# Chapter 5
# The Human Context and Natural Character of Wilderness Lands

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This chapter describes the lands that make up the National Wilderness Preservation System (NWPS). The first section includes statistics on trends in designations since the creation of the NWPS and describes the current size of the System in total land area and number of areas across the country. Also included are descriptions of the prevalence of NWPS lands by states and regions of the country and for each of the four federal land management agencies responsible for their management. The second section describes the human context of Wilderness lands; that is, their location relative to human population centers, other land uses, and roads. A third section summarizes three key natural features of Wilderness—elevation, precipitation, and ecosystem types—represented in the System.

Data to describe the NWPS were obtained from a number of major sources. These include the Wilderness Information Network, the U.S. Geological Survey (USGS), the Bureau of Census, the USDA Natural Resources Conservation Service, and the USDA Forest Service. To calculate acreage, area, and the spatial distribution of Wilderness lands, and to track trends by year of their designation, data were obtained from the Wilderness Information Network (Wilderness Institute, 2003). Data describing the uses of land across the country were obtained from the National Resources Inventory (USDA, 2001). Data for describing the relationship between roads and Wilderness were obtained through the National Land Cover Database (Vogelmann et al., 2001; Vogelmann, Sohl & Howard, 1998). Much of the descriptive data summarized here are reported by Census region or by Census division within regions (Figure 5.1). Alaska is reported separately from the West region where data availability permits. Alaska is officially in the West Census region, but that state is so geographically separated and different from other western states that it is treated as a separate region. Throughout this chapter, and as in preceding chapters, Wilderness is capitalized to distinguish lands officially designated by Congress as areas within the NWPS.

## Trends in Designations and Current Size of the NWPS

The first lands designated as units of the National Wilderness Preservation System in 1964 included 54 areas the legislation identified as totaling 9.1 million acres, but later determined to be 11.4 million acres. Today, after numerous new designations over the four decades since passage of the original Act, the NWPS is made up of 662 units that total 105,678,911 acres (as of January 2004; see Table 5.1, page 60). This is nearly a twelve-fold increase over the original System land area (Wilderness Institute, 2003). The total area of Wilderness to date is 4.7 percent of the land area of the United States, including Alaska.

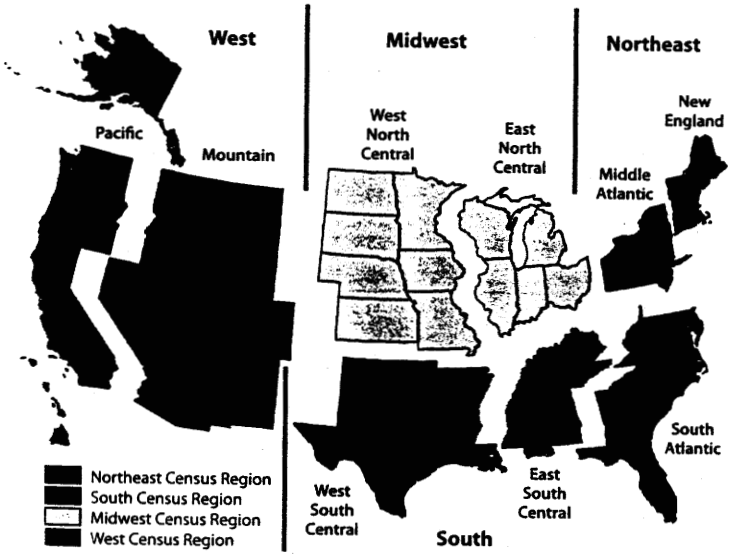


Alaska alone accounts for almost 55 percent of the total area of the NWPS (Campaign for America's Wilderness, 2002). And, as noted in Chapter 3, the System continues to grow. Eighteen new areas were designated in November 2002 alone, adding 452,530 acres. As well, legislation was under way to make further additions in 2004 (Wilderness Institute, 2003).

### System Designation Trends

Figures 5.2 through 5.4 (pages 61–63) show the changes in total acreage and number of Wilderness areas over time in the East, West, and Alaska regions. The Mississippi River is used to distinguish between the East and West regions. The five periods used to show trends include the first year of the system, 1964, and the subsequent periods of 1965–1974, 1975–1984, 1985–1994, and 1995–2003.

Figure 5.2 (page 61) shows the number of acres (millions) designated in the East and West in the contiguous United States from 1964 to 2003. Comparison of the number of acres added between these two regions emphasizes the significantly greater amount of federal land in the West which has met the definition presented in the Wilderness Act. The areas originally comprising the




*Source:* Map created using the states shape file provided by Environmental Systems Research Institute (ESRI), 1999

**Figure 5.1** Census regions and divisions of the United States

NWPS included mostly mountainous National Forest land in the West, much of which had been administratively designated for protection as primitive or wilderness areas by the Forest Service decades earlier. In 1964 only 36 thousand acres were designated Wilderness in the East. But, as significant additions have occurred across the years to include lands representing alpine tundra, shortgrass prairie, swamp, and ocean strand, a greater representation of eastern ecosystems types has also been added (Carter, 1992).

In the following ten years, 1965 to 1974, more acres were designated in the East, a total of 390 thousand. In the West during this same period, 1.9 million acres were added. From 1975 to 1984, highly active legislation added areas and acreage throughout the United States. In the East during this period, some 2.3 million acres were added. This included some major additions resulting from the Eastern Wilderness Areas Act of 1975 (EWAA). In the West, 16.8 million

**Table 5.1** Number of Wilderness areas and acres by census region, managing agency, and in Alaska, 2004

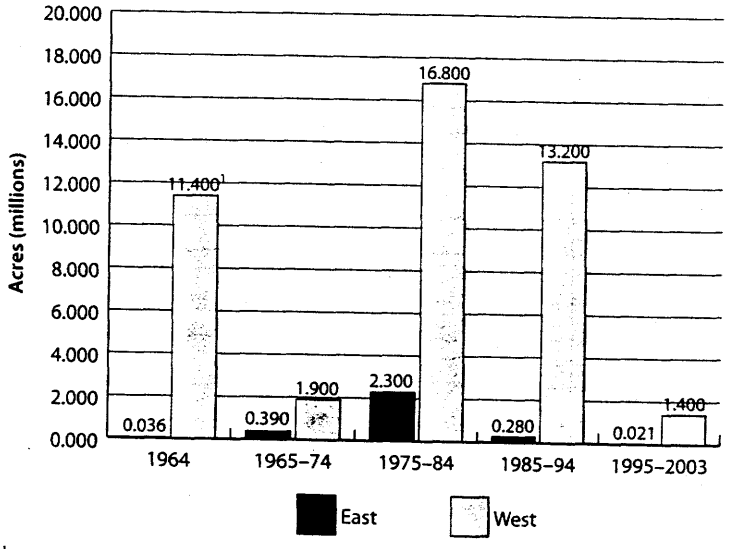
| Census Region | Areas | Acres | Percentage of National Total |
|---|---|---|---|
| **Alaska** | 48 | 57,509,859 | 54.4 |
| Forest Service | 19 | 5,753,336 | 5.4 |
| Fish & Wildlife Service | 21 | 18,676,912 | 17.7 |
| National Park Service | 8 | 33,079,611 | 31.3 |
| **West** | 438 | 43,856,229 | 41.5 |
| Bureau of Land Management | 159 | 6,512,227 | 6.2 |
| Forest Service | 239 | 27,059,553 | 25.6 |
| Fish & Wildlife Service | 15 | 1,461,047 | 1.4 |
| National Park Service | 25 | 8,823,402 | 8.4 |
| **Midwest** | 48 | 1,354,061 | 1.3 |
| Forest Service | 33 | 1,070,237 | 1.0 |
| Fish & Wildlife Service | 12 | 57,742 | 0.1 |
| National Park Service | 3 | 226,082 | 0.2 |
| **South** | 109 | 2,753,038 | 2.6 |
| Forest Service | 84 | 796,966 | 0.8 |
| Fish & Wildlife Service | 18 | 470,280 | 0.5 |
| National Park Service | 7 | 1,485,792 | 1.4 |
| **Northeast** | 19 | 205,724 | 0.2 |
| Forest Service | 13 | 183,384 | 0.2 |
| Fish & Wildlife Service | 5 | 20,977 | 0.0 |
| National Park Service | 1 | 1,363 | 0.0 |
| **National Total** | 662 | 105,678,911 | 100.0 |

*Source:* Wilderness Institute, 2003



acres were added between 1975 and 1984. Between 1985 and 1994, 280 thousand acres were added in the East. In the West there was another round of sizeable designations adding 13.2 million acres. From 1995 through 2003, designation continued, adding 20 thousand acres in the East and 1.4 million acres in the West. Again, the large difference in acreage reflects the relative abundance of federal lands in each region.

Alaska seems to hold a special place in people's minds with regard to wildness. In 1879 John Muir remarked, "To the lover of pure wildness Alaska is one of the most wonderful countries in the world" (Nash, 1982). It was not until 1980, however, that substantial acreage in Alaska was added to the NWPS. Figure 5.3 (page 62) shows the number of acres designated Wilderness in Alaska over the three time periods: 1965–1974, 1975–1984, and 1985–1994. No Alaskan lands were designated with the first Wilderness legislation in 1964, and none has been added of late; that is, between the years 1995 and 2003. It




[1] The Wilderness Act requires that agencies validate the acreage of any areas designated by Congress. The validation that occurred after passage of the Wilderness Act later showed that the acreage for the 54 original areas designated actually totaled 11.4 million acres, rather than the estimated of 9.1 million.

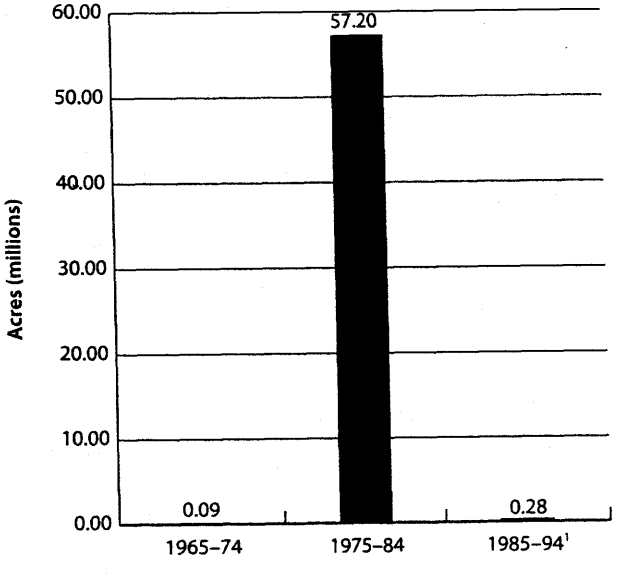
*Source:* Wilderness Institute, 2003

**Figure 5.2** Number of acres designated as Wilderness in the East and West regions of the contiguous United States between 1964 and 2003 (excluding Alaska)

was during the decade from 1965 to 1974 that the first designations were made in Alaska, totaling just 90 thousand acres. In the next ten years, however, very significant additions were legislated, totaling 57.2 million acres—more than half the total area of the Wilderness System as it exists today. This was a result, as noted in Chapter 3, of the Alaska National Interest Lands Conservation Act of 1980 (Wilderness Institute, 2003). The most recent Wilderness designations in Alaska between 1985 and 1994 consisted of 280 thousand acres.

Figure 5.4 shows the number of individual Wilderness areas designated in the East, West and Alaska from 1964 to 2003. The number of areas designated generally follows the same trend as the number of acres designated. In 1964 there were 3 areas designated in the East and 51 in the West. From 1965 to 1974, 12 areas were designated in the East, 21 in the West. During this period as well, 6 areas were added in Alaska.

The highest number of Wilderness areas designated among the time periods for a single region was during the period 1975 to 1984 in the West region. During these years, 229 areas were designated in the West, 82 in the East, and




[1] No acres have been added in Alaska since 1994.

*Source:* Wilderness Institute, 2003

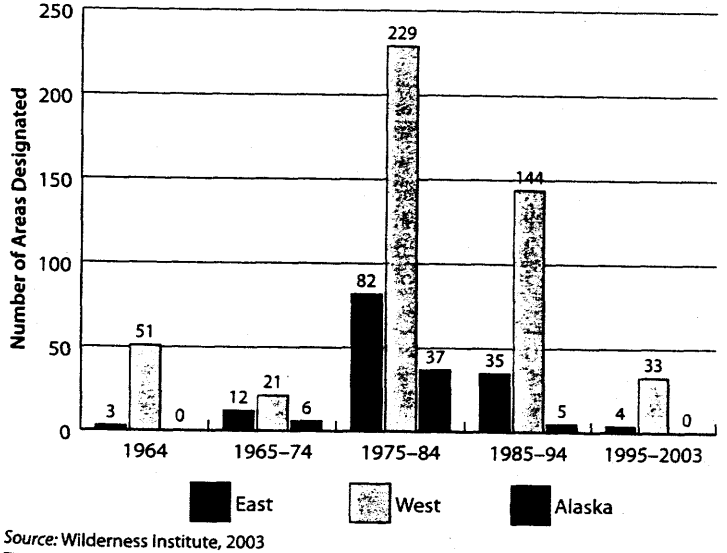
**Figure 5.3** Number of acres designated Wilderness in Alaska, 1965 through 1994



37 in Alaska. During the next decade, 1985 to 1994, 35 areas were added in the East, and 144 areas were added in the West. The last additions made to the NWPS in Alaska (5 areas) were legislated between 1985 and 1994. From 1995 to now, only 4 areas have been added in the East while 33 areas were added in the West. Although relatively few areas have been designated in Alaska, by far that state has the greatest total acreage of designated Wilderness. The average size per designated Wilderness area in Alaska is 1.2 million acres. In the West the average size is considerably less at around 94 thousand acres. In the East, it is only 22 thousand acres (Wilderness Institute, 2003).

## Size, Regions, and Management Agencies

Table 5.2 (page 64) shows Wilderness areas as a percentage of total U.S. land area and as a percentage of total federal land area. Wilderness makes up almost 16 percent of all land in Alaska. Of federally owned land in Alaska, 26 percent is Wilderness. Relative to the other regions in the contiguous United States, the West Census region (excluding Alaska) has the largest percentage of its total land area (public plus private) designated Wilderness (5.8%). Of federal lands in the West region, just over 12 percent is Wilderness. The West Census




*Source:* Wilderness Institute, 2003

**Figure 5.4** Number of Wilderness areas designated in the East, West, and Alaska between 1964 and 2003

region is followed, in order, by the South, Midwest, and Northeast regions in terms of percentage of total land area designated. In none of these three regions, however, is designated Wilderness a substantial percentage of land area. In the Northeast Census region, Wilderness is only 0.2 percent of total land area. Of all federally owned lands in the Northeast Census region, Wilderness comprises 8.3 percent. In the South, Wilderness is almost 0.5 percent of total land area, and 9.6 percent of federal lands in that region. In the Midwest, Wilderness is almost 0.3 percent of total land area and 5.7 percent of that region's federal lands.

The NWPS is managed by four federal land management agencies (see Table 5.1, page 60). These agencies include the Bureau of Land Management (BLM), which manages 6.5 million acres (2% of total BLM land, none is in Alaska). The NWPS is also managed by the USDA Forest Service which is responsible for 34.6 million acres (18% of all National Forest land). Almost 5.8 million acres of National Forest lands in Alaska are designated Wilderness. The U.S. Fish and Wildlife Service (FWS) manages 20.7 million acres of Wilderness (22% of that agency's total land area). Of the FWS designations, 18.7 million acres are in Alaska. The National Park Service (NPS) manages more Wilderness land than any of the other agencies, 44.2 million acres. Of the NPS lands in the lower 48 states, about 10.5 million acres has been designated. Almost 34 million acres of the National Park System land in Alaska is designated (Wilderness Institute, 2003). Figure 5.5 shows the proportion of Wilderness managed across all four managing agencies.

Table 5.1 also includes the number of Wilderness areas and acres of land area designated in each Census region and in Alaska. Fifty-eight percent of Wilderness in Alaska is managed by the National Park Service. Another 32 percent is managed by U.S. Fish and Wildlife Service. The remaining area of Wilderness is under the jurisdiction of the Forest Service. The West Census region contains over 41 percent of the total area of land in the NWPS and 438 of its 662 areas. This is two thirds of the Nation's total count of areas. The U.S.

**Table 5.2** Percentage of total U.S. land base and percentage of land area designated as Wilderness by census region and for Alaska, 2004

| Census Regions | Percentage of total land area | Percentage of Federal land area |
|---|---|---|
| Alaska | 15.9 | 26.3 |
| West | 5.8 | 12.1 |
| South | 0.5 | 9.6 |
| Midwest | 0.3 | 5.7 |
| Northeast | 0.2 | 8.3 |

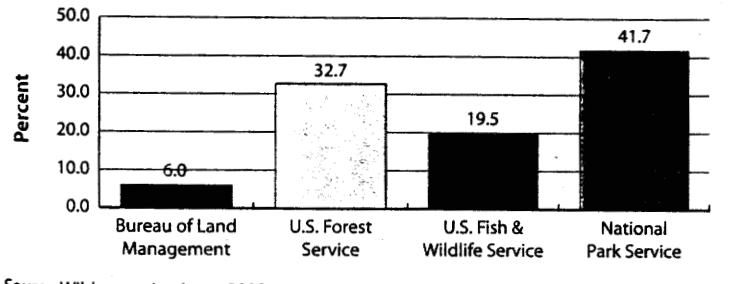
*Sources:* Total land area from U.S. Census Bureau, 2000; Wilderness land area from wilderness.net, November 2004



Forest Service manages 56 percent of the West's total land area designated as Wilderness, and about 59 percent of all of this region's designated areas. Following the Forest Service in terms of percentage of the West region's number of designated areas, but third in percentage of total land area designated, is the Bureau of Land Management. The Bureau manages 36 percent of the West region's Wilderness areas and just under 15 percent of its Wilderness land area. In descending order, the South has 2.8 million acres of designated Wilderness in 109 areas, the Midwest has over 1.3 million acres and 48 areas, and the Northeast region contains the least amount of Wilderness with a total of almost 205 thousand acres and 19 areas. Obviously, the average size of designated Wilderness areas in the West and in Alaska is much larger than in the other three regions to their east. Figure 5.5 shows the distribution of Wilderness management across all four managing agencies.

Table 5.3 (page 66) highlights the number of areas and acres in the ten states with the greatest total acreage of congressionally designated Wilderness (Wilderness Institute, 2003). As one might expect, the states with the greatest amount of designated land are Alaska, followed by nine other West region states. The nine western states in order of area within the System are: California, Arizona, Washington, Idaho, Montana, Colorado, Wyoming, Oregon, and Nevada. Together, Wilderness acreage in the top ten states comprises 93 percent of the NWPS. Total acreage of Wilderness among the ten states listed in Table 5.3 ranges from a high of 57.5 million in Alaska (15.4% of that state's total land area) to just over 2.1 million acres in Nevada. Of the "lower" 48 states, the state with the largest number of Wilderness areas is California, which has 130 areas. Wilderness in California makes up 13.8 percent of that state's total land area.

Average size of Wilderness areas varies considerably among the top ten states. For example, Idaho has the smallest number of Wilderness areas of the




*Source:* Wilderness Institute, 2003

**Figure 5.5** Percent of the National Wilderness Preservation System managed by each agency

ten top states listed in Table 5.3, but it ranks fifth in total land area designated. Average size of Wilderness areas in Idaho is approximately 574 thousand acres. The Frank Church River of No Return Wilderness in Idaho is one of the larger areas in the contiguous 48 states encompassing about 2.4 million acres. Nevada, on the other hand, has 42 designated areas statewide which total just over 2.1 million acres with an average area size of only 67 thousand acres, about one eighth the Idaho average. Six states do not have any designated Wilderness. They are Connecticut, Delaware, Iowa, Kansas, Maryland, and Rhode Island.

## The Human Context of Wilderness

### Ambient Population

The 2003 U.S. permanent resident population was estimated to be around 292 million. By 2020 the U.S. population is projected to be almost 325 million. Rising population and economic growth typically lead to increased land development and other intensive land uses. In the last few decades, land development has increasingly pushed into rural areas in regions such as the South, including forests and other areas previously dominated by natural processes (Cordell & Overdevest 2001; Wear, 2002). This spread of development and population onto rural lands often occurs near and sometimes adjacent to public lands, including lands designated as Wilderness. In turn, land development and associated human activities usually lead to disruptions of the natural functions of eco-

**Table 5.3** Number of Wilderness areas and acres in the ten states having the greatest total acres, 2004

| State | Areas | Acres | Percentage of national total acres |
|---|---|---|---|
| Alaska | 48 | 57,509,859 | 54.4 |
| California | 130 | 13,975,535 | 13.2 |
| Arizona | 90 | 4,518,442 | 4.3 |
| Washington | 30 | 4,324,182 | 4.0 |
| Idaho | 7 | 4,015,061 | 3.8 |
| Montana | 15 | 3,442,416 | 3.3 |
| Colorado | 40 | 3,171,685 | 3.0 |
| Wyoming | 15 | 3,111,132 | 2.9 |
| Oregon | 40 | 2,258,238 | 2.1 |
| Nevada | 42 | 2,123,343 | 2.0 |
| **Total** | 457 | 98,449,893 | 93.0 |
| **National Total** | **662** | **105,678,911** | |

*Source:* Wilderness Institute, 2003



systems and sometimes can threaten their natural integrity and their ability to provide adequate life support to the plant and animal populations making up and inhabiting those ecosystems. In describing the National Wilderness Preservation System, it is important to include the spatial relationship of System lands with the uses and human habitation of surrounding lands. Because these surrounding lands do not have the same protection as designated Wilderness lands have, significant impacts are highly possible. Generally, the closer Wilderness is to developed, populated areas, the less autonomy they have and, therefore, the more vulnerable they are to outside, human influences. This section examines the spatial proximity of designated Wilderness to population centers of different sizes, roads, and nearby lands being used in different ways.

The first measure used for proximity of human habitation and activity to Wilderness examines how much of Wilderness System lands lay within 100 miles of populated areas of different sizes (Table 5.4). Population center sizes considered are: under 50,000, 50 to 100 thousand, 100 to 500 thousand, those 500 thousand to 1 million, and large cities of over 1 million.

This examination shows that most of the total land area designated as Wilderness lies within 100 miles of a population center of some size. In the contiguous 48 states, 93 percent of all designated Wilderness areas are within

**Table 5.4** Number of areas and acres of Wilderness within 100 miles of population centers of selected sizes, by census region and in Alaska, 2004

| Alaska | Areas | Acres |
|---|---|---|
| 0–50k | 42 | 49,501,853 |
| 50–100k | 0 | 0 |
| 100–500k | 1 | 1,350,592 |
| 500k–1 million | 0 | 0 |
| over 1 million | 0 | 0 |

| West | Areas | Acres |
|---|---|---|
| 0–50k | 409 | 42,503,512 |
| 50–100k | 250 | 24,049,945 |
| 100–500k | 240 | 16,525,460 |
| 500k–1 million | 54 | 3,817,420 |
| over 1 million | 61 | 2,660,127 |

| South | Areas | Acres |
|---|---|---|
| 0–50k | 106 | 2,752,137 |
| 50–100k | 98 | 2,647,156 |
| 100–500k | 67 | 2,040,936 |
| 500k–1 million | 15 | 456,353 |
| over 1 million | 1 | 3,855 |

| Midwest | Areas | Acres |
|---|---|---|
| 0–50k | 44 | 1,344,387 |
| 50–100k | 17 | 988,837 |
| 100–500k | 9 | 51,737 |
| 500k–1 million | 1 | 12,945 |
| over 1 million | 0 | 0 |

| Northeast | Areas | Acres |
|---|---|---|
| 0–50k | 16 | 197,432 |
| 50–100k | 13 | 169,502 |
| 100–500k | 11 | 155,862 |
| 500k–1 million | 0 | 0 |
| over 1 million | 3 | 11,704 |

*Sources:* Cities and towns data from USGS, 2003; 2000 population data from U.S. Census Bureau, 2003; Wilderness data from Wilderness Institute, 2003

100 miles of at least one small to moderate size town with population under 50 thousand people. In Alaska 85 percent of all Wilderness areas are within 100 miles of a community of under 50 thousand. As the size of population centers is increased, however, the number of Wilderness areas within 100 miles decreases. Even at the upper extreme of population size—that is, population centers with greater than 1 million—there is at least one Wilderness area within 100 miles in the West, South, and Northeast. In terms of land area of designated Wilderness, across the country about 90 percent is within 100 miles of the smaller population centers of up to 50 thousand. Only 2.5 percent of total Wilderness land area is within 100 miles of the largest metropolitan centers; that is, those with a population of over 1 million.

The second measure of proximity of human habitation relative to the location of Wilderness is an examination of the number of people living within 25, 50, 100, 200, and 400 miles, whether urban or rural. Population enumeration for this second measure was at a fine scale; that is, census block group level. The data source is the 2000 Census of Population (Geolytics, Inc., 2001).

The entire population of the United States as of the 2000 Census, 282 million people, lives within 400 miles of one or more Wilderness areas (Table 5.5). About 70 percent of this national population lives within 100 miles of a Wilderness area. Loosely translated, this means that over 195 million persons live within a two-hour drive of one or more areas of the NWPS. Almost 41 percent live within 50 miles, roughly a one-hour drive, and nearly 17 percent are within 25 miles. Population within 25 miles accounts for around 47.5 million people, which is approximately 2.23 acres of wilderness per person living within 25 miles.

## Uses of Nearby Non-Wilderness Land

Generally, as human population increases and spreads further from metropolitan areas into rural areas, there is greater influence on natural lands, including nearby

**Table 5.5** Number and percentage of population of people living within 25, 50, 100, 200, and 400 miles of Wilderness, 2004

| Distance from Wilderness | Population | Percent of Population |
|---|---|---|
| 25 miles | 47,495,997 | 16.8 |
| 50 miles | 114,497,257 | 40.6 |
| 100 miles | 195,745,452 | 69.4 |
| 200 miles | 262,151,985 | 93.0 |
| 400 miles | 281,918,792 | 100.0 |

*Sources:* Geolytics (2001). Note: Census Tract group 22075LA Plaquemines Parish, tract number 22075050100 was not available, therefore 3,025 people were not included; Wilderness data from Wilderness Institute (2003)



forest, range, wetlands, and other lands with natural cover. Some of these impacted natural lands are designated Wilderness (Sarkar, 1999). Not only are the physical and biological characteristics of natural lands altered as human activities increase but often their ecological health is diminished as well (Sanderson et al., 2002). Negative effects can include loss of biodiversity, air pollution, deforestation, and withdrawal of water (Kilic, Senol & Evrendilek, 2003).

The nature of the land use–ecosystem health relationship depends, of course, on the intensity and type of interaction occurring between humans and their external environment (Sanderson et al., 2002). Even though humans are not permitted to live in or substantially alter Wilderness areas, increasing numbers of people nearby, along with their activities, can effect the ecological health of Wilderness. Examples of such activities include expanding development (both commercial and residential), greater withdrawal of ground and surface water, and many other forms of human consumption and alteration of nearby natural lands. At the same time human activity may be damaging to ecological health, protected Wilderness lands typically provide substantial positive benefits and improved quality of life for the same nearby human settlements. An example is the role Wilderness plays in supplying clean, potable water. Another is the scenic beauty of wild lands as a pleasing backdrop for nearby rural or resort communities. For Wilderness and its management, surrounding human activities and uses of land are a highly important context that can have both positive and negative sides.

Land use in North America over the past four centuries, especially over the last century, has drastically reduced the amount and changed the look and function of rural land. One clear example of land use as a change agent is the growth of intensive agriculture (Turner & Rabalais, 2003). Cropping, use of fertilizers and pesticides, and depletion of soils has had many effects—one of which is lowering the quality of water. Turner and Rabalais conducted a study to examine the link between intensive land use and water quality in the Mississippi River Basin. They found that 44 percent of the rivers that they surveyed in the 15 Mississippi River Basin states were impacted as a result of conversions from natural to intensive uses, such as agricultural and industrial development. Such transformations of natural lands, along with extensive areas used for intensive agriculture can also lead to habitat fragmentation and destruction. Agricultural land use over the past 30 years is responsible for changes in the rates of nitrogen fixation and phosphorus accumulation in soils, soil erosion, and runoff causing nutrient loading in waterways like the Mississippi River (Sanderson et al., 2002).

Land uses in the United States have been classified by the USDA Natural Resources Conservation Service and inventoried through that agency's ongoing National Resources Inventory System (NRI; USDA, 2001). The 1997 county-level NRI data were used to calculate percentage of total county land area

being used as cropland, developed (urban and other built-up), forest and water uses. These land uses are depicted in relation to the locations of designated Wilderness areas in Plates 1 through 4 (see Appendix). Plates 1 through 4 are further divided by region to make map images easier to interpret.

Almost all counties of the United States have some percentage of land area devoted to cropland use (see Plate 1). Percentages of crop land range from nearly zero to almost 94 percent across the counties of the country. Most of the land in the country used for cropping and other agriculture generally is in the Midwest, Great Lakes states, and the Mississippi River valley. In the West, the counties with the greatest percentages of total land area in crops lie in eastern Colorado, northern Montana, southeastern Washington, parts of Idaho, and central California. In all of these states, some cropland lies close or adjacent to designated Wilderness. Adjacency of croplands to Wilderness is especially noticeable in north central Montana and central California. In the Midwest, South, and Northeast there is relatively little land area designated as Wilderness. In part, this is because little natural land existed in these regions after passage of the Wilderness Act that would meet the criteria for designation. From western North Dakota to Chicago and western Ohio, down the Mississippi valley and southwest from Indiana to northern Texas, vast stretches of land are in crops. The small amount of Wilderness in these states (except for northern Minnesota) translates to very little cropland adjacent to Wilderness lands. In comparison with some areas of the West, no eastern states have large areas of designated Wilderness near croplands. Relative to other eastern States, however, Vermont and northern Virginia have greater amounts of designated Wilderness in counties near or within those heavily used for crops.

Developed land is more prominent in the East and along the Great Lakes, including the Minneapolis–St. Paul metropolitan area and eastern Texas (see Plate 2). Percentages of total land area that is developed across the country's counties range from near zero in counties made up from public land to well over 90 percent in several metropolitan counties. While less pervasive among counties in the West, relative to counties in the Midwest and East, there are nonetheless a number of areas that are heavily developed in that region. Included are western Washington, coastal California, southwestern Arizona and cities from Denver, Colorado, to Spokane, Washington. As one might expect, the majority of Wilderness lands are in areas that are not highly developed. In the West, the exceptions are southern California and Arizona, central Colorado, northwestern Oregon and northwestern Washington, and a few other scattered urban areas, such as in the Salt Lake City area. In the Midwest, very few Wilderness areas lie close to or within the more developed counties. The South and Northeast are much more highly developed. Wilderness in southern Florida, the southern Appalachians, northern Virginia, and northern New Hampshire are in close proximity to developed land uses, relative to the rest of the East.



Plate 3 shows percentages of total county area under water across the United States. Water area percentages range from nearly zero in many of the arid western counties to almost 70 percent in some coastal and riverine areas of the country. In the West, greater areas of water cover are found in northwestern Wyoming, northern Idaho, coastal Washington, and north central and coastal California. In these western areas, almost all counties with relatively high water cover have Wilderness. In the South, a region of relatively high precipitation, the Mississippi River area, Gulf of Mexico counties, and Atlantic coast counties have the highest proportion of county land area covered by water. Still, there is little association between high water coverage and Wilderness in this region. In the Midwest, central Minnesota, central North Dakota, eastern and northeastern Wisconsin, and in a few other areas in that region, relatively high water area percentages are found. Only modest association between the location of Wilderness areas and the higher water concentrations in this region exist with the exception of the Boundary Waters Canoe area of northern Minnesota. In the Northeast, coastal and north central Maine, northeastern New York and coastal counties in other New England states have relatively high water coverage. Because most of the Wilderness acreage in this region is inland in Vermont and New Hampshire, there again is only modest association between the location of Wilderness and water area.

Forest lands, almost all of which are managed for tree crops, water, and wildlife, are much more compatible with the management and protection of Wilderness values than more intensive land uses. The map of forest land shows that most forest land is located in the eastern half of the United States (see Plate 4). Of the Wilderness areas in the East, most lie within areas that are 27.5 to 95 percent forested. In the West, relative to other states in that region, most forest land counties are in the coastal states of Washington, Oregon, and California, and also in northern Idaho, northwestern Montana, central Colorado, northern New Mexico and northeastern Arizona. Vast stretches of Wilderness lie in these forested zones, especially in western Washington, Oregon, and California. But it is evident by comparing Plates 3 and 4 that most designated land in the West is relatively arid with sparse forest cover. In contrast, except for the Everglades in southern Florida, almost all Wilderness in the East is in heavily forested counties. This is especially true for southern Georgia, the southern Appalachians, and the New England states.

## Proximity to Major Roads and Rivers

One of the most intensive and irreversible uses of land is development of roads. As with other intensive land uses, roads have many impacts on the natural appearance and functioning of nearby lands (Forman et al., 2002). Because roads provide transportation, they bring people, activities, vehicles, and equipment close to and, at times, even into the borders of Wilderness. The existence

of roads can sometimes stimulate building additional roads and other development in lands adjacent to Wilderness. Examples are building of primary and secondary homes and development of resorts. Thus, the location of roads is a highly significant spatial context for Wilderness. This is especially the case for major roads, such as interstate highways, which carry large volumes of traffic into the proximity of public lands. Examples of activities stimulated by roads include extraction of raw materials (e.g., minerals), waste disposal, off-highway vehicle driving, and many other uses (Sanderson et al., 2002). In addition to roads, rivers also provide transportation for people and for their activities. As is the case for major roads, the transportation provided by rivers can have substantial effects on uses of land near Wilderness. Obviously, nearby roads and navigable rivers in part determine how much interior use Wilderness areas receive.

To assess the distribution of Wilderness areas relative to roads and rivers, GIS software was used to overlay Wilderness boundaries on digital maps containing major roads and rivers to see their spatial coincidence (see Plates 5–9, Appendix). Interstate map data were obtained from the *National Atlas of the United States* (USGS, 1999). But, as is often the case for Alaska, comparable roads data for that state were not available. River map data were available for all states, including Alaska, and show the location of the country's 56 largest rivers (ESRI, 1999).

Because of the broad-scale coverage of the roads and river data, Alaska and each of the four Census regions covering the 48 contiguous states were mapped separately. These maps show the location of Wilderness areas in relation to major interstates and rivers. Boundaries for the states making up each Census region are also shown. Wilderness areas are green, interstates black, and rivers blue.

In Alaska (Plate 5, showing only rivers),Wilderness areas are large and highly significant portions of the landscape. The major rivers in Alaska (e.g., the Yukon and Kuskokwim) tend to flow from southeast to northwest. These major rivers are for the most part distant from Wilderness areas and do not seem to play a large role in providing human access to this state's designated areas. Wilderness areas do serve as watersheds and thus act in part as the sources of water for those rivers. There are only a few major highways in Alaska, mostly in and emanating from the Anchorage area. These are not shown on the map.

In the West Census region (i.e., states west of a line drawn south from the western border of North Dakota to the western border of Texas), there are a number of major rivers. Examples are the Colorado flowing southwest to the Gulf of California and the Columbia/Snake River System flowing west into the Pacific (see Plate 6). The Colorado River begins in northern Colorado and moves southwest to end in the Gulf of California. It is approximately 1,500



miles long and passes through numerous canyons along its path, including the Grand Canyon in northern Arizona. The Columbia/Snake River System is a fast-flowing river coming from southeastern British Columbia in Canada passing through the state of Washington to empty into the Pacific Ocean. This river system rises in Canada and Wyoming and passes through Idaho. It is about 1,150 miles in length and serves as migration routes for a number of species of anadromous fish, including salmon. The reach of these and other western rivers inland from the Pacific, Gulf of California, and Gulf of Mexico includes many thousands of miles across multiple states. The headwaters for most western rivers lie, in part, in designated Wilderness.

Because rivers are crossed many times by highways and interstates, they provide a considerable amount of upstream and downstream access to the Wilderness areas of the West, as well as to other close-by public lands. There are 10 different Interstate highways in the 11 western states (see Plate 6). They run north-south and east-west and often pass close to, and in some cases between designated Wilderness areas. In areas where Interstates pass near Wilderness, physical access to these designated areas is significantly easier to larger numbers of people. Interstates in the West and in all U.S. regions, connect countless state, county, and local roads giving access to state and federal public lands throughout the West. At the same time, travelers using these highways benefit from visual access and scenic vistas made up in part and sometimes entirely from these highly protected lands. An example subregion where Interstate highways run close to and through Wilderness areas is the Sierra Nevada Mountain area in eastern California. Another is Interstate 70 running west from Denver into western Utah.

The portion of the South region lying east of the Mississippi River, has many more Wilderness areas than are found in the Northeast (cf. Plates 7 and 9, Appendix). As well, the South has significant stretches of major rivers and highways. In Texas, the Rio Grande and the Brazos flow in a southeasterly direction into the Gulf of Mexico. Further North, the Missouri and Ohio Rivers flow generally south to form the Mississippi, the largest river in the country. The Mississippi flows through the South to empty into the Gulf of Mexico where it forms the boundary between Louisiana and Mississippi. The Mississippi is almost 2,340 miles in length and has its origins in northwestern Minnesota. This river serves as a major national transportation artery, especially when combined with its major tributaries, the Missouri and Ohio Rivers. Combined, these three rivers stretch almost 3,400 miles, but they generally do not link people and their activities to designated Wilderness.

There are 14 major interstate highway routes throughout the South, all of which are linked to a considerable number of connector routes and three-digit local loops (see Plate 7, Appendix). From Interstate 95, which connects Florida with the Northeast, to Interstate 25, which begins in New Mexico and

extends to the north into the foothills of the Rockies, the north-south system of interstate highways carry enormous traffic loads. The north-south interstates east of Texas often pass close to and sometimes through national forests, national parks, and other public lands. Some of these public lands have been designated as Wilderness areas. Unlike the West, the East has much less public land to act as a buffer between highways and designated Wilderness. In fact, unlike the West, very few designated Wilderness areas in the East can be considered remote. Thus, because the interstate highways of the East carry large numbers of travelers and are often located near or nearly next to Wilderness, they play a significant role in providing access to designated Wilderness. A good example is Interstate 81 from Dandridge, Tennessee, through the Southern Appalachian Mountains northeast through Shenandoah National Park in central and northern Virginia, to within 70 miles west of Washington, DC.

In the Midwest and the Northeast Census regions (Plates 8 and 9 respectively) there are relatively few designated Wilderness areas. In areal size, the Boundary Waters Canoe Area in the extreme north of Minnesota, and the areas designated Wilderness in New Hampshire and Vermont are exceptions. Much of the Wilderness in New Hampshire and Vermont lies close to Interstate 93. Unlike the Wilderness in these states, the Boundary Waters Canoe Area is relatively remote and uninfluenced by traffic on either major rivers or on interstate highways.

## Pervasiveness of Roads Near Wilderness

In 2001, the contiguous states of the United States contained approximately 3.9 million miles of public roads. Over 990 thousand of these road miles were classified as nonlocal rural roads (U.S. Department of Transportation [USDT], 2002). The ecological change brought about by roads is easily seen within a few feet of roadsides, but their impacts can extend out several miles. Building and using roads can alter water drainage patterns, modify habitats, disrupt wildlife movements, introduce exotic species, modify microclimates and the chemical environment, increase noise levels, and provide direct human access. Roads also contribute to development impacts by facilitating commercial and residential building and further extending the road network itself (Riitters & Wickham, 2003). Generally, the more pervasive the road systems in any given area, the more impacts they are likely to have on adjacent and nearby lands.

This section examines the spatial pervasiveness of roads in relation to the locations of Wilderness areas. There are three measures used to examine pervasiveness. The first measure looks from Wilderness boundaries outward to examine average miles of roads and railroads at different distances from Wilderness boundaries. The second measure looks from the nearest road at different distances back toward designated Wilderness to examine total acres and proportion of protected Wilderness within those distances by Census region. The



third measure is the mapped relationship between the location of lands with different densities of roads and the location of Wilderness areas. Density of roads is measured as the proportion of equal size units of land having one or more roads.

The first measure is average miles of roads at three distances from Wilderness boundaries. This first measure was estimated for the lower 48 and for each region of the country. (Alaska is not included because comparable road data are not available for that state.) Table 5.6 summarizes these estimates. The original source of these data was Geographic Data Technology (2002). From 0 to 3 miles of area boundaries, the highest average miles of road per designated area is in the West with 220 miles. Next highest is the South with 152 miles per Wilderness area. Average miles of road per area is highest in the West in part because area size in this region is much larger than area size in the other regions. The national average miles of road per area from 0 to 3 miles of area boundaries is approximately 198 miles. It is important to note that there are some historic roads within Wilderness boundaries. For the most part, these roads predated passage of the Wilderness legislation designating an area. After designation, however, mechanical transportation on these preexisting roads is prohibited.

The average miles of road per Wilderness area increased at the greater distance of between 3 and 6 miles from area boundaries. In the West, slightly over 300 miles of road are found within these distances, about 278 are found in areas of the South, and just over 260 miles of road per area in the Northeast region. Estimates of miles of road per Wilderness area are even closer among regions at distances within 6 to 9 miles. The national average is just over 392 miles per Wilderness area between these distances. Highest is the South at about 414 miles per area, next is the Northeast with about 400 miles per area, and least is the Midwest with about 330 miles per area. At these longer distances, the

**Table 5.6** Average miles of roads, highways, and railroads per Wilderness area by distance from area boundary and by census region, 2004

| Census Region | Average Miles per Wilderness Area | | |
|---|---|---|---|
| | 0–3 miles | 3–6 miles | 6–9 miles |
| West | 219.8 | 303.9 | 393.0 |
| South | 151.7 | 277.5 | 413.6 |
| Midwest | 135.6 | 227.7 | 331.6 |
| Northeast | 120.8 | 261.4 | 400.9 |
| **National (lower 48 only)** | 198.0 | 292.1 | 392.4 |

Note: Land area within 3, 3–6, and 6–9 miles out from Wilderness boundaries vary by size of Wilderness area. Thus large areas may be associated with greater average road mileage.

*Sources:* Geographic Data Technology, 2002; Wilderness land area from wilderness.net, November 2004

much more prevalent road systems of the South and Northeast become evident. Third in average miles of road per area is the West with 393 miles per area. Obviously, roads near Wilderness are important in describing the context within which the ecosystems represented by Wilderness areas must function, and they are important to understanding a very significant aspect of the context for Wilderness management and protection decisions.

The second measure of the pervasiveness of roads is acreage of designated Wilderness within different distances from the nearest road. Examined is area in acres and percent of total land area designated Wilderness that is 0.02, 0.23, and 3.2 miles from the nearest road. These distances were selected to correspond with distances used in the primary literature source on which this spatial analysis was based (Riitters & Wickham, 2003). Riitters and Wickham conducted their research to look at the proportion of total and forest land area in the United States located within nine different distances of the nearest road. As one might expect, they found that as distance from the nearest road increases, there is an increase in proportion of total land area included (both forest and nonforest). Their estimated proportions increased rapidly at the shorter distances, but then leveled off at around 800 meters (approximately 0.5 mile). Compared with total land area, forest land was slightly more remote, but followed a similar trend line. The difference in total land area and forest area varied only by 2 percent at each distance.

Like the analysis of forest land area near roads, area of designated Wilderness was computed by Census region for the same three distances from nearest road (i.e., 0.02 mi., 0.23 mi., and 3.2 mi.) that were used by Riitters and Wickham (2003). Results are presented in Table 5.7. Like the forest land analysis, the Wilderness distance-to-area analysis was based on maps gridded at 30 meters and distances were based on the diagonal of a 30-meter grid cell, which is 42.4 meters. So each distance is a multiple of 42.4 meters. The shorter two of the three distances were used in this and in the original study because at these distances the distance-to-area relationship changed rapidly. These three selected distances were used to examine a conservative, medium, and liberal measure of potential impact from roads.

On average, across the four Census regions, quite small areas of Wilderness lay within the nearest distance of 0.02 miles. As well, at approximately one quarter of a mile (0.23 mi.), a distance at which road traffic is usually out of sight, but easily heard, less than 10 percent of designated land area is included. At this distance, the least land area and percentage of total Wilderness acres are in the West, where roads are less prevalent and where there is significantly more other federal land as a buffer. In the South, almost 10 percent of all designated Wilderness is within 0.23 miles of the nearest road. At 3.2 miles, a distance just over the Recreation Opportunity Spectrum distance for the primitive class of unroaded wildlands (More, Bulmer, Henzel & Mates, 2003), considerably more of National Wilderness Preservation System lands are included. The largest percentage is in the Northeast, at almost 64 percent, nearly two thirds of that region's Wilderness. Next in order is the South at almost 54 percent. The West is lowest at 39 percent. From these estimates across the three distances, it seems that Wilderness in the South is at greatest exposure from road impacts. Next in exposure is the Midwest, followed by the Northeast and West.



Plate 10 (see Appendix) maps the spatial distribution of grid cells across the United States containing one or more roads. To create this map, the United States was divided into 140,000 squares, each square being approximately 7.5 square kilometers. Each of these squares was then further divided into 62,500 subcells, each being 30 square meters in size. A detailed road map was overlayed and each 30-square-meter cell that contained a road was scored. The percentage of 30-square-meter cells containing a road was calculated (Riitters & Wickham, 2003; Wear, Pye & Riiters, 2004).

As evident from the map in Plate 10, most of the Wilderness in the West is in areas of relatively low road density (i.e., buffered from roads by other lands of low or zero road density). Exceptions in the West region are the Salt Lake

**Table 5.7** Total percentage of Wilderness acres within 0.02 miles (141 ft), 0.23 miles (1,253 ft), and 3.2 miles (16,980 ft) of the nearest road, by census region (excluding Alaska), 2004

| Census Region<br>Distance to nearest road | | Acres | Proportion of total area |
|---|---|---|---|
| **West** | Region Total | 43,519,489 | |
| 0.02 miles | | 136,294 | 0.3 |
| 0.23 miles | | 2,084,581 | 4.8 |
| 3.20 miles | | 17,057,393 | 39.2 |
| **South** | Region Total | 2,752,198 | |
| 0.02 miles | | 18,194 | 0.7 |
| 0.23 miles | | 271,852 | 9.9 |
| 3.20 miles | | 1,477,281 | 53.7 |
| **Midwest** | Region Total | 1,344,652 | |
| 0.02 miles | | 6,913 | 0.5 |
| 0.23 miles | | 107,516 | 8.0 |
| 3.20 miles | | 625,064 | 46.5 |
| **Northeast** | Region Total | 204,900 | |
| 0.02 miles | | 647 | 0.3 |
| 0.23 miles | | 11,425 | 5.6 |
| 3.20 miles | | 130,630 | 63.8 |

*Sources:* Distance to roads from Riitters and Wickham, 2003; Wilderness land area from wilderness.net, November 2004

City, Utah; Denver, Colorado; Albuquerque, New Mexico; Phoenix, Arizona; coastal California; the Klamath area of southern and central Oregon; and the Seattle, Washington, areas. In the South, Wilderness is found in areas with road densities greater than in the West. Examples are the Miami, Florida; Little Rock, Arkansas; the southern Appalachians of north Georgia; western North Carolina; southwestern Virginia; and the Charleston, South Carolina, areas. In the Northeast, nearly all Wilderness areas reside in moderate to heavy road-density areas with little buffering. Greater density of roads indicates greater fragmentation of the landscape and the natural systems making up the landscape. The functioning and appearance of these fragmented landscapes can be dramatically altered as roads expand in number, density, and width (Riitters & Wickham 2003). Further treatment of road density as a natural land fragmentation factor will be provided in Chapter 11.

## The Natural Character of Wilderness

Thus far the National Wilderness Preservation System has been described in terms of its size, the number of people living in nearby communities, surrounding land uses, and the network of transportation systems in the local area. This section examines some of the natural characteristics of the System's protected lands. First, the range of elevation of the lands included within the NWPS are described. Next precipitation amounts over the areas in the NWPS are shown. Following, at a macroscale, the ecosystems represented in the Wilderness System are inventoried at the Division level of the ecoregion classification system. The system widely known as the *Bailey system* was adopted for this analysis (Bailey, 1995).

Over the years, Congressional designations have protected some ecosystems better than others. For example, high-elevation lands, sometimes above tree line, are generally better represented in the NWPS. These lands typically are less roaded and have had little detectable human disturbance. Nevertheless, the NWPS includes a wide variety of natural land forms and habitats. The natural character of these protected lands differs greatly across the country. Some areas are extremely remote, expansive, and unmodified cool climate lands, like the 8.7-million-acre Wrangell–St. Elias Wilderness in Alaska. Others are much smaller, warmer, nearer to sea level, and closer to places heavily inhabited by humans, such as the five-acre Pelican Island Wilderness in Florida. Protection of natural character is more difficult in the areas that lay in close proximity to large urban areas. These areas are often heavily influenced by nearby human land uses (Cole, 2000). Following is an overview of three of the natural characters of Wilderness: elevation, precipitation, and broad-scale ecosystem classification.



### Wilderness at Different Elevations

Elevation is an important characteristic of natural lands because it is closely associated with, and over time has played a large role in, determining the distribution of species of native animals or plants. A good example is that of the northern spotted owl, whose native habitat occurs at lower elevations in the Pacific Northwest (Noss, 1996). This species was federally listed as threatened in 1990 (Forsman, n.d.). Because much of the designated Wilderness in the Pacific Northwest has been at higher elevations, there tend to be significantly fewer spotted owl locations within Wilderness than in the managed forests of that same region. In general, the more diverse the elevation and other natural characteristics of the Wilderness System, the greater its contributions toward sustaining a variety of native species.

To examine the diversity of elevations represented by the current inventory of areas within the NWPS in the 48 contiguous states, a digital elevation map was used to identify the range of elevations within each Wilderness area. This digital elevation map is a giant grid of cells where each cell measures about 85 meters a side. Across the Wilderness System, this map indicates that elevations range from 262 feet below sea level to approximately 14,370 feet. Elevations across the landscape within each cell were averaged and rounded to the nearest 10 meters. Then, for each Wilderness area, the number of square meters of land area falling within each of the resulting 444 10-meter elevation classes was calculated. Ultimately, to facilitate presentation in a table for this chapter, these 444 elevation classes were aggregated into seven classes as follows: less than 0, 0–99, 100–499, 500–2,499, 2,500–4,999, 5,000–9,999, and 10,000 feet and over. To correct for coarseness in the estimation procedure used, the amount of Wilderness area was summed across each of these seven elevation ranges for each Wilderness area and then divided by the sum across ranges to obtain an estimate of percentage of area within each range for each Wilderness area. The resulting elevation percentages were then multiplied by the known land area of each Wilderness area to get an adjusted estimate of number of acres by elevation class that would sum to the true acreage of Wilderness, area by area and within the NWPS. The number of designated Wilderness acres was summed across elevation ranges for each of the nine census division of the United States as well. Results are shown in Table 5.8 (all elevation ranges; see page 80) and in Figure 5.6 (which focuses only on the highest two elevation ranges; see page 81).

Table 5.8 shows acres and percentage of the total area estimated for the seven elevation ranges for the contiguous 48 states. (Comparable data were not available for Alaska.) Focusing on the 21.5 million acres of designated Wilderness in the 48 contiguous states that lie under 5,000 feet in elevation, one can see that just over 17 million acres, approximately 80 percent, is in the West Census region, mostly in the Pacific West. Slightly over half of the acres

**Table 5.8** Acres and the proportion (%) of Wilderness system total area by elevation ranges and by census division of the contiguous 48 states

| | Number of acres in elevation range | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Census Division** | **<0 feet** | **0 - 99 feet** | **100 - 499 feet** | **500 - 2,499 feet** | **2,500 - 4,999 feet** | **5,000 - 9,999 feet** | **>9,999 feet** | **Total acreage** |
| West—Pacific | 166,553 (0.01) | 91,929 (0.00) | 284,875 (0.01) | 4,159,823 (0.20) | 7,594,485 (0.36) | 7,605,439 (0.36) | 1,041,387 (0.05) | 20,944,491 (0.44) |
| West—Mountain | 0 (0.00) | 0 (0.00) | 21,381 (0.00) | 2,359,155 (0.11) | 2,574,016 (0.12) | 12,967,006 (0.58) | 4,279,866 (0.19) | 22,201,424 (0.47) |
| Midwest—West North Central | 0 (0.00) | 0 (0.00) | 7,957 (0.01) | 915,033 (0.90) | 79,746 (0.08) | 9,558 (0.01) | 0 (0.00) | 1,012,294 (0.02) |
| Midwest—East North Central | 0 (0.00) | 0 (0.00) | 6,957 (0.02) | 325,136 (0.98) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 332,093 (0.01) |
| South—South Atlantic | 0 (0.00) | 1,571,060 (0.67) | 317,457 (0.14) | 158,745 (0.07) | 283,264 (0.12) | 10,124 (0.00) | 0 (0.00) | 2,340,650 (0.05) |
| South—West South Central | 0 (0.00) | 8,965 (0.03) | 57,616 (0.21) | 165,243 (0.59) | 4,073 (0.01) | 43,226 (0.15) | 0 (0.00) | 279,123 (0.01) |
| South—East South Central | 0 (0.00) | 8,961 (0.07) | 1,722 (0.01) | 85,283 (0.66) | 33,760 (0.26) | 0 (0.00) | 0 (0.00) | 129,726 (0.00) |
| Northeast—New England | 0 (0.00) | 5,902 (0.03) | 3,909 (0.02) | 90,571 (0.49) | 82,780 (0.45) | 1,003 (0.01) | 0 (0.00) | 184,165 (0.00) |
| Northeast—Middle Atlantic | 0 (0.00) | 8,044 (0.39) | 3,660 (0.18) | 8,663 (0.43) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 20,367 (0.00) |
| **National Total** | 166,553 | 1,694,861 | 705,534 | 8,267,652 | 10,652,124 | 20,636,356 | 5,321,253 | 47,444,333 |

*Source:* USGS, 1993



under 5,000 feet in the West are at between 2,500 and 4,999 feet. Very little lies under 500 feet above sea level. Outside the West, the greatest acres and percentages are in the South, mostly in the South Atlantic states from West Virginia to Florida. The Florida Everglades, the Okefenokee Swamp, and areas in the southern Appalachians make up most of that designated land. Of the designated land in the South, 58 percent is under 99 feet in elevation. Nearly 12 percent of the designated Wilderness in the South is between 2,500 and 4,999 feet. Most of the Wilderness designated in the Midwest lies between 500 and 4,999 feet. Of designated Wilderness in the Northeast, about 58 percent is under 2,500 feet in elevation, while most of that (about 90%) is between 500 and 2,499 feet.

Figure 5.6 focuses on designated Wilderness lands at or above 5,000 feet elevation. Shown are percentages of the NWPS between 5,000 and 9,999 and above 10,000 feet by Census division and nationally. As mentioned earlier, a substantial portion of the Wilderness System is at the higher elevations. Nationally, there are almost 26 million acres over 5,000 feet, making up approximately 55 percent of the total Wilderness area in the lower 48 states. Most of this high elevation Wilderness is in the West Census region. At elevations between 5,000 and 9,999 feet in this region, there are over 20 million acres.




*Source:* USGS, 1993

**Figure 5.6** Percentage of total Wilderness area at elevations above 5,000 feet by census division and nationally

Even at the very highest elevations, at or beyond 10,000 feet, there are almost 5.3 million acres of western Wilderness. In the Pacific West, over one third of Wilderness lands are between 5,000 and 9,999 feet; about 5 percent are at 10,000 or more feet. In the Mountain West, almost 60 percent of Wilderness lands are between 5,000 and 9,999 feet, another 19 percent are at elevations of 10,000 feet and above. Just under 10,000 acres of the Midwest Wilderness is over 5,000 feet in elevation, and none is above 10,000 feet. Around 47 thousand designated acres in the South are above 5,000 feet, mostly in the West South Central states. In the Northeast, only about 1,000 acres lie above 5,000 feet. In no region other than the West is there any representation of landscapes above 10,000 feet.

## Precipitation Over Wilderness

Precipitation data in inches per year were obtained from the *National Atlas of the United States* (USGS, 1999) for the 48 contiguous states. Alaska was not included because comparable precipitation data are not available for that state. Ranges in rainfall amounts were identified using GIS software to spatially outline overall land area within each precipitation range. Following this step, boundary shape images of Wilderness areas were overlain onto the spatially outlined precipitation ranges in each census region. A precipitation range was assigned to each Wilderness area based on the area's geographic midpoint. Precipitation ranges included 0–15, 16–30, 31–40, 41–60, 61–90, and 100 or more inches per year. The estimates of areas and acres are not additive. If a Wilderness area midpoint lays on a break between precipitation ranges, it was double counted.

In the West there were over 30 percent of area and 146 areas designated Wilderness within the driest precipitation range of 0–15 inches annually (Table 5.9). Unlike the other three regions, Wilderness in the West is spread across all levels of annual precipitation, including some areas receiving over 100 inches. Because much of the West is arid to semiarid, just over 70 percent of the designated land in the West receives less than 41 inches, just over 50 percent receives under 31 inches, and 30 percent receives less than 16 inches. In the Midwest, all areas receive at least 16 inches and none more than 60 inches. Most of the Wilderness in the Midwest receives between 16 and 30 inches. In the South, much more rainfall is intercepted per acre of Wilderness. Most of the System acres in the South receive between 41 and 60 inches. A similar precipitation pattern is found for Wilderness in the Northeast. Nationally, about two thirds of the Wilderness in the lower 48 states receives between 0 and 40 inches of precipitation per year. About 28 percent of this Wilderness receives under 16 inches. Natural attributes, such as amount of precipitation, contribute enormously to determining the plant and animal species making up protected Wilderness ecosystems.



## Ecosystems Represented

Every acre designated as Wilderness protects a number of aspects of natural systems. This is true whether that acre (or those thousands of acres) is in high mountain desert in Arizona, in natural wetlands in the Florida Everglades, or in native grasslands in South Dakota. All protected acres contribute to sustaining native ecosystems. A related goal of many organizations and individuals in their support of Wilderness is preservation of biodiversity across ecosystems. Lands protected across a range of elevations, precipitation, and other natural attributes contribute to this goal. By protecting a range of ecosystems, the sustainability of ecological and evolutionary processes, the maintenance of species diversity, and the encouragement of native species in natural patterns of abundance and distribution are all enhanced (Noss, 1996).

**Table 5.9** Number of areas and percentage of acres of Wilderness by precipitation amounts per year and by census region (excluding Alaska), 2004

| West | | |
|---|---|---|
| Precipitation (inches) | Areas | Percent of acres |
| 0–15 | 146 | 30.2 |
| 16–30 | 127 | 20.0 |
| 31–40 | 76 | 20.1 |
| 41–60 | 75 | 16.8 |
| 61–90 | 37 | 7.5 |
| 100+ | 20 | 5.5 |

| Midwest | | |
|---|---|---|
| Precipitation (inches) | Areas | Percent of acres |
| 0–15 | 0 | 0.0 |
| 16–30 | 10 | 77.7 |
| 31–40 | 15 | 13.0 |
| 41–60 | 17 | 9.4 |
| 61–90 | 0 | 0.0 |
| 100+ | 0 | 0.0 |

| South | | |
|---|---|---|
| Precipitation (inches) | Areas | Percent of acres |
| 0–15 | 0 | 0.0 |
| 16–30 | 1 | 1.7 |
| 31–40 | 10 | 1.1 |
| 41–60 | 79 | 87.4 |
| 61–90 | 22 | 9.8 |
| 100+ | 0 | 0.0 |

| Northeast | | |
|---|---|---|
| Precipitation (inches) | Areas | Percent of acres |
| 0–15 | 0 | 0.0 |
| 16–30 | 0 | 0.0 |
| 31–40 | 0 | 0.0 |
| 41–60 | 14 | 74.4 |
| 61–90 | 4 | 25.6 |
| 100+ | 0 | 0.0 |

| National | | |
|---|---|---|
| Precipitation (inches) | Areas | Percent of acres |
| 0–15 | 146 | 27.6 |
| 16–30 | 138 | 20.3 |
| 31–40 | 101 | 18.7 |
| 41–60 | 185 | 20.9 |
| 61–90 | 63 | 7.5 |
| 100+ | 20 | 5.0 |

*Sources:* Annual precipitation shapefile from Daly and Taylor, 2000; Wilderness land area from wilderness.net, November 2004

The NWPS preserves lands with a variety of natural attributes that may otherwise be lost to human uses and development of land. In 1990, more than half of current Wilderness areas protected one or more federal- or state-listed species classified as threatened and/or endangered (Cordell & Reed, 1990). But, protection of listed species is only one aspect representative of nature. It falls short of adequately describing the full range of diversity of natural systems. Typically, *biological diversity* is thought of as diversity and balance of genes, species, and other elements making up an ecosystem (Sarkar, 1999). Noss (1990) argued only very large Wilderness areas can support broad-scale level biodiversity that is full spectrum. He pointed out that only 2 percent of the 261 Bailey-Kuchler ecosystem types in the United States and Puerto Rico are represented in Wilderness areas of 1 million hectares or more. And, all of these are in Alaska (Noss, 1990). Only 19 percent of all the ecosystem types are represented in units of at least 100,000 hectares.

An alternative to viewing diversity as a large-area phenomena is to take the perspective that diversity also pertains to representation of different natural ecosystems regardless of scale. While this system-of-systems approach may not account for some important species or natural functions, this approach can enhance understanding of how broadly and to what degree the diversity of ecosystems has been retained for the future. U.S. Forest Service ecologist Robert Bailey (1995) and others have produced a widely accepted system for differentiating ecosystems from regional to local scales. In that work, land areas are classified into domains, divisions, provinces, and sections. The resulting groupings reflect similarities in ecological processes, vegetation, climate, and groups of species (Stein, 2001). They aid in inventorying landscape diversity across all biological gradients (e.g., elevation, aspect, latitude) and the species that respond to those gradients (Noss, 1990). The broadest scale of ecological regions are domains, which are primarily based on climate. The four domains in the Bailey system are the Polar, Humid Temperate, Dry, and Humid Tropical domains. The Polar domain ecosystems are located at higher latitudes and are controlled by arctic and polar air flows. In the middle latitudes, the Humid Temperate domain climate is regulated by both polar and tropical air masses. The Dry domain is defined by the absence of water. The Humid Tropical domain is found at low latitudes and controlled by equatorial and tropical air masses. Domains are broken down into divisions that are subdivided into provinces based on vegetational macrofeatures. The smallest ecosystem level is the section. Sections are defined by more refined climactic differences. For this chapter, description of ecosystems represented within the NWPS is limited to the division level.

Table 5.10 shows the number of acres in total for the United States, acres protected as Wilderness, and percentage of total area protected for each Bailey's domain and division by Census region in the lower 48 states and in Alaska.



**Table 5.10** *Area in acres (thousands) and percentage of ecoregional division total area by ecoregional division and by Census region (Alaska shown separately)*

| | Alaska (W) | West | Midwest | South | Northeast | Total Acres Protected by Wilderness | Total Acres in the United States | Percent Protected by Wilderness |
|---|---|---|---|---|---|---|---|---|
| **100 Polar Domain** | | | | | | **43,494** | **332,736** | **13.07** |
| 120 Tundra Div. | 2,577 | 0 | 0 | 0 | 0 | 2,577 | 57,344 | 4.49 |
| M120 Tundra Regime Mtns | 26,655 | 0 | 0 | 0 | 0 | 26,655 | 103,104 | 25.85 |
| 130 Subarctic Div. | 2,129 | 0 | 0 | 0 | 0 | 2,129 | 54,272 | 3.92 |
| M130 Subarctic Regime Mtns | 12,133 | 0 | 0 | 0 | 0 | 12,133 | 118,016 | 10.28 |
| **200 Humid Temperate Domain** | | | | | | **29,230** | **1,035,264** | **2.82** |
| 210 Warm Continental Div. | 0 | 0 | 1,399 | 0 | 20 | 1,419 | 94,272 | 1.51 |
| M210 Warm Continental Regime Mtns | 0 | 0 | 0 | 0 | 164 | 164 | 27,904 | 0.59 |
| 220 Hot Continental Div. | 0 | 0 | 117 | 68 | 12 | 197 | 239,680 | 0.08 |
| M220 Hot Continental Regime Mtns | 0 | 0 | 0 | 581 | 0 | 581 | 47,680 | 1.22 |
| 230 Subtropical Div. | 0 | 0 | 1 | 742 | 0 | 743 | 263,104 | 0.28 |
| M230 Subtropical Regime Mtns | 0 | 0 | 0 | 49 | 0 | 49 | 5,632 | 0.86 |
| 240 Marine Div. | 0 | 56 | 0 | 0 | 0 | 56 | 9,536 | 0.59 |
| M240 Marine Regime Mtns | 13,922 | 5,181 | 0 | 0 | 0 | 19,103 | 75,072 | 25.45 |
| 250 Prairie Div. | 0 | 0 | 0 | 2 | 0 | 2 | 190,912 | <0.01 |
| 260 Mediterranean Div. | 0 | 259 | 0 | 0 | 0 | 259 | 21,824 | 1.19 |
| M260 Mediterranean Regime Mtns | 0 | 6,656 | 0 | 0 | 0 | 6,656 | 59,648 | 11.16 |
| **300 Dry Domain** | | | | | | **30,871** | **919,872** | **3.36** |
| 310 Tropical/Subtropical Steppe Div. | 0 | 1,221 | 0 | 10 | 0 | 1,230 | 162,432 | 0.76 |
| M313 Tropical/Subtropical Regime Mtns | 0 | 1,292 | 0 | 22 | 0 | 1,314 | 32,128 | 4.09 |
| 320 Tropical/Subtropical Desert Div. | 0 | 10,469 | 0 | 22 | 0 | 10,491 | 110,656 | 9.48 |
| 330 Temperate Steppe Div. | 0 | 412 | 118 | 0 | 0 | 531 | 271,808 | 0.20 |
| M330 Temperate Steppe Regime Mtns | 0 | 14,696 | 10 | 0 | 0 | 14,696 | 144,576 | 10.16 |
| 340 Temperate Desert Div. | 0 | 1,990 | 0 | 0 | 0 | 1,990 | 170,368 | 1.17 |
| M340 Temperate Desert Regime Mtns | 0 | 620 | 0 | 0 | 0 | 620 | 27,904 | 2.22 |
| **400 Humid Tropical Domain** | | | | | | **1,447** | **7,360** | **19.67** |
| 410 Savanna Div. | 0 | 0 | 0 | 1,447 | 0 | 1,447 | 7,360 | 19.67 |

*Sources:* Bailey, 1995; Bailey, McNab, Avers, and King, 1994

(Protected ecosystem details at scales finer than division level appear in Chapter 11.) The last column in Table 5.10 is especially important to understanding representation because it shows the percentage of total land area by ecosystem type included in the NWPS.

The results in Table 5.10 show the greatest number of divisions (11) found in any single region is in the West. Next are 8 divisions found in the South Census region. Represented by Alaskan Wilderness are 5 divisions, the same number as found in the Midwest region. In the Northeast region there are only 3 divisions represented. Across the country, the greatest percentage of any single domain represented by Wilderness is the Humid Tropical domain at almost 20 percent, mainly represented by the Everglades National Wildlife Refuge in south Florida. Next is the other extreme of climate, the Polar domain represented by various designations in Alaska totaling just over 13 percent of the tundra and subartic divisions. Just over 3 percent of the steppe and desert divisions of the Dry domain are represented and under 3 percent of the Humid Temperate domain of the Midwest and South are represented. As noted when describing elevations of Wilderness lands, much of the preserved Wilderness is classified as mountain ecosystems (roughly ¾). Almost 12 percent is classified as desert in the Dry domain.

Plates 11 and 12 (see Appendix) show the geographic distribution of Wilderness lands relative to the location of the Bailey's ecosystem domains and divisions, respectively for the four Census regions of the 48 contiguous states and Alaska. Plate 11 shows that the Temperate Prairie (at less than 0.01%), Temperate Continental (a band stretching from northern Arkansas to southern Michigan and New York at just over 0.25%), and Temperate Subtropical (from coastal Louisiana to the tristate area of Kentucky, Missouri, and Arkansas) are poorly represented in terms of percent land area of each ecosystem type. Much greater representation, because of the history of federal lands and the designation process noted in Chapter 3 are the dry, mountainous, interior lands of the West and the marine ecosystems of the Pacific Coast. Vast stretches of the tundra, subartic, and marine mountains of Alaska have been designated as shown in Plate 12.

## Conclusion

Since passage of the Wilderness Act in 1964, a large number of areas and acres have been added to the National Wilderness Preservation System. Most of the original and added lands are at higher elevations or are otherwise not highly accessible. Thus, they historically have not been occupied or utilized in substantial ways, or at all. Increasingly, however, lands once remote with highly limited accessibility can be reached. This chapter has shown how closely associated many of the areas in the NWPS are with human habitation and activity. As a growing population distributes itself further and further onto the rural landscape, as the mileage and distribution of roads rises, and as utilization and development of rural lands expands, wildlands, especially designated Wilderness, will become of greater uniqueness. While the diversity of ecosystem types represented by the 662 areas in the NWPS is highly varied, it does not represent the full spectrum of ecosystem types once found in this country very well. Prairie, for example, has long since been devoted to agricultural and developed uses. It is highly unlikely that appreciable representation of prairie ecosystems will ever come about because these lands are solidly committed for long-term agricultural, commercial, and residential uses. There are, however, still natural lands in this country representative of other ecosystem types. Many of these lands are roadless, and many of them exhibit a relatively high degree of wildness (as Chapter 6 describes). These lands, and those already designated will surely become ever more rare in the face of the steady development trend in the United States. As they become more and more scarce, they will likely become even more valued. Chapters 7 through 12 explore the multiple values of Wilderness as a unique and ever more scarce resource.



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# The Multiple Values of Wilderness

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