General Conclusions

Changes in the Willamette River Basin have been substantial since EuroAmerican settlement. By 1990, 42% of the Willamette Valley Ecoregion had been converted from natural vegetation to agricultural use and 11% to built structures. The acreage of older conifer forests (>80 years) in the basin was reduced by two-thirds. As a result of these and other landscape changes, indicators of natural resource condition were generally 30 to 90% higher prior to EuroAmerican settlement than today (Fig. 169).

Over the next 50 years, the number of people living in the WRB is expected to nearly double, reaching almost 4 million by 2050. Even so, more landscape change, and thus more environmental effects, occurred from 1850 to 1990 than stakeholders considered plausible from 1990 to 2050, regardless of the future scenario (Figs. 168, 169).

There are, however, significant differences in environmental qualities among the scenarios and significant local variations within each future (Figs. 168, 169; Table 49). For example, in Plan Trend 2050 and Conservation 2050, much of the population growth is accommodated via compact development in urban areas, minimizing the conversion of farmland and natural areas to built classes. In these two futures, UGB population density nearly doubles, but the amount of built land expands by less than 25% over circa 1990 levels. The lower density development in Development 2050, in contrast, requires a 56% increase in the amount of built land, and an associated loss of 24% of prime farmland. Most indicators of natural resource condition show substantial improvement in Conservation 2050, recovering 20 to 70% of the losses sustained since EuroAmerican settlement, but little change or further decline in Plan Trend 2050 and Development 2050. In general, indicators of terrestrial biodiversity responded more strongly to among-scenario differences than did aquatic biodiversity indicators. Table 49 summarizes key results for each future scenario.

Human behavior and preferences are inherently unpredictable and major shifts in social norms have occurred in the past. Thus, the unexpected is not completely unlikely, and the actual future in 2050 could be more extreme than any of the alternative scenarios presented.

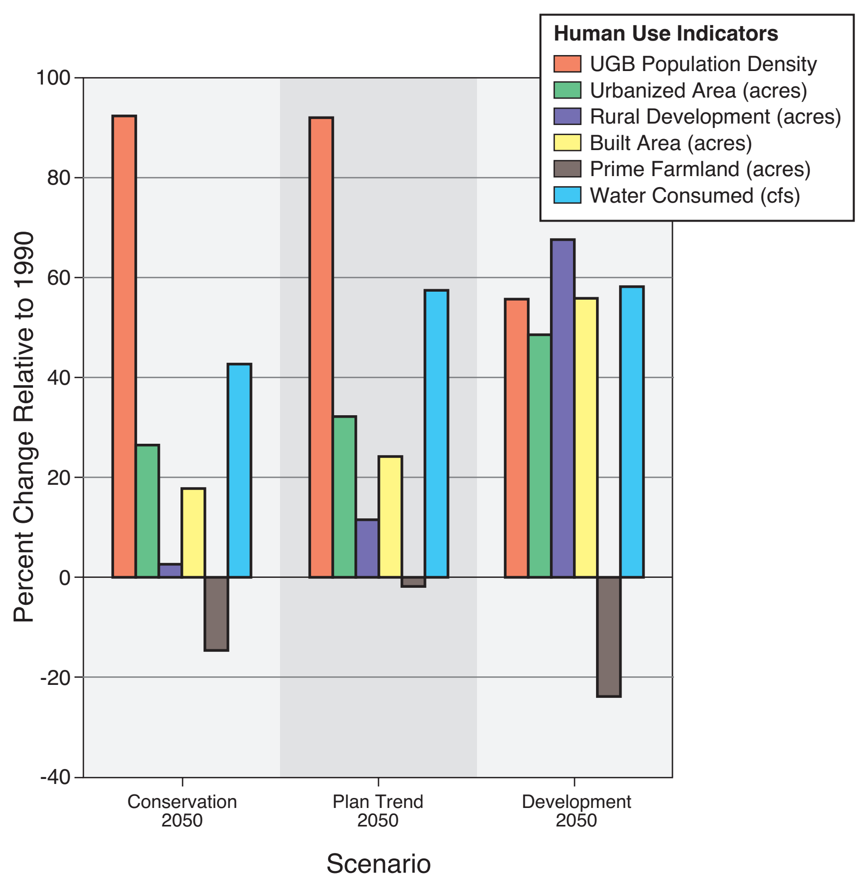

Figure 168. *Percent change in indicators of human use of the Willamette River Basin, in the three future scenarios, relative to LULC ca. 1990. Areas of rural and urban development, population density within UGBs, and water consumption increase, while the area of prime farmland decreases, but to varying amounts in the different future scenarios.*

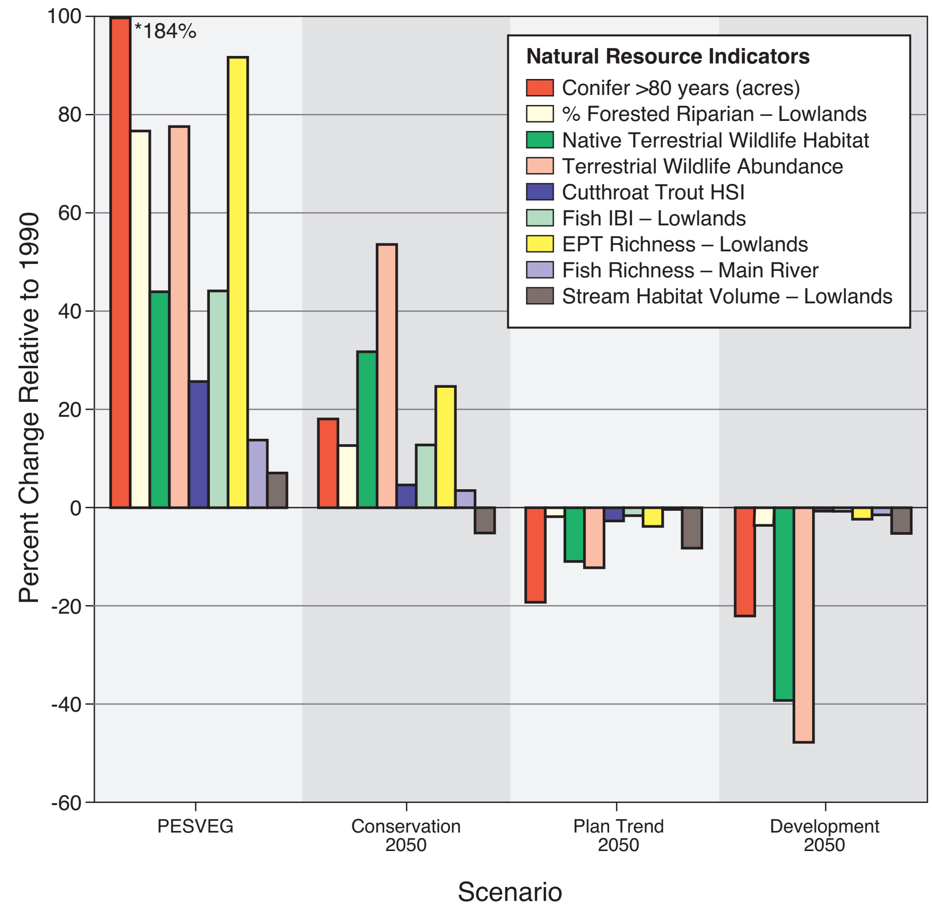

Figure 169. *Percent change in indicators of natural resource condition, in the three future and Pre-EuroAmerican scenarios, relative to LULC ca. 1990. Most indicators (except stream habitat volume) show substantial recovery in Conservation 2050, while showing little change or further decline in Plan Trend 2050 and Development 2050. See Table 48 for further description of indicators.*

Indicator	Magnitude Circa 1990	Change Relative to LULC ca.1990			
		PESVEG	CON 2050	PT 2050	DEV 2050
Acres within UGBs	444,000	n/a	54,000	51,000	129,000
Population density in UGBs (residents/acre)	3.8	n/a	3.5	3.5	2.1
% Basin population in UGBs	86	n/a	8	7	1
Urbanized acres	313,000	n/a	82,000	100,200	152,000
Acres influenced by rural structures	178,200	n/a	4,500	20,500	121,500
Acres prime farmland	619,500	n/a	-90,700	-9,100	-150,000
Water consumed in dry summer (cfs)	432	n/a	184	246	251
Number of WABs dry in August of dry year	0	0	0	17	11
Miles of dry 2nd to 4th order streams	82	-82	57	87	62
Acres with closed conifer >80 years	1,486,413	2,740,983	248,247	-280,793	-321,053
% Riparian area forested along all lowland streams	32.2	24.6	4.4	-0.5	-1.4
Median cutthroat Habitat Suitability Index (HSI) all 2nd to 4th order streams	0.62	0.16	0.03	-0.01	0.00
Median fish Index of Biotic Integrity (IBI) in lowland streams	47.1	20.8	5.6	-0.7	-0.2
Median invertebrate EPT Richness in lowland streams	5.7	5.2	1.4	-0.2	-0.1
Native wildlife habitat: % species increasing minus % decreasing	n/a	44	31	-10	-39
Wildlife abundance: % species increasing by >10% minus % species decreasing >10%	n/a	76	53	-12	-47
Median fish richness in main river	14.5	2.1	0.6	0.0	-0.2

n/a = not applicable

Table 48. *Projected changes in indicators of human use and natural resources in the Willamette River Basin, in three future scenarios (year 2050) and Pre-EuroAmerican (PESVEG), relative to LULC ca. 1990.*

Table 49. *Summary of results by future scenario (see Figs. 168, 169, and Table 48).*

	Scenario		
	Conservation 2050 **Places greater priority on ecosystem protection and restoration, although still reflecting a plausible balance between ecological, social, and economic considerations as defined by citizen stakeholders.**	**Plan Trend 2050** **Assumes existing comprehensive land use plans are implemented as written, with few exceptions, and recent trends continue.**	**Development 2050** **Assumes current land use policies are relaxed and greater reliance on market-oriented approaches to land and water use.**
Urban and Rural Development	Like Plan Trend 2050, Conservation 2050 emphasizes high-density development. The area and human population density within urban growth boundaries (UGBs) are very similar in the two scenarios. However, use of clustered rural housing in Conservation 2050 further constrains the land area affected by rural residential development. The near doubling of the human population in the basin from 1990 to 2050 is accommodated with only an 18% increase in the amount of land urbanized or influenced by rural structures.	New development is concentrated within UGBs and existing rural residential zones. Rural residential zones are completely developed, to maximum capacity, by 2020. All subsequent development constrained to UGBs. UGB area expands by 11% (51,000 acres), while population density in UGBs nearly doubles, increasing from 3.8 residents per acre in 1990 to 7.3 in 2050.	New development occurs at lower densities over a larger area. Even so, population densities within UGBs increase by 55% (to 5.9 residents per acre) relative to 1990. UGB area expands by 29% (129,000 acres); the area influenced by rural structures by 68% (121,500 acres). Jointly, urbanized areas and areas influenced by rural structures account for 10.4% of the total basin area, compared to 6.7% of the basin area in 1990 and 8.3% in Plan Trend 2050.
Agriculture	15% of 1990 prime farmland is lost, converted mostly to natural vegetation. Conservation strategies on agricultural lands include riparian vegetation along all streams, conversion of some cropland to native vegetation (in particular, natural grasslands, wetlands, oak savanna, and bottomland forests) in high priority conservation zones, establishment of field borders and consideration of wildlife habitat as a factor in crop selection in environmentally sensitive areas, and increased irrigation efficiency to reduce water consumption by 10%.	Consistent with current policies, little agricultural land is converted to other uses (<2%).	Most new development occurs on agricultural lands. Furthermore, the location of UGBs, a consequence of historic settlement patterns, predisposes urban expansion to occupying higher quality soils and particularly valuable agricultural resource lands. As a result, 24% (150,000 acres) of 1990 prime farmland is lost.
Forestry	Conservation measures implemented on private forestry lands include 100-foot or wider riparian zones on all streams, a gradual decrease in the average clear-cut size, and retention of small patches of legacy trees. The result is a 17% increase in the area with conifer forests aged 80 years and older, relative to 1990. Still, the extent of older age conifer forest would be less than half (41%) of what occurred prior to EuroAmerican settlement.	Area of older conifer forest (>80 years) declines by 19% (281,000 acres) relative to 1990, and what remains is concentrated on federally owned lands protected by the Northwest Forest Plan.	Forestry practices include greater emphasis on clear-cutting and less stream protection compared to Plan Trend, although the influence of these policy shifts on older growth conifer forest is not dramatic. Under Development 2050, the area of conifer forest >80 years in age is reduced by 22% relative to 1990, compared to the 19% reduction for Plan Trend 2050.
Willamette River	Areas along the Willamette River that historically had complex, dynamic channels are targeted for restoration. As a result of these changes median fish richness is expected to increase 4.1% (0.6 species) relative to 1990.	No change relative to ca. 1990.	Further simplification of the river channel, continuing recent trends. Median fish richness is expected to decrease by 0.2 species (-1.4%) as a result of these changes.
Water Availability	Water consumption increases by 43% relative to 1990, a somewhat smaller increase than for Plan Trend 2050 and Development 2050 (57-58% increase relative to 1990). While stream flows decrease in some Water Availability Basins (WABs), none are projected to have near zero flow in a dry summer. However, an estimated 139 miles of 2nd to 4th order streams would go dry. Demands for water for municipal, industrial, and domestic use would be met in most areas.	Water consumption for out-of-stream uses increases by 57% over 1990, reflecting a 20% increase in diversions for municipal and industrial uses and 65-120% increase in diversions for irrigated agriculture. Demands for water for municipal, industrial, and domestic uses met in most areas, but stream flows decline. Miles of 2nd to 4th order streams expected to go dry during a dry summer doubles, from 82 miles in 1990 to 169 miles in Plan Trend 2050. Seventeen of 178 WABs, representing an area of 915 square miles, likewise experience near zero stream flow at their outfall, compared to zero WABs with no flow circa 1990.	As in Plan Trend 2050, water consumption for out-of-stream uses increases markedly (by 58% relative to 1990). However, the extent of streams with near zero flow in a dry summer would be slightly less in Development 2050 than for Plan Trend 2050, because of a shift in the spatial distribution of withdrawals. An estimated 143 miles of 2nd to 4th order streams (75% more miles than in 1990) and 11 WABs (encompassing 609 square miles) would have near zero flow in a dry summer. Demands for water for municipal, industrial, and domestic use would be met in most areas.
Aquatic and Terrestrial Wildlife	31% more terrestrial wildlife species gain habitat than lose habitat relative to 1990. Of the 17 wildlife species modeled for population abundance, 10 are projected to increase in abundance by >10%, relative to 1990, and only one (the Mourning Dove) would decrease by >10%. Thus, a substantial number of wildlife species would benefit from Conservation 2050, positively impacting biodiversity in the basin. Median wildlife abundances, however, would still be below historical estimates for most species. In Lowland streams, indicators of stream condition, such as the fish Index of Biotic Integrity and EPT richness, increase by 9-24% relative to 1990, representing a recovery of 20-65% of the decline in these indicators estimated to have occurred since EuroAmerican settlement.	Except for the shift in forest age and densification of urban development, the changes in land use and land cover under Plan Trend 2050 are fairly minor. As a result, projected effects on aquatic and terrestrial wildlife are relatively small basinwide (Fig. 165), although significant declines occur in some locations and for some species. We were unable to evaluate the degree to which declines in stream flow would adversely affect aquatic and terrestrial wildlife.	39% more terrestrial wildlife species lose habitat than gain habitat relative to the 1990 landscape. Of the 17 wildlife species modeled for changes in population abundance, 9 experience a 10% or greater decline in abundance relative to 1990; only one species (the coyote) is projected to increase in abundance by >10%, almost the reverse of projected wildlife responses in Conservation 2050. Projected effects on aquatic life, on the other hand, were relatively small (<5% decline relative to 1990). Both agriculture and residential development have similar adverse effects on aquatic life. Streams already degraded due to agricultural land uses in 1990 would not be significantly further degraded by conversion of agricultural land to residential development, as occurs in Development 2050.

Recommendations

If Oregonians choose to enhance protection and restoration of natural resources and biodiversity in the Willamette Basin, the Pacific Northwest Ecosystem Research Consortium recommends the following.

Balance effort in uplands and lowlands. Differences among scenarios result from the combined influence of numerous policies and individual actions. There is no single “major problem” or “bad actor.” Rather, efforts will be required across the board, in all areas of the landscape and in all environmental settings. To date, conservation policies and projects have focused disproportionately on upland, forested systems. Because upland and lowland portions of the basin support distinctly different types of habitats and species, a balanced effort in both areas will be required.

Manage urban and rural residential expansion. Use available information on basinwide and local patterns of terrestrial and aquatic native species richness (e.g., Fig. 164, p. 125) and prime farmland (Fig. 110, p. 102) to tailor comprehensive land use plans in order to minimize urban and rural development in areas with high ecosystem and resource value.

Encourage clustered rural residences as a means to conserve/restore native habitat on large parcels planned for development. Identify and promote habitat conservation incentives that could be incorporated into rural residential designs.

Restore riparian vegetation in lowlands. Establish riparian vegetation along lowland streams and rivers in agricultural and urban settings. Riparian areas are important habitat for many species of terrestrial wildlife and play a disproportionately large role in stream habitat quality. Thus, riparian vegetation can be a cost-effective means to enhance both aquatic and terrestrial wildlife, in all types of environmental settings: forested, agricultural, urban, and rural residential.

All forms of natural vegetation (grass, shrubs, trees) within riparian areas can be beneficial. Forested riparian areas, however, provide a wider range and magnitude of benefits than non-forested riparian areas.

For several riparian functions (stream shading, woody debris input, nutrient trapping), vegetation nearest the stream has the greatest influence. As a result, plugging gaps in the longitudinal extent of riparian zones is likely to be more beneficial than widening existing zones of riparian vegetation. Current understanding also suggests that one long zone is more useful than several shorter, but disconnected zones of riparian vegetation.

Restore rivers and their floodplains. Functioning riparian areas are more than simply trees planted beside a stream or river. Natural flow regimes, periodic flooding, complex channels, and fairly wide riparian zone widths are required to create and maintain the habitat features and dynamics that make riparian areas especially productive and biologically diverse portions of the landscape. Thus, in regulated rivers, manage reservoirs to achieve more natural flow regimes (both high and low flows).

Anticipate and encourage erosion and deposition in the active channel. Site-specific restoration projects may well be destroyed by the fluvial geomorphic actions of the river. These are important natural processes that have been greatly reduced from historical times.

The maps and figures on pages 144-47 identify areas of the Willamette River where the potential for recovery of complex and biologically diverse river habitats and floodplains is high and the economic and social constraints are comparatively low.

Minimize urban and residential development in 100-year floodplains and actively identify opportunities to reverse past development of buildings and other structures within floodplains (e.g., after flood damage occurs).

River flow through gravel bars can substantially reduce water temperatures. Thus, increases in area of off-channel habitats and gravel bars, as well as increases in overall river habitat complexity, would not only have direct habitat benefits, but could also contribute to river cooling during summer.

Manage water availability and use. If Oregonians choose to protect or enhance stream flows for fish, wildlife, and other in-stream uses, the moderate water conservation measures included in Conservation 2050 will not be adequate. Future changes in crop types are likely to lead to increased water withdrawals for irrigation with subsequent adverse effects on in-stream flows in some locations. Explore ways for voluntarily retired consumptive water rights to convert to in-stream water rights while maintaining their original priority date. Areas that are likely to experience the greatest flow reductions, and thus are high priority for obtaining additional in-stream water rights, are identified in the maps on pages 115-16.

Plan for terrestrial wildlife. Because different species have different habitat requirements, the greater the diversity of habitat types in the basin, the greater the number of species (biodiversity) likely to occur.

About 80% of bottomland forest, 97% of natural grassland, and nearly 100% of oak-savanna habitats that occurred historically in the basin have been lost. These habitats once supported unique sets of species that do not thrive as well in the remaining habitats in the basin. Thus, protection and restoration of these specific habitat types would be particularly beneficial to biodiversity in the basin. Figure 103 on page 90 identifies areas where habitat restoration would be both plausible (as defined by the Consortium’s Possible Futures Working Group) and desirable, if Oregonians wish to protect and restore native biodiversity.

Habitat-based maps of species richness, and species richness change between scenarios (Fig. 164, p. 125), can identify areas where changes in land use/land cover are likely to have the greatest effect on wildlife biodiversity.

In addition to the amount of habitat available for a species, the distribution of habitat on the landscape can be a major factor in determining wildlife abundance and viability. General recommendations regarding landscape pattern, if Oregonians wish to protect wildlife species, include the following.

Avoid surrounding or fragmenting high quality habitats with very poor habitats. It is preferable to place high quality habitat within reach of other good sites, and likewise to cluster poor quality habitats. Design the habitat to support the spread of individuals from good habitat to good habitat, and avoid movements from good to poor habitat. One implication of this principle is that lands adjacent to established refuge areas should be managed differently (with increased attention to conservation practices) than lands remote from such refuges. Avoid barriers to movement that separate good habitats.

Aggregate habitat degradation activities (e.g., forest harvest or residential development) rather than dispersing across the entire landscape. Dispersed habitat degradation can result in a landscape composed mainly of demographic sinks, where wildlife mortality exceeds reproduction. Species do very poorly in such landscapes. Concentrating habitat degradation activities will leave some areas of high quality habitat, which can serve as demographic sources (where reproduction exceeds mortality). Good sources can sometimes compensate for the presence of demographic sinks in other parts of the landscape, and thus the species can persist in relatively large numbers.

Natural processes and dynamics. Restoring natural processes and dynamics is generally more ecologically and economically effective, over the long term, than attempting to create desirable habitat features by construction, direct manipulation, or other engineering solutions.