WILD ABOUT THE CITY:

Phase One Of

The West Hills Wildlife Corridor Study

Prepared For:

Multnomah County Division of Planning and Development

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INTRODUCTION

An unusual situation exists in the rapidly urbanizing county of Multnomah in Portland, Oregon. In this setting of over a half million people, a 5,000 acre city park of national significance-- Forest Park -- is juxtaposed between the densely urban setting of the City of Portland and a relatively natural Douglas fir forest ecosystem. This condition has aroused the interest of the Multnomah County Division of Planning and Development, who must make judgments regarding the future of lands surrounding this park, and whose decisions will directly influence the park's long term viability as a natural reserve.

It is well documented that the Douglas fir forests of western Oregon and Washington have an unusually high richness of bird and mammal species. The region is about three times richer in species of mammals and twice as rich in species of breeding birds as coniferous forests of the southeastern United States. The 48 families of breeding birds represent a greater richness of classification than in any other area north of the Rio Grande (Harris 1984).

While this is true of the natural forest system, urban ecosystems, however, are generally severely altered. They are essentially dominated by man and his artifacts, and exhibit a paucity of native wildlife (Bolen and VanDruff 1987). Introduced pest species that cohabit easily with man -- house sparrows, starlings, rock doves, Norway rats, and house mice -- are abundant (Bolen and VanDruff 1987).

Forest Park, however, is different. It presently exhibits a wide array of native wildlife -- over 112 species of birds and 52 species of mammals -- making it an anomaly in terms of urban parks (Houle 1982, 1986). One major factor contributing to its richness is that a natural corridor of Douglas fir forest, presently free of urbanization, connects the park's northwest boundary in Multnomah County to the rural Coast Range of Oregon. This has allowed movement of a wide variety of animals, including such mammals as black bear, elk, and bobcat, into and out of the park. This fact is significant, as these animals have been either eliminated entirely or dramatically reduced throughout the eastern United States (Wilcove et al., 1986, Harris and Gallagher 1989).

With continual encroachment of urban development and potential industrial activities in northwest Portland, Oregon, however, this natural condition will change unless steps are taken to define and protect important features of the corridor. Recognizing this, the Multnomah County Division of Planning and Development has authorized a study of this corridor, and its relationship between Portland's Forest Park and the larger natural area of the Coast Range.

The following report, representing Phase One of this study, is a condensation of a thorough literature review on what is presently known on landscape linkages and habitat fragmentation. It offers a conceptual framework to aid in understanding and in future planning for this relatively undeveloped portion of Multnomah County. Eleven recommendations are proposed to sustain the viability of the wildlife species presently inhabiting Forest Park and the corridor. These recommendations, based on the literature, are further substantiated by discussions with leading researchers and land managers throughout the United States. They are also in accordance with the goals of the Forest Park Management Policy, as adopted by the City Council of Portland, Oregon, November 10, 1976, and amended December 21, 1989 (Forest Park Committee of Fifty 1976).

HABITAT FRAGMENTATION AND THE THEORY OF ISLAND BIOGEOGRAPHY

The fragmentation and isolation of natural habitat is recognized as the most serious threat to biological diversity today (Wilcox and Murphy 1985; Noss 1987a). Given the state of the world's development, virtually all habitats are becoming surrounded by human activity (Lyle 1987). The study of habitat fragmentation and its effect on wildlife is a relatively new field, founded to a large degree on MacArthur and Wilson's (1967) classic work, The Theory of Island Biogeography. The model MacArthur and Wilson proposed has emerged as a conceptual framework for understanding the wildlife population potential in regional landscapes. Although the theory was first developed for oceanic islands and archipelagoes, it has been shown to be valid for continental habitats as well (Adams and Dove 1989).

Simply stated, island biogeography theory states that an island develops a community of animals over time that includes a relatively constant number of species. As some species die out, others migrate in. In general, the number of extinctions equals the number of immigrations. Additionally, the rates of immigration and extinction are influenced by the size of the island and its distance (isolation) from other islands and the mainland. Immigration rates are predicted to increase on less isolated islands, and extinction rates decrease. This results in a higher equilibrium number of species on larger, closer-in islands, and fewer species on those islands that are smaller and farther away from a mainland source.

In the midst of today's disturbed landscapes, there exists many man-made "islands" -- fragments of once large, homogeneous ecosystems that are now surrounded by urban, suburban, or agricultural land or severely fragmented by roads (Whitcomb et al. 1981, Noss 1987a). Many species cannot use these oceans of unsuitable habitat, and, as a consequence, on isolated habitat islands, immigration does not contribute to the maintenance of equilibrium because of the disappearance of recolonization sources (Pickett and Thompson 1978). Extinction thereby often becomes the dominant population process within regional landscape fragments.

Throughout the world, this process has been documented historically. Wilcove et al. (1986), in discussing the temperate zone, tells that in Great Britain, reduction and fragmentation of the original forest cover began 5000 years ago with permanent clearances by Neolithic farmers, and was well advanced by the time of the Norman conquest in 1066. Several extinctions were related to this, including brown bear, wolf, and goshawk (now reestablished in conifer plantations). They also document the same story for the animals of the deciduous forest of the eastern

United States, where forest fragmentation became widespread with the arrival of European settlers, approximately 300 years ago. Many species vanished from the east as a result of destruction of habitat combined with over-hunting: wolf (19th century), cougar (20th century, although a few persist in Florida), elk (19th century), passenger pigeon (20th century), and ivory-billed woodpecker (20th century).

Prior to 1960, nearly one quarter of the earth's land was covered by forest. But by 1980, forest lands had been reduced to one fifth of the world's surface, and by 2000 the acreage will be reduced to one sixth. The pattern will only accelerate. This condition, coupled together with the fragmentation of habitats into small, disjunct patches, leaves wildlife today in a state of triple jeopardy: At the same time that development reduces the total amount of remaining habitat, it forces wildlife into smaller and more isolated patches and makes these animals subject to roads and vehicles that claim a high share of wildlife mortality (Harris and Gallagher 1989).

THE CONSEQUENCES OF FRAGMENTATION

The implications of parks and natural reserves becoming habitat islands in human-dominated landscapes was not adequately recognized until only recently (Harris and Gallagher 1989). Now, after years of land development around natural areas, significant problems resulting from the creation of isolated populations of plants and animals are becoming recognized and must be dealt with. Fragmentation of natural habitats generally results in smaller populations of animals that are subject to several factors making them highly vulnerable to local extinction. Wilcove (1987) and others have identified five serious consequences of fragmentation:

1. Fragments of habitat that are smaller than the minimum home ranges of a species (the area around its home that is used for breeding, feeding, and other activities) will lose these species.

2. Wildlife species that must move widely and exist at low densities often disappear from fragmented landscapes.

3. Populations that are small and isolated may lose much of their genetic variability, as a result of inbreeding, genetic drift, and bottleneck effects.

4. Natural catastrophes such as storms, fires, and disease

epidemics are events that, over the long-term, can wipe out a small population restricted to a patch habitat.

5. Species that thrive in the fragmented, man-dominated landscapes -- usually those already common and often regarded as pest species -- will increase in population-size, often at the expense of the native, "forest -interior" wildlife species.

Loss of Area Sensitive Species

Islands of habitat smaller than the minimum home ranges of certain birds and mammals cannot, of course, be inhabitated by these species. However, species often disappear from habitat fragments that far exceed their minimum home range sizes (Whitcomb et al. 1981) (See Appendix I and II). The explanation for this seemingly contradictory set of circumstances is that for many species there appears to be a psychological need for a substantially larger, forested buffer zone around the smaller area that is actually used (Whitcomb et al. 1981).

Some species of birds are particularly sensitive to the size of a forest island and show behavioral rejection of smaller tracts as breeding sites. These animals, often referred to as "area-sensitive" or "forest -interior" species, are predominantly long-distance, insect-eating migrants (e.g, warblers, vireos, and flycatchers) (Adams and Dove 1989). Studies by Lynch and Whigham (1984) indicate that even a slight degree of habitat fragmentation and isolation critically reduces the local abundance of some species in forest patches.

Throughout the northeastern United States and southeastern coastal plain regional extinctions have regularly occurred as a result of declining natural vegetation and fragmentation of habitat. Walcott (1974), in studying the natural biota of Cambridge, Massachusetts, documented a 65% reduction in numbers of nesting species between 1860 and 1964, which was attributable to a 68% reduction in natural vegetation. Modification of forest habitat and the small size of parks were associated with reduced diversity and abundance of birds in urban parks in Seattle, Washington (Gavareski, 1976), in Connecticut (Butcher et al., 1981), and Illinois (Blake 1986). Whitcomb et al. (1981) conclude that thousands of acres of contiguous habitat are required for the maintenance of stable population levels of even small bird species in the absence of regular recolonization from the outside.

Loss of Wide-Ranging Species

Many of the larger vertebrates of Western Oregon have home range sizes of thousands of acres (e.g. black bear, elk, and cougar) and cannot be conserved within any single forest stand (Harris 1984) (See Appendix II). These animals must move: they must range widely to find mates, to use different habitats during different seasons, to allow the dispersal of young, and to seek refuge from humans. In addition to requiring extensive ranges, species at the top of the trophic ladder, for example, bears, hawks and eagles, cougars and bobcats, typically exhibit low population densities (Terborgh 1976). As a result, as a forested area becomes fragmented, these species become isolated from recolonization sources and fall prey to local extinction. In the eastern United States, cougar, black bear, and elk have either been wiped out completely or are very dramatically reduced and restricted in range (Harris and Gallagher 1989).

Scientists are recognizing that when movement corridors are not incorporated across human-dominated landscapes, other significant problems besides the extirpation of wide-ranging mammals occur (Sullivan 1989). Large parks that are completely surrounded by urban, suburban, or agricultural development result in some populations of animals, such as deer, burgeoning in population and causing significant damage to surrounding areas. For example, in one large park in the East Bay Regional Park System near San Francisco -- a park completely surrounded by human development -- local deer populations, trapped within this island of habitat, are swelling in size and causing $70,000-$80,000 a year damage to surrounding agricultural lands (Shea 1989). Additionally, clashes between large moving animals and automobiles, causing loss of human and animal lives, occurs when habitats become fragmented.

Roads, in and of themselves, can be significant fragmenting forces (Noss 1987a). The intrusion of multilane interstates and primary highways generally has devastating effects on resident wildlife, including small mammals, snakes, turtles, salamanders, and frogs, as well as large carnivores and herbivores (Harris and Gallagher 1989).

As a secondary consequence to the loss of large carnivores and even large herbivores, dramatically altered, usually less diverse communities often result (Terborgh 1976, Sullivan 1989).

Two important "flagship" species rarely found in urban parks -- black bear and elk -- are known to range through Forest Park on occasion (Houle 1982, 1988). This places the park in the highly unusual situation of being a city park that has, at present, the qualities of a wildlife reserve. For these species to persist in Forest Park in the face of human encroachment, careful planning will be required, for several, species-specific reasons:

ELK

Studies have shown that elk avoid areas of high road densities. Generally, one-half mile of land or more on either side of a road is used significantly less by elk (Edge et al. 1987, Wuerthner 1990). The distance to roads may be more important in determining elk habitat use and distribution than vegetation or cover type (Edge and Marcum 1989). Additionally, elk, particularly those that are hunted, avoid large openings such as clearcuts or mining operations (Edge et al. 1985, Edge 1990). Hiding cover is critical for maintaining elk populations where hunting or human encroachment occur (Edge et al. 1990, in press). While the distribution of deer is also subject to man-dominated disturbances, elk are far less adaptable than deer, greatly more sensitive to the effects of habitat fragmentation, and will be much more quickly extirpated from a landscape (Noble 1990).

BLACK BEAR

Originally widespread throughout the forested regions of America, black bears today are becoming isolated and scattered in distribution (Pelton 1982). Their numbers are declining as habitat is reduced and fragmented, particularly in the midwestern, eastern, and southeastern U.S., where lands have been most intensively developed and human population density is high (Schoen 1989). In Florida, the black bear is on the threatened species list (Noss 1987a).

Because bears are wide-ranging animals, their habitat needs must be evaluated in a broad context. Seasonal variability in food abundance and quality often result in extensive movements from one portion of their range to another (Schoen 1989). They may move 25 miles at a time (Sullivan 1989).

Until only recently, there has been a paucity of published literature on bears and particularly bear habitat relationships. Recent studies, however, have repeatedly shown that as habitat is reduced and fragmented, bear populations decline at a constant or increasing rate until they reach a threshold point at which the rate of decline becomes precipitous. Once this point is reached, even a small additional deterioration of habitat may drive the population below viable levels (Schoen 1989).

Schoen (1989) concludes that because human tolerance for bears is generally low, inaccessible forested habitat appears to be a prerequisite for their continued existence south of 60 degrees latitude. Mortality increases and populations decline as forest clearing and roads penetrate bear habitat. Recent studies have indicated that quality of available habitat can significantly affect the female bear´s ability to reproduce and the survival of her cubs (Mollohan et al. 1989).

For these reasons, scientists concur that options for conserving black bears decline with each passing year as humans and new land use developments continually encroach on bear habitat (Schoen 1989).

Loss of Population Viability

Small, isolated populations may lose much of their genetic variability; this can result in the decreased adaptibility of species to changing environmental conditions -- including human encroachment and modification of habitat -- and threaten a animals´ persistence in an area (Miller 1979, Wilcove 1987). Geneticists consider three processes to be the primary causes of this: 1. inbreeding (mating between genetically related individuals within a population), 2. genetic drift (a random drift of genes which can result in loss of variability), and 3. bottleneck effects (when only a few individuals pass on a mere fraction of the genetic endowment of the original population) (Miller 1979). All of these phenomena generate predictable changes in isolated populations, and decrease the probability of short-term and long-term survival of many plant and animal species (Wilcove 1987).

Inbreeding provides a greater opportunity for recessive genes, and since most genes for defects and nonadaptive traits are recessive, it provides a higher probability for these negative characters to appear within a population (Miller 1979). In inbred populations, scientists have documented noticeable loss of libido and fertility, and marked increases in mortality of newborn young (Soule and Simberloff 1986).

The consequences of inbreeding, genetic drift, and bottleneck effects all increase in importance as population size decreases. Once genetic variability is lost, it can be regained only through the slow process of mutation, which requires many generations (Miller 1979).

Preventing the extinction of small populations is one of the most difficult challenges of natural area managers (Wilcove 1987). Minimum viable population sizes for species of concern must be addressed in conservation strategies (Harris 1984). The term "viable" refers to the persistence of a population over a long-term interval (Gilpin and Soule 1986). Animal scientists and geneticists have learned that in order to maintain genetic integrity within a population, over 1000 breeding animals may be required, and populations below 500 must be considered in danger of extinction without intervention, that is, introduction of new individuals into the population to increase genetic variability (Whitcomb et al. 1981, Lehmkuhl 1984).

In natural populations, it must be remembered that the effective breeding population number is often much less than the census number because: 1. only breeding adults contribute genetically to the next generation, 2. many mating patterns exclude fertile members of the adult population from breeding, 3. populations may exhibit unequal sex-ratios, 4. some individuals contribute more progeny to the next generation than do others, and 5. the seasonal population fluctuations may skew genetic contributions (Miller 1979).

Harris (1984) stresses that it is important to appreciate that conservation of genetic resources is not so much aimed at protecting what occurs at present as it is at providing for the future. Management plans that do not allow the evolution of populations, species, and ecosystems will be seriously flawed; in planning only for the short-term, the necessary flexibility that will be required of future generations of animals--adaptatibility to deal with global warming, acid rain, human alteration of habitat -- will be impaired, threatening many species with local extinction.

Loss of Populations Because of Significant, Natural Disturbances

An entire small population can be extinguished by a random, natural event such as a major fire, flood, mud slide, wind storm, or epidemic. Soule and Simberloff (1986) have stated that the persistence of certain species in a small reserve of habitat ("patch") will eventually depend on whether the isolated population can survive such environmental perturbations as the 300 year flood or 200 year drought.

The "minimum dynamic area" necessary to maintain populations of animal and plant species is defined by Pickett and Thompson (1978) as the smallest area with a natural disturbance regime which allows internal recolonization sources and hence minimizes extinctions. Because this requires so much land area, it is unlikely to be realized within a single park. Therefore, land managers and planners must consider the fact that in isolated and fragmented habitats, the size of a major catastrophe may well exceed that of the preserve itself (Noss 1987c). It is crucial, then, that these random events be accounted for and recolonization sources provided for species if many populations of birds and mammals are to persist over the long-term (White 1987).

Increase of edge and Alien Species

Perhaps the most common response to fragmentation is an increase in alien and already common species of wildlife (Harris and Gallagher 1989). A variety of plants and animals thrive in human dominated landscapes that surrounds fragments, and many of these are the predators, parasites, or potential competitors of naturally occurring species within the fragments (Wilcove 1987). Many of these species are European species -- ones that have experienced thousands of years of interaction with humans and well adapted to the human impacted environment -- and cause the demise of native species (Harris and Gallagher 1989).

For example, starlings and english sparrows compete with native cavity-nesting birds and are causing reductions of species such as the bluebird. Alien species such as pigeons, english sparrows, starlings, Norway rats, and house mice become pests in man-dominated habitats. In addition, as the top predators such as bobcat, black bear, cougar, and forest dwelling hawks are extirpated, middle-sized omnivores such as opossums, raccoons, skunks burgeon in population, wreaking havoc with native songbirds, whose eggs and nestlings they prey upon, as well as native small mammals, turtles, and salamanders (Wilcove et al. 1986, Wilcove 1987).

In the past, forest edges as habitat for game animals were thought to be advantageous; today, however, scientists generally concur that edges also have less beneficial sides that need to be considered in any management plan.

Wilcove et al. (1986) state that edge-related increases in predation of native songbirds may extend as far as 650 yards into the forest. In addition, they explain that climatological consequences of edges, such as the fluctuations in temperature and humidity of the forest understory caused from hot, dry air sweeping in from adjacent open areas, can be significant. In addition, wind uproots trees near the edge and creates many gaps in the canopy. These scientists conclude that it takes an enormous area to show no effects from the edges surrounding it. Even a forested area as large as the Great Smoky Mountains National Park, at 516,439 acres, is not immune from the edge-effects of development outside its borders. Since the late 1940's, the park has experienced tremendous increases in its breeding populations of blue jays and crows, which is thought to represent a spillover from burgeoning populations in more settled areas outside the park (Wilcove et al. 1986).

Because of the increasing evidence that birds characteristic of forest interior habitats are unable to maintain their populations where edge is abundant, the emphasis of land managers and planners on sheer numbers of species, especially if they include alien and exotic species, can be dangerous when applied simplistically and irrespective of regional ecology (Noss 1983).

CONSERVATION STRATEGIES
FOR THE AMELIORATION OF FRAGMENTATION

An important goal for conservation is to maintain, in the long-term, the natural diversity of a region, striving to preserve viable populations of as many as possible of the species that inhabited the natural, pristine landscape (Noss 1983). For Portland's Forest Park in particular, this objective is in accordance with the goals of the Forest Park Management Policy, as adopted by the city council of Portland, Oregon, in 1976, and amended by the Friends of Forest Park on December 21, 1989 (Forest Park Committee of Fifty 1976) (see Appendix III).

To achieve this end in the face of increasingly fragmented landscapes will be a difficult task that will require innovation and critical long-term planning. Definitive habitat requirements of many species of wildlife are unknown. Relatively few studies have integrated human activities or cumulative effects into habitat analyses for specific animals. Most habitat assessment studies are but "snapshots" of a species' habitat relationships at a particular point in time, often near the time of habitat alteration (Schoen 1989).

All of these things together mean that in states experiencing rapid human population growth or in areas of rapid forest clearance, the contextual setting of habitats is changing so rapidly that the presence of small numbers of animals cannot predict either adequate habitat or the likely future occurrence of the species (Harris and Kangas 1988).

Scientists recognize today that effective habitat management requires a working definition of habitat that is more encompassing than merely the place an animal lives. Harris and Kangas (1988) propose that primary habitat requirements extend beyond the needs of the individual and must include a sufficient area capable of supporting a viable <u>population</u> of the species under consideration. In the past, the failure to differentiate between habitat requirements of the individual versus the requirements for a viable population for the species in question has often produced ineffective results. In many instances, this limited view has only conserved small, nonviable subpopulations of animals that ultimately dwindled away for want of adequate space (Harris and Kangas 1989).

Ideally, a natural reserve should be large enough to encompass a minimum dynamic area and minimum viable populations of the desired species. Since geneticists consider population sizes smaller than 1000 to be very vulnerable, thousands of contiguous acres are required to assure the long term survival of many species (Whitcomb et al. 1981). Because this is often impractical in today's broken landscape, Noss (1987a) proposes that a system of natural areas, interconnected with each other and integrated with the land use of the surrounding landscape, may provide some of the functions of a minimum dynamic area, such as recolonization sources, gene flow, a mix of habitats throughout the system as a whole, and alternative refuges for species to escape natural enemies and disturbance episodes.

Wildlife corridors ("landscape linkages") and multiple-use buffer zones are two methods to achieve this end and to ameliorate the negative consequences of habitat fragmentation and isolation (MacClintock et al. 1977, Noss and Harris 1986, Noss 1987a).

WILDLIFE CORRIDORS

Many scientists have concluded that physical interconnection of habitats must be developed and protected if adequate populations of many species are to be maintained , particularly wide-ranging terrestrial species such as bobcat, bear, cougar and elk (MacClintock et al. 1977, Noss 1987a, Harris and Gallagher 1989, Sullivan 1989). The virtues of corridors include facilitating gene flow and dispersal of individuals between island habitats. This in turn decreases the rate of extinction of semi-isolated populations, increases the effective size of populations and the recolonization rate of extinct patches (Soule and Simberloff 1986). Linking together high-quality nodes of diversity via wildlife corridors can, in effect, create a larger whole, greater than the sum of its parts (Noss and Harris 1986).

Harris and Gallagher (1989) discuss positive examples of functional corridors already in place throughout the world. In Costa Rica, a 15 miles long, two mile wide riparian corridor connects lowland La Selva Biological Station with the montane Baaulio Carrillo National Park. Tanzania implemented wildlife corridors so elephants could migrate between Lake Manyara National Park and Ngorongoro Conservation Area. In New Jersey, Pinelands National Reserve depends on corridors near its boundaries and around major towns to reinforce the integrity of the area as a whole. The city of Tucson has implemented corridors to facilitate movement of large mammals from city and county parks to national forest land surrounding the city (Shaw et al. 1986). Interstate highway underpasses have been installed in several western states to allow movement of migrating deer and elk. A 50 mile river valley corridor in Olympic National Park has been set aside to accommodate wildlife movement.

Most scientists agree that the advantages of corridors outweigh any disadvantages, particularly in urban and suburban settings (Noss 1987b, Soule et al. 1988, Adams and Dove 1989). The disadvantages, as pointed out by Simberloff and Cox (1987) include the possible facilitation of transmission of contagious diseases, fires, or other catastrophes, and possible increased exposure of animals to predators, domestic animals, isolated taxa, and poachers. Scientists do not suggest, however, that corridors be built between naturally isolated habitats. As Noss (1987b) elucidated, the best argument for corridors is that the original landscape was interconnected. Corridors are simply an attempt to maintain or restore some of the natural landscape connectivity.

Width of corridors

Properly designed landscape linkages are crucial for countering the effects of habitat fragmentation and isolation. A common question planners are asked is how wide corridors need to be. Noss (1987b) states that the necessary width will vary depending on four key factors: 1. the specific species that is expected to use the corridor, 2. the habitat structure and quality within the corridor, 3. the nature of the surrounding habitat, and 4. the human use patterns within and surrounding the corridor.

Because each animal's requirements are different, the necessary width of a corridor will vary for the individual species being considered. For example, narrow corridors, such as fencerows, can be very important for some organisms, such as woodlot rodents, yet because of edge effects, wider corridors are better for forest interior species. Wilderness species probably require corridors that are miles wide to be insulated from developed land and human activities (Noss 1987a).

Because the first animals eliminated in fragmented habitats are usually area-sensitive and wide ranging species, many scientists recommend that land management prescriptions should be oriented around the needs of these "flagship" species. Wilcove (1987) states that satisfying the needs of these animals should suffice for many (but not all) of the other species with smaller home ranges whose exact microhabitat requirements are unknown. He concludes that too often management plans are developed around the needs of popular game species such as deer that are more tolerant of human fragmentation.

Three such sensitive, flagship species exist in Forest Park today and would be highly vulnerable to extirpation if a corridor of sufficient width and structure is not provided for them. For the long-term viability of populations of black bear, elk, and, to a lesser degree, bobcat, a corridor no less than one and a half miles wide, or even more, is a necessary requirement (Harris 1989, Maser 1989, Noss 1989).

The abundance, distribution, and movement patterns of the species in question must be assessed. For black bear and elk, the necessary width of a functional corridor will depend upon several additional factors:

1. if the population is protected or hunted within the corridor,

2. the natural dispersal/ topographic features that exist within the corridor and surrounding area (ridge tops, drainages, etc.)

3. the relative impenetrability of the understory the animals are traversing (e.g., if the landscape is open and park like, black bear will need a wider corridor for dispersing) ,

4. if the landscape is a travel corridor alone, or an important feeding corridor, and

5. if the animals that move through Forest Park are resident

breeding individuals or widely dispersing juveniles (Pelton 1989, Edge 1990, Noble 1990).

It must be remembered that for wide-ranging animals such as these, the preservation of suitable but intermittently, perhaps currently, unoccupied habitat may be a crucial variable and should not be overlooked in management decisions (Harrison 1989).

The structure, quantity and quality of the habitat within the corridor is also important to the design of a functional corridor. Soule (1990) has stated that the effect of edges on the interior habitat of the corridor is profound: animals' mortality rates along edges are two to ten times greater than in the middle of the protected habitat. Therefore, any perpendicular barrier in a corridor -- for example if a corridor is dog-leg shaped -- hampers movements of organisms significantly. Also, a funnel-shaped corridor is detrimental, for animals keep running into edge habitat, and thus experience greater mortality. Many animals will not use a corridor that lacks sufficient width or interior habitat; for psychological reasons, they refuse to head into a cul-de-sac, thereby rendering a narrow corridor disfunctional (Harris 1989).

Corridors must also be wide enough to resist destruction by blowdown and fire. In the Pacific Northwest, fire, pest outbreaks, and blowdown are natural occurrences which are inevitable over time for any particular forest stand (Harris 1989). Therefore, corridors must be wide enough to absorb occasional disruptions from natural factors without negating the corridors' function.

As well as width, unobstructed dispersal between habitat patches is critical to the survival of many fragmented, sub-populations of animals (Harrison 1989). If the habitat within the corridor is dissected with roads, barriers to movement such as chain link fences, barking dogs, garbage cans, housing developments, clear cuts, and/or mining operations, the corridor will probably be rendered ineffective (Harris 1989).

Corridors as "Stepping Stones"

Studies have demonstrated the value of a park's regional location in maintaining species diversity. Preserve networks at various scales, if physically and strategically integrated with one another through corridor connections, can complement one another's preservation functions (MacClintock et al. 1977, Butcher et al. 1981, Blake 1986, Noss 1987a). In other words, large preserves can serve as sources of colonists for the smaller local preserves, which themselves may serve reciprocally as stepping stones (Wilcove et al. 1986).

In a regional context then, by protecting Forest Park's connection with the Coast Range via a corridor, the diversity of the park is improved, and, in turn, Forest Park can act as a stepping stone for other parks in the Portland area.

This stepping stone model has been shown to be valid in several different parts of the United States. Galli et al. (1976) have shown that a preserve as small as five acres can have some benefit in the preservation of forest interior birds in the context of a system that includes much larger primary areas. MacClintock et al. (1977) discovered in one 35 acre tract in Maryland, the bird composition closely approximated that of much larger woodlands. Examination of the biogeographic context of this tract revealed that it was an island connected to a 400 acre woodland by a corridor, which, in turn, was connected by subsequent corridors to an additional extensive forest system of more than 10,000 acres. Isolated tracts of similar size and quality not connected by corridors to the larger forest system lacked the natural species diversity.

MacClintock et al. (1977) concluded that natural species diversity in many isolated fragments of habitat is apparently only possible if the fragment is "subsidized" by a nearby major forest system.

MULTIPLE-USE BUFFER ZONES

Any natural habitat will be enhanced or degraded according to the pattern of the landscape elements surrounding it (Noss 1987c). Small reserves of natural habitat with large perimeter-area ratios (edge), have proportionately greater management problems resulting from interactions with the surrounding urban, suburban, and agricultural landscape. A focus on the content of a natural area alone is incomplete because the structure and use of the surrounding landscape will determine whether a protected area will be able to maintain the most threatened elements and allow for their continued evolution (Noss 1983).

A gradation of buffer zones around parks and reserves can insulate natural areas from many problems (Hench et al. 1987, Noss 1987a). Noss and Harris (1986) have suggested that a concept of multiple-use modules (MUMS) can provide a good basis for a conservation network. These modules consist of a well protected core of interior habitat, surrounded by buffer zones of increasing utilization by man. Interior buffer zones might permit human uses ranging from backpacking and birdwatching, and outer zones allow forestry, hunting, and low density residential development.

Tilghman (1987) has listed several recommendations for improving the management and design of urban woodlots for the enrichment of forest birds. He suggests that wherever possible, buildings within 100 yards to natural reserves should be kept to a minimum. Additionally, trail systems should be limited in scope. Instead of a fine network of trails throughout the landscape, a few well-marked trails providing access to certain portions of the woods should be maintained.

CONCLUSION

Throughout the world, habitat fragmentation is the most serious threat to the long-term persistence of wildlife today. Only a conscious effort to prevent or reverse the ongoing reduction and insularization of habitat is likely to avert significant population declines of native animals (Wilcove 1987).

The Global 2000 report to the President predicts that worldwide, 500,000 to 2 million species will become extinct by the year 2000 and the rate will increase from one per day in 1980 to one per hour by the end of the century. In North America, over 500 species and subspecies of plants and animals have become extinct since the Puritans arrived at Plymouth Rock in 1620 (Samson and Knopf 1982).

The preservation of biological diversity should be a concern of highest ethical weight (Soule 1986). As Harris and Gallagher (1989) have said, while some would argue that we can always maintain genetic diversity in gene banks and species diversity in zoos, these approaches can never conserve the unique combinations that occur in nature and are maintained through the constant interplay of natural forces. Greater attention must be given to conserving natural plant and animal assemblages that can function as a working system.

To achieve this goal, the land manager's approach must move to the landscape level, and parks should be thought of in terms of their context within a region, not only on a site by site basis (Butcher et al. 1981, Harris 1990). Value should be placed on abundance and composition of species, not merely on the simple number of species living within a given area. Native species are to be preferred over those that are exotic to the habitat, and reduced species over the widespread and superabundant that exist because of their tolerance to man dominated landscapes (Whitcomb et al. 1976, Noss 1983). Noss (1983) concludes that the ideal condition against which contemporary diversity and composition should be compared with is the presettlement landscape, i.e., the area's natural heritage.

Scientists agree that conservation actions must be based on specific requirements of the species concerned, but it is impractical if not impossible to focus on all species within a given area. Therefore, a useful strategy is to focus on a top-down framework to provide context. The large, wide-ranging, low density mammals such as elk, black bear, cougar, and even bobcat can be umbrella species for many conservation efforts (Noss 1987a). These species are usually the first ones lost in fragmented habitats. Attempts to save only common or smaller species will usually be ill fated because of the complex ecological relationships that exist between species (e.g., predator-prey relationships) (Soule and Simberloff 1986). Without large carnivores and top predators (e.g., bear, cougar, bobcat, hawks and eagles) a natural reserve runs the risk of becoming a misleading caricature of an entire ecosystem (Whitcomb et al. 1981). Middle-sized omnivores, such as skunks, opossums, raccoons, swell in population without larger predators to keep them in check, and depredate the nests of native ground-nesting birds, small mammals, turtles, and salamanders (Harris and Gallagher 1989).

For wide-ranging species to survive, planners must take action to alleviate the problems these animals face when they move across their sizable home ranges, for movement is fundamental to their lives (Harris 1988). Planners need to consider the mobility of individual animals now and over future generations of animals (Noss 1990). One important approach to achieve this goal is to preserve landscape linkages, e.g., wildlife corridors, that maintain the remaining natural animal movement passages. Wildlife corridors are crucial for the persistence of many species, for even if a forest fragment has suitable habitat to support a population of forest animals, there is no assurance that it will remain viable if it is isolated from other populations (Harris 1989). Another valuable management tool is the implementation of buffer zones around important natural areas. These zones allow human use and development to proceed in an orderly and centrifugally increasing fashion (i.e., little development permitted in the interior buffer, greater density allowed in the outer buffer), and insulate the core of the natural habitat from deleterious edge effects (Noss and Harris 1986, Hench et al. 1987).

The benefits of planning for and protecting landscape linkages go beyond the needs of the animals themselves. The President's commission on American Outdoors recommended a network of greenways across the United States and called for linking up existing parks, river corridors, open space, trails, and abandoned rail lines for use by people and wildlife (Salwasser 1987). Natural habitat and open space should be viewed as a multifunctional element within the urban landscape, important to conservation as well as to public health and spatial design (Adams and Dove 1989). There is evidence that children who are brought up with frequent encounters with the natural world tend to have enhanced physical, intellectual, and social development (Jones 1988).

Portland's Forest Park, in all its native diversity, today allows people the opportunity to observe, study, and interact with the natural heritage of the Pacific Northwest. This is an enviable situation, for in the eastern U.S., existing urban and suburban parks are devoid of many native, forest-interior species as a result of their combination of small size, increasing isolation from sources of potential colonists, and high level of human related disturbance (Lynch and Whitcomb 1978). In addition, most of the wide-ranging large carnivores and herbivores,(e.g., elk and black bear), have all been extirpated from east coast cities.

As Jones (1988) has said, urban wildlife is one of the keys to protecting our quality of life. It should not be necessary to have to travel to distant locations in order to view wildlife and inspiring scenery. Opportunities for encounters with nature must be provided for the 80% of United States population who live in developed areas. But unless careful planning is done now, the wildlife potential of Forest Park will dramatically change.

Three wide-ranging mammals -- elk, black bear, and bobcat-- presently range through the park. Black bear, elk, and to a lesser degree, bobcat, are sensitive to the effects of fragmentation, much more so than deer, and could be used as indicator species of the naturalness of the park (Noss 1989, Schoen 1990). If the area is maintained for black bear and elk, both of which roam over large distances, by default the area is protected for the use of many other native species (Harris 1989, Maser 1989, Schoen 1990). To meet these animals needs, many scientists have agreed that a corridor of natural habitat at least one and a half miles wide, or even more, connecting the northwest boundary of Forest Park to the Coast Range, needs to be recognized and protected (Harris 1989, Maser 1989, Noss 1989). The width and structure of a functional corridor is contingent upon several factors, including topography, quality and quantity of habitat within the corridor, distribution of roads, and level of human activities. A corridor should be as free from man-made barriers (e.g., housing developments, roads, chain-linked fences) as possible; it should also be linear in structure, for it is thought that dog-legged or funnel shaped corridors potentially render a linkage disfunctional (Harris 1989, Soule 1990).

The protection of a wildlife corridor can potentially be achieved by a variety of methods, including conservation easements, tax incentives, management agreements, and local zoning ordinances (Bissell et al. 1987, Noss 1987b). Because animals such as bear, elk, and bobcat are traveling through Forest Park and its surrounding habitat today, the linkage, at present, is considered to be large enough. However, if it becomes splintered, making Forest Park more isolated from recolonization sources from the Coast Range, the long-term persistence of black bear, elk, and other top-of-the-food-chain species continuing in Forest Park is doubtful. In addition, without a corridor for emigration, populations of animals, such as deer, trapped within Forest Park, could get out of balance, resulting in many problems, ranging from human interactions with injured animals to animals wreaking havoc with suburban and agricultural lands outside the park (Shea 1989).

It must be remembered that man-made developments have an accumulative effect on wildlife. While it is unlikely that any single development will threaten an entire population, additional man-made pursuits incrementally increase impacts to a wildlife population. As habitat is reduced and fragmented, some natural wildlife populations decline until they reach a threshold point, at which time the rate of decline becomes precipitous (Schoen 1989). At this point, populations may never again reach viable levels and face local extinction.

In other words, the job is not done when an area is set aside as a park. At that point, the work has only begun. What happens to the habitat within a natural area may be less important than what happens in the surrounding contextual setting (Harris and Gallagher 1989).

As Noss (1987a) has stated, the inevitability of compromise makes it imperative that the original management plan be an optimal one and that weakening compromises are opposed at all stages of the implementation process. The process of fragmentation is, for all practical purposes, irreversible (Terborgh 1976). In the final analysis, the success of efforts to retain natural diversity in places such as Forest Park will be judged on the number of native species surviving, not just the next ten years, but in the year 2100.

RECOMMENDATIONS

Recommendation 1:

Maintain the regionally distinctive natural heritage of the western Oregon Douglas fir ecosystem within Forest Park. Success of conservation efforts can be evaluated by comparing the assemblage of species within the park with the distribution and abundance of naturally occurring wildlife under natural, pristine conditions. Management actions that increase the abundance of alien and exotic species that thrive in human dominated landscapes should be avoided.

Recommendation 2:

Plan a conservation strategy for the park and surrounding areas that focuses on the species most threatened by the encroachment of human activities and the fragmentation of natural habitat. For Forest Park, these species include black bear, elk, and, to a lesser degree, bobcat and large birds of prey, all of which require large home ranges. Protect the populations of these wide-ranging species by establishing a corridor of natural habitat linking Forest Park to the Coast Range. At a minimum, this corridor should be one and a half miles wide, or perhaps even more, the width and structure contingent upon topography, quality and quantity of habitat within the corridor, amount of roads and intrusive human activities.

Recommendation 3:

Structure the corridor as linear as possible; dog-legged or funnel-shaped corridors may prove disfunctional.

Recommendation 4:

Reduce barriers to wildlife movement within Forest Park and the corridor. Limit, or if all possible, close roads, and discourage installation of chain-link fences, garbage cans and dumpsters, all of which cause problems with wildlife. Encourage planting with natural vegetation.

Recommendation 5:

Undertake additional studies to establish the abundance, distribution, and seasonal movement cycles of target species, such as bear, elk, and, to a lesser extent, bobcat. These species are thought to act as an umbrella for hundreds of other species that have less stringent requirements, smaller home ranges, disperse less widely, and are more tolerant of habitat fragmentation, such as deer. These studies should attempt to answer the following questions: Are the animals migratory or resident? Are the populations hunted or not? Are the animals resident adults or dispersing juveniles? What are the historic routes of movement? What parts of the corridor are used as feeding stations and what as travel routes? How varied is seasonal and yearly use?

Recommendation 6:.

Study the interaction of the wildlife of Forest Park and the corridor with Multnomah Channel and the Columbia River. Address the influences of natural drainages, estuaries, and other riparian influences on native species of wildlife.

Recommendation 7:

Conduct censuses of the existing birds and mammals within the corridor to determine population sizes. The need to preserve minimum viable populations of animals must be kept in mind when developing long-term conservation strategies. Populations of animals below 500 breeding individuals must be considered in danger of local extinction without intervention. Additionally, because breeding individuals only make up a fraction of a population, the actual census number of individuals must be far greater to assure long-term persistence of a species. Since an entire, small population can be extinguished by a random catastrophe such as a major fire, flood, wind storm, or epidemic, it is vital to have recolonization sources from outlying areas to safeguard against local extinction.

Recommendation 8:

Prepare a comprehensive map of the wildlife corridor for use by planners. The map would consist of a base aerial photograph overlain with a series of maps depicting natural vegetation types, animal distribution, including known locations of rarer species, land ownership status, existing roads, areas of development, and adjacent land use.

Recommendation 9:

Establish a gradation of multiple-use buffer zones around Forest Park and the corridor to insulate and protect sensitive, forest-interior species. Without such buffers, alien and exotic species that thrive in human impacted environments can decimate populations of native songbirds.

Recommendation 10:

Investigate the regional significance of the location and wildlife diversity of Forest Park and adjacent habitats to the other parks of Portland. Because larger natural areas can serve as sources of colonists for smaller, local parks, Forest Park can and probably does function as a "stepping stone" that subsidizes the natural diversity of other parks in the Portland metro area. Therefore, reducing the populations of birds and mammals of Forest Park might reduce the native wildlife potential in other urban parks.

Recommendation 11:

Develop long term planning goals for protecting the corridor and adjacent buffer areas through a combination of conservation easements, zoning codes, tax incentives, registry programs, and management agreements, as well as possible acquisition of the core area. Cooperation of many local and state agencies within Multnomah, Washington, and Columbia Counties will be necessary to ensure that the whole habitat system is greater than the sum of its parts. Public support for the wildlife corridor might be fortified by expanding the idea to include recreational pursuits, such as a major greenway. A hiking trail from the City of Portland through Forest Park to the Pacific Ocean, which would include the length of the corridor, would benefit both people and wildlife, and could be conceptualized: Oregon's "Greenway To The Pacific".

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Appendix I. Checklist of bird species that occur in Forest Park: their preference of vegetation type and home-range requirements.

(from: Houle, M.C. 1982. Forest Park --one city's wilderness: its wildlife and habitat interrelationships. Oregon Parks Foundation. Portland, OR. 85pp.)

Key:
B - Breeding habitat
F - Feeding habitat
1 - Preferred habitat thought to support a higher population density
2 - Habitat used by a species but thought to support a lower population density
SR - Summer resident
WR - Winter resident
NPD - No precise data

BIRD NAME		(2-5 yrs) Grass Forb	(3-30 yrs) Shrub	(10-35 yrs) Hardwood Young Conifer	(30-80 yrs) Hardwood Topped By Conifer	(80-250 yrs) Mid-Aged Conifer	(250 yrs) Old Growth	(30-100 yrs) Mature Hardwood	Home Range Size (if known)	Observed In Forest Park	Special Notes
Mallard	B								700 ac	x	
	F										
Turkey Vulture	B	2	2				2		N.P.D.	x	SR
	F	1	2								
Goshawk	B				2	1	1		25,000-30,000		
	F				2	1	1	2	acre min.		
Sharp Shinned Hawk	B			2	1	1	2		2500 ac.	x	
	F			2	1	1	1	2			
Cooper's Hawk	B			2	1	2	2		700 ac.	x	
	F	2	2	2	1	2	2	2			
Red Tailed Hawk	B				2	1		2	1000 ac.	x	
	F	1	2			2					
Bald Eagle	B						1		4 mile radius		
	F	2	2				2				
Osprey	B				2	2		2	72,000 ac.	x	
	F										
Merlin	B					2	2		N.P.D.		
	F	2	2			2	2				
Kestrel	B					1	1		270 ac.	x	
	F	1	2			2	1				
Ruffed Grouse	B		1	1	1			1	10-30 ac.	x	
	F	2	1	1	1	2	2	1			
Blue Grouse	B	2	2	1	1				31-300 ac.	z	
	F	1	2	2	1	2	2	2			
California Quail	B	2	2	2					17-45 ac.		
	F	1	2	2							
Mountain Quail	B	2	2				2		640 ac.		
	F	2	2			2	2				
Ring Necked Pheasant	B	2	2						4-8 ac.	x	
	F	2	2								
Great Blue Heron	B						2	1	10 mi. radius	x	
	F	2									
Killdeer	B	2							N.P.D.		
	F	2									
Band Tailed Pigeon	B			2	1	1		1	.1-.5 mi. radius	x	SR
	F	2	2	2	1	2	2	2			
Mourning Dove	B		1	2	1	1	2	2	4 sq. mile	x	
	F	2	2	2	1	2		2			
Rock Dove	B								N.P.D.	x	
	F										

BIRD NAME		(2-5 yrs) Grass Forb	(3-30 yrs) Shrub	(10-35 yrs) Hardwood Young Conifer	(30-80 yrs) Hardwood Topped By Conifer	(80-250 yrs) Mid-Aged Conifer	(250 yrs) Old Growth	(30-100 yrs) Mature Hardwood	Home Range Size (if known)	Observed In Forest Park	Special Notes
Barn Owl	B						1	1	8.5 sq. mile		
	F	1	2				2	2			
Screech Owl	B					1	2		.5-.7 mi. radius	x	
	F	2	2			1	2				
Great Horned Owl	B				2	1	1		160 ac.	x	
	F	1	2		2	2	2	2			
Pygmy Owl	B				2	1	2	2	N.P.D.	x	
	F	2	2		2	1	2	2			
Spotted Owl	B				2	2	1		2900 ac.		
	F					2	1				
Long Eared Owl	B			2	2	2	2	2	83-260 ac.		
	F	1	1	2							
Saw Whet Owl	B				2	1	1	2	100 ac.	x	
	F	1	2				2				
Common Nighthawk	B	1	1	2	2	2	2	2	.5 mi dia. home range		SR
	F	1	1								
Vaux's Swift	B				2	2	1		N.P.D.	x	SR
	F	1	1		2	2	2				
Anna's Hummingbird	B		1	1				2	5-15 ac.	z	
	F	2	1	1	2	1		2			
Rufous Hummingbird	B		1	2	1	1	2	1	N.P.D.	x	SR
	F	1	1	1	2	1	1				
Belted Kingfisher	B										
	F										
Pileated Woodpecker	B				2	1	1		320-600 ac.	x	
	F				2	1	1	2			
Lewis' Woodpecker	B				2	2	1		N.P.D.		
	F	2	2	2	2	2	1				
Yellow Bellied Sapsucker	B				2			2	5 ac.	x	
	F		2	2	2	2		2			
Hairy Woodpecker	B					1	1	1	22-37 ac.	z	
	F		2	2	2	1	1	1			
Downy Woodpecker	B			2	2	1		2	5-8 ac.	x	
	F				2	2		2			
Common Flicker	B				1	1	1	2	40 ac.	x	
	F	1	2	2	1	1	1	1			
Willow Flycatcher	B		1	2					.8-2.9 ac.	x	SR
	F	2	1	2							
Dusky Flycatcher	B		1	1					3.5-4.5 ac.		M
	F	2	1	1							

BIRD NAME		(2-5 yrs) Grass Forb	(3-30 yrs) Shrub	(10-35 yrs) Hardwood Young Conifer	(30-80 yrs) Hardwood Topped By Conifer	(80-250 yrs) Mid-Aged Conifer	(250 yrs) Old Growth	(30-100 yrs) Mature Hardwood	Home Range Size (if known)	Observed In Forest Park	Special Notes
Western Flycatcher	B			2	2	1	2	2	N.P.D.	x	SR
	F			2	2	1	2	2			
Western Wood Pewee	B				2	1	1	2	3-4 ac.	x	SR
	F		1	1	2	1	1	2			
Olive Sided Flycatcher	B					1	1	2	N.P.D.	x	SR
	F	1	1	2	2	1	1				
Violet Green Swallow	B				1	2	2		N.P.D.	x	SR
	F	2	2		2		2	2			
Tree Swallow	B				2	2	1	2	N.P.D.	x	SR
	F	1	1		2	2	2	2			
Barn Swallow	B	1	2						1/4-3/4 mi. radius	x	SR
	F	2	2		2						
Cliff Swallow	B	2							N.P.D.		SR
	F	2									
Purple Martin	B				2	2	2		N.P.D.		SR
	F	2	2	2	2	2	2				
Steller's Jay	B			2	2	1	1		N.P.D.	x	
	F	2	2	2	2	1	1	1			
Scrub Jay	B		1	2	2				7.5 ac.	x	
	F	2	1	2	2			2			
Common Raven	B					1	1		2.6-4.2 mi^2		
	F	1	1	1	2	1	1	2			
Common Crow	B			2	2	2	2	2	N.P.D.	x	
	F	2	2	2	2	2	2	2			
Black Capped Chickadee	B			2	1	2	2	1	2.2-2.5 ac.	x	
	F		2	1	1	2	2	1			
Chestnut Backed Chickadee	B				2	1	1	2	3.2 ac./pr.	x	
	F		2	1	2	1	1	2			
Common Bushtit	B		1	1	2	2	2	2	N.P.D.	x	
	F	2	1	1	2	2	2	2			
White Breasted Nuthatch	B						2		37 ac./pr.		M
	F						2				
Red Breasted Nuthatch	B			2	2	1	1	2	N.P.D.	x	
	F				2	1	1				
Brown Creeper	B				2	1	1	2	N.P.D.	x	
	F				2	1	1	2			
Wrentit	B		2	2					.5-2.7 ac.		
	F		2	2							
Dipper	B										WR
	F										

BIRD NAME		(2-5 yrs) Grass Forb	(3-30 yrs) Shrub	(10-35 yrs) Hardwood Young Conifer	(30-80 yrs) Hardwood Topped By Conifer	(80-250 yrs) Mid-Aged Conifer	(250 yrs) Old Growth	(30-100 yrs) Mature Hardwood	Home Range Size (if known)	Observed In Forest Park	Special Notes
House Wren	B			2		2			1.1-4.4 ac.	x	SR
	F		1	2		2					
Winter Wren	B			2	1	1	1	2	0.1-3 ac.	x	
	F				1	1	1	2			
Bewick's Wren	B	2	2					2	3-12 ac.	x	
	F		1	1	1	2		2			
Robin	B		2	1	1	2	2	2	N.P.D.	x	
	F	1	2	2	1	2	2	2			
Varied Thrush	B				2	1	1	2	N.P.D.	x	WR
	F	2	2	1	1	1	1	2			Spring
Hermit Thrush	B		1	1	2	1	1	2	1.5-2.5 ac.	x	WR
	F		1	1	1	1	1	2			
Swainson's Thrush	B		2	1	1	1	2	2	N.P.D.	x	SR
	F		2	2	1	1	2	2			
Western Bluebird	B				2				N.P.D.	x	
	F		1	1	2						
Townsend's Solitaire	B		1	1	2	1	1		N.P.D.	x	
	F		1	1	2	1	1				
Golden Crowned Kinglet	B				1	1	1	2	N.P.D.	x	
	F		2	1	1	1	1	1			
Ruby Crowned Kinglet	B				2	1	1		N.P.D.	x	WR
	F		2	2	2	1	1	2			
Cedar Waxwing	B		1	2		2		1	.06-.22 ac.	x	
	F		1	2	2	2		2			
Bohemian Waxwing	B								N.P.D.		WR
	F		2	2	2	1					
Starling	B				2	2	2	1	N.P.D.	x	
	F	2	2								
Hutton's Vireo	B		2	2	1	1		2	N.P.D.	x	SR
	F	2	2	2	1			2			
Solitary Vireo	B		2	1	2			2	N.P.D.	x	SR
	F		1	1	1	1		1			
Red Eyed Vireo	B		2	2	2				N.P.D.	x	SR
	F		1	2							
Warbling Vireo	B		2	2	2			2	N.P.D.	x	SR
	F		2	2	1			2			
Orange Crowned Warbler	B		1	1	1	2		2	5 ac.	x	SR
	F	2	1	1	1	2		2			
Nashville Warbler	B		1	1	2	2	2	2	N.P.D.		SR
	F		1	1	2	2	2	2			
Yellow Warbler	B		1	1	2	2		2	.2-.9 ac.	x	SR
	F	2	1	1	2	2	2	2			

BIRD NAME		(2-5 yrs) Grass Forb	(3-30 yrs) Shrub	(10-35 yrs) Hardwood Young Conifer	(30-80 yrs) Hardwood Topped By Conifer	(80-250 yrs) Mid-Aged Conifer	(250 yrs) Old Growth	(30-100 yrs) Mature Hardwood	Home Range Size (if known)	Observed In Forest Park	Special Notes
Yellow-Rumped Warbler	B		1	1	2	2		2	N.P.D.	x	
	F		1	1	1	1	1	1			
Black Throated Gray Warbler	B		2	1	1	2	2	2	N.P.D.	x	SR
	F		2	1	1	1	1	1			
Townsend's Warbler	B				2	1	1	2	N.P.D.	x	M
	F				1	1	1	2			
Hermit Warbler	B					1	1		N.P.D.		SR
	F				1	1	1				
MacGillivray's Warbler	B		1	2	2	2		2	N.P.D.	x	SR
	F		2	2	2	1		2			
Yellow Throat	B		2						.5-3.5 ac.		SR
	F	2	2								
Yellow Breasted Chat	B		2	2					.15-.75 ac.		M
	F		2	2							
Wilson's Warbler	B		2	2	1	1	2	1	.5-3.2 ac.	x	SR
	F		2	2	1	1	2	2			
House Sparrow	B								Near Human Habitat	x	
	F										
Western Meadowlark	B								3-15 ac.		
	F	2									
Northern Oriole	B		2	2				2	2 ac.		M
	F	2	2	2	2	2	2	2			
Brewer's Blackbird	B		1	2					1-6.2 mi.		
	F	1	2	2							
Brown Headed Cowbird	B		2	1	2			1	12-40 ac.	x	
	F	2	2	2	2	2	2	2			
Western Tanager	B			2	1	1	2	2	N.P.D.	x	SR
	F	2	1	2	1	2	2	2			
Black Headed Grosbeak	B		2	2	1	2	2	1	N.P.D.	x	SR
	F		1	1	1	2	2	2			
Lazuli Bunting	B		2	2					N.P.D.	x	SR
	F	1	2	2							
Evening Grosbeak	B		2	2	2	1		1	N.P.D.	x	
	F		2	2	1	1		2			
Purple Finch	B		2	2	2	2	1	2	N.P.D.	x	
	F	2	2	2	1	2	1	2			
House Finch	B		2						.03-17 ac.	x	
	F	2	2								
Pine Siskin	B			2	1	1	1	2	N.P.D.	x	
	F	1	1	2	1	1	1	2			
American Goldfinch	B		1	2	2			2	N.P.D.	x	
	F	2	2	2	2	2					

BIRD NAME		(2-5 yrs) Grass Forb	(3-30 yrs) Shrub	(10-35 yrs) Hardwood Young Conifer	(30-80 yrs) Hardwood Topped By Conifer	(80-250 yrs) Mid-Aged Conifer	(250 yrs) Old Growth	(30-100 yrs) Mature Hardwood	Home Range Size (if known)	Observed In Forest Park	Special Notes
Lesser Goldfinch	B		2	2					N.P.D.		
	F	1	2	2							
Red Crossbill	B				2	1	1		N.P.D.	x	
	F				2	1	1	2			
Rufous-Sided Towhee	B		1	1	2	2	2	2	.17-.60 ac.	x	
	F	2	1	1	1	2	2	2			
Vesper Sparrow	B	1							1.5-2.7 ac.		M
	F	1									
Dark-Eyed Junco	B	1	1	1	2	2	2	2	N.P.D.	x	
	F	1	2	2	1	2	2	2			
Chipping Sparrow	B		1	1	2	2	2	2	.5-1.5 ac.		SR
	F	1	1	1	2	2	2	2			
White Crowned Sparrow	B		1	2					1-20 ac.	x	WR
	F	2	1	1							
Golden Crowned Sparrow	B								3-20 ac.	x	WR
	F	2	1	2	2						
Fox Sparrow	B		1	1		2	2	2	N.P.D.		WR
	F	2	1	1		2	2	2			
Lincoln's Sparrow	B	2	2						1 ac.		M
	F	2	2								
Song Sparrow	B		1	1	2	2		1	.1-.65 ac.	x	
	F	1	2	2	1	2		1			
Total Number of Species Breeding in Each Category		13	52	58	69	70	62	60			
Total Number of Species Feeding in Each Category		67	89	70	72	73	62	62			
Total Number of Species Recorded in Park 2/15 - 7/15										81	
Total Number of Birds Potentially Present in Late Winter - Early Summer Seasons in Forest Park										113	

Appendix II. Home range requirements of mammals that occur in western Oregon Douglas fir forests.

(from: Harris, L.W. 1984. The fragmented forest -- island biogeography theory and the preservation of biotic diversity. Univ. Chicago Press. 211 pp.)

Calculated home-range sizes and linear travel distances assuming circular and elliptically shaped home ranges. Shape of the ellipse determined by major axis = 2 × minor axis. 1,000 m = 1 km, 1,609 m = 1 mile.

Species	Home range (ha)	Circular home range		Elliptical home range major axis (m)
		r (m)	2r (m)	
white-footed vole	0.049	12	25	35
Oregon vole	0.053	13	26	37
California red-backed vole	0.056	13	26	38
deer mouse	0.056	13	26	38
heather vole	0.062	14	28	40
Pacific jumping mouse	0.064	14	29	40
red tree vole	0.082	16	32	46
yellow-pine chipmunk	0.10	18	36	50
long-tailed vole	0.15	22	44	62
Mazama pocket gopher	0.17	23	47	66
Townsend vole	0.18	24	48	68
Townsend chipmunk	0.19	25	49	70
Siskiyou chipmunk	0.19	25	49	70
Richardson vole	0.22	26	53	75
wandering shrew	0.28	30	60	84
Trowbridge shrew	0.28	30	60	84
northern flying squirrel	0.33	32	65	92
pika	0.36	34	68	96
northern water shrew	0.44	37	75	106
shrew mole	0.44	37	75	106
dusky shrew	0.44	37	75	106
dusky-footed woodrat	0.48	39	78	111
mantled ground squirrel	0.50	40	80	113
chickaree	0.54	42	83	117
Yaquina shrew	0.56	42	84	120
Pacific shrew	0.68	46	93	132
bushy-tailed woodrat	0.80	51	101	143
marsh shrew	1.09	59	118	167
Beechey ground squirrel	1.34	65	131	185
western gray squirrel	1.76	75	150	212

Species	Home range (ha)	Circular home range r (m)	2r (m)	Elliptical home range major axis (m)
brush rabbit	1.76	75	150	212
snowshoe hare	2.55	90	180	255
mountain beaver	2.55	90	180	255
muskrat	2.90	96	192	272
coast mole	3.97	112	224	318
short-tailed weasel	5.26	129	258	370
spotted skunk	26.7	292	584	824
ringtail	30.2	310	620	876
long-tailed weasel	30.7	313	626	884
porcupine	34.9	333	667	942
beaver	53.2	412	824	1,160
striped skunk	101	567	1,130	1,600
red fox	62	718	1,440	2,040
marten	215	827	1,650	2,340
mink	52	896	1,790	2,530
mule deer	420	1,160	2,320	3,270
coyote	453	1,200	2,400	3,400
raccoon	480	1,240	2,480	3,500
elk	943	1,730	3,460	4,900
fisher	1,610	2,260	4,520	6,400
black bear	1,760	2,370	4,740	6,700
otter	3,010	3,100	6,200	8,760
wolverine	4,900	3,950	7,900	11,200
lynx	5,710	4,260	8,520	12,100
bobcat	11,600	6,080	12,200	17,200
cougar	49,700	12,600	25,200	35,600

Appendix III. Forest Park Management Plan: statement for wildlife, as amended December 21, 1989, by Friends of Forest Park.

"An important value for the management of Forest Park is to retain the indigenous and endemic wildlife species diversity that exists in the Park due to its connectivity to the larger ecosystem of the Tualatin Mountains and the Coast Range. This species diversity occurs in Forest Park today because it has retained a relatively undisturbed connection through northwest Multnomah County to the larger forested lands of Columbia, Washington, and Clatsop Counties. This presents the unique circumstance of a 5,000 acre urban park inside the urban growth boundary of the Portland metropolitan area that has wildlife diversity not normally found in other urban settings. It is of great benefit to the citizens of this region to have the opportunity to live in close proximity to wildlife species rarely found in the urban environment. The importance of this resource will surely grow over time as the population in the metropolitan area increases."