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## 6.2 Basin Landform

Landform includes elements that describe the topography and geology that make up a landscape. Landform composition affects weathering and vegetation growth, which in turn determine the rate at which runoff enters a river system and the amount and type of sediment that the system is likely to transport. This section covers watershed delineation, topography, geology, stream channel gradients, and longitudinal profile.

### 6.2.1 Watershed Delineation and Topography

#### ■ Objectives

The objective of this assessment was to delineate the primary watersheds within the Tillamook Bay Basin and to show the relationship of those watersheds to the topography and geology of the basin's five major rivers, the Miami, Kilchis, Wilson, Trask, and Tillamook.

The topography of the Tillamook basin is described to help characterize its effect on hydrology and to provide a general template for understanding the spatial extent of flooding. In addition, topography can be used to evaluate the potential for processes such as soil erosion and slope failures.

#### ■ Methods

The watershed boundaries shown (Figure 6-2-1) were generated digitally from digital elevation models (DEM), but they can also be created manually by tracing high-quality topographic maps.

USGS 7.5-minute topographic maps and historical aerial photographs were used to describe the broad-scale topography of the five watersheds in the Tillamook basin. In addition, 10-meter resolution DEM coverages were used to produce GIS maps describing the elevation (Figure 6-2-2), slope, and aspect (Figure 6-2-3) of the watershed at the basin scale.

#### ■ Discussion

The Tillamook Bay covers up to 12 square miles at high tide. Five major rivers flow into the bay. Four of these, the Tillamook, Wilson, Trask, and Kilchis, flow from the Southeast and are part of the major floodplain of the basin. A fifth river, the Miami, flows into the bay from the Northeast. The bay receives water from 550 square miles of steep forested hillsides and flat lowlands.

The Tillamook basin is characterized by steep, forested slopes along the eastern, northern, and southern extents of the watershed. Elevations reach a maximum of 3,690 feet. In the upper basin, river channels are generally moderately confined by adjacent hillslopes. Below an elevation of 100 feet, the basin grades into the valley floor. Here, unconfined channels traverse the valley, ultimately reaching Tillamook Bay.

Precipitation on the steep relief of the uppermost portions of the watershed is likely routed rapidly downhill. As streams converge and gradient decreases rapidly, large volumes of water accumulate in the lowermost alluvial valleys, resulting in valley flooding.

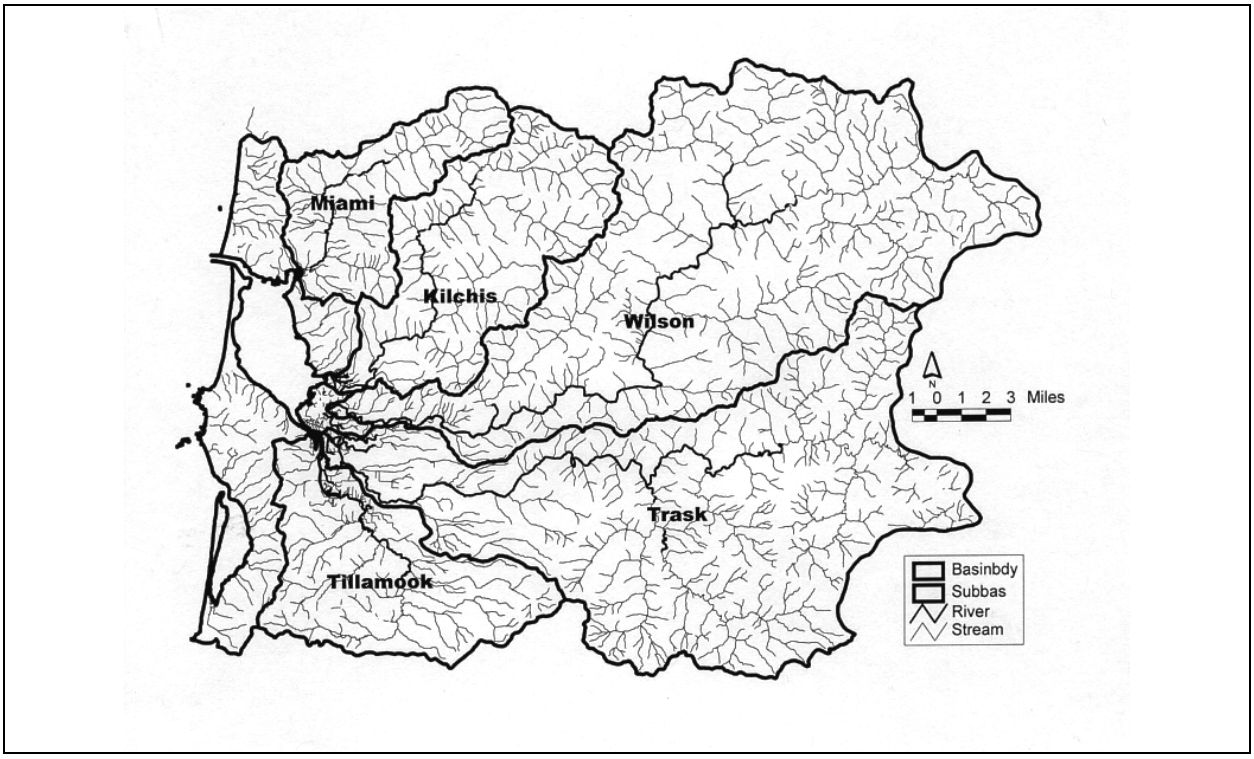


**Figure 6-2-1. Tillamook Bay Basin Watersheds**

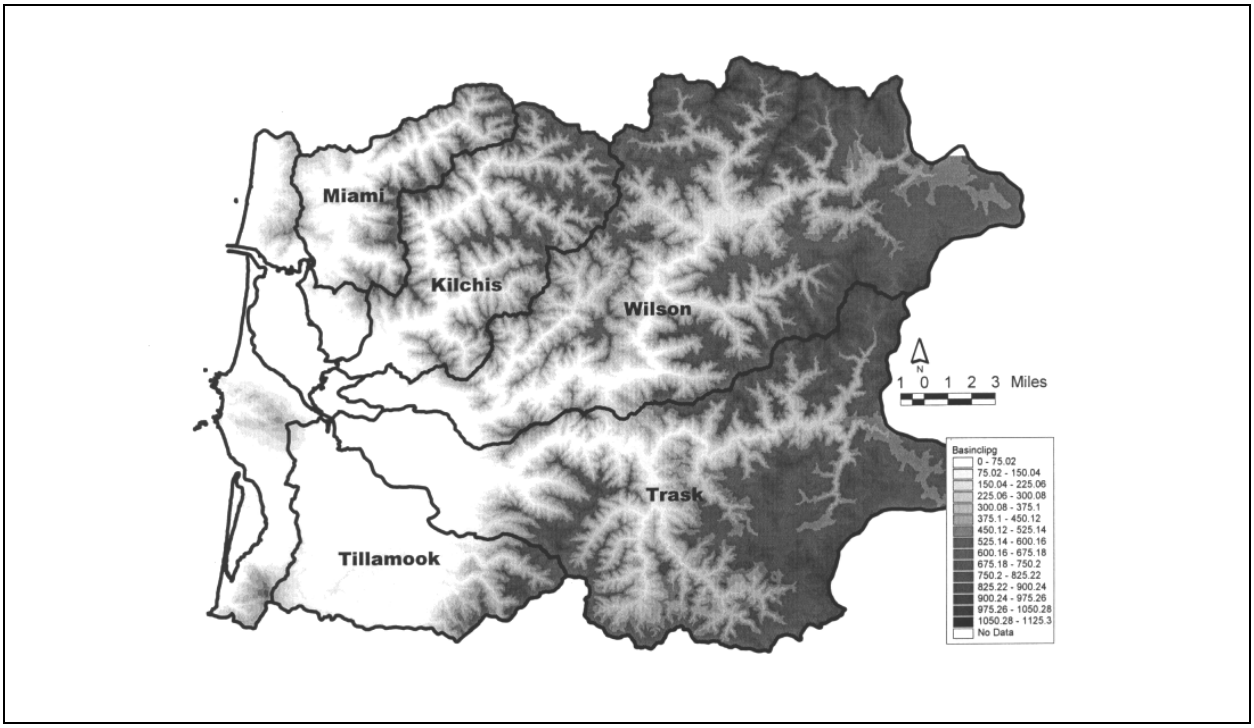


**Figure 6-2-2. Tillamook Bay Basin Elevation in Meters**

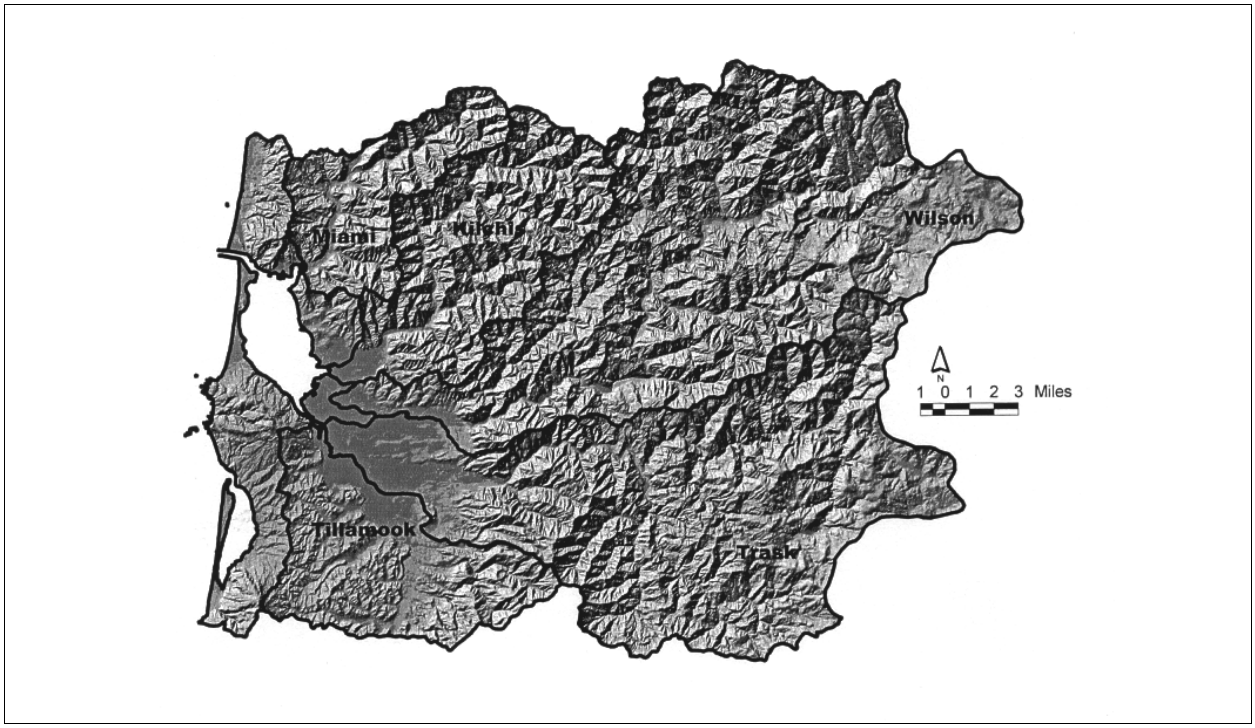


**Figure 6-2-3. Tillamook Bay Basin Hillshade (a Graphic Representation of Aspect)**

## 6.2.2 Estuary Size

### ■ Objectives

In its historic natural state, the 582-square mile Tillamook Bay basin provided a highly diverse physical habitat for plants, animals, and aquatic species such as salmon. The diversity of these habitats was largely a reflection of the geomorphic characteristics and interrelationships of the basin's uplands, lowlands, and estuary. To gain a better understanding of its historically diverse and productive aquatic ecosystems we compared the size of the Tillamook Bay estuary to its surrounding drainage basin and to the estuaries elsewhere in coastal Oregon.

### ■ Methods

The assessment of estuary size was based on summaries of Oregon's coastal estuaries by Percy *et al.* (1974), along with planimetric measurements of additional estuary and watershed areas taken from 7.5-minute USGS topographic maps.

### ■ Discussion

Although small when compared to estuaries globally, Tillamook Bay is large in proportion to its drainage basin when compared to other estuaries along the Oregon Coast (Figure 6-2-4). This is of significance because estuaries and tidal wetlands are the most productive natural systems. Tiner (1984) has demonstrated that salt marshes are the most productive ecosystem type in terms of biomass generated per unit area, greater than even tropical rainforests.

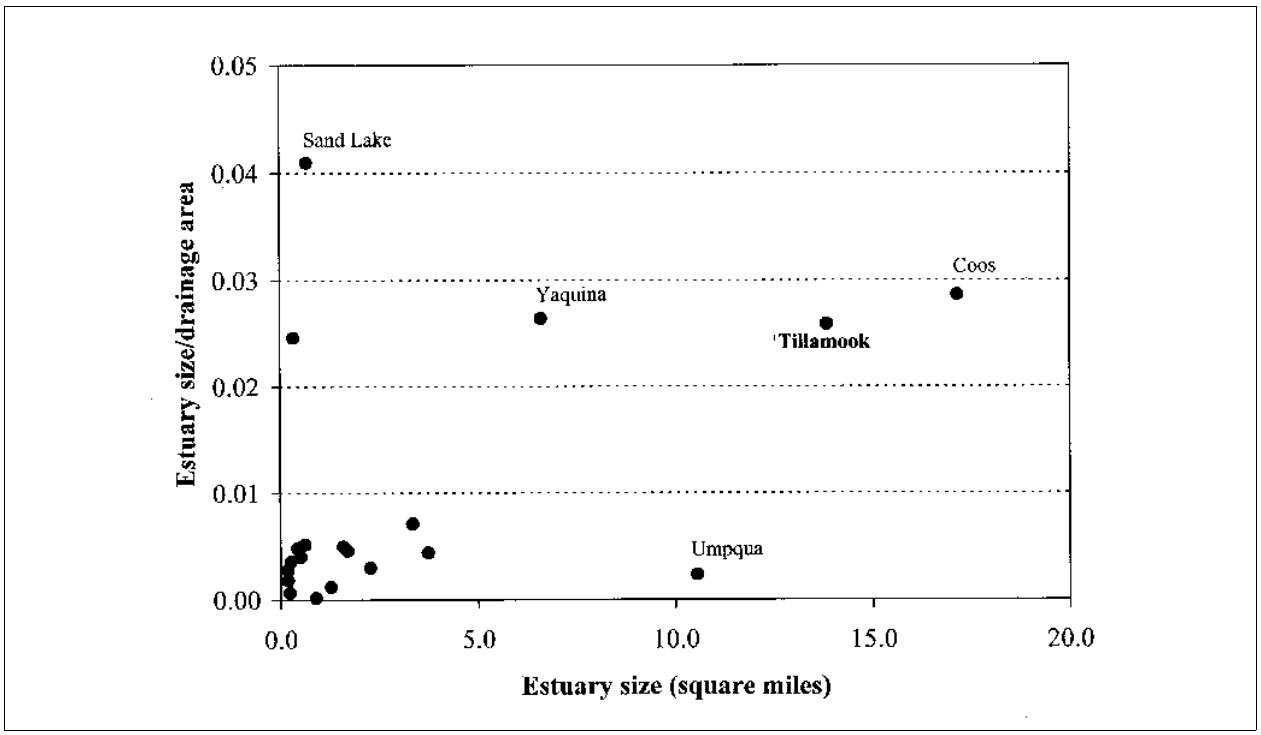


**Figure 6-2-4. Estuary Size and Drainage Area for Oregon Coastal Basins**

### 6.2.3 River System Classification

#### ■ Objectives

Watershed morphology is controlled by slope, water discharge and sediment supply (Montgomery and Buffington, 1993). The landscape within a watershed can be generally divided into three spatial scales: watershed, valley and channel reach (Figure 6-2-5). The spatial arrangement of source, transport and response reaches within these watershed divisions can be an indication of the degree of potential impacts and recovery times from disturbances to the river system. The objective of this assessment was to perform a reconnaissance-level classification of the basin watershed and river system, including source, transport and response landforms and river areas, in order to develop a conceptual model of watershed processes.

#### ■ Methods

Reconnaissance-level channel classification methods developed by Montgomery and Buffington (1993) (Figures 6-2-6) were used together with the 10-meter DEM of the basin to define the spatial extent of source, transport and response areas within the basin and along the river channel network based on land slope. The entire land surface of the basin was categorized according to the slope classes of 30% and greater for source areas, 30% to 3% for transport areas, and less than 3% for response areas (Figures 6-2-7 to 6-2-9). This mapping extends beyond the linear river channel network to include hillslopes and terrain features, and provides a general indication of the spatial variation of watershed processes within and beyond the river channel network.

#### ■ Discussion

A majority of the basin land surfaces exceed 30 % slope and serve as source areas for sediment. The Kilchis subbasin appears to have the greatest density of source areas (black shading in figure 6-2-7), with high concentrations also located along ridge lines and generally throughout the lower third of the forested uplands that ring the lowland valley of the south bay. Attention should be focused on these areas for source control management efforts, to limit disturbances that may increase runoff and erosion. This is especially true where source reaches are directly tributary to lowland valley response reaches, where increased sediment loads from disturbances could not be stored and gradually released to the lowland valley rivers, as could be done in connecting transport reaches.

Transport reaches (dark shading in figure 6-2-8) may be higher priority areas for the installation of engineered wood jams to increase sediment trapping. Transitions between transport and response reaches can be significantly impacted by increased sediment supply (Montgomery and Buffington, 1993), and these locations along river channels should be monitored to assess channel morphology responses. Since anadromous salmon tend to spawn in pool-riffle reaches of the river system where slope is between 0.1 and 2 percent (Figure 6-2-6), these response reaches (Figure 6-2-9 shaded areas) should receive prioritized attention for management and protection.

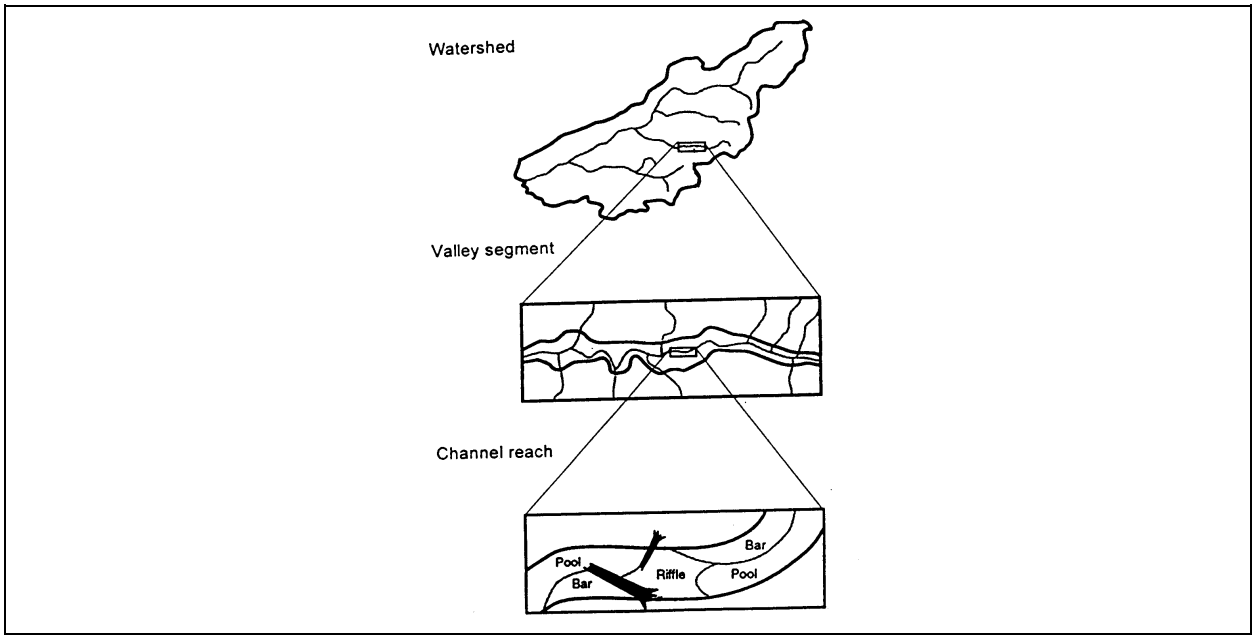


**Figure 6-2-5. Landscape Classifications Illustrating Process Divisions at the Watershed, Valley Sediment and Channel Reach Levels** (After Montgomery and Buffington, 1998)

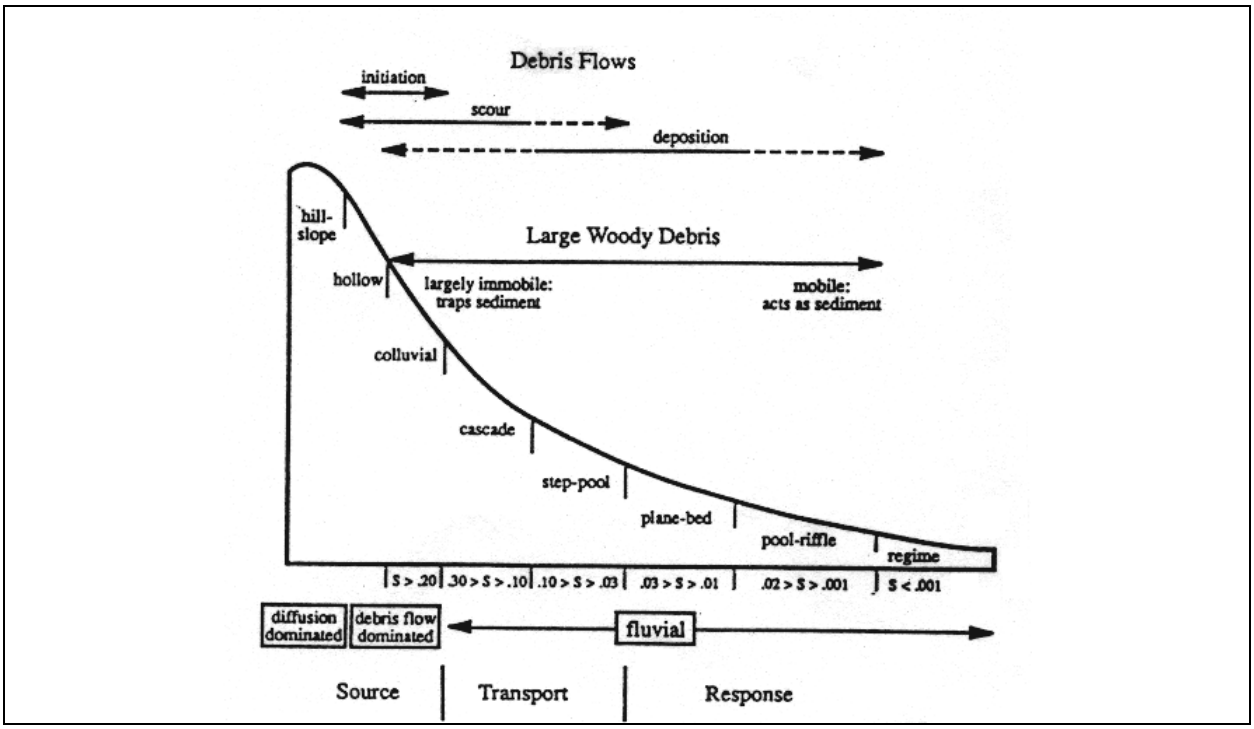


**Figure 6-2-6. Debris Flow** Source: Montgomery and Buffington, 1997

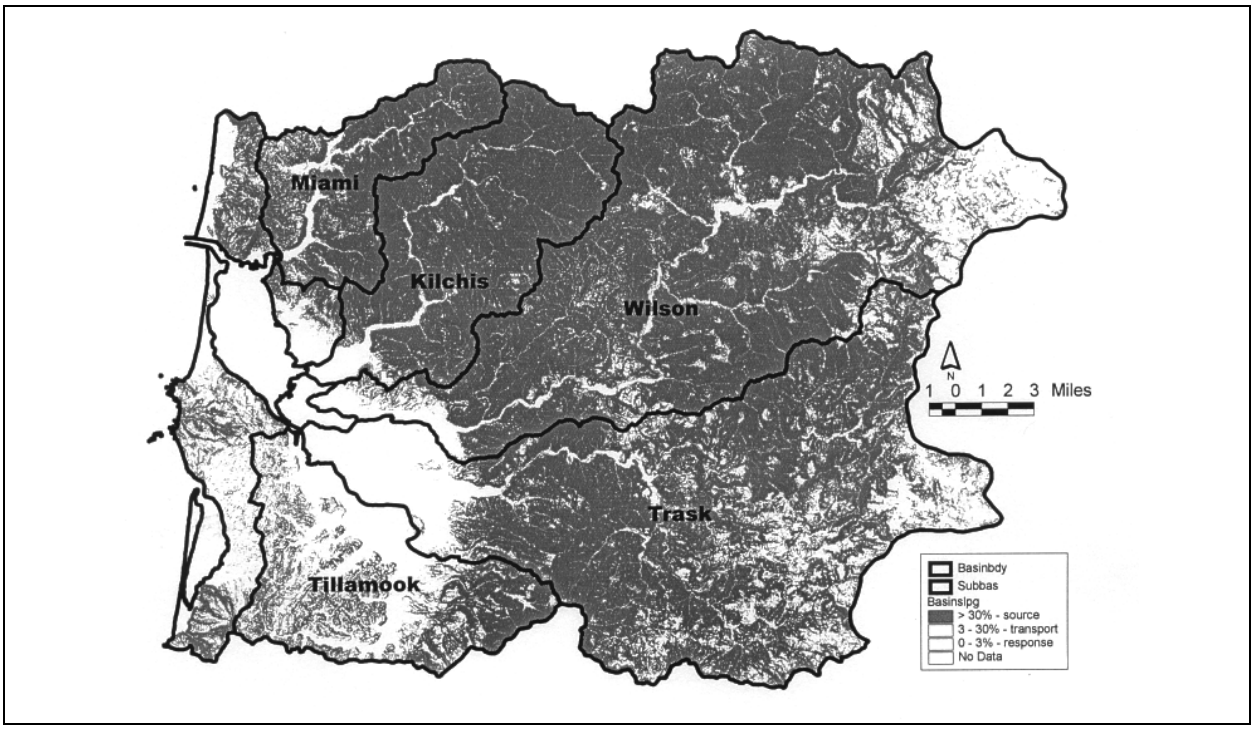


**Figure 6-2-7. Basin Slope > 30% - Source Zone**

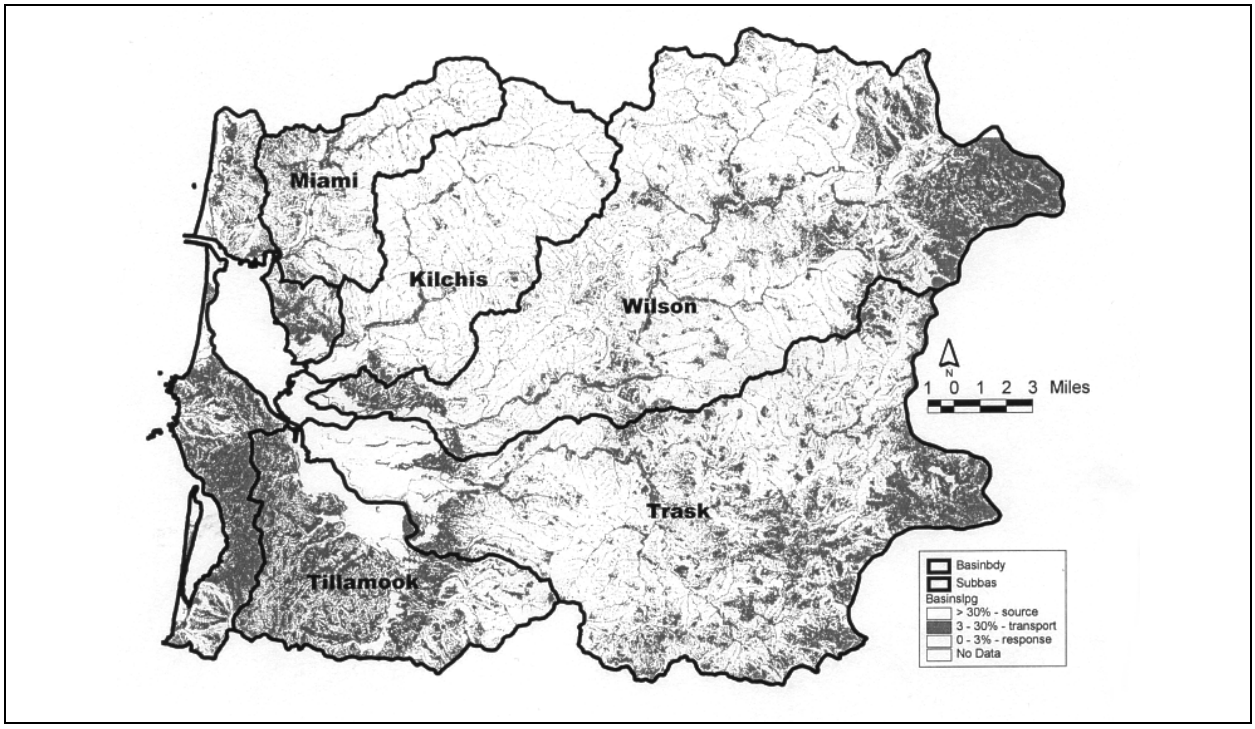


**Figure 6-2-8. Basin Slope 3 to 30% - Transport Zone**

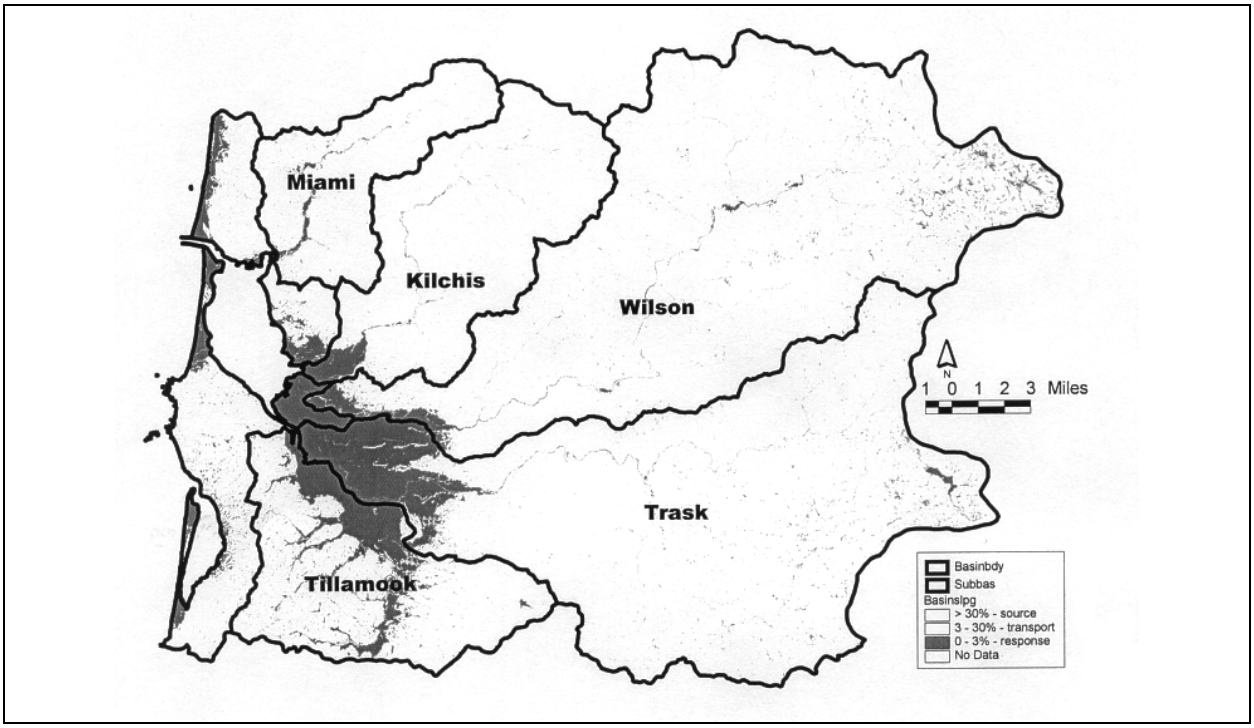


**Figure 6-2-9. . Basin Slope < 3% - Response Zone**