Floodplains and riparian forests are some of the most dynamic zones of any landscape, and they contain some of the highest levels of biological diversity and habitat complexity. These areas also are highly valued for their access to water, transportation potential, food, recreation, and beauty. Historically, towns and cities along rivers have encroached on this zone and then attempted to create stable streambanks in areas that are, by nature, dynamic. This inherent contradiction is the basis for management of floodplains and riparian forests worldwide. Integrated regional assessment of biophysical and socioeconomic patterns in rivers and floodplains improves our understanding and provides greater potential for long-term persistence of river restoration efforts and increased likelihood of ecological effectiveness.

Land use and other human activities in the Willamette River Basin have extensively modified rivers and their floodplains. Most restoration efforts are based on opportunities (e.g., willing land owners, public lands, and short-term funding sources) and are treated as add-ons to other river modification projects. These projects often lack a broader strategic framework based on both the ecological resources of the river *and* future pressures to develop land along the river. As a result, attempts to modify rivers or "restore" river systems often fall short of their goals. In some cases these attempts unintentionally cause detrimental changes to the ecosystem by not considering the larger river network and its interactions. Restoration efforts based on short-term opportunities are not undesirable. However, their success can be increased by application of a strategic conceptual framework based on ecological potential and patterns of human activity within the river corridor.

Ecologically designed restoration efforts commonly are based on vegetation patterns,[148] hydrology,[149] geomorphic processes,[150] or floodplain dynamics.[151] These approaches tend to focus on the biological or physical components of rivers but rarely consider the human activities that shape the potential for ecological recovery and create future pressures to modify the river ecosystem. Patterns of human population densities and structural development, as well as economic values and productivity of the land along rivers, create critical constraints on the locations and outcomes of restoration.

Conceptual Framework

The primary focus of this integrated analysis of biophysical and socio-economic potential for restoration is to 1) spatially identify ecological, demographic, and economic potential for riparian restoration and 2) identify changes in patterns, policies, or practices that influence the future likelihood of restoration. In our conceptual framework (Fig. 170), patterns of critical riverine ecosystem components and major human population centers and land uses create a spatial context for locating restoration efforts.[153] Important biophysical and human processes interact differently at different spatial extents (Fig. 171), leading to changes in what matters most in prioritizing locations as one considers, first, the entire river network, then high priority river reaches within the network, and finally focal areas within priority reaches. This approach assumes that potential for increased ecological function of various candidate river reaches and focal areas is related to the difference between current patterns and historical conditions in 1) river channel complexity and hydrology and 2) floodplain vegetation (Fig. 173). Constraints and incentives for restoration created by human systems are determined by 3) the patterns of human populations and structural development of the floodplain and 4) the economic values and productivity of the land within the floodplain.

We have classified the floodplain along the Willamette River using these four major typologies, and thereby have provided a quantitative basis for identifying areas with both high potential for increased ecological benefit and low socioeconomic obstacles to restoration.
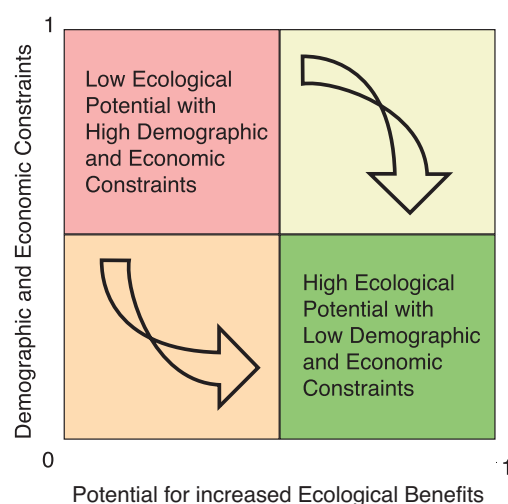

Figure 170. *Conceptual framework for prioritizing locations where potential for ecological restoration will be large and will endure.*
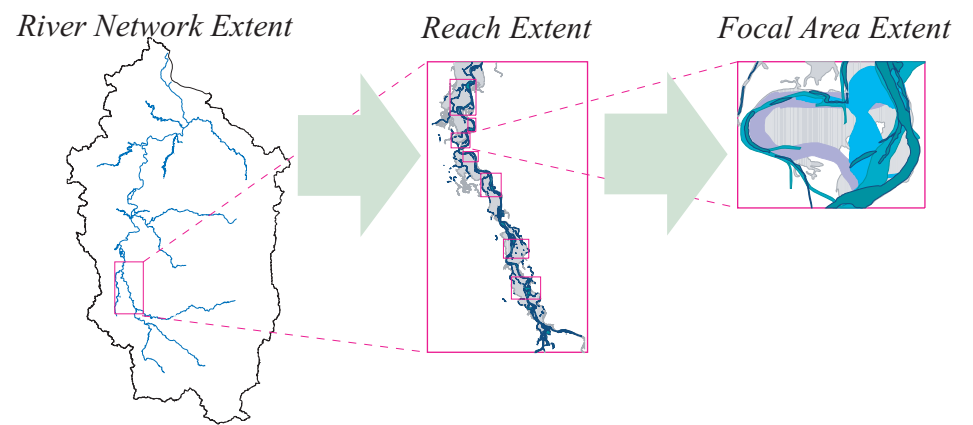

Figure 171. *Three spatial extents at which the conceptual framework for prioritizing restoration locations is applied.*

High Restoration Potential

The lower right quadrant of Figure 170 represents areas with high potential for ecological recovery and low constraint from human settlement and land value. These lands should have the greatest potential for future ecosystem recovery. Such areas are better suited for conservation and restoration because their ecological values could increase more than other areas. The efforts put forth and costs absorbed by communities to prevent channel change and flooding are often higher here than elsewhere. Economic constraints and demographic pressures are frequently lower. Ecological recovery is likely to be greater on these lands, while social pressures to reverse restoration are likely to be lower.

Potential for Policy Change and Incentives

The upper right and lower left quadrants of Figure 170 depict those areas that combine either high potential for increased ecological value with high demographic and economic constraints or low potential for increased ecological value with few constraints. Lands in these categories are mixes of positive and negative features. In these areas, decision makers can focus on alternative policies or practices that might move a site into the lower right quadrant. Policy changes and incentives tend to modify demographic and economic constraints rather than changing the potential for ecological benefits. Examples would be changes in lending rules or interest rates, federal farm assistance requirements, or converting through purchase, private to public lands. Other possibilities would be use of land zoning restrictions or taxation policies that would have minimal economic consequences but major ecological benefits.

Low Restoration Potential

Areas that combine low potential for increased ecological response with high demographic and economic costs are likely to be poor choices for restoration. These areas fall in the upper left quadrant of Figure 170. These sites provide little ecological benefit, are located in areas where pressures for future modification are high, and investments in restoration may be costlier than other areas because of property values.   In contrast to lands described above, these areas are more suited for intensive use because their conversion will achieve less ecological response per unit of investment.

Before rejecting lands in the low restoration potential category, however, the following questions should be asked. First, are critical habitats or at-risk species present? If so, restoration outcomes may warrant heroic efforts even in the face of large socioeconomic obstacles. Second, do these lands present opportunities to learn about the values of and approaches for conservation and ecological restoration? Particularly in urban areas, these sites are where people live and work. As we pass these habitats every day and use them for recreation, such landscapes provide a tangible link between people and the natural processes upon which we depend.

Spatial Framework

In this analysis of the Willamette River and its floodplain, the floodplain provides the most constant and quantifiable spatial framework for comparing physical, biological, demographic, and economic characteristics of the river corridor. Channel position, forests, and land use may change, but the floodplain, i.e., the area historically inundated by floods, is relatively constant (see pp. 28-29). We employ a framework for floodplain assessment by mapping 1-km "slices" of the Willamette River floodplain at right angles to the floodplain's center axis (Fig. 172). Within each of 228 1-km slices,

numbered 0 (zero) starting at the confluence of the Willamette and Columbia Rivers and ending with 227 at the confluence of the Middle and Coast Forks of the Willamette, we measured characteristics of channel complexity, floodplain forests, human systems, and economic patterns. The longitudinal display of these features creates a linear illustration of the characteristics of the Willamette River and allows consistent and simultaneous analysis of a floodplain river and the human systems along its course. Additionally, it creates a spatial context based on the natural processes that shape river channels and create their floodplains.
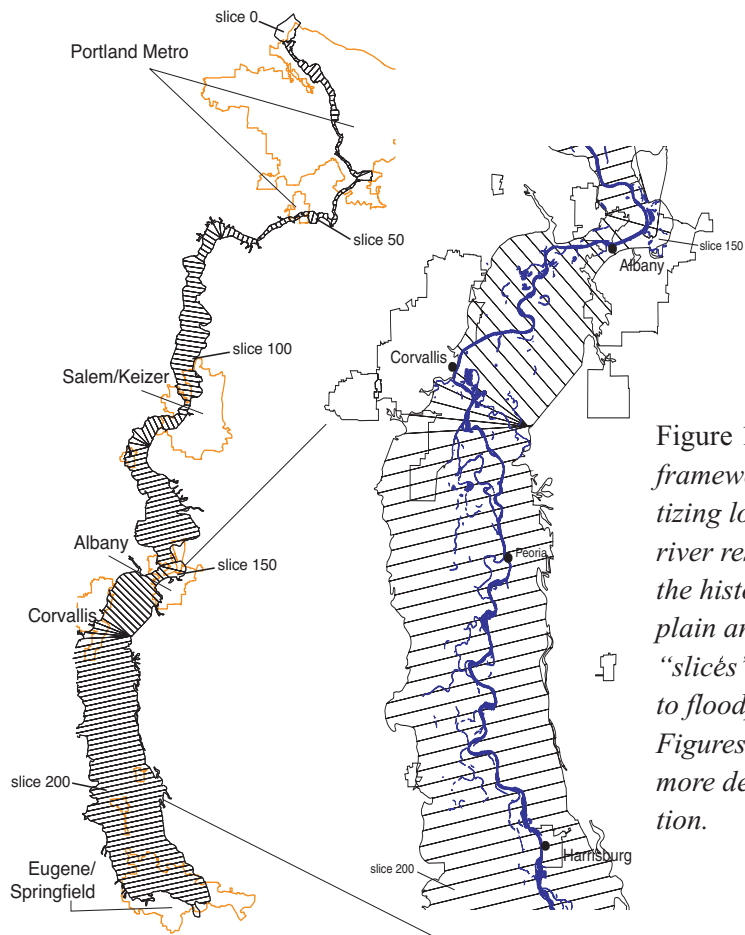

Figure 172. *Spatial framework for prioritizing locations for river restoration using the historical floodplain and 1-km "slices" perpendicular to floodplain axis. See Figures 226, 227 for more detailed information.*

In the paragraphs and pages that follow, we use this spatial framework for each slice to compare the presence and amount of several key factors that influence restoration planning. Implicit throughout this work is the conviction that there are important advantages to allowing natural processes, e.g., floods, to assist in accomplishing restoration goals. It is also imperative that these processes be allowed to operate in ways that minimize risk to human life and property.

Next, we briefly introduce the two broad categories of, first, biophysical factors and then social factors that are used in the restoration prioritization approach illustrated at the conclusion of the chapter. Pages 134-43 present detailed descriptions of longitudinal patterns, by slice, of the measured characteristics used in prioritizing locations.

Geomorphic Characteristics

Channels, floodplains, and hydrology create the physical setting for the development of the ecological properties of a river system. The primary role of these physical processes is recognized in fundamental ecological ideas, such as the river continuum concept[153] and the flood pulse concept.[154]

Restoration is a process of change, and channel features prone to frequent change (e.g., river tributary junctions, multiple channel reaches) have greater potential for rapid restoration. On the other hand, when people attempt to stabilize these dynamic reaches, enormous investments are required by agencies and local communities to confine channels. Historical patterns of river channels offer useful contexts for determining potential responses to restoration in the future.

Floodplain Vegetation

Diversity and extent of floodplain forests are closely linked to channel structure and dynamics of flooding. River reaches with high geomorphic complexity and frequent channel changes are characterized by high vegetative species diversity of riparian patches and related diversity within those stands. Tributary junctions and multiple channel reaches exhibit complex mosaics of riparian forests, and single channel reaches contain simpler patterns of floodplain vegetation. The stability of the single channel reaches can support older forests because the vegetation is not exposed to the effects of floods as frequently as more complex channel reaches.

Demographic Characteristics

Patterns of recent and current human land use create a context for considering potential future ecosystem patterns and locations for restoration efforts. Efforts to limit the impacts of development along the major rivers in the region have intensified as measures to limit development in floodplains and minimize impervious surface area are being applied in rapidly urbanizing lands.[155] Major urban development in river floodplains is largely irreversible over the near future, while adjacent agricultural and forest lands at the urban fringes offer much greater potential for change.

Economic Characteristics

Economic production influences landowner decisions about the use of lands along the Willamette River. Prices of goods and services derived from riparian lands provide an indication of the likelihood of landowner participation in restoration efforts. Regulatory processes also influence landowners' decisions, and the longevity of governmental policies may be sources of uncertainty for land owners. Patterns of land productivity strongly influence the feasibility of restoration and must be evaluated along with patterns of river modification and ecological condition.
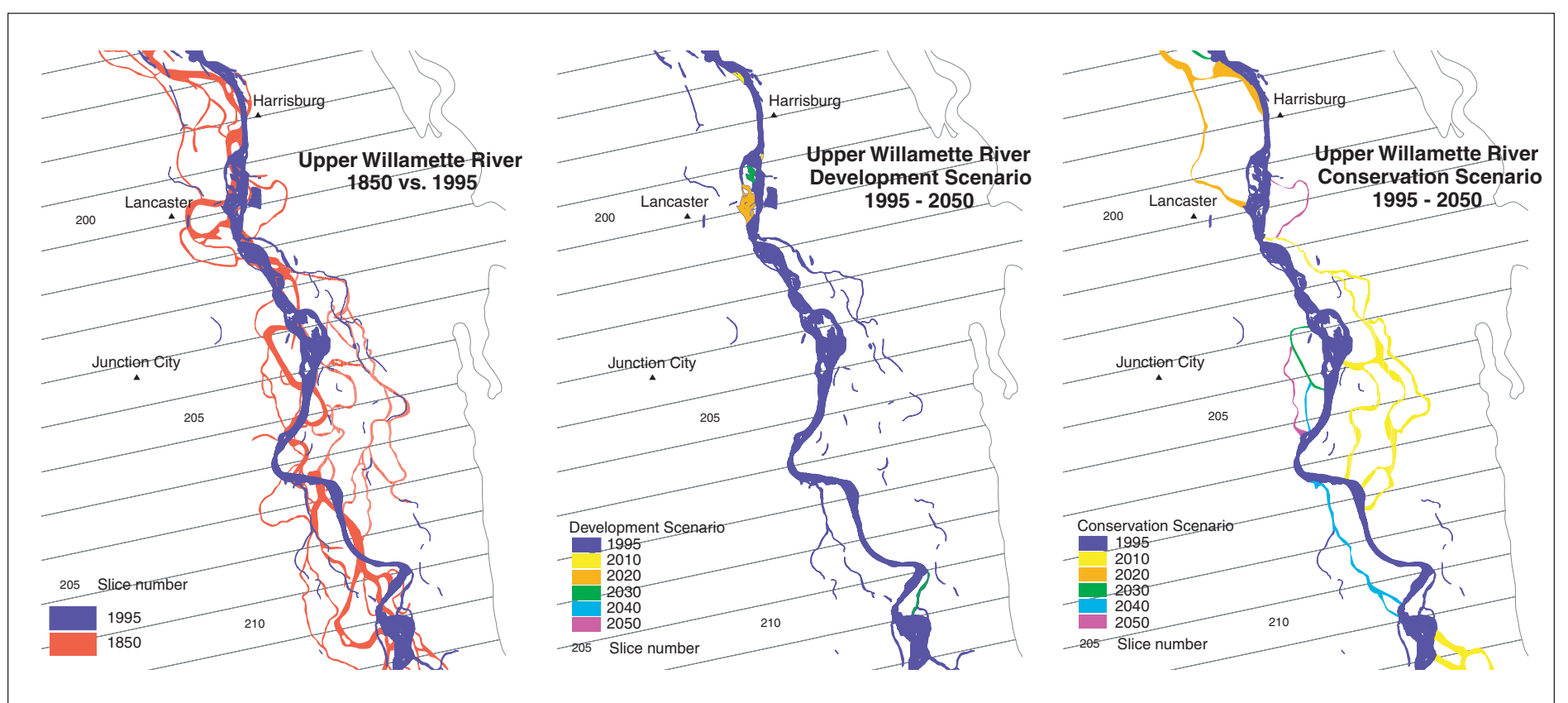

Figure 173. *Past, present, and alternative futures of a portion of the upper Willamette River between Harrisburg and Eugene. The left panel is a comparison of the river between 1850 (red) and 1995 (blue). The middle panel uses the colors shown to illustrate river channel habitat change (loss) by decade under the Development Scenario in this reach. The right panel uses the same colors to illustrate channel change (gain) by decade under the Conservation Scenario.*
Note every fifth slice number at left of each map in the figure.