Protection, Restoration, and Management of Terrestrial Habitats and Species of the Willamette Sub-Basin

Technical Appendix

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Detail Files and Map Files

(ftp from: http://oregonstate.edu/~adamusp/)

(if difficulties encountered, email: adamus7@comcast.net)

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UNSWEPT
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HistoricalVegTNC_by_PCA
PresentVegEC90_by_Wshed
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Executive Summary

Despite being Oregon's most populated subbasin, the Willamette hosts a notable 281 wildlife species. Loss of suitable habitat has been and continues to be among the most important factors that limit wildlife populations in the subbasin. In particular, the loss of six vital habitats -- upland prairie-savanna, oak woodlands, wetland prairie and seasonal marsh, ponds and their riparian zones, stream riparian zones, and old growth conifer forest – has been accompanied by the decline of many wildlife, plant, and butterfly species that use these habitat types. Other factors known or hypothesized to limit terrestrial species populations in this subbasin include roads and other barriers, vegetation change, diminished supply of dead wood, water regime change, pollution, temperature change, soil degradation, harassment, and invasive species, pathogens, and parasites. Agents and practices that contribute to these limiting factors are described in this report. Together, these limiting factors comprise habitat degradation, and often tend to fragment and simplify the internal structure of terrestrial habitats making them less able to support viable plant and wildlife populations.

To help reverse these losses, a three-pronged strategy should be vigorously implemented, involving habitat protection, restoration, and multiple use management, on both public and private lands. Conservation actions should focus primarily on the most threatened species and on the habitat types named above. Protection of terrestrial habitat for wildlife and rare plants should emphasize priority areas shown on maps generated by the PNW-ERC Alternative Futures project and TNC's Ecoregional Assessments. Consideration also should be given to habitats and species underrepresented by those efforts as identified by analyses conducted for this report, and to important habitat areas identified in municipal natural resource inventories, watershed assessments, forest plans, and other sources. Protection and restoration of fish habitat, especially riparian areas, will nearly always benefit terrestrial wildlife but cannot be relied on as the sole means of protecting most terrestrial wildlife and rare plants. Strong support is needed for efforts to improve habitat mapping, species-habitat modeling, characterization of key demographic characteristics of species, research into factors that limit the rarest species, and field monitoring of trends in species and indicators of degradation in the most vulnerable terrestrial habitat types. Development of habitat models for 65 wintering and migrant bird species is especially needed because lack of such models limited systematic analysis of their needs in the prior PNW-ERC and for this report.

This report and especially the accompanying Detail Files and MapFiles provide relatively detailed information on status, trends, distribution, limiting factors, and conservation needs of all of the Willamette's wildlife species, listed plants, and vulnerable habitats. Data on habitat suitability for each species is provided by watershed (170 HUC6s), elevation (6 zones), and land ownership (2 categories). Tables and maps describing the possible extent of historical and current habitat are presented for 43 focal species. Databases also are provided for helping assess the tradeoffs among species that accompany every restoration or land management decision.

Analyses conducted for this project demonstrated that well-managed public lands, when augmented by the 93 Priority Conservation Areas identified by TNC's Ecoregional Analysis, would collectively offer some level of protection to all of the subbasin's species. The combination of public lands and Priority Conservation Areas would provide some amount of habitat to all wildlife species in 53% of the 170 individual watersheds. The analyses also showed that focal species described in this report may represent the subbasin's rarest habitats better than species that have been used previously as HEP (Habitat Evaluation Procedure) indicators for assessing mitigation credits.

Acknowledgments

Preparation of this Terrestrial chapter involved collaboration among many specialists over a short time. Paul Adamus[1] (ARA Inc. and OSU-COAS) designed the spatial data queries, organized and analyzed data, and wrote the report. Most of the spatial data analysis was conducted by the Oregon Natural Heritage Information Center (ORNHIC -- Kuuipo Walsh), with portions of the effort also involving The Nature Conservancy (TNC -- Chris Robbins, Mary Finnerty, Michael Schindel) and Earth Design Consultants (Becci Anderson, Ralph Garono). Members of a Terrestrial Technical Advisory Group provided overall guidance and internal review: Bob Altman (American Bird Conservancy), Jimmy Kagan (ORNHIC), Catherine MacDonald (TNC), Holly Michael and Greg Sieglitz (Oregon Department of Fish and Wildlife, ODFW), and Steve Smith (USFWS). Tom O'Neil and Cory Langhoff (NHI, Northwest Habitat Institute) shared species attribute information from the IBIS database, generated species maps, and contributed to the compilation of land cover data. Patti Haggerty facilitated access to the USEPA habitat suitability layer, and Mary Santelmann shared her unpublished species clustering analysis. Lori Hennings shared information compiled in the Portland area by Metro, and Susan Payne (Lane Council of Governments) provided the spatial data on wildlife response to land cover changes that she had prepared while working with Alan Branscomb and David Hulse at the University of Oregon. Dave Primozich and Rick Bastasch of the Willamette Restoration Initiative guided the effort and administered the contract in collaboration with the Mid-Willamette Council of Governments

The level of detail incorporated in such a short time would not have been possible without the outstanding groundwork laid by previous efforts, most notably the *Ecoregional Assessment* prepared over a 4-year period by TNC, the "Alternative Futures" analyses prepared over a 5-year period by the Pacific Northwest Ecosystem Research Consortium (PNW-ERC), and the regional *Conservation Strategies* sponsored by Oregon-Washington Partners In Flight and the American Bird Conservancy. We are deeply indebted to the authors of those works.

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Abbreviations Used in this Report

BBS: Breeding Bird Survey, a volunteer, nationwide, annual roadside survey of birds in June (Sauer et al. 2003)
CBC: Christmas Bird Count, a volunteer, nationwide, annual survey of birds in December-January
CROA: Conservation and Restoration Opportunity Area, a priority area identified with stakeholder input as part of the Alternative Futures project of PNW-ERC (Hulse et al. 2004)
ERC (or PNW-ERC): Pacific Northwest Ecosystem Research Consortium (Baker et al. 2004)
EC90: a digital map of circa-1990 land cover in the Willamette subbasin (Oetter et al. 2001)
HEP: Habitat Evaluation Procedures, a standardized method developed by USFWS for calculating mitigation credits (USFWS 1981)
HS: Habitat suitability, as calculated using procedures described in section 1.4
HUC: Hydrologic Unit Code, a unique numeric identifier for watersheds
IBIS: Interactive Biodiversity Information System, a species-habitat database assembled by NHI and ODFW (Johnson & O'Neil 2001).
NHI: Northwest Habitat Institute
ODFW: Oregon Department of Fish and Wildlife
ONHP: Oregon Natural Heritage Program
ORNHIC: Oregon Natural Heritage Information Center
PCA: Priority Conservation Area identified by TNC as part of their Ecoregional Assessment (Floberg et al. 2004)
PIF: Partners In Flight, an interagency consortium concerned about declining species of birds that winter in the neotropics.
PNW-ERC: see ERC
TNC: The Nature Conservancy
USFWS: U.S. Fish and Wildlife Service
WPG: Willamette Valley – Puget Trough – Georgia Basin ecoregion

1. Introduction

1.1 Purpose and Objectives

Building upon and updating previous related efforts, this report and its supporting databases attempt to compile, analyze, and interpret the best available technical information on terrestrial habitats and species in the Willamette sub-basin (termed simply the "Willamette River Basin" by many people). The primary objectives of this synthesis are:

- to identify "focal species" and habitats that warrant attention due to their scarcity or other factors at regional (Willamette subbasin) and/or local (watershed) scales;
- to summarize ecological relationships of terrestrial species and habitats with aquatic focal species and with aquatic habitat restoration/ management activities;
- to describe Willamette watersheds according to their native species habitat suitability -- for both focal species and for all wildlife species;
- to describe factors that might be limiting the distribution and abundance of terrestrial focal species and habitats within the Willamette Basin;
- to propose biological objectives for focal species, and to suggest structure/process objectives and/or indicators for focal habitats;
- to describe monitoring needs to support these objectives;
- to identify critical needs and priorities for restoring, creating, enhancing, and managing terrestrial habitats either as part of mitigating losses due to regulated activities or as part of non-regulatory programs.

In addition, some specific objectives of this report include:

- provide publicly-accessible tools and databases, with detailed descriptions of how to use them, for systematically comparing and prioritizing species and habitats;
- compare the likely current vs. historic distribution of habitats and focal species within the Willamette Basin;
- systematically assess the possible effectiveness of several wildlife species as indicators of conditions suitable for the broader group of wildlife species, i.e., effectiveness as "umbrella" or "indicator" species;
- systematically assess the possible effectiveness -- for conserving focal species and all terrestrial wildlife species -- of the "Priority Conservation Areas" (PCAs) identified by The Nature Conservancy's *Ecoregional Assessment* (Floberg et al. 2004).

The information compiled here is intended primarily to aid decisions regarding expenditures for habitat and species protection, restoration, enhancement, and monitoring within the Willamette Basin. This report involved no collection of new data, and has no regulatory authority. It is based on biological information without overt consideration of socioeconomic factors. This report also is intended as a general resource for personnel involved in other aspects of habitat and species planning at federal, state, local, and tribal resource agencies. This surely is not the sole information source useful for such purposes. The potential usefulness of this report stems largely from its consideration of the full suite of breeding wildlife species, evaluated at both landscape (subbasin, watershed) and finer scales, and its systematic approach to compiling and analyzing available data. Nonetheless, information and judgments of qualified local biologists will in many cases provide more accurate answers regarding questions about specific habitats, land parcels, species, and management priorities. Thus, this report is intended to advise and augment -- not substitute for -- information provided by professional biologists. This report and its component databases must be updated and refined regularly as technical information expands and improves or its usefulness may diminish over time.

The general themes covered by this report and its general organizational structure were prescribed in guidance from the Northwest Power Conservation Council (Marcot et al. 2002, Scheeler et al. 2003). However, the selections of focal species, focal habitats, and data analysis methods were made independently so as to best address the particular information base and needs of the Willamette subbasin.

1.2 Scope and Scale of the Report

This report covers all lands and waters, both public and private, that contribute water to the Willamette River. This include the area from the crest of the Cascades to the crest of the Coast Range, from just south of Cottage Grove northward to the confluence of the Willamette River with the Columbia River (MapFile: HUC6map). Under the definition of "terrestrial" this report also includes non-fish species that reproduce or feed predominantly in rivers, streams, lakes, or wetlands – not just species that inhabit forests, fields, and other habitats traditionally categorized as terrestrial. An example is river otter.

This report does not address all terrestrial species; it focuses mainly on wildlife and selected rare plants. Within the Willamette Basin, it addresses 281 wildlife species (80 mammals, 167 birds, 15 reptiles, 19 amphibians) plus 2 terrestrial invertebrates and 10 plants. Of this total of 293 species, 10 are suspected to no longer breed within the basin, i.e., are extirpated[2]. All of the included species are believed to reproduce regularly within the basin, or (in the case of extirpated species) to have bred here regularly 150 years ago. Including both current and extirpated species, 9% of the mammals, 10% of the birds, 27% of the reptiles, and 37% of the amphibians are designated as sensitive, threatened, or endangered by state or federal laws. Of the wildlife species considered by this report, 16 (6%) apparently are not native to the subbasin[3]. The breeding status and potential for population expansion of some additional non-native species is

[2] Vertebrate species considered to be extirpated as breeders in this region are: sandhill crane, black-crowned night-heron, short-eared owl, Lewis's woodpecker, yellow-billed cuckoo, Say's phoebe, black-billed magpie, lark sparrow, Canada lynx, and fisher. Some of these occur regularly in the region as non-breeding (wintering or vagrant) individuals, and occur to varying degrees as breeders elsewhere in the western United States. Wintering species that may now be much less common include snow goose, trumpeter swan, long-billed curlew, and sandhill crane (Taft & Haig 2003). Also, 3 extirpated vertebrates were not included because of limited fidelity to specific habitats, inadequate data on habitat preferences, and/or unlikelihood of their becoming naturally re-established in the region: California condor, grizzly bear, gray wolf. The current breeding status of a few additional terrestrial vertebrates in the region is uncertain due partly to limited survey effectiveness and consequent lack of recent verified records. These include wolverine, Baird's shrew, black-tailed jackrabbit, and American pipit.

[3] Bullfrog, ring-necked pheasant, wild turkey, California quail, rock dove (pigeon), European starling, house sparrow, Virginia opossum, eastern cottontail, eastern gray squirrel, eastern fox squirrel, black rat, Norway rat, house mouse, nutria, red fox.

uncertain so they have not been included[4]. Among the thousands of plant and invertebrate species, the numbers that are not native to the subbasin are unknown.

With regard to plants and terrestrial invertebrates, due to this project's limited time and resources only federally-listed species were included[5]. These comprise fewer than 1% of all plant and terrestrial invertebrate species. Also, for the same reasons ***this report did not consider systematically the 65 bird species that occur here regularly only as migrants or winter visitors*** (Table 1).

This report's geographic tabulations use "watersheds" as the primary accounting unit. The use of watershed boundaries for describing and comparing regional wildlife distributions has several drawbacks and is not supported technically, but no practical alternative is more supportable. Use of watersheds as accounting units should facilitate integration with aquatic biological data, water quality data, and information on major geomorphic processes that influence vegetation and thus wildlife habitat. Except where noted otherwise, in this report watersheds are delimited by sixth-field hydrologic unit code (HUC6) boundaries as depicted in the digital layer available from www.nwhi.org/ibis/mapping/GISData/gisdata.asp Use of this scale for depicting watersheds is recommended by the Oregon Watershed Enhancement Board (OWEB), and is the finest scale for which watershed boundaries are available digitally for the entire Willamette subbasin (MapFile PCAmap).

This report focuses on species -- but ultimately, it is imperative to understand the functions of species and groups of interacting species. Only then will we understand the basic driving forces behind ecosystems. Such an understanding is essential to predicting not only the utility of species to human systems, but also the factors needed to ensure the long term viability of all species across landscapes and continents. Yet, despite serious attempts to catalog our knowledge of species functions (e.g., IBIS database), for the vast majority of species we are a long way from knowing with certainty some of their most basic functions.

[4] These include, for example several exotic turtles (snapping turtle, red-eared slider, box turtle) and birds (monk parakeet, mute swan).
[5] One of these plant species (*Howellia*) is apparently extirpated from the Willamette subbasin, and another (golden paintbrush, *Castilleja levisecta*) is extirpated but targeted for re-introduction.

Table 1. Species not included in the analysis and which use the Willamette Basin only during winter or migration or as non-breeders in summer

Regularly-occurring*
American Pipit
American Wigeon
Black-crowned Night-heron
Burrowing Owl
California Gull
Canvasback
Caspian Tern
Clark's Grebe
Common Goldeneye
Common Loon
Double-crested Cormorant
Eurasian Wigeon
Gadwall
Glaucous-winged Gull
Golden-crowned Sparrow
Great Egret
Greater White-fronted Goose
Greater Yellowlegs
Herring Gull
Least Sandpiper
Lesser Scaup
Lesser Yellowlegs
Lewis's Woodpecker
Long-billed Dowitcher
Merlin
Mew Gull
Northern Shrike
Pectoral Sandpiper
Prairie Falcon
Redhead
Ring-billed Gull
Rough-legged Hawk
Ruby-crowned Kinglet
Sandhill Crane
Say's Phoebe
Semipalmated Plover
Snow Goose
Solitary Sandpiper
Swamp Sparrow
Thayer's Gull
Trumpeter Swan
Tundra Swan
Western Sandpiper
White-throated Sparrow

Less Regularly-occurring
Baird's Sandpiper
Black-bellied Plover
Calliope Hummingbird
Eared Grebe
Forster's Tern
Glaucous Gull
Greater Scaup
Gyrfalcon
Horned Grebe
Loggerhead Shrike
Marbled Godwit
Oldsquaw (Long-tailed Duck)
Pacific Golden-Plover
Pacific Loon
Red-throated Loon
Ross's Goose
Semipalmated Sandpiper
Short-billed Dowitcher
Western Gull
White-faced Ibis

* generally >1 record/year in Willamette Basin

1.3 Principal Sources of Data

Accomplishing the objectives set out in section 1.1 required not only a synthesis and interpretation of existing information, but also fresh compilation and analyses of the existing data. The principal types of data that were compiled and analyzed were:

- Land cover (or vegetation) maps
- Species distributional data. and maps
- Species-habitat relationship models
- Species attributes

The manner in which these were used together to generate some of this report's findings is described in section 1.4 below.

Land cover (or vegetation) maps. Spatial data on land cover and/or vegetation is a prerequisite for mapping and analyzing wildlife species distributions. Three main sources of land cover or vegetation data that cover most of the Willamette subbasin are available:

1. IBIS vegetation

This layer originated with the statewide vegetation ("Idaho Gap Analysis") layer at www.gis.state.or.us and was enhanced ("IBIS version") for the subbasin planning effort in part by using spatial data from (2) below. That version is at www.nwhi.org/nhi/default.asp. The maps are based mainly on supervised classification of satellite imagery (Landsat Thematic Mapper). Minimum map unit size of the original map is about 247 acres, and the IBIS version maps no more than 14 vegetation classes in the Willamette subbasin. For the Willamette Valley portion of their *Ecoregional Assessment*, TNC modified this further,

2. ODFW Land Use/ Land Cover

Available at: www.nwhi.org/nhi/default.asp. This was based mainly on interpretation of aerial photographs (Klock et al. 1998). Minimum map unit size is less than 1 acre for most land cover classes. There are 27 land cover classes. It covers only the Willamette Valley, not the entire subbasin, and some counties are not included. It has been field-checked more than the other land cover maps, and overall accuracy is estimated at 81%.

3. PNW-ERC Land Cover

This map was developed by the Forest Sciences Laboratory at Oregon State University (Oetter et al. 2001) for an *ad hoc* multi-institution group of investigators calling themselves the Pacific Northwest Ecosystem Research Consortium (PNW-ERC), or simply ERC. This digital map is based on partly-automated interpretation of Landsat Thematic Mapper (satellite) imagery from multiple seasons. It is available at www.fsl.orst.edu/pnwerc/wrb/access.html. All map units (pixels) are 0.22 acres, and 60 land cover types are mapped. Overlays with other themes have subsequently been done by TNC, Oregon State University (Bolte), University of Oregon (ISE: Hulse, Payne, Branscomb), and others to reclassify and enhance some of the mapped classes[6]. Several of the land cover classes were regrouped for support of wildlife habitat modeling.

[6] For example, EC90 consistently misidentified shrub wetlands as orchards, and misclassified some streams as lakes (Payne 2002).

Independently, the USGS also used TM imagery to derive a land cover map for the region. Availability is described at: http://oregon.usgs.gov/projs_dir/pn366/landuse.html

Except where noted otherwise, most of this report's findings are based the PNW-ERC layer (EC90 version). This is a departure from subbasin assessments being conducted elsewhere in Oregon, where the Gap/IBIS vegetation layer is being used instead. However, a technical committee of wildlife experts recommended use of the PNW-ERC layer for the Willamette assessment because of its very fine degree of spatial resolution, the relatively large number land cover classes (34) it depicts in the Willamette subbasin, the fact that it covers the entire subbasin, and the availability of results from previous application of sensitive wildlife habitat models to this coverage.

Species distributional data and maps. To identify species whose ranges in the Pacific Northwest are likely to encompass all or part of the subbasin, and for which application of models was therefore relevant, three principal sources were used:

1. ORNHIC's "Element of Occurrence" (EOR) database. This is the official repository for documented records of rare species, including all federally-listed species and many state-listed species. A total of 2166 Willamette subbasin occurrence records covering 40 species and 160 (of 170) watersheds was retrieved and used.
2. Oregon Breeding Bird Atlas database (Adamus et al. 2001). At a fairly coarse scale (survey units of 245 square miles) this contains maps and documentation for all bird species that nested in the Willamette subbasin during the period 1995-1999. Most of the maps were republished in the subsequent *Birds of Oregon: A General Reference* (Marshall et al. 2003).
3. *Land Mammals of Oregon* (Verts and Carraway 1998). This contains a listing of specimen records of most mammal species.

Information on species ranges from the IBIS database (Northwest Habitat Institute 2003) was not used in database queries because of its spatial coarseness, i.e., most species distributions are listed only by county.

Species-habitat relationship models. Such models are used in subbasin assessments to convert spatial data on vegetation or land cover to spatial data on possible wildlife habitat. For this purpose, and except where noted otherwise, analyses contained in this report used the peer-reviewed models developed for 279 wildlife species as part of the USEPA's contribution to the PNW-ERC "Willamette Basin Alternative Futures" project (Baker et al. 2004). The basis for these models, and their characteristics and limitations, are detailed in Adamus (2000) and Adamus et al. (2000).

Species attributes. Tabular information on particular characteristics of each species came from the IBIS database, databases of the ORNHIC, major compendia such as Marshall et al. (2003) and Verts & Carraway 1998, and Natureserve Explorer (http://www.natureserve.org/explorer). The ORNHIC databases provided a code that allowed sorting of species in phylogenetic order, as well as information whether a species is considered native to the region. The IBIS database indicated which species are currently included or being considered for inclusion on official federal and state lists of threatened, endangered, or sensitive species. IBIS also contained codes describing the ecological function(s) of each species. Other species attributes were assigned after consulting various references, e.g., Altman (2000).

Conservation priority maps. The two primary sources of information on locations of areas considered a priority for conservation or restoration are compared in Table 54. These are not the only sources of such information.

1.4 Analytical Approaches

Analyses conducted for this report involved using GIS to overlay spatial data layers of various themes, outputting tables (spreadsheets) that quantified associations among the themes, and querying the tables to generate subtotals by species, species attributes, and watersheds. Such an approach has several important constraints (Table 2). A first step was to overlay five spatial data layers covering the entire subbasin: (a) modeled wildlife species distributions from ERC (Adamus et al. 2000a,b), (b) sixth-field watershed (HUC6), (c) elevation, (d) land ownership, and (e) PCA status.

- The raster-format wildlife layer consisted of a score that had been assigned previously to each of the 2 million pixels in the Willamette subbasin, reflecting the possible suitability of the predominant land cover type in that 0.22-acre pixel for that species. The scores potentially ranged from 0 (probably not suitable) to 10 (most suitable). About 13 species had not been modeled by the previous PNW-ERC effort so models were drafted for this effort with input from ORNHIC and technical literature. For details on assumptions and development of the original wildlife models see Adamus (2000).
- The version of sixth-field HUCs that we used was downloaded from www.nwhi.org/ibis/mapping/GISData/gisdata.asp. This version depicts the Willamette subbasin as containing 170 HUC6s, which are nested within 70 fifth-field HUCs.
- The elevation layer was compiled by ORNHIC as 6 zones: <500 ft, 500-1000 ft, 1000-2000 ft, 2000-3000 ft, 3000-4000 ft, and >4000 ft.
- Land ownership information was mainly from a very recent layer provided to ORNHIC by the Oregon Department of Forestry. We categorized ownership simply as “public” or “private.” Some private lands are managed for the primary purpose of conservation.
- The PCA layer was provided courtesy of TNC. Areas of the subbasin were categorized simply as “within a PCA” or “not within a PCA” (see section 1.5 below for description of how TNC selected the PCAs).

For each species, ORNHIC’s overlay of the last 4 of these layers resulted in a coverage with 1670 spatial “accounting units.” Each unit represents a unique combination of HUC6, elevation zone, ownership, and PCA status. Not every elevation zone, ownership category, or PCA category was present in every HUC6. From the overlay, a database (file: SPHABHUC6) was created that contains an accounting unit identifier, a species name, and the acres within that accounting unit that had been scored a 0, 1, 2, 3, …10 for the species (the greater of the breeding or feeding score) by previous application of the wildlife models. We then converted the acres to proportions (of each accounting unit’s area), and computed an integrated “habitat suitability score” for each species-accounting unit combination by multiplying each score for a species by the percent of the accounting unit containing that score and then summing the products. We added these integrated scores as columns to the root file (SPHABHUC6). For example, for "species A" in "accounting unit Z":

Proportion of HUC6 scored a 0 = 0.85 x 0 = 0
Proportion of HUC6 scored a 1 = 0 x 1 = 0
Proportion of HUC6 scored a 2 = 0 x 2 = 0
Proportion of HUC6 scored a 3 = 0 x 3 = 0
Proportion of HUC6 scored a 4 = 0.02 x 4 = 0.08
Proportion of HUC6 scored a 5 = 0.03 x 5 = 0.15
Proportion of HUC6 scored a 6 = 0.05 x 6 = 0.30
Proportion of HUC6 scored a 7 = 0 x 7 = 0
Proportion of HUC6 scored a 8 = 0 x 8 = 0
Proportion of HUC6 scored a 9 = 0 x 9 = 0
Proportion of HUC6 scored a 10 = 0.05 x 10 = 0.50

In this example, summing the products gives 1.03. This indicates that on a scale of 0 to 10, this accounting unit would score a 1.03 overall for "species A." Such a low habitat suitability score reflects the fact that 85% of the accounting unit was projected to be completely unsuitable (0) for the species. Because some subsequent analyses involved computing subtotals for accounting units that had disparate areas, each habitat suitability score (e.g., 1.03) also was multiplied by the proportionate area of its accounting unit (i.e., the proportion of the HUC6 comprised of the accounting unit) to give an "area-weighted habitat suitability." These calculations are similar to those performed by HEP, where habitat suitability is the product of a suitability index value (0 to 1) multiplied by acres, summed for all indicator species and then weighted by some measure of area. We used proportions instead of acres in order to factor out watershed or accounting unit size as an influence.

Before proceeding with further analysis, we used queries to systematically add and delete selected records from the SPHABHUC6 database. Records were added if ORNHIC's EOR database contained documented occurrences of a species in a particular accounting unit but its presence had not been predicted by the habitat models. Fewer than 500 records (of 268,454) were added in this manner. Occurrences predicted from the models were deleted from the database if any of the following was true:

(a) The model had predicted that all (100%) of the accounting unit is completely unsuitable, i.e., score of 0 for the given species; or
(b) The accounting unit is outside the species' known elevational and/or geographic range; or
(c) For accounting units within the Portland metropolitan area, a peer-reviewed list of species for that region does not include the given species; or
(d) For bird species, no evidence of breeding was found by the Oregon Breeding Bird Atlas project in any of the survey units (BBA hexagons) of which the accounting unit is a part.

Table 2. Background considerations important to correctly applying and interpreting the species models and geographic distribution data used as a basis for Detail Files HABTYPE, HABSTRUC, and SPHABWRB.

1. Neither the habitat models (HABTYPE or HABSTRUC) nor geographic distribution databases (SPHABWRB) have been field-validated. This is true of nearly all wildlife habitat association models developed in North America. Conducting meaningful validation (or invalidation) of habitat models and species distributions is a complex and very labor-intensive process.   2. The scores for a species more closely reflect *rankings* of the habitats than intensity of use or preference (Adamus 2000). For example, a score of 8 should not be interpreted to mean that the species uses a particular habitat twice as much a habitat scored 4 for the species. In general, scores greater than 5 are expected to describe habitats that, if sufficiently extensive and of a suitable spatial pattern and location, might be "sources" of potential breeders, whereas scores less than 5 are expected to describe habitats that often are "sinks" for potential breeders (although they sometimes may comprise necessary dispersal corridors).   3. The scores were based mainly on (a) the author's 20 years of field experience, (b) review of several hundred technical papers, mainly from studies in the Pacific Northwest and pertaining to habitat requirements of these species, and (c) the author's interpretation of ratings in two similar but less-detailed databases that also had been based on judgments of experts: The Muddy Watershed Species-Habitat Relationships Matrix. A database that covered a small portion of the Willamette River Basin and rated, on a 0-10 scale, the relationship of 236 vertebrates to 26 habitat classes. (a) The Oregon-Washington Species-Habitat Relationships Matrix. A database that rated, on a 0-3 scale (1 = present, 2 = associated, 3 = closely associated, 0 = not associated), the relationship of all Willamette River Basin vertebrates to 21 habitat (b) The scores for mammal species were also influenced by examining the recent exhaustive literature review for Oregon by Verts and Carraway (1998). Before being applied, all species models were reviewed by experts in all-day structured workshops, held in April 2000. Patti Haggerty conducted the GIS analyses required to evaluate and implement the habitat assessment approach, under guidance provided partly by Denis White (EPA).
4. The choice of these particular 34 classes to describe habitat for an immensely diverse group of species is somewhat arbitrary. We do not know the degree to which wildlife species perceive habitat the same way humans do, e.g., whether 20 or 80 or 200 vegetation classes would do a significantly better job of representing breeding site selection. The classes largely represent the maximum number that could be interpreted consistently from satellite (Thematic Mapper) imagery. Somewhat different results might have resulted from the correlation analysis if a greater or fewer number of score categories and classes for habitat type and structure had been used, or if the classes had been weighted according to their physiognomic similarity.   5. Ideally, habitat classes should explicitly *integrate* both habitat type and habitat structure, e.g., by dividing each habitat class into multiple structural classes using the NHI categories. This was not possible because of the different sources of the data, software and conceptual limitations in dealing with such complexity, and time and funding limitations. However, some of the ERC habitat types (particularly those for conifer forest) are defined by stand age, and this can reflect stand structure in a very broad sense. Habitat patch size and adjacency to water (i.e., riparian condition) are also important considerations in associating species with particular habitat types and structures, but could not be accounted for in generating the correlations. They are, however, incorporated in the model-based scores in the SPHABWRB file.   6. Many species may select breeding sites based on non-vegetation elements such as climate, presence of dead wood, and topography. Such elements were not incorporated explicitly into the species models or habitat classification because they cannot be detected consistently from satellite imagery. However, before scores were assigned to the 34 habitat types, assumptions (described by Adamus 2000) were made about the likely relative extent of these elements within pixels comprising the 34 classes. Those assumptions were provided to experts who refined the models.

7. The classifications of the 2 million-plus pixels (each 30 x 30 m) that comprise the Willamette Basin have not been extensively field-verified. However, other sources of digital data which had a higher degree of field-checking were used to “enhance” the satellite-derived classification, particularly for wetland, riparian, and oak habitats.

8. The satellite imagery on which these classes were based is from the early 1990s. Extent and distribution of some habitats undoubtedly has changed since then.

After compiling the final databases, they were then subjected to queries pertinent to answering specific questions:

> ***Which breeding species are most likely to occur in each watershed, elevation zone, and priority conservation area? What is the approximate area of habitat in each watershed, elevation zone, and priority conservation area that may be highly suitable, or at least moderately suitable, for each species?***

Answering the above questions is fundamental to knowing which species’ needs must potentially be addressed, and where. “Likelihood of occurrence” was represented by the habitat suitability score of each accounting unit. This is not a precise or statistical measure of likelihood, and species presence or absence sometimes is determined primarily by factors other than habitat suitability, e.g., competition. Partial results for focal species are presented under the relevant species in section 2. Detailed results (for all species and accounting units) are contained in file SPHABHUC6.

> ***In which watersheds is the largest acreage of a species’ habitat on private land? … on private land not identified as a Priority Conservation Area (PCA) by TNC’s Ecoregional Assessment?***

Answering this question is essential to targeting habitat protection and restoration efforts in a manner that allows them to “fill in” geographic gaps for particular species. Partial results for focal species are presented under the relevant species in chapter 2. Overall results are presented in chapter 3, and the full database is contained in file SPHABHUC6. Results include not only a comparison of the acreages of suitable habitat that are “missed,” but also comparison of the integrated habitat suitability score for each species on public vs. private land, PCA vs. non-PCA land lists the PCAs by watershed, and a map of their general location is in accompanying MapFile: PCA.PDF.

> ***If habitat protection and restoration emphasizes only the “focal” species, which additional species are most and least likely to benefit incidentally?***

By identifying additional species that are <u>most</u> likely to be “swept along” by protecting just the habitat of the focal species, one can build a stronger case for a particular project or acquisition that is designed mainly to help the focal species. By identifying species <u>least</u> likely to be swept along, one can organize efforts to protect or restore their different habitat in a complementary manner. We answered this and related questions by computing Spearman rank correlations among habitat scores of all species pairings (83,282 total), and querying by species category (focal vs. not) as described and illustrated further in section 3.2. The need for analyzing species overlaps in three dimensions -- habitat type overlap, habitat structure overlap, and geographic/ elevational overlap – is emphasized, and databases for each are provided (Detail Files:

HABTYPE, HABSTRUC, and SPHABHUC6 respectively). The correlations based on habitat type and habitat structure are contained in Detail File SPHABCOR.

Which Willamette watersheds are currently the most and least important for wildlife?

Answering this is fundamental to helping decide where to restore habitat and where to conserve habitat. Decisions about what priority to assign to a particular watershed should take into account many factors, only three of which are considered by this report: native species richness, mean habitat suitability, and degree of species protection as inferred from ownership of suitable habitat. Each of these "importance" factors can be examined for all species, for federally-listed species only, and for the focal species only. To a large extent, this question already has been addressed by previous efforts described in the next section.

1.5 Building Upon Previous Efforts

This surely is not the Willamette subbasin's first or only multispecies assessment of wildlife or of habitat protection priorities. Several of this report's purposes (as listed in section 1.1 above) are shared by other wildlife assessment projects, both completed and ongoing. The analyses described above were conducted with the intention of building upon and refining such efforts, so that goals and needs specific to subbasin planning could be achieved. Chief among the related assessments are the following:

<u>Completed Broadscale Wildlife Habitat Analyses or Prioritizations in the Willamette Subbasin</u>

1. *Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment* (Floberg et al. 2004). This 4-year effort involved over 100 experts from Oregon and Washington. It did not cover the entire Willamette subbasin, just the 44% that comprises the Willamette Valley and adjoining foothills. Priority Conservation Areas comprising 11% of the Willamette subbasin and 24% of the part of TNC's study region that fell within the subbasin were selected iteratively by systematic application of several criteria and models followed by extensive peer review. TNC considers the resulting PCAs to be "a first approximation of the most important places for conserving native species and ecosystems" in the Willamette Valley, Washington's Puget Trough, and British Columbia's Georgia Basin. By design, the assessment did not address salmon. Areas were identified initially based on geographic concentrations of listed and sensitive wildlife and plant species and communities (as documented by the EOR database and expert knowledge), and from mapping of potential habitat for these species and communities (mainly for ones having few or no EOR records). Not all of the subbasin's species were analyzed explicitly. Final selection of the PCAs took into account the quality of each documented occurrence, e.g., Is a particular species likely to persist at a particular location based on connectivity and patch size of its habitat, number of individuals present, vulnerability, etc.? Acreage goals were set for each priority community type, mainly by scientific consensus. TNC applied a computer model (SITES) to select from millions of possibilities an optimal combination of potential PCAs that would meet acreage goals for each target community type at the lowest cost. Costs were not estimated directly. The final list of PCAs does not include every location for every listed or sensitive species, and is mostly comprised of private lands. Higher-elevation portions of the subbasin were not analyzed.

2. *Willamette River Basin Planning Atlas* (Hulse et al. 2002, Hulse et al. 2004, Baker et al. 2004). For this atlas a team of planners and scientists, with extensive stakeholder input, identified "Conservation and Restoration Opportunity" areas covering a total of 57% of the subbasin[7]. They then applied the same wildlife models (Adamus et al. 2000) used in this report to a scenario that included these areas, as well as to scenarios representing an 1850s-era landscape and to scenarios that cartographically described future landscapes under various levels of development. Using the PNW-ERC (EC90) land cover map as a reference point, the scenarios were compared with regard to many factors, including wildlife species composition and richness. Subsequently, a graduate student (Susan Payne) created a refined "CC90" map of present-day land cover and applied the Adamus et al. (2000) models to it to predict the net effects on wildlife of cluster development vs. conventional development. Also, recently a consortium of university scientists used a version of the EC90 layer and simplified wildlife models to run scenarios involving alternative forest management practices in the Coast Range portion of the subbasin, and described likely net effects of each alternative on species richness (Radosevich et al. 2004).

3. *Pacific Coast Joint Venture Implementation Plans: Willamette Valley Draft* (Roth et al. 2002). Although this effort did not use a systematic and explicit multispecies approach, the resulting document recommends specific acreage targets for restoration and protection of two focal habitat types (wetland/floodplain/riparian and oak savanna/woodland/ grassland). Recommendations are specific to each of 15 major portions of the Willamette Valley. They are based on best professional opinion of the authors with input from some experts. Specific locations for conservation action within each general area are not mapped, but in some cases are described generally along with their featured species.

4. *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000) and *Conservation Strategy for Landbirds in Coniferous Forests of Western Oregon and Washington* (Altman 1999). These plans were prepared by and for the American Bird Conservancy and Oregon-Washington Partners In Flight, an interagency effort focusing specifically on migrant terrestrial birds. They are based mainly on literature review and expert opinion. They identify priority species and habitats, and suggest indicators and targets (mainly qualitative) for monitoring each. Specific locations for restoration or conservation within the subbasin were not identified or prioritized.

5. *Preliminary Biodiversity Conservation Plan for the Oregon Coast Range* (Noss 1992). This plan was prepared privately for the Oregon Coast Range Association. One of the first plans of its type in the Northwest, it involved systematic application of scientific criteria in order to identify and prioritize broad areas for protection. Due to data constraints at the time, a comprehensive multispecies analysis process was not used.

<u>Ongoing Multispecies Wildlife Habitat Analyses or Prioritization in the Willamette Subbasin</u>

[7] 22% of the subbasin was predicted to be subject to future conservation was "Tier 1" habitat areas, and 35% was "Tier 2" habitat areas. Tier 1 habitats are assumed to be managed for the purpose of achieving a naturally functioning landscape. Tier 2 habitats are habitats of comparatively lower habitat suitability (e.g., orchard, vineyard) set within a mosaic of more important habitats and assumed to be managed for sustainable production of goods and services compatible with more-limited habitat on-site conservation.

1. *West Cascades Ecoregional Assessment.* This TNC effort, scheduled for completion in late 2004, is similar to (1) above and will cover portions of the Willamette subbasin not addressed by that effort.

2. *Oregon's Important Bird Areas* initiative (www.oregoniba.org). This Audubon-sponsored effort is part of a national program. An objective is to involve birders in giving recognition to areas they believe are most important for the abundance or diversity of bird species present. Currently seven areas – all on public lands -- have been approved within the Willamette subbasin.

3. *Willamette biodiversity cost-benefit analysis projec*t. This nearly-completed effort, led by Dr. Steve Polasky at the University of Minnesota, involves computer simulations designed to determine land use patterns that would best optimize both biological (terrestrial wildlife habitat) and economic objectives. The project used data from the Willamette Valley to add realism to the modeling. Results are applicable to conservation planning generally, especially when it involves integration of wildlife with working farms and forests, but the results do not define the specific parcels or locations within the Willamette subbasin that would best balance biological and economic objectives. For each of 97 non-aquatic wildlife species, the simulations applied models that took into account not only habitat patch type, but patch size (relative to needs of a breeding pair), distance to other patches of varying suitability to the species, and dispersal ability. For a given landscape pattern, these were used to compute a landscape connectivity score for the species, and the probability of persistence of that species given a particular land use pattern. Using the same land use pattern, the economic model examined characteristics of a land parcel and its location to predict the value of commodity production. The biological and economic models were then combined to search for efficient land use patterns in which the conservation outcome cannot be improved without lowering the value of commodity production. The simulation examined 3 land uses (forestry, agriculture, conservation), 6 habitat types, and 196 parcels on a 193,726-acre virtual landscape.

Several other types of reports address the subbasin's wildlife and rare plants, at least minimally. To date, most **watershed assessment reports** in the Willamette subbasin have provided mainly descriptive information on wildlife and rare plants, or have mainly discussed the needs of just a few species. A few watershed assessments (e.g., McKenzie, Luckiamute) have utilized field surveys or species-habitat models in a systematic, analytical, multispecies approach to wildlife. Some **natural resource inventories conducted by municipalities** to meet requirements for "Goal 5 planning" have featured use of standardized data forms, visual assessments of habitat structure, and professional judgment to assign "habitat scores" to individual wetlands, forested tracts, riparian strips, or other semi-discrete spatial units. The purpose generally has been for local governments to channel development away from habitat areas perceived as important, or to better manage development impacts within or near them. Scores from such wildlife habitat assessments are available, for example, for Salem, Eugene, Springfield, Corvallis, Gresham, Tualatin, Tigard, King City, Hillsboro, West Linn, Lake Oswego, Wilsonville, Newberg, and Stayton (P. Fishman, pers. comm.). Perhaps the most ambitious of the municipal assessments have been conducted in the greater Portland area by Metro, beginning with field surveys (Poracsky et al. 1992) and extending to use of species-habitat models (Hak 2000) and as well as field-based scoring of habitat patches to prioritize lands for possible acquisition, restoration, and/or management (see: www.metro-region.org/habitat).

1.6 How to Apply this Report and Databases to Decision-making

If your objective is to **identify and prioritize** particular land parcels for **protection**, then a good place to start is by reviewing the map (File: PCA.PDF) of Priority Conservation Areas (PCAs) identified by TNC's carefully-researched *Ecoregional Assessment*. On the map, note the relative priorities of particular PCAs are indicated by their color codes. A complementary and largely overlapping information source is the "Tier 1" category on the *Conservation and Restoration Opportunities* map prepared by the PNW-ERC[8]. See Table 54 for summary of differences between the maps. Give particular attention to areas considered a priority by both the TNC and PNW-ERC maps. Where this occurs, consider what percentage of each the Tier 1 habitat type is being satisfied by the particular PCA, and use this as one indicator of the PCA's relative importance (Table 4). Also consider spatial overlaps with priority wildlife areas recommended by watershed assessments, county and local "Goal 5" natural resource inventories, and other types of reports described in section 1.5.

Within the PCAs or other recommended areas, determine specific *parcels* that would best protect biodiversity by reviewing and discussing all of the above maps with appropriate specialists in the Oregon Natural Heritage Program, ODFW, US Fish and Wildlife Service, and other relevant agencies and non-governmental organizations. Also, consider enlarging the focal species maps that accompany this report and show distribution of higher-suitability habitat for each of the focal wildlife species. This can help indicate (somewhat coarsely) important areas to protect.

For parts of the subbasin not addressed by the *Ecoregional Assessment*, or for species not considered focal by this report (and therefore not mapped), use this report to identify at least which watersheds and elevation zones provide the most suitable and extensive habitat for any species (and thus might be priorities for protection). This can be done by querying Detail File:SPHABHUC6 which accompanies this report.

If your objective is to identify and prioritize particular land parcels for **restoration**, consider the above maps but also consider which land cover types occurred historically in your watershed (see Table 46 and 47, and DetailFile:VegChangeNHI) and in the PCAs (Table 44). Land cover types that have experienced the greatest losses (Table 45) and species associated with those (Tables 48 and 49) should be given preference for restoration, other factors being equal. Enlarge and review the maps that accompany this report, showing the historical distribution of habitat suitable for the focal species, to geographically focus your search. To identify specific habitat features you may wish to emphasize in your restoration project, review the narrative for that focal habitat type and its focal species (section 2).

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[8] Approximately 60% of the area within the PCAs also was identified as a conservation priority by the PNW-ERC, and approximately 13% of the ERC's Tier 1 and Tier 2 Conservation and Restoration Opportunities land was also identified as a PCA by TNC (Table 3). The latter percentage is smaller mainly because PCAs were idenfied over a smaller region than were the ERC areas.

If your objective is to **learn how stream restoration activities might affect wildlife and rare plants**, so their habitat can be better managed, see section 2.6.6.

If your objective is to learn more about **what may be limiting the populations of particular rare terrestrial species**, see section 4.

If your objective is to see **which species might be most and least likely to benefit from protection of habitat of one or a few other species**, see section 3.2 and Detail File:SPHABCOR.

Table 3. Summary: percent of ERC-identified Conservation and Restoration Opportunity Areas (CROAs) included within TNC-identified Priority Conservation Areas (PCAs)

Note: The PNW-ERC defined Tier 1 habitats as priority habitats managed for the purpose of achieving a naturally functioning landscape. Tier 2 habitats are habitats of comparatively lower habitat suitability (e.g., orchard, vineyard) set within a mosaic of more important habitats and managed for sustainable production of goods and services compatible with limited habitat conservation. Table compiled by Chris Robbins, Oregon Chapter of The Nature Conservancy.

Feature	Acres identified as PCA	Total acres in subbasin	Percent of feature identified as PCA
tier 1 oak	35210	55144	64
tier 1 prairie	24294	37870	64
tier 1 floodplain forest	39551	57638	69
tier 1 upland forest	4701	766765	1
tier 1 mid-elevation forest	25930	53289	49
tier 1 forest riparian protection zones	7630	496958	2
tier 1 wetlands	35661	87714	41
Willamette R. restored channels	39448	94846	42
SUBTOTAL Tier 1	(212,425)	(1,650,224)	(13)
tier 2 forests	42923	71388	60
tier 2 oak and prairie	11014	21450	51
tier 2 riparian protection zones	44443	743164	6
tier 2 wetland protection zones	15528	62563	25
SUBTOTAL Tier 2	(113,907)	(898,565)	(13)

Table 4. Area of each CROA type included in each PCA

Note: All figures are in acres. CROAs are Conservation and Restoration Opportunity Areas identified by the PNW-ERC. PCAs are Priority Conservation Areas identified by TNC. See accompanying MapFile: PCAmap for locations. Data compiled by Chris Robbins, Oregon Chapter of The Nature Conservancy, using TNC and PNW-ERC spatial data.

PCA	Total acres	Tier 1 wetland	Tier 1 forest riparian	Tier 1 forest floodplain	Willamette restored channels	Tier 1 prairie	Tier 1 oak	Tier 1 forest mid-elevation	Tier 1 forest upland	Tier 2 wetland	Tier 2 riparian	Tier 2 oak	Tier 2 forest
Airlie Oaks	3615	6	0	0	0	0	978	0	0	10	94	7	0
Alderwood Wayside	154	0	0	0	0	0	0	0	0	0	46	0	0
Amity Oaks	2345	26	0	0	0	0	500	0	0	31	16	0	0
Banks Swamp	573	244	0	0	0	0	0	0	0	61	15	0	0
Basket Butte	13876	373	6	0	57	2409	3822	0	128	233	284	235	0
Bear Creek Oaks	1253	0	0	0	0	0	0	0	0	0	67	0	0
Bear Creek Wetlands	1374	86	0	0	0	252	0	0	0	50	87	0	0
Buell	394	23	0	0	0	0	1	0	0	13	57	0	0
Calapooia Oak Savanna	955	0	0	0	0	0	0	0	0	0	2	0	0
Camas Swale BLM	201	0	49	0	0	0	0	0	83	0	36	0	0
Camas Swale Oaks	4600	23	0	0	0	543	1123	0	0	11	126	218	0
Camas Swale Wetlands	2168	66	0	0	0	0	0	0	0	49	117	0	0
Camp Creek Ridge	1429	0	0	0	0	0	932	0	0	0	6	100	0
Cedar Creek	8082	0	0	455	3	0	0	0	0	0	533	0	32
Champoeg State Park	283	8	0	251	4	0	0	0	0	0	12	0	0
Clackamas	20566	328	284	0	479	0	0	2064	0	292	1985	0	209
Clear Creek	17660	55	1413	0	4	0	0	8730	0	8	539	0	1210
Coast Fork/Middle Fork Willamette Riparian	13425	215	0	4225	1013	145	669	0	0	67	1011	55	1429
Coburg Ridge	4979	14	0	151	7	0	2899	0	0	10	108	325	31
Cogswell Foster	91	0	0	0	0	84	0	0	0	0	1	0	0
Cooper Mountain	1072	0	0	0	0	0	0	0	0	0	43	0	0
Corvallis Watershed	9753	0	3406	0	6	0	0	0	3074	0	328	0	0
Corvallis-Philomath Oaks	11489	90	0	0	0	407	1869	0	0	43	702	1526	0
Crawfordsville Oak-Pine Savanna	5802	126	0	0	0	0	0	0	0	112	141	0	0

PCA	Total acres	Tier 1 wetland	Tier 1 forest riparian	Tier 1 forest floodplain	Willamette restored channels	Tier 1 prairie	Tier 1 oak	Tier 1 forest mid-elevation	Tier 1 forest upland	Tier 2 wetland	Tier 2 riparian	Tier 2 oak	Tier 2 forest
Dundee Oaks	1786	43	0	0	3	0	357	0	0	81	57	0	0
Dunn Forest	10556	444	0	207	8	1905	0	0	0	186	578	1173	3
EE Wilson	2499	1435	0	0	3	369	0	0	0	135	18	14	0
Eola Hills	22950	318	0	144	36	77	2422	0	0	184	869	334	36
Fern Ridge Reservoir	9175	1104	0	0	6533	61	0	0	0	362	79	1	0
Forest Park-Coast Range	76169	7	1316	0	25	0	0	14133	181	6	4955	0	644
Fox Hollow BLM RNA	451	0	0	0	0	0	0	0	0	0	107	0	0
Gales Creek	66	11	0	0	0	0	0	0	0	9	10	0	0
Gettings Creek	825	8	0	0	4	0	0	0	0	4	28	0	0
Golden Valley	7363	503	0	0	6	102	0	0	0	349	255	0	0
Habeck Oaks	17638	76	0	0	3	13	1191	0	0	98	718	398	0
Hidden Oaks	1144	53	0	0	0	456	0	0	0	3	30	0	0
High Pass	10082	18	316	0	0	0	0	0	181	24	1517	0	0
Indian Head/Horse Rock Ridge	30773	785	182	0	14	954	0	0	143	581	2855	0	0
Jackson Frazier Wetlands	935	139	0	0	0	80	0	0	0	45	36	0	0
Johnson Hill	740	1	0	0	0	10	0	0	0	4	7	0	0
Kingston Prairie	985	135	0	0	0	85	0	0	0	38	14	152	0
Lane Community College Basin	1352	45	0	0	0	19	255	0	0	4	1	54	0
Little Sink RNA	52	0	1	0	0	0	0	0	15	0	10	0	0
Logsden Ridge	1120	0	0	0	0	0	0	0	0	0	17	0	0
Lower Calapooia River Riparian	14612	586	0	2545	10	962	0	0	0	374	469	542	869
Lower Mckenzie Riparian	9571	254	0	2275	1008	1	71	0	0	81	988	154	1349
Luckiamute River Riparian	11129	145	0	1429	349	495	391	0	0	150	831	159	823
Main Stem Willamette, Corvallis to Albany	7098	137	0	1454	1078	0	0	0	0	96	572	0	2663
Main Stem Willamette, Harrisburg to Corvallis	23945	453	0	3319	3847	0	0	0	0	378	2281	0	11264

PCA	Total acres	Tier 1 wetland	Tier 1 forest riparian	Tier 1 forest floodplain	Willamette restored channels	Tier 1 prairie	Tier 1 oak	Tier 1 forest mid-elevation	Tier 1 forest upland	Tier 2 wetland	Tier 2 riparian	Tier 2 oak	Tier 2 forest
Main Stem Willamette, Luckiamute-Santiam confluence area	13593	610	0	3159	2495	0	0	0	0	338	874	3	3674
Main Stem Willamette, McKenzie confluence to Harrisburg	11780	472	0	1776	2596	0	0	0	0	184	1275	2	4933
Main Stem Willamette, Mission Bottom area	29393	1012	0	5161	4330	0	0	0	0	760	1536	0	9404
Maxfield Creek BLM	1646	0	0	0	0	0	0	0	0	0	149	0	0
McCully Mtn BLM	474	13	0	0	0	0	0	0	0	15	12	0	0
McDonald Forest/Soap Creek Forest and Balds	12294	0	12	0	1	0	0	0	36	0	536	0	0
Minto Island	2494	193	0	733	439	0	0	0	0	96	129	0	270
Missouri Ridge	7396	128	55	0	0	0	322	0	34	76	1001	0	0
Mount Angel	292	20	0	0	0	0	0	0	0	25	0	0	0
Mt Pisgah	2761	3	0	218	33	735	865	0	0	1	22	0	57
Muddy Creek/Finley	15158	1537	47	1664	136	2764	1415	0	211	299	603	50	336
North Santiam River Riparian	19713	1773	27	3080	1469	46	0	0	60	944	1625	0	1796
Oak Creek USFWS	368	44	0	0	0	0	0	0	0	33	24	0	0
Oak Creek/Freeway Lakes Park	138	10	0	31	11	0	0	0	0	7	2	0	0
Oak Ridge/Moore's Valley	3596	102	0	0	0	0	677	0	0	63	45	0	0
Orchard Heights	2280	0	0	0	0	62	348	0	0	0	42	0	0
Oregon Country Fair	1085	0	1	0	3	0	0	0	14	0	117	0	0
Peterson Butte	1391	202	0	0	0	280	537	0	0	13	0	88	0
Pudding River riparian	7864	750	0	1419	489	0	0	0	0	349	637	0	388
Rattlesnake Oaks	1790	0	0	0	0	0	0	0	0	0	45	0	0
Richardson Gap/Crabtree Wetlands	12192	2106	0	0	0	957	0	0	0	905	583	0	0
Rock Hill	1675	187	0	0	0	103	1070	0	0	31	0	0	0
Salem Hills/Ankeny NWR	25893	1917	2	196	132	2425	1477	0	74	1168	863	1976	84
Scio Oak Pine Savanna	1878	63	0	0	3	0	579	0	0	73	58	235	0

PCA	Total acres	Tier 1 wetland	Tier 1 forest riparian	Tier 1 forest floodplain	Willamette restored channels	Tier 1 prairie	Tier 1 oak	Tier 1 forest mid-elevation	Tier 1 forest upland	Tier 2 wetland	Tier 2 riparian	Tier 2 oak	Tier 2 forest
Silver Creek	3533	221	0	0	5	0	0	0	0	100	210	0	0
South Fork Yamhill River	12225	217	0	1344	386	0	0	0	0	213	624	0	393
Stout Mountain	1652	164	0	0	0	0	0	0	0	141	53	0	0
Swamp Creek Wetlands	1472	10	19	0	0	0	0	0	59	10	120	0	0
The Butte RNA	124	0	0	0	0	0	0	0	0	0	53	0	0
Timber Grove	9588	0	249	0	8	0	0	896	0	0	1077	0	36
Tryon Creek Nature Park	926	0	0	0	0	0	0	0	0	0	172	0	0
Tualatin National Wildlife Refuge	9651	278	0	802	319	0	0	0	0	245	855	0	118
Tualatin Hills Park	987	72	0	0	3	0	0	0	0	74	63	0	0
Upper Siuslaw Site	73643	0	221	0	0	5	0	0	394	0	1815	28	0
Wapato Marsh	10651	949	0	852	97	226	0	0	0	718	545	0	403
Ward Butte	374	1	0	0	0	0	0	0	0	2	0	0	0
Washburn Butte	3352	70	0	0	0	0	1830	0	0	35	17	193	0
Waterloo Rocks	1114	64	0	0	55	0	0	0	0	65	104	0	0
Weiss Rd BLM Oaks	495	0	0	0	0	0	0	0	0	0	91	0	0
West Eugene/Spencer Creek	35370	3482	0	815	1029	3357	591	0	0	1011	694	1023	60
Willamette Narrows	2642	17	0	682	508	0	0	0	0	12	204	0	143
Willamina Oaks 1	4622	6	0	0	0	0	950	0	0	0	97	620	0
Willamina Oaks 2	2442	3	0	0	0	81	1054	0	0	5	124	0	0
Yamhill Oaks	13948	291	0	0	0	411	5951	0	0	150	221	1246	0
TOTAL	755108	25373	7607	38387	29051	20880	35144	25823	4687	12344	40975	10914	42656

Table 5. Acreage of Priority Conservation Area (PCA) in each watershed (HUC6) of the Willamette subbasin

HUC5	HUC5 name	HUC6	HUC6 name	HUC6 Area	PCA in HUC6	PCA as % of HUC6 Area
1709000101	Willamette R. Middle Fk.	170900010101	Rattlesnake & Hills Cr.	36051.93	8186.58	22.71
1709000102	Willamette R. Middle Fk.	170900010201	Hills Cr.	37446.83	22.67	0.06
1709000103	Willamette R. Middle Fk.	170900010301	Fall Cr. Reservoir N.	42105.66	0	0
1709000103	Willamette R. Middle Fk.	170900010302	Fall & Delp Cr.	41226.83	9.32	0.02
1709000104	Willamette R. Middle Fk.	170900010401	Fall Cr. Reservoir S.; Winberry Cr.	40212.46	496.81	1.24
1709000105	Willamette R. Middle Fk.	170900010501	Dexter Reservoir	15454.71	1134.18	7.34
1709000105	Willamette R. Middle Fk.	170900010502	Hemlock; Lookout Point Reservoir	51811.62	0	0
1709000106	Willamette R. Middle Fk.	170900010601	Lost R.; Anthony Cr.	34658.09	423.19	1.22
1709000107	Willamette R. Middle Fk.	170900010701	Hemlock; Middle Fk. of N. Fk. of Willamette	36657.78	0	0
1709000107	Willamette R. Middle Fk.	170900010702	Christy Cr.	28705.01	3.78	0.01
1709000107	Willamette R. Middle Fk.	170900010703	Grassy Cr.	23063.49	5.76	0.02
1709000108	Willamette R. Middle Fk.	170900010801	Oakridge E.	34948.13	0	0
1709000108	Willamette R. Middle Fk.	170900010802	Black & Salmon & Wall Cr.	25561.66	9.33	0.04
1709000108	Willamette R. Middle Fk.	170900010803	Waldo Lake; Black & Salmon Cr.	21921.51	6.67	0.03
1709000109	Willamette R. Middle Fk.	170900010901	Waldo Lake; Cayuse & Fisher Cr.	70231.05	69157.04	98.47
1709000110	Willamette R. Middle Fk.	170900011001	Salt & Gold & Eagle Cr.	72125.56	10	0.01
1709000111	Willamette R. Middle Fk.	170900011101	Groundhog Cr: S.Fork	38455.79	37.8	0.1
1709000112	Willamette R. Middle Fk.	170900011201	Staley & Swift & Spruce Cr.	113141.15	110902.75	98.02
1709000113	Willamette R. Middle Fk.	170900011301	Oakridge W.; Hills Creek Reservoir	109888.7	17.11	0.02
1709000201	Willamette R. Coast Fk./ Row R.	170900020101	Creswell E. Bear & Gettings Cr.	59249.52	9795.36	16.53
1709000201	Willamette R. Coast Fk./ Row R.	170900020102	Creswell W.; Camas Swale	29827.18	10431.61	34.97
1709000202	Willamette R. Coast Fk./ Row R.	170900020201	Mosby Cr.	62177.54	0	0
1709000203	Willamette R. Coast Fk. - upper	170900020301	Cottage Grove Reservoir N.	44705.22	10585.06	23.68
1709000203	Willamette R. Coast Fk. - upper	170900020302	Cottage Grove Reservoir S.	52732.06	5588.39	10.6
1709000204	Willamette R. Coast Fk./ Row R.	170900020401	Dorena Reservoir	50692.41	0	0
1709000205	Willamette R. Coast Fk. - lower	170900020501	Laying & Dinner & Herman Cr.	48587.74	0	0
1709000205	Willamette R. Coast Fk. - lower	170900020502	Brice Cr.	36610.24	0	0
1709000205	Willamette R. Coast Fk. - lower	170900020503	Sharps & Martin Cr.	41665.78	0	0
1709000301	Long Tom R.	170900030101	W. Eugene; Junction City	102859.41	24628.77	23.94
1709000301	Long Tom R.	170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge	103138.7	18801.02	18.23
1709000301	Long Tom R.	170900030103	Coyote Cr.	67331.01	19623.86	29.15
1709000302	Muddy Cr.	170900030201	Corvallis N.; Adair Village	37855.04	12750.02	33.68
1709000302	Muddy Cr.	170900030202	Monroe; Muddy Cr. E.	59905.7	22053.51	36.81

HUC5	HUC5 name	HUC6	HUC6 name	HUC6 Area	PCA in HUC6	PCA as % of HUC6 Area
1709000302	Muddy Cr.	170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	95368.03	22741.11	23.85
1709000302	Muddy Cr.	170900030204	E. Eugene; Harrisburg; Springfield	47743.55	12269.91	25.7
1709000303	Calapooia R.	170900030301	Courtney Cr.	41757.11	13796.13	33.04
1709000303	Calapooia R.	170900030302	Brownsville	68485.42	13305.11	19.43
1709000303	Calapooia R.	170900030303	Calapooia R - middle	72985.47	4061.24	5.56
1709000304	Calapooia R./ Oak Cr.	170900030401	N. Albany; W. Lebanon; Cox Cr.	47845.1	3524.65	7.37
1709000304	Calapooia R./ Oak Cr.	170900030402	S. Albany; Tangent.	36687.32	6845.15	18.66
1709000304	Calapooia R./ Oak Cr.	170900030403	Sodaville	19266.1	990.28	5.14
1709000305	Marys R.	170900030501	Corvallis; Philomath; Mary's R.-lower	44388.14	31226.61	70.35
1709000305	Marys R.	170900030502	Mary's R -middle	47582.14	6036.51	12.69
1709000305	Marys R.	170900030503	Mary's R. -upper	20986.07	0	0
1709000305	Marys R.	170900030504	Finley NWR; Muddy & Hammer Cr.	80134.1	53812.76	67.15
1709000306	Luckiamute R.	170900030601	Luckiamute R.4	17370.45	9004.33	51.84
1709000306	Luckiamute R.	170900030602	Soap Cr.	37037.37	20188.76	54.51
1709000306	Luckiamute R.	170900030603	Luckiamute R.1.	25046.96	2032.84	8.12
1709000306	Luckiamute R.	170900030604	Luckiamute R.2.	43584.92	4057.71	9.31
1709000306	Luckiamute R.	170900030605	Luckiamute R.3.	26769.37	6.67	0.02
1709000306	Luckiamute R.	170900030606	Little Luckiamute R. - lower	26347.51	9638.35	36.58
1709000306	Luckiamute R.	170900030607	Little Luckiamute R. -upper	25186.28	10531.9	41.82
1709000401	McKenzie R. - upper	170900040101	E. Springfield; Camp & Ritchie Cr.	124362.52	124035.29	99.74
1709000401	McKenzie R. - upper	170900040102	Gate Cr. S. Fk.	40200.93	40063.28	99.66
1709000402	McKenzie R. - upper	170900040201	Horse & Parsons & Cash & Mill Cr.	114885.93	2247.39	1.96
1709000403	McKenzie R.	170900040301	Blue River Reservoir & Cook Cr.	20656.23	20600.59	99.73
1709000404	McKenzie R.	170900040401	Blue River Reservoir & Elk Cr.	59076.85	167.42	0.28
1709000405	McKenzie R.	170900040501	Boulder Cr. & Smith R.	160051.86	159473.16	99.64
1709000405	McKenzie R.	170900040502	White Branch	70052.19	69281.12	98.9
1709000406	McKenzie R./ Mohawk R.	170900040601	Separation Cr.	60974.58	89.38	0.15
1709000406	McKenzie R./ Mohawk R.	170900040602	Horse & Eugene Cr.	38742.05	34.02	0.09
1709000407	McKenzie R. - lower	170900040701	Quartz Cr.	27066.61	24.87	0.09
1709000408	McKenzie R. - S. Fk.	170900040801	Cougar Reservoir & Walker Cr.	38172.62	38026.18	99.62
1709000408	McKenzie R. - S. Fk.	170900040802	French Pete Cr.	36025.65	36028.26	100.01
1709000408	McKenzie R. - S. Fk.	170900040803	Roaring R. & Elk Cr.	63810.52	62766.22	98.36
1709000501	North Santiam R. - upper	170900050101	Detroit; Idanha	41995.32	0	0
1709000501	North Santiam R. - upper	170900050102	Marion Lake	60071.65	0	0
1709000501	North Santiam R. - upper	170900050103	Pyramid Cr.	42319.56	100.49	0.24
1709000502	North Santiam R.	170900050201	Breitenbush R.	69593.97	7.55	0.01

HUC5	HUC5 name	HUC6	HUC6 name	HUC6 Area	PCA in HUC6	PCA as % of HUC6 Area
1709000503	North Santiam R.	170900050301	Detroit Reservoir	74134.54	0	0
1709000504	North Santiam R. - middle	170900050401	Gates; Lyons; Mill City	56674.07	2249.67	3.97
1709000505	North Santiam R.	170900050501	Little North Santiam R.	72332.79	692.27	0.96
1709000506	North Santiam R. - lower	170900050601	Jefferson; Lyons; Bear Branch	80169.28	24552.71	30.63
1709000601	South Santiam R./ Crabtree Cr.	170900060101	Crabtree Cr. & Onehorse Slough	17626.16	4251.41	24.12
1709000601	South Santiam R./ Crabtree Cr.	170900060102	E. Lebanon; Hamilton Cr.	45633.26	7510.97	16.46
1709000601	South Santiam R./ Crabtree Cr.	170900060103	Waterloo; Sweet Home; McDowell Cr.	55796.18	1113.49	2
1709000602	South Santiam R./ Crabtree Cr.	170900060201	Beaver Cr.	46226.92	46113.19	99.75
1709000602	South Santiam R./ Crabtree Cr.	170900060202	Roaring R.	53657.78	53518.74	99.74
1709000603	South Santiam R. /Thomas Cr.	170900060301	Lower Thomas Cr. -lower; Scio	28696.41	2935.07	10.23
1709000603	South Santiam R. /Thomas Cr.	170900060302	Upper Thomas & Neil Cr. & Indian Prairie	63750.53	580.39	0.91
1709000604	South Santiam R.	170900060401	Greenpeter Reservoir	53489.67	17.32	0.03
1709000604	South Santiam R.	170900060402	Quartzville Cr.-upper	55731.09	4.89	0.01
1709000605	Santiam R. - middle	170900060501	Pyramid Cr. & Quartzville Cr.-lower	66720.62	48.02	0.07
1709000606	South Santiam R.	170900060601	Sevenmile & Soda & Squaw Cr.	68134.53	14.44	0.02
1709000606	South Santiam R.	170900060602	Canyon Cr.	33814.24	0	0
1709000607	South Santiam R.	170900060701	Sweet Home; Foster Reservoir	36220.87	0	0
1709000608	South Santiam R.	170900060801	Wiley Cr.	40589.36	0	0
1709000701	Willamette R. - middle	170900070101	Baskett Slough NWR	15553.44	8757.24	56.3
1709000701	Willamette R. - middle	170900070102	Independence; Monmouth	44112.53	9583.2	21.72
1709000701	Willamette R. - middle	170900070103	Ankeny NWR	31841.64	18468.78	58
1709000702	Mill Cr.	170900070201	Sublimity & Turner	31897.07	57.81	0.18
1709000702	Mill Cr.	170900070202	Aumsville & Beaver Cr.	20680.03	182.58	0.88
1709000702	Mill Cr.	170900070203	S. Salem; McKinney Cr.	18624.77	6879.39	36.94
1709000702	Rickreall Cr.	170900070204	Rickreall Cr. -upper	25640.75	88.03	0.34
1709000703	Willamette R./Chehalem Cr.	170900070301	Saint Paul	29193.34	262.85	0.9
1709000703	Willamette R./Chehalem Cr.	170900070302	Dundee; Newberg	30055.11	7121.14	23.69
1709000703	Willamette R./Chehalem Cr.	170900070303	Chehalem Cr.	26469.24	1400.16	5.29
1709000703	Willamette R./Chehalem Cr.	170900070304	Lincoln	26315.77	14790.02	56.2
1709000703	Willamette R./Chehalem Cr.	170900070305	Keizer; Spring Valley Cr.	31409.7	12008.8	38.23
1709000703	Willamette R./Chehalem Cr.	170900070306	W. Salem	11275.33	3541.09	31.41
1709000703	Willamette R./Chehalem Cr.	170900070307	Salem	17361.37	3017.14	17.38
1709000704	Molalla R./ Abernethy Cr.	170900070401	W.Wilsonville	26079.08	969.83	3.72
1709000704	Molalla R./ Abernethy Cr.	170900070402	N. Canby; E. Wilsonville	33725.7	2244.78	6.66
1709000704	Molalla R./ Abernethy Cr.	170900070403	Oregon City; West Linn	26303.55	5826.35	22.15
1709000801	South Yamhill R. - upper	170900080101	S. Willamina	33134.02	813.68	2.46

HUC5	HUC5 name	HUC6	HUC6 name	HUC6 Area	PCA in HUC6	PCA as % of HUC6 Area
1709000801	South Yamhill R. - upper	170900080102	Agency Cr.	40472.9	54.23	0.13
1709000801	South Yamhill R. - upper	170900080103	Jackass & Rogue Cr.	15790.39	112.5	0.71
1709000802	North Yamhill R./ Willamina Cr.	170900080201	Willamina	13690.95	241.5	1.76
1709000802	North Yamhill R./ Willamina Cr.	170900080202	Coast Cr.	14488.49	3.33	0.02
1709000802	North Yamhill R./ Willamina Cr.	170900080203	Willamina Cr. -upper	25493.19	9007.87	35.33
1709000803	South Yamhill R.	170900080301	Mill & Gooseneck Cr.	34169.12	18715.17	54.77
1709000804	South Yamhill R. - lower	170900080401	Sheridan	28137.43	17485.62	62.14
1709000804	South Yamhill R. - lower	170900080402	Salt Cr.	12305.14	7764.74	63.1
1709000804	South Yamhill R. - lower	170900080403	Deer Cr.	35782.89	9145.3	25.56
1709000805	South Yamhill R./ Salt Cr.	170900080501	Ash Swale & Deer Cr.	23437.73	8906.02	38
1709000805	South Yamhill R./ Salt Cr.	170900080502	Amity	39705.75	13766.8	34.67
1709000806	North Yamhill R.	170900080601	Yamhill	24565.45	831.05	3.38
1709000806	North Yamhill R.	170900080602	McMinnville N.	19141.26	1719.5	8.98
1709000806	North Yamhill R.	170900080603	Panther & Haskins Cr.	28367.22	1710.81	6.03
1709000806	North Yamhill R.	170900080604	Turner Cr.	19603.12	1042.54	5.32
1709000806	North Yamhill R.	170900080605	Fairchild Cr.	21758.71	18537.69	85.2
1709000807	Yamhill R.	170900080701	Palmer Cr.	25142	3808.86	15.15
1709000807	Yamhill R.	170900080702	Lafayette	18541.82	588.43	3.17
1709000807	Yamhill R.	170900080703	McMnnville S.	20064.04	8256.21	41.15
1709000901	Pudding R.	170900090101	Aurora	12087.87	4482.7	37.08
1709000901	Pudding R.	170900090102	Woodburn; Hubbard	23136.96	248.18	1.07
1709000902	Pudding R.	170900090201	S. Canby	20213.03	150.99	0.75
1709000902	Pudding R.	170900090202	Molalla R. -middle	14743.54	0	0
1709000903	Pudding R.	170900090301	Butte Cr.	35371.11	1459.76	4.13
1709000903	Pudding R.	170900090302	Cedar Cr.	10359.83	3755.23	36.25
1709000903	Pudding R.	170900090303	Woodcock Cr.	20389.47	7174.92	35.19
1709000903	Pudding R.	170900090304	Canyon Cr. & Colton	22113.47	685.61	3.1
1709000903	Pudding R.	170900090305	Milk Cr.	12445.73	4694.17	37.72
1709000904	Pudding R.	170900090401	Scotts Mills Senecal Cr. & Mill Cr.	37398.48	638.89	1.71
1709000904	Pudding R.	170900090402	Abiqua Cr.	31938.36	0	0
1709000905	Molalla R. - upper	170900090501	Molalla	54961.38	8073.37	14.69
1709000906	Molalla R. - lower	170900090601	Molalla R. N. Fk.	35925.8	0	0
1709000906	Molalla R. - lower	170900090602	Molalla R. S. Fk.	40016.24	0	0
1709000906	Molalla R. - lower	170900090603	Table Rock Fk.	22463.18	12.45	0.06
1709000906	Molalla R. - lower	170900090604	Copper & Henry Cr.	22543.76	1.33	0.01
1709000907	Pudding R./ Silver Cr.	170900090701	Little Pudding R.; E. Salem	45746.91	0	0

HUC5	HUC5 name	HUC6	HUC6 name	HUC6 Area	PCA in HUC6	PCA as % of HUC6 Area
1709000907	Pudding R./ Silver Cr.	170900090702	Drift Cr.	47781.56	1344.32	2.81
1709000907	Pudding R./ Silver Cr.	170900090703	Silverton N.	16814.7	21.79	0.13
1709000907	Pudding R./ Silver Cr.	170900090704	Silverton S.	35047.18	3344.5	9.54
1709001001	Tualatin R./ Dairy Cr.	170900100101	Tigard; Tualatin; Sherwood; King City	62242.59	7547.46	12.13
1709001001	Tualatin R./ Dairy Cr.	170900100102	Hillsboro	47895.87	3005.36	6.27
1709001001	Tualatin R./ Dairy Cr.	170900100103	Beaverton & Rock & Cedar Mill Cr.	48731.36	24912.54	51.12
1709001002	Tualatin R./ Dairy Cr.	170900100201	Dairy Cr. W. Fk. & Council Cr.; Banks	69079.49	2835.88	4.11
1709001002	Tualatin R./ Dairy Cr.	170900100202	Diary Cr. E.	41318.94	24185.3	58.53
1709001002	Tualatin R./ Dairy Cr.	170900100203	North Plains; McKay Cr.	37569.31	22971.28	61.14
1709001003	Tualatin R./ Scoggins Cr.	170900100301	Gales & Clear Cr.	60112.9	4370.63	7.27
1709001003	Tualatin R./ Scoggins Cr.	170900100302	Sain & Scoggins Cr.	36162.84	2005.51	5.55
1709001003	Tualatin R./ Scoggins Cr.	170900100303	Gaston; Sunday & Roaring Cr.	50846.28	2888.39	5.68
1709001101	Clackamas R. - Collawash R.	170900110101	Estacada; E. Gladstone	40142.76	40104.67	99.91
1709001101	Clackamas R. - Collawash R.	170900110102	Clear Cr.	45115.13	45057.22	99.87
1709001101	Clackamas R. - Collawash R.	170900110103	Sandy	31871.18	31329.38	98.3
1709001102	Clackamas R. - upper	170900110201	Eagle Cr.	57545.76	3988.75	6.93
1709001103	Clackamas R. - Oak Grove Fk.	170900110301	Big Cliff Reservoir	47190.82	28.42	0.06
1709001103	Clackamas R. - Oak Grove Fk.	170900110302	Fish Cr. W.	30301.98	15.56	0.05
1709001103	Clackamas R. - Oak Grove Fk.	170900110303	Fish Cr. E.	33594.8	31.32	0.09
1709001103	Clackamas R. - Oak Grove Fk.	170900110304	Roaring R.	27423.38	0	0
1709001104	Clackamas R. - middle	170900110401	Harriet Lake	35302.67	48.69	0.14
1709001104	Clackamas R. - middle	170900110402	Timothy Lake; Dinger Lake	57075.52	4	0.01
1709001105	Clackamas R. - Eagle Cr.	170900110501	Clackamas R. – upper	41051.06	40583.01	98.86
1709001105	Clackamas R. - Eagle Cr.	170900110502	Berry & Cub & Lowe Cr.	59566.28	58417.59	98.07
1709001106	Clackamas R. - lower	170900110601	Nohorn Cr.	45989.44	45932.42	99.88
1709001106	Clackamas R. - lower.	170900110602	Dickey & Elk Cr.	51425.31	51373.4	99.9
1709001202	Willamette R. - lower	170900120201	Portland; Forest Hills; Multnomah Channel	40694.63	37414.41	91.94
1709001202	Willamette R. - lower	170900120202	S. Milwaukie; Happy Valley; Lake Oswego	25868.97	3756.59	14.52
1709001202	Willamette R. - lower	170900120203	Gresham; Portland; N. Milwaukie	34181.14	855.51	2.5

Table 6. Extent of undeveloped land and buildable land within boundaries of the Priority Conservation Areas (PCAs), and their overlap with Conservation and Restoration Opportunity Areas (CROAs)

Note: **Boldfaced** sites are ones where the percent buildable land exceeds the percent of the PCA that is a Tier-1 CROA, indicating high vulnerability. Tier 1 habitats are priority habitats managed for the purpose of achieving a naturally functioning landscape. Tier 2 habitats are habitats of comparatively lower habitat suitability (e.g., orchard, vineyard) set within a mosaic of more important habitats and managed for sustainable production of goods and services compatible with limited habitat conservation. Data compiled by Chris Robbins, Oregon Chapter of The Nature Conservancy, and Jon Bowers, ODFW, using TNC and PNW-ERC spatial data plus "buildable lands" data supplied by Susan Payne (formerly at Institute for a Sustainable Environment, U. of Oregon). She mapped buildable lands where future development is unlikely due to steep slopes, wet soils, high-value forest or agricultural lands, floodplains, critical ground water areas, debris flow hazard, 100-ft riparian buffer, or other factors (Payne 2002).

ID #	Priority Conservation Area (PCA)	Total acres	% CROA Tier 1	% CROA Tier 2	% undeveloped	% buildable	% private
318	**Airlie Oaks**	3617	27	3	36	33	
352	Alderwood Wayside	161	0	30		1	
299	Amity Oaks	2346	22	2	69	20	
272	Banks Swamp	572	43	13	21	2	
306	Baskett Butte	13883	49	5	18	7	81
351	Bear Creek Oaks	1254	0	5		11	
348	Bear Creek Wetlands	1373	25	10			
304	Buell	396	6	18	17	17	100
344	Calapooia Oak Savanna	954	0	0	100	30	81
369	Camas Swale BLM RNA	201	66	18	44		100
363	**Camas Swale Oaks**	4604	37	8		39	100
364	Camas Swale Wetlands	2170	3	8	39	0	99
285	Camassia	46					
356	Camp Creek Ridge	1429	65	7	96	11	100
292	**Cedar Creek**	8082	6	7		16	
291	Champoeg State Park	283	93	4	34		100
286	Clackamas	20584	15	12	73	7	96
290	Clear Creek	17663	58	10		11	
365	**Coast Fork/Middle Fork Willamette Riparian**	13434	0	19	35	6	94
354	Coburg Ridge	4985	62	10	72	26	98
343	Cogswell Foster	89	92	1			
282	Cooper Mountain	1073	0	4			
333	Corvallis Watershed	9755	67	3		1	
331	**Corvallis-Philomath Oaks**	11494	21	20	49	25	58
342	**Crawfordsville Oak-Pine Savanna**	5804	2	4		44	
289	Dundee Oaks	1785	23	8	39	9	100
321	Dunn Forest	10559	24	18	42	9	100
322	EE Wilson	2496	72	7	49	0	54
305	Eola Hills	22962	13	6	45	1	100
357	Fern Ridge Reservoir	9175	84	5	11	1	25
270	Forest Park-Coast Range	76200	21	7	90	6	98
367	Fox Hollow BLM RNA	451	0	24	99	0	71
275	Gales Creek	68	17	29	34	2	100

370	**Gettings Creek**	824	1	4		32	
332	**Golden Valley**	7370	8	8		16	
310	**Habeck Oaks**	17640	7	7	54	7	98
309	Hidden Oaks	1145	44	3		0	
347	High Pass	10088	5	15	80	4	81
345	**Indian Head/Horse Rock Ridge**	30782	7	11	66	22	92
328	Jackson-Frazier	939	23	9	24		100
361	Jasper Prairie	739			60	37	100
314	**Johnson Hill**	738	1	1	32	26	100
316	Kingston Prairie	984	22	21	9	1	95
362	**Lane Community College Basin**	1350	24	4	79	33	100
311	Little Sink RNA	52	31	19	100	2	0
326	**Logsden Ridge**	1122	0	2	42	3	100
334	Lower Calapooia River Riparian	14616	28	15	12	1	100
355	**Lower McKenzie Riparian**	9581	0	27	30	3	99
317	**Luckiamute River Riparian**	11139	0	18		3	
329	Main Stem Willamette, Corvallis to Albany	7107	0	47	15	0	100
341	**Main Stem Willamette, Harrisburg to Corvallis**	23952	0	58	10	1	100
315	Main Stem Willamette, Luckiamute-Santiam confluence area	13596	0	36	17	0	100
349	**Main Stem Willamette, McKenzie confluence to Harrisburg**	11780	0	54	21	1	100
298	**Main Stem Willamette, Mission Bottom area**	29401	0	40	14	1	94
323	**Maxfield Creek BLM**	1647	0	9	100	23	100
319	**McCully Mtn BLM**	476	3	6	85	15	100
327	**McDonald Forest/ Soap Creek Forest and Balds**	12296	0	4	97	13	100
308	Minto Island	2492	55	20	19		0
301	**Missouri Ridge**	7397	7	15	83	16	90
302	Mount Angel	292	7	9	23		100
360	Mt Pisgah	2764	67	3	57	6	47
339	Muddy Creek/Finley	15162	51	8	22	1	82
324	North Santiam River Riparian	19728	33	22	43	5	96
330	Oak Cr. Freeway Lakes	137	38	7	22		100
336	Oak Creek USFWS	367	12	15	16	4	100
287	Oak Ridge/Moore's Valley	3599	22	3	84	2	100
346	Orchard Heights	2282	18	2	71	10	100
359	**Oregon Country Fair**	1085	2	11	43	7	78
335	Peterson Butte	1393	73	7	78	8	100
293	Pudding River riparian	7865	34	17	20	5	97
366	**Rattlesnake Oaks**	1790	0	3	55	22	100
325	Richardson Gap/Crabtree Wetlands	12197	25	12	17	5	100
350	Rock Hill	1673	81	2	52	44	100
312	Salem Hills/Ankeny NWR	25905	24	16	38	0	88
320	Scio Oak Pine Savanna	1878	34	19	39	26	100
307	**Silver Creek**	3534	6	9	49	11	100
297	South Fork Yamhill River	12230	16	10	13	2	100
313	**Stout Mountain**	1653	10	12	77	30	100
353	**Swamp Creek Wetlands**	1474	6	9		6	100
294	The Butte RNA	125	0	43	99	6	0

295	Timber Grove	9593	12	12		6	
283	Tryon Creek N	925	0	19	85		1
279	Tualatin Hills	988	14	13	51		100
284	Tualatin National Wildlife Refuge	9661	8	14			
371	**Upper Siuslaw**	73673	1	3		3	
281	Wapato Marsh	10660	20	16	3	3	100
338	**Ward Butte**	373	0	1	8	17	100
340	Washburn Butte	3353	57	7	97	27	100
337	Waterloo Rocks	1113	11	15		2	
368	Weiss Rd BLM Oaks	496	0	18	99	7	1
358	West Eugene/Spencer Creek	35391	26	8	35	14	87
288	Willamette Narrows	2643	46	14	61	3	99
300	Willamina Oaks 1	4623	21	16	60	10	100
303	Willamina Oaks 2	2442	47	5	44	10	100
296	Yamhill Oaks	13956	48	12	59	14	100

Table 7. Focal habitat types and threats associated with Willamette subbasin Priority Conservation Areas (PCAs) identified by TNC's Ecoregional Assessment

In the last 14 columns, the first number is TNC's assessment of the urgency of the threat and the number following the slash is their assessment of its severity (3 = high, 1 = low). For more information on the locations of the PCAs, see Floberg et al. (2004)

Priority Conservation Area (TNC)	Acres	Oak woodland	Upland Prairie-savanna	Wetland prairie & seasonal wetland	Ponds, sloughs, & their riparian	Stream riparian	Old growth conifer forest	Crop production	Dams & river regulation	Fire suppression	Forestry practices	Grazing	Diversions, drainage, dikes	Invasive species	Mining	Water pollution	Pathogens	Recreational activity	Roads	Residential construction	Conversion to agriculture
Airlie Oaks	3616	X				X				3/2	3/3	3/1		3/3			2/3			3/2	3/3
Amity Oaks	2344	X								3/2	3/3	3/1		3/3			2/3			3/2	3/3
Banks Swamp	571				X					3/2			3/2	3/3				3/1		3/1	1/2
Baskett Butte	13876	X	X		X	X				3/2			3/2	3/3			2/3	3/1		3/1	1/2
Buell	395	X				X				3/2	3/3	3/2		3/3			2/3			3/2	3/3
Camas Swale BLM RNA	200		X			X				3/2				3/3			2/3				
Camas Swale Oaks	1863	X	X			X				3/2	3/3	3/2		3/3			2/3			3/2	3/3
Camas Swale Wetlands	2169	X				X				3/2		3/2		3/3		3/1	2/3		3/1		
Camassia	46	X			X	X				3/2				3/3			2/3	3/1		3/1	
Camp Creek Ridge	1428	X	X			X				3/2	3/3	3/1		3/3			2/3			3/2	3/3
Champoeg State Park	282	X				X		3/1		3/2				3/3			2/3	3/2			
Clackamas	20575					X			3/2	3/2				3/3		3/2				3/2	
CoastFk/MidFk Willamette	13429	X	X		X	X			3/2	3/2	2/2			3/3		3/2	2/3		2/2	3/2	
Coburg Ridge	4984	X	X		X	X				3/2	3/3			3/3			2/3		3/2	3/2	3/3
Corvallis Watershed	9752						X			3/2	2/1		1/1	2/1							
Corvallis-Philomath Oaks	11490	X	X	X	X					3/2	3/3	3/2		3/3			2/3			3/3	3/3
Dundee Oaks	1783	X			X	X				3/2	3/3	3/2		3/3			2/3			3/3	3/3
Dunn Forest	10554	X	X			X					3/3			2/2			2/3			2/1	
EE Wilson	2495	X				X				3/2				3/3		3/1	2/3			3/1	2/2
Elk Creek	3636						X			3/2	3/2	3/2	3/2	3/2							
Eola Hills	22954	X				X				3/2	3/3	3/2		3/3			2/3			3/3	3/3
Fern Ridge	9171	X		X		X			3/2					3/3		3/2		3/2			
Fox Hollow BLM RNA	452		X							2/2	2/2			2/2							
Forest Park	76170					X					3/2			3/1	3/1			3/1			3/1
Gales Cr.	69					X		2/3	2/2					3/3		2/2				1/2	
Habeck Oaks	17633	X	X			X				3/2	3/3	3/2		3/3			2/3			3/3	3/3
High Pass	10085	X				X	X				3/2	3/1	3/1							2/2	2/2
Indian Head –	30769	X	X	X		X		2/2			3/2	2/1		3/3						1/2	

Willamette Main Stem – Corvallis to Albany	7104	X			X	X			3/2				3/2	3/3	3/2	3/2			3/2	2/1	
Willamette Main Stem – Luckiamute Confluence	13590	X			X	X		3/3	3/2				3/2	3/3	3/2	3/2			3/2	2/1	
Willamette Main Stem – Mission Bottom	29388	X			X	X		3/3	3/2				3/2	3/3			3/2		3/2	3/1	
Maxfield Creek	1645	X								3/1	2/2			3/2							
McCully Mtn.	474	X								3/2		2/2		3/3							2/2
McDonald Forest / Soap Cr. Forest & Balds	12291	X	X	X		X					3/3			3/2						3/1	
Minto Island	2490	X			X	X								3/3				3/1			
Missouri Ridge	7395	X				X				3/2	3/3	3/2		3/3		2/3				3/3	3/3
Mount Angel	291									2/2				3/2						2/2	
Mount Pisgah	2761	X	X	X	X	X				3/2	3/3	3/2		3/3		2/3		3/2		3/1	3/3
Muddy Cr. – Finley NWR	15156	X	X	X	X	X		3/3	3/2				3/2	3/3			3/2		3/2	2/1	
North Santiam	19720	X	X		X	X		3/2	3/2		3/2	3/2	3/2	3/3	3/2		3/2			3/2	
Oak Creek USFWS	366	X		X	X	X				2/1		3/1		3/2						2/1	
Oak Cr. Freeway Lakes	136	X				X				1/1				3/3						2/1	3/2
Oak Ridge – Moore's Valley	3596	X				X				3/3	3/3	3/2		3/3		2/3				3/1	3/2
Orchard Heights	2280	X	X		X	X				3/2				3/3				3/3		3/2	3/3
Oregon County Fair	1084	X			X	X							1/1	3/2			2/1	2/1		1/1	
Peterson Butte	1393	X	X							3/3	3/3	3/2		3/3		2/3			3/2	2/1	3/2
Pudding River	3183	X				X		3/2	3/2			3/2		3/3			3/2			3/1	
Rattlesnake Oaks	1788	X				X				3/2	3/3	3/2		3/3		2/3				2/3	3/3
Richardson Gap – Crabtree	12192	X			X	X		3/2		3/2	3/3	3/2		3/3						3/2	
Rock Hill	1672	X			X					2/2		3/2		3/3	2/1					1/1	
Salem Hills – Ankeny	25893	X		X	X	X		3/2		3/2	3/3	3/2		3/3		2/3				3/3	3/3

Scio Oak Pine Savanna	1877	X			X	X				3/2	3/3	3/2		3/3						3/3	3/3
Stout Mtn.	1652	X	X			X				3/2	2/3	3/2		3/3	3/1					1/2	
Silver Creek	1430	X			X						2/2			3/2						1/2	
South Fork Yamhill River	12224	X			X	X		3/3				3/1	3/2	3/3			3/2			3/2	
Swamp Creek	1475	X			X	X	X			3/2			3/2	3/3			3/2				3/2
The Butte BLM RNA	126					X	X				3/2			2/2							
Tryon Cr.	924																	3/2		3/2	
Tualatin Hills	988	X			X	X								3/2				3/2			
Wapato Marsh	10656	X			X	X		1/3				3/1		3/3			3/1			3/1	
Ward Butte	373	X	X					2/2				2/2		3/2							
Washburn Butte	3352	X	X		X	X		2/2				2/2		3/3							
Waterloo Rocks	1112	X	X		X	X		3/3	3/2				3/2	3/3	3/2		3/2		3/2		
Weiss Road BLM Oaks	496		X							3/2	3/2			3/2							
West Eugene – Spencer Cr.	35375	X	X	X	X	X		3/1		3/2	3/2	3/1		3/3			3/2		3/2	3/2	
Willamette Narrows	2643	X	X		X	X				3/2	3/1			3/3						3/2	
Willamina Oaks 1	4621	X				X				3/2	3/3	3/2		3/3		2/3				3/3	3/3
Willamina Oaks 2	2440	X				X				3/2	3/3	3/2		3/3						3/3	3/3
Yamhill Oaks	13951	X	X		X	X				3/2	3/3	3/2				2/3				3/3	3/3

2. Focal Habitats and Associated Focal Species

2.1 Introduction

This report uses focal habitats (Table 8) as a primary organizing concept and focal species (Table 9) as a secondary component. In this report, ***focal habitats*** are land cover or vegetation classes that are considered to be the most important in the subbasin due to their scarcity, difficulty (e.g., time span) to replace, rate of decline from historical extent, exceptional wildlife or plant diversity, and/or consistent use by a relatively large number of plant and wildlife species that are threatened, endangered, sensitive, or declining in the subbasin. ***Focal species*** are plant or wildlife species or subspecies that serve to focus management and/or monitoring activities. Some authors have used this phrase to denote species that encompass the structural and functional needs of broader ecological communities. Some of the focal species in this report were chosen not only to address this concept, but also (or instead) because they are keystones (species that significantly alter the physical environment), endemic (restricted to Oregon), highly specialized, declining, or especially vulnerable to extirpation.

Several agencies and groups involved with the Willamette subbasin (e.g., USDA Forest Service, BLM, Corps of Engineers, ODFW) had previously used diverse criteria to designate particular species as "focal." The composition of these lists is largely a function of legal and geographic responsibilities of the particular agency. We drew heavily from such lists, using the following criteria to select species for our purposes: (1) species is listed or a current candidates for listing as threatened or endangered by federal agencies; and/or (2) listed by ODFW as sensitive, i.e., endangered, threatened, critical, or vulnerable; and/or (3) declining in the subbasin or region as indicated by Breeding Bird Survey (BBS) data; and/or (4) endemic to the subbasin; and/or (5) perform ecological functions quite different from those performed by other species that regularly occur in the same habitat type. All species that met the first of these five criteria were included, except for Canada lynx (federal "Threatened") which likely has been extirpated as a resident of the subbasin. Including species that met *any* of the other criteria would have resulted in an impractically long list of 120+ species[9] The geographic range of several of the focal species does not encompass the *entire* Willamette subbasin, and this should be considered when using these species to monitor focal habitats. ***The focal species in this report should not be considered to be the only ones deserving heightened concern and attention.***

A few of this report's focal species did not meet any of these criteria but were included because of their consistent association with a particular focal habitat type, and apparently minimal redundancy between their habitat associations and those of species already selected as focal

[9] State-listed wildlife species of the Willamette subbasin that were not designated as focal species are: *Endangered*: peregrine falcon; *Threatened*: wolverine; *Critical*: fisher, black-backed woodpecker, northern goshawk, common nighthawk, northern pygmy-owl, yellow-breasted chat, painted turtle; *Vulnerable*: western toad, Cascade torrent salamander, southern torrent salamander, foothill yellow-legged frog, pallid bat, fringed myotis. These species were excluded because of low fidelity to any of the focal habitats, likely extirpation, narrow geographic range within the subbasin, or because other sensitive species associated with the focal habitat are mostly sufficient to address needs of the excluded species. ODFW is currently updating its listing of sensitive species. Presence of state-listed wildlife species in a particular area is a legal concern mainly if the area is a state-owned forest or other forest subject to the Oregon Forest Practices Act.

species (for description of approach used to analyze overlap, see section 3.2). Species were added in this manner mostly where a focal habitat hosts relatively few legally-listed species. No attempt was made to mathematically optimize the suite of focal species selected to represent a particular focal habitat type.

Each focal habitat section in this report also includes a list of some of the more important “indicators of ecological condition” for that type. These are suggested partly because the focal species alone are not intended to represent the full spectrum of important successional stages, geomorphic conditions, and structural elements contained within each focal habitat type. Although the focal species have been grouped according to the focal habitats in which they are most likely to occur, ***focal species are not necessarily the same as “indicator species”*** **or** ***“umbrella species.”*** Among the species identified as focal in this report, there is considerable variation in the strength of their association with the focal habitat under which they are listed, and with their association with non-focal species. Most of these focal species use multiple habitat types and the other habitats they use may or may be considered to be “focal.” Thus, any use of species surveys to monitor status and trends in the condition of focal habitats should not be limited just to species categorized as focal by this report. The focal species concept is used mainly to ensure that evaluation and management of focal habitat types includes consideration of the needs of some of the rarest and most dependent species that use that type. Of course, by addressing only a limited list of focal species, one potentially overlooks the needs of many other species. Although this is unavoidable, an analytical approach used in this effort provided an estimate of the degree to which protecting only the selected focal species might “sweep” the habitat needs of the non-focal species. Details are provided in section 3.2.

Table 8. Comparison of focal habitats in this report with habitats identified by selected previous plans and assessments that address wildlife in the Willamette subbasin

Proposed by:	The Nature Conservancy	ODFW	Oregon-Washington Partners In Flight	Defenders of Wildlife	ODFW & USFWS
Source:	*Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment* (Floberg et al. 2004)	*Willamette River Basin Operational Plan* (draft chapter in the Oregon Plan and ODFW's Vision 2006 Strategic Plan)	*Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000)	*Restoring Rare Native Habitats in the Willamette Valley* (Campbell 2004)	Application of Habitat Evaluation Procedures (HEP) to Willamette subbasin projects
Oak Woodlands	Oak woodlands	Oak woodland	Oak woodlands	Oak woodlands	Oak savanna
Upland Prairie & Savanna	Upland prairies & savanna	Grassland; Rocky habitats	Grassland- savanna	Prairies and grasslands	Grass-forb; Oak savanna
Wetland prairie & Seasonal Marsh	Wetland prairies; Vernal pools; Freshwater marshes	Wetland; Grassland	N/A	Prairies and grasslands; Wetlands	Herbaceous wetland; Grass-forb
Perennial ponds, sloughs, & their riparian	Freshwater marshes; Freshwater aquatic beds	Wetland; Aquatic	N/A	Wetlands	Reservoir
Stream riparian	Riparian forests & shrublands; Autumnal freshwater mudflats; Depressional wetland shrublands & broadleaf forests	Riparian	Riparian	Riparian forests	River Riparian hardwood; Red alder
Old Growth Conifer Forest	Douglas fir – western hemlock – western redcedar forests	Conifer	N/A	N/A	Conifer forest

N/A= not applicable to the intended scope of that plan

Table 9. Comparison of focal species with species identified as "indicators" or "focal species" by previous wildlife plans and assessments in the Willamette subbasin, grouped by the most similar focal habitat type

Sponsor:	WRI/ NWPCC	OWEB – ONHP	PIF	ODFW	ODFW & USFWS
Source:	This report	"Key species for land acquisition priorities" (J. Kagan, pers. comm.)	*Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington*	*Willamette River Basin Operational Plan* (draft chapter in the *Oregon Plan* and ODFW's Vision 2006 Strategic Plan)	Application of Habitat Evaluation Procedures (HEP) to Willamette subbasin projects
Oak Woodlands	Acorn woodpecker Chipping sparrow W. Wood-pewee White-breasted nuthatch Southern alligator lizard Sharptail snake W. gray squirrel	Acorn woodpecker Chipping sparrow W. Wood-pewee White-breasted nuthatch Sharptail snake W. gray squirrel Bullock's oriole	Acorn woodpecker Bewick's wren Bushtit Chipping sparrow W. Wood-pewee White-breasted nuthatch	Acorn woodpecker Band-tailed pigeon White-breasted nuthatch	Elk Black-tailed deer Black bear Cougar Ruffed grouse Yellow warbler Pileated woodpecker Red fox Western gray squirrel Ring-necked pheasant California quail Wood duck
Upland Prairie-Savanna & Rock Outcrops	American kestrel Horned lark Vesper sparrow Western meadowlark Western rattlesnake Black-tailed jackrabbit Taylor's checkerspot Fender's blue butterfly Kincaid's lupine Golden paintbrush White rock larkspur White-topped aster	American kestrel Bullock's oriole Grasshopper sparrow Horned lark Northern harrier Vesper sparrow Western meadowlark Taylor's checkerspot Fender's blue butterfly	American kestrel Grasshopper sparrow Horned lark Northern harrier Vesper sparrow Western meadowlark	Horned lark Vesper sparrow Western bluebird Western meadowlark Western rattlesnake	Elk Black-tailed deer Red fox Western gray squirrel Ring-necked pheasant California quail Wood duck

continued

Sponsor:	WRI/ NWPCC	OWEB - ONHP	PIF	ODFW	ODFW & USFWS
Wetland Prairie & Seasonal Marsh	Dunlin Common yellowthroat Northern harrier Sora Red-legged frog Water howellia Bradshaw's lomatium Nelson's checkermallow Willamette Valley daisy Peacock larkspur	Dunlin Short-eared owl	N/A	Dunlin Painted turtle Pond turtle Red-legged frog Wood duck	Roosevelt elk Black-tailed deer Black bear Cougar Ruffed grouse Red fox Ring-necked pheasant California quail Common merganser
Perennial ponds, sloughs, & their riparian areas	Western pond turtle Oregon spotted frog Cascades frog Purple martin Green heron Wood duck Yellow warbler	Western pond turtle Painted turtle Red-legged frog Purple martin American bittern Hooded merganser Wood duck	Purple martin Yellow warbler	Western pond turtle Painted turtle Red-legged frog Yellow warbler	River otter American beaver Common merganser Mink Wood duck
Stream Riparian	American dipper Bald eagle Harlequin duck Red-eyed vireo Willow flycatcher Coastal tailed frog American beaver River otter	Foothill yellow-legged frog Yellow warbler	Downy woodpecker Red-eyed vireo Swainson's thrush Willow flycatcher	Bald eagle Great blue heron American beaver	American Beaver American Dipper Black Bear Black-tailed Deer California Quail Common Merganser Cougar Elk Harlequin Duck Mink Pileated Woodpecker Red Fox Ring-necked Pheasant River Otter Ruffed Grouse Western Gray Squirrel Wood Duck Yellow Warbler

N/A= not applicable to the intended scope of that plan

Sponsor:	WRI/ NWPCC	OWEB - ONHP	PIF	ODFW	ODFW & USFWS
Source:	This report	"Key species for land acquisition priorities" (J. Kagan, pers. comm.)	*Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington*	*Willamette River Basin Operational Plan* (draft chapter in the *Oregon Plan* and ODFW's Vision 2006 Strategic Plan)	Application of Habitat Evaluation Procedures (HEP) to Willamette subbasin projects
Old Growth Conifer Forest	Pileated woodpecker Olive-sided flycatcher Vaux's swift Marbled murrelet Spotted owl Great gray owl Oregon slender salamander American marten Red tree vole Townsend's big-eared bat	Townsend's big-eared bat	Brown creeper Red crossbill Vaux's swift	Elk Black-tailed Deer	Elk Black-tailed Deer Black Bear Cougar Ruffed Grouse Yellow Warbler Pileated Woodpecker Spotted Owl

2.2 Focal Habitat: Oak Woodlands

2.2.1 Definition

For purposes of this report, oak woodland is defined as stands of Oregon white oak (*Quercus garryana*), with either closed canopies (oak forest) or with open canopy but tree densities of generally greater than about 100 trees per acre (oak woodland). At least during recent decades, oak woodlands have increasingly become oak forests with Doug-fir (*Pseudotsuga menziesii*) as a common co-dominant. Oak woodlands may include the following 7 plant communities recognized by TNC's *Ecoregional Assessment*:

Oregon white oak – Oregon ash / common snowberry
Oregon white oak – long-stolon sedge – common camas
Oregon white oak – wedgeleaf ceanothus – Roemer's fescue
Oregon white oak - Roemer's fescue
Oregon white oak – common snowberry – long-stolon sedge
Oregon white oak – common snowberry – sword fern
Oregon white oak - oval-leaf viburnum – poison-oak

2.2.2 Recognition of Importance

Oak woodland has been identified explicitly as a priority for protection and restoration in nearby regions and specifically in the Willamette subbasin (Table 10) Although no legally-listed threatened or endangered species use oak woodland predominantly, several may use it periodically or as part of an overall mosaic of natural habitats. Several occur along oak woodland edges. These include the following legally listed species: Kincaid's lupine and Fender's blue butterfly (both federal – endangered); vesper sparrow (state – critical); and sharptail snake, western rattlesnake, and western bluebird (state-vulnerable). Wildlife species that may have used oak woodland regularly before vanishing (as breeders) from the Willamette subbasin include: Lewis's woodpecker, black-billed magpie, and lark sparrow. Thirteen of 27 plant associations listed as occurring in oak woodlands in the National Vegetation Classification are considered globally imperiled or critically imperiled by the Oregon Natural Heritage Program. Loss of oak woodland has been targeted as a major biodiversity concern, and conservation strategies have been proposed, in Washington (Larsen & Morgan 1998), California (California Partners in Flight 2002), and British Columbia (Garry Oak Ecosystems Recovery Team 2002).

2.2.3 Status and Distribution

No maps showing oak woodlands are available for the entire subbasin. Thus, no completely reliable data are available on the present extent of this habitat type. Nonetheless some existing vegetation and land cover maps use categories that include oak to a varying and uncertain extent (herein termed "mixed oak"). The Eugene BLM office also has mapped oak woodlands, but just in southern portions of the Willamette subbasin. In some assessments, one of the maps of current mixed oak has been overlaid on a map of historic distribution of oak woodlands (from 1800's General Land Office records) in order to discern "true" (presumably the most sustainable) patches of remaining oak woodland. However, the actual "purity" of the historical oak categories is unknowable.

Table 10. Acreage estimates of land cover types that include oak woodland

Source	Map categories that include oak woodland	Estimated area (acres)	% of mapped area
EC1850	"oak savanna"	527,136	7.23
EC90	"hardwood semiclosed upland"	106,448	1.46
IBIS - 1850	"westside oak & dry Douglas-fir forest and woodlands"	1,864,879	25.98
IBIS -1990	"westside oak & dry Douglas-fir forest and woodlands"	285,280	4.00
ODFW*	"oak – Douglas fir >50% oak"	61,580	3.18

* Valley only – not entire subbasin

2.2.4 Past Impacts, Limiting Factors, and Future Threats

Setting aside the data limitations described above, a rough comparison of historic distribution of oak woodland with current distribution of mixed oak suggests over 1.5 million acres have been converted to other vegetation or land cover types over the past 150 years. Watersheds within the subbasin may be ranked according to their presumed historic extent of oak woodland as well as current extent of mixed oak, and the very approximate percent change (Table 45). These data show both the historic and present oak woodland occurring mostly in the southern and western portions of the subbasin. Most of the mixed oak map category exists on private land.

Much of the remaining oak woodland exists in the foothills where expanding vineyards and Christmas tree plantations, as well as residential developments, have been removing oak woodlands. Although residential developments usually leave most of the canopy intact, conversion of the understory native shrub, grass, and forb layer to lawns severely reduces its suitability for wildlife, especially when accompanied by disturbances from pets and people (Klock et al. 1998). Ironically, land use regulations may be one of the largest causes of oak woodland loss because policies tend to direct development to oak woodlands, inasmuch as oak woodland in its natural state generates little income from agriculture or forestry (Steve Smith, pers. comm.).

In many of the oak woodlands that remain, oaks are stunted due to overcrowding and production of mast (acorn) may consequently decline. This has occurred largely as a result of decades of fire suppression. Overcrowding of oaks and invasion of oak stands by faster-growing Douglas-fir has reduced the amount of light reaching the woodland floor of most oak woodlands, thus reducing the percent cover and diversity of understory plants (Thilenius 1964). This trend toward structural simplification and smaller-diameter trees has been documented as having adverse effects on at least 12 bird species (Hagar & Stern 2001). It also has reduced foods for deer and elk, causing them to concentrate to a greater degree in nearby agricultural areas where they create problems. Unfortunately, in oak woodlands that are regulated by the Oregon Forest Practices Act, harvested oaks must be replaced with conifers (150/ac) unless prior exemption is requested. In running computer simulations of future environmental conditions in the Willamette subbasin, one researcher (Payne 2002) assumed the maximum rate at which Douglas-fir might invade oak stands to be about 100 lateral feet per 15 years, as opposed to an expansion rate for oak of 100 ft per 100 years. Oak stands that are perhaps least vulnerable to Douglas-fir dominance are those in the driest settings.

Surely the most potent future threat to oak woodland is Sudden Oak Death, a disease that is decimating California oaks and has begun spreading to Oregon. Depending on accompanying changes in precipitation patterns, global warming has the potential to create microclimates in the Willamette subbasin that are even more favorable for oak woodlands.

Especially near urban areas and roads, oak woodlands are vulnerable to invasive plants such as English ivy (*Hedera helix*), false-brome (*Brachypodium sylvaticum),* and scotch broom *(Cytiscus scoparius).* Minor harvesting of oaks for firewood and lumber also occurs. Threats to specific areas containing oak woodlands in the subbasin were assessed by The Nature Conservancy (Table 7).

2.2.5 Protection, Restoration, and Management

In the portion of their *Ecoregional Assessment* covering the Willamette Valley, TNC recommended a goal of conserving all remaining viable acres of oak woodland, which they estimated at 48,346 acres (Floberg et al. 2004). As part of the *Willamette River Basin Operational Plan* ODFW recommended conservation of 50,000 acres. The Willamette Joint Venture set an objective of 14,000 acres (Roth et al. 2002). Recognition of the importance of oak woodlands in the Willamette subbasin has lagged behind recognition of the importance of riparian, wetland, and prairie habitats, but is increasing. There is presently no program to compensate landowners for lost direct economic value of their land when they conserve oak woodlands.

Protection of remaining oak woodlands should emphasize low-elevation sites in parts of the subbasin where data indicate oak woodland existed historically, and/or where soils and other site factors are most likely to support oak woodland over the long term. Nonetheless, some higher-elevation oak woodlands should be protected in anticipation of global warming. Protecting or restoring oak woodlands near water will provide additional benefits to some oak woodland species, such as wood duck and tree swallow. No data are available to support a minimum patch size or appropriate interpatch distance for maintaining a disjunct oak stand's ability to be self-sustaining over the long term. Managing oak woodlands within or near urban areas presents additional challenges due to (a) increased vulnerability of oak stands to invasive plants, (b) increased competition between native and non-native (e.g., European starling) birds for nest sites, and (c) impracticality of using controlled burns as a potential management tool.

Most existing oak stands can benefit from selective (not total) removal of conifers, densely-packed oaks, and competing deciduous tree species. This will encourage the eventual creation of large-diameter oaks and greater development of a subcanopy. When feasible the developing subcanopy should be managed to reverse or minimize invasion by non-native shrubs, e.g., Himalayan blackberry (*Rubus discolor*). Mistletoe and poison ivy are natural components of oak woodlands and both produce berries that are used heavily by oak woodland species. They, as well as snags and downed wood, should not be removed from oak stands except where they pose an immediate and extreme safety hazard to people. Specific practices useful for restoring and maintaining oak woodlands (e.g., acorn harvesting and cultivation, thinning, prescribed burning, control of invasives) are described in detail by Campbell (2004).

Other techniques and strategies for managing oak woodlands include managing grazing, retaining all trees larger than 22 inches diameter, and protecting all tracts larger than 100 acres (Altman 2000). Areas of the subbasin most suitable for restoration of oak woodland have been mapped at a coarse scale using soils and other spatial data, e.g., Payne (2002).

2.2.6 Compatibility of Oak Woodland Management and Stream Habitat Management.

There is no inherent incompatibility between managing oak woodlands and stream habitats. However, stream restorations alone do not provide a significant benefit to oak woodlands and their wildlife and plant species, except to the degree that restoration of riparian cover connects fragmented tracts of oak woodland. Although Oregon white oak often occurs as a component of riparian habitats, the largest tracts of oak woodland are situated in the subbasin's foothills. When warranted by site conditions Oregon white oak should be considered for inclusion in stream bank planting programs. A disadvantage is that oak grows more slowly than riparian species such as willow and cottonwood. Along stream banks, removal of invasive species such as Himalayan blackberry will likely benefit natural establishment of oaks. If controlled burns are used to enhance oak woodlands, the potential for adverse effects on quality of nearby aquatic habitats should be evaluated.

2.2.7 Contribution of Oak Woodlands to Regional Biodiversity

Compared with other Willamette habitat types, oak woodlands in good condition provide the best habitat for 37 wildlife species, and are used regularly by at least an additional 100 wildlife species (Detail File: HABTYPE). The oak woodland avifauna includes 27 birds whose numbers appear to be declining regionally.

2.2.8 Selected Focal Species

Monitored at a regional or watershed scale, the relative abundance and spatial distribution of oak woodland focal species (along with other indicators described in section 2.2.9) should reflect the extent and ecological condition of oak woodlands. The following wildlife species are proposed as focal species for this habitat type: acorn woodpecker, chipping sparrow, western wood-pewee, white-breasted nuthatch, southern alligator lizard, sharptail snake, and western gray squirrel.

On a scale of 0 to 10, their average degree of association with oak woodlands[10] is a 9.2. Compare this with HEP "loss assessment" species[11] used in many previous mitigation

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[10] Calculated from accompanying Detail File: HABTYPE, using the "Hardwood Open" class as a surrogate for oak woodland, which could not be mapped. See section 1.4 for explanation of the scoring scale.
[11] HEP = Habitat Evaluation Procedure (USFWS 1980). HEP is the procedure that has been used most often by Bonneville Power Administration and other agencies to determine the amount of mitigation required for loss of habitat in the region due to construction of reservoirs.

calculations and land acquisitions in the Willamette subbasin. Of the "hardwood forest" species used in HEP applications, the average degree of association with oak woodlands is only 7.5. This suggests there may have been an unintentional but systematic bias against at oak woodlands in previous mitigation land dealings in the Willamette subbasin.

Acorn Woodpecker

Special Designations: "Species of Concern" (USFWS). Partners In Flight focal species. Distribution, Status, and Trends: In the Willamette subbasin this non-migratory, cavity-nesting species seldom occurs above 1000 ft elevation. Application of simple species-habitat models to aerial imagery (that did not delineate oak woodlands specifically) using GIS suggests 5.75% of the subbasin might contain habitat that could be at least marginally suitable and 0.26 might contain good habitat. NHI models and data project this species has a close association with habitat in 1% of the subbasin. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 17% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 13% of the units[12] Along Willamette subbasin BBS routes[13], the species was detected at 0.25% of surveyed points in 2003, with a maximum during the period 1968-2003 of 0.86% in 1976. Wintering birds are found by most subbasin CBCs; numbers are generally 10-30 birds per count area. Acorn woodpecker apparently was absent in the Willamette subbasin until about 1920 (Simmons 2003). Its spread northward has coincided with disappearance of the closely-related Lewis' woodpecker. BBS data covering the period 1968-2003 show a decrease in the Willamette Valley and western Oregon-Washington generally, with possibly a slight increase since 1980 in the Willamette. Several pairs may nest in the same oak stand, forming a loose colony. Populations may fluctuate in response to semi-annual cycles in acorn production, so several years of monitoring data are needed to infer trends. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate oak woodlands specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	1105	99	2.27
170900090101	Aurora	1	837	30	1.81
170900070306	W. Salem	1	780	211	1.68

[12] The area of each survey unit was 245 square miles, and obviously no unit could be surveyed in its entirety. Species occurrence in a unit means it was found in at least one spot within the unit – not necessarily throughout the unit – during at least one year (late spring and summer) 1995-1999. About 53 units were located entirely or mainly within the Willamette subbasin.

[13] Beginning in 1968, an average of 8 Breeding Bird Survey (BBS) routes have been run each year in the Willamette subbasin (range = 2 to 14), with 50 point counts conducted per route. As a result of this relatively small sample size none of the species trends reported herein and using the BBS data are statistically, unless noted otherwise.

170900090102	Woodburn; Hubbard	1	747	83	1.65
170900070305	Keizer; Spring Valley Cr.	1	1895	230	1.60

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090602	Molalla R. S. Fk.	3	462	40	0.10
170900080203	Willamina Cr. –upper	3	253	14	0.09
170900050401	Gates; Lyons; Mill City	3	455	45	0.07
170900010502	Hemlock; Lookout Point Reservoir	3	379	78	0.06
170900030503	Mary's R. –upper	3	147	11	0.06

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070304	Lincoln	1	1756	0	1.10
170900090101	Aurora	1	636	12	0.83
170900120201	Portland; Forest Hills; Multnomah Channel	1	1093	446	0.77
170900030601	Luckiamute R.4	1	906	0	0.71
170900060101	Crabtree Cr. & Onehorse Slough	1	911	0	0.62

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	1086	97	1.16
170900070303	Chehalem Cr.	1	1567	82	1.10
170900100101	Tigard; Tualatin; Sherwood; King City	1	3221	878	1.08
170900070401	W.Wilsonville	1	1732	185	1.03
170900120202	S. Milwaukie; Happy Valley; Lake Oswego	1	934	295	1.03

Key Environmental Correlates: A main requirement seems to be a relatively open area, such as lawn or heavily grazed pasture, beneath a high canopy that contains some oaks (Simmons 2003). Occupied oak stands in Benton County had a mean density of 107 trees/ac and 167 trees/home range, with a mean diameter of 19.2 inches and 2 dead limbs per tree (Doerge 1978). Granary trees (required for storing acorns) are generally of large diameter. Generally not found within the interior of short, dense oak stands. Occupies patches of oak woodland of less than 1 acre in size provided additional oak stands are not too distant and other structural requirements are met (personal observation).

Threats, Limiting Factors, Population Viability: Although it seems to thrive where oaks are large, its increase in the subbasin also has coincided with increased canopy closure and stunting of oaks within remaining oak stands. Possibly the greatest threats are the gradual loss (due to fire suppression) of oak stands having at least a few larger-diameter trees, and increased traffic on roads between suitable oak stands thus endangering dispersing birds. This woodpecker sometimes nests along lightly-trafficked roads in suburbs and does not appear to be extremely sensitive to human presence, but its flycatching behavior may put it at greater risk around roads

with high-speed traffic. No estimates are available of population size or viability. Of the 43 focal wildlife species, this is one of only 14 whose habitat is projected to not increase as a result of future actions described by ERC's Conservation and Restoration Opportunities scenario.
Biological Objectives: As proposed in *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), the habitat objectives should include:

- maintain a mean oak tree diameter of at least 15 inches, with >20% of the trees larger than 22 inches.
- maintain canopy cover of Douglas-fir at less than 5%
- maintain or create a deciduous (predominantly oak) canopy cover of less than 75% and a subcanopy cover of less than 50%

Chipping Sparrow

Special Designations: Partners In Flight focal species.
Distribution, Status, and Trends: Application of simple species-habitat models to aerial imagery (that did not delineate oak woodlands specifically) using GIS suggests 5.75% of the subbasin might contain habitat that could be at least marginally suitable and 0.21% might contain higher-suitability habitat. NHI models and data project this species has a close association with habitat in less than 1% of the subbasin, and a general association with 28%. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 4`% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 54%. Along Willamette subbasin BBS routes the species was detected at 2.25% of surveyed points in 2003, with a maximum during the period 1968-2003 of 10.80% in 1968. BBS data show a decrease for both the Willamette Valley and western Oregon-Washington generally over the period 1968-2003, with a possible increase in the larger region during 1980-2003. The Willamette Valley trends are statistically significant. At Finley NWR, this species was present on all surveyed plots in 1968 but was absent from all in 1994-96 (Hagar & Stern 1997). Since 1850, suitable habitat for this species may have declined by 53% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate oak woodlands specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080601	Yamhill	1	2520	1	1.89
170900090102	Woodburn; Hubbard	1	1667	0	1.75
170900070303	Chehalem Cr.	1	3427	0	1.64
170900070301	Saint Paul	1	1838	0	1.54
170900110103	Sandy	2	4363	0	1.45

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110402	Timothy Lake; Dinger Lake	5	2476	312	0.74
170900010802	Black & Salmon & Wall Cr.	6	620	77	0.65
170900010702	Christy Cr.	5	378	32	0.55
170900110401	Harriet Lake	5	841	87	0.54
170900011101	Groundhog Cr: S.Fork	6	984	235	0.50

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900011201	Staley & Swift & Spruce Cr.	6	4386	1204	1.15
170900110103	Sandy	2	4357	0	1.12
170900040501	Boulder Cr. & Smith R.	5	4721	437	0.84
170900110101	Estacada; E. Gladstone	1	3119	1	0.77
170900070306	W. Salem	2	758	0	0.77

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	2931	0	1.61
170900070303	Chehalem Cr.	1	3177	0	1.48
170900070402	N. Canby; E. Wilsonville	1	3721	0	1.22
170900080601	Yamhill	1	2410	1	1.09
170900070401	W.Wilsonville	1	2365	0	1.08

Key Environmental Correlates: Within oak woodlands, the presence of a native shrub and herbaceous (especially grassy) understory appears to be important (Altman 2000), and the species is more common near edges and openings in oak woodlands or where trees are widely-spaced. Not correlated with oak height or diameter.

Threats, Limiting Factors, Population Viability: Habitat loss and degradation is the greatest threat, with loss of an open grassy ground cover in oak woodlands being a likely limiting factor. Habitat degradation consists of increased density of oaks within stands as a consequence of fire suppression. Other limiting factors may include cowbird parasitism of nests. No estimates are available of population size or viability.

Biological Objectives: As proposed in *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), the habitat objectives should include:

- Maintain or create multiple patches of native shrub cover (e.g., snowberry, poison oak) and herbaceous openings within oak woodlands such that cover of native shrubs is 10-40%, cover of blackberries is <10%, and cover of herbaceous plants is 30-70%

And the following population objectives:

- Reverse declining BBS trends to achieve stable populations (trends of <2%/year) or increasing trends by 2020. Maintain cowbird parasitism rates below 5% within specific woodlands.

Western Wood-Pewee

Special Designations: Partners In Flight focal species.

Distribution, Status, and Trends: This migratory species is fairly common in wooded and partly wooded landscapes of the Willamette subbasin, except in moderate- and high-density residential areas and in landscapes with unbroken conifer forests. Application of simple species-habitat models to aerial imagery (that did not delineate oak woodlands specifically) using GIS suggests 9.95% of the subbasin might contain habitat that could be at least marginally suitable and 1.61% might contain good habitat. NHI models and data project this species has a close association with habitat in less than 1% of the subbasin, and a general association with 92%. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 37% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 59%. Along Willamette subbasin BBS routes the species was detected at 20% of surveyed points in 2003, with a maximum during the period 1968-2003 of 23% in 1974. BBS data covering the period 1968-2003 and 1980-2003 show a decrease in the Willamette Valley, but possibly an increase in western Oregon-Washington generally. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate oak woodlands specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	1263	99	2.91
170900090101	Aurora	1	960	30	2.46
170900010302	Fall & Delp Cr.	4	1871	235	2.29
170900040301	Blue River Reservoir & Cook Cr.	3	1775	359	2.23
170900010803	Waldo Lake; Black & Salmon Cr.	6	982	289	2.21

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010802	Black & Salmon & Wall Cr.	6	1910	579	2.25
170900010702	Christy Cr.	5	2636	673	1.93
170900110402	Timothy Lake; Dinger Lake	5	5259	1973	1.84
170900050102	Marion Lake	6	2630	764	1.77
170900010803	Waldo Lake; Black & Salmon Cr.	6	982	288	1.70

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900011201	Staley & Swift & Spruce Cr.	6	13227	5293	3.10
170900110103	Sandy	2	2041	2	2.59
170900010901	Waldo Lake; Cayuse & Fisher Cr.	6	4270	1691	2.37
170900040301	Blue River Reservoir & Cook Cr.	3	1775	359	2.23
170900040501	Boulder Cr. & Smith R.	5	13146	4522	2.08

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	1086	97	1.16
170900070303	Chehalem Cr.	1	1567	82	1.10
170900100101	Tigard; Tualatin; Sherwood; King City	1	3221	878	1.08
170900070401	W.Wilsonville	1	1732	185	1.03
170900120202	S. Milwaukie; Happy Valley; Lake Oswego	1	934	295	1.03

Key Environmental Correlates: A main requirement seems to be a somewhat open canopy of oaks or other deciduous trees, with few or no conifers (Schrock 2003). The understory may contain herbaceous plants or shrubs.
Threats, Limiting Factors, Population Viability: Possibly the greatest threats are the gradual loss (due to fire suppression) of oak stands having at somewhat open canopy, and increased conversion of its habitat to agriculture, conifer forest, or residential use. The species' flycatching behavior may put it at higher risk around roads with heavy traffic. Sometimes nests along lightly-trafficked roads in suburbs. No estimates are available of population size or viability.
Biological Objectives: As proposed in *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), the habitat objectives should include:

- maintain canopy cover of Douglas-fir at less than 5%
- maintain or create a deciduous canopy cover of 40-85% of which more than 80% is oak

And the following population objective:

- reverse declining BBS trends to achieve stable populations (trends of <2%/year) or increasing trends by 2020.

<u>White-breasted Nuthatch</u>
Special Designations: Partners In Flight focal species.
Distribution, Status, and Trends: In the Willamette subbasin this non-migratory, cavity-nesting species diminishes rapidly above about 1000 ft elevation. Along Willamette subbasin BBS routes the species was detected at 2.25% of surveyed points in 2003, with a maximum during the period 1968-2003 of 6.29% in 1971. BBS data covering the period 1968-2003 and 1980-2003 show a decrease in the Willamette Valley, but possibly an increase in western Oregon-Washington generally. Data from Willamette CBCs also suggest a long-term regionwide decline. Has nearly been extirpated from oak woodlands in Washington. Nesting densities of 3-6 birds/40 ac have been noted in Willamette oak woodlands (Hagar & Stern 2001). Of

Willamette oak woodland birds, it is perhaps the most dependent on large-diameter oaks in semi-open stands (Hagar & Stern 2001). Application of simple species-habitat models to aerial imagery (that did not delineate oak woodlands specifically) using GIS suggests 4.93% of the subbasin might contain habitat that could be at least marginally suitable and 0.21% might contain good habitat. NHI models and data project this species has a close association with habitat in 0.09% of the subbasin, and a general association with 8%. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 30% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 43%. Since 1850, suitable habitat for this species may have declined by 14% (Payne 2002). Wintering birds are found by most subbasin CBCs. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate oak woodlands specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	1105	99	2.38
170900090101	Aurora	1	837	30	1.96
170900070306	W. Salem	1	780	211	1.76
170900060101	Crabtree Cr. & Onehorse Slough	1	1084	0	1.67
170900070305	Keizer; Spring Valley Cr.	1	1895	230	1.59

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010801	Oakridge E.	4	1278	324	0.43
170900010703	Grassy Cr.	4	634	264	0.43
170900010302	Fall & Delp Cr.	4	788	214	0.38
170900040401	Blue River Reservoir & Elk Cr.	4	1074	415	0.31
170900110302	Fish Cr. W.	4	605	209	0.29

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070304	Lincoln	1	1756	0	1.22
170900090101	Aurora	1	636	12	0.95
170900110103	Sandy	2	1445	2	0.88
170900040301	Blue River Reservoir & Cook Cr.	3	1242	359	0.88
170900120201	Portland; Forest Hills; Multnomah Channel	1	1093	446	0.88

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070303	Chehalem Cr.	1	1567	82	0.97
170900090201	S. Canby	1	1086	97	0.97
170900070401	W.Wilsonville	1	1732	185	0.97
170900070402	N. Canby; E. Wilsonville	1	2002	230	0.93
170900070403	Oregon City; West Linn	1	1621	127	0.89

Key Environmental Correlates: Strongly tied to the presence of large-diameter oak or ponderosa pine in semi-open stands, and occasionally associated with other hardwoods, uncommonly in floodplain deciduous forests. Generally not found within the interior of short, dense oak stands. May be sensitive to oak woodland patch size (stands larger than 90 ac had >0.8 birds/ac compared with 0.6 birds/ac in smaller patches; Hagar & Stern 1997).
Threats, Limiting Factors, Population Viability: Habitat loss and degradation is the greatest threat, and large-diameter oaks in semi-open stands are a likely limiting factor. Habitat degradation consists of conifer invasion of oak woodlands as a consequence of fire suppression. No estimates are available of population size or viability.
Biological Objectives: As adapted from the *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), habitat objectives should include the following, applied mainly to areas where oak woodland predominated historically, i.e., where elevation, soil, and other factors can support oak woodland:

- oak canopy cover within woodlands of 40-80%
- non-oak canopy cover within woodlands of less than 10%
- mean oak tree diameter of >22 inches with 20% of the oaks larger than 28 inches
- at a landscape scale, oak woodland patches should be at least 100 ac in size, with at least one patch per watershed (fifth-field HUC) being larger than 300 acres if soil and elevation conditions are suitable for this

And the following population objective:

- achieve stable or increasing populations within 10 years

Sharptail Snake
Special Designations: "Vulnerable" (ODFW). "Rare, threatened, or uncommon" (ONHP).
Distribution, Status, and Trends: Based on information from other states, this species probably occurs in suitable habitat in all parts of the Willamette subbasin, but documented records are few. The ORNHIC database contains documented records from 8 of the 170 Willamette watersheds. NHI models and data project this species has a close association with habitat in less than 1% of the subbasin and a general association in 27%. Little is known of status or trends. Some evidence suggests the Willamette population may be a separate race or species (Hoyer 2001). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate oak woodlands specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft

HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080502	Amity	1	3274	3133	3.03
170900070102	Independence; Monmouth	1	3606	3191	2.80
170900030602	Soap Cr.	1	2287	1714	2.45
170900030101	W. Eugene; Junction City	1	5345	3820	2.03
170900020301	Cottage Grove Reservoir N.	2	2635	2120	1.00

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900100301	Gales & Clear Cr.	2	785	10	0.22
170900030503	Mary's R. -upper	2	289	21	0.21
170900080201	Willamina	2	103	4	0.16
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	2	713	32	0.13
170900080202	Coast Cr.	2	38	2	0.10

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080502	Amity	1	1534	1485	1.24
170900030602	Soap Cr.	1	1212	904	1.14
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	2	1824	1775	0.34
170900030101	W. Eugene; Junction City	2	1263	825	0.24
170900030502	Mary's R -middle	1	462	410	0.20

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	2503	2455	3.39
170900080601	Yamhill	1	2366	2328	3.21
170900070102	Independence; Monmouth	1	2155	1935	2.20
170900030101	W. Eugene; Junction City	1	3767	2894	1.55
170900030603	Luckiamute R.1.	1	1064	650	0.76

Key Environmental Correlates: South-facing talus slopes provide critical sites for egg incubation and hibernation. The relatively few records from the Willamette subbasin are mainly from lowland oak woodlands. However, data from other areas suggest that if ground cover (logs, boulders, etc.) is adequate this snake may occur in conifer forests, clearcuts, deciduous riparian areas, low-density residential areas, and grasslands at any elevation (Nussbaum et al. 1983, Leonard & Ovaska 1998). Feeds largely on slugs.

Threats, Limiting Factors, Population Viability: No estimates are available of population size or viability, but among the snake species currently inhabiting the subbasin its rarity appears to be second only to that of western rattlesnake. Threats might include conversion of woodlands to agriculture land cover; fragmentation of habitat by roads; mining near talus slopes; decimation of invertebrate foods by pesticides; influence of non-native soil invertebrates on soil leaf litter and slugs; reduced subsoil moisture (required by slugs) as a result of agricultural drainage, global warming, and groundwater extraction; and removal of downed wood by landowners (e.g., for fire risk reduction or landscaping).

Biological Objectives:

- Maintain or increase downed wood (especially large-diameter logs) within oak woodlands
- Survey and maintain or increase present population in the subbasin.

Southern Alligator Lizard

Special Designations: None

Distribution, Status, and Trends: Apparently uncommon to common within lower elevations of the subbasin. Found at 1 of 10 oak woodland sampling sites in 1997-1998 (Vesely et al. 1999). NHI models and data project this species has a close or general association with land cover in less than 1% of the subbasin. No trends information is available. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate oak woodlands specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	3482	1947	3.89
170900080601	Yamhill	1	3900	2110	3.63
170900090101	Aurora	1	2398	1343	3.60
170900070301	Saint Paul	1	2444	1463	3.44
170900080702	Lafayette	1	2412	1131	3.36

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900100301	Gales & Clear Cr.	2	981	10	0.23
170900030503	Mary's R. –upper	2	334	18	0.22
170900080201	Willamina	2	118	4	0.16
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	2	806	32	0.13
170900080202	Coast Cr.	2	64	2	0.10

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110103	Sandy	2	5980	2798	2.57
170900060201	Beaver Cr.	1	4629	2711	1.95
170900070304	Lincoln	1	2678	858	1.86
170900110101	Estacada; E. Gladstone	1	5019	1951	1.86
170900080402	Salt Cr.	1	1426	707	1.85

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	3444	1932	3.06
170900080601	Yamhill	1	3727	2007	2.72
170900070402	N. Canby; E. Wilsonville	1	5266	2555	2.55
170900070303	Chehalem Cr.	1	4609	2412	2.54
170900080702	Lafayette	1	2264	1072	2.53

Key Environmental Correlates: Reported from "open, dryer hillsides and oak woodlands, usually where there are clumps of poison oak and other brush" (St. John 1987).
Threats, Limiting Factors, Population Viability: Threats might include fragmentation of habitat by roads; decimation of invertebrate foods by pesticides; and removal of downed wood by landowners (e.g., for fire risk reduction or landscaping).
Biological Objectives:

- Maintain or increase semi-open oak woodlands, especially near rocky areas.
- Maintain or increase present population in the subbasin.

Western Gray Squirrel
Special Designations: ODFW "status uncertain."
Distribution, Status, and Trends: Widely distributed within the subbasin's deciduous woodlands, especially at lower elevations. No data on density or trends are available, but in southern Oregon a density of 3/ac was documented in one area over a 2-year period (Verts & Carraway 1998). Populations fluctuate partly in response to semi-annual cycles in acorn production so several years of monitoring data are needed to infer trends. NHI models and data project this species has a close association with land cover in 1% of the subbasin and a general association in 4%. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate oak woodlands specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation

zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	6282	3646	4.66
170900030503	Mary's R. -upper	2	7081	6591	4.47
170900120202	S. Milwaukie; Happy Valley; Lake Oswego; W	1	2987	2454	4.43
170900110103	Sandy	2	12366	7984	4.24
170900060701	Sweet Home; Foster Reservoir	3	12649	12497	4.15

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010502	Hemlock; Lookout Point Reservoir	3	7005	6943	2.32
170900110303	Fish Cr. E.	3	4101	4078	1.98
170900010301	Fall Cr. Reservoir N.	3	4539	4533	1.88
170900010302	Fall & Delp Cr.	3	4086	4076	1.37
170900080203	Willamina Cr. -upper	3	1800	1794	1.30

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110103	Sandy	2	12360	7979	5.08
170900040301	Blue River Reservoir & Cook Cr.	3	7517	7093	4.39
170900110101	Estacada; E. Gladstone	1	11160	7608	3.57
170900120201	Portland; Forest Hills; Multnomah Channel	1	2629	2382	3.43
170900040102	Gate Cr. S. Fk.	3	7917	7787	2.95

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070402	N. Canby; E. Wilsonville	1	10163	7306	3.31
170900070403	Oregon City; West Linn	1	7516	5311	3.22
170900090201	S. Canby	1	6215	3599	3.14
170900070303	Chehalem Cr.	1	7876	4489	3.04
170900100101	Tigard; Tualatin; Sherwood; King City	1	11923	8081	2.94

Key Environmental Correlates: Acorns comprise a major portion of diet so this species inhabits oak woodlands extensively but not exclusively. Also occurs in riparian woodlands, orchards, and mixed forest. Nests (dreys) are constructed in tall trees but large tree cavities also are apparently important for birthing, sleeping, and shelter.

Threats, Limiting Factors, Population Viability: Loss of contiguous oak woodland and degradation of remaining tracts (i.e., reduced occurrence of large oaks suitable for nest cavities) may limit populations. Populations also have been impacted by disease (mange), at least in Washington (Larsen & Morgan 1998). Increased fragmentation of woodlands with heavily trafficked roads may be having a substantial impact, as roadkill of dispersing squirrels appears to be common.

Biological Objectives:

- Maintain or increase conditions supportive of sustaining a supply of large oaks within woodlands
- Survey and maintain (or increase) the present population in the subbasin.

<u>Other Priority Species in Oak Woodlands</u>

If the focal species list was expanded to include other species, some strong candidates for focal-species status -- based on degree of association with oak woodland -- are wood duck, American kestrel, white-tailed kite, western screech-owl, downy woodpecker, western scrub-jay, black-capped chickadee, bushtit, Bewick's wren, house wren, Cassin's vireo, western bluebird, cedar waxwing, yellow warbler, Nashville warbler, lazuli bunting, American goldfinch, western fence lizard, and dusky-footed woodrat. In addition, many rare plant species not currently listed as threatened or endangered at the federal level could be included as focal species.

2.2.9 Synthesis: Indicators of Oak Woodland Ecological Condition and Sustainability

The following indicators – which must be assessed in the field -- may be useful for prioritizing oak woodland parcels for protection and restoration, as well as for monitoring success of restoration projects and long-term trends in quality of remaining oak woodlands.

> *Extent of oak woodland*: the mean patch size and acreage of oak woodland (subtotaled by age class and canopy cover if possible) compared with historical extent; should be subtotaled within watersheds by geomorphic position (elevation, geology, soils, orientation) and degree of fragmentation (distance to nearest similar patch and type of intervening land cover types);
>
> *Focal species status*: the density, interannual frequency of occurrence, and distribution (proportion of sample points where detected) of each focal species within parts of a watershed that are projected (by models, aerial imagery, historical vegetation data, and professional judgment) to be generally suitable for the species based on elevation and gross land cover type.
>
> *Characteristics of live oaks*: the density and diversity of sizes (based on diameter and height) of Oregon white oak within and among individual tracts of oak woodland in a particular watershed.
>
> *Dead wood characteristics*: the density and diversity of sizes (based on diameter and stage of decay) of standing and downed Oregon white oak within and among individual tracts of oak woodland in a particular watershed. See: Gumtow-Farrior (1991).
>
> *Understory native herbaceous plant cover*: the percentage of the total subcanopy herbaceous (non-shrub) plant cover that is comprised of native species, especially those characteristic of Willamette oak woodlands, e.g., long-stolon sedge, common camas, sword fern, Roemer's fescue, poison-oak.

Understory native shrub cover: the percentage of the total subcanopy woody (shrub) cover that is comprised of native shrub species, especially those characteristic of Willamette oak woodlands, e.g., wedgeleaf ceanothus, common snowberry, oval-leaf viburnum.

Characteristic epiphytes: presence or absence of mistletoe as well as lichens and mosses (especially those that are pollution-sensitive) that often grow amid the branches of Oregon white oak and/or other hardwood trees. See: McCune & Geiser 1997, Merrifield 2000, Peterson & McCune 2003.

It is not possible, without first collecting an appropriate array of reference data, to specify exact criteria for evaluating each of these indicators or to indicate how they could best be combined into a single index of oak woodland functional integrity. Earlier in this section, numeric criteria were suggested for a few focal species for which minimally adequate data were available to judge habitat quality.

2.3 Focal Habitat: Upland Prairie, Savanna, and Rock Outcrops

2.3.1 Description

For purposes of this report, upland prairie is defined as communities where native grasses (especially bunchgrasses) and forbs predominate, with little or no woody vegetation, and not dominated by hydric soils or plant communities characteristic of wetland environments. When shrubs and/or trees are also present, but comprise less than 30% canopy cover, the habitat is termed "savanna" and some authors have grouped this with oak woodland rather than with upland prairie. Likewise, some authors have grouped upland (dry) prairie with wetland prairie which is discussed in section 2.4. This report includes herbaceous balds, bluffs, talus slopes, and rock outcrops under the upland prairie-savanna category, although rocky conditions sometimes occur within other cover types, and certainly not all upland prairie occurs in rocky areas. Also included are caves, which are generally rare in the Willamette subbasin.

Upland prairie/savanna occurs primarily on hillslope meadows and forest clearings at generally low elevations, where soils are mostly shallow, well-drained, and subject to chronic natural disturbance. At least historically, prairies, savanna, and oak woodlands formed a successional mosaic throughout lower-elevation parts of the Willamette subbasin. Many such areas were maintained by fire, often set intentionally by indigenous tribes. The major native dominant bunchgrass is Roemer's fescue (*Festuca idahoensis* var. *roemeri*). More locally, red fescue (*F. rubra*), California oatgrass (*Danthonia californica*) sometimes are dominant or co-dominant. Common camas (*Camassia quamash*) is a frequent forb, as is bracken fern (*Pteridium aquilinum*). The presence of several native slow-growing, colorful forbs also is characteristic of upland prairies. The scattered native shrubs include common snowberry (*Symphoricarpos albus*), Nootka rose (*Rosa nutkana*), poison- oak (*Toxicodendron diversilobum*), and serviceberry (*Amelanchier alnifolia*), and trees are typically Oregon white oak and (especially in presettlement times) ponderosa pine (*Pinus ponderosa*).

2.3.2 Recognition of Importance

Upland native prairie is among the rarest of North American ecosystems. Upland prairie-savanna has been identified explicitly as a priority for protection and restoration in nearby regions and in the Willamette subbasin specifically (Table 8). Much of the recent attention directed at this habitat has been due to its hosting three federally-listed species: Golden Paintbrush (*Castilleja levisecta*, now extirpated from the subbasin), Kincaid's lupine (*Lupinus sulphureus var kincaidii*), and Fender's blue butterfly (*Icaricia icarioides fenderi*). In addition, this habitat hosts the streaked race of the horned lark (currently being considered for federal listing); vesper sparrow (state-listed as "critical"); and sharptail snake, western rattlesnake, and western bluebird (all state-listed as "vulnerable"). Wildlife species that may have used savanna regularly before vanishing as breeders from the Willamette subbasin include Lewis's woodpecker, black-billed magpie, lark sparrow, and Oregon spotted frog. Literature pertaining to wildlife of grasslands and including the Willamette subbasin was reviewed by Altman et al. (2001), and two useful web sites provide bibliographies, botanical information, and research news on Willamette prairies:
http://oregonstate.edu/~wilsomar/Index.htm and http://www.appliedeco.org/reports.html

2.3.3 Status and Distribution

No maps showing upland prairie and/or savanna are available for the entire subbasin. Thus, no completely reliable data are available on the present extent of this habitat type. Nonetheless some existing vegetation and land cover maps use categories that include upland prairie/savanna to a varying and uncertain extent, as shown in Table 11 below.

Table 11. Acreage estimates of land cover types that include upland prairie-savanna

Source	Map categories that include upland prairie and/or savanna	Estimated area (acres)	Percent of mapped area
EC1850	"oak savanna" + "grass natural"	1,294,450	17.76
EC90	"grass natural"	22,041	0.30
IBIS	--		
ODFW*	"unmanaged pasture"	171,558	8.84
TNC	"Upland prairie & savanna" "Herbaceous balds & bluffs"		

* Valley only – not entire subbasin

Table 12. Remaining upland prairies of the Willamette Valley

From Wilson (1998a). Savanna, roadside, and very small sites are excluded, as are sites that formerly were prairie but now are dominated by non-native vegetation. See also Table 4, which overlaps to some degree.

Site	County	Ownership	Quality
Bald Hill	Benton	Corvallis	Medium-high
Baldy (Finley NWR)	Benton	FWS	Low
Butterfly Meadows	Benton	Private, OSU	Medium-very high
Carson Prairie	Benton	OSU	High
Forest Peak	Benton	OSU/BLM	Medium-high
Henkle Way	Benton		Unknown
Jackson Prairie	Benton	OSU	Low
Noble Pasture	Benton	Private	Low-high
Open Space Park	Benton	County	Medium-high
Philomath Prairie	Benton	Private	Low-high
Pigeon Butte	Benton	FWS	Low-medium
Shafer Creek	Benton		Unknown
Shoulder-to-Shoulder Farm	Benton	Private	Medium
West Hills Road	Benton	Private	Medium
Wren	Benton	TNC	Medium-high
Camassia Natural Area	Clackamas	TNC	Medium
NE of Estacada	Clackamas		Low
Coburg Ridge	Lane	Private	Medium-very high
Dorena Prairie	Lane	BLM	Medium
Fern Ridge	Lane	COE	Low-medium
Fir Butte	Lane	Eugene	Low
Hilaire Rd.	Lane	Private	Low
McKenzie Drive	Lane	Private	Medium
Mt. Pisgah	Lane	Lane Co	Medium
Rattlesnake Butte	Lane	TNC, US Bank	Medium

Site	County	Ownership	Quality
Row Point	Lane	COE	Medium
Sanford Drive	Lane	Private	Medium
Spencer Butte Summit	Lane	Eugene	Medium
Willow Creek	Lane	TNC	Low-medium
Horse Rock Ridge	Linn	BLM	Low-very high
Kingston Meadows	Linn	Private	Low-very high
Peterson Butte	Linn	Private	Low
Twin Buttes	Linn		Low
Wisner Cemetery	Linn	Private	Low
Edison Road Grassland	Marion		Medium
Fire Knob	Marion		Medium
Hidden Oaks	Marion		Medium
Riches Road	Marion	Private	Low
Sublimity Grassland Preserve	Marion	TNC Easement	Medium-high
Tower Ridge	Marion		Low
Baskett Butte	Polk	FWS	Low- high
Dallas	Polk	Private	Medium
Dolph Corner Hills	Polk		Low
Grand Ronde Strip	Polk	Private?	Low
Mill Creek	Polk	ODOT	Low-medium
Oak Ridge	Yamhill	Private	Low-medium
Unnamed Butte	Yamhill		Low

2.3.4 Past Impacts, Limiting Factors, and Future Threats

Upland prairies were among the first habitats to be plowed by early settlers of the Willamette Valley. Plowing altered the native plant and animal communities, but not nearly as severely as later development would. Grazing also occurred, first with free-ranging livestock and eventually within fenced prairies. This, along with increasing size of farms as farm machinery became more effective, changed the early landscape from a patchwork of small scattered farms interspersed with prairies to the monocultural expanses that prevail today. In the 1990s, many landowners established hybrid poplar plantations on former prairies. Most of these plantations are now being cut and not replanted. Because it is generally infeasible to convert them to cropland (due to extensive left-over stumps and roots), this may pose an opportunity for restoration to prairie habitat.

Watersheds within the subbasin may be ranked according to their presumed historic and present extent of upland prairie/savanna, and by the very approximate percent change (Table 47). These data show both the historic and present upland prairie/savanna occurring mostly in the southern and western portions of the subbasin. Most exists on private land.

Much of the upland prairie-savanna that remains exists in the foothills. There, the acreage of vineyards and Christmas tree plantations, as well as residential neighborhoods, has been expanding As is true of oak woodlands, land use regulations and property tax policies contribute to loss of this habitat type because upland prairie-savanna, unless planted with trees or crops, generates little income. A few of the rare plants characteristic of upland prairie-savanna persist as well along shoulders of rural roads and other rights-of-way, but are vulnerable there to routine herbicide applications. Butterflies of upland prairies are vulnerable to elimination by pesticide drift, even by the drift of relatively innocuous (to other insects) pesticides such as BT (Severns 2002).

Most of the few remaining areas of upland prairie-savanna, if not being planted with trees on purpose, are changing to upland forest through natural succession. This has occurred largely as a result of decades of fire suppression. It is mainly the sites located in extremely rocky, steep terrain that have not succumbed to this or to development pressures. Upland prairie-savanna is vulnerable to invasion by a wide variety of plants, both herbaceous (e.g., tall oatgrass, *Arrhenatherum elatius*) and woody (e.g., scotch broom), and both native (e.g., snowberry) and non-native (e.g., Himalayan blackberry). These form dense patches that exclude most native plant species, consequently altering habitat structure (Kaye et al. 2003). In some situations grazing may help check the spread of invasive shrubs (e.g., short-duration, high-intensity grazing by goats) whereas in other situations it can serve as a vector for introduction or spread of non-native grasses and forbs. If global warming results in increased frequency and severity of drought in the subbasin, the area of upland prairie might eventually increase, provided seed banks in the soil are still viable. Threats to specific areas containing upland prairie-savanna in the Willamette subbasin were assessed by The Nature Conservancy.

2.3.5 Protection, Restoration, and Management

As is the case with oak woodlands, recognition of the importance of upland prairie-savanna has lagged behind recognition of the importance of riparian, wetland, and wetland prairie habitats, but is increasing, e.g., Wilson (1998a). Given the scarcity of this habitat and the severity of past losses, all remaining relicts of upland prairie-savanna larger than an acre or so should be protected and managed to maintain their characteristic communities. Growth of widely scattered trees may be encouraged for their benefits to wildlife, but when implementing restoration projects, most trees within areas that historically were upland prairie should be removed. Other techniques and strategies include controlling invasive vegetation, managing grazing, protecting no-spray buffers of natural vegetation, and researching techniques to manage commercial grasslands, lawns, and plantations in ways that will encourage the development of some of the structural features present in native prairies. Specific practices useful for restoring and maintaining upland prairie (e.g., seeding, mowing, prescribed burning, direct control of invasives) are described in detail by Campbell (2004). Areas of the subbasin most suitable for restoration of upland prairie have been mapped at a coarse scale using soils and other spatial data, e.g., Payne (2002).

2.3.6 Compatibility of Upland Prairie-Savanna Management and Stream Management

There is no inherent incompatibility between managing upland prairie-savanna and stream habitats. However, stream restorations alone do not provide a significant benefit to upland prairie-savanna habitats and their wildlife and plant species. When controlled burns are used to enhance prairie-savanna, the potential for adverse effects on quality of nearby aquatic habitats should be evaluated. If stream restoration activities involve regrading or planting of woody cover, efforts should be made to insure that those activities do not impact adjoining upland prairie-savanna.

2.3.7 Contribution of Upland Prairie-Savanna to Regional Biodiversity

In the Willamette subbasin, this habitat includes the most endemic species (species that occur nowhere else in the world). Upland prairie in good condition provides the best reproductive habitat for 22 wildlife species, and is used regularly by at least an additional 56 breeding wildlife species (see file HABTYPE). Adding the list of oak savanna species to the upland prairie list brings the total number of potentially-occurring wildlife species in upland prairie-savanna to 135. Several species associated with upland prairie also use wetland prairie (section 2.4). Some use agricultural lands as well, perhaps at some cost to reproductive success and survival. The upland prairie-savanna habitat type supports several birds whose numbers appear to be declining regionally, based on BBS data.

2.3.8 Selected Focal Species

The following are proposed as focal species for this habitat type:

Plants: golden paintbrush, white rock larkspur, white-topped aster, Kincaid's lupine
Wildlife: Fender's blue butterfly, Taylor's checkerspot butterfly, horned lark (streaked subspecies), vesper sparrow (Oregon subspecies), western meadowlark, western bluebird, western rattlesnake, black-tailed jackrabbit

On a scale of 0 to 10, their average degree of association with upland prairie is a 7.0, and their association with savanna[14] is 8.3. Compare this with HEP "loss assessment" species used in many previous mitigation credit calculations and land acquisitions in the Willamette subbasin. Of the "grass-forb" species used in HEP applications, the average degree of association with upland prairie is 4.6 and the association of HEP's "hardwood forest" species is 7.7. This suggests there may have been an unintentional but systematic bias against upland prairie-savanna in previous mitigation land dealings in the Willamette subbasin.

Golden Paintbrush (*Castilleja levisecta*)
Special Designations: "Threatened" (federal). "Endangered" (ODA). "Possibly Extirpated" (ONHP).
Distribution, Status, and Trends: Attempts are currently being made to re-establish this apparently extirpated species which occurs only in the Pacific Northwest. This species is an herbaceous perennial that may reproduce only by seed, although clumps may spread vegetatively over short distances.
Key Environmental Correlates: Occurs in shallow soils at unshaded or partly shaded locations in lowlands or foothills. Also probably once occurred on edges of wetland prairies.
Threats, Limiting Factors, Population Viability: Its extirpation apparently has been caused by loss and degradation of upland prairie-savanna habitat as a result of factors discussed in section 2.2.4. Some types of controlled burns and mowing may benefit this species. Other factors that

[14] Calculated from file HABTYPE, using the "Oak Savanna" class as a surrogate for savanna, which could not be mapped, and the "Grassland Natural" as a surrogate for upland prairie.

have been cited as contributing to its disappearance include gravel mining and grazing by both livestock and by wildlife).
Biological Objectives: Maintain and increase current numbers and distribution through habitat protection, restoration, and management. The species recovery plan (USFWS 2000) describes objectives and identifies population reintroduction and development of propagation methods as high priority actions to meet the recovery objectives.
For Further Information: USFWS 2000, Caplow 2001, Kaye 2001, Kaye & Lawrence 2003, Thomas et al. 2003

White Rock Larkspur (*Delphinium nuttallii* ssp. *ochroleucum*)
Special Designations: "Endangered" (ODA). "Imperiled" (ONHP).
Distribution, Status, and Trends: Occurs in the northern part of the subbasin and at one Washington location. Currently exists at fewer than 20 locations. The ORNHIC database contains documented records from 9 of the 170 Willamette watersheds. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units contain records of this species in the ORNHIC database.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?
170900070301	Saint Paul	1	yes	yes
170900070403	Oregon City; West Linn	1	no	no
170900120202	S. Milwaukie; Happy Valley; Lake Oswego; W	1	no	no
170900070402	N. Canby; E. Wilsonville	1	no	yes
170900070403	Oregon City; West Linn	1	no	yes
170900100102	Hillsboro	1	no	yes
170900110101	Estacada; E. Gladstone	1	no	yes
170900110102	Clear Cr.	1	no	yes
170900090401	Scotts Mills Senecal Cr. & Mill Cr.	2	no	yes
170900090501	Molalla	2	no	yes
170900090501	Molalla	3	no	yes

Key Environmental Correlates: Requires relatively dry prairies.
Threats, Limiting Factors, Population Viability: Its extirpation apparently has been caused by loss and degradation of upland prairie-savanna habitat as a result of factors discussed in section 2.2.4. Drift of herbicides applied during agricultural operations and roadside maintenance may also be having an effect.
Biological Objectives: Maintain and increase current numbers and distribution through habitat protection, restoration, and management.

White-topped (Curtus's) Aster (*Aster curtus = Sericocarpus rigidus*)
Special Designations: "Threatened" (ODA). "Imperiled" (ONHP).
Distribution, Status, and Trends: Restricted to the Pacific Northwest. The ORNHIC database documents records from 8 of the 170 Willamette watersheds. Of the 170 sixth-field watersheds

in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units contain records of this species in the ORNHIC database.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?
170900030101	W. Eugene; Junction City	1	yes	yes
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	1	yes	yes
170900090702	Drift Cr.	2	no	no
170900090704	Silverton S.	2	no	no
170900030103	Coyote Cr.	3	no	no
170900030101	W. Eugene; Junction City	1	no	yes
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	1	no	yes
170900030103	Coyote Cr.	1	no	yes
170900070403	Oregon City; West Linn	1	no	yes
170900020102	Creswell W.; Camas Swale	2	no	yes
170900030103	Coyote Cr.	2	no	yes
170900050601	Jefferson; Lyons; Bear Branch	2	no	yes
170900090702	Drift Cr.	2	no	yes

Key Environmental Correlates: Requires relatively dry prairies.
Threats, Limiting Factors, Population Viability: Its extirpation apparently has been caused by loss and degradation of upland prairie-savanna habitat as a result of factors discussed in section 2.2.4. Other threats include the continued loss or degradation of habitat due to development, grazing, and off-road vehicle use.
Biological Objectives: Maintain and increase current numbers and distribution through habitat protection, restoration, and management.
For More Information: Kaye et al. 2003

Kincaid's Lupine (*Lupinus sulphureus* var. *kincaidii*)
Special Designations: "Threatened" on both federal and state lists. "Imperiled" (ONHP).
Distribution, Status, and Trends: Occupies 51 sites comprising 357 acres and located within 21 of the 170 watersheds in the Willamette subbasin (ORNHIC data). It persists in the areas where upland prairie has been protected but future survival will require active management within these areas and probably the protection of additional upland prairies. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units contain records of this species in the ORNHIC database.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?	HS
170900080601	Yamhill	1	no	no	2.49
170900070102	Independence; Monmouth	1	no	no	1.54
170900030601	Luckiamute R.4	1	no	no	1.24

170900030606	Little Luckiamute R. - lower	1	no	yes	0.75
170900080603	Panther & Haskins Cr.	1	no	no	0.75
170900030504	Finley NWR; Muddy & Hammer Cr.	1	no	yes	0.74
170900080403	Deer Cr.	1	no	no	0.74
170900030602	Soap Cr.	1	no	yes	0.73
170900030604	Luckiamute R.2.	1	no	no	0.65
170900030103	Coyote Cr.	1	no	yes	0.55
170900030103	Coyote Cr.	2	no	no	0.53
170900030501	Corvallis; Philomath; Mary's R.-lower	1	no	yes	0.50
170900030603	Luckiamute R.1.	1	no	no	0.49
170900070101	Baskett Slough NWR	1	yes	yes	0.41
170900030502	Mary's R -middle	2	no	no	0.33
170900080403	Deer Cr.	1	no	yes	0.32
170900030101	W. Eugene; Junction City	1	no	yes	0.25
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	1	no	yes	0.21
170900030504	Finley NWR; Muddy & Hammer Cr.	1	yes	yes	0.16
170900030502	Mary's R -middle	2	no	yes	0.12
170900080301	Mill & Gooseneck Cr.	1	no	yes	0.10
170900080603	Panther & Haskins Cr.	2	no	yes	0.08
170900080604	Turner Cr.	2	no	yes	0.07
170900030201	Corvallis N.; Adair Village	2	no	no	0.04
170900030101	W. Eugene; Junction City	1	yes	yes	0.03
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	1	yes	yes	0.03
170900030501	Corvallis; Philomath; Mary's R.-lower	3	no	yes	0.02
170900040201	Horse & Parsons & Cash & Mill Cr.	3	no	yes	0.01

Key Environmental Correlates: The species is restricted almost entirely to upland prairie. Although sometimes found on steep grassy slopes and rock outcrops, these habitats are usually too dry to sustain significant populations. The lupine is a long-lived (up to 25 years) perennial that requires pollination by insects. Populations have been invigorated by controlled burns, fall mowing, and other measures to reduce shading (Clark & Wilson 1998). The species is amenable to re-establishment in suitable habitats using seeding or transplants, and restoration may best be accomplished by expanding populations at known sites rather than attempting establishment at sites where historical occurrence is undocumented (Severns 2003).
Threats, Limiting Factors, Population Viability: Habitat loss and degradation are the main limiting factors, and are being caused by factors discussed in section 2.2.4. Long-term viability depends largely on control of shading plants, reducing competition from invasive herbaceous plants, and maintaining pollinator populations.
Biological Objectives: Maintain and increase current numbers and distribution through habitat protection, restoration, and management.
For Further Information: USFWS 1998, Kaye & Kuykendall 2001, Kaye & Cramer 2002, Kaye et al. 2003

Fender's Blue Butterfly
Special Designations: "Endangered" (federal). "Critically Imperiled" (ONHP).
Distribution, Status, and Trends: Once thought extirpated from the Willamette subbasin, it was rediscovered in 1989. The population fluctuates annually but current estimates are of about 3,000 to 4,000 individuals at about 32 sites in 12 (of 170) watersheds in the Willamette subbasin. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the

following watershed-elevation zone units contain records of this species in the ORNHIC database.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?	HS
170900070102	Independence; Monmouth	1	no	no	1.63
170900030101	W. Eugene; Junction City	1	no	no	1.10
170900030606	Little Luckiamute R. - lower	1	no	yes	0.89
170900080403	Deer Cr.	1	no	no	0.84
170900030604	Luckiamute R.2.	1	no	no	0.76
170900030501	Corvallis; Philomath; Mary's R.-lower	1	no	yes	0.58
170900070101	Baskett Slough NWR	1	yes	yes	0.44
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	1	no	yes	0.24
170900030502	Mary's R -middle	2	no	yes	0.17
170900070102	Independence; Monmouth	2	no	yes	0.15
170900030606	Little Luckiamute R. - lower	2	no	no	0.12
170900080301	Mill & Gooseneck Cr.	1	no	yes	0.12
170900080604	Turner Cr.	2	no	yes	0.09
170900070102	Independence; Monmouth	2	no	no	0.07
170900040101	E. Springfield; Camp & Ritchie Cr.	3	no	yes	0.05
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	1	yes	yes	0.03
170900030501	Corvallis; Philomath; Mary's R.-lower	3	no	yes	0.03

Key Environmental Correlates: Distribution parallels that of Kincaid's lupine (see above), upon which it is completely dependent. Thus, it is restricted to upland prairie and shares the same requirements as the lupine. Biological information is summarized in Schultz et al. (2003).
Threats, Limiting Factors, Population Viability: Habitat loss and degradation are the main limiting factors, as caused by factors discussed in section 2.2.4. Controlled burning may benefit the species by benefiting its host plant, Kincaid's lupine (Schultz 1998, Pendergrass 1999). Habitat destruction is the largest threat to the survival of both the Fender's blue butterfly and Kincaid's lupine (USFWS 1998). Of 12 sites identified as having this species in 1991, agricultural or urban development had caused habitat loss in six sites by 1997 (Hammond 1998). Pesticide drift, even from otherwise benign "biological" pesticides (BT), has the potential to imperil local populations in some instances. Population viability is discussed by Schultz & Hammond (2003).
Biological Objectives: Maintain and increase current numbers and distribution through habitat protection, restoration, and management.

Taylor's Checkerspot Butterfly
Special Designations: "Candidate" for listing (federal). "Critically Imperiled" (ONHP). The Xerces Society has initiated a lawsuit to place the species on the federal endangered species list.
Distribution, Status, and Trends: Only 2-5 Oregon sites containing about 1500 individuals are known for this subspecies. About 30 years ago they were known from 70 sites. The ORNHIC

database contains documented records from just 3 of the 170 Willamette watersheds. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units contain records of this species in the ORNHIC database.

HUC6	Watershed name (not comprehensive)	Elev	Public?	PCA?
170900030501	Corvallis; Philomath; Mary's R.-lower	2	yes	yes
170900030501	Corvallis; Philomath; Mary's R.-lower	2	No	yes
170900030502	Mary's R -middle	2	No	yes
170900030602	Soap Cr.	2	yes	yes

Key Environmental Correlates: Requires relatively dry prairies that are usually sheltered from prevailing winds by a ring of forest or hills. Often, this butterfly occurs on the sides of hills, perhaps because of the warmer microclimate (Mace Vaughn, pers. comm.).
Threats, Limiting Factors, Population Viability: Habitat loss and degradation are the main limiting factors, as caused by factors discussed in section 2.2.4. Fire, even from prescribed burns, has contributed to loss of this subspecies. Drift of pesticides – even the relatively benign BTK formulation -- has the potential to imperil local populations in some instances. The viability of the few remaining populations is questionable.
Biological Objectives: Maintain and increase current numbers and distribution through habitat protection, restoration, and management. Protect existing sites, survey for additional sites, restore habitat.

American Kestrel
Special Designations: Partners In Flight focal species.
Distribution, Status, and Trends: This resident species once bred commonly in savanna and forest edges in the Willamette subbasin, and is still moderately common. Application of simple species-habitat models to aerial imagery using GIS suggests 4% of the subbasin might contain habitat that could be at least marginally suitable and less than 1% might contain good habitat. NHI models and data project this species has a close association with land cover in less than 1% of the subbasin and a general association in 92%. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 28% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 48%. Along Willamette subbasin BBS routes the species was detected at fewer than 1% of surveyed points in 2003, with a maximum during the period 1968-2003 of 3.25% in 1968. BBS data covering the period 1968-2003 and 1980-2003 show decreases in the Willamette Valley and western Oregon-Washington generally, but perhaps not in the Cascades. Since 1850, suitable habitat for this species may have increased by 84-87% due to increases in forest edge (Payne 2002). At least 525 were present almost simultaneously in January 2004 in farmlands of Lane-Linn-Benton-Polk-Yamhill-Marion Counties (J. Fleischer, pers. comm.). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate upland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation

zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080601	Yamhill	1	2096	1	1.00
170900070301	Saint Paul	1	1510	0	0.96
170900050103	Pyramid Cr.	5	315	49	0.91
170900090201	S. Canby	1	2190	0	0.90
170900080702	Lafayette	1	1232	0	0.87

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110103	Sandy	2	3139	0	0.50
170900060201	Beaver Cr.	1	2745	1	0.48
170900080402	Salt Cr.	1	696	0	0.46
170900110101	Estacada; E. Gladstone	1	2431	1	0.42

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	2172	0	0.79
170900070402	N. Canby; E. Wilsonville	1	2940	0	0.71
170900080601	Yamhill	1	2023	1	0.63
170900070303	Chehalem Cr.	1	2142	0	0.60
170900070401	W.Wilsonville	1	1901	0	0.59

Key Environmental Correlates: For nest sites, kestrels require tree cavities excavated by other species, but will occasionally use nest boxes. Nests are within or along the edge of clearcuts, pastures, or other open areas dominated by grasses and forbs. Kestrels generally do not nest or forage in closed-canopy forest or in fields totally overgrown by shrubs. At all seasons, requires elevated perch within or along a field.

Threats, Limiting Factors, Population Viability: Habitat loss and degradation have been the greatest contributors to decline of the species in the subbasin, and are being caused by factors discussed in section 2.2.4. Being largely insectivorous, kestrels are vulnerable to pesticide-related reductions in their prey. Also, increases in residential development are typically accompanied by increases in European starling and house sparrow, non-native species that usurp nesting cavities. Increased high-speed traffic on rural roads also may contribute to mortality.

Biological Objectives:

- Manage woodlands to provide a sustained supply of cavities (especially in oaks) in trees of at least 24 inch diameter and located either along forest edges that adjoin open areas or within the open areas themselves, i.e., areas with <30% canopy.
- Maintain scattered mid-sized and large trees along field edges, and especially where prairie exists or is being restored.

Population objectives should include:

- Achieve stable populations (negative trends of less than 2% per year) or increasing trends by 2010.

Horned Lark (*strigata* subspecies)

Special Designations: The streaked (*strigata*) subspecies of horned lark was proposed for federal listing in 2002. "Critical" (ODFW). "Critically Imperiled" (ORHP). Partners In Flight focal species.

Distribution, Status, and Trends: The horned lark occurs in large numbers throughout much of eastern Oregon, but the resident population in the Willamette subbasin is a different subspecies and has declined dramatically over the past 50 years. The current breeding population in the subbasin is estimated at under 200 pairs (Altman 2003a). Research on the wintering population is currently underway (R. Moore and D. Robinson, OSU, pers. comm.). The ORNHIC database contains documented records from 18 of the 170 Willamette watersheds. Along Willamette subbasin BBS routes the species was detected at 1% of surveyed points in 2003, with a maximum during the period 1968-2003 of 6.4% in 1981. Application of simple species-habitat models to aerial imagery using GIS suggests 0.78% of the subbasin might contain habitat that could be at least marginally suitable and 0.46% might contain good habitat. NHI models and data project this species has a close association with land cover in less than 1% of the subbasin and a general association in 20%. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 11% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 15%. BBS data covering the period 1968-2003 and 1980-2003 show a decrease in the Willamette Valley, but possibly an increase in western Oregon-Washington generally. The Willamette decrease is statistically significant. Since 1850, suitable habitat for this species may have declined by 162-1014% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate upland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030602	Soap Cr.	1	933	474	0.90
170900030302	Brownsville	1	513	269	0.93
170900030504	Finley NWR; Muddy & Hammer Cr.	1	2029	1271	0.81
170900030402	S. Albany; Tangent.	1	613	421	1.59
170900030202	Monroe; Muddy Cr. E.	1	1488	1130	1.48

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030202	Monroe; Muddy Cr. E.	1	16	15	0.06

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030602	Soap Cr.	1	21	3	0.02
170900070301	Saint Paul	1	18	14	0.02
170900070307	Salem	1	7	0	0.01
170900070304	Lincoln	1	4	3	0.01

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070304	Lincoln	1	1756	0	1.10
170900090101	Aurora	1	636	12	0.83
170900120201	Portland; Forest Hills; Multnomah Channel	1	1093	446	0.77
170900030601	Luckiamute R.4	1	906	0	0.71
170900060101	Crabtree Cr. & Onehorse Slough	1	911	0	0.62

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030402	S. Albany; Tangent.	1	425	284	1.43
170900080702	Lafayette	1	462	316	1.26
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	1	926	693	1.26
170900030301	Courtney Cr.	1	204	166	1.08
170900030202	Monroe; Muddy Cr. E.	1	1005	739	1.06

Key Environmental Correlates: Formerly bred in upland and wetland prairies, but as the area of these has diminished the species has adapted to nesting in some types of agricultural lands, including row crops, conifer plantations, ryegrass fields, grazed pastures, burned fields) as well as road and railroad rights-of-way, wetland prairies, and mudflats. In all cases, prefers large open expanse with short, sparse grass/forb cover and patches of bare ground (mean = 17%). Mean territory size is 1.9 ac. (Altman 2003a).

Threats, Limiting Factors, Population Viability: Habitat loss and degradation have been the greatest contributors to decline of the species in the subbasin, and are being caused by factors discussed in section 2.2.4. Nest failures also occur as a result of trampling by livestock and farm machinery, and possibly from increased predator densities (cats, raccoons) associated with residential development. Pesticides potentially affect feeding and reproduction. Increased high-speed traffic on rural roads also may contribute to mortality.

Biological Objectives: As proposed in *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), the habitat objectives should include:

- maintain or create patches of suitable habitat (individually less than an acre in extent) throughout native and agricultural grasslands; the patches should have these characteristics:
- vegetation shorter than 1 ft
    - 20-50% bare or sparsely vegetated
    - located where disturbance from people, animals, and vehicles is minimal

Population objectives should include:

- maintain more than 20 distinct breeding populations in the subbasin by 2010

Vesper Sparrow (*affinis* subspecies)

Special Designations: "Critical" (ODFW). "Imperiled" (ONHP). Partners In Flight focal species.

Distribution, Status, and Trends: Like the horned lark, the vesper sparrow is common throughout much of eastern Oregon but the population in the Willamette subbasin (which is migratory) is a different subspecies and has declined dramatically over the past 50 years. The current breeding population in the subbasin is estimated at under 200 pairs (Altman 2003b). The ORNHIC database contains documented records from 24 of the 170 Willamette watersheds. Along Willamette subbasin BBS routes the species was detected at 0.75% of surveyed points in 2003, with a maximum during the period 1968-2003 of 3.2% in 1981. Application of simple species-habitat models to aerial imagery using GIS suggests 0.71% of the subbasin might contain habitat that could be at least marginally suitable and 0.20% might contain higher-suitability habitat. NHI models and data project this species has a close association with land cover in 20% of the subbasin. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 20% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 26%. BBS data covering the period 1968-2003 show a decrease in the Willamette Valley and in western Oregon-Washington generally. Since 1850, suitable habitat for this species may have declined by 680-854%, the largest decline of any of the focal species (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate upland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	514	26	0.73
170900090702	Drift Cr.	2	799	4	0.58
170900010101	Rattlesnake & Hills Cr.	2	247	68	0.54
170900090501	Molalla	1	1273	127	0.51
170900070202	Aumsville & Beaver Cr.	2	231	8	0.49

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030602	Soap Cr.	1	18	17	0.02
170900070301	Saint Paul	1	4	2	0.01
170900010502	Hemlock; Lookout Point Reservoir	2	33	1	0.01
170900020401	Dorena Reservoir	2	8	1	0.01

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070307	Salem	1	7	3	0.01

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900060201	Beaver Cr.	1	793	578	0.47
170900030601	Luckiamute R.4	1	166	54	0.25
170900030504	Finley NWR; Muddy & Hammer Cr.	1	893	376	0.25
170900030602	Soap Cr.	1	464	243	0.24
170900080502	Amity	1	53	30	0.20

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	514	26	0.74
170900090501	Molalla	1	1253	127	0.51
170900070202	Aumsville & Beaver Cr.	2	231	8	0.45
170900060301	Lower Thomas Cr. -lower; Scio	1	222	167	0.36
170900080502	Amity	1	148	79	0.23

Key Environmental Correlates: Formerly bred in upland prairie-savanna, but as this habitat has diminished the species has adapted to nesting in two environments: (1) lightly grazed pastures with generally short grass and scattered shrubs, and (2) conifer plantations younger than 5 years old with extensive weeds and grasses. Mean territory size is 3.1 ac (Altman 2003b). Along with other grassland species, this species may be impacted by increases in predator densities associated with urbanization, as well as by diminished inclusion of hedgerows in croplands as farm parcel sizes increase, i.e., agricultural intensification.
Threats, Limiting Factors, Population Viability: Probably similar to horned lark, above.
Biological Objectives: As proposed in *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), the habitat objectives should include:

- maintain or provide patches of suitable habitat individually greater than 20 acres and having these characteristics, which apply mainly to pasture, native prairie, and fallow fields:
- grass of variable heights, generally less than 18 inches tall
- some areas of bare or sparsely vegetated ground
- shrub cover of 5 to 15%
- located where disturbance from people, animals, and vehicles is minimal

Population objectives should include:

- maintain more than 20 distinct breeding populations in the subbasin by 2010

<u>Western Meadowlark</u>
Special Designations: “Critical” (ODFW) just in the Willamette Valley ecoregion. Partners In Flight focal species.

Distribution, Status, and Trends: Like the above two species (horned lark and vesper sparrow) the western meadowlark is common throughout much of eastern Oregon but the Willamette subbasin population (which is mostly resident) has declined dramatically over the past 50 years. The current breeding population in the subbasin is estimated to be less than 300 pairs (Altman 2003c). Along Willamette subbasin BBS routes the species was detected at a maximum of 14.3% surveyed points (in 1974), but none during 2003. Application of simple species-habitat models to aerial imagery using GIS suggests 0.25% of the subbasin might contain habitat that could be at least marginally suitable and 0.20% might contain good habitat. NHI models and data project this species has a close association with land cover in 20% of the subbasin. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 11% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 30%. BBS data covering the period 1968-2003 show a decrease in the Willamette Valley as well as in western Oregon-Washington generally. These declines are statistically significant. Willamette CBC data show a decline from about 100 birds per CBC in the late 1970s to about 50 birds per CBC in the mid 1990s. Since 1850, suitable habitat for this species may have declined by 285-5769% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate upland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080501	Ash Swale & Deer Cr.	1	69	64	2.16
170900030402	S. Albany; Tangent.	1	99	59	2.04
170900070101	Baskett Slough NWR	1	20	20	1.99
170900080402	Salt Cr.	1	21	18	1.93
170900030202	Monroe; Muddy Cr. E.	1	246	206	1.79

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030202	Monroe; Muddy Cr. E.	1	0	0	0.08
170900030602	Soap Cr.	1	17	17	0.03
170900070301	Saint Paul	1	2	2	0.02
170900070304	Lincoln	1	0	0	0.01
170900020401	Dorena Reservoir	2	3	1	0.01

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900060201	Beaver Cr.	1	614	578	1.27
170900080402	Salt Cr.	1	12	11	1.08
170900070101	Baskett Slough NWR	1	19	19	0.95
170900080401	Sheridan	1	227	202	0.91
170900030601	Luckiamute R.4	1	57	54	0.71

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030402	S. Albany; Tangent.	1	63	36	1.90
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	1	145	130	1.72
170900080601	Yamhill	1	32	27	1.64
170900080702	Lafayette	1	74	53	1.59
170900070301	Saint Paul	1	25	20	1.58

Key Environmental Correlates: Formerly bred in upland prairie-savanna, but as this habitat has diminished the species has adapted to nesting in some fallow fields and lightly grazed pastures. Prefers large open expanse (greater than 100 ac) of uncultivated grassland with grass-forb cover of 1-2 ft height and scattered shrubs (less than 10% cover) or artificial perches (fences, telephone poles). Only 24% of the Willamette territories included cultivated grass fields and none contained more than 50% cultivated grass. Mean territory size is 14.3 ac (Altman 2003c).

Threats, Limiting Factors, Population Viability: Probably similar to horned lark and vesper sparrow, above.

Biological Objectives: As proposed in *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), the habitat objectives should include:

- maintain or create patches of suitable habitat (individually less than 200 acres in extent) throughout native and agricultural grasslands; the patches should have these characteristics:
  - variable grass heights, generally shorter than 30 inches
  - containing some shrubs, trees, or other perches, but over less than 10% of area
  - located where disturbance from people, animals, and vehicles is minimal

Guidance on Willamette grassland management for this species is provided in ODFW (2001).
Population objectives should include:

- reverse the declining BBS trends to achieve stable populations (negative trends of less than 2% per year) or increasing trends by 2010.

Western Bluebird

Special Designations: “Vulnerable” (ODFW). Partners in Flight focal species.

Distribution, Status, and Trends: This species is currently absent as a breeder from nearly all of the valley floor, and is an uncommon breeder in foothills. Along Willamette subbasin BBS routes the species was detected at 0.5% of surveyed points in 2003, with a maximum during the period 1968-2003 of only 0.8% in 1968. Application of simple species-habitat models to aerial imagery using GIS suggests 8.3% of the subbasin might contain habitat that could be at least marginally suitable but less than 1% might contain good habitat. NHI models and data project this species has a close association with land cover in 65% of the subbasin and a general association in 31%. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 60% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 32%. Wintering birds are found by most subbasin CBCs. Local increases have been documented in response to extensive placements of nest boxes. This species once bred commonly in savanna and forest edges in the Willamette subbasin. Declines were first noted in the 1950s and 1960s (Prescott 1980, Prescott & Gillis 1985). BBS data covering the period 1968-2003 and 1980-2003 show a decrease in western Oregon-Washington generally. Since 1850, suitable habitat for this species in the subbasin may have increased by 3-23% due to increased forest edge (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate upland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010302	Fall & Delp Cr.	4	2800	0	1.66
170900050103	Pyramid Cr.	5	4367	0	1.59
170900011101	Groundhog Cr: S.Fork	5	3005	0	1.49
170900110402	Timothy Lake; Dinger Lake	5	9977	0	1.46
170900060501	Pyramid Cr. & Quartzville Cr.-lower	5	9141	0	1.42

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110402	Timothy Lake; Dinger Lake	5	8806	0	1.44
170900110401	Harriet Lake	5	3522	0	0.94
170900050103	Pyramid Cr.	5	4340	0	0.93
170900011101	Groundhog Cr: S.Fork	6	3104	0	0.78
170900010702	Christy Cr.	5	2346	0	0.78

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900011201	Staley & Swift & Spruce Cr.	6	11124	0	1.99
170900110501	Clackamas R. - upper	4	2005	0	1.29
170900040501	Boulder Cr. & Smith R.	5	10833	0	1.08
170900110501	Clackamas R. - upper	5	4247	0	0.96
170900040501	Boulder Cr. & Smith R.	6	4626	0	0.94

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	11	0	1.28
170900080601	Yamhill	1	9	0	1.09
170900080702	Lafayette	1	46	0	1.03
170900090701	Little Pudding R.; E. Salem	1	27	0	1.00
170900090301	Butte Cr.	1	0	0	0.98

Key Environmental Correlates: For nest sites, bluebirds require artificial nest boxes or tree cavities excavated by other species. Nests are within or along the edge of upland prairies, clearcuts, pastures, or other open areas, especially those dominated by native grasses and forbs. Bluebirds do not nest in closed-canopy forest or in fields overgrown by shrubs but may feed in such areas during winter, especially where mistletoe, madrone, and other berries are available (California Partners in Flight 2002).
Threats, Limiting Factors, Population Viability: Habitat loss and degradation have been the greatest contributors to decline of the species in the subbasin, and are being caused by factors discussed in section 2.2.4. May be more sensitive to changes in forest practices (rotation ages, patterns) than other focal species inhabiting this habitat type. Also, increases in residential development are typically accompanied by increases in European starling and house sparrow, non-native species that usurp nesting cavities. This may be less a problem at higher-elevation forested areas. Increased high-speed traffic on rural roads also may contribute to mortality.
Biological Objectives:
Habitat objectives should include:

- Manage woodlands to provide a sustained supply of snags (at least 10 ft tall and 15 inch diameter) located along edges that adjoin open areas, i.e., areas with fewer than 5 trees/ac (Hansen et al. 1995)
- Following forest fires, leave larger snags whenever feasible.

Population objectives should include:

- Achieve stable populations (negative trends of less than 2% per year) or increasing trends by 2010.

<u>Black-tailed Jackrabbit</u>
Special Designations: none
Distribution, Status, and Trends: Jackrabbits once were abundant on the valley floor and foothills, but anecdotal evidence suggests a long term population decline has occurred (Verts & Carraway 1998). ORNHIC databases contain no records from the last 20 years. Incidental to avian surveys conducted during summers 1996-1999, the species was noted at 15 rural locations in the Willamette Valley (Altman et al. 2001). Apparently extirpated from the greater Portland area (Metro 2003) and generally more common in southern parts of the subbasin. NHI models and data project this species is associated with land cover in 20% of the subbasin. Since 1850, suitable habitat for this species in the subbasin may have decreased by 33-51% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-

habitat models to early 1990s aerial imagery (that did not delineate upland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080501	Ash Swale & Deer Cr.	1	16810	0	5.24
170900030402	S. Albany; Tangent.	1	27257	0	5.22
170900080402	Salt Cr.	1	7986	0	4.96
170900070101	Baskett Slough NWR	1	10697	0	4.86
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	1	59165	0	4.41

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030202	Monroe; Muddy Cr. E.	1	1690	0	0.20
170900030602	Soap Cr.	1	421	0	0.09
170900070301	Saint Paul	1	227	0	0.06
170900070307	Salem	1	51	0	0.04
170900090704	Silverton S.	3	24	0	0.04

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900060201	Beaver Cr.	1	19284	0	3.33
170900080402	Salt Cr.	1	4567	0	2.79
170900070101	Baskett Slough NWR	1	4948	0	2.33
170900080401	Sheridan	1	8734	0	2.24
170900030601	Luckiamute R.4	1	4973	0	1.73

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030402	S. Albany; Tangent.	1	23204	0	4.78
170900080601	Yamhill	1	14331	0	4.38
170900080702	Lafayette	1	10284	0	4.23
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	1	54653	0	4.22
170900070301	Saint Paul	1	15946	0	4.12

Key Environmental Correlates: Historically this species inhabited upland prairie-savannah with scattered shrubs. Most recent observations have been from the vicinity of conifer plantations.

Threats, Limiting Factors, Population Viability: Habitat loss and fragmentation have been the greatest contributors to decline of the species in the subbasin, and are being caused by factors discussed in section 2.2.4. Other factors that might be contributing to decline include hunting, disease (tularemia), increases in predator densities, increases in farming efficiency and field size (i.e., fewer hedgerows), and roadkill due to increased high-speed traffic on rural roads. Home range is about 500 acres.
Biological Objectives: Survey, then maintain or increase present densities and distribution in the subbasin, consistent with minimizing potential damage to nearby crops.

Western Rattlesnake

Special Designations: "Vulnerable" (ODFW, Willamette Valley ecoregion only).
Distribution, Status, and Trends: Once common on the valley floor and in foothills, rattlesnakes now persist at fewer than a dozen locations in the subbasin. NHI models and data project this species has a general association with land cover in 34% of the subbasin. Since 1850, suitable habitat for this species in the subbasin may have decreased by 15-19% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit (*this does not mean the species is present*). The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate upland prairie or rock outcrops specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090702	Drift Cr.	2	2933	2933	0.73
170900090703	Silverton N.	2	764	764	0.46
170900060102	E. Lebanon; Hamilton Cr.	2	1445	1445	0.46
170900080604	Turner Cr.	2	594	594	0.44
170900060301	Lower Thomas Cr. -lower; Scio	2	1063	1063	0.40

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010502	Hemlock; Lookout Point Reservoir	2	58	58	0.01
170900080101	S. Willamina	2	22	22	0.01
170900080605	Fairchild Cr.	2	12	12	0.01
170900030602	Soap Cr.	2	21	21	0.01
170900090602	Molalla R. S. Fk.	2	17	17	0.00

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070203	S. Salem; McKinney Cr.	2	333	333	0.18
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	2	1638	1638	0.17
170900070101	Baskett Slough NWR	2	251	251	0.16
170900060102	E. Lebanon; Hamilton Cr.	2	701	701	0.16
170900030606	Little Luckiamute R. - lower	2	394	394	0.15

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090702	Drift Cr.	2	2742	2742	0.57
170900090703	Silverton N.	2	764	764	0.46
170900060301	Lower Thomas Cr. -lower; Scio	2	840	840	0.29
170900030603	Luckiamute R.1.	2	606	603	0.25
170900080604	Turner Cr.	2	472	472	0.24

Key Environmental Correlates: Historically this species inhabited upland prairie-savannah as well as rock outcrops, but as this habitat has declined the remaining populations have become restricted to rock outcrops, especially ones on grassy south-facing slopes below 2000 ft elevation (Alan St. John, pers. comm.).

Threats, Limiting Factors, Population Viability: Loss, fragmentation, and degradation of upland prairie-savanna has been a major contributor to decline of the species in the subbasin, and is being caused by factors discussed in section 2.2.4. Persecution surely has also been a major contributor, especially around ranches and residential areas. Animal burrows are important for refuge during inclement weather and have diminished as prairies have been converted to cropland.

Biological Objectives: Survey present densities in the subbasin and then formulate biological objectives.

Other Species of Note

If the focal species list was expanded to include other species, some strong candidates for focal-species status -- based on degree of association with upland prairie-savanna – are American kestrel, white-tailed kite, grasshopper sparrow, lazuli bunting, American goldfinch, gopher snake, southern alligator lizard, western fence lizard, Camas pocket gopher, gray-tailed vole, dusky-footed woodrat, and especially, several butterflies and plants. The butterflies include checkered skipper (*Pyrgus ruralis*), Sonora skipper (*Polites sonora*), anise swallowtail (*Papilio zelicaon*), Acmon blue (*Icaricia acmon*), and field crescent (*Phyciodes pratensis*). In addition, Clark's day sphinx moth (*Proserpinus clarkiae*) reportedly survives at only at two prairie sites in the Willamette subbasin. Plants strongly associated with upland prairie-savanna and/or rock outcrops (balds) are listed in Table 13.

2.3.9 Synthesis: Indicators of Ecological Condition and Sustainability for Upland Prairie-Savanna

The following indicators – which must be assessed in the field -- may be useful for prioritizing upland prairie-savanna parcels for protection and restoration, as well as for monitoring success of restoration projects and long-term trends in quality of remaining upland prairie-savanna.

> *Extent of upland prairie-savanna*: the mean patch size and total acreage of upland prairie-savanna compared with historical extent; should be subtotaled within watersheds by geomorphic position (elevation, geology, soils) and degree of fragmentation (distance to nearest similar patch and type of intervening land cover types);
>
> *Focal species status*: the density, interannual frequency of occurrence, and distribution (proportion of sample points where detected) of each focal species within parts of a watershed that are projected (by models, aerial imagery, historical vegetation data, and professional judgment) to be generally suitable for the species based on elevation and gross land cover type.
>
> *Tree density:* the density and spacing (mean separation distance) of trees within tracts of upland prairie-savanna in a particular watershed.
>
> *Shrub density:* the number, density, and spacing (mean separation distance) of shrub patches within tracts of upland prairie-savanna in a particular watershed.
>
> *Native shrub cover*: the percentage of the total subcanopy woody (shrub) cover that is comprised of native shrub species, especially those characteristic of upland prairie-savanna.
>
> *Native herbaceous height diversity:* The number and proportional evenness of different height classes of native grasses and forbs, and including bare areas as a height class;
>
> *Native herbaceous plant cover*: the percentage of the total herbaceous (non-shrub) plant cover that is comprised of native species, especially those characteristic of upland prairie-savanna, e.g., Table 13.
>
> *Native herbaceous plant richness*: the number of herbaceous species per site (or per plot if the site so large it must be statistically sampled), especially those species characteristic of upland prairie-savanna, e.g., Table 13.

It is not possible, without first collecting an appropriate array of reference data, to specify exact criteria for evaluating each of these indicators or to indicate how they could best be combined into a single index of upland prairie-savanna functional integrity. Separate criteria might need to be developed for upland prairie, savanna, and balds. Earlier in this section, criteria were suggested for a few focal species (mostly birds) for which minimally adequate data are available to judge quantitatively the suitability of upland prairie-savanna habitat.

Table 13. Native plant species characteristic of prairie, savanna, and rocky outcrops of the Willamette subbasin

Adapted from Floberg et al. 2004.

Species	Habitat
Agroseris grandiflora	upland prairie, balds
Allium acuminatum	upland prairie, balds
Allium amplectens	upland prairie, balds
Aster curtus	upland prairie, savanna, balds
Balsamorhiza deltoidea	upland prairie
Brodiaea congesta	upland prairie
Brodiaea coronaria/elegans	upland prairie, balds
Brodiaea howellii	upland prairie
Brodiaea hyacinthina	balds
Bromus sitchensis var. sitchensis	upland prairie, balds
Bryum miniatum	upland prairie, savanna, balds
Calochortus tolmiei	upland prairie
Camassia leichtlinii ssp. suksdorfii	upland prairie, balds
Camassia quamash	upland prairie, balds, savanna
Carex inops	upland prairie, savanna, balds
Carex tumulicola	upland prairie
Camassia leichtlinii	balds
Castilleja hispida	upland prairie, balds
Centaurium muehlenbergii	balds
Cerastium arvense	balds
Cirsium remotifolium	upland prairie
Clarkia amoena	upland prairie, balds
Clarkia quadrivulnera	upland prairie, balds
Comandra umbellata var. californica	upland prairie
Convolvulus nyctagineus	upland prairie
Cynoglossum grande	savanna
Danthonia californica	upland prairie, savanna, balds
Daucus pusillus	upland prairie, balds
Delphinium menziesii	upland prairie, balds
Dodecatheon hendersonii	upland prairie, savanna
Dodecatheon pulchellum	balds
Elymus trachycaulus (Agropyron caninum)	upland prairie, balds
Epilobium minutum	upland prairie, balds
Erigeron speciosus	upland prairie
Eriophyllum lanatum	upland prairie, balds, savanna
Erythronium oregonum	upland prairie, savanna, balds
Festuca californica	savanna
Festuca roemeri	upland prairie, savanna, balds
Festuca rubra	balds
Fritillaria affinis (lanceolata)	upland prairie, savanna
Galium boreale	savanna
Geranium oreganum	upland prairie
Githopsis specularioides	balds
Grindelia integrifolia var. macrophylla	balds
Hieracium cynoglossoides	upland prairie
Koeleria macrantha	upland prairie, balds

Species	**Habitat**
Ligusticum apiifolium	savanna, upland prairie
Lithophragma parviflora	savanna, balds
Lomatium dissectum	savanna, upland prairie
Lomatium nudicaule	upland prairie, balds
Lomatium triternatum	upland prairie
Lomatium utriculatum	upland prairie, balds
Lupinus albicaulis	upland prairie
Lupinus laxiflorus	upland prairie
Lupinus lepidus	upland prairie
Madia gracilis	balds
Microseris laciniata	upland prairie
Mimulus alsinoides	balds
Mimulus guttatus	balds
Nemophila menziesii var. atromaria	upland prairie
Orobanche uniflora	balds
Perideridia gairdneri ssp. borealis	balds, upland prairie
Pinus ponderosa	savanna
Plectritis congesta	upland prairie, balds, savanna
Poa scabrella	upland prairie, balds
Polygonum douglasii ssp. spergulariaeforme	balds
Potentilla glandulosa var. glandulosa	upland prairie, savanna
Potentilla gracilis var. gracilis	upland prairie
Quercus garryana	savanna
Ranunculus occidentalis	upland prairie, balds, savanna
Sanicula bipinnatifida	upland prairie, balds, savanna
Saxifraga integrifolia	upland prairie, balds
Sidalcea malviflora ssp. *virgata*	savanna
Silene hookeri	upland prairie
Sisyrinchium douglasii	balds
Stipa lemmonii	upland prairie, balds
Thysanocarpus curvipes	upland prairie, balds
Tonella tenella	savanna
Trifolium eriocephalum	upland prairie, savanna
Trifolium macraei var. *dichotomum*	balds
Trifolium microcephalum	balds
Trifolium microdon	balds
Trifolium oliganthum	balds
Trifolium tridentatum	balds
Trifolium variegatum	balds
Trillium albidum	savanna
Viola adunca	upland prairie, savanna
Viola sheltonii	savanna

2.4 Focal Habitat: Wetland Prairie and Seasonal Marsh

2.4.1 Description

The wetland prairie and seasonal marsh (hereinafter termed simply "wetland prairie") includes areas that are outside of the annual floodplain of rivers, are inundated or saturated for only part of the year by lentic (non-flowing) water, are dominated by the types of herbaceous vegetation that are characteristically associated with wetlands according to USFWS databases, and show evidence of reducing conditions in the upper soil horizon or contain soils considered by the NRCS to be "hydric." In the Willamette subbasin most such areas exist (or existed) on the valley floor, but this definition also includes some springs and seeps on the valley margin and foothills if these are dominated by herbaceous vegetation, i.e., marsh. This definition includes vernal pools but not *Sphagnum*-dominated bogs. Many wetland prairies appear to be isolated, i.e., not permanently connected to other water bodies by surface water. Wetland prairies are classified as "slope" or "flats" wetland according to the classification scheme used by Oregon Division of State Lands (Brinson 1993, Adamus 2001) and includes "emergent wetland" (with semipermanent, seasonal, or temporarily inundated hydroperiod) as defined by the Cowardin et al. (1978) classification and used in maps published by the National Wetland Inventory. Western Oregon wetland plant associations and natural disturbance processes are described by Christy (2004).

2.4.2 Recognition of Importance

Wetlands included under this definition have been identified explicitly as a priority for protection and restoration in other regions and specifically in the Willamette subbasin (Titus et al. 1996, Morlan 2000, and Table 8). Legally-listed species that are strongly associated with this habitat include Bradshaw's lomatium (federal "endangered,"); Willamette Valley daisy and Nelson's checker-mallow (federal "threatened"); streaked horned lark (proposed for federal listing, and state-listed as "critical"); red-legged and Cascades frogs (both ODFW "Vulnerable"), and western toad (now almost extirpated, ODFW "Vulnerable").

Many species that are associated strongly or partially with wetland prairie have disappeared from the subbasin. These include at least one plant (water howellia, federally-listed as "threatened"), one amphibian (Oregon spotted frog), and three breeding birds (sandhill crane, black-crowned night-heron, short-eared owl). Two other birds – Wilson's snipe and golden eagle – are probably close to extirpation as breeders in the subbasin.

At a continental scale, the Willamette Valley's wetland prairies are recognized as being particularly important for shorebirds and waterfowl during migration and winter. Over 20,000 dunlin and 10,000 killdeer winter in seasonal wetlands here, comprising a significant component of Pacific Coast populations of these shorebirds (Sanzenbacher & Haig 2001, Taft & Haig 2003). Although enormous declines have occurred over the past 100 years among waterfowl using the subbasin, the seasonal marshes, ponds, and reservoirs of the Willamette Valley still host up to 300,000 wintering waterfowl. Five races of the Canada goose winter in the Valley, including nearly the entire population of dusky Canada geese and increasingly, much of the population of cackling Canada geese. Numbers of wintering Canada geese have grown from

20,000 to over 250,000 birds in the last two decades .

2.4.3 Status and Distribution

Compared with the other focal habitats wetlands have been well-mapped (Table 14), although small wetlands and forested wetlands are often missed, and prairies generally have not been distinguished from seasonal marshes. Also, the aerial imagery used to construct wetland maps may not allow wetland prairies and other seasonal marshes to be distinguished consistently from permanently-inundated wetlands, which are included under ponds and sloughs (section 2.5). Many seasonal marshes are too small to be detected at all from conventional aerial imagery, although OWEB-sponsored mapping of areas inundated in the winter in the Willamette Valley, using radar, has been fairly successful (Taft et al. 2003). Wetlands remain unmapped in much of the higher-elevation portion of the subbasin, and the level of agreement among map sources can vary significantly. Several communities in the Willamette subbasin have conducted finer-scale mapping of wetlands – with more field verification – as part of Oregon DSL's legally-mandated support for "Local Wetland Inventories" (see: http://statelands.dsl.state.or.us/lwi.htm).

Table 14. Acreage estimates of land cover types that include wetland prairie and seasonal marsh

Source	Map categories that include wetland prairie	Estimated area (acres)	Percent of mapped area
EC1850	"seasonal wetlands"	309,360	4.24
EC1990	"seasonal wetlands"	27,081	0.37
IBIS 1850	--	--	--
IBIS 1990	"herbaceous wetlands"	10,757	0.15
ODFW*	"hairgrass prairie" "cattail-bulrush" "reed canary grass"	7,200	0.37

* Valley area only

2.4.4 Past Impacts, Limiting Factors, and Future Threats

Along with upland prairies and oak woodlands, wetland prairies were a prominent feature of the lower elevations of the Willamette subbasin until the late 1800s. As was true of the upland prairies, the predominance of herbaceous vegetation was maintained largely by frequent fires set by indigenous tribes. Loss of wetland prairie in the Willamette Valley since presettlement times has been estimated at 99%, and loss of other herbaceous wetlands (probably including some perennially-inundated ones) is estimated at 57% (Titus et al. 1996, Morlan 2000).

Despite laws that regulate some activities in wetlands, the net (uncompensated) loss and degradation of wetlands – and especially of wetland prairie and seasonal marsh in the Willamette subbasin – continues. For example, destruction of 546 wetland acres per year between 1982 and 1994 was measured in the Willamette Valley (Daggett et al. 1998, Bernert et al. 1999). Probably the largest contributing factor to wetland destruction in the subbasin has been legally-exempted agricultural activities (Shaich 2000). Remaining wetland prairies have become so fragmented and separated by roads carrying high-speed traffic that populations of wildlife, and especially reptiles and amphibians, may not be self-sustaining in some areas of the subbasin. And being supported by only a seasonal water regime, wetland prairies are particularly vulnerable to potential effects of global warming (Graham 2000). Natural and altered hydrologic regimes of some Willamette wetlands are described by Finley 1994, Shaffer et al. 1999, D'Amore et al. 2000, and Cole et al. 2002.

Wetland prairies also are being ecologically degraded. Many are being gradually invaded by shrubs, especially Oregon ash (*Fraxinus latifolia*) and Himalayan blackberry, due to altered local water regimes and long term suppression of fires (see also section 2.2.4). In running computer simulations of future environmental conditions in the Willamette subbasin, one researcher (Payne 2002) assumed the maximum rate at which ash might invade wet prairies and other open areas to be about 100 lateral feet per 40 years. Within the past few decades, highly invasive reed canarygrass (*Phalaris arundinacea*) also has come to dominate many if not most of the subbasin's seasonal marshes, choking out large numbers of native species and profoundly altering wildlife habitat structure and food sources.

Pesticides, toxic substances, and excessive loads of sediment from roads, logging, and suburban and agricultural lands reach wetlands and diminish their capacity to support wildlife and rare plants (Azous & Horner 2001). Some recent evidence suggests that nitrate fertilizers are harmful to native amphibians (Marco et al. 1999, 2001). Near residential areas, increased predator densities (cats, raccoons) may be significantly impacting some birds that nest in wetland prairies. Scientific literature on all of these impacts to wetland plants and animals was reviewed by Adamus & Brandt (1990) and Adamus et al. (2001).

Threats to specific areas of the subbasin containing wetland prairies were assessed by The Nature Conservancy (Table 7).

2.4.5 Protection, Restoration, Management

Of the 6 focal habitats described in this report, wetland prairies are one of two that currently receive significant legal protection from federal and state laws. However, recent legislative initiatives and policy changes at federal and state levels have sought to undo most of this protection, and many destructive activities -- such as most kinds of artificial drainage of wetlands -- are still legal. Non-regulatory programs to preserve and restore wetland prairies in the Willamette subbasin have been very active (e.g., The Wetlands Conservancy, The Nature Conservancy, Ducks Unlimited, NRCS, USFWS, BLM) and have received national acclaim, e.g., West Eugene Wetlands Plan (Lane Council of Governments and City of Eugene 1992). Specific wetlands that have been prioritized as candidates for increased protection include some in Table 7, some identified by Titus et al. (1996), and some identified administratively by communities as "Locally Significant Wetlands" through the Goal 5 Local Wetland Inventory process. The availability of assistance for wetlands protection and restoration is described in a published guide (Oregon Wetlands Conservation Alliance 1993) and at several sites on the internet:

http://www.sherm.com/wild/index.html
http://www.nrcs.usda.gov/programs/
http://www.epa.gov/owow/wetlands/facts/funding.pdf
http://publicworks.co.marion.or.us/parks/nhp/partnerships.asp
http://www.oregon-plan.org/archives/steelhead_dec1997/st-12.html

No data are available to support a minimum patch size or appropriate interpatch distance for maintaining a disjunct wetland prairie's ability to be self-sustaining over the long term. Managing wetland prairies within or near urban areas presents additional challenges due to (a) increased vulnerability to invasive plants, (b) impracticality of using controlled burns as a potential management tool, and (c) increased loads of some contaminants. Specific practices useful for restoring and maintaining wetland prairies and/or seasonal marshes (e.g., water regime control, prescribed burning, control of invasives) are described in detail by Campbell (2004), Hayes et al. (2000), and California Native Plant Society (1998).

Areas of the subbasin most suitable for restoration of wetland prairie have been mapped at a coarse scale using soils and other spatial data, e.g., Payne (2002). A need now exists to refine and prioritize these areas. Sites should be prioritized according to their potential to be self-sustaining wetland prairies or seasonal marshes. Non-regulatory strategies for wetlands restoration in Oregon are discussed by Good & Sawyer (1998).

In the 1990s, many landowners established hybrid poplar plantations in wetland prairies and seasonal marshes. Most of these plantations are now being cut and not replanted. Because it is generally infeasible to convert them to cropland (due to extensive left-over stumps and roots), this may present an opportunity for restoration to wetland prairie habitat.

2.4.6 Compatibility of Wetland Management and Stream Management

There is no inherent incompatibility between managing wetland prairies and stream habitats. However, stream restorations alone do not provide a significant benefit to wetland prairies and their wildlife and plant species. If controlled burns are used to enhance wetland prairies, the potential for adverse effects on quality of nearby aquatic habitats should be evaluated. If stream restoration activities involve regrading or planting of woody cover, efforts should be made to insure that those activities do not impact water levels or vegetation of adjoining wetland prairies.

2.4.7 Contribution of Wetland Prairies to Regional Biodiversity

Compared with other Willamette habitat types, wetland prairies in good condition provide the best reproductive habitat for 38 wildlife species, and are used regularly by at least an additional 54 breeding wildlife species (see file HABTYPE). Many of these species are associated as well with upland prairie. Some use seasonally-inundated agricultural lands, perhaps at some cost to reproductive success and survival. The wetland prairie - seasonal marsh avifauna includes several nesting bird species whose numbers appear to be declining regionally. Many plant species found in the Willamette subbasin's wetland prairies are rare and found in none of the other 5 habitat types featured in this report (Titus et al. 1996, Wilson 1998b).

2.4.8 Selected Focal Species

The following are proposed as focal species for this habitat type:

Plants: Bradshaw's lomatium, Nelson's checker-mallow (sidalcea), Willamette Valley daisy, peacock larkspur

Wildlife: red-legged frog, sora, northern harrier, common yellowthroat, dunlin

On a scale of 0 to 10, their average degree of association with wetland prairies and seasonal marshes is a 8.43, as calculated from Detail File: HABTYPE. Compare this with HEP "loss assessment" species used in many previous mitigation calculations and land acquisitions in the Willamette subbasin. Of the "grass-forb" species used in HEP applications, the average degree of association with wetland prairie or seasonal wetland is only 2.78. This suggests there may have been an unintentional but systematic bias against the wetland prairie habitat type in previous mitigation land dealings in the Willamette subbasin.

Bradshaw's Lomatium (*Lomatium bradshawii*)
Special Designations: "Endangered" (federal). "Imperiled" (ONHP).
Distribution, Status, and Trends: This species occurs only in the Willamette Valley and southern Washington. Once abundant, there now are documented records from just 13 of the 170 Willamette watersheds. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030101	W. Eugene; Junction City	1	2177	1008	1.26
170900030504	Finley NWR; Muddy & Hammer Cr.	1	1253	612	1.20
170900030302	Brownsville	1	364	154	1.18
170900030403	Sodaville	1	169	59	1.05
170900020102	Creswell W.; Camas Swale	2	175	121	0.89

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030202	Monroe; Muddy Cr. E.	1	31	3	0.10
170900070301	Saint Paul	1	3	2	0.02
170900030204	E. Eugene; Harrisburg; Springfield	1	2	0	0.01
170900030602	Soap Cr.	1	25	6	0.01
170900070102	Independence; Monmouth	1	7	6	0.01

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030504	Finley NWR; Muddy & Hammer Cr.	1	1182	571	0.70
170900030103	Coyote Cr.	1	943	721	0.39

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030101	W. Eugene; Junction City	1	806	499	0.19
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	1	449	387	0.14
170900020102	Creswell W.; Camas Swale	2	21	15	0.32

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030302	Brownsville	1	238	96	1.08
170900030201	Corvallis N.; Adair Village	1	526	174	0.93
170900030101	W. Eugene; Junction City	1	1353	494	0.92
170900020102	Creswell W.; Camas Swale	2	154	107	0.56
170900070202	Aumsville & Beaver Cr.	2	1	0	0.04

Key Environmental Correlates: This species occurs mainly on clayey soils with seasonally high water tables and little or no shade.
Threats, Limiting Factors, Population Viability: Habitat loss to development and succession of wetland prairies to woodland as a result of fire suppression and altered soil moisture regimes pose the greatest threat (Kagan 1980). Insects are essential for pollinating this plant and may be impacted by pesticides drifting from residential, forest (gypsy moth control), and agricultural areas.
Biological Objectives:

- Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

For More Information: Kagan 1980, Kaye et al. 1999, Kaye et al. 2001, 2003

Nelson's Checkermallow (*Sidalcea nelsoniana*)
Special Designations: "Threatened" (federal); "Imperiled" (ONHP).
Distribution, Status, and Trends: Once common, this species remains at fewer than 48 sites in just 5 portions of the subbasin, plus one area in southern Washington. Most sites have fewer than 100 plants, and only 5 have more than 1000.
Key Environmental Correlates: Typically occurs in moist unshaded soils that are not regularly plowed or mowed. Found mostly in remnant patches of native prairie such as along roadsides, fencerows, along streams or ditches, and in cemeteries. Also occurs in relatively open ash swales and on somewhat gravelly well-drained soils. Some sites contain standing water for long periods.
Threats, Limiting Factors, Population Viability: The greatest threats are of habitat loss to development, and habitat degradation as a result of succession of wetland prairies to woodland, following fire suppression and alteration of soil moisture regimes by agricultural drainage and residential development. Specific examples of loss through conversion to agricultural or other unsuitable land cover include known sites at Lewisburg, Philomath, Dallas, Corvallis (Starker Park), and the Salem Municipal Airport Additional habitat losses have been reported from habitat loss has been reported in Polk County at Van Well Road, Dyck Road, McTimmonds Valley, and Hess Road (CH2M Hill 1991). The species is thriving in several areas where regular burning and/or cutting of woody plants continues. Plants at some locations have been impacted

by plowing, deposition of fill and yard debris, improvement of tile drain networks in wet fields, competition with invasive non-native plants, trampling by livestock and recreationists, and intense roadside vegetation management (regrading, mowing, herbicide applications). Especially in past decades, improvements in field drainage and stream channelization have harmed the species by reducing the seasonal persistence of water on the land. Mowing adversely impacts the plants if it takes place before the plants set seed. Insects essential for pollinating this plant may be impacted by pesticides. In the Coast Range, a proposed reservoir threatens the largest population of this species, containing one-third of the species population. Although the area is currently protected under the state Scenic Waterway System, there have been attempts in the Oregon Legislature to remove this designation so reservoir construction can proceed. In addition, a proposed capacity increase of an existing reservoir in Washington County would destroy some plants. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080402	Salt Cr.	1	5723	86	3.80
170900070101	Baskett Slough NWR	1	6904	61	3.17
170900070102	Independence; Monmouth	1	18375	457	3.16
170900070201	Sublimity & Turner	1	10566	270	3.12
170900080502	Amity	1	15988	247	3.06

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030202	Monroe; Muddy Cr. E.	1	1594	4	0.19
170900030602	Soap Cr.	1	306	17	0.08
170900080603	Panther & Haskins Cr.	3	0	0	0.07
170900080203	Willamina Cr. -upper	3	0	0	0.06
170900100303	Gaston; Sunday & Roaring Cr.	3	0	0	0.05

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030504	Finley NWR; Muddy & Hammer Cr.	1	12767	734	1.41
170900030602	Soap Cr.	1	6176	619	1.32
170900060201	Beaver Cr.	1	12396	781	2.23
170900080402	Salt Cr.	1	2672	68	1.71

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030606	Little Luckiamute R. - lower	1	2282	191	0.82

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080601	Yamhill	1	9913	141	3.24
170900070102	Independence; Monmouth	1	16613	302	2.91
170900070201	Sublimity & Turner	1	10535	266	2.77
170900090701	Little Pudding R.; E. Salem	1	14176	396	2.68
170900080502	Amity	1	11050	178	2.16

Biological Objectives: Maintain or expand existing numbers and geographic distribution of this plant through protection, restoration, and management of suitable habitat.

Willamette Valley Daisy (*Erigeron decumbens* var. *decumbens*)

Special Designations: "Endangered" (federal). "Critically Imperiled" (ORNHIC).

Distribution, Status, and Trends: This very rare plant is known only from the Willamette Valley. The ORNHIC database contains records from 14 of the 170 Willamette watersheds. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate wetland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	1	1957	230	1.96
170900070101	Baskett Slough NWR	1	62	12	1.57
170900030504	Finley NWR; Muddy & Hammer Cr.	1	813	168	1.13
170900030101	W. Eugene; Junction City	1	1325	654	0.97
170900020102	Creswell W.; Camas Swale	2	190	134	0.84

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030202	Monroe; Muddy Cr. E.	1	28	0	0.07
170900070301	Saint Paul	1	3	2	0.03
170900030602	Soap Cr.	1	24	4	0.02

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030204	E. Eugene; Harrisburg; Springfield	1	2	0	0.01
170900030602	Soap Cr.	2	0	0	0.01

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070101	Baskett Slough NWR	1	58	12	0.81
170900030504	Finley NWR; Muddy & Hammer Cr.	1	729	128	0.51
170900030103	Coyote Cr.	1	985	647	0.46
170900020102	Creswell W.; Camas Swale	2	27	18	0.34
170900030101	W. Eugene; Junction City	1	735	452	0.19

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070202	Aumsville & Beaver Cr.	1	113	83	0.76
170900070202	Aumsville & Beaver Cr.	2	8	7	0.63
170900090703	Silverton N.	2	14	14	0.56
170900050601	Jefferson; Lyons; Bear Branch	1	145	59	0.22
170900030603	Luckiamute R.1.	2	11	11	0.12

Key Environmental Correlates: Similar to preceding species.
Threats, Limiting Factors, Population Viability: Similar to preceding species.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.
For More Information: Clark et al. 1997, USFWS 1998, Kaye & Cramer 2002, Kaye et al. 2003

Peacock Larkspur (*Delphinium pavonaceum*)

Special Designations: “Endangered” (ODA). “Critically Imperiled” (ONHP). Not recognized as a species by some authorities because of its propensity to hybridize.
Distribution, Status, and Trends: The ORNHIC database contains documented records from 10 of the 170 Willamette watersheds. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units contain records of this species in the ORNHIC database.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?
170900030504	Finley NWR; Muddy & Hammer Cr.	1	yes	yes
170900050601	Jefferson; Lyons; Bear Branch	1	yes	yes
170900070103	Ankeny NWR	1	yes	yes
170900070301	Saint Paul	1	yes	yes
170900030201	Corvallis N.; Adair Village	1	no	no
170900030602	Soap Cr.	1	no	no
170900070102	Independence; Monmouth	1	no	no

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?
170900070103	Ankeny NWR	1	no	no
170900090202	Molalla R. -middle	1	no	no
170900030501	Corvallis; Philomath; Mary's R.-lower	1	no	yes
170900030601	Luckiamute R.4	1	no	yes
170900030602	Soap Cr.	1	no	yes

Key Environmental Correlates: Native prairies, especially wetland prairies.
Threats, Limiting Factors, Population Viability: Its extirpation apparently has been caused by loss and degradation of wetland prairie-savanna habitat as a result of factors discussed in section 2.2.4. Drift of herbicides applied during agricultural operations and roadside maintenance may also be having an effect.
Biological Objectives: Maintain and increase current numbers and distribution through habitat protection, restoration, and management.

Water Howellia (*Howellia aquatilis*)
Special Designations: "Threatened" (federal). "Extirpated" (ONHP).
Distribution, Status, and Trends: This species once occurred widely in the Pacific Northwest. Currently, the remaining individuals are clustered mainly at two locations, one in eastern Washington and one in Montana, with a third cluster in Mendocino County, California.
Key Environmental Correlates: Historically this plant occurred in vernal wetlands with consolidated mud bottoms. These probably included edges of some oxbows and sloughs in portions of the floodplains of the Willamette and other rivers.
Threats, Limiting Factors, Population Viability: Reasons for its apparent disappearance are unclear, but could be related to river regulation, reduction in riparian shade, and increased water pollution (particularly increased deposition of sediment).
Biological Objectives: Determine limiting factors through research and seek opportunities to reintroduce if and where suitable habitat is found.
For More Information: Rice 1990, Lesica 1992

Red-legged Frog
Special Designations: "Vulnerable" (ONHP).
Distribution, Status, and Trends: The ORNHIC database contains documented records from 34 of the 170 Willamette watersheds. This frog potentially occurs at all elevations but is more common in the foothills and in southern parts of the subbasin.
Key Environmental Correlates: Although listed here as a focal species for wetland prairie and seasonal marshes, red-legged frogs often prefer ponds and sloughs with more-permanent water (section 2.5), especially when those waters are bounded by partly inundated shrubs and are relatively free of predatory bass and bullfrogs (Kiesecker & Blaustein 1998). The presence of a surrounding riparian area that is wooded enhances the habitat suitability of a pond, slough, or wetland where this species lays its eggs. Eggs are attached to sedges, cattails, or narrow stems of flooded shrubs when available, but flooded reed canarygrass is also used. Isolated wooded pools that contain at least a foot of water through April (or longer) may be used for egg deposition, especially if they are located somewhat close to perennial water. Predation pressure from

bullfrogs and especially bass may be less in such pools than in deeper perennial waters, partly because there may be more aquatic predators (e.g., dragonfly larvae) to keep numbers of predatory bullfrog tadpoles in check (Adams et al. 2003). Occasionally eggs are laid in the emergent vegetation of slow-flowing streams and rivers, or along wave-washed shores of reservoirs, but stagnant waters with relatively predictable springtime water levels are more typical. Velocity thresholds for successful egg hatching and tadpole survival are not known. During the summer some frogs move into woodland burrows or bury themselves under moist leaf litter up to 65 ft from water, and during heavy rains they can move overland up to 300 ft from ponds and wetlands. NHI models and data project this species has a close association with land cover in 3% of the subbasin. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate wetland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS*
170900030504	Finley NWR; Muddy & Hammer Cr.	1	3235	2305	0.72
170900030101	W. Eugene; Junction City	1	3399	1825	0.69
170900050601	Jefferson; Lyons; Bear Branch	1	3834	2650	0.62
170900030202	Monroe; Muddy Cr. E.	1	2448	1650	0.45
170900100102	Hillsboro	1	1071	827	0.37

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040201	Horse & Parsons & Cash & Mill Cr.	3	14	13	0.00
170900040201	Horse & Parsons & Cash & Mill Cr.	2	6	3	0.00
170900011001	Salt & Gold & Eagle Cr.	4	4	0	0.00
170900040201	Horse & Parsons & Cash & Mill Cr.	4	4	4	0.00
170900050501	Little North Santiam R.	3	2	0	0.00

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030504	Finley NWR; Muddy & Hammer Cr.	1	2652	1949	0.50
170900050601	Jefferson; Lyons; Bear Branch	1	2026	1589	0.29
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Reservoir	1	2589	1781	0.24
170900030202	Monroe; Muddy Cr. E.	1	1176	906	0.24
170900110101	Estacada; E. Gladstone	1	649	246	0.12

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080601	Yamhill	1	1166	830	0.46
170900030101	W. Eugene; Junction City	1	2477	1400	0.22
170900030606	Little Luckiamute R. - lower	1	195	95	0.07
170900120203	Gresham; Portland; N. Milwaukie	1	177	52	0.05
170900080604	Turner Cr.	3	1	0	0.00

Threats, Limiting Factors, Population Viability: Predation by bullfrogs and bass is the most commonly cited current threat to this species in the Willamette subbasin. However, there are wetlands where these species appear to coexist, so the interaction of these species is complex and possibly mediated by emergent vegetation density, water temperature, and other factors. Threats include continued destruction or drainage of seasonal wetlands (some of it not subject to regulatory review), as well as water pollution, airborne pesticides, ultraviolet radiation (Belden & Blaustein 2002), parasites, and disease.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Common Yellowthroat

Special Designations: none.
Distribution, Status, and Trends: Fairly common in the subbasin's lowland wetlands. Along Willamette subbasin BBS routes the species was detected at 9% of surveyed points in 2003, with a maximum during the period 1968-2003 of 17% in 1993. Application of simple species-habitat models to aerial imagery suggests 10.2% of the subbasin might contain habitat that could be at least marginally suitable and 0.38% might contain good habitat. NHI models and data project this species has a close association with land cover in 2% of the subbasin and a general association in 82%. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 52% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 35%. BBS data show statistically significant increases in the Willamette Valley for both the periods 1968-2003 and 1980-2003, but a decline in western Oregon-Washington generally during these periods. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate wetland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080501	Ash Swale & Deer Cr.	1	7572	259	4.31

170900070101	Baskett Slough NWR	1	5130	171	4.08
170900030402	S. Albany; Tangent.	1	8783	192	4.02
170900030202	Monroe; Muddy Cr. E.	1	16338	624	3.92
170900080402	Salt Cr.	1	3257	125	3.87

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110402	Timothy Lake; Dinger Lake	5	829	155	0.72
170900050103	Pyramid Cr.	5	327	8	0.49
170900110401	Harriet Lake	5	213	2	0.45
170900011101	Groundhog Cr: S.Fork	4	449	1	0.40
170900010702	Christy Cr.	5	246	0	0.40

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900060201	Beaver Cr.	1	12262	250	2.92
170900080402	Salt Cr.	1	2323	99	2.30
170900070101	Baskett Slough NWR	1	2589	128	2.00
170900080401	Sheridan	1	4104	64	1.79
170900030601	Luckiamute R.4	1	2887	79	1.66

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080601	Yamhill	1	7361	225	3.55
170900030402	S. Albany; Tangent.	1	6446	95	3.49
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	1	20511	405	3.28
170900080702	Lafayette	1	4243	177	3.25
170900070301	Saint Paul	1	5197	308	3.13

Key Environmental Correlates: Nests in a wide variety of marsh vegetation types, including reed canarygrass. Especially thrives in marshes with scattered plants that are more robust, e.g., cattail, bulrush, shrubs.
Threats, Limiting Factors, Population Viability: Like other low-nesting marsh birds, this species might be especially vulnerable to feral cats, raccoons, snakes, and all-terrain vehicles. Nests are destroyed when fields are mowed before mid-July. Pesticides potentially affect the insects it consumes. As a neotropical migrant, its abundance could be limited by factors along its migration route or in its wintering range. Prairie restoration activities that feature complete removal of shrubs might adversely affect this common species.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Dunlin

Special Designations: none

Distribution, Status, and Trends: This arctic-nesting shorebird resides in the Willamette subbasin from autumn to late spring. Largest wintering concentrations (over 10,000 individuals) are regularly reported from the vicinity of Fern Ridge Reservoir, Halsey, Junction City, Tangent, and in parts of the national wildlife refuges that are managed for shorebirds (Sanzenbacher & Haig 2002). Trends are unmeasured, but widespread loss of wetland prairie over the last century seems likely to have had a major adverse impact.

Key Environmental Correlates: Flocks of dunlin feed in vernal pools and other seasonal wetlands with very short grass (<6 inches) or with bare saturated soils. Dunlin generally avoid wetlands bordered by woody vegetation (especially tall trees) unless such wetlands are very large. Pools or wet soils that are richest in earthworms, fly larvae, and other soil invertebrates are probably favored. Because invertebrate productivity of wet soil shows enormous temporal and spatial variability, dunlin flocks frequently wander large portions of the landscape (over 100 square miles per day) searching for food (Haig et al. 1998). When not feeding, dunlin flocks roost in bare or short-grass areas relatively free from constant human activity, such as gravel islands in rivers, sewage treatment plants, and large agricultural fields.

Threats, Limiting Factors, Population Viability: Improvements in agricultural drainage probably pose the greatest immediate and fully legal threat to this species. Other threats may include pesticides, invasion of wet prairies by woody shrubs as a result of fire suppression, conversion of favored roosting sites to other cover types or uses, and harassment of flocks by dogs and humans. Mowing, burning, plowing, and grazing probably benefit this species to some degree by reducing vegetative cover.

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. Connectivity and size of moist soil patches in its mainly agricultural habitat is very important, especially during dry years (Taft 2004).

Northern Harrier

Special Designations: Partners In Flight focal species.

Distribution, Status, and Trends: Also called "marsh hawk," this species nests throughout most lowland regions of Oregon. It is not known if wintering birds are raised locally or migrate from other regions. Application of simple species-habitat models to aerial imagery suggests 1.16.% of the subbasin might contain habitat that could be at least marginally suitable and 0.38% might contain good habitat. NHI models and data project this species has a general association with land cover in 20% of the subbasin. Breeding population in the Willamette Valley probably is less than about 100 birds (Altman 2000). The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 13% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 41%. Along Willamette subbasin BBS routes the species was detected at 0.5% of surveyed points in 2003, with a maximum during the period 1968-2003 of 1.5% in 1989. BBS data covering the period 1968-2003 and 1980-2003 show increases in the Willamette Valley, but a decrease in western Oregon-Washington generally during 1980-2003. Populations vary significantly from year to year in response to rodent population fluctuations. This species is also fairly common in the subbasin in winter. At least 127 were present almost simultaneously in January 2004 in farmlands of Lane-Linn-Benton-

Polk-Yamhill-Marion Counties (J. Fleischer, pers. comm.). Since 1850, suitable habitat for this species in the subbasin may have decreased by 308-890% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate wetland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030402	S. Albany; Tangent.	1	1001	602	1.54
170900080501	Ash Swale & Deer Cr.	1	766	447	1.54
170900060101	Crabtree Cr. & Onehorse Slough	1	754	227	1.52
170900070101	Baskett Slough NWR	1	481	265	1.45
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	1	2788	1067	1.41

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030202	Monroe; Muddy Cr. E.	1	22	14	0.06
170900090704	Silverton S.	3	172	0	0.03
170900030602	Soap Cr.	1	37	5	0.02
170900070307	Salem	1	57	6	0.02
170900070301	Saint Paul	1	8	1	0.01

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900060201	Beaver Cr.	1	3591	328	1.18
170900080402	Salt Cr.	1	256	184	0.79
170900030602	Soap Cr.	1	1983	200	0.75
170900070101	Baskett Slough NWR	1	261	175	0.70
170900030504	Finley NWR; Muddy & Hammer Cr.	1	2434	1240	0.69

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030402	S. Albany; Tangent.	1	678	426	1.39
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	1	2245	822	1.28
170900080601	Yamhill	1	925	329	1.17
170900080501	Ash Swale & Deer Cr.	1	526	374	1.14

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070301	Saint Paul	1	701	405	1.13

Key Environmental Correlates: Resident year-round in both wetland prairie and wetland prairie, as well as in other types of non-forested wetlands, irrigated hayfields, wet meadows, lightly-grazed pastures, and possibly some ryegrass fields if not mowed before mid-July.
Threats, Limiting Factors, Population Viability: Has been impacted by loss of prairie and wetland habitat in the Willamette subbasin, but possibly more adaptable to some types of agricultural land cover than short-eared owl, which otherwise has similar habits but is nearly extirpated. Like other low-nesting marsh birds, this species might be especially vulnerable to feral cats, raccoons, snakes, and all-terrain vehicles. Like most raptors, it requires large blocks of suitable habitat (not necessarily contiguous) and when nesting is sensitive to mere presence of livestock, humans, and domestic pets. Nests are destroyed when fields are mowed before mid-July.
Biological Objectives: As proposed in *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), the habitat objectives should include:

- maintain a mosaic of non-managed grasslands in blocks of larger than 400 ac located at least one-quarter mile from human development or recreational activities
- where nests are located, provide a no-activity buffer of at least 400 ft radius around nests

<u>Sora</u>
Special Designations: none
Distribution, Status, and Trends: At least historically, this species occurred throughout lowlands of the Willamette subbasin. Due to its secretive nature it is seldom detected on BBS routes so local trends are unknown. Application of simple species-habitat models to aerial imagery suggests 0.57% of the subbasin might contain habitat that could be at least marginally suitable. NHI models and data project this species has a close association with land cover in less than 1% of the subbasin and a general association in 20%. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 7% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 31%. On BBS routes in the Willamette subbasin, soras have seldom been detected. Since 1850, suitable habitat for this species in the subbasin may have decreased by 558-666% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate wetland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a “10”; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6’s, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	326	298	0.73
170900060101	Crabtree Cr. & Onehorse Slough	1	311	301	0.70

170900030101	W. Eugene; Junction City	1	1644	1426	0.55
170900030204	E. Eugene; Harrisburg; Springfield	1	639	565	0.49
170900090101	Aurora	1	256	232	0.48

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900050301	Detroit Reservoir	3	423	412	0.06
170900010502	Hemlock; Lookout Point Reservoir	2	234	234	0.05
170900011301	Oakridge W.; Hills Creek Reservoir	3	372	370	0.04
170900110402	Timothy Lake; Dinger Lake	5	155	155	0.03
170900060401	Greenpeter Reservoir	3	154	154	0.03

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030202	Monroe; Muddy Cr. E.	1	724	709	0.26
170900070304	Lincoln	1	381	370	0.25
170900090101	Aurora	1	161	153	0.24
170900030504	Finley NWR; Muddy & Hammer Cr.	1	1215	1208	0.24
170900030601	Luckiamute R.4	1	165	162	0.24

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080501	Ash Swale & Deer Cr.	1	426	419	0.24
170900090201	S. Canby	1	323	295	0.21
170900080601	Yamhill	1	345	314	0.20
170900070301	Saint Paul	1	482	466	0.20
170900100102	Hillsboro	1	741	635	0.19

Key Environmental Correlates: This species inhabits taller denser marsh vegetation than may be typical of some wetland prairies, but perhaps not as tall as that used by two other secretive marsh species (American bittern and Virginia rail). Marshes of sedge or cattail, flooded either seasonally or year-round, are frequently used, as are (occasionally) irrigated hayfields, wet meadows, and lightly-grazed pastures on poorly-drained soils.

Threats, Limiting Factors, Population Viability: This species apparently has not been recorded nesting in reed canarygrass so the recent proliferation of that invasive throughout the subbasin's marshes may be having an effect. Populations may also decline as woody plants invade wet prairies, inasmuch as soras do not tolerate much tree cover. Soras may be more sensitive to marsh water quality and pesticide drift than some other species due to its consumption of aquatic invertebrates. Also may be more likely to suffer collision mortality due to habit of migrating at low elevations at night.

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Other Species of Note

Many other species regularly inhabit seasonal wetlands of the Willamette subbasin. These include the following which are noted because of their rarity, restricted range, declining trends, or other factors: Aleutian Canada goose (a subspecies listed federally as threatened, with mostly a coastal range), short-eared owl (probably extirpated as a breeder), white-tailed kite, marsh wren, American bittern, killdeer, Wilson's snipe, Virginia rail, sandhill crane (extirpated), bald eagle, peregrine falcon; purple martin, common nighthawk, tree swallow, cliff swallow, red-winged blackbird, western toad (nearly extirpated), Cascades frog, long-toed salamander, western pond turtle, painted turtle, muskrat, mink, river otter, pallid bat, and fringed myotis. Most of these also frequently use the herbaceous margins of ponds, sloughs, reservoirs, and other water bodies, discussed in section 2.5.

2.4.9 Synthesis: Indicators of Wetland Ecological Condition and Sustainability

The following indicators – which must be assessed in the field -- may be useful for prioritizing wetland prairie and seasonal wetland parcels for protection and restoration, as well as for monitoring success of restoration projects and long-term trends in quality of the remaining tracts of this habitat type.

Extent of wetland prairies and seasonal marshes: the mean patch size and total acreage of this type compared with historical extent of wetland prairie; should be subtotaled within watersheds by geomorphic position (elevation, geology, soils) and degree of fragmentation (distance to nearest similar patch and type of intervening land cover types);

Focal species status: the density, interannual frequency of occurrence, and distribution (proportion of sample points where detected) of each focal species within parts of a watershed that are projected (by models, aerial imagery, historical vegetation data, and professional judgment) to be generally suitable for the species based on elevation and gross land cover type.

Tree density: the density and spacing (mean separation distance) of trees within all patches of wetland prairie and seasonal herbaceous wetland in a particular watershed.

Shrub density: the density and spacing (mean separation distance) of shrubs within all patches of wetland prairie and seasonal herbaceous wetland in a particular watershed.

Native herbaceous plant cover: the percentage of the total herbaceous (non-shrub) plant cover that is comprised of native species, especially those characteristic of wetland prairies and seasonal herbaceous wetlands, e.g., Table 15.

Water regime: the extent of different water regime classes (including vernal pools), defined by depth and duration of seasonal inundation or soil saturation, within a wetland

and among wetlands within a subbasin (see Richter et al. 1996 and www.freshwaters.org for assistance with hydrologic indicator selection, measurement, and data interpretation).

Microtopographic complexity: Many wetland prairies are characterized by small (<1 square meter, <0.25 m high) mounds or hummocks formed by bunches of tufted hairgrass and sedges; the extent of such microtopography should be assessed.

Additional biological indicators – such as invertebrates -- should be considered for wetland monitoring. Impacts, equipment, and measurement protocols are reviewed in Adamus & Brandt (1990), Adamus (2001), and Adamus et al. (2001), and at:
http://www.epa.gov/waterscience/criteria/wetlands/

The above indicators include those recommended in the wetland chapter of Oregon's *State of the Environment Report* (Morlan 2000). It is not possible to specify exact criteria for evaluating each of these indicators. Doing so would require collecting and interpreting an appropriate array of biological data from a series of reference wetlands. Portions of such a reference data set for the Willamette Valley were assembled, with an accompanying protocol, by Adamus & Field (2001; database for slope-flats wetlands). Reference data (mainly vegetation) for wetland prairies also are available from studies of the West Eugene wetlands and regionwide by Titus et al. (1996). An interagency committee currently is drafting additional protocols for assessing Willamette wetland vegetation in the course of monitoring mitigation sites (John Marshall and Kathy Pendergrass, USFWS, pers. comm.).

Table 15. Native plant species that often characterize wetland prairies and/or seasonal marshes in the Willamette Valley.

Note: Projects seeking to restore wetland prairies and other seasonal herbaceous wetlands should strive to favor these species through seeding, burning, and/or manipulation of flooding depth, duration, frequency, and seasonality. List from Kathy Pendergrass (US Fish & Wildlife Service) and Floberg (2004).

Agrostis exarata
Allium amplectens
Aristida oligantha
Asclepias fascicularis
Aster curtus
Aster hallii ssp. *chilensis*
Barbarea orthoceras
Beckmannia syzigachne
Boisduvalia densiflora
Brodiaea (Triteleia) hyacinthina
Brodiaea coronaria
Calandrinia ciliata
Callitriche heterophylla
Camassia leichtlinii
Camassia quamash
Cardamine penduliflora
Carex aperta
Carex aurea
Carex densa
Carex echinata
Carex feta
Carex pachystachya
Carex tumulicola
Carex unilateralis
Centaurium muhlenbergii
Centunculus minimus
Danthonia californica
Deschampsia cespitosa
Deschampsia danthonioides
Deschampsia elongata
Dodocatheon hendersonii
Downingia elegans
Downingia yina
Eleocharis acicularis
Eleocharis ovata
Eleocharis palustris
Epilobium ciliatum var. watsonii
Epilobium paniculatum
Erigeron decumbens var. decumbens
Eriophyllum lanatum
Eryngium petiolatum
Fraxinus latifolia
Gentiana sceptrum
Glyceria occidentalis
Gnaphalium palustre
Gnaphalium purpureum
Gratiola ebracteata
Grindelia intergrifolia
Haplopappus racemosus
Heterocodon rariflorum
Hordeum brachyantherum
Horkelia congesta
Isoetes nutalli
Juncus bolanderi
Juncus bufonius
Juncus nevadensis
Juncus tenuis
Lasthenia glaberrima
Lindernia anagallidea
Lomatium nudicaule
Lotus formosissimus
Lotus pinnatus
Lotus purshiana
Lupinus polyphyllus
Luzula campestris
Madia glomerata
Microseris laciniata
Microsteris gracilis
Mimulus guttatus
Montia fontana
Montia lineari
Myosotis laxas
Myosurus minimus
Navarretia intertexta
Navarretia squarrosa
Orthocarpus bracteosus
Orthocarpus hispidus
Panicum capillare
Panicum occidentale
Perederidia oregana
Perideridia gairdneri
Plagiobothrys figuratus
Plagiobothrys scouleri
Poa scabrella
Polygonum bistortoides
Polygonum douglasii
Potentilla gracilis
Prunella vulgaris var. lanceolata
Psilocarphus elatior
Ranunculus alismaefolius
Ranunculus flammula
Ranunculus occidentalis
Ranunculus orthorhynchus
Rorippa curvisiliqua
Rosa eglanteria
Rosa nutkana
Sanquisorba occidentalis
Saxifraga oregana
Sidalcea cusickii
Sidalcea virgata
Sisyrinchium idahoense (angustifolium)
Sisyrinchium hitchcockii
Spiranthes romanzoffiana
Spiraea douglasii
Trichestema lanceolatum
Vaccinium caespitosum
Veronica peregrina
Veronica scutellata
Viola adunca
Wyethia angustifolia
Zigadenus venenosus

2.5 Focal Habitat: Perennial Ponds and Their Riparian Areas

2.5.1 Description

In this report, this focal habitat includes all lentic (non-flowing) areas that are inundated year-round, extending spatially to include basically lentic areas that are inundated seasonally by other lentic water bodies or by rivers ("sloughs"). This focal type includes natural ponds, sloughs, lakes, and perennially-inundated marshes as well as lakes, regulated reservoirs, farm ponds, gravel-pit ponds, irrigation ponds, log ponds, beaver-created ponds, and ponds constructed for wildlife, fire control, or as visual amenities in developed areas. Vegetation (woody or herbaceous) within one tree-length of the lentic waters at the time of annual maximum inundation is included. As such, this type includes some of the systems included in TNC's *Ecoregional Assessment* "depressional wetland broadleaf forests" and "depressional wetland shrublands." Aquatic plant associations in the subbasin are described by Christy (2004).

2.5.2 Recognition of Importance

Compared with other focal habitat types featured in this report, ponds and most other lentic waters have not been accorded high priority in other ecological assessments of the Willamette subbasin. This may be due to their relative abundance, lack of evidence of major decline from historical extent (see below), apparent absence of any endemic species, and lack of ecological survey effort, e.g., of aquatic plants and lentic invertebrates. Nonetheless, ponds and their riparian areas provide a remarkable contribution to regional biodiversity, as described further in section 2.5.7.

2.5.3 Status and Distribution

Defined broadly, the acreage of perennially-inundated lentic water bodies in the Willamette subbasin probably has not diminished since pre-settlement times and if anything, has increased. Maps of their current distribution (from NHI and other sources) are probably quite accurate and relatively complete (Table 16). However, historical maps and accounts of vegetation almost surely do not adequately depict the distribution of very small sloughs, ponds, and perennial marshes. Rough estimates suggest they may have occupied at least 40,000 acres (0.55% of the subbasin).

Table 16. Acreage estimates of land cover types that include lentic habitat

Source	Map categories that include lentic habitats	Estimated Area (acres)	Percent of mapped area
EC1850	"lakes & permanent wetlands"	40,693	0.55
EC90	"lakes, reservoirs, & permanent wetlands"	53,191	0.72
IBIS 1850	"lakes, rivers, and streams"	23,009	0.32
IBIS 1990	"lakes, rivers, and streams"	77,710	1.09
ODFW*	"water"	30,728	1.58

*Valley area only

2.5.4 Past Impacts, Limiting Factors, and Future Threats

Regardless of possible change in total area of the subbasin's lentic waters, the size distribution of these waters has changed. Prior to colonial settlement, very large bodies of lentic perennial water may have been virtually non-existent on the valley floor, and existed at higher elevations only as scattered lakes, e.g., Waldo Lake. As more settlers arrived, small perennial sloughs along the Willamette River were isolated from the river with berms to improve river navigation. Some were subsequently drained to provide additional agricultural land (IMST 2002). More dramatically, new lentic waters were created by damming rivers, e.g., Fern Ridge Reservoir, Foster Reservoir, Bull Run Reservoir. This may have had the effect of increasing the mean size and depth of lentic waters in the subbasin, and decreasing the mean water temperature within this habitat type. These changes would be expected to have caused shifts in the composition of wildlife communities that historically used the subbasin (Marcot 1990). Species that are more likely to occur in wooded lowland ponds (e.g., hooded merganser, river otter, red-legged frog) than in large reservoirs (or for which only the shoreline of reservoirs counts as suitable habitat) may now have less habitat. In contrast, species that are more likely to use large and/or marsh-fringed water bodies than wooded ponds (e.g., Canada goose, black tern) may now have more habitat available.

Ponds, lakes, sloughs, and other lentic waters of the Willamette subbasin have been ecologically degraded to varying degrees. Alien species of fish (especially bass, carp) and wildlife (bullfrog, nutria) intentionally released into lentic waters are believed to be at least partly responsible for decline of some native species (e.g., Oregon spotted frog) unaccustomed to new predators or competitors. Apparently the problem of bullfrogs decimating native frog populations occurs mainly where alien fish have been introduced, because they reduce densities of the dragonfly larvae that otherwise help keep bullfrog populations in check (Adams et al. 2003). Some scientists have suggested that construction of perennial ponds for farm use or wetland mitigation (Gwin et al. 1999), as well as construction of large reservoirs, has facilitated the establishment and spread of some harmful non-native animals. Many of the subbasin's lentic waters have become degraded by invasive aquatic weeds and abnormal blooms of algae. Although some invasive aquatic plants provide food for waterfowl, they can deprive small lentic water bodies of light and oxygen, thus diminishing or changing communities of bottom-dwelling invertebrates important to many birds and amphibians, reducing the diversity of native aquatic plants, and harming larval amphibians.

Pesticides, toxic substances, and excessive loads of sediment from roads, logging, motorboats, and suburban and agricultural lands reach lentic waters and potentially diminish their capacity to support wildlife and rare plants. In some cases, changes in physical characteristics of receiving waters (temperature, oxygen, pH) triggered by drought, reservoir drawdown, or land clearing in adjoining watersheds can mobilize heavy metals and other contaminants lying latent in sediments, accelerating their bioconcentration in food chains.

Increased frequency and duration of human visits can cause some wildlife species to avoid lentic waters, at least temporarily. Local waterbird populations can be harmed when this occurs in smaller bodies of lentic water, and/or during sensitive times (e.g., nesting), and/or when it involves chronic visitation and/or highly disturbing activities (e.g., use of jet-skis).

Riparian areas associated with lentic waters in the Willamette subbasin are being completely cleared in some instances, and degraded by several factors in other instances (IMST 2002). Consequently, the associated lentic waters can be degraded by increased water temperature, excessive sediment, and nutrient runoff. The supply of partly-submerged woody material important to turtles and a few other wildlife inhabitants also has been reduced (IMST 2002).

2.5.5 Protection, Restoration, Management

As protected waters of the state, most ponds and other lentic water bodies are not subject to loss by conversion to agricultural, forestry, or residential land uses. Additional conservation efforts therefore have been largely unnecessary. However, considerable potential exists to restore ponds and sloughs in the subbasin that have been ecologically degraded. This can be accomplished by restoring their riparian zones or original water regimes, and reducing contaminants. Some of the restoration techniques described by Campbell (2000) for wetlands and riparian areas are applicable here.

Before ponds and sloughs can be prioritized effectively for restoration, their relative levels of degradation should be determined through regionwide or watershed-wide surveys, focusing on invasive plant cover, water quality, and condition of their riparian zones. Opportunities should also be pursued for enhancing the suitability of reservoirs and ponds for turtles, amphibians, and waterbirds. The U.S. Army Corps of Engineers currently has an active program for conducting such enhancements in the Willamette reservoirs it manages.

2.5.6 Compatibility of Pond Management and Stream Management

There is no inherent incompatibility between managing wildlife habitat in ponds and in stream habitats. However, stream restorations alone do not provide a significant benefit to pond wildlife and plant species. Construction of new ponds and reservoirs by impounding streams has the potential to harm fish if entrapment occurs. Conversely, restoring flow to backchannel ponds in order to increase fish rearing habitat has the potential to harm wildlife. This can occur if flow restoration reduces habitat for red-legged frog, pond turtle, and some other species that do not thrive in swiftly flowing water and fare poorly in water bodies accessible to predatory fish. On the other hand, by returning flows to sloughs, managers can potentially benefit the same or other species if doing so reduces water temperatures enough to lower habitat suitability for predators such as bullfrogs. Also, any increase in native fish populations or distribution at a watershed scale has the potential to benefit many fish-feeding terrestrial wildlife species. Thus, projects that involve any impounding or restoring of flows should examine carefully the consequences for fish, wildlife, and plant species.

2.5.7 Contribution of Ponds and Their Riparian Areas to Regional Biodiversity

Whether natural or man-made, lentic water bodies and their riparian areas support a fauna quite unlike that found in other habitats. However, introduced animals -- such as bullfrogs, bass, carp, and nutria – have increased the direct or indirect loss of native wildlife and especially native plants (such as wapato, *Sagittaria latifolia*) in many lentic waters of the Willamette subbasin.

2.5.8 Selected Focal Species

The following species are proposed as focal species for this habitat type: western pond turtle, Cascades frog, Oregon spotted frog, purple martin, green heron, wood duck, and yellow warbler.

On a scale of 0 to 10, their average degree of association with pond and pond riparian habitat is 8.5. Compare this with HEP "loss assessment" species used in many previous mitigation calculations and land acquisitions in the Willamette subbasin. Of the "reservoir" species used in HEP applications, the average degree of association with pond and/or pond riparian is 7.8. This suggests there may have been an unintentional but systematic bias against pond and pond riparian habitat in previous mitigation land dealings in the Willamette subbasin.

Western Pond Turtle

Special Designations: "Critical" (ODFW).

Distribution, Status, and Trends: Most turtle population centers are in lowlands of the central and southern parts of the subbasin. The ORNHIC database contains documented records from 78 of the 170 Willamette watersheds, covering over 400 sites. Several biologists have noted the rarity of reports of hatchlings and sub-adult turtles in the Willamette subbasin in recent years (Holland 1994, Adamus 2003a). This is perhaps only partly due to the difficulties in locating turtle nests and detecting young. There is growing concern that it may largely reflect declining reproductive success and diminished subadult survival. Naturalists in the early 1900s reported turtles to be abundant in the region, with hundreds present in some sloughs. At least initially, precipitous declines were a result of habitat loss (near-extirpation of beaver which where responsible for creating productive pond habitat), habitat alteration (especially channelization of rivers), and intensive commercial collecting. Most current populations are on private lands below about 2000 ft elevation. Public lands that appear to host the most individuals are within the Willamette River Greenway, Fern Ridge Reservoir, Fall Creek Reservoir, and scattered holdings of the US Bureau of Land Management (Adamus 2003b). NHI models and data project this species has a close association with land cover in 3% of the subbasin. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate upland prairie specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030601	Luckiamute R.4	1	48	46	2.32
170900080501	Ash Swale & Deer Cr.	1	26	24	1.68
170900070201	Sublimity & Turner	1	120	75	1.62
170900030402	S. Albany; Tangent.	1	72	48	1.47
170900030403	Sodaville	1	59	40	1.43

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010502	Hemlock; Lookout Point Reservoir	2	0	0	0.04
170900020401	Dorena Reservoir	2	0	0	0.00
170900020503	Sharps & Martin Cr.	2	0	0	0.00
170900011301	Oakridge W.; Hills Creek Reservoir	3	0	0	0.00
170900040201	Horse & Parsons & Cash & Mill Cr.	2	0	0	0.00

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080402	Salt Cr.	1	8	7	0.85
170900030601	Luckiamute R.4	1	38	36	0.73
170900070101	Baskett Slough NWR	1	11	11	0.64
170900030202	Monroe; Muddy Cr. E.	1	60	54	0.52
170900080703	McMnnville S.	1	12	8	0.49

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900080601	Yamhill	1	19	16	1.42
170900060101	Crabtree Cr. & Onehorse Slough	1	21	18	1.40
170900030401	N. Albany; W. Lebanon; Cox Cr.	1	137	68	1.21
170900080702	Lafayette	1	34	25	1.19
170900030403	Sodaville	1	47	31	1.14

Key Environmental Correlates: Pond turtle habitat is not limited to ponds, but potentially includes nearly all water bodies with stagnant or slow-flowing water, whether seasonal or perennial. Turtles use sloughs and wetlands that contain surface water only seasonally if perennially inundated areas are nearby. Pools, alcoves, and backwater sloughs along rivers such as the mainstem Willamette, McKenzie, Calapooia, and Row contain many turtles. Some seasonal movement may occur between habitats, with some turtles (especially juveniles) tending to use warmer, invertebrate-rich vernal pools and shallow wetlands more often during spring when river currents are too swift, and then moving to cooler and more permanent waters of rivers, deep ponds, and reservoirs during late summer. Turtles are frequently sighted where ponds or rivers are situated near relatively open areas -- including natural gaps in the forest canopy, agricultural lands, golf courses, sewage treatment facilities, and prairies – especially if these are not far from wooded areas. Turtles lay eggs on land, and apparently the open land provides warmth needed for egg development and thermoregulation. The understory of wooded areas is at least equally important to turtles when it provides a thick mat of leaves suitable for hibernation. Riparian wood, when it enters rivers and ponds, provides important basking sites. Nest and hibernation sites are generally within about 100 ft of surface water, but can be over 300 ft away. Within rivers and large reservoirs, movements of over 1 mile are common.

Threats, Limiting Factors, Population Viability: Threats to this species include the following in no particular order: habitat loss and fragmentation, habitat degradation (e.g., channel downcutting, blanketing of floodplains with Himalayan blackberry), roads (collisions with vehicles), water pollution (Henny et al. 2003), predation of juveniles, illegal shooting/ collecting, and introduction of exotic turtles (Holland 1994, Adamus 2003b). Increased residential or recreational use of an area can imperil turtles because of associated increases in road traffic, trampling of nest and hibernation sites, introduction of warmwater fish, illegal shooting, accidental take on fish hooks, garbage that attracts predators such as raccoons, and lethal puncturing of turtle carapaces (shells) by curious dogs.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. Specific suggestions for habitat enhancement techniques and conservation strategies are provided by Adamus (2003b) and ODFW (www.dfw.state.or.us/ODFWhtml/springfield/W_Pond_Turtle.htm).

Cascades Frog

Special Designations: "Vulnerable" (ONHP). "Vulnerable" (ODFW).
Distribution, Status, and Trends: There are about 70 locations of this species in Oregon. The ORNHIC database contains records from 8 of the 170 Willamette watersheds. NHI models and data project this species has a close association with land cover in 0.27% of the subbasin. In some mountain meadows in Oregon, hundreds were estimated to be present within an area of just a few acres (Nussbaum et al. 1983). Although little information is available on trends, at a series of surveyed sites in Oregon where it was known to have existed historically, 22% of the sites were found to be no longer occupied (Sype 1975, Fite et al. 1998). Severe declines have been documented in California. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units are the only ones in which the species has been documented in recent years. The habitat estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate montane meadows specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110402	Timothy Lake; Dinger Lake	5	293	155	0.05
170900040803	Roaring R. & Elk Cr.	6	283	269	0.04
170900011001	Salt & Gold & Eagle Cr.	6	197	182	0.03
170900050102	Marion Lake	6	163	148	0.03
170900040501	Boulder Cr. & Smith R.	6	89	86	0.01
170900040802	French Pete Cr.	5	9	8	0.00
170900090601	Molalla R. N. Fk.	5	3	2	0.00
170900110401	Harriet Lake	3	--	--	--

Key Environmental Correlates: This species occurs mainly in montane ponds and lakes, but also uses slow-flowing streams, wet mountain meadows, sphagnum bogs, and open moist coniferous forests.
Threats, Limiting Factors, Population Viability: Factors potentially responsible for the declines include introductions of non-native predatory fishes, gradual loss of open wet meadows and associated aquatic habitats due to grazing-caused downcutting of outlet channels, drying of the forest floor microclimate as a result of logging-related forest fragmentation and global warming, spread of pathogenic fungi and parasites as perhaps accelerated by fish stocking, food chain contamination by airborne chemicals (Davidson et al. 2002), and increased exposure to ultraviolet radiation (Blaustein et al. 1994b) resulting from atmospheric ozone layer depletion.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Oregon Spotted Frog
Special Designations: "Candidate species" (federal). "Imperiled" (ONHP).
Distribution, Status, and Trends: The ORNHIC database contains documented records from just 2 of the 170 Willamette watersheds. Both records are from the upper McKenzie watershed:

170900040803 Roaring R. & Elk Cr.
170900011001 Salt & Gold & Eagle Cr.

NHI models and data project this species has a close association with land cover in just 0.02% of the subbasin. Drastic declines in distribution and abundance have occurred in much of its range, which is limited to the Pacific Northwest. Apparently it once occupied much of the Willamette Valley, but now is confined to higher elevations.
Key Environmental Correlates: Similar to the Cascades frog, this species occurs along grassy edges of ponds and lakes as well as slow-flowing streams and wet mountain meadows. A thick layer of dead leaves beneath the water surface, in areas shallower than 1 ft, may be important.
Threats, Limiting Factors, Population Viability: Similar to Cascades frog, but reasons for its more-dramatic decline are unknown. Nitrate contamination, e.g. from fertilizers, may be at least partly responsible inasmuch as tadpoles of this species were found to be 4 times more sensitive to nitrate than was another frog (Pacific tree frog) that has healthy populations throughout the subbasin (Marco et al. 1999, 2001; Hatch et al. 2001). Pesticide drift could also be a factor (Davidson et al. 2002). Lower-elevation populations are aggressively preyed on by bullfrogs.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Purple Martin
Special Designations: "Critical" (ODFW sensitive species). "Imperiled" (ONHP). Partners in Flight focal species.
Distribution, Status, and Trends: Formerly common in this region, the martin is now an uncommon to rare and localized colonial nester, occurring mainly at Fern Ridge Reservoir and at scattered locations in the foothills. Statewide, there are about 784 pairs (Horvath 1999). The ORNHIC database contains documented records from 13 of the 170 Willamette watersheds. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 28% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 7%. Along Willamette subbasin BBS routes the species was detected at a maximum of 0.4% of surveyed points (in 1981). BBS data covering the period 1968-2003 and 1980-2003 show increases in

western Oregon-Washington generally, but there were too few detections in the Willamette Valley to calculate trends for there. NHI models and data project this species has a general association with land cover in 35% of the subbasin. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate ponds completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HS
170900030605	Luckiamute R.3.	3	0.43
170900030607	Little Luckiamute R. –upper	4	0.32
170900030607	Little Luckiamute R. –upper	3	0.30
170900030502	Mary's R –middle	3	0.19
170900020301	Cottage Grove Reservoir N.	2	0.15

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HS
170900040201	Horse & Parsons & Cash & Mill Cr.	2	0.02
170900011101	Groundhog Cr: S.Fork	4	0.39
170900010302	Fall & Delp Cr.	4	0.30
170900110302	Fish Cr. W.	4	0.24
170900080203	Willamina Cr. –upper	3	0.22

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HS
170900030607	Little Luckiamute R. –upper	3	0.28
170900030607	Little Luckiamute R. –upper	4	0.19
170900120201	Portland; Forest Hills; Multnomah Channel	1	0.06
170900050601	Jefferson; Lyons; Bear Branch	2	0.04
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	1	0.04

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HS
170900090602	Molalla R. S. Fk.	4	0.37
170900010501	Dexter Reservoir	3	0.31
170900030606	Little Luckiamute R. – lower	3	0.10
170900050601	Jefferson; Lyons; Bear Branch	3	0.05

HUC6	Watershed Name (not comprehensive)	Elev	HS
170900030103	Coyote Cr.	3	0.02

Key Environmental Correlates: Martins historically nested in cavities of enormous old-growth trees located near water bodies or other open areas. With widespread reduction of this habitat element, the species has adapted to nesting in artificial structures (bird houses, hollow gourds, hollow pilings in rivers) erected for its use by humans.
Threats, Limiting Factors, Population Viability: The greatest threats are continued loss of old growth snags of the proper proportions situated in suitable landscapes, and lack of maintenance of artificial nesting structures. In addition, the artificial nest sites are sometimes usurped by exotic species (European starling, house sparrow). Like other swallows, martins are wide-ranging aerial foragers and consequently are vulnerable to collisions with vehicles and reductions in insect prey as a result of severe weather and contaminants.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Green Heron

Special Designations: none
Distribution, Status, and Trends: This small heron is an uncommon to fairly common breeder at lower elevations in much of the subbasin. Application of simple species-habitat models to aerial imagery suggests about 1.6% of the subbasin might contain habitat that could be at least marginally suitable. NHI models and data project this species has a close association with land cover in 2% of the subbasin. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 24% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 35%. Along Willamette subbasin BBS routes the species was detected at 0.7% of surveyed points (in 1986), with none found in 2003. BBS data covering the period 1968-2003 and 1980-2003 show decreases in the Willamette Valley. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate ponds completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	806	0	2.02
170900060101	Crabtree Cr. & Onehorse Slough	1	841	0	1.32
170900090102	Woodburn; Hubbard	1	599	0	1.30
170900090101	Aurora	1	650	0	1.30
170900070301	Saint Paul	1	668	0	1.17

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010502	Hemlock; Lookout Point Reservoir	3	415	0	0.29
170900010601	Lost R.; Anthony Cr.	3	176	0	0.16
170900040401	Blue River Reservoir & Elk Cr.	3	376	0	0.16
170900080203	Willamina Cr. -upper	3	220	0	0.15
170900090704	Silverton S.	3	136	0	0.15

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070304	Lincoln	1	1341	0	0.76
170900090101	Aurora	1	525	0	0.69
170900030601	Luckiamute R.4	1	681	0	0.67
170900110103	Sandy	2	670	0	0.64
170900060101	Crabtree Cr. & Onehorse Slough	1	724	0	0.57

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070403	Oregon City; West Linn	1	932	0	0.54
170900070401	W.Wilsonville	1	1281	0	0.54
170900070402	N. Canby; E. Wilsonville	1	1150	0	0.51
170900080702	Lafayette	1	723	0	0.41
170900090202	Molalla R. -middle	1	359	0	0.39

Key Environmental Correlates: This species is strongly associated with wooded or brushy ponds and channels, especially those that contain water year-round.
Threats, Limiting Factors, Population Viability: A diet comprised mainly of small fish and frogs may make this species especially vulnerable to biaccumulation of pesticides. Destruction of riparian areas by residential development, agricultural and forestry operations also is detrimental.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Wood Duck
Special Designations: none
Distribution, Status, and Trends: This colorful duck is fairly common year-round mostly at lower elevations of the subbasin. Application of simple species-habitat models to aerial imagery suggests 2.3% of the subbasin might contain habitat that could be at least marginally suitable. NHI models and data project nearly the same amount of habitat. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 56% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 26%. Along Willamette subbasin

BBS routes the species was detected at 1% of surveyed points (in 1989), and at none in 2003. Although this species was extirpated from much of its continental range by the early 1900s, it has since recovered. BBS data covering the periods 1968-2003 and 1980-2003 show increases in the Willamette Valley and in western Oregon-Washington generally. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate ponds completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	806	0	2.02
170900060101	Crabtree Cr. & Onehorse Slough	1	841	0	1.32
170900090102	Woodburn; Hubbard	1	599	0	1.31
170900090101	Aurora	1	650	0	1.30
170900070306	W. Salem	1	502	0	1.17

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900050102	Marion Lake	6	302	0	0.49
170900010703	Grassy Cr.	4	185	0	0.43
170900040602	Horse & Eugene Cr.	6	209	0	0.40
170900010803	Waldo Lake; Black & Salmon Cr.	6	64	0	0.37
170900010502	Hemlock; Lookout Point Reservoir	3	415	0	0.36

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070304	Lincoln	1	1341	0	0.76
170900090101	Aurora	1	525	0	0.69
170900030601	Luckiamute R.4	1	681	0	0.67
170900110103	Sandy	2	670	0	0.65
170900120201	Portland; Forest Hills; Multnomah Channel	1	487	0	0.57

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070403	Oregon City; West Linn	1	932	0	0.55

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070401	W.Wilsonville	1	1281	0	0.54
170900070402	N. Canby; E. Wilsonville	1	1150	0	0.51
170900080702	Lafayette	1	723	0	0.41
170900090202	Molalla R. -middle	1	359	0	0.40

Key Environmental Correlates: As their name indicates, wood ducks prefer wooded sloughs, shaded ponds, shallow portions of reservoirs, and slow-water sections of wooded rivers and wide streams. They nest in large tree cavities as well as artificial nest boxes placed for their use. They feed extensively on acorns, but also on aquatic invertebrates, berries, seeds of aquatic plants, and even hazelnuts.
Threats, Limiting Factors, Population Viability: River regulation and floodplain development have diminished their favored feeding habitat -- flooded stands of trees – as well as reduced the sustained supply of natural nesting cavities. At some locations water quality may limit the aquatic invertebrates upon which they feed.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Yellow Warbler
Special Designations: Designated as a focal species by Partners In Flight.
Distribution, Status, and Trends: This species is currently uncommon (to locally fairly common) in the Willamette subbasin. Application of simple species-habitat models to aerial imagery suggests 0.8% of the subbasin might contain marginally-suitable habitat and 0.6% might contain good habitat. NHI models and data project this species has a close association with land cover in 2.5% of the subbasin. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 19% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 67%. Along Willamette subbasin BBS routes the species was detected at 2.5% of surveyed points in 2003, with a maximum during the period 1968-2003 of 6.4% in 1969. This species may have been the most abundant warbler in the Willamette Valley up until the mid-1900s, but has since declined dramatically. BBS data covering the period 1968-2003 show a decrease in the Willamette Valley and in western Oregon-Washington generally, with a possible increase in the Willamette during the 1980-2003 period. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate ponds completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900060101	Crabtree Cr. & Onehorse Slough	1	450	430	1.20
170900090101	Aurora	1	328	308	1.03

170900070301	Saint Paul	1	324	284	0.93
170900090201	S. Canby	1	238	204	0.84
170900030602	Soap Cr.	1	1771	1738	0.74

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110402	Timothy Lake; Dinger Lake	5	339	0	0.17
170900110401	Harriet Lake	5	87	0	0.10
170900050103	Pyramid Cr.	5	54	0	0.10
170900011101	Groundhog Cr: S.Fork	6	242	0	0.10
170900011101	Groundhog Cr: S.Fork	4	13	0	0.08

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900060201	Beaver Cr.	1	2755	2606	0.64
170900030602	Soap Cr.	1	1553	1520	0.64
170900060101	Crabtree Cr. & Onehorse Slough	1	232	231	0.53
170900090101	Aurora	1	261	251	0.53
170900070304	Lincoln	1	384	381	0.39

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070303	Chehalem Cr.	1	695	620	0.35
170900080601	Yamhill	1	606	546	0.31
170900080604	Turner Cr.	1	522	494	0.30
170900090102	Woodburn; Hubbard	1	468	435	0.29
170900090201	S. Canby	1	232	200	0.28

Key Environmental Correlates: This neotropical migrant prefers deciduous shrubs or trees within a few dozen feet of standing or flowing water. In western Oregon it occurs mostly in lowland riparian areas containing willow and/or cottonwood.

Threats, Limiting Factors, Population Viability: Nests of yellow warblers are often parasitized by brown-headed cowbirds, which occur mostly within a few miles of livestock. Thus, fragmentation of riparian forests is likely to threaten this species the most in such agricultural landscapes. In contrast, dispersed (patch-like) removal of riparian forest canopy in low-density residential or forested landscapes might be beneficial, especially if a subcanopy layer of native shrubs is encouraged. As insectivores, yellow warblers are particularly vulnerable to pesticides. They also appear to fair poorly in high-density residential areas (Hennings 2001), perhaps partly because of heightened predation by feral cats and raccoons associated with such development.

Biological Objectives: As proposed in *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), the habitat objectives should include:

- maintain or create at least 70% deciduous shrub cover, of which at least 40% is beneath a forest canopy
- maintain or create a mosaic of shrub or wetland patches amid a larger landscape of forest or other land devoid of cattle

The ultimate objective is to expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Other Species of Note

Many other species regularly inhabit perennial ponds and/or their riparian areas within the Willamette subbasin. These obviously include all waterfowl species, as well as the following which are noted because of their rarity, restricted range, declining trends, habitat specialization, or other factors: American bittern, great blue heron, cinnamon teal, Wilson's snipe (nearly extirpated from the Willamette Valley), killdeer, spotted sandpiper, Virginia rail, northern harrier, bald eagle, osprey, peregrine falcon, black tern, belted kingfisher, yellow-billed cuckoo (probably extirpated), common nighthawk, marsh wren, tree swallow, cliff swallow, red-eyed vireo, willow flycatcher, Swainson's thrush, Bullock's oriole, red-winged blackbird, long-toed salamander, red-legged frog, western toad and Oregon spotted frog (both nearly extirpated), Cascades frog, western pond turtle, painted turtle, muskrat, mink, river otter, pallid bat, and fringed myotis. Many of these also frequently use riparian areas along streams (section 2.6) and/or wetland prairies and seasonal marshes (section 2.3).

2.5.9 Synthesis: Indicators of Pond Riparian Ecological Condition and Sustainability

The following indicators – which must be assessed in the field -- may be useful for prioritizing ponds, sloughs, and their riparian areas for protection and restoration. They may also be useful for monitoring success of restoration projects and long-term trends in quality of the remaining ponds, sloughs, and their riparian areas.

> *Extent of ponds and pond riparian areas:* the mean patch size and total acreage of this type compared with its historical extent. This should be subtotaled within watersheds by geomorphic characteristics (elevation, geology, soils, position in floodplain if any, and presence of permanent or seasonal inlet/outlet connections), predominant type of riparian vegetation, degree of fragmentation (distance to nearest similar pond and type of intervening land cover types), and when feasible, whether the pond or reservoir is naturally-occurring or constructed.
>
> *Focal species status*: the density, interannual frequency of occurrence, and distribution (proportion of sample points where detected) of each focal species within parts of a watershed that are projected (by models, aerial imagery, historical vegetation data, and professional judgment) to be generally suitable for the species based on elevation.

Tree density: the stem density or canopy cover of trees, subtotaled by species, within the riparian zone of each pond or slough in a particular watershed;

Shrub density: the stem density or percent cover of shrubs, subtotaled by species, within the riparian zone of each pond or slough in a particular watershed;

Native emergent plant cover: the percentage of the herbaceous (non-shrub) emergent plant cover that is comprised of native species;

Native aquatic plant cover: the percentage of the aquatic plant cover that is comprised of native species;

Water regime: the extent of different water regime classes, defined by depth and duration of inundation or soil saturation, within a wetland and among wetlands within a subbasin

The above indicators include those recommended in the wetland chapter of Oregon's *State of the Environment Report* (Morlan 2000). It is not possible to specify exact criteria for evaluating each of these indicators. Doing so would require collecting and interpreting an appropriate array of biological data from a series of reference ponds, sloughs, and associated riparian areas. Portions of such a reference data set for the Willamette Valley were assembled, with an accompanying protocol, by Adamus & Field (2001). Additional biological indicators – such as invertebrates and algae -- should be considered for monitoring of these lentic waters.

2.6 Focal Habitat: Riparian Areas of Rivers and Streams

2.6.1 Description

In this report all lotic (flowing water) areas and their adjoining riparian areas are included under this focal habitat type. This focal type includes natural as well as artificial channels, e.g., rivers, streams, and ditches. Vegetation (woody or herbaceous) within one tree-length of the lotic waters at the time of annual maximum inundation is included.

2.6.2 Recognition of Importance

The importance of the Willamette subbasin's perennial streams, rivers, and riparian areas for aquatic animals (notably salmon and trout) is widely recognized by laws, policies, and science (e.g., Gregory et al. 1991, IMST 2002). Less often noted is the importance of this habitat type for wildlife. In its analysis of "Freshwater Systems and Species," TNC's Ecoregional Assessment did not explicitly (by use of a "fine filter") address the habitat needs of riverine wildlife species such as bald eagle, osprey, American merganser, mink, and amphibians. Associations of riverine wildlife species with salmon -- and presumably other fish -- are catalogued and described by Cedarholm et al. (2001). Wildlife of riparian areas in Oregon and Washington are similarly described by Kauffman et al. (2001) and all Oregon vertebrates are categorized according to riparian dependence by Adamus (2001b). "Riparian habitat" is one of just four habitat types targeted as priorities in the Willamette Valley by the Partners In Flight *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000)

2.6.3 Status and Distribution

Various estimates of the extent of riparian habitat are as shown below in Table 17.

Table 17. Acreage estimates of land cover types that include stream riparian habitat

Source	Map categories that include stream riparian	Estimated area (acres)	Percent of mapped area
EC1850	"streams"	42,937	0.59
EC90	"streams"	36,806	0.51
IBIS 1850	"lakes, rivers, and streams" "westside riparian – wetlands"	23,009 362,181	0.32 5.05
IBIS 1990	"lakes, rivers, and streams" "westside riparian – wetlands"	77,710 114,117	1.09 1.60
ODFW*	"ash-cottonwood-bottomland pasture"	86,559	4.46

*Valley area only

2.6.4 Past Impacts, Limiting Factors, and Future Threats

As a result of river regulation and land development, major changes in wildlife habitat have occurred within the channels and riparian zones of many of the subbasin's rivers and streams. One of the most extreme examples is the Willamette River itself (see Tables 18 and 19).

Table 18. Changes in acres of channel habitat of the Willamette River, Eugene to Portland.

Adapted from Gregory et al. (2002)

Year	Primary channel	Side channels	Alcoves	Islands
1850	35.2	1.6	8.9	54.2
1895	42.8	1.7	9.7	45.7
1932	45.9	1.1	9.5	43.5
1995	55.0	1.9	7.1	36.0

Table 19. Area of the Willamette Valley inundated by major floods since 1860

Adapted from Gregory et al. (2002)

	Acres inundated by major floods
1861 & 1890	320,337
1943 & 1945	149,797
1964	152,789
1996	194,533

Information on past impacts and future threats to the subbasin's riverine systems is provided in the section of the Willamette subbasin plan dealing with aquatic habitat, and in IMST (2002). In the subbasin's riverine and riparian systems, factors most likely to limit wildlife in particular include:

- decline of fish stocks and their spatial and temporal distribution in some watersheds;
- food chain contamination with agrochemicals and industrial pollutants (e.g., Thomas & Anthony 2003)
- other water quality effects (e.g., excessive sedimentation affecting frog eggs, waterfowl food plants, and riparian plant germination);
- simplification of channel complexity and consequently riparian vegetation as a result of river regulation, altered runoff regimes, and channelization;
- increased disturbance of wildlife and vegetation due to increased frequency and duration of human visits;
- increased cover of invasive plants within riparian areas, largely in response to all of the above.
- spread of non-native wildlife such as bass, bullfrogs, nutria.

Potential incompatibilities of listed threatened or endangered species with specific types of activities subject to Oregon's Removal-Fill laws are analyzed in a Division of State Lands report.

2.6.5 Protection, Restoration, Management

Although there has been considerable success in protecting and restoring riparian areas on public lands, e.g., the Willamette River Greenway, riparian protection on private lands not under active forest management has been spotty at best. Additional information on restoration of the subbasin's riverine systems is provided in the section of the Willamette subbasin plan dealing with aquatic habitat.

Efforts are underway, through calibration and use of EDT models and other approaches, to prioritize the Willamette subbasin's stream reaches and watersheds in terms of their existing and potential fish habitat. A comparable reach- or watershed-scale effort has not been implemented to incorporate explicitly their importance as habitat for wildlife and rare plants. Activities to enhance riverine habitat for wildlife can be as simple as installing osprey nest platforms, or as complex as restoring the natural geomorphic profile of a channelized floodplain. Other techniques and strategies include controlling invasive vegetation, managing grazing, protecting buffers of natural vegetation, seeking alternatives to application of pesticides and fertilizers near streams, retaining all trees larger than 22 inches diameter, and instituting a policy of "no net loss" of riparian areas (Altman 2000).

2.6.6 Compatibility of Wildlife Management and Stream Management

Overall, stream management activities (restoration, enhancement) provide enormous benefits to stream- and riparian-associated wildlife, both directly by increasing the productivity of fish and other aquatic organisms upon which wildlife feed, and indirectly by improving habitat complexity and quality. Stream management activities likely to benefit wildlife the most are perhaps those that restore natural flow regimes to rivers, those that provide a long-term supply of wood to the channel, and those that improve water quality (especially sediment runoff). Nonetheless, some stream restoration activities could potentially have adverse effects on some wildlife species in certain situations. *The purpose of listing these below is not to discourage their use.* In most instances their benefits to wildlife exceed their detriments. Rather, they are listed in order to call attention to the need for *species-specific wildlife analyses on a project-by-project basis* when stream restoration programs are implemented.

<u>Riparian planting</u>: Stream banks are frequently planted to help streams meet legal criteria for water temperature. However, increases in tree canopy cover can shade out some rare plants, such as Willamette Valley daisy. Riparian planting should never extend into areas that are (or were, historically) wetland or upland prairies. Complete shade can also diminish the suitability of habitat for several stream-associated species that normally prefer early-successional conditions, e.g., willow flycatcher, common nighthawk, killdeer, common yellowthroat, most waterfowl. Historically, these species relied on major floods to reset succession and provide unshaded conditions in a semi-random manner. Natural disturbances of that type are now subdued as a result of dams regulating flow on many rivers. In addition, planting of forests in urban or agricultural landscapes increases habitat connectivity that benefits the movements not only native wildlife, but also of some invasive species and predators.

<u>Stabilizing stream banks</u>: Steep, eroding stream banks potentially degrade water quality so are often the focus of remedial measures. However, a few wildlife species use this habitat exclusively or opportunistically, to create burrows where they then nest or breed. These include belted kingfisher, northern rough-winged swallow, bank swallow (rare in this subbasin), barn owl, mink, beaver, and otter. Placement of riprap or planted willows on all eroding banks potentially can diminish local populations of these species.

Reconnecting isolated sloughs, side channels, and oxbows: Many backwater sloughs and oxbows were originally connected to rivers year-round or during high water but became isolated through intentional human activities (e.g., to improve river navigation) or due to natural events (beaver dams, flood deposits, channel meander). When barriers (e.g., debris jams, beaver dams, concrete dams) that block fish access to these areas are removed, it increases habitat (especially nursery habitat and flood refugia) for several fish species. As a result several fish-feeding bird and mammal species will reap some benefits. However, other rare aquatic plants and listed aquatic amphibians and turtles could be harmed if (a) current velocities become excessive, e.g., exceed thresholds for frog and salamander egg deposition, juvenile maturation, aquatic plant metabolism, waterfowl foraging, (b) water temperatures in the newly-reconnected slough rise or fall below optimal temperatures for particular amphibians or turtles during critical periods, (c) conversion from seasonal to permanent inundation degrades the habitat of some plants that thrive only in seasonally-wet soils, (d) reconnecting increases the isolated slough's vulnerability to waterborne seeds of invasive plants, or to fish (especially exotic species) that prey on juvenile turtles and amphibians, or (e) newly-increased boat access to isolated areas increases disturbance of wildlife significantly. Wildlife species most likely to be directly harmed by reconnecting isolated sloughs include red-legged frog, Oregon spotted frog, northwestern salamander, western pond turtle, and several dabbling ducks.

Removing barriers; culvert replacement: Similar to the above.

Fencing streams: Because riparian areas support habitat for salmon and trout by cooling stream water, fences are sometimes erected to protect riparian areas from overgrazing. Depending on their design and location, fences also can unintentionally restrict movements of some wildlife species (large mammals).

Riparian buffers: Riparian buffers are nearly always beneficial to both fish and wildlife. The main difference is that many wildlife species prefer wider buffers than those commonly recommended for protecting fish and water quality. There is no particular width threshold below which woodland wildlife are known to avoid using a buffer. Generally speaking, "the wider the better." Acceptable widths depend on the density and type of riparian vegetation, the harshness of adjoining unbuffered landscape (impervious surfaces vs. native non-forest vegetation), the wildlife species, and distance to its source populations (e.g., Vesely & McComb 2002). For protecting individual wildlife species or wildlife generally, buffer widths (measured on one side of a channel) ranging from 100 to over 1000 ft have been documented (McComb & Hagar 1992, Washington Dept. of Fish & Wildlife 1995, Metro 2002). In the urban Portland area, narrower riparian buffers have been shown to be dominated to a greater degree by invasive plants and animals, and have lower species richness, than wider buffers (O'Neill & Yeakley 2000, Hennings 2001).

2.6.7 Contribution of Stream Riparian Areas to Regional Biodiversity

No wildlife species are restricted entirely to streams or stream riparian areas, but several are restricted to aquatic habitats generally, and/or use streams or stream riparian areas predominantly (Kauffman et al. 2001). Hundreds of plant and invertebrate species, none of them listed as threatened or endangered, reside exclusively in or along flowing water. Among the more sensitive features within stream and pond riparian areas are great blue heron rookeries (English 1978). Intermittent headwater streams in the Oregon Coast Range are “hotspots” for many amphibians (Sheridan et al. 2003). Several bird species appear to depend highly on the Willamette subbasin’s riparian habitats as critical stopover areas during long migrations, especially in urban areas (Hennings 2001).

2.6.8 Selected Focal Species

The following wildlife species are proposed as focal species for this habitat type: American dipper, bald eagle, harlequin duck, red-eyed vireo, willow flycatcher, American beaver, river otter, coastal tailed frog. On a scale of 0 to 10, their average degree of association with riverine riparian is a 4.86. Compare this with HEP “loss assessment” species used in many previous mitigation calculations and land acquisitions in the Willamette subbasin. Of the “riparian” species used in HEP applications, the average degree of association with riverine riparian is only 2.65. This suggests there may have been an unintentional but systematic bias against riverine riparian in previous mitigation land dealings in the Willamette subbasin.

American Dipper

Special Designations: none

Distribution, Status, and Trends: Dippers are fairly common year-round residents of streams in forested parts of the Willamette subbasin. Along the subbasin’s BBS routes, dippers were detected at 0.5% of surveyed points in 2003, with a maximum over the period 1968-2003 of 0.8% (in 1969). The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 52% of the 53 survey units in the subbasin and found evidence of possible or probable nesting in 19%. BBS data covering the period 1968-2003 show a decrease in western Oregon-Washington generally, but a possible increase during 1980-2003. It is hypothesized that dippers were once present (perhaps even common) along the Willamette River and are now absent there due to water pollution, river regulation, and accompanying reduction in gravel bars and downed wood. However, historical data are insufficient to determine this. NHI models and data project this species has a close association with land cover in less than 1% of the subbasin. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate streams specifically) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a “10”; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6’s, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030502	Mary's R -middle	2	446	446	0.39
170900010101	Rattlesnake & Hills Cr.	2	120	120	0.35
170900090601	Molalla R. N. Fk.	3	233	233	0.30

170900080602	McMinnville N.	2	70	70	0.25
170900030503	Mary's R. -upper	2	431	431	0.24

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010703	Grassy Cr.	4	443	443	0.19
170900010502	Hemlock; Lookout Point Reservoir	3	766	766	0.15
170900050102	Marion Lake	6	868	868	0.15
170900110402	Timothy Lake; Dinger Lake	5	711	711	0.13
170900050201	Breitenbush R.	4	886	886	0.13

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110602	Dickey & Elk Cr.	5	759	759	0.15
170900040803	Roaring R. & Elk Cr.	6	850	850	0.14
170900110601	Nohorn Cr.	4	640	640	0.14
170900040102	Gate Cr. S. Fk.	3	542	542	0.14
170900110501	Clackamas R. - upper	4	549	549	0.14

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090601	Molalla R. N. Fk.	3	222	222	0.06
170900090601	Molalla R. N. Fk.	4	218	218	0.06
170900090602	Molalla R. S. Fk.	3	232	232	0.06
170900010501	Dexter Reservoir	3	67	67	0.04
170900100302	Sain & Scoggins Cr.	3	151	151	0.04

Key Environmental Correlates: Dippers occur mostly in larger streams (third order and greater) with noticeable current and exposed boulders, partly submerged logs, and/or gravel bars. They also nest along the shores of mountain ponds and lakes. They feed almost entirely on larval aquatic invertebrates and nest within 1 ft of the water's edge (Loegering & Anthony 1999). Characteristics of adjoining riparian areas do not appear to directly influence the local distribution of this species.

Threats, Limiting Factors, Population Viability: Water pollution from forest roads and logging operations potentially affects the food base of this species. Nest wash-outs from severe water level fluctuations are also a likely limiting factor. Reservoir operations (flow regulation) could either help or hurt this.

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. Stream restoration actions that benefit salmon and trout are likely to benefit this species.

Harlequin Duck

Special Designations: "Species of Concern" (USFWS). "Imperiled" (ONHP).

Distribution, Status, and Trends: Within the Willamette subbasin, this strikingly-patterned duck breeds mainly along larger streams in the Cascades (major tributaries to the McKenzie, North and South Santiam, Clackamas, Molalla, and Middle Fork of the Willamette). Fewer than 50 nesting pairs are present statewide. NHI models and data project this species has a close association with land cover in less than 1% of the subbasin. The ORNHIC database contains records from 27 of the 140 sixth-field watersheds. The Oregon BBA Project confirmed nesting in 9% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 17%. Birds spend the winter in coastal waters. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units are documented in the ORNHIC database.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?
170900010301	Fall Cr. Reservoir N.	3	yes	no
170900010302	Fall & Delp Cr.	3	yes	no
170900010801	Oakridge E.	3	yes	no
170900011001	Salt & Gold & Eagle Cr.	3	yes	no
170900011101	Groundhog Cr: S.Fork	3	yes	no
170900011301	Oakridge W.; Hills Creek Reservoir	3	yes	no
170900040101	E. Springfield; Camp & Ritchie Cr.	2	no	yes
170900040301	Blue River Reservoir & Cook Cr.	3	yes	yes
170900040401	Blue River Reservoir & Elk Cr.	3	yes	no
170900040401	Blue River Reservoir & Elk Cr.	3	no	no
170900040501	Boulder Cr. & Smith R.	3	yes	yes
170900040501	Boulder Cr. & Smith R.	4	yes	yes
170900040502	White Branch	3	yes	yes
170900040502	White Branch	3	no	yes
170900040802	French Pete Cr.	4	yes	yes
170900040803	Roaring R. & Elk Cr.	4	yes	yes
170900050102	Marion Lake	4	yes	no
170900050102	Marion Lake	4	no	no
170900050201	Breitenbush R.	4	yes	no
170900050301	Detroit Reservoir	3	yes	no
170900050301	Detroit Reservoir	3	no	no
170900050401	Gates; Lyons; Mill City	2	no	no
170900050401	Gates; Lyons; Mill City	2	no	yes
170900060201	Beaver Cr.	1	no	yes
170900060401	Greenpeter Reservoir	3	yes	no
170900060402	Quartzville Cr.-upper	3	yes	no
170900060402	Quartzville Cr.-upper	3	no	no
170900060601	Sevenmile & Soda & Squaw Cr.	3	yes	no
170900090601	Molalla R. N. Fk.	4	yes	no
170900090603	Table Rock Fk.	3	yes	no
170900090603	Table Rock Fk.	3	no	no
170900090604	Copper & Henry Cr.	3	yes	no
170900110302	Fish Cr. W.	2	yes	no

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?
170900110302	Fish Cr. W.	3	yes	no
170900110601	Nohorn Cr.	3	yes	yes
170900110602	Dickey & Elk Cr.	4	yes	yes

Key Environmental Correlates: Similar to those of American dipper, above. Nests are placed within 1 to 82 ft of water, generally under shrubs or on logs or rock ledges (Bruner 1997).
Threats, Limiting Factors, Population Viability: Similar to those of American dipper, above. Wintering populations are vulnerable to oil spills.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Bald Eagle
Special Designations: "Threatened" (federal). Proposed for delisting in 1999. "Vulnerable" (ONHP).
Distribution, Status, and Trends: Breeds and resides year-round in the Willamette subbasin, although some seasonal turnover of individual birds occurs. The number of occupied territories in the Willamette subbasin in 2003 was 59 with an average of 1.11 young produced per occupied territory (F. Isaacs, pers. comm.), and the USFWS-sponsored surveys show the nesting population has been increasing. Documented records maintained by ORNHIC indicate nesting in 46 of the 170 Willamette watersheds during at least one of the past 20 years. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in 52% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 28%. BBS data covering the period 1968-2003 show a statistically significant increase in western Oregon-Washington generally. During winter, many birds roost communally (DellaSalla et al. 1989). About 93 were present almost simultaneously in March 2004 in farmlands of Lane-Linn-Benton-Polk-Yamhill-Marion Counties (J. Fleischer, pers. comm.). Counts of wintering birds from the USFWS mid-winter survey are depicted in Table 20. The wintering population is stable or increasing, and is not necessarily comprised of the same individuals present in summer. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units contain records of this species in the ORNHIC database.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?
170900010101	Rattlesnake & Hills Cr.	2	no	yes
170900010401	Fall Cr. Reservoir S.; Winberry Cr.	4	yes	no
170900010501	Dexter Reservoir	2	no	yes
170900010501	Dexter Reservoir	3	no	no
170900010502	Hemlock; Lookout Point Reservoir	3	yes	no
170900010901	Waldo Lake; Cayuse & Fisher Cr.	6	yes	yes
170900011001	Salt & Gold & Eagle Cr.	6	yes	no
170900011101	Groundhog Cr: S.Fork	4	yes	no
170900011301	Oakridge W.; Hills Creek Reservoir	3	yes	no
170900020101	Creswell E. Bear & Gettings Cr.	1	no	yes
170900020101	Creswell E. Bear & Gettings Cr.	2	yes	yes
170900020301	Cottage Grove Reservoir N.	3	no	yes

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?
170900020401	Dorena Reservoir	3	yes	no
170900020401	Dorena Reservoir	4	yes	no
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	1	yes	yes
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	3	yes	yes
170900030201	Corvallis N.; Adair Village	1	no	yes
170900030202	Monroe; Muddy Cr. E.	1	no	yes
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	3	no	yes
170900030204	E. Eugene; Harrisburg; Springfield	1	no	yes
170900030301	Courtney Cr.	2	no	yes
170900030302	Brownsville	3	no	no
170900030302	Brownsville	3	no	yes
170900030501	Corvallis; Philomath; Mary's R.-lower	2	yes	yes
170900030504	Finley NWR; Muddy & Hammer Cr.	1	yes	yes
170900040101	E. Springfield; Camp & Ritchie Cr.	3	yes	yes
170900040401	Blue River Reservoir & Elk Cr.	3	yes	no
170900040501	Boulder Cr. & Smith R.	5	yes	yes
170900040501	Boulder Cr. & Smith R.	6	yes	yes
170900050102	Marion Lake	6	yes	no
170900050301	Detroit Reservoir	4	no	no
170900050601	Jefferson; Lyons; Bear Branch	1	no	no
170900050601	Jefferson; Lyons; Bear Branch	1	no	yes
170900060101	Crabtree Cr. & Onehorse Slough	1	no	yes
170900060102	E. Lebanon; Hamilton Cr.	1	no	no
170900060103	Waterloo; Sweet Home; McDowell Cr.	2	no	no
170900060401	Greenpeter Reservoir	3	yes	no
170900060401	Greenpeter Reservoir	3	no	no
170900060701	Sweet Home; Foster Reservoir	2	no	no
170900070102	Independence; Monmouth	1	no	no
170900070103	Ankeny NWR	1	no	yes
170900070302	Dundee; Newberg	1	no	no
170900070302	Dundee; Newberg	1	no	yes
170900070304	Lincoln	1	no	yes
170900070305	Keizer; Spring Valley Cr.	1	no	yes
170900070307	Salem	1	no	no
170900090101	Aurora	1	yes	yes
170900100101	Tigard; Tualatin; Sherwood; King City	1	no	yes
170900100102	Hillsboro	1	no	yes
170900100202	Diary Cr. E.	2	yes	yes
170900100301	Gales & Clear Cr.	1	no	yes
170900100302	Sain & Scoggins Cr.	2	no	no
170900110101	Estacada; E. Gladstone	1	no	yes
170900120201	Portland; Forest Hills; Multnomah Channel	1	no	yes
170900120202	S. Milwaukie; Happy Valley; Lake Oswego; W	1	no	no

Key Environmental Correlates: Mostly associated with forested rivers and lakes, but during some months occurs extensively in open areas with livestock. Nests mainly in large Douglas-fir (mean diameter = 42 inches, Anthony et al. 1982) or cottonwood, either live or dead. Home range during breeding encompasses 1-10 square miles, and is manyfold larger in winter. During summer, Oregon eagles feed mainly on fish (live or dead), then augment this in at other seasons with waterfowl and sheep (carrion and afterbirth). Very sensitive to human disturbance at all seasons, but some individuals adapt somewhat, e.g., Jackson Bottom eagle nest near urban Hillsboro. The increased nesting success and population increase in recent years can be attributed largely to reduction of some persistent contaminants (DDT) and to increased protection of nest and roosting sites from harvesting and human visitation (Isaacs and Anthony 2001).

Threats, Limiting Factors, Population Viability: Illegal killing of eagles continues, as evidenced by recent discovery of 17 intentionally poisoned eagles in the Willamette Valley. Long term survival of the Willamette eagle population depends on managing forests so they are capable of providing a continuous supply of large-diameter open-branched trees near water, and on improving water quality.

Biological Objectives: See the species Recovery Plan (USFWS 1986).

Table 20. Mean and maximum (among-year) counts of bald eagles from USFWS mid-winter survey routes in the Willamette subbasin, 1988-2000

Survey Area	Mean	Maximum	Mean ratio of Immatures to Adults	Maximum ratio of Immatures to Adults
Fern Ridge Reservoir	1.67	4	0.44	3.00
Lookout Point Reservoir	1.92	7	0.19	1.00
Muddy Creek (Cabell Marsh)	2.38	6	0.78	5.00
Muddy Creek (McFadden Marsh)	1.69	5	0.69	4.00
North Santiam River (Reservoirs)	1.00	4	0.25	1.00
South Santiam River (Reservoirs)	5.09	8	0.17	0.60
Odell Lake	7.50	21	0.51	2.00
Upper Middle Fork Willamette	3.62	6	0.40	1.00
Willamette River (Calapooya R. 1)	14.09	31	1.29	6.00
Willamette River (Calapooya R. 2)	12.00	21	1.65	3.20
Willamette River (Calapooya R. 3)	6.60	21	0.63	2.67

<u>Red-eyed Vireo</u>

Special Designations: none.

Distribution, Status, and Trends: Probably fewer than a dozen pairs of this neotropical migrant songbird currently nest in the Willamette subbasin, mainly on the valley floor and Cascade foothills. Breeding is erratic – a site may be occupied one year but often not the next. It is common in other parts of North America. The Oregon BBA Project (Adamus et al. 2001) confirmed nesting in just one of the 53 survey units in the subbasin and found evidence of possible or probable nesting in 19%. BBS data covering the period 1968-2003 show a decrease in western Oregon-Washington generally, but the species is seldom encountered on BBS routes in the Willamette subbasin. NHI models and data project this species has a close association with land cover in 2% of the subbasin. Since 1850, suitable habitat for this species in the subbasin may have decreased by 95-101% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate streams and riparian zones completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	399	383	2.09
170900060101	Crabtree Cr. & Onehorse Slough	1	665	665	1.41
170900070301	Saint Paul	1	110	106	1.33
170900090101	Aurora	1	408	403	1.12
170900070305	Keizer; Spring Valley Cr.	1	583	566	0.93

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070307	Salem	1	41	29	0.02
170900070401	W.Wilsonville	1	12	12	0.01
170900090202	Molalla R. -middle	1	7	7	0.00
170900070305	Keizer; Spring Valley Cr.	1	12	12	0.00
170900070302	Dundee; Newberg	1	10	10	0.00

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070304	Lincoln	1	1099	1099	0.70
170900060101	Crabtree Cr. & Onehorse Slough	1	633	633	0.62
170900090101	Aurora	1	390	387	0.62
170900030601	Luckiamute R.4	1	437	437	0.61
170900030202	Monroe; Muddy Cr. E.	1	1198	1175	0.39

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	1086	97	1.16
170900070303	Chehalem Cr.	1	1567	82	1.10
170900100101	Tigard; Tualatin; Sherwood; King City	1	3221	878	1.08
170900070401	W.Wilsonville	1	1732	185	1.03
170900120202	S. Milwaukie; Happy Valley; Lake Oswego	1	934	295	1.03

Key Environmental Correlates: In western Oregon this species is mainly associated with large (>100 ft tall) canopy trees in cottonwood stands near water.
Threats, Limiting Factors, Population Viability: Loss of mature riparian habitat has probably limited this species, although its historical abundance in the region is unclear. Another bird species – yellow-billed cuckoo – that uses generally similar habitat is now extirpated from the

subbasin presumably due to habitat loss. As insectivores, both species are potentially vulnerable to pesticides.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Willow Flycatcher
Special Designations: "Vulnerable" (ODFW sensitive species). Partners In Flight focal species.
Distribution, Status, and Trends: As its name implies, this uncommon migratory songbird is associated with willows and similar deciduous shrubs. Along Willamette subbasin BBS routes the species was detected at 6.8% of surveyed points in 2003, with a maximum during the period 1968-2003 of 22.4% in 1970. Application of simple species-habitat models to aerial imagery suggests 11% of the subbasin might contain habitat that could be at least marginally suitable and 0.6% might contain good habitat. NHI models and data project this species has a close association with land cover in 2% of the subbasin and a general association with 72%. The Oregon BBA Project confirmed nesting in 41% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 54%. Historical accounts suggest it was once much more abundant in the subbasin. BBS data covering the periods 1968-2003 and 1980-2003 show a decrease both in the Willamette Valley and in western Oregon-Washington generally. Declines have been most noticeable on the valley floor. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate streams and riparian zones completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070301	Saint Paul	1	1832	326	1.45
170900010302	Fall & Delp Cr.	4	2630	0	1.45
170900011101	Groundhog Cr: S.Fork	5	2809	0	1.41
170900090101	Aurora	1	1697	325	1.32
170900060501	Pyramid Cr. & Quartzville Cr.-lower	5	8743	0	1.31

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110402	Timothy Lake; Dinger Lake	5	7440	0	1.08
170900050103	Pyramid Cr.	5	3914	0	0.75
170900110401	Harriet Lake	5	3065	0	0.70
170900011101	Groundhog Cr: S.Fork	4	2972	0	0.63
170900010702	Christy Cr.	5	2107	0	0.60

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900011201	Staley & Swift & Spruce Cr.	6	9088	0	1.41
170900110501	Clackamas R. - upper	4	1793	0	1.22
170900060201	Beaver Cr.	1	5553	2808	1.10
170900030602	Soap Cr.	1	2400	1558	0.83
170900110501	Clackamas R. - upper	5	3762	0	0.75

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090201	S. Canby	1	2359	217	0.97
170900080601	Yamhill	1	2638	619	0.93
170900070303	Chehalem Cr.	1	2817	708	0.92
170900080604	Turner Cr.	1	1637	534	0.74
170900070402	N. Canby; E. Wilsonville	1	3010	108	0.73

Key Environmental Correlates: In addition to using riparian alder, willow, and vine maple, this species regularly uses clearcuts (4 to 15 years post-harvest); patches of scotch broom, hawthorn, trailing blackberry, and bracken fern; and Himalayan blackberry. It tends to prefer shrubs in the open rather than ones beneath an extensive forest canopy, and fragmenting of large shrub stands with paths may benefit the species. One local study found no difference in nest success in native vs. non-native shrubs (Altman 2003d). Mean nest height was 3.9 ft. This species is not typically found in higher-density residential areas.

Threats, Limiting Factors, Population Viability: Loss of riparian habitat as a result of agriculture, forest practices, and urban development is possibly the greatest threat. Regulation of the Willamette River has probably diminished the extent of riverine willow habitat as well. The species' flycatching behavior may put it at higher risk around roads with heavy traffic. Pesticides and other contaminants potentially diminish its insect foods. Nests are sometimes parasitized by cowbirds. Pesticides can diminish the primary foods of this species. Territory size averages 1.1 ac at lower elevations and 0.6 ac at higher elevations.

Biological Objectives: As proposed in *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000), habitat objectives should include the following:

- maintain or provide a patchy deciduous shrub layer with several scattered herbaceous openings (i.e., 30-80% shrub cover)
- do not allow tree canopy cover to exceed 20%
- provide the above at a distance of no less than 0.6 mi from residential areas and not less than 3 mi from areas with livestock (due to cowbird threat)

And the following population objective:

- reverse declining BBS trends to achieve stable populations (trends of <2%/year) or increasing trends by 2020.

Coastal Tailed Frog

Special Designations: "Vulnerable" (ODFW sensitive species). "Imperiled" (ONHP).
Distribution, Status, and Trends: Occurs at all elevations where habitat is suitable. The ORNHIC database contains records from 15 of the 170 Willamette watersheds.
Key Environmental Correlates: Occurs in cold streams with moderate to high gradients in moist forests, usually in forests with a full canopy and scattered logs within the channel.
Threats, Limiting Factors, Population Viability: Water temperature and suspended sediment may be key limiting factors. Thus, fires, forest disease infestations, logging and associated road building can degrade habitat, especially when landslide-prone areas near steep-gradient streams are affected.(Bury 1983, Corn & Bury 1989, Aubry & Hall 1991, Bull & Wales 2001, Sutherland & Bunnell 2001). Being dependent on invertebrates for food, this species is vulnerable to effects of pesticide applications. It also might be vulnerable to pathogenic fungi perhaps spread by fish stocking. Bullfrog predation is an unlikely limiting factor due to the cold water temperatures and steep channel gradients preferred by this species. Stream warming is a greater threat. NHI models and data project this species has a close association with land cover in just 0.43% of the subbasin. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units are the only ones that contain records of this species in the ORNHIC database.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?
170900020503	Sharps & Martin Cr.	4	yes	no
170900030101	W. Eugene; Junction City	3	yes	no
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	3	yes	no
170900040101	E. Springfield; Camp & Ritchie Cr.	3	yes	yes
170900040102	Gate Cr. S. Fk.	3	yes	yes
170900040102	Gate Cr. S. Fk.	4	yes	yes
170900040802	French Pete Cr.	4	yes	yes
170900050401	Gates; Lyons; Mill City	4	yes	no
170900060202	Roaring R.	4	yes	yes
170900060202	Roaring R.	5	yes	yes
170900070204	Rickreall Cr. -upper	3	no	no
170900080301	Mill & Gooseneck Cr.	3	no	yes
170900080602	McMinnville N.	3	yes	no
170900080602	McMinnville N.	3	no	no
170900090601	Molalla R. N. Fk.	4	no	no
170900090603	Table Rock Fk.	5	yes	no
170900090604	Copper & Henry Cr.	5	yes	no
170900110402	Timothy Lake; Dinger Lake	5	yes	no

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

American Beaver

Special Designations: None. Included because it is widely considered by ecologists to be a keystone species due to its capacity to modify habitat in ways that benefit many other species, as documented for example by Perkins (2000) in studies in Coast Range portions of the Willamette subbasin.

Distribution, Status, and Trends: Beavers occur throughout wooded and partly wooded portions of the subbasin. Densities in the Coast Range may be somewhat greater than in the Cascades and valley, and over the entire subbasin average about 10 per acre. Unregulated trapping almost eliminated the beaver from Oregon by the early 1900's, but populations have recovered significantly, to the point of being a primary source of damage complaints (due to their impounding water and felling trees). NHI models and data project this species has a close association with land cover in less than 1% of the subbasin. Since 1850, suitable habitat for this species in the subbasin may have decreased by 74-117% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate streams and riparian zones completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030204	E. Eugene; Harrisburg; Springfield	1	3057	903	1.28
170900060101	Crabtree Cr. & Onehorse Slough	1	1243	717	1.12
170900090201	S. Canby	1	930	499	1.04
170900070402	N. Canby; E. Wilsonville	1	1256	736	1.00
170900070301	Saint Paul	1	1217	722	0.87

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010703	Grassy Cr.	4	450	450	0.19
170900050102	Marion Lake	6	1034	886	0.17
170900110402	Timothy Lake; Dinger Lake	5	912	757	0.16
170900010502	Hemlock; Lookout Point Reservoir	3	785	776	0.15
170900110303	Fish Cr. E.	3	471	280	0.13

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030204	E. Eugene; Harrisburg; Springfield	1	1823	430	0.60
170900030202	Monroe; Muddy Cr. E.	1	2764	331	0.53
170900030601	Luckiamute R.4	1	607	151	0.53
170900070304	Lincoln	1	1375	224	0.43
170900090101	Aurora	1	471	58	0.38

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030401	N. Albany; W. Lebanon; Cox Cr.	1	2248	1527	0.43
170900060101	Crabtree Cr. & Onehorse Slough	1	756	631	0.41
170900090201	S. Canby	1	912	499	0.40
170900080601	Yamhill	1	1085	739	0.39
170900070201	Sublimity & Turner	1	1297	1074	0.38

Key Environmental Correlates: Beavers inhabit wooded rivers, streams, lakes, and sloughs. They generally do not reside in wave-swept portions of reservoirs, intermittent streams, and very steep montane channels. Beavers select relatively low-gradient channels whose geomorphic characteristics make them suitable for dam and lodge placement (see Suzuki & McComb 1998), but in wide channels and lakes will tunnel into bank and place lodges against the bank.
Threats, Limiting Factors, Population Viability: Densities probably are regulated by availability of suitable dam sites, trapping, and disease.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat, consistent with minimizing ecological and economic damages.

River Otter

Special Designations: none.
Distribution, Status, and Trends: Occurs mainly in aquatic and riparian areas throughout the subbasin. Application of simple species-habitat models to aerial imagery suggests about 3% of the Willamette subbasin might contain habitat that could be at least marginally suitable. Unregulated trapping decimated river otters in the 1800s but populations have recovered significantly. NHI models and data project this species has a close association with land cover in 3% of the subbasin. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate streams and riparian zones completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900070402	N. Canby; E. Wilsonville	1	1591	1591	3.19
170900030204	E. Eugene; Harrisburg; Springfield	1	3539	3539	2.82
170900090501	Molalla	1	1453	1453	2.63
170900090201	S. Canby	1	685	685	2.32
170900070403	Oregon City; West Linn	1	1160	1160	2.19

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110402	Timothy Lake; Dinger Lake	5	2108	2108	0.53
170900050301	Detroit Reservoir	3	3204	3204	0.49
170900010703	Grassy Cr.	4	450	450	0.38
170900050102	Marion Lake	6	1331	1331	0.38
170900011301	Oakridge W.; Hills Creek Reservoir	3	3159	3159	0.37

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030204	E. Eugene; Harrisburg; Springfield	1	2340	2340	1.20
170900010901	Waldo Lake; Cayuse & Fisher Cr.	6	7092	7092	1.13
170900120201	Portland; Forest Hills; Multnomah Channel	1	3654	3654	1.10
170900030202	Monroe; Muddy Cr. E.	1	2958	2958	1.09
170900030601	Luckiamute R.4	1	452	452	0.93

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900120202	S. Milwaukie; Happy Valley; Lake Oswego; W	1	1401	1401	1.99
170900010501	Dexter Reservoir	2	2141	2141	1.49
170900070307	Salem	1	630	630	1.42
170900070306	W. Salem	1	545	545	1.32
170900100101	Tigard; Tualatin; Sherwood; King City	1	1528	1528	1.31

Key Environmental Correlates: May be associated with relatively clean waters with adequate streamside cover (e.g., downed wood, forest canopy). Often occurs in beaver flowages. Regularly reported from urban waterways and from upland forested areas.
Threats, Limiting Factors, Population Viability: This species is vulnerable to reproductive problems associated with chemical contamination (e.g., pesticides, endocrine disrupters) of its largely aquatic foods.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

Other Species of Note

The focal species list could be expanded to include northern waterthrush (ONHP “Imperiled”), black swift (ONHP “Vulnerable”), Cascade torrent salamander and foothills yellow-legged frog (both ODFW “Vulnerable” and ONHP “Imperiled“), western pond turtle (ODFW “Critical” and ONHP “Critically Imperiled”), water shrew, marsh shrew, mink, and others. Many of these also frequently use wet prairies and seasonal marshes (section 2.4) and/or ponds and their riparian areas (section 2.5). Several bird species that once were probably common in bottomland hardwood forests along the Willamette River, but which now are seldom if ever found nesting there, include yellow-billed cuckoo (ODFW "Critical;" ONHP "Imperiled;" "Candidate" for federal list), ruffed grouse, MacGillivray's warbler, and Wilson's warbler. In addition, several species use holes or burrows in eroding banks as nest sites. These include belted kingfisher, northern rough-winged swallow, bank swallow (rare in this subbasin), and barn owl.

2.6.9 Synthesis: Indicators of Ecological Condition and Sustainability of Stream Riparian Habitat

The following indicators – which must be assessed in the field -- may be useful for prioritizing streams and their riparian areas with regard to their potential as habitat for wildlife and rare plants. They also may be useful for monitoring success of restoration projects (Innis et al. 2000), and long-term trends in quality of streams and stream riparian areas.

Extent of channel and riparian area: the length, mean width, connectivity, and total acreage of channel and riparian zone compared with its historical extent. This should be subtotaled within watersheds by canopy closure class, stream order, geomorphic characteristics (elevation, geology, soils, channel gradient, bank slope), predominant type of riparian vegetation, degree of fragmentation (distance to nearest similar riparian patch and type of intervening land cover types), and whether the channel is natural or artificial, perennial or intermittent (e.g., Schuft et al. 1999).

Focal species status: the density, interannual frequency of occurrence, and distribution (proportion of sample points where detected) of each focal species within parts of a watershed that are projected (by models, aerial imagery, historical vegetation data, and professional judgment) to be generally suitable for the species based on elevation.

Tree density: the stem density or canopy cover of trees, subtotaled by species, within the riparian zone of each stream reach in a particular watershed;

Shrub density: the stem density or percent cover of shrubs, subtotaled by species, within the riparian zone of each stream reach in a particular watershed;

Native emergent plant cover: the percentage of the herbaceous (non-shrub) emergent plant cover that is comprised of native species;

Native aquatic plant cover: the percentage of the underwater plant cover that is comprised of native species;

Partly-submerged logs and boulders: the number, area, and mean size of logs and boulders during annual high and low flow conditions, that potentially serve as resting or basking sites for turtles, waterbirds, and some mammals;

Water regime: the number and extent of different water regime classes, defined by depth and duration of inundation or soil saturation, within a stream reach and a watershed, especially as compared with historical conditions if known (see Richter et al. 1996 and www.freshwaters.org for assistance with hydrologic indicator selection, measurement, and data interpretation).

It is not possible to specify exact criteria for evaluating each of these indicators. Doing so would require collecting and interpreting an appropriate array of biological data from a series of reference wetlands. Portions of such a reference data set for riparian areas of the Willamette Valley were assembled by Adamus & Field (2001), and reference data for riparian areas in the Coast Range were collected by Pabst & Spies 1998, 1999, Nierenberg & Hibbs 2000, Hibbs & Bower 2001. The USEPA-Corvallis also has reference data describing riparian and channel structure from a probabilistic sample of Willamette subbasin streams. An interagency committee currently is drafting additional protocols for assessing Willamette riparian vegetation in the course of monitoring mitigation sites (John Marshall and Kathy Pendergrass, USFWS, pers. comm.).

2.7 Focal Habitat: Old Growth Conifer Forest

2.7.1 Description

For this report, old growth forests were defined as multi-layered (structurally-complex) forests generally older than 200 years. Some publications include forests as young as 150 years, but this report uses 200 years because that is the oldest forested category specified in the spatial layer available for wildlife habitat modeling (the next oldest was 80-200 years). Most old growth forests are "virgin" forests that have never been subject to logging. Usually, it is not forest stand age that directly accounts for use of old growth by certain wildlife species, but rather specific features of such stands that correlate (to varying degrees) with stand age. Depending on species, this can include canopy closure, abundance and diversity of downed wood and snags, and extent of deciduous trees within a stand.

2.7.2 Recognition of Importance

The subject of years of debate and litigation, old growth conifer forest is among the most famous of endangered ecosystems. Public attention to the importance of this habitat was initially raised by legal listing of the spotted owl as a threatened species, with concomitant restrictions on timber harvest in the old growth conifer forests that comprise its primary habitat. Information documenting the importance of old growth to wildlife is compiled, for example, in the Northwest Forest Plan, specifically in reports of the Scientific Panel on Late-Successional Forest Ecosystems (Johnson et al. 1991, Thomas et al. 1993), the subsequent *Record of Decision* and *Standards and Guidelines*, as well as in Kellogg (1992), Haynes & Perez (2001), reports of the CLAMS project, and many other documents.

2.7.3 Status and Distribution

Reliable information on the extent of old growth forest, especially on private lands, is difficult to obtain. Several maps exist that include categories which incorporate old growth conifer forest, but vary in their geographic coverage and definition of this habitat type. The CLAMS Project mapped coastal conifer forest, with the largest diameter category being "greater than 30 inches." Those data were not obtained for this report. For this report we used the category "Forest Closed Conifer older than 200 years" in the EC90 layer, which is described in section 1.3. This indicates a total of 709,948 acres of old-growth conifer forest on both public and private land within the subbasin in the early 1990s, and is undoubtedly an overestimate due to limitations of imagery classification. Approximate distribution in 1990 is shown in Table 21 below.

Table 21. Watersheds with the most old-growth conifer forest in the early 1990s, based on the EC90 land cover layer

HUC6	Name of HUC5	Name of HUC6	Acres	% of HUC6
170900040501	McKenzie R.	Boulder Cr. & Smith R.	36274	22.66
170900011201	Willamette R. Middle Fk.	Staley & Swift & Spruce Cr.	33462	29.58
170900011301	Willamette R. Middle Fk.	Oakridge W.; Hills Creek Reservoir	28914	26.31
170900011001	Willamette R. Middle Fk.	Salt & Gold & Eagle Cr.	26205	36.33

HUC6	Name of HUC5	Name of HUC6	Acres	% of HUC6
170900110502	Clackamas R. - Eagle Cr.	Berry & Cub & Lowe Cr.	18678	31.36
170900050102	North Santiam R. – upper	Marion Lake	18592	30.95
170900040502	McKenzie R.	White Branch	18326	26.16
170900040803	McKenzie R. - S. Fk.	Roaring R. & Elk Cr.	17992	28.2
170900040601	McKenzie R./ Mohawk R.	Separation Cr.	17734	29.08
170900110402	Clackamas R. – middle	Timothy Lake; Dinger Lake	17384	30.46
170900010901	Willamette R. Middle Fk.	Waldo Lake; Cayuse & Fisher Cr.	16980	24.18
170900050201	North Santiam R.	Breitenbush R.	16353	23.5
170900110602	Clackamas R. - lower.	Dickey & Elk Cr.	16091	31.29
170900060402	South Santiam R.	Quartzville Cr.-upper	15268	27.4
170900050501	North Santiam R.	Little North Santiam R.	14125	19.53
170900050301	North Santiam R.	Detroit Reservoir	13125	17.7
170900050103	North Santiam R. – upper	Pyramid Cr.	13050	30.84
170900060601	South Santiam R.	Sevenmile & Soda & Squaw Cr.	12930	18.98
170900040602	McKenzie R./ Mohawk R.	Horse & Eugene Cr.	12881	33.25
170900010502	Willamette R. Middle Fk.	Hemlock; Lookout Point Reservoir	12829	24.76
170900040401	McKenzie R.	Blue River Reservoir & Elk Cr.	12717	21.53

2.7.4 Past Impacts, Limiting Factors, and Future Threats

Around 1850, old growth and mature (>80 year-old) conifer forest may have occupied about 4.1 million acres (58%) of the Willamette subbasin. Loss of old growth conifer forest throughout the Pacific Northwest is ongoing and has been widely documented, e.g., Wimberly et al. 2000, Wimberly 2002.

Logging and fire clearly have been responsible for most losses of old growth forest in the Willamette subbasin during the past century, and will likely continue to dominate in the future. Nonetheless, harvest levels of timber generally (not necessarily old growth) are at about half the levels of the late 1980s, especially in the Cascades. Past harvesting of old growth was probably greater at lower elevations and (at least recently) greater on private than on public lands. Largely due to Oregon’s strong land use laws, relatively little forest in the Willamette subbasin has been converted to residential or agricultural use since the 1970s (Azuma 1999).

Old growth conifer forests are thought to have once been a major component of the valley floor, especially prior to the annual setting of large fires by indigenous tribes. Nearly all of the old growth conifer forest at low elevations has now been converted to agriculture or residential development, resulting in a higher mean elevation of the remaining old growth. In the Coast Range and Cascades, infrequent but large fires during the pre-settlement era resulted in extensive even-aged stands, forming much of what today is old growth. Fires also had the effect of skewing the distribution of the largest trees closer to more fire-resistant streams and wetlands.

Forest stand age and size correlates somewhat with property ownership. Watersheds with mixed ownership appear to provide greater forest cover diversity, whereas watersheds with concentrated ownership provide less diverse but more connectivity of cover (Stanfield et al. 2002). Some experts have expressed concern that current government and private industry policies are creating a strongly bimodal landscape pattern in the Cascades and Coast Range, with mainly old forests on public land, young forests on private land, and little mid-aged forest.

Growth and harvest on private timberlands in Oregon generally are believed to be in balance (Johnson 2001) but location-specific data are typically not available. Rotation ages on most private lands are shorter than the ages that would result in maximum growth rates. Rotations may continue to shorten if present corporate management strategies persist. The net effect of current forest management practices may be that, by 2050, the average age of conifers may fall from about 70 years to around 58 years, assuming an even distribution of age within each conifer age group (Payne 2002). Shorter rotation lengths may not allow development of structural complexity comparable to that found in mature or old-growth forests. Structural features such as snags and downed wood are often removed from harvested stands for logistical reasons or to reduce fire or safety hazards.

As world trade continues to expand, increased transnational transport of pathogens and insect pests may increase, and thus threaten plants and animals not adapted to new types of plagues. At the same time spreading urbanization and global warming, if accompanied by prolonged drought, will lower the resistance of forests to insects and diseases, and possibly increase the frequency of fires.

2.7.5 Protection, Restoration, Management

Within federal lands in the Willamette subbasin, remnants of this habitat type have received a relatively high level of protection over the past decade under the Northwest Forest Plan. The fate of old growth forest on private timberlands during this period is unquantified. Recently the national offices of the Boise Corporation, a major timberland owner in the Willamette subbasin, announced plans to stop harvesting some types of old growth conifer forest.

For species protection, the Northwest Forest Plan features several habitat provisions, land allocations, and species-specific mitigations. The Plan not only recommended protection of some existing old growth stands, but also recommended management strategies (such as extending the length of harvest rotations) that may expand the area of old growth available on public lands in the future, although still falling short of historical extent. Old growth stands on public lands were reserved in a manner intended to avoid concentrating populations of sensitive species in just a few areas. Habitat provisions sought to create a sustained supply of woody debris, specified criteria for retaining green trees and snags (for example, a minimum of 15% of the trees in a harvest unit be retained), and emphasized creation of dispersal corridors for spotted owl and red tree vole. Computer tools (DecAID and DEMO[15]) are now available for evaluating, site-specifically, the amount and spatial distribution of downed wood and green tree retention necessary to protect particular species, or conversely, the species and areas that are most likely being limited when forest inventories show suboptimal occurrences of downed wood or green trees. For species deemed unlikely or uncertain to benefit directly from these practices, the Plan specified "Survey and Manage" requirements to protect sensitive species wherever ground disturbance activities are proposed. These requirements were recently withdrawn.

With continued research and feedback from monitoring, strategies and planning tools for forest biodiversity conservation are evolving beyond those originally envisioned in The Northwest Forest Plan. Research and experimental applications have focused on determining the features of

[15] Demonstration of Ecosystem Management Options (DEMO)

old growth forest that are most critical to biodiversity – especially features and processes related to natural disturbances -- and to then replicate those features and processes in younger forests using specific management practices and harvest strategies that emulate the frequency, intensity and spatial pattern of historical natural disturbances (Cissel et al. 2002). Wildlife research has accompanied several such experiments in the Willamette subbasin and has yielded practical recommendations (e.g., Hansen & Hounihan 1996, Chambers & McComb 1997, Chambers et al. 1999). In addition, results of forest management experiments are supporting the need for greater emphasis on the protection of consolidated blocks of habitat, and less emphasis on distributing an equal amount of the same habitat throughout the landscape. The consolidation strategy is intended to minimize edge effects detrimental to several sensitive species (Vega 1993), but may increase other risks to wildlife. At the same time, there has been growing public interest in voluntary certification of timber harvest operations on private lands (Radosevich 2004). Guidelines for conservation of biodiversity in this context are provided by what is known as the *Montreal Protocol*.

2.7.6 Compatibility of Old Growth Management and Stream Management

Many species, such as Coastal tailed frog, thrive best where old growth conifer forest is traversed by stream channels. Thus, where stream restoration allows retention of adjoining old growth forest, benefits will generally accrue to wildlife as well as fish populations.

2.7.7 Contribution of Old Growth Forest to Regional Biodiversity

In Oregon, old-growth and late-successional conifer forests are closely associated with occurrence of 16 amphibians, 38 birds, and 21 mammals (Thomas et al. (1993). Many of these species use few other habitat types. Oregon's old growth forest may be particularly important to bats (Thomas 1998).

2.7.8 Selected Focal Species

The following wildlife species are proposed as focal species for this habitat type: marbled murrelet, spotted owl, great gray owl, olive-sided flycatcher, pileated woodpecker, Vaux's swift, Oregon slender salamander, American marten, red tree vole, and Townsend's big-eared bat.

On a scale of 0 to 10, their average degree of association with old growth conifer forest is 9.1. Compare this with HEP "loss assessment" species used in many previous mitigation calculations and land acquisitions in the Willamette subbasin. Of the "conifer" species used in HEP applications, the average degree of association with old growth conifer forest is only 7.0. This suggests there may have been an unintentional but systematic bias against old growth forest in previous mitigation land dealings in the Willamette subbasin.

Pileated Woodpecker
Special Designations: "Vulnerable" (ODFW sensitive species). Partners In Flight focal species.
Distribution, Status, and Trends: This large, uncommon, resident woodpecker occurs throughout forested parts of the Willamette subbasin. Along subbasin BBS routes, the species

was detected at 1.5% of surveyed points in 2003, with a maximum over the period 1968-2003 of 2.4% in 1981. Application of simple species-habitat models to aerial imagery suggests about 10% of the subbasin might contain habitat that could be at least marginally suitable. The Oregon BBA Project confirmed nesting in 44% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 52%. BBS data covering the periods 1968-2003 and 1980-2003 show an increase in the Willamette Valley, and in western Oregon-Washington generally during the latter period. It is not known what part of these reports might be attributed to birds that formerly inhabited old growth shifting to new areas and habitats as old growth is logged. Wintering birds are found by most subbasin CBCs. NHI models and data project this species has a general association with land cover in 67% of the subbasin. Since 1850, suitable habitat for this species in the subbasin may have decreased by 36-38% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate old growth forest completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010802	Black & Salmon & Wall Cr.	6	14448	4102	5.86
170900040602	Horse & Eugene Cr.	6	27068	9805	5.51
170900010803	Waldo Lake; Black & Salmon Cr.	6	12510	5297	5.48
170900011001	Salt & Gold & Eagle Cr.	6	39473	19719	4.99
170900040601	Separation Cr.	6	29711	11630	4.94

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040602	Horse & Eugene Cr.	6	26947	9774	6.57
170900050102	Marion Lake	6	34753	14600	5.57
170900010803	Waldo Lake; Black & Salmon Cr.	6	12504	5296	5.52
170900010802	Black & Salmon & Wall Cr.	6	14439	4097	5.45
170900011001	Salt & Gold & Eagle Cr.	6	39465	19715	5.26

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010901	Waldo Lake; Cayuse & Fisher Cr.	6	46055	13992	6.20
170900040803	Roaring R. & Elk Cr.	6	39958	13548	5.94
170900110502	Berry & Cub & Lowe Cr.	6	27647	10710	4.52
170900040301	Blue River Reservoir & Cook Cr.	3	9565	1109	4.35

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040802	French Pete Cr.	6	15942	4909	4.20

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010501	Dexter Reservoir	3	4769	350	2.87
170900080201	Willamina	2	3480	63	2.60
170900030103	Coyote Cr.	2	17358	903	2.52
170900030603	Luckiamute R.1.	2	6116	173	2.40
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	2	19397	651	2.02

Key Environmental Correlates: Strongly associated with old growth conifer forest (Mannan et al. 1980, Carey et al. 1991, Mellen et al. 1992, McGarigal and McComb 1995). Also uses large-diameter stands of deciduous trees (e.g., large cottonwoods and maples) in riparian areas and even in low-density residential neighborhoods. The mean diameter of snags on which it fed in the Coast Range was 41 inches (range 8-73 inches). Forages on both standing and fallen trees, and will use less mature forests if a few large-diameter trees are present or if mature stands are present nearby. Feeds extensively on carpenter ants. Home range on individual birds during the course of a year encompasses over 2000 acres, and birds commonly travel up to 4 miles.

Threats, Limiting Factors, Population Viability: This species faces several threats, including conversion of forests to non-forest habitats; shift to shorter-rotation even-aged forests; and removal of downed wood (for fuels reduction) that is important as a foraging substrate. Because they feed extensively on the ground, woodpeckers are vulnerable to being killed by several mammalian predators and by vehicles. For this reason downed wood should not be placed near roads.

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. The density of breeding pairs should be an average of one pair per 1500 acres within the percent of the landscape that is suitable habitat (Altman 1999). As proposed in *Conservation Strategy for Landbirds in Coniferous Forests of Western Oregon and Washington* habitat objectives should include the following in managed stands older than 60 years:

- maintain >70% canopy closure and >70% conifer species canopy trees
- maintain 2 nest snags per 10 ac, each being >30 inches in diameter
- retained snags should be spatially well distributed and mostly hard snags, but some may be defective live trees.
- provide an average of 12 foraging snags per acre (mix of hard and soft snags) in the following size classes:
    - 10-20 in dbh = 7/ac
    - 20-30 in dbh = 3/ac
    - >30 in dbh = 2/ac (may include the nest snags)

- Maintain a 5 acre no-harvest buffer around known nest or roost sites.
- Extend rotation ages to >80 years to provide potential snags of sufficient size, and retain these snags and recruit replacement snags (large live trees) at each harvest entry.
- Retain large live trees with defective or dying conditions such as broken tops, fungal conks, and insect infestations.

- If snags have not been retained (or are insufficient in number), create snags through blasting tops or inoculation with heart rot if size of trees meets species requirements.
- Retain known or suitable nesting and roosting snags from all harvest and salvage activities and restrict access for fuelwood cutters.
- During harvest operations, retain large logs and stumps in various stages of decay for foraging sites.
- Avoid use of pesticides near retained snags

Olive-sided Flycatcher

Special Designations: "Vulnerable" (ODFW sensitive species). Partners In Flight focal species.

Distribution, Status, and Trends: This neotropical migrant songbird is uncommon throughout the subbasin. Application of simple species-habitat models to aerial imagery using GIS suggests about 0.8% of the subbasin might contain suitable habitat. In contrast, NHI models and data project this species has a close association with land cover in 68% of the subbasin. Along Willamette subbasin BBS routes it was detected at 5.5% of surveyed points in 2003. The Oregon BBA Project confirmed nesting in 28% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 65%. BBS data covering the periods 1968-2003 and 1980-2003 show a decrease both in the Willamette Valley and in western Oregon-Washington generally. The regional trends are statistically significant. Since 1850, suitable habitat for this species in the subbasin may have decreased by 53-83% (Payne 2002).Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate old growth forest completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010802	Black & Salmon & Wall Cr.	6	7069	243	4.40
170900110402	Timothy Lake; Dinger Lake	5	18764	1279	4.09
170900040602	Horse & Eugene Cr.	6	15900	73	3.89
170900010803	Waldo Lake; Black & Salmon Cr.	6	7086	149	3.77
170900011001	Salt & Gold & Eagle Cr.	6	25342	630	3.74

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040602	Horse & Eugene Cr.	6	15859	73	4.78
170900050102	Marion Lake	6	19407	293	4.16
170900010803	Waldo Lake; Black & Salmon Cr.	6	7085	149	4.12

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900011001	Salt & Gold & Eagle Cr.	6	25336	630	3.96
170900010802	Black & Salmon & Wall Cr.	6	7063	243	3.94

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040803	Roaring R. & Elk Cr.	6	20089	226	4.18
170900010901	Waldo Lake; Cayuse & Fisher Cr.	6	19028	201	4.18
170900110502	Berry & Cub & Lowe Cr.	6	14103	552	3.35
170900011201	Staley & Swift & Spruce Cr.	6	39296	2912	3.05
170900040802	French Pete Cr.	6	10495	52	3.00

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010501	Dexter Reservoir	3	1679	35	1.91
170900030103	Coyote Cr.	2	7786	156	1.52
170900080201	Willamina	2	1058	11	1.45
170900030603	Luckiamute R.1.	2	1848	33	1.42
170900090202	Molalla R. -middle	3	1390	294	1.34

Key Environmental Correlates: In the Willamette subbasin this species is strongly associated with old growth conifer forest (Carey et al. 1991, McGarigal and McComb 1995). However, it is not an indicator of old growth conifer forest per se, but rather is associated with canopy gaps created by blowdowns, mudflows, lightning strikes, beaver impoundments, and other natural processes or from human-related activities (logging, low-density residential development, controlled burns). In fact, it is one of the few species that appear to benefit from some types of fragmentation of conifer forests. However, the continuing increase in logged forest runs contrary to the documented overall decline in numbers of this species Habitat requirements were described by Altman (1999):

> Optimal habitat is edges and forest openings where tall trees and snags are present for singing and foraging perches, and varying sized conifers for nesting. This may include harvest units, post-fire habitat, natural edges of bodies of water, or old-growth forest with extensive areas of broken canopies. It is more abundant in two-story (green-tree retention) treatments than small (0.1 ac) patch cuts, modified clearcuts, or unharvested control stands. Optimal habitat in early-seral forest appears to be stands larger than 50 acres with an open canopy and retained green-trees and snags. The most important variable for nest success in managed early successional forest may be the presence of snags taller than 40 ft. Successful nesting in harvest units occurs in both small clumps of trees (aggregates) with canopy closure less than 50%, and in singular, dispersed trees throughout the harvest unit. Successful nesting also occurs in understory suppressed trees and in young plantation trees.

Threats, Limiting Factors, Population Viability: As is true of all neotropical migrants, numbers currently may be limited as much or more by conditions on wintering grounds in the tropics than by habitat on breeding grounds, but evidence is lacking. An insectivore, this species is potentially vulnerable to pesticides. Fire suppression, dead wood removal (e.g., for fuels reduction and “forest health” programs), and low beaver populations undoubtedly limit the acreage of available habitat (snags in open-canopy forests and forest gaps).

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. The density of breeding pairs should be an average of one pair per 50 acres within the percent of the landscape that is suitable habitat (early successional with conditions described below or old growth with large canopy gaps) (Altman 1999). As proposed in *Conservation Strategy for Landbirds in Coniferous Forests of Western Oregon and Washington* habitat objectives should include the following, applied within harvest units larger than 50 acres:

- retain >2.5 ac areas (aggregate clumps) with 4-12 trees/ac) that are >40 ft high and are within the harvest unit, not adjacent to the forest edge.
- the remainder of the harvest unit should average 1-2 trees/ac that are >40 ft high, dispersed relatively equally throughout the harvest unit
- retained trees should be >50% hemlocks or true firs to provide preferred nest trees, and have at least 25% foliage volume (canopy lift) for nesting substrate.
- retain or provide suppressed or plantation trees throughout the harvest unit (>5/ac) that are 10-40 ft high.

In addition to green-tree retention, seed tree, shelterwood, or group selection cuts may be used to meet the biological objectives (Altman & Sallabanks 2000).

- In reforestation units, include at least 10% hemlock or true fir seedlings, and retain these trees through thinnings and harvest.
- Retain residual clumps of older forest in association with retained green-trees to increase edge and reduce effects of wind-throw on retained green-trees.
- Retain large trees in association with retained large snags where snags can serve as guard and foraging perches.
- Maintain retained large canopy trees through stand development and recruit replacement green-trees at each harvest entry.

<u>Vaux's Swift</u>

Special Designations: Partners In Flight focal species.

Distribution, Status, and Trends: This aerial-foraging neotropical migrant traditionally nested only in large snags typical of old growth forests, and still does in parts of Oregon (Bull & Hohmann 1993). However, with the disappearance of many of these has adapted to nesting mostly in uncapped unused brick chimneys (Griffee 1961). The Oregon BBA Project confirmed nesting in 37% of the large survey units in the subbasin and found evidence of possible or probable nesting in an additional 5%. Along Willamette subbasin BBS routes the species was detected at 2.5% of surveyed points in 2003, with a maximum during the period 1968-2003 of 6.3% in 1972. BBS data covering the periods 1968-2003 show a decrease both in western Oregon-Washington generally but possibly not in the Willamette Valley. Tall chimneys also are used as staging and roosting areas by enormous numbers of swifts just prior to migration. As many as 20,000 birds roost annually in one tall chimney at a school in Portland, and a total of 55,000 were estimated to be roosting in the few chimneys in the Willamette Valley used for this purpose in mid-September 2000 (Bull 2003). NHI models and data project this species has a general association with land cover in 79% of the subbasin. Since 1850, suitable habitat for this species in the subbasin may have decreased by 121-150% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate old growth forest completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900120202	S. Milwaukie; Happy Valley; Lake Oswego; W	1	13669	13669	4.57
170900100103	Beaverton & Rock & Cedar Mill Cr.	1	20904	20904	4.45
170900120203	Gresham; Portland; N. Milwaukie	1	13256	13256	4.34
170900120201	Portland; Forest Hills; Multnomah Channel	1	15623	15623	3.51
170900010802	Black & Salmon & Wall Cr.	6	4102	4102	3.28

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040602	Horse & Eugene Cr.	6	9774	9774	3.56
170900011001	Salt & Gold & Eagle Cr.	6	19715	19715	3.21
170900010803	Waldo Lake; Black & Salmon Cr.	6	5296	5296	2.97
170900050102	Marion Lake	6	14604	14604	2.95
170900040601	Separation Cr.	6	11609	11609	2.51

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040803	Roaring R. & Elk Cr.	6	13548	13548	2.86
170900010901	Waldo Lake; Cayuse & Fisher Cr.	6	13992	13992	2.68
170900120201	Portland; Forest Hills; Multnomah Channel	1	14348	14348	2.67
170900040802	French Pete Cr.	6	4909	4909	2.24
170900110502	Berry & Cub & Lowe Cr.	6	10710	10710	2.20

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900120202	S. Milwaukie; Happy Valley; Lake Oswego; W	1	11249	11249	4.39
170900120203	Gresham; Portland; N. Milwaukie	1	12676	12676	3.76
170900070307	Salem	1	5979	5979	3.47
170900100101	Tigard; Tualatin; Sherwood; King City	1	20515	20515	3.37
170900030204	E. Eugene; Harrisburg; Springfield	1	12358	12358	2.59

Key Environmental Correlates: In forested areas it prefers old growth but will use logged areas if snags suitable for nesting are available (Manuwal 1991). It is more common in old growth on moist soils than on dry soils, and preferentially selects streams and wetlands for aerial foraging (Manuwal 1991, Bull and Beckwith 1993). Swifts also forage in the multi-layered, broken canopy of old-growth forests, and over agricultural fields, lakes, rivers, and residential neighborhoods. Snags used for nesting by pairs or colonies of swifts generally have a diameter of at least 27 inches and contain holes excavated by pileated woodpeckers or resulting from detached limbs or rot.

Threats, Limiting Factors, Population Viability: As is true of all neotropical migrants, numbers currently may be limited as much or more by conditions on wintering grounds in the tropics than by habitat on breeding grounds, but evidence is lacking. Loss of old growth forest, however, is probably a major contributor to its decline. Fire suppression, dead wood removal (e.g., for fuels reduction and "forest health" programs), shorter harvest rotations, and low beaver populations undoubtedly limit the acreage of available habitat (i.e., snags in open-canopy forests and forest gaps). In developed areas, fewer new houses are being built with brick chimneys and where they are, they typically are partially capped to exclude swifts and other wildlife. At the same time some of the older, taller brick chimneys have been torn down or are being used to vent heat and gases at times when they are most-needed by staging swifts. As insectivores, swifts also are potentially vulnerable to pesticides.

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. To accomplish this, the *Conservation Strategy for Landbirds in Coniferous Forests of Western Oregon and Washington* (Altman 1999) recommends the following habitat objectives for managed forests:

- increase the length of harvest rotations to greater than 100 years;
- retain or create nest structures with diameter greater than 27 inches and height greater than 82 ft, that are in different stages of decay and in stands with less than 60% canopy closure (e.g., canopy gaps) so they are accessible to flying swifts;
- Provide an average of 5 of these potential nest/roost structures per square mile at any point in time, with up to 30% being live trees with broken tops (created or natural), and up to 20% being snags;
- Maintain a 5 acre no-harvest buffer around known nest or roost sites.

Marbled Murrelet

Special Designations: "Threatened" (federal and state). "Imperiled" (ONHP).

Distribution, Status, and Trends: This forest-nesting seabird breeds mostly within about 36 miles of the Oregon coast, so its occurrence in the Willamette subbasin is very limited. The ORNHIC database contains records from just 3 of the 170 Willamette watersheds. Nonetheless, NHI models and data project this species has a close association with land cover in 11% of the subbasin. Locational data are available from: http://www.reo.gov/gis/data/gisdata/index.htm. During the mid-1990s the Oregon population was estimated at 6,600 – 20,000 individuals (Nelson 2003). Predators and other factors have caused failure of two-thirds of the nests, and the Pacific population may be declining at a rate of 4-7% per year. Since 1850, habitat for this species in the subbasin may have decreased by 526-851% (Payne 2002).

Key Environmental Correlates: Requires a natural platform high in a conifer tree for laying its eggs (it does not build a nest). The platform, generally of moss or dwarf mistletoe based on a stout horizontal limb beneath the forest canopy, must be at least 4 inches wide (preferably 10) and located at least 30 ft up (preferably 185) in a large conifer. Unlike spotted owls, whose territories encompass hundreds of acres of well-connected old growth stands, marbled murrelets do not defend large territories and even tend to nest in loose colonies. Presence of nearby river corridors may facilitate daily movements between nesting trees and marine waters. Populations might be influenced as much or more by ocean conditions (where murrelets feed and winter) as by the availability of suitable nest sites.

Threats, Limiting Factors, Population Viability: Populations of this species are experiencing very low recruitment rates, due partly to nest predation and partly to high mortality in young prior to reaching the ocean (USFWS 1994, 1996). Harvest of old growth forest not only removes suitable egg placement sites, but also – by fragmenting the forest -- increases habitat suitability for and search efficiency of ravens, other corvids, and raptors that prey on murrelet eggs and/or young. Although the Northwest Forest Plan established late-successional reserves, the habitat in large areas within these reserves will not be suitable for 50-100 years. Meanwhile, harvest of suitable habitat continues under the umbrella of Habitat Conservation Plans, land exchanges, and misidentification of habitat suitability during surveys of sites slated for timber sales (Nelson 2003). Moreover, the "survey and manage" requirements that apply to many rare species on federal lands may soon be eliminated. In marine waters, murrelets face a wide arrange of threats, including oil spills, marine pollutants, incidental mortality from gill nets, incidental harvest of some of their fish prey, and effects of mariculture facility operations (e.g., alteration of local food base due to pollution).

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.

For Further Information: Nelson et al. 1992, US Departments of Agriculture and Interior 1993, Ralph et al. 1994, Nelson & Hamer 1995, USFWS 1996, 1997, Evans et al. 2000, Jodice & Collopy 2000, Nelson & Wilson 2000, Nelson 2003, Strong 2003

Spotted Owl

Special Designations: "Threatened" (federal). "Vulnerable" (ONHP).

Distribution, Status, and Trends: This legendary owl occurs rarely but widely in the Willamette subbasin. The ORNHIC database contains records from 96 of the 170 Willamette subbasin watersheds. The relatively large number is attributable partly to implementation of extensive surveys for this species. Potential habitat for this species was mapped in part of the subbasin by McComb et al. (2002). NHI models and data project this species has a close association with land cover in 52% of the subbasin. Locational data are available from:http://www.reo.gov/gis/data/gisdata/index.htm. A population decline (but not necessarily a decline in survival or reproductive rates) during the period 1985-1998 was documented partly by an analysis of banding data. Since 1850, suitable habitat for this species in the subbasin may have decreased by 29-83% (Payne 2002).

Key Environmental Correlates: Spotted owls nest and roost within or very near old growth conifer forest, feeding on forest mammals (primarily flying squirrels and red tree voles) beneath the forest canopy, and sometimes along edges of canopy gaps and clearcuts. The requirement of this species for large (>3000 acre) blocks of old growth conifer forest has been well-documented (e.g., Forsman et al. 1984, Thomas et al. 1990, Carey et al. 1992, Ripple et al. 1997, Swindle et al. 1999). Younger forests are used as well, although secondarily and mainly when they contain relict patches of old growth in locations where no old growth forest otherwise exists. Nests are placed on natural platforms in trees (e.g., formed by deformed or broken tops) or in cavities of live or dead trees, generally 72-99 ft above the ground. Diameter of nest trees averages 42–53 inches in Oregon (Forsman et al. 1984).

Threats, Limiting Factors, Population Viability: Although the Northwest Forest Plan established late-successional reserves, much of the potential habitat within these reserves will not be optimal for 50-100 years. Meanwhile, harvest of old growth conifers continues on some forest lands. Simultaneously, the integrity of spotted owl as a species may be threatened by increasing numbers of barred owls which have displaced spotted owls from some areas and occasionally hybridize with them (Forsman 2003).
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat.
For Further Information: Thomas et al. 1990, USDA & USDI 1994, Thrailkill et al. 1997, Marcot & Thomas 1997, Meyer et al. 1998, Irwin et al. 2000, Forsman et al. 2002, Noon & Franklin 2002, Glenn et al. 2004.

Great Gray Owl

Special Designations: "Vulnerable" (ODFW sensitive species).
Distribution, Status, and Trends: Although this is Oregon's largest owl, it is difficult to survey and consequently little is known of its status or trends in the Willamette subbasin. In Oregon it resides mainly on the east slope of the Cascades and in the Blue Mountains, but there are scattered reports of birds breeding within the subbasin, especially at higher elevations (e.g., Goggans & Platt 1992). NHI models and data project this species has a close association with land cover in less than 1% of the subbasin. Since 1850, suitable habitat for this species in the subbasin may have decreased by 95-100% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate old growth forest completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900010802	Black & Salmon & Wall Cr.	6	7593	77	2.95
170900040602	Horse & Eugene Cr.	6	15867	54	2.34
170900011001	Salt & Gold & Eagle Cr.	6	25511	331	2.32
170900011101	Groundhog Cr: S.Fork	6	9914	236	1.97
170900040802	French Pete Cr.	6	10491	18	1.97

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040602	Horse & Eugene Cr.	6	15827	54	3.16
170900011001	Salt & Gold & Eagle Cr.	6	25507	331	2.77
170900010803	Waldo Lake; Black & Salmon Cr.	6	6865	89	2.49
170900050102	Marion Lake	6	18790	68	2.48
170900010802	Black & Salmon & Wall Cr.	6	7587	77	2.26

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900011201	Staley & Swift & Spruce Cr.	6	43664	1204	2.46
170900040803	Roaring R. & Elk Cr.	6	19774	107	2.41
170900040802	French Pete Cr.	6	10487	18	2.24
170900010901	Waldo Lake; Cayuse & Fisher Cr.	6	18874	64	2.11
170900110502	Berry & Cub & Lowe Cr.	6	14657	236	1.79

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090703	Silverton N.	3	806	151	0.41
170900090602	Molalla R. S. Fk.	4	754	3	0.14
170900090702	Drift Cr.	3	433	0	0.09
170900090602	Molalla R. S. Fk.	3	290	4	0.06
170900010101	Rattlesnake & Hills Cr.	4	99	0	0.05

Key Environmental Correlates: Like spotted owls, great gray owls nest and roost in old-growth conifer forest, but appear to feed to a greater degree than other owls in montane meadows. They also forage in natural forest gaps and clearcuts if they support a vigorous herbaceous layer. Flightless fledglings may benefit from partially downed wood which they use as perches.
Threats, Limiting Factors, Population Viability: Loss of old-growth conifer forests, through logging and fire, is probably the greatest immediate threat. Succession of montane meadows into forest as a potential result of global warming may be a longer-term problem.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. Lengthen the usual harvest rotation period to sustain the supply of old growth trees.
For Further Information See: Quintana-Coyer et al. 2004.

Oregon Slender Salamander
Special Designations: “Critically Imperiled” (ONHP).
Distribution, Status, and Trends: This salamander is reported to be locally common in parts of the eastern (Cascade) portion of the subbasin, and its range is confined entirely to Oregon. NHI models and data project this species has a general association with land cover in 38% of the subbasin. The ORNHIC database contains documented records from 18 of the 170 Willamette watersheds. Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units contain records of this species in the ORNHIC database.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft

HUC6	Watershed name (not comprehensive)	Elev	Public land?	In PCA?

170900030302	Brownsville	3	yes	no
170900040802	French Pete Cr.	5	yes	yes
170900040803	Roaring R. & Elk Cr.	4	yes	yes
170900050101	Detroit; Idanha	4	yes	no
170900050101	Detroit; Idanha	5	yes	no
170900050201	Breitenbush R.	4	yes	no
170900050301	Detroit Reservoir	4	yes	no
170900050301	Detroit Reservoir	5	yes	no
170900050401	Gates; Lyons; Mill City	4	yes	no
170900050501	Little North Santiam R.	4	yes	no
170900050601	Jefferson; Lyons; Bear Branch	4	yes	no
170900060302	Upper Thomas & Neil Cr. & Indian Prairie	3	yes	no
170900060401	Greenpeter Reservoir	3	yes	no
170900060401	Greenpeter Reservoir	3	no	no
170900060401	Greenpeter Reservoir	4	yes	no
170900090303	Woodcock Cr.	2	yes	yes
170900090401	Scotts Mills Senecal Cr. & Mill Cr.	4	yes	no
170900090402	Abiqua Cr.	3	yes	no
170900090604	Copper & Henry Cr.	4	yes	no
170900110301	Big Cliff Reservoir	3	yes	no
170900110301	Big Cliff Reservoir	4	yes	no
170900110303	Fish Cr. E.	3	yes	no
170900110601	Nohorn Cr.	4	yes	yes

Key Environmental Correlates: Moist coniferous forests, especially mature and old growth stands, appear to provide the primary habitat for this species. Nests have been found under bark and in large rotten logs. Tall, multi-layered canopies of old growth retain humidity and intercept fog, which maintains ground-level moisture essential to this species.
Threats, Limiting Factors, Population Viability: Habitat loss and degradation (i.e., reduced soil moisture) is the major threat. The accumulations of large-diameter moist woody debris required by this species are much less available in younger managed forests, especially with the implementation of fuels reduction programs and shorter harvest rotations. Fragmentation of forests with roads and clearcuts potentially decreases soil moisture in the adjoining forest. Global climate warming also could potentially diminish soil moisture and result in more frequent fires, with negative impacts on salamanders.
Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. Lengthen the usual harvest rotation period to sustain the supply of old growth trees.

American (Pine) Marten
Special Designations: "Vulnerable" (ODFW sensitive species).
Distribution, Status, and Trends: Mainly resides in higher-elevation portions of the subbasin. The ORNHIC database contains 3 documented records of this species. All were from one watershed within the upper Middle Fork of the Willamette River, in the mid-1990s. Application of simple species-habitat models to aerial imagery suggests about 6% of the subbasin might have contained (in the early 1990s) habitat that could be at least marginally suitable and 0.7% might contain good habitat. NHI models and data project this species has a close association with land cover in 7% of the subbasin. Historically, unregulated trapping for pelts eliminated martens

from some areas. In addition, since 1850 suitable habitat for this species in the subbasin may have decreased by 19-37% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate old growth forest completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040602	Horse & Eugene Cr.	6	19120	239	3.37
170900040501	Boulder Cr. & Smith R.	6	44810	3752	2.91
170900040802	French Pete Cr.	6	13940	414	2.87
170900050103	Pyramid Cr.	6	12596	2377	2.43
170900011201	Staley & Swift & Spruce Cr.	6	24943	4681	2.13

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900040602	Horse & Eugene Cr.	6	19102	239	3.77
170900050102	Marion Lake	6	19314	1272	2.55
170900050103	Pyramid Cr.	6	12551	2361	2.54
170900010802	Black & Salmon & Wall Cr.	6	7551	1235	2.41
170900010702	Christy Cr.	6	6973	1438	2.11

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900011201	Staley & Swift & Spruce Cr.	6	24937	4679	3.16
170900110502	Berry & Cub & Lowe Cr.	6	26980	2580	3.16
170900040802	French Pete Cr.	6	13934	414	3.11
170900040803	Roaring R. & Elk Cr.	6	23760	903	2.91
170900040501	Boulder Cr. & Smith R.	6	44757	3748	2.85

Finally, the following units include the only suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900090601	Molalla R. N. Fk.	6	1313	520	0.34
170900090602	Molalla R. S. Fk.	6	269	100	0.06

Key Environmental Correlates: Martens are usually found in dense old-growth conifer forests, possibly favoring those closer to water. Abundant downed woody material of diverse sizes appears to be very important, and is affected by fuels reduction programs (Bull & Blumton 1999). To a lesser degree martens use dense deciduous or mixed forest, and rocky alpine areas.
Threats, Limiting Factors, Population Viability: Continued loss of unmanaged old growth stands may threaten this species. Its requirement for accumulations of woody debris makes it less likely to survive in younger managed forests, especially with the implementation of fuels reduction programs and shorter harvest rotations.
Biological Objectives:

- Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat, particularly as:
- -- tracts of greater than 640 acres that contain >45% mature and old growth forest.
- -- riparian areas or other corridors wider than 600 ft wide
- Lengthen the usual harvest rotation period to sustain the supply of old growth trees and create and maintain uneven-aged stands of timber
- Retain downed dead wood to the maximum extent (ideally covering >20% of the ground) consistent with fuel reduction needs and in a spatially dispersed pattern

For More Information: Lacy & Clark 1993

Red Tree Vole

Special Designations: "Vulnerable" (ONHP).
Distribution, Status, and Trends: This small, highly specialized rodent resides mainly in the Cascade and Coast Range portions of the subbasin. From 650 surveys in potentially suitable habitat on national forests and BLM lands in western Oregon, a total of over 254 sites were discovered (Biswell et al. 2000). Survey data suggest the species may be less frequent in the more northerly part of the Cascades (e.g., Clackamas and North Santiam watersheds). NHI models and data project this species has a close association with land cover in less than 1% of the subbasin. NHI models and data project this species has a close association with land cover in less than 59% of the subbasin. Since 1850, suitable habitat for this species in the subbasin may have decreased by 108-149% (Payne 2002). Of the 170 sixth-field watersheds in the subbasin, each subdivided by elevation zones, the following watershed-elevation zone units may contain the generally most suitable habitat for this species over the largest proportion of the unit. The estimates are from application of simple species-habitat models to early 1990s aerial imagery (that did not delineate old growth forest completely) so are very approximate.

Elevation zones (Elev) are:
1= <500 ft, 2= 500-1000 ft, 3= 1000-2000 ft; 4= 2000-3000 ft; 5= 3000-4000 ft, 6= >4000 ft
HabAcOK is the acres of possible habitat, i.e., scored >5 for habitat suitability on a 0-10 scale; HabAcBest is the acres of habitat scored a "10"; HS is the habitat suitability score, a relative index that represents the proportional extent (not acres) of higher-suitability habitat in the unit defined by the HUC6 and elevation zone; see section 1.4 for more explanation, map files accompanying this report for location of the HUC6's, and electronic files accompanying the report for ranking of all watersheds and units.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110402	Timothy Lake; Dinger Lake	5	15565	10823	3.16
170900040301	Blue River Reservoir & Cook Cr.	3	3063	1111	2.80
170900020102	Creswell W.; Camas Swale	2	2500	290	2.73
170900030103	Coyote Cr.	2	12864	1456	2.36

170900110301	Big Cliff Reservoir	4	9847	2759	2.35

Considering just the public lands within all units, those in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110402	Timothy Lake; Dinger Lake	5	12777	8841	2.55
170900010302	Fall & Delp Cr.	4	8992	5704	2.53
170900020502	Brice Cr.	5	8657	4228	2.33
170900110304	Roaring R.	5	6049	3134	2.33
170900010502	Hemlock; Lookout Point Reservoir	3	10949	5356	2.18

Considering just the Priority Conservation Areas within each unit, the PCAs in the following units may contain the generally most suitable habitat over the largest proportion of the unit.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900110602	Dickey & Elk Cr.	5	11965	7544	2.49
170900110501	Clackamas R. - upper	5	7999	4995	2.18
170900040102	Gate Cr. S. Fk.	3	7280	2937	2.08
170900110601	Nohorn Cr.	5	8985	4635	2.08
170900040802	French Pete Cr.	5	7612	2471	2.03

Finally, the following units include the generally most suitable habitat that is on private lands not identified as PCAs. Units where TNC did not attempt to identify PCAs are excluded.

HUC6	Watershed Name (not comprehensive)	Elev	HabAcOK	HabAcBest	HS
170900030103	Coyote Cr.	2	9696	903	1.63
170900080201	Willamina	2	1310	63	1.44
170900030102	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	2	10002	651	1.33
170900030603	Luckiamute R.1.	2	2239	173	1.27
170900010501	Dexter Reservoir	3	1452	324	1.22

Key Environmental Correlates: The preferred habitat of this vole appears to be moist, old-growth coniferous forest, especially Douglas-fir. To a lesser degree this vole uses mid-aged closed-canopy forests that have significant stands of large-diameter (>21 inch) trees. It spends nearly its entire life high in conifer trees (Meiselman and Doyle 1996). Tall, multi-layered canopies of old growth retain humidity and intercept fog, which functions as a climatic buffer and a source of free water. Large branches provide stable support for nests, protection from storms, and travel routes (Biswell et al. 2000).

Threats, Limiting Factors, Population Viability: Continued loss of unmanaged old growth stands due to logging and fire will threaten this species. Changes in forest microclimate (drying) as a result of adjoining clearcuts, roads, and global warming also could adversely it.

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. Lengthen the usual harvest rotation period to sustain a supply of old growth trees.

For More Information: Aubry et al. 1991, Biswell et al. 2000, Carey 1996, Huff et al. 1992.

<u>Townsend's (Pacific Western) Big-eared Bat</u>

Special Designations: "Vulnerable" (ONHP).

Distribution, Status, and Trends: This is one of the least common of the bats that use old growth conifer forest. The ORNHIC database contains documented records from 16 of the 170 Willamette watersheds. It may be more common in the Coast Range than Cascades; numbers in northwestern Oregon were coarsely estimated at 300-400 individuals in 1987 but reliable survey data are too few to determine trends or densities. NHI models and data project this species has a general association with land cover in 35% of the subbasin.

Key Environmental Correlates: This species may not be highly dependent on old growth coniferous forests, but neither does it appear to be strongly associated with other forested cover types. Like many bats, its main requirement is for cool roosting and hibernation sites, and for these the bark and cavities of very large trees provides suitable sites. This need is also met by caves, large rock outcrops, and some abandoned buildings or mine tunnels. Most bats forage primarily over water, riparian areas, wetlands, and small canopy gaps in forests (Arnett & Hayes 2002), and this one is probably no exception.

Threats, Limiting Factors, Population Viability: Major threats include disturbance of cave roosts (especially maternity colonies and hibernation sites) by recreationists; blockage of cave entrances from intentional or natural events; and loss of mature and old growth forest from logging and fire. Pesticide spraying can potentially affect the insect populations upon which this bat feeds.

Biological Objectives: Maintain or expand existing numbers and geographic distribution through protection, restoration, and management of suitable habitat. Lengthen the usual harvest rotation period to sustain a supply of old growth trees.

<u>Other Species of Note</u>

Although not included in this section as focal species, the following species use old growth conifer stands (as well as other habitats in most cases) and are of particular note because of possible population declines in the region, small regional populations, and/or very specialized habitat requirements:

- brown creeper, northern goshawk (state-listed as "Critical"), varied thrush, chestnut-backed chickadee, golden-crowned kinglet, Hammond's flycatcher, Pacific-slope flycatcher, winter wren, hermit warbler, red crossbill, evening grosbeak, Baird's shrew, fog shrew, northern flying squirrel, pallid bat (state-listed as "Vulnerable"), fringed myotis (state-listed as "Vulnerable"), Dunn's salamander
- rufous hummingbird, MacGillivray's warbler, purple finch, blue grouse, ruffed grouse, Swainson's thrush, Cassin's vireo -- these species primarily use open-canopy stands with deciduous or conifer understory shrubs (Morrison & Meslow 1983)
- black-backed woodpecker – uses snags in high-elevation burned forests almost exclusively

In addition, an extensive array of rare plants, fungi, and invertebrates are exclusively or strongly associated with old growth forests.

2.7.9 Synthesis: Indicators of Old Growth Ecological Condition and Sustainability

The following indicators – which must be assessed in the field -- may be useful for monitoring success of old growth management projects and long-term trends in quality of the remaining old growth forests. This list is not intended to be comprehensive.

Extent of old growth conifer forest: the mean patch size and total acreage of old growth compared with its historical extent. This should be subtotaled within watersheds by geomorphic characteristics (elevation, geology, soils, length of streams bordered), predominant type of canopy and subcanopy vegetation, vertical complexity, degree of fragmentation (distance to nearest other old growth stand, and intervening land cover types), and management or natural disturbance history (Brooks 1997).

Focal species status: the density, interannual frequency of occurrence, and distribution (proportion of sample points where detected) of each focal species within parts of a watershed containing old growth conifer forest and which are projected (by models, aerial imagery, historical vegetation data, and professional judgment) to be generally suitable for the species based on elevation. In addition, it may be useful to monitor forest-floor small mammals and arboreal rodents, partly because their year-round presence and small territories make them easier to monitor (Carey & Johnson 1995, Martin & McComb 2002, Suzuki & Hayes 2003).

Tree density: the stem density or canopy cover of trees, subtotaled by species and diameter class, and by condition (live or dead) within old growth stands in a particular watershed;

Shrub density: the stem density or percent cover of shrubs, subtotaled by species, within the old growth stands in a particular watershed;

Native herb cover: the percentage of the herbaceous (non-shrub) plant cover that is comprised of native species;

Downed woody debris: the density and diversity (size classes, decay classes) of downed woody material. This is critical to many species (Chambers et al. 1997, Rose et al. 2001). Some forest biologists have suggested there may currently be a paucity of hard large-diameter woody material on forest floors, with unknown consequences for wildlife. Much of the existing larger-diameter downed wood is a relict of high-grading practices of a century ago, and thus is in a more advanced state of decay (Carey 2001). Models (e.g., DecAID, see: http://wwwnotes.fs.fed.us:81/pnw/DecAID/DecAID.nsf) are available for projecting the amount and type of snags or downed woody material available in the future within a particular forest stand, given its current age structure.

It is not possible to specify exact criteria for evaluating each of these indicators. Doing so would require additional collection and interpretation of biological data from a series of reference old growth areas. Portions of such a reference data set may be obtainable from national timber inventories, national forest offices, and university projects, e.g., CLAMS. The above indicators include those recommended in the forests chapter of Oregon's *State of the Environment Report* (Johnson 2000). Forest ecological indicators also were proposed by Spies et al. (2002) and were applied in computer simulations to examine consequences for wildlife of alternative harvest practices in the Oregon Coast Range.

2.8 Non-focal Natural Habitats of Note

As stated earlier, the previous detailed discussion of just 6 focal habitats should not divert attention from several other habitats important to wildlife and/or rare plants, but which could not be addressed with similar level of detail within the constraints of this project. Largely by conducting a "sweep" analysis of the attribute data for species associated with the 6 focal habitats (files: HABTYPE and HABSTRUC), it becomes apparent that protection or restoration of several additional habitat types will be required to adequately protect habitat for several other species. Table 25 shows species for which none of the 6 focal habitats provides ideally (or in some cases, any) suitable habitat. Habitats associated with some of these "unswept" species are now briefly described.

Unshaded native shrublands occur as both inclusions within some of the 6 focal habitat types, and also in patches distant from any of those. Native shrubs collectively provide an abundance of wildlife foods year-round. They include (for example) willow, red alder, dogwood, elderberry, cascara, hawthorn, snowberry, Nootka rose, ocean spray, serviceberry, and hardhack. Except in heavily forested areas or very wet areas, relatively few of the subbasin's shrub communities remain free of non-native invaders such as Himalayan blackberry and scotch broom, which have uncertain effects on suitability of this habitat for native wildlife. In the Willamette subbasin, regularly-associated native species include (for example) band-tailed pigeon, yellow-breasted chat, lazuli bunting, Bewick's wren, bushtit, wrentit, rufous hummingbird, MacGillivray's warbler, Wilson's warbler, blue grouse, ruffed grouse, Swainson's thrush, Cassin's vireo, striped skunk, and brush rabbit. **Willow** communities in particular appear to have diminished in the subbasin, at least in the lowlands, partly as a consequence of river regulation that has reduced the extent of gravel bars and has allowed less flood-tolerant trees and non-native shrubs to dominate much of the remaining gravel bar and shoreline habitat. At the same time, the extent of native shrub communities at higher elevations, except in riparian zones, might be reduced by forest management practices that continually seek to shorten the maturation period of commercially-important conifer trees. Fortunately, many native shrub communities are relatively easy to restore, and can easily be inserted within a matrix of agricultural and residential lands. **Flowering plants**, regardless of the particular larger habitat within which they grow, provide essential nectar to hummingbirds that migrate long distances to winter in the Neotropics, yet are vulnerable to herbicides applied widely to tree plantations, roadsides, and crop fields.

Broadleaf deciduous forests (other than oak, which was discussed in section 2.2) also add diversity to local landscapes throughout the subbasin. They include (for example) cottonwood, maple, Oregon ash. They are favored by several species that occur only infrequently in conifer forests, e.g., warbling vireo, black-headed grosbeak, Bullock's oriole. Nearly all of these species also nest in oak woodlands, but sometimes at smaller densities.

Ponderosa pine ("valley pine") once was much more common in the Willamette lowlands, being maintained partly by occasional fires (Hibbs et al. 2002). Only scattered stands now remain, mostly in the Cascade foothills and southern parts of the subbasin. Some landowners are attempting to restore this community using seed sources from within the subbasin, and a nonprofit organization has mapped locations of ponderosa stands (see: www.westernforestry.org/wvppca/historyvision.htm). Ponderosa thrives on sites too dry or wet for optimum growth of Douglas-fir, but is relatively susceptible to damage from insects and disease. Its disappearance from the lowlands may partly account for the recent extirpation of nesting Lewis's woodpecker from the subbasin and the possible decline of some other species, e.g., long-eared owl, white-breasted nuthatch.

Sphagnum moss bogs were once more common in the Willamette Valley but only a single one now exists in the lowlands, and that is being protected by Metro. An unknown but probably small number exist in the West Cascades, e.g., at Gold Lake, Olallie Lake. The subbasin's bogs are best known for their rare plants, but also have probably hosted nesting Lincoln's sparrow and solitary sandpiper, the former also occurring in **montane meadows** and the latter not known to nest anywhere else in Oregon. **Montane coniferous wetlands** also occur in the same Cascades settings, and are supported by springs, local snowmelt, and beaver damming activity. From aerial imagery, the National Wetland Inventory estimates there may be 3066 acres of such wetlands in the subbasin. **Alpine grasslands and subalpine parkland** also host breeding Lincoln's sparrow and (rarely) Wilson's snipe and American pipit, as well as many rare plants. The pika, golden-mantled ground squirrel, and Clark's nutcracker occur almost exclusively in this habitat and in **alpine shrublands** which also are important to nesting fox sparrow, Townsend's solitaire, and several small mammal species. From aerial imagery, NHI estimates the subbasin presently has 4755 acres of alpine grasslands and shrublands, and 19,669 acres of subalpine parkland habitat. Global warming is an enormous threat to these habitats, nearly all of which are on federal land (Martin 2001). Potential impacts of ski area expansion are a more localized concern. Limited banding and observational data suggest that major numbers of migrant birds may forage in late summer in the High Cascades, building up energy reserves just prior to their long southward migration, and finding water more extensively than at lower elevations.

Waterfalls not only are aesthetically appealing, but also are the only habitat used by rare nesting pairs of black swift (e.g., at Salt Creek Falls above Oakridge; for regional inventory data see: http://home.pacifier.com/~neawanna/BLSW/BLSW.html). **Caves** are well-known as essential habitat for bats, and were included in the upland prairie discussion (section 2.3). Many pollinating insects upon which flowering plants depend are vulnerable to pesticides. And taking a functional rather than structural perspective, it is apparent that **wildlife corridors and yarding areas**, wherever they occur, are critical to many larger mammals (e.g., deer) and some smaller ones (e.g., squirrels). Corridors are traditional routes followed by dispersing young or more regularly (often daily) by individuals in search of food and cover. Yarding areas are points where animals traditionally congregate, often during the winter. Corridors often follow ridge lines, and roads that intercept corridors are often plagued by major roadkill issues.

Many of the habitats just discussed will be described in more detail, and the most important examples of each will be identified, in TNC's upcoming West Cascades Ecoregional Assessment. Also, TNC's Ecoregional Assessments provide finer (community-level) classifications of the 6 focal habitats and some of the habitats listed above. Such finer distinctions appear to be of concern primarily for the protection of botanical diversity, but much has yet to be learned about the importance of species- or community-level differences in wildlife use.

2.9 Non-focal Developed Habitats of Note

Several components of *developed* landscapes have proven to be important to the subbasin's wildlife. Although most species that reach their greatest levels of abundance in developed landscapes are often not native, a few species that do are. **Large expanses of farmland** continue to support exceptional densities of wintering raptors, perhaps at lower densities than when such areas were native prairies with greater internal variation in cover. For the first time, during the 2003-2004 winter volunteers conducted systematic surveys of these raptors throughout much of the Willamette Valley. Some of the data demonstrating the importance of open, mostly undeveloped habitat are shown in Tables 22 and 23. In parts of the subbasin, **corn fields** seem particularly valued by wildlife. Not only are they used extensively by waterfowl in winter, but in late summer (before stalks are mowed) their use as pre-migration staging and roosting areas by as many as 500,000 swallows has been documented, e.g., near Dayton (Nehls 2003). Economic and other factors that drive farm planting decisions can indirectly influence wildlife in ways that seldom have been studied. One type of important developed habitat that currently may be declining is **abandoned barns**. Especially when distant from roads and urban centers, these provide nearly the only nesting habitat in the subbasin for cliff swallows and barn owls, and are one of the more valuable habitats for barn swallows and several bat species. Also important are **uncapped brick chimneys** (especially tall ones), as described in this report's account of Vaux's swift. **Bridges** are often used as night roosts by bats in the Oregon Coast Range and Cascades, especially in summer (Adam & Hayes 2000) and are a favored nesting substrate for cliff swallows.

Table 22. Raptor totals from mid-Willamette Valley farmland surveys, winter 2003-2004

Note: This survey involved about 10 volunteers and was initiated and coordinated by Jeff Fleischer, who generously shared this preliminary compilation of the data. This is not a complete census. Data also can be broken out by sub-county survey route locations.

	December	January	February	March	TOTAL
Lane	180	272	266	183	901
Linn	367	507	523	440	1837
Benton	92	120	128	105	445
Polk	212	253	260	227	952
Yamhill	103	97	78	73	351
Marion	(no data)	65	58	45	168
TOTAL	(954)	1314	1313	1073	
miles covered	1049	1144	1151	1150	4496

Table 23. Diurnal raptor species: maximum counts from mid-Willamette Valley farmland surveys, December 2003 – March 2004

Source: Jeff Fleischer (see preceeding table)

	Lane	Linn	Benton	Polk	Yamhill	Marion
Red-tailed Hawk	111	215	45	121	42	32
American Kestrel	82	238	44	107	60	25
Northern Harrier	43	31	19	33	7	4
Bald Eagle	27	54	8	4	2	4
Rough-legged Hawk	6	4	9	13	5	4
Red-shouldered Hawk	5	0	1	0	0	0
White-tailed Kite	30	0	4	2	1	0
Peregrine Falcon	2	3	2	1	0	0
Praririe Falcon	0	3	1	1	2	0
Merlin	3	1	2	1	0	1
Gyrfalcon	0	0	0	1	0	0
Sharp-shinned Hawk	1	2	1	3	1	0
Cooper’s Hawk	4	3	1	3	0	1
Burrowing Owl	1	1	0	0	1	0

2.10 Interspecies Relationships: Wildlife and Fish

Overall, stream management activities (restoration, enhancement) provide enormous benefits to stream- and riparian-associated wildlife, both directly by increasing the productivity of fish and other aquatic organisms upon which some terrestrial animals feed, and indirectly by improving habitat complexity and quality. Approximately 6 terrestrial vertebrates of the Willamette subbasin (4 of which are residents) have been documented as having a “strong and consistent association” with salmonid fish (Table 24). An additional 70 (including 44 residents) have been documented as having a “recurrent” “indirect” or “rare” association (Cedarholm et al. 2002). The predicted suitability of habitat for these species is by watershed (sixth-field HUC) is presented in DetailFile: SPHABWRB that accompanies this report. No population trends data are available for mammals or amphibians listed in this table, and for birds trends are known only for the period beginning in 1968, from Breeding Bird Survey data. Those data, which mainly cover roadsides, do not show any statistically significant regional decreases for any bird species having a “strong and consistent” or “recurrent” relationship to salmonids, and in fact, some of the species (e.g., osprey) have had significant increases.

Most of the wildlife species shown may feed as much or more on other types of fish besides salmon, including all non-native fish. Predation rates probably depend on seasonal availability of salmonids, size, and habitat use. No data are available to adequately quantify predation rates in the Willamette subbasin. In addition to these species that consume fish, one species (American beaver) has a profound and usually positive effect on stream environments. Beavers are recovering from near-extirpation as a result of trapping in the early 1900s. Also, native ungulates that use riparian areas can, under extreme conditions, reduce canopy cover (shade) important to fish. Wildlife also transport nutrients across riparian-upland boundaries, thus increasing the functional connectivity of habitats. Virtually every environmental correlate important to fish populations is at least indirectly important to some wildlife populations. For this report, environmental correlate data for fish habitats in the Willamette subbasin were not available for the entire subbasin at the watershed (sixth-field HUC) scale, as would be necessary to allow a geographically-comprehensive and detailed description of linkages between fish and wildlife. Stream management activities likely to benefit wildlife the most are perhaps those that restore riparian vegetation, those that restore natural flow regimes to rivers, those that provide a long-term supply of wood to the channel, and those that improve water quality (especially sediment runoff).

Table 24. Wildlife species of the Willamette subbasin documented to feed on (or otherwise functionally linked to) live or dead salmonid fish

Note: Most of these species may feed as much or more on other types of fish. Among birds whose status is "seasonal," only those that occur regularly in this subbasin are included. Adapted from IBIS database file provided by NHI.

Species Grouped by Degree of Association with Salmonids	Species Status	How or When Associated with Salmonids
STRONG & CONSISTENT ASSOCIATION:		
Bald Eagle	resident	Carcasses
Bald Eagle	resident	Spawning – freshwater
Black Bear	resident	Carcasses
Black Bear	resident	Spawning – freshwater
Common Merganser	resident	Freshwater rearing – fry, fingerling, and parr
Common Merganser	resident	Incubation - eggs and alevin
Northern River Otter	resident	Carcasses
Northern River Otter	resident	Freshwater rearing – fry, fingerling, and parr
Northern River Otter	resident	Spawning – freshwater
Harlequin Duck	seasonal	Incubation - eggs and alevin
Osprey	seasonal	Freshwater rearing – fry, fingerling, and parr
Osprey	seasonal	Spawning – freshwater
RECURRENT ASSOCIATION:		
American Crow	resident	Carcasses
American Crow	resident	Freshwater rearing – fry, fingerling, and parr
American Dipper	resident	Carcasses
American Dipper	resident	Freshwater rearing – fry, fingerling, and parr
American Dipper	resident	Incubation - eggs and alevin
Barrow's Goldeneye	resident	Carcasses
Barrow's Goldeneye	resident	Freshwater rearing – fry, fingerling, and parr
Barrow's Goldeneye	resident	Incubation - eggs and alevin
Belted Kingfisher	resident	Freshwater rearing – fry, fingerling, and parr
Belted Kingfisher	resident	Spawning – freshwater
Bobcat	resident	Carcasses
Bobcat	resident	Spawning – freshwater
Common Merganser	resident	Carcasses
Common Raven	resident	Carcasses
Common Raven	resident	Freshwater rearing – fry, fingerling, and parr
Common Raven	resident	Spawning - freshwater
Coyote	resident	Carcasses
Great Blue Heron	resident	Freshwater rearing - fry, fingerling, and parr
Mink	resident	Carcasses
Mink	resident	Freshwater rearing - fry, fingerling, and parr
Mink	resident	Spawning - freshwater
Pacific Giant Salamander	resident	Freshwater rearing - fry, fingerling, and parr
Pacific Giant Salamander	resident	Incubation - eggs and alevin
Pied-billed Grebe	resident	Freshwater rearing - fry, fingerling, and parr
Raccoon	resident	Carcasses
Raccoon	resident	Freshwater rearing - fry, fingerling, and parr

Species Grouped by Degree of Association with Salmonids	Species Status	How or When Associated with Salmonids
Steller's Jay	resident	Carcasses
Virginia Opossum	resident	Carcasses
Water Shrew	resident	Carcasses
Water Shrew	resident	Freshwater rearing - fry, fingerling, and parr
Water Shrew	resident	Incubation - eggs and alevin
California Gull	seasonal	Carcasses
Common Goldeneye	seasonal	Carcasses
Common Goldeneye	seasonal	Freshwater rearing - fry, fingerling, and parr
Common Goldeneye	seasonal	Incubation - eggs and alevin
Common Loon	seasonal	Freshwater rearing - fry, fingerling, and parr
Double-crested Cormorant	seasonal	Freshwater rearing - fry, fingerling, and parr
Forster's Tern	seasonal	Freshwater rearing - fry, fingerling, and parr
Glaucous Gull	seasonal	Carcasses
Glaucous-winged Gull	seasonal	Carcasses
Glaucous-winged Gull	seasonal	Incubation - eggs and alevin
Glaucous-winged Gull	seasonal	Spawning - freshwater
Golden Eagle	seasonal	Carcasses
Golden Eagle	seasonal	Spawning - freshwater
Herring Gull	seasonal	Carcasses
Herring Gull	seasonal	Freshwater rearing - fry, fingerling, and parr
Ring-billed Gull	seasonal	Carcasses
Ring-billed Gull	seasonal	Freshwater rearing - fry, fingerling, and parr
Turkey Vulture	seasonal	Carcasses
Western Grebe	seasonal	Freshwater rearing - fry, fingerling, and parr
INDIRECT ASSOCIATION:		
American Dipper	resident	Carcasses
Bald Eagle	resident	Carcasses
Bald Eagle	resident	Freshwater rearing - fry, fingerling, and parr
Bald Eagle	resident	Incubation - eggs and alevin
Fog Shrew	resident	Carcasses
Killdeer	resident	Carcasses
Pacific Shrew	resident	Carcasses
Pacific Water Shrew	resident	Carcasses
Peregrine Falcon	resident	Carcasses
Peregrine Falcon	resident	Freshwater rearing - fry, fingerling, and parr
Spotted Sandpiper	resident	Carcasses
Trowbridge's Shrew	resident	Carcasses
Vagrant Shrew	resident	Carcasses
Water Shrew	resident	Carcasses
Cliff Swallow	seasonal	Carcasses
Harlequin Duck	seasonal	Carcasses
Northern Rough-winged Swallow	seasonal	Carcasses
Tree Swallow	seasonal	Carcasses
Violet-green Swallow	seasonal	Carcasses
Willow Flycatcher	seasonal	Carcasses
RARELY ASSOCIATED:		
American Marten	resident	Carcasses

Species Grouped by Degree of Association with Salmonids	Species Status	How or When Associated with Salmonids
American Robin	resident	Incubation - eggs and alevin
Canvasback	seasonal	Carcasses
Common Garter Snake	resident	Freshwater rearing - fry, fingerling, and parr
Common Loon	seasonal	Carcasses
Deer Mouse	resident	Carcasses
Douglas' Squirrel	resident	Carcasses
Fog Shrew	resident	Carcasses
Franklin's Gull	seasonal	Freshwater rearing - fry, fingerling, and parr
Gray Fox	resident	Carcasses
Gray Jay	resident	Carcasses
Great Egret	seasonal	Freshwater rearing - fry, fingerling, and parr
Greater Scaup	seasonal	Carcasses
Greater Scaup	seasonal	Incubation - eggs and alevin
Greater Yellowlegs	seasonal	Incubation - eggs and alevin
Green Heron	seasonal	Freshwater rearing - fry, fingerling, and parr
Green-winged Teal	resident	Incubation - eggs and alevin
Hooded Merganser	resident	Carcasses
Hooded Merganser	resident	Freshwater rearing - fry, fingerling, and parr
Hooded Merganser	resident	Incubation - eggs and alevin
Long-tailed Weasel	resident	Carcasses
Mallard	resident	Carcasses
Mallard	resident	Incubation - eggs and alevin
Mew Gull	seasonal	Incubation - eggs and alevin
Mountain Lion	resident	Spawning - freshwater
Northern Flying Squirrel	resident	Carcasses
Pacific Shrew	resident	Carcasses
Pacific Water Shrew	resident	Carcasses
Red Fox	resident	Carcasses
Red-tailed Hawk	resident	Carcasses
Song Sparrow	resident	Carcasses
Spotted Towhee	resident	Carcasses
Striped Skunk	resident	Carcasses
Trowbridge's Shrew	resident	Carcasses
Trumpeter Swan	seasonal	Carcasses
Trumpeter Swan	seasonal	Freshwater rearing - fry, fingerling, and parr
Trumpeter Swan	seasonal	Incubation - eggs and alevin
Vagrant Shrew	resident	Carcasses
Varied Thrush	seasonal	Carcasses
Varied Thrush	seasonal	Incubation - eggs and alevin
Western Grebe	seasonal	Carcasses
Western Pond Turtle	resident	Carcasses
Western Pond Turtle	resident	Freshwater rearing - fry, fingerling, and parr
Winter Wren	resident	Carcasses
Wolverine	resident	Carcasses

3. Conservation Efficiency

An opportunistic approach to habitat protection and restoration – that being collaboration with landowners whenever and wherever such collaboration is offered -- is a practical necessity. This is because the essential combination of critically important habitat types, willing landowners, and affordable land parcels is too often scarce. Nonetheless, a systematic, science-based strategic approach is imperative as well. Without such an approach, there is a risk that public funds will be expended on restoration projects on lands that, for intrinsic reasons, will provide only marginally suitable habitat even after restoration, or that funds will be spent purchasing lands that provide a less than optimal gain in protection of the biodiversity of the subbasin. It will never be possible to purchase or restore *all* the habitat required to guarantee the sustained survival of *every* species. Thus, priorities must be established among land parcels in a manner that minimizes unnecessary redundancy of the features they are intended to protect.

3.1 Efficiency of the Selected Priority Conservation Areas

Conservation priorities can be set among units measured at any scale, from ecoregions to watersheds and on down to individual land parcels. As noted in section 1.5, there have been two major efforts to systematically and geographically prioritize potential conservation units throughout lowlands of the Willamette subbasin (Table 54). One is TNC's *Ecoregional Assessment* (Floberg et al. 2004). From an initially large set of candidate units (land parcels aggregated in geographic clusters), the *Ecoregional Assessment* selected the set that would come closest to meeting specific conservation goals[16] at the least cost, i.e., greatest conservation efficiency. This was accomplished through use of a model called SITES. Cost was not measured in dollars but rather was represented by variables that correlate highly with cost, such as proximity to urban areas. The SITES model minimized cost by selecting the most compact set of units, especially units with multiple high-priority features (high "conservation value") located in areas rated as most attractive for long-term conservation (low "vulnerability"). The SITES model compared each unit against all others and analyzed millions of hypothetical combinations to arrive at the most efficient set. The final "portfolio" includes 95 priority conservation areas (PCAs) dispersed across 102 of the 170 watersheds (HUC6s) of the Willamette subbasin, and covering a combined area of about 538,757 acres. They occupy about 10% of the subbasin area and between 0 and 63% of the area of individual watersheds.

TNC's assessment covered about 44% of the Willamette subbasin. Within that area, TNC identified 96 semi-distinct PCAs, comprising a total of 11% of the lowland and foothill area that TNC assessed. Individual PCAs range in size from 46 acres to 119 square miles (median = 2569 acres), and comprise from less than 1 percent to 100 percent of the 148 watersheds (HUC6s) within which they wholly or partly occur (Table 5). A majority (54% by area) are on private land not currently managed for conservation. Most encompass some oak woodland and riparian habitat. Few include any old growth conifer forest; this is largely because of the low elevation of

[16] TNC drafted area or population goals both for habitat types and for species. Examples include "all remaining upland prairie," "20% of historical habitat extent," "occurrence score of 7000," "20 times the number of current locations." A default goal of 30% of historical area of a habitat type was used when no better information was available for goal-setting.

the assessed region. Within individual PCAs, an average of 50% of the land is currently devoted to agriculture, residential and commercial development, roads, and other intensive uses. Activities mentioned most widely as current or future threats to the integrity of individual PCAs include invasive species, fire suppression, pathogens (Sudden Oak Death), residential construction, and conversion to agriculture or intensive logging (Table 7).

The other major effort to prioritize areas for protection was the ERC assessment. It covered the entire subbasin and identified 1,650,223 acres (23% of the subbasin) as "Tier-1" CROAs. Those areas are mostly upland forest, upland forest riparian zones, Willamette River restorable channels, and wetlands (Table 3). They currently have varying levels of protection. The PNW-ERC assessment identified an additional 2,548,788 acres (36% of the subbasin) as Tier-2 CROA. Those areas are mostly other riparian zones, other forests, and other wetlands. Most are on private land not currently managed for conservation. Together, the Tier-1 and Tier-2 CROAs comprise 13% of the subbasin.

Also noted earlier (in section 1.3) is the existence of a significantly overlapping map of "Conservation and Restoration Opportunities" prepared by the PNW-ERC. The main differences in these sources are:

> (a) Due to differences in the geographic objectives of the respective projects, the TNC map includes mainly the valley floor and foothills, whereas the PNW-ERC map includes the entire subbasin;
>
> (b) Drafting of the PNW-ERC map was done in consultation with stakeholders and partly represents the type and extent of conservation actions that the stakeholders believed are most likely to be economically and politically supported, whereas the TNC map is intended to represent the type, location, and amount of habitat necessary to achieve specific regional goals for biodiversity, with less regard for sociopolitical feasibility;
>
> (c) Among (but not within) the PCAs, vulnerability to alteration (as well as conservation value) has been assessed by TNC; no comparable assessment of relative vulnerability of the ERC Tier 1 lands is directly available, but could be determined through use of other ERC maps.

Comparing these two sources, it is apparent that approximately 60% of the area within the PCAs coincides with the PNW-ERC areas, and approximately 13% of the ERC areas (Tier 1 and Tier 2 Conservation and Restoration Opportunities) was identified by TNC as a Priority Conservation Area (Table 3). For the entire Willamette subbasin, 4.6% is recognized as most important by <u>both</u> the ERC analysis <u>and</u> the TNC assessment. This 4.6% is comprised 3.0% of Tier 1 areas and 1.6% of Tier 2 lands[17].

[17] Tier 1 habitats are assumed to be managed for the purpose of achieving a naturally functioning landscape. Tier 2 habitats are habitats of comparatively lower habitat suitability (e.g., orchard, vineyard) set within a mosaic of more important habitats and assumed to be managed for sustainable production of goods and services compatible with more-limited habitat on-site conservation.

In attempting to apply these sources to the task of prioritizing areas for conservation or restoration within the entire Willamette subbasin, some limitations become apparent:

1. Although TNC intends to identify potential conservation areas in the West Cascades by late 2004 and prioritize them using a similar intensive approach, those identified areas will not be added to those from the previous lowlands *Ecoregional Assessment* and a comprehensive re-prioritization conducted, which would allow direct comparison with the ERC's Conservation and Restoration Opportunity areas.

2. TNC's assessment extended northward into parts of Washington and southern British Columbia. Had the candidate units processed by the SITES model been limited strictly to the Oregon portion, a different set of selected units and priorities might have emerged.

3. Because of its limited objectives, geographic coverage, and/or data availability, the *Ecoregional Assessment* did not analyze all wildlife species, nor include fish.

4. Because of timing and data availability, the *Ecoregional Assessment* did not use some recent digital coverages that might have yielded improved estimates of cost and vulnerability (factors the SITES model uses to prioritize areas). For example, a digital coverage compiled by Payne (2002) maps "suitability for development" throughout most of the subbasin.

5. Conservation goals used by the SITES model represent just one set of possibilities. Although the choice of goals was partly driven by interpretation of conservation theory, other goals and sets of species -- as defined by other stakeholders -- could result in selection of a different number and area of PCAs, as well as different rankings of PCAs (Lamy et al. 2002, Hulse et al. 2004). This was partly explored (sensitivity analysis) by Floberg et al. (2004).

Because time and limited resources did not allow us to remedy these limitations, and because the *Ecoregional Assessment* despite these issues probably represents some of the best available information for prioritizing land parcels for protection or restoration, we have referred often to its findings extensively in this report. However, we also conducted an analysis to gauge the severity of limitation #3 above. We assumed that habitat would be best-protected on existing public lands plus lands identified as Priority Conservation Areas (PCAs) by TNC. Then we asked the specific question:

> ***If only the PCAs and public lands are managed for biodiversity in each watershed, which species native to each watershed might be "left out," and therefore be most needy of management within other private lands?***

Going a step further, we also determined within which *elevation zone* in each watershed there might be available habitat for these "needy" species.

[18] TNC drafted area or population goals both for habitat types and for species. Examples include "all remaining upland prairie," "20% of historical habitat extent," "occurrence score of 7000," "20 times the number of current locations." A default goal of 30% of historical area of a habitat type was used when no better information was available for goal-setting.

To answer the basic question, the ERC species models were applied to the land cover layer using GIS, and ORNHIC species occurrence data were also included, to generate lists of wildlife species both within and outside of the PCAs and public lands in each watershed. These lists were compared, and species that were predicted to occur only outside of the PCAs were highlighted by watershed. Results are summarized in Tables 25, 26, and 27. Geographically-specific information is in the accompanying Detail File: UNSWEPT. A similar analysis using instead the ERC's *Conservation and Restoration Opportunity Areas* maps (Hulse et al. 2004) would have provided a useful "second opinion" but could not be conducted with available resources and time.

Table 25. Relative amount of possibly suitable habitat in the PCAs plus public lands, by species.

Note: Species are sorted in ascending order by values in column 3. That is, species that are most poorly protected solely by public lands plus PCAs are listed first. Extirpated species are excluded. Column 3 is the area of habitat in the subbasin which, based on models applied to aerial imagery, scored a "6" or higher on a 0-10 scale AND is on public lands or within PCAs – expressed as a percent of the area of all such habitat for the species on public lands and PCAs. Column 4 is similar, but is based on the acreage of "good" habitat (score of 10). Status codes are: BBS= declining in region according to Breeding Bird Survey; C= Candidate species for federal threatened/endangered listing; CFL= critically functionally linked species according to NHI; E= federal Endangered species; FS= functional specialist species according to NHI; PIF= focal species of Oregon-Washington Partners In Flight program SC= ODFW "Critical" sensitive species; SE= ODFW or ODA "Endangered" sensitive species; ST= ODFW "or ODA Threatened" sensitive species; SV= ODFW " Vulnerable" sensitive species; T= federal Threatened species

Species	Status	% of OK habitat in PCA+ public	% of good habitat in PCA+ public
Pallid Bat	SV	18	0
Eastern Fox Squirrel		18	18
Western Kingbird		19	29
Say's Phoebe		20	29
Nelson's Checker-Mallow	T	22	37
Camas Pocket Gopher		22	40
Eastern Cottontail		22	22
Savannah Sparrow	BBS	22	38
Feral House Cat		22	22
Gray-Tailed Vole		22	39
Anna's Hummingbird		23	24
House Sparrow		23	23
Norway Rat		23	23
House Mouse		23	23
Red-Winged Blackbird		23	38
Ring-Necked Pheasant		24	32
Golden Paintbrush	T	24	28
Barn Owl		24	24
Black-Tailed Jackrabbit		24	0
Townsend's Mole		25	36
Barn Swallow	BBS	25	24
Brewer's Blackbird		26	22
House Finch		26	21
Rock Dove		26	26
Red Fox		28	31
Horned Lark	C	28	26
Violet-Green Swallow		30	27
Striped Skunk		30	31
Pacific Shrew	FS	30	23
Lesser Goldfinch		30	31
European Starling		30	23
Bewick's Wren		31	32
Sharptail Snake	SV	31	30
Western Scrub-Jay		31	26
Gopher Snake		32	31
Bradshaw's Lomatium	E	32	44
California Quail		32	31
Racer		32	31
Yellow-Breasted Chat	SC	32	33
American Crow		32	27
Vesper Sparrow	SC	32	39
Common Yellowthroat	BBS	32	50
American Goldfinch	BBS	33	30
Willamette Valley Daisy		33	47
California Ground Squirrel		33	36
Brown-Headed Cowbird		33	38
White-Crowned Sparrow	BBS	33	68
Virginia Opossum		33	34
Mourning Dove		33	31
Black Rat		34	34
Western Skink		34	31
Ringneck Snake	FS	34	31
Hoary Bat		34	0
Brush Rabbit		35	32
Townsend's Vole		35	40
Western Fence Lizard		35	31
Pacific Treefrog		35	39
Southern Alligator Lizard		35	32

Species	Status	% of OK habitat in PCA+ public	% of good habitat in PCA+ public
Nutria		35	41
Fender's Blue Butterfly	E	35	43
Western Rattlesnake	SV	36	36
California Vole		36	26
Western Meadowlark	SC	36	39
Coast Mole		36	39
Kincaid's Lupine	T	36	43
Dusky-Footed Woodrat		36	39
Water Howellia		37	37
Eastern Gray Squirrel		37	37
Killdeer	BBS	37	27
Cliff Swallow		37	24
American Kestrel	PIF	37	69
Red-Legged Frog	SV	37	40
Western Gray Squirrel		38	40
Grasshopper Sparrow		38	43
Western Pond Turtle	SC	39	42
Lazuli Bunting		39	31
Long-Toed Salamander	CFL	39	40
Bushtit	PIF	39	42
Northern Harrier	PIF	40	38
Coyote		40	33
Common Snipe		40	38
Painted Turtle	SC	40	43
Yellow-Headed Blackbird		40	51
Western Terrestrial Garter Snake		40	38
Southern Torrent Salamander	SV	40	42
Wilson's Phalarope		41	41
Black-necked Stilt		41	41
Gray Fox		41	34
Wrentit	PIF	41	40
Acorn Woodpecker	PIF	41	31
Chipping Sparrow	PIF	41	67
Bullock's Oriole	PIF	41	41
Wild Turkey		42	47
American Bittern		42	51
Northwestern Salamander		42	61
Northern Pintail		42	49
Virginia Rail	BBS	42	42
Northern Shoveler		42	51
White-Tailed Kite		43	40
Green Heron	BBS	43	0
Fringed Myotis	SV	44	33

Species	Status	% of OK habitat in PCA+ public	% of good habitat in PCA+ public
Northwestern Garter Snake		44	40
Song Sparrow	BBS	44	32
Marsh Wren		44	37
Canada Goose	CFL	44	53
Mallard		44	59
Spotted Sandpiper	BBS	45	70
White-Breasted Nuthatch	PIF	45	47
Blue-Winged Teal	CFL	45	60
Cinnamon Teal	BBS	45	60
Sora	BBS	46	47
Green-Winged Teal		46	58
House Wren	PIF	46	44
Yellow Warbler	PIF	46	40
Red-Shouldered Hawk	PIF	47	42
Spotted Towhee		47	35
Short-Eared Owl		47	48
Muskrat		48	53
Cedar Waxwing		48	57
Bullfrog		48	48
Roughskin Newt		49	59
Black-Capped Chickadee		49	63
Willow Flycatcher	SV	49	39
Common Garter Snake		51	43
Mink		52	53
Wood Duck		52	0
Western Screech-Owl	PIF	52	54
Orange-Crowned Warbler	PIF	52	46
American Beaver		52	52
Purple Finch	BBS	53	50
Foothill Yellow-Legged Frog	SV	54	79
Common Nighthawk	SC	55	26
Black-Throated Gray Warbler	PIF	55	67
Western Spotted Skunk		56	62
Western Red-Backed Salamander		56	59
Deer Mouse		57	48
Downy Woodpecker	PIF	57	72
Northern River Otter		57	57
Warbling Vireo		58	53
Western Pocket Gopher		58	68
Tree Swallow	PIF	58	69

Species	Status	% of OK habitat in PCA+ public	% of good habitat in PCA+ public
Rubber Boa		58	53
Common Merganser		58	70
Macgillivray's Warbler	BBS	58	58
Vagrant Shrew		59	33
Western Wood-Pewee	PIF	59	73
Western Bluebird	SV	59	0
Pied-Billed Grebe		59	60
American Coot		59	59
Ruddy Duck	BBS	59	59
Great Horned Owl		60	69
Red-Tailed Hawk		60	69
Long-Tailed Vole		60	58
Ermine		61	39
American Robin		61	45
Long-Tailed Weasel		61	39
Pacific Water Shrew		61	41
Hutton's Vireo	PIF	62	64
Black-Headed Grosbeak		62	57
Cooper's Hawk	PIF	63	73
Raccoon		63	67
Ruffed Grouse	BBS	63	65
Townsend's Solitaire		63	68
Ensatina		64	66
Black-Tailed Deer		64	53
Shrew-Mole		64	64
Cassin's Vireo		65	77
Long-Eared Owl		65	89
Baird's Shrew	FS	65	71
Black Phoebe		66	72
Dunn's Salamander	FS	66	66
Marbled Murrelet	T	66	69
Creeping Vole		66	59
Pacific Giant Salamander		66	66
Elk		66	61
Steller's Jay		66	91
Townsend's Chipmunk		66	77
Common Porcupine	CFL	66	54
Bushy-Tailed Woodrat		66	92
Western Toad	SV	66	68
Mountain Lion		66	66
Northern Flying Squirrel		67	89
Rufous Hummingbird	PIF	67	67
Pacific Jumping Mouse		67	39
Trowbridge's Shrew		67	73
Black Bear		67	76
Northern Flicker		67	69
White-Footed Vole		67	78
Northern Rough-Winged Swallow		67	74
Red-Eyed Vireo	PIF	68	70
Bobcat		68	65
Vaux's Swift	PIF	68	68
Dark-Eyed Junco		68	58
Big Brown Bat		68	75
Little Brown Myotis		68	75
Yuma Myotis		68	75
Western Tanager		68	64
Douglas' Squirrel		68	92
Swainson's Thrush	PIF	68	64
Belted Kingfisher	CFL	69	69
Sharp-Shinned Hawk		69	92
Long-Eared Myotis		69	75
Winter Wren	PIF	69	89
Red-Breasted Nuthatch		69	92
Band-Tailed Pigeon	PIF	69	69
Pileated Woodpecker	SV	69	92
Northern Alligator Lizard		70	60
Cascade Torrent Salamander	SV	70	76
Brown Creeper	PIF	70	92
Red-Breasted Sapsucker		70	64
Clouded Salamander		70	91
Mountain Beaver		71	83
Long-Legged Myotis		71	75
Turkey Vulture	FS	71	59
Silver-Haired Bat		71	41
Chestnut-Backed Chickadee	BBS	71	92
California Myotis		71	77
Golden-Crowned Kinglet	BBS	71	92
Pacific-Slope Flycatcher	PIF	71	73
Hairy Woodpecker		71	92
Red Crossbill	PIF	71	92
Hermit Warbler	PIF	71	92
Northern Saw-Whet Owl		72	72
Great Blue Heron		73	92
Pine Siskin		73	92
Hooded Merganser		73	91

Species	Status	% of OK habitat in PCA+ public	% of good habitat in PCA+ public
Northern Pygmy-Owl	SC	73	92
Bald Eagle	T	73	89
Nashville Warbler	PIF	73	73
Blue Grouse	BBS	74	51
American Dipper		74	74
Red Tree Vole		75	89
Fog Shrew	FS	75	86
Western Red-Backed Vole		75	80
Water Shrew		77	31
Wilson's Warbler	PIF	77	76
Common Raven		77	91
Mountain Quail		78	68
Olive-Sided Flycatcher	SV	80	75
Dusky Flycatcher		80	80
Fox Sparrow		80	80
Hermit Thrush		81	69
Evening Grosbeak	BBS	81	69
Barred Owl		82	92
Oregon Slender Salamander		82	82
Harlequin Duck		82	82
Osprey		82	89
Western Grebe		83	84
Snowshoe Hare		84	86
Spotted Owl	T	84	93
Black Tern		85	90
Coastal Tailed Frog		85	91
Hammond's Flycatcher	PIF	85	80
Fisher	SC	85	96
Water Vole		88	87
Gray Jay		88	97
Golden Eagle	BBS	89	0
Ring-Necked Duck		89	89
Lincoln's Sparrow	PIF	91	91
Varied Thrush	PIF	93	97
Townsend's Warbler		93	97
Yellow-Rumped Warbler		93	68
Great Gray Owl	SV	94	83
Cascades Frog	SV	96	98
Northern Goshawk	SC	96	98
Lynx	T	97	93
American Marten	SV	97	88
Wolverine	ST	97	97
Mountain Chickadee		98	98
Black-Backed	SC	98	98
Woodpecker			
Golden-Mantled Ground Squirrel		99	96
Heather Vole		99	99
Clark's Nutcracker		100	98
Black Swift	PIF	100	100
Barrow's Goldeneye		100	100
Bufflehead		100	100
Oregon Spotted Frog	C	100	0
Peregrine Falcon	SE	100	100
Pika		100	100
Rock Wren	FS	100	100

Table 26. Watersheds ranked according to number of species whose habitat was not substantially included in the PCAs and public land within the watershed

Only the watersheds containing PCAs were analyzed. Suitable habitat was considered to be any acreage of habitat having a score of 6 or greater on a 0-10 scale. Identities of the species comprising these omissions can be found in the accompanying Detail File: UNSWEPT.

HUC6	Watershed name (not inclusive)	Number of Species Missed
170900070202	Aumsville & Beaver Cr.	70
170900090703	Silverton N.	60
170900030603	Luckiamute R.1.	27
170900070201	Sublimity & Turner	22
170900030403	Sodaville	19
170900070302	Dundee; Newberg	19
170900070401	W.Wilsonville	18
170900120203	Gresham; Portland; N. Milwaukie	15
170900080201	Willamina	13
170900100102	Hillsboro	13
170900090301	Butte Cr.	12
170900100202	Diary Cr. E.	12
170900080702	Lafayette	11
170900030204	E. Eugene; Harrisburg; Springfield	10
170900090305	Milk Cr.	10
170900090501	Molalla	10
170900030202	Monroe; Muddy Cr. E.	7
170900080601	Yamhill	7
170900080604	Turner Cr.	7
170900090102	Woodburn; Hubbard	7
170900070403	Oregon City; West Linn	6
170900090201	S. Canby	6
170900100203	North Plains; McKay Cr.	6
170900060101	Crabtree Cr. & Onehorse Slough	5
170900080502	Amity	5
170900090702	Drift Cr.	5
170900100101	Tigard; Tualatin; Sherwood; King City	5
170900100302	Sain & Scoggins Cr.	5
170900080602	McMinnville N.	4
170900020102	Creswell W.; Camas Swale	3
170900030504	Finley NWR; Muddy & Hammer Cr.	3
170900050601	Jefferson; Lyons; Bear Branch	3
170900060301	Lower Thomas Cr. -lower; Scio	3
170900030103	Coyote Cr.	2
170900030203	Coburg; Halsey; Little Muddy R.; Pierce Cr	2
170900070303	Chehalem Cr.	2
170900090302	Cedar Cr.	2
170900100103	Beaverton & Rock & Cedar Mill Cr.	2
170900100201	Dairy Cr. W. Fk. & Council Cr.; Banks	2
170900010501	Dexter Reservoir	1
170900030201	Corvallis N.; Adair Village	1
170900030401	N. Albany; W. Lebanon; Cox Cr.	1

HUC6	Watershed name (not inclusive)	Number of Species Missed
170900030402	S. Albany; Tangent.	1
170900070102	Independence; Monmouth	1
170900070301	Saint Paul	1
170900070307	Salem	1
170900080701	Palmer Cr.	1

Table 27. Comparison of mean suitability of habitat for focal species in public lands, PCAs, and private non-PCAs.

Note: Habitat suitability scores were calculated within HUC6 watersheds using aerial imagery and models as described in section 1.4. Scores could potentially range from 0 (unsuitable habitat) to 10 (best habitat) and do not account for the area of habitat. Means are the average suitabilities for the species among all HUC6-elevation zone combinations that contained both the species and a PCA. For statistical reasons the scores should not be compared among species – just among columns.

Focal species	All lands	Public lands	PCA lands	Private Non-PCA
Acorn Woodpecker	0.96	0.82	**1.10**	0.97
American Beaver	0.48	**0.59**	0.57	0.28
American Dipper	0.21	**0.28**	0.22	0.11
American Kestrel	0.62	0.49	**0.69**	0.66
American Marten	6.50	6.67	**6.74**	6.03
Bald Eagle	0.31	**0.46**	**0.45**	0.07
Black-Tailed Jackrabbit	1.86	1.28	1.91	**2.40**
Bradshaw's Lomatium	0.76	**1.02**	0.64	0.61
Cascades Frog	0.00	**0.01**	0.00	0.00
Chipping Sparrow	1.06	0.79	1.16	**1.19**
Coastal Tailed Frog	1.17	1.17	**1.29**	0.97
Common Yellowthroat	1.50	1.10	1.65	**1.77**
Fender's Blue Butterfly	1.26	0.95	**1.40**	**1.39**
Golden Paintbrush	0.32	0.32	0.28	**0.34**
Great Gray Owl	1.61	**1.97**	1.28	1.43
Green Heron	0.80	**1.04**	0.93	0.39
Harlequin Duck	0.26	**0.37**	0.35	0.04
Horned Lark	0.99	0.91	0.93	**1.12**
Kincaid's Lupine	1.02	0.76	**1.13**	**1.14**
Marbled Murrelet	0.63	**0.89**	0.72	0.28
Nelson's Checker-Mallow	1.26	1.12	1.26	**1.41**
Northern Harrier	0.60	0.60	**0.68**	0.57
Northern River Otter	1.00	**1.18**	1.12	0.71
Olive-Sided Flycatcher	3.01	**3.82**	2.91	2.25
Oregon Slender Salamander	3.95	**4.88**	3.77	3.10
Pileated Woodpecker	4.96	**6.03**	4.97	3.83
Purple Martin	0.39	**0.47**	0.37	0.32
Red Tree Vole	3.05	**3.85**	3.03	2.34
Red-Eyed Vireo	0.57	**0.92**	0.84	0.06
Red-Legged Frog	0.44	0.52	**0.59**	0.27
Rufous Hummingbird	3.85	**4.16**	3.87	3.47
Sharptail Snake	2.93	2.47	3.10	**3.26**
Sora	0.22	**0.30**	**0.30**	0.10
Southern Alligator Lizard	3.02	2.66	**3.29**	3.11
Spotted Owl	3.57	**4.35**	3.57	2.88
Townsend's Big-Eared Bat	0.34	0.31	0.19	**0.46**
Vaux's Swift	1.67	**1.88**	1.54	1.58
Vesper Sparrow	0.45	0.31	0.50	**0.53**
Water Howellia	0.15	**0.19**	0.14	0.10
Western Bluebird	1.00	0.84	0.98	**1.17**
Western Gray Squirrel	5.40	**5.83**	5.53	4.73
Western Meadowlark	0.70	0.53	0.72	**0.88**

Focal species	All lands	Public lands	PCA lands	Private Non-PCA
Western Pond Turtle	0.68	0.54	0.67	**0.80**
Western Rattlesnake	0.54	0.35	**0.62**	0.60
Western Wood-Pewee	2.54	2.53	**2.68**	2.40
White-Breasted Nuthatch	1.19	1.09	**1.36**	1.09
Willamette Valley Daisy	0.74	0.74	**0.77**	0.75
Willow Flycatcher	0.98	0.86	1.00	**1.04**
Wood Duck	0.77	**0.98**	0.92	0.40
Yellow Warbler	0.26	0.24	**0.33**	0.24

These results suggest that the combination of PCAs plus public lands would include possibly-suitable habitat for all wildlife species in the majority (53%) of the Willamette watersheds in which PCAs were identified. As expected, the number of "misses" per watershed is greater in watersheds with less area and a small proportion of their area identified as PCA or public land. Watershed data could be partitioned further according to elevation zones within each watershed to generate more localized rates of species inclusion or exclusion.

If a need is identified in lowland portions of the Willamette subbasin to extend conservation activities beyond the areas defined as PCAs by TNC, then those additional conservation activities should focus on (for example, and according to Detail File: UNSWEPT) the Aumsville-Beaver Creek watershed (HUC 170900070202), the Silverton North watershed (HUC 170900090703), and the lower part of the Luckiamute watershed (170900030603), other factors being equal. Conservation activities in those watersheds should not just be opportunistic, but rather focus on habitats of the particular species that are "missing" (i.e., have habitat deficiencies on public and PCA land) as shown for those watersheds in Detail File: UNSWEPT.

3.2 Efficiency of Focal Species

Earlier in this report (section 2.1) it was noted that the selection of particular species as "focal' was not based exclusively on their ability to serve either as "indicator" species (i.e., species most closely associated with the habitat type under which they are grouped) or "umbrella" species (i.e., species whose habitat requirements are broad enough to include those of many other species). Nonetheless, a need was identified to at least measure how well protection of habitat just for the selected species might address the requirements of other species. This is important because:

- Restoration and preservation proposals are easier to support when it can be demonstrated that benefits will accrue to more than just a few target species whose habitat preferences overlap closely, i.e., inclusion of one species will "sweep" others.
- By identifying which species have the least overlap in their habitat preferences, one can identify which species need attention over-and-beyond that given to a particular target species. This allows for greatest efficiency in restoring or preserving complementary areas.

Determining the potential for overlap among any two species requires consideration of three primary factors:

(a) the habitat types each associates with the most,

(b) the habitat structural conditions each associates with the most, and
(c) overlap in the geographic/ elevation ranges of the species.

Information on these three factors is contained in databases compiled for this project. The databases provide for systematic, relatively thorough comparisons of species. In doing so, they are not intended to be used alone, but rather complement and serve as a check on "common sense" judgments that are frequently made. To use the databases in this manner, follow this procedure:

Step 1.
1.1. Open the file HABTYPE. Write down the codes of the two species of interest.

1.2. Open file SPHABCOR. This contains correlations among the 85,547 unique pairings of all 293 species included in this subbasin analysis. Species have been sorted alphabetically in columns 1 and 2. Using the species codes, find species A in column 1, and species B in column 2. Columns 3 and 4 indicate any special designations species A and species B may have, respectively. Columns 5 and 6 indicate which species are being used as focal species, and for which habitat types. See the DataDictionary file for definitions.

1.3. Note the number (Spearman paired correlation coefficient) in column 7. It can range from –1 to +1. The larger and more positive the number, the more likely are the species to share the same types of habitat. The degree of uncertainty in that conclusion is indicated by column 7 (the p-value), with smaller numbers indicating less uncertainty/ greater certainty.

1.4. Note the numbers in columns 9 and 10, if not blank, and interpret them as described above. These columns refer to habitat structure rather than habitat type. So, if a species pair has a relatively high number in both columns 7 and 9, one can infer that those species are especially likely to share the same habitat. Negative numbers in both indicate the species are unlikely to co-occur.

1.5. If you want to rank all other species according to the likely overlap of their habitat type preferences with those of species A, sort the database first by column 1 (ascending) and secondarily by column 7 (descending). Do likewise with columns 1 and 9 if you want to rank species based on habitat structural preferences.

1.6. If you want to see what it is that differs between the species with regard to their preferred habitat types and structure, see files HABTYPE and HABSTRUC, respectively. See the DataDictionary file for definitions.

Step 2.
2.1. Examine the map of sixth-field watersheds (HUC6.PDF), zooming on the image until you can read the numeric identifier label (HUC code) of each watershed. Write down the code for the watershed(s) of interest.

2.2 Open file SPHABHUC6. Watersheds have been sorted numerically by their codes in column 1, and by elevation category (if the watershed contains more than one) in column 2.

Find the watershed-elevation combination that best describes your area of interest. Look in column 3 for a list of species that potentially may occur there. If species A and B are both on the list, and correlations described in Step 1 above were relatively large and positive, then the species are very likely to overlap (or not overlap, if the numbers were large and negative).
Note: Step 2 can be performed before Step 1 if you wish.

3.2.1 Application Example 1

You're wondering if management focused on restoring habitat of the Fringed Myotis (FRMY, a state-listed "vulnerable" bat species) might also directly benefit – or at least be compatible with general needs of Blue Grouse (BLGR, a species that Breeding Bird Survey data suggests may be declining in the Cascades) and Hutton's Vireo (HUVI, a species designated as of concern by the Partners-in-Flight program). Searching file SPHABCOR, you find the correlation with habitat *type* to be positive both for Blue Grouse (0.35, with statistical uncertainty of 4%) and for Hutton's Vireo (0.42, with 2% statistical uncertainty). Considering next the habitat *structure*, you find in columns 7 and 8 of SPHABCOR that Fringed Myotis has a positive correlation with Blue Grouse of 0.38 (with uncertainty of 1%) and a positive correlation (0.05) with Hutton's Vireo, although the statistical uncertainty of 25% is rather high. Considering the foregoing results for both habitat type and habitat structure, and the uncertainties associated with the correlations, you would conclude that protecting or restoring habitat for Fringed Myotis is more likely than not to benefit or be compatible with requirements of both Blue Grouse and Hutton's Vireo. Before finalizing this conclusion, you will want to review file SPHABHUC6 to be sure the species' ranges overlap within your specific area of interest in the Willamette subbasin.

3.2.2 Application Example 2

Suppose you need to know how many other species might benefit from (or be generally compatible with) elk habitat, and perhaps compare the total to that from a management plan focused instead on another species. By querying the file SPHABCOR using the term "ELK" and the species designations in column 4, you determine results shown in Table 28 below. Because this only defines overlaps in habitat type, the same query should be run as well to determine overlaps in habitat structure.

Table 28. Similarity of elk habitat-type associations with habitat-type associations of other species in the Willamette sub-basin.

Species with multiple designations were counted only once, in the category of greatest conservation priority. Not all of the associations were statistically significant.

	Negative Associations	Positive Associations
Threatened spp. (Federal)	2	6
Endangered (Federal)	1	2
Candidate (Federal)	2	1
Extirpated spp.	2	6
Critical spp. (State)	3	8
Endangered (State)	1	2
Threatened spp. (State)	1	1
Vulnerable spp. (State)	3	12

	Negative Associations	Positive Associations
Critical Functionally Linked (NHI) spp.	3	2
BBS declining spp.	7	16
Functional Specialist (NHI) spp.	1	6
Partners-in-Flight spp.	6	28
Other Species	40	130

Note that a negative association does not necessarily mean that a species would be ***harmed*** *by preserving or restoring elk habitat – just that it would not benefit.* This query also will tell you *which* species are the ones that benefit from or are generally compatible with elk habitat. This same type of approach can be used to determine which additional species would be most and least likely to benefit from actions focused on a particular "indicator" species.

3.2.3 Application Example 3

Suppose it is possible to preserve all the habitat types and structures with which Federally-listed Threatened, Endangered, or Candidate wildlife (and plant and butterfly) species are associated. Which *additional* species might be most likely to benefit? The following table shows the results.

Table 29. Wildlife species *most* likely to benefit from habitat management of only the Federally-listed threatened/endangered terrestrial species in the Willamette sub-basin.

All species shown had statistically significant ($p<0.05$) positive correlations with one or more Federally-listed species with regard to both habitat type and habitat structure (or structural data were lacking). Just the species with special status are shown. Special Status: SV= state-listed Vulnerable, SC= state-listed Critical, PIF= Partners-in-Flight species of concern, FS = functional specialist (NHI), BBS= species with statistically significant decline according to Breeding Bird Survey data. Species were counted only once, in the category of greatest conservation priority.

Species	Special Status	Maximum correlation with T&E habitat types (larger = stronger)	Maximum correlation with T&E habitat structure
Cascade Torrent Salamander	SV	.73	.76
Fringed Myotis	SV	.73	.90
Great Gray Owl	SV	.48	.42
Southern Torrent Salamander	SV	.73	.76
Northern Goshawk	SC	.62	.41
Northern Pygmy-Owl	SC	.89	.76
Townsend's Big-Eared Bat	SC	.76	.53
Acorn Woodpecker	PIF	.47	.47
Black-Throated Gray Warbler	PIF	.63	.59
Brown Creeper	PIF	.61	.55
Hammond's Flycatcher	PIF	.94	.48
Pacific-Slope Flycatcher	PIF	.83	.66
Red Crossbill	PIF	.87	.61
Rufous Hummingbird	PIF	.61	.80
Swainson's Thrush	PIF	.78	.78
Tree Swallow	PIF	.70	.55
Varied Thrush	PIF	.95	.74
Western Screech-Owl	PIF	.53	.48

Species	Special Status	Maximum correlation with T&E habitat types (larger = stronger)	Maximum correlation with T&E habitat structure
Wilson's Warbler	PIF	.79	.80
Winter Wren	PIF	.89	.80
Fog Shrew	FS	.68	.62
Pacific Shrew	FS	.68	.62
Chestnut-Backed Chickadee	BBS	.87	.50
Evening Grosbeak	BBS	.83	.50
Golden-Crowned Kinglet	BBS	.92	.48
MacGillivray's Warbler	BBS	.67	.80
Ruffed Grouse	BBS	.66	.51

The above provides only a coarse-scale assessment. To determine more definitively the probabilities of overlap, more detailed information about habitat requirements of the individual species should be reviewed and as before, the potential for overlap in geographic and elevational ranges of the species must be considered (e.g., by reference to file SPHABHUC6).

Perhaps of even greater interest is learning which species are likely to be left out of efforts to protect habitat only of federally-listed T & E species, because their habitat needs are so different from (overlap the least with) those of the federally-listed species. Applying the same query structure as before yields the list in Table 30 below.

Table 30. Wildlife species *least* likely to benefit from habitat management of only the Federally-listed threatened/endangered terrestrial species in the Willamette sub-basin.

All species shown had statistically significant ($p<0.05$) negative correlations with one or more Federally-listed species with regard to both habitat type and habitat structure (or structural data were lacking). Larger numbers indicate stronger negative or positive association with T & E species. For codes for Special Status: see legend of Table 29.

Species	Special Status	Maximum negative correlation with T&E habitat types	Maximum negative correlation with T&E habitat structure
Barn Swallow	BBS	-.56	-.89
Killdeer	BBS	-.48	-.49
Ruffed Grouse	BBS	-.43	
Blue Grouse	BBS	-.39	
Chestnut-backed Chickadee	BBS	-.39	
Evening Grosbeak	BBS	-.39	
Golden-crowned Kinglet	BBS	-.36	
Horned Lark	C	-.38	-.49
Canada Goose	CFL	-.42	-.49
Common Porcupine	CFL	-.36	
Dunn's Salamander	FS	-.36	
American Kestrel	PIF	-.51	
Western Screech-Owl	PIF	-.42	
Winter Wren	PIF	-.39	
Northern Harrier	PIF	-.36	-.91
Western Pond Turtle	SC	-.46	-.59
Painted Turtle	SC	-.43	
Common Nighthawk	SC	-.36	-.34

Species	Special Status	Maximum negative correlation with T&E habitat types	Maximum negative correlation with T&E habitat structure
Northern Pygmy-Owl	SC	-.36	
Sharptail Snake	SV	-.45	
American Marten	SV	-.43	
Pileated Woodpecker	SV	-.36	

Special efforts are needed to manage habitats of the above species (at least those with special status and with the strongest negative correlations) because management of federally-listed species alone may do little to benefit these.

3.2.4 Application Example 4

Suppose protection, restoration, and management in a particular area can be applied to only a single focal habitat type or a single structural class – in this example let's assume it is "Oak Woodland" Begin by generating a species list for this habitat. Find the habitat type in the column headings of file HABTYPE (for explanation of those abbreviations, see the Data Dictionary, section 6 below). In this case, there isn't an exact match so the most similar type should be used – in this case, Oak Savanna (OakSav). If a structural class (rather than habitat type) is of primary interest, go instead to file HABSTRUC and look for it in the column headings. Querying the database to select just the species with scores greater than 8 for Oak Savanna yields the list shown in Table 31.

Table 31. Species most likely to be associated with oak-savanna habitat type

Species	Special Designa-tions*
Acorn Woodpecker	PIF
American Goldfinch	BBS
American Kestrel	PIF
American Robin	0
Barn Owl	0
Black-Capped Chickadee	0
Black-Tailed Deer	0
Black-billed Magpie	X
Bradshaw's Lomatium	E
Bullock's Oriole	PIF
California Ground Squirrel	0
California Quail	0
Camas Pocket Gopher	0
Cedar Waxwing	0
Chipping Sparrow	PIF
Common Garter Snake	0
Coyote	0
Deer Mouse	0
Ermine	0
Fender's Blue Butterfly	E
Feral House Cat	0

Species	Special Designa-tions*
Golden Paintbrush	T
Gopher Snake	0
Kincaid's Lupine	T
Lazuli Bunting	0
Lesser Goldfinch	0
Lewis's Woodpecker	X
Long-Tailed Weasel	0
Nelson's Checker-Mallow	T
Northwestern Garter Snake	0
Racer	0
Red Fox	0
Ringneck Snake	FS
Rubber Boa	0
Sharptail Snake	SV
Southern Alligator Lizard	0
Striped Skunk	0
Turkey Vulture	FS
Vesper Sparrow	SC
Virginia Opossum	0
Western Bluebird	SV
Western Fence Lizard	0

Species	Special Designa-tions*
Western Kingbird	0
Western Meadowlark	SC
Western Rattlesnake	SV
Western Skink	0
Western Wood-Pewee	PIF
White-Breasted Nuthatch	PIF
White-Tailed Kite	0
Willamette Callipe Butterfly	X
Willamette Daisy	E

* see section 6 for abbreviations. Only one designation is listed per species.

Next, suppose we want to see which other species would be most- and least-likely to benefit from a policy that protects only oak woodland. (A similar analysis could be done to predict species gains and losses associated with a particular change in forest structure as a result of new forest management objectives) Querying the file SPHABCOR produces the results Table 32.

Table 32. Species, excluding the oak woodland focal species, most and least likely to benefit from management of the oak woodland habitat type.

Those with the largest positive numbers in column 3 are the most likely to benefit, assuming habitat structural conditions are also sufficient. Those with the most negative numbers in column 3 are the least likely to benefit, so their habitat requirements would need to be addressed by other strategies. Only species with special status are listed.

Species	Special Desig-nations*	Correlation with Oak Savanna Species
Black-Throated Gray Warbler	PIF	1
Lark Sparrow	X	1
Bushtit	PIF	.96
Downy Woodpecker	PIF	.93
Evening Grosbeak	BBS	.89
Pacific-Slope Flycatcher	PIF	.89
House Wren	PIF	.88
Northern Goshawk	SC	.88
Willow Flycatcher	SV	.87
Orange-Crowned Warbler	PIF	.86
Band-Tailed Pigeon	PIF	.85
Pileated Woodpecker	SV	.85
Brown Creeper	PIF	.84
Winter Wren	PIF	.84
Long-Toed Salamander	CFL	.83
Baird's Shrew	FS	.82
Wrentit	PIF	.82
Swainson's Thrush	PIF	.81
Fog Shrew	FS	.8
Rufous Hummingbird	PIF	.8
Song Sparrow	BBS	.8
Dunn's Salamander	FS	.79
Nashville Warbler	PIF	.79
Sandhill Crane	X	.79
Spotted Sandpiper	BBS	.79
Northern Harrier	PIF	.78
Ruffed Grouse	BBS	.78
Pacific Shrew	FS	.77
Savannah Sparrow	BBS	.77
S. Torrent Salamander	SV	.77
Western Screech-Owl	PIF	.77
Vaux's Swift	PIF	.75
White-Crowned Sparrow	BBS	.75
Yellow-Breasted Chat	SC	.74
American Marten	SV	.73
Green Heron	BBS	.73
Tailed Frog	SV	.73
Wilson's Warbler	PIF	.73
Yellow Warbler	PIF	.73
Cascade Torrent Salamander	SV	.72
Macgillivray's Warbler	BBS	.72
Blue Grouse	BBS	.71
Red-Shouldered Hawk	PIF	.71
Western Pond Turtle	SC	.71
Common Porcupine	CFL	.7
Fisher	SC	.7
Short-Eared Owl	X	.7
Tree Swallow	PIF	.7

Species	Special Desig-nations*	Correlation with Oak Savanna Species
Cooper's Hawk	PIF	.69
Oregon Spotted Frog	C	.68
Chestnut-Backed Chickadee	BBS	.65
Yellow-billed Cuckoo	X	.65
Golden-Crowned Kinglet	BBS	.64
Fringed Myotis	SV	.63
Purple Finch	BBS	.63
Common Yellowthroat	BBS	.62
Hutton's Vireo	PIF	.62
Virginia Rail	BBS	.61
Northern Pygmy-Owl	SC	.6
Red Crossbill	PIF	.6
Painted Turtle	SC	.59
Townsend's Big-Eared Bat	SC	.59
Olive-Sided Flycatcher	SV	.58
Red-Legged Frog	SV	.58
Howellia	T	.57
Killdeer	BBS	.57
Purple Martin	SC	.57
Belted Kingfisher	CFL	.53
Cascades Frog	SV	.53
Horned Lark	C	.53
Western Toad	SV	.53
Canada Goose	CFL	.52
Red-Eyed Vireo	PIF	.52
Peregrine Falcon	SE	.51
Bald Eagle	T	.49
Barn Swallow	BBS	.49
Lynx	T	.47
Sora	BBS	.47
Pallid Bat	SV	.46
Black Swift	PIF	.45
Foothill Yellow-legged Frog	SV	.44
Blue-Winged Teal	CFL	.42
Cinnamon Teal	BBS	.42
Lincoln's Sparrow	PIF	.42
Golden Eagle	BBS	.41
Wolverine	ST	.4
Great Gray Owl	SV	.39
Hermit Warbler	PIF	.39
Common Nighthawk	SC	.37
Ruddy Duck	BBS	.36
Varied Thrush	PIF	.36
Hammond's Flycatcher	PIF	-.05
Spotted Owl	T	-.46

* see section 6 for abbreviations. Only one designation is listed per species

3.2.5 Application Example 5

Finally, let's suppose that in a particular watershed it's feasible to restore and protect an adequate area of <u>all</u> habitat types considered "focal" in this report. Querying the file HABTYPE (to select species scoring 9 or 10 in any of the 6 focal habitat types) reveals that such a strategy might protect 249 of the 291 species that breed (or historically bred) in the Willamette sub-basin. This is a liberal estimate because it assumes (a) geographic and elevational ranges of all these species include the particular watershed of interest, and (b) habitat area is the key factor limiting these species. A related question is:

> *Which native species – because of their different habitat associations -- might benefit the <u>least</u> from protecting only these focal habitats?*

Results are shown in Table 33 which resulted from queries of Detail Files HABTYPE and SPHABCOR.

Table 33. Native species least likely to associate with habitat types designated as "focal" by this report.

Species	Special Desig-nations*	Maximimum correlation with species in focal habitats
Golden-Mantled Ground Squirrel	0	.6
Golden Eagle	BBS	.65
Lincoln's Sparrow	PIF	.65
Red-Shouldered Hawk	PIF	.71
Yellow-Rumped Warbler	0	.71
House Finch	0	.73
Townsend's Solitaire	0	.73
Long-Eared Owl	0	.75
White-Crowned Sparrow	BBS	.75
Killdeer	BBS	.77
Northern Alligator Lizard	0	.79
Western Pocket Gopher	0	.79
Brewer's Blackbird	0	.8
Cooper's Hawk	PIF	.81
Black-crowned Night-Heron	X	.82
Clark's Nutcracker	0	.82
Orange-Crowned Warbler	PIF	.86
Western Scrub-Jay	0	.86
Wrentit	PIF	.86
California Vole	0	.87
Mountain Chickadee	0	.87
Nashville Warbler	PIF	.87
Water Vole	0	.87
Anna's Hummingbird	0	.88
Red-Breasted Sapsucker	0	.88

Species	Special Desig-nations*	Maximimum correlation with species in focal habitats
Western Spotted Skunk	0	.88
Northern Flicker	0	.89
Creeping Vole	0	.9
Dark-Eyed Junco	0	.9
Long-Tailed Vole	0	.9
Mountain Quail	0	.9
Great Gray Owl	SV	.91
Spotted Towhee	0	.91
Black-Throated Gray Warbler	PIF	.92
House Wren	PIF	.92
Mourning Dove	0	.92
Ruffed Grouse	BBS	.92
Rufous Hummingbird	PIF	.92
Common Porcupine	CFL	.95
Northern Saw-Whet Owl	0	.95
Band-tailed Pigeon	PIF	.96
Bushtit	PIF	.96
Evening Grosbeak	BBS	.96
Hermit Thrush	0	.98
Swainson's Thrush	PIF	.98
Purple Finch	BBS	.99
Red-Tailed Hawk	0	.99
American Crow	0	1
Blue Grouse	BBS	1
Cassin's Vireo	0	1
Dusky Flycatcher	0	1
Fox Sparrow	0	1

Species	Special Desig-nations*	Maximimum correlation with species in focal habitats
Great Horned Owl	0	1
Horned Lark	C	1
Hutton's Vireo	PIF	1
MacGillivray's Warbler	BBS	1

* see DataDictionary for abbreviations. Only one designation is listed per species.

4. Environmental Correlates and Limiting Factors

4.1 Major Types of Environmental Correlates and Limiting Factors

A diverse array of factors limit the occurrence of rare plants and wildlife, both statewide (Kaye et al. 1997) and in the Willamette subbasin. These factors act both individually and in a cumulative, interactive manner. Within this subbasin, a compilation of environmental correlates for just the 39 focal wildlife species (Figure 1) emphasizes the wide variety of factors that can influence terrestrial wildlife. (The prevalence of aquatic correlates is simply an artifact of this report's choice of focal habitats).

Rational and efficient discussion of limiting factors first requires some definitions and a classification. At the broadest level, eight major factors potentially limit any wildlife species:

Food
Water
Cover/substrate (shelter)
Habitat space
Pathogens and Parasites
Competition, Predation, and Harvest
Harassment (intentional or not, from presence of people, vehicles, livestock)

The loss (or reduced accessibility or suitability) of the first four factors -- food, water, cover/substrate, or habitat space -- is termed "habitat loss" or "habitat degradation." There is not a clear distinction between habitat loss and habitat degradation; at some undefined point habitat degradation becomes habitat loss. For this report, **habitat loss** includes changes that are long-term and that radically change habitat structure as perceived by wildlife:

- conversion of any land cover type to impervious surface, e.g., pavement, buildings, other infrastructure;
- permanent inundation of land, e.g., by large dams;
- permanent filling of seasonally or permanently inundated areas, e.g., by intentional or natural deposition of sediment, rock, or debris
- conversion of naturally vegetated land to agricultural production;
- creation of persistently unvegetated surfaces, e.g., from gravel extraction;
- conversion of mature forests to very early successional land cover, e.g., clearcuts.

Habitat degradation involves physical and biological changes that are technically easier to reverse or mitigate, or which can be reversed over shorter time periods, although there may be substantial socioeconomic barriers to doing so. Their effect on wildlife and rare plants is to decrease the accessibility or suitability of food, water, and cover/substrate -- and therefore increase crowding, competition, predation, pathogen or parasite transmission, and/or mortality rates. Often, a single change can contribute both to habitat degradation and to habitat enhancement, depending on species potentially affected and the distribution of the change in time and space. Changes which, at extreme levels, most often lead to degradation of habitat for wildlife and rare plants are:

- increased air or water pollution, e.g., excessive toxins, nutrients, sediments

- increased air or water temperature, e.g., from global warming, urbanization
- increased soil compaction and trampling
- increased or decreased tree canopy cover
- increased or decreased shrub cover
- increased or decreased herbaceous plant cover
- increased or decreased dead wood (standing or downed) and soil organic matter
- increased or decreased soil saturation and/or water levels and persistence, e.g., from irrigation, climate change, agricultural drainage, groundwater withdrawals
- increased or decreased barriers to movement, e.g., roads, fences, unsuitable habitat
- increased density of invasive species

The last two changes are frequently a consequence of the preceding ones, and complex feedbacks may occur among any of these changes. All of these changes have the potential to cause two fundamental changes at a landscape (watershed, subbasin) scale:

- increased simplification of habitat, i.e., fewer habitat types and structures
- increased distance between patches of suitable habitat

Together, all of the above have the potential to affect the other major factors that limit wildlife:

- Pathogens and Parasites, Predation and Competition, Harassment.

As shown in Tables 35-40, these changes vary in their effects on the focal species. As shown in Table 34, the changes listed above can be attributed to specific **agents** (human disturbance elements). This facilitates managing the agents that cause the changes, and thus ultimately reducing habitat degradation by insuring the improvement of the major factors important to wildlife and rare plants.

Table 34. Changes having a potential to degrade habitat for wildlife and rare plants, and some of their causative agents.

1= stronger likelihood of association with positive or negative change, 2= secondary likelihood of association with positive or negative change, based on published opinions of other biologists, the author, or field data from this region.

Agent	Changes Having a Potential to Degrade Wildlife Habitat										
	Air-Water Pollution	Warming	Soil Degradation	Tree Canopy Cover (+ / -)	Shrub Cover (+ / -)	Herb Cover (+ / -)	Dead Wood & Soil Organic Matter (+ / -)	Water Levels & Water Persistence (+ / -)	Barriers (+ / -)	Fragmentation	Invasive Plants
Agriculture	1	2	1	1	1	2	2	1	1	1	2
Grazing	1		2	2	2	1			2		1
Mining	1		2	1	1	1	1	1	2	2	2
Forestry	2		2	1	1	1	1		1	1	1
Urbanization	1	1	1	1	1	1	1	1	1	1	1
Fire Suppression				1	1	1	1		2	2	2
Recreation	1		1			1	1				1
Water Control Infrastructure	1							1	1	1	2

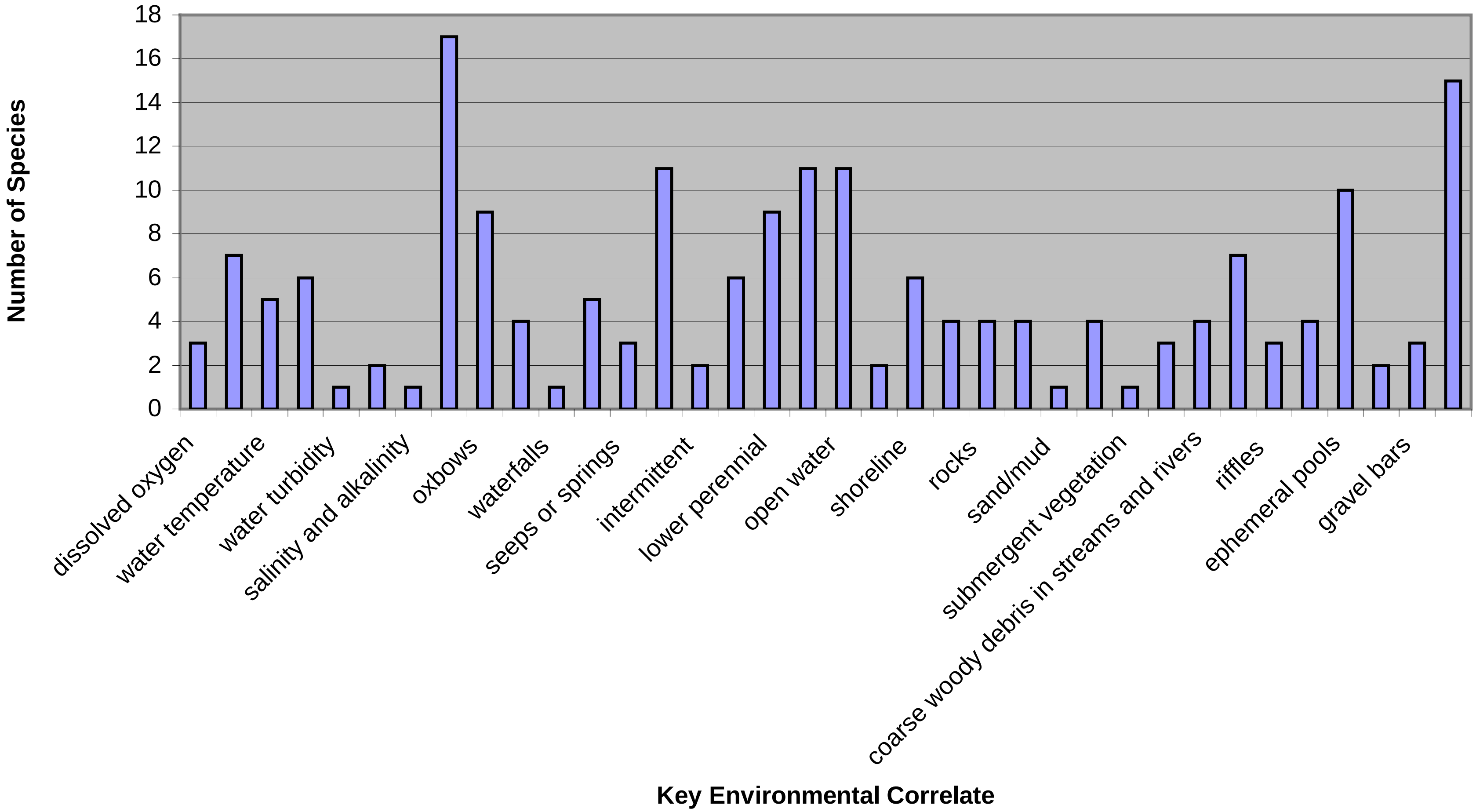

Figure 1. Number of focal species correlated with each of several habitat elements (adapted from graphic provided by NHI)

Table 35. Hypothesized or documented importance and prevalence of the limiting factors to focal species in oak woodland.

1 = primary factor; 2= secondary factor, based on published opinions of other biologists, the author, or (least often, due to unavailability) field data from this region. For more explanation see section 2.2.4

	Habitat Loss	Roads/ barriers	Vegetation change	Deadwood supply	Water regime change	Pollution	Warming	Soil degradation	Harassment	Invasives Parasites Diseases
Acorn woodpecker	1	2	1	1	--	2	--	--	--	1
Chipping sparrow	1	2	1	2	--	2	--	--	--	2
Western wood-pewee	1	2	1	2	--	2	--	--	--	2
White-breasted nuthatch	1	2	1	1	--	2	--	--	--	1
Southern alligator lizard	1	2	2	2	--	2	--	--	--	2
Sharptail snake	1	2	2	1	--	2	--	1	2	2
Western gray squirrel	1	1	2	1	--	2	--	--	--	2

Table 36. Hypothesized or documented importance and prevalence of the limiting factors to focal species in upland prairie.

1 = primary factor; 2= secondary factor, based on published opinions of other biologists, the author, or (least often, due to unavailability) field data from this region. For more explanation see section 2.2.4

	Habitat Loss	Roads/ barriers	Vegetation change	Deadwood supply	Water regime change	Pollution	Warming	Soil degradation	Harassment	Invasives Parasites Diseases
American kestrel	1	2	1	1	2	1	--	2	2	1
Horned lark	1	2	1	--	1	2	--	--	2	--
Vesper sparrow	1	2	1	--	2	2	--	2	2	--
Western meadowlark	1	2	1	--	2	2	--	2	2	--
Western rattlesnake	1	1	1	2	2	2	--	1	1	--
Black-tailed jackrabbit	1	1	1	--	2	2	--	2	2	2
Taylor’s checkerspot	1	1	1	--	--	1	--	2	--	1
Fender’s blue butterfly	1	1	1	--	--	1	--	2	--	1
Kincaid’s lupine	1	2	1	--	--	2	--	1	--	1
Golden paintbrush	1	2	1	--	--	2	--	1	--	1
White rock larkspur	1	2	1	--	--	2	--	1	--	1
White-topped aster	1	2	1	--	--	2	--	1	--	1

Table 37. Hypothesized or documented importance and prevalence of the limiting factors to focal species in wetland prairie and seasonal marsh.

1 = primary factor; 2= secondary factor, based on published opinions of other biologists, the author, or (least often, due to unavailability) field data from this region. For more explanation see section 2.2.4

	Habitat Loss	Roads/ barriers	Vegetation change	Deadwood supply	Water regime change	Pollution	Warming	Soil degradation	Harassment	Invasives Parasites Diseases
Dunlin	1	2	1	--	1	2	--	2	1	2
Common yellowthroat	1	2	2	--	2	2	--	2	2	2
Northern harrier	1	1	2	--	2	1	--	2	1	2
Sora	1	2	2	--	1	2	--	2	2	2
Red-legged frog	1	1	2	--	1	1	1	2	2	1
Water howellia	1	--	1	--	1	2	--	2	--	1
Bradshaw’s lomatium	1	--	1	--	1	2	--	1	--	1
Nelson’s checkermallow	1	--	1	--	1	2	--	1	--	1
Willamette Valley daisy	1	--	1	--	1	2	--	1	--	1
Peacock larkspur	1	--	1	--	1	2	--	1	--	1

Table 38. Hypothesized or documented importance and prevalence of the limiting factors to focal species in pond and pond riparian habitat.

1 = primary factor; 2= secondary factor, based on published opinions of other biologists, the author, or (least often, due to unavailability) field data from this region. For more explanation see section 2.2.4

	Habitat Loss	Roads/ barriers	Vegetation change	Deadwood supply	Water regime change	Pollution	Warming	Soil degradation	Harassment	Invasives Parasites Diseases
Western pond turtle	1	1	2	1	2	1	1	1	1	2
Oregon spotted frog	1	1	2	2	1	1	1	2	--	1
Cascades frog	2	1	2	2	1	1	1	2	--	1
Purple martin	1	2	2	1	2	2	2	--	--	1
Green heron	1	2	2	2	2	2	2	--	2	--
Wood duck	1	2	2	1	2	2	2	--	2	--
Yellow warbler	1	2	2	--	--	2	2	--	2	1

Table 39. Hypothesized or documented importance and prevalence of the limiting factors to focal species in stream and stream riparian habitat.

1 = primary factor; 2= secondary factor, based on published opinions of other biologists, the author, or (least often, due to unavailability) field data from this region. For more explanation see section 2.2.4

	Habitat Loss	Roads/ barriers	Vegetation change	Deadwood supply	Water regime change	Pollution	Warming	Soil degradation	Harassment	Invasives Parasites Diseases
American dipper	--	--	--	2	1	2	--	--	--	--
Bald eagle	2	2	2	--	2	1	--	--	1	--
Harlequin duck	--	--	--	--	2	2	--	--	2	--
Red-eyed vireo	1	2	--	--	--	2	--	--	--	2
Willow flycatcher	1	2	1	--	2	2	--	--	--	2
Coastal tailed frog	2	--	--	2	--	1	1	--	--	2
American beaver	2	--	--	--	--	--	--	--	2	--
River otter	2	2	--	2	--	1	--	--	2	--

Table 40. Hypothesized or documented importance and prevalence of the limiting factors to focal species in old growth conifer forest.

1 = primary factor; 2= secondary factor, based on published opinions of other biologists, the author, or (least often, due to unavailability) field data from this region. For more explanation see section 2.2.4

	Habitat Loss	Roads/ barriers	Vegetation change	Deadwood supply	Water regime change	Pollution	Warming	Soil degradation	Harassment	Invasives Parasites Diseases
Pileated woodpecker	1	--	--	1	--	--	--	--	2	--
Olive-sided flycatcher	2	--	2	2	--	2	--	--	2	--
Vaux's swift	1	--	--	1	--	2	--	--	2	--
Marbled murrelet	1	--	--	--	--	--	--	--	--	--
Spotted owl	1	2	--	1	--	--	--	--	2	2
Great gray owl	2	--	--	1	--	--	--	--	2	--
Oregon slender salamander	1	2	--	2	2	2	2	2	--	--
American marten	1	2	--	1	--	--	--	--	2	--
Red tree vole	1	1	--	2	--	--	--	--	--	--
Townsend's big-eared bat	2	--	--	1	--	2	--	--	2	--

4.2 Limiting Factor: Habitat Loss (Land Conversion)

For many species, habitat loss is the single most important cause of past declines, while for some of the same species plus others it may pose the greatest threat of future population losses. To gauge the possible magnitude of this impact, this section first describes current land cover conditions (section 4.2.1), then historic (section 4.2.2), and hypothesized future conditions (section 4.2.3). Much of the discussion focuses on data from three sources: the EC90 (ERC) land cover layer which was used in this report's species models, the NHI (Oregon Gap) vegetation layer, and the ONHP historical vegetation layer. These are described in more detail in section 1.3. Using GIS, these layers were queried to generate tables and "detail files" (tables too long and detailed to publish in this report). The most important of these are as follows:

Habitat Loss: Important Tables and Data Files

Table 41. Subbasin totals: current land cover class acres by ownership category, NHI classes
Table 42. Subbasin totals: current land cover class acres, EC90 classes
Error! Reference source not found. Table 43 Subbasin totals: historical land cover class acres by ownership category, NHI classes
Table 44. Predominant land cover that existed historically in Priority Conservation Areas (PCAs) identified by TNC Ecoregional Assessment, by watershed (or PCA#), NHI classes
Table 45. Subbasin totals: changes in land cover class acres by ownership category, NHI classes
Table 46. Land cover classes experiencing the greatest loss or gain, by watershed (HUC6), mid-1800's to early 1990s, NHI classes
Table 47. Change in the *predominant* land cover type, by watershed (HUC6), mid-1800's to early 1990s, NHI classes
Table 48. Change in breeding habitat (Payne's analysis)
Table 49. Change in breeding habitat for focal species (NHI analysis)

Detail File: PresentVegEC90_by_Wshed = one version of early 1990s vegetation
Detail File: PresentVegNHI_by_Wshed+Owner = another version of early 1990s vegetation
Detail File: HistoricalVegNHI_by_Wshed+Owner = circa 1850 vegetation (broad categories)
Detail File: VegChangeNHI_by_Wshed+Owner = complete listing of vegetation changes
Detail File: HistoricalVegTNC_by_PCA = circa 1850 vegetation types (detailed) in Priority Conservation Areas identified by TNC

4.2.1 Habitat Availability: Current Conditions

As is apparent from Table 41, the most prevalent land cover types in the Willamette subbasin currently (or in the early 1990s at least) are Westside lowland conifer-hardwood forest, followed by Agriculture, Montane mixed conifer forest, and then Urban/ residential. An alternative and more detailed classification (Table 42) indicates that the most prevalent type is Forest: closed mixed, followed by Forest: closed conifer 81-200 yrs., then Forest: closed conifer > 200 yrs, Conifers 0 - 20 yrs, Forest: closed hardwood, and Forest closed conifer 41-60 yrs. Within the agriculture category, the most prevalent class is Grass seed rotation, followed by Pasture, then Hayfield, and Grains. Obviously, different land cover types dominate in different watersheds. This is highlighted in Table 44. Currently, approximately 2.7 million acres of the subbasin are in public ownership, and about 60,516 acres of these and other lands have designations protective of wildlife habitat (Payne 2002).

Table 41. Subbasin totals: current land cover class acres, using NHI classes, by ownership category.

Note: Data compiled by NHI

Land cover class (NHI) in 1990	Private	Local	State	Federal	Tribal	NGO	Water	TOTAL
Agriculture	1393661	1267	6777	9106	0	234	911	1411955
Alpine grasslands & shrublands	30	0	0	7894	237	0	0	8161
Herbaceous wetlands	713	0	6	2423	0	0	1	3144
Montane mixed conifer forest	18519	87	405	482146	6018	0	189	507365
Open water - lakes, rivers, streams	15126	12	817	21935	50	0	28383	66324
Ponderosa pine & interior white oak forest & woodlands	5855	3	12	313	0	3	12	6199
Urban or residential	336371	453	1368	8418	43	26	619	347298
Westside grasslands	16438	7	189	740	0	107	2	17483
Westside lowland conifer-hardwood forest	2452655	5786	61110	2062537	11913	324	4189	4598515
Westside oak & dry Douglas-fir forest & woodlands	70689	485	272	785	0	77	4	72312
Westside riparian wetlands	124147	87	3422	1774	0	149	1716	131295

Table 42. Subbasin totals: early 1990s land cover class acres, using EC90 classes.

Note: Compiled by NHI from EC90 layer. The USEPA has estimated the accuracy of the EC90 layer varies from 100% to near 0%, depending on the particular class. For closed conifer forest, the overall accuracy was determined to be 65%.

EC90 land cover class present in 1990	Acres in Willamette subbasin
Forest closed mixed	1624378.06
Forest closed conifer 81 - 200 yrs.	770742.08
Forest closed conifer > 200 yrs.	709948.00
Conifers 0 - 20 yrs	547234.13
Forest closed hardwood	405835.48
Forest closed conifer 41 - 60 yrs.	367292.01
Grass seed rotation	352950.65
Pasture	339147.05
Natural shrub	330481.43
Hayfield	206366.42
Forest closed conifer 61 - 80 yrs.	173928.57
Grains	140082.52
Forest closed conifer 21 - 40 yrs.	138883.14
Residential 0 - 4 DU/ac	129937.98
Upland forest semi- closed hardwood	106068.34
Light duty roads	96786.91
Permanent lentic water	75235.74
Irrigated annual rotation	65568.45
Orchard	60982.89
Rural non-vegetated unknown	58640.63
Upland forest semi- closed mixed	55234.65
Christmas trees	45340.97
Field crop	43237.56
Irrigated perennial	42539.02
Urban non-vegetated unknown	31493.78
Rural structures	26170.32
Commercial	24674.71
Natural grassland	23264.50
Grass	22078.03
Secondary roads	21977.50
Barren	21536.94
Bare/fallow	21006.53
Residential 4 - 9 DU/ac	20344.01
Upland forest semi- closed conifer	19726.20
Row crop	19631.02
Flooded/marsh	18320.44
Industrial	18183.23
Upland forest open	15902.57
Stream orders 5 – 7	13659.27
Nursery	13458.67
Berries & vineyards	13323.23
Topographic shadow	12989.86
Urban tree overstory	12500.37
Railroad	12070.48
Turfgrass	10012.44

EC90 land cover class present in 1990	Acres in Willamette subbasin
Primary roads	9529.84
Late field crops	8673.62
Snow	5856.99
Commercial/Industrial	3922.16
Burned grass	2147.00
Residential 9 - 16 DU/ac	2036.47
Main channel non-vegetated	1670.85
Double cropping	1123.09
Mint	811.96
Hybrid poplar	801.29
Conifer woodlot	706.10
Residential > 16 DU/ac	598.02
Hops	564.66
Sugar beet seed	156.79
Radish seed	90.51

4.2.2 Habitat Availability: Looking Back

According to the ONHP data layer as interpreted by Gregory et al. (2002), the land cover class that was most prevalent in the subbasin during the mid-1800s was the same as currently (Westside lowland conifer-hardwood forest), but was followed by Westside grasslands, then Westside oak and dry Douglas-fir forest and woodlands, and Montane mixed conifer forest (Table 43). The two habitat classes that have experienced the largest acreage losses are Westside grasslands, and Westside oak - dry Douglas-fir forest/woodlands (Table 46). Not surprisingly, those that have experienced the largest acreage gains are Agriculture, Urban/ Residential, and Westside lowland conifer-hardwood forest. Finer breakouts are illustrated in the Willamette River Basin Planning Atlas (Hulse et al. 2002):

- Conversion of Wet and Dry Prairie can be attributed overwhelmingly to Agriculture, with much of the rest attributable about equally to conversion to Built Features and to Other Natural Vegetation
- Conversion of Emergent Wetlands also can be attributed overwhelmingly to Agriculture, with much of the rest attributable about equally to conversion to Other Natural Vegetation, and secondarily to Built Features and (about equally) to Other Forest
- Conversion of Riparian Forest (closed canopy) can be attributed mostly to Agriculture, followed by Other Forest and Other Natural Vegetation.
- Conversion of Savanna can be attributed mostly to Agriculture, with much of the rest attributable about equally to conversion to Other Forest and to Other Natural Vegetation.
- Conversion of Woodland (mostly oak woodland) can be attributed about equally to Agriculture, Closed Canopy Conifer Forest, and Other Forest.
- Conversion of Shrubland (both wet and dry) can be attributed overwhelmingly to Agriculture, with much of the rest attributable to Other Natural Vegetation
- Conversion of Hardwood and Mixed Forest can be attributed mostly to Conifer Forest (closed canopy), and secondarily to Other Forest.

Obviously, the land cover in some watersheds has changed more than in others, and different classes have been converted depending on location (Table 47). More information is available in Detail File: VegChangeNHI. Of particular interest in focusing restoration activity is the land cover types that existed within areas identified as Priority Conservation Areas (PCAs) by TNC's Ecoregional Assessment. Most of the PCA land was originally prairie, which is expected, given that TNC's assessment was focused entirely on the valley and foothill portion of the subbasin. Historical land cover of the PCAs varies by watershed, as shown in Table 47.

Table 43. Subbasin totals: historical land cover class acres by ownership category, NHI classes and ONHP data.

Note: Data compiled by NHI.

Land cover class (NHI) present circa 1850	Now Private	Now Local	Now State	Now Federal	Now Tribal	Now NGO	Now Water	TOTAL
Alpine grasslands and shrublands	694	0	0	48138	609	0	56	49498
Ceanothus-manzanita shrubland	2534	0	523	6473	0	0	0	9529
Herbaceous wetlands	7437	0	96	456	0	0	41	8030
Lodgepole pine forest and woodlands	0	0	0	122602	5764	0	127	128493
Montane mixed conifer forest	36040	0	723	582556	8367	0	1077	628763
Open water - lakes, rivers, streams	25295	27	1601	8662	0	10	9235	44831
Westside grasslands	1007798	1118	5929	20852	0	597	2477	1038771
Westside lowland conifer-hardwood forest	2173158	5610	48447	1790191	3488	171	13117	4034182
Westside oak and dry Douglas-fir forest and woodlands	952760	1186	11141	10364	0	112	1323	976885
Westside riparian wetlands	228348	249	5889	7490	0	31	8574	250581

Table 44. Predominant land cover that existed historically in PCAs, compared with present land cover, by watershed.

See MapFile:PCAmap for locations. See legend at end for vegetation codes.

ID#	PCA name	Predominant HUC6	Undeveloped %	Predominant Historic Vegetation*	Oak woodland	Upland prairie	Wetland prairie & seasonal marsh	Ponds & their riparian	Stream riparian	Old growth conifer forest
318	Airlie Oaks	170900030601	36	SO	X				X	
299	Amity Oaks	170900080502	69	SO	X					
272	Banks Swamp	170900100201	21	FALW				X		
306	Baskett Butte	170900070101	18	PU	X	X		X	X	
351	Bear Creek Oaks	170900030101		PU						
348	Bear Creek Wetlands	170900030101		FAW						
304	Buell	170900080301	17	PU	X				X	
344	Calapooia Oak	170900030303		SOF						
369	Camas Swale BLM RNA	170900020102	100	FED		X			X	
363	Camas Swale Oaks	170900020102	44	PU	X	X			X	
364	Camas Swale Wetlands	170900020102	3	PW	X				X	
285	Camassia	170900070403	39	OFOZ	X			X	X	
356	Camp Creek Ridge	170900040101	96	SOP	X	X			X	
292	Cedar Creek	170900090305	87	FFHC					X	
291	Champoeg State Park	170900070301	34	FFCL	X				X	
286	Clackamas	170900110103	73						X	
365	CoastFk/MidFk Willamette	170900010101	35	FFA	X	X		X	X	
354	Coburg Ridge	170900040201	72	FF	X	X		X	X	
343	Cogswell Foster	170900030203		SO						
282	Cooper Mountain	170900100102	54	FFHC						
333	Corvallis Watershed	170900030501	100							X
331	Corvallis-Philomath Oaks	170900030502	49	PU	X	X	X	X		
342	Crawfordsville	170900030303		SOFP						
289	Dundee Oaks	170900070303	39	OOZ	X			X	X	
321	Dunn Forest	170900030602	42	PU	X	X			X	
322	EE Wilson	170900030602	49	PU	X				X	
352	Elk Creek	170900030102	99	FED						X
305	Eola Hills	170900080501	45	SO	X				X	
357	Fern Ridge	170900030102	11	PU	X		X		X	

ID#	PCA name	Predominant HUC6	Undeveloped %	Predominant Historic Vegetation*	Oak woodland	Upland prairie	Wetland prairie & seasonal marsh	Ponds & their riparian	Stream riparian	Old growth conifer forest
270	Forest Park	170900100202	90	FFHC					X	
367	Fox Hollow BLM RNA	170900030103	99	FED		X				
275	Gales Cr.	170900100301	34	OFOZ					X	
370	Gettings Creek	170900020101		PU						
332	Golden Valley	170900060102		PU						
310	Habeck Oaks	170900030606	54	SO	X	X			X	
309	Hidden Oaks	170900090702	4	PU						
347	High Pass	170900030101	80	FED	X				X	X
345	Indian Head - Horse Rock Ridge	170900030203	66	PU	X	X	X		X	
328	Jackson-Frazier	170900030201	24	PW	X			X	X	
361	Jasper Prairie	170900010101	60	SO	X	X	X			
314	Johnson Hill	170900070103	32	SO	X					
316	Kingston Prairie	170900050601	9	PU	X	X				
362	Lane Community College Basin	170900020101	79	SOBFP	X					
311	Little Sink RNA	170900030606	100	FF						X
326	Logsden Ridge	170900030201	42	SO	X					
334	Lower Calapooia River Riparian	170900030302	12	PU	X				X	
355	Lower McKenzie Riparian	170900040101	30	FFA	X		X	X	X	
317	Luckiamute River Riparian	170900030601	13	FFA	X			X	X	
323	Maxfield Creek	170900030603	100	SO	X					
319	McCully Mtn.	170900060302	85	OFZ	X					
327	McDonald Forest / Soap Cr.	170900030602	97	FF	X	X	X		X	
308	Minto Island	170900070307	19	FFA	X			X	X	
301	Missouri Ridge	170900090501	83	FFHC	X				X	
302	Mount Angel	170900090702	23	SO						
360	Mount Pisgah	170900020101	57	PU	X	X	X	X	X	
339	Muddy Cr. - Finley NWR	170900030504	22	PW	X	X	X	X	X	
324	North Santiam	170900050601	43	FFA	X	X		X	X	
330	Oak Cr. Freeway Lakes	170900030402	22	SO	X				X	
336	Oak Creek USFWS	170900030403	16	PW	X		X	X	X	
287	Oak Ridge - Moore's Valley	170900080604	84	SO	X				X	
346	Orchard Heights	170900030101	71	SO	X	X		X	X	

ID#	PCA name	Predominant HUC6	Undeveloped %	Predominant Historic Vegetation*	Oak woodland	Upland prairie	Wetland prairie & seasonal marsh	Ponds & their riparian	Stream riparian	Old growth conifer forest
359	Oregon County Fair	170900030102	43	FED	X			X	X	
335	Peterson Butte	170900030302	78	PU	X	X				
293	Pudding River	170900090101	20	FFCL	X				X	
366	Rattlesnake Oaks	170900020101	55	SOF	X				X	
325	Richardson Gap - Crabtree	170900060201	17	PW	X			X	X	
350	Rock Hill	170900030203	52	SO	X			X		
312	Salem Hills - Ankeny	170900070103	38	SO	X		X	X	X	
320	Scio Oak Pine Savanna	170900060301	39	SOF	X			X	X	
307	Silver Creek	170900090704	49	FFHC	X			X		
297	South Fork Yamhill River	170900080703	13	PU	X			X	X	
313	Stout Mtn.	170900050601	77	PU	X	X			X	
353	Swamp Creek	170900030102	87	FF	X			X	X	X
294	The Butte BLM RNA	170900080403	99	FF					X	X
295	Tryon Cr.	170900090303	85							
283	Tryon Creek N	170900120202	85	FFHC						
279	Tualatin Hills	170900100103	51	OFOPZ	X			X	X	
284	Tualatin National Wildlife Refuge	170900100101	21	FF	X			X		
371	Upper Siuslaw	170900020301	96	FED	X					X
281	Wapato Marsh	170900100301	3	FFA	X			X	X	
338	Ward Butte	170900030302	8	PU	X	X				
340	Washburn Butte	170900030302	97	SO	X	X		X	X	
337	Waterloo Rocks	170900060103	49	FFA	X	X		X	X	
368	Weiss Road BLM Oaks	170900020102	99	OFOZ		X				
358	West Eugene - Spencer Cr.	170900030103	35	PW	X	X	X	X	X	
329	Willamette Main Stem - Corvallis to Albany	170900030201	15	FFA	X			X	X	
315	Willamette Main Stem - Harrisburg to Corvallis	170900070103	10	FFA	X			X	X	
341	Willamette Main Stem - Luckiamute Confluence	170900030202	17	FFA	X			X	X	
298	Willamette Main Stem - McKenzie Confluence to Harrisburg	170900070304	21	FFA	X			X	X	
349	Willamette Main Stem - Mission Bottom	170900030204	14	FFA	X			X	X	
288	Willamette Narrows	170900070402	61	OFZ	X	X		X	X	

ID#	PCA name	Predominant HUC6	Undeveloped %	Predominant Historic Vegetation*	Oak woodland	Upland prairie	Wetland prairie & seasonal marsh	Ponds & their riparian	Stream riparian	Old growth conifer forest
300	Willamina Oaks 1	170900080401	60	SO	X				X	
303	Willamina Oaks 2	170900080301	44	SO	X				X	
296	Yamhill Oaks	170900080403	59	SO	X	X		X	X	

Legend for historical vegetation codes used in the table above:

FALW Ash-alder-willow swamp, sometimes with bigleaf maple often with vine maple, ninebark, hardhack, cattails and coarse gravel

FAW Ash-willow swamp, sometimes w/ ninebark & briars; very thick

FED Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone on S slopes & ridgetops & (2) more mesic Douglas fir-western red cedar

FF Douglas fir forest, often with bigleaf maple, grand fir,dogwood, hazel, yew. No other conifers present.

FFA Ash-mixed deciduous riparian forest with combinations of red alder, bigleaf maple, black cottonwood, white oak, dogwood.

FFCL Red alder-mixed conifer riparian forest; combinations of red cedar, grand & Douglas fir, hemlock, bigleaf maple.

FFHC Mesic mixed conifer forest with mostly deciduous understory. May include Douglas fir, western hemlock, red cedar, grand fir.

OFOPZ scattered" or "thinly timbered" Douglas fir-white oak-ponderosa pine woodland, with brushy undergrowth of hazel, bracken.

OFOZ scattered or thinly timbered Douglas fir-white oak woodland. May contain bigleaf maple; brushy understory of hazel, young oaks.

OFZ Douglas fir woodland or timber" often with bigleaf maple, alder, or dogwood. No oak, hemlock or cedar. Brushy undergrowth.

OOZ scattered" or "thinly timbered" white oak woodland understory of hazel, oak, bracken. No fir or black oak.

PU Upland prairie, xeric. May have scattered trees.

PW Seasonally wet prairie. May have scattered trees.

SO White oak savanna

SOBFP White oak-black oak-Douglas fir-ponderosa pine savanna

SOF White oak-Douglas fir savanna, mostly herbaceous undergrowth

SOFP White oak-Douglas fir-ponderosa pine savanna

SOP White oak-ponderosa pine savanna

W Water bodies wider than 60 ft, including rivers, sloughs, ponds, beaver ponds, lakes, marshy lakes and bayous.

Table 45. Subbasin totals: changes in land cover class acres, using NHI classes, by ownership category.

Land cover class (NHI) present circa 1850	Now Private	Now Local	Now State	Now Federal	Now Tribal	Now NGO	Now Water	TOTAL
Agriculture	9106	1267	234	1393661	6777	0	911	+1411955
Alpine grasslands and shrublands	-40244	0	0	-663	0	-373	-56	-41336
Ceanothus-manzanita shrubland	-6473	0	0	-2534	-523	0	0	-9529
Herbaceous wetlands	1968	0	0	-6724	-90	0	-40	-4886
Lodgepole pine forest and woodlands	-122602	0	0	0	0	-5764	-127	-128493
Montane mixed conifer forest	-100410	87	0	-17521	-317	-2349	-888	-121398
Open water - lakes, rivers, streams	13273	-15	-10	-10169	-784	50	19148	+21493
Ponderosa pine and interior white oak forest and woodlands	313	3	3	5855	12	0	12	+6199
Urban or residential	8418	453	26	336371	1368	43	619	+347298
Westside grasslands	-20112	-1110	-489	-991360	-5740	0	-2475	-1021287
Westside lowland conifer-hardwood forest	272346	176	153	279497	12664	8425	-8927	+564333
Westside oak and dry Douglas-fir forest and woodlands	-9578	-701	-35	-882071	-10869	0	-1319	-904573
Westside riparian wetlands	-5717	-161	118	-104201	-2466	0	-6858	-119285

Table 46. NHI land cover classes experiencing the greatest loss or gain, by watershed (HUC6), mid-1800's to early 1990s.

Note: Other factors being equal, watersheds that have experienced the most drastic structural change in land cover should be given higher consideration for habitat restoration. See MapFile: HUC6map for locations. Data compiled by NHI from ONHP historical and Gap vegetation layers.

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
170900010101	Willamette R. Middle Fk.	Rattlesnake & Hills Cr.	Gain	Agriculture	8599
170900010101	Willamette R. Middle Fk.	Rattlesnake & Hills Cr.	Loss	Westside grasslands	-9351
170900010201	Willamette R. Middle Fk.	Hills Cr.	Gain	Westside lowland conifer-hardwood forest	1905
170900010201	Willamette R. Middle Fk.	Hills Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-1714
170900010301	Willamette R. Middle Fk.	Fall Cr. Reservoir N.	Gain	Open water - lakes, rivers, streams	870
170900010301	Willamette R. Middle Fk.	Fall Cr. Reservoir N.	Loss	Westside lowland conifer-hardwood forest	-1120
170900010302	Willamette R. Middle Fk.	Fall & Delp Cr.	Gain	Montane mixed conifer forest	406
170900010302	Willamette R. Middle Fk.	Fall & Delp Cr.	Loss	Westside lowland conifer-hardwood forest	-456
170900010401	Willamette R. Middle Fk.	Fall Cr. Reservoir S.; Winberry Cr.	Gain	Westside lowland conifer-hardwood forest	2314
170900010401	Willamette R. Middle Fk.	Fall Cr. Reservoir S.; Winberry Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-2868
170900010501	Willamette R. Middle Fk.	Dexter Reservoir	Loss	Westside grasslands	-2128
170900010501	Willamette R. Middle Fk.	Dexter Reservoir	Gain	Westside lowland conifer-hardwood forest	1879
170900010502	Willamette R. Middle Fk.	Hemlock; Lookout Point Reservoir	Gain	Montane mixed conifer forest	1443
170900010502	Willamette R. Middle Fk.	Hemlock; Lookout Point Reservoir	Loss	Westside riparian wetlands	-1701
170900010601	Willamette R. Middle Fk.	Lost R.; Anthony Cr.	Loss	Westside grasslands	-1669
170900010601	Willamette R. Middle Fk.	Lost R.; Anthony Cr.	Gain	Westside lowland conifer-hardwood forest	1537
170900010701	Willamette R. Middle Fk.	Hemlock; Middle Fk. of N. Fk. of Willamette	Gain	Agriculture	960
170900010701	Willamette R. Middle Fk.	Hemlock; Middle Fk. of N. Fk. of Willamette	Loss	Westside grasslands	-1655
170900010702	Willamette R. Middle Fk.	Christy Cr.	Gain	Montane mixed conifer forest	2497
170900010702	Willamette R. Middle Fk.	Christy Cr.	Loss	Westside lowland conifer-hardwood forest	-2429
170900010703	Willamette R. Middle Fk.	Grassy Cr.	Gain	Westside lowland conifer-hardwood forest	582
170900010703	Willamette R. Middle Fk.	Grassy Cr.	Loss	Westside riparian wetlands	-906
170900010801	Willamette R. Middle Fk.	Oakridge E.	Gain	Montane mixed conifer forest	1583
170900010801	Willamette R. Middle Fk.	Oakridge E.	Loss	Westside lowland conifer-hardwood forest	-1710
170900010802	Willamette R. Middle Fk.	Black & Salmon & Wall Cr.	Loss	Montane mixed conifer forest	-75

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
170900010802	Willamette R. Middle Fk.	Black & Salmon & Wall Cr.	Gain	Open water - lakes, rivers, streams	72
170900010803	Willamette R. Middle Fk.	Waldo Lake; Black & Salmon Cr.	Loss	Montane mixed conifer forest	-4550
170900010803	Willamette R. Middle Fk.	Waldo Lake; Black & Salmon Cr.	Gain	Westside lowland conifer-hardwood forest	4596
170900010901	Willamette R. Middle Fk.	Waldo Lake; Cayuse & Fisher Cr.	Loss	Montane mixed conifer forest	-11155
170900010901	Willamette R. Middle Fk.	Waldo Lake; Cayuse & Fisher Cr.	Gain	Westside lowland conifer-hardwood forest	20849
170900011001	Willamette R. Middle Fk.	Salt & Gold & Eagle Cr.	Loss	Montane mixed conifer forest	-12111
170900011001	Willamette R. Middle Fk.	Salt & Gold & Eagle Cr.	Gain	Westside lowland conifer-hardwood forest	11552
170900011101	Willamette R. Middle Fk.	Groundhog Cr: S.Fork	Loss	Montane mixed conifer forest	-240
170900011101	Willamette R. Middle Fk.	Groundhog Cr: S.Fork	Gain	Open water - lakes, rivers, streams	390
170900011201	Willamette R. Middle Fk.	Staley & Swift & Spruce Cr.	Loss	Montane mixed conifer forest	-18668
170900011201	Willamette R. Middle Fk.	Staley & Swift & Spruce Cr.	Gain	Westside lowland conifer-hardwood forest	20453
170900011301	Willamette R. Middle Fk.	Oakridge W.; Hills Creek Reservoir	Gain	Open water - lakes, rivers, streams	2093
170900011301	Willamette R. Middle Fk.	Oakridge W.; Hills Creek Reservoir	Loss	Westside riparian wetlands	-2312
170900020101	Willamette R. Coast Fk./ Row R.	Creswell E. Bear & Gettings Cr.	Gain	Agriculture	16223
170900020101	Willamette R. Coast Fk./ Row R.	Creswell E. Bear & Gettings Cr.	Loss	Westside grasslands	-19548
170900020102	Willamette R. Coast Fk./ Row R.	Creswell W.; Camas Swale	Loss	Westside grasslands	-13067
170900020102	Willamette R. Coast Fk./ Row R.	Creswell W.; Camas Swale	Gain	Westside lowland conifer-hardwood forest	11294
170900020201	Willamette R. Coast Fk./ Row R.	Mosby Cr.	Gain	Agriculture	1165
170900020201	Willamette R. Coast Fk./ Row R.	Mosby Cr.	Loss	Westside grasslands	-1568
170900020301	Willamette R. Coast Fk. - upper	Cottage Grove Reservoir N.	Loss	Westside grasslands	-9144
170900020301	Willamette R. Coast Fk. - upper	Cottage Grove Reservoir N.	Gain	Westside lowland conifer-hardwood forest	8010
170900020302	Willamette R. Coast Fk. - upper	Cottage Grove Reservoir S.	Gain	Westside lowland conifer-hardwood forest	1159
170900020302	Willamette R. Coast Fk. - upper	Cottage Grove Reservoir S.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-1205
170900020401	Willamette R. Coast Fk./ Row R.	Dorena Reservoir	Loss	Westside grasslands	-6483

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
170900020401	Willamette R. Coast Fk./ Row R.	Dorena Reservoir	Gain	Westside lowland conifer-hardwood forest	5629
170900020501	Willamette R. Coast Fk. - lower	Laying & Dinner & Herman Cr.	Gain	Montane mixed conifer forest	1913
170900020501	Willamette R. Coast Fk. - lower	Laying & Dinner & Herman Cr.	Loss	Westside lowland conifer-hardwood forest	-1931
170900020502	Willamette R. Coast Fk. - lower	Brice Cr.	Gain	Montane mixed conifer forest	5966
170900020502	Willamette R. Coast Fk. - lower	Brice Cr.	Loss	Westside lowland conifer-hardwood forest	-5959
170900020503	Willamette R. Coast Fk. - lower	Sharps & Martin Cr.	Gain	Montane mixed conifer forest	1730
170900020503	Willamette R. Coast Fk. - lower	Sharps & Martin Cr.	Loss	Westside lowland conifer-hardwood forest	-1687
170900030101	Long Tom R.	W. Eugene; Junction City	Gain	Agriculture	49927
170900030101	Long Tom R.	W. Eugene; Junction City	Loss	Westside grasslands	-56045
170900030102	Long Tom R.	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	Gain	Agriculture	19405
170900030102	Long Tom R.	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	Loss	Westside oak and dry Douglas-fir forest and woodlands	-25015
170900030103	Long Tom R.	Coyote Cr.	Gain	Westside lowland conifer-hardwood forest	24268
170900030103	Long Tom R.	Coyote Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-26235
170900030201	Muddy Cr.	Corvallis N.; Adair Village	Gain	Agriculture	19097
170900030201	Muddy Cr.	Corvallis N.; Adair Village	Loss	Westside grasslands	-17790
170900030202	Muddy Cr.	Monroe; Muddy Cr. E.	Gain	Agriculture	46215
170900030202	Muddy Cr.	Monroe; Muddy Cr. E.	Loss	Westside grasslands	-30344
170900030203	Muddy Cr.	Coburg; Halsey; Little Muddy R.; Pierce Cr	Gain	Agriculture	64085
170900030203	Muddy Cr.	Coburg; Halsey; Little Muddy R.; Pierce Cr	Loss	Westside grasslands	-65942
170900030204	Muddy Cr.	E. Eugene; Harrisburg; Springfield	Gain	Agriculture	20681
170900030204	Muddy Cr.	E. Eugene; Harrisburg; Springfield	Loss	Westside grasslands	-23919
170900030301	Calapooia R.	Courtney Cr.	Gain	Agriculture	26950
170900030301	Calapooia R.	Courtney Cr.	Loss	Westside grasslands	-29534

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
170900030302	Calapooia R.	Brownsville	Gain	Agriculture	33519
170900030302	Calapooia R.	Brownsville	Loss	Westside grasslands	-33273
170900030303	Calapooia R.	Calapooia R - middle	Gain	Agriculture	6249
170900030303	Calapooia R.	Calapooia R - middle	Loss	Westside oak and dry Douglas-fir forest and woodlands	-6538
170900030401	Calapooia R./ Oak Cr.	N. Albany; W. Lebanon; Cox Cr.	Gain	Agriculture	32102
170900030401	Calapooia R./ Oak Cr.	N. Albany; W. Lebanon; Cox Cr.	Loss	Westside grasslands	-31908
170900030402	Calapooia R./ Oak Cr.	S. Albany; Tangent.	Gain	Agriculture	29199
170900030402	Calapooia R./ Oak Cr.	S. Albany; Tangent.	Loss	Westside grasslands	-28423
170900030403	Calapooia R./ Oak Cr.	Sodaville	Gain	Agriculture	11084
170900030403	Calapooia R./ Oak Cr.	Sodaville	Loss	Westside grasslands	-11714
170900030501	Marys R.	Corvallis; Philomath; Mary's R.-lower	Gain	Agriculture	11294
170900030501	Marys R.	Corvallis; Philomath; Mary's R.-lower	Loss	Westside grasslands	-15212
170900030502	Marys R.	Mary's R -middle	Loss	Westside grasslands	-9418
170900030502	Marys R.	Mary's R -middle	Gain	Westside lowland conifer-hardwood forest	12847
170900030503	Marys R.	Mary's R. -upper	Gain	Agriculture	1460
170900030503	Marys R.	Mary's R. -upper	Loss	Westside grasslands	-1889
170900030504	Marys R.	Finley NWR; Muddy & Hammer Cr.	Gain	Agriculture	27147
170900030504	Marys R.	Finley NWR; Muddy & Hammer Cr.	Loss	Westside grasslands	-31783
170900030601	Luckiamute R.	Luckiamute R.4	Gain	Agriculture	12657
170900030601	Luckiamute R.	Luckiamute R.4	Loss	Westside grasslands	-9855
170900030602	Luckiamute R.	Soap Cr.	Gain	Agriculture	16622
170900030602	Luckiamute R.	Soap Cr.	Loss	Westside grasslands	-17190
170900030603	Luckiamute R.	Luckiamute R.1.	Gain	Westside lowland conifer-hardwood forest	10486
170900030603	Luckiamute R.	Luckiamute R.1.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-8573
170900030604	Luckiamute R.	Luckiamute R.2.	Gain	Westside lowland conifer-hardwood forest	20316
170900030604	Luckiamute R.	Luckiamute R.2.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-18222
170900030605	Luckiamute R.	Luckiamute R.3.	Gain	Westside lowland conifer-hardwood forest	2135
170900030605	Luckiamute R.	Luckiamute R.3.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-2451
170900030606	Luckiamute R.	Little Luckiamute R. - lower	Gain	Westside lowland conifer-hardwood forest	9087

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
170900030606	Luckiamute R.	Little Luckiamute R. - lower	Loss	Westside oak and dry Douglas-fir forest and woodlands	-10499
170900030607	Luckiamute R.	Little Luckiamute R. -upper	Gain	Westside lowland conifer-hardwood forest	3205
170900030607	Luckiamute R.	Little Luckiamute R. -upper	Loss	Westside oak and dry Douglas-fir forest and woodlands	-4504
170900040101	McKenzie R. - upper	E. Springfield; Camp & Ritchie Cr.	Loss	Westside grasslands	-9372
170900040101	McKenzie R. - upper	E. Springfield; Camp & Ritchie Cr.	Gain	Westside lowland conifer-hardwood forest	14308
170900040102	McKenzie R. - upper	Gate Cr. S. Fk.	Loss	Ceanothus-manzanita shrubland	-2526
170900040102	McKenzie R. - upper	Gate Cr. S. Fk.	Gain	Westside lowland conifer-hardwood forest	3363
170900040201	McKenzie R. - upper	Horse & Parsons & Cash & Mill Cr.	Gain	Agriculture	6789
170900040201	McKenzie R. - upper	Horse & Parsons & Cash & Mill Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-5169
170900040301	McKenzie R.	Blue River Reservoir & Cook Cr.	Loss	Ceanothus-manzanita shrubland	-2007
170900040301	McKenzie R.	Blue River Reservoir & Cook Cr.	Gain	Westside lowland conifer-hardwood forest	2501
170900040401	McKenzie R.	Blue River Reservoir & Elk Cr.	Loss	Montane mixed conifer forest	-7291
170900040401	McKenzie R.	Blue River Reservoir & Elk Cr.	Gain	Westside lowland conifer-hardwood forest	6450
170900040501	McKenzie R.	Boulder Cr. & Smith R.	Loss	Lodgepole pine forest and woodlands	-35685
170900040501	McKenzie R.	Boulder Cr. & Smith R.	Gain	Westside lowland conifer-hardwood forest	41051
170900040502	McKenzie R.	White Branch	Loss	Alpine grasslands and shrublands	-11310
170900040502	McKenzie R.	White Branch	Gain	Westside lowland conifer-hardwood forest	16492
170900040601	McKenzie R./ Mohawk R.	Separation Cr.	Loss	Alpine grasslands and shrublands	-2953
170900040601	McKenzie R./ Mohawk R.	Separation Cr.	Gain	Westside lowland conifer-hardwood forest	6183
170900040602	McKenzie R./ Mohawk R.	Horse & Eugene Cr.	Loss	Lodgepole pine forest and woodlands	-18912
170900040602	McKenzie R./ Mohawk R.	Horse & Eugene Cr.	Gain	Montane mixed conifer forest	12859
170900040701	McKenzie R. - lower	Quartz Cr.	Loss	Montane mixed conifer forest	-2298
170900040701	McKenzie R. - lower	Quartz Cr.	Gain	Westside lowland conifer-hardwood forest	2298
170900040801	McKenzie R. - S. Fk.	Cougar Reservoir & Walker Cr.	Loss	Alpine grasslands and shrublands	-2404
170900040801	McKenzie R. - S. Fk.	Cougar Reservoir & Walker Cr.	Gain	Westside lowland conifer-hardwood forest	1914
170900040802	McKenzie R. - S. Fk.	French Pete Cr.	Loss	Lodgepole pine forest and woodlands	-3895
170900040802	McKenzie R. - S. Fk.	French Pete Cr.	Gain	Montane mixed conifer forest	5210
170900040803	McKenzie R. - S. Fk.	Roaring R. & Elk Cr.	Loss	Lodgepole pine forest and woodlands	-16757
170900040803	McKenzie R. - S. Fk.	Roaring R. & Elk Cr.	Gain	Westside lowland conifer-hardwood forest	14338
170900050101	North Santiam R. - upper	Detroit; Idanha	Loss	Montane mixed conifer forest	-6096

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
170900050101	North Santiam R. - upper	Detroit; Idanha	Gain	Westside lowland conifer-hardwood forest	6691
170900050102	North Santiam R. - upper	Marion Lake	Loss	Montane mixed conifer forest	-13845
170900050102	North Santiam R. - upper	Marion Lake	Gain	Westside lowland conifer-hardwood forest	19869
170900050103	North Santiam R. - upper	Pyramid Cr.	Loss	Lodgepole pine forest and woodlands	-9020
170900050103	North Santiam R. - upper	Pyramid Cr.	Gain	Westside lowland conifer-hardwood forest	11361
170900050201	North Santiam R.	Breitenbush R.	Loss	Montane mixed conifer forest	-13156
170900050201	North Santiam R.	Breitenbush R.	Gain	Westside lowland conifer-hardwood forest	15176
170900050301	North Santiam R.	Detroit Reservoir	Loss	Montane mixed conifer forest	-10107
170900050301	North Santiam R.	Detroit Reservoir	Gain	Westside lowland conifer-hardwood forest	7508
170900050401	North Santiam R. - middle	Gates; Lyons; Mill City	Gain	Agriculture	2241
170900050401	North Santiam R. - middle	Gates; Lyons; Mill City	Loss	Westside lowland conifer-hardwood forest	-4073
170900050501	North Santiam R.	Little North Santiam R.	Loss	Montane mixed conifer forest	-6179
170900050501	North Santiam R.	Little North Santiam R.	Gain	Westside lowland conifer-hardwood forest	7184
170900050601	North Santiam R. - lower	Jefferson; Lyons; Bear Branch	Gain	Agriculture	42266
170900050601	North Santiam R. - lower	Jefferson; Lyons; Bear Branch	Loss	Westside oak and dry Douglas-fir forest and woodlands	-27047
170900060101	South Santiam R./ Crabtree Cr.	Crabtree Cr. & Onehorse Slough	Gain	Agriculture	12610
170900060101	South Santiam R./ Crabtree Cr.	Crabtree Cr. & Onehorse Slough	Loss	Westside grasslands	-5641
170900060102	South Santiam R./ Crabtree Cr.	E. Lebanon; Hamilton Cr.	Gain	Agriculture	11598
170900060102	South Santiam R./ Crabtree Cr.	E. Lebanon; Hamilton Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-12858
170900060103	South Santiam R./ Crabtree Cr.	Waterloo; Sweet Home; McDowell Cr.	Gain	Agriculture	11448
170900060103	South Santiam R./ Crabtree Cr.	Waterloo; Sweet Home; McDowell Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-15770
170900060201	South Santiam R./ Crabtree Cr.	Beaver Cr.	Gain	Agriculture	22041
170900060201	South Santiam R./ Crabtree Cr.	Beaver Cr.	Loss	Westside grasslands	-13955
170900060202	South Santiam R./ Crabtree Cr.	Roaring R.	Gain	Agriculture	759
170900060202	South Santiam R./ Crabtree	Roaring R.	Loss	Westside oak and dry Douglas-fir forest and	-661

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
	Cr.			woodlands	
170900060301	South Santiam R. /Thomas Cr.	Lower Thomas Cr. -lower; Scio	Gain	Agriculture	14925
170900060301	South Santiam R. /Thomas Cr.	Lower Thomas Cr. -lower; Scio	Loss	Westside oak and dry Douglas-fir forest and woodlands	-11153
170900060302	South Santiam R. /Thomas Cr.	Upper Thomas & Neil Cr. & Indian Prairie	Loss	Westside grasslands	-5864
170900060302	South Santiam R. /Thomas Cr.	Upper Thomas & Neil Cr. & Indian Prairie	Gain	Westside lowland conifer-hardwood forest	7261
170900060401	South Santiam R.	Greenpeter Reservoir	Loss	Montane mixed conifer forest	-3842
170900060401	South Santiam R.	Greenpeter Reservoir	Gain	Open water - lakes, rivers, streams	3588
170900060402	South Santiam R.	Quartzville Cr.-upper	Loss	Montane mixed conifer forest	-820
170900060402	South Santiam R.	Quartzville Cr.-upper	Gain	Westside lowland conifer-hardwood forest	796
170900060501	Santiam R. - middle	Pyramid Cr. & Quartzville Cr.-lower	Loss	Alpine grasslands and shrublands	-2393
170900060501	Santiam R. - middle	Pyramid Cr. & Quartzville Cr.-lower	Gain	Westside lowland conifer-hardwood forest	3575
170900060601	South Santiam R.	Sevenmile & Soda & Squaw Cr.	Loss	Montane mixed conifer forest	-855
170900060601	South Santiam R.	Sevenmile & Soda & Squaw Cr.	Gain	Westside lowland conifer-hardwood forest	524
170900060602	South Santiam R.	Canyon Cr.	Loss	Montane mixed conifer forest	-2810
170900060602	South Santiam R.	Canyon Cr.	Gain	Westside lowland conifer-hardwood forest	3509
170900060701	South Santiam R.	Sweet Home; Foster Reservoir	Gain	Open water - lakes, rivers, streams	1064
170900060701	South Santiam R.	Sweet Home; Foster Reservoir	Loss	Westside lowland conifer-hardwood forest	-1480
170900060801	South Santiam R.	Wiley Cr.	Gain	Agriculture	598
170900060801	South Santiam R.	Wiley Cr.	Loss	Westside grasslands	-740
170900070101	Willamette R. - middle	Baskett Slough NWR	Gain	Agriculture	10085
170900070101	Willamette R. - middle	Baskett Slough NWR	Loss	Westside grasslands	-9632
170900070102	Willamette R. - middle	Independence; Monmouth	Gain	Agriculture	29042
170900070102	Willamette R. - middle	Independence; Monmouth	Loss	Westside grasslands	-27743
170900070103	Willamette R. - middle	Ankeny NWR	Gain	Agriculture	19269
170900070103	Willamette R. - middle	Ankeny NWR	Loss	Westside oak and dry Douglas-fir forest and woodlands	-10567
170900070201	Mill Cr.	Sublimity & Turner	Gain	Agriculture	18075
170900070201	Mill Cr.	Sublimity & Turner	Loss	Westside grasslands	-15369
170900070202	Mill Cr.	Aumsville & Beaver Cr.	Gain	Agriculture	15001
170900070202	Mill Cr.	Aumsville & Beaver Cr.	Loss	Westside grasslands	-12105

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
170900070203	Mill Cr.	S. Salem; McKinney Cr.	Gain	Agriculture	9431
170900070203	Mill Cr.	S. Salem; McKinney Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-13304
170900070204	Rickreall Cr.	Rickreall Cr. -upper	Gain	Westside lowland conifer-hardwood forest	4568
170900070204	Rickreall Cr.	Rickreall Cr. -upper	Loss	Westside oak and dry Douglas-fir forest and woodlands	-6149
170900070301	Willamette R./Chehalem Cr.	Saint Paul	Gain	Agriculture	23576
170900070301	Willamette R./Chehalem Cr.	Saint Paul	Loss	Westside grasslands	-12592
170900070302	Willamette R./Chehalem Cr.	Dundee; Newberg	Gain	Agriculture	16010
170900070302	Willamette R./Chehalem Cr.	Dundee; Newberg	Loss	Westside oak and dry Douglas-fir forest and woodlands	-16563
170900070303	Willamette R./Chehalem Cr.	Chehalem Cr.	Gain	Agriculture	11970
170900070303	Willamette R./Chehalem Cr.	Chehalem Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-19351
170900070304	Willamette R./Chehalem Cr.	Lincoln	Gain	Agriculture	17577
170900070304	Willamette R./Chehalem Cr.	Lincoln	Loss	Westside oak and dry Douglas-fir forest and woodlands	-7920
170900070305	Willamette R./Chehalem Cr.	Keizer; Spring Valley Cr.	Gain	Agriculture	14711
170900070305	Willamette R./Chehalem Cr.	Keizer; Spring Valley Cr.	Loss	Westside grasslands	-11375
170900070306	Willamette R./Chehalem Cr.	W. Salem	Gain	Agriculture	3687
170900070306	Willamette R./Chehalem Cr.	W. Salem	Loss	Westside oak and dry Douglas-fir forest and woodlands	-6503
170900070307	Willamette R./Chehalem Cr.	Salem	Gain	Urban or residential	8201
170900070307	Willamette R./Chehalem Cr.	Salem	Loss	Westside oak and dry Douglas-fir forest and woodlands	-13703
170900070401	Molalla R./ Abernethy Cr.	W.Wilsonville	Gain	Agriculture	12393
170900070401	Molalla R./ Abernethy Cr.	W.Wilsonville	Loss	Westside lowland conifer-hardwood forest	-6535
170900070402	Molalla R./ Abernethy Cr.	N. Canby; E. Wilsonville	Gain	Agriculture	13437
170900070402	Molalla R./ Abernethy Cr.	N. Canby; E. Wilsonville	Loss	Westside lowland conifer-hardwood forest	-13196
170900070403	Molalla R./ Abernethy Cr.	Oregon City; West Linn	Gain	Urban or residential	5196
170900070403	Molalla R./ Abernethy Cr.	Oregon City; West Linn	Loss	Westside lowland conifer-hardwood forest	-6603
170900080101	South Yamhill R. - upper	S. Willamina	Gain	Westside lowland conifer-hardwood forest	10170
170900080101	South Yamhill R. - upper	S. Willamina	Loss	Westside oak and dry Douglas-fir forest and woodlands	-9579

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
170900080102	South Yamhill R. - upper	Agency Cr.	Gain	Westside lowland conifer-hardwood forest	3997
170900080102	South Yamhill R. - upper	Agency Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-3314
170900080103	South Yamhill R. - upper	Jackass & Rogue Cr.	Loss	Westside grasslands	-430
170900080103	South Yamhill R. - upper	Jackass & Rogue Cr.	Gain	Westside lowland conifer-hardwood forest	1001
170900080201	North Yamhill R./ Willamina Cr.	Willamina	Gain	Westside lowland conifer-hardwood forest	8520
170900080201	North Yamhill R./ Willamina Cr.	Willamina	Loss	Westside oak and dry Douglas-fir forest and woodlands	-9181
170900080202	North Yamhill R./ Willamina Cr.	Coast Cr.	Gain	Westside lowland conifer-hardwood forest	440
170900080202	North Yamhill R./ Willamina Cr.	Coast Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-397
170900080203	North Yamhill R./ Willamina Cr.	Willamina Cr. -upper	Gain	Westside lowland conifer-hardwood forest	1371
170900080203	North Yamhill R./ Willamina Cr.	Willamina Cr. -upper	Loss	Westside oak and dry Douglas-fir forest and woodlands	-1339
170900080301	South Yamhill R.	Mill & Gooseneck Cr.	Gain	Agriculture	4932
170900080301	South Yamhill R.	Mill & Gooseneck Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-4598
170900080401	South Yamhill R. - lower	Sheridan	Gain	Agriculture	16746
170900080401	South Yamhill R. - lower	Sheridan	Loss	Westside grasslands	-15330
170900080402	South Yamhill R. - lower	Salt Cr.	Gain	Agriculture	8834
170900080402	South Yamhill R. - lower	Salt Cr.	Loss	Westside grasslands	-8424
170900080403	South Yamhill R. - lower	Deer Cr.	Gain	Westside lowland conifer-hardwood forest	13054
170900080403	South Yamhill R. - lower	Deer Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-14980
170900080501	South Yamhill R./ Salt Cr.	Ash Swale & Deer Cr.	Gain	Agriculture	16477
170900080501	South Yamhill R./ Salt Cr.	Ash Swale & Deer Cr.	Loss	Westside grasslands	-14276
170900080502	South Yamhill R./ Salt Cr.	Amity	Gain	Agriculture	23015
170900080502	South Yamhill R./ Salt Cr.	Amity	Loss	Westside grasslands	-17417
170900080601	North Yamhill R.	Yamhill	Gain	Agriculture	15237
170900080601	North Yamhill R.	Yamhill	Loss	Westside grasslands	-11803
170900080602	North Yamhill R.	McMinnville N.	Gain	Agriculture	6223
170900080602	North Yamhill R.	McMinnville N.	Loss	Westside oak and dry Douglas-fir forest and	-7091

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
				woodlands	
170900080603	North Yamhill R.	Panther & Haskins Cr.	Gain	Agriculture	6352
170900080603	North Yamhill R.	Panther & Haskins Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-9981
170900080604	North Yamhill R.	Turner Cr.	Gain	Agriculture	6944
170900080604	North Yamhill R.	Turner Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-8660
170900080605	North Yamhill R.	Fairchild Cr.	Gain	Agriculture	1008
170900080605	North Yamhill R.	Fairchild Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-1728
170900080701	Yamhill R.	Palmer Cr.	Gain	Agriculture	17357
170900080701	Yamhill R.	Palmer Cr.	Loss	Westside grasslands	-11408
170900080702	Yamhill R.	Lafayette	Gain	Agriculture	12133
170900080702	Yamhill R.	Lafayette	Loss	Westside oak and dry Douglas-fir forest and woodlands	-8876
170900080703	Yamhill R.	McMnnville S.	Gain	Agriculture	11684
170900080703	Yamhill R.	McMnnville S.	Loss	Westside grasslands	-12845
170900090101	Pudding R.	Aurora	Gain	Agriculture	6991
170900090101	Pudding R.	Aurora	Loss	Westside lowland conifer-hardwood forest	-2780
170900090102	Pudding R.	Woodburn; Hubbard	Gain	Agriculture	14944
170900090102	Pudding R.	Woodburn; Hubbard	Loss	Westside grasslands	-10142
170900090201	Pudding R.	S. Canby	Gain	Agriculture	12792
170900090201	Pudding R.	S. Canby	Loss	Westside oak and dry Douglas-fir forest and woodlands	-6714
170900090202	Pudding R.	Molalla R. -middle	Gain	Agriculture	3992
170900090202	Pudding R.	Molalla R. -middle	Loss	Westside grasslands	-2969
170900090301	Pudding R.	Butte Cr.	Gain	Agriculture	27349
170900090301	Pudding R.	Butte Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-17751
170900090302	Pudding R.	Cedar Cr.	Gain	Agriculture	2453
170900090302	Pudding R.	Cedar Cr.	Loss	Westside lowland conifer-hardwood forest	-2334
170900090303	Pudding R.	Woodcock Cr.	Gain	Agriculture	2339
170900090303	Pudding R.	Woodcock Cr.	Loss	Westside lowland conifer-hardwood forest	-2668
170900090304	Pudding R.	Canyon Cr. & Colton	Gain	Agriculture	1492

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
170900090304	Pudding R.	Canyon Cr. & Colton	Loss	Westside lowland conifer-hardwood forest	-1475
170900090305	Pudding R.	Milk Cr.	Gain	Agriculture	3464
170900090305	Pudding R.	Milk Cr.	Loss	Westside lowland conifer-hardwood forest	-2882
170900090401	Pudding R.	Scotts Mills Senecal Cr. & Mill Cr.	Gain	Agriculture	1787
170900090401	Pudding R.	Scotts Mills Senecal Cr. & Mill Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-1180
170900090402	Pudding R.	Abiqua Cr.	Gain	Agriculture	1126
170900090402	Pudding R.	Abiqua Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-932
170900090501	Molalla R. - upper	Molalla	Gain	Agriculture	30473
170900090501	Molalla R. - upper	Molalla	Loss	Westside oak and dry Douglas-fir forest and woodlands	-30161
170900090601	Molalla R. - lower	Molalla R. N. Fk.	Loss	Montane mixed conifer forest	-2559
170900090601	Molalla R. - lower	Molalla R. N. Fk.	Gain	Westside lowland conifer-hardwood forest	2512
170900090602	Molalla R. - lower	Molalla R. S. Fk.	Loss	Montane mixed conifer forest	-172
170900090602	Molalla R. - lower	Molalla R. S. Fk.	Gain	Westside lowland conifer-hardwood forest	197
170900090603	Molalla R. - lower	Table Rock Fk.	Loss	Montane mixed conifer forest	-169
170900090603	Molalla R. - lower	Table Rock Fk.	Gain	Westside lowland conifer-hardwood forest	167
170900090604	Molalla R. - lower	Copper & Henry Cr.	Gain	Montane mixed conifer forest	250
170900090604	Molalla R. - lower	Copper & Henry Cr.	Loss	Westside lowland conifer-hardwood forest	-215
170900090701	Pudding R./ Silver Cr.	Little Pudding R.; E. Salem	Gain	Agriculture	33510
170900090701	Pudding R./ Silver Cr.	Little Pudding R.; E. Salem	Loss	Westside grasslands	-15922
170900090702	Pudding R./ Silver Cr.	Drift Cr.	Gain	Agriculture	31405
170900090702	Pudding R./ Silver Cr.	Drift Cr.	Loss	Westside grasslands	-25170
170900090703	Pudding R./ Silver Cr.	Silverton N.	Gain	Agriculture	8803
170900090703	Pudding R./ Silver Cr.	Silverton N.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-5749
170900090704	Pudding R./ Silver Cr.	Silverton S.	Gain	Agriculture	5130
170900090704	Pudding R./ Silver Cr.	Silverton S.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-3470
170900100101	Tualatin R./ Dairy Cr.	Tigard; Tualatin; Sherwood; King City	Gain	Urban or residential	29264
170900100101	Tualatin R./ Dairy Cr.	Tigard; Tualatin; Sherwood; King City	Loss	Westside lowland conifer-hardwood forest	-33712
170900100102	Tualatin R./ Dairy Cr.	Hillsboro	Gain	Agriculture	24482
170900100102	Tualatin R./ Dairy Cr.	Hillsboro	Loss	Westside oak and dry Douglas-fir forest and	-14936

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
				woodlands	
170900100103	Tualatin R./ Dairy Cr.	Beaverton & Rock & Cedar Mill Cr.	Gain	Urban or residential	28372
170900100103	Tualatin R./ Dairy Cr.	Beaverton & Rock & Cedar Mill Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-19426
170900100201	Tualatin R./ Dairy Cr.	Dairy Cr. W. Fk. & Council Cr.; Banks	Gain	Agriculture	26686
170900100201	Tualatin R./ Dairy Cr.	Dairy Cr. W. Fk. & Council Cr.; Banks	Loss	Westside oak and dry Douglas-fir forest and woodlands	-15379
170900100202	Tualatin R./ Dairy Cr.	Diary Cr. E.	Gain	Agriculture	10076
170900100202	Tualatin R./ Dairy Cr.	Diary Cr. E.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-5895
170900100203	Tualatin R./ Dairy Cr.	North Plains; McKay Cr.	Gain	Agriculture	12071
170900100203	Tualatin R./ Dairy Cr.	North Plains; McKay Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-8182
170900100301	Tualatin R./ Scoggins Cr.	Gales & Clear Cr.	Gain	Agriculture	12163
170900100301	Tualatin R./ Scoggins Cr.	Gales & Clear Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-6466
170900100302	Tualatin R./ Scoggins Cr.	Sain & Scoggins Cr.	Gain	Westside lowland conifer-hardwood forest	4832
170900100302	Tualatin R./ Scoggins Cr.	Sain & Scoggins Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-6842
170900100303	Tualatin R./ Scoggins Cr.	Gaston; Sunday & Roaring Cr.	Gain	Westside lowland conifer-hardwood forest	11678
170900100303	Tualatin R./ Scoggins Cr.	Gaston; Sunday & Roaring Cr.	Loss	Westside oak and dry Douglas-fir forest and woodlands	-16617
170900110101	Clackamas R. - Collawash R.	Estacada; E. Gladstone	Gain	Agriculture	10662
170900110101	Clackamas R. - Collawash R.	Estacada; E. Gladstone	Loss	Westside lowland conifer-hardwood forest	-13950
170900110102	Clackamas R. - Collawash R.	Clear Cr.	Gain	Agriculture	7738
170900110102	Clackamas R. - Collawash R.	Clear Cr.	Loss	Westside lowland conifer-hardwood forest	-8106
170900110103	Clackamas R. - Collawash R.	Sandy	Gain	Agriculture	9707
170900110103	Clackamas R. - Collawash R.	Sandy	Loss	Westside lowland conifer-hardwood forest	-12352
170900110201	Clackamas R. - upper	Eagle Cr.	Gain	Agriculture	3414
170900110201	Clackamas R. - upper	Eagle Cr.	Loss	Westside lowland conifer-hardwood forest	-5111
170900110301	Clackamas R. - Oak Grove Fk.	Big Cliff Reservoir	Loss	Montane mixed conifer forest	-4083
170900110301	Clackamas R. - Oak Grove Fk.	Big Cliff Reservoir	Gain	Westside lowland conifer-hardwood forest	3508
170900110302	Clackamas R. - Oak Grove	Fish Cr. W.	Loss	Montane mixed conifer forest	-1531

HUC6	Name of HUC5	Name of HUC6	Trend	Class experiencing greatest gain or loss	Change in acreage
	Fk.				
170900110302	Clackamas R. - Oak Grove Fk.	Fish Cr. W.	Gain	Westside lowland conifer-hardwood forest	1529
170900110303	Clackamas R. - Oak Grove Fk.	Fish Cr. E.	Loss	Montane mixed conifer forest	-638
170900110303	Clackamas R. - Oak Grove Fk.	Fish Cr. E.	Gain	Open water - lakes, rivers, streams	295
170900110304	Clackamas R. - Oak Grove Fk.	Roaring R.	Gain	Montane mixed conifer forest	1291
170900110304	Clackamas R. - Oak Grove Fk.	Roaring R.	Loss	Westside lowland conifer-hardwood forest	-1348
170900110401	Clackamas R. - middle	Harriet Lake	Loss	Montane mixed conifer forest	-4957
170900110401	Clackamas R. - middle	Harriet Lake	Gain	Westside lowland conifer-hardwood forest	5203
170900110402	Clackamas R. - middle	Timothy Lake; Dinger Lake	Loss	Montane mixed conifer forest	-12027
170900110402	Clackamas R. - middle	Timothy Lake; Dinger Lake	Gain	Westside lowland conifer-hardwood forest	15850
170900110501	Clackamas R. - Eagle Cr.	Clackamas R. - upper	Loss	Lodgepole pine forest and woodlands	-1669
170900110501	Clackamas R. - Eagle Cr.	Clackamas R. - upper	Gain	Westside lowland conifer-hardwood forest	1365
170900110502	Clackamas R. - Eagle Cr.	Berry & Cub & Lowe Cr.	Loss	Lodgepole pine forest and woodlands	-13506
170900110502	Clackamas R. - Eagle Cr.	Berry & Cub & Lowe Cr.	Gain	Westside lowland conifer-hardwood forest	22657
170900110601	Clackamas R. - lower	Nohorn Cr.	Loss	Montane mixed conifer forest	-7837
170900110601	Clackamas R. - lower	Nohorn Cr.	Gain	Westside lowland conifer-hardwood forest	7772
170900110602	Clackamas R. - lower.	Dickey & Elk Cr.	Loss	Montane mixed conifer forest	-4557
170900110602	Clackamas R. - lower.	Dickey & Elk Cr.	Gain	Westside lowland conifer-hardwood forest	4745
170900120201	Willamette R. - lower	Portland; Forest Hills; Multnomah Channel	Gain	Urban or residential	28131
170900120201	Willamette R. - lower	Portland; Forest Hills; Multnomah Channel	Loss	Westside lowland conifer-hardwood forest	-23626
170900120202	Willamette R. - lower	S. Milwaukie; Happy Valley; Lake Oswego; W	Gain	Urban or residential	20418
170900120202	Willamette R. - lower	S. Milwaukie; Happy Valley; Lake Oswego; W	Loss	Westside lowland conifer-hardwood forest	-15633
170900120203	Willamette R. - lower	Gresham; Portland; N. Milwaukie	Gain	Urban or residential	18790
170900120203	Willamette R. - lower	Gresham; Portland; N. Milwaukie	Loss	Westside lowland conifer-hardwood forest	-22199

Table 47. Change in the predominant land cover type, by watershed (HUC6), mid-1800's to early 1990s.

Note: The most detailed land cover classification was used for present land cover (column 4), even though it differed from the only available classification for the historical (column 7). Both sources have significant limitations with regard to their analytical methods but are the only data available basinwide. The more significant changes are highlighted. Other factors being equal, watersheds that have experienced the most drastic structural change in land cover should be given higher consideration for habitat restoration. See MapFile: HUC6map for locations. Data compiled by NHI from ONHP historical and EC90 vegetation layers.

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
170900010101	Willamette R. Middle Fk.	Rattlesnake & Hills Cr.	Westside lowland conifer-hardwood forest	35	12522	Forest closed mixed	20	7147
170900010201	Willamette R. Middle Fk.	Hills Cr.	Westside lowland conifer-hardwood forest	90	33736	Forest closed mixed	48	18076
170900010301	Willamette R. Middle Fk.	Fall Cr. Reservoir N.	Westside lowland conifer-hardwood forest	91	38108	Forest closed mixed	34	14335
170900010302	Willamette R. Middle Fk.	Fall & Delp Cr.	Westside lowland conifer-hardwood forest	100	41225	Forest closed mixed	38	15516
170900010401	Willamette R. Middle Fk.	Fall Cr. Reservoir S.; Winberry Cr.	Westside lowland conifer-hardwood forest	82	32922	Forest closed mixed	33	13386
170900010501	Willamette R. Middle Fk.	Dexter Reservoir	Westside lowland conifer-hardwood forest	64	9846	Forest closed mixed	29	4427
170900010502	Willamette R. Middle Fk.	Hemlock; Lookout Point Reservoir	Westside lowland conifer-hardwood forest	98	51030	Forest closed mixed	25	13100
170900010601	Willamette R. Middle Fk.	Lost R.; Anthony Cr.	Westside lowland conifer-hardwood forest	71	24741	Forest closed mixed	30	10535
170900010701	Willamette R. Middle Fk.	Hemlock; Middle Fk. of N. Fk. of Willamette	Westside lowland conifer-hardwood forest	95	34868	Forest closed mixed	30	10917
170900010702	Willamette R. Middle Fk.	Christy Cr.	Westside lowland conifer-hardwood forest	90	25873	Forest closed mixed	35	10176
170900010703	Willamette R. Middle Fk.	Grassy Cr.	Westside lowland conifer-hardwood forest	89	20416	Forest closed mixed	31	7202
170900010801	Willamette R. Middle Fk.	Oakridge E.	Westside lowland conifer-hardwood forest	90	31509	Forest closed mixed	28	9797
170900010802	Willamette R. Middle Fk.	Black & Salmon & Wall Cr.	Westside lowland conifer-hardwood forest	78	19944	Forest closed mixed	39	9973
170900010803	Willamette R. Middle Fk.	Waldo Lake; Black & Salmon Cr.	Westside lowland conifer-hardwood forest	56	12325	Forest closed mixed	36	7813
170900010901	Willamette R. Middle Fk.	Waldo Lake; Cayuse & Fisher Cr.	Montane mixed conifer forest	43	29770	Forest closed mixed	44	30457

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
170900011001	Willamette R. Middle Fk.	Salt & Gold & Eagle Cr.	Montane mixed conifer forest	51	36591	Forest closed conifer older than 200 yrs.	37	26205
170900011101	Willamette R. Middle Fk.	Groundhog Cr: S.Fork	Westside lowland conifer-hardwood forest	83	31769	Forest closed conifer older than 200 yrs.	29	11343
170900011201	Willamette R. Middle Fk.	Staley & Swift & Spruce Cr.	Westside lowland conifer-hardwood forest	54	60413	Forest closed conifer older than 200 yrs.	30	33462
170900011301	Willamette R. Middle Fk.	Oakridge W.; Hills Creek Reservoir	Westside lowland conifer-hardwood forest	91	98280	Forest closed conifer older than 200 yrs.	27	28914
170900020101	Willamette R. Coast Fk./ Row R.	Creswell E. Bear & Gettings Cr.	Westside oak & dry Douglas-fir forests	39	22844	Forest closed mixed	20	11864
170900020102	Willamette R. Coast Fk./ Row R.	Creswell W.; Camas Swale	Westside oak & dry Douglas-fir forests	53	15712	Forest closed mixed	15	4584
170900020201	Willamette R. Coast Fk./ Row R.	Mosby Cr.	Westside lowland conifer-hardwood forest	86	52875	Forest closed mixed	29	17972
170900020301	Willamette R. Coast Fk. - upper	Cottage Grove Reservoir N.	Westside oak & dry Douglas-fir forests	45	19599	Forest closed mixed	20	8751
170900020302	Willamette R. Coast Fk. - upper	Cottage Grove Reservoir S.	Westside lowland conifer-hardwood forest	85	44205	Conifers 0 - 20 yrs	22	11615
170900020401	Willamette R. Coast Fk./ Row R.	Dorena Reservoir	Westside lowland conifer-hardwood forest	65	33115	Forest closed mixed	30	15222
170900020501	Willamette R. Coast Fk. - lower	Laying & Dinner & Herman Cr.	Westside lowland conifer-hardwood forest	100	48377	Forest closed mixed	26	12457
170900020502	Willamette R. Coast Fk. - lower	Brice Cr.	Westside lowland conifer-hardwood forest	96	35084	Forest closed conifer older than 200 yrs.	27	10023
170900020503	Willamette R. Coast Fk. - lower	Sharps & Martin Cr.	Westside lowland conifer-hardwood forest	99	40592	Forest closed conifer 81 - 200 yrs.	27	11097
170900030101	Long Tom R.	W. Eugene; Junction City	Westside grasslands	48	49105	Grass seed rotation	12	12384
170900030102	Long Tom R.	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	Westside oak & dry Douglas-fir forests	68	68832	Forest closed mixed	15	15728
170900030103	Long Tom R.	Coyote Cr.	Westside oak & dry	62	40487	Forest closed mixed	16	10551

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
			Douglas-fir forests					
170900030201	Muddy Cr.	Corvallis N.; Adair Village	Westside oak & dry Douglas-fir forests	37	14020	Grass seed rotation	19	7051
170900030202	Muddy Cr.	Monroe; Muddy Cr. E.	Westside riparian wetlands	52	31360	Grass seed rotation	29	17486
170900030203	Muddy Cr.	Coburg; Halsey; Little Muddy R.; Pierce Cr	Westside grasslands	63	59649	Grass seed rotation	43	41253
170900030204	Muddy Cr.	E. Eugene; Harrisburg; Springfield	Westside grasslands	53	25423	Residential 0-4 dwellings/ac	15	7037
170900030301	Calapooia R.	Courtney Cr.	Westside grasslands	66	27667	Grass seed rotation	49	20462
170900030302	Calapooia R.	Brownsville	Westside grasslands	51	34610	Grass seed rotation	34	22985
170900030303	Calapooia R.	Calapooia R - middle	Westside lowland conifer-hardwood forest	64	46819	Forest closed mixed	30	21854
170900030401	Calapooia R./ Oak Cr.	N. Albany; W. Lebanon; Cox Cr.	Westside grasslands	60	28620	Grass seed rotation	31	14929
170900030402	Calapooia R./ Oak Cr.	S. Albany; Tangent.	Westside grasslands	71	26150	Grass seed rotation	59	21593
170900030403	Calapooia R./ Oak Cr.	Sodaville	Westside grasslands	71	13674	Grass seed rotation	34	6464
170900030501	Marys R.	Corvallis; Philomath; Mary's R.-lower	Westside lowland conifer-hardwood forest	40	17470	Forest closed mixed	19	8263
170900030502	Marys R.	Mary's R -middle	Westside lowland conifer-hardwood forest	55	25275	Forest closed mixed	30	13902
170900030503	Marys R.	Mary's R. -upper	Westside oak & dry Douglas-fir forests	76	15585	Forest closed mixed	33	6826
170900030504	Marys R.	Finley NWR; Muddy & Hammer Cr.	Westside oak & dry Douglas-fir forests	44	35254	Grass seed rotation	15	12166
170900030601	Luckiamute R.	Luckiamute R.4	Westside grasslands	57	9904	Grass seed rotation	24	4097
170900030602	Luckiamute R.	Soap Cr.	Westside grasslands	51	18853	Grass seed rotation	18	6694
170900030603	Luckiamute R.	Luckiamute R.1.	Westside oak & dry Douglas-fir forests	81	20262	Forest closed mixed	31	7813
170900030604	Luckiamute R.	Luckiamute R.2.	Westside oak & dry Douglas-fir forests	58	25207	Forest closed mixed	24	10594
170900030605	Luckiamute R.	Luckiamute R.3.	Westside lowland conifer-hardwood forest	94	24463	Forest closed mixed	34	8905
170900030606	Luckiamute R.	Little Luckiamute R. - lower	Westside oak & dry Douglas-fir forests	66	17488	Forest closed mixed	14	3611
170900030607	Luckiamute R.	Little Luckiamute R. - upper	Westside lowland conifer-hardwood forest	60	14772	Forest closed conifer 41 - 60 yrs.	22	5290

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
170900040101	McKenzie R. - upper	E. Springfield; Camp & Ritchie Cr.	Westside lowland conifer-hardwood forest	70	87086	Forest closed mixed	31	38084
170900040102	McKenzie R. - upper	Gate Cr. S. Fk.	Westside lowland conifer-hardwood forest	98	39382	Forest closed mixed	32	12755
170900040201	McKenzie R. - upper	Horse & Parsons & Cash & Mill Cr.	Westside lowland conifer-hardwood forest	76	87849	Forest closed mixed	32	36920
170900040301	McKenzie R.	Blue River Reservoir & Cook Cr.	Westside lowland conifer-hardwood forest	96	19849	Forest closed mixed	40	8345
170900040401	McKenzie R.	Blue River Reservoir & Elk Cr.	Westside lowland conifer-hardwood forest	82	48672	Forest closed mixed	35	20397
170900040501	McKenzie R.	Boulder Cr. & Smith R.	Westside lowland conifer-hardwood forest	49	77843	Forest closed mixed	33	53339
170900040502	McKenzie R.	White Branch	Montane mixed conifer forest	36	25176	Forest closed mixed	32	22349
170900040601	McKenzie R./ Mohawk R.	Separation Cr.	Westside lowland conifer-hardwood forest	56	34152	Forest closed mixed	29	17800
170900040602	McKenzie R./ Mohawk R.	Horse & Eugene Cr.	Lodgepole pine forests	49	18821	Forest closed conifer older than 200 yrs.	33	12881
170900040701	McKenzie R. - lower	Quartz Cr.	Westside lowland conifer-hardwood forest	90	24278	Forest closed mixed	38	10388
170900040801	McKenzie R. - S. Fk.	Cougar Reservoir & Walker Cr.	Westside lowland conifer-hardwood forest	77	29573	Forest closed mixed	28	10820
170900040802	McKenzie R. - S. Fk.	French Pete Cr.	Westside lowland conifer-hardwood forest	69	24928	Forest closed conifer 81 - 200 yrs.	35	12503
170900040803	McKenzie R. - S. Fk.	Roaring R. & Elk Cr.	Westside lowland conifer-hardwood forest	43	27132	Forest closed mixed	40	25536
170900050101	North Santiam R. - upper	Detroit; Idanha	Westside lowland conifer-hardwood forest	77	32174	Forest closed mixed	33	13842
170900050102	North Santiam R. - upper	Marion Lake	Montane mixed conifer forest	55	32874	Forest closed mixed	35	21134
170900050103	North Santiam R. - upper	Pyramid Cr.	Westside lowland conifer-hardwood forest	44	18608	Forest closed mixed	33	14107
170900050201	North Santiam R.	Breitenbush R.	Westside lowland conifer-hardwood forest	70	49030	Forest closed mixed	38	26240
170900050301	North Santiam R.	Detroit Reservoir	Westside lowland conifer-hardwood forest	91	67739	Forest closed mixed	33	24450

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
170900050401	North Santiam R. - middle	Gates; Lyons; Mill City	Westside lowland conifer-hardwood forest	87	49441	Forest closed mixed	36	20288
170900050501	North Santiam R.	Little North Santiam R.	Westside lowland conifer-hardwood forest	83	59728	Forest closed mixed	42	30192
170900050601	North Santiam R. - lower	Jefferson; Lyons; Bear Branch	Westside oak & dry Douglas-fir forests	47	37916	Pasture	15	12270
170900060101	South Santiam R./ Crabtree Cr.	Crabtree Cr. & Onehorse Slough	Westside riparian wetlands	57	9992	Grass seed rotation	22	3832
170900060102	South Santiam R./ Crabtree Cr.	E. Lebanon; Hamilton Cr.	Westside oak & dry Douglas-fir forests	50	22596	Forest closed conifer 81 - 200 yrs.	15	6644
170900060102	South Santiam R./ Crabtree Cr.	E. Lebanon; Hamilton Cr.	Westside oak & dry Douglas-fir forests	50	22596	Forest closed mixed	19	8894
170900060103	South Santiam R./ Crabtree Cr.	Waterloo; Sweet Home; McDowell Cr.	Westside oak & dry Douglas-fir forests	66	37076	Forest closed mixed	26	14331
170900060201	South Santiam R./ Crabtree Cr.	Beaver Cr.	Westside oak & dry Douglas-fir forests	53	24671	Grass seed rotation	20	9255
170900060202	South Santiam R./ Crabtree Cr.	Roaring R.	Westside lowland conifer-hardwood forest	78	41645	Forest closed mixed	36	19125
170900060301	South Santiam R. /Thomas Cr.	Lower Thomas Cr. - lower; Scio	Westside oak & dry Douglas-fir forests	48	13641	Grass seed rotation	18	5159
170900060302	South Santiam R. /Thomas Cr.	Upper Thomas & Neil Cr. & Indian Prairie	Westside lowland conifer-hardwood forest	62	39367	Forest closed mixed	36	22741
170900060401	South Santiam R.	Greenpeter Reservoir	Westside lowland conifer-hardwood forest	99	53039	Forest closed mixed	32	17119
170900060402	South Santiam R.	Quartzville Cr.-upper	Westside lowland conifer-hardwood forest	100	55685	Forest closed mixed	29	16139
170900060501	Santiam R. - middle	Pyramid Cr. & Quartzville Cr.-lower	Westside lowland conifer-hardwood forest	89	59394	Conifers 0 - 20 yrs	31	20732
170900060601	South Santiam R.	Sevenmile & Soda & Squaw Cr.	Westside lowland conifer-hardwood forest	89	60729	Forest closed mixed	32	21953
170900060602	South Santiam R.	Canyon Cr.	Westside lowland conifer-hardwood forest	84	28528	Forest closed mixed	37	12573
170900060701	South Santiam R.	Sweet Home; Foster Reservoir	Westside lowland conifer-hardwood forest	88	32020	Forest closed mixed	49	17695
170900060801	South Santiam R.	Wiley Cr.	Westside lowland conifer-hardwood forest	91	36927	Forest closed mixed	45	18334
170900070101	Willamette R. - middle	Baskett Slough NWR	Westside grasslands	65	10158	Pasture	28	4374

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
170900070102	Willamette R. - middle	Independence; Monmouth	Westside grasslands	64	28158	Grass seed rotation	19	8591
170900070103	Willamette R. - middle	Ankeny NWR	Westside riparian wetlands	35	11054	Pasture	16	4936
170900070201	Mill Cr.	Sublimity & Turner	Westside grasslands	51	16191	Pasture	26	8206
170900070202	Mill Cr.	Aumsville & Beaver Cr.	Westside oak & dry Douglas-fir forests	78	16076	Grass seed rotation	20	4076
170900070203	Mill Cr.	S. Salem; McKinney Cr.	Westside oak & dry Douglas-fir forests	82	15298	Pasture	20	3806
170900070204	Rickreall Cr.	Rickreall Cr. -upper	Westside lowland conifer-hardwood forest	64	16397	Forest closed mixed	24	6195
170900070301	Willamette R./Chehalem Cr.	Saint Paul	Westside oak & dry Douglas-fir forests	61	17741	Grass seed rotation	26	7465
170900070302	Willamette R./Chehalem Cr.	Dundee; Newberg	Westside oak & dry Douglas-fir forests	49	14792	Natural shrub	13	3782
170900070303	Willamette R./Chehalem Cr.	Chehalem Cr.	Westside oak & dry Douglas-fir forests	83	22062	Natural shrub	20	5178
170900070304	Willamette R./Chehalem Cr.	Lincoln	Westside riparian wetlands	45	11883	Irrigated annual rotation	23	6105
170900070305	Willamette R./Chehalem Cr.	Keizer; Spring Valley Cr.	Westside oak & dry Douglas-fir forests	50	15746	Pasture	12	3634
170900070306	Willamette R./Chehalem Cr.	W. Salem	Westside oak & dry Douglas-fir forests	66	7477	Residential 0 - 4 dwellings/ac	18	1979
170900070307	Willamette R./Chehalem Cr.	Salem	Westside oak & dry Douglas-fir forests	78	13563	Residential 0 - 4 dwellings/ac	20	3432
170900070401	Molalla R./ Abernethy Cr.	W.Wilsonville	Westside oak & dry Douglas-fir forests	50	13110	Natural shrub	14	3533
170900070402	Molalla R./ Abernethy Cr.	N. Canby; E. Wilsonville	Westside oak & dry Douglas-fir forests	95	32198	Natural shrub	17	5696
170900070403	Molalla R./ Abernethy Cr.	Oregon City; West Linn	Westside oak & dry Douglas-fir forests	80	21049	Forest closed mixed	21	5575
170900080101	South Yamhill R. - upper	S. Willamina	Westside lowland conifer-hardwood forest	53	17614	Forest closed mixed	21	7031
170900080102	South Yamhill R. - upper	Agency Cr.	Westside lowland conifer-hardwood forest	74	29140	Forest closed mixed	34	13318
170900080103	South Yamhill R. - upper	Jackass & Rogue Cr.	Westside lowland conifer-hardwood forest	84	12670	Forest closed mixed	29	4438

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
170900080201	North Yamhill R./ Willamina Cr.	Willamina	Westside oak & dry Douglas-fir forests	60	8231	Forest closed mixed	22	3062
170900080202	North Yamhill R./ Willamina Cr.	Coast Cr.	Westside lowland conifer-hardwood forest	79	11128	Forest closed mixed	30	4174
170900080203	North Yamhill R./ Willamina Cr.	Willamina Cr. -upper	Westside lowland conifer-hardwood forest	89	21800	Forest closed mixed	32	7914
170900080301	South Yamhill R.	Mill & Gooseneck Cr.	Westside lowland conifer-hardwood forest	69	23547	Forest closed mixed	21	7237
170900080401	South Yamhill R. - lower	Sheridan	Westside grasslands	39	10990	Pasture	15	4306
170900080402	South Yamhill R. - lower	Salt Cr.	Westside grasslands	49	5977	Grass seed rotation	20	2491
170900080403	South Yamhill R. - lower	Deer Cr.	Westside oak & dry Douglas-fir forests	58	20612	Forest closed hardwood	17	6117
170900080501	South Yamhill R./ Salt Cr.	Ash Swale & Deer Cr.	Westside grasslands	59	13787	Pasture	21	4810
170900080502	South Yamhill R./ Salt Cr.	Amity	Westside oak & dry Douglas-fir forests	76	30097	Pasture	17	6767
170900080601	North Yamhill R.	Yamhill	Westside grasslands	47	11629	Grains	15	3707
170900080602	North Yamhill R.	McMinnville N.	Westside lowland conifer-hardwood forest	39	7472	Forest closed mixed	15	2812
170900080603	North Yamhill R.	Panther & Haskins Cr.	Westside oak & dry Douglas-fir forests	60	16827	Forest closed mixed	21	5729
170900080604	North Yamhill R.	Turner Cr.	Westside oak & dry Douglas-fir forests	56	10986	Forest closed mixed	14	2742
170900080605	North Yamhill R.	Fairchild Cr.	Westside lowland conifer-hardwood forest	94	19931	Forest closed mixed	31	6685
170900080701	Yamhill R.	Palmer Cr.	Westside oak & dry Douglas-fir forests	57	14244	Grass seed rotation	12	2935
170900080702	Yamhill R.	Lafayette	Westside riparian wetlands	36	6647	Hayfield	17	3140
170900080703	Yamhill R.	McMnnville S.	Westside grasslands	53	10697	Hayfield	13	2647
170900090101	Pudding R.	Aurora	Westside riparian wetlands	55	6650	Natural shrub	16	1877
170900090102	Pudding R.	Woodburn; Hubbard	Westside oak & dry Douglas-fir forests	58	13474	Grass seed rotation	13	3027
170900090201	Pudding R.	S. Canby	Westside oak & dry Douglas-fir forests	60	12047	Pasture	21	4153
170900090202	Pudding R.	Molalla R. -middle	Westside oak & dry	67	9812	Forest closed mixed	23	3462

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
			Douglas-fir forests					
170900090301	Pudding R.	Butte Cr.	Westside oak & dry Douglas-fir forests	69	24534	Pasture	17	5923
170900090302	Pudding R.	Cedar Cr.	Westside oak & dry Douglas-fir forests	76	7898	Forest closed mixed	30	3060
170900090303	Pudding R.	Woodcock Cr.	Westside lowland conifer-hardwood forest	50	10136	Forest closed mixed	33	6644
170900090304	Pudding R.	Canyon Cr. & Colton	Westside lowland conifer-hardwood forest	77	16971	Forest closed mixed	37	8157
170900090305	Pudding R.	Milk Cr.	Westside oak & dry Douglas-fir forests	87	10843	Forest closed mixed	22	2723
170900090401	Pudding R.	Scotts Mills Senecal Cr. & Mill Cr.	Westside lowland conifer-hardwood forest	75	27981	Forest closed mixed	40	14988
170900090402	Pudding R.	Abiqua Cr.	Westside lowland conifer-hardwood forest	74	23555	Forest closed mixed	36	11432
170900090501	Molalla R. - upper	Molalla	Westside oak & dry Douglas-fir forests	78	42796	Pasture	22	12332
170900090601	Molalla R. - lower	Molalla R. N. Fk.	Westside lowland conifer-hardwood forest	87	31337	Forest closed mixed	31	11030
170900090602	Molalla R. - lower	Molalla R. S. Fk.	Westside lowland conifer-hardwood forest	95	38080	Forest closed mixed	34	13740
170900090603	Molalla R. - lower	Table Rock Fk.	Westside lowland conifer-hardwood forest	86	19373	Forest closed mixed	37	8353
170900090604	Molalla R. - lower	Copper & Henry Cr.	Westside lowland conifer-hardwood forest	98	22032	Forest closed mixed	32	7133
170900090701	Pudding R./ Silver Cr.	Little Pudding R.; E. Salem	Westside grasslands	46	20891	Pasture	14	6584
170900090702	Pudding R./ Silver Cr.	Drift Cr.	Westside oak & dry Douglas-fir forests	53	25509	Grass seed rotation	20	9367
170900090703	Pudding R./ Silver Cr.	Silverton N.	Westside oak & dry Douglas-fir forests	80	13450	Natural shrub	19	3140
170900090704	Pudding R./ Silver Cr.	Silverton S.	Westside lowland conifer-hardwood forest	46	16010	Forest closed mixed	24	8385
170900100101	Tualatin R./ Dairy Cr.	Tigard; Tualatin; Sherwood; King City	Westside oak & dry Douglas-fir forests	74	45970	Residential 0 - 4 dwellings/ac	22	13723
170900100102	Tualatin R./ Dairy Cr.	Hillsboro	Westside oak & dry Douglas-fir forests	68	32645	Natural shrub	12	5657

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
170900100103	Tualatin R./ Dairy Cr.	Beaverton & Rock & Cedar Mill Cr.	Westside oak & dry Douglas-fir forests	79	38503	Residential 0 - 4 dwellings/ac	29	13929
170900100201	Tualatin R./ Dairy Cr.	Dairy Cr. W. Fk. & Council Cr.; Banks	Westside oak & dry Douglas-fir forests	50	34223	Forest closed mixed	12	8303
170900100202	Tualatin R./ Dairy Cr.	Diary Cr. E.	Westside lowland conifer-hardwood forest	58	23633	Forest closed mixed	20	8119
170900100203	Tualatin R./ Dairy Cr.	North Plains; McKay Cr.	Westside lowland conifer-hardwood forest	44	16455	Forest closed mixed	18	6687
170900100301	Tualatin R./ Scoggins Cr.	Gales & Clear Cr.	Westside lowland conifer-hardwood forest	57	33677	Forest closed mixed	20	11552
170900100302	Tualatin R./ Scoggins Cr.	Sain & Scoggins Cr.	Westside lowland conifer-hardwood forest	59	21259	Forest closed mixed	28	9966
170900100303	Tualatin R./ Scoggins Cr.	Gaston; Sunday & Roaring Cr.	Westside lowland conifer-hardwood forest	43	21407	Forest closed mixed	20	10202
170900110101	Clackamas R. - Collawash R.	Estacada; E. Gladstone	Westside oak & dry Douglas-fir forests	90	36289	Forest closed mixed	17	7013
170900110102	Clackamas R. - Collawash R.	Clear Cr.	Westside lowland conifer-hardwood forest	56	25469	Forest closed mixed	27	12038
170900110103	Clackamas R. - Collawash R.	Sandy	Westside oak & dry Douglas-fir forests	100	31781	Forest closed mixed	21	6643
170900110201	Clackamas R. - upper	Eagle Cr.	Westside lowland conifer-hardwood forest	68	39299	Forest closed mixed	31	17844
170900110301	Clackamas R. - Oak Grove Fk.	Big Cliff Reservoir	Westside lowland conifer-hardwood forest	89	42206	Forest closed conifer 81 - 200 yrs.	30	14208
170900110302	Clackamas R. - Oak Grove Fk.	Fish Cr. W.	Westside lowland conifer-hardwood forest	85	25716	Forest closed mixed	32	9702
170900110303	Clackamas R. - Oak Grove Fk.	Fish Cr. E.	Westside lowland conifer-hardwood forest	87	29148	Forest closed mixed	29	9867
170900110304	Clackamas R. - Oak Grove Fk.	Roaring R.	Westside lowland conifer-hardwood forest	79	21540	Forest closed mixed	32	8709
170900110401	Clackamas R. - middle	Harriet Lake	Westside lowland conifer-hardwood forest	83	29155	Forest closed mixed	34	12078
170900110402	Clackamas R. - middle	Timothy Lake; Dinger Lake	Westside lowland conifer-hardwood forest	74	41012	Forest closed conifer older than 200 yrs.	31	17384
170900110501	Clackamas R. - Eagle Cr.	Clackamas R. - upper	Westside lowland conifer-hardwood forest	87	35566	Forest closed mixed	29	11706

HUC6	Name of HUC5	Name of HUC6 (not comprehensive)	Historically Dominant	% of HUC6	1850s acres	Currently Dominant (EC90 layer)	% of HUC6	1990 acres
170900110502	Clackamas R. - Eagle Cr.	Berry & Cub & Lowe Cr.	Westside lowland conifer-hardwood forest	41	24279	Forest closed mixed	37	21850
170900110601	Clackamas R. - lower	Nohorn Cr.	Westside lowland conifer-hardwood forest	80	36696	Forest closed mixed	25	11663
170900110602	Clackamas R. - lower.	Dickey & Elk Cr.	Westside lowland conifer-hardwood forest	72	37072	Forest closed conifer older than 200 yrs.	31	16091
170900120201	Willamette R. - lower	Portland; Forest Hills; Multnomah Channel	Westside oak & dry Douglas-fir forests	69	27931	Light duty roads	19	7769
170900120202	Willamette R. - lower	S. Milwaukie; Happy Valley; Lake Oswego; W	Westside oak & dry Douglas-fir forests	75	19420	Residential 0 - 4 dwellings/ac	47	12049
170900120203	Willamette R. - lower	Gresham; Portland; N. Milwaukie	Westside oak & dry Douglas-fir forests	97	33168	Residential 0 - 4 dwellings/ac	23	8014

4.2.3 Habitat Availability: Looking Ahead

In attempts to estimate the future impacts of habitat change on wildlife (section 4.2.4) and other resources, two studies (Hulse et al. 2002, Payne 2002) have involved economists, land use planners, foresters, and other resource managers in drafting "most likely" future landscapes. These studies paint a picture of land cover changes that experts believe are most likely to occur in the Willamette subbasin given no change in current practices and policies, and given various alternative assumptions.

On public forest lands, these studies assume the continued implementation of the Northwest Forest Plan. Management of private timberlands is presumed to continue the practices employed generally from 1972 to 1994. Specifically, the average size of clearcut patches is presumed to continue to be about 30 acres on public and private industrial timberland and 5.6 acres on private non-industrial timberland. Clearcutting on federal timberland is presumed to continue on a rotation of 80-150 years, on a rotation of 60 years on private industrial timberland, and on a rotation of 128 years on private non-industrial timberland. The present practices used to protect riparian areas on timberlands are presumed to continue, i.e., as specified by Oregon Forest Practices Act and federal riparian reserves policy. For example, requirements will continue for a 300 ft buffer (each side) of large fish-bearing streams, and 150 ft on smaller streams.

On agricultural lands, it is likely that restoration of riparian habitat will continue mainly on a voluntary basis, and then covering only a small fraction (<10%) of the total channels that traverse agricultural lands. It also is presumed that protection of the most productive farmlands will continue under state land use laws, and that the median size of a farm in the subbasin will remain about 12-38 acres. By 2050, it is expected that approximately 1,367,000 acres in the Willamette subbasin will be available for farm use, in contrast to 1,406,000 acres today.

In urban residential areas, expansion of designated urban growth boundaries by 51,000 acres is anticipated by 2050 to accommodate an urban population increase of 1.9 million people (up from 1.7 million in 1990). It is presumed that in urban areas the housing density will average about 7.9 dwelling units per acre, or 7.3 residents per acre.

Elsewhere, rural residential zones (as they existed in 1990) are presumed to be completely built out by 2020, with 12,382 dwellings added, and it is presumed additional rural zones will be designated for development. It is presumed state land use laws will exclude construction on the most productive lands (e.g., forest lands that produce >5000 cu. ft. of wood per year) and that this constraint plus those imposed by wet soils and other geotechnical factors will allow future development of only 455,738 acres (6% of the subbasin). These developable areas are located mainly in the foothills and are more prevalent on the east than west side of the Willamette Valley (Payne 2002).

4.2.4 Consequences of Habitat Loss (Land Conversion) for Wildlife

In terms of wildlife habitat, what do all the past (section 4.2.2) and future (section 4.2.3) changes in land cover and land management practices mean? Which species are most likely to be "winners" and "losers"? Conservation biologists have explored these questions using two approaches: (1) application of species-habitat models to future landscapes as projected by the scenarios described in section 4.2.3, and (2) application of population dynamics models to the same future landscapes. The latter approach is mechanistic and is more scientifically defensible, but has stiff requirements for species demographic data. Such data are seldom available and are costly to collect. In the Willamette subbasin, two PNW-ERC studies have used the former approach, despite its many limitations, and one has used the latter.

Conclusions from White et al. (2002) Analysis

As expected, the historical landscape was found to provide the best overall habitat. Habitat for reptiles (as represented by the among-species median score that is based on both acreage and habitat suitability) has declined 52%, for birds has declined 35%, for amphibians has declined 23%, and for mammals has declined 20%. Species richness was much greater in 1850 in areas that are now in the Willamette River riparian corridor or in developed urban areas, whereas species richness was less then (i.e., has now increased) in foothills.

Conclusions from Payne's (2002) Analysis

The assumptions used in this analysis were considerably more detailed and spatially explicit than those of the above simulation. For example, the effects of future vegetative succession on unmanaged lands, over and above the effects of development, were modeled and factored into the analysis. Again, for the majority of native species the historical landscape was found to provide better habitat than the present or any future scenario, even assuming conservation. Specifically, in 61% of the subbasin the local wildlife richness was greater in 1850 than currently. Focusing just on species that are currently rare, Payne found that 4 gained habitat since 1850, 33 lost habitat, and for 3 there was no significant change in habitat area.

Looking toward the future (year 2050), under all scenarios about 21-22% of the subbasin is projected to lose wildlife species and 17-18% may gain species. Among the species projected to lose the most habitat are vesper sparrow, wood duck, white-tailed kite, Hutton's vireo, brown creeper, spotted owl, green heron, pileated woodpecker, common snipe, western rattlesnake, and Oregon slender salamander (Table 50). Focusing just on the 40 rarest species, and this time assuming current policies continue unchanged, by 2050 roughly 3 rare species will gain habitat, 6 will lose, and 31 will experience neither.

Conclusions from application of PATCH model

As reported in Hulse et al. (2002), this analysis covered just 17 wildlife species[19] for which background data on demographic characteristics were available. Results for this small suite of species mostly echoed those of White et al. (2002) for all wildlife species, with the historical landscape supporting the largest populations. Simulated application of habitat conservation throughout the subbasin increased the populations of 14 of the 17 species.

[19] Cooper's hawk, northern goshawk, red-tailed hawk, blue grouse, great horned owl, spotted owl, mourning dove, pileated woodpecker, black-capped chickadee, gray jay, marsh wren, western meadowlark, Douglas squirrel, bobcat, coyote, red fox, raccoon

Table 48. Historical change in breeding habitat in the Willamette subbasin for all terrestrial vertebrates as projected by habitat relationship models applied by Payne (2002) to circa-1850 land cover maps.

Note: * = focal species. The values in the last 2 columns of this table are relative to the 1990 condition. Their accuracy for individual species is expected to be lower, and much lower in some cases, than for means or medians of values for groups of species. Species have been sorted in descending order according to the last column. "Suitability" is the sum of acres weighted by the suitability (0-10 scale).

Species	Historic minus current suitability	Historic minus current area	% change in suitability	% change in area
Lewis' Woodpecker	10620421	1062161	-3329286	-1685970
Lark Sparrow	1857001	198604	-4619	-4731
Short-Eared Owl	33924288	3862982	-978	-4083
*Vesper Sparrow	59906459	7011639	-854	-680
*Marbled Murrelet	9965476	941440	-851	-526
Northern Shoveler	6733937	1124037	-791	-900
Northern Pintail	3687109	613213	-724	-815
Grasshopper Sparrow	9964900	849455	-722	-3260
Yellow-Headed Blackbird	7039604	1176386	-661	-771
Green-Winged Teal	1806691	304236	-660	-761
*Sora	14117787	1245276	-558	-666
American Bittern	7408453	1245276	-548	-666
Blue-Winged Teal	7408453	1245276	-548	-666
Cinnamon Teal	7408453	1245276	-548	-666
Western Kingbird	27223020	2983517	-535	-3191
Marsh Wren	12049915	1245276	-534	-666
Common Snipe	28296194	3944890	-528	-674
Canada Goose	11003909	1245276	-485	-666
Black Tern	2928801	630331	-455	-786
Yellow-Rumped Warbler	102142346	17379275	-368	-512
*Northern Harrier	33646445	4206451	-308	-890
*Western Meadowlark	46684871	5717072	-285	-5769
Pied-Billed Grebe	2331381	-23992	-270	37
Muskrat	10961182	1233115	-231	-217
Ruddy Duck	385058	-9111	-227	71
Virginia Rail	11732503	928652	-218	-169
White-Tailed Kite	3131253	422885	-200	-3496
Pacific Shrew	18521858	1304074	-168	-98
*Horned Lark	17013954	3575690	-162	-1014
Lesser Goldfinch	39561934	2438047	-162	-99
Townsend's Warbler	70045440	6513418	-151	-133
*Vaux's Swift	114596560	10407521	-150	-121
Western Grebe	188823	-5763	-144	49
*Acorn Woodpecker	17874804	2314176	-136	-239
Northern Goshawk	49745552	5638446	-126	-156
Black-Backed Woodpecker	38278020	3655843	-117	-105
Wolverine	10392656	994535	-115	-98
*Red Tree Vole	96636184	11025571	-108	-149
Yellow-Breasted Chat	15990106	753321	-106	-52
*Great Gray Owl	34283080	4320743	-100	-95
*Harlequin Duck	174930	17493	-100	-100

Species	Historic minus current suitability	Historic minus current area	% change in suitability	% change in area
Mallard	12609676	2982069	-99	-265
*Red-Eyed Vireo	1413252	143027	-95	-101
Townsend's Vole	43136640	3706309	-91	-58
California Vole	1799773	6909	-88	-3
*Olive-Sided Flycatcher	90202016	7563586	-83	-53
*Spotted Owl	84614080	4221006	-83	-29
Clark's Nutcracker	3221127	250083	-80	-169
Barred Owl	91628504	5453548	-79	-31
*American Beaver	7300469	1234984	-74	-117
Northern Pygmy-Owl	85107928	10555852	-71	-99
Barn Owl	11527764	1534008	-69	-183
Hooded Merganser	20331510	732424	-68	-16
Great Blue Heron	21412010	1223196	-67	-28
Varied Thrush	48050472	2884923	-67	-31
Hammond's Flycatcher	60491384	5353827	-65	-44
Red Crossbill	85422640	5113384	-65	-30
Mountain Quail	50111032	11781304	-64	-133
Common Raven	76298912	4083630	-62	-25
Pine Siskin	83857584	5943595	-61	-37
Osprey	3187795	186871	-60	-21
*Bald Eagle	3446794	228223	-59	-27
Fisher	66816872	3465579	-59	-24
Golden-Crowned Kinglet	77275856	7001321	-59	-47
Brown-Headed Cowbird	57791152	6826583	-58	-247
Evening Grosbeak	53023520	3943726	-58	-29
Ring-Necked Duck	109039	2107	-58	-12
Hairy Woodpecker	81316592	9371573	-57	-63
Savannah Sparrow	23832288	2442253	-56	-51
*Chipping Sparrow	16023202	2678857	-53	-131
Fringed Myotis	25581776	1362823	-52	-21
Chestnut-Backed Chickadee	71040432	6995350	-51	-47
Gray Jay	39452920	2682035	-51	-31
Brown Creeper	74986992	6987556	-48	-38
Hermit Warbler	64598992	3075073	-47	-18
Macgillivray's Warbler	27976256	-2617449	-47	95
Pallid Bat	888000	-140676	-47	100
Sharp-Shinned Hawk	73738304	3782602	-46	-18
Turkey Vulture	60872952	9545093	-46	-62
Lynx	5354448	220164	-44	-13
Belted Kingfisher	3442139	-43642	-42	4
Western Red-Backed Vole	58614704	4575652	-42	-28
Douglas' Squirrel	59798400	4490092	-40	-26
Hermit Thrush	41216472	1565358	-40	-10
Steller's Jay	58469968	571946	-39	-3
*Pileated Woodpecker	61854704	6084934	-38	-36
Long-Legged Myotis	57010176	2651922	-38	-13
Wilson's Warbler	39458224	9959436	-38	-93
*American Marten	43625472	2828754	-37	-19
Fog Shrew	64864608	1627706	-37	-7
Red-Breasted Nuthatch	57897392	4546006	-37	-26
Winter Wren	58023168	5092814	-37	-30
Great Horned Owl	37840576	7757470	-35	-44

Species	Historic minus current suitability	Historic minus current area	% change in suitability	% change in area
Pacific-Slope Flycatcher	55481568	7001321	-35	-47
Red-Tailed Hawk	37840576	7757470	-35	-44
Silver-Haired Bat	51833200	1147462	-35	-5
White-Footed Vole	58230912	3153504	-35	-16
Barrow's Goldeneye	740789	-285	-34	0
California Myotis	52237312	265644	-34	-1
Little Brown Myotis	52935056	2633460	-34	-12
*Black-Tailed Jackrabbit	14650656	3071840	-33	-51
Big Brown Bat	50564816	265644	-33	-1
Gray-Tailed Vole	17898480	1198024	-31	-20
Long-Eared Myotis	49834672	2633460	-31	-12
Northern Saw-Whet Owl	39482432	2596754	-31	-15
Yuma Myotis	48194560	263206	-31	-1
Baird's Shrew	61418688	5056090	-30	-23
Elk	44346384	6061478	-28	-27
Western Tanager	44733984	4479796	-28	-26
White-Crowned Sparrow	8652178	-1644390	-28	41
Pacific Jumping Mouse	49314624	11064686	-27	-52
Northern Flying Squirrel	43241120	3347872	-26	-17
Northern Flicker	36637120	4534908	-25	-22
Red-Winged Blackbird	10377292	-404052	-25	8
Mountain Beaver	41326528	-165016	-24	1
Mink	9196320	-157567	-23	4
Bufflehead	340658	-20320	-22	9
Trowbridge's Shrew	43745168	3214542	-22	-15
Bushy-Tailed Woodrat	38399936	700856	-20	-3
Shrew-Mole	44025264	6643056	-20	-28
Brush Rabbit	10569064	1591081	-19	-37
Townsend's Chipmunk	40099712	3071108	-19	-14
Ermine	40000464	3323152	-18	-11
Long-Tailed Weasel	39986032	4148936	-18	-15
Rufous Hummingbird	23851088	1905070	-18	-9
Orange-Crowned Warbler	10271224	-1883659	-16	44
Townsend's Mole	12742216	316324	-16	-4
*Western Rattlesnake	56810929	7325028	-15	-19
Black Bear	28864080	3110006	-15	-16
Blue Grouse	18735744	4453705	-15	-27
Bullock's Oriole	4548556	141504	-15	-4
*White-Breasted Nuthatch	4609086	977749	-14	-42
Deer Mouse	30616128	5397364	-14	-20
*Common Yellowthroat	6544044	-1025210	-13	12
Band-Tailed Pigeon	20165984	4463612	-13	-22
Red-Breasted Sapsucker	20648272	5453548	-13	-31
Western Spotted Skunk	23624592	6210800	-12	-27
Coyote	18400496	-8057976	-11	40
Vagrant Shrew	16281984	-678478	-11	5
Dark-Eyed Junco	13636384	706984	-10	-3
Dusky-Footed Woodrat	3844944	-793815	-9	17
Western Screech-Owl	14180176	7339660	-9	-36
Snowshoe Hare	10342984	1491171	-8	-9
Black-Tailed Deer	16900624	7021184	-7	-28
Camas Pocket Gopher	3758296	-543092	-7	9

Species	Historic minus current suitability	Historic minus current area	% change in suitability	% change in area
Common Merganser	561711	82993	-7	-8
Raccoon	16391536	1173134	-7	-5
*American Dipper	269748	28551	-6	-7
Killdeer	1209210	855075	-6	-126
Purple Finch	6192208	2429479	-6	-19
California Ground Squirrel	4678088	-929556	-5	9
Gray Fox	7190768	7528556	-5	-44
Water Shrew	284801	180395	-5	-19
Wrentit	461850	4886	-4	0
Bobcat	5073200	325400	-3	-1
*Red-Legged Frog	9302215	913020	-2	-1
Long-Toed Salamander	31993088	4294729	-2	-8
Song Sparrow	1334296	-1406763	-2	27
Striped Skunk	2101024	434333	-2	-4
*Oregon Slender Salamander	73261088	10185295	-1	-2
*Sharptail Snake	40047672	5955612	-1	-2
*Southern Alligator Lizard	34718632	6717224	-1	-3
*Western Pond Turtle	8983739	501150	-1	0
*Wood Duck	123786	-1223151	-1	46
Black Swift	2430	243	-1	-1
Coast Mole	667544	666288	-1	-7
Gopher Snake	45123692	6638776	-1	-3
Painted Turtle	10736809	911153	-1	-1
Racer	47854976	6654103	-1	-3
Ringneck Snake	32582632	5974902	-1	-1
Roughskin Newt	7072062	883113	-1	-1
Western Toad	127539	8750	-1	0
Yellow-Billed Cuckoo	36495	-11085	-1	4
*Cascades Frog	-7803	-620	0	0
*Oregon Spotted Frog	337213	35360	0	0
*Tailed Frog	7070656	512651	0	0
American Robin	-563264	4488066	0	-19
Bullfrog	-217920	-31853	0	0
Cascade Torrent Salamander	1494932	106025	0	0
Clouded Salamander	48779976	3517369	0	0
Common Garter Snake	4545264	-5776776	0	0
Dunn's Salamander	20441904	2705705	0	0
Ensatina	46293072	4158066	0	0
Foothill Yellow-Legged Frog	161815	11737	0	0
Northern Alligator Lizard	33880376	10259174	0	-1
Northwestern Garter Snake	26156784	-1790854	0	0
Pacific Giant Salamander	96794	8465	0	0
Pacific Treefrog	-10960984	2245779	0	0
Rubber Boa	-12846560	-5321080	0	0
Southern Torrent Salamander	94040	-2790	0	0
W. Red-Backed Salamander	19208480	909441	0	0
Water Vole	13357	65843	0	-141
Western Fence Lizard	14073032	2567731	0	-1
Western Garter Snake	-7428787	-299164	0	0
Western Skink	23356736	5974902	0	-1
Creeping Vole	-1982768	513624	1	-2
Mountain Lion	-2180256	682526	1	-3

Species	Historic minus current suitability	Historic minus current area	% change in suitability	% change in area
Northwestern Salamander	-2437712	-308686	1	1
*Green Heron	-228369	-280716	2	17
Pika	-13270	-1327	2	2
*Western Bluebird	-1103948	-746865	3	23
Cassin's Vireo	-2501752	-7253051	3	90
Common Porcupine	-8346704	700856	5	-3
Mourning Dove	-2220500	2460110	5	-111
N. Rough-Winged Swallow	-133664	-20133	5	13
Swainson's Thrush	-8512896	665636	5	-3
Pacific Water Shrew	-1226352	-169920	7	8
Bewick's Wren	-3509820	-861950	9	21
Hutton's Vireo	-12770120	-3694663	10	37
Ruffed Grouse	-13879072	2604306	10	-13
Spotted Sandpiper	-345603	-46785	10	12
Bushtit	-5638944	1725107	11	-57
Long-Tailed Vole	-11527136	-1049806	13	30
Spotted Towhee	-9038840	-3538788	13	57
*Western Gray Squirrel	-24489104	-4434927	15	34
House Wren	-9638812	-3411062	15	58
*Northern River Otter	-4254674	-382609	16	13
Cedar Waxwing	-10671632	1478943	16	-35
Western Scrub-Jay	-12084952	-1807190	19	22
Brewer's Blackbird	-13118988	-3713259	23	42
Black-Capped Chickadee	-18123828	728846	25	-15
House Finch	-8190542	-1246420	27	36
Western Pocket Gopher	-16575304	-619413	27	23
Cooper's Hawk	-26917648	-3760873	29	37
Brazilian Free-Tailed Bat	-45132	-14489	31	100
Downy Woodpecker	-17399360	756269	32	-28
Golden-mantled Ground Squirrel	-1367626	-56045	35	40
Black-Headed Grosbeak	-46758688	-3760873	36	37
American Coot	-239920	-23992	37	37
Black-Throated Gray Warbler	-39268256	-4675853	38	53
*Western Wood-Pewee	-31110184	-6701640	40	62
Anna's Hummingbird	-6574884	-1891585	41	100
Red-Shouldered Hawk	-971462	33330	43	-20
Townsend's Solitaire	-9438692	-688485	45	27
Long-Eared Owl	-10729243	-2045300	47	82
Eastern Fox Squirrel	-8928545	-1805682	50	100
Black-Crowned Night-Heron	-644441	0	54	0
Warbling Vireo	-49270356	-8559117	63	67
American Goldfinch	-22773472	-2293714	65	55
Mountain Chickadee	-11231150	339080	70	-142
Peregrine Falcon	-894400	-155313	73	82
*Yellow Warbler	-4297653	-388506	75	88
Nashville Warbler	-15778853	-1604256	75	73
*Willow Flycatcher	-24055807	-3495979	78	95
Cliff Swallow	-8267365	-827006	80	75
Hoary Bat	-20191245	-3765130	80	98
Golden Eagle	-2469953	-466957	81	83
Lincoln's Sparrow	-129683	-29225	82	96
*American Kestrel	-13945053	-2177166	84	87

Species	Historic minus current suitability	Historic minus current area	% change in suitability	% change in area
Common Nighthawk	-18066065	-2708653	86	97
Lazuli Bunting	-13966616	-1751730	86	89
Tree Swallow	-11898826	-1395565	87	87
Barn Swallow	-12268853	-1493846	89	89
Rock Wren	-9729032	-18328	89	18
American Crow	-19881349	-2042908	91	91
Violet-Green Swallow	-26021589	-2540825	91	90
*Purple Martin	-12165275	-2406571	92	92
Dusky Flycatcher	-21493172	-2150332	96	96
Fox Sparrow	-8503231	-854009	97	97

Table 49. Current and historical area of breeding habitat projected by NHI for 43 focal wildlife species.

Area is expressed as a % of the Willamette subbasin. According to NHI, “closely associated” indicates a dependent or essential need for a habitat type. “Generally associated” indicates habitat types that support the species to a lesser degree. “Present” indicates habitats that are of marginal use. Species are sorted from greatest to least negative habitat loss using the third column from right. These figures have been broken out further by watershed (HUC6) in the accompanying Detail File: FocSpNHIchange_by_Wshed

Focal Species	Currently "present"	Currently "closely associated"	Currently "generally associated"	Current Total	Historically "present"	Historically "closely associated"	Historically "generally associated"	Historic Total	Change in "present"	Change in "closely associated"	Change in "generally associated"	Total Change	Ratio: Current-to-Historic (presence)	Ratio: Current-to-Historic (closely-associated)	Ratio: Current-to-Historic (generally-associated)	Ratio: Current-to-historic
Acorn Woodpecker	0.24	1.09	0.00	1.34	0.00	0.00	96.66	96.66	0.24	1.09	-96.66	-95.32	0.0000	0.0000	0.0000	0.0138
Green Heron	0.00	1.85	0.00	1.85	3.49	0.00	0.00	3.49	-3.49	1.85	0.00	-1.64	0.0000	0.0000	0.0000	0.5297
Western Rattlesnake	0.00	0.00	34.39	34.39	0.00	0.00	60.29	60.29	0.00	0.00	-25.89	-25.89	0.0000	0.0000	0.5064	0.5705
Great Gray Owl	41.42	0.01	0.00	41.43	64.96	1.79	0.00	66.75	-23.54	-1.78	0.00	-25.32	0.4025	0.0000	0.0000	0.6207
Vaux's Swift	0.00	0.00	79.13	79.13	0.00	0.00	96.66	96.66	0.00	0.00	-17.53	-17.53	0.0000	0.0000	0.7908	0.8187
White-Breasted Nuthatch	19.67	0.09	7.92	27.67	0.00	0.00	31.57	31.57	19.67	0.09	-23.65	-3.90	0.0000	0.0000	0.5294	0.8766
Purple Martin	8.28	0.00	35.05	43.32	0.00	0.00	45.84	45.84	8.28	0.00	-10.80	-2.52	0.0000	0.0000	0.7186	0.9450
Southern Alligator Lizard	26.66	0.00	0.83	27.49	7.82	0.00	19.63	27.45	18.84	0.00	-18.79	0.04	8.0140	0.0000	0.0389	1.0016
Chipping Sparrow	68.98	0.00	28.06	97.04	56.87	0.00	38.60	95.47	12.10	0.00	-10.54	1.57	7.8152	0.0000	1.9770	1.0164
Western Wood-Pewee	7.07	0.00	91.73	98.80	8.89	0.00	87.77	96.66	-1.82	0.00	3.97	2.14	9.9323	0.0000	1.0601	1.0222
American Kestrel	0.00	0.00	91.65	91.65	0.00	0.00	87.77	87.77	0.00	0.00	3.88	3.88	0.0000	0.0000	1.0595	1.0442
Pileated Woodpecker	28.29	0.00	66.92	95.22	13.61	0.00	70.93	84.54	14.69	0.00	-4.00	10.68	8.1915	0.0000	1.1587	1.1264
Oregon Slender Salamander	0.00	0.00	37.86	37.86	0.00	0.00	33.58	33.58	0.00	0.00	4.28	4.28	0.0000	0.0000	0.6569	1.1273
Black-tailed Jackrabbit	19.67	0.00	0.00	19.67	0.00	14.47	0.00	14.47	19.67	-14.47	0.00	5.20	0.0000	0.0000	0.0000	1.3593
Northern Harrier	6.67	0.00	19.96	26.62	3.49	0.00	14.58	18.07	3.18	0.00	5.37	8.55	4.7318	0.0000	19.1117	1.4731
Bald Eagle	0.00	0.00	7.32	7.32	0.00	0.00	4.11	4.11	0.00	0.00	3.20	3.20	0.0000	0.0000	2.8015	1.7787

Focal Species	Currently "present"	Currently "closely associated"	Currently "generally associated"	Current Total	Historically "present"	Historically "closely associated"	Historically "generally associated"	Historic Total	Change in "present"	Change in "closely associated"	Change in "generally associated"	Total Change	Ratio: Current-to-Historic (presence)	Ratio: Current-to-Historic (closely-associated)	Ratio: Current-to-Historic (generally-associated)	Ratio: Current-to-historic
Townsend's Big-eared Bat	1.10	0.00	34.80	35.90	0.00	14.47	0.00	14.47	1.10	-14.47	34.80	21.43	0.0000	0.0000	0.0000	2.4807
Sharptail Snake	0.00	0.00	27.49	27.49	0.00	0.00	0.00	0.00	0.00	0.00	27.49	27.49	0.0000	0.0000	0.0000	0.0000
Oregon Spotted Frog	0.00	0.02	0.00	0.02	0.00	4.23	0.00	4.23	0.00	-4.21	0.00	-4.21	0.0000	0.0007	0.0000	0.0051
Sora	0.00	0.04	19.67	19.71	0.00	2.97	25.02	27.99	0.00	-2.92	-5.35	-8.27	0.0000	0.0091	1.0435	0.7044
Horned Lark	4.05	0.23	19.78	24.07	0.00	14.47	0.68	15.15	4.05	-14.24	19.11	8.92	0.0000	0.0261	0.0404	1.5889
Western Gray Squirrel	64.06	1.01	4.92	69.99	56.20	13.61	0.00	69.81	7.86	-12.60	4.92	0.18	5.2797	0.0430	0.0000	1.0026
Yellow Warbler	0.00	2.52	0.00	2.52	0.00	69.80	23.20	93.01	0.00	-67.29	-23.20	-90.49	0.0000	0.0646	0.0000	0.0271
Western Pond Turtle	88.54	2.84	0.33	91.70	56.20	17.10	14.47	87.77	32.34	-14.26	-14.14	3.94	24.6501	0.0975	0.0298	1.0449
Harlequin Duck	0.00	0.28	0.00	0.28	0.00	0.28	0.00	0.28	0.00	0.00	0.00	0.00	0.0000	0.4412	0.0000	1.0000
Cascades Frog	0.00	0.27	0.00	0.27	0.00	0.22	0.00	0.22	0.00	0.05	0.00	0.05	0.0000	0.4571	0.0000	1.2154
American Beaver	0.00	0.72	0.00	0.72	0.00	4.22	0.00	4.22	0.00	-3.51	0.00	-3.51	0.0000	0.4668	0.0000	0.1696
Coastal Tailed Frog	0.00	0.43	0.00	0.43	2.86	1.05	0.00	3.91	-2.86	-0.62	0.00	-3.48	0.0000	0.5992	0.0000	0.1106
Red Tree Vole	0.30	59.17	0.00	59.47	0.63	68.13	0.00	68.76	-0.33	-8.96	0.00	-9.29	8.7152	0.8276	0.0000	0.8649
Marbled Murrelet	0.00	10.69	0.00	10.69	0.00	8.42	3.16	11.58	0.00	2.28	-3.16	-0.88	0.0000	0.8558	0.0000	0.9237
American Marten	0.00	6.89	31.47	38.36	0.00	10.52	56.20	66.71	0.00	-3.63	-24.72	-28.35	0.0000	0.8712	0.3981	0.5750
Western Bluebird	0.63	65.10	31.20	96.93	0.00	69.80	23.20	93.01	0.63	-4.70	8.00	3.92	0.0000	0.8917	7.4300	1.0421
American Dipper	0.00	0.72	0.00	0.72	0.00	0.72	0.00	0.72	0.00	0.00	0.00	0.00	0.0000	0.9706	0.0000	1.0000
Spotted Owl	0.00	52.48	7.02	59.50	0.00	56.20	8.73	64.93	0.00	-3.72	-1.72	-5.43	0.0000	1.0225	1.2456	0.9163
Wood Duck	0.00	2.52	0.00	2.52	0.00	4.11	0.00	4.11	0.00	-1.60	0.00	-1.60	0.0000	1.0492	0.0000	0.6118
Northern River Otter	0.00	3.45	0.00	3.45	0.00	4.83	0.00	4.83	0.00	-1.38	0.00	-1.38	0.0000	1.2354	0.0000	0.7150
Red-legged Frog	0.00	3.45	0.00	3.45	0.00	4.83	0.00	4.83	0.00	-1.38	0.00	-1.38	0.0000	1.2354	0.0000	0.7150
Willow Flycatcher	24.59	1.83	72.09	98.51	0.00	3.49	81.04	84.54	24.59	-1.66	-8.95	13.98	0.0000	1.5506	0.8321	1.1654
Common Yellowthroat	5.08	1.87	82.22	89.17	14.47	3.60	69.81	87.88	-9.39	-1.73	12.41	1.29	1.0302	1.5566	1.3902	1.0147

Focal Species	Currently "present"	Currently "closely associated"	Currently "generally associated"	Current Total	Historically "present"	Historically "closely associated"	Historically "generally associated"	Historic Total	Change in "present"	Change in "closely associated"	Change in "generally associated"	Total Change	Ratio: Current-to-Historic (presence)	Ratio: Current-to-Historic (closely-associated)	Ratio: Current-to-Historic (generally-associated)	Ratio: Current-to-historic
Red-Eyed Vireo	0.00	1.85	0.00	1.85	0.00	3.49	0.00	3.49	0.00	-1.64	0.00	-1.64	0.0000	1.5631	0.0000	0.5312
Olive-Sided Flycatcher	2.66	68.42	1.92	73.00	0.00	64.93	5.27	70.20	2.66	3.49	-3.36	2.80	0.0000	2.4420	1.5784	1.0398
Western Meadowlark	0.00	19.91	0.00	19.91	0.00	14.47	0.00	14.47	0.00	5.44	0.00	5.44	0.0000	2.5963	0.0000	1.3761
Vesper Sparrow	0.00	19.91	0.00	19.91	0.00	14.47	0.00	14.47	0.00	5.44	0.00	5.44	0.0000	2.5963	0.0000	1.3761

4.2.5 How Much Habitat is Enough?

Seldom are existing data adequate to pinpoint **thresholds** at which any of these potential changes may begin to affect wildlife and rare plants. Making such determinations would require not only improved species-habitat relationship models and better information on potential causal factors (magnitude, frequency, duration, timing, location of the limiting factors), but also better information on fundamental demographic characteristics of individual species, including reproductive rate, territory size, dispersal distance, juvenile survival, adult survival, and fecundity. With such information, spatially-explicit demographic models such as PATCH can be used to estimate minimum amounts and configuration of habitat necessary to sustain viable populations (and identify "source" habitats) of a species. Currently, only 22 of the 281 wildlife species in the subbasin have data for all required input variables[20]. Even then, the input data are often from a single study, typically from another geographic regions, so results may not be appropriate for local use. An alternative – which allows application of spatially-explicit models even when data are lacking for critical variables – involves an allometric approach, i.e., estimates of critical variables available for one well-studied species are statistically extrapolated to other species based on known similarities of body size, food habits, or other factors. This approach compounds the uncertainties already noted, but is used when no better alternatives exist.

An even greater degree of uncertainty surrounds area requirements derived empirically, e.g., by regression analysis of observed species presence/absence in different patch sizes. Such estimates have been used as the basis for recommending buffer widths to protect wildlife habitat along streams (see section 2.6.5) and for suggesting minimum patch sizes and land cover compositions to sustain wildlife generally or particular species (as indicted in this report for some focal species). In the Seattle area, forest patches smaller than about 75-100 acres generally supported many fewer forest birds during the nesting season than did larger patches, especially if the surrounding landscape was more than 52% developed and less than 30% forested (Marzluff & Ewing 2001). Forested patches smaller than about 7 acres supported few breeding bird species, unless they were close to larger patches. However, many rare plants and a few rare wildlife species seem unaffected by habitat patch size. For selecting regions for habitat restoration, Payne (2002) assumed areas smaller than 10 acres would not provide adequate habitat for most wildlife species.

4.2.6 Ability of Restoration and Management to Reverse Habitat Losses

Given the enormous historical and ongoing losses of some habitat types described in this report, to what degree might various restoration strategies slow the future net loss of these habitats? This question has been examined by a few projects:

[20] These are: red-shouldered hawk, red-tailed hawk, Cooper's hawk, northern goshawk, spotted owl, great gray owl, great horned owl, blue grouse, mourning dove, gray jay, black-capped chickadee, marsh wren, grasshopper sparrow, savannah sparrow, fisher, long-tailed vole, bushy-tailed wood rat, porcupine, red fox, American beaver, snowshoe hare, and black-tailed jackrabbbit.

Conclusions from White et al. (2002) Analysis

Of the future scenarios, the conservation scenario was projected to provide the most benefits to wildlife (31% gain compared to present), followed by the Plan Trend scenario (10% loss). A loosening of land use laws and other impacts envisioned by the Development scenario indicated that 39% more species would lose habitat than gain habitat. Each of these figures is the percent of species that are winners minus the percent that are losers. Outcomes for each species are shown in Table 50. The conservation scenario involved the following assumptions (for example) for the year 2050:

- To accommodate development, 54,000 acres (rather than 129,000) are added to UGBs
- About half the new housing adjacent to the 1990 rural residential areas is in clustered developments (9.3 dwellings per acre vs. 6.2).
- Urban areas contain 94% of the population instead of 87%.
- All streams contain some wooded riparian habitat, and this occupies at least 100 ft on both sides of all streams crossing private land and 300 ft on both sides of streams on public land
- Average clearcut size on public timberlands declines from 30 to 10 acres, and averages between 5.6 and 13 acres on private timberlands

Conclusions from application of PATCH model

Simulations suggested that application of the same habitat conservation measures could increase the populations of 14 of the 17 species.

Conclusions from Payne's (2002) Analysis

Payne assumed restoration would be required as mitigation for all cluster developments within less productive areas of the subbasin. If such a policy were adopted, Payne predicted it could result in restoration of 84,819 acres of habitat, specifically: 38,146 acres of oak savanna, 29,218 acres of conifer forest, 8319 acres of upland prairie, 3184 acres of wetland prairie, 2394 acres of wetland, 2340 acres of mixed forest, and 1229 acres of riparian forest. This simply reflects the distribution in 2050 of these habitat types within these less productive (= more likely to be developed) lands. Such restoration gains would be added to those accomplished through projects on public lands and through non-regulatory incentives programs for private landowners.

Payne concluded that restoration as part of cluster development alone would make only small inroads into shifting the landscape structure and wildlife habitat back toward that of 1850. Current patterns of agriculture and forestry provide more wildlife habitat than an alternative of rural residential construction without mandated restoration. She noted that whether or not restoration improves local wildlife richness would depend on which habitat type is being restored to which other habitat type. If a policy is adopted of allowing increased home construction in less productive rural areas, but with the provision that houses are clustered and development is mitigated through habitat restoration or conservation, then by 2050 about 8 rare species will gain habitat, 5 will lose habitat, and 29 will have neither. Thus cluster development of rural areas accompanied by conservation, while helpful, is projected to be only marginally better for most wildlife than continuing present policies and practices which will lead to complete build-out of rural residential zones by 2020. Still, of several scenarios she simulated, this one was the only one under which habitat improves for more species (and more rare species) than declines.

Preliminary Conclusions from Polasky et al. (pers. comm.) Analysis
The optimum solution of this simulation, using a hypothetical Willamette Valley landscape, indicated that perhaps 96% of the habitat suitability for the 97 terrestrial wildlife species examined could be maintained with (at most) a 7% economic loss to agricultural or forest use objectives. Residential development objectives were not examined. The researchers determined the optimum case to be one in which:

- the presettlement vegetation was 37% conifer forest, 26% prairie and other non-forest, 25% oak woodland and other deciduous forests, and 12% shrubland;
- parcels whose most valuable activity is agriculture occupied 28% of the landscape with a mean per acre value of $3743 and standard deviation of 3762;
- parcels whose most valuable activity is forestry occupied 72% of the landscape, with a mean per acre value of $3933 and standard deviation of 485.

Taken together, the above four studies demonstrate the value for wildlife of modest habitat restoration proposals. At the same time they caution that restoration -- unless undertaken much more extensively -- cannot hope to (a) create a net benefit for wildlife if habitat destruction continues unabated, and (b) replace a significant fraction of the habitat losses that have occurred historically.

Table 50. Species ranked according to possible gains from future habitat conservation measures as defined by the ERC Conservation scenario.

Note: * indicates focal species. Species that might benefit the most from habitat protection and restoration (within CROAs identified by the Conservation scenario of the Alternative Futures project) are listed first. Numbers are the difference between the basinwide score for the species under the conservation scenario minus its score under the development scenario. The scores reflect both the suitability of habitat and its area.

	Benefit from Conservation
Lark Sparrow	210
Common Snipe	121
*Marbled Murrelet	117
Wilson's Phalarope	101
Short-Eared Owl	78
Green-Winged Teal	75
*Western Rattlesnake	67
Grasshopper Sparrow	67
Marsh Wren	66
Northern Shoveler	66
Northern Pintail	62
Canada Goose	60
Yellow-Headed Blackbird	58
American Bittern	56
Blue-Winged Teal	56
Cinnamon Teal	56
*Sora	55
Nutria	55
*Vesper Sparrow	53
Yellow-Billed Cuckoo	52
Black-Crowned Night-Heron	50
Virginia Rail	46
*Northern Harrier	44
*Red-Eyed Vireo	43
Black Tern	41
Ruddy Duck	41
Yellow-Rumped Warbler	39
*Bald Eagle	34
Osprey	33
Pied-Billed Grebe	32
Western Kingbird	29
Townsend's Warbler	27
Muskrat	26
Mallard	24
*Western Meadowlark	24
*Horned Lark	24
Pacific Water Shrew	24
*Oregon Slender Salamander	23
Northern Goshawk	22
Hooded Merganser	21
Pacific Shrew	21
Great Blue Heron	20
Western Grebe	20

	Benefit from Conservation
Long-Toed Salamander	20
Townsend's Vole	19
*Red Tree Vole	19
Black-Backed Woodpecker	18
*Spotted Owl	18
Hammond's Flycatcher	18
*Green Heron	16
*Olive-Sided Flycatcher	16
Barred Owl	16
Hairy Woodpecker	15
Red-Winged Blackbird	14
Dunn's Salamander	14
Clouded Salamander	14
Wood Duck	13
*Pileated Woodpecker	13
Red Crossbill	13
Common Raven	13
Golden-Crowned Kinglet	13
Varied Thrush	13
*Red-Legged Frog	13
Northwestern Salamander	13
*Great Gray Owl	12
Western Red-Backed Salamander	12
Brown Creeper	12
Ensatina	12
Hermit Warbler	12
Pacific-Slope Flycatcher	12
*Vaux's Swift	12
Pacific Jumping Mouse	11
Gray Jay	11
Chestnut-Backed Chickadee	11
*American Beaver	11
Savannah Sparrow	10
Evening Grosbeak	10
Fisher	10
Pine Siskin	10
Winter Wren	10
Barrow's Goldeneye	10
Red-Breasted Sapsucker	9
Blue Grouse	9
Mink	9
Northern Pygmy-Owl	9
Western Red-Backed Vole	9
Northern Saw-Whet Owl	9

	Benefit from Conservation
Roughskin Newt	9
Yellow-Breasted Chat	8
Sharp-Shinned Hawk	8
Great Horned Owl	8
Red-Tailed Hawk	8
Trowbridge's Shrew	8
Bufflehead	8
Wilson's Warbler	7
Baird's Shrew	7
Shrew-Mole	7
White-Tailed Kite	7
Hutton's Vireo	7
Mountain Beaver	7
Black Bear	7
Western Screech-Owl	7
Red-Breasted Nuthatch	7
Belted Kingfisher	7
*Cascades Frog	7
Douglas' Squirrel	7
Racer	7
Wolverine	6
Northern Flicker	6
White-Footed Vole	6
Fog Shrew	6
Western Tanager	6
American Coot	6
*Tailed Frog	6
Painted Turtle	6
Ring-Necked Pheasant	5
*Black-Tailed Jackrabbit	5
Hermit Thrush	5
Long-Tailed Weasel	5
Elk	5
Ring-Necked Duck	5
Silver-Haired Bat	5
Dusky-Footed Woodrat	5
Long-Legged Myotis	5
*Western Pond Turtle	5
Mountain Quail	4
Bushy-Tailed Woodrat	4
Deer Mouse	4
Ruffed Grouse	4
Band-Tailed Pigeon	4
Common Merganser	4
Ermine	4
Long-Eared Myotis	4
California Myotis	4
Northern Flying Squirrel	4
Spotted Sandpiper	4
*Yellow Warbler	3
*Common Yellowthroat	3
Turkey Vulture	3

	Benefit from Conservation
Gray-Tailed Vole	3
Mountain Lion	3
Purple Finch	3
Rufous Hummingbird	3
Big Brown Bat	3
Little Brown Myotis	3
N. Rough-Winged Swallow	3
Yuma Myotis	3
Water Shrew	3
Gopher Snake	3
Macgillivray's Warbler	2
Red-Shouldered Hawk	2
Bobcat	2
Cassin's Vireo	2
Townsend's Chipmunk	2
Vagrant Shrew	2
Brown-Headed Cowbird	2
Gray Fox	2
Fringed Myotis	2
Lynx	1
Black-Tailed Deer	1
Creeping Vole	1
Swainson's Thrush	1
Cooper's Hawk	1
*Western Gray Squirrel	1
Steller's Jay	1
*American Dipper	1
California Vole	1
California Ground Squirrel	0
Coast Mole	0
Wild Turkey	0
Black-Headed Grosbeak	0
Camas Pocket Gopher	0
Black Swift	0
Foothill Yellow-Legged Frog	0
Long-Eared Owl	0
Pacific Giant Salamander	0
Pika	0
Raccoon	0
Western Spotted Skunk	0
Bullfrog	0
Brush Rabbit	0
Eastern Cottontail	0
*Chipping Sparrow	-1
Black-Throated Gray Warbler	-1
*White-Breasted Nuthatch	-1
*American Marten	-1
Snowshoe Hare	-1
Western Toad	-1
Coyote	-1
Townsend's Mole	-1
Virginia Opossum	-1

	Benefit from Conservation
*Southern Alligator Lizard	-1
Long-Tailed Vole	-2
Water Vole	-2
American Robin	-2
Black-Capped Chickadee	-2
Downy Woodpecker	-2
Red Fox	-2
*Sharptail Snake	-2
Warbling Vireo	-3
Common Porcupine	-3
Mourning Dove	-3
Killdeer	-3
Striped Skunk	-3
Clark's Nutcracker	-4
Dark-Eyed Junco	-4
Northwestern Garter Snake	-4
*Northern River Otter	-4
Lincoln's Sparrow	-5
Orange-Crowned Warbler	-5
*Oregon Spotted Frog	-5
Song Sparrow	-5
Cascade Torrent Salamander	-5
Lewis' Woodpecker	-6
*Western Wood-Pewee	-6
Cedar Waxwing	-6
Rubber Boa	-6
Lesser Goldfinch	-6
Southern Torrent Salamander	-6
Spotted Towhee	-7
Common Garter Snake	-7
Lazuli Bunting	-7
Western Pocket Gopher	-8
California Quail	-8
Bullock's Oriole	-8
Western Scrub-Jay	-8
*American Kestrel	-9
Pacific Treefrog	-10
American Goldfinch	-10
Bushtit	-10
Ringneck Snake	-10
White-Crowned Sparrow	-11
Northern Alligator Lizard	-11
Tree Swallow	-11
Bewick's Wren	-11
Mountain Chickadee	-11
Western Skink	-11
Wrentit	-12
Western Fence Lizard	-12
*Willow Flycatcher	-13
House Wren	-13
*Harlequin Duck	-15
Brewer's Blackbird	-15

	Benefit from Conservation
*Western Bluebird	-16
Golden Eagle	-16
Townsend's Solitaire	-18
Western Terrestrial Garter Snake	-18
*Acorn Woodpecker	-18
Nashville Warbler	-19
Feral House Cat	-19
Golden-Mantled Ground Squirrel	-20
Dusky Flycatcher	-21
Common Nighthawk	-21
*Purple Martin	-23
Rock Wren	-23
Peregrine Falcon	-23
European Starling	-24
Fox Sparrow	-26
Eastern Fox Squirrel	-26
Pallid Bat	-29
Hoary Bat	-30
Eastern Gray Squirrel	-30
House Finch	-32
Brazilian Free-Tailed Bat	-40
Violet-Green Swallow	-41
American Crow	-43
Townsend's Big-Eared Bat	-55
Barn Owl	-58
House Mouse	-59
Black Rat	-59
House Sparrow	-59
Norway Rat	-59
Anna's Hummingbird	-64
Rock Dove	-67
Barn Swallow	-70
Cliff Swallow	-82

4.3 Limiting Factors: Habitat Degradation and Fragmentation

Habitat protection alone is not enough if habitat degradation is ongoing. Habitat degradation is the partial loss of suitability of an area as habitat for wildlife or rare plants. As noted earlier, habitat degradation (and consequent fragmentation) are the result of unfavorable conditions with regard to roads/barriers, vegetation change, supply of dead wood, water regime, pollution, temperature, soil quality, harassment, or invasive species/pathogens. These are described below. In addition, Table 51 provides a more detailed classification of management activities that can degrade (or in some cases enhance) wildlife habitat in the Willamette subbasin.

Table 51. Human activities having the potential to degrade or enhance habitat of particular focal wildlife species in the Willamette subbasin.

Note: Compiled from IBIS database information provided by NHI. Association of a management activity with a larger number of species does not necessarily mean it is generally more limiting or important, because activities vary with regard to their spatial and temporal extent and intensity.

Management Activity	Number of Focal Wildlife Species Affected Positively or Negatively
Building houses and businesses	43
Clearcutting	43
Commercial thinning	43
Conversion of native habitats	43
Decreasing water supply	43
Establishing/maintaining greenways/greenbelts	43
Forest management (in general)	43
Increasing water supply	43
Landscaping and vegetation management	43
Livestock grazing	43
Mineral exploration	43
Prescribed/controlled high intensity burns	43
Recreational developments	43
Retaining riparian buffer strips	43
Road and bridge construction and obliteration	43
Seed tree cuts	43
Suppressing wildfire	43
Surface/strip mining and processing	43
Trail use and camping	43
Conversion of shrubland to native or non-native grassland	42
Fencing to protect or restore habitat	42
Group selection	42
Retaining riparian buffers	42
Roads (in general)	42
Agriculture (in general)	41
Applying herbicides	41
Operational aspects of road maintenance and use	41
Prescribed burning	41

Management Activity	Number of Focal Wildlife Species Affected Positively or Negatively
Creating and maintaining impoundments	40
Prescribed/controlled low intensity burns	40
Shelterwood cuts	40
Creating/maintaining corridors	39
Selective harvest across all tree sizes	39
Selective harvest of specific sizes or conditions or species	39
Type conversion	39
Fire (in general)	38
Simplifying species composition and/or structure	37
Burning wetlands to maintain successional stages	36
Restoration	35
Site reclamation	35
Burning	34
Decreasing water supply - flow withdrawal	34
Livestock grazing of riparian areas	34
Excluding livestock from riparian areas	33
Fencing to excluding livestock from riparian areas	33
Utility corridors	33
Wetland management techniques	33
Creating/maintaining edges	32
Urban aquatic habitat management	32
Applying pesticides	31
Applying insecticides	30
Mechanical vegetation management	30
Off-road driving	30
Restoring/maintaining beaver populations	30
Implementing farmland conservation programs	29
Sand/gravel (aggregate) and peat mining	29
Special forest products (in general)	29
Controlling water levels	28
Maintaining mature/old growth	28
Oil and gas extraction	28
Retaining/creating snags	28
Armoring banks for erosion control	27
Restoration of wetlands	27
Retaining forest openings	27
Applying fertilizers	26
Dredging	26
Shrubland management (in general)	26
Controlling sedimentation by revegetation of banks with grass-sedge-forb mixtures	25
Fish stocking	25
Grazing livestock	25
Haying/mowing	25
Retaining/providing dead/down wood	25
Clean farming	24
Draining wetlands, marshes, ponds, lakes	23
Firewood cutting	23

Management Activity	Number of Focal Wildlife Species Affected Positively or Negatively
Maintaining grasses and forbs within orchards, Christmas tree farms, vineyards, etc.	23
Controlling water pollution	22
Harbor, marina, and ferry terminal development	22
Irrigating	22
Retaining trees with defects	22
Strip intercropping	22
Toxic spills in fresh and saltwater	22
Using herbicides	22
Control of vertebrates considered to be agricultural pests	21
Developing/maintaining brush/slash piles	21
Disposing/assimilating wastewater	21
Mining (in general)	21
No-till farming/minimum till farming	21
Controlling aquatic plants	20
Grassland Management (in general)	20
Pre-commercial thinning	20
Water quality and stormwater management	20
Altering drainage	19
Introducing exotic vegetation	19
Motorized boating	19
Providing/maintaining vegetation along field and ditch margins	19
Removing hazard trees	19
Retaining large green trees	19
Road closures	19
Applying fungicides	18
Building skid roads and landings	18
Placer prospecting and mining	18
Pruning	18
Tilling prior to planting	18
Paving/creation of impervious surfaces	17
Planting or seeding for reforestation	17
Removing slash	17
Retaining medium-sized green trees	17
Aquaculture	16
Marine dredging and filling	16
Residential docks in marine and freshwaters	16
Adding coarse woody debris and boulders to streams and rivers	15
Channelization	15
Locating/constructing stream crossings	15
Marine fisheries	15
Removing coarse woody debris from streams and rivers	15
Fertilizing plantations	14
Flooding fields and wetlands	14
Removing riparian vegetation	14
Underground mining and processing	14
Creating water sources	12
Non-motorized boating	12

Management Activity	Number of Focal Wildlife Species Affected Positively or Negatively
Developing underwater marine structures	11
Fencing to control or direct wildlife access	11
Marine shoreline armoring	11
Creating or providing stockponds	9
Providing artificial nesting sites	9
Mountain/rock climbing	8
Owning domestic animals	8
Retaining mast trees	8
Swimming	8
Providing artificial nest sites	7
Creating/maintaining islands or rafts within impoundments	4
Retaining crop residue	3
Bough collection	2
Maintaining access to abandoned subsurface mines and tunnels	2
Snowmobiling	2
Snowshoeing/snow skiing/sledding	2
Harvesting wild mushrooms	1

4.3.1 Roads and Other Barriers

This includes all structures or terrains that kill or interfere with movement/dispersal of plants and/or wildlife. It includes roads (and vehicles), other paved surfaces, communications towers, wind turbine towers, picture windows, powerlines and transmission poles, some types of fences, and unvegetated or very steep terrain. In includes factors that are directly lethal (collisions) as well as those that expose animals to greater predation risk (e.g., paved surfaces). Technical information on the seriousness of these impacts is available, for example, at:

http://migratorybirds.fws.gov/issues/tower.html
http://www.flap.org

In addition to reducing population survival, barriers over the long term can limit gene pool mixing and thus the adaptability of local populations. However, in some instances isolation by barriers impenetrable by humans or predators can benefit particular wildlife species.

Residential and industrial development is the largest source of physical barriers. Roads occur throughout such development, but heavily trafficked roads pose the greatest hazard, and are mostly near urban areas. Roads probably are a significant factor limiting populations of some amphibians and turtles in the Willamette subbasin. The extent of future road construction will depend largely on the types of development that are proposed. With development in clusters, fewer roads are needed: 2.9 miles per square mile of development, compared with 4.8 if rural development is scattered in 5-acre parcels. In either case road densities are greater within developed areas. The current road density is 3.8 miles of road per square mile across the entire subbasin, 4.3 on the valley floor, and about 4.6 in the developed rural parts of the subbasin. By 2050, the total area of new roads within the subbasin's developable rural areas is anticipated to increase by 2376 acres (if development is clustered) or 5072 acres (if not clustered) (Payne 2002).

Wide roads and other features that create large breaks in contiguous tree canopies, especially at strategic locations, comprise the most prominent form of habitat fragmentation that is detrimental to some species. Evidence of negative fragmentation effects in western U.S. forests is much weaker than in eastern U.S. forests, but in the urban Portland area, some evidence suggests the following native bird species may be especially sensitive to fragmentation of the forest canopy and/or increased road density: winter wren, rufous hummingbird, Pacific-slope flycatcher, brown creeper, yellow warbler, common yellowthroat, Swainson's thrush, black-headed grosbeak, and olive-sided flycatcher (Hennings 2001).

4.3.2 Vegetation Change

This consists of changes in vegetative structural and species diversity, and percent cover of live foliage and live woody material at heights exceeding about 20 feet. Vegetation is directly important for cover, nesting substrate, and support of food resources of wildlife. By providing shade and buffering wind, vegetation also moderates the microclimate near the ground that is important to many small mammals. Vegetation shields some species from the view of aerial predators, decreasing risks of dispersal to other habitat patches. However, there is no such thing as "generally good wildlife cover." Each species responds differently, with some prairie species avoiding all shaded areas. For such species, areas with tree canopy actually cause fragmentation of their habitat. Thus, habitat "connectivity" must be evaluated very carefully with regard to the particular species of interest.

Vegetation changes can be induced by fire, disease, insect damage, wind, ice storms, grazing of saplings, flood events, alteration of natural hydrologic regimes, soil compaction, and intentional removal or planting of vegetation by humans. Herbaceous (e.g., prairie) vegetation is maintained by fire, other natural disturbances, soil health, high water table levels or grazing that limit woody cover establishment, and some types of human activities that reduce shading from trees and shrubs.

The absence of a woody canopy is of greatest concern in parts of the subbasin where tree canopy cover was previously the most extensive, such as along rivers, streams, and in the mountains. The least amount of residual tree canopy remains in the lowlands, yet much of this area existed as open prairie for centuries, allowing wildlife and plants adapted to open areas to colonize. Vegetation succession poses the greatest threat to wildlife and rare plants of upland prairies, oak woodlands, and wetland prairies (in that order of priority). Additional information on this limiting factor is presented in the report sections on those focal habitats.

4.3.3 Diminished Supply of Dead Wood

Wildlife species are often limited by the supply and lack of diversity of standing (snag) or downed dead wood of various sizes. A few woodpecker species excavate cavities in snags, which are then used as nesting, roosting, and/or hibernation sites by dozens of other species. The presence of dense soil leaf litter (duff layer) also is important to some species, e.g., hibernating turtles. Soil organic matter also helps maintain soil invertebrate communities and biogeochemical processes.

A supply of dead wood is sustained by forest management than favors multi-aged stands at multiple spatial scales. Snag availability can increase as a result of disease, fire, flood events, wind or ice storms, water level changes, and climate change. A scarcity of dead wood is most limiting to wildlife where forest has been converted, at multiple scales, to other land cover types or to a nearly single-aged stand. Dead wood scarcities also arise where river regulation has largely eliminated sporadic tree mortality due to flooding and channel migration. Simple computer models are available for predicting dead wood supply and adapting management to sustain the supply. See: http://wwwnotes.fs.fed.us:81/pnw/DecAID/DecAID.nsf

During much of the fall, winter, and spring, there is hardly a rural neighborhood in the region where the sight of someone burning "yard waste" is absent. Often this "waste" is downed limbs and other dead wood highly valued by wildlife and crucial to healthy forest soils. Dead wood is removed to reduce hazards to buildings from wildland fires, but also for firewood and as part of general fuel reduction programs, forestry operations, and homeowner landscaping.

4.3.4 Water Regime Change

Even with implementation of aggressive water conservation programs, major water shortages are anticipated in the Willamette subbasin before the year 2050 (Baker et al. 2004, Dole & Niemi 2004). Drought or flood, low or high water, can both help or hurt wildlife and rare plant populations. And it is not only the severity of extreme events, but the frequency, duration, and variability of water on the landscape that imposes consequences. Increased water provides habitat space and feeding opportunities for amphibians and waterbirds while decreasing these elements for some other species. Surface water is essential as a drinking source for many wildlife species. Water levels alter plant cover and successional processes, and availability and type of soil invertebrates. Aquatic amphibians are especially sensitive to large water level fluctuations (Richter 1997).

Precipitation and runoff regimes can be altered by global climate change, pavement, land conversion, or water control infrastructure (dams, ditches, tile drains). When water regimes consequently fall outside the range to which plants and wildlife species are adapted, populations suffer. Altered water regimes are perhaps most limiting to wildlife and rare plants where naturally hydric soils have been paved, drained, or otherwise altered, or where dams have inundated areas that historically were not wetlands or lakes. Construction of dams on the upper Willamette permanently removed habitat for many forest species but created habitat for some waterbirds.

Significant differences exist among agricultural operations with regard to their need for irrigation, and thus potentially their off-site impacts on low flows in streams (and water table levels in wetlands). Row crops and landscape nurseries tend to have higher water demands than land used for grass seed, hay, Christmas trees, hops, orchards, vineyards, or pasture. As discussed below, there also are significant differences among crop types in the amount, frequency, timing, persistence, and toxicity of pesticides (primarily herbicides and fungicides) used, and thus their relative risks to specific native plants and wildlife.

4.3.5 Pollution

In extreme concentrations many substances, both natural and manufactured, can adversely affect wildlife and plants. These include but are not limited to some synthetic hydrocarbon, heavy metals, and radiation. Some originate from local sources, while others are carried long distances (even from Asia) in aerosols or attached to airborne dust. Local sources include agricultural, mining, road maintenance, and forestry activities, as well as industrial effluent and stormwater runoff from residential neighborhoods. Natural sources of toxic substances are sometimes locally common and can be mobilized or immobilized by some types of land conversion or alteration, as well as by extreme weather events.

Toxic effects on wildlife are observed directly only rarely, but sublethal effects (such as reduced fertility, increased vulnerability to predation, reduced disease-resistance, increased metabolic demands as a result of having to search farther and longer for invertebrate foods) could be widespread and devastating to populations, while going largely unnoticed (Sparling et al. 2000). Some pesticides used commonly in the subbasin persist for months or longer after application (Field et al. 2003), and the Willamette subbasin is a major contributor to problems with these substances in the Columbia River (McCarthy & Gale 2001).

Considerable data are available concerning pollution of surface and ground waters in the Willamette subbasin, and considerable progress has been made in reducing the most toxic substances in our rivers and lakes. Nonetheless, very few measurements have been made of exposure levels of most wildlife species to these contaminants, e.g., as indicted by contaminant levels in eggs and tissues. Moreover, sublethal effects on native wildlife of the majority of contaminants are unknown, and the number of new and virtually untested compounds in the environment is growing daily, e.g., pharmaceuticals, nanotechnology “buckyballs,” growth hormones. Exposure of wildlife to pollutants is presumably greater near urban and industrial areas, but there are many exceptions. High Cascade lakes are exposed to elevated levels of ultraviolet radiation, due to thinning of the earth’s protective ozone layer, and some evidence suggests several frog species may be adversely impacted (Blaustein et al. 1994b, 1998).

Also of particular concern are nitrate fertilizers from suburban lawns, golf courses, and crop fields. They are known to contaminate groundwater in parts of the subbasin and have been shown to be toxic to larvae of some Willamette frog species at anticipated exposure levels (Hatch et al. 2001, Marco et al. 2001), and even at levels considered safe for human drinking. Thus, nonpoint source control programs are as essential to aquatic wildlife as to fish.

4.3.6 Temperature Change

Warming temperatures are partly a reflection of globally changing climate, and partly a result of regional and local changes in land cover, e.g., the “heat sink” effect of urban environments. At a finer scale, the magnitude, seasonality, and variability of temperatures can change as a result of removing the forest canopy and altering the distribution of water on the landscape.

Changes in air and water temperatures can have subtle but profound effects on wildlife. Warming temperatures can eliminate perennial snow packs in the Cascades, thus reducing or eliminating late-summer stream flow and depriving wildlife and vegetation of critical moisture. Diminished soil moisture and drought-killed trees then increase the risk of further habitat loss from wildfire. In contrast, reservoir regulation has brought generally cooler temperatures to some streams downriver of reservoirs.

Warming climate may already be starting to influence Willamette wildlife. Many local naturalists are noting that arrival dates of migrant birds during the past 3-5 years are earlier than recorded previously, and temperatures have averaged warmer during this time. At least 2 bird species with southern distribution ranges have bred in the subbasin for the first time in recorded history.

4.3.7 Soil Degradation

Soil degradation consists mainly of soil compaction (a reduction in space between soil particles). Compaction is most often the result of off-road vehicles employed for farming, forestry, or recreation, and herding of livestock in a confined area. Compaction is of particular concern to rare plants, nesting western pond turtles, and burrowing mammals. Burrows are easily crushed and although they are readily recreated, chronic travel over the same area may compact the soil to a point where it is unsuitable for burrowing. Soil compaction and associated traffic also kills vegetation directly and may limit ability of natural seed banks to germinate and/or survive until they can develop sufficient root systems. By reducing the pore space in soils, compaction can reduce habitat space for soil invertebrate communities and sensitive plants. Wet clayey soils that typify much of the Willamette Valley are the most vulnerable to compaction, especially when they lack organic material. Compaction usually is a localized problem, concentrated mainly around developed areas, heavily grazed areas, and plowed lands. For additional technical information, see: http://soils.usda.gov/sqi/sqiproductlist.html

4.3.8 Harassment

Harassment of wildlife includes the exposure of wildlife to presence of humans and/or to loud noise and scents of humans, or to those of pets closely associated with humans, at greater-than-normal frequencies. Harassment need not be intentional. It also includes legal and illegal harvest of wildlife, and is commonly associated with recreation and other outdoor activities.

Harassment increases physiological stress on wildlife. This results in increased metabolic demands and can cause some species to have to search longer for food, exposing them to greater risk from predators and adverse weather. Nests temporarily unattended by a parent while they move away from approaching humans may be quickly predated or parasitized. Alien scents may interfere with establishment of territories by some mammal species. Persistent noise reduces cues that breeding birds require to attract mates and/or food, thus potentially diminishing reproductive success.

Thresholds for inducing harassment (i.e., frequency, intensity, duration, distance, type) are not well defined and depend partly on the species. Some species appear to adapt well to human presence while others do so slowly or not at all. At one extreme, a single intrusion into a cave harboring colonial bats during a critical period may cause the bats to completely abandon the site. At the other extreme, chipmunks at campgrounds often become so accustomed to humans they feed directly out of the human hand. Most large birds and mammals flee when humans on foot approach within a few hundred feet. Smaller birds and mammals seem unaffected until humans are within a few feet. Harassment depends not only on the species, but on timing. Many species are most sensitive during the nesting season (mostly late spring and summer) and when they are roosting or congregating. Waterfowl are sensitive during their annual plumage molt. Willingness of an animal to leave a habitat patch completely may depend partly on the availability of refuges of suitable habitat nearby.

The severity of harassment is generally proportional to the local population density of humans. Although extensive trail networks are important to fostering public understanding of wildlife, the routing of trails near sensitive features such as heron rookeries and turtle basking sites should be minimized.

4.3.9 Invasive Species, Pathogens, and Parasites

This includes species, pathogens, and parasites – especially ones not native to the Willamette subbasin -- which (a) spread rapidly and/or (b) are unusually efficient competitors with or predators of native species, and/or (c) which drastically modify habitat structure in ways that reduce native species diversity and abundance. Species lists and information on control of invasive plants and weeds are available from several sources, including:

http://www.emeraldnpso.org/inv_ornmtls.html
http://www.invasivespecies.gov
http://invasivespecies.nbii.gov/

Invasive plants species are one of the most widespread and serious threats to native plant populations in all of the focal habitat types, except perhaps old growth conifer forest. Invasive species increase competition or predation on native species not adapted to co-existing with the invader, thus reducing population viability. Non-native species tend to be less frequent and/or less invasive where natural drainage, thermal, fire, and nutrient regimes have not been widely altered, where native predators have not been decimated, and where access by humans and other dispersal agents is minimal. Global warming may contribute to the establishment of some invasive plants (Probably the most prevalent invasive plants in the Willamette subbasin are Himalayan blackberry, Scotch broom, reed canarygrass, and English ivy. Some relatively recent additions of significant concern are Japanese knotweed and false-brome.
Invasive species are most detrimental to wildlife when they physically alter habitat structure or cause total elimination of some habitat types. Unfortunately the effects of invasive plants on wildlife have seldom been studied, but anecdotal observations of local naturalists and scientists suggest both positive and negative effects. In rare instances invasive species may benefit wildlife by reducing physical access to nest or roosting sites and thus minimize harassment by people, predators, and pets. In other instances non-native species can foster the expansion of

widely detrimental native species. For example, livestock introduction fostered the spread of brown-headed cowbird which severely parasitizes nests of songbirds.

Diseases and parasites occasionally are a major factor limiting plants and wildlife. Deformities noted among native frogs have been linked to parasites known as flukes (Johnson et al. 1999). Flukes have always parasitized frogs and caused a limited amount of deformities, but evidence is mounting that some additional factor – perhaps nitrate pollution – has indirectly caused an expansion of fluke populations and thus has possibly increased the incidence of frog deformities. Pathogenic fungi also may be impacting amphibians (Blaustein et al. 1994). In addition, two diseases -- Sudden Oak Death, which largely affects oaks, and West Nile virus, which affects birds and people, are poised to invade the Willamette subbasin. When they do the damage to vegetation and wildlife could be catastrophic, judging from what has happened elsewhere in the United States.

4.4 Geography of Disturbance Within the Subbasin

The potential limiting factors described in the section above vary in their geographic distribution within the subbasin. Nonetheless, some efforts have been made to geographically characterize disturbance patterns in the subbasin. Information of this sort can be used as one factor in deciding which areas to protect (e.g., least-disturbed) or restore (e.g., more-disturbed). One source that characterizes "general" disturbance is TNC's *Ecoregional Assessment* (Table 52). The types of current and anticipated disturbance within individual PCAs is shown in Table 7, and the potential for future development within each PCA is shown in Table 6.

4.5 Limiting Factors Outside the Subbasin

In general, most mammals, amphibians, reptiles, and rare plant species are not strongly and directly affected by factors outside the Willamette subbasin. This is because, except for a few large predators and scavengers, their seasonal and annual movements are constrained to areas entirely within the subbasin. Thus, external factors most likely to affect these groups are ones that occur over broad regions, such as global warming, spread of invasive species, and long-distance movement of airborne contaminants and food sources (such as fish). In contrast, many bird species (like fish) migrate or forage beyond the subbasin and thus can be limited more strongly by factors elsewhere. However, sound information is lacking with regard to which species are being limited by which particular external factors, and whether factors beyond the subbasin are more limiting than those within. As is true within the subbasin, habitat loss and degradation are likely to be major limitations for many birds.

Table 52. Relative level of terrestrial disturbance in Willamette watersheds as reported by TNC's Ecoregional Assessment.

In the last column, the watersheds (HUC6s) are ranked from most (1) to least (77) disturbed using index scores computed by TNC (Floberg 2004). No scores were available for the 93 watersheds that extend into higher portions of the subbasin. Scores are the same as the "terrestrial suitability" or "cost" scores that TNC calculated for all units in a hexagonal grid covering the region. TNC then translated those scores to the HUC6 units used in this analysis, with some loss of precision. Higher scores (lower ranks) indicate greater proximity to (or inclusion within) urban areas, greater amounts of private land, and/or proportionally more roads within or near natural land cover. These variables were measured from available spatial data and were weighted equally. See the original report for more details. See MapFile: HUC6map for boundaries of the watersheds.

HUC6	Name of HUC5	Name of HUC6	HUC acres	Score	Rank
170900010101	Willamette R. Middle Fk.	Rattlesnake & Hills Cr.	36052	584733	32
170900010501	Willamette R. Middle Fk.	Dexter Reservoir	15455	148298	75
170900020101	Willamette R. Coast Fk./ Row R.	Creswell E. Bear & Gettings Cr.	59250	861698	18
170900020102	Willamette R. Coast Fk./ Row R.	Creswell W.; Camas Swale	29827	492459	44
170900030101	Long Tom R.	W. Eugene; Junction City	102859	1855219	1
170900030102	Long Tom R.	Veneta; Poodle & Swamp Cr.; Fern Ridge Res	103139	1291933	5
170900030103	Long Tom R.	Coyote Cr.	67331	955167	16
170900030201	Muddy Cr.	Corvallis N.; Adair Village	37855	789435	22
170900030202	Muddy Cr.	Monroe; Muddy Cr. E.	59906	1096525	9
170900030203	Muddy Cr.	Coburg; Halsey; Little Muddy R.; Pierce Cr	95368	1637302	2
170900030204	Muddy Cr.	E. Eugene; Harrisburg; Springfield	47744	1070778	11
170900030301	Calapooia R.	Courtney Cr.	41757	635642	30
170900030302	Calapooia R.	Brownsville	68485	1080843	10
170900030401	Calapooia R./ Oak Cr.	N. Albany; W. Lebanon; Cox Cr.	47845	1029303	12
170900030402	Calapooia R./ Oak Cr.	S. Albany; Tangent.	36687	757255	24
170900030403	Calapooia R./ Oak Cr.	Sodaville	19266	374554	56
170900030504	Marys R.	Finley NWR; Muddy & Hammer Cr.	80134	1251983	6
170900030601	Luckiamute R.	Luckiamute R.4	17370	283219	65
170900030602	Luckiamute R.	Soap Cr.	37037	581411	34
170900030603	Luckiamute R.	Luckiamute R.1.	25047	350330	60
170900030606	Luckiamute R.	Little Luckiamute R. - lower	26348	353263	59
170900050601	North Santiam R. – lower	Jefferson; Lyons; Bear Branch	80169	1374655	4
170900060101	South Santiam R./ Crabtree Cr.	Crabtree Cr. & Onehorse Slough	17626	318549	63
170900060201	South Santiam R./ Crabtree Cr.	Beaver Cr.	46227	769079	23
170900060301	South Santiam R. / Thomas Cr.	Lower Thomas Cr. -lower; Scio	28696	503219	43
170900070101	Willamette R. – middle	Baskett Slough NWR	15553	234981	70
170900070102	Willamette R. – middle	Independence; Monmouth	44113	857029	19
170900070103	Willamette R. – middle	Ankeny NWR	31842	543536	39

HUC6	Name of HUC5	Name of HUC6	HUC acres	Score	Rank
170900070201	Mill Cr.	Sublimity & Turner	31897	662987	28
170900070202	Mill Cr.	Aumsville & Beaver Cr.	20680	394925	53
170900070203	Mill Cr.	S. Salem; McKinney Cr.	18625	392343	55
170900070301	Willamette R./Chehalem Cr.	Saint Paul	29193	472615	45
170900070302	Willamette R./Chehalem Cr.	Dundee; Newberg	30055	541437	40
170900070303	Willamette R./Chehalem Cr.	Chehalem Cr.	26469	465933	46
170900070304	Willamette R./Chehalem Cr.	Lincoln	26316	422474	50
170900070305	Willamette R./Chehalem Cr.	Keizer; Spring Valley Cr.	31410	683313	26
170900070306	Willamette R./Chehalem Cr.	W. Salem	11275	248683	67
170900070307	Willamette R./Chehalem Cr.	Salem	17361	370610	58
170900070401	Molalla R./ Abernethy Cr.	W.Wilsonville	26079	529544	41
170900070402	Molalla R./ Abernethy Cr.	N. Canby; E. Wilsonville	33726	704300	25
170900070403	Molalla R./ Abernethy Cr.	Oregon City; West Linn	26304	580898	35
170900080201	North Yamhill R./ Willamina Cr.	Willamina	13691	244344	69
170900080401	South Yamhill R. – lower	Sheridan	28137	513427	42
170900080402	South Yamhill R. – lower	Salt Cr.	12305	219368	72
170900080403	South Yamhill R. – lower	Deer Cr.	35783	569620	36
170900080501	South Yamhill R./ Salt Cr.	Ash Swale & Deer Cr.	23438	371096	57
170900080502	South Yamhill R./ Salt Cr.	Amity	39706	669412	27
170900080601	North Yamhill R.	Yamhill	24565	426029	49
170900080602	North Yamhill R.	McMinnville N.	19141	320197	62
170900080604	North Yamhill R.	Turner Cr.	19603	310142	64
170900080701	Yamhill R.	Palmer Cr.	25142	435399	48
170900080702	Yamhill R.	Lafayette	18542	330537	61
170900080703	Yamhill R.	McMnnville S.	20064	414294	51
170900090101	Pudding R.	Aurora	12088	218050	73
170900090102	Pudding R.	Woodburn; Hubbard	23137	453184	47
170900090201	Pudding R.	S. Canby	20213	394334	54
170900090202	Pudding R.	Molalla R. -middle	14744	234244	71
170900090301	Pudding R.	Butte Cr.	35371	659778	29
170900090302	Pudding R.	Cedar Cr.	10360	189099	74
170900090305	Pudding R.	Milk Cr.	12446	245658	68
170900090501	Molalla R. - upper	Molalla	54961	973874	14
170900090601	Molalla R. - lower	Molalla R. N. Fk.	35926	295	76
170900090602	Molalla R. - lower	Molalla R. S. Fk.	40016	192	77
170900090701	Pudding R./ Silver Cr.	Little Pudding R.; E. Salem	45747	945055	17
170900090702	Pudding R./ Silver Cr.	Drift Cr.	47782	829494	20
170900090703	Pudding R./ Silver Cr.	Silverton N.	16815	266900	66
170900100101	Tualatin R./ Dairy Cr.	Tigard; Tualatin; Sherwood; King City	62243	1391134	3
170900100102	Tualatin R./ Dairy Cr.	Hillsboro	47896	987021	13
170900100103	Tualatin R./ Dairy Cr.	Beaverton & Rock & Cedar Mill Cr.	48731	1129108	8
170900100201	Tualatin R./ Dairy Cr.	Dairy Cr. W. Fk. & Council Cr.; Banks	69079	1155860	7
170900100202	Tualatin R./ Dairy Cr.	Diary Cr. E.	41319	409032	52
170900100203	Tualatin R./ Dairy Cr.	North Plains; McKay Cr.	37569	582957	33
170900100302	Tualatin R./ Scoggins Cr.	Sain & Scoggins Cr.	36163	549586	38
170900110103	Clackamas R. - Collawash R.	Sandy	31871	551754	37
170900120201	Willamette R. - lower	Portland; Forest Hills;	40695	956035	15

HUC6	Name of HUC5	Name of HUC6	HUC acres	Score	Rank
		Multnomah Channel			
170900120202	Willamette R. - lower	S. Milwaukie; Happy Valley; Lake Oswego; W	25869	625606	31
170900120203	Willamette R. - lower	Gresham; Portland; N. Milwaukie	34181	814463	21

5. Synthesis

5.1 Working Hypotheses: Limiting Factors and Conditions

Factors that potentially limit wildlife and rare plants are more severe in the Willamette subbasin than in most other subbasins of the Columbia Basin. A large portion of the subbasin is privately owned, with only a few large ownerships. This fragmentation of ownership as well as the spatially patchy nature of the landscape heightens the challenge of mounting a well-coordinated and effective conservation effort. Land costs are high, complicating any plans for broadscale purchase of private lands for conservation. Habitats for the rarest plant species are frequently only tiny patches along roadsides or along agricultural fields. ***With over 280 species breeding in the Willamette subbasin, each with specific needs and vulnerabilities that vary across time and space, it is impossible to prove conclusively with available data which agents and changes are "generally" the most limiting***. Nonetheless, this report's review of limiting factors for selected focal species, as well as reviews completed by other biologists (e.g., Floberg 2004), suggests the following may be the most limiting at the present time:

1. Insufficient amount of readily-accessible suitable (non-degraded) habitat, especially of the habitat types considered "focal" in this report, meaning:
    - Quality of these focal habitats is being degraded by changes highlighted in Table 7.
    - Diversity of habitat types and structures within some local landscapes is decreasing as a consequence of habitat loss and degradation
    - Wildlife access to suitable habitat is being restricted by increased barriers and interpatch distances (fragmentation)

2. Increased predation by and/or competition with introduced wildlife species (e.g., bullfrog) and subsidized populations of particular native species (e.g., raccoon)

3. Collisions with vehicles, windows, radio towers, powerlines, other objects.

Looking ahead, all of the above limiting factors are likely to increase unless vigorous efforts are made to mitigate their effects. In addition, the future holds the possibility that two factors -- which until recently appear not to have been very influential – may become significantly more limiting to wildlife and rare plants:

- increased regional warming and associated hydrologic regime changes
- increased incidence of parasites and pathogens, e.g., Sudden Oak Death

5.2 Desired Future Conditions

With regard to terrestrial wildlife and plants in the Willamette subbasin, the overall goal should be to maintain and/or restore healthy and well-distributed (i.e., not confined to just a few watersheds or refuges) populations of all species native to the subbasin.

5.3 Opportunities for Protection and Restoration

Opportunities for protecting particular areas in the Willamette subbasin have been identified for lowlands and foothill areas by TNC's *Ecoregional Assessment*, and for the subbasin generally by the ERC's *Conservation and Restoration Opportunity Areas* (Hulse et al. 2004). These two maps should be used as the primary references for locating protection or restoration opportunities.

The maps can be augmented by recommendations from the other types of reports described in section 1.5, and by using this report and databases to address species whose habitat needs may not have be optimally covered by protecting only the areas identified in the TNC analysis For higher-elevation areas, information on conservation priorities will become available in late 2004 from TNC's West Cascades *Ecoregional Assessment*. In some instances, Federal agencies also have identified opportunities for protecting or restoring specific tracts of terrestrial habitat. For any specific wildlife or rare plant species, watersheds that may currently be providing the most extensive and/or highest suitability habitat can be identified by querying or sorting Detail File:SPHABHUC6 which accompanies this report.

Additional opportunities specifically for restoration can be identified partly by:

1. Conducting field surveys to assess where ecological degradation is occurring, as often indicated by prevalence of invasive plant cover. However, many sites without extensive cover of invasive plants can nonetheless be experiencing ecological degradation, and a predominance of invasive plant cover on a site does not automatically mean the habitat of native wildlife species had been degraded.

2. Identifying the types of land cover that existed historically within a particular watershed (DetailFile: HistoricalVegNHI), especially the types that have decline the most (DetailFile: ChangeVegNHI), and those that existed in a particular priority conservation area), then:

3. Learning about factors needed to sustain that habitat type and the focal species that use it (section 2) as well as limiting factors that are present in the subbasin generally (section 4), and then:

4. Considering the relative sustainability of habitat, once it is restored, in that particular watershed. This can be done partly by reviewing Tables 7 and 52, evaluating the extent of developable lands (Table 6), and by reviewing municipal and county government projections of population growth in the vicinity.

6. Management Plan

6.1 Vision for the Willamette Subbasin

Ideally, despite a net loss of undeveloped land and possible doubling of the population in the subbasin's lowlands by the year 2050, the Willamette landscape of the future is proposed to be one with a variety, composition, and abundance of native plants and animals that is much closer to what existed historically than to what exists today. Yet, at the same time it will be a landscape with enough functional connectivity and evolutionary potential to allow its flora and fauna to deal with both traditional and untraditional disturbances.

6.2 Biological Objectives for the Willamette Subbasin

By intent, this report specifies no "new" biological objectives, i.e., ones not already specified by other plans. Biological objectives for Federally-listed species are given in recovery plans for those species and are given for some additional bird species in Partners In Flight documents (Altman 1999, 2000). Quantitative objectives pertaining to specific habitat ("ecological system") and community types are specified in TNC's *Ecoregional Assessments*, and some other plans. Examples are shown in Table 53.

To reduce the factors that limit terrestrial wildlife and rare plants, and thus achieve the vision stated above, the following objectives should be pursued through habitat protection, restoration, and management:

Minimize further habitat loss and degradation. Specifically, and where feasible:

- minimize construction of new roads and other wildlife hazards
- situate development so fragmentation of undeveloped land will be minimized
- restore former fire regimes
- remove and/or control invasive species; respond rapidly to new plant pathogens
- achieve an adequate and sustainable supply of standing and downed dead wood
- maintain natural water level and soil moisture regimes
- reduce point and nonpoint sources of air and water pollution
- minimize soil degradation caused by compaction and other factors
- mitigate adverse effects of warming from global climate change and other causes
- minimize intentional or unintentional harassment of wildlife

6.3. Prioritized Strategies for the Willamette Subbasin

A three-pronged strategy should be vigorously implemented, involving habitat protection, restoration, and multiple use management, on both public and private lands. Restoration and especially protection strategies which exclude intensive use of the land (i.e., exclude urban development and farming) are undesirable for economic, social, and political reasons, at least not on a scale sufficient to maintain viable populations of some species. Thus, a complementary strategy -- involving enlightened management of existing agricultural, urban, and forest lands in ways that provide more benefits to rare plants and wildlife -- is critical. "Enlightened stewardship" (or management of "Tier 2 habitats" in the language of the Alternative Futures project) could involve, for example, incentives or subsidies for using longer harvest rotations in timberlands, planting water-conserving crops, and locating new residential developments strategically so as to better maintain connectivity of habitats important to the most mobile of the focal species. It could include energetic application of best management practices to activities in urban as well as agricultural and forest landscapes. For example, some of these are summarized for agricultural lands by Edge (2001), for urban areas by Ferguson et al. (2001) and Marzluff & Ewing (2001), and for forest lands by Haynes & Perez (2001), McComb (2001), Olson et al. (2001), Muir et al. (2002), and others. In some cases farmers themselves (e.g., California Association of Winegrape Growers) have taken the initiative to brainstorm ideas and implement a coordinated approach for protecting and improving farmland for wildlife habitat while maintaining its commercial productivity. Also see:

www.dfw.state.or.us/ODFWhtml/springfield/urban.html
www.oacd.org/fs16wild.htm
www.dfw.state.or.us/ODFWhtml/InfoCntrHbt/wldhbt_facts.htm
www.cawg.org/pdf/vineyard_wildlife_action_plan.pdf

But no matter how enlightened or extensively practiced, this strategy will never be enough to maintain populations of many species that require large blocks of habitat completely free of intensive human uses. Thus, the primary strategy for achieving the vision described in section 6.1 should be **to *protect self-sustaining populations and habitats, especially those that are rarest or have declined the most historically*** (i.e., "Tier 1 habitats" of the Alternative Futures project)**.** This depends critically on maintaining or improving existing land use and forest practice laws, mitigation requirements, and landowner conservation incentives (Berger & Bolte 2004, Baker et al. 2004). It also means continuing the obtaining of conservation easements to the most critical land parcels, and outright land purchases from willing landowners when appropriate. A secondary but important and complementary strategy will be ***to manage, minimize continued damage to, and restore (where feasible) areas that are ecologically degraded.*** For both strategies the habitat types and species described in this report as "focal" should be emphasized. Among the focal species, highest priority should be accorded to those that are federally listed. The next-highest priorities should be species listed as sensitive by ODFW and species extirpated from the subbasin but for which recovery is feasible.

In planning for wildlife and rare plant habitat, a consciously and comprehensively multi-species approach, with emphasis on (but not limited to) this report's focal habitat types and species, should be adopted. This should be applied, for example, when assessing wildlife when calculating mitigation credits, analyzing the consequences of alternative landscape patterns and practices, prioritizing land acquisitions, and managing watersheds for fish, rare plants, and wildlife. This will involve analyzing and articulating the specific tradeoffs among species that accompany individual aquatic or terrestrial management decisions. It will involve basing tradeoff decisions on the overarching goal of maintaining wildlife and plant diversity as measured at subbasin and watershed scales.

Taken together, the PCAs and CROAs identified by previous projects appear to reasonably represent the best remaining habitat for the widest variety of species in the Willamette subbasin.

Nonetheless some gaps in species habitat coverage remain. These can and should be addressed by minor inclusion of additional areas, as identified partly from the following sources:

- This report (see section 8 for guidance)
- Aquatic or fish conservation priority areas recommended by other agencies and institutions
- Higher-elevation areas recommended in TNC's forthcoming *West Cascades Ecoregional Assessment*
- *Pacific Coast Joint Venture Implementation Plan* (Roth et al. 2002)
- Natural resource management plans completed by communities[21]
- Watershed assessments by local watershed councils and various agencies
- Management plans of the subbasin's state and national forests
- Recommendations of Audubon's "Important Bird Areas" initiative and The Wetland Conservancy's "Oregon's Greatest Wetlands" initiative

A continuing effort also should be undertaken to prioritize (for acquisition or conservation easement) specific land parcels or tax lots encompassed by the expanded list of opportunity areas. Priorities among PCAs have been carefully assessed by TNC's ecoregional assessment, but additional areas identified from the above should be assessed using a prioritization scheme that considers factors that include but are not limited to the following:

- The degree to which the parcel provides habitat for species identified in this report as being poorly protected in the particular watershed by public lands and PCA lands (see Detail Files: UNSWEPT and SPHABCOR);
- The degree to which the parcel's botanical and wildlife communities differ from (i.e., are complementary to) those of the same associated habitat type which are already protected. (Botanical community types are listed in Appendix 15b of Floberg et al. 2004, and for wetlands by Christy 2004);
- The degree to which the parcel provides a corridor (or "stepping stone") between two patches of habitat of greater suitability or importance;
- The likely vulnerability, conservation value (number of focal, listed, or ranked species), ecological condition, and sustainability of the land parcel. Future vulnerability can be assessed partly by reference to the "Buildable Lands" map accompanying this report (Map File: Buildable).

Additional opportunities specifically for restoration can be identified partly by:

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[21] These have been done to meet requirements for "Goal 5 planning" have featured use of standardized data forms, visual on-the-ground assessments of habitat structure, and professional judgment to assign "habitat scores" to individual wetlands, forested tracts, riparian strips, or other semi-discrete spatial units. Their intended use has been to help local governments channel development away from habitat areas perceived as important, or to better manage development impacts within or near them. Habitat ratings for individual properties from such wildlife habitat assessments are available, for example, for Salem, Eugene, Springfield, Corvallis, Gresham, Tualatin, Tigard, King City, Hillsboro, West Linn, Lake Oswego, Wilsonville, Newberg, and Stayton (P. Fishman, pers. comm.). Perhaps the most ambitious of the municipal assessments have been conducted in the greater Portland area by Metro, beginning with field surveys (Poracsky et al. 1992) and extending to use of species-habitat models and as well as field-based scoring of habitat patches and connectivity, to prioritize lands for possible acquisition, restoration, and/or management (see: www.metro-region.org/habitat).

1. Conducting field surveys to assess where ecological degradation of focal habitat types is occurring. Guidelines for assessing the ecological condition of parcels of each type of habitat ("ecological system") are given in Appendix 11 of Floberg et al. 2004. Prevalence of invasive plant cover is one indicator. However, many sites without extensive cover of invasive plants can nonetheless be experiencing ecological degradation by factors described in section 3. Conversely, a predominance of invasive plant cover on a site does not automatically mean the habitat of native wildlife or fish species had been degraded.

2. Identifying the types of land cover that existed historically within a particular watershed (DetailFile: HistoricalVegNHI), especially the types that have declined the most (DetailFile: ChangeVegNHI), and those that existed in a particular priority conservation area.

3. In the case of wetland restoration opportunities, reviewing county soil survey maps for locations of hydric soils, which generally indicate historical as well as current wetlands.

4. Learning about factors needed to sustain the habitat type of interest and the focal species that use it (section 2) as well as limiting factors that are present in the subbasin generally (section 4).

5. Considering the relative sustainability of habitat, once it is restored, in that particular watershed. This can be done partly by reviewing Tables 7 and 52, partly by evaluating the extent of developable lands (Table 6), and partly by reviewing municipal and county government projections of population growth in the vicinity.

The preceding pages have described activities necessary to *plan* for effective wildlife conservation. But ultimately, conservation depends on *implementing* activities on the ground. In this regard, to reduce the factors that limit the Willamette subbasin's terrestrial wildlife and rare plants, and thus achieve the vision stated above, the following objectives should be pursued through habitat protection, restoration, and management:

- Minimize further habitat loss and degradation. Specifically, and where feasible:
- minimize or at least concentrate the construction of new roads and other wildlife hazards
- situate development so fragmentation of undeveloped land will be minimized
- restore former fire regimes to the extent possible
- remove and/or control invasive species; respond rapidly to new plant pathogens
- achieve an adequate and sustainable supply of standing and downed dead wood
- maintain natural water level and soil moisture regimes
- reduce point and nonpoint sources of air and water pollution
- minimize soil degradation caused by compaction and other factors
- mitigate adverse effects of warming from global climate change and other causes

minimize intentional or unintentional harassment of wildlife.

Table 53. Examples of quantitative objectives for focal habitat types (or their approximate equivalents) as proposed in the Willamette subbasin by other assessments.

	Oak woodland	Upland prairie & savanna	Wetland prairie	Ponds & sloughs	Stream riparian	Old growth conifer forest
Willamette Restoration Strategy (ODFW; Nov. 2000 draft)[1]	50,000 ac	50,000 ac ["grasslands"]	93,000 ac ["wetlands"]; 50,000 ac ["grasslands"]	93,000 ac ["wetlands"]; 200,000 ac ["riparian"]	200,000 ac ["riparian"]	100,000 ac ['conifer forest']
Ecoregional Assessment (TNC; Floberg et al. 2004)	all remaining viable (~ 48,346 ac)	all remaining viable	all remaining viable prairie; 8 marshes	N/A	55,192 ac	N/A
Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington (Altman 2000)	all tracts >100 ac	all tracts >200 ac ["grassland-savanna"]	N/A	N/A	all tracts >50 ac and/or 30% of historical area	
Joint Venture Implementation Plan: Willamette Valley(Roth et al. 2002)	14,000		58,000			
Hulse et al. 2002 [2]	55,200	37,900		N/A	N/A	N/A
Payne 2002 [3]	38,136	8319	3184	2394 ["wetlands"]	1229	N/A

[1] "by 2050, distributed throughout its historic range in patches of sufficient size and quality to sustain populations of dependent species, with an interim target of no net loss by 2006"
[2] sociopolitically likely (best-case) additional amount that could be protected/ restored according to the Possible Futures Working Group (a stakeholder group convened by Governor Kitzhaber)
[3] amount that could be gained through restoration if mandated as part of mitigation packages associated with all future cluster development on low-productivity lands

Table 54. Comparison of the two main sources of mapped information on terrestrial habitat priorities.

	ERC Alternative Futures Project	TNC Ecoregional Assessment
Reference:	Hulse et al. 2002 & 2004, Baker et al. 2004	Floberg et al. 2004
Coverage	Entire subbasin	Valley and foothill portions of subbasin (44% of entire subbasin)
Term used in this report for the selected areas	CROA (Conservation and Restoration Opportunity Area)	PCA (Priority Conservation Area)
Boundaries of selected areas	Defined by one or more 30m pixels	Defined mostly by natural boundaries
Procedure for initial selection	Use of historical and current land cover maps, discussions with experts	Use of historical and current land cover maps, Oregon Natural Heritage Program (ONHP) occurrence database, discussions with experts
Procedure for final selection	Workshops with stakeholders, allowing ecological considerations to be tempered by sociopolitical feasibility. Selected areas were not systematically optimized so are not necessarily the most cost-effective for conserving biodiversity.	Iterative application of SITES optimization model and expert feedback, to achieve prespecified species habitat goals and other ecological goals. Selected areas are the most cost-effective for conserving the targeted species and ecological communities, but sociopolitical feasibility did not influence selection.
Total subbasin acreage proposed as a conservation priority	Tier 1: 1,650,224 acres (~23% of the subbasin)	~ 755,108 acres (~ 11% of the subbasin, and ~24% of the WPG ecoregion)
Species occurrence data used to select priority areas?	No	Yes
Every wildlife species explicitly assessed?	Yes	No
Listed plants & invertebrates assessed?	No	Yes
Sustainability of individual selected areas evaluated?	No	Yes

6.4 Consistency with ESA/CWA Requirements

[to be written by ODFW or USFWS]

6.5 Research, Monitoring, and Evaluation to Support the Objectives

For most focal species and habitats, technical data are currently inadequate for adopting quantitative biological objectives or standards that represent desired conditions and could be used to evaluate progress towards meeting ecological goals. Nonetheless, some broad "acreage" objectives specific to the Willamette subbasin provide interim benchmarks that should be monitored and considered in non-regulatory decisions. Table 53 shows a few examples.

Over the longer term, data needed to support sound biological objectives should be developed using four strategies:

1. Research to measure key *demographic characteristics* of focal species, e.g., home range size, reproductive success, and survival. Such research should emphasize the focal habitats, and select research sites stratified by landscape configuration and geomorphic settings, so as to ultimately allow estimation of minimum viable population sizes and population viability;

2. Research to prioritize the relative importance of each focal species' *limiting factors*, from among the possibilities listed generally in this report;

3. Interdisciplinary research to better understand the *functions* of individual species, so that their role in predicting the evolutionary potential in the landscape can be better determined;

4. *Monitoring* of species populations, especially species that are suspected – based on paucity of recent reports -- of having recently become (or are about to become) extirpated from the Willamette subbasin. These might include, for example, breeding populations of short-eared owl, Wilson's snipe, black-tailed jackrabbit, Baird's shrew (endemic to this subbasin), and several species of bats, plants, and invertebrates.

5. *Measurement of both typical and desired structural characteristics* of each focal habitat from a statistical sample (probabilistic frequency distribution) stratified by geomorphic setting, e.g., mean patch size of oaks in south-facing slopes between 500 and 1000 ft elevation, expected cover of non-native shrubs in wetland prairies on Bashaw clay soils. A field and GIS-based inventory of such characteristics is necessary to add realism to biological objectives. Examples of meaningful characteristics that might be inventoried are highlighted in subsections under each focal habitat titled "Indicators of [focal habitat type] Ecological Condition and Sustainability."

Simultaneously, existing species-habitat models and demographic models, upon which many of the recommendations of this report are based, should be updated and refined using:

- new or supplemental spatial data layers
- results of research studies published since 1999 (when the models were drafted)
- field validation and improvement of land cover (habitat) spatial data used in model predictions
- incorporation of data from federal agency species observation databases (e.g., ISMS)
- local biologist review of the watershed species lists (Detail File: SPHABHUC6) generated by existing models.

The models should then be re-run for the entire subbasin with results again subtotaled by watershed (HUC6) and for specific conservation opportunity areas. If feasible, assumptions made earlier about the frequency of habitat elements within each map class (e.g., relative extent of snags in 40-60 year-old closed-canopy conifer forest; see pages A-12 through A-15 in Payne 2002) should be field-verified. This will allow for improved assessments of the consequences of adopting alternative biological objectives for particular species, as well as improved identification and prioritization of lands for restoration or conservation within individual watersheds.

Over the long term the needs of species, genetic groups, habitat types, and ecosystem functions not considered by this or other Willamette reports should be determined, taken into account, and monitored. Only then can we be assured that ecological integrity – not simply wildlife diversity – is being maintained in the Willamette subbasin.

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