ABSTRACT

Within the Willamette River basin of Oregon, populations of terrestrial vertebrate species associated with grassland and oak savanna ecosystems are declining as their habitats are lost through land conversion and plant succession in the absence of natural disturbance. While State land use regulations have protected and encouraged forestry and farming on private lands and have directed rural housing development to designated zones, planning and implementation of protection for native ecosystems has been limited. In the lowlands of the basin, an area where most of the land is privately owned, less than 1.6% is dedicated to the conservation of biodiversity. If biodiversity is to be maintained, the conservation network will have to be expanded in this region.

This need is present even as human populations in the basin are expected to double over the next 60 years, and current rural residential zones are projected to reach capacity by 2020. Thus, demand for new rural housing will likely rise concurrent with the increasing urgency for establishment of new conservation reserves.

One approach toward meeting both of these needs is to couple the wealth production of rural development to conservation by permitting rural housing development in return for conserving and/or restoring native ecosystems.

The objective of this project is to test whether such a mitigation policy can be deployed in less environmentally sensitive areas of the basin so as to provide useful amounts of housing while improving habitat conditions for species of concern.

Four alternative rural development scenarios are defined: 5 acre subdivision, 15 acre subdivision, cluster housing, and cluster housing with mitigation. A fifth scenario, “plan trend”, represents the continuation of current policies with no additional areas of rural development. The landscapes for each scenario in the year 2050 are modeled by applying scenario-specific land use/land cover changes to the starting landscape of 1990. A habitat model is then used to evaluate the changes, with respect to 1990 conditions, in the cumulative amount of habitat provided by each landscape for each animal species.

The results indicate that only cluster development with mitigation provides meaningful habitat improvement for species both basinwide and in the region of new development. Under plan trend and all other alternative development scenarios, habitat conditions decline for more species than improve, basinwide. Oak and grassland species, in particular, respond favorably to the mitigation policy which restores 84,819 acres of native habitats in the foothills of the basin, an amount equivalent to an increase of 140% in the conservation network of the lowlands.

The cluster scenarios site 40,930 homes, in comparison to 50,450 homes in 5 acre subdivisions, and 18,030 homes in 15 acre subdivisions. Cluster development is found to be the most efficient in terms of developed area per house, and new road miles per house. This type of development uses the least amount of high value farm lands and the least amount of the most productive forests (site class I and II).

It is concluded that rural cluster development in certain areas of the basin when accompanied by conservation and restoration of native habitats, can benefit both humans and wildlife.

KEYWORDS: alternative futures, landscape modeling, habitat evaluation, rural housing, cluster development, biodiversity, wildlife, Willamette River basin.
# Table of Contents

List of Figures ......................................................................................... vii  
List of Tables ......................................................................................... ix  
List of Appendices .................................................................................. xi  
List of Acronyms ..................................................................................... xiii

## Chapter 1. INTRODUCTION ................................................................. 1-1

## Chapter 2. BACKGROUND ................................................................. 2-1

### Biodiversity in the WRB ................................................................. 2-3

- Species .......................................................................................... 2-3
- Ecosystems and Habitats ................................................................ 2-5
  - Floodplain forests ........................................................................ 2-5
  - Wet and Upland Prairie ................................................................. 2-8
  - Oak Savannas ............................................................................. 2-8
  - Woodlands .................................................................................. 2-9
  - Conifer Forests .......................................................................... 2-9

### Landscape matrix and Ownership ................................................. 2-10

### Human Populations in the WRB .................................................... 2-12

- Oregon State Land Use Planning ..................................................... 2-13
  - Goal 3 ....................................................................................... 2-13
  - Goal 4 ....................................................................................... 2-14
  - Goal 14 ..................................................................................... 2-15
  - Goal 5 ....................................................................................... 2-16

- Population Growth and Distribution ................................................ 2-16

### Bringing together People and Habitat ......................................... 2-17

- Alternative Futures ......................................................................... 2-18

## Chapter 3. METHODS ......................................................................... 3-1

### Approach ....................................................................................... 3-2

- Scale and Extent ............................................................................. 3-2
- Time .............................................................................................. 3-3

### Description of Scenarios .............................................................. 3-3

- Current Conditions circa 1990 (CC90) ............................................ 3-4
- Pre-settlement Vegetation (PESVEG) .............................................. 3-6

- Scenarios of Alternative Futures .................................................... 3-7

- Plan Trend (PT-EX) ...................................................................... 3-7
- 5 acre Rural Residential Subdivision (RR-5) .................................. 3-7
- 15 acre Rural Residential Subdivision (RR-15) ............................. 3-10
- Cluster Rural Residential Development (RR-CL) ......................... 3-10
- Conservation Clusters (RR-CNS) ..................................................... 3-11

- Modeling Rural Development ....................................................... 3-11

- Locating the Residential Overlay Zone (ROZ) ............................... 3-11
- Creating parcels ........................................................................... 3-15
- Creating clusters .......................................................................... 3-16
- Siting roads ................................................................................... 3-16
- Siting houses ................................................................................. 3-17
- Developing Taxlots over Time ....................................................... 3-18
Table of Contents (continued)

Modeling Land Cover Changes ................................................................. 3-18
Vegetative Succession .............................................................................. 3-18
Land cover management within the ROZ ........................................... 3-20
Habitat restoration .................................................................................. 3-21

Description of Habitat Evaluation Model ............................................. 3-23
Required Species Data ............................................................................ 3-23
Evaluation Modeling Process ............................................................... 3-24
Evaluation Products ................................................................................ 3-26
Change in “Species Richness” ............................................................... 3-28
Species trends ......................................................................................... 3-29

Chapter 4. RESULTS ........................................................................... 4-1

KEY CHARACTERISTICS OF DEVELOPMENT ...................................... 4-2
Where are the targeted taxlots? ............................................................. 4-2
How many dwellings were sited? ......................................................... 4-3
How does the rural population change? .............................................. 4-7
How many more roads are needed? ...................................................... 4-7
What losses of high value farmland occurred? .................................. 4-8
What losses of high productivity forests occurred? ......................... 4-9
What is the zoning of the targeted taxlots? ......................................... 4-9

KEY CHANGES IN LAND USE/LAND COVER AND HABITAT ................ 4-11
How is habitat expected to change under current policies? .............. 4-11
Closed conifer forest ............................................................................ 4-11
Urbanization ......................................................................................... 4-15
Agriculture ............................................................................................ 4-15
Natural Vegetation ................................................................................ 4-15
How is habitat expected to change under the alternative futures? .... 4-16
Closed conifer forest ............................................................................ 4-17
Urbanization ......................................................................................... 4-18
Agriculture ............................................................................................ 4-18
Natural Vegetation ................................................................................ 4-19
How much and what type of habitat is restored in the conservation clusters future? ...... 4-20
What does the landscape look like? ...................................................... 4-20

Species Responses to Habitat Changes ................................................. 4-26
How does local species richness change from 1990 to 2050? ............ 4-26
For what species are habitat conditions improving or declining? .... 4-28
Species Trends within the WRB under PT-EX .................................... 4-28
Species trends in the WRB under alternative futures ....................... 4-32
Species Trends within the Impact Region ........................................... 4-33
Does restoration improve conditions for oak and grassland species? 4-37

Chapter 5. KEY FINDINGS and SYNTHESIS ...................................... 5-1

Key points concerning biodiversity ..................................................... 5-2
Key points concerning development .................................................. 5-7
Table of Contents (continued)

Chapter 6. RECOMMENDATIONS ............................................................................................................. 6-1

REFERENCES ............................................................................................................................................. A-1

APPENDICES ........................................................................................................................................... A-7
List of Figures

Fig. 2.1. Location of the Willamette River Basin in the Pacific Northwest context. .................................................. 2-2
Fig. 2.2. Level 3 and 4 ecoregions of the Willamette River Basin .......................................................... 2-2
Fig. 2.3. Photograph taken in Willamette Valley ecoregion .......................................................... 2-3
Fig. 2.4. Photograph showing a typical landscape of the West Cascades Lowlands and Valleys ecoregion. ... 2-3
Fig. 2.5. Photograph from the Cascade Crest Montane Forest ecoregion. ........................................ 2-3
Fig. 2.6. Conversion of land cover from ca. 1850 to ca. 1990 within the Willamette River Basin. .............. 2-4
Fig. 2.7. Comparison of pre-settlement (ca. 1850) and contemporary (ca.1990) land cover .................. 2-6
Fig. 2.8. Mature bottomland forest riparian vegetation along an alcove of the Willamette River .......... 2-8
Fig. 2.9. Willamette Valley wet prairie at the Nature Conservancy’s Willow Creek Preserve, Eugene. .... 2-8
Fig. 2.10. Oregon white oak overtopped by 50 year old conifers, near Veneta, Lane Co. ......................... 2-9
Fig. 2.11. Open grown Oregon white oak in oak savanna at Finley Wildlife Refuge, Benton Co. .......... 2-9
Fig. 2.12. Oak Forest, near Eugene, Lane Co. .................................................................................. 2-9
Fig. 2.13. Areas of old growth forest (>200 years) and resource conservation areas ................................ 2-10
Fig. 2.14. Public ownership in the WRB. ...................................................................................... 2-11
Fig. 2.15. Urban centers and rural development in 1990. ....................................................................... 2-13
Fig. 2.16. High value farmland as defined by soil capability classes under Goal 3 administrative rules. .... 2-14
Fig. 2.17. Forest productivity within the WRB, as defined by NRCS in the SSURGO soils mapping. .......... 2-15

Fig. 3.1. Flow diagram of the steps in the process to depict and evaluate the landscapes produced by the alternative scenarios. ........................................................................................................ 3-2
Fig. 3.2. Decision flow showing the outline of the steps taken to create the alternative futures from the five scenarios. ........................................................................................................ 3-8
Fig. 3.3. Calculation of slope dependent area for siting cluster houses on slopes. ................................ 3-11
Fig. 3.4. Components of the residential overlay zone. .......................................................................... 3-12
Fig. 3.5. Criteria for selecting buildable sites. .................................................................................... 3-14
Fig. 3.6. Subdivision process for scenarios RR-5 and RR-15 within taxlots of the ROZ. ......................... 3-15
Fig. 3.7. New roads within the RR-5 landscape in the Spencer Creek watershed, south of Eugene. ...... 3-17
Fig. 3.8. Area considered to be open to succession by woody plants. ................................................ 3-19
Fig. 3.9. Habitat scores for a selected set of species. ........................................................................... 3-25
Fig. 3.10. Number of species for which each habitat serves as a population source. ................................. 3-26
Fig. 3.11. Summary of adjacency rules that are used to adjust habitat scores based on proximity of one habitat to another, and on geographic or physical constraints. ................................................. 3-27

Fig. 4.1. Location of buildable areas ........................................................................................................ 4-2
Fig. 4.2. The taxlots of the residential overlay zone, targeted for development. ................................ 4-2
Fig. 4.3. Taxlots targeted for development, shown in context with 1990 rural residential zones, 1990 zoning, travel time, and public and NGO natural areas ......................................................... 4-4
Fig. 4.4. Length of roads within taxlots of the ROZ under different scenarios and within 1990 RRZs. ... 4-7
Fig. 4.5. Comparison of use of high value farm soils in 1990 with 2050 for the RR-15 scenario. .............. 4-8
Fig. 4.6. Comparison of use of forest site class I-IV soils in 1990 with 2050 for the RR-15 scenario. ...... 4-10
Fig. 4.7. 1990 Current Conditions, CC90. .......................................................................................... 4-12
List of Figures (continued)

Fig. 4.8. 2050 Plan Trend conditions, (PT-EX) ................................................................. 4-13
Fig. 4.9. Comparison of habitat classes in the WRB in 1990 with PT-EX 2050, and with 1850. 4-11
Fig. 4.10. Age distribution of conifers under Plan Trend Scenario, PT-EX. 4-14
Fig. 4.11. Area of closed conifer forests in Plan Trend scenario, PT-EX, compared with area in 1990. 4-14
Fig. 4.12. Map of “impact region” .................................................................................. 4-16
Fig. 4.13. Composition of habitat in the impact region in for all scenarios. ................... 4-17
Fig. 4.14. Comparison of the distribution of area of closed conifer habitats for all alternative futures, and 4-17
1990 within the impact region. ....................................................................................... 4-17
Fig. 4.15. Comparison of the change in agricultural habitats within the impact region, for all alternative 4-18
futures with respect to PT-EX. ....................................................................................... 4-18
Fig. 4.16. Extent of restoration delineated in the 2050 RR-CONS scenario. ................... 4-21
Fig. 4.17. Habitat maps for 1850, 1990 and all alternative futures except RR-CL. ....... 4-22
Fig. 4.18. Visualizations of Spencer Creek Watershed in 1850, 1990, and in 2050 under plan trend scenario, 4-24
PT-EX, and conservation cluster scenario, RR-CONS. .................................................. 4-24
Fig. 4.19. Changes in native species richness within breeding habitats of the WRB ........ 4-27
Fig. 4.20. Net number of species increasing for different scenarios relative to 1990 .......... 4-29
Fig. 4.21. Comparison of breeding habitat preferences exhibited by selected groups of species ........ 4-31
Fig. 4.22. Improvement in habitat conditions for oak woodland-savanna-grassland species under the 4-37
conservation clusters landscape, RR-CONS, compared with the plan trend landscape, PT-EX
List of Tables

Table 2.1. Areas of lands in conservation management and in public ownership by ecoregion .................. 2-11
Table 2.2. Conservation and restoration areas defined in Conservation scenario of Willamette River Basin Trajectories of Change Project ................................................................. 2-12
Table 2.3. Areas of private lands in which NRCS wood productivity values are defined. ......................... 2-16

Table 3.1. Summary of each of the scenarios and the source of the landscapes pertaining to each. ........ 3-4
Table 3.2. Listing of the habitat classes defined for the landscapes. ....................................................... 3-5
Table 3.3. Comparison of policies and processes between alternative futures scenarios. ....................... 3-9

Table 4.1. Statistics describing 1990 and 2050 Rural Residential Zones .................................................. 4-3
Table 4.2 Statistics describing taxlots targeted for development, and the resulting development sites. .... 4-6
Table 4.3. Estimated rural population and the percent of total basin population for each scenario. ........ 4-7
Table 4.4. Statistics comparing length and density of roads within rural developments ......................... 4-8
Table 4.5. Statistics describing the status of high value farm soils within the WRB and changes due to development under different scenarios. ................................................................. 4-9
Table 4.6. Statistics describing the status of timberlands within the WRB and changes due to development under different scenarios. ................................................................. 4-10
Table 4.7. Habitat areas gained and lost through vegetative succession, compared with areas lost due to development, PT-EX scenario, 2050 ................................................................. 4-14
Table 4.8. Comparison of trends in rare habitats of the WRB ................................................................. 4-20
Table 4.9. Total area over which various intervals of change in the number of native vertebrate species occurs ................................................................. 4-26
Table 4.10. Number of species with increasing, decreasing, or unchanged summed habitat scores for different scenarios relative to 1990. ................................................................. 4-29
Table 4.11. List of species showing significant responses to changes since 1990 in habitat scores under PT-EX scenario, basinwide. ................................................................. 4-30
Table 4.12. Changes in habitat scores of selected native species under plan trend, PT-EX, and conservation cluster scenario RR-CONS, with respect to 1990 conditions within the impact region. .......... 4-34
Table 4.13. Response of rare and sensitive species within the impact region to changes in habitat due to scenarios plan trend, PT-EX, and conservation clusters, RR-CONS ........................................... 4-35

Table 5.1. Summary of key results from evaluations of the landscape of the alternative scenarios, and from the habitat evaluation. ................................................................. 5-3
Table 5.2. Hypothetical example illustrating balance sheet for development of 60 acres with restoration. .. 5-8
List of Appendices

Appendix A.1  List of rare and sensitive breeding vertebrate species in the WRB, showing their conservation status ................................................................. A-8
Appendix A.2  Legend for all land use/land cover maps, and for all habitat maps ................................................................. A-9
Appendix A.3  Listing of the land use/land cover categories describing the landscapes. ................................................. A-10
Appendix A.4  Description of the habitat classes and the underlying assumptions concerning the content and structure, and the type of management employed in each. ........................................ A-12
Appendix A.5  Adjacency rules of the habitat evaluation model. ......................................................................................... A-16
Appendix A.6  Pre-settlement vegetation described in terms of habitat classes. ................................................................. A-19
Appendix A.7  Area of each habitat present in the WRB landscape of each scenario. ......................................................... A-20
Appendix A.8  Area of each habitat present within the "impact region" of the landscape of each scenario. A-21
Appendix A.9  Tabulation of the changes in the area of each habitat class within the WRB, with respect to the amount of habitat present in 1990. .................................................. A-22
Appendix A.10  Tabulation of the changes in habitat class within the impact region, with respect to the amount of habitat present in 1990. ........................................................................ A-23
Appendix A.11  Trends in the number of herp species increasing, decreasing, or unchanged for different scenarios relative to 1990, for the WRB ................................................................. A-24
Appendix A.12  Changes in the breeding habitat scores for each herp species with respect to 1990 conditions, over the WRB. ........................................................................ A-25
Appendix A.13  Changes in the breeding habitat scores for each herp species with respect to 1990 conditions, over the impact region. ................................................................. A-26
Appendix A.14  Trends in the number of herp species increasing, decreasing, or unchanged for different scenarios relative to 1990, for the impact region ......................................................... A-27
Appendix A.15  Trends in the number of mammal species increasing, decreasing, or unchanged for different scenarios relative to 1990, for the WRB ................................................................. A-28
Appendix A.16  Changes in the breeding habitat scores for each mammalian species with respect to 1990 conditions, over the WRB. ........................................................................ A-29
Appendix A.17  Changes in the breeding habitat scores for each mammalian species with respect to 1990 conditions, over the impact region. ................................................................. A-30
Appendix A.18  Trends in the number of mammal species increasing, decreasing, or unchanged for different scenarios relative to 1990, for the impact region ......................................................... A-31
Appendix A.19  Trends in the number of bird species increasing, decreasing, or unchanged for different scenarios relative to 1990. Analysis area is the WRB. ........................................................................ A-32
Appendix A.20  . Changes in the breeding habitat scores for each bird species with respect to 1990 conditions, over the WRB. ........................................................................ A-33
Appendix A.21  Changes in the breeding habitat scores for each bird species with respect to 1990 conditions, over the impact region. ........................................................................ A-34
Appendix A.22  Trends in the number of bird species increasing, decreasing, or unchanged for different scenarios relative to 1990. Analysis area is the impact region. ......................................................... A-35
Appendix A.23  List of vertebrate species associated with oak woodland - savanna - grassland communities of the Willamette River Basin. ........................................................................ A-36
List of Acronyms

BLM .............. Bureau of Land Management
BMPs ............. Best management practices
CC90 ............ Landscape of current conditions circa 1990, derived from EC90 (see below)
EC90 ............ Landscape of existing conditions circa 1990, from PNW-ERC
EFU .............. Exclusive Farm Use
ESA .............. Endangered Species Act
ESEE ........... Economic, Social, Environment and Energy
GLO ............. General Land Office
HSI ............... Habitat Suitability Index
LCDC ........... Land Conservation and Development Commission
LU/LC ........... Land use/land cover
NGO ............. Non-Governmental Organization
NRCS ........... Natural Resource Conservation Service, US Dept. of Agriculture
NWI .............. National Wetlands Inventory
OAR ............. Oregon Administrative Rules
ODF ............. Oregon Department of Forestry
ODFW ........... Oregon Department of Fish and Wildlife
ODOT ........... Oregon Department of Transportation
ONHP ........... Oregon Natural Heritage Program
ORS ............. Oregon Revised Statutes
OWEB ........... Oregon Watershed Enhancement Board
OWRD.......... Oregon Water Resources Department
PESVEG ...... Landscape of pre-settlement vegetation, circa 1850, from PNW-ERC study
PNW-ERC .... Pacific Northwest Ecosystem Research Consortium
PT ................. Plan Trend landscape for year 2050, from the PNW-ERC study.
PT-EX........... Plan trend scenario 2050, extended from the PNW-ERC work for this project to include, in particular, vegetative succession.
RNA ............. Research natural areas
ROZ ............. Residential overlay zone; defined for this project as a planning zone in which rural residential development can occur if special conditions are met; otherwise, the primary zoning of farm or forest land guides land use.
RR ............... Rural residential
RR-5 ............. Scenario of 5 acre rural residential subdivision within the ROZ
RR-15 .......... Scenario of 15 acre rural residential subdivision within ROZ
RR-CL ........... Scenario of rural cluster housing within the ROZ
RR-CONS .... Scenario of rural cluster housing accompanied by habitat restoration with the ROZ; also referred to as the “conservation cluster” scenario
RRZs .......... Rural residential zones; areas zoned for rural housing under Oregon state land use regulations
SSURGO ...... soil survey data base, from NRCS
T&E species . Threatened and endangered species
TNC .............. The Nature Conservancy
TOC Project . Willamette River Basin Trajectories of Change Project; alternative futures study by PNW-ERC of the Willamette River Basin in 2050.
UGB ............. Urban Growth Boundary
USDA ........... US Dept of Agriculture
USDI ............. US Dept of Interior
WRB .......... Willamette River Basin