integral part of their natural environment, birds have been shown to both promote and prosper from forest restoration by stimulating regeneration, creating new habitat for a number of forest dependent species (Reid et al. 2014, Germaine and

Germaine 2002). Native bird species respond to changing plant communities and familiar disturbance practices that mimic historic regimes, such as fire (Kalies and Rosenstock 2013, Burke et al. 2011) which creates patchy mosaics of complex vegetation and natural succession. Re-establishing and maintaining historically complex and healthy forested parklands is the best way to improve and sustain avian abundance and diversity over the long term. In the short term, as forest stewards continue to remediate forested parklands, we can expect to see gradual changes in avian composition.

Forest succession is an important, natural process enabling the gradual replacement of one biological community (flora and fauna) with another. Changes in vegetation composition and structure ensure a dynamic environment valuable to various species, and to species at different stages in their life cycle. The loss of successional stages can result in vegetative monocultures where exotic and invasive species thrive (Environment Canada 2006). Disturbance that occurs due to restoration activities can positively alter the course of succession by providing space for native ground and understory species, leading to a multidimensional, uneven-aged, native urban forest.

How will this forested relief transition and vegetation succession alter bird populations over time? The size of the site, timing and frequency of disturbance, and intensity of restoration activities can influence bird abandonment or colonization of the habitat (Marzluff and Ewing 2001, Marzluff 1997), making it important that only a portion of the area be disturbed at any one time while leaving adjacent refuges untouched. Avian responses to forest restoration are dependent on the bird species and the resources that it requires; bird communities fluctuate alongside successional changes accordingly (Burke et al. 2011, Betts et al. 2010, Altman and Hagar 2007, Rodewald 2001). For example, birds such as the Cedar Waxwing and Song Sparrow that do well in more open canopies will proliferate in a recently disturbed early successional woodlot (Thompson et al. 1992). In addition, many fledglings leaving mature forest nests will make use of early successional vegetation with dense shrub cover for protection from predators and abundant invertebrate resources (Burke et al. 2011, Ausprey 2010). Other species such as the Brown Creeper and woodpecker species will increase in abundance as the forest matures and canopy coverage expands over time. Overall, it appears that while avian community composition changes in response to restoration, species diversity, the number of nesting species, and their rate of turnover remains relatively constant (Schmiegelow et al. 1997, Horn 1985), and many species return to their pre-disturbance abundance over time (Altman and Hagar 2007).

THREATS FACING BREEDING BIRDS IN URBAN ENVIRONMENTS

Disturbance

Direct and indirect disturbance types can alter breeding bird habitat and/or bird behavior, potentially impacting nest and/or fledgling success.

Restoration Disturbance

Urban green spaces are unique in that they are generally fragmented with sparser vegetation coverage and more exotic plants than are found in less developed environments. The practice of restoration alters the structure and composition of the existing vegetation, with the intention of mimicking the site's natural state, improving habitat sustainability and diverse use. In Seattle's forested parklands, restoration follows a four-phase approach involving invasive species removal, secondary invasive removal and planting, continued invasive removal, watering, and mulching, and long-term site stewardship and maintenance (Green Seattle Partnership 2011). In summary, restoration begins by clearing the site of exotic vegetation before re-planting various beneficial native species. Ground, shrub, and cavity nesting species are likely to be most affected by disturbance intended to "clean up" a site (Marzluff and Ewing 2001). The potential loss of nest, forage, and brood habitat subjects eggs, nestlings, fledglings, and tending adults to heightened levels of predation and reduced invertebrate resources, which in turn may affect nest survival and fledgling success. If unavoidable during nesting season, the intermediate disturbance and/or loss of habitat caused by restoration activities should be mitigated directly by protective action (avoidance, or buffer or barrier creation around utilized vegetation) (Rashin and Frye 2013, Ikuta and Blumstein 2003), and indirectly by ensuring the retention of nearby residual patch reserves (Machmer 2002). These actions may also be beneficial during the transitional period of regrowth.

Recreational Trails

Seattle parks boast well over 65 miles of developed (paved) and 125 miles of semi-developed (gravel) recreation trails in forested areas. The impact of trails on birds depends on the trail location, and the frequency, extent, and timing in which it is used (Marzluff 1997). Trails themselves can fragment the landscape and act as physical barriers to movement, especially for specialist or edge-sensitive species in low quality habitat, or they can have indirect effects by facilitating the movement of humans and animals into the interior of habitat area (Miller et al. 1998, Environment Canada 2006, Mason et al. 2007, Hull 2003). Trails are not only used by people, but also by predators accessing forest interiors through easy corridors (Marzluff 1997). Predation has been shown to both increase (Miller et al. 1998) and decrease (Miller and Hobbs 2000) as proximity to trails increases; avian predation appears higher closer to trails, while mammalian predation may be higher in interior areas (Miller and Hobbs 2000).

Human occupancy tends to decrease the quality of bird habitat; increased volume and frequency of pedestrians has been shown to decrease species diversity and abundance, and use of available habitat (Fernandez-Juricic 2000, Mallord et al. 2007, Marzluff 1997, Environment Canada 2006). Movement through trails can disturb nesting birds, advertising their location to predators, as well as increase seed dispersal of exotic plants (Marzluff 1997, Marzluff and Rodewald 2008). Recreational trails have been shown to decrease bird abundance and diversity in habitat that is within approximately 75 meters (246 feet) of the trail, and greater for species more sensitive to disturbance (Miller et al. 1998). The smaller the habitat area, the greater the influence zone around the trail (Moskal and Halabisky 2010).

Recreational disturbance along trails appears to have minimal effect on reproductive success, perhaps due to higher reproductive outputs of urban birds (Mallord et al. 2007), refuge from predators avoiding humans on high-use trails (Merkle 2002), and/or nest site selection changes (Smith-Castro 2008). However, once disruption increases beyond species' disturbance thresholds, nesting activity decreases (Merkle 2002). The absence of disturbance entirely is likely to increase overall species productivity (Mallord et al. 2007). As such, protection zones or setback distances should be calculated based on the highest level of disturbance occurring in the area (Beale and Monaghan 2004).

Noise

Research related to the effects of human produced noise on birds in urban environments has focused primarily on construction, industrial, aerial, military, recreational vehicles, and road or traffic sounds, and their impact on species communication, with indirect effects on reproductive success such as the inability to attract and maintain a mate, the inability to hear chick solicitation, the inability to hear impending predation, and nest abandonment when noise levels increase after nest site selection (Ortega 2012). Conversely, noise may also increase the reproductive success of some species by keeping predators at bay (Ortega 2012, Francis et al. 2009). Study results suggest the effects of noise pollution on reproductive success are species-specific, and that birds more tolerant to noise disturbance will do well in urban environments, and perhaps benefit from the disruption of predation caused by unfamiliar sounds (Ortega 2012, Francis et al. 2009).

There is a certain level of habituation that tends to occur in response to chronic noise pollution, whereas unexpected, intermittent acoustic intrusions may have bigger impact (Ortega 2012). The intensity of human induced noise also influences species response. Noise produced by restoration activities is relatively infrequent and varies in volume. Presumably, the louder the noise and the longer its duration, the more disruptive it is to the bird. The majority of forested parkland restoration activities fall within the low volume, low intensity category, including the use of chainsaws. In California, researchers demonstrated the tolerance of Spotted Owls (*Strix occidentalis occidentalis*) to chainsaw activity within 100 meters of active nest sites; the birds showed no physical or chemical stress response to this mechanical disturbance (Tempel and Gutierrez 2003).

Outdoor Cats and Off-leash Dogs

Human sponsored non-native predators such as outdoor cats and off leash dogs are considered independent of natural ecosystems. This means that because their lifecycle requirements are met by humans, their populations do not change in response to prey population fluctuations as is the case in normal predator-prey relationships. Therefore, their impacts on urban wildlife populations are felt regardless of the health of the ecosystem (Miller 1994, Ditchkoff et al. 2006).

Domestic and feral free-ranging cats are responsible for significant negative effects on wildlife, including the death of an estimated 1.3 – 4 billion birds and 6.3 – 22.3 billion mammals in the United States each year (Loss et al. 2013). Predation appears greatest during the spring and summer breeding season, likely illustrating increased juvenile depredation (Baker et al. 2005). Along a rural-urban gradient in Michigan, researchers estimated that cats killed at minimum one bird per kilometer (.62 miles) per day during the breeding season (Lepczyk et al. 2003). The urban-forest interface appears to be especially dangerous for birds (Gillies and Clout 2003) and perhaps naive migratory birds in particular (Shochat 2004). Pet owners in the City of Seattle provide homes for more cats than dogs or even children (Balk 2013), and their outdoor activities often go unmonitored (Miller 1994). In order to prevent the high level of urban bird mortality caused by outdoor cat predation, owners must be educated about the negative ecosystem impacts of free-ranging felines, including depredation, the spread of disease, and fecal pollution in local waters. Some easily accessible resources include the American Bird Conservancy's Cats Indoors campaign (http://www.abcbirds.org/abcprograms/policy/cats/index.html), and fact sheets prepared by The Wildlife Society (http://www.wildlife.org/policy/fact-sheets).

The impacts of human recreation are often intensified when companion dogs are present (Banks and Bryant 2007, Sime 1999, Miller et al. 2001). Dogs can disrupt and displace birds, cause behavioral changes, and may kill or injure birds during instinctive chasing (Sime 1999, Miller 1994). Birds that spend a substantial amount of time on the ground such as shorebirds, grouse and waterfowl are highly susceptible to intentional and unintentional canine disturbance (Sime 1999). In Australia, even dogs on leash have been shown to reduce woodland bird abundance by 41% and bird diversity by 35%, suggesting that dogs should be excluded from sensitive conservation areas (Banks and Bryant 2007). As stated by Young et al. (2011), "[m]an's best friend may not be wildlife's best steward." More studies that scientifically assess the impacts of off leash dogs on urban wildlife, public awareness campaigns that educate owners on wildlife-dog interactions, and enforcement of state and county canine policies and leash laws would help to relieve disturbance caused by dogs (Young et al. 2011).

Invasive plants

Exotic, invasive plants such as English ivy and Himalayan blackberry degrade native ecosystems by outcompeting indigenous vegetation, creating monocultures of impenetrable relief, suffocating native plants and decreasing habitat diversity. This decrease in vegetative complexity caused by exotic, invasive plants has been shown to decrease avian species and age diversity, reduce food availability, and increase nest predation due to vulnerable nest placement in poor nesting habitat, particularly in urban areas (Astley 2010, Schmidt and Whelan 1999, Ortega et al. 2014, Ortega et al. 2006, Meister 2005, Rodewald et al. 2010, Borgmann and Rodewald 2004, Donnelly and Marzluff 2004*a*, Donnelly 2002, Marzluff and Rodewald 2008, Cleeton 2012, Miller 1994).

The benefits of native plants appear greater than those of non-native vegetation, and the practice of planting species that mimic the evolutionary environment as it was before European settlement is advisable for a number of reasons including native bird requirements, ease of maintenance, plant longevity, and habitat sustainability (Kalies and Rosenstock 2013, City of Seattle 2009). Restoration activity involving the removal of exotic vegetation and the planting of 100% native species, as stated in the City of Seattle's Native Plant Policy (City of Seattle 2009), should benefit the majority of breeding bird species, increasing habitat and avian diversity (Miller 1994).

Herbicide Use

Herbicides are selectively used to control or eliminate undesired plant species such as English ivy when manual methods are ineffective. The City of Seattle uses an integrated pest management (IPM) approach that encompasses all strategies and methods, and uses only EPA approved, low-toxicity products containing the active ingredients glyphosate, triclopyr, and imazapyr. These ingredients are broad-spectrum herbicides effective at killing invasive plants including grasses, herbaceous material, and woody vegetation.

Glyphosate is a non-selective herbicide that is absorbed rapidly through the plant leaf or stock and transported throughout the plant so that, within one to three weeks, no part of the plant survives (Glyphosate Fact Sheet 1996, Monsanto 2002). There has been extensive research on the effects of glyphosate to wildlife, including upland game birds, waterfowl, and passerine species (Sullivan and Sullivan 2000). When used according to label directions and under normal use conditions, studies have found no evidence of direct toxicity, and no adverse effects on avian reproduction or nestling development (United States EPA 1993, Giesy et al. 2000, Monsanto 2002). Rather, changes in site occupancy are the result of temporary decreases in available vegetation (Giesy et al. 2000, Monsanto 2002, Santillo et al. 1989). Similarly, changes in plant communities at treated sites have been shown to decrease invertebrate abundance and diversity, indirectly affecting avian food availability (Giesy et al. 2000, Monsanto 2002).

Triclopyer is a selective herbicide most effective at controlling broadleaf and woody plants by imitating a plant hormone causing vegetative deformation and death. After application it remains somewhat persistent in the environment and has been detected in most urban Seattle streams (Cox 2000), though bioaccumulation in the food chain appears unlikely (Tu et al. 2001). Studies indicate chronic exposure to triclopyer may be slightly toxic to birds inducing weight loss, changes in behavior, and decreased hatchling survival (Tu et al. 2001, Cox 2000). However, if used according to label instructions, the herbicide should not have negative, long term environmental implications (United States EPA 1998).

Like glyphosate, imazapyr is a non-selective systemic herbicide that is absorbed through plant leaves and roots where is accumulates and disrupts cell growth, resulting in plant death within one month of treatment (Tu et al. 2004, Cox 1996). It can remain in soil for an extended period of time – up to one year in drought conditions – but degrades quickly once it enters a water system (Tu et al. 2004). Within approved usage, imazapyr is essentially non-toxic to birds and poses minimal direct risk to birds, mammals and honeybees, with no evidence of accumulation in the animal or obvious birth defects (Tu et al. 2004, United States EPA 2006, Cox 1996). However, as with glyphosate, indirect effects based on altered plant and invertebrate availability may be present (United States EPA 2006). As such, it is suggested that herbicide treatments be applied in a mosaic pattern, leaving adjacent, untreated vegetation as refuge for negatively impacted birds and insects (Santillo et al. 1989). As early successional plants begin to colonize the area, new food resources may attract seed-eating species to treated sites (Giesy et al. 2000). With native regrowth and increased habitat complexity post-treatment, initial species re-colonization is likely to occur (Morrison and Meslow 1984), or new species will occupy the site according to available food resources and habitat (Giesy et al. 2000).

NESTING BEHAVIOR OF BREEDING BIRDS

Most birds use one of two general nesting strategies: open cup or cavity. Open cup nesters like the American Robin build nests in various habitat layers using available vegetation. Primary cavity nesters like the Pileated Woodpecker hollow out their own hole in trees, while secondary cavity nesters like the Pacific-slope Flycatcher use holes created by other species, or naturally occurring hollows (Burke et al. 2011). Open cup nest success is often less than 50%, while cavity nesting species are more productive, specifically primary cavity nesters (Burke et al. 2011, Martin and Li 1992). However, competition for space among cavity nesting species can favor non-native species such as European Starlings (Marzluff 1997, Miller 1994). Urban parks typically host more cavity and high tree nesting species, and fewer ground nesters, especially naturalized sites with less human development (Jokimaki 1999, Reale and Blair 2005, Lancaster and Rees 1979). Vegetation density is an important factor influencing food availability, cover, and nest site selection (Reale and Blair 2005). Nests built low in trees or on the ground suffer increased rates of predation and human disturbance (Jokimaki 1999, Reale and Blair 2005). The substrate used and the height at which open cup nests are built influence predation rates, indicating that species distribution within the area is partly determined by the availability of appropriate nesting habitat (Reale and Blair 2005).

The amount and diversity of available nesting habitat, as well as its distance to the forest edge, greatly influence the nesting success of forest birds (Reale and Blair 2005, Twedt et al. 2010, Bakermans et al. 2012, Manolis et al. 2002). Approximately 80% of nest failures are caused by predation; direct disturbance, abandonment, and vegetation collapse each account for less than 10% of failed nests (Donnelly and Marzluff 2004*a*, Burke et al. 2011). Nest parasitism, the deposit of foreign eggs into the nest of a different species, is another common cause of nest failure or chick mortality, whereby the unsuspecting parents feed the more aggressive foreign chick before their own (Burke et al. 2011, Marzluff 1997).

The fledging stage of the breeding period is also a dangerous time. Once chicks have left the nest, they spend the majority of their time on the ground, foraging and learning to fly. They seek areas of dense, complex vegetation for increased invertebrate resources, and protective cover (Ausprey 2010). Fledglings are highly vulnerable to exposure caused by disturbance and consequent predation.

Restored habitat positively impacts birds by increasing vegetation heterogeneity which creates appropriate nesting and fledgling habitat for a variety of species and decreases predation rates. However, temporary disturbance caused by restoration activities may not only expose nests and chicks to predation, it can also alter the behavior of nesting birds, causing increased aggression, forced nesting and/or feeding in less desirable locations (Marzluff 1997, Jokimaki et al. 2005), and ultimately, nest and/or brood failure.

Timing

Due to the risk of disturbance, it is important to practice restoration activities outside of nesting season whenever possible, i.e. between August 1 and January 31 (Altman and Hagar 2007)(Table 2). Guidelines to decrease nest disturbance and breeding bird mortality while working during nesting season are detailed in Appendix D.

Table 2. Nesting seasons (Puchy 2010)		
Non-nesting	August 1 – January 31	
Early nesting	February 1 – April 15	Larger species such as herons, geese, and raptors (owls, eagles, hawks, falcons), as well as hummingbirds. A number of early nesting species practice longer breeding cycles and will not complete reproductive activity until June or July.
Primary nesting	April 15 – July 31	The majority of songbird species. Some birds such as the Willow Flycatcher are late nesters and will not complete reproductive activity until the end of August.

Nesting Habitat Type

Nests can be built almost anywhere using natural and human-made materials. The following table outlines the places you are most likely to find nests during restoration projects and maintenance work (Table 3). A diagram of possible nest locations can be found in Appendix B.

Table 3. Nest location and vegetation type (Puchy 2010)	
Trees	Made out of sticks and other binding material, these above ground nests are usually easy to see, and disturbance is more easily avoidable.
Shrubs	The majority of open cup nesters build their nest in the shrub/understory layer of vegetation. Many species of exotic invasive plant also exist in this layer such as Himalayan blackberry and English holly.
Ground	These nests are built on the ground in dense vegetation to conceal their location.
Cavity	Cavity nesting birds use holes located in live trees, dead or dying trees, or in the ground.
Riparian	A few species including the Northern Rough-winged Swallow and Belted Kingfisher conceal their nest using burrows in stream banks or human-made structures such as pipes or building crevices.
Structure	Birds may use human-made structures that mimic the protective capabilities of their natural habitat. Urban areas tend to have high numbers of maintained bird boxes, but birds will also nest under bridges, on balconies and building ledges, under house eves, on utility poles, on fences, essentially where ever there are appropriate nest building materials, and they feel safe at the time of construction.

GUIDELINES TO AVOID HARM TO BREEDING BIRDS

Bird Protection Guidelines

When to Plan and When to Avoid Disturbance

Although there is evidence that birds may become habituated to consistent and predictable human disturbance (Fernandez-Juricic et al. 2001*a*, Marzluff 1997, Francis et al. 2009), increased frequency and intensity of disturbance have been shown to negatively impact nesting habitat use, density, and diversity (Fernandez-Juricic 2000, Marzluff 1997, Merkle 2002). The adverse effects of human disturbance to breeding birds are most pronounced early in the season during nest construction and incubation (Marzluff 1997). Birds may begin to display increased tolerance to disturbance once their territory and nest are established (Tilghman 1987), or later in the season when chicks are more mature (Mathisen 1968). With this in mind, we can designate time periods when potential nesting habitat should and should not be disturbed by restoration activities (Table 4).

<table>
<tr><th colspan="3">Table 4. When to practice restoration activities (Puchy 2010)</th></tr>
<tr><td>When to plan disturbance</td><td>August 1 – January 31</td><td>Most species have completed reproductive activities by August, or are far enough along in the breeding cycle to tolerate greater disturbance caused by restoration, including tree and invasive species removal.</td></tr>
<tr><td rowspan="2">When to avoid disturbance</td><td>February 1 – April 15</td><td>During this early nesting season, restoration activities, especially those involving trees where raptors nest, should be avoided.</td></tr>
<tr><td>April 15 – July 31</td><td>The majority of birds are nesting and/or fledgling during this time, and restoration activities should be avoided.</td></tr>
<tr><td colspan="3">Note: If a bird is located within the treatment area, check their predicted nesting season and species status in Appendix A. If listed as a species of concern by an agency, contact the appropriate state (WDFW) or federal (USFWS) authorities before proceeding.</td></tr>
<tr><td colspan="3">Note: If there are no breeding birds or active nests found within the treatment area, restoration activities may proceed with caution.</td></tr>
</table>

Restoration During Breeding Season

If restoration must take place during breeding season (February 1 – July 31), the project area and the vegetation being disturbed should be surveyed for nesting birds before work begins. If an active nest is found, it should be avoided until the young have left the nest. An active nest is defined as a nest under construction, or a nest occupied by eggs or young birds. Nests that are critical to the life history of the bird are considered active all year; this includes species that exhibit nest site fidelity such as raptors, or birds that nest in colonies. Avoidance, or setback distances from active nests are discussed below.

Establishing Protection Zones and Residual Reserves

Measures of tolerance to disturbance are often calculated according to the species' flight initiation distance (FID), the point at which a bird flees or flushes upon approach, or alert distance (AD), the point at which a bird becomes alert to approach (Whitfield et al. 2008, Taylor and Knight 2003, Fernandez-Juricic et al. 2005, Fernandez-Juricic et al. 2001*a,* Fernandez-Juricic et al. 2001*b,* Blumstein et al. 2003, Blumstein 2006, Blumstein et al. 2005, Cooke 1980). These measurements are often used by biologists, industrial and construction companies, and other entities to designate avoidance/buffer/protection zones or setback distances meant to exclude human activity from wildlife (Whitfield et al. 2008, Taylor and Knight 2003, Fernandez-Juricic et al. 2005, Fernandez-Juricic et al. 2001*a,* Fernandez-Juricic et al. 2001*b,* Blumstein et al. 2003).

Flight initiation distance and alert distance measurements are species-specific, and can be influenced by a number of additional factors including the height at which the nest is built, the availability of escape cover which increases tolerance, and the manner in which the bird is approached (Smith-Castro 2008, Blumstein et al. 2003, Blumstein et al. 2005, Fernandez-Juricic et al. 2005, Fernandez-Juricic et al. 2001*a,* Fernandez-Juricic et al. 2001*b*, Taylor and Knight 2003). A number of studies have suggested that birds approached directly have shorter flight initiation distances (flush sooner) than birds that are approached tangentially (Taylor and Knight 2003, Smith-Castro 2008). However, Fernandez-Juricic et al. 2005 found that some species show shorter flight initiation distances when approached indirectly. Similarly, many studies report that larger species have shorter flight initiation distances, and smaller species are more tolerant to disturbance (Fernandez-Juricic et al. 2001*a,* Fernandez-Juricic et al. 2001*b*, Cooke 1980), while opposing research shows increased tolerance of larger species suggesting additional factors may influence flight initiation distance such as diet preference, species sociability, and breeding age (Blumstein et al. 2005, Blumstein 2006, Marzluff 1997).

These findings further demonstrate the species-specific nature of disturbance response, illustrating the need to develop protection practices and setback distances on a case-by-case basis incorporating factors such as the location, type, size, time and duration of disturbance, the nest location, species habitat requirements, stage and duration of nesting activity, as well as the species' average flight initiation distance or alert distance (Rashin and Frye 2013, Marzluff and Ewing 2001, Houston 2013) (Table 5). Setback distances established in consideration of these factors have been shown to be effective at mitigating nest disturbance and breeding bird mortality (Rashin and Frye 2013). In some cases, physical barriers such as fences may allow birds to behave as they would in natural settings without human disturbance (Ikuta and Blumstein 2003). The mechanism works to exclude human activity and protect utilized habitat. Whether the bird views the barrier itself as protection, or whether the setback distance is perceived to offer security is not yet known (Ikuta and Blumstein 2003).

The distance a bird flies when flushed and the species' average home range size may also be used to identify areas of nearby accommodation. Short term disturbance of cavity nesting species' habitat, while temporarily decreasing nest density and species diversity, may be partially offset by residual patch retention (Machmer 2002). The existence of adjacent habitat for intermediate use should be verified prior to initiating restoration activities, and the size of the habitat to be treated and the intensity and duration of disturbance adjusted accordingly (Machmer 2002).

Federal, state, county, and/or City of Seattle regulations provide management guidelines and setback recommendations for WDFW priority species including the Bald Eagle, Great Blue Heron, Marbled Murrelet, Osprey, Peregrine Falcon, Red-tailed Hawk, and Vaux's Swift. At this time, there are no standard nest protection zones available for non-priority birds in Washington State. In this report, suggested setback distances for non-priority species are recommended based on Environment Canada's migratory bird avoidance guidelines (Environment Canada 2014). Note that these are conservative estimates that may be improved with scientific field study. Restoration stewards and technicians should use their best judgment in the field, taking into account all the factors listed in Table 5 and present at the site, in order to establish setback distances of comfort to both the bird(s) and the restoration participants.

Table 5. Factors to consider when establishing nest protection zones (Rashin and Frye 2013, Marzluff and Ewing 2001, Houston 2013)

Relating to the disturbance	Type/cause of the disturbance (e.g. manual removal, chainsaw, etc.)
	Location (e.g. high-use park, isolated site, etc.)
	Size of treatment area
	Timing (season of the year disturbance is planned)
	Duration (length of time disturbance is expected to take)
	Visibility of disturbance to birds
	Recreational impacts (frequency and intensity of human activity)
Relating to the nest	Location (e.g. tree, shrub, ground, building)
	Stage of nesting cycle (construction, incubation, nestling, fledgling)
	Duration (remaining length of time until breeding activity complete)
Relating to the species	Habitat requirements (i.e. vegetation used, average home range size, etc.)
	Average flight initiation or alert distance
	Level of habituation to human disturbance

Conducting a Nesting Bird Survey

The first step towards reducing nest disturbance and breeding bird mortality is to identify the presence and location of nesting birds within the restoration site, so that the area may be avoided and/or mitigation measures may be taken. Common techniques used to locate nesting birds are outlined in Table 6. Observers that are patient and attentive, and are familiar with the habitat and the species that use it, increase their probability of locating active nests. Nests are easier to find earlier in the season, particularly during nest construction when females are most active. Careful scanning of appropriate potential nesting vegetation in the vicinity of an active female often leads to nest discovery (Ralph et al. 1993). A breeding bird assessment form is located in Appendix C.

Breeding bird surveys should be conducted no more than 3 days prior to the start of restoration activities. If a nest is discovered after a restoration project has already begun, either in the treatment area or adjacent to it, care should be taken to avoid the nest using appropriate protection zones and/or barrier materials, and the nest should be monitored until the final nest outcome is determined (Houston 2013). Protection zones should be marked using flagging or signage. If established setback distances and/or barriers are found to be ineffective at preventing breeding bird disturbance, the mitigation strategy should be re-evaluated and adjusted accordingly by increasing the protection zone width, modifying the restoration activity schedule or method, and/or changing the type of barrier used (Houston 2013).

Most species will attempt to re-nest after a failed nest. Construction of the new nest occurs within 8-10 days of initial nest failure. The earlier in the breeding season that initial nest failure occurred, the farther apart the nesting locations may be (Ralph et al. 1993).

Table 6. Techniques used to locate nesting birds (Ralph et al. 1993)
Visually search vegetation, substrate, terrain, and human-made structures where nests are likely to be found. See Appendix B for an illustration of possible nest locations.
Visually search cavities for signs of use, such as feathers or fecal matter and white wash.
Follow birds displaying territorial behavior.
Follow birds making repeated flights to specific areas.
Follow females that disappear into a tree or shrub.
Follow birds carrying nesting materials.
Follow birds displaying courtship rituals. Copulation often occurs in the same tree, on the same branch, or in a tree adjacent to where the nest is located.
Learn the communication vocalizations of mating species and listen for these acoustic signals.
Follow birds carrying food.
Follow females foraging quickly, usually occurs during incubation and nestling stages.
Follow begging calls by nestlings.

Habitat Management Guidelines

Guidelines to avoid harm to breeding birds during the removal of specific exotic invasive plants, other managed vegetation, planting and monitoring activities, and the maintenance of human-made structures are available in matrix format in Appendix D.

GUIDELINES TO PROTECT BREEDING BIRDS IN SEATTLE FORESTS

Key Restoration Components

Forest restoration creates healthy, sustainable habitat for birds and other wildlife, adding enjoyment to human activity. The following recommendations may improve urban forest habitat, helping to reduce nest disturbance and breeding bird mortality, and increase the productivity of both resident and long distance migratory bird species that breed in Seattle forested parklands (Table 7).

Table 7. Key components for successful forest parkland restoration (Marzluff and Ewing 2001, Manuwal et al. 1998, Miller 1994, Rodewald 2001, Puchy 2010, MacDonald 2008)

Habitat Components	**Maintain connectivity** – Reduce fragmentation and promote vegetative growth between patches to increase available habitat, allow safe movement, and enable gene flow between populations.
	Maintain natural riparian areas, slopes and cliffs – These areas are natural corridors for wildlife movement within the urban matrix.
	Maintain protected interiors – Plant dense, simple-structure, semi-permeable, uninhabitable vegetation buffers around forest interiors to decrease disturbance from human recreation and exotic predators.
	Decrease the size of the treatment site – Protect more species, especially forest interior birds, by restoring smaller areas at a time.
	Create irregular edges – Feather-pattern the removal of unwanted vegetation to decrease negative edge effects.
	Create small openings in the canopy layer – Allowing sunlight to penetrate to the forest floor will promote the growth of understory layers, important for many nesting bird species.
	Leave standing deadwood (snags) – Preserve and/or create snags by girdling trees or blasting tops of trees to create valuable nesting and foraging habitat.
	Practice on-site composting – Compost rafts with decomposing invasive plant material provide good wildlife habitat; birds have been observed using compost piles after invasive blackberry stands have been removed.
	Create habitat structure – Salvage and restructure disturbed vegetation to create new habitat features such as brush piles, rock piles, perch logs, and scattered woody debris, building useful habitat niches for a variety of bird species (see MacDonald 2008 for more detailed information).
	Control exotic, invasive species – Many non-native plants outcompete with native vegetation and provide inferior habitat for native wildlife.
	Plant native vegetation – Establish a diversity of native plants creating complex habitat for a variety of species.
	Create complex structural diversity with many forest layers – Multidimensional vegetation is key to creating as many habitat niches as possible, increasing suitable habitat for a larger number of species.
	Mow less frequently and in the late summer – Increase habitat volume by allowing grasses and forbs to mature and seed. Only mow during non-nesting season to avoid breeding bird mortality.

	Control exotic predation – Off leash dogs and outdoor cats disturb birds and other wildlife, causing additive mortality and contributing to avian population declines.
	Minimize human-wildlife conflicts – Build trails, playgrounds, picnic areas, amphitheaters, etc. away from riparian and interior forest areas, and other sites with quality nesting habitat.
Human Components	**Understand bird behavior** – Learn bird songs and calls; learn what species nest in which habitats; spend more time observing birds while out in nature. Excellent introductory resources are available through Seattle Audubon Society's BirdWeb (www.birdweb.org), and the Cornell Lab of Ornithology's All About Birds (www.allaboutbirds.org) and All About Bird Biology (http://biology.allaboutbirds.org).
	Education and outreach – Teach others what you know about birds that live in Seattle, and the ways in which the public can contribute to bird protection (e.g. staying on trails, keeping dogs on leash, keeping cats indoors).
	Citizen science – Join a population monitoring program in one of eight Seattle neighborhood parks, or participate in various bird counts around Puget Sound. Visit the Seattle Audubon Society (http://www.seattleaudubon.org/sas/WhatWeDo/Science/CitizenScience.aspx) or the Puget Sound Bird Observatory (http://pugetsoundbirds.org/projects/) for more information.

Breeding Birds in Seattle Forest Types

Vegetation, management, and avian information related to Green Seattle Partnership target forest types are available in matrix format in Appendix E.

GLOSSARY

Confirmed Breeding Bird Species

Evidence of confirmed breeding activity such as brood patch or egg in oviduct, distraction display, used nest or eggshell (of positive identity), recently fledged young incapable of sustained flight, occupied nest (adults entering, leaving, or incubating, but nest contents unseen), adult bringing food to nest, adult removing fecal sac from nest, nest with eggs, nest with young seen or heard.

Disturbance

A natural or human caused event that alters the structure and composition of an ecosystem, or the behavior of species within the ecosystem. Breeding birds in urban environments are challenged by direct threats such as habitat alteration, barriers to connectivity, recreational impacts, and toxins, and indirect influences such as noise, food resource changes, increasing nest parasitism and species competition, and human-sponsored predators including off leash dogs, outdoor cats, and aggressive corvids and small mammals supplemented by bird feeders (Environment Canada 2006, Marzluff and Ewing 2001, Marzluff 1997).

Probable and Possible Breeding Bird Species

Evidence indicated probable or possible breeding activity such as multiple singing mails (7) found during one visit, pair observed in suitable habitat, territory established, singing male present at same location on two dates a week or more apart, courtship behavior, copulation, or enlarge cloacal protuberance, visiting probable nest site, agitated behavior from adults, nest building or excavation of nest cavity, species in suitable habitat during nesting season, singing male present in suitable habitat.

Restoration

Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem that has been degraded, damaged, or destroyed, with the purpose of improving habitat health, integrity, and sustainability.

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APPENDIX A: SUMMARY OF BREEDING BIRD SPECIES IN SEATTLE	**Arrival Date**				**Nesting Season**		**General Habitat Type**				**Nesting Location**					**Setback Distance[a] (meters)**	**Species of Concern[b]**			**Native/ Non-Native**	
Revised: September 2014	Resident	Early (March)	Mid (April – May)	Late (June)	Early (Feb 1 - April 15)	Primary (April 15 - July 31)	Riparian	Early Successional (0 to 15-20 years)	Mid Successional (15-20 to 60-80 years)	Late Successional (80+ years)	Tree (>20 feet)	Shrub (<20 feet)	Ground	Snag	Cavity (tree/snag or ground)		Organization	State	Federal	Native	Non-Native
American Bittern*	•					•	Wetland/marsh				Floating veg platform					30 m	•			•	
American Coot	•					•	Wetland/marsh				Floating veg platform					100 m				•	
American Crow	•				•				•		•					30 m				•	
American Dipper	•					•	•				Cliffs and bridges near fast streams					30 m				•	
American Goldfinch	•					•	•	•			•	•				30 m				•	
American Kestrel	•				•		•	•			•			•	•	100 m				•	
American Robin	•					•	•	•	•	•	•	•				30 m				•	
American Wigeon	•					•	Wetland/marsh						•			100 m				•	
Anna's Hummingbird	•				•		•					•				30 m				•	
Bald Eagle*°	•				•					•	•					122 - 244 m	•	•	•	•	
Band-tailed Pigeon*°	•				•			•	•	•	•					30 m	•			•	
Barn Owl	•				•		Grassland/forest edge				•			•	•	100 m				•	
Barn Swallow+			•			•	Open urban areas				Human-made structures.					50 m				•	
Barred Owl	•				•					•	•			•	•	100 m				•	
Belted Kingfisher	•					•	•				Burrows in banks near water.					30 m				•	

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Bewick's Wren	•					•		•					•	•	•	30 m				•	
Black-capped Chickadee+	•					•		•	•		•			•	•	30 m				•	
Black-headed Grosbeak			•			•	•	•			•					30 m				•	
Black-throated Gray Warbler*			•			•	•		•		•					30 m	•			•	
Blue-winged Teal			•			•	Wetland/marsh						•			100 m				•	
Brewer's Blackbird	•					•	•					•				30 m				•	
Brown Creeper	•					•				•	•			•	•	30 m				•	
Brown-headed Cowbird+	•					•	•	•	•		Nest parasite – deposits eggs in other birds' nests.					30 m				•	
Bullock's Oriole			•			•	•				•					30 m				•	
Bushtit	•					•	Open woods/scrubland and parks					•				30 m				•	
California Quail	•					•	Forest/scrubland edges						•			Intro. spp.					•
Canada Goose	•					•	Grassland/marshland						•			100 m				•	
Cassin's Vireo*			•			•		•				•				30 m	•			•	
Cedar Waxwing	•					•	•	•			•					30 m				•	

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Chestnut-backed Chickadee+	•					•				•	•			•	•	30 m				•	
Chipping Sparrow*+		•				•		•	•		•	•				30 m	•			•	
Cinnamon Teal		•				•	Wetland						•			100 m				•	
Cliff Swallow		•				•	Cliffs and human-made structures near water				Cliffs and human-made structures near water					50 m				•	
Common Merganser	•				•		Forested lakes and rivers				•			•	•	100 m				•	
Common Nighthawk				•		•	•	•					•			30 m				•	
Common Yellowthroat		•				•	•	•				•	•			30 m				•	
Cooper's Hawk*	•				•		•	•	•	•	•					100 m	•			•	
Dark-eyed Junco+	•					•		•	•	•			•			30 m				•	
Downy Woodpecker	•				•					•	•			•	•	50 m				•	
European Starling	•					•		•			•			•	•	Intro. spp.					•
Evening Grosbeak	•					•			•	•	•					30 m				•	
Gadwall	•					•	Ponds and marshland						•			100 m				•	
Glaucous-winged Gull	•					•	Shoreline				Cliffs and human-made structures					200 m				•	
Golden-crowned Kinglet+	•					•			•	•	•					30 m				•	

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Great Blue Heron°	•				•					•	•					152 m				•	
Great Horned Owl	•				•				•	•	•			•	•	100 m				•	
Green Heron	•					•	Wetland/marsh				•	•				100 m				•	
Green-winged Teal	•					•	Wetland/marsh						•			100 m				•	
Hairy Woodpecker	•					•				•	•			•	•	50 m				•	
Hammond's Flycatcher*			•			•	•		•	•	•					30 m	•			•	
Hooded Merganser*°	•				•		Forested lakes and rivers				•			•	•	100 m	•			•	
House Finch	•					•	Open urban areas				•					30 m				•	
House Sparrow+	•					•	Near human development				•	•		•	•	Intro. spp.					•
House Wren			•			•	•	•	•		•			•	•	30 m				•	
Hutton's Vireo	•					•			•		•	•				30 m				•	
Killdeer+	•				•		Grassland species						•			30 m				•	
Mallard	•				•		Wetland						•			100 m				•	
Marbled Murrelet*	•					•				•	•					805 m	•	•	•	•	
Marsh Wren	•				•		Marshland					•				30 m				•	

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Mourning Dove	•				•		Forest/urban edge				•		•			30 m				•	
Northern Flicker	•				•		•	•	•		•			•	•	50 m				•	
Northern Rough-winged Swallow		•				•	•						•		•	30 m				•	
Northern Shoveler	•					•	•						•			100 m				•	
Olive-sided Flycatcher+			•			•		•	•	•	•					30 m				•	
Orange-crowned Warbler+	•					•	•	•					•			30 m				•	
Osprey		•			•		•				•			•		70 - 200 m				•	
Pacific Wren	•					•			•	•			•	•	•	30 m				•	
Pacific-slope Flycatcher*			•			•	•		•	•		•				30 m	•			•	
Peregrine Falcon*°	•				•			•			Cliffs and human-made structures					400 - 800 m	•	•	•	•	
Pied-billed Grebe	•					•	•						•			100 m				•	
Pigeon Guillemot	•					•	Rocky shoreline				Cliffs and human-made structures					200 m				•	
Pileated Woodpecker*°	•				•					•	•			•	•	50 m	•	•		•	
Pine Siskin+	•					•		•	•	•	•					30 m				•	
Purple Finch	•					•		•	•		•					30 m				•	

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Purple Martin*°			•			•	•				Cavity in nest boxes or snags near/over water					30 m	•	•		•	
Red Crossbill+	•				All year					•	•					30 m				•	
Red-breasted Nuthatch	•					•				•	•			•	•	30 m				•	
Red-eyed Vireo+			•			•	•		•			•				30 m				•	
Red-tailed Hawk	•				•		•	•	•		•					100 - 200 m				•	
Red-winged Blackbird	•				•		•					•				30 m				•	
Ring-necked Duck	•					•	Ponds and marshland						•			100 m				•	
Ring-necked Pheasant+°	•				•		Grassland species						•			Intro. spp.					•
Rock Pigeon	•				All year		Cliffs and human-made structures				Cliffs and human-made structures					Intro. spp.					•
Ruddy Duck	•					•	•						•			100 m				•	
Rufous Hummingbird*+		•			•		•	•	•			•				30 m	•			•	
Savannah Sparrow+	•					•	Grassland species						•			30 m				•	
Sharp-shinned Hawk	•					•	•	•	•	•	•					100 m				•	
Song Sparrow	•					•	•	•				•				30 m				•	

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Sora			•			•	Wetland/marsh				Floating veg platform					30 m				•	
Spotted Sandpiper	•					•	Shoreline						•			30 m				•	
Spotted Towhee	•					•	•	•					•			30 m				•	
Steller's Jay	•					•			•	•	•					30 m				•	
Swainson's Thrush			•			•	•	•	•	•		•	•			30 m				•	
Townsend's Warbler	•					•				•	•					30 m				•	
Tree Swallow			•			•	•				•			•	•	30 m				•	
Vaux's Swift*°			•			•	•			•	•			•	•	30 - 500 m	•	•		•	
Violet-green Swallow			•			•	•				•			•	•	30 m				•	
Virginia Rail	•					•	Marshland						•			30 m				•	
Warbling Vireo			•			•	•	•			•	•				30 m				•	
Western Screech-Owl	•				•		•	•			•			•	•	100 m				•	
Western Scrub-Jay	•				•		Oak woodlands and urban areas					•				30 m				•	
Western Tanager			•			•	•		•	•	•					30 m				•	
Western Wood-Pewee			•			•	•	•			•	•				30 m				•	

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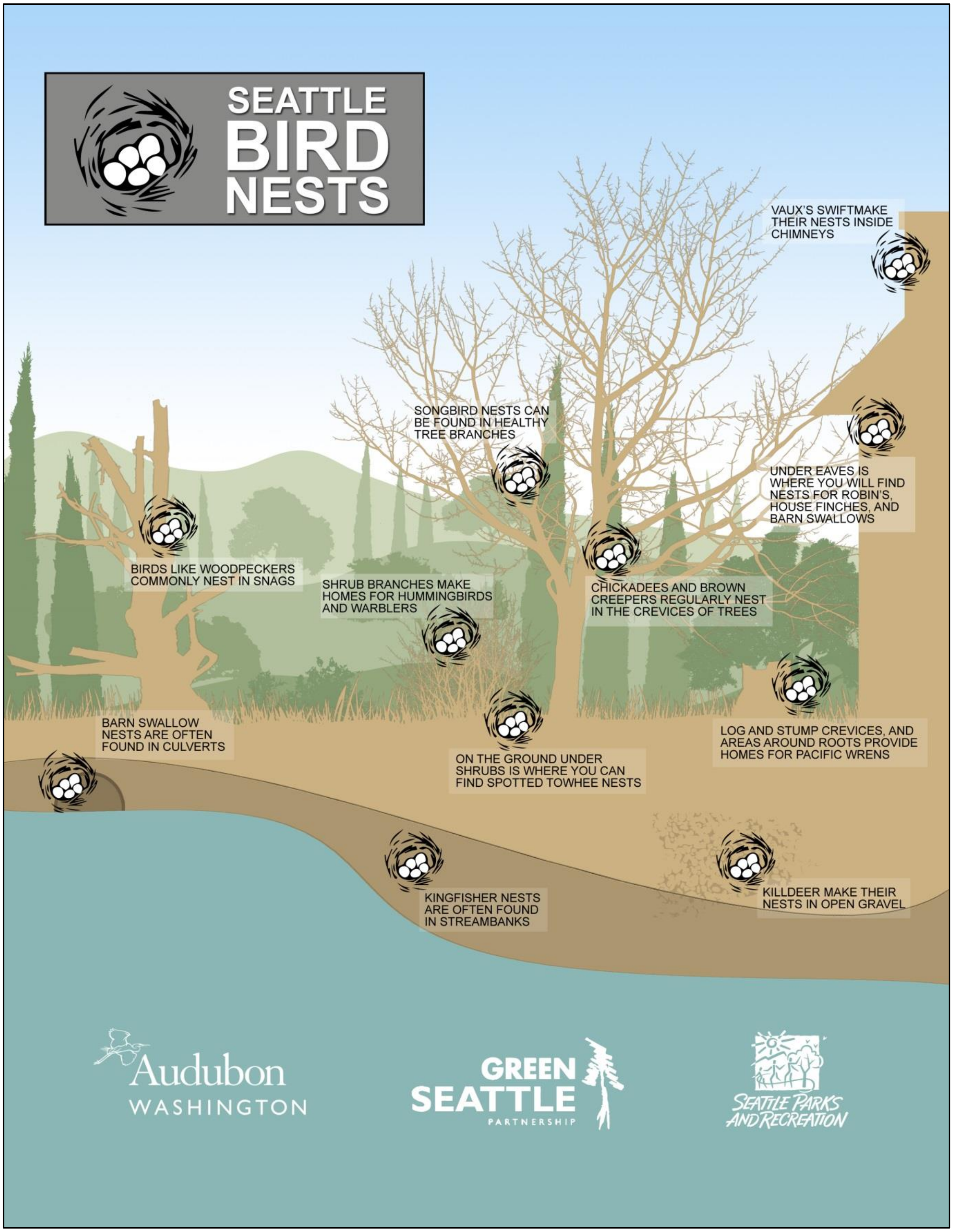
White-crowned Sparrow	•					•	Forest/shrub edges with bare ground					•				30 m				•	
Willow Flycatcher*+			•			•	•	•				•				30 m	•			•	
Wilson's Snipe	•					•	Wetland/marsh						•			30 m				•	
Wilson's Warbler+			•			•	•	•	•	•		•	•			30 m				•	
Wood Duck°	•				•		Forested lakes and rivers				•			•	•	100 m				•	
Yellow Warbler*			•			•	•	•				•				30 m	•			•	

+ Breeding Bird Survey data indicate declining population trends.
*** Status of species is of concern to agency and/or organization.**
° WDFW priority bird species. See management recommendations at http://wdfw.wa.gov/publications/00026/
a **Recommendations by various agencies (see page 24). Setback distance may also be calculated based on observed flight initiation distance (FID) and adding an additional 130-170 feet (about half a meter) to the FID (Bentrup 2008). Refer to Table 5 for additional factors to consider when establishing nest protection zones.**
b **If listed by an agency, contact the appropriate state (WDFW 360.902.2534) or federal (USFWS 360.753.9440) authorities before proceeding.**

GREEN = Confirmed Breeding Bird Species in Seattle (75)
BLUE = Probable and Possible Breeding Bird Species in Seattle (34)

APPENDIX B

ILLUSTRATION OF POSSIBLE NEST LOCATIONS



APPENDIX C

BREEDING BIRD ASSESSMENT REPORT

Logistics
Name of assessor:
Date:
Time:
Site:

Planned Restoration Activity
Restoration phase:
Vegetation to be affected:
Tools to be used:
Project dates (duration):

Bird Observations

Species	# of birds obs.	Breeding Behavior[a]	Habitat/Vegetation	FID[b]	Location Relative to Project Site	Notes
unknown	2	pair	shrub/oceanspray	15 m	middle	yellow breast, chatty

[a]*Breeding Behavior Codes:*

song = singing adult
displ. = courtship or territorial display
alarm = alarm call
pair = pair observed
copl. = copulation
forag. = foraging
mat. carry = carrying nesting material
food carry = adult carrying food or fecal sac

[b]Flight initiation distance – approximate distance between the bird and the observer if/when the bird flushed.

Nest Observations

Species	Habitat/Vegetation	Nest Stage[a]	Location Relative to Project Site	Protection Zone Possible	FID[b]	Notes
owl spp.	tree cavity	incub.	adjacent	yes	n/a	

[a]*Nest Stage Codes:*

build = under construction
incub. = incubating
nest = nestling
fledge = fledgling
old = old/unused/abandoned

[b]Flight initiation distance – approximate distance between the bird and the observer if/when the bird flushed.

Concerns or recommendations before proceeding (use back of page): ______________________

____

APPENDIX D: HABITAT MANAGEMENT GUIDELINES FOR BREEDING BIRDS IN SEATTLE *Revised: September 2014*				
INVASIVE SPECIES REMOVAL				
Species	**Non-nesting season August 1 – January 31**	**Early nesting season February 1 – April 15**	**Primary nesting season April 15 – July 31**	**Watch For**
English Ivy (Ground) *Hedera helix*	Herbicide treatment and hand pulling ok.	Herbicide treatment and hand pulling ok.	Avoid disturbance if nesting species present. Hand pull with caution.	Spotted Towhee, Winter Wren
English Ivy (Tree) *Hedera helix*	Survival ring and manual section removal ok.	Vine cutting ok, but leave vines in tree.	Vine cutting ok, but leave vines in tree.	American Robin, Vireo species
Blackberry *Rubus armeniacus* (Himalayan) *Rubus laciniatus* (Evergreen)	Herbicide treatment, mechanical removal and hand pulling ok.	Herbicide treatment, mechanical removal and hand pulling ok.	Avoid disturbance if nesting species present. Hand pull with caution.	All species, esp. early-nesting Anna's Hummingbird and late-nesting Willow Flycatcher*+
Clematis *Clematis orientalis*	Vine cutting and manual root removal ok.	Vine cutting and manual root removal ok, but avoid pulling down vines.	Vine cutting ok, but avoid root removal and pulling down vines.	Spotted Towhee, Winter Wren
Field Bindweed (Morning Glory) *Convolvulus arvensis*	Herbicide treatment and hand pulling ok.	Herbicide treatment and hand pulling ok.	Avoid disturbance if nesting species present. Hand pull with caution.	Seed-eating species, esp. waterfowl
Garlic Mustard *Alliaria petiolata*	Herbicide treatment and hand pulling ok.	Herbicide treatment and hand pulling ok.	Selective herbicide treatment and hand pull with caution.	Ground nesting species, esp. Killdeer+, and ducks
English Holly and English Laurel *Ilex aquifolium* (Holly) *Prunus laurocerasus* (Laurel)	Herbicide treatment and injection ok; mechanical removal and hand pulling ok.	Mechanical removal and hand pulling ok.	Avoid disturbance if nesting species present. Mechanical removal and hand pull with caution.	American Robin
English Hawthorne *Crataegus laevigata*	Herbicide treatment and injection ok; mechanical removal and hand pulling with caution.	Girdling ok. Avoid tree removal if nesting species present.	Avoid disturbance if nesting species present.	Cedar Waxwing, American Robin, late-nesting Willow Flycatcher*+

Scotch Broom *Cytisus scoparius*	Herbicide treatment, mechanical removal and hand pulling ok.	Herbicide treatment, mechanical removal and hand pulling ok.	Herbicide treatment, mechanical removal and hand pulling ok.	
Knotweed** *Fallopia japonica*	Herbicide treatment and injection ok.	Herbicide treatment and injection ok.	Herbicide treatment and injection ok.	
OTHER VEGETATION REMOVAL				
Type	**Non-nesting season** **August 1 – January 31**	**Early nesting season** **February 1 – April 15**	**Primary nesting season** **April 15 – July 31**	**Watch For**
Live Tree	Girdling and tree removal ok.	Girdling ok. Avoid tree removal if nesting species present.	Girdling ok. Avoid tree removal if nesting species present.	All species, esp. early-nesting Anna's Hummingbird and raptor species
Snag (Dead Tree)	Removal ok.	Avoid removal if nesting species present.	Avoid removal if nesting species present.	Cavity-nesting species and raptor species
Shrub	Removal ok.	Remove with caution.	Avoid removal if nesting species present.	All species, esp. early-nesting Anna's Hummingbird and ducks
Mowing and Ground Cover	Mowing and removal ok.	Mow and remove with caution.	Avoid mowing and removal if nesting species present.	Ground nesting species, esp. Savannah Sparrow+, Killdeer+, and ducks
PLANTING AND MONITORING ACTIVITIES				
Type	**Non-nesting season** **August 1 – January 31**	**Early nesting season** **February 1 – April 15**	**Primary nesting season** **April 15 – July 31**	**Watch For**
Planting	Planting ok.	Planting ok.	Planting ok.	Any species occupying habitat adjacent to the treatment site.
Plant establishment and watering	Weeding, watering and mulching ok.	Weed with caution. Avoid if nesting species present.	Water and mulch with caution. Avoid if nesting species present.	Ground nesting species during early growing season weeding.
Site monitoring and vegetation measuring	Monitoring and measuring ok.	Monitoring and measuring with caution. Avoid if nesting species present.	Monitoring and measuring with caution. Avoid if nesting species present.	Consider recording observed bird and wildlife use at the site.

OTHER MAINTENANCE				
Type	**Non-nesting season August 1 – January 31**	**Early nesting season February 1 – April 15**	**Primary nesting season April 15 – July 31**	**Watch For**
Structural and Building	Removal and maintenance ok if no species roosting. If roosting, flush bird(s) and encourage/observe roosting elsewhere prior to disturbance.	Avoid if nesting species present.	Avoid if nesting species present.	Osprey*, Barn Owl, Vaux's Swift+, Cliff Swallow, Barn Swallow+, House Finch

**** GSP staff and paid technicians only. Volunteers are not permitted to remove knotweed.**

*** Status of species is of concern to agency and/or organization.**

+ Breeding Bird Survey data indicate declining population trends.

APPENDIX E: BREEDING BIRDS IN SEATTLE FOREST TYPES

Revised: September 2014

Target Forest Type*	Target Vegetation Structure				Management Notes	Bird Notes
	Canopy	**Sub-canopy**	**Understory/Shrub Layer**	**Herbaceous Layer**		
Douglas-fir - Pacific madrone / salal	Douglas-fir	Pacific madrone	Salal, oceanspray	Braken and Sword fern	Historically fire. More research on combatting madrone fungus required.	Many species enjoy madrone fruit such as band-tailed pigeon, northern flicker, cedar waxwing, evening grosbeak, mourning dove and American robin. Oceanspray supports insects for bushtit and chickadees.
Douglas-fir - Pacific madrone / oceasnspray / honeysuckle	Douglas-fir	Pacific madrone	Oceanspray, honeysuckle, snowberry	Minimal forbs	Historically fire. More research on combatting madrone fungus required.	Northern flicker, American robin, cedar waxwing, black-eyed junco, Swainson's thrush, grosbeaks, finches and warblers enjoy honeysuckle fruit, and tubular flowers with nectar attract hummingbirds.
Douglas-fir - Pacific madrone / evergreen huckleberry	Douglas-fir	Pacific madrone	Salal, evergreen huckleberry, oceanspray, hazelnut, honeysuckle	Minimal braken and sword fern	Historically fire. More research on combatting madrone fungus required.	Pheasant, mourning dove, northern flicker, cedar waxwing, American robin, western tanager, spotted towhee, jays, sparrows and chickadees eat huckleberry fruit.

APPENDIX E: BREEDING BIRDS IN SEATTLE FOREST TYPES

Revised: September 2014

Target Forest Type*	Target Vegetation Structure				Management Notes	Bird Notes
	Canopy	**Sub-canopy**	**Understory/Shrub Layer**	**Herbaceous Layer**		
Bigleaf maple - red alder / sword fern - fringecup	Bigleaf maple, red alder, some Douglas-fir		Sword fern, fringecup, oceanspray, salmonberry, elderberry; Minimal western hemlock and cedar	Stinging nettle, Columbia brome, thimbleberry, trailing blackberry, licorice fern	Maple does well with mass disturbance. High invasion by English ivy and Himalayan blackberry.	Habitat attractive to Pacific-slope flycatcher. Bigleaf maple supports insects for woodpeckers, red-breasted nuthatch and song sparrow. Red alder provides seeds and insects for waterfowl, bushtit, golden-crowned kinglet, pine siskin, northern flicker, downy woodpecker, vireos, warblers and chickadees. Deciduous canopy, understory, and shrub layer preferred by black-throated gray warbler, Wilson's warbler, and orange-crowned warbler, respectively.

APPENDIX E: BREEDING BIRDS IN SEATTLE FOREST TYPES

Revised: September 2014

Target Forest Type*	Target Vegetation Structure				Management Notes	Bird Notes
	Canopy	Sub-canopy	Understory/Shrub Layer	Herbaceous Layer		
Douglas-fir - salal / sword fern	Douglas-fir, sometimes Bigleaf maple		Salal, oceanspray, hazelnut, Oregon grape, snowberry	Sword and bracken fern, bedstraw, starflower, fescue	Historically fire and logging. English ivy threat.	Red crossbill and pine siskin eat Douglas-fir seeds. Douglas fir supports insects eaten by red-breasted nuthatch, brown creeper, chickadees, and woodpeckers. Townsend's warbler and Hammond's flycatcher indicate Douglas-fir dominated habitat.
Douglas-fir - western hemlock / salal - dwarf Oregon grape	Douglas-fir, western hemlock, cedar		Salal, Oregon grape, vine maple, trailing blackberry, huckleberry, rose	Sword and bracken fern	Historically fire. Disturbance good for Douglas-fir, decreases hemlock and cedar. Moderately low tree growth.	Western hemlock seeds consumed by dark-eyed junco, pine siskin, red crossbill, chickadees and finches, and provide insects for pileated woodpeckers.
Douglas-fir - western hemlock / salal / sword fern	Douglas-fir, western hemlock, cedar	Sometimes Bigleaf maple	Salal, Oregon grape, vine maple, trailing blackberry, huckleberry, oceanspray, rose	Sword fern, sometimes bracken fern, starflower, bedstraw	Historically fire. Disturbance good for Douglas-fir, decreases hemlock and cedar. Sometimes produces red alder. Moderate tree growth. English ivy threat.	Sword fern is Wilson's warbler preferred nesting vegetation. Red-breasted nuthatch, grosbeaks, woodpeckers and finches eat vine maple seeds.

APPENDIX E: BREEDING BIRDS IN SEATTLE FOREST TYPES

Revised: September 2014

Target Forest Type*	Target Vegetation Structure				Management Notes	Bird Notes
	Canopy	**Sub-canopy**	**Understory/Shrub Layer**	**Herbaceous Layer**		
Douglas-fir - western hemlock / dwarf Oregon grape / sword fern	Douglas-fir, western hemlock, cedar	Sometimes Bigleaf maple	Oregon grape, vine maple, huckleberry, trailing blackberry, salal	Sword fern, bedstraw, starflower	Historically fire. Disturbance good for Douglas-fir, decreases hemlock and cedar. Disturbance produces red alder. Productive tree growth. English ivy and Herb Robert threats.	Oregon grape and salal fruit eaten by cedar waxwing, spotted towhee, Swainson's thrush, band-tailed pigeon, pheasants and other ground-feeding species.
Western red cedar - western hemlock / devils club / sword fern	Western red cedar and western hemlock. Some Douglas-fir	Bigleaf maple	Devils club, salmonberry, red elderberry, red huckleberry, vine maple, Indian plum	Sword fern, lady fern, bedstraw	Historically fire and flooding. Disturbance produces red alder and salmonberry. Moderate tree growth. English ivy and Herb Robert threats.	Grosbeaks, sparrows, cedar waxwing, red-breasted nuthatch, and pine siskin eat western red cedar seeds. Salmonberry flowers attract bees and hummingbirds. Salmonberry is preferred nesting habitat for Swainson's thrush. Elderberry provides fruit for sparrows, warblers, jays, grosbeaks, woodpeckers, Swainson's thrush, western tanager, and band-tailed pigeon.

APPENDIX E: BREEDING BIRDS IN SEATTLE FOREST TYPES

Revised: September 2014

Target Forest Type*	Target Vegetation Structure				Management Notes	Bird Notes
	Canopy	Sub-canopy	Understory/Shrub Layer	Herbaceous Layer		
Oregon white oak - Douglas-fir / common snowberry / sword fern	Oregon oak, Douglas-fir		Snowberry, trailing blackberry, tall Oregon grape, Indian plum, serviceberry, beaked hazelnut, baldhip rose	Sword fern	Historically rare. An intermediate seral stage between oak-dominate communities and outcompeting Douglas-fir forest types. Must thin or remove Douglas-fir to preserve oak.	Oregon white oak acorns used by wood duck, mallard, band-tailed pigeon, spotted towhee, red-breasted nuthatch, woodpeckers and jays. Snowberry provides fruit for cedar waxing and nectar for hummingbirds. Fruit eating birds enjoy rosehips into winter.

*** Target forest types are consistent with a statewide effort to characterize the plant associations that naturally occur in forest ecosystems in the Puget Trough Ecoregion. Plant associations are named by dominant plant species (the dashes in the names separate trees, shrubs and herbs in the same canopy layer; slashes in the names separate species in different canopy layers).**