



PORTLAND PARKS & RECREATION
Healthy Parks, Healthy Portland



Forest Park Wildlife Report

December 2012

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Sustaining a healthy park and recreation system to make Portland a great place to live, work and play.

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COVER PHOTOS:

Coastal cutthroat trout, Melissa Brown
Coastal giant salamander, John Deshler
Haplotrema vancouverense, Bruce Marcot
Wilson's warbler, Scott Carpenter
Pterostichus lama, Jim LaBonte
Spotted skunk, Dan Richardson
Heptageniid, Patrick Edwards
Douglas squirrel (*Tamiasciurus douglasii*)

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Black-headed grosbeak
(Photo: Scott Carpenter)

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Red-legged frog

Executive Summary



Introduction and Objectives

The primary objectives of this report are to provide both a broad description of Forest Park wildlife and detailed species information based on the best available data, whether historical, recent, anecdotal, or rigorously collected via research. Other major goals of this report are to

- identify gaps in our wildlife knowledge,
- identify threats to wildlife, and
- define next steps in the research and management of wildlife that could close important gaps and mitigate threats.

Interest in Forest Park wildlife began with the park's founding, and the goal of preserving and attracting wildlife was emphasized in the *Forest Park Natural Resources Management Plans* (1976, 1995) and the *Forest Park Ecological Prescriptions* (2011). Wildlife concerns in the park came to the forefront in 2010 during meetings about potentially increasing recreational trails in the park.

Park Description and Key Wildlife Habitat Components

Forest Park is a 5,100-acre forested preserve, and is divided into three management units: south, central, and north. Per the 1995 *Forest Park Natural Resources Management Plan*, wildlife and ecological concerns are a priority throughout the park, and the balance of recreation and wildlife concerns follows a gradient such that recreation is of a higher priority in the south unit than in the north.

The park forms a narrow extension of Oregon's Coast Range. The park is bounded by urban, rural, and industrial development and somewhat fragmented by roads and powerline corridors. Park wildlife are therefore a combination of species that are native to the Coast Range ecosystem and other species that are associated with human disturbance. *Interior Forest*, a Special Status Habitat in the Portland metropolitan area, dominates the park landscape. The most abundant and well-distributed vertebrate species in the park are associated with forest interior habitat. Seven major streams cut the full width of the park; a few are perennial and support fish and aquatic mollusks.

Wildlife habitat in the park has been influenced by historical logging and fires. These disturbances created a patchwork of deciduous, coniferous, and mixed stands, which affects wildlife distributions. Some terrestrial wildlife species are associated with

either coniferous or deciduous habitat. Fire and logging have not recurred since soon after the park was created. Forest regrowth in the past 65 years has produced a mature canopy throughout the park, excluding the powerline corridors. As the forest matured, species such as the pileated woodpecker returned. Powerline corridors are dominated by native shrubs and ground cover and are habitat for shrub-nesting birds, grazing mammals, insectivores, and pollinators such as hummingbirds, beetles, bees, and bats. Habitat alteration beyond the park boundary continues today and affects the ability of terrestrial mammals to disperse and immigrate, and reduces foraging habitat for some species. Some species are no longer present due to habitat alterations.

Late-successional conifer stands containing old-growth remnants occur in all units. Mature conifer forests are structurally complex ecosystems and are important for many native wildlife species. Older stands tend to hold a greater abundance of key wildlife habitat components including standing dead trees (snags), large broken-top trees, and fallen trees (coarse woody debris). These structures are important to all wildlife classes.

Wildlife Information

Most of the wildlife information for Forest Park comes from the past 17 years during which many graduate student research projects; federal, state, and city agency research efforts; and citizen science surveys have provided great insight into the diversity, relative abundance, distribution, and population trends of park wildlife. Valuable information on park wildlife and habitat are also found in historical documents, such as the writings of Lewis and Clark and the 1901 *Park Commission Report*, as well as reports, research, and observational accounts from the intermediate past, 1980–1995.

For each wildlife species the focus has been on the following qualities:

- Presence or absence
- Breeding status
- Relative abundance
- Distribution
- Special-status concerns

Vertebrate wildlife diversity is dominated by 104 avian and 45 mammalian species; of these about 30% have been identified by the City of Portland as Terrestrial Ecology Enhancement Strategy (TEES) Special Status Species and few are non-native. However,

many bird and mammal species are only seasonally present, rare, or nocturnal, or occur naturally at low density, and are seldom experienced by park visitors. In contrast to birds and mammals, few species of amphibian, reptile, and fish inhabit the park. All the fish, reptiles, and amphibians that do occur in the park are native species. The amphibian species tend to be well-distributed, abundant residents. Among vertebrate species, eight are federal species of concern, one is threatened, and the northern spotted owl is federally endangered.

A variety of methods have been used to catalog mammalian diversity in the park including capture-based research, motion-detection camera surveys, owl prey analyses, and observational accounts by park staff, users, and neighbors. About two-thirds of the 65 mammal species known to occur in Oregon's Coast Range are also known to occur in Forest Park, and about 30 species breed there; 19 mammalian species are considered abundant and well-distributed in the park and most of these are small terrestrial mammals. Mammalian diversity in the park is dominated by bats, rodents, and carnivores. Most of the park's mammalian wildlife species are some combination of nocturnal, small, arboreal (tree-dwelling), or fossorial (burrowing), and are seldom seen by park visitors. Exceptionally, the Douglas squirrel and Townsend's chipmunk are common diurnal mammals often seen near trails. Two of the most abundant mammals are the deer mouse and Trowbridge's shrew, and these are important food resources for many carnivores and owls. In contrast, some large rodent and carnivore species, such as the porcupine and black bear, are rarely found in the park. Deer and elk occur in the park, but only deer are common year-round residents. Elk occur seasonally, typically in low numbers, and appear to rely heavily on external resources beyond the park perimeter for foraging and breeding. Most of the bat species that occur or may occur in the park are special-status species. However, the distribution, abundance, breeding status, circannual patterns, and habitat use of bats in Forest Park is poorly understood. The few non-native mammals are rats and squirrels, and these are typically found near the residential park perimeter. Some other mammalian species—particularly woodrats, tree voles, and pocket gophers—are considered absent from the park though they are at least somewhat likely to occur based on forest and riparian habitat associations. The red tree vole and the dusky-footed and bushy-tailed woodrats are candidates for reintroduction.



Hillside north of Balch Creek

Executive Summary



Robin's nest

Information on birds in Forest Park comes from the Portland Christmas Bird Count, natural areas management reports, academic research projects, the Bureau of Environmental Services stream monitoring, citizen science projects, local bird and wildlife experts, and the U.S. Fish and Wildlife Service bald eagle monitoring program. A dozen bird species are rare and many others are uncommon. Birds are the most conspicuous wildlife class because they are vocal, diurnally active, and abundant. The sights and sounds of up to three dozen of the most common, well-distributed, and strident bird species will define most visitors' experience with Forest Park wildlife. Of all the wildlife species, perhaps the most vocal and prominent year-round resident is the tiny Pacific wren.

Ten avian families each contribute four or five species toward the park's breeding avifauna. Some of the flycatchers, vireos, and warblers are localized to a few sites, but many avian species thrive in the extensive forest interior habitat. Relative to some other regional natural areas, Forest Park has *lower* overall avian diversity, but a *higher* diversity of TEES Special Status Species. The relatively low avian diversity is attributable to low habitat diversity—the park is mostly a broad swath of interior forest. One-third of Forest Park's birds are special-status species and several of these are among the most abundant birds in the park. Long-term data collected in recent years indicate that nearly three dozen species of common birds—including chickadees, sparrows, kinglets, and thrushes—are experiencing population declines within the park. At the state level, at least 17 Forest Park species show evidence of population decline across broader Oregon, despite their apparent abundance in the park. A few species, such as the pileated woodpecker and purple finch, show recent evidence of population increases in the park.

Relatively few species of amphibian, reptile, and fish occur in the park. This is likely due to a lack of perennial standing water, springs, and ponds. Six amphibians are well distributed and abundant in the park in a combination of stream, riparian, and upland habitats. Most amphibians, like reptiles and fish, are silent, small, and elusive, and go unnoticed by park visitors. Some regionally common amphibian species are not found in the park or are localized to just a few sites due in part to a lack of ponds for breeding or a lack of wetlands.

Only a single fish species, a small sculpin, is a well-distributed breeder in the park. An isolated population of cutthroat trout breeds in Balch Creek, and a few cutthroats also breed in Miller Creek. Fingerling-sized coho salmon and steelhead are occasionally found in the lowest reaches of Miller Creek, suggesting that adult salmon also breed there. Other regional fish species are restricted by grated culverts, which physically exclude them from park streams.

No extensive surveys for reptiles have been completed in Forest Park, and only garter snakes are considered common and well distributed, mostly in sunlit powerline corridors and at the park perimeter.

Twenty-three species of terrestrial and aquatic mollusks occur in Forest Park. Most are native species, and several are common and well distributed. Mollusks are the most abundant class of terrestrial animals after insects. Slugs, snails, and microsnails contribute relatively equally toward terrestrial mollusk diversity, with snails being the most abundant group. Mollusks are important decomposers in the forest ecosystem, and are food for other wildlife such as coastal giant salamanders and barred owls.

Invertebrate animal species make up approximately 97% of the diversity of animals worldwide. Arthropods, a group that includes insects, arachnids, millipedes, centipedes, and crustaceans, are the most diverse and abundant invertebrate group in Forest Park. Great strides were made in 2012 to document the diversity of arthropods in Forest Park. More than 400 species of insects are currently known to occur. Beetles and moths contribute at least 340 species and dominate insect diversity, as they do worldwide. Within Balch Creek, diversity of invertebrates is relatively evenly split between the families of stoneflies, caddisflies, mayflies, and true flies, but mayflies are especially abundant there. Despite a substantial recent increase in our knowledge of Forest Park arthropod diversity, much remains to be known, and the diversity of these animals is likely to greatly exceed current figures. The diversity found during the 2012 BioBlitz for Forest Park Wildlife showed little overlap with years of data collected by Oregon Department of Agriculture and U.S. Department of Agriculture surveys, suggesting that additional surveys would substantially broaden our knowledge of arthropod diversity. In contrast to vertebrate wildlife groups, many arthropod species in the park are non-native. The number and impact of non-native species is poorly understood. About 10% of the insects and arachnids in the park have their origins in Europe and Asia.



Snail found during 2012 BioBlitz



Invasive Garlic mustard

Threats to Forest Park Wildlife

The 1995 *Forest Park Natural Resources Management Plan* states that the establishment of an ancient forest ecosystem and the protection of wildlife communities are primary management goals. Several factors threaten the preservation of wildlife and their habitat in the park:

- Climate change
- Non-native invasive plants
- Non-native invasive insects and other wildlife
- Habitat alteration outside of the park
- Utility corridor management (habitat alteration within the park)
- Illegal park activities: homeless camps, rogue trails, nocturnal recreation
- Domestic cats at the park perimeter
- Air pollution
- Water quality degradation in Balch Creek
- Parasites, poisons, and persecution
- Fire and fire management

Some threats have been partially addressed through management actions such as the ongoing removal of invasive plants and the addition of staff and volunteer park rangers to enforce park regulations. Threats such as climate change are global in scale and preserving wildlife in the face of this and other challenges will require an adaptive management strategy.

Gaps and Next Steps

For some wildlife taxa, the following basic information is lacking:

- Diversity (presence or absence)
- Abundance
- Breeding
- Habitat use
- Distribution
- Seasonality
- Population trends
- Ecology and threats to forest health

Important gaps are made clear from the available data on park wildlife. This is especially true for invertebrate animals, about which fundamental questions of diversity remain, and which are important to all aspects of park ecology. In other cases, knowledge gaps are more complex.

Stemming the pattern of ongoing loss of species, especially of birds and mammals, is a core concern of the recommended next steps.

Academic research projects, partnerships with regional agencies and other city bureaus, citizen science projects, and Portland Parks & Recreation (PP&R) actions will be necessary to fill gaps in our understanding of park wildlife.

Gaps:

Mammals

1. Mammalian population trends and annual cycles of abundance
2. Bat abundance, breeding status, and habitat use
3. Source of red and gray fox decline
4. Meso-rodent diversity
5. Elk habitat use and movements
6. Feasibility of woodrat and vole reintroduction
7. Porcupine abundance and habitat use

Birds

8. Avian population trends beyond the southern boundary
9. Source of known avian population declines
10. Source of the loss of landfowl. Feasibility of landfowl reintroduction
11. Special-status bird population dynamics for *common* and *uncommon* species

Reptiles

12. Rubber boa occurrence or absence

Amphibians

13. Red-legged frog breeding habitat access
14. Pond breeding habitat beyond the southern boundary
15. Northwestern salamander occurrence
16. Amphibian population trends

Mollusks

17. European red slug impacts

Arthropods

18. Arthropod diversity
19. Non-native arthropod impacts and abundance
20. Population trends among common species and threats to forest health

Wildlife response

21. To habitat restoration
22. To utility corridor management
23. To park users and dogs
24. To expansion of the trail system
25. To illegal park activities

Wildlife habitat assessment

26. Relative abundance of snags in the three management units
27. Coarse woody habitat volume
28. Regional habitat use by park species that forage and/or breed beyond the park boundary

Summary

The data currently available on Forest Park wildlife are fairly robust and cover many taxonomic groups and habitat components. Forest Park supports a diversity of vertebrate wildlife that is dominated by birds. Songbirds and a few diurnal squirrels are the wildlife most commonly experienced by park visitors. Many of the park's birds are special-status species and many bird species are in decline, including common species and species of concern. Among regularly occurring mammals, all the special-status species are bats. Apex mammalian predators of the Coast Range ecoregion are effectively absent from the park. Many Coast Range species were likely to have been lost from the Tualatin Mountains prior to park establishment. Ongoing species losses among birds and mammals, including landfowl, woodrats, and foxes, have continued into recent decades, and the cause of these losses is mostly unknown.

The relatively few amphibian species in the park are all native to the region and are well-distributed residents. Few snakes, lizards, or fish inhabit the park. Arthropods, especially insects, are the most diverse and abundant group of animals in the park, and their diversity remains greatly underreported. Several threats to park wildlife are known: some of these include a great deal of uncertainty, some can be mitigated through PP&R management actions, and some are of a scale that reaches well beyond the park boundary. Many gaps remain in our knowledge of park wildlife and these can be filled over time by a combination of academic research; partnerships with federal, state and local agencies; citizen science projects; and PP&R management actions.



Mountain beaver burrow

Introduction



Interest in Forest Park wildlife began with the park's creation and continues today. In 1948, the year Forest Park was created, the Committee of Fifty declared that one of the five primary objectives for park creation was “to provide food, cover, and a sanctuary for wildlife.”¹ In the 1976 *Management Plan for Forest Park*,² this objective was reiterated verbatim and expanded, stating that “a comprehensive [wildlife management] plan should be prepared by staff experts which would identify habitat needs to encourage and attract appropriate forms to Forest Park.” In the succeeding decades, management interest in park wildlife increased, driven partly by concerns about non-native plants such as English ivy, a focus on regional water quality, increased development at the park perimeter, and new forms of recreation.

The 1995 *Forest Park Natural Resources Management Plan*³ was the first comprehensive set of guidelines for park management. The plan designated “the health of natural resources the top priority for park managers.” Among the many management guidelines, an entire section of the management plan was devoted to wildlife diversity, habitat use, and threats, and 16 wildlife-related projects were outlined, each with the single, explicitly stated goal of preserving, protecting, or improving “wildlife habitat value.” In subsequent years, some of these projects were implemented, while others, due primarily to budget constraints, were not.

In 2010, wildlife concerns once again came to the forefront during meetings of the *Forest Park Single-Track Advisory Committee*, a citizen group convened to examine the proposed expansion of mountain biking opportunities in the park. The committee's final report⁴ recommended four management actions to Portland Parks & Recreation (PP&R) to better inform any proposed expansion of recreational use. The first recommendation was to “complete a comprehensive wildlife and vegetative study to create a baseline to be used for management decisions and to better understand the park ecology.”

Public and management interest in Forest Park wildlife continues today, 65 years after the park's founding. The *Forest Park Ecological Prescriptions Report*⁵ outlines 39 projects, and among these 15 are centered on wildlife and wildlife habitat. Another 17 projects are closely linked to wildlife values, and these focus on water quality, forest structure, and intact native ecosystems.

Objectives

The primary objectives of this report are to provide both a broad description of Forest Park wildlife and detailed species information based on the best available data, whether historical, recent, anecdotal, or rigorously collected via research. For each species, we have focused on its standing within the park boundary, and the main goals have been to determine the following:

- Presence or absence
- Breeding status
- Relative abundance
- Distribution
- Special status

Many sources of information have been queried, previous analyses have been reviewed and used when possible, and new analyses and presentations of data undertaken.

The other major goals of this report are to

- identify gaps in our knowledge about park wildlife,
- identify threats to park wildlife, and
- define next steps in the research and management of park wildlife that could be taken to close important gaps and mitigate threats.



Youth Conservation Crew members

Report Framework



Audience

This report is intended for the following audiences:

- City commissioners, park managers, and staff, to provide wildlife information that can assist in making management decisions
- The public, to provide insights into wildlife diversity and ecology in this large, public natural area
- Academic and agency researchers, to provide information that supports current and guides future research

Wildlife

For the purposes of this report the term “wildlife” includes all undomesticated, free-roaming animals, including vertebrate and invertebrate species (not plants, fungi, water, soil, geological features, or humans).

A few focal species are of management concern due to their status, home range requirements, well-documented ecological impact, or public interest, and these are sometimes discussed at greater length. Other species are less frequently discussed due to a lack of information about them, or conversely, due to their regional familiarity, and well-documented life histories. In some cases wildlife have been described relative to habitat strata (aerial, arboreal, terrestrial, fossorial, aquatic) and circadian (diurnal, nocturnal, crepuscular) and circannual patterns (winter, spring, summer, fall) to best examine the current knowledge of wildlife and where and why gaps exist.

Wildlife have usually been grouped taxonomically in order to best frame the abundance and distribution for each class, family, and species in the park. We examine two fish families, four amphibian groups, three reptilian groups, 18 bird families, and seven mammalian orders. Arthropod *classes* and *orders* are typically discussed rather than individual *species*, because some of these groups are so large. Four groups of mollusks are also discussed.

Invertebrate animals are the most diverse and poorly understood of all park wildlife. Invertebrates function as leaf shredders, pollinators, wood decomposers, soil aerators, and pest controllers and are the basis of the food chain for many species of vertebrate wildlife. Invertebrates can also be threats to forest health. However, we tend to know little about the relative abundance and habitat use of invertebrates, especially insects, despite recent efforts to catalog this diversity.

In some cases, species that have not been detected in the park are nevertheless included in tables and figures (e.g., Table 5, where occurrence is *undetermined*). Such species are considered of *interest* for Forest Park because they are found regionally and the park may have suitable habitat, but their presence or breeding status remains undetermined because they have not been the target of surveys in the appropriate habitat or season. Rare species and those that are difficult to detect have been included, particularly when they are species of management concern. Similarly, extirpated species are of interest for understanding historical diversity and trends in species losses, and as possible reintroduction candidates.

Birds that are strictly flyovers and do not physically alight on Forest Park habitat are not discussed. Species that only occur near but not in the park, and that are found in habitats that are rare or absent from the park (e.g., river otter in Multnomah Channel) are also not mentioned.

Special Status Species

The City of Portland's *Terrestrial Ecology Enhancement Strategy (TEES) Summary and Update*⁶ created a list of Special Status Wildlife Species whose range includes Portland and that are listed or of concern by the following agencies and organizations:

- U.S. Fish and Wildlife Service (USFWS)
- Oregon Department of Fish and Wildlife
- Oregon Biodiversity Information Center (formerly the Oregon Natural Heritage Information Center)
- Oregon Watershed Enhancement Board
- Partners In Flight
- Northwest Power and Conservation Council
- National Audubon Society and the American Bird Conservancy

For the purposes of this report, we have adopted the TEES Special Status Species criteria, while paying closest attention to species that receive federal or state-level protections.

Wildlife Gap Analysis

A *gap* is the missing information between our current level and our desired level of knowledge about a species or group of wildlife in Forest Park. Our current level of wildlife knowledge is found in the detailed wildlife information sections of this report. Our desired level of knowledge for any species is a complete picture of its ecology with respect to the park. We recognize that we shall seldom have all the desired information on any species.

Some key types and examples of gaps in wildlife information include the following:

- Presence/absence: a lack of information on the presence or absence of a species such that targeted surveys are necessary
- Breeding status: a lack of knowledge about whether a species breeds in the park
- Breeding success: for special-status species, breeding success rates and whether the park population is self-sustaining, or perhaps represents a population source or sink
- Distribution: a lack of information on where a species is found in the park, especially per management unit
- Habitat use: a lack of information about how a species uses habitat structure in the park, for example, whether bats use mature broken-top coniferous trees as colonial roosts
- Wildlife response to management actions: for example, a lack of information about how wildlife respond to removal of invasive species or to oak release through conifer removal, or whether shrub-associated birds and invertebrate pollinators are using restored powerline corridors and breeding there successfully
- Details of habitat features that were historically common, but are now rare or absent, especially those that could be restored to benefit wildlife
- Long-term trends in abundance, especially for special-status species
- Invasive species impacts: for insects in particular, it is important to know if native species are declining and whether the forest is becoming vulnerable to invasive wood-borers due to a lack of natural controls

Eras

The data and observational accounts that describe the current level of wildlife information for Forest Park include sources going back to 1901. For the purposes of this document we have adhered to three eras when describing source information:

- Historical 1800–1979
- Intermediate past 1980–1995
- Recent 1996–2012

Data from the historical era are often scant and lacking in methodological structure, but give insights into the historical habitat condition, and into wildlife diversity before extensive human habitat alteration and afterwards, including when much of Forest Park was regenerating following logging and fires. Data

from the intermediate past include the first few methodological surveys for wildlife prior to the 1995 *Natural Resources Management Plan*, when some of the park was still immature second-growth forest and the trail system was incomplete. During the recent era, the forest transitioned to mostly mature second-growth trees and abundant ground and shrub cover, the trail system was completed, and numerous systematic wildlife studies were undertaken.

Edge Habitats

Forest Park contains a variety of forest edge habitats. Edge habitat is created by a linear landscape feature, often a road, powerline corridor, residential boundary, logging clear-cut, or natural ecotone. The effect of an edge on wildlife often extends into the adjacent forest. However, edge habitats in Forest Park are often dissimilar with respect to vegetative structure and wildlife habitat value. Because wildlife diversity and response is likely to vary with edge type, this report distinguishes between the following forest edges:

- The hard forest edge, where the forest gives way to a great expanse of unforested area (e.g., near Highway 30)
- Powerline corridors, which create a narrow swath of shrub habitat between broad forested tracts (e.g., Firelane 4)
- The residential edge (e.g., segments of NW Skyline Boulevard), where single-family homes abut the park and the forest is broken up but not completely eliminated
- Interior park roads and firelanes, which seldom break the forest canopy (e.g., Germantown Road and Firelane 10)



Bobcat near a residence

Forest Park Description and Wildlife Habitat Key Components



Forest Park is located on the northeast-facing slope of the southernmost segment of the Tualatin Mountain Range, a narrow, westerly extension of Oregon's Coast Range ecoregion (Figs. 1 and 2). The park is a forested peninsula that is surrounded on three sides by the Willamette Valley ecoregion. The park is approximately 7.5 miles long and 1 mile wide, and the park boundary encloses nearly 5,000 acres between NW Newberry Road, NW Skyline Boulevard, West Burnside Road, and NW St. Helens Road.

The long northeastern boundary sits about 100 feet above mean sea level, and is separated from the Willamette River by Highway 30 and an industrial area under which nearly all of the park's streams run through closed culverts after exiting the park. From the low northeastern boundary, the park rises to approximately 1,000 feet in elevation along most of its long southwestern boundary, and its highest point is nearly 1,200 feet.

For the purposes of this report, Forest Park is restricted to the area within the official park boundary, which is primarily forested, but includes utility corridors, trails, water tower buffers, and NW 53rd Avenue and Germantown Road. The Portland Audubon Society's sanctuaries, which lie adjacent to Forest Park, are not included.

From a management perspective, Forest Park is divided along its southeast to northwest axis into three units (Fig. 3):

- South Management Unit: West Burnside Road to Firelane 1
- Central Management Unit: Firelane 1 to NW Germantown Road
- North Management Unit: NW Germantown Road to NW Newberry Road

Per the 1995 *Natural Resources Management Plan*, wildlife habitat is to be protected and restored in all units, and all units are open to recreation. However, the management plan outlines an inverse geographical gradient for balancing recreational user activity and wildlife habitat protection, such that wildlife habitat values reach their highest priority in the North Management Unit, while recreational uses are more intensive in the South Management Unit.

Landscape

Forested landscape summary

The park is similar in habitat character to Oregon's Coast Range, which has been broadly designated as *Westside Lowlands Coniferous-Hardwood Forest*.⁷ Aerial and ground-based surveys show that Forest

Forest Park Description and Wildlife Habitat Key Components

Park is overwhelmingly forested, with few woodlands, meadows, or other openings, except at trailheads, water tower buffers, and the approximately 8.5 miles of utility corridors (Fig. 1; Table 1). The park is mostly *Interior Forest*, a TEES Special Status Habitat.⁶ Mixed conifer-hardwood forest dominates the park, but not uniformly. Due to historical disturbance, the park landscape is an irregular patchwork of forest types and ages (Fig. 3; Table 1, National Vegetation Classification Standard [NVCS] subclass).

The park is a peninsular forest fragment with connections to Coast Range forest; urban, suburban, and rural environments; and broad, hardscape barriers near the Willamette River. Movements by terrestrial wildlife across the long northeastern boundary and urban southeastern boundary are limited. Therefore, the park is likely to function as a wildlife *reservoir* for most forest interior species, and a stopover for migratory birds, more so than as a wildlife *corridor* for dispersing or migrating terrestrial wildlife. Narrow forested and open corridors beyond the park boundary allow some park wildlife to move to and from natural areas in suburban neighborhoods to the southwest, the Coast Range to the northwest, and rural lands and natural area corridors to the west.

Historical logging and fires

For nearly 100 years prior to 1960 many areas in the park were logged, both legally and illegally.¹ For example, as a form of assistance for Depression-era victims, the city ran a logging camp that clear-cut areas between Saltzman and Springville roads. Even as late as 1951, high-lead logging, a system of cutting that employed cables, pulleys, a spar tree, and heavy duty equipment (a yarder), was still being used in the park.¹ Today, more than 1,200 acres still show direct evidence of historical logging in the form of cut stumps (Table 1). During the same pre-1960 era that included logging, three stand-replacing fires razed broad areas in the central and southern parts of the park.

Major streams

Seven major streams (Table 2; Fig. 3) cut the full width of Forest Park, and numerous smaller ones cut the northeastern side. The perennial streams that drain much of the park's habitat are designated as *Westside Riparian-Wetlands*.⁷ The volume and continuous flow in the large park watersheds are important for all types of wildlife. Balch Creek is the largest park stream and is the only one that supports breeding salmonids. Only 25% of its 2,236-acre watershed is protected within the park boundary.⁸ Only Miller Creek's short, ungrated culvert allows fish passage to the Willamette River. Other park streams, including dozens of

intermittent ones, enter buried culverts upon exiting the park, and remain culverted to their confluence with the Willamette River. A few culvert sections are daylighted. Many culverts are >500 feet in length, and some are >1,000 feet. The culverted section of Balch Creek is greater than 1 mile long. The design of the current culverts includes grated inflows and drop-offs which make upstream passage impossible for fish.

The park boundary and beyond

The area at and beyond the park boundary is characterized by urban, suburban, and rural residential properties and commercial businesses, a habitat that has been described as *Urban and Mixed Environs*.⁹ These areas support species that thrive in human-dominated habitats and such species often use the park boundary areas due to proximity. In addition, some residential properties in these areas contain ponds that may be valuable to park wildlife, especially pond-breeding amphibians.

The northeastern boundary: Willamette River connection

The northeastern park boundary includes a hard forest edge and is often steep. This area has been impacted by powerline corridors, an historic rock quarry, well-established invasive vines, industrial businesses, and residential neighborhoods. Nevertheless, this area is still important for wildlife because the lowest and wettest reaches of all the park's major streams are in the northeastern boundary. In addition, this part of the park is nearest to the Willamette River, an important resource for some park wildlife, including nesting bald eagles.

The north- and southwestern boundaries: Coast Range and Tualatin Valley connections

The northwestern park boundary is a forested connection to the Coast Range and abuts rural-residential properties, including small farms near NW Newberry Road. In addition, Portland Metro and the Forest Park Conservancy own approximately 500 acres of protected lands (*Agency Creek* and the *Ancient Forest Preserve*) near this boundary. Much of the private forest and publicly owned, protected forest near this boundary has been logged in recent decades and has regrown as young coniferous forest. Thus species that prefer young forest or residential edge habitat, and those dispersing from and to the Coast Range are likely to occur near this boundary. For some large mammalian species, travel through the forested corridor to and from the broader Coast Range forests may be impeded by an active rock quarry, residential properties, and fencing near NW Cornelius Pass and NW McNamee roads.¹⁰

Forest Park Description and Wildlife Habitat Key Components

Nevertheless, elk are known to enter and exit the park annually via this corridor.

The southwestern boundary lies along a ridgetop near NW Skyline Boulevard and is abutted mostly by single-family homes and a few small farms and ranches. Species that prefer residential edge habitat, as well as those dispersing to and from nearby pasturelands, woodlands, and streams are likely to use this boundary. The rural lands of the eastern Tualatin Valley (a.k.a. “Skyline south” or “upper Rock Creek”) are used by a variety of wildlife including medium-sized and large terrestrial mammals such as beaver, bobcat, and deer. Elk in particular are found in this area and are believed to move to and from Forest Park across the southwestern park boundary.

The southeastern boundary: the urban connection

The southeastern park boundary is winding and jagged and abuts a mix of urban and suburban residential homes as well as the Audubon sanctuaries and private forest lands before giving way to extensive urban and suburban development. The Audubon sanctuaries provide wildlife with an extension of the forest interior habitat that dominates the park, and contain old-growth remnants that are especially valuable habitat. Near the southernmost boundary of the park, terrestrial wildlife such as elk are prevented from further movements southward by dense residential development, major roadways, and downtown Portland.

Wildlife Habitat Key Components

Snags, mature conifer forest, and old-growth remnants

Five native tree species dominate the park, and several others contribute <5% to the forest canopy (Fig. 4).¹¹ Nearly one-half of all trees are bigleaf maples. Late-successional conifer stands are evidenced by mature Douglas-fir trees, many of which are >100 years old, >175 feet in height, and >3 feet in diameter at breast height (dbh). Some stands also contain old-growth Douglas-fir remnant trees that are >200 years old, >200 feet in height, and >6 feet dbh. Field surveys of these stands have located some ancient, broken-top trees that achieve great diameter but not height. Large broken-top trees can be especially valuable for bats, owls, hawks, squirrels, voles, and weasels for roosting, nesting, and feeding, and for clouded salamanders where they occur.

Approximately 8% of standing trees are snags, ranging from 4% for bigleaf maple, to 12% for Douglas-fir.¹² Snags and the fungi they contain are a primary food source for wood-boring beetle larvae, and plump beetle larvae are themselves important food for



Snag towering above the forest canopy

Forest Park Description and Wildlife Habitat Key Components

woodpeckers, corvids, shrews, and other wildlife. Woodpeckers often create nest cavities in the soft, dead wood of snags, and these cavities are used secondarily by rodents, small owls, nuthatches, chickadees, and snakes for nesting. Cavities initiated by pileated woodpeckers in live western red-cedar trees are also relatively abundant and are preferred by at least one owl species.¹³

Ground cover and shrubs

Ground cover and shrub species are important for most park wildlife and are diverse and abundant throughout most of the park in both forested and unforested areas (Table 3). Leafy green vegetation such as vanilla leaf, Pacific waterleaf, and trillium provide food for larval moths, snails, slugs, mountain beaver, and deer, and are cover for the shrews, rodents, sparrows, and thrushes that forage on the forest floor. Berry-producing plants including salal, thimbleberry, and red huckleberry provide food for thrushes, rodents, raccoon, skunks, deer, and coyote. Shrubs such as beaked hazel and vine maple provide nest structure and insect habitat for the warblers, wrens, and other species that breed and forage in that layer. Red elderberry is common and is a preferred food of band-tailed pigeons.

Coarse woody habitat

Fallen trees and large branches on the forest floor and in streams (coarse woody debris, large woody debris) become important wildlife habitat for fish, amphibians, reptiles, birds, mammals, and invertebrates in uplands, streams, and riparian areas. In uplands, downed wood holds moisture and creates damp, shady microhabitat that is ideal for slugs, snails, arthropods, frogs, salamanders, and their mammalian and avian predators. The abundance of *Ensatina* salamanders and Trowbridge's shrews, common Forest Park species, is known to increase directly with the volume of coarse woody debris.¹⁴ In addition, beetle larvae thrive on the interior wood, and the small cavities in the exposed root balls of downed trees are often used by Pacific wrens for nesting. In-stream large woody debris is important for fish, stream-associated amphibians, and invertebrates. Riparian sites in Forest Park vary widely in in-channel woody habitat volume (Fig. 5). Some sites fall below the undesirably low benchmark (20 m³/100-m stream length) set by the Oregon Department of Fish and Wildlife, but other Forest Park sites approached or exceeded the desirable benchmark (30 m³/100-m stream length).¹⁵

Forest floor

The forest floor across most of the park is a thick duff layer (leaf litter) of decomposing leaves, needles, and twigs—organic material

Forest Park Description and Wildlife Habitat Key Components



Mountain beaver foraging near its burrow entrance at night in the north management unit of Forest Park, August 2012
(Photo: Shervin Hess and John Desbler)

that is especially valuable to leaf-shredding invertebrates including millipedes and adult beetles, which are themselves valuable food for amphibians, small mammals, and birds. Moles tunnel through the duff and underlying soil in search of worms, and mountain beaver and other mammals construct burrows there. The leaf litter sits atop a sometimes deep layer of wind-blown sand, silt, and clay (loess), which lies atop a bed of igneous rock created by volcanic activity that was especially productive 17 to 14 million years ago.¹⁶ In steep park drainages the soil and duff layers are often thin and the basalt rock is nearly exposed.

Exposed rock

Areas of exposed rock are habitat for reptiles, chipmunks, and cliff-nesting species. The abandoned rock quarry (a.k.a. “Rivergate”) on the main stem of Doane Creek provides the only expansive rocky habitat in the park. Peregrine falcons have nested there, and it is the only location where lizards have been found in the park. Rock that was exposed by the construction of Leif Erikson Drive is now forested over, and provides habitat for small mammals, amphibians, and invertebrates.

Water

All wildlife rely on water. During much of the year water is not a limiting resource, because both perennial and intermittent streams are available to wildlife and small seasonal ponds and micro-pools dot the landscape. However, during the summer dry season, perennial streams become especially valuable to wildlife, thus water quality in these streams is particularly important. Water quality is directly related to the protected watershed area, at least with respect to waste load allocations (bacterial), ammonia, and total suspended solids.¹⁷ For example, the Saltzman/Rocking Chair Creek watershed lies mostly within the park boundary and had the highest water quality relative to Miller and Balch creeks. Conversely, Balch Creek watershed lies mostly outside the park’s protective boundary, and water quality has decreased across several metrics from 2002 to 2008.¹⁷ The decrease in water quality may impact wildlife.

Habitat Distribution

Forest Park is primarily a mixture of forested uplands and riparian areas (Fig. 3; Table 1, NVCS class). Narrow, riparian bottomlands occur throughout the park and are often dominated by red alder, bigleaf maple, and dense, fruiting shrubs, especially salmonberry. The park’s riparian areas are a component of *Bottomland Hardwood Forest and Riparian Habitat*, a TEES Special Status Habitat.⁶

Upland areas are commonly a mixture of mature, second-growth Douglas-fir and bigleaf maple trees, shrubs, and dense ground cover. Several late-successional, conifer-dominated stands are scattered throughout the park, and these cover approximately 17% of the park (Fig. 3; Table 1, NVCS formation: Giant temperate needle-leaved evergreen forest). The broadest late-successional stand is nearly 125 acres between Germantown and Springville roads (Fig. 3B). *Late Successional Conifer Forests* are a TEES Special Status Habitat.⁶ The oldest remnant trees in the park are down in the draws created by Balch, Springville, Newton, and Linnton creeks. The easily accessible junction of Firelane 10 and the south fork of Linnton Creek holds several older Douglas-fir and grand fir specimens.

The forest is a patchwork of successional stages due to historical disturbances and subsequent forest regeneration (Fig. 3). Broadly speaking, the northern half of the park is conifer-dominated, whereas the southern half contains extensive stands of deciduous-dominated forest. Pure deciduous and pure coniferous stands occasionally occur as a result of regrowth or replanting following historical disturbances (Table 1, NVCS subclass). In a few patches, the forest is dominated by young Douglas-fir, such as at the junction of the Wildwood Trail and Saltzman Road. In contrast, the broad area between Firelane 1 and the Alder Trail stands out as a mostly deciduous stand lacking a major stream (Fig. 3C). This patchy variation in forest character affects wildlife distributions, because some species, such as the northern flying squirrel and red-breasted sapsucker, have a preference for mature coniferous forest, whereas others, including the downy woodpecker and warbling vireo, are associated with deciduous-dominated habitat.

Small sections of *Oak Woodlands* can be found in a narrow band on the steep slopes of the northeastern edge of the park, especially near the junction of the BPA and Newton roads.^{6,11,18} Oregon white oak (*Quercus garryana*) and Oregon ash (*Fraxinus latifolia*) are representative tree species in this TEES Special Status Habitat. Some oak-associated wildlife species, including white-breasted nuthatch, are found occasionally in these isolated habitats in the park, but others, such as the western gray squirrel, are considered absent from the park despite the presence of oaks.

*Herbaceous Wetlands*¹⁹ are mostly absent from Forest Park, though many low-lying, forested microsites do support lilies and other aquatic plants characteristic of wetlands (Table 1, *Hydrophilic vegetation*).



Black-tailed deer seen in Forest Park during the 2012 BioBlitz

A Broad Description of Forest Park Wildlife

Vertebrate Wildlife: Birds, Mammals, Amphibians, Reptiles, and Fish

Vertebrate wildlife diversity is dominated by avian and mammalian species, and of these about 30% are TEES Special Status Species and few are non-native (Figs. 6–9; Tables 4–7). However, many bird and mammal species are only seasonally present, rare, or nocturnal, or occur naturally at low density, and as such are seldom experienced by park visitors. In contrast to birds and mammals, few species of amphibian, reptile, and fish inhabit the park, although the amphibian species that do occur tend to be well-distributed, abundant residents. All the fish, reptiles, and amphibians that occur in the park are native species. Eight vertebrate species are federal species of concern, one is threatened, and the northern spotted owl is federally endangered (Table 8).

The most abundant and well-distributed vertebrate species in the park are associated with forest interior habitat in either riparian or upland areas, or both. Species that have strong associations with open shrublands, grasslands, forest edge, human settlement, or bright sun tend to be found only along powerline corridors, the park perimeter, or park-bisecting roadways. Other species that require habitats that are rare in the park such as ponds, meadows, open forest, exposed rock, oak woodlands, perennial streams, wetlands, or springs tend to be absent from the park, or are found in low numbers at only a few sites.

Birds

One hundred and four avian species are known to occur in the park, and about a dozen of these are rare (Table 4). Many avian species are uncommon because they occur at naturally low densities, or only in specific habitats, and others are present only during spring and fall migration. Birds are the most conspicuous wildlife class because they are vocal, diurnally active, and abundant. The sights and sounds of up to three dozen of the most common, well-distributed, and strident bird species will define most visitors' experience with Forest Park wildlife. Of all the wildlife species, perhaps the most vocal and prominent year-round resident is the tiny Pacific wren.

Ten avian families contribute in nearly equal proportions to the diversity of breeding birds (Fig. 10). Some of the flycatchers, warblers, sparrows, and finches are localized to a few sites, but many species thrive in the extensive forest interior habitat (Fig. 11). Relative to some other regional stream corridors, Forest Park



*Black-tailed deer foraging at night
in Forest Park, 2010
(Photo: Dan Richardson and PP&R)*

riparian areas had *lower* overall avian diversity, but a *higher* diversity of TEES Special Status avian species.²⁰ One-third of Forest Park's birds are Special Status Species (Fig. 12; Table 4) and several of these are among the most abundant birds in the park (Fig. 13). The relatively low avian diversity is likely symptomatic of low habitat diversity. Despite their abundance in the park, several species show evidence of population declines in recent years, including bushtits and chestnut-backed chickadees (Fig. 14). Across the Oregon landscape, at least 17 Forest Park species show evidence of decline (Table 9).

Mammals

Forty-five species of mammals representing seven taxonomic orders are known to occur in Forest Park (Table 5). These constitute more than two-thirds of the 65 terrestrial mammal species known to occur in western Oregon²¹; however, only 17 of the mammalian species are considered abundant and well-distributed in the park. Mammalian diversity is dominated by rodents, bats, and carnivores (Fig. 8). Most of the park's mammalian wildlife species are some combination of nocturnal, small, arboreal (tree-dwelling), or fossorial (burrowing), and are seldom seen by park visitors. Exceptionally, the Douglas squirrel and Townsend's chipmunk are common, vocal, diurnal mammals often seen and heard near trails. Two of the most abundant mammals are the deer mouse and Trowbridge's shrew, and these are an important food resource for many carnivores and owls (Fig. 15). In contrast, some large rodent and carnivore species are rarely found, such as the porcupine and black bear. Deer and elk occur in the park, but only deer are common year-round residents. Elk occur seasonally, typically in low numbers, and appear to rely heavily on external resources beyond the park perimeter for foraging and breeding, especially in upper Rock Creek, Skyline south, and the northwest Tualatin Mountains. Most of the bat species that occur or may occur in the park are on the TEES Special Status Species list. However, the distribution, abundance, breeding status, circannual patterns, and habitat use of bats in Forest Park is poorly understood.

Five mammalian species are non-native (two rats, two squirrels, and the opossum), and these are typically found near the residential park perimeter, though opossum are likely well distributed in the park. Some other mammalian species, particularly woodrats, tree voles, and pocket gophers, have not been documented in the park though they are at least somewhat likely to occur based on forest and riparian habitat associations (Table 5).^{21,22,23} A variety of methods have been used to catalog mammalian diversity in the park including capture-based research, motion-detection camera

surveys, owl prey analyses, and observational accounts by park staff, users, and neighbors.

Amphibians, Fish, and Reptiles

Relatively few species of amphibian, reptile, and fish occur in the park (Table 6), and part of the discrepancy in diversity with respect to birds and mammals is likely due to habitat factors related to ponds, stream size, stream gradient, sunlight penetration, rocky outcroppings, and canopy closure. Six amphibians, including four salamanders and two frogs, are well distributed and abundant in a combination of stream, riparian, and upland habitats. Most amphibians, like the reptiles and fish, are silent, small, and elusive, and go unnoticed by park visitors. However, the Pacific tree frog is especially vocal during the breeding season, and the “chorus” of these frogs at some sites can be enjoyed by park visitors, especially at dusk. Some regionally common amphibian species have not been found in the park and may be localized to just a few sites.

Only a single, small fish species, a sculpin, is a well-distributed breeder and even this species is absent from some large streams. Most other regional fish species are restricted by grated culverts that physically exclude them from park streams. An isolated population of cutthroat trout breeds in Balch Creek, and a few cutthroats also breed in Miller Creek. Fingerling-sized coho salmon and steelhead are occasionally found in the lowest reaches of Miller Creek, suggesting that adult salmon also breed there.

No systematic surveys for reptiles have been undertaken in Forest Park. Common and northwestern garter snakes are the only well-distributed reptile species, and these are seen by park visitors in summer at trailheads and along powerline corridors and firelanes. Based on observational sources and habitat associations, only a few species of live-bearing reptiles are likely to be found. The rubber boa is a live-bearing snake that is likely to occur in Forest Park, but it has never been reported. Many reptiles need direct sunlight to raise and maintain their body temperature to be active. In addition to body-warming sunlight, egg-laying reptiles often require sites with soft soils to excavate their nests, and direct sunlight to warm those nests. Such sites are uncommon in the park. These factors and a lack of perennial ponds also exclude turtles from the park.



Ensatina salamander found during BioBlitz in Forest Park, 2012

Invertebrate Wildlife: Mollusks and Arthropods

Invertebrate animal species make up approximately 95% of the diversity of animals worldwide, and a similarly large percentage of Oregon's terrestrial animal species are invertebrates (approximately 10,000–10,500). Therefore, an understanding of wildlife in Forest Park needs to include a discussion of invertebrate species, even though and because data are often lacking.

Mollusks

Twenty-three species of terrestrial and aquatic mollusks are known to occur in Forest Park (Table 7). Most are native species, and several are common and well distributed. Banana slugs and Pacific side-band snails are large and beautifully marked, and are often seen by park visitors. Mollusks are the most abundant class of terrestrial animals after arthropods. Slugs, snails, and microsnails (shell diameter <3 mm) contribute relatively equally toward terrestrial mollusk diversity, but snails are the most abundant group (Fig. 16). Specifically, the banana slug, the robust lancetooth, and the denticulate tightcoil are the most abundant slug, snail, and microsnail, respectively, and each contributes >50% toward total abundance within its group.



*Coastal giant salamander (adult)
near Linnton Creek with a
banana slug in its mouth, 2008
(Photo: John Desbler and Ian
Matthews)*

Mollusks are important decomposers in the forest ecosystem. They eat parts of dead and living plants as well as fungi and carrion. In addition, slugs and snails are important food for other wildlife. Banana slugs are a preferred food of coastal giant salamanders, and several species of birds, small mammals, and snakes—including corvids, owls, shrews and garter snakes—eat both snails and slugs.

Two species of small aquatic snails and one small clam also occur, but several larger, regionally common aquatic mussels are absent.²⁴ In the aquatic environment, bivalves filter small organisms from freshwater, and snails scrape algae from rocks.

Arthropods

Great strides were made in 2012 to document the diversity of arthropods in Forest Park (Tables 10 and 11). Arthropods, members of the phylum of animals that includes insects, spiders, millipedes, centipedes, crustaceans, and others, are the most diverse and abundant animals in Forest Park, as they are worldwide. More than 400 species of insects are currently known to occur, and they are the dominant arthropod group (Fig. 17). Beetles and moths contribute at least 340 species and dominate insect diversity (Fig. 18). Within Balch Creek, diversity of invertebrates is relatively evenly split between the families of stoneflies, caddisflies, mayflies, and true flies, but mayflies are

especially abundant (Figs. 19 and 20). The abundance of Balch Creek invertebrates has been shown to follow continental patterns of climate²⁵ (Fig. 21). It is believed that increased rains in some years washes nitrogen from the air into park streams, and increased nitrogen negatively affects invertebrate populations there. Despite a substantial increase in our knowledge of Forest Park arthropod diversity much remains to be known, and the diversity of these animals is likely to greatly exceed current figures.²⁶ The diversity found during the 2012 BioBlitz for Forest Park Wildlife showed little overlap with data from Oregon Department of Agriculture and U.S. Department of Agriculture (USDA) surveys, suggesting that additional surveys will quickly broaden our knowledge of arthropod diversity.

Insects function in many ecologically important roles, including the recycling of biological material and as food for other wildlife. For example, carpenter ants consume dead wood and are also a preferred food of pileated woodpeckers. Many insects are pollinators, including bees, wasps, ants, moths, butterflies, beetles, and flies. Insect pollinators facilitate seed production and plant propagation, and both the seeds and the insects themselves are important food resources for birds such as warblers, kinglets, thrushes, and sparrows; amphibians, including northern red-legged frogs; and small mammals such as mice, bats and shrews. Twenty-four-hour video surveillance indicates that moths are an important part of the summer diet of pygmy-owls. Nevertheless, among all wildlife groups in Forest Park, we know the least about the diversity, function, and ecology of insects and other arthropods.

In contrast to vertebrate wildlife groups, about 10% of arthropod species in the park are non-native. The number and impact of non-native species is poorly understood. Several arthropods in the park have their origins in Europe and Asia, including some spiders, ants, beetles, and moths.

Historical Changes to Wildlife Diversity

Forest Park wildlife habitat has undergone a series of alterations in the preceding 150 years, particularly to the tree canopy and forest floor. These changes have affected the diversity and abundance of species. Lewis and Clark described the area including present-day Forest Park as an old-growth coniferous forest with tree diameters of 5 to 8 feet. Old-growth habitats such as the one they described tend to have all elements of a structurally complex forest ecosystem, including extensive standing and downed wood and deep, uncompacted soils. Thus, it seems likely that the historical forest supported many more of the wildlife species described for

A Broad Description of Forest Park Wildlife

the Oregon Coast Range²¹ than it does today. In addition, until the early 1900s, the park was wholly connected to the Willamette River, Tualatin Valley, and coastal forests by a combination of broad wetland and riparian forest, unbroken old-growth forest, and west-side savannahs and grasslands. Forest Park was historically within a matrix of diverse habitat types through which wildlife could move freely.

Fire, logging, and development prior to 1960 eliminated or opened much of the forest canopy, and photographic evidence shows that the canopy in Forest Park remained somewhat open into the 1980s. Subsequently, the diversity and abundance of species such as bluebirds, landfowl, sparrows, flycatchers, woodpeckers, grassland voles, and ungulates is likely to have shifted.

Around 1990, some notable transitions in faunal diversity and distribution occurred. The forest canopy had matured and closed, and species such as the pileated woodpecker had returned, whereas the northern flicker abandoned the forest interior for the park perimeter. Barred owls were becoming established in Oregon. Gray foxes disappeared from the area, and bear sightings declined. Woodrats (*Neotoma sp.*) were being replaced by non-native rat species (*Rattus sp.*), and species such as sooty grouse and mountain quail were seen and heard for the last time in the park around this time. These transitions were likely driven by the combination of factors both within and beyond the park boundary. Some of these factors were forest regeneration, hunting, habitat fragmentation, increased residential and commercial development, the expanding range of some wildlife species such as coyote, and large-scale habitat alteration in the absence of fire and other natural disturbance regimes.

Detailed Wildlife Information: Vertebrates



Birds

Information on birds in Forest Park comes from sources of the historical era^{27,28} and the intermediate past,^{10,22} and also from the recent era in the form of research projects,^{12,29,30,31} riparian monitoring, citizen science projects,^{32,33,34} local bird and wildlife experts,^{35,36,37} and the USFWS bald eagle monitoring program³⁸ (Table 10). Avian surveys were mostly point counts and transect counts, and the breeding biology and nest habitat use of some owls and raptors has been explored in detail.

Current bird diversity in the park reflects the combination of the park's mature, mixed-forest interior, with forest edge and shrub habitat along the park perimeter and in powerline corridors. Many birds, particularly water-associated species, regularly fly over the park but seldom or never alight in it and are not considered part of the park's avifauna.

Bird families of interest for Forest Park (*in taxonomic order*)

Waterfowl

Mallard ducks use Forest Park, and pairs may breed there but no nests have been found. Mallards commonly nest in forested habitat, sometime more than a mile from the lakes and rivers where they are more commonly observed. No other waterfowl are known to use Forest Park.

Landfowl

Mountain quail, ruffed grouse, and sooty grouse (formerly "blue grouse") were formerly common in the park, but all have been extirpated. The 1901 *Park Commission's Report* lists them among the species present in City Park, a precursor to Washington Park, which at that time had unbroken habitat connectivity with the nearby lands of the future Forest Park. In the early 1900s, mountain quail were so common that local ornithologist Dave Marshall recalled that his father hunted them near Council Crest, and said that his great-grandfather "gave him [Dave's father] five shotgun shells and expected him to bring back five quail." Mountain quail were last reported on the Christmas Bird Count (CBC) in 1962. Similarly, ruffed grouse continued to be found in Forest Park into the 1980s,^{22,30} but were last reported on the CBC in 1986 and have not been detected in Forest Park since 1990.¹⁰ The sooty grouse were historically the least common among Forest Park's landfowl, but were common enough in the 1960s that a male was seen displaying for a harem of six or seven females.³⁵ The sooty



*Bald eagle brooding young on its nest high
in an old-growth Douglas fir
in Forest Park, May 2012
(Photo: Bill Price)*

grouse was the last of the landfowl to be extirpated, such that a single individual was audibly detected in Forest Park in 1982,²² and individuals were last reported regionally during the 1989 CBC. Sooty grouse, though often considered resident, are in fact short-distance migrants that move from relatively open breeding areas to the denser conifer forest in winter.^{39,40} So the presence of sooty grouse during the winter-season CBC was expected, though their loss is not well understood. California quail, a native species, are still somewhat common in rural lands near, but not in, the park. Forest regeneration is believed to be a primary factor excluding quail from the park today.

Hérons

Among ardeids, only the great blue heron is known to use Forest Park, where they occasionally feed in the lower reaches of Balch Creek.^{41,42} However, in the decades prior to Forest Park being created, the great blue heron was a common breeding bird near the northeastern park boundary: “A rookery of great blue herons east of the Skyline and north of Saltzman Road, where hundreds of these great birds built their huge nests, each year attracted Audubon Society members and other nature study enthusiasts until the birds abandoned the area because of nearby logging.”¹

Vultures, Eagles, and Hawks

Turkey vultures are spring and summer inhabitants of Forest Park, and may be seen roosting in and below the forest canopy, or soaring above it. Turkey vultures select a variety of structures for nesting, including stumps, logs, and tree hollows near the forest floor, but the most important component of nest selection appears to be isolation from human disturbance.⁴³ No vulture nests have been located in the park.

Osprey breed annually along the Willamette River. This species occasionally roosts in the forest canopy from Balch Creek to the North Management Unit, but is not known to nest within the park.

Three pairs of bald eagles nested successfully in Forest Park in 2012, producing a total of four eaglets.³⁸ Each nest was constructed by the eagles in an old-growth Douglas-fir tree, and some pairs have been nesting at the same sites in the park for at least 5 years. In one case, thick braids of tree ivy were cut and removed from a nest-tree trunk by habitat restoration crews, helping preserve the tree for future nest attempts. The proximity of suitable nest trees to the Willamette River appears to be an important factor that limits bald eagle breeding to the central and north management units.

Among the true hawks, the Cooper's hawk is relatively common, initiating its breeding somewhat conspicuously in all sections of the park in March and April. The smaller and closely related sharp-shinned hawk is also found in the park and is presumed to breed there. The much larger northern goshawk sometimes nests in mature Douglas-fir forests,⁴⁴ but the species is only occasionally seen in the metro region and there are no records of its presence in Forest Park.

Red-tailed hawks are a common, widely distributed raptor in Forest Park and are often seen roosting and hunting below the interior forest canopy and soaring above it. Red-tailed hawks prefer open habitats and it is presumed that most red-tailed hawk breeding sites are near or beyond the park boundary.

Among falcons, only the peregrine falcon, a TEES Special Status Species that was federally delisted in 1999, has bred in the park.³⁷ Peregrine falcons are common breeders on bridges over the Willamette River along the park's northeastern edge and the abandoned rock quarry at Doane Creek is suitable habitat for hunting and breeding. The merlin, a small falcon species, is an uncommon but annual winter resident in the Portland area. Individual merlins are presumed to use the park occasionally during migration and winter, but not during the breeding season. The American kestrel is an annual breeding species in semi-open country in this region, including upper Rock Creek. Kestrels are seen occasionally in the uppermost section of the Firelane 15 corridor in the park, and in the industrial area along the Willamette corridor, but are not present in the forest interior and are not believed to nest in the park.



Red-tailed hawk

Doves

The band-tailed pigeon, a special-status species whose population is declining across Oregon, is the only common, well-distributed dove in the park. Band-tailed pigeons breed in closed-canopy forests in western Oregon, placing nests near the bole of a sturdy tree in which they normally raise only a single squab. They typically nest two or three times per season.⁴⁵ The owl-like calls of this large bird are a conspicuous harbinger of spring. The mourning dove, a species that prefers open habitat, was formerly common in the park,³⁵ but increasing canopy closure has made them an uncommon, non-breeder. Rock pigeons mostly avoid the forested park despite their great abundance in the industrial area along the Willamette River. Non-native Eurasian collared doves are increasingly common regionally and may soon colonize the park perimeter, but this species prefers open habitat and is not using the park today.



*Three of the four owlets that successfully fledged from a barred owl nest in an alder tree in Forest Park, May 2012
(Photo: Scott Carpenter)*

Owls

Five species of owl breed in Forest Park and all are well-distributed residents. The invasive barred owl is a relatively recent addition to the park. Among the two larger owl species—the great horned owl and the barred owl—from five to seven pairs of each are known to breed in the park each year. In contrast, it is estimated that seven to 15 pairs of each species of smaller owl—the northern pygmy-owl and the northern saw-whet owl—breed each year in the park. The western screech owl is intermediate-sized, and is at home in both natural, forested habitats and urban and mixed environs. Nests of all four of the above species were located in 2012 in an exploration of predator ecology and small mammal diversity in the park. Both barred and great horned owls used old-growth, broken-top Douglas-fir trees for nesting, but barred owls also used maple and alder trees. All owls fed often on deer mice, but prey biomass of great horned owls was dominated by species including squirrels, rats, and rabbits.⁴⁶ Among owls, the northern pygmy-owl has been researched extensively for 6 years, and Forest Park is now the premier research site for data on breeding and habitat selection for this otherwise understudied owl.^{12,13} The remarkable breeding success of pygmy-owls in Forest Park relative to small owls at other sites suggests that the park provides excellent breeding habitat and food resources.^{12,47,48} Unlike larger owls that prey mostly upon mammals (Fig. 15), the diurnal northern pygmy-owl consumes a diversity of small birds about often as small mammals, and occasionally gorges on moths. Trends in pygmy-owl reproduction indicate an odd-even year cycle similar to that demonstrated by spotted owls at some sites,⁴⁹ such that pygmy-owls lay larger clutches and fledge more young in odd-numbered years.¹³ This suggests the presence of a related trend in small mammal abundance, particularly of deer mice.

The northern spotted owl was a probable historical breeding resident based on habitat descriptions by Lewis and Clark and land surveyors. Even today this species is sometimes found in the park, though it does not breed there. In 2009 an individual northern spotted owl was observed and photographed at the southern park boundary, but this individual was likely a dispersing juvenile and not a breeding adult.⁵⁰ Remnant older forest stands in Forest Park may provide adequate breeding sites for northern spotted owls,⁵¹ but declining spotted owl population in Oregon due to habitat loss, and the strong, detrimental competition from the invasive barred owl are reducing the potential for spotted owl breeding in the park.^{52,53}

Nighthawks, Swifts, and Hummingbirds

Common nighthawks were once well distributed and abundant in the Willamette Valley and the Portland area.^{35,36} Though they still occur here annually, they have become relatively rare and there are no reports of them using Forest Park. Vaux's swifts are abundant and common in Portland during annual migrations. This species historically nested and made nightly roosts in the hollow tops of old-growth broken-top conifers, which are now rare on the landscape. Portions of the large migrating flocks that make a month-long roost at the Chapman School chimney in late summer are seen splintering off and heading for Forest Park to roost at dusk.⁵⁴ Rufous hummingbirds nest in the interior of Forest Park, and are common in flowering forest edges and shrublands in spring and summer. Anna's hummingbirds also feed and nest near the forest edge, including in residential areas, and are present year round. Data from the Portland CBC suggest that the regional abundance of Anna's hummingbirds has increased dramatically in that past 40 years, from fewer than 10 hummingbird detections per CBC in the early 1970s, to more than 100 in recent years.²⁸

Woodpeckers

Woodpeckers are important ecosystem engineers and create cavities and feeding holes that become future homes for many other species of mammal, bird, and reptile. Five species of woodpecker breed in Forest Park, and the downy and pileated woodpeckers are TEES Special Status Species. Pileated woodpeckers, hairy woodpeckers, and red-breasted sapsuckers are relatively abundant and well distributed throughout the park interior. They are often conspicuous breeders because their nestlings beg loudly from within the safety of the nest cavity, and remain in the nest longer than similarly sized birds. Pileated woodpeckers, the largest, are associated with mature conifer forests and have returned to Forest Park as it has matured, after a decades-long absence.^{35,36} Pileated woodpeckers have continued to increase during the past decade.³³ Downy woodpeckers are associated with deciduous forests, and their distribution in the park is patchy. Red-breasted sapsuckers show some preference for mature and second-growth coniferous or mixed forests and these habitats are abundant in the park. The least common Forest Park woodpecker, the northern flicker, prefers open forests and woodlands for breeding, and is common in residential areas near the park perimeter, particularly in winter. Though flickers were formerly abundant in the park, the increasingly closed forest canopy has made them rare in the park interior today. Historically, Lewis's woodpeckers were relatively common in the Portland area^{27,28} when black cottonwood



Pileated woodpecker
(Photo: Scott Carpenter)



Olive-sided flycatcher
(Photo: Scott Carpenter)

riparian forests were also common. But this species has not been seen on the CBC since 1982. Lewis's and acorn woodpeckers, and yellow-bellied and red-naped sapsuckers are seen rarely.³³ These four species are not currently considered part of the avifauna of the park, though future management actions in favor of oaks and cottonwoods could benefit Lewis's and acorn woodpeckers.

Flycatchers

Flycatchers are found in the park during migration and the breeding season. The Pacific-slope flycatcher is nearly ubiquitous in the forest interior during the breeding season in all management units. This is unique among the flycatchers. Olive-sided flycatchers and western wood-pewees also breed in the park, but are relatively uncommon and found almost exclusively along roadways including Cornell and Germantown roads, and at shrubby forest edges, especially near Firelane 13. The olive-sided flycatcher is a federal species of concern that is experiencing steep population declines in western North America (Table 9). Willow flycatchers and western kingbirds are only rarely found in the park near the shrubby powerline corridors such as the BPA Road. Hammond's flycatchers are occasionally found at the southern end of the park but their breeding status is undetermined.

Vireos

Four vireo species have been found in Forest Park, and Cassin's, Hutton's, and warbling vireos are uncommon annual breeders. For these species, their abundance and distribution in the park is poorly understood. Forest Park lies near the southwestern breeding range limit of the red-eyed vireo, a deciduous forest species. The red-eyed vireo is considered rare and its occurrence in the park is known only from historical sources.

Corvids

Five species of crows and jays breed in the park, but only the Steller's jay is relatively common in the forest interior. American crows and western scrub jays are common along the forest edge. Common ravens are a relatively recent addition to the Portland metropolitan area and the park's avifauna, and despite their name are relatively uncommon breeders in the park. Since 2008, a least two family groups of common ravens have been recorded breeding near Saltzman and the BPA roads. Similarly, but much less conspicuously, groups of gray jays have been recorded annually in recent years exclusively north of Germantown Road.⁵⁵ Besides these breeding-season detections, gray jays were found in Forest Park during the 2010 Portland CBC for the first time in 41 years.

Swallows

Four species of swallow commonly forage above the forest canopy and along edges, and are presumed to occasionally roost in the canopy as well. These aerial insectivores feast on flying insects during spring, summer, and early fall. The barn swallow is known to nest in man-made structures along the park perimeter, especially near Skyline Boulevard. Tree and violet-green swallows are cavity nesters that often breed near water, and though they may breed in the park no nests have been reported. Purple martins and northern rough-winged swallows are rarely detected in the park.

Chickadees, Nuthatches, and their Allies

Black-capped and chestnut-backed chickadees and red-breasted nuthatches are ubiquitous throughout the park in all seasons. These species are among the most abundant in the park, but nevertheless, both black-capped and chestnut-backed chickadees show evidence of recent population declines (Fig. 14). Brown creepers are also common and well distributed, and their nests are occasionally found behind the peeling bark of dead alder trees. Bushtits are also fairly common, but also show evidence of decline. Flocks of bushtits are found foraging in the forest from late summer through winter. The white-breasted nuthatch, often associated with oak habitat, is a TEES Special Status Species, and is uncommon to rare in the park. A few isolated oak-ash stands along the eastern park boundary provide limited habitat for them today, and could be increased with management efforts.

Wrens, Kinglets, and Thrushes

The Pacific wren is probably the most abundant and well-distributed avian species in the interior of Forest Park, and is common in all seasons. In contrast, Bewick's wren occurs only along the shrubby forest edges, and is much less abundant. The house wren is mostly absent from the park, but may occur along the park's residential edge.

Golden-crowned and ruby-crowned kinglets are fall and winter residents, and flocks occur across the Portland region, including Forest Park, during those seasons.

The American robin and the Swainson's thrush are abundant avian species during the breeding season and are widely distributed in the park. Unpublished data on the population trend for robins in the park are contradictory, in one case showing a significant decrease near the southern park boundary,³³ and in another, an increase.³⁰ Among *Catharus* thrushes, the Swainson's thrush is in the park only in spring and summer, whereas the similar-looking



Pacific wren
(Photo: Scott Carpenter)

hermit thrush is strictly a fall and winter resident, so these two congeners complement one another temporally. In recent years, the varied thrush, a TEES Special Status Species, has been detected singing in the North Management Unit throughout the spring and early summer, and is now considered a breeding species in the park. In contrast, large flocks of varied thrush overwinter in the park annually.

Warblers

Nine warbler species occur in the park, six of them breed there, and six are TEES Special Status Species. Wilson's warblers are among the most common and well-distributed avian species in the park interior during the breeding season. They are found breeding in the shrub layer beneath the closed forest canopy, while black-throated gray warblers breed in the canopy, and orange-crowned warblers breed in shrubby forest edges. In some years, a few yellow warblers can also be found in shrubby edge habitat. Other warbler species, especially yellow-rumped and Townsend's warblers, are particularly abundant and conspicuous during spring migration, and are often found in mixed flocks, sometimes in large numbers.

Sparrows

The spotted towhee has been studied in depth in regional city parks, not including Forest Park. Though it was abundant in all four parks where it was studied recently, two of the four park populations were *sinks*, indicating that local reproduction did not offset the level of adult mortality.³¹ In Forest Park, the spotted towhee, song sparrow, and dark-eyed junco are common, vocal, conspicuous, and well-distributed residents in the interior and the perimeter edges in all seasons. Though still common, each of these species shows evidence of population decline in recent years in the park.³³ In contrast, white-crowned sparrows are found near the park boundary, especially near Skyline Boulevard. Fox, Lincoln's, and golden-crowned sparrows occur annually in winter in firelanes and utility corridors, and the white-throated sparrow is also an annual visitor.

Cardinals and Blackbirds

Each spring, the western tanager and the black-headed grosbeak are colorful additions to the park avifauna, and are common breeders throughout the park. Tanagers tend to breed and forage in the forest canopy, whereas grosbeaks often inhabit understory trees. Lazuli buntings are known only from historical sources and are considered rare at forest edges. Blackbirds are found at the park perimeter.

Finches

Among finches, only the purple finch, a TEES Special Status Species, is a well-distributed breeder in the park. The closely related house finch is mostly restricted to the residential edge. During the past decade, house finches have declined in abundance in the park while purple finches have increased (Fig. 14). Pine siskins, American goldfinches, and lesser goldfinches form conspicuous, noisy flocks and forage in the canopy during migration and in winter; they may also breed in the park. Pine siskins show evidence of steep decline in the park in the past decade. In contrast, both the American and lesser goldfinch appear to be increasing, the latter having increased dramatically in the metropolitan area in recent years (Fig. 14).³³ The evening grosbeak and the red crossbill, a TEES Special Status Species, also form noisy flocks and feed in the canopy throughout the park during migration. Red-crossbills also appear to be declining.³³

Mammals

Information on the diversity, abundance and distribution of mammals in Forest Park comes from capture surveys,^{10,56,57} daytime visual surveys,^{53,58} 24-hour motion-detection camera surveys,⁵⁹ small-owl prey analyses,¹³ large-owl prey and coyote-scat analyses,⁴⁶ bat surveys,⁶⁰ red tree vole surveys,⁶¹ the BioBlitz for Forest Park Wildlife,³⁴ oak habitat surveys,⁶² and observational records by regional wildlife experts, park staff, trail crews, researchers, users, and neighbors (Table 10). Two reference works on regional mammals, *Natural History of Oregon Coast Mammals*²¹ and *Land Mammals of Oregon*,⁶³ guided the species considered.

The years of field work overlapped for the Lichti (2002–2003)⁵⁷ and Dizney (2002–2004)⁵⁶ projects, and much of our information on the relative abundance of small mammals is from this brief period. Lichti surveyed at two sites, one each in the Central and North management units, while Dizney surveyed more intensively at only a single upland site in the north along Firelane 10. No trapping has been done in the brushy powerline corridors or the few grassy areas in the park, but some owl and coyote prey items may have been taken from these areas (e.g., rabbits). Motion-detection camera surveys used the length of the Wildwood Trail as a transect and thus surveyed all three management units. Cameras were placed off-trail, and camera surveys complemented the small-mammal surveys by locating meso-predators and flying squirrels. Results of small-mammal surveys for some common species, such as Douglas squirrels and deer mice, were consistent across sources, but other results varied greatly such that species that were



A northern flying squirrel foraging at night in Forest Park, 2011
(Photo: Dan Richardson and PP&R)

commonly detected by cameras or as owl prey were able to avoid capture. Opportunistic observations by neighbors beyond the park boundary and reports from park boundary residents were helpful in understanding elk seasonal movements, and confirming elusive species such as bobcat.

Information on carnivores is conflicting with respect to diversity, abundance, and distribution, because observational information in two management reports from the early 1990s is inconsistent with other reports. For example, one report includes sightings and sign of black bears at 9 of 23 sites during daytime visual surveys,⁵⁸ and another reports that black bears were observed at three of four sites on just a few surveys.¹⁰ In contrast, other reports of black bears in the park are rare.

Bats

Ten species of bat have been recorded for Forest Park; all are native to the region, and six are federally listed species of concern (Tables 5 and 9). The relative abundance, distribution, and habitat use of bats in Forest Park is unknown, but bats have been detected in all three management units. Surveys have been brief and isolated to only a few sites. Both mist-netting and acoustic detection have been used to sample bat diversity. Of the 30 individuals captured, only three were females, half were captured in 1982 on a single night, and 80% were from three species. The hoary bat was the most common species captured, followed by the silver-haired bat and the little brown bat. Sex-bias in the capture data was not unexpected, because male and female bats are known to partition food resources and select different feeding sites.⁶⁴ In 2012, three new species of bat (long-eared, long-legged, and Yuma myotis) were detected by Susan Hurley and Justin Hiatt during the 2012 BioBlitz for Forest Park Wildlife.³⁴

Bats of this region depend on insects for food, standing water to drink, and structures for roosting. Locally common species such as the long-legged myotis show a preference for large grand fir snags in late-successional forests for roosting.⁶⁵ The silver-haired bat also roosts in snags, preferring canopy-topping ones with exfoliating bark, vertical cracks, and cavities.⁶⁶ Other bats may use basal tree hollows for roosting, and bats are sometimes found at greater density in fragmented, remnant old-growth stands than in continuous old-growth.⁶⁷ Forest Park has many habitat components that are important for bats: streams, proximity to major waterways, bridges, large grand fir, canopy-topping snags, basal hollows, and fragmented old-growth remnants. But the relative density, condition, and distribution of snags, hollows, and other potential

roost sites is unknown, and it is not known to what extent these structures and waterways are being used by bats.

Rodents

Squirrels

Six species of sciurids are found in the park and among these, Douglas squirrels and Townsend's chipmunks are native, diurnally active, abundant, and widely distributed.^{10,56,57} In addition, the native northern flying squirrel is relatively common in mature conifer stands and widely distributed in the park. The invasive eastern fox and eastern gray squirrels are common along the park perimeter, but both appear to be outcompeted or heavily preyed on in the forest interior and are rarely found there. All of the above squirrels are fed upon by owls that breed in the park. Isolated groups of California ground squirrels are known to occur along the Willamette River and near Hoyt Arboretum,^{41,55,68} but it is unknown whether any ground squirrel populations are using the park. The native western gray squirrel is often associated with oak habitat, but none have been found in that or other habitats in Forest Park.

Mice, Voles, and Woodrats

Two species of native mice occur in the park, the deer mouse and the Pacific jumping mouse. The former has been captured or detected as owl prey more than 1,200 times in the park, and is abundant and ubiquitous on the landscape, while the latter is rare and its distribution poorly understood. Part of the discrepancy in capture history may be habitat-related. Pacific jumping mice prefer riparian alder, which has been seldom surveyed. Deer mice are an important prey source for many park species. Deer mice made up two-thirds of the prey animals identified in the combined diets of barred owls, great horned owls, and coyotes in Forest Park in the spring of 2012. Northern pygmy-owls in Forest Park produce larger clutches and more owlets in years when deer mice are especially abundant.¹²

Two species of vole occur in the park, the creeping and Townsend's voles. Both of these are relatively abundant and well distributed. Townsend's are the largest North American vole and often occur at high densities, making them valuable prey for other wildlife species. The red tree vole, a federally listed species of concern, is arboreal, shows a preference for older forests,⁶⁹ and is important prey for northern spotted owls in the Coast Range.⁷⁰ Although Forest Park habitat appears suitable for red tree voles, targeted surveys in the old-growth forest canopy in 2012 found none.⁶¹ Red tree vole habitat in the north Oregon Coast Range has been



Deer mouse

mostly eliminated by logging and stand-replacing fires, and the voles are mostly extirpated from that region, so naturally occurring recolonization of the park is unlikely. Four other vole species may occur in the park, but have never been detected (Table 4, occurrence *undetermined*). Among these, white-footed voles are endemic to Oregon and northern California and of concern at the state and federal levels (Table 9). Forest Park lies at the northern range limit of both the white-footed and red tree vole. White-footed, Townsend's, and long-tailed voles are somewhat associated with riparian alder habitat,²¹ which is common in Forest Park but has been poorly surveyed. Gray-tailed voles are a grassland-associated species are thus habitat-limited in the park. Western red-backed voles spend much of their lives below ground or in and under downed logs and stumps,²¹ and are not readily detected by terrestrial trapping surveys.

No woodrats (*Neotoma* species) have been reported in Forest Park in recent decades. The habitat may support both the dusky-footed and bushy-tailed species, and the park lies within the range of both.²¹ Woodrats are large relative to most small mammals, and are an important food source for many predators including northern spotted owls, bobcats, coyotes, and weasels. At least one regional wildlife expert observed woodrats in the park into the 1980s, and has suggested that non-native rat species may have replaced woodrats in the park.³⁵

The North American porcupine is known to occur in the park from observational records of a single live specimen in the central management unit in 2008⁵⁴ and a road-killed individual found later that same year on NW Cornell Road.⁶⁸ Porcupines are nocturnal and semi-arboreal, and occur in mature mixed-conifer forest where they sometimes gnaw the bark off the boles of trees to eat the cambium layer.²¹ Sign of porcupines can therefore be conspicuous despite their nocturnal habits. Porcupines are considered rare in the park and may be mostly absent, but their distribution and abundance is poorly understood.

Pocket gophers

Pocket gophers (*Thomomys* species) are considered absent from Forest Park pending additional targeted surveys. Two species, the Mazamas pocket gopher and the Camas pocket gopher, occur regionally. Pocket gophers may occur in Forest Park, because a few, small, isolated grassy meadows are found in the South (Holman meadow, Birch trailhead), Central (under water towers), and North management units (Keilhorn meadow). Members of this genus have been located in the Tualatin Mountain Range.¹⁰

Mountain beaver

Mountain beaver (a.k.a. “boomer”) occur and breed in Forest Park but their distribution and abundance is poorly understood. The lack of records in the park, and the few observed burrows, suggests that mountain beaver may be localized and not well distributed. Boomers are seldom seen because they are nocturnal. Two separate, active burrow chambers were located in the North management unit in 2012 and individual boomers were photographed there. Mountain beavers gather and neatly store food resources just outside of their numerous, burrow entrances and therefore the presence of even a single animal on the landscape is somewhat conspicuous. Mountain beavers feed on foods that are common in Forest Park such as ferns, herbs, young woody shoots, and sapling trees. One burrow entrance in Forest Park contained fresh clippings from Pacific waterleaf and trillium, and another entrance was littered with discarded sword fern stems.⁵⁵

American beaver

American beaver are relatively common in the Willamette and Tualatin valleys, but are rare in Forest Park. In 2012, during late winter, evidence of recent beaver activity was found in the upper reaches of Doane Creek near the Wildwood Trail.⁷¹ The evidence included a recently felled western hemlock tree, chews, and tracks. No lodges or dams have ever been reported in the park, and park soils and streams do not support bank denning, so beaver do not breed there.

Lagomorphs

Rabbits

Only the brush rabbit has been observed in Forest Park. Rabbits are typically found in brushy habitat along the forest edge, and are seldom seen in the park’s forest interior. Great horned owls and coyotes are known to feed on rabbits in the park.

Insectivores (Soricomorpha)

Shrews

Among the three species of native shrew that occur in the park, Trowbridge’s shrew is widely distributed and the most abundant. Seventy-five percent of all shrews captured in three studies were Trowbridge’s shrew.^{10,56,57} They eat a variety of foods that are abundant in the park, including conifer seeds, fungi, mollusks, worms, spiders, and insects.⁷² The vagrant shrew, an insectivore famous for its use of echo-location, is also common and well distributed, especially in riparian habitat. The Pacific water shrew is stream-associated and considered rare because its occurrence in the park is based on a single capture record in 2002.⁵⁶ Forest Park



Tree felled by beaver

lies near the western edge of the broad range of the American water shrew and it has not been found here, but may occur. In addition to the above “true shrews,” the shrew-mole is also relatively common and well distributed in the park based mainly on owl prey analyses^{13,46} and dead trailside specimens.

Moles

Two species of mole inhabit the park, and the coast mole, due to its strong association with forest habitat, is the most abundant and widely distributed. Nevertheless, coast moles have mostly avoided capture, perhaps because they are fossorial (burrowing) and insectivorous, and may ignore typical trapping baits. The much larger Townsend’s mole is usually found in grasslands rather than forests. Nevertheless, an individual Townsend’s mole was captured in the park,⁵⁶ several were found in the diet of large owls,⁴⁶ and dead specimens are occasionally found.

Carnivores

Coyote, raccoons, striped skunks, long-tailed weasels, and short-tailed weasels are relatively common and well distributed in the park. All of these species are primarily active at night and are seldom encountered by park visitors. In contrast, several other carnivores are considered rare in the park. Photographic evidence of a single spotted skunk in the central management unit in 2010 is the only record for that species in the park.

Bobcat are secretive and nocturnal, but adults with young have been photographed near Balch Creek. Bobcats breed annually beyond the park boundary along Cedar Mill Creek.⁷³ Bobcats are presumed to occupy and use the park at the low densities typical for medium-sized, wide-ranging carnivorous species. Cougar have never been reported in the park, but are considered a rare species due to their habitat associations, elusive habits, regional sightings,⁷⁴ and occupancy in the Coast Range.



Short-tailed weasel hunting at night in winter in Forest Park, 2012
(Photo: John Deshler and PP&R)

Observational records indicate that black bears use the park for short durations about once or twice every 10 years. For example, in 1986 a volunteer trail worker, Bruno Kowalski, reported observing a sow black bear with two cubs along a newly constructed section of the Wildwood Trail between Germantown and Springville roads. Bear sightings in the early 1990s were relatively common^{10,58} and may have been of the same individual animal. Since then, black bear have not been reported within the park boundary. Two black bear sightings were among the many wildlife observations collected by upper Rock Creek residents just beyond the northwest park boundary from 2003 to 2006.⁷⁴ The park does contain foods

for bears, including succulent shoots, huckleberries, salmonberries, thimbleberries, salal berries, small mammals, nestling birds and eggs, ants, flowers, grubs, and fungi. In most years, no bears or their sign are found in the park. Berry-filled coyote scats and runny deer scat are commonly mistaken for bear scat.

Observations of foxes in Forest Park are rare, and mostly historical. Audubon staff observed an individual red fox moving along the Lower Macleay Trail in late 2011. However, prior to that, a red fox had not been reported since 1991.⁵⁸ The regional fox population may have declined due to the historical trapping of foxes on Sauvie Island to prevent waterfowl harassment.³⁶ Gray foxes have not been reported in the park, but occurred regionally until around 1990.⁷⁵

Gray wolves do not occur in Forest Park, and no historical records for wolves exist because the wolf was extirpated from Oregon by hunting and trapping prior to park establishment. The Coast Range is suitable habitat for wolves, and in recent years a few collared wolves have dispersed hundreds of miles into central and southern Oregon. Only a small fraction of the wolf population in Oregon and the surrounding states are collared. Recolonization of suitable habitat by wolves is a process that can occur rapidly,⁷⁶ and wolves may soon recolonize the Coast Range.

Ungulates

Black-tailed deer and elk both occur annually in the park, which offers forest edge habitat for cover, a few broad trail-less forest interior areas for bedding down, and food. The park lacks extensive grasslands that hold the preferred foods for these species, but does offer a few small grassy areas at Holman meadow, Keilhorn meadow, near trailheads along NW 53rd Avenue, and in utility corridors.

Black-tailed deer are well distributed in the park. Bucks, does, and fawns have been photographed in the park, which can be considered breeding habitat. Deer often travel to and from the park to rural grasslands, and move across Highway 30 to reach habitat along the Willamette River.

Elk occur annually in some seasons. In some years, small numbers of elk will be resident throughout the winter or summer seasons, remaining inconspicuous in the few broad trail-less areas in the North management unit. In places where elk breed, they are often conspicuous and noisy during the fall, because cow elk aggregate into harems, and bulls bugle loudly and often. Elk are seldom observed in Forest Park during the fall breeding season, though two bulls spent several weeks near the extreme southern edge of the park in late summer and early fall 2012.

Near the northern part of the park, Linnton neighborhood residents report annual early winter incursions by elk,⁷⁷ and tracks and scat are regularly found along powerline corridors, near Firelanes 12 and 13, in Linnton Park, and near Newton Creek.⁵⁵ Skyline area residents also report elk movements in and out of the park along the southwestern boundary, and upper Rock Creek residents regularly see herds numbering from 10 to 50 individuals in their private fields and pastures northwest of the park boundary.⁷⁴ Small elk herds are also occasionally seen along the park boundary at Newberry Road, occasionally numbering around 20 individuals.⁷⁸ In 2009, a herd of approximately 20 elk moved through the park.

Marsupials

The Virginia opossum is common and widely distributed in and around Forest Park. Opossums are native to the southeastern United States and were first introduced into Oregon around 1915 as released pets.⁷⁹

Fish

Information on fish comes mostly from in-stream surveys by Portland's Bureau of Environmental Services (BES),¹⁵ and from observations by regional wildlife experts. Fish diversity is low in Forest Park relative to other regional waterways and other taxonomic groups in the park. The four species that do occur are native to the region. No fish species are widely distributed in the park, and two federally listed species are found only as juveniles in the lowest reach of Miller Creek in some seasons. Only two species occur and breed in multiple streams. Fish populations are limited in the park by stream conditions, including stream gradients and culverts that prevent upstream fish passage except at Miller Creek.

Salmonids

A small viable population of cutthroat trout is present in Balch Creek. This disjunct trout population has been self-sustaining for many decades. It is unknown whether the current population is a remnant of an historic population that was isolated by culvert construction, or whether trout were introduced to the stream afterward. A few juvenile cutthroat trout, juvenile coho salmon, and juvenile steelhead are occasionally found in the lowest reaches of Miller Creek, and late in 2012, crews collected an adult cutthroat trout there. All three species are presumed to breed there.

Cottids

Reticulate sculpin occur and breed in some major streams in Forest Park, but are absent from Balch and Saltzman creeks.

Amphibians

Information on amphibians in Forest Park comes from research projects,^{80,81} an amphibian monitoring program,⁸² surveys by regional amphibian experts,^{75,83,84} the BioBlitz for Forest Park Wildlife,³⁴ and reports from PP&R staff, trail crews, and boundary residents (Table 10). Most surveys were conducted in the Central and North management units. Information on amphibians is often complementary (upland vs. stream surveys), but is sometimes conflicting with respect to the abundance and distribution of terrestrial-, pond-, and stream-breeding species in Forest Park. Interestingly, some fall surveys found gravid female salamanders, suggesting that some amphibians in Forest Park are able to extend the spring season breeding into other wet seasons.⁸²

At least seven species of amphibian inhabit Forest Park, including five salamanders and two frog species (Table 6). All amphibians in the park are Oregon native species, and the northern red-legged frog is a TEES Special Status Species. One additional species, the northwestern salamander, may occur in the park, but has not been detected. Amphibian species that require water for egg-laying are limited by the scarcity of ponds and cold, clear streams. Forested habitat is abundant for fully terrestrial salamanders that lay their eggs underground or in rotting logs.

Pond-breeding salamanders

Rough-skinned newts are locally abundant in the park, but only at a few sites. Newts require ponds for breeding and are found mostly near Balch Creek, due to its proximity to the Portland Audubon Society's pond where hundreds breed each year, and near Miller Creek, where dozens are found annually during dispersal to and from breeding sites. One backyard pond on Newberry Road near Miller Creek is a known breeding site for newts. Terrestrial-phase newts have not been encountered during trapping surveys and terrestrial habitat searches, and are considered uncommon across most of the park. The regionally occurring northwestern and long-toed salamanders have not been detected in Forest Park. Northwestern salamanders breed in nearby ponds and are likely to occur in the park, but adults spend most of their lives underground and are seldom encountered even where they do occur. Egg mass surveys are necessary to determine if this species occurs in the park. Long-toed salamanders are associated with wetlands, small ponds, and meadows, which are rare in Forest Park, so this species is not believed to occur there although it is common in nearby wetlands.



Western red-backed salamander

Stream-breeding salamanders

Coastal giant salamanders are abundant as neonates in the low reaches of major streams in the park, and adults are occasionally found in nearby upland habitat. A single survey in Saltzman Creek in 2011 found 90 juvenile giant salamanders there.⁸¹ The streams in Forest Park are not cold or fast enough to support other regional stream-breeding amphibians such as Cope's giant salamander or Columbia or Cascade torrent salamanders.

Terrestrial salamanders

Ensatina salamanders, Dunn's salamander, and western red-backed salamander are abundant and widely distributed, particularly where large woody debris is shaded by coniferous forest. *Ensatina* salamanders are the most common salamander in upland habitats in the park. Western red-backed and Dunn's salamanders are also common in riparian and upland habitats.

Neither the Oregon slender salamander nor the clouded salamander, which occur regionally, has been detected in the park. The clouded salamander, a climbing salamander and a TEES Special Status Species, occurs regionally in the Tualatin Mountains. This species prefers moist habitats on the forest floor, but is at least semi-arboreal and has been found high up on large snags. Further surveys could discover its presence in the park.

The Oregon slender salamander, a federal species of concern that occurs in the Cascade Mountains of Oregon, has not been detected in Forest Park. However, the habitat requirements and distribution of the Oregon slender salamander are poorly understood, and although this species is most often associated with late-successional Douglas-fir forests in the Cascades, breeding populations have been found in Gresham in narrow riparian buffers of suburban residential areas.⁸⁴

Frogs

Two resident frogs, the northern red-legged frog and Pacific tree frog, have been captured in undocumented numbers during surveys. Pacific tree frogs appear widely distributed and abundant across the most of the park in moist upland and riparian habitat. At some locations, including lower Maple Creek, large numbers vocalize during the breeding season, creating a chorus that gives this species its alternative name: the Pacific chorus frog.

Northern red-legged frogs, an Oregon vulnerable species and federal species of concern, are relatively common in both riparian and upland habitats in the park. Dispersal distances of up to 2



Northern red-legged frog found at Springville Creek in Forest Park, April 2012
(Photo: John Desbler and Art Colson)

miles are possible for this species, so it is able to breed both in and beyond the park boundary, and to use upland habitats in the park for foraging outside of the breeding season. Many breed in ponds on private lands along the north and northwest boundaries of the park.

Forest Park has no suitable habitat for the rare, sensitive Oregon spotted frog, which occurred historically in the Willamette Valley, and they are not present in the park. The streams are too warm and silty for the regionally occurring coastal tailed frog to be present in the park. The regionally abundant and non-native American bullfrog also does not occur there, due to a lack of sunny, permanent ponds.

Reptiles

No formal reptile surveys or research projects have occurred in Forest Park so all evidence of reptiles there is based on observations by regional wildlife experts,^{75,83,85} many of these from the intermediate past. Only three reptilian species are confirmed for the park, and two are closely related snakes (Table 6). The closed forest canopy limits the amount of available habitat for most species, except live-bearing ones. Egg-laying species rely on direct sunlight to warm their nests, and direct sunlight only strikes the forest floor in profusion along portions of utility corridors, at the historic rock quarry along Highway 30, and at the forest edge.

Snakes

The common garter snake and northwestern garter snake are known to occur and breed in the park. At the height of summer garter snakes are conspicuous along open utility corridors, and they are occasionally road-killed near the forest edge.

The rubber boa, a constricting snake, inhabits a variety of habitats in Oregon, and though it has not been reported in the park, it may occur there.⁸⁵ Rubber boas are found regionally in coniferous forests, and unlike many reptiles, boas are sometimes active at mild temperatures (e.g., 50° F). They will inhabit the forest floor under a closed tree canopy that other reptiles shun, and they give birth to live young. Surveys using methods developed by Hoyer⁸⁶ should be able to confirm the presence or absence of this species.

Detailed Wildlife Information: Vertebrates

Lizards

Among lizards, only the northern alligator lizard, a live bearer, has been recorded in Forest Park, and only a single specimen from the early 1990s.⁸³ Forest Park is within the range of the southern alligator lizard, western skink, and western fence lizard, but these lizards have not been detected and the latter two are egg-laying and therefore unlikely to occur.

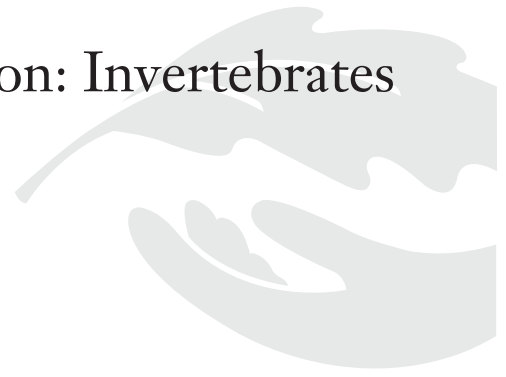
Turtles

No turtles occur in Forest Park due to the lack of sunny permanent ponds and adjacent open uplands.



Banana slugs

Detailed Wildlife Information: Invertebrates



Mollusks

Information on the diversity and abundance of most terrestrial slugs and snails in Forest Park comes primarily from a research project at Upper Macleay Park.⁸⁰ Additional information on mollusk diversity was collected during in-stream and terrestrial surveys,¹⁵ during the BioBlitz for Forest Park Wildlife,³⁴ and from observations by park staff and researchers. Surveys for stream invertebrates in Balch Creek are the only source of information on freshwater clams and snails.¹⁵ Surveys targeting aquatic mussels were conducted in the low reaches of some major streams, and none were found.²⁴

Most mollusk species in Forest Park are native and terrestrial, and six terrestrial species are relatively abundant (Table 7; Fig. 16). A single species, the Oregon megomphix (*Megomphix hemphilli*) is a species of concern for the Oregon Natural Heritage Program and the U.S. Bureau of Land Management. Some large slugs and snails are abundant and well distributed in the park, but information on small, inconspicuous species are lacking. Details on mollusk ecology in the park are also mostly lacking.

Slugs

Four species of slug have been documented, and 79% of individuals detected in 2005 were banana slugs. Two tailedropper species made up most of the rest of the specimens in that survey. The fact that only a single specimen of European red slug was found was used to suggest that invasive mollusks in Forest Park are being outcompeted by native species.⁸⁷ However, the European red slug made up nearly 30% of the slug specimens found during the 2012 BioBlitz³⁴ and no tailedroppers were found during the event. Banana slugs are a common prey item of coastal giant salamanders.

Snails

Six species of larger snail occur in Forest Park.⁸⁷ Although the large, beautifully marked Pacific sideband snail is abundant, well distributed, and often noticed by park visitors, the smaller, pale-green robust lancetooth is the most common snail in the park. The robust lancetooth and northwest hesperian made up 91% of all snails found in surveys in 2005, though only a single northwest hesperian was found during the 2012 BioBlitz. Thus, the limited information on relative abundance of snails is somewhat contradictory, perhaps due to differing moisture conditions at the time of surveys. The Oregon forest snail, a common snail of northwest Oregon forests, has not been found. Although basic

information on snail ecology is known, detailed information on the ecology of snails in the park is lacking. Barred owls preyed upon Pacific sideband snails in 2012, sometimes swallowing the entire snail and shell whole, later regurgitating the unbroken snail shell within a pellet of discarded fur and bones from other prey items.⁴⁶

Microsnails

Among the seven species of microsnails, three species contributed 85% of total abundance in one survey (Fig. 16). Microsnails are an inconspicuous and poorly understood group of park wildlife. Most microsnails are semelparous, breeding only once in their lifetime, and die within a year.

Aquatic bivalves and snails

Freshwater bivalves, mussels and clams, have complex life cycles and can be exceptionally long-lived. In some ecosystems they function as important food resources, and their filter-feeding cleans bacteria, algae, and sediment from waterways. Three species of aquatic snail and clam were found in Balch Creek in 2011.¹⁵ Surveys of major park streams for aquatic mussels, including floaters (*Anodonta* sp.) and western pearlshells, found none.²⁴ Data from other streams in the park are lacking.

Arthropods

Information on the diversity of insects, spiders, millipedes, springtails, crustaceans, and other arthropods comes primarily from annual surveys for wood-boring insect pests,^{88,89} regional entomologists participating in the BioBlitz for Forest Park Wildlife,³⁴ stream invertebrate monitoring in Balch Creek,²⁵ and riparian monitoring.¹⁵ A few additional species identifications have been contributed by park staff and researchers.

More than 440 species have been placed in an inventory for the park (Table 11). However, our understanding of insects and their allies remains poor relative to vertebrate wildlife. For example, although more than 50 mosquito species occur in Oregon, none have been identified to species in the park and placed in our inventory. Thus, we not only lack information on relative abundance, distribution, and ecology of most arthropods in the park, but our best estimate of diversity is certainly low.

About 10% of the arthropod species documented for the park are non-native,²⁶ and their impact is poorly understood. Several spiders, ants, beetles, and moths in the park have their origins in Europe and Asia. A few of these are a bark beetle (*Xyleborinus saxesenii*), a common woodlouse (*Oniscus asellus*), a pavement ant



An eight-spotted skimmer, a dragonfly, from the BioBlitz for Forest Park Wildlife, 2012
(Photo: Rachel Felice with Robert Richardson and Brendon Boudinot)

(*Tetramorium caespitum*), a spotted-wing fly (*Drosophila suzukii*), and a crab spider (*Philodromus rufus*).

The most diverse, conspicuous, and abundant groups of arthropods are highlighted below.

Arachnids

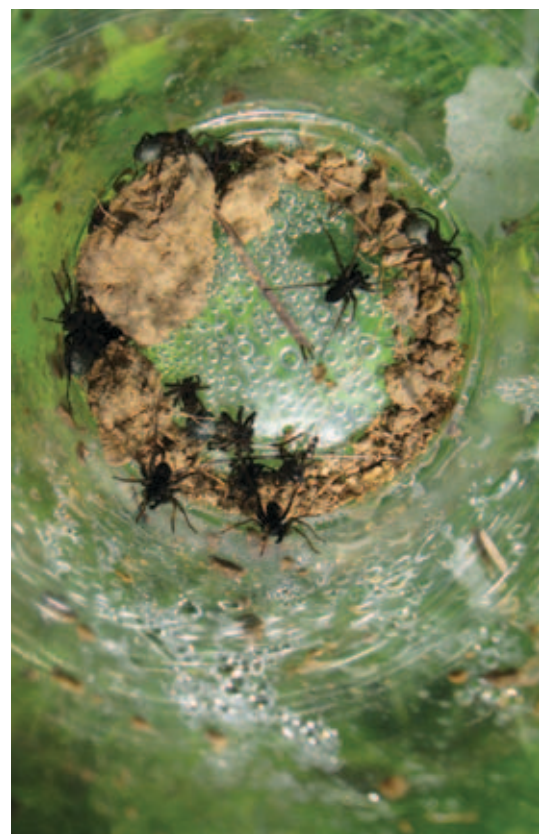
All information on arachnids is from the 2012 BioBlitz for Forest Park Wildlife. Eighteen species of arachnids were collected, and these are mostly spiders and harvestmen (Table 11). Spiders are abundant and become conspicuous, especially the orb-weaving species, during the summer months. Systematic arachnid surveys are lacking, and no pseudoscorpions, a common, diverse, and abundant taxonomic group, have been documented. Similarly, ticks and mites have not been well accounted. Only a single tick species has been documented (*Ixodes sp.*), even though 13 more species of *Ixodes* occur in Oregon, each with a specific host preference.

Centipedes and millipedes

Four species of millipede and two centipedes are known to occur in Forest Park, and there are probably many more. The clown millipede, *Harpabe haydeniana*, is distinctive for its aposematic coloration: bright yellow spots on a black or dark brown background. The clown millipede is able to release hydrogen cyanide as a defense against predators, which may allow it to be active during the day. Other millipedes, such as an all-dark cylindrical spirobolid millipede, are typically nocturnal. One ground beetle found in the park, *Promecognathus crassus*, is a specialist predator of the clown millipede; the Dejean's night-stalking tiger beetle (*Omus dejeani*) and *Pterostichus lama* have also been observed feeding on this species. Studies at the H.J. Andrews Experimental Forest, located in the Cascade foothills east of Eugene, suggest that the clown millipede is a keystone decomposer.⁹⁰

Springtails (Collembola)

Although long regarded as primitive insects, springtails are now treated as a separate class of six-legged arthropod (Hexapoda). Springtails occur in Forest Park, but none have yet been identified to species. These small arthropods get their common name from an appendage that hooks under the abdomen, acquiring such great muscle tension that it hurls the springtail into the air 30 times or more its length. Springtails are important components of forest floor food web, and can be incredibly abundant within the upper soil layers and within decomposing leaves, needles, and wood. Some species of pseudoscorpion and beetle are specialist



Wolf spiders collected in a container during the 2012 BioBlitz

springtail predators. Recent research also shows that springtails are important in the transportation of moss spores, acting in a similar manner to bees pollinating flowers.⁹¹

Insects

Beetles

Beetles are among the most diverse orders of animals in the world, and are the most diverse group documented in Forest Park at nearly 200 species (Table 10). Over 5,000 species occur in Oregon, and the full diversity in Forest Park is certainly greater than currently documented. Most beetle surveys in Forest Park have focused on the northeastern edge near the Port of Portland in attempts to detect wood-boring, non-native pests that could harm Oregon forests. Beetle families that were not the target of those surveys are underrepresented. For example, over 80 species of lady beetle occur in Oregon, but only three species have been identified in the park. Other diverse families in Oregon are also currently underrepresented, such as the Chrysomelidae (leaf beetles) and Staphylinidae (rove beetles).



One of the many beetles found during the 2012 BioBlitz

The great species diversity of beetles is also reflected in the diversity of their ecological roles. Beetles are important decomposers, particularly of dead wood and vegetation, animal waste, and carrion. For instance, larvae of two families well represented in Forest Park, the Buprestidae (flatheaded borers and jewel beetles) and Cerambycidae (long-horned beetles), bore under the bark and into the wood of shrubs and trees. Although most species attack severely stressed, dying, or recently dead trees, some are notable for attacking and possibly killing healthy hosts. Beetle activities such as these help create coarse woody debris and snags, key habitat components that benefit many vertebrate species. The adults of many beetles also are important pollinators. Some beetle species even mimic the colors of wasps and bees, such as the black-and-yellow-banded long-horned beetles in the genus *Xestoleptura*. The larvae of jewel beetles and long-horned borers are well known as important food for woodpeckers and other wildlife, comprising nearly one-third of the diet of hairy woodpeckers in some locales.⁹² Bark beetles burrow through bark and produce the familiar gallery tunnels in the sapwood immediately inside the bark of trees and shrubs. Beetles often thought of as wood-feeding actually feed on fungi instead. Most wood-boring species have one or more associated symbiotic fungi which are either food for larval beetles, or are important for reducing tree defenses. One species that occurs in Forest Park, the Douglas-fir beetle, *Dendroctonus pseudotsugae*, sometimes attacks and kills healthy trees. In some cases in western Oregon, trees have been killed over large areas.⁹³

Ambrosia beetles, a group of bark beetles, bore directly into the sapwood and sometimes even the hardwood. Some ambrosia beetles are restricted to just one or two plant genera. For instance, the only hosts of the oak ambrosia beetle, *Monarthrum scutellare*, are oaks and their relatives. Without oaks in the park, this species would be absent.

Predation is a common foraging strategy for beetles, particularly in the families of ground beetles (Carabidae), soldier beetles (Cantharidae), lady beetles (Coccinellidae), and rove beetles (Staphylinidae). Soldier beetles and lady beetles are particularly noted for preying upon soft-bodied plant-feeding insects such as aphids and help control these populations. Members of the genus *Scaphinotus* readily feed on snails and slugs, regurgitating digestive enzymes onto the flesh of their prey and slurping up the resulting “escargot soup.” Another ground beetle, *Promecognathus crassus*, is a specialized predator of the clown millipede and related millipedes. Although its prey is often three times its length and 5 to 10 times its weight, this beetle easily and quickly subdues the millipedes through an elegant and sophisticated prey capture behavior. Some soil fungal feeders are so adapted to their habitat that they are completely eyeless, including *Pinodytes newelli*, found during the 2012 BioBlitz. While we generally think of lady beetles as aphid-eating machines, one of the three species documented from Forest Park is *Psyllobora vigintimaculata*, which feeds on mildew.

Ants, bees and wasps

Hymenopterans are a fairly diverse order of insects in Forest Park, currently represented by four families and 19 species, mostly bees and ants. Ants are conspicuous at the forage edges and in disturbed area due to their abundance. At least nine ant species are found in the park. Two of the most readily encountered species are non-native, the odorous house ant (*Tapinoma sessile*) and the pavement ant (*Tetramorium caespitum*). The thatching ant, *Formica obscuripes*, is also noticeable because of the large mounds of plant debris over nest entrances. Ants consume a wide variety of foods in the forest including the honeydew from aphids. Some ant species, like some beetles, cultivate fungi as a food source. Carpenter ants, represented in Forest Park at this time by a single species, *Camponotus modoc*, provide a crucial step in the decomposition of wood by excavating galleries for their colonies within standing snags, downed woody debris, and stumps. The carpenter ants don’t consume wood; they just chew out cavities in which to live. Ants and their larvae can be an important seasonal food for many other wildlife species, including woodpeckers.

Bees and wasps are important pollinators in the park, and are more diverse than ants in Oregon. Most species are solitary. Bumblebees (*Bombus* sp.) are a relatively diverse genus, with four species currently documented in the park. Yellow-jackets (Vespidae), which are wasp species, also occur in the park. Some of these wasps create the familiar football-shaped nests that hang from tree branches, and others nest in the ground. Two of the families of wasps known from Forest Park, Cimicidae and Tenthredinidae, are sawflies. The larvae of these primitive wasp species feed on the foliage of shrubs and trees. Others bore within dying and dead trees, similar to the larvae of wood-boring beetles. Occasionally, the conifer-feeding Tenthredinidae species can defoliate large areas, though this has not occurred in the park.

Moths and Butterflies

After beetles, species in the order Lepidoptera are the most diverse group of animals in Forest Park. One hundred fifty species from 25 families of moths and butterflies are currently known to occur and many of these are abundant. Adult moths and butterflies are important as pollinators, especially of night-flowering plants. Adult moths are also important food for wildlife, including bats, flycatchers, swallows, and pygmy-owls. Larval forms are important consumers of plant material and are food for wildlife species at all levels of forest structure. Warblers and chickadees pluck caterpillars from shrubs and the tree canopy, and thrushes, sparrows, frogs, and shrews ply them from the forest floor. Larval lepidopterans are voracious herbivores and some species, such as spruce budworms and tussock moths, can act as defoliators, typically of ornamental rather than native plant species. The western tent caterpillar, *Malacosoma disstria*, has periodic outbreaks and defoliates host trees, but rarely has lasting detrimental effects to tree health. The conversion of plant biomass into caterpillars and their excrement is an important cycle for forest health. Several species of the moth in the park are non-native, including the beautifully patterned cinnabar moth (*Tyria jacobaeae*). Recent surveys in the park by the Oregon Department of Agriculture (ODA) and the USDA for the Asian gypsy moth, a serious forest pest, have found none, but gypsy moths were found and eradicated in years past.



Swallowtail butterfly

Stoneflies, Mayflies, and Caddisflies

Stream invertebrates in Balch Creek are an important food for many other species, especially the cutthroat trout and the juvenile coastal giant salamanders there. Depending on the year, 20 to 70 individual insects are found in a single square foot of streambed in Balch Creek.²⁵ Seventeen families of caddis-, may-, true-, and

stoneflies are known to occur there, and although the family richness is relatively even among these groups, abundance is heavily weighted toward mayflies (Figs. 19 and 20). For the collection of all stream invertebrates in Balch Creek, including amphipods, annual abundance follows climatic cycles (Fig. 21). Precipitation, driven by climatic cycles, brings nitrogen into the stream, and increased nitrogen negatively affects invertebrate populations there.

Worms

Information on worms in Forest Park is scant. The common earthworm (*Lumbricus terrestris*) is known to occur, and aquatic oligochaete worms are found in Balch Creek. Worms can be important food for birds and other wildlife, and aquatic species are sometimes eaten by juvenile giant salamanders.



Data being collected during the 2012 BioBlitz in Forest Park



Band-tailed pigeon adult and juvenile on nest
(Photo: Scott Carpenter)

Threats to Forest Park Wildlife



The 1995 *Forest Park Natural Resources Management Plan* establishes two conservation goals that are particularly relevant to wildlife. The first regards a trajectory for park management that creates an ancient forest ecosystem and protects animal communities. The second mandates the design of restoration projects that (1) maintain and enhance regional biodiversity, (2) provide wildlife habitat for both resident and migrant species, (3) improve aquatic habitat, and (4) repair damaged and fragmented natural systems. Through park management efforts, several goals have been achieved and some others are pending, but several threats also exist that may hinder the park management trajectory with respect to wildlife:

- Climate change
- Non-native invasive plants
- Non-native invasive insects and other wildlife
- Habitat alteration outside of the park
- Utility corridor management (habitat alteration within the park)
- Illegal park activities: homeless camps, rogue trails, nocturnal recreation
- Domestic cats at the park perimeter
- Air pollution
- Water quality degradation in Balch Creek
- Parasites, poisons, and persecution
- Fire and fire management

Climate Change

Perhaps no greater threat exists to the stated goal of growing an ancient forest and to the wildlife that would inhabit it than climate change. Regional scientists and natural resource agency directors have recently published *The Oregon Climate Change Adaptation Framework*⁹⁴ and the *Washington Climate Change Impact Assessment*⁹⁵ outlining the possible effects of climate change on the region over the next 40 to 50 years. The effects mentioned are pertinent to the habitat and the wildlife in Forest Park, and the ones below have been deemed *very likely*, *likely*, or *more than likely* for Oregon:

- increase in average annual temperatures and the likelihood of extreme heat events
- changes in the timing and quality of available water
- increase in wildfire frequency, intensity, and extent
- increased incidence of drought
- loss of wetlands
- increased frequency of extreme precipitation events and flood magnitude
- increased landslides

Based on the above, the Oregon report predicts that some wildlife and plant species will undergo both latitudinal and elevational shifts in their geographical distribution. Some species are predicted to decline in abundance or become locally extinct. In particular, species that are strongly associated with aquatic, wetland, and riparian habitats are predicted to suffer detrimental impacts as stream flows are reduced and droughts increase. Fish and amphibians are therefore most directly vulnerable to changes in climate. The impact of climate change on park habitats, especially water availability, will alter the diversity and abundance of all wildlife groups, including mammals and birds that rely on daily water intake, and on the plant and insect food sources near the bottom of the food web. Insects, including non-native pests, will likely increase in abundance annually as average temperatures gradually rise. Furthermore, the life cycle of plants and animals may become offset such that leaf emergence, flowering, and fruiting are no longer timed to match the appetites of larval moths and migratory birds, or the development of bee colonies. Fruit-bearing plants are likely to suffer poor crops and become less available as food for many species, from coyotes and deer to waxwings and thrushes. Because Forest Park is a relatively isolated forest fragment, any species losses will be difficult to regain through recolonization.

Non-native Invasive Plants

Invasive plants are among the greatest threats to wildlife diversity and abundance in the park, and are likely to remain so well into the future. Non-native invasive plants, particularly English ivy, English holly, and Himalayan blackberry, can reduce diverse, native plant communities to indistinct monocultures of a single or few groundcover or shrub species. When invasive plants are not controlled, the resulting lack of floristic diversity is particularly detrimental to arthropod diversity, but it is likely to have broad negative impacts on the distribution and abundance of vertebrate wildlife too. PP&R staff (the Protect the Best Program and City Nature West), Portland's BES crews, and volunteers and staff at the No Ivy League and the Forest Park Conservancy are currently engaged in activities to control the spread and establishment of invasive plants in Forest Park. This annual work has been effective at reducing and controlling many invasive plants, particularly at sites rated "healthy," "good," or "fair" condition (i.e., the "best" sites to be protected), and at volunteer-accessible sites. Through the Protect the Best Program from 2007 to 2012, from 750 to 1,000 acres have been treated or retreated annually in Forest Park.⁹⁶ From 2009 to 2011, over 3,000 park acres received a one-time treatment

of weedy trees such as English holly and laurel and invasive vines including English ivy and clematis. Comprehensive treatment of invasive species in the understory has not been accomplished throughout the park. If this work is not undertaken then the initial investment made in invasive species treatment will be lost. To sustain current wildlife populations, invasive plant treatments and retreatments are necessary on an ongoing basis to prevent invasive plants from dominating the ecosystem. The expansion of treatments into the remaining park acreage, especially near the park boundary, will best serve to meet the park management goals stated at the beginning of this section.

Non-native Wildlife

Invertebrates

Non-native, wood-boring insects, especially moths and beetles, are among the biggest potential threats to Forest Park. The close proximity of the Port of Portland facilities to the park increases the risk of introduction of these insects. Introduced species, such as gypsy moths (*Lymantria dispar*), have decimated otherwise healthy forests in regions of the Pacific Northwest. Asian long-horned beetles are particularly prone to destroying maple trees, a dominant tree class in the park. The Douglas-fir beetle, *Dendroctonus pseudotsugae*, a species that occurs in the park, sometimes attacks and kills healthy trees, and occasionally destroys broad swaths of forest. In recognition of these threats, both the ODA and the USDA-APHIS (Animal and Plant Health Inspection Service) have monitored sites in Forest Park for the presence of non-native insect pests for more than 10 years, and these efforts are ongoing. While some forest threats are known, and in some cases the displacement of native species by invasives is well documented, the ecological impacts of invasive arthropods are most often poorly understood.



Gypsy moth is an introduced species

Vertebrates

Most of the park's vertebrate wildlife are native species, and the relatively few non-native species tend to be restricted to park boundary areas. A few non-native species are threats to the native forest interior species with which they compete. Barred owls are a relatively recent addition to Oregon forests and are well established as breeding year-round residents in the park.⁴⁶ Barred owls outcompete the closely related and native northern spotted owl and may prevent their recolonization of the park regardless of whether the habitat succeeds to old-growth condition.⁵³ Similarly, invasive Norway rats appear to have displaced native woodrat species at the park perimeter, and no woodrats have been detected in the park in decades. Woodrats were formerly common at the park edge.

Woodrats are an abundant and valuable ecosystem component in some regions, both as food for many avian and mammalian predators, and as microhabitat engineers that build massive aboveground nests out of forest debris. Also among rodents, non-native tree squirrels now dominate the forest perimeter and occasionally penetrate the forest interior. Eastern gray and fox squirrels have displaced native western gray squirrels in many habitats, and compete strongly with other native sciurids where their territories overlap. Large patches of late-successional, interior, coniferous forest are still dominated by native squirrel species such as the Douglas and northern flying squirrels, and preservation of these habitats remains important.

Habitat Alteration Beyond the Park Boundary: Population Isolation and Loss of Foraging and Breeding Areas

Development guidelines set forth by the Skyline West Conservation Plan⁹⁷; land acquisition by Metro, PP&R, and the Forest Park Conservancy; and efforts by Washington County residents (e.g., the Save Helvetia campaign) have protected some natural areas and rural lands surrounding Forest Park from development. However, much of these surrounding lands remains privately held and at risk of conversion. The loss of habitat for foraging and immigration, and the potential isolation of terrestrial wildlife populations is an ongoing threat to their persistence in the park. Population isolation is often heavily influenced by large-scale habitat alteration, and has already factored into the extirpation of some species from the park.

Some wide-ranging species of Forest Park wildlife are currently able to disperse to and from the park to regional grassland, pond, riparian, and coastal forest habitat by crossing the southwestern and northwestern park boundaries. The availability of these unprotected habitats is important for many species. Several reports from the intermediate past have tended to focus on the preservation of *forested* lands beyond the northwestern park boundary.^{10,58,97} However, the pastures, agricultural lands, streams, and ponds across Skyline Boulevard may be even more important to northern red-legged frogs, deer, elk, and other wildlife species. Northern red-legged frogs are known to breed there. Band-tailed pigeons that breed in the park forage there. Ungulates prefer the ecotone between the grasslands and forests, where they can move back and forth between the relative safety of forest cover and the more open foraging habitat. The protection of habitat beyond the park boundary is therefore a key to maintaining certain species

within the park. Future residential and commercial development beyond the park boundary in the natural areas of Skyline West, upper Rock Creek, and Tualatin Hills may have negative impacts for wide-ranging species that also use the park.

The already noted declines in local avian populations may be especially influenced by habitat loss at broad scales, including the continental scale. Migratory species in particular require adequate foraging habitat and cover at migration stopovers and overwintering grounds, and these habitats may be hundreds or thousands of miles from their breeding habitat in Forest Park.

Habitat Alteration Within the Park Boundary: Utility Corridor Management

Forest Park is a protected natural area with easements for the construction and maintenance of utility facilities. Powerline corridor maintenance activities by regional utility companies sometimes result in extensive removal of shrubs and trees, as well as soil compaction. Recent shrub damage along the BPA Road in Forest Park in 2012 is an example. Shrub habitat is relatively uncommon and important in the park, and the wildlife species that use it are often localized breeders. The removal of shrubs during powerline corridor maintenance reduces breeding habitat for sparrows, thrushes, and warblers, and razes flowering plants that are important to hummingbirds, moths, bees, and other pollinators. In some cases PP&R has worked successfully with utility partners such as Kinder Morgan to analyze and modify right-of-way maintenance activities such as tree cutting, and thereby substantially reduce habitat losses. Habitat losses have also been mitigated by topping rather than cutting down some trees, leaving branchless boles standing to become snags, an especially valuable wildlife habitat component.

Illegal Park Activities: Transient Campers, Rogue Trails, Nocturnal Recreation, Plant Harvest

Illegal park activities may be particularly detrimental to wildlife, and such activities are not considered uncommon. Many illegal activities involve off-trail movements, which disturb wildlife and destroy habitat. Users that stay on designated trails are ignored by many wildlife species, especially smaller ones.

Transient campers, who invade all areas of the park, but are particularly common near Balch Creek and the northeastern edge, pose many threats to wildlife. Transient campers build cooking fires that may become wildfires. They create camps in



Illegal campsite

inconspicuous, off-trail areas and may drive wildlife out of these otherwise unpeopled large, forest fragments. They also destroy habitat, build structures and trails, defecate and urinate near streams, and are sometimes active at night.

Forest Park is officially closed from 10 PM until 5 AM. Nighttime activities disturb wildlife, particularly terrestrial mammalian species, a majority of which are nocturnal, and thus forage, travel, breed, and rest at night. Many arthropods, salamanders, and mollusks are also nocturnal and commonly use trails at night, where they cannot be avoided in the darkness and are susceptible to being crushed. The extent of this disturbance and the frequency of this illegal activity are poorly understood. But nighttime cycling is considered to be somewhat common by some park users, and has been admitted by some cycling advocates.⁴

Similarly, geocaching has become a popular pastime, and one that openly encourages participants to place and pursue caches in off-trail areas and to be active in the park at night. Based on the geocaching.com website (2012), more than 75 geocaches are currently hidden in Forest Park, and many of these are off-trail. PP&R supports geocaching and has recently reached an agreement with geocaching.com to allow a maximum of 10 geocaches in each of the Central and South management units. All geocaches must be within reach from the tread of the trail. All other geocaches are to be removed and will no longer be displayed on the geocaching website, including all those in the North Management Unit and all off-trail caches.

Rogue trail creation is a relatively uncommon occurrence in the park, but has occurred at multiple sites in recent years.⁴ In some cases, trails result from the expansion of existing deer trails, or from human or biking trails near the park boundary. In another case, trees were cut down, streambanks were modified, and a mile-long trail was constructed. Rogue trails further fragment the park and their use disturbs wildlife, particularly elk and other large mammals that tend to use the few larger, trail-less areas in the North Management Unit for foraging and resting during winter and early spring following fall breeding. PP&R has worked to deconstruct these trails and restore habitat as they are found.

Illegal plant harvesting in Portland's natural areas is somewhat common, and typical targets are nettles (*Urtica dioica*) and salal (*Gaultheria shallon*). Like several threats, the extent of this problem and its impact on wildlife is poorly understood, but birds and mammals feed on salal berries and will nest under and within salal cover.

Domestic Cats at the Park Perimeter

Feral or otherwise free-roaming domestic cats are a serious, direct threat to birds and small mammals in many habitats.^{98,99} Approximately 40% of intakes at the Portland Audubon Society Wildlife Care Center in 2011 were either injured or orphaned by house cats.¹⁰⁰ But the extent of the domestic cat impact on park wildlife has not been quantified. Domestic cats commonly prey upon songbirds, squirrels, shrews, voles, and mice, especially recently fledged birds, and all of these are common in the park. Free-roaming domestic cats living along the park *perimeter* are likely to kill small birds and mammals that forage and breed there. However, motion-detection camera surveys and observational accounts indicate that feral cats do not roam the *forest interior* and cat colonies are not established there,⁵⁹ perhaps because bobcats, raccoons, coyotes, and other wildlife are controlling the cat population. Some coyote scats collected within the park in 2012 were found to contain domestic cat bones and claws, suggesting that coyotes are among the species that control free-roaming cats, though the data sample was small ($n = 30$ scats). Cats were a minor portion of coyote prey. In 2012, more than 80% of the coyote vertebrate prey items found in scats were rodents, shrews, and moles, and a few large mammals such as deer contributed disproportionately to coyote prey biomass.⁴⁶

The extent to which dogs pose a threat to Forest Park wildlife populations is less well understood, and is considered a *gap* more so than a *threat*. Unlike domestic cats, the impact of domestic dogs on wildlife is often behavioral rather than lethal. Scent-marking by dogs along trails can cause some mammalian wildlife such as deer to use trail corridors less often, but may cause coyotes and foxes to investigate trails more often. Trailheads where both human and dog activity are heaviest tend to be avoided by some mammalian wildlife.¹⁰¹ In 2011, approximately 3% of intakes at the Portland Audubon Wildlife Care Center were dog-caught.¹⁰⁰ The addition of a full-time ranger for Forest Park, the implementation of a volunteer park ranger program, and increased signage has led to a gradual reduction in the number of warnings and citations issued to park visitors for having dogs off-leash.¹⁰² Based on motion-detection camera studies, no free-roaming domestic dog packs occur in the Forest Park.⁵⁹ Nevertheless, some leashed and unleashed dogs walking with human companions will dig for and dispatch moles, chase trailside squirrels and birds foraging on the forest floor, and bark at the scent or presence of mammalian wildlife such as coyote, deer, and raccoons. Numerous dead coast moles are found along park trails each spring and a few moles



Coyote at night in Forest Park, 2010
(Photo: Dan Richardson and PP&R)



Townsend's mole

are known to have been killed by dogs.⁵⁵ Mole specimens also die in spring due to flooding of burrows and the destruction of earthworms.¹⁰³ Stream impacts by dogs, including disturbance of fish and salamanders and stream-bank degradation, are often concentrated near the short segments where trails intersect streams perpendicularly. The Lower Macleay, Chestnut, and Nature trails parallel stream reaches for relatively long lengths, and therefore wildlife in and around Balch and upper Rocking Chair creeks are prone to disturbance by both dogs and humans that enter the creek.

Air Pollution

Forest Park is adjacent to some of the areas of poorest air quality in the Portland airshed. Recent studies at Portland State University (PSU) through the Center for Life in Extreme Environments (CLEE) and Center for Climate and Aerosol Research have investigated the changes in lichen composition over the past 20 years in a comparative diversity study.¹⁰⁴ Air pollution has been documented to alter lichen community composition, species distribution, physiology, or appearance. Initial results from this study show altered lichen communities, with fewer air-quality-sensitive species present at study locations throughout the park. Additionally, individual lichen structure shows signs of poor air quality in reduced physiology of the vegetative body of the lichen (thallus). This emerging data will be informed further by subsequent field research by CLEE laboratory. Currently, wildlife impacts are unknown and are not a research component of the research, but it is anticipated that a reduction in lichen and moss species diversity, abundance, and quality of individual structures may adversely impact wildlife that nest in, live on, and rely upon lichens as a primary food source, as food source habitat (e.g., insects and arthropods living in moss and lichen patches), or as nesting material (e.g., northern flying squirrels).

Water Quality Degradation in Balch Creek

As already noted, water quality in Balch Creek has declined in recent years, especially with regard to dissolved solids, ammonia, and bacterial load.¹⁰⁴ Balch Creek is the largest park watershed and supports an abundance and diversity of stream macroinvertebrates and other wildlife species such as cutthroat trout, American dipper, and great blue heron that are uncommon elsewhere in the park, and that rely on the aquatic environment. Balch Creek is also especially important to terrestrial wildlife because it is the only perennial stream in the South Management Unit. Numerous management plans have been developed in recent decades that

highlight the value of Balch Creek to wildlife, the ongoing concerns about water quality and habitat, and the need for ongoing management efforts there.^{8,106,107,108}

Approximately three-fourths of the Balch Creek watershed is beyond the protection of the park boundary and the Audubon sanctuaries, so the ongoing support of private individuals is also necessary to sustain the creek's ecological health.

Parasites, Poisons, and Persecution

The recent outbreak of avian botulism that killed thousands of birds at a northeast Portland wetland not far from Forest Park demonstrates the seriousness of the threat of disease for wildlife. For some wildlife species, body condition and disease can be related to human effects. In one study, urban coyotes with higher rates of mange (*Sarcoptes scabiei*) also consumed significantly more anthropogenic foods, whereas healthy coyotes consumed more natural prey.¹⁰⁹ In another study, 95% of 60 bobcats that ranged in both urban and natural habitats showed exposure to “alarming rates” of the anticoagulants used in rodent poisons.¹¹⁰ These studies highlight the potential for negative human impacts on wide-ranging park wildlife species, especially the few remaining large carnivores that occupy the top of the food chain in the park.

Persecution of species can also be a threat to their existence in Forest Park. Pocket gophers and coyotes are two of the many examples of species that continue to experience intense persecution by humans, despite their ecological function and value. Pocket gophers are ecological engineers that aerate the soil, cycle nutrients, create burrows that are used by dozens of other species, and feed on herb roots, helping to maintain the grass habitats where they occur.¹¹¹ Coyotes in the Forest Park ecosystem are a top predator, and as such may *benefit* many other wildlife species through trophic cascade effects.¹¹² Both of these species are commonly targeted by animal control operators in response to human complaints, real or otherwise. Continued persecution within urban habitats where wildlife population densities are sometime relatively low can lead to species losses.

Fire and Fire Management

Three stand-replacing fires in and around Forest Park in from 1889 to 1951 suggest that fire remains a threat to the forest and to wildlife. The *Forest Park Wildfire Risk Reduction Final Report* outlines 13 projects and provides other guidelines to manage fire risk in Forest Park.¹¹³ The risk of catastrophic fire in Forest Park is so

strongly mitigated by the abundance and distribution of hardwood tree species, especially bigleaf maple, that no management actions have been implemented at this time. Because Forest Park is ringed by residential and commercial properties, wildfires in the park are closely monitored and in most cases, immediately extinguished. The eastern park edge is considered to be at higher risk for wildfire than other areas due to a combination of factors including slope, aspect, fuel loads, easterly dry-season winds, homes, industrial businesses, the railroad, and transient camps.

Wildfire, including stand-replacing fires, can be both beneficial and detrimental to wildlife, depending on the species being considered, and the size of the forest area affected. Stand-replacing fires create forest openings that may ultimately be attractive to species such as quail, woodpeckers, bluebirds, clouded salamanders, and elk.

Wildfire risk management actions, including those actions recommended in the wildfire risk assessment, can also be both beneficial and detrimental to wildlife. Protecting the forest from catastrophic fire maintains the status quo and protects wildlife. However, risk management actions call for the removal of *forest fuels*, a term that includes any living or dead plant, but especially dead, woody species and fire-prone live evergreen trees, including grand fir. The removal of large grand fir trees could be detrimental for some Pacific Northwest bat species for which it is the preferred roost structure.⁶⁵ And removal of other forest fuels could be detrimental to wide variety of wildlife species from all classes, because downed logs and snags are important cover, foraging substrate, and nesting structure for many species including salamanders, shrews, voles, woodrats, woodpeckers, squirrels, owls, brown creepers, chickadees, swifts, and weasels.



Red-breasted sapsucker
(Photo: Scott Carpenter)

Gaps and Next Steps



While much is known about Forest Park wildlife, much remains to be known. For some taxa, the following basic information is lacking:

- Diversity
- Abundance
- Breeding
- Distribution
- Habitat use and availability of key habitat components
- Seasonality
- Population trends
- Ecology
- Threats to population persistence

This is especially true for invertebrate animals, about which fundamental questions of diversity remain, and which are important to all aspects of park ecology. In other cases, knowledge gaps are more complex. Data are sometimes lacking on the reproductive success of species of concern, wildlife response to management actions, or whether non-native animals are impacting native species. Perhaps most importantly, information is lacking on a populations trend over time, especially for TEES Special Status Species, uncommon species, and those with home range requirements that extend beyond park boundaries. Where monitoring has occurred, many common and seemingly abundant species appear to be in decline, some others appear stable, and relatively few are increasing in abundance.³³ Results like these demonstrate the importance of ongoing monitoring.

Collecting data on complex questions can be time-consuming and labor- intensive, and a robust understanding of even a single species' population, habitat use, and breeding biology within Portland parks can take several years.^{12,31} With more than 150 vertebrate species and perhaps thousands of invertebrate ones, it is not possible to know everything about all species. Nevertheless, key information on wildlife remains important for park management and is of interest to the public and the academic community. To guide future efforts on wildlife research in the park, a table of gaps and next steps has been developed (Table 12).

Mammals

Data on mammalian diversity in the park is relatively robust, and none of the rodents, carnivores, insectivores, ungulates, or rabbits known to breed there are special-status species. A review of the basic information on mammals makes clear that although bats



Red fox

make up nearly one-quarter of the park's mammalian species, they are the least understood group. Because the park is mostly interior forest, it is sometimes dismissed as less than ideal habitat for bats, but 10 bat species are known to occur there, and eight are special-status species. Collecting data on the abundance, breeding, distribution, ecology, and, especially, habitat use of bats in the park is a priority.

Data on population trends among mammals in the park is absent, and relative to the solid information on avian trends this stands out as an important gap. A few studies indicate that the deer mouse population may experience boom and bust years in the park, and that these fluctuations may have impacts on both their food resources and the breeding success of their many predators.^{12,46,56} But not even the hint of such trends or cycles is available for other mammalian species. Population trend data are important for detecting potential species losses of rare animals such as porcupine and spotted skunk, for assessing the impact of non-native species such as black rats, and for understanding common species, including native squirrels, shrews, moles, and small weasels that can experience negative population changes despite their seeming abundance. Data would be especially valuable for rare species, such as porcupine, Pacific jumping mouse, and red fox, and for the many special-status bats.

Large mammalian carnivores other than coyote are seldom encountered in the park or its surrounds, due in part to the broad habitat requirements and nocturnal habits of these species. The relative isolation from the broader Coast Range makes some species rare in the park. When large carnivores are observed, they are often reported to PP&R staff. A lack of such reports on gray foxes in recent decades stands out and suggests that gray foxes are now extirpated from the park and the surrounding landscape. Similarly, the red fox now seems to be a rare, transient visitor to the park and no longer a resident. Data are nevertheless lacking. A regional study that includes Forest Park is necessary to understand fox abundance and habitat use in the park.

Burrowing rodents, especially pocket gophers and ground squirrels, are not known to occur in the park, and surveys are needed in the few areas where they may occur. Because their presence can be relatively easily detected in the isolated grasslands where they may occur, surveys would be valuable and economical. The Camas pocket gopher is a special-status species.

Elk sightings in Forest Park are reported annually to PP&R management by park visitors and neighbors, indicating strong

public interest in maintaining this species as a non-game animal in the park preserve. Systematic monitoring of this species' use of the park is needed, as is information on their abundance, seasonality, and use of broad trail-less areas in the North Management Unit. Elk are a species that could be lost from the park unless their movements, habitat use, and relative abundance are understood, and management efforts taken to maintain their presence.

Woodrats and voles are important ecological components in Pacific Northwest forests, though they are relatively small and nocturnal and often overlooked by park visitors. Native woodrats and voles (Cricetidae family) are not closely related to the non-native, Old World rats and mice (Muridae family) that occupy the disturbed park perimeter. Woodrats and voles have intriguing life histories and are important food resources for spotted owls and many other predators; members of both groups construct elaborate nests that become nesting and roosting structures for other wildlife.^{21,114} The feasibility of reintroducing the red tree vole and the dusky-footed and bushy-tailed woodrats into the park should be explored.

Rare, but recently detected, species need further research to determine whether they are on the verge of being lost from the park. The North American porcupine, the Pacific water shrew, and Pacific jumping mouse have rarely been seen or captured in Forest Park and their presence, abundance, and distribution in the park are in question. Trapping and or motion-detection camera surveys that target these species in their preferred habitats are recommended to explore their relative abundance in the park.

Birds

We have excellent information about avian population trends at the southern boundary of the park, and that citizen science effort is ongoing. The recently implemented and ongoing avian monitoring by Portland's BES has yet to produce population trend data at some riparian sites, but may begin to do so in the next few years.^{15,20} While population trends for some bird species are well understood, in other cases the results are contradictory.^{28,30,33} Because so many bird species appear to be in decline, monitoring of bird population trends at the north end of the park is recommended to understand whether trends at the southern tip may be related to urban effects that may be less impactful in the north.

Despite having the robust data on bird *diversity* in the park, the *population dynamics* of several common, special-status breeding bird species is in need of study. Even common species can experience population sinks in Portland parks,³¹ and we know very little



American robin nesting
(Photo: Scott Carpenter)

about how many common species are faring in terms of their reproduction. The list of species of interest includes the band-tailed pigeon, purple finch, pileated woodpecker, brown creeper, black-throated gray warbler, and bushtit. These projects are candidates for researcher-led citizen science efforts.

Uncommon bird species are even more susceptible to being lost from the park over time due to the affects of a population sink, and many uncommon birds are also special-status species. It is recommended that the population dynamics of varied thrush, Hutton's vireo, western wood peewee, and, especially, the olive-sided flycatcher be studied.

The loss of three species of landfowl in Forest Park greatly diminished the wildlife experience for park visitors. The reasons for these losses are unknown. It is recommended that an investigation be made into the regional range limits for sooty grouse, ruffed grouse, and mountain quail, and into the feasibility of reintroduction based on the current literature and expert opinion. Ultimately, the goal should be the reintroduction of these birds into the park if possible.

Nearly three dozen species show evidence of decline at the southern boundary of the park,³³ but the sources of these declines are poorly understood. Many of these birds are among the most common and abundant species in the park and nearly all of them are native species. For some species, a thorough review of the ornithological literature may elucidate the cause of their decline. In addition, local research may be necessary to best understand these declines, and potentially mitigate the threat of losing additional species from the park.

Reptiles

Few reptile species use the park, and none are special-status species. The priority gaps for reptiles are to determine the presence or absence of the rubber boa snake and the northern and southern alligator lizards using straightforward survey methods. The search for rubber boa in the park is a candidate for a citizen science project.

Amphibians

Data on amphibian diversity are robust because fewer than 10 species are likely to occur in the park, and because many in-stream, riparian, and upland surveys have been conducted. The presence of northwestern salamanders stands out as a credible question, and its occurrence should be investigated.

Other more complex questions about amphibian breeding still need answers, especially for the northern red-legged frog, a special-status species. Breeding sites for this species are ponds that lie outside of Forest Park on private, unprotected lands. Providing protection, access or substitutes for these breeding sites is likely to be a key to maintaining the red-legged frog population in the park. Methods for mitigating the potential loss of red-legged frogs should be explored.

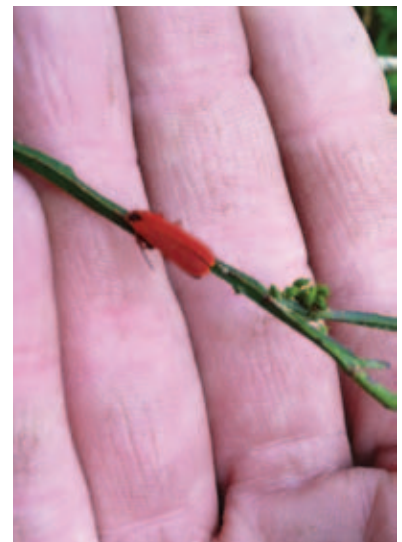
Mollusks

We have excellent information about the diversity of mollusks at the southern boundary of the park. Researcher-led citizen science surveys in the North and/or Central management units would be beneficial for understanding whether that diversity is well distributed and whether any non-native species have recently invaded. The increased abundance and impacts of the European red slug stand out as another research question.

Arthropods

The number of arthropod species in the park, especially insect species, remains an important question, despite the great strides that have recently been made toward documenting invertebrate diversity. Knowledge of regional and statewide diversity and the ease with which species continue to be added to the park inventory suggest that many additional species are present and unaccounted. One of Oregon's leading entomologists, Jim LaBonte, estimates that as many as 10,000 species of terrestrial invertebrates inhabit the Portland metro area.²⁸ With over 5,000 species of beetle and moth in Oregon, it seems likely that thousands of additional species may be present in the park. Insect families other than beetles and moths have been mostly ignored, except during the BioBlitz for Forest Park Wildlife, so thousands of these species have likely been missed. Surveys by the ODA and the USDA have focused on collecting and identifying wood-boring beetles and moths because of their potentially devastating impacts to agricultural and forest resources. Many invertebrate experts are eager to explore regional diversity, but the process of creating a mostly complete inventory of invertebrate species for the park is a large, long-term one. An effective strategy must involve many partners, including ODA, USDA, and regional universities. The creation of a voucher collection in association with PSU has been proposed.

Beyond basic questions of diversity, myriad questions surround arthropod ecology in the park. Data for the park are almost completely lacking on invertebrate ecology, despite the hundreds



Red net-winged beetle

of beetle and moth species and dozens of spiders, bees, wasps, and ants known to occur there. The lack of data has led to a lack of exposition on these taxa in this report, but does not diminish their ecological impact or the need for additional research. The need for further research is highlighted by the fact that, unlike vertebrate wildlife, a relatively high percentage of the park's insects are non-native, and several non-native species are serious threats to forest health. We have a poor understanding of the extent of non-native insect diversity and impacts, and these should be researched in greater depth.

Wildlife Response

Although extensive efforts have been made to remove invasive vegetation and restore habitat, the response of wildlife to these actions has not been measured. We should test the “build it and they will come” management strategy by measuring diversity and abundance in pre- and post-treatment experiments.

Similarly, we need quantitative data on whether habitat alteration within the park is negatively impacting special-status species. Shrub habitat in the park is limited, but is sometimes extensively cut during utility corridor maintenance activities. Including shrub habitat sites in wildlife monitoring efforts may be enough to elucidate these impacts.

Dogs are often postulated as the source of negative wildlife impacts. Dog walking is the third most popular activity in the park, after hiking and running.¹¹⁵ Observance of leash requirements has increased markedly in recent years.¹⁰² But the impact of dogs on wildlife remains poorly understood and should be studied in the park.

Many wildlife species are *area-sensitive* and require relatively large habitat patches for breeding, foraging, and resting.¹¹⁶ Occupancy of forest fragments by songbirds in particular is primarily influenced by forest patch size and habitat type.¹¹⁷ Maintaining large forest patches is necessary for maintaining high levels of avian diversity and the presence of elk and some other mammals. In one local study, trail density was indirectly related to the population growth rate of spotted towhees, meaning that as the number of trails increased, the rate of population growth decreased, apparently due to the negative effects of trail density on adult survival.³¹

In one study, half of all park visitors felt that passive recreation had no negative effect on wildlife, despite evidence that the probability that an on-trail pedestrian would flush an animal, such as a native

mule deer, was 70% when approaching within 100m. Recreational users also tend to blame other types of park users for impacts to wildlife, rather than their own group.¹¹⁸ The extent to which park users influence wildlife depends on the wildlife taxa under consideration, but the response of most species to pedestrian and domestic animal disturbance is poorly understood. In one study, pedestrian activity was correlated with a negative impact on avian species' foraging and occupancy of forest fragments.¹¹⁹ Others have suggested that an inverse relationship exists between a species' body size and its negative response to park users, such that smaller wildlife species must be approached more closely than larger ones before they respond negatively. Furthermore, larger *groups* of animals tend to flush at longer distances than individuals of the same species, so human activity may contribute to the rarity of ungulate herds in the park.¹¹⁸ Large and predatory mammalian wildlife species are prone to avoid human interactions, thus any human presence in their habitat is impactful. However, many mammalian species are nocturnal, and thus naturally avoid most park visitors that use the park legally (5 AM–10 PM). In contrast with mammals and some birds, the distribution and abundance of amphibians, reptiles, mollusks, and arthropods is not believed to be strongly influenced by park users.

The response by wildlife to illegal park activities is also poorly understood. Numerous encampments, the construction of rogue trails, and instances of nocturnal cycling have been postulated as negative impacts on wildlife, particularly large terrestrial mammals, but no quantitative data exist to support these notions.

Wildlife Habitat Assessment

A wildlife habitat assessment needs to be completed for Forest Park. Snags, coarse woody debris, shrubs, ground cover, and soil are key wildlife habitat components in the park, and relatively little quantitative data exist about these. PP&R's vegetation surveys were focused on understanding plant diversity and composition, but not wildlife habitat.¹¹ The data on wildlife habitat that are available are often localized to just a few sites or short stream reaches. For wildlife of concern, such as bats, voles, northern red-legged frogs, woodpeckers, flycatchers, and beetles, an assessment of specific wildlife habitat components may be necessary to understand whether the park currently offers adequate habitat, and whether the existing habitat could be altered to attract and maintain populations of interest.



Low shrubs and groundcover create a habitat for wildlife in Forest Park

Additionally, some wide-ranging species use habitat beyond the park boundary, and then return to the park for breeding or foraging in other seasons, or at other times of day. An understanding of the use of non-park habitat by park wildlife has been identified as an important gap, especially for special-status species and others of interest including elk, northern red-legged frogs, band-tailed pigeons, Vaux's swifts, and grouse.

Special Status Habitats

Oak stands and forested wetlands are TEES Special Status Habitats and need to be surveyed systematically in the appropriate seasons, especially late winter and spring. These habitats may attract wildlife species that occur nowhere else in the park. Oak stands may harbor southern alligator lizards, white-breasted nuthatches, western gray squirrels, and some special-status woodpecker species. Forested wetlands may provide unknown breeding habitat for northern red-legged frogs.

Wildlife Recolonization and Reintroduction

The recognition of the inability of some Coast Range species to recolonize the park makes obvious that we lack information on the feasibility of reintroduction of species. Reintroductions of small native mammals and landfowl species, such as the red tree vole and the dusky-footed woodrat, are opportunities to improve park ecology by restoring historical diversity while expanding the habitat of species of concern, and improving the wildlife experience for park visitors. Although Forest Park has transitioned to a mature second-growth forest with some late-successional conifer stands, species such as these appear unable to recolonize the park from the Coast Range or the Tualatin Valley due to extensive regional habitat disturbance and the relative isolation of the park for some species.

In addition, reintroduction of native sculpin and freshwater mussels could improve the ecology and water quality of some park streams. In remnant oak stands, restoration projects that include the use of artificial nest boxes could encourage recolonization by white-breasted nuthatch, western bluebird, and Lewis's woodpecker to the park.

Glossary



<i>abundance</i>	(n.) The number of individuals of a given species or other taxonomic group.
<i>arboreal</i>	(adj.) Tree-dwelling.
<i>aposematic coloration</i>	(adj.) Typically bright coloration that acts as a warning to predators that an animal has defenses and eating it would be unprofitable. It may be an honest or dishonest signal.
<i>circadian</i>	(adj.) Characterized by a 24-hour pattern of activity.
<i>circannual</i>	(adj.) Characterized by a yearly pattern of activity.
<i>coarse woody debris</i>	(n.) Large trees or branches that are dead and on the ground or in a stream; a valuable habitat component for wildlife.
<i>congeneric</i>	(adj.) belonging to the same genus. (n.) congener.
<i>conifer-dominated forest</i>	A forest area with greater than 50% conifer cover (see Fig. 3).
<i>diameter at breast height (dbh)</i>	(n.) The diameter of a standing tree at 4.5 feet above the ground on the uphill side of the tree.
<i>deciduous forest</i>	A forest area with less than 25% conifer cover (see Fig. 3).
<i>ecotone</i>	(n.) The transition area between two distinct habitats.
<i>forest</i>	(n.) A broad area with a high density of trees, and few or no open spaces. A broader, more densely treed area than a woodland.
<i>forest edge</i>	<see <i>Edge Habitats</i> in the <i>Report Framework</i> section>.
<i>fossorial</i>	(adj.) Living underground.

Glossary

<i>gravid</i>	(adj.) Carrying fertilized eggs internally.
<i>home range</i>	(n.) The area where an animal lives, forages, and travels, often larger than the animal's territory.
<i>invasive species</i>	(n.) A species capable of rapidly expanding its range or abundance in an area, often as the result of recent colonization and an absence of strong competition.
<i>interior forest</i>	(n.) A forest patch of 30 acres in size or greater that is more than 300 feet from the nearest forest edge.
<i>invertebrate</i>	(n.) An animal, such as an insect, spider or slug, that lacks a spinal column.
<i>mixed conifer-deciduous forest</i>	A forest area with between 25 and 50 percent conifer cover (see Fig. 3).
<i>non-native species</i>	(n.) A species that did not occur historically in an area.
<i>perennial stream</i>	(n.) A stream with continuous flow throughout the year except in dry years.
<i>relative abundance</i>	(n.) The number of individuals in a given taxonomic group stated in relationship to another taxonomic group, often as a percentage.
<i>riparian</i>	(adj.) Of or relating to the area surrounding a stream or other water body.
<i>roost</i>	(v.) To sit, rest or sleep. (n.) A location used, often repeatedly, for resting, sometimes by large numbers of individuals of the same species ("communal roost").
<i>snag</i>	(n.) A standing dead tree, at least 4 inches dbh and 6 feet tall, often valuable for wildlife for nesting, roosting and feeding.

territory

(n.) The area that an animal defends, especially from individuals of the same species and sex, and most often during its breeding season. Animals that do so are considered "territorial." An animal's territory is often smaller than its home range.

wildlife corridor

(n.) An area of habitat connecting wildlife populations separated by human activities, such as roads, development, or logging. A wildlife corridor allows an exchange of individuals between populations, which may help prevent the negative effects reduced genetic diversity that often occur within isolated populations.

woodland

(n.) An area covered by trees with many open spaces; an area with 40% or less tree canopy cover.



Pacific wren
(Photo: Scott Carpenter)



Bobcat tracks

Appendix A: Figures

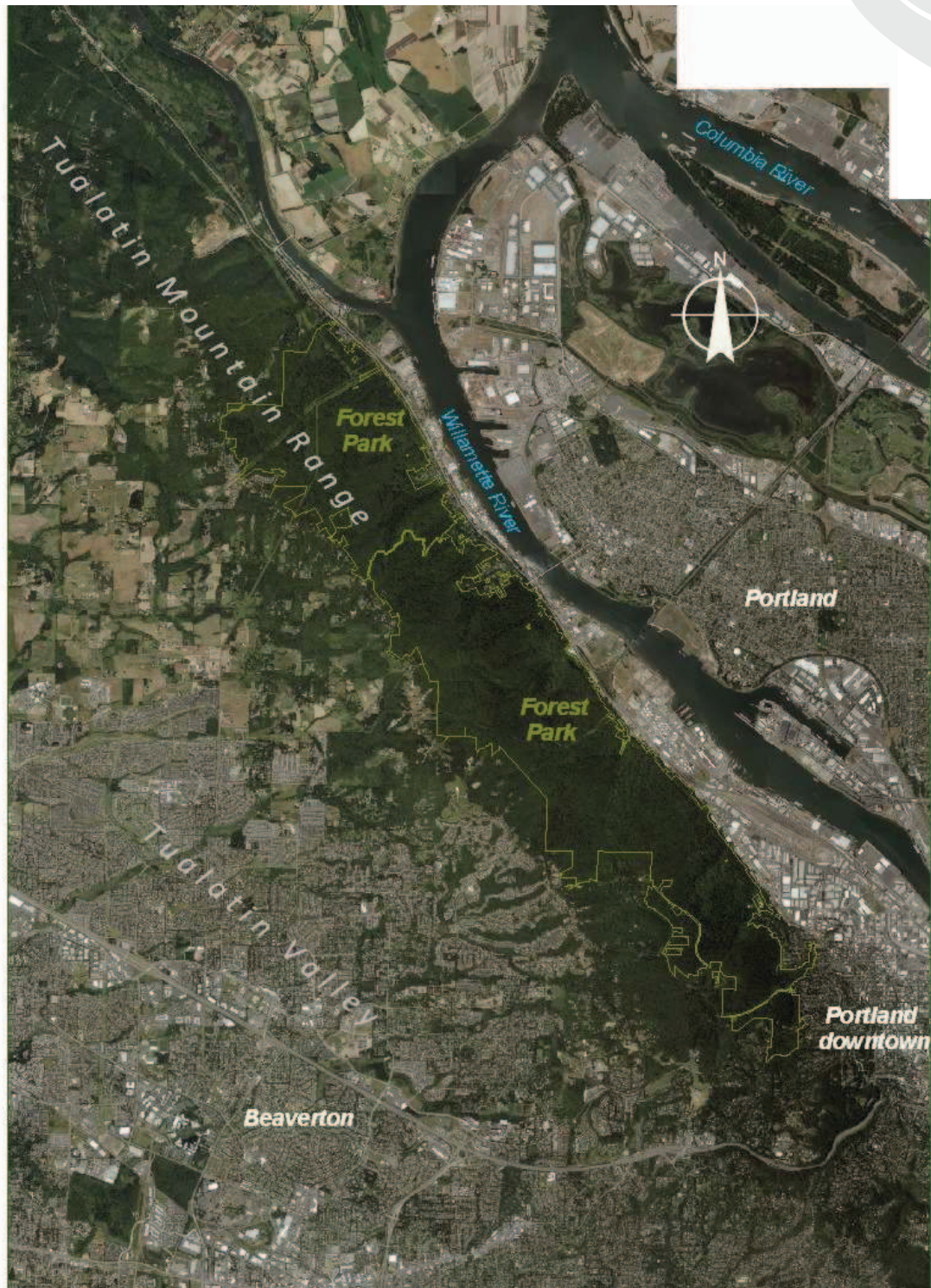


Figure 1. Aerial view of Forest Park and the surrounding landscape, 2010 (scale: 1:68,000).

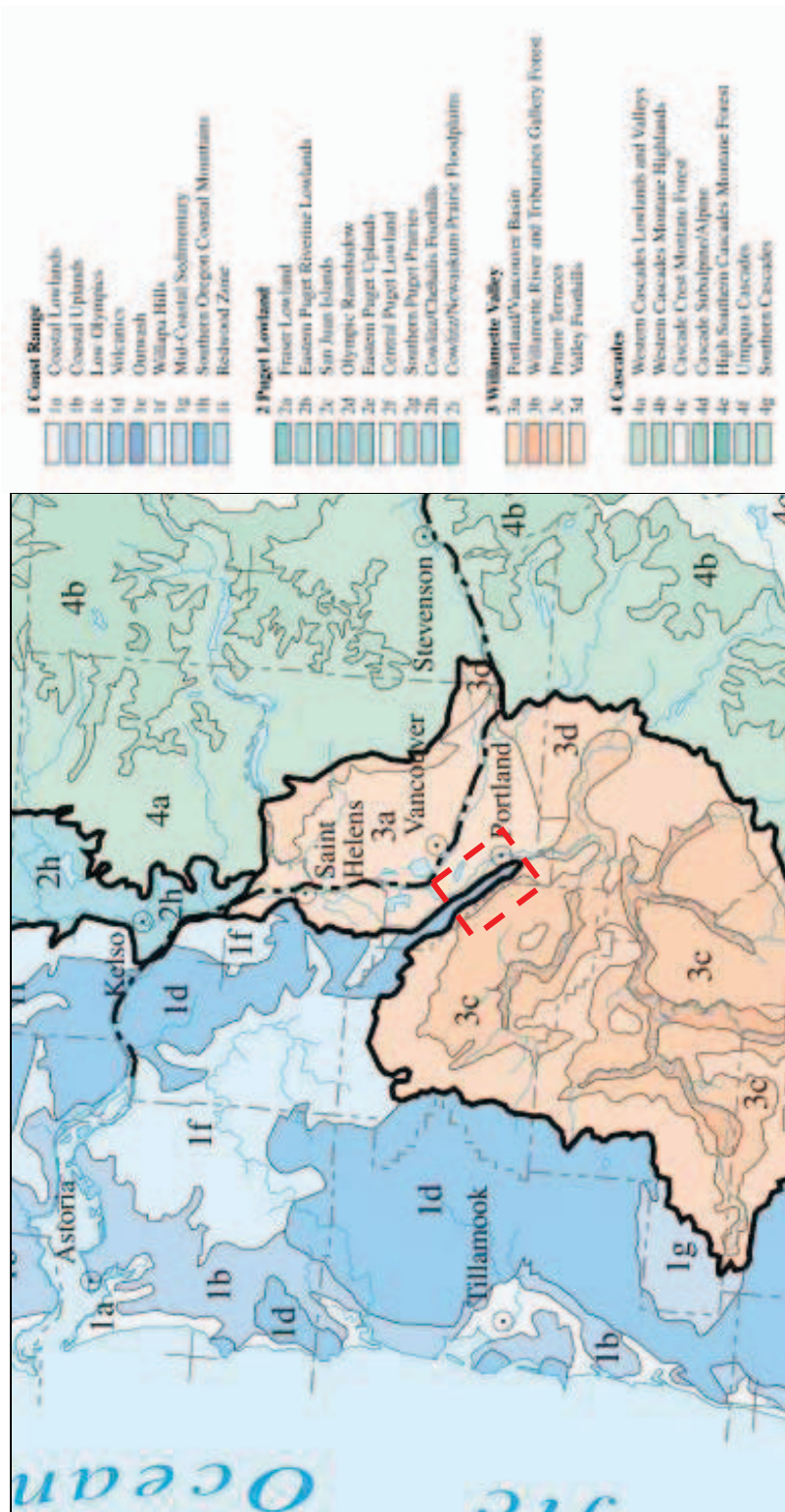


Figure 2. Ecoregions surrounding the Portland metropolitan area showing Forest Park (in red dashed rectangle) as a narrow, peninsular extension of the Coast Range ecoregion.¹²¹

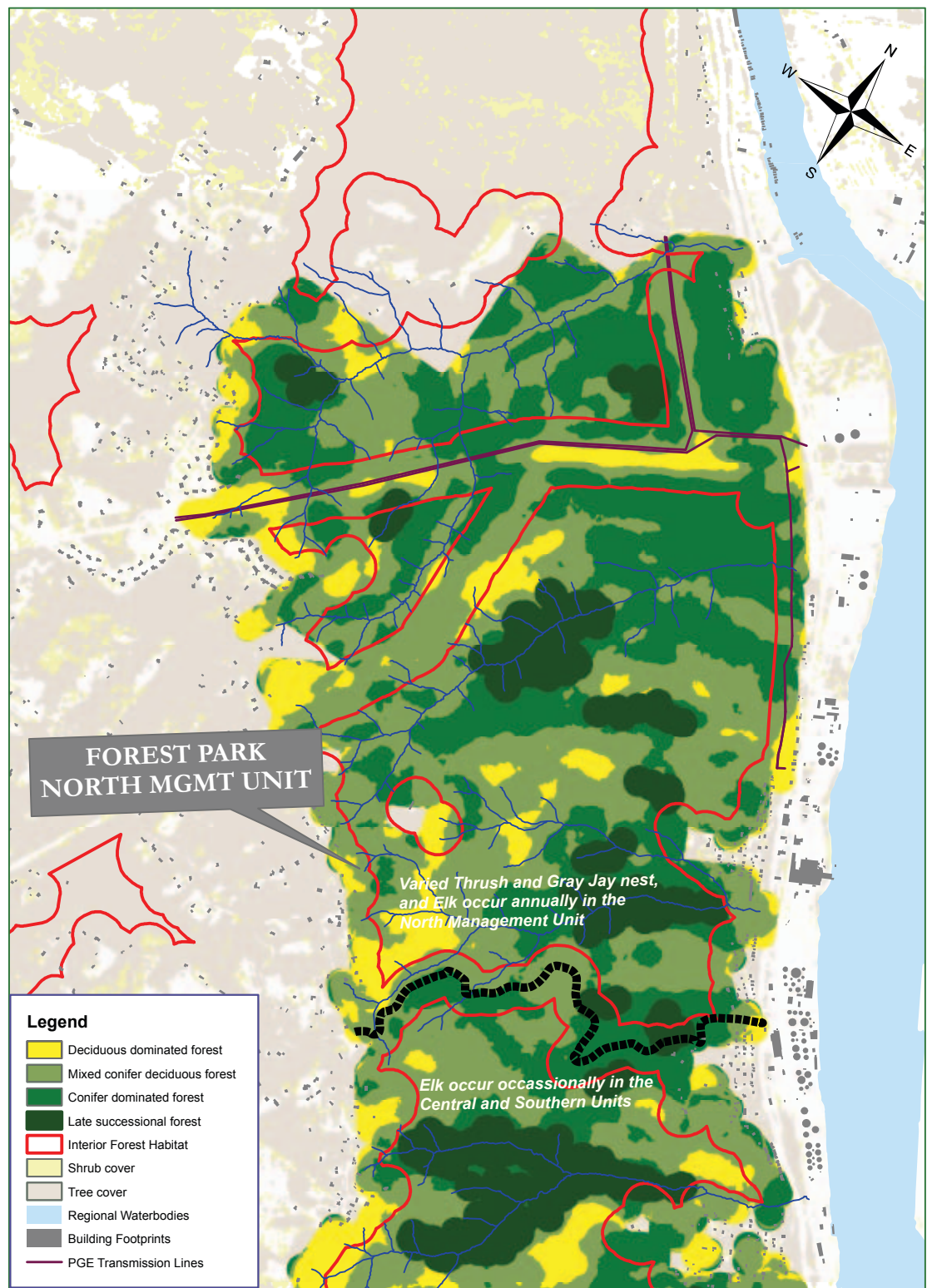


Figure 3. (A) Forest Park North Management Unit: wildlife and habitat distribution.

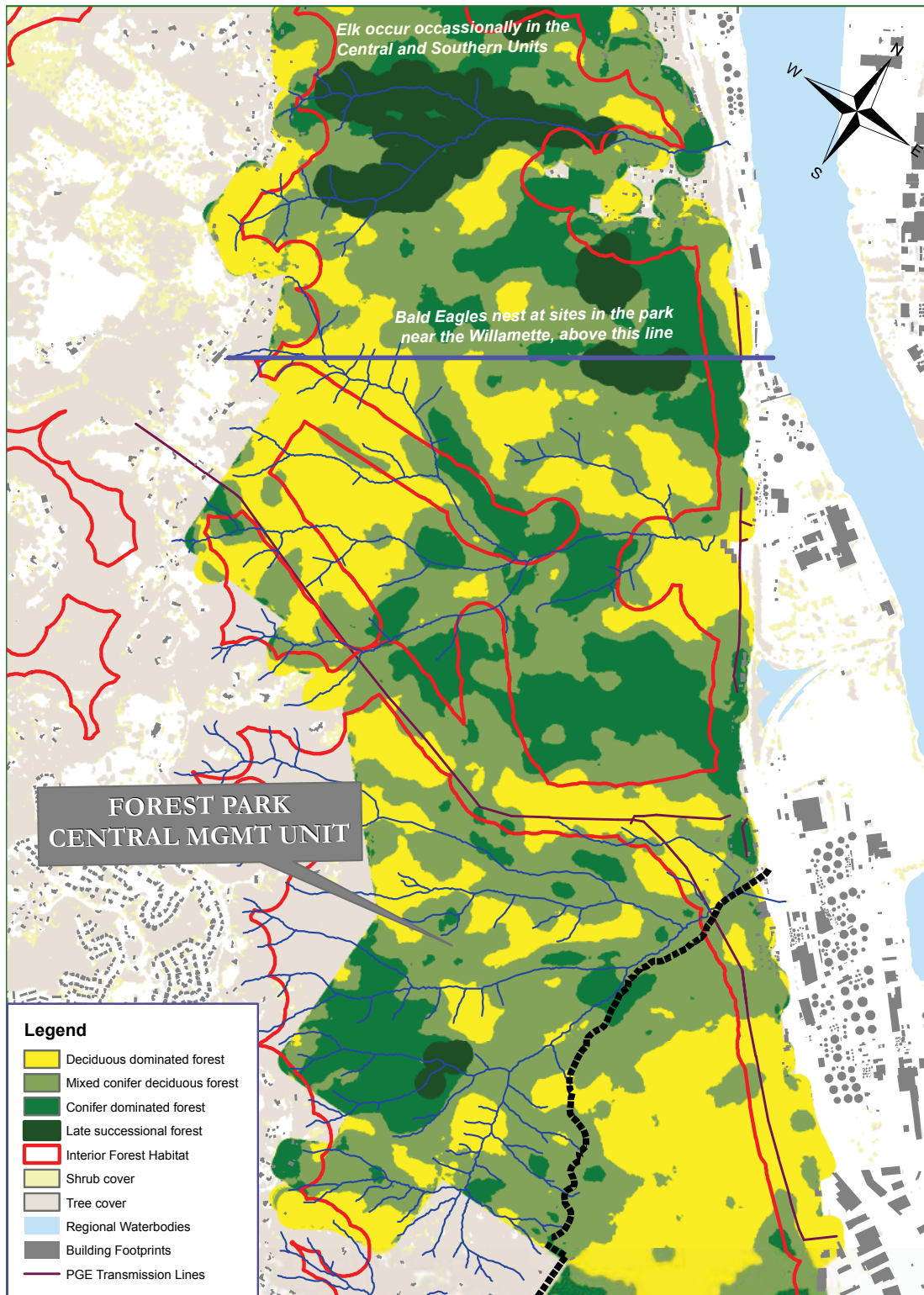


Figure 3. (B) Forest Park Central Management Unit: wildlife and habitat distribution.

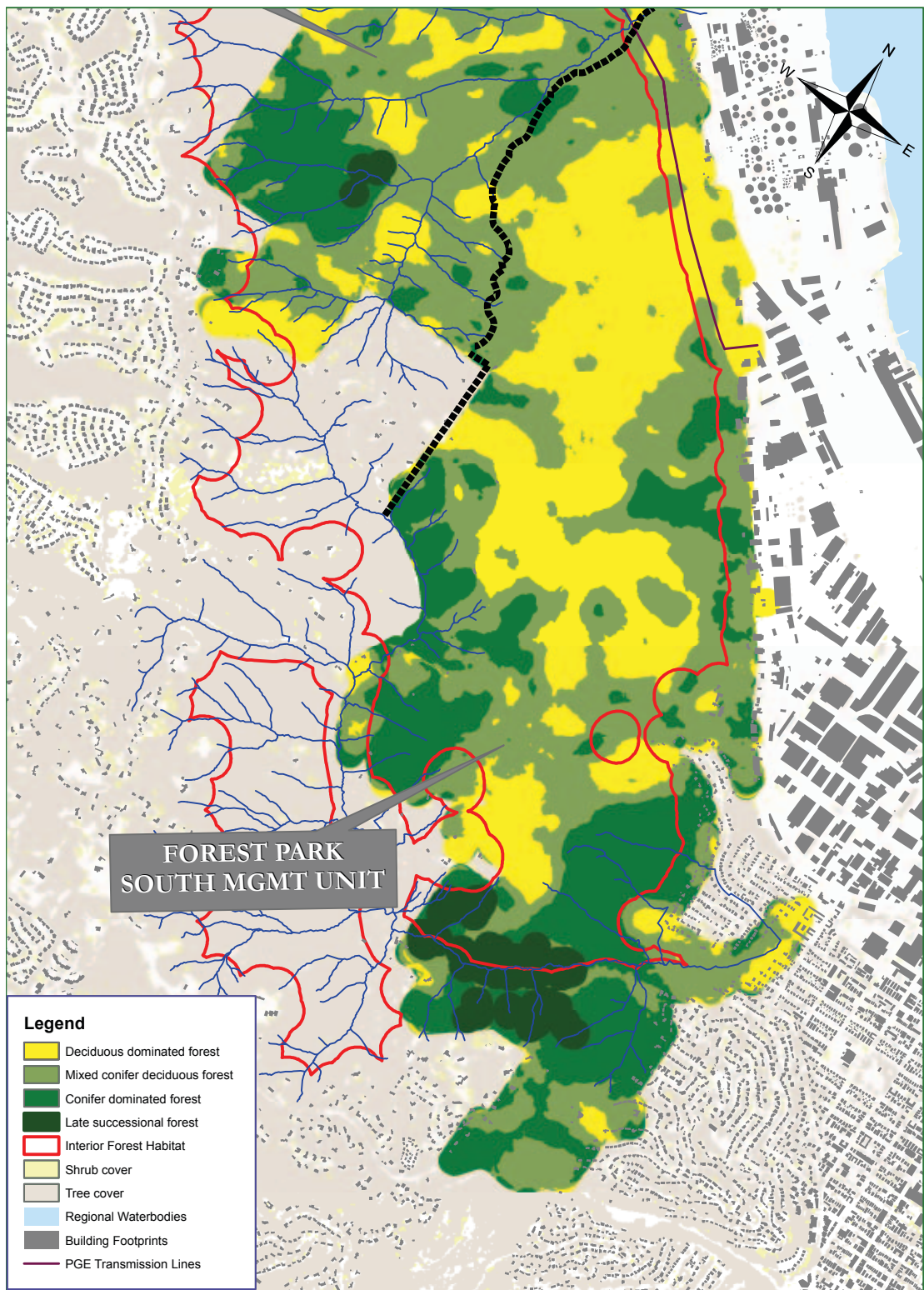


Figure 3. (C) Forest Park South Management Unit: wildlife and habitat distribution.

Appendix A: Figures

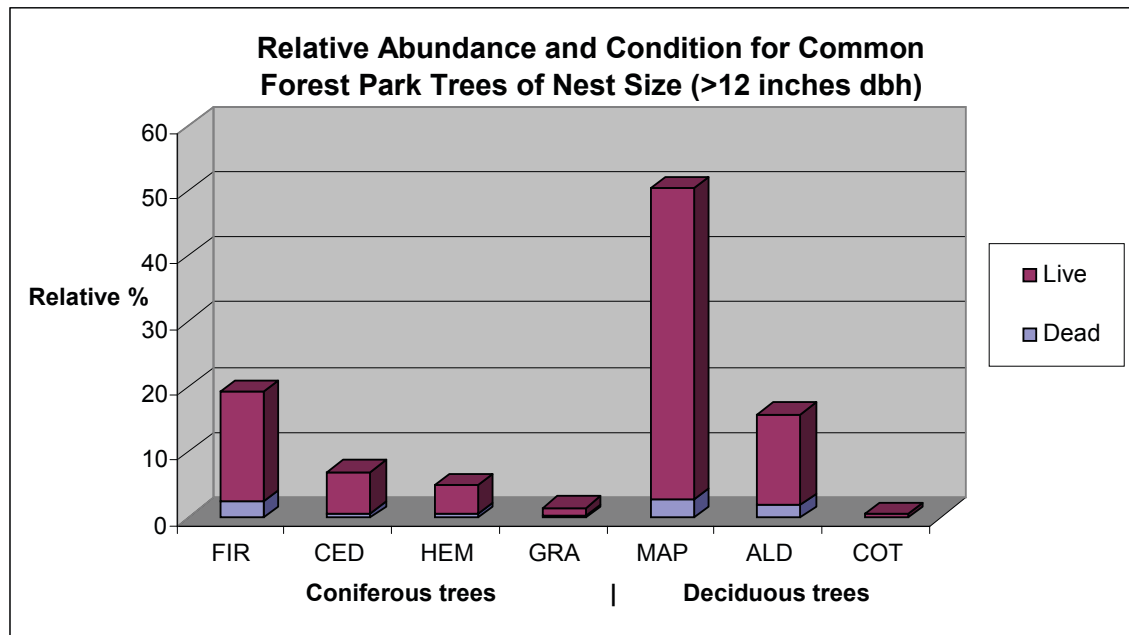


Figure 4. Percentage of relative abundance and condition for specimens of the seven most common trees species in Forest Park that achieve at least 12 inches in diameter at breast height.¹² Tree species are Douglas-fir (FIR), western red-cedar (CED), western hemlock (HEM), grand fir (GRA), big-leaf maple (MAP), red alder (ALD), and black cottonwood (COT) .

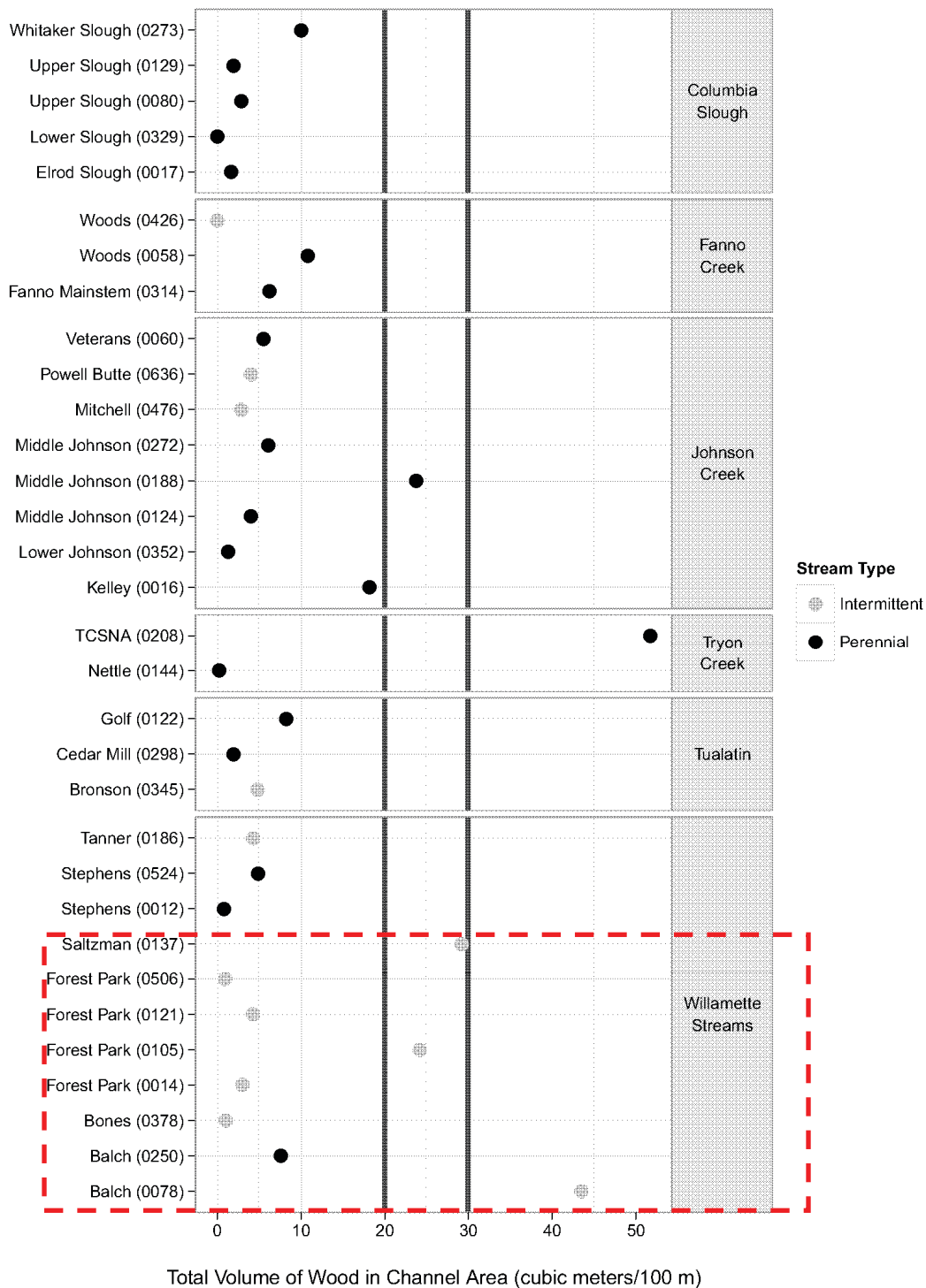
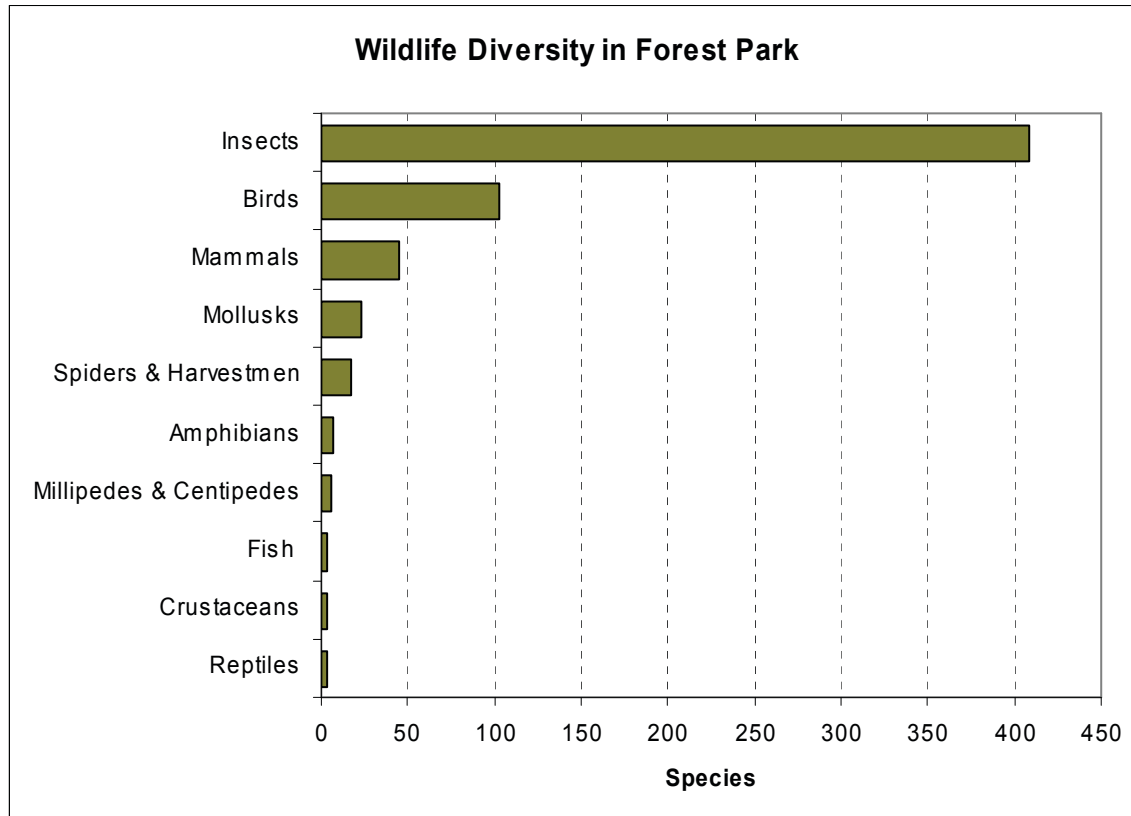
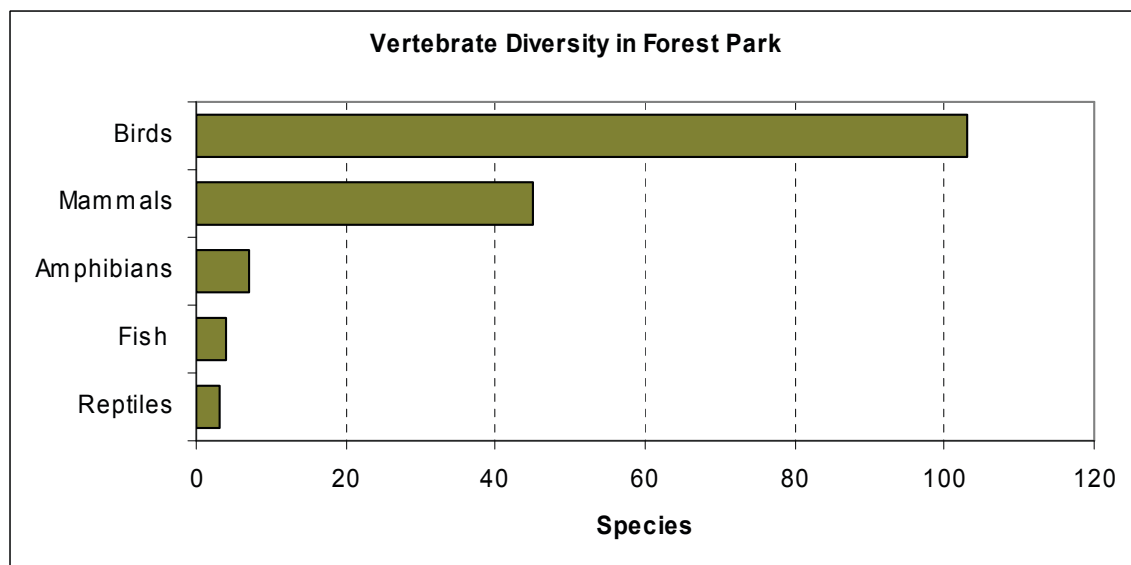


Figure 5. Volume of in-channel coarse woody debris in randomly selected Forest Park streams (“Saltzman,” “Forest Park” [unnamed, intermittent streams], and “Balch”) relative to Oregon Department of Fish and Wildlife’s undesirable (20 m³/100-m stream length) and desirable benchmarks (30 m³/100-m stream length) and other regional streams.²⁰

Appendix A: Figures



A



B

Figure 6. (A) Relative diversity of Forest Park wildlife. The known diversity of arthropod groups may be a substantial underestimate of their actual diversity. **(B)** Relative diversity of vertebrates.

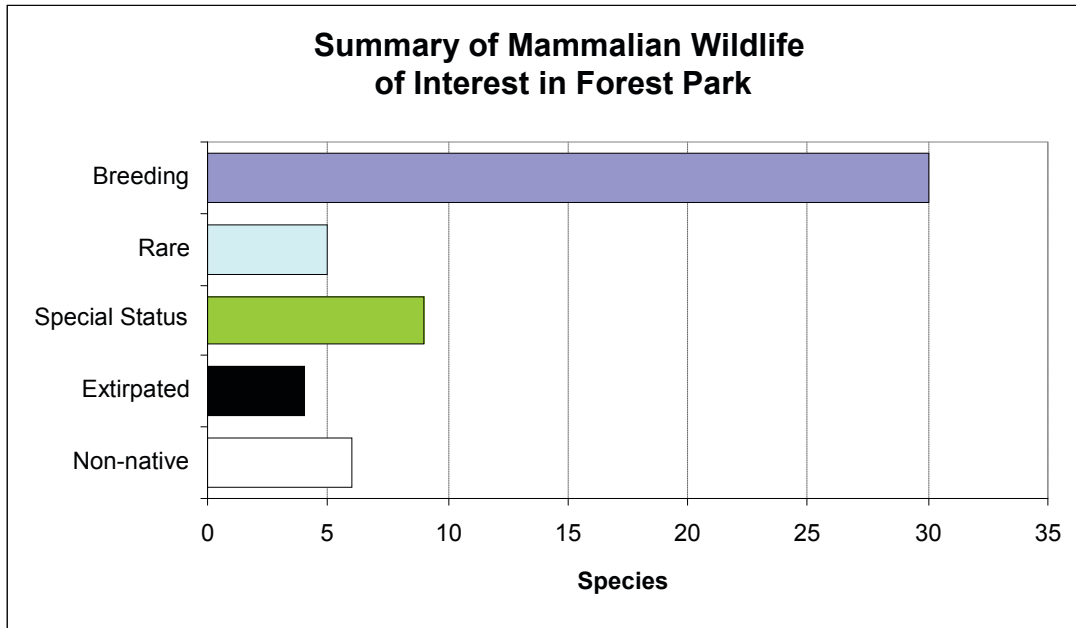


Figure 7. Summary of mammalian wildlife in Forest Park. The categories are non-exclusive.

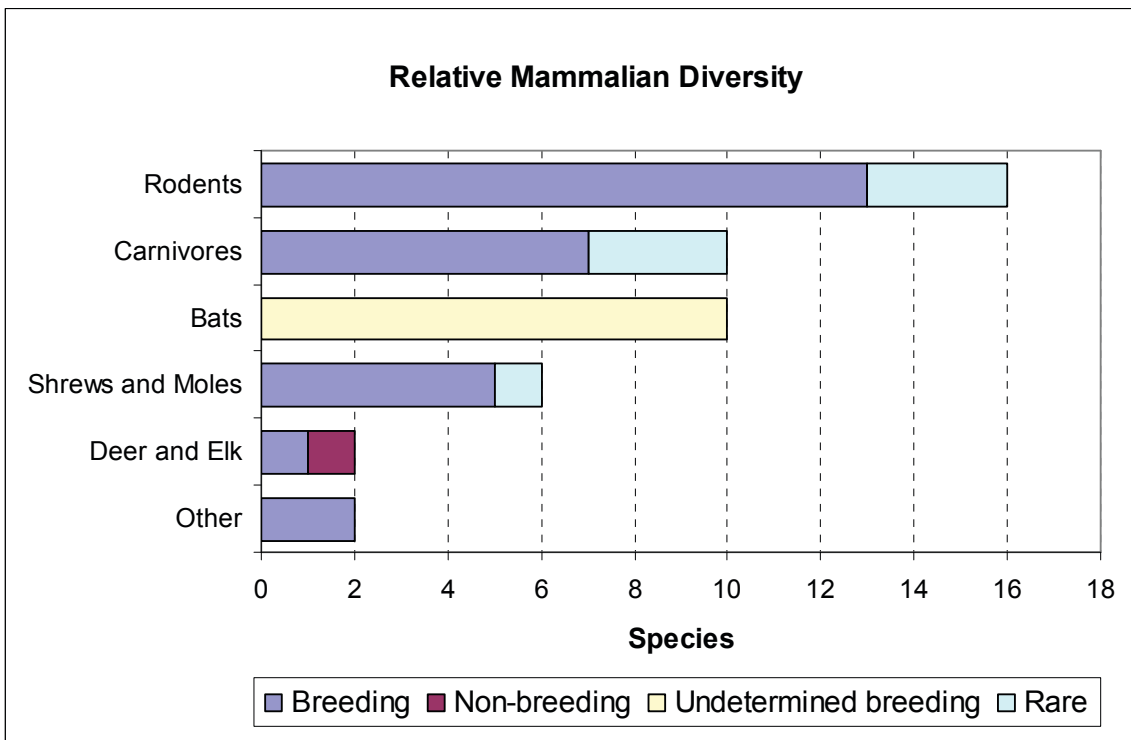


Figure 8. Relative species diversity of mammalian orders in Forest Park.

Appendix A: Figures

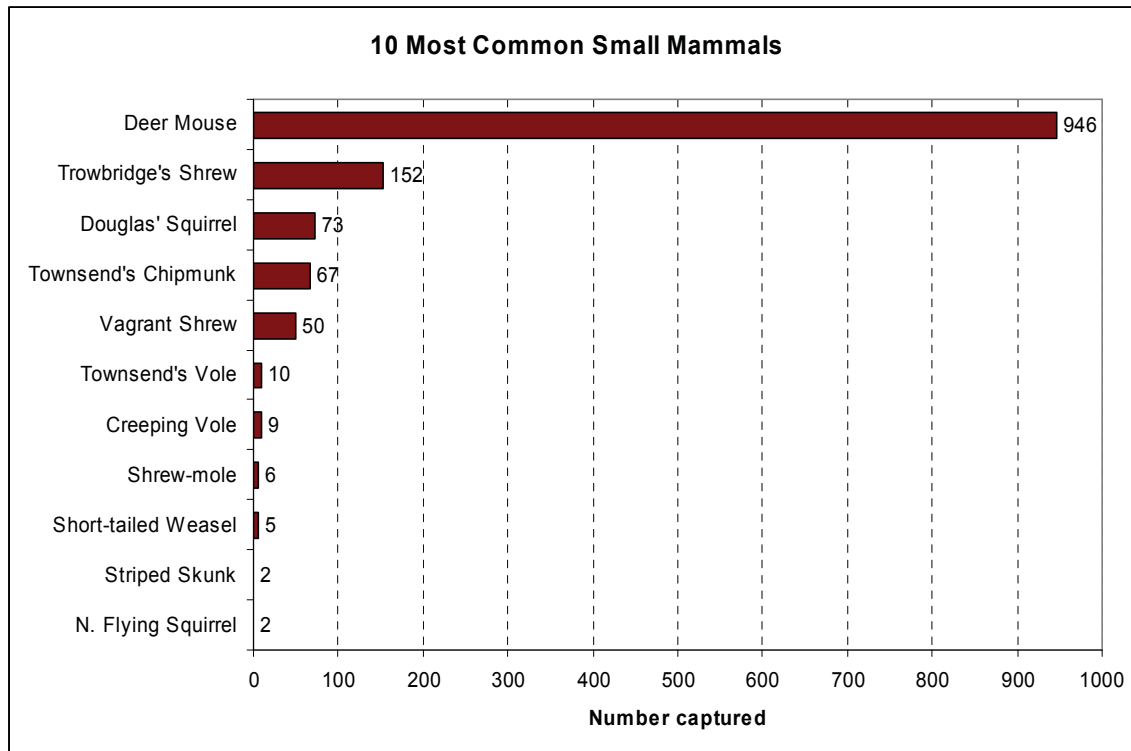


Figure 9. Top 10 most common small mammal species captured in Forest Park. Northern flying squirrel and striped skunk tied for 10th place.^{10,56,57}

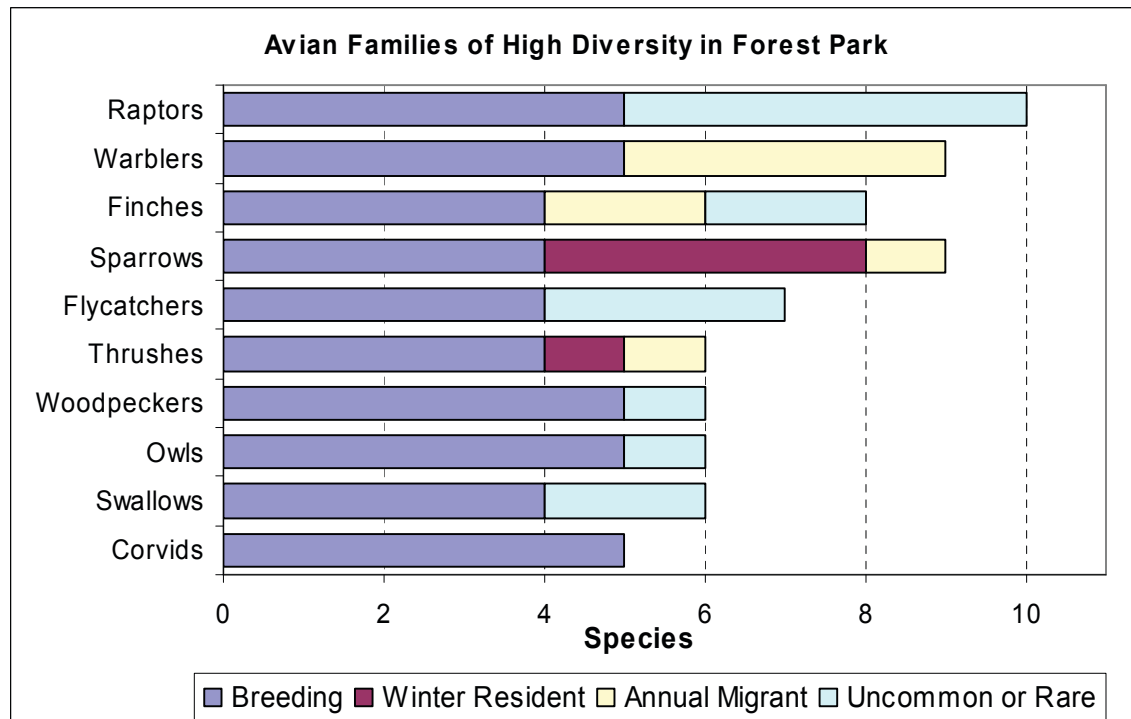


Figure 10. Relative diversity and seasonality among avian families of high diversity in Forest Park.

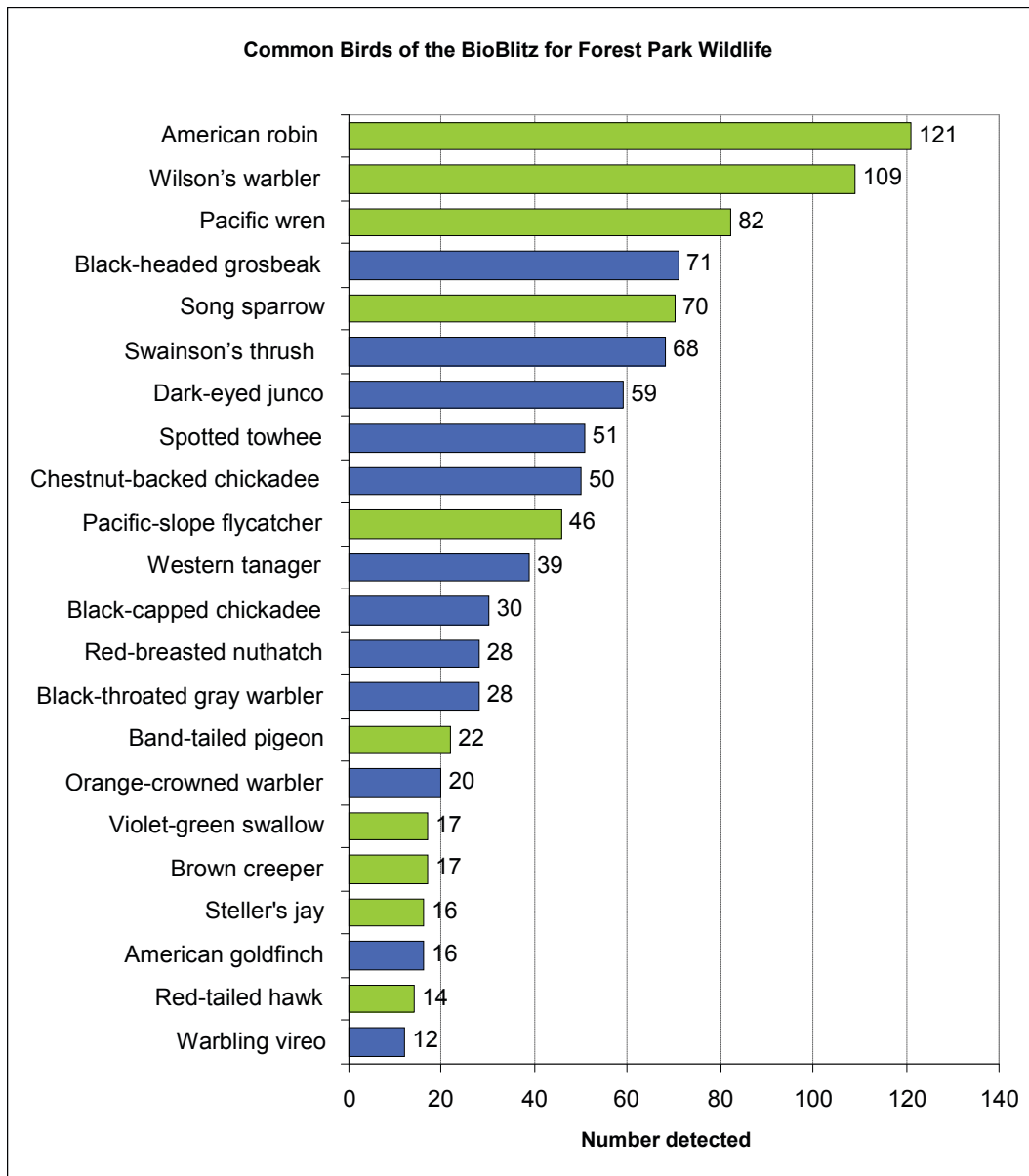


Figure 11. The top 35 most common birds of the BioBlitz for Forest Park Wildlife, May 2012.³⁴ TEES Special Status Species are shown in green. Pacific wren was formerly winter wren.

Appendix A: Figures

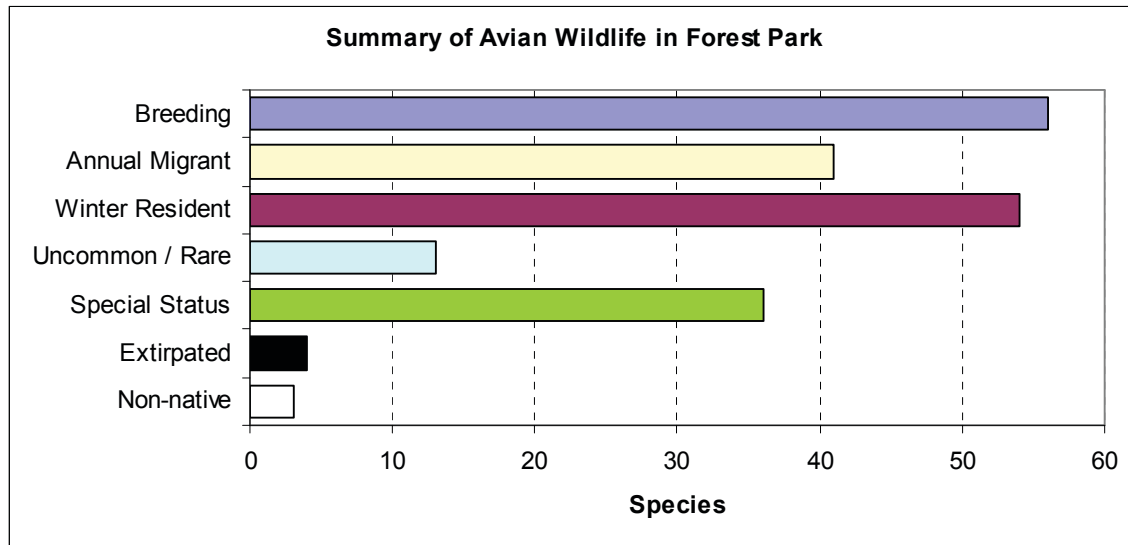


Figure 12. A summary of avian wildlife indicating breeding diversity, seasonality, and status. Some species fall into multiple categories.

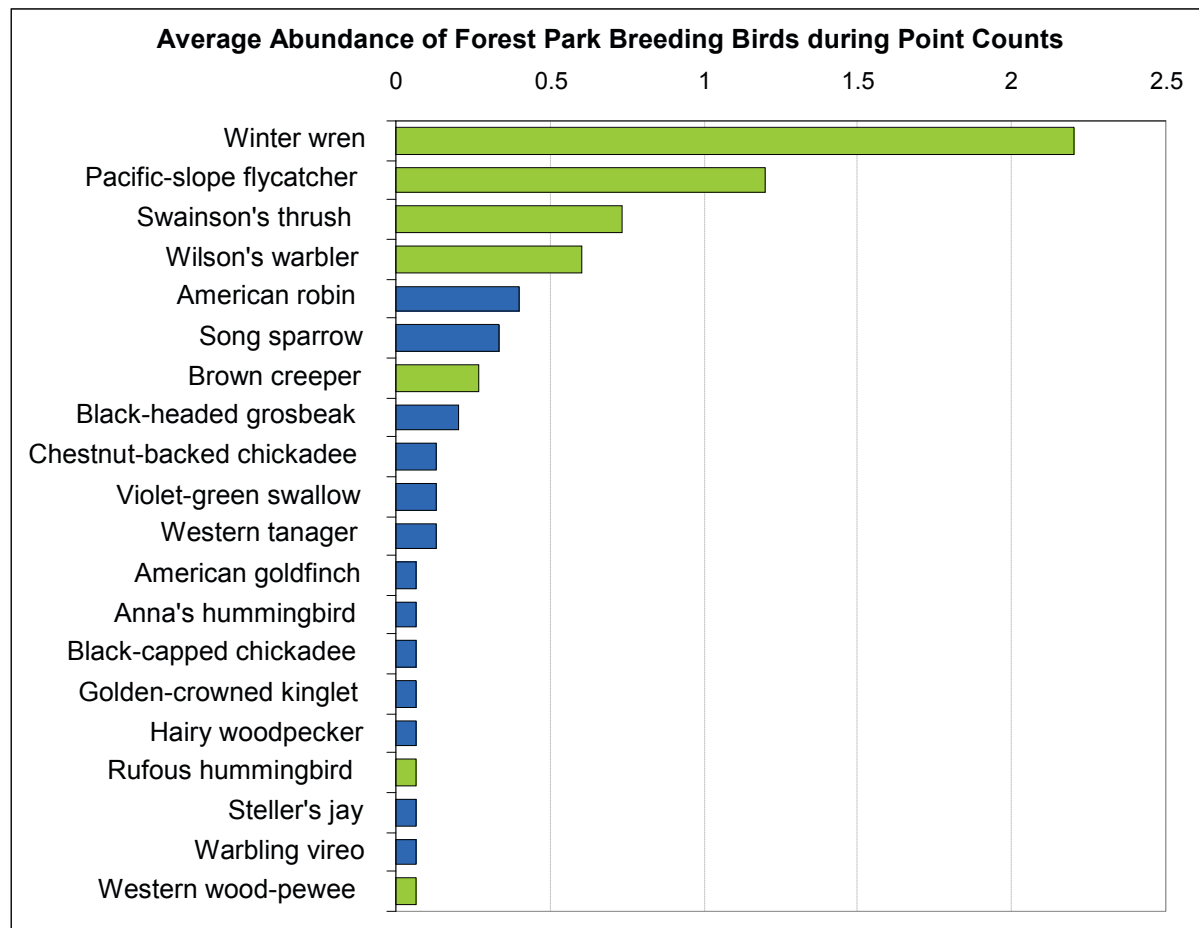
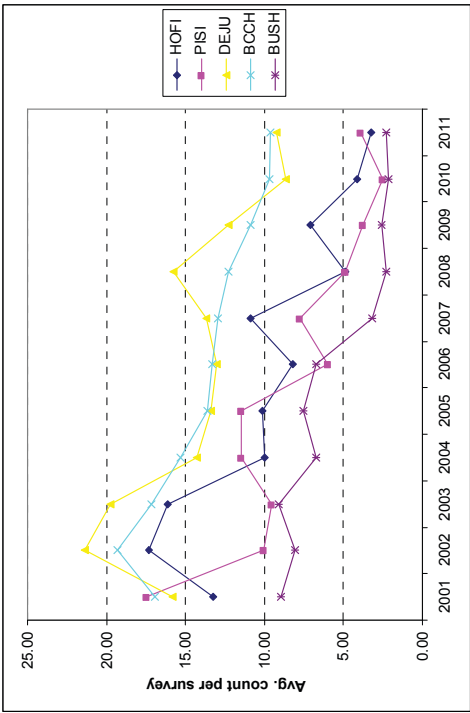
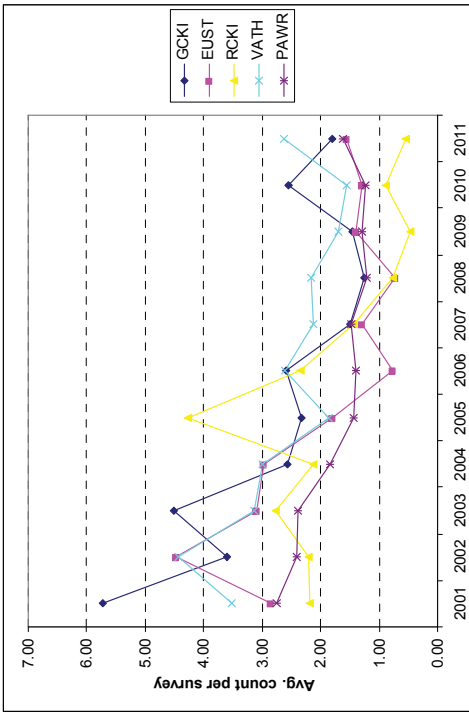


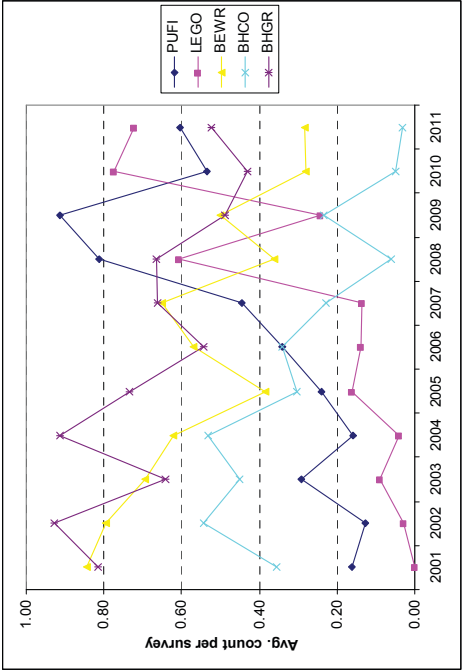
Figure 13. Average abundance of breeding birds detected during point count surveys at five sites in Forest Park in 2011.²⁰ TEES Special Status Species are shown in green.



(A) Trends for five **abundant** bird species that averaged >5 detections per survey most years. HOFI = house finch, PISI = pine siskin, DEJU = dark-eyed junco, BCCH = black-capped chickadee, BUSH = bushtit.



(B) Trends for five **common** bird species that averaged 1 to 5 detections per survey most years. GCKI = golden-crowned kinglet, EUST = European starling, RCKI = ruby-crowned kinglet, VATH = varied thrush, PAWR = Pacific wren.



(C) Trends for five **fairly common** bird species that averaged 0.1 to 1 detection per survey most years. PUFI = purple finch, LEGO = lesser goldfinch, BEWR = Bewick's wren, BHCO = brown-headed cowbird, BHGR = black-headed grosbeak.

Figure 14. Trends in avian abundance near the southern boundary of Forest Park, 2001–2011.³³ The 59 species for which adequate data were collected were grouped by whether they were (A) abundant, (B) common, or (C) fairly common. The five species from each group that had the highest magnitude change in abundance (i.e., change in slope of fitted line) are ordered by their relative abundance in 2001.

Appendix A: Figures

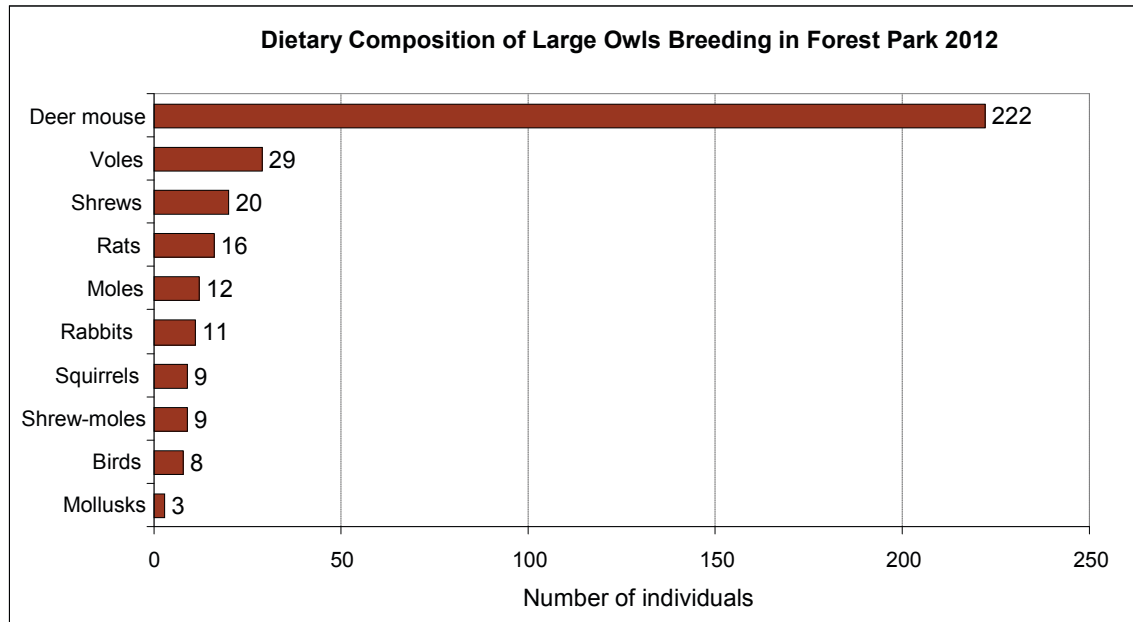


Figure 15. Composition of combined prey items of great horned owls and barred owls that bred in Forest Park in 2012.⁴⁶

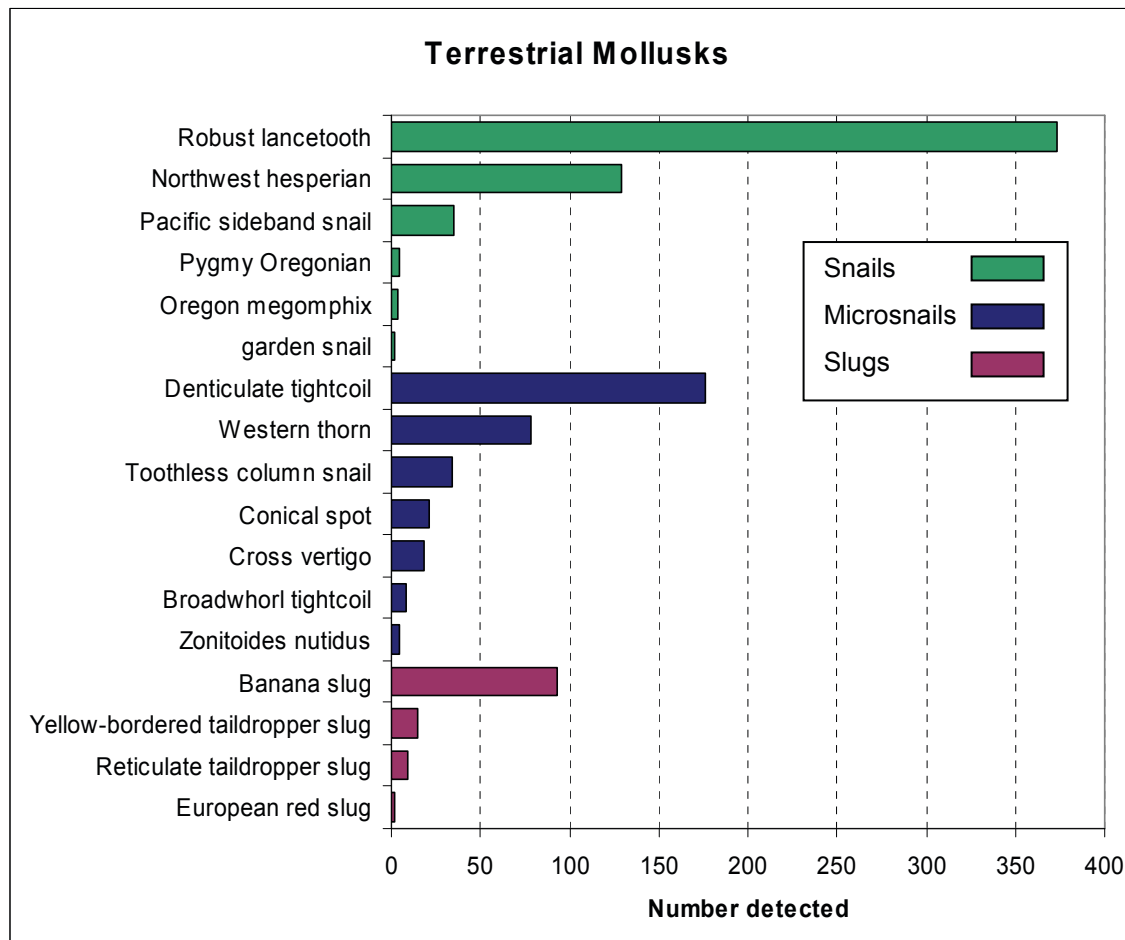


Figure 16. Terrestrial mollusk diversity and relative abundance at 26 plots ($r = 5$ m) near the southern boundary of Forest Park.⁸⁷

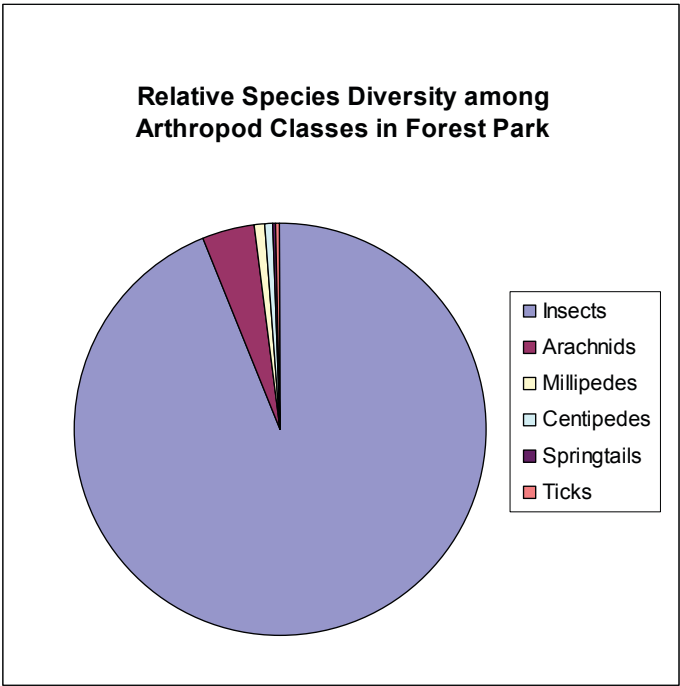


Figure 17. Relative species diversity among arthropod classes for Forest Park.^{25,34,88,89}

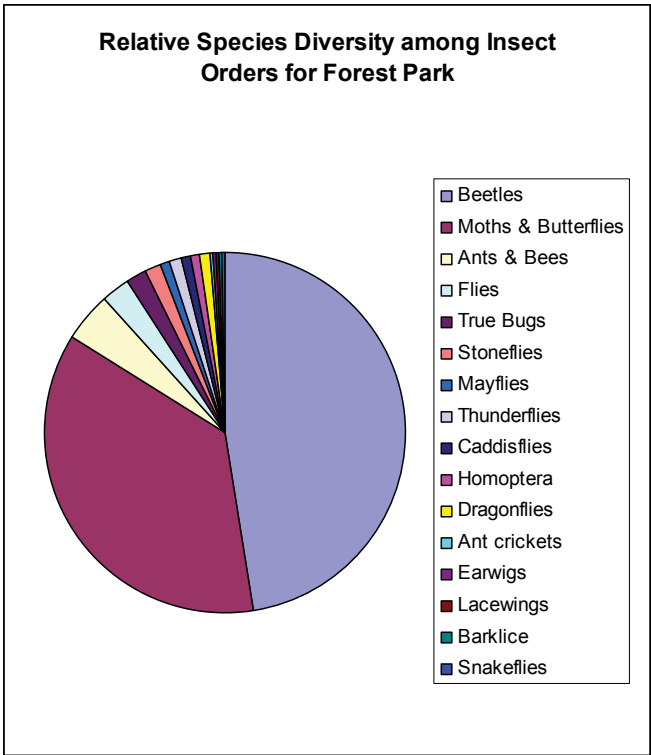


Figure 18. Relative species diversity among insect orders in Forest Park.^{25,34,88,89}

Appendix A: Figures

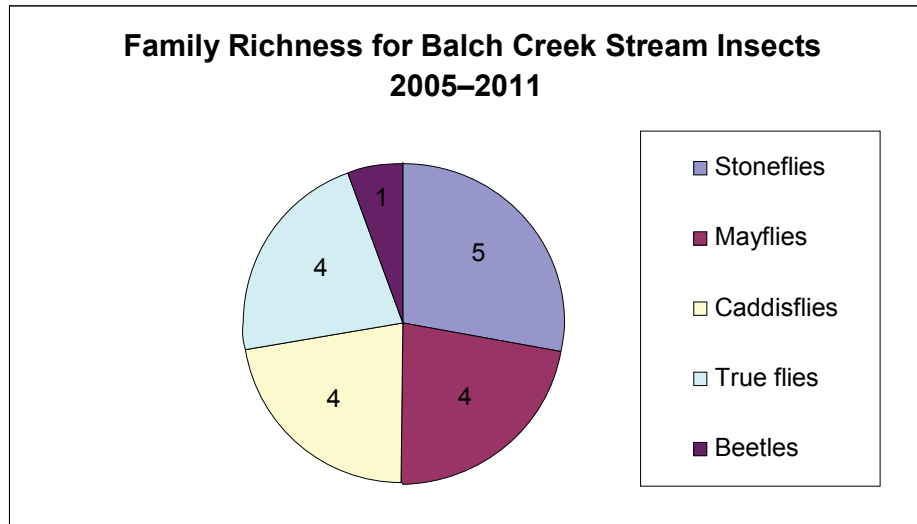


Figure 19. Taxonomic family richness for Balch Creek stream insects, 2005–2011.^{25,89}

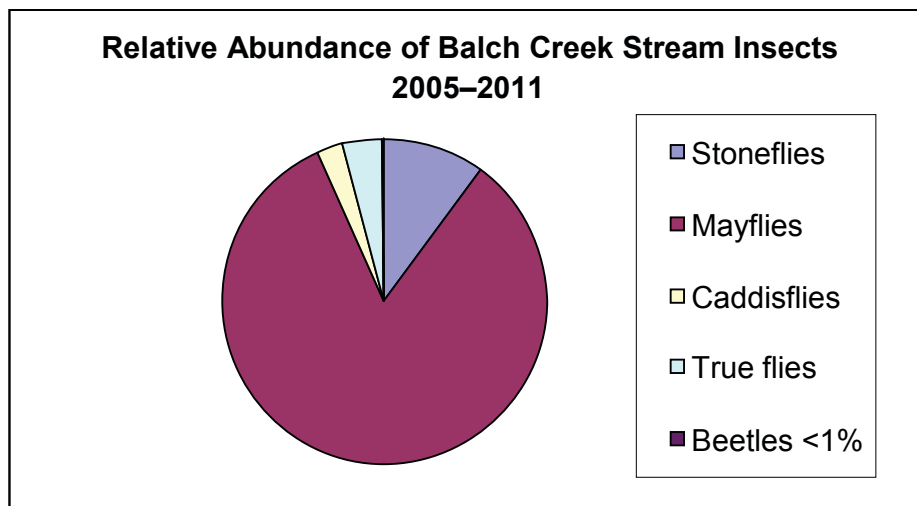


Figure 20. Relative abundance of Balch Creek stream insects, 2005–2011.²⁵

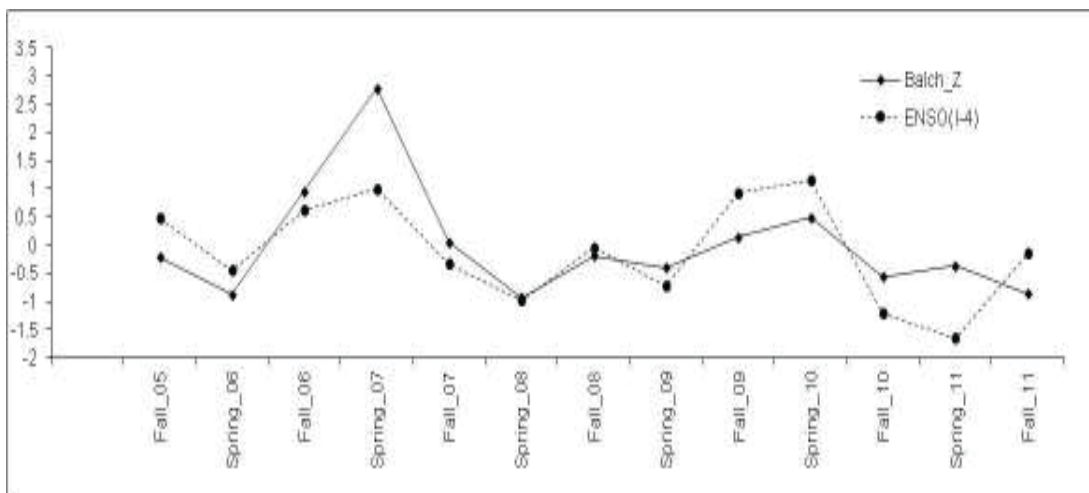


Figure 21. Relationship between abundance of Balch Creek stream insects (Balch_Z) and the strength of El Niño/La Niña events (ENSO) 4 months prior to sample date.²⁵

Appendix B: Tables

Table 1. Forest Park vegetation summary and human impact information relevant to wildlife as derived from the Vegetation Unit Summaries for Forest Park.¹¹ The U.S. Geological Survey (USGS) National Vegetation Classification Standard (NVCS) protocol was used for these surveys.

Total Forest Park Natural Resource Units		324				
Total acres surveyed		5,011				
		Units	% Units	Acres	% Acres	Avg. % per unit
NVCS class	Forest	273	84	4,734	94	
	Shrubland	13	4	86	2	
	Woodland	17	5	86	2	
	Herbaceous	9	3	8	<1	
NVCS subclass	Mixed evergreen-deciduous forest	132	41	2,425	48	
	Deciduous forest	89	27	1,453	29	
	Evergreen forest	52	16	857	17	
	Deciduous woodland	11	3	47	1	
	Deciduous shrubland	15	5	15	<1	
	Perennial grasses	8	2	7	<1	
	Other	17	5	207	4	
NVCS formation	Giant temperate needle-leaved forest	47	15	844	17	
Ecohealth rating	Healthy	4	1	97	2	
	Good	125	39	2,146	43	
	Fair	115	35	1,760	35	
	Poor	43	13	323	6	
	Severely degraded	18	6	84	2	
	Unrated	19	6	601	12	
Human impacts	Logging*	54	17	1,241	25	
	Informal trails	107	33			
	Homeless camps	21	6			
	Soil compaction	14	4			
	Domestic animals	44	14			
Other wildlife-relevant factors	Non-native plant cover	247	76	849**	17	21
	Canopy closure	305	100			70
	Hydrophilic vegetation	182	56			
	Beaver evidence	0	0			

*Units still showing direct evidence of logging (cut stumps).

**21% of the total acreage (4,042) for the 247 units.

Appendix B: Tables

Table 2. Major creeks of Forest Park ranked by watershed area. For most creeks, 30 to 75% of the watershed lies outside the park boundary.

Creek	Watershed (acres)	Management unit
Balch	1,401	South
Saltzman/Rocking Chair	956	Central
Miller	739	North
Doane	722	Central
Linnton	376	North
Newton	319	North
Springville	264	Central

Table 3. Common plants of Forest Park.

Type	Common name	Scientific name
Tree	Bigleaf maple	<i>Acer macrophyllum</i>
	Douglas-fir	<i>Pseudotsuga menziesii</i>
	Grand fir	<i>Abies grandis</i>
	Red alder	<i>Alnus rubra</i>
	Western hemlock	<i>Tsuga heterophylla</i>
	Western redcedar	<i>Thuja plicata</i>
	Oregon oak	<i>Quercus garryana</i>
	Oregon ash	<i>Fraxinus latifolia</i>
Shrub	English holly	<i>Ilex aquifolium</i> (non-native)
	Beaked hazel	<i>Corylus cornuta</i>
	Indian plum	<i>Oemleria cerasiformis</i>
	Oregon grape	<i>Mahonia aquifolium</i>
	Red elderberry	<i>Sambucus racemosa</i>
	Red huckleberry	<i>Vaccinium parvifolium</i>
	Salal	<i>Gaultheria shallon</i>
	Salmonberry	<i>Rubus spectabilis</i>
	Thimbleberry	<i>Rubus parviflorus</i>
	Vine maple	<i>Acer circinatum</i>
	Himalayan blackberry	<i>Rubus armeniacus</i> (non-native)
Groundcover	Ducks foot	<i>Vancouveria hexandra</i>
	English ivy	<i>Hedera helix</i> (non-native)
	Maidenhair fern	<i>Adiantum aleuticum</i>
	Pacific waterleaf	<i>Hydrophyllum tenuipes</i>
	Stream violet	<i>Viola glabella</i>
	Sword fern	<i>Polystichum munitum</i>
	Trailing blackberry	<i>Rubus ursinus</i>
	Trillium	<i>Trillium grandiflorum</i>
	Vanilla leaf	<i>Achylys triphylla</i>

Forest Park Wildlife Inventory

Table 4: Birds of interest for Forest Park grouped by occurrence and listed taxonomically. Seasons are “A” for all, “S” for spring and summer breeding season, “W” for winter, “M” for migration in spring and fall, and “U” for undetermined seasonal pattern.

Common name	Scientific name	Taxon	Occurrence	Breeding	TEES		
					Special Status	Species	Non-native Season
Mallard	<i>Anas platyrhynchos</i>	Waterfowl	Occurs	Unknown			A
Great blue heron	<i>Ardea herodias</i>	Heron	Occurs	Non-breeder	✓		A
Turkey vulture	<i>Cathartes aura</i>	Raptor	Occurs	Unknown			S
Osprey	<i>Pandion haliaetus</i>	Raptor	Occurs	Non-breeder			S
Bald eagle	<i>Haliaeetus leucocephalus</i>	Raptor	Occurs	Breeds	✓		A
Sharp-shinned hawk	<i>Accipiter striatus</i>	Raptor	Occurs	Breeds			A
Cooper's hawk	<i>Accipiter cooperii</i>	Raptor	Occurs	Breeds			A
Red-tailed hawk	<i>Buteo jamaicensis</i>	Raptor	Occurs	Breeds			A
Peregrine falcon	<i>Falco peregrinus</i>	Raptor	Occurs	Breeds	✓		A
Rock pigeon	<i>Columba livia</i>	Dove	Occurs	Undetermined		✓	A
Band-tailed pigeon	<i>Patagioenas fasciata</i>	Dove	Occurs	Breeds	✓		S
Mourning dove	<i>Zenaidura macroura</i>	Dove	Occurs	Non-breeder			A
Western screech-owl	<i>Megascops kennicottii</i>	Owl	Occurs	Breeds			A
Great horned owl	<i>Bubo virginianus</i>	Owl	Occurs	Breeds			A
Northern pygmy-owl	<i>Glaucidium gnoma</i>	Owl	Occurs	Breeds			A
Barred owl	<i>Strix varia</i>	Owl	Occurs	Breeds		✓	A
Northern saw-whet owl	<i>Aegolius acadicus</i>	Owl	Occurs	Breeds			A
Vaux's swift	<i>Chaetura vauxi</i>	Swift	Occurs	Breeds	✓		S
Anna's hummingbird	<i>Calypte anna</i>	Hummingbird	Occurs	Breeds			A
Rufous hummingbird	<i>Selasphorus rufus</i>	Hummingbird	Occurs	Breeds	✓		S
Red-breasted sapsucker	<i>Sphyrapicus ruber</i>	Woodpecker	Occurs	Breeds			S
Downy woodpecker	<i>Picoides pubescens</i>	Woodpecker	Occurs	Breeds	✓		A
Hairy woodpecker	<i>Picoides villosus</i>	Woodpecker	Occurs	Breeds			A
Northern flicker	<i>Colaptes auratus</i>	Woodpecker	Occurs	Breeds			A
Pileated woodpecker	<i>Dryocopus pileatus</i>	Woodpecker	Occurs	Breeds	✓		A
Olive-sided flycatcher	<i>Contopus cooperi</i>	Flycatcher	Occurs	Breeds	✓		S

Appendix B: Tables

Common name	Scientific name	Taxon	Occurrence	Breeding	TEES	
					Special Status	Non-native
Western wood-pewee	<i>Contopus sordidulus</i>	Flycatcher	Occurs	Breeds	✓	S
Willow flycatcher (little)	<i>Empidonax traillii brewsteri</i>	Flycatcher	Occurs	Undetermined	✓	S
Hammond's flycatcher	<i>Empidonax hammondi</i>	Flycatcher	Occurs	Undetermined		S
Pacific-slope flycatcher	<i>Empidonax difficilis</i>	Flycatcher	Occurs	Breeds	✓	S
Cassin's vireo	<i>Vireo cassinii</i>	Vireo	Occurs	Breeds		S
Hutton's vireo	<i>Vireo huttoni</i>	Vireo	Occurs	Breeds	✓	S
Warbling vireo	<i>Vireo gilvus</i>	Vireo	Occurs	Breeds		S
Gray jay	<i>Perisoreus canadensis</i>	Corvid	Occurs	Breeds		A
Steller's jay	<i>Cyanocitta stelleri</i>	Corvid	Occurs	Breeds		A
Western scrub-jay	<i>Aphelocoma californica</i>	Corvid	Occurs	Breeds		A
American crow	<i>Corvus brachyrhynchos</i>	Corvid	Occurs	Breeds		A
Common raven	<i>Corvus corax</i>	Corvid	Occurs	Breeds		A
Tree swallow	<i>Tachycineta bicolor</i>	Swallow	Occurs	Undetermined		S
Violet-green swallow	<i>Tachycineta thalassina</i>	Swallow	Occurs	Undetermined		S
Barn swallow	<i>Hirundo rustica</i>	Swallow	Occurs	Breeds		S
Black-capped chickadee	<i>Poecile atricapillus</i>	Chickadee	Occurs	Breeds		A
Chestnut-backed chickadee	<i>Poecile rufescens</i>	Chickadee	Occurs	Breeds		A
Bushtit	<i>Psaltiriparus minimus</i>	Bushtit	Occurs	Breeds	✓	A
Red-breasted nuthatch	<i>Sitta canadensis</i>	Nuthatch	Occurs	Breeds		A
White-breasted nuthatch (SB)	<i>Sitta carolinensis aculeata</i>	Nuthatch	Occurs	Undetermined	✓	U
Brown creeper	<i>Certhia americana</i>	Creeper	Occurs	Breeds	✓	A
Bewick's wren	<i>Thryomanes bewickii</i>	Wren	Occurs	Breeds		A
House wren	<i>Troglodytes aedon</i>	Wren	Occurs	Non-breeder	✓	A
Pacific wren	<i>Troglodytes pacificus</i>	Wren	Occurs	Breeds	✓	A
Golden-crowned kinglet	<i>Regulus satrapa</i>	Kinglet	Occurs	Non-breeder		W
Ruby-crowned kinglet	<i>Regulus calendula</i>	Kinglet	Occurs	Non-breeder		W
Townsend's solitaire	<i>Myadestes townsendi</i>	Thrush	Occurs	Non-breeder		M
Swainson's thrush	<i>Catharus ustulatus</i>	Thrush	Occurs	Breeds	✓	S
Hermit thrush	<i>Catharus guttatus</i>	Thrush	Occurs	Non-breeder		W

Common name	Scientific name	Taxon	Occurrence	Breeding	TEES		
					Special Status	Species	Non-native
American robin	<i>Turdus migratorius</i>	Thrush	Occurs	Breeds			A
Varied thrush	<i>Ixoreus naevius</i>	Thrush	Occurs	Breeds	✓		W
European starling	<i>Sturnus vulgaris</i>	Starling	Occurs	Non-breeder			✓ A
Cedar waxwing	<i>Bombycilla cedrorum</i>	Waxwing	Occurs	Undetermined			S
Orange-crowned warbler	<i>Oreothlypis celata</i>	Warbler	Occurs	Breeds	✓		S
Nashville warbler	<i>Oreothlypis ruficapilla</i>	Warbler	Occurs	Non-breeder	✓		M
MacGillivray's warbler	<i>Geothlypis tolmiei</i>	Warbler	Occurs	Unknown			M
Yellow warbler	<i>Setophaga petechia</i>	Warbler	Occurs	Unknown	✓		S
Yellow-rumped warbler	<i>Setophaga coronata</i>	Warbler	Occurs	Undetermined			S
Black-throated gray warbler	<i>Setophaga nigrescens</i>	Warbler	Occurs	Breeds	✓		S
Townsend's warbler	<i>Setophaga townsendi</i>	Warbler	Occurs	Breeds			S
Hermit warbler	<i>Setophaga occidentalis</i>	Warbler	Occurs	Undetermined	✓		M
Wilson's warbler	<i>Cardellina pusilla</i>	Warbler	Occurs	Breeds	✓		S
Spotted towhee	<i>Pipilo maculatus</i>	Sparrow	Occurs	Breeds			A
Chipping sparrow	<i>Spizella passerina</i>	Sparrow	Occurs	Non-breeder	✓		A
Fox sparrow	<i>Passerella iliaca</i>	Sparrow	Occurs	Non-breeder			M
Song sparrow	<i>Melospiza melodia</i>	Sparrow	Occurs	Breeds			A
Lincoln's sparrow	<i>Melospiza lincolni</i>	Sparrow	Occurs	Non-breeder			M
White-throated sparrow	<i>Zonotrichia albicollis</i>	Sparrow	Occurs	Non-breeder			W
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	Sparrow	Occurs	Breeds			A
Golden-crowned sparrow	<i>Zonotrichia atricapilla</i>	Sparrow	Occurs	Non-breeder			W
Dark-eyed junco	<i>Junco hyemalis</i>	Sparrow	Occurs	Breeds			A
Western tanager	<i>Piranga ludoviana</i>	Cardinal	Occurs	Breeds			S
Black-headed grosbeak	<i>Phaeucticus melanocephalus</i>	Cardinal	Occurs	Breeds			S
Brewer's blackbird	<i>Euphagus cyanocephalus</i>	Blackbird	Occurs	Undetermined			A
Brown-headed cowbird	<i>Molothrus ater</i>	Blackbird	Occurs	Undetermined			S
Purple finch	<i>Carpodacus purpureus</i>	Finch	Occurs	Breeds	✓		S
House finch	<i>Carpodacus mexicanus</i>	Finch	Occurs	Breeds			M
Red crossbill	<i>Loxia curvirostra</i>	Finch	Occurs	Non-breeder	✓		A
Pine siskin	<i>Spinus pinus</i>	Finch	Occurs	Breeds			A

Appendix B: Tables

Common name	Scientific name	Taxon	Occurrence	Breeding	TEES	
					Special Status	Non-native
Lesser goldfinch	<i>Spinus psaltria</i>	Finch	Occurs	Undetermined		M
American goldfinch	<i>Spinus tristis</i>	Finch	Occurs	Breeds		A
Evening grosbeak	<i>Coccothraustes vespertinus</i>	Finch	Occurs	Non-breeder		A
House sparrow	<i>Passer domesticus</i>	Passerid	Occurs	Breeds		✓ A
American kestrel	<i>Falco sparverius</i>	Raptor	Rare	Non-breeder	✓	A
Merlin	<i>Falco columbarius</i>	Raptor	Rare	Non-breeder	✓	W
Northern spotted owl	<i>Strix occidentalis caurina</i>	Owl	Rare	Non-breeder	*	U
Common nighthawk	<i>Chordeiles minor</i>	Nighthawk	Rare	Non-breeder	✓	S
Lewis's woodpecker	<i>Melanerpes lewis</i>	Woodpecker	Rare	Non-breeder	✓	M
Dusky flycatcher	<i>Empidonax oberholseri</i>	Flycatcher	Rare	Non-breeder		M
Ash-throated flycatcher	<i>Myiarchus cinerascens</i>	Flycatcher	Rare	Non-breeder		M
Western kingbird	<i>Tyrannus verticalis</i>	Flycatcher	Rare	Non-breeder		S
Red-eyed vireo	<i>Vireo olivaceus</i>	Vireo	Rare	Non-breeder	✓	S
American dipper	<i>Cinclus mexicanus</i>	Dipper	Rare	Non-breeder		W
Lazuli bunting	<i>Passerina amoena</i>	Cardinal	Rare	Non-breeder		S
Pine grosbeak	<i>Pinicola enucleator</i>	Finch	Rare	Non-breeder		M
California quail	<i>Callipepla californica</i>	Landfowl	Extirpated	Non-breeder		
Mountain quail	<i>Oreortyx pictus</i>	Landfowl	Extirpated	Non-breeder		
Ruffed grouse	<i>Bonasa umbellus</i>	Landfowl	Extirpated	Non-breeder		
Sooty grouse	<i>Dendragapus fuliginosus</i>	Landfowl	Extirpated	Non-breeder		

*Federally threatened, not listed by TEES.

Table 5. Mammals of interest for Forest Park listed by occurrence and alphabetically by mammalian order and scientific name.

Common name	Scientific name	Order	Occurrence	Breeding	TEES Special Status Species	Non-native
Elk	<i>Cervus canadensis</i>	Artiodactyla	Occurs	Non-breeder		
Mule deer	<i>Odocoileus hemionus</i>	Artiodactyla	Occurs	Breeds		
Coyote	<i>Canis latrans</i>	Carnivora	Occurs	Breeds		
Bobcat	<i>Lynx rufus</i>	Carnivora	Occurs	Breeds		
Striped skunk	<i>Mephitis mephitis</i>	Carnivora	Occurs	Breeds		
Short-tailed weasel	<i>Mustela erminea</i>	Carnivora	Occurs	Breeds		
Long-tailed weasel	<i>Mustela frenata</i>	Carnivora	Occurs	Breeds		
Raccoon	<i>Procyon lotor</i>	Carnivora	Occurs	Breeds		
Western spotted skunk	<i>Spilogale putorius</i>	Carnivora	Occurs	Breeds		
Long-eared myotis	<i>Myotis evotis</i>	Chiroptera	Occurs	Undetermined	✓	
Long-legged myotis	<i>Myotis volans</i>	Chiroptera	Occurs	Undetermined	✓	
Yuma myotis	<i>Myotis yumanensis</i>	Chiroptera	Occurs	Undetermined	✓	
Big brown bat	<i>Eptesicus fuscus</i>	Chiroptera	Occurs	Undetermined		
Silver-haired bat	<i>Lasionycteris noctivagans</i>	Chiroptera	Occurs	Undetermined	✓	
Hoary bat	<i>Lasiurus cinereus</i>	Chiroptera	Occurs	Undetermined	✓	
California myotis	<i>Myotis californicus</i>	Chiroptera	Occurs	Undetermined	✓	
Little brown bat	<i>Myotis lucifugus</i>	Chiroptera	Occurs	Undetermined		
Fringed myotis	<i>Myotis thysanodes</i>	Chiroptera	Occurs	Undetermined	✓	
Western big-eared bat	<i>Corynorhinus townsendii</i>	Chiroptera	Occurs	Undetermined	✓	
Brush rabbit	<i>Sylvilagus bachmani</i>	Lagomorpha	Occurs	Breeds		
Virginia opossum	<i>Didelphis virginiana</i>	Marsupial	Occurs	Breeds		✓
Mountain beaver	<i>Aplodontia rufa</i>	Rodentia	Occurs	Breeds		
Northern flying squirrel	<i>Glaucomys sabrinus</i>	Rodentia	Occurs	Breeds		
Creeping vole	<i>Microtus oregoni</i>	Rodentia	Occurs	Breeds		
Townsend's vole	<i>Microtus townsendii</i>	Rodentia	Occurs	Breeds		
Deer mouse	<i>Peromyscus maniculatus</i>	Rodentia	Occurs	Breeds		✓
Norway rat	<i>Rattus norvegicus</i>	Rodentia	Occurs	Breeds		✓
Black rat	<i>Rattus rattus</i>	Rodentia	Occurs	Breeds		✓
Eastern gray squirrel	<i>Sciurus carolinensis</i>	Rodentia	occurs	breeds		

Appendix B: Tables

Common name	Scientific name	Order	Occurrence	Breeding	TEES Special Status	Non-native
Eastern fox squirrel	<i>Sciurus niger</i>	Rodentia	Occurs	Breeds		✓
Townsend's chipmunk	<i>Tamias townsendii</i>	Rodentia	Occurs	Breeds		
Douglas squirrel	<i>Tamiasciurus douglasii</i>	Rodentia	Occurs	Breeds		
Shrew mole	<i>Neurotrichus gibbsii</i>	Soricomorpha	Occurs	Breeds		
Coast mole	<i>Scapanus orarius</i>	Soricomorpha	Occurs	Breeds		
Townsend's mole	<i>Scapanus townsendii</i>	Soricomorpha	Occurs	Breeds		
Trowbridges shrew	<i>Sorex trowbridgii</i>	Soricomorpha	Occurs	Breeds		
Vagrant shrew	<i>Sorex vagrans</i>	Soricomorpha	Occurs	Breeds		
Cougar	<i>Felis concolor</i>	Carnivora	Rare	Non-breeder		
Black bear	<i>Ursus americanus</i>	Carnivora	Rare	Non-breeder		
Red fox	<i>Vulpes vulpes</i>	Carnivora	Rare	Undetermined		
American beaver	<i>Castor canadensis</i>	Rodentia	Rare	Non-breeder	✓	
North american porcupine	<i>Erethizon dorsatum</i>	Rodentia	Rare	Undetermined		
Pacific jumping mouse	<i>Zapus trinotatus</i>	Rodentia	Rare	Breeds		
Pacific water shrew	<i>Sorex bendirii</i>	Soricomorpha	Rare	Breeds		
American marten	<i>Martes americana</i>	Carnivora	Historical	Not applicable	✓	
Gray fox	<i>Urocyon cinereoargenteus</i>	Carnivora	Historical	Not applicable		
Red tree vole	<i>Arborimus longicaudus</i>	Rodentia	Historical	Not applicable	✓	
White-footed vole	<i>Arborimus albipes</i>	Rodentia	Undetermined	Undetermined	✓	
Western red-backed vole	<i>Clethrionomys californicus</i>	Rodentia	Undetermined	Undetermined		
Gray-tailed vole	<i>Microtus canicaudus</i>	Rodentia	Undetermined	Undetermined		
Long-tailed vole	<i>Microtus longicaudus</i>	Rodentia	Undetermined	Undetermined		
Bushy-tailed woodrat	<i>Neotoma cinerea</i>	Rodentia	Undetermined	Undetermined		
Dusky footed woodrat	<i>Neotoma fuscipes</i>	Rodentia	Undetermined	Undetermined		
Camas pocket gopher	<i>Thomomys bulbivorus</i>	Rodentia	Undetermined	Undetermined	✓	
Mazama pocket gopher	<i>Thomomys mazama</i>	Rodentia	Undetermined	Undetermined		
Dusky shrew	<i>Sorex monticolus</i>	Soricomorpha	Undetermined	Undetermined		

Table 6. Amphibians, reptiles, and fish of interest for Forest Park.

Class	Common name	Scientific name	Group	Occurrence	Breeding	TEES Special Status		Habitat association in Forest Park
						Species	Species	
Amphibians	Pacific treefrog	<i>Pseudacris regilla</i>	Frog	Occurs	Breeds			Pond breeding
	Northern red-legged frog	<i>Rana aurora</i>	Frog	Occurs	Breeds	✓		Pond breeding
	Ensatina	<i>Ensatina eschscholtzii</i>	Salamander	Occurs	Breeds			Terrestrial breeding
	Dunn's salamander	<i>Plethodon dunni</i>	Salamander	Occurs	Breeds			Stream breeding
	Western red-backed salamander	<i>Plethodon vehiculum</i>	Salamander	Occurs	Breeds			Terrestrial breeding
	Rough-skinned newt	<i>Taricha granulosa</i>	Salamander	Occurs	Breeds			Pond breeding
	Coastal giant salamander	<i>Dicamptodon tenebrosus</i>	Salamander	Occurs	Breeds			Stream breeding
	Northwestern salamander	<i>Ambystoma gracile</i>	Salamander	Undetermined	Undetermined			Pond breeding
	Long-toed salamander	<i>Ambystoma macrodactylum</i>	Salamander	Undetermined	Undetermined			
	Clouded salamander	<i>Aneides ferreus</i>	Salamander	Undetermined	Undetermined			
	Oregon slender salamander	<i>Batrachoseps wrighti</i>	Salamander	Undetermined	Undetermined	✓		
Reptiles	Common garter snake	<i>Thamnophis sirtalis</i>	Snake	Occurs	Breeds			Forest openings
	Northwestern garter snake	<i>Thamnophis ordinoides</i>	Snake	Occurs	Breeds			Forest openings
	Northern alligator lizard	<i>Elgaria coerulea</i>	Lizard	Rare	Breeds			Rock quarry
	Rubber boa	<i>Charina bottae</i>	Snake	Undetermined	Undetermined			Forest
	Ring-necked snake	<i>Diadophis punctatus</i>	Snake	Undetermined	Undetermined			
	Western skink	<i>Plestiodon skiltonianus</i>	Lizard	Undetermined	Undetermined			
	Western fence lizard	<i>Sceloporus occidentalis</i>	Lizard	Undetermined	Undetermined			
	Southern alligator lizard	<i>Elgaria multicarinata</i>	Lizard	Undetermined	Undetermined			
	Coastal cutthroat trout	<i>Oncorhynchus clarkii clarkii</i>	Salmonid	Occurs	Breeds	✓*		Balch, Miller creeks
	Coho salmon	<i>Oncorhynchus kisutch</i>	Salmonid	Occurs	Breeds	✓		Miller Creek only
Fish	Steelhead	<i>Oncorhynchus mykiss</i>	Salmonid	Occurs	Breeds	✓*		Miller Creek only
	Sculpin	<i>Cottus</i> sp.	Cottid	Occurs	Breeds			some major creeks

*Listed as Sensitive or Threatened species under the federal Endangered Species Act; not also listed by TEES.

Table 7. Mollusks of interest for Forest Park grouped by type and occurrence, and listed alphabetically by scientific name. Microsnails have a shell diameter <3 mm.

Common Name	Scientific Name	Habitat	Type	Occurrence	Breeding
Banana slug	<i>Ariolimax columbianus</i>	Terrestrial	Slug	Occurs	Breeds
European red slug	<i>Arion rufus</i>		Slug	Occurs	Breeds
Reticulate taildropper slug	<i>Prophysaon andersoni</i>		Slug	Occurs	Breeds
Yellow-bordered taildropper slug	<i>Prophysaon foliolatum</i>		Slug	Occurs	Breeds
Northwest hesperian	<i>Vespericola columbiana</i>		Slug	Occurs	Breeds
Cochlicopa lubrica	<i>Cochlicopa lubrica</i>		Snail	Occurs	Breeds
Pygmy Oregonian	<i>Cryptotomastix germana germana</i>		Snail	Occurs	Breeds
garden snail	<i>Cryptomphalus aspersus</i>		Snail	Occurs	Breeds
Robust lancetooth	<i>Haplotrema vancouverense</i>		Snail	Occurs	Breeds
Oregon megomphix	<i>Megomphix hemphilli</i>		Snail	Occurs	Breeds
Pacific sideband snail	<i>Monadenia fidelis fidelis</i>		Snail	Occurs	Breeds
Oregon forestsnail	<i>Allogona townsendiana</i>		Snail	Does not occur	Not applicable
Western thorn	<i>Carychium occidentale</i>		Microsnail	Occurs	Breeds
Toothless column snail	<i>Columella edentula</i>		Microsnail	Occurs	Breeds
Paralaoma servilis	<i>Paralaoma servilis</i>		Microsnail	Occurs	Breeds
Broadwhorl tightcoil	<i>Pristiloma johnsonii</i>		Microsnail	Occurs	Breeds
Denticulate tightcoil	<i>Pristiloma langsingi</i>		Microsnail	Occurs	Breeds
Conical spot	<i>Punctum randolphi</i>		Microsnail	Occurs	Breeds
<i>Pupilla hebes</i>	<i>Pupilla hebes</i>	Aquatic	Microsnail	Occurs	Breeds
Cross vertigo	<i>Vertigo modesta</i>		Microsnail	Occurs	Breeds
<i>Zonitoides nitidus</i>	<i>Zonitoides nitidus</i>		Microsnail	Occurs	Breeds
Ramshorn snail	Planorbidae		Freshwater snail	Occurs	Breeds
Pleurocerid	<i>Juga</i> sp.		Freshwater snail	Occurs	Breeds
Pea clam	Pisidiidae		Bivalve	Occurs	Breeds
Floater	<i>Anodonta</i> sp.		Bivalve	Does not occur	Not applicable
Western pearlshell	<i>Margaritifera falcata</i>		Bivalve	Does not occur	Not applicable
Western ridged mussel	<i>Gonidea angulata</i>		Bivalve	Does not occur	Not applicable
Asian clam	<i>Corbicula fluminea</i>		Bivalve	Does not occur	Not applicable

Table 8. Species of interest to Forest Park that are either listed, candidate, sensitive, or of concern at the state or federal levels.

Group	Common name	Scientific name	Federal	Oregon	Forest Park occurrence	Forest Park breeding
Birds	Bald eagle	<i>Haliaeetus leucocephalus</i>	(delisted)	Threatened	Occurs	Breeds
	Peregrine falcon	<i>Falco peregrinus</i>	(delisted)	Sensitive, Vuln.	Occurs	Breeds
	Band-tailed pigeon	<i>Patagioenas fasciata</i>	of Concern		Occurs	Breeds
	Northern spotted owl	<i>Strix occidentalis caurina</i>	Threatened		Rare	Non-breeder
	Common nighthawk	<i>Chordeiles minor</i>		Sensitive, Crit.	Rare	Non-breeder
	Lewis's woodpecker	<i>Melanerpes lewis</i>	of Concern	Sensitive, Crit.	Rare	Non-breeder
	Pileated woodpecker	<i>Dryocopus pileatus</i>		Sensitive, Vuln.	Occurs	Breeds
	Olive-sided flycatcher	<i>Contopus cooperi</i>	of Concern	Sensitive, Vuln.	Occurs	Breeds
	American marten	<i>Martes americana</i>	Candidate	Sensitive, Vuln.	Historical	N/a
	Red tree vole	<i>Arborimus longicaudus</i>	Candidate	Sensitive, Vuln.	Historical	N/a
Mammals	White-footed vole	<i>Arborimus albipes</i>	of Concern		Undetermined	Undetermined
	Camas pocket gopher	<i>Thomomys bulbivorus</i>	of Concern		Undetermined	Undetermined
	Western gray squirrel	<i>Sciurus griseus</i>		Sensitive, Vuln.	Does not occur	N/a
	Silver-haired bat	<i>Lasionycteris noctivagans</i>	of Concern	Sensitive, Vuln.	Occurs	Undetermined
	Fringed myotis	<i>Myotis thysanodes</i>	of Concern	Sensitive, Vuln.	Occurs	Undetermined
	Western big-eared bat	<i>Corynorhinus townsendii</i>	of Concern	Sensitive, Crit.	Occurs	Undetermined
	Long-eared myotis	<i>Myotis evotis</i>	of Concern		Occurs	Undetermined
	Long-legged myotis	<i>Myotis volans</i>	of Concern	Sensitive, Vuln.	Occurs	Undetermined
	Yuma myotis	<i>Myotis yumanensis</i>	of Concern		Occurs	Undetermined
	California myotis	<i>Myotis californicus</i>		Sensitive, Vuln.	Occurs	Undetermined
Amphibians	Northern red-legged frog	<i>Rana aurora</i>	of Concern	Sensitive, Vuln.	Occurs	Breeds
Fish	Oregon slender salamander	<i>Batrachoseps wrighti</i>	of Concern	Sensitive, Vuln.	Does not occur	N/a
	Coastal cutthroat trout	<i>Oncorhynchus clarkii clarkii</i>	of Concern	Sensitive, Vuln.	Occurs	Breeds
	Steelhead	<i>Oncorhynchus mykiss</i>	Threatened	Sensitive, Crit.	Occurs	N/a

Sources: U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, 14 January 2012, and Oregon Department of Fish and Wildlife, 2008.

Appendix B: Tables

Table 9. Oregon-wide USGS Breeding Bird Survey (BBS) population trends, 1966–2009, for TEES Special Status bird species of interest for Forest Park.¹²⁰ Trends shown in red have the highest possible confidence and credibility ratings for the available data.

Common name	Scientific name	Trend : avg. annual %	Trend confidence	Data Credibility
Great blue heron	<i>Ardea herodias</i>	−0.9	Low	Low
Bald eagle	<i>Haliaeetus leucocephalus</i>	5.6	Moderate	Medium low
American kestrel	<i>Falco sparverius</i>	−1.6	Moderate	Moderate
Merlin	<i>Falco columbarius</i>	5.0	Low*	Medium low
Peregrine falcon	<i>Falco peregrinus</i>	26.0	Moderate	Medium low
Band-tailed pigeon	<i>Patagioenas fasciata</i>	−0.5	Low	Moderate
Northern spotted owl	<i>Strix occidentalis caurina</i>	−3.7	High**	High
Common nighthawk	<i>Chordeiles minor</i>	−1.1	Low	Moderate
Vaux's swift	<i>Chaetura vauxi</i>	1.0	Low	Moderate
Rufous hummingbird	<i>Selasphorus rufus</i>	−3.1	Moderate	Moderate
Lewis's woodpecker	<i>Melanerpes lewis</i>	−2.9	Low	Medium low
Downy woodpecker	<i>Picoides pubescens</i>	−0.3	Low	Low
Pileated woodpecker	<i>Dryocopus pileatus</i>	2.1	Moderate	Low
Olive-sided flycatcher	<i>Contopus cooperi</i>	−3.0	Moderate	Moderate
Western wood-pewee	<i>Contopus sordidulus</i>	−1.7	Moderate	Moderate
Willow/alder flycatcher	<i>Empidonax</i> spp.***	−5.6	Moderate	Moderate
Pacific-slope/Cordilleran flycatcher	<i>Empidonax</i> spp.***	−3.2	Moderate	Moderate
Hutton's vireo	<i>Vireo huttoni</i>	4.4	Moderate	Low
Red-eyed vireo	<i>Vireo olivaceus</i>	0.5	Low	Medium low
Bushtit	<i>Psaltiriparus minimus</i>	−3.7	Moderate	Moderate
White-breasted nuthatch	<i>Sitta carolinensis</i>	−0.2	Low	Low
Brown creeper	<i>Certhia americana</i>	0.1	Low	Low
House wren	<i>Troglodytes aedon</i>	−3.1	Moderate	Moderate
Pacific wren	<i>Troglodytes pacificus</i>	−0.2	Low	Moderate
Swainson's thrush	<i>Catharus ustulatus</i>	−1.2	Moderate	Moderate
Varied thrush	<i>Ixoreus naevius</i>	−2.3	Moderate	Moderate
Orange-crowned warbler	<i>Oreothlypis celata</i>	−3.2	Moderate	Moderate
Nashville warbler	<i>Oreothlypis ruficapilla</i>	−0.2	Low	Moderate
Yellow warbler	<i>Setophaga petechia</i>	−3.1	Moderate	Moderate
Black-throated gray warbler	<i>Setophaga nigrescens</i>	−2.5	Moderate	Moderate
Hermit warbler	<i>Setophaga occidentalis</i>	0.0	Low	Moderate
Wilson's warbler	<i>Cardellina pusilla</i>	−1.4	Moderate	Moderate
Chipping sparrow	<i>Spizella passerina</i>	−2.2	Moderate	Moderate
Purple finch	<i>Carpodacus purpureus</i>	−1.6	Moderate	Moderate
Red crossbill	<i>Loxia curvirostra</i>	1.4	Low	Low

Trend confidence: “Low” indicates the 95% confidence interval (CI) includes zero. “Moderate” indicates the 95% CI does not include zero.

Data credibility: “Low” has an important deficiency; “medium low” has a deficiency; “moderate” is of moderate precision with possible deficiencies; “high” is supported by intense research unrelated to the BBS. Moderate is the highest possible rating for BBS data and trends. More information available at the USGS BBS web site: <http://www.mbr-pwrc.usgs.gov/bbs>

*BBS data for Washington state. Data for Oregon not available.

**Northern spotted owl trend data from Forsman et. al. 2012.⁵¹

***Though currently separate species, these two were taxonomically combined during much of the survey period.

Table 10. Data sources for the Forest Park wildlife inventory.

Topic	Contributors	Title	Field years / report date	Organization	Document/data type	Methods	No. of surveys	No. of captures or specimens	No. of sites or transects, area	No. of mgmt units (1–3)
All taxa	PP&R, Deshler, J., Felice, R., Petersen-Morgan, K., Roth, E; Brimecombe, T., Bushman, M., Corkran, C., Engel, S., Guderyahn, L., Helzer, D., Hiatt, J., Hitchcox, M., Houle, M., Hurley, S., LaBonte, J., Lagasa, E., Marshall, C., Masta, S., Matthews, I., Mattson, M., Plissner, J., Reddick, K., Roberts, L., Smith, M., Swanson, S., Turner, C., Weil, K., Williamson, T., Young, M.	Summary Report from the BioBlitz for Forest Park Wildlife	2012	City of Portland	Report	Pit fall traps, sweep nets, acoustic bat surveys, call playback, in-stream surveys, riparian and terrestrial hand searches, transect birding by ear	30	89 vertebrate species, 9 mollusks, 149 arthropods	30	3
Amphibians	Dietrich, Andrew	Stream-Associated Amphibian Habitat Assessment in the Portland-Vancouver Metropolitan Region	2011	PSU	Masters thesis	In-stream surveys	6	191 specimens, 3 species	6 sites	3
	Hayes, Marc	Amphibians and Reptiles in Forest Park: Composition and Constraints		Washington Department of Fish & Wildlife	Presentation	Informal surveys, habitat associations				
	Roberts, Laura	Woodland Amphibian Distribution in Parks and Greenspaces in Portland	2003–2005	PSU	Masters thesis	Terrestrial and riparian surveys		6 species	6 sites	2
	Young, M., Taylor, K., PP&R Environmental Education	Amphibian Monitoring Program: 2011 Field Season Results and Recommendations	2008–2011	City of Portland	Report	Terrestrial and riparian surveys		4 species	1 site	1
Arthropods	Edwards, Patrick	A Non-lethal Subsampling Procedure for Aquatic Macroinvertebrates	2007–2011	PSU	PhD dissertation	In-stream surveys for macroinverts	13	4,770 specimens; 24 families	1	1
	Hitchcox, Mark	Insects of Forest Park		USDA-Animal & Plant Health Inspection Service	Raw data					
	LaBonte, Jim	Insects of Forest Park	1997–2012	ODA	Raw data	Pitfall, Lindgren funnels, UV-light		>300 species	50 sites	3
Birds	Broshot, Nancy	A Decade of Change in Avian Abundance and Richness in FP	1993–1995 2003–2005	Linfield College	Presentation	Point counts			25 sites	3
	Buck, J., Price, B.	Bald Eagle Monitoring Program	2010–2012	USFWS	Raw data	Surveys		3 pairs	3 nest sites	2
	Gross, Wink	Trends in Avian Abundance near Pittock Mansion (presentation)	1990–2011		Raw data	Surveys, nest monitoring	3,025		1 transect, 275 days/yr	1

Topic	Contributors	Title	Field years / report date	Organization	Document/data type	Methods	No. of surveys	No. of captures or specimens	No. of sites or transects, area	No. of mgmt units (1-3)
Birds, amphibians, fish, habitat, mollusks, stream invertebrates	Hennings, Lori	Riparian Bird Communities in Portland	1999	Oregon State University	Masters thesis	Point counts	5	25 species, 126 detections	1	1
	Marshall, Dave	Transcript of Portland BES's conversation with D.B. Marshall, 10 November 2008	1940-1980	USFWS, retired	Informal discussion	Bird watching	n/a	n/a	n/a	3
	National Audubon Society, Audubon Society of Portland, W. Gross, Portland compiler	Christmas Bird Count database	1926-2011	Audubon Society	Raw data	Winter surveys	85	1-2 transects,1 day/yr		3
	Nehls, Harry		1960-2012		Informal discussion	Bird watching	n/a	n/a	n/a	3
Birds, habitat	Portland Park Commissioners	1901 Park Commissioners Report	Before 1902	City of Portland	Annual report	Bird watching	unknown	77 species	unknown	unknown
	Portland Bureau of Environmental Services (BES)	Portland Watershed Management Plan (PAWMAP)	2008-2011	City of Portland	Management plan, natural areas monitoring	Bird point counts, stream electroshocking, surveys of woody debris volume	25	55 species	25 sites	3
	Swingle, S., Forsman, E., Pederson, J., Peterson, B., Deshler, J.	Nest-tree Characteristics of 3 Barred Owl (<i>Strix varia</i>) and 1 Great Horned Owl (<i>Bubo virginianus</i>) Nests Obtained During Tree Climbing to Collect Prey Remains, Forest Park	2012	City of Portland	Report	Arboreal surveys	4	4 nests	4 sites	2
	Deshler, John	Breeding Biology and Habitat Selection of Northern Pygmy- Owls	2007-2012	PSU	Masters thesis	Surveys	Habitat: 65 sites; owls: 300	105 small mammals as prey	Habitat: 65 sites, 325 plots; owls in all park acres	3
Habitat	Lev, E., Fugate, J., Sharp, L.	West Hills Study of Forest Wildlife Habitat	1992	Multnomah County	Report	Small mammal trapping	4	176 captures	4 transects	2
	Portland Parks & Recreation	Vegetation Summaries for Forest Park		City of Portland	Raw data	NVCS classification	324	n/a	All park acreage	3
Mammals	Dizney, Laurie	Zoonotic Disease Emergence : Host-Pathogen-Ecosystem Dynamics	2002-2004	PSU	PhD dissertation	Trapping		1,031 captures	1 site	1
	Forsman, E., Swingle, J.	Preliminary Investigation of Red Tree Vole (<i>Arborimus langicaudus</i>) Presence in Forest Park	2009-2012	USFS	Report	Arboreal surveys	6	0 red tree voles	16 sites inc. old-growth conifer and owl nest sites	2

Topic	Contributors	Title	Field years / report date	Organization	Document/data type	Methods	No. of surveys Thousands of park visits	No. of captures or specimens	No. of sites or transects, area	No. of mgmt units (1-3)
	Nilsen, Fred		2012	PP&R	Informal discussion	Wildlife watching; park management	4	30 captures, 7 species	2	3
	Perkins, J. Mark	Bats Within the Urban Growth Boundary of Portland	2002-2003	Greenspace Program	Report					2
	Richardson, D., PP&R	Forest Park Predators: Results from a Camera Study	2010-2011	Portland	Presentation	Motion detection camera surveys	588 camera days	13 mammal species	42 sites, 14 camera days/site	3
Mammals, habitat	Lichti, Nathan	Biogeography of Vascular Plants and Small Mammals in Portland	2004	PSU	Masters thesis	Trapping, squirrel point counts	16	182 captures, 7 species	2 sites, 16 transects	2
Mammals, carnivores, owls	PP&R, SWCA Environmental Consultants, and the University of Oregon	Predator Diets Project Summary Report	2012	City of Portland	Report	Dissection of predator scat and owls pellets; surveys for barred owl nests	40	386 small mammals	6 owl nest sites and 5 transects for coyote scats	3
Mollusks	Hodges, Nathan	Terrestrial Molluscs of an Urban Forest Fragment in Portland	2005	PSU	Senior thesis	Terrestrial hand searches	26	1,005	26 sites, 5 m radius each	1
	Smith, Al		2012	ODFW retired	Raw data	In-stream surveys w/ glass- bottomed viewer	4	0	3	3
Natural resources management	City Club Committee of Fifty, City of Portland staff	A Management Plan for Forest Park	1976	City of Portland	Management plan	n/a	n/a	n/a	n/a	n/a
	Houle, Marci	West Hills Wildlife Corridor Study	1990	Multnomah County	Report	n/a	n/a	n/a	n/a	n/a
	Munger, Thorton	History of Portland's Forest Park	1960	City Club	Report	n/a	n/a	n/a	n/a	n/a
	Peterson-Morgan, K., PP&R	Forest Park Ecological Prescriptions	2011	City of Portland	Management plan	n/a	n/a	n/a	n/a	n/a
	Portland Bureau of Planning	Northwest Hills Natural Areas Portection Plan	1991	City of Portland	Report	n/a	n/a	n/a	n/a	n/a
	Portland Bureau of Planning (Gronkowski, Sjulin, Brooks, Nilsen)	Forest Park Natural Resource Management Plan	1995	City of Portland	Management plan	n/a	n/a	n/a	n/a	n/a
	Portland Environmental Services	Terrestrial Ecology Enhancement Strategy	2011	Portland	Management plan	n/a	n/a	n/a	n/a	n/a

Table 11. Insects, spiders, millipedes, and other arthropods of Forest Park listed alphabetically by class, order, family, and genus.^{25,34,88,89}

Class	Order	Family	Scientific Name	Common name
Arachnida		Amaurobiidae	<i>Callobius</i> sp.	Hacklemesh spider
		Araneidae	<i>Araneus diadematus</i>	Cross orbweaver
			<i>Cyclosa conica</i>	Trashline orbweaver
		Linyphiidae		Filmy dome spider
		Oxyopidae	<i>Oxyopes</i> sp.	Lynx spider
		Philodromidae	<i>Philodromus rufus</i>	Crab spider
		Salticidae		Jumping spider
		Theridiidae		Tangle-web spiders
		Thomisidae	<i>Bassaniana utahensis</i>	Crab spider
			<i>Misumena vatia</i>	Crab spider
		Ixodidae	<i>Ixodes</i> sp.	Tick
		Ceratolasmidae	<i>Dendrolasma mirabile</i>	Harvestmen
			<i>Hesperonemastoma</i> sp.	Harvestmen
		Phalangiidae	<i>Leptobunus</i> sp.	Harvestmen
		Sabaconidae	<i>Sabacon</i> sp.	Harvestmen
		Sironoidea	<i>Siro acaroides</i>	Harvestmen
		Triaenonychidae	<i>Metanonychus setulus</i>	Harvestmen
				Centipede
			<i>Lithobius</i> sp.	Centipede
		Macrostermesmidae	<i>Nearctodes mus</i>	Millipede
Diplopoda		Xystodesmidae	<i>Harpaphe haydeniana</i>	Clown millipede
		Hirudisomatidae	<i>Octoglena anura</i>	Millipede
		Spirolidae	<i>Tylobolus</i> sp.	Nocturnal millipede
				Springtail
Entognatha		Collembola		Two-pronged bristletails
		Diplura		Death watch beetle
Insecta		Coleoptera	<i>Coelostethus quadrulus</i>	Death watch beetle
			<i>Ernobius punctulatus</i>	Death watch beetle
			<i>Ernobius socialis</i>	Death watch beetle

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			<i>Hadrobregeus gibbicollis</i>	Death watch beetle
			<i>Priobium punctatus</i>	Death watch beetle
			<i>Vrileta decorata</i>	Death watch beetle
			<i>Xestobium affine</i>	Death watch beetle
	Bostrichidae		<i>Lyctus planicollis</i>	Powder post beetle
			<i>Melalgus confertus</i>	Bostrichid beetle
			<i>Rhyzopertha dominica</i>	Bostrichid beetle
			<i>Stephanopachys sobrinus</i>	Bostrichid beetle
	Bruchidae		<i>Acanthoscelides aureolus</i>	Bean weevil
	Buprestidae		<i>Agrilus politus</i>	Jewel beetle
			<i>Buprestis aurulenta</i>	Golden buprestid
			<i>Buprestis lyrata</i>	Jewel beetle
			<i>Buprestis subornata</i>	Jewel beetle
			<i>Chrysobothris femorata</i>	Jewel beetle
			<i>Chrysophaeana placida</i>	Jewel beetle
			<i>Melanophila acuminata</i>	Jewel beetle
	Canthanidae		<i>Podabrus piniphilus</i>	Soldier beetle
			<i>Podabrus pruinosis</i>	Soldier beetle
			<i>Silis lutea</i>	Soldier beetle
	Carabidae		<i>Agonum limbatum</i>	Ground beetle
			<i>Agonum muelleri</i>	Ground beetle
			<i>Anisodactylus binotatus</i>	Ground beetle
			<i>Calathus fuscipes</i>	Ground beetle
			<i>Calathus ruficollis</i>	Ground beetle
			<i>Carabus nemoralis</i>	Ground beetle
			<i>Dromius piceus</i>	Ground beetle
			<i>Harpalus affinis</i>	Ground beetle
			<i>Harpalus cordifer</i>	Ground beetle
			<i>Harpalus somnulentus</i>	Ground beetle
			<i>Nebria brevicollis</i>	European gazelle-beetle
			<i>Omus audouini</i>	Audouin's night-stalking tiger beetle
			<i>Omus dejeanii</i>	Greater night-stalking tiger beetle

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			<i>Platynus brunneomarginatus</i>	Ground beetle
			<i>Platynus ovipennis</i>	Ground beetle
			<i>Promecognathus crassus</i>	Ground beetle
			<i>Pterostichus algidus</i>	Ground beetle
			<i>Pterostichus crenicollis</i>	Ground beetle
			<i>Pterostichus lama</i>	Ground beetle
			<i>Pterostichus melanarius</i>	Ground beetle
			<i>Pterostichus pumilus</i>	Ground beetle
			<i>Scaphinotus angusticollis</i>	Ground beetle
			<i>Scaphinotus marginatus</i>	Ground beetle
			<i>Scaphinotus velutinus</i>	Ground beetle
			<i>Trechus obtusus</i>	Ground beetle
			<i>Zacotus matthewsii</i>	Ground beetle
		Cerambycidae	<i>Arhopalus asperatus</i>	Longhorn beetle
			<i>Arhopalus productus</i>	Longhorn beetle
			<i>Atimia confusa dorsalis</i>	Longhorn beetle
			<i>Brachyleptura dehiscens</i>	Longhorn beetle
			<i>Callidium cicatricosum</i>	Longhorn beetle
			<i>Centrodera dayi</i>	Longhorn beetle
			<i>Centrodera spurca</i>	Longhorn beetle
			<i>Clytus planifrons</i>	Longhorn beetle
			<i>Cosmosalia chrysocoma</i>	Longhorn beetle
			<i>Desmocerus aureipennis cribripennis</i>	Longhorn beetle
			<i>Dicentrus bidentatus</i>	Longhorn beetle
			<i>Dorcasina matthewsi</i>	Longhorn beetle
			<i>Eumicthus oedipus</i>	Longhorn beetle
			<i>Grammoptera subargentata</i>	Longhorn beetle
			<i>Holopleura marginata</i>	Longhorn beetle
			<i>Hybodera tuberculata</i>	Longhorn beetle
			<i>Leptalia macilenta</i>	Longhorn beetle
			<i>Leptura oblitterata oblitterata</i>	Longhorn beetle
			<i>Lepturopsis dolorosa</i>	Longhorn beetle

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			<i>Megasemum asperum</i>	Longhorn beetle
			<i>Necydalis diversicollis</i>	Longhorn beetle
			<i>Necydalis laevicollis</i>	Longhorn beetle
			<i>Necydalis laevipennis</i>	Longhorn beetle
			<i>Opsimus quadrilineatus</i>	Longhorn beetle
			<i>Ortholeptura valida</i>	Longhorn beetle
			<i>Phymatodes aeneus</i>	Longhorn beetle
			<i>Phymatodes decussatus decussatus</i>	Longhorn beetle
			<i>Phymatodes maculicollis</i>	Longhorn beetle
			<i>Phymatodes nitidus</i>	Longhorn beetle
			<i>Phymatodes oregonensis</i>	Longhorn beetle
			<i>Phymatodes testaceus</i>	Longhorn beetle
			<i>Pidonia gnathoides</i>	Longhorn beetle
			<i>Pidonia quadrata</i>	Longhorn beetle
			<i>Pidonia scripta</i>	Longhorn beetle
			<i>Plectrura spinicauda</i>	Longhorn beetle
			<i>Stenocorus vestitus</i>	Longhorn beetle
			<i>Stictoleptura canadensis cribricollis</i>	Longhorn beetle
			<i>Strophiona laeta</i>	Longhorn beetle
			<i>Xestoleptura behrensi</i>	Longhorn beetle
			<i>Xestoleptura crassicornis</i>	Longhorn beetle
			<i>Xestoleptura crassipes</i>	Longhorn beetle
			<i>Xylotrechus annosus emotus</i>	Longhorn beetle
			<i>Xylotrechus longitarsis</i>	Longhorn beetle
			<i>Xylotrechus mormanus</i>	Longhorn beetle
			<i>Xylotrechus nauticus</i>	Longhorn beetle
	Chrysomelidae		<i>Calligrapha californica</i>	Leaf beetle
			<i>Chrysomela mainensis interna</i>	Leaf beetle
			<i>Macrohaltica ambiens</i>	Alder flea beetle
			<i>Syneta hamata</i>	Leaf beetle
			<i>Timarcha intricata</i>	Leaf beetle
	Cleridae		<i>Boschella fasciata</i>	Checkered beetle

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			<i>Enoclerus eximus</i>	Checkered beetle
			<i>Enoclerus lecontei</i>	Checkered beetle
			<i>Enoclerus schaefferi</i>	Checkered beetle
			<i>Enoclerus spegeus</i>	Checkered beetle
			<i>Phyllobaenus scaber</i>	Checkered beetle
	Coccinellidae		<i>Cycloneda polita</i>	Western blood-red lady beetle
			<i>Mulsantina picta</i>	Lady beetle
			<i>Psyllobora vigintimaculata</i>	Lady beetle
	Colydiidae		<i>Lasconotus complex</i>	Colydiid beetle
			<i>Lasconotus subcostulatus</i>	Colydiid beetle
			<i>Namunaria pacifica</i>	Colydiid beetle
			<i>Oxylaemus californicus</i>	Colydiid beetle
	Cucujidae		<i>Pediacus depressus</i>	Flat bark beetle
	Curculionidae		<i>Barypeithes pellucidus</i>	Hairy spider weevil
			<i>Dryophthorus americanus</i>	Weevil
			<i>Nemolestes incomptus</i>	Woods weevil
			<i>Otiorynchus ovatus</i>	Strawberry root weevil
			<i>Otiorynchus rugostriatus</i>	Rough strawberry root weevil
			<i>Otiorynchus singularis</i>	Clay-colored weevil
			<i>Panscopus gemmatus</i>	Weevil
			<i>Rhyncolus spretus</i>	Weevil
			<i>Sciopithes obscurus</i>	Weevil
	Elateridae		<i>Ampedus phoenicopterus</i>	Click beetle
			<i>Ampedus varipilis</i>	Click beetle
			<i>Sylvanelater furtivus</i>	Click beetle
	Elmidae			Riffle beetle
	Histeridae		<i>Platysoma lecontei</i>	Clown beetle
	Laemophloeidae		<i>Laemophloeus alternans</i>	Lined flat bark beetle
	Lampyridae		<i>Ellychnia hatchi</i>	Firefly
	Latridiidae		<i>Aridius nodifer</i>	Minute brown scavenger beetle
			<i>Melanophthalma distinguenda</i>	Minute brown scavenger beetle
	Leiodidae		<i>Pinodytes newelli</i>	Eyeless soil fungivore beetle

		Lucanidae	<i>Platycerus oregonensis</i>	Oregon stag beetle
			<i>Sinodendron rugosum</i>	Rugose stag beetle
		Lycidae	<i>Dictyoptera simplicipes</i>	Red net-winged beetle
		Melandryidae	<i>Eustrophus tomentosus</i>	False darkling beetle
		Nitidulidae	<i>Eपुरaea avara</i>	Sap beetle
			<i>Pityophagus rufipennis</i>	Sap beetle
		Oedemeridae	<i>Oxaxis bicolor</i>	False blister beetle
		Pyrochroidae	<i>Dendroides ephemeroides</i>	Red beetle
		Monotomidae	<i>Monotoma longicollis</i>	Root-eating beetle
		Salpingidae	<i>Rhinosimus viridiaeneus</i>	Narrow-waisted bark beetle
	Hemiptera	Scarabaeidae	<i>Dichelonyx</i> sp.	Scarab beetle
	Coleoptera	Scirtidae	<i>Cyphon concinnus</i>	Marsh beetle
		Scolytidae	<i>Alniphagus aspericollis</i>	Alder bark beetle
			<i>Anisandrus dispar</i>	Pear-blight beetle
			<i>Carphoborus vandykei</i>	Bark beetle
			<i>Cryphalus pubescens</i>	Bark beetle
			<i>Cryphalus ruficollis ruficollis</i>	Bark beetle
			<i>Dendroctonus pseudotsugae</i>	Douglas-fir beetle
			<i>Dendroctonus valens</i>	Red turpentine beetle
			<i>Gnathotrichus retusus</i>	Ambrosia beetle
			<i>Gnathotrichus sulcatus</i>	Ambrosia beetle
			<i>Hylastes nigrinus</i>	Bark beetle
			<i>Hylastinus obscurus</i>	Bark beetle
			<i>Hylesinus californicus</i>	California ash bark beetle
			<i>Hylocurus hirtellus</i>	Bark beetle
			<i>Hylurgops porosus</i>	Bark beetle
			<i>Ips paraconfusus</i>	California five-spined engraver
			<i>Ips pini</i>	Pine engraver
			<i>Ips tridens englemanni</i>	Bark beetle
			<i>Monarthrum scutellare</i>	Oak ambrosia beetle
			<i>Phloeosinus hoppingi</i>	Bark beetle
			<i>Phloeosinus punctatus</i>	Western cedar bark beetle

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			<i>Pityogenes carinulatus</i>	Bark beetle
			<i>Pityokteines elegans</i>	Bark beetle
			<i>Pseudips concinnus</i>	Bark beetle
			<i>Pseudips mexicanus</i>	Bark beetle
			<i>Pseudohylesinus dispar dispar</i>	Bark beetle
			<i>Pseudohylesinus granulatus</i>	Bark beetle
			<i>Pseudohylesinus nebulosus nebulosus</i>	Bark beetle
			<i>Pseudohylesinus sericeus</i>	Bark beetle
			<i>Pseudohylesinus tsugae</i>	Bark beetle
			<i>Pseudopityophthorus pubipennis</i>	Bark beetle
			<i>Scolytus multistriatus</i>	Smaller European elm bark beetle
			<i>Scolytus oregoni</i>	Bark beetle
			<i>Scolytus rugulosus</i>	Shot-hole borer
			<i>Scolytus unispinosus</i>	Douglas-fir engraver
			<i>Trypodendron lineatum</i>	Lined ambrosia beetle
			<i>Trypophloeus salicis</i>	Bark beetle
			<i>Trypophloeus thatcheri</i>	Bark beetle
			<i>Xyleborinus attenuatus</i>	Ambrosia beetle
			<i>Xyleborinus saxesenii</i>	Lesser shot-hole borer
			<i>Xyleborus intrusus</i>	Ambrosia beetle
			<i>Xyleborus pfeili</i>	Ambrosia beetle
			<i>Xylosandrus germanus</i>	Black stem borer
			<i>Xyloterinus politus</i>	Ambrosia beetle
	Scaptiidae		<i>Anaspis rufa</i>	False flower beetle
	Silvanidae		<i>Silvanus bidentatus</i>	Silvanid flat bark beetle
	Staphylinidae		<i>Eusphalerum pothos</i>	Rove beetle
			<i>Xantholinus linearis</i>	Rove beetle
	Tenebrionidae			Darkling beetle
	Trachypachidae		<i>Trachypachus gibbsii</i>	False ground beetle
			<i>Trachypachus holmbergii</i>	False ground beetle
Dermaptera	Forticulidae		<i>Forficula auricularia</i>	European earwig
Diptera	Agromyzidae		<i>Chromatomyia tiarella</i>	Leaf miner

		Bibionidae	<i>Bibio vestitus</i>	March fly
		Blephariceridae		Net-winged midge
		Chironomidae		Midge
		Drosophilidae	<i>Drosophila suzukii</i>	Spotted-wing drosophila
		Rhagionidae		Snipe fly
		Simuliidae		Black fly
		Syrphidae	<i>Eupeodes lapponica</i>	Flower fly
			<i>Eupeodes volucris</i>	Flower fly
			<i>Scaeva pyrastris</i>	Flower fly
		Tipulidae	<i>Tipula oleracea</i>	Crane fly
	Ephemeroptera	Heptageniidae		Mayfly
		Baetidae		Mayfly
		Leptophlebiidae		Mayfly
		Ameletidae		Mayfly
	Hemiptera	Lygaeidae	<i>Plinthisus brevipennis</i>	Seed bug
		Pentatomidae	<i>Cosmopepla conspiciaris</i>	Stink bug
			<i>Zicrona caeruleus</i>	Stink bug
		Acanthosomatidae	<i>Elasmotethus cruciatus</i>	Red-cross shield Bug
		Rhopalidae	<i>Boisea rubrolineatus</i>	Western boxelder bug
	Homoptera	Aphididae	<i>Rhopalosiphum enigmae</i>	Aphid
		Cercopidae	<i>Philaenus spumarius</i>	Spittle bug
		Psyllidae	<i>Arytaina genistae</i>	Jumping plantlouse
	Hymenoptera	Apidae	<i>Apis mellifera</i>	European honey bee
			<i>Bombus fervidus californicus</i>	Bumblebee
			<i>Bombus melanopygus</i>	Bumblebee
			<i>Bombus mixtus</i>	Bumblebee
			<i>Bombus ternarius</i>	Bumblebee
		Cimicidae	<i>Zaraea sp. (inflata OR americana)</i>	Sawfly
		Formicidae	<i>Camponotus modoc</i>	Modoc carpenter ant
			<i>Formica obscuripes</i>	Ant
			<i>Formica pacifica</i>	Ant
			<i>Lasius niger</i>	Ant

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			<i>Lasius pallitarsis</i>	Ant	
			<i>Leptothorax muscorum</i>	Ant	
			<i>Stenamma diecki</i>	Ant	
			<i>Tapinoma sessile</i>	Odorous house ant	
			<i>Temnothorax rudis</i>	Ant	
			<i>Tetramorium caespitum</i>	Pavement ant	
		Tenthredinidae	<i>Monsoma pulveratum</i>	Sawfly	
			<i>Empria</i> sp.	Sawfly	
			<i>Lycaota</i> sp.	Sawfly	
	Lepidoptera	Arctiidae	<i>Arctia caja</i>	Great tiger moth	
			<i>Clemensia albata</i>	Little white lichen moth	
			<i>Pyrrharcia isabella</i>	Isabella tiger moth/banded woolly bear	
			<i>Spilosoma virginica</i>	Virginia tiger moth/yellow woolly bear	
			<i>Tyria jacobaeae</i>	Cinnabar moth	
		Blastobasidae	<i>Blastobasidae</i> sp. A		
		Cossidae	<i>Prionoxystus robiniae</i>	Carpenterworm	
		Crambidae	<i>Herpetogramma pertextalis</i>	Bold-feathered grass moth	
		Gelechiidae	<i>Chionodes mediofuscella</i>		
			<i>Gelechiidae</i> sp.		
			<i>Recurvaria nanella</i>		
			<i>Sorhagenia nimbosa</i>	Cascara moth	
		Geometridae	<i>Anticlea vasiculata</i>	Geometer moth	
			<i>Aplacera plagiata</i>	Geometer moth	
			<i>Apodrepanulatrix litaria</i>	Geometer moth	
			<i>Biston betularia</i>	Peppered moth	
			<i>Ceratodalia gueneata</i>	Geometer moth	
			<i>Coryphista meadii</i>	Geometer moth	
			<i>Costaconvexa centrostrigaria</i>	Geometer moth	
			<i>Diagrammia neptaria</i>	Geometer moth	
			<i>Dysstroma bruceata</i>	Geometer moth	
			<i>Dysstroma citrata</i>	Geometer moth	
			<i>Ecliptopera silaceata</i>	Geometer moth	

			<i>Epirrhoe alternata</i>	Geometer moth
			<i>Eupithecia</i> sp.	Geometer moth
			<i>Geometridae</i> sp. A	Geometer moth
			<i>Geometridae</i> sp. B	Geometer moth
			<i>Hydriomena</i> sp.	Geometer moth
			<i>Idea dimidiata</i>	Geometer moth
			<i>Macaria dispuncta</i>	Geometer moth
			<i>Macaria signaria</i>	Geometer moth
			<i>Nealcis californiaria</i>	Geometer moth
			<i>Pero mizon</i>	Geometer moth
			<i>Plemyria georgii</i>	Geometer moth
			<i>Proitame matilda</i>	Geometer moth
			<i>Sabulodes aegrotata</i>	Omnivorous looper
			<i>Thalophaga taylorata</i>	Geometer moth
			<i>Trichodezia albivittata</i>	Geometer moth
			<i>Udea</i> sp. (<i>rubigatus</i> or <i>profundalus</i>)	Geometer moth
			<i>Venusia pearsalli</i>	
			<i>Xanthorhoe defensoria</i>	
			<i>Xanthorhoe ferugatta</i>	
			<i>Xanthorhoe</i> sp. (probable <i>pontiarai</i>)	
			<i>Phylonorycter</i> sp.	
Gracillariidae			<i>Malacosoma disstria</i>	Forest tent caterpillar
Lasiocampidae			<i>Celastrina agriolus echo</i>	Spring azure
Lycaenidae			<i>Evers amyntula</i>	Western tailed blue
			<i>Orgyia antiqua</i>	Tussock moth
Lymantriidae			<i>Microlep a</i>	
Micro			<i>Microlep b</i>	
			<i>Abagrotis baurei</i>	Owlet moth
Noctuidae			<i>Adelphagrotis indeterminata</i>	Owlet moth
			<i>Adelphagrotis stellaris</i>	Owlet moth
			<i>Agrotis vancouverensis</i>	Owlet moth
			<i>Amphipyra pyramoides</i>	Owlet moth

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			<i>Androplia aedon</i>	Owlet moth
			<i>Apamea amputatrix</i>	Owlet moth
			<i>Apamea devastator</i>	Owlet moth
			<i>Apamea ophiogramma</i>	Owlet moth
			<i>Aseptis adnixa</i>	Owlet moth
			<i>Bomolocha abalienalis</i>	Owlet moth
			<i>Brachylomia rectifascia</i>	Owlet moth
			<i>Caenurgina crassiuscula/erechtea</i>	Owlet moth
			<i>Caradrina morpheus</i>	Owlet moth
			<i>Chytonix divesta</i>	Owlet moth
			<i>Cosmia praecuta</i>	Owlet moth
			<i>Diarsia esurialis</i>	Owlet moth
			<i>Diarsia rosaria</i>	Owlet moth
			<i>Dolicocuculia dentilinea</i>	Owlet moth
			<i>Egira rubrica</i>	Owlet moth
			<i>Egira</i> sp.	Owlet moth
			<i>Enargia infumata</i>	Owlet moth
			<i>Euxoa</i> sp.	Owlet moth
			<i>Graphiphora haruspica</i>	Owlet moth
			<i>Homorthodes communis</i>	Owlet moth
			<i>Ipimorpha veridipallida</i>	Owlet moth
			<i>Lacinipolia patalis</i>	Owlet moth
			<i>Lacinipolia</i> sp.	Owlet moth
			<i>Leucania farcta</i>	Owlet moth
			<i>Lithphana petulia</i>	Owlet moth
			<i>Mythimna oxygala</i>	Owlet moth
			<i>Neoligia exhausta?</i>	Owlet moth
			<i>Noctua comes</i>	Owlet moth
			<i>Noctua pronuba</i>	Owlet moth
			<i>Ochropleura implecta</i>	Owlet moth
			<i>Orthosia hibisci</i>	Owlet moth
			<i>Parabagrotis exertistigma</i>	Owlet moth

			<i>Polychrysia</i> sp.	Owlet moth
			<i>Properigea albimacula</i>	Owlet moth
			<i>Protodeltote albidula</i>	Owlet moth
			<i>Proxenus minanda</i>	Owlet moth
			<i>Raphia frater</i>	Owlet moth
			<i>Xestia xanthographa</i>	Owlet moth
			<i>Zanclognatha</i> sp.	Owlet moth
			<i>Zosteropoda hirtipes</i>	Owlet moth
	Notodontidae		<i>Gluphisia septentrionis</i>	Prominent moth
			<i>Gluphisia severa</i>	Prominent moth
			<i>Schizura unicornis</i>	Prominent moth
	Nymphalidae		<i>Polygonia satyrus</i>	Satyr comma butterfly
	Oecophoridae		<i>Agonopterix alstroemeriana</i>	
			<i>Batia lunaris</i>	
			<i>Decantha stonda</i>	
			<i>Hoffmanophila pseudospretella</i>	
	Papilionidae		<i>Papilio</i> sp.	Swallow-tail butterfly
	Pieridae		<i>Pieris rapae</i>	Cabbage white
			<i>Pieris marginalis</i>	Margined white
	Plutellidae		<i>Plutella xylostella</i>	Diamondback moth
	Prodoxidae		<i>Greya punctiferella</i>	
	Pyralidae		<i>Acrobasis tricolorella</i>	Snout moth
			<i>Agriphila</i> sp.	Snout moth
			<i>Chalcoela iphitalis</i>	Snout moth
			<i>Chrysoteuchia topiaria</i>	Snout moth
			<i>Crambus cypridellus</i>	Snout moth
			<i>Crambus</i> sp.	Snout moth
			<i>Euchromius oscellus</i>	Snout moth
			<i>Euzophora semifuneralis/vinulella</i>	Snout moth
			<i>Euzophora vinulella</i> ?	Snout moth
			<i>Herpetogramma pertextalis</i>	Snout moth
			<i>Hypsopygia costalis</i>	Snout moth

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			<i>Perispasta caeculalis</i>		Snout moth
			<i>Phycitinae</i> sp.		Snout moth
			<i>Pyalidae</i> sp. A		Snout moth
			<i>Pyalidae</i> sp. B		Snout moth
			<i>Pyrausta californicalis?</i>		Snout moth
			<i>Pyrausta subsequalis</i>		Snout moth
			<i>Scoparia</i> sp.		Snout moth
			<i>Synclita oblitalis</i>		Snout moth
			<i>Udea profundalis</i>		Snout moth
			<i>Udea washingtonalis</i>		Snout moth
			<i>Udonia</i> sp.		Snout moth
		Symmocidae	<i>Oegoconia quaripuncta</i>		
		Thyatiridae	<i>Pseudothyatira cymatophoroides</i>		
		Tineidae	<i>Tineidae</i> sp.		
		Tortricidae	<i>Archips argyrospilus</i>		Tortrix moth
			<i>Archips rosanus</i>		Tortrix moth
			<i>Argyrotaenia citrana</i>		Tortrix moth
			<i>Argyrotaenia franciscana (complex)</i>		Tortrix moth
			<i>Choristoneura rosaceana</i>		Tortrix moth
			<i>Clepsis consimilana</i>		Tortrix moth
			<i>Clepsis</i> sp.		Tortrix moth
			<i>Ditula angustiorana</i>		Tortrix moth
			<i>Eana</i> sp. ?		Tortrix moth
			<i>Epinotia</i> sp. (<i>solicitona</i> OR <i>momonana</i>)		Tortrix moth
			<i>Grapholita populana</i>		Tortrix moth
			<i>Olethreutes</i> sp.		Tortrix moth
			<i>Proteoteras aesculana</i>		Tortrix moth
			<i>Tortricidae</i> sp. A		Tortrix moth
			<i>Tortricidae</i> sp. B		Tortrix moth
		Yponomeutidae	<i>Zelleria</i> sp.		Moth
Neuroptera		Chrysopidae	<i>Chrysopa</i> sp.		Green lacewing
Odonata		Aeshnidae	<i>Anax junius</i>		Green darner

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		Coenagrionidae	<i>Enallagma carunculatum</i>	Tule bluet damselfly
		Libellulidae	<i>Libellula forensis</i>	Eight-spotted skimmer
	Orthoptera	Acrididae	<i>Melanoplus femurrubrum</i>	Red-legged grasshopper
		Myrmecophilidae		Ant cricket
	Plecoptera	Perlodidae		Stonefly
		Perlidae		Common stonefly
		Nemouridae		Spring stonefly
		Chloroperlidae		Green stonefly
		Leuctridae		Rolled-wing stonefly
	Psocoptera			Booklouse, barklouse or barkfly
	Raphidioptera	Raphidiidae	<i>Agulla</i> sp.	Snakefly
	Thysanoptera	Thripidae	<i>Chirothrips aculeatus</i>	Thrips
			<i>Ewartithrips ehrhornii</i>	Thrips
			<i>Franliniella occidentalis</i>	Western flower thrips
			<i>Rhipidothrips brunneus</i>	Thrips
	Trichoptera	Rhyacophilidae		Primitive caddisfly
		Limnephilidae		Northern caddisfly
		Hydropsychidae		Net-spinner caddisfly
		Glossosomatidae		Saddle-case caddisfly
Malacostraca	Amphipoda	Gammaridae		Amphipod
	Decapoda	Astacidae		Crayfish
	Isopoda	Armadillidiidae	<i>Armadillidium vulgare</i>	Common pill-bug
		Oniscidae	<i>Oniscus asellus</i>	Common woodlouse

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Table 12. Research items that would increase understanding of Forest Park wildlife. This is not a list of prescriptives to accomplish prior to implementing management actions.

Category	Gap/focal taxa	Gap type	Special status concern?	Questions	Next steps	Methodological sample	Citizen science opportunity	Effort
Mammals	Monitoring: mammalian population trends	Population dynamics	Yes	We have no information on trends in mammals and no studies are currently underway to address this. Are common mammalian species declining in abundance as is the case with many common birds?	Monitor populations of mammalian wildlife in all combinations of habitat type (shrub, grass, riparian, upland, edge and interior forest) using methods that appropriate for each taxonomic group.	(1) Trap for small mammals using arrays of baited Sherman traps; (2) survey for ungulates, carnivores, and large rodents using baited motion-detection cameras, track plates, and Havahart traps; (3) survey for bats using acoustic detectors and mist netting; and (4) survey for fossorial mammals (moles, pocket gophers, mountain beaver, ground squirrels) by quantifying species-specific burrows per unit area.	Yes	L
	Bats: diversity and habitat use	Relative abundance	Yes	Are any bat species abundant or rare in the park? In which seasons are which species present?	Survey for bats in all management units and habitat types over the course of one full year.	Conduct acoustic surveys throughout the park in all seasons and resolve acoustic data to species. Conduct mist-netting surveys where feasible to increase species level information.	Yes	L
		Breeding		Do any bat species breed in the park?	Survey for bats in all management units and habitat types over the course of one full year.			
		Habitat use		Are late successional coniferous forest patches important for park bats? Grand fir? Broken top trees? Thurman bridge?	Survey for bats in all management units and habitat types over the course of one full year. Explore known bat-preferred habitat structures for use by bats.			
		Distribution		Are bats well distributed in the park, or restricted to a few key sites or colonial roosts?	Survey for bats in all management units and habitat types over the course of one full year.			

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			Which invertebrates are especially important for park bats?	Analyze bat dietary composition	Capture bats in mist nets, disgorge stomach contents, release bats otherwise unharmed, and analyze stomach contents to the lowest possible taxonomic level.	
	Foxes: mammalian carnivore diversity	Diversity	Have foxes been eliminated from the park, perhaps due to the expansion and abundance of coyotes?	Research the presence/absence of foxes in regional habitat and survey for the presence of foxes in the park.	Survey for foxes in the park using motion-detection cameras and track plates for one full year. Research the presence/absence of foxes in the region through discussions with regional wildlife experts and experts on fox ecology, and by reading the scientific wildlife literature relevant for this region.	M
	Ground squirrels and pocket gophers: meso-rodent diversity	Diversity	Do pocket gophers occur in FP, perhaps in grassy trailheads or near water towers? Do California ground squirrels occur in FP?	Survey for ground squirrels and pocket gophers within and near the perimeter of park.	Survey for the conspicuous, species-specific burrows of pocket gophers and ground squirrels in relatively open, grassy habitat near the park perimeter, in meadows, and around water towers.	S
	Elk: movements of the largest park inhabitant	Habitat use	Do elk have a migration pattern with respect to their occurrence in the park?	Survey for elk for one full year, especially at the park perimeter and forest interior sites.	Various options are possible. (1) Rely on scats and tracks to estimate the presence, number, sex, age class, and habitat use of elk in the park. (2) Use an array of motion-detection cameras to estimate the same. (3) Capture, radio-collar, and track elk in and around the park to best estimate movements and demographics.	M/ L
			What areas of the park are being used by elk and in what seasons?			
			Do elk enter the park after fall breeding? How long do they stay?			
			How many elk inhabit the park each year? Each season?			
			Where do park elk go to breed? Is the park used for calving?			

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	Woodrats and voles: Small-rodent diversity	Diversity	Yes	Do long-tailed, white-footed or western red-backed voles occur in FP?	Survey for voles in heretofore unsurveyed habitat types including shrub, perennial riparian, and grass habitats.	Survey for voles using an array of Sherman traps in shrub, grass, and riparian habitats. For white-footed voles, survey in mature, riparian alder stands with abundant beaked hazel shrub.	M
		Reintroduction		North American woodrats and tree voles are not closely related to their Old World cousins, and these species are valuable ecosystem components. These rodents readily breed in captivity. Could they be successfully reintroduced into the park?	Outline the feasibility of reintroducing red tree voles and woodrats to the park in the form of a SWOT analysis (strengths, weaknesses, opportunities, threats). Discuss the outline with known stakeholders including the Oregon Zoo, USFWS, USFS, OSU, park perimeter residents, Metro, West Multnomah Soil & Water Conservation District, and others.	The Oregon Zoo could offer a potential breeding facility for rapidly generating an introductory population. The USFS might provide funding, and OSU could generate graduate student interest for monitoring the reintroduction of a federal candidate species (red tree vole). The project also lends itself to citizen science for nest monitoring and arboreal surveys (tree-climbing).	M
	Porcupine: abundance trends for this rare, large rodent	Diversity		The park seems to have adequate habitat to support porcupine, but they are nevertheless rare and sign of them is essentially absent. Are we on the verge of forever losing the porcupine from the park?	Perform systematic surveys for porcupine sign in the park. Determine the porcupine's range limit in the Tualatin Valley and Tualatin Mountains.	Search for porcupine sign (chews, tracks, scats) in the park. Use motion-detection cameras and track-plates to locate porcupines. Research the regional range limit of porcupines.	S
	Small "Pacific" rarities	Diversity		Are Pacific water shrew and Pacific jumping mouse truly rare in the park? Are they still present?	Survey in perennial riparian and upland areas for these small mammals.	Review the scientific literature to determine the best methods for locating these two rare species.	S
Birds	Monitoring: avian population trends beyond the southern boundary	Population dynamics	Yes	We have excellent information about population trends at the southern urban boundary of the park, and that citizen science effort is ongoing. BES has started a new project that will sample the abundance of common species at sites in other	Survey for avian species along transects in the north and central management units.	Conduct transect surveys in all seasons, similar to those done by Gross at Pittock Mansion, and produce a basis for comparison of population trends among both breeding and non-breeding avian species throughout the park.	L

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					management units on a rotating schedule that will require many years to discern annual population trends there. What's going in the central or northern management units where the habitat is less urban and habitat connectivity is better?					
	Avian population decline research	Population dynamics	Yes	Yes	Approximately one-third of the park's bird species show evidence of decline. The source of these declines may be regional, statewide, or continental in scale, or a combination of these.	For each species, examine the scientific literature and citizen science reports to determine whether its decline has been noted elsewhere, and whether the reasons for its decline are well understood or not.	Conduct transect surveys in all seasons, as done by Gross at Pittock Mansion, and produce a basis for comparison of population trends among breeding and non-breeding avian species in other areas of the park.	Yes	L	
	Common special-status breeders: population dynamics	Population dynamics	Yes	Yes	To what extent are common TEES Special Status birds breeding successfully in the park? These include band-tailed pigeon, pileated and downy woodpeckers, red-breasted sapsucker, brown creeper, black-throated gray warbler. Do park populations represent a source or sink for any of these species?	Conduct avian ecology research into the breeding success of each of these species in the park.	Conduct species-specific breeding biology studies into common special-status birds, including nest-finding, and measure annual rates of nest success, timing of breeding, reproductive output, etc.	Yes	M	
	Uncommon special-status breeders: population dynamics	Population dynamics	Yes	Yes	To what extent are uncommon TEES Special Status birds breeding successfully in the park? What is the density and distribution of western wood-pewees, olive-sided and Hammond's flycatchers, varied thrush,	Conduct avian ecology research into the breeding success of each of these species in the park.	Conduct species-specific breeding biology studies into rare special status birds, including nest-finding, and measure annual rates of nest success, timing of breeding, reproductive output, etc.	Yes	M	

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					and Hutton's vireo? Do park populations represent a source or sink for any of these species?							
					Why were landfowl lost from the park and could they be reintroduced? What are the regional population boundaries for these species? Is a local or regional reintroduction feasible? Unlike small rodents, landfowl have large home ranges and are likely to require a broader regional population to sustain a population in the park.							

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	Rough-skinned newts: breeding location of the population in the North Mgmt. Unit	Breeding	Rough-skinned newts migrate to the Audubon Sanctuary pond to breed in the South Mgmt. Unit. But where do rough-skinned newts go to breed in the north and central units? Are they breeding in the park or on private lands? Should we provide them with ponds inside the park boundary?	Locate and map known pond-breeding sites. Investigate the possibility of additional pond breeding sites in the private ornamental and stock ponds of residents at the park perimeter. Create a plan for preserving access to known breeding sites, or create new breeding sites within the park preserve.	Identify potential amphibian breeding ponds by conducting remote aerial surveys using Google Maps and Google Earth. Ask park perimeter residents about amphibian breeding in their private ponds. Confirm amphibian breeding at identified and accessible sites. Create a plan to protect current breeding habitat access or build new breeding sites within the park preserve.	Yes	M/ L
	NW salamander occurrence	Diversity	Do northwestern salamanders occur in the park? If so, where are they breeding?	Conduct targeted surveys for northwestern salamanders and for breeding sites.	Review the literature to determine the best methods for locating this difficult to detect species.	Yes	S
	Monitoring: herpetile population trends	Population dynamics	The amphibian monitoring project has done a good job of documenting diversity and abundance of salamanders at one site in the park in recent years. We need a long-term monitoring project, perhaps a citizen science one, that samples additional sites to track population trends.	Review the scientific literature and local citizen science efforts and create a monitoring plan for salamanders and frogs in the park.	Review the scientific literature and local citizen science efforts and create a monitoring plan for salamanders and frogs in the park.	Yes	M
Mollusks	Snail and slug diversity beyond the southern park boundary	Diversity	Nathan Hodges conducted an excellent survey near the southern park boundary that contributed greatly to our knowledge of terrestrial mollusks. But what's going on in other parts of the park?	Survey for mollusk diversity and relative abundance in the central and north management units.	Conduct terrestrial hand-search methods similar to those used by Hodges to record mollusk diversity and relative abundance.	Yes	S
	European red slug: impacts of a recent non-native invader	Non-native impacts	When Hodges conducted his study in 2005, European red slugs were rare. They are now widespread and abundant. Are they merely an addition to the local	Survey for mollusk diversity and relative abundance in the park and explore the relative abundance of native species vs. the European red slug. Examine red slug ecology in	Create a plan for the management of red slugs in the park based on the available information and site specific research into the ecology of this species.	Yes	S

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				fauna or are they having impacts on native species abundance? Will anything, such as coastal giant salamanders or barred owls, eat red slugs to control their population?	the park. Analyze the benefits and risks of reducing or eliminating red slugs in the park.			
Arthropods	Arthropod diversity	Diversity	Yes	What is arthropod diversity to the correct order of magnitude? 100s? 1,000s? 10,000s? We lack basic information on diversity.	Survey for arthropods with a focus on documenting diversity.	Conduct annual surveys in all habitats in the park for insects and other taxa using the wide array of methods commonly employed by entomologists (sweep nets, pitfall traps, terrestrial hand searches, bug lights, sheets, funnel traps, etc.). Partner with ODA, USDA, PSU, and others to create a reference collection for the park. Engage regional entomologists in a citizen science effort to document the diversity of arthropods in the park.	Yes	L
	Dominant arthropods	Ecology		Which arthropod species are especially abundant (an ecological “dominant,” like a deer mouse relative to other small mammals), and perhaps a primary food source for bats, woodpeckers, warblers, or shrews? How are the great many species of arthropods interacting with the habitat and each other?	Survey for arthropods with a focus on documenting the relative abundance of species of interest, and on forest ecology. Conduct in-depth research into the ecology of dominant (highly abundant) arthropod species, if any occur, to best understand their roles as an indicator species of forest health, and their ecological value (as food, ecosystem engineers, etc.) to other species.	See Arthropod Diversity. Review literature and conduct in-depth research in the park into the ecology of dominant (highly abundant) arthropod species, if any occur, to best understand their roles in forest ecology, especially their ecological value (as food, ecosystem engineers, etc) to other animal species.	Yes	M
	Non-native vs. native Insects	Non-native impacts		How many non-native arthropods are on the landscape now? Are they outcompeting closely related native invertebrates?	Monitor populations of arthropods for changes in the relative abundance of native and non-native species.	See Arthropod Diversity and Dominant Arthropods.	Yes	M

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	Beetles, moths, and trees	Ecology		Do any beetles or moths currently in the inventory for the park pose an immediate threat to forest health, especially live trees?	Identify potential pest insects in the current species inventory, monitor ODA and USDA surveys to identify new threats to trees, and monitor the forest for diseased trees.	Monitor the annual results of ODA and USDA surveys. Conduct annual surveys for diseased trees as part of non-native plant controls.	Yes	M
	Monitoring: Population trends of insects and other arthropods	Population dynamics	Y	Though moth and beetle diversity has been monitored along the eastern park boundary for many years, data on population trends of arthropod species are utterly lacking, even for common species, and also for known threats to forest health.	Monitor populations of arthropods for changes in the relative abundance of native and non-native species.	See previous arthropod strategies. Conduct annual surveys for insects and other arthropods, by expanding current surveys beyond their focus on beetle and moth pests.	Yes	L
Wildlife response	Wildlife response to habitat restoration in the park	Wildlife response	Yes	Are habitat restoration actions increasing the diversity and/or abundance of rare or special status species?	Conduct pre- and post-treatment experiments where habitat restoration activities are scheduled and implemented. Survey for indicator species (e.g., breeding and migratory birds, amphibians) to determine whether habitat restoration efforts are having the desired effect.	Conduct site-specific and taxa-specific surveys (avian point counts, amphibian surveys, etc.) before and after actions to restore habitat.	Yes	M
	Wildlife response to utility corridor mgmt.	Wildlife response	Yes	Are development, utility corridor maintenance, or other anthropogenic impacts effecting wildlife occurrence, especially for uncommon species or large terrestrial ones?	Conduct pre- and post-treatment experiments where utility corridor maintenance activities are scheduled and implemented. Survey for indicator species (e.g., breeding and migratory birds, amphibians, pollinators) to determine whether and how habitat alteration is affecting wildlife diversity and abundance.	Conduct site-specific and taxa-specific surveys (avian point counts, amphibian surveys, etc.) before and after actions that adversely affect habitat.	Yes	M

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	Wildlife response to park users and domestic dogs	Wildlife response	Yes	Do any wildlife species in the park, especially large mammals and birds, show a strong preference for trail-less areas? Are wildlife more or less abundant near trails? Which species? Do dogs, on or off-leash, have a detectable impact on park wildlife?	Research and design scientific experiments that appropriately test for the lethal and non-lethal effects of park visitors and dogs on the diversity, abundance, and behavior of wildlife species of interest. Conduct experiments on the impact of legal park users and dogs along trail transects.	Review the scientific literature for the best available information on user and dog impacts on wildlife, and write a report on findings applicable to Forest Park. Conduct site-specific and taxa-specific experiments to test whether changes to wildlife behavior (non-lethal) and on lethal impacts are correlated with dogs, either on or off leash. Use off-trail areas in the central and north management units as controls, especially Linnton Park and the Newton Creek areas.	Yes	M
	Wildlife response to trail system expansion	Wildlife response	Yes	Do trail-less and trailed areas of the park support the same diversity and abundance of wildlife?	Conduct a comparative analysis of vertebrate wildlife diversity, abundance, and breeding rates at sites near and far from trails.	Review the scientific literature for the best available information on user and trail impacts on wildlife, and write a report on findings applicable to Forest Park. Conduct site-specific and taxa-specific experiments to test whether changes to wildlife diversity, abundance and breeding success are correlated with trails and park user impacts. Use off-trail areas in the central and north management units as controls, especially Linnton Park and the Newton Creek areas.	Yes	M
	Wildlife response to illegal park activities	Wildlife response	Yes	Are illegal park activities such as homeless camps, rogue trail construction and nocturnal cycling on trails having negative impacts on wildlife?	Design a study to test for the effects of homeless camps, rogue trail construction and use, and nocturnal cycling on wildlife.	Similar to previous two strategies.	Yes	M
Wildlife habitat assessment	Snag abundance	Habitat	Yes	What is the relative abundance, size, species, condition, height, etc. of snags throughout the park? Evidence of wildlife use?	Quantify the type, number, size, and condition of snags at randomly selected sites in all management units, and the use of snags by wildlife, especially woodpecker nest cavities. If some park areas are depauperate, write a plan for increasing snag abundance by judiciously "snagging" selected live trees.	Quantify the number, size, species, condition, and wildlife use of snags at randomly selected sites throughout the park and in various habitat types (forest edge, forest interior). Measure the annual rate of change in snag abundance.	Yes	S/ M

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	Coarse Woody Habitat volume	Habitat	Yes	What is the volume of coarse woody debris (CWD) in upland and riparian areas throughout the park, especially near major streams?	Quantify the volume of CWD in major streams and upland sites. Quantify the annual natural change in CWD over 5 years. If certain streams are below threshold values (see ODFW reports), judiciously select trees for felling to increase CWD in upland or riparian areas as necessary	Quantify the volume of CWD in each major stream and at randomly selected upland sites. Measure the annual rate of natural change in CWD over 5 years.	Yes	M
	Regional foraging and breeding habitat beyond the park boundary for wide-ranging species of interest	Habitat	Yes	Band-tailed pigeons, Vaux's swifts, northern red-legged frogs, grouse, and elk are a few of the species of interest that are known to forage and/or breed beyond the park boundary while also using the park in some seasons. An understanding of exactly which habitats are key to maintaining these and other species of interest in the park is necessary to maintain park populations.	Research the use of habitat beyond the park boundary by rare and special-status park wildlife by working with public and private landholders and regional wildlife experts. Document the sites used by regional elk herds, band-tailed pigeon flocks, breeding northern red-legged frogs, breeding grouse, and other species of interest.			M
	Quantitative data on shrubs and ground cover	Habitat		For instance, what is the relative abundance of shrubs in the north, central and south mgmt units? A great number of questions could be supported by having quantitative habitat data.	Quantify and compare the percent cover of shrubs and herbaceous ground plants at randomly selected sites in all management units to better understand the distribution of these important habitat components, and inform habitat restoration activities.	Use quadrats to quantitatively assess shrub and groundcover density at randomly selected sites.	Yes	S
	Soil and forest floor profiles	Habitat		What is the profile of park soils and leaf litter? Are the soils wildlife friendly for aplodontia, gophers, moles, leaf litter shredders, burrowing mesopredators, and forest-floor birds?	Study park soils and document the wildlife therein, especially arthropods.	Review the scientific literature for the best methods to sample and document soil profiles.	Yes	S

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Appendix B: Tables

	Special-status habitats	Habitat	Yes	Are any rare or undocumented species using special-status habitats such as <i>Oaks</i> or <i>Forested Wetlands</i> ? Only cursory habitat assessments have been done in oak stands.	Search off-trail areas for forested wetlands, oak remnants, and other special habitats and record their location, size, type, wildlife value, and current wildlife use.	Explore low-lying off-trail areas and the Highway 30 perimeter for wetlands, ponds, hydrophilic vegetation, and oak remnants.	Yes	S
Wildlife recolonization	Wildlife recolonization and re-introduction	Reintroduction	Yes	If we build great habitat, is it likely that some historical wildlife will nevertheless never return? Would a few historical, special-status small mammalian species (e.g., red tree vole, dusky-footed woodrat) improve park ecology and benefit from reintroduction to the park?	Estimate the regional range limits of the red tree vole, bushy-tailed woodrat, gray fox, sooty grouse, ruffed grouse, and other extirpated or rare species of interest. Estimate the probability of natural recolonization of the park by those species. Estimate the probability of maintaining populations of the species in the park, or in the park and surrounding landscape, if recolonization or reintroduction occurred. Define the ecological value and feasibility of reintroduction or extirpated or rare species that are good candidates for reintroduction, and are unlikely to successfully recolonize the park naturally.	See foxes, woodrats and voles, porcupines, small "Pacific" rarities, grouse and mountain quail, and red-legged frogs. Review the literature on recolonization and reintroduction and on the individual species to estimate the probability of maintaining rare species, the probability of natural recolonization, and the probability of reintroduction success.	Yes	L

Table 12

Appendix C: Footnotes

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