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Mapping Human-Environment Connections on the Olympic Peninsula: An Atlas of Landscape Values

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Introduction

The advent of computerized mapping has greatly expanded the ability of land managers to map many aspects of ecological systems, such as tree species, soil types, wildlife habitat, air quality, and water conditions. Mapping the social and cultural aspects of ecological systems, however, has proved much more challenging. This atlas uses the Olympic Peninsula in western Washington to illustrate how the application of computerized mapping to the study of human ecology can help address this challenge.

Human ecology is a science that takes a systems approach to understanding human-environmental interactions at multiple scales. These interactions can include visible connections, such as hunting, hiking, mushroom harvesting, taking photographs, snowmobiling, and other activities. They can also include invisible connections such as the importance or meanings that people associate with a particular mountain, meadow, seascape, or other location. By capturing these complex connections in the form of computerized maps, human ecology mapping makes it easier to combine them with other mapped data, such as vegetation types, geological formations, and transportation networks.

This atlas provides an overview of what human ecology mapping is and demonstrates how it can be used to reach better understandings of the complex ways in which humans are connected to landscapes. Some of the questions that it can help answer include the following.

- Are there areas where meaningful places and the values associated with them are concentrated?
- Are there places where many different values coincide?
- Are there values that tend to overlap or be located close to other values?
- Are there areas where outdoor activities are concentrated?
- Are there biophysical and built features, such as vegetation types, water bodies, or road networks, that may be associated with meaningful places?

By answering these questions and showing the diverse ways in which humans connect with their environment, human ecology maps can help identify areas of the landscape that are especially meaningful for a large number of people and what natural resource-related activities take place in particular locations. They also provide information about the variety of meanings that people attach to different places. Knowledge about what places are important for which people and why they are important can help land managers understand how management activities, such as building a campground, decommissioning a road, or putting in a cell phone tower, are likely to affect different types of users. This knowledge allows managers to propose actions that are less likely to result in conflicts and use scarce resources more efficiently.

Section one of this atlas describes the approach we used to record areas that are meaningful to peninsula residents and the places that they go to engage in natural resource-related activities. Section two summarizes the ecological and socioeconomic characteristics of the peninsula. Section three presents regional data patterns that display social values and resource activities; section four looks at sub-regional patterns. Section five summarizes the major patterns identified through the project, provides an assessment of how well the human ecology mapping approach worked, and describes the steps envisioned for improving the approach.

Additional details on the workshop format, data processing steps, and analysis techniques are provided in appendices A to E. For this atlas, we chose to display information visually, with minimal discussion or interpretation. The maps are meant to serve as starting points for conversations among land managers, planners, and citizens.

Section 1—Study Approach

To develop this atlas, we collected data on meaningful places and outdoor activities from 169 Olympic Peninsula residents through mapping workshops held in eight communities (Shelton, Hoodsport, Quilcene, Port Townsend, Port Angeles, Forks, Quinault, and Aberdeen). We held one workshop in each community with the exception of Aberdeen, where two workshops were held because of unusually low turnout during the first workshop. The methods we used were adapted from an approach developed by Brown and Reed (2009) on national forests in Alaska, Oregon, and Arizona. The number of participants per community workshop ranged from a low of 10 in Quilcene, to a high of 39 in Quinault. The small sample size relative to the peninsula's total population (234,772) reflects the exploratory nature of the study, which had as its primary goal the development of a method for collecting spatial data for cultural values in a workshop setting as well as testing a variety of analytical techniques.

Six workshops were held in the summer and fall of 2010. Budget constraints delayed the workshops in Forks and Quinault and a follow-up workshop in Aberdeen until fall 2011. Table 1 shows the dates and number of participants at each workshop. In both years, the timing of the workshops was constrained by when funds for field work became available. Appendix A provides a more detailed description of the workshop format.

Table 1 — Number of participants and dates of mapping workshops

Workshop community	Number of participants	Date of workshop
Aberdeen/Hoquiam	17 (8 in 2010; 9 in 2011)	Fall 2010; Fall 2011
Forks	32	Fall 2011
Hoodsport	17	Fall 2010
Quinault	39	Fall 2011
Port Angeles	19	Fall 2010
Port Townsend	18	Fall 2010
Quilcene	10	Summer 2010
Shelton	17	Fall 2010
Total	169	

We recruited participants with a mix of social, occupational, and ethnic backgrounds. Additionally we sought to include individuals with a range of views about natural resource management. We used a variety of recruitment methods, such as working closely with community leaders and organizations to advertise the workshop, making phone calls or sending out emails to prospective participants, providing press releases to local newspapers and radio stations, and by posting flyers in central locations, such as libraries and post offices. We held the workshops in locations identified as being politically neutral, usually a community hall or local government conference room.

The average age of the workshop participants was 56 years. The average length of time participants had resided on the Olympic Peninsula was 32 years. Of the 169 workshop participants, 98 (58%) were men, 65 (38%) were women, and 6 (4%) did not indicate their gender.

A number of participants attended workshops located outside their home communities. Consequently, when we created community-level maps from the workshop data, we used participants' zip codes to assign them to communities. For example, if a person from Forks participated in the Port Angeles workshop, her data were included in the analysis for Forks rather than in the analysis for Port Angeles. A detailed description of the zip code zones used for the data analysis is provided in section 3.

Participants were assigned to tables on which we had laid out 3' x 3' paper base maps of the Olympic Peninsula. We used a scale of 1:750,000 for the base maps. This scale provided sufficient detail that participants could locate places at the watershed scale, but enabled us to use maps that would easily fit on ordinary folding tables. Our goal was to have no more than five persons working on each map, but in some workshops as many as seven individuals worked at each table. Figure 1 shows the mapping process.

Figure 1 — Mapping workshop at Lake Quinault Lodge

A clear sheet of plastic mylar placed over each map served as the drawing surface. Each individual at a table mapped locations with a unique color of fine point permanent marker. Participants who wished to correct their mapped features could easily do so using cotton swabs and nail polish remover provided for that purpose. The final map from each table represented a composite of the meaningful places or activities of the individuals at the table; they were *not* maps produced through a group consensus process.

We used a coding system that included a combination of letters (Table A, B, C, etc.), numbers (individual 1, 2, 3, etc.) and colors (red, green, black, etc.) to link each mapped location to the appropriate person's data sheet. Details of the coding system are described in Appendix B. Copies of the worksheets are included in Appendix F.

Before starting the mapping exercises, we asked participants to provide data on their age, gender, length of residence in the community, occupation, and residential zip code. Participants then did two separate mapping exercises.

Mapping exercise 1—meaningful places: In the first exercise, we had participants map up to five places they felt were particularly meaningful to them. We also asked them to assign values to each place, choosing from the 14 values listed in Table 2. The list was adapted from earlier mapping studies (Brown and Reed 2009) and included values such as aesthetic, recreation, home, and economic. A definition for each value was provided. Participants could assign more than one value from the list to a place. We used the standardized list so as to increase the likelihood of consistency across respondents in the meaning of the mapped values. However, we also asked participants to briefly describe in their own words why they valued the place and the types of activities they did there so as to obtain a richer understanding of the values and uses for each mapped feature. For both exercise 1 and 2, participants were asked to provide a place name for each mapped feature as a means for cross-checking locational accuracy.

Mapping exercise 2—outdoor activities*:* In the second exercise, we asked participants to think of three activities they did outdoors. We then had them map up to five places where they did these activities on a new sheet of mylar overlaid on the base map. Participants used the same color of marker for mapping their activities as they used for marking their meaningful places. This allowed us to link each individual's meaningful places map with her activities map while retaining confidentiality of mapped places and demographic characteristics.

For the second mapping exercise, we provided the list of activities shown in table 3. However, unlike in the values exercise where participants could only select the values provided, participants could add other activities if they wished. In addition to mapping the activity locations, we also asked participants to indicate how often they went to each place and why they went to that place to engage in that particular activity.

Points, lines, and polygons: In similar mapping processes done elsewhere (Alessa et al. 2008, Brown and Reed 2009, Zhu et al. 2010), researchers have asked participants to mark meaningful places or activity locations using sticker dots or points. Points are easy to digitize and analyze. However, many activities and meaningful places are better represented using either lines or polygons. Consequently, in our mapping exercises participants could use points, lines, or polygons (areas) to map meaningful places or activity sites, depending on which they felt best represented those locations. For example, many people marked camping or fishing sites with points, hiking trails with lines, and berry gathering areas with large polygons.

Table 2 — List of landscape values provided for participants during the meaningful places mapping exercise. This list is adapted from a similar list described in Brown and Reed 2009.

Landscape value	Description
Aesthetic	I value this place for the scenery, sights, smells or sounds.
Economic	I value this place because it provides income and employment opportunities through industries such as forest products, mining, tourism, agriculture, shellfish, or other commercial activity.
Environmental quality	I value this place because it helps produce, preserve, and renew air, soil and water or it contributes to healthy habitats for plants and animals.
Future	I value this place because it allows future generations to know and experience it as it is now.
Health	I value this place because it provides a place where I or others can feel better physically and/or mentally.
Heritage	I value this place because it has natural and human history that matters to me and it allows me to pass down the wisdom, knowledge, traditions, or way of life of my ancestors.
Home	I value this place because it is my home and/or I live here.
Intrinsic	I value this place just because it exists, no matter what I or others think about it or how it is used.
Learning	I value this place because it provides a place to learn about, teach or research the natural environment.
Recreation	I value this place because it provides outdoor recreation opportunities or a place for my favorite recreation activities
Social	I value this place because it provides opportunities for getting together with my friends and family or is part of my family's traditional activities.
Spiritual	I value this place because it is sacred, religious, or spiritually special to me.
Subsistence	I value this place because it provides food and other products to sustain my life and that of my family.
Wilderness	I value this place because it is wild.

Table 3 — List of activities provided to participants during the activity site mapping exercise

ATV/off-road
Backpacking/hiking
Bird watching/wildlife viewing
Camping (developed or remote)
Cultural activities (ceremonies and other traditions)
Environmental monitoring or scientific study
Farming/ranching
Fishing/shellfishing
Foraging/gathering (commercial and non-commercial)
Forest restoration/stewardship (planting trees, restoration, trails construction)
Golfing
Guiding, interpretation
Horseback riding
Hunting/trapping
Logging
Mining (including pit mining and gold panning)
Motorized boating and water sports (boating, water-skiing, jet-skiing)
Non-motorized boating activities (kayaking, canoeing, rafting, sailing, rowing)
Organized play (such as in playgrounds and amusement parks)
Orienteering/geocaching
Outdoor team sports
Photography
Picnicking or relaxing with friends and family
Religious/spiritual activities (such as vision quests or meditation)
Resort use
Road or mountain biking
Rock, fossil, shell collecting
Rock/mountain climbing
Sightseeing (natural features)
Swimming
Visiting historic or cultural sites
Walking/running
Water sports (scuba diving, snorkeling, surfing, wind surfing, parasailing)
Winter sports (skiing/snowboarding, snowshoeing, snowmobiling)

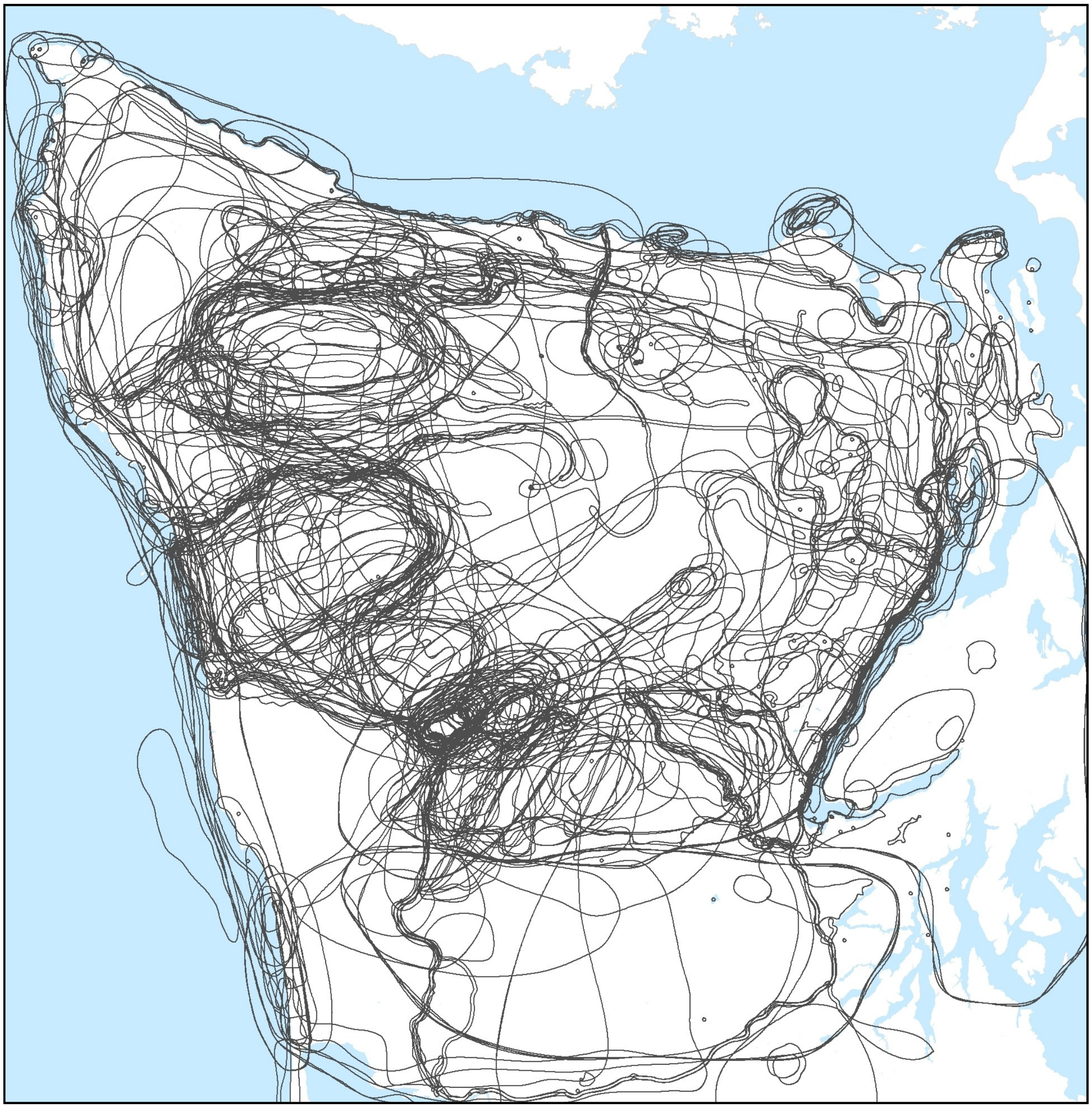

Figure 2—Raw data compiled from the meaningful places exercise for all workshops

Data processing: After collecting the data, we scanned the plastic overlays with the mapped locations and digitized them using ArcGIS 10.0 software. Feature location accuracy was cross-checked with the description or location name provided on the worksheet during the data processing phase. We encountered only three cases in which the location of the feature did not correspond with the place name listed on the worksheets. The three inaccurately mapped features were specific enough (a mountain peak, a river and a small town) that we were able to replace the mapped feature with the feature listed in the worksheet. In some cases, we ran across "scribbled out" polygons with no corresponding worksheet entry. We assumed these were mistakes and did not digitize them. Figure 2 shows the raw mapped data for meaningful places when the maps from all the workshops are combined. We joined the two data tables to link the descriptive and demographic data to each of the mapped locations. Appendix C describes the data processing techniques in more detail.

Section 2—The Olympic Peninsula

The Olympic Peninsula is a land of rugged mountains, towering conifer trees, rocky coastlines, and fast-running rivers (fig. 3). Hood Canal, a long narrow arm of Puget Sound, forms the eastern border. To the north, the San Juan de Fuca Strait separates the peninsula from Vancouver Island, Canada. The Pacific Ocean serves as the western boundary. Washington State Highway 12 is the southern boundary. US Highway 101 circles the peninsula and is the main road used by residents and tourists alike.

Land Ownership and Management

The Olympic National Park covers an area of 923,000 acres, most of which is in the Olympic Mountain Range at the peninsula's center. Portions of the park also form a narrow band along the Pacific coast between the Makah and Quinault Indian Reservations. Additionally, several arms of park land follow the Hoh, Queets, and Quinault Rivers. The park is extremely rugged, and many areas are reachable only on foot or by horseback. Roughly 95% of the park is designated wilderness. The park is internationally recognized for its exceptional natural qualities, and has more than 3.2 million visits annually (Olympic National Park 2007).

The Olympic National Forest covers about 627,000 acres, nearly encircling the park. With the exception of the steep mountains along the park's eastern boundary, the terrain in the Olympic National Forest is less rugged than in the park. The US Forest Service managed the Olympic National Forest primarily for timber during much of the 20th century, converting about one-third of the forest from older mixed-aged stands of trees to younger, even-aged stands (Halofsky et al. 2011). In the mid-1990s, two-thirds of the Olympic National Forest was set aside in late successional reserves which are managed to conserve old growth species. An additional 15 percent of the forest is managed as wilderness (Halofsky et al. 2011). During the 20th century, the Olympic National Forest subsidized the building of a dense network of logging roads to move logs from the forest to the mills. Although little logging now takes place on the national forest these roads continue to provide access to many areas of the peninsula.

A mixture of State, tribal, and private land makes up the third and outermost ring of land ownership. The terrain in this outer ring is both flatter and lower in elevation than in the Olympic National Park and the Olympic National Forest. Large timber companies and real estate investment trusts own much of the private land in the southern and western portions of the peninsula. These lands are used primarily for timber or wood fiber production (Turner et al. 1996). The majority of state lands on the peninsula are state trust lands. Most of the forested state trust lands on the peninsula are managed as working forests by the Washington Department of Natural Resources.

Nine federally recognized Indian nations — the Elwha Klallam, Jamestown S'Klallam, Port Gamble S'Klallam, Hoh, Makah, Quileute, Quinault (which includes the Queets), Skokomish, and Squaxin Island — have traditional claims to the peninsula (Wray 2002). The tribes reserved the rights to fish in their usual and accustomed places and the privilege to hunt and gather products in open and unclaimed lands (Wray 2002). The three largest reservations are the Quinault (208,000 acres), Makah (27,000 acres), and Skokomish (5,000 acres).

Jefferson and Clallam counties cover the northern two-thirds of the peninsula, while the southern third is comprised of portions of Grays Harbor and Mason counties.

Figure 3—The Olympic Peninsula

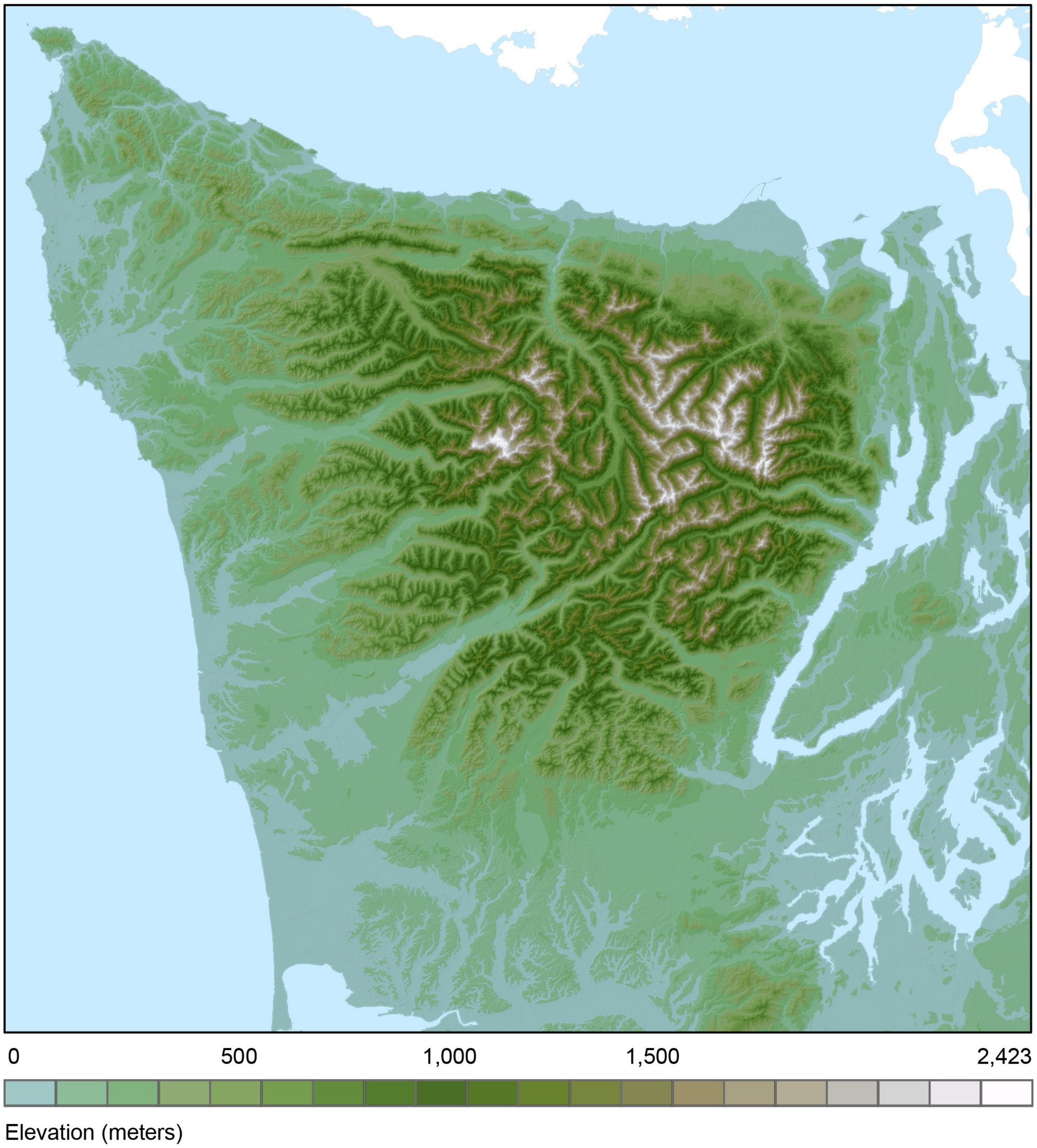

Figure 4—Elevation with shaded relief, Olympic Peninsula

Elevation

The Olympic Mountains rise abruptly from sea level to nearly 8,000 feet at their highest point at the top of Mount Olympus near the peninsula's center (fig. 4). This rugged mountain range strongly influences the region's climate, ecology, and settlement patterns. Most of the Peninsula's cities and towns are clustered around the peninsula's edges. Temperatures are mild year round at elevations below 2000 feet, rarely dropping below freezing in winter. High elevations experience heavy snowfalls in winter. Several large glaciers are found on Mount Olympus, and permanent snow fields are located on nearby peaks.

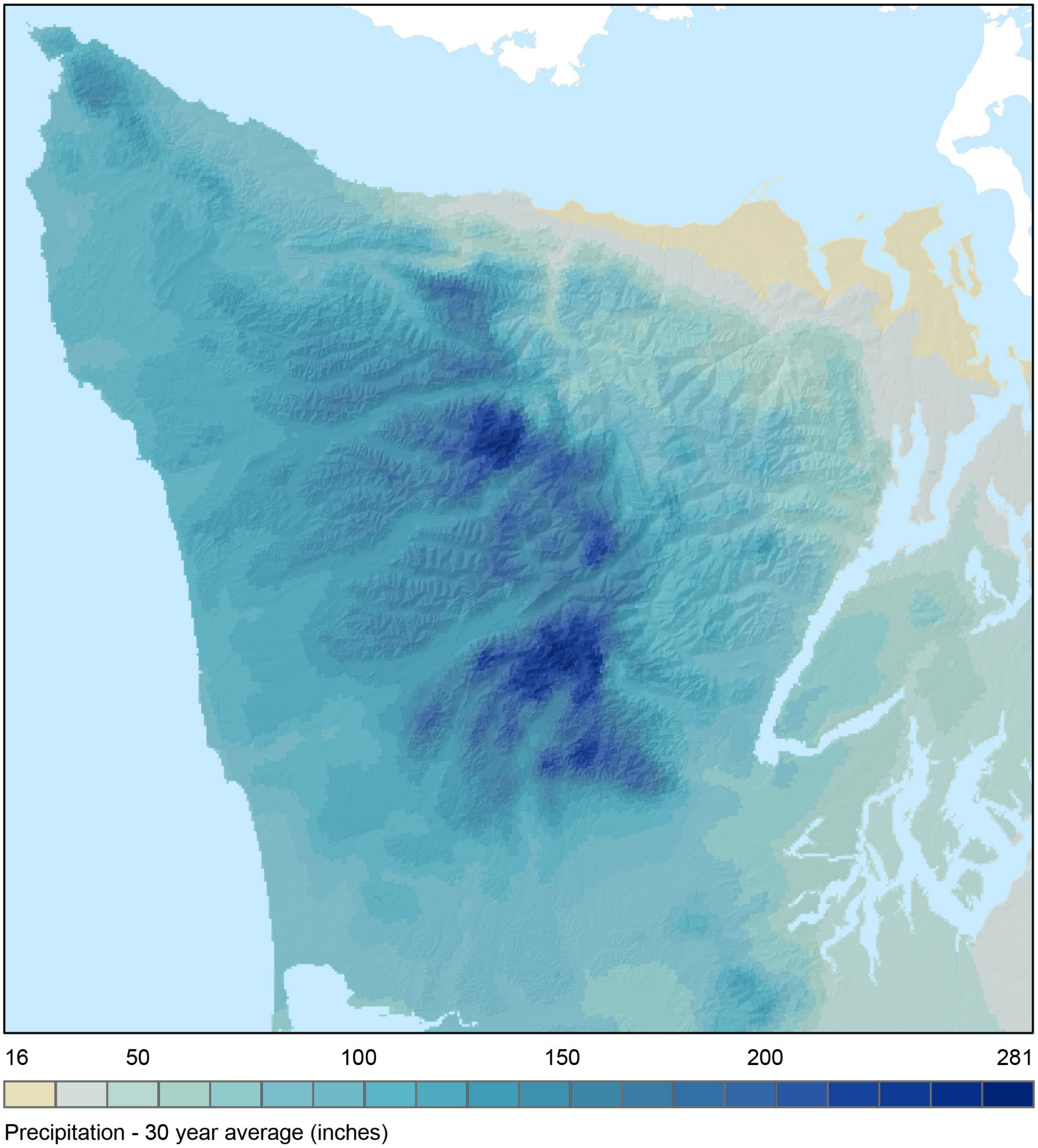

Figure 5—Precipitation on the Olympic Peninsula

Precipitation

Most of the Olympic Peninsula receives more than 50 inches of precipitation annually (fig. 5), as the comparatively warm, moisture-laden air from the Pacific Ocean encounters the colder land mass of the Olympics. Annual precipitation exceeds 200 inches per year in the upper reaches of the Sol Duc, Hoh, Queets, and Quinault Rivers (Anders et al. 2007). The northeastern corner of the peninsula, however, lies in the rain shadow of the Olympic Mountains and receives less that 30 inches of precipitation annually (Anders et al. 2007). Rainfall drops throughout the peninsula in the summers, which are typically dry and sunny.

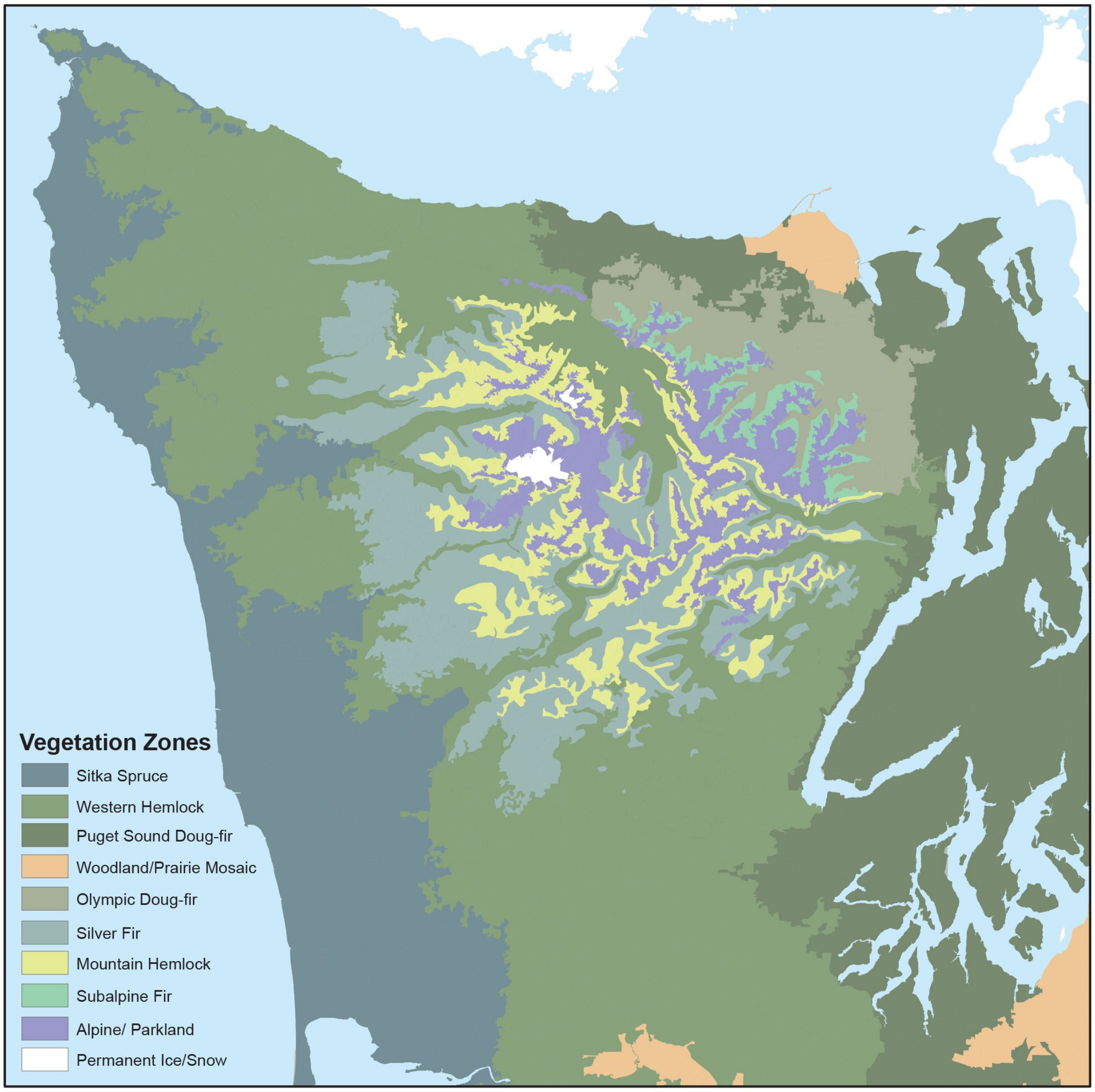

Figure 6— Vegetation zones on the Olympic Peninsula

Vegetation

The Olympic Peninsula has ten major vegetation zones (fig. 6). Sitka spruce and western hemlock dominate the forest overstory in the western lowlands, grading into Pacific silver fir at higher elevations. Above 3000 feet, mountain hemlock and Pacific silver fir are the major tree species, with subalpine fir found in drier spots. In the Olympic rain shadow zone, Olympic and Puget Sound Douglas-fir dominate the overstory in most locations, although an anthropogenic woodland/prairie mosaic is found around Sequim. The lowland forests on the eastern Peninsula have a mix of western hemlock and Puget Sound Douglas-fir.

Figure 7—Population density of the Olympic Peninsula

Population

The total population for Clallam, Grays Harbor, Jefferson, and Mason counties is 234,772. However, as indicated in Figure 7, the population is very unevenly distributed. Figure 7 shows the population density for the peninsula based on 2010 data (US Census Bureau 2010) and provides a sense of just how sparsely populated most of the Olympic Peninsula is. Areas in green are public lands or commercial forests and are virtually uninhabited. Areas with the highest population densities include Aberdeen, Hoquiam, Shelton, Port Townsend, Sequim, and Port Angeles. The northeastern coast, which lies in the rain shadow is the most populated part of the peninsula.

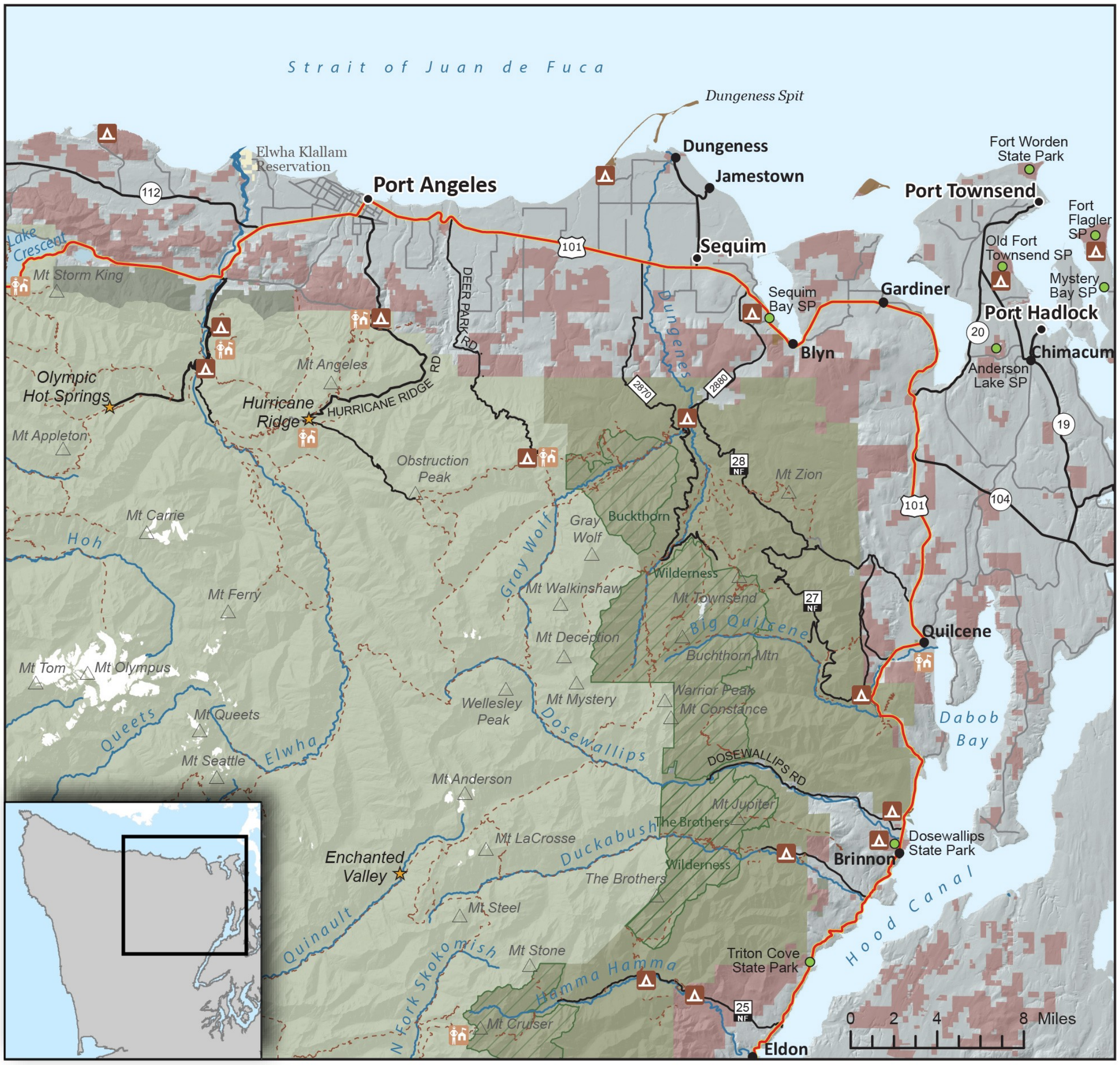

Figure 8—Northeastern Olympic Peninsula

Northeastern Olympic Peninsula

Mapping workshops were held in three communities located in the northeastern Olympic Peninsula (fig. 8). The eastern front of the Olympics rises steeply from sea-level, and much of the area is inaccessible except on foot. However, the dry mild climate along the coast has attracted many permanent residents to the cities of Port Angeles (pop. 19,038), Sequim (pop. 6,606), and Port Townsend (pop. 9,113). The town of Quilcene (pop. 591) is located on Dabob Bay, which has a very productive shellfishery. The Olympic National Park is headquartered in Port Angeles, and Hurricane Ridge, one of the Park's most heavily visited sites, is just 17 miles south of the city. The Dosewallips river valley south of Quilcene is the major access route into the park interior. The majority of the land in this part of the peninsula is managed by federal agencies, including the Olympic National Park and the Olympic National Forest.

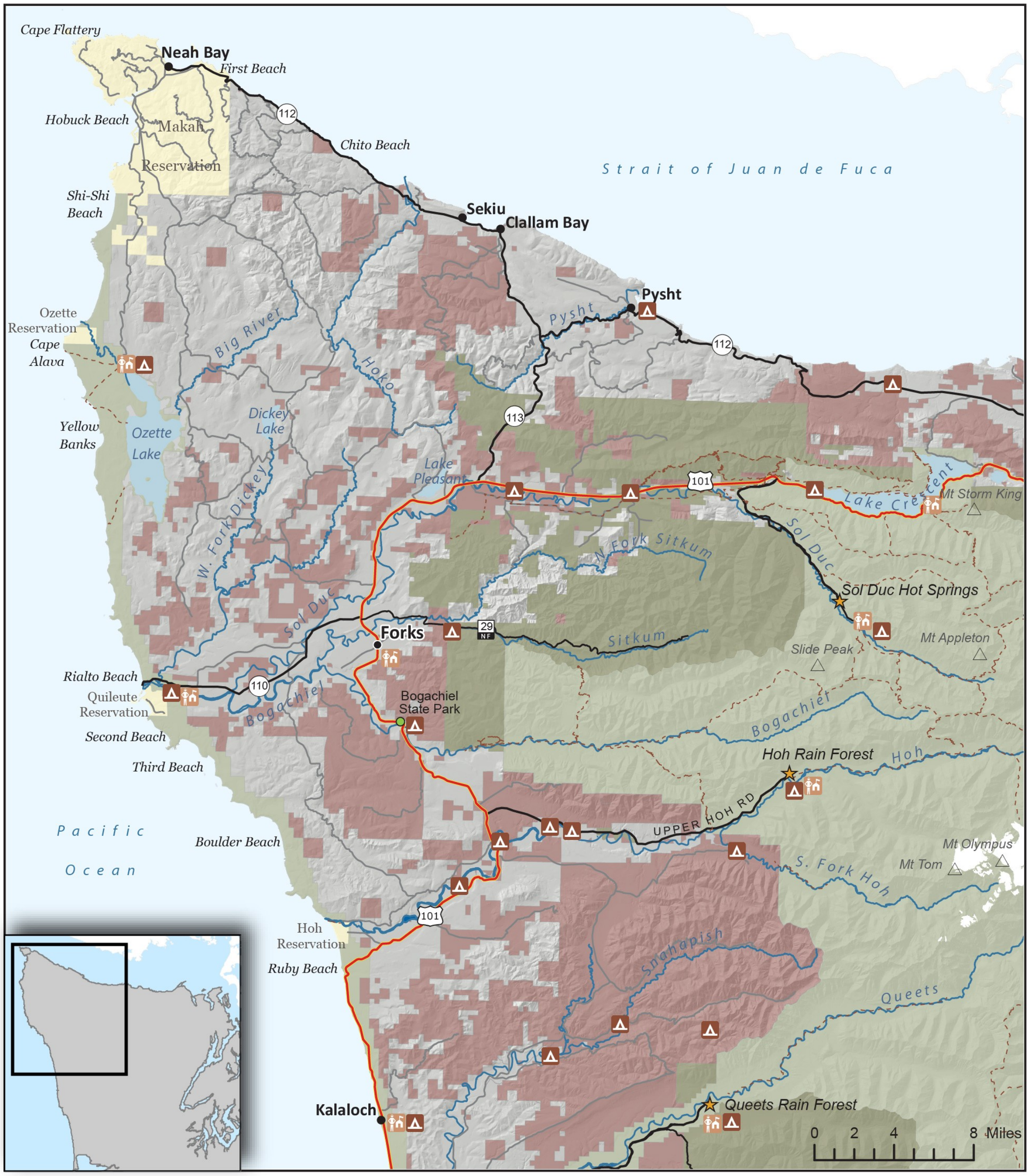

Figure 9 — Northwestern Olympic Peninsula

Northwestern Olympic Peninsula: From Timber to Twilight

The mapping workshop in Forks (pop. 3,532) was the only workshop held in the sparsely populated northwestern corner of the peninsula (fig. 9).The forest products industry was the economic mainstay of this area during the 20th century, and remains an important employment source for local residents. The area's many natural attractions, such as the Hoh Rain Forest, Lake Crescent, and miles of beaches and rivers attract a large number of tourists every year. Forks has recently become a popular destination for fans of the Twilight movie series.

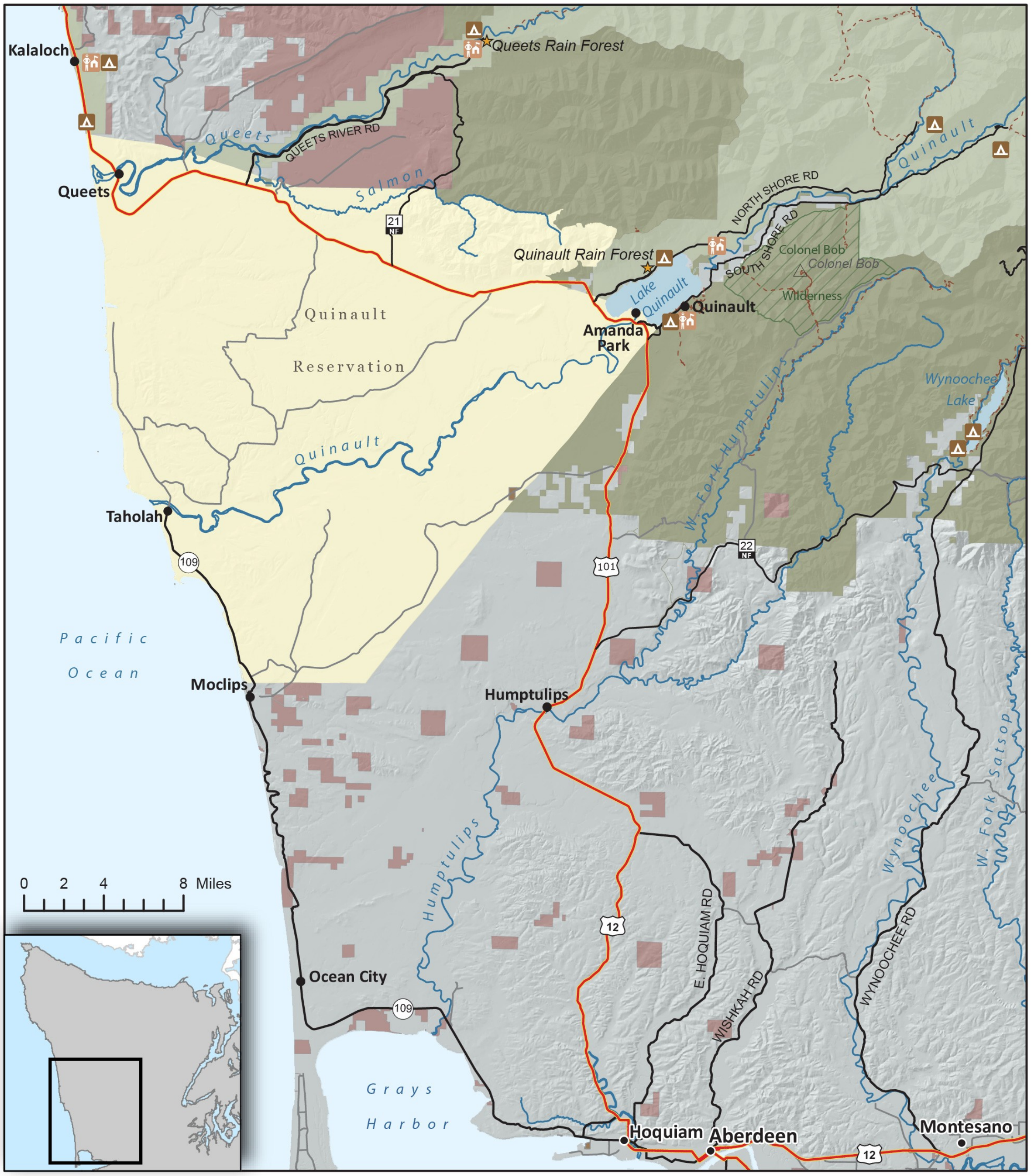

Figure 10—Southwestern Olympic Peninsula

Southwestern Olympic Peninsula

In the southwestern peninsula (fig. 10), workshops were held in the town of Aberdeen and in Quinault. The twin cities of Aberdeen (pop. 16,896) and Hoquiam (pop. 8,726) are the only large population centers in this part of the peninsula. Lake Quinault, with its historic lodge and hiking trails into Olympic National Park, is a major tourist attraction. The beaches south and north of the Quinault Indian Reservation are popular with locals and visitors alike. Since the 1990s, the county's economy has diversified from logging and commercial fishing, with employment growth in tourism, renewable energy, retail trade, and health and social services.

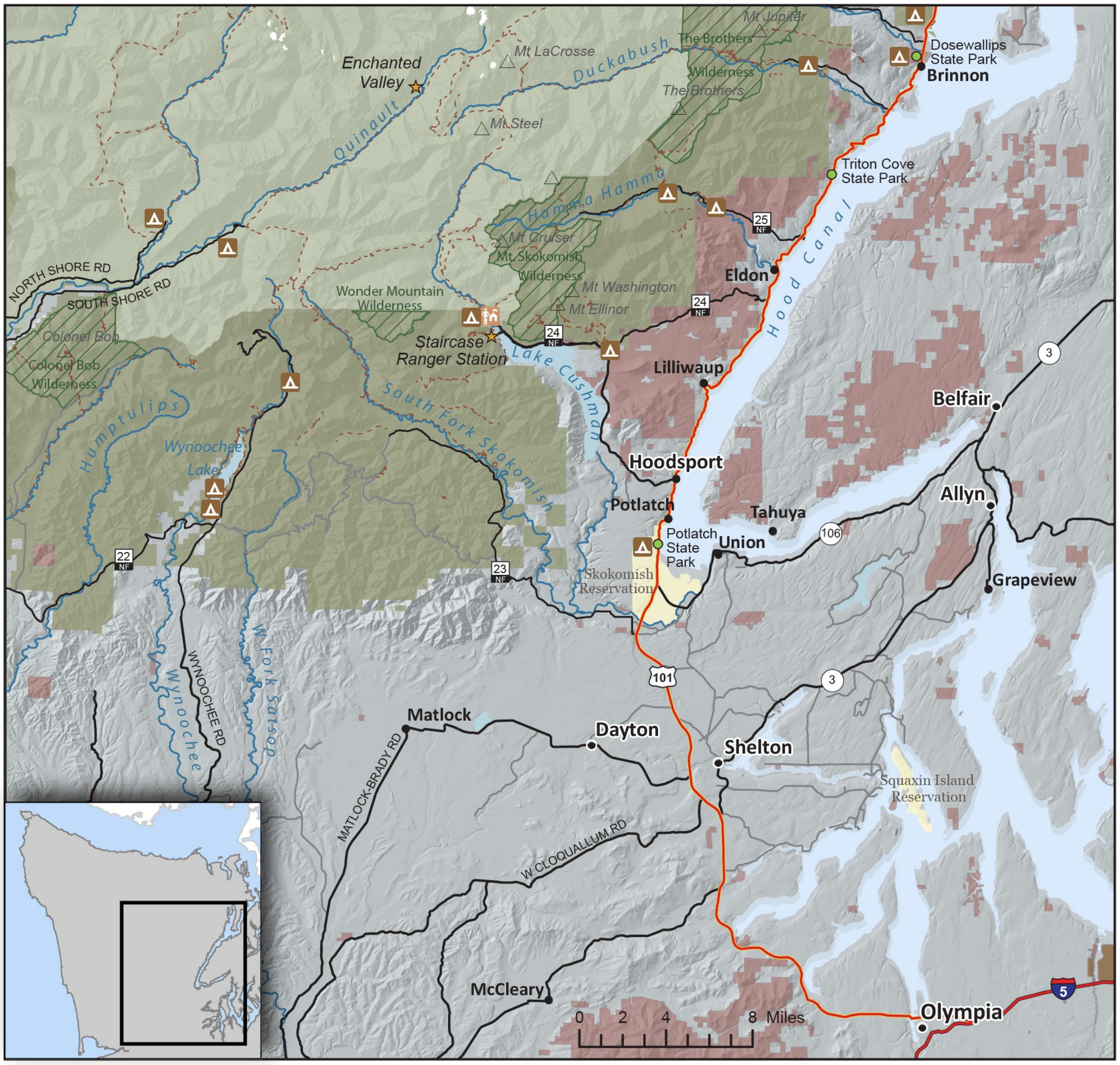

Figure 11—Southeastern Olympic Peninsula

Southeastern Olympic Peninsula

In the southeastern peninsula (fig.11), mapping workshops took place in Shelton (pop. 9,834) and Hoodsport (pop. 376). Hood Canal was once a major transportation corridor. It is now heavily used for water-based recreation, such as sailing, boating, fishing, shellfishing, and diving. Shelton is the only large population center in this part of the peninsula. Lake Cushman, west of Hoodsport, is a popular destination for local residents, and many hikers enter the Olympic National Park through the Staircase entrance at the western end of the lake. Enchanted Valley, a popular destination for hikers and backpackers, is often accessed from the Dosewallips river valley to the north. Logging, fishing, and aquaculture were the economic mainstays for area residents during most of the 20th century. Although these industries remain important economically, many residents now work locally in the service sector or commute to jobs in nearby cities. Olympia, the state capitol, is only a twenty-minute drive from Shelton.

Section 3—Regional Analyses

Workshop participants mapped 818 meaningful places and 1,594 outdoor activity sites. For both datasets we created a set of regional density and diversity maps to identify patterns in the way that meaningful places and activities were distributed across the Olympic Peninsula. We then created a set of sub-regional maps to see whether meaningful places and activity locations differed depending on where participants lived. We used ArcGIS 10.0 to develop the maps and spatial analyses.

For land management planning, it is useful to know whether there are places on the landscape where meaningful places and the values associated with them are concentrated. Likewise, it is helpful to know whether there are areas that are especially popular for outdoor activities. Areas where activities or meaningful places are concentrated are likely to be contentious if proposed actions will restrict access to the locations or change the sense of place associated with them. Areas with high concentrations of meaningful places or activities are also likely candidates for efforts to maintain or expand visitor infrastructure, such as roads, trails, or information kiosks.

Density Analysis

To identify portions of the Olympic Peninsula where meaningful places or activities are particularly concentrated we developed composite density maps by combining the data from all the workshops. The density maps answer the question "How many times was this location mapped as an activity site?" or "How many times was this location mapped as a meaningful place?'

A composite density map can be visualized as a series of semi-transparent maps — one for each individual — stacked on top of each other. The meaningful places and outdoor activity locations are colored in on each map. Because all of the maps are translucent, any areas that have been mapped more than once show up as dark areas on the top map in the stack; areas that have not been mapped show up as the same color as the base map (in our case, gray). The more times a location is mapped, the darker that place is on the top map in the stack. If a place is mapped only a few times, it shows up as a much lighter color. Appendix D provides more detail on how we created the density maps.

To highlight density differences in the meaningful places maps, we developed a scale with gradations in color tones, with the darker color tones representing areas mapped most frequently, and the lighter color tones representing areas least frequently mapped. Because an individual could mark meaningful places that overlapped, the density values measure the total number of times an area was mapped rather than the number of individuals who included that location in their maps.

We used a similar process for creating activity density maps. As with meaningful places, activity locations can overlap. The composite activity density maps thus indicate the number of times a location was mapped as an outdoor activity site, rather than the number of people who mapped that location.

Diversity Analysis

Density maps are useful for identifying areas that many people find meaningful or go to when doing outdoor activities. However, they don't convey any information about whether people attach different meanings to those areas, or whether they do a variety of activities in those places. To get a sense for the diversity of activities or values associated with mapped locations, we developed a series of diversity maps using the process described in appendix E.

To create the value diversity maps from the meaningful places data, we used the primary values associated with each mapped location. Primary values are the values that participants marked first on their worksheets. As with the density maps, one can visualize the diversity maps as being created from a series of transparent maps stacked on each other.

The activity diversity map allows us to answer the question "How many different activities take place here?" The value diversity map allows us to answer the question, "How many different primary values are listed for this meaningful place?"

Distinguishing between Diversity and Density Analysis

A hypothetical example illustrates the difference between density and diversity analyses. Imagine that a density analysis of the peninsula data shows equally high concentrations of values at a major lake and at a more remote but particularly spectacular rocky beach. A diversity analysis of the data, however, shows that five different types of primary values are associated with the lake, while only 1 primary value is associated with the rocky beach. The lake is likely to be much more challenging to manage, as people value it for different reasons whereas they all value the rocky beach for the same reason.

We analyzed the maps visually to identify major patterns in the spatial distribution of meaningful places and activities. Given the qualitative nature of the data and the self-selected sample approach, the use of spatial statistics was not appropriate for these two datasets.

A Cautionary Note

The locations that people map may differ depending on the mapper's familiarity with the region, residence, life experience, values, preferences, gender, age, and many others factors. It is thus important to understand the underlying data structure when interpreting the regional values and activities density maps. As an example, we discovered that people tend to map locations that are relatively close to their homes. If a much large number of people from one community participated in the mapping compared to other communities, the composite results will tend to show denser areas close to the community that had a large number of participants. As indicated in Table 1, two communities — Forks and Quinault — had many more participants than the other six communities. The impacts of this difference in participation along with differences in mapping styles among the communities on the regional density and diversity patterns are discussed later in this section.

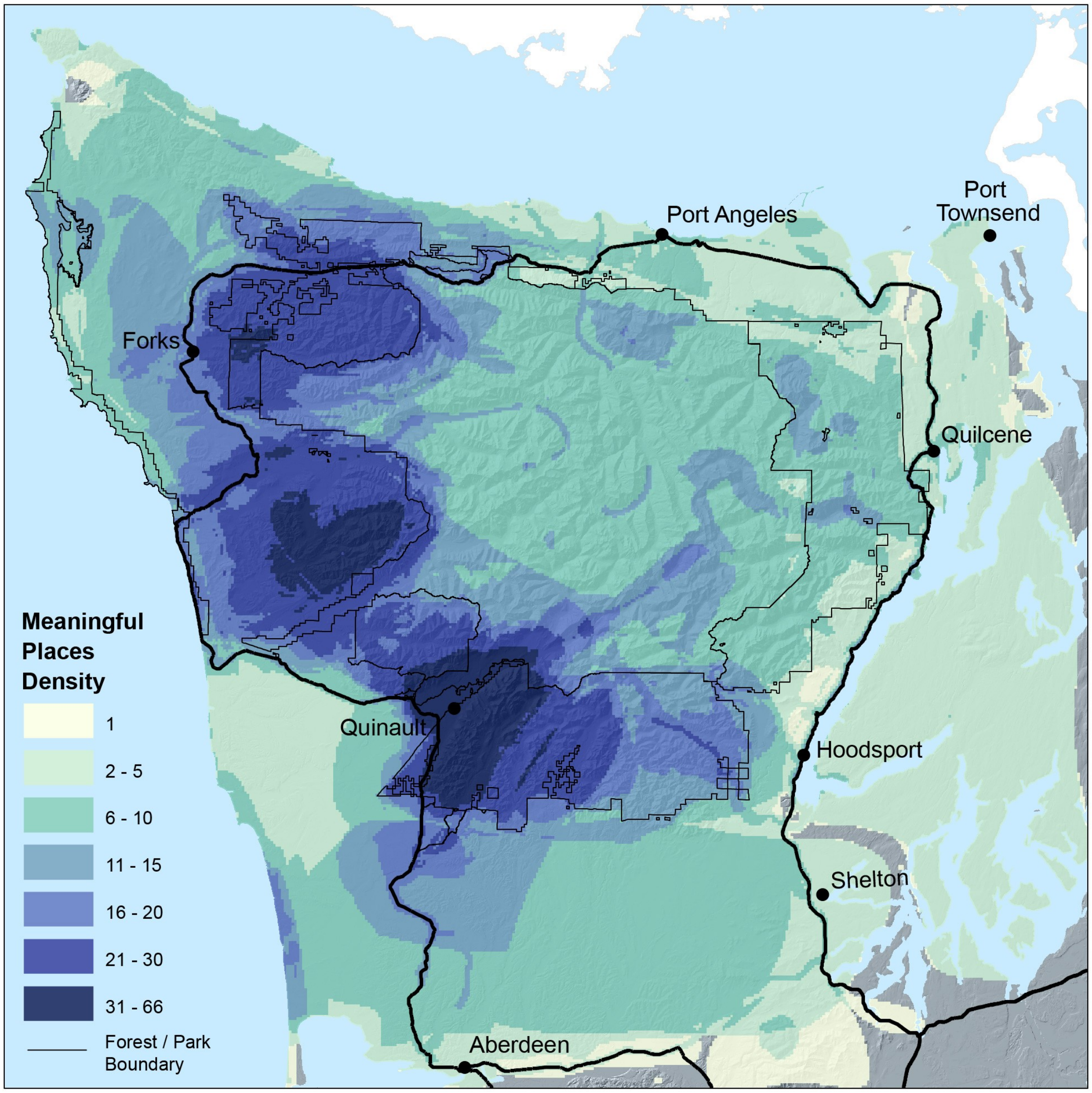

Figure 12 — Meaningful place density (all participants); counts per one-sixteenth square mile.

Concentration of Meaningful Places

Figure 12 shows the composite density map of meaningful places for all workshops. The highest densities were located along the southwestern and western flanks of the Olympics. The densest concentrations are located primarily on the Olympic National Forest, along the western edge of the Olympic National Park, or on state trust lands. The high density around Lake Quinault, which extends northeast of the settlement of Quinault, is attributable to several factors, including the importance of the lake to workshop participants, a much higher level of participation at the Quinault workshop compared to other workshops, and tensions over a proposed expansion of the national park in the vicinity of the lake. Virtually the entire peninsula was marked as meaningful by more than one person.

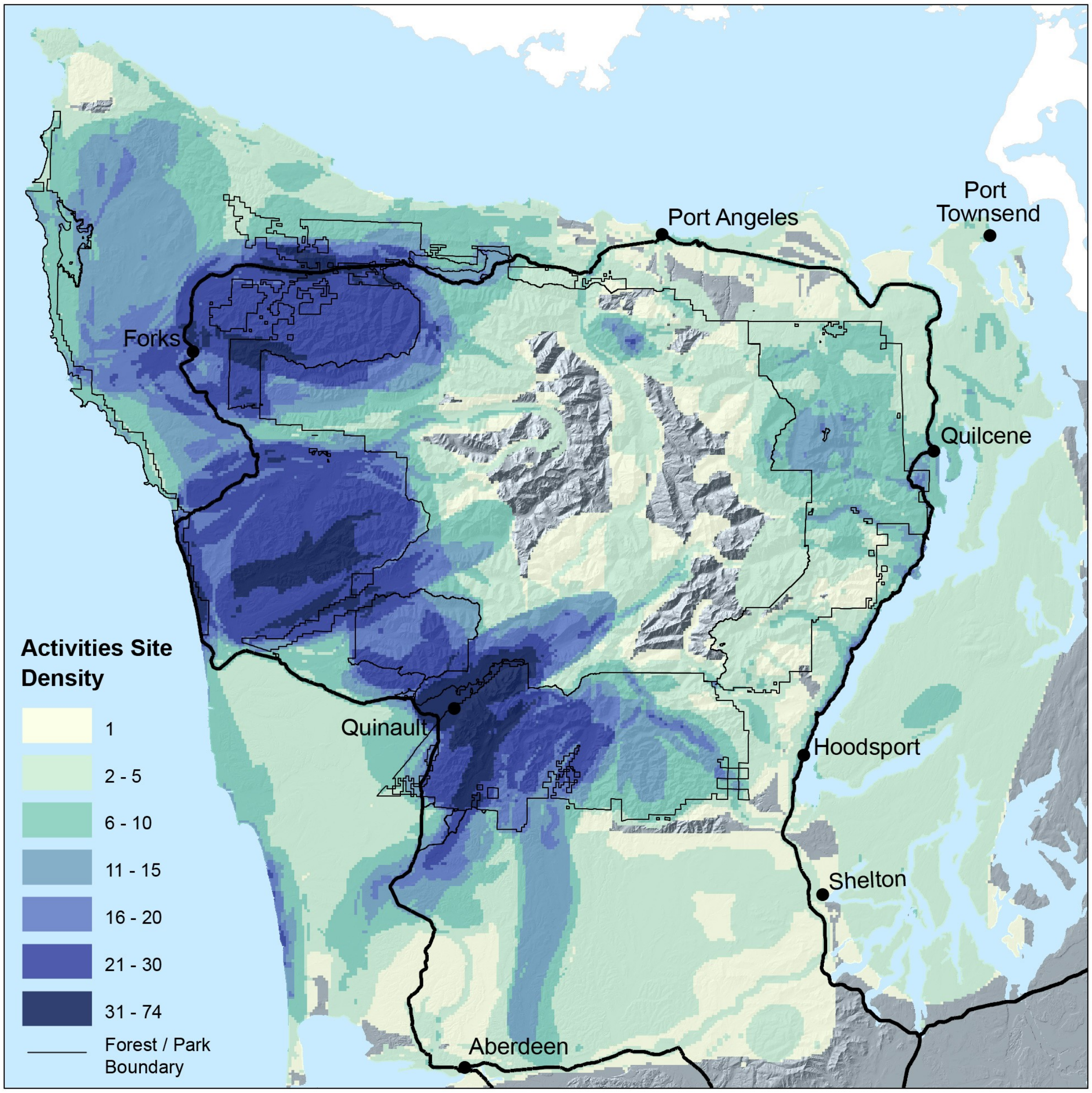

Figure 13—Activity site density (all participants); counts per one-sixteenth square mile.

Concentration of Outdoor Activities

Outdoor activity sites were heavily concentrated in the southwestern and western slopes of the Olympic range (fig. 13). As with meaningful places, activities were concentrated on the Olympic National Forest and state trust lands. However, the activity density pattern was less expansive than that of meaningful places. Small areas of high density values also occurred along the Pacific coast, in the Enchanted Valley northeast of Lake Quinault, and at Hurricane Ridge. A large portion of the Olympic National Park's interior, which is reachable only on foot or horseback, had no activities mapped on it even though those areas had low to moderate density ratings as meaningful places. This suggests that people may attach meaning to places even if they do not visit those locations.

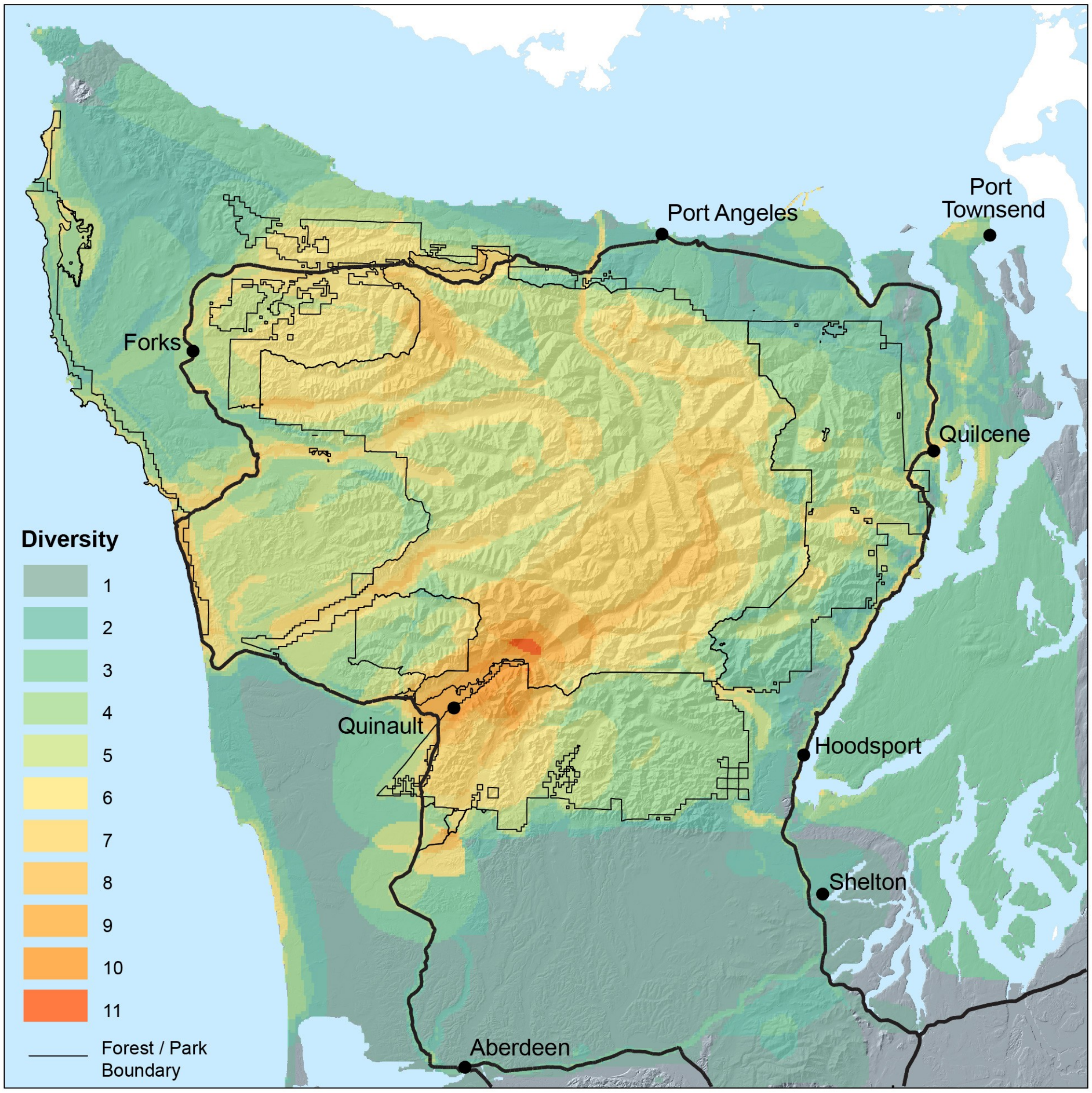

Figure 14 — Value diversity (all participants); number of different values per grid cell.

Diversity of Values Associated with Meaningful Places

The number of different values associated with meaningful places ranged from 1 to 11 (fig. 14). The most extensive area with high values diversity (eight or more different values) was in the southern Olympic National Park, with smaller concentrations in the watersheds east and south of Forks. Major rivers as well as Lake Crescent and the stretch of Highway 101 near Kalaloch on the Pacific Coast also had high values diversity. Large areas of the park had six or more different values associated with them, whereas most areas of the southern peninsula, which is predominately privately owned, had only one value. In general, areas with the highest values diversity were located within the Olympic National Park and Olympic National Forest, with narrow bands of moderate to high diversity found along the Pacific coast and on the western bank of Hood Canal.

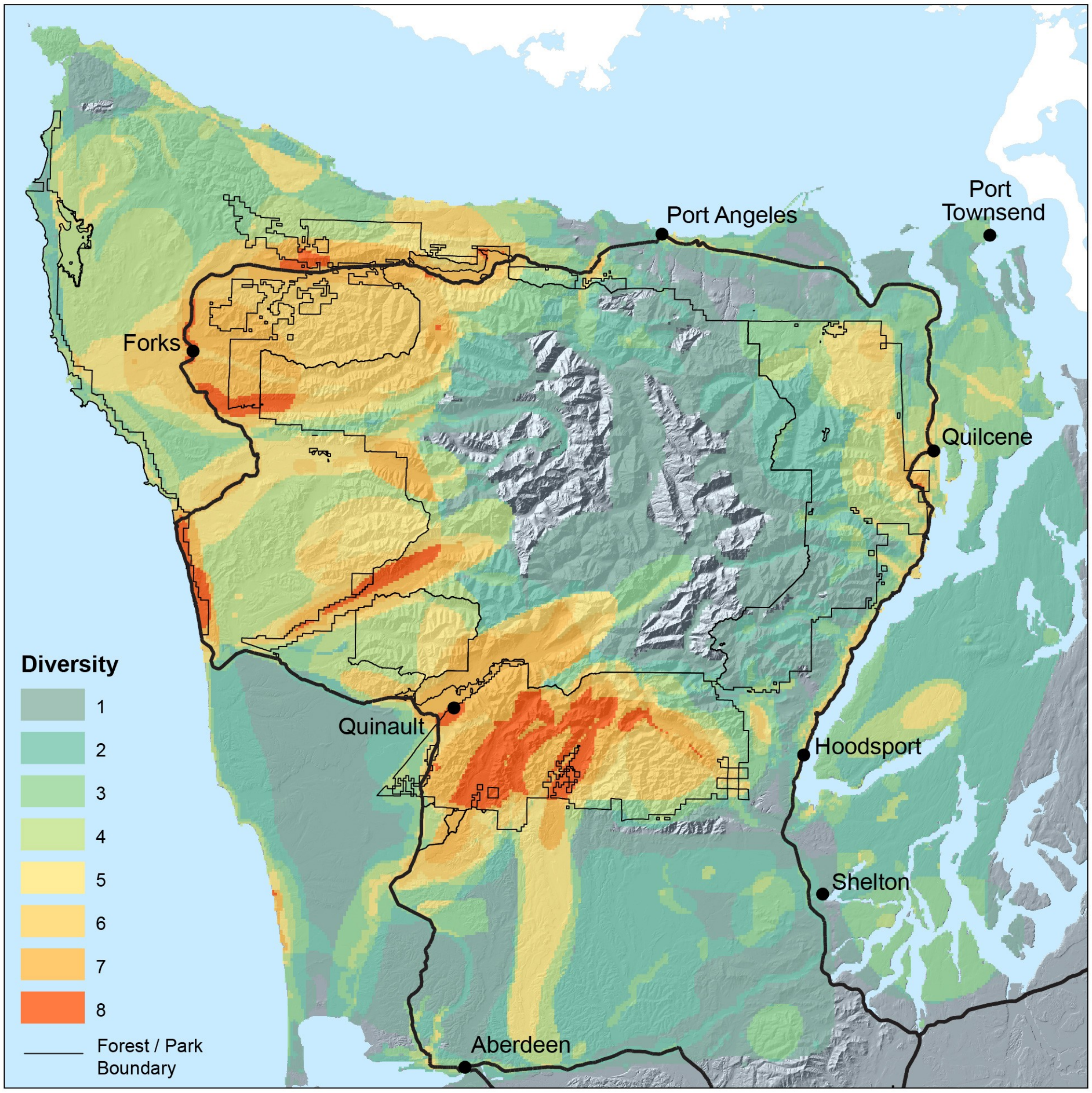

Figure 15 — Activity diversity (all participants); number of different activities per grid cell

Diversity of Outdoor Activities

The number of different activities associated with mapped activity sites ranged from one to eight (fig. 15). Areas of high activity diversity (six or more different activities) are concentrated along the southern and western slopes of the Olympic mountain range in a pattern similar to that for activity density. Smaller areas of high activity diversity occur at beaches along the Pacific coast, on the northeastern front of the Olympics near Quilcene, and in the vicinity of Port Angeles. Areas with the least diversity in outdoor activities include the core of the Olympic National Park, most of the Quinault Indian Reservation, and areas managed by industrial timber companies in the southern part of the peninsula. Most of the park had three or fewer activities mapped at any given location. This contrasts sharply with the values diversity map, where six or more values were associated with most areas in the park.

Distribution of Values Associated with Meaningful Places

Table 4 shows the number of times that each type of value was marked as the primary value for meaningful places. Recreation was by far the most commonly marked, followed by economic, aesthetic, and home. Figure 16 displays how these four primary values were distributed across the peninsula. The economic values density map most closely resembles the composite values density map, with high concentrations along the western and southwestern flanks of the Olympic range. This part of the peninsula is relatively flat and has some very productive timber lands. Portions of this area have recently been proposed for wilderness designation, but many local residents believe these lands should remain open to timber harvesting. The link between economic values and timberlands is reflected in the absence of economic values associated with the Olympic National Park, an area where logging is not permitted. Economic values dominated in the area south of the national forest border. Much of this land is in private ownership and managed for industrial wood fiber and timber production.

High density areas for recreation were concentrated east of Forks, a part of the peninsula popular with ATV riders as well as hikers and campers. The Upper Quinault, the Sol Duc, and Bogachiel river valleys also had high recreation value densities, as did the western and northern coastlines and the peaks in the northeastern corner of the peninsula. The area south of the national forest boundary had very few areas where recreation was the primary value. In general, recreation values were more broadly dispersed than economic, aesthetic, and home values. They were also associated with a much larger portion of the Olympic National Park than other values.

Table 4 — Frequency of primary values for meaningful places

Primary value	Number of features	Percent of all features
Recreation	264	32.3
Economic	138	16.9
Aesthetic	108	13.2
Home	81	9.9
Heritage	50	6.1
Spiritual	27	3.3
Environmental quality	27	3.3
Social	26	3.2
Wilderness	26	3.2
Subsistence	20	2.4
Intrinsic	17	2.1
Future	17	2.1
Learning	9	1.1
Health	8	1.0
Total	818	100

Meaningful places that had aesthetics as their primary value occupied substantially less area than places deemed important primarily for recreation or economic values. For many people, aesthetic values appears to be equated with views, as high concentrations of aesthetic values were located primarily near water bodies, in river valleys, along Highway 101, and at points such as Hurricane Ridge and the eastern crest of the Olympics with spectacular views of Puget Sound, the Olympics, and the Cascade Range to the east.

Meaningful places with the primary value "home", were mapped primarily as point locations, and thus overall occupied a relatively small area of the peninsula. Locations associated with the value "home" were most heavily concentrated around Lake Quinault. Portions of this area have recently been proposed for wilderness designation, with the possibility that landowners might be approached about selling their land to expand the park.

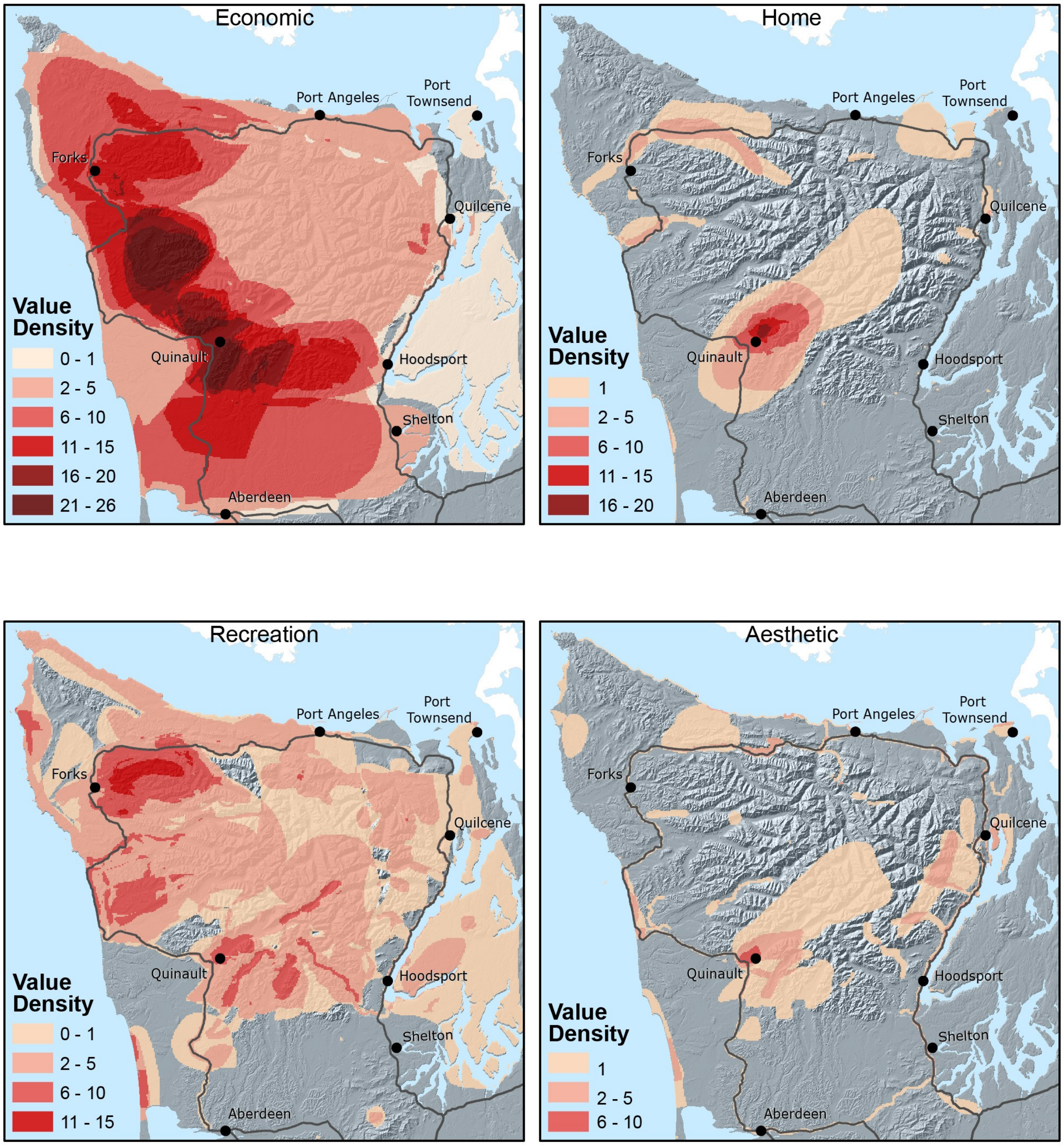

Figure 16 — Density maps for the top four primary values (all participants)

A comparison of the four density maps is helpful for identifying areas where one or more of the values overlap. As indicated in figure 16, the area immediately surrounding Lake Quinault has high densities for economic, aesthetic, and home, and moderate density values for recreation. The mountains east of Forks have high densities for recreation and moderate to high densities for economic values, but the density of meaningful places associated with aesthetics or home is low to none. High densities for aesthetics and recreation overlap along the southwestern coast south of the Quinault Indian Reservation, but this area has only low densities for home and economic values. No high density areas of values overlap on the east side of the peninsula.

Several factors explain the presence of large areas of high density for economic values compared to other values. One factor has to do with differences in how people mapped different values. Participants tended to represent economic values with very large polygons, whereas they used smaller polygons, points, or lines to map other values. The chances of obtaining overlap for economic values, and therefore higher density values, were much higher.

The use of large polygons to represent economic values also reflects the still-strong importance of the wood products industry for many Olympic Peninsula communities. Many participants who marked economic as a primary value included comments such as “It provides timber which provides jobs to our local community” or “The timber is ripe and ready for harvest; there is enough timber here to revive our community.” The wood products industry sources raw materials from relatively large areas of the peninsula. Large-sized polygons are therefore appropriate for representing those economically important places.

The high density of values in the Calawah and Bogachiel watersheds on the westside of the peninsula is partially explained by the co-occurrence of the Forks workshop with the Olympic National Forest’s efforts in 2011 to identify a location for an off-road vehicles trail system in that area. Many of the features mapped during the Forks workshop were located in the vicinity of the proposed trail system and had motorized recreation as their primary value.

Similarly, the high density of economic and home values in the watersheds near Lake Quinault is partly attributable to the co-occurrence of the Quinault workshop with the Wild Olympic Campaign’s efforts to pass national legislation designating 127,000 acres of Olympic National Forest as wilderness and establishing 19 new Wild and Scenic Rivers in and around Olympic National Park (see fig. 17). In addition to representing values and activities with large polygons, many participants in the Quinault workshop mapped the exact same locations as those of other participants. This contrasts with the other workshops, where a more dispersed mapping style was used. Figure 18 illustrates this difference in mapping styles.

Figure 17—Signs along Highway 101 reflecting differences in viewpoints about the Wild Olympics campaign (photos by A. Todd)

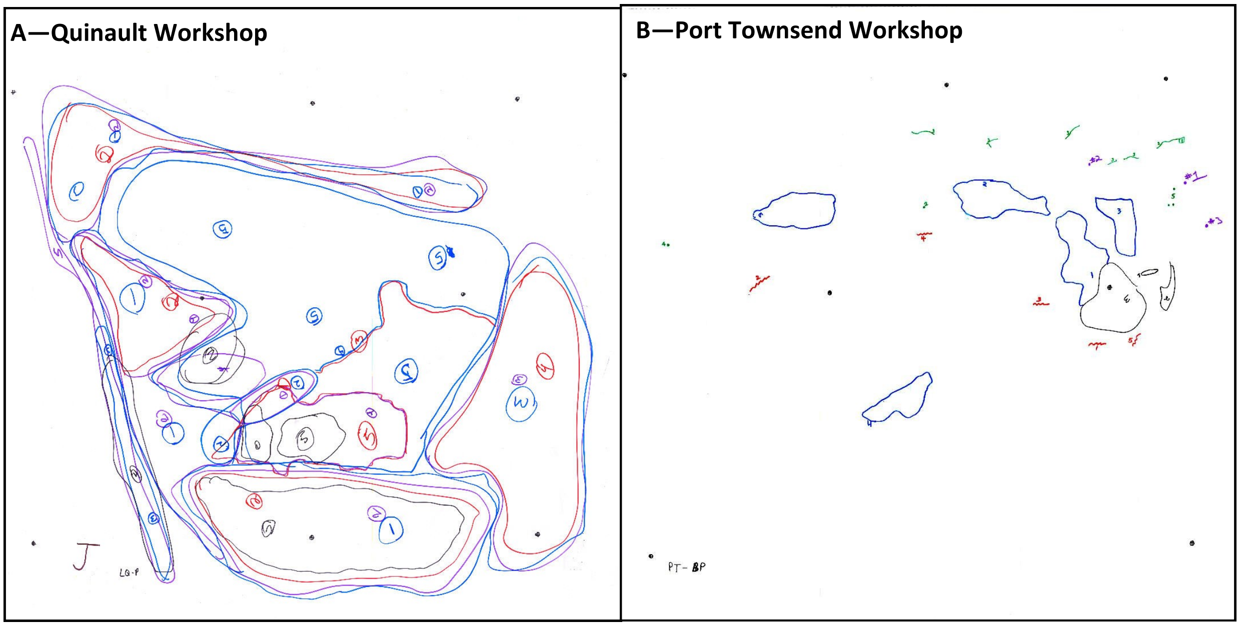

Figure 18—Differences in mapping styles between participants in the Quinault (A) and Port Townsend (B) workshops

The high value densities for locations on the westside are also partially attributable to the higher numbers of people who participated in the Forks (32) and Quinault (39) workshops compared with the other workshops (low of 10 in Quilcene and a high of 19 in Port Angeles). The higher turnout at the two westside workshops suggests a strong interest exists within those communities in having the values and activities they associate with the peninsula documented. The existing concerns about off road vehicle access and the Wild Olympics Campaign within those communities likely helped motivate greater participation. In conversations after the workshops had been completed, several of the participants from Forks and Quinault attributed the higher turnout at these workshops to the long history many participating community members had in the area, and their concerns that recent changes in land management policies and practices have negatively affected their livelihoods and the types of outdoor activities that they can engage in. Participating in the mapping workshops was one way for community members to make their concerns known to a broader audience and to ensure their values were represented in the mapping project.

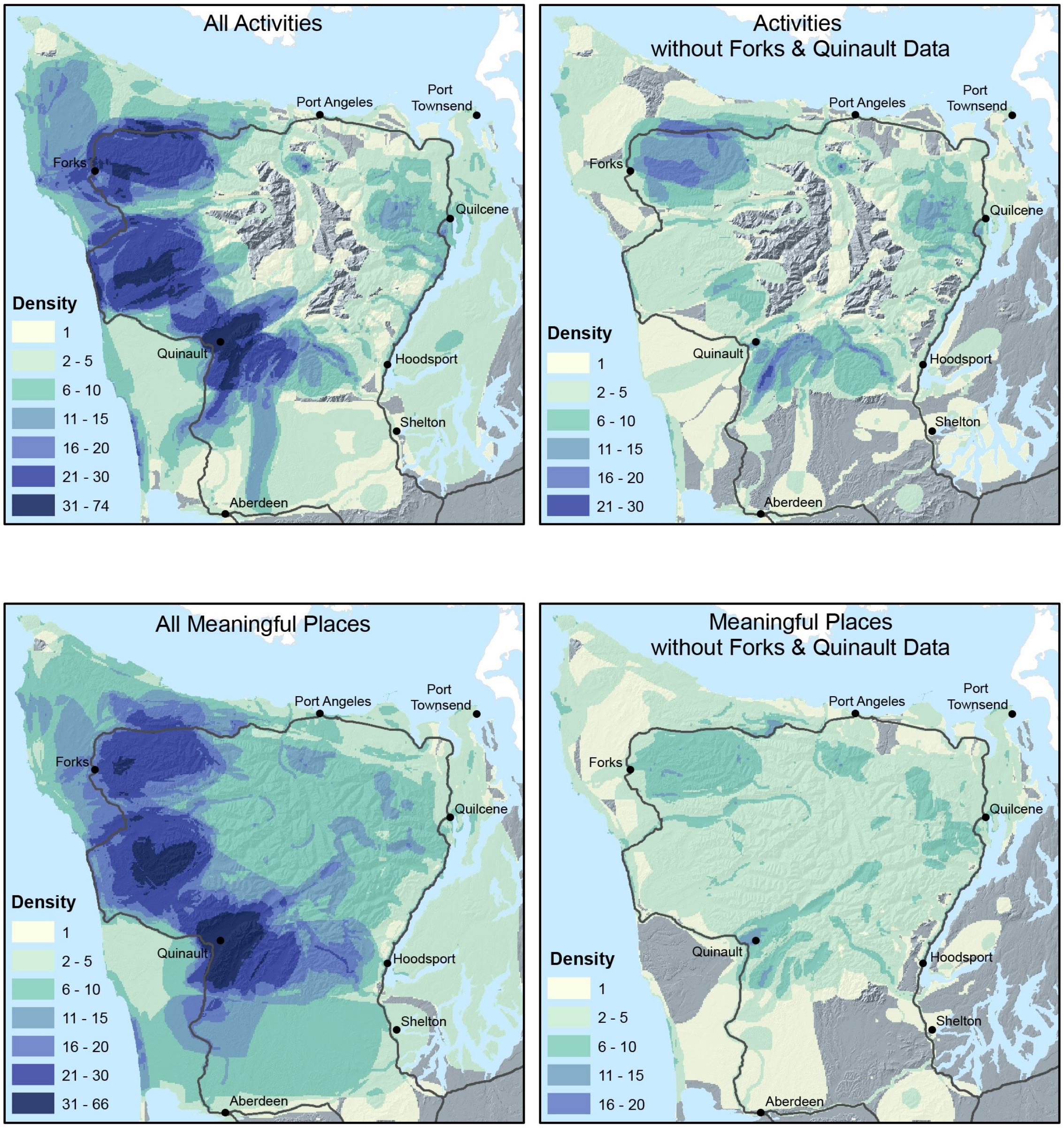

Figure 19—Activity and meaningful place density maps, with and without Forks and Quinault

Figure 19 contrasts activity and meaningful place density maps created using data from all the residents with maps created without data from Forks and Quinault residents. The differences in density patterns between the two sets of maps indicate that the majority of the features located in the high density areas on the westside in the overall composite maps were mapped by westside residents. The overall maps highlight areas that westside participants valued highly, many of which are areas over which tensions over resource management exist. The overall maps thus provide data that is important for land managers and planners to be aware of. However, the maps also underline the importance of developing both regional and community-level maps in human ecology mapping projects since the types and locations of values may differ greatly across communities.

Spatial Distribution of Outdoor Activities

Table 5 lists the number and percentage of different types of activities associated with the sites mapped by workshop participants. Non-motorized recreation was by far the most diversified category, with 18 sub-categories. It was also the type of activity most frequently mapped. Of the 1,594 outdoor activity sites mapped, more than one-third (38.3 percent) fell into the non-motorized recreation category. Economic activities (12.1 percent), fishing (12.0 percent), and education/science (11.7 percent) comprised roughly the same percent of mapped features. Motorized recreation (4.3 percent) was the least commonly mapped activity category.

Table 5—Frequency of activity categories (all participants)

Type of activity	Percent of all activity sites	Number of activity sites
Non-motorized recreation	38.3	610
Economic	12.1	193
Fishing/shellfishing	12.0	191
Science/education	11.7	187
Cultural/social	8.7	138
Hunting/trapping	6.6	106
Foraging/collecting	6.3	101
Motorized recreation	4.3	68
Total features	100	1594

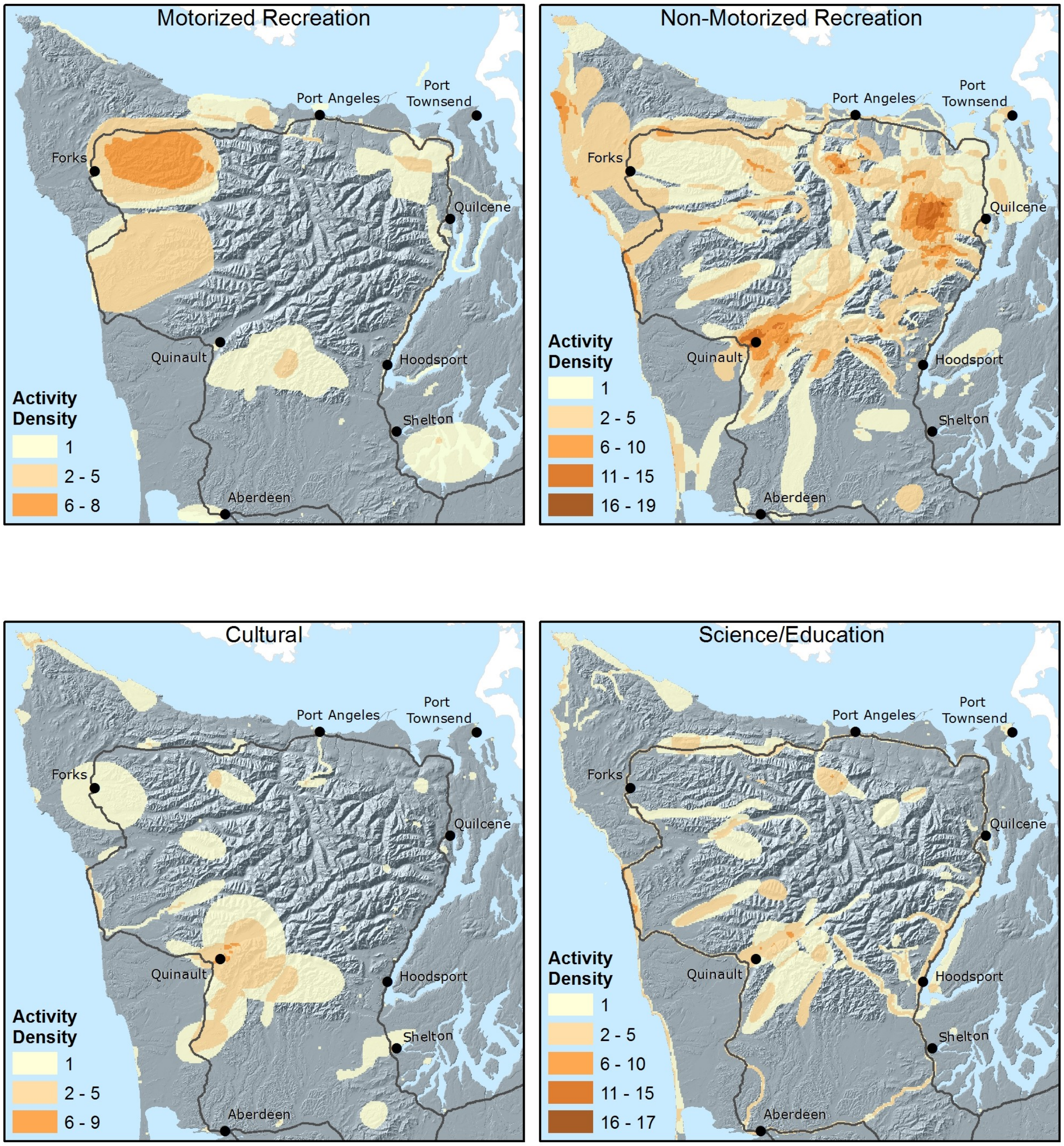

Figure 20—Density maps for motorized recreation, non-motorized recreation, cultural, and science/education (all participants)

Density maps for economic activities, hunting, and foraging/gathering had a pattern similar to the overall map, with heavy concentrations along the lower slopes of the western Olympics (fig. 20 and 21). A number of participants mapped the area south of the Olympic National Forest as having economic value, but only about half that area was mapped as places where people do economic activities. Motorized recreation was concentrated in the Forks area. Non-motorized recreation activities were more widely dispersed than other activities, with extensive concentrations in the Quinault River Valley and along the northeastern crest of the Olympics, and smaller concentrations along the western beaches. Non-motorized recreation was the only activity category that occurred extensively within the national park.

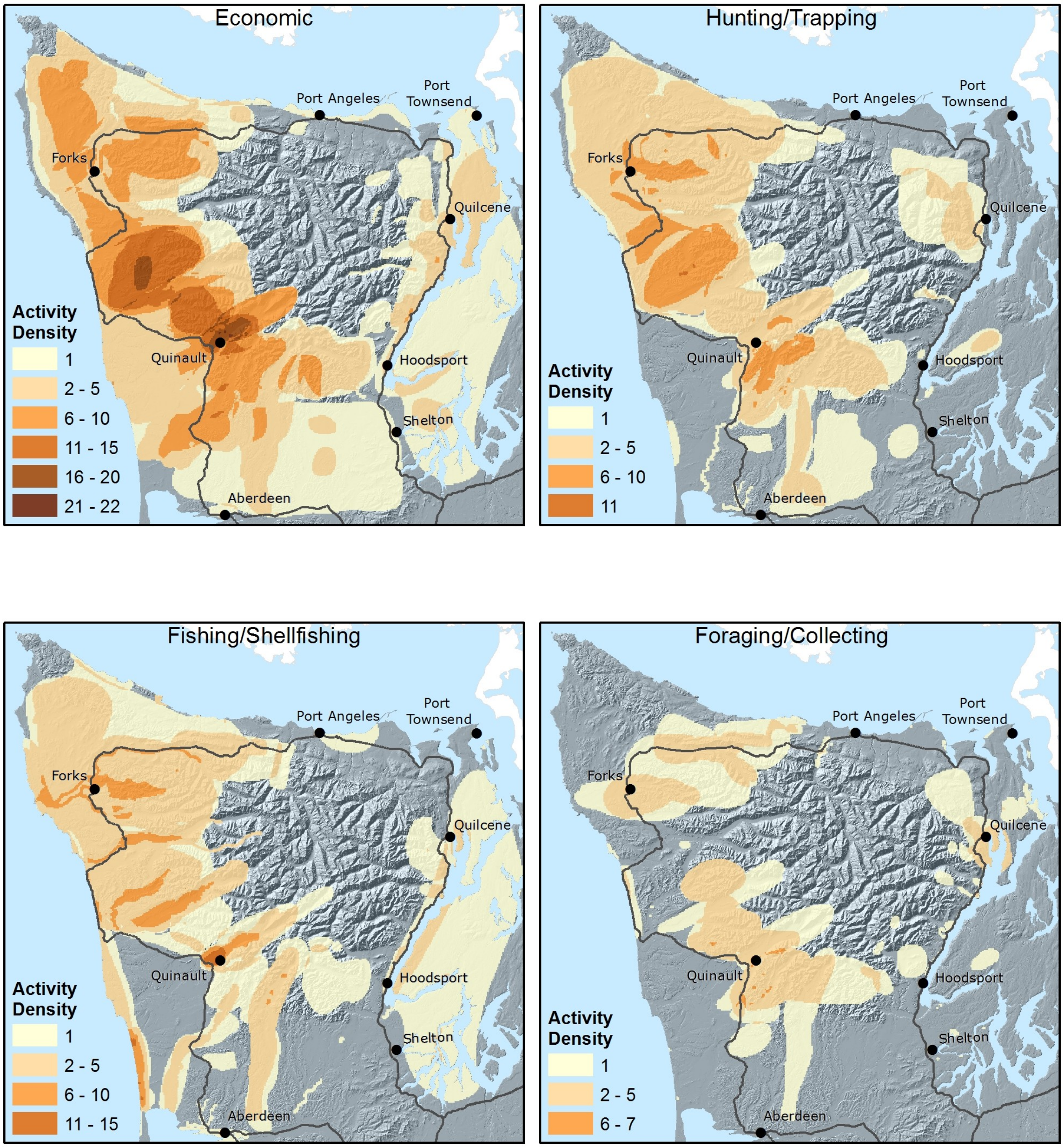

Figure 21—Density maps for economic, hunting/trapping, fishing/shellfishing, foraging/collecting (all participants)

While it is logical that motorized recreation, hunting, and economic activities would not show up within the park's boundaries, activities in the other categories are compatible with the park's management objectives. For example, park rules permit the gathering of berries for daily use and some types of fishing. Yet few foraging or fishing sites were mapped in the park's core. With the exception of the area around Lake Quinault and the beach near Kalaloch, cultural activity sites were not intensely concentrated and cover a relatively small portion of the peninsula. Science/education activity sites were the most broadly dispersed and occupy a relatively small area.

Gender Differences in Meaningful Places

Planners may wish to know whether the spatial distributions of meaningful places and activity sites differ for different population subgroups. Gender, age, ethnicity, and race are just a few of the dimensions along which one might expect to find differences. This section uses gender as an example for illustrating why planners might wish to analyze human ecology mapping data by population subgroups.

Figure 22 contrasts meaningful place density maps for women, men, and women and men combined. This comparison shows that men had a meaningful place density pattern that very closely resembles the overall density map, with large areas of high densities along the lower western slopes of the Olympics and a few smaller areas of moderate density along the Pacific coast. The meaningful places density map for women, however, showed extensive areas of very high density only around Lake Quinault, with scattered spots of moderate density along the southern Pacific coast beaches and in the national park.

The top four primary values associated with men's and women's meaningful places were identical (recreation, economic, aesthetic, and home) (fig. 23). Home was cited as a primary value more frequently by women (17.7%) than men (11.1%); while men more frequently cited economic (25.5%) as a primary value than women (19.4%).

Gender Differences in Activity Sites

The activity density map for men closely resembled the overall pattern (fig. 22). As with meaningful places, the activity pattern for women differed substantially from that for men, with high densities only around Lake Quinault, but not in the northwestern river valleys. Overall, women's activity sites were less extensively distributed than men's and occupied a substantially smaller area than men's activities. Activity sites for women were noticeably less prevalent in the southern peninsula, an area dominated by private industrial timber holdings.

The kinds of activities mapped by women and men also differed considerably (fig. 24). Nearly half of the activity sites for women were places the mappers went to do non-motorized recreational activities. Non-motorized recreational activity sites were also the type of site most frequently mapped by men, but they represented only a third of men's activity sites.

Men's activities were more broadly spread out across a range of activity categories, with roughly equal number of sites mapped for economic activity, fishing/shellfishing, hunting/trapping, and science/education. For women, the next most frequently mapped types of activities after recreation were science/education, cultural, economic, and foraging/collecting. Compared to men, women mapped very few activity sites for fishing/shellfishing or hunting/trapping.

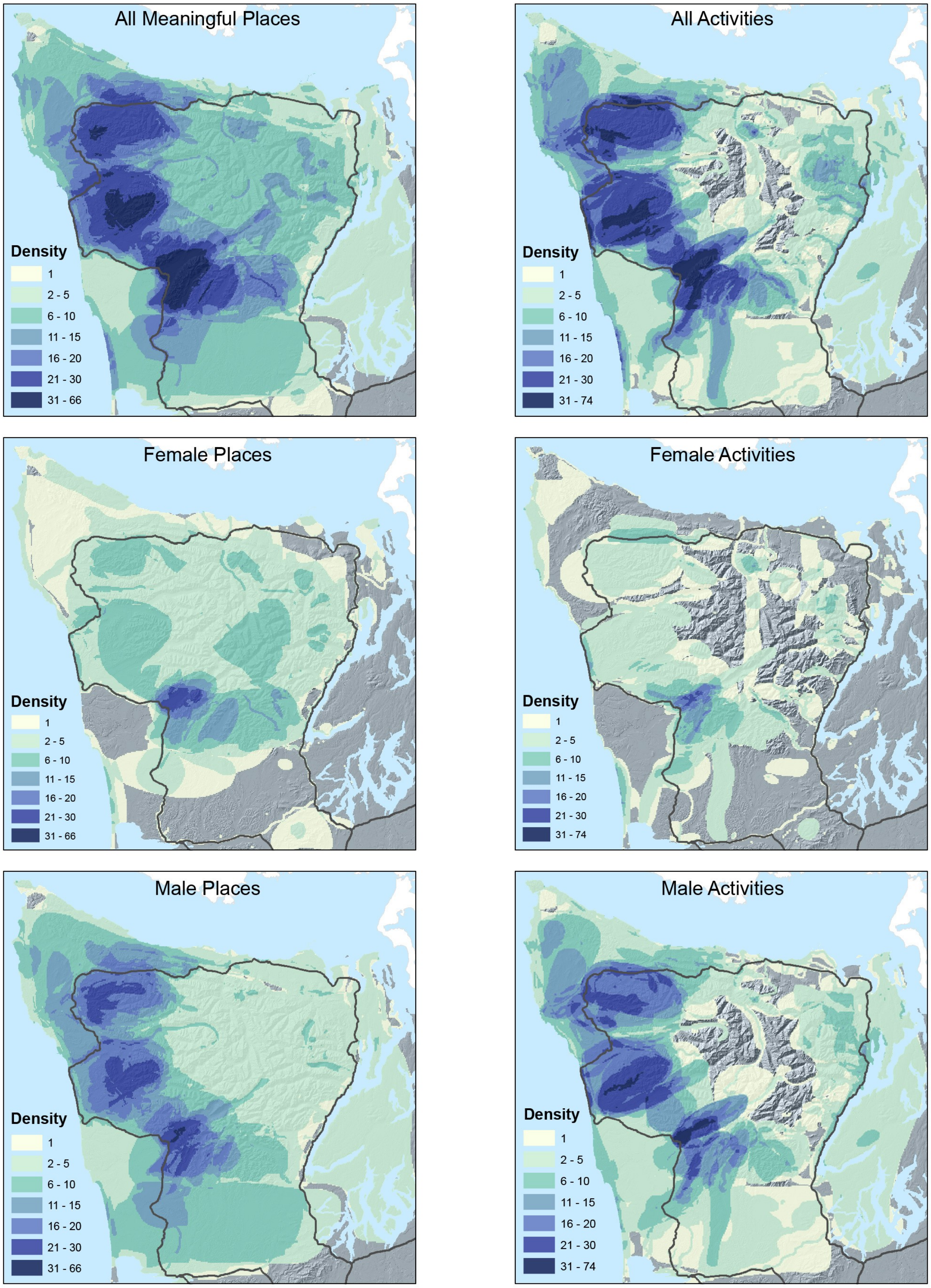

Figure 22—Gender differences in meaningful places and outdoor activity site densities

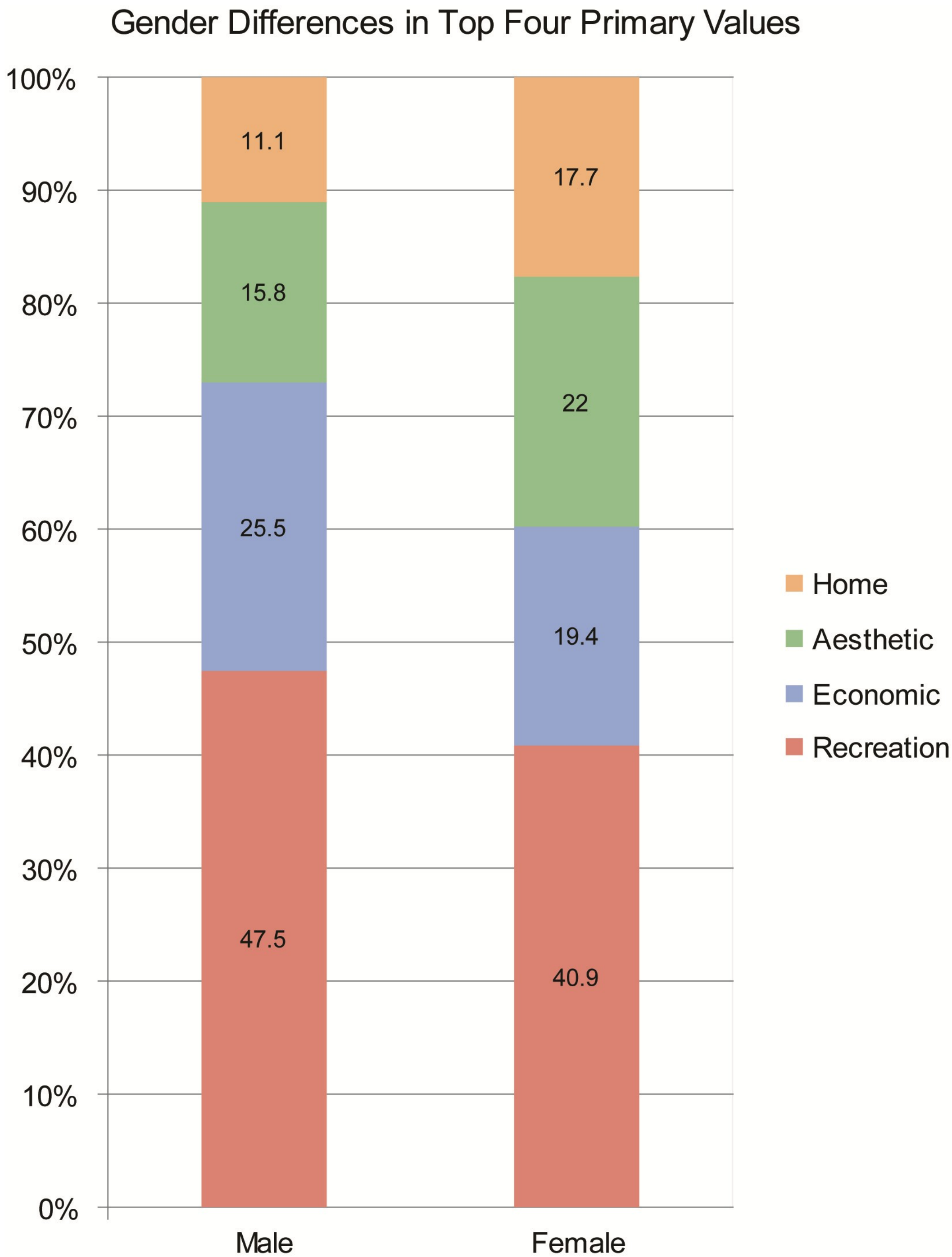

Figure 23—Gender differences in top four primary values for meaningful places. The top four value categories represent 72% of the total features. Percentages are based on the total for these four values only. The 18 features mapped by participants who did not specify their gender were not included in this analysis.

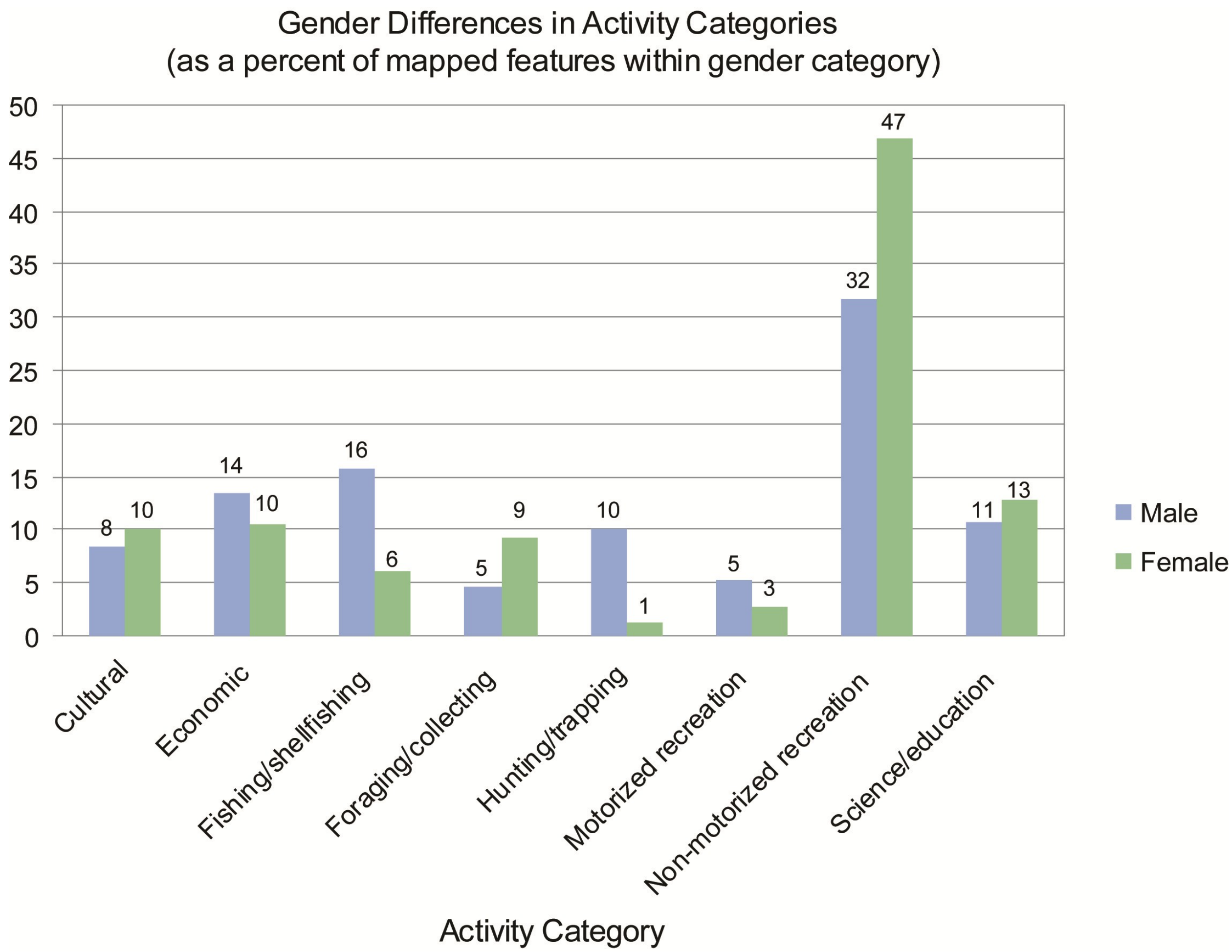

Figure 24—Gender differences in activity categories. All categories are included in the analysis. The 60 features mapped by participants who did not specify their gender were not included in the calculations.

Section 4—Sub-Regional Analyses

One goal of the mapping project was to find out whether the location and types of meaningful places and activities were similar for residents from different communities around the peninsula. To accomplish this goal, we divided the Olympic Peninsula into six sub-regions based on zip code groupings or zones. To create the zones, we drew on the residential zip code data from the demographic worksheets participants completed during the workshops. In the few cases where participants did not provide a residential zip code, we assigned them the workshop location's zip code.

We used the set of zip codes provided in the workshops to identify general boundaries for the residential area covered by each of the eight workshop communities. For example, residents of Elma in the south central part of the Peninsula generally attended the Shelton workshop rather than the Aberdeen workshop. Thus residents of Elma were placed into the South Hood zip code zone rather than into the Grays Harbor zip code zone, regardless of which workshop they attended. We also took into consideration historical and contemporary socioeconomic connections between communities when aggregating zip code areas into larger zip code zones. For example, Sequim residents tend to go to Port Angeles rather than to Port Townsend for major shopping trips. Consequently, Sequim was placed in the North Central zone rather than in the North Hood zone.

Table 6—Major communities by zip code zone

	Zip Code Zone					
	Grays Harbor	Quinault	Forks	North Central	North Hood	South Hood
	Aberdeen Hoquiam Montesano Westport Cosmopolis	Quinault Amanda Park Neilton Humptulips	Forks Beaver LaPush	Port Angeles Blyn Sequim	Port Townsend Port Hadlock Port Ludlow Chimacum Quilcene *Bremerton *Port Orchard	Shelton Hoodsport Union Lilliwaup Elma Satsop *Allyn *Belfair *Olympia *Grapeview
Men	16 (80%)	20 (54%)	16 (73%)	18 (64%)	14 (52%)	16 (46%)
Women	4 (20%)	17 (46%)	4 (18%)	10 (36%)	10 (37%)	19 (54%)
Unknown			2 (9%)		3 (11%)	
Total Participants	20	37	22	28	27	35

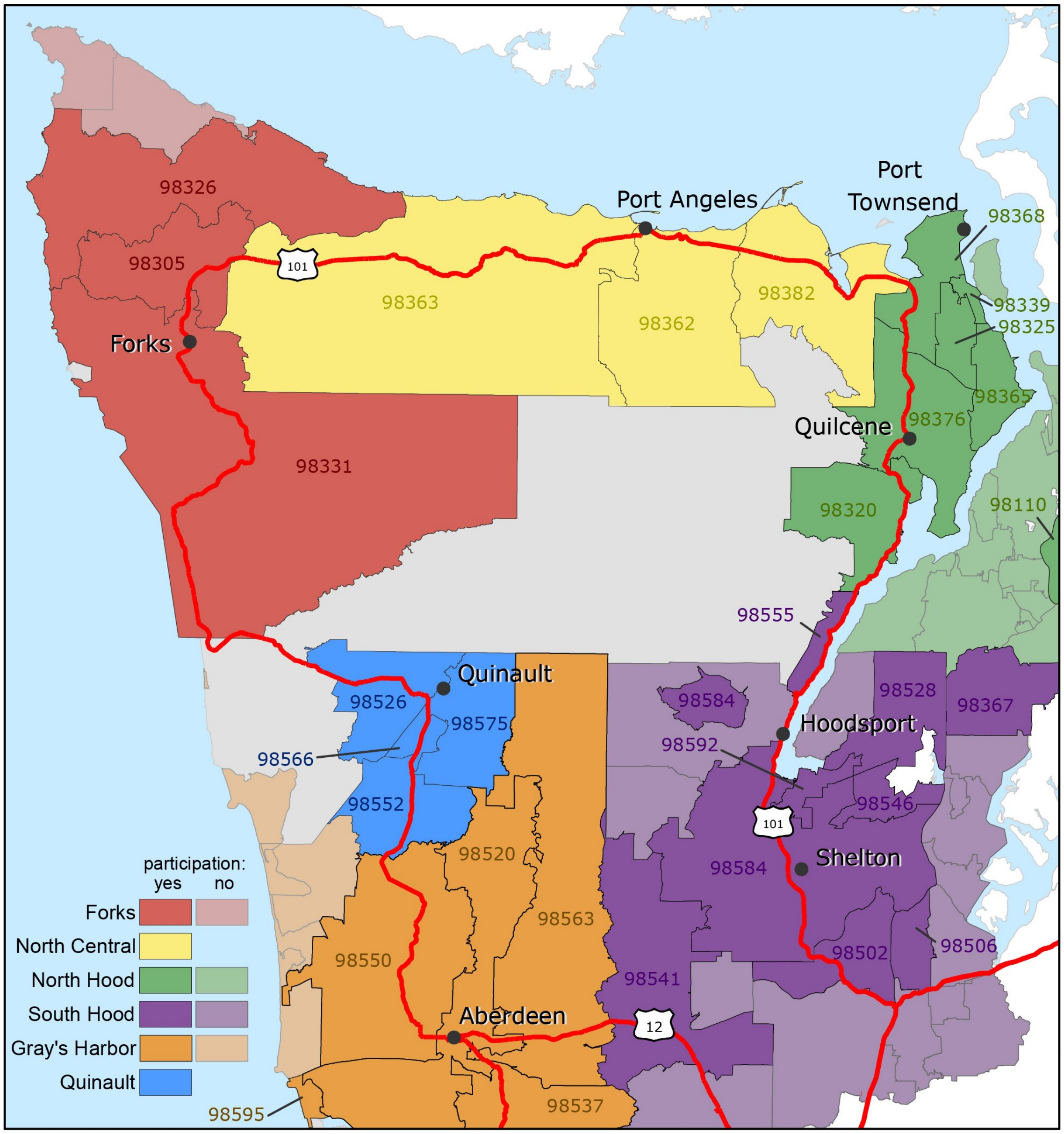

Figure 25 — Zip code zones for sub-regional analysis. The gray area is unpopulated and has no zip code. The white area lies outside the study area.

Figure 25 shows the geographic area included in each of the six zip code zones. Table 6 on the previous page lists the communities included in each of the zip code zones. It also shows differences in the percentages of men and women participating in each of the zones. Male participants outnumbered women in all of the zones except South Hood. The Hoodsport and Shelton workshops attracted seven participants residing in the area bordering the Olympic peninsula to the east. We included these participants in the analysis, as well as one participant from Bainbridge Island who attended the Port Townsend workshop.

Differences in Meaningful Places by Zip Code Zone

Meaningful place density maps for the six zip code zones indicate that participants tended to map areas that were relatively close to their homes (fig. 26). This pattern was strongest for residents in the Forks and Quinault zip code zones, both of which had large and very dense concentrations of meaningful places near the largest settlement within the zone. Among the North Hood and South Hood residents, dense concentrations of meaningful places occupied much less extensive areas and were much more dispersed than for Forks, Quinault, and North Central Zone residents. For residents of the Grays Harbor zone, meaningful places were concentrated around Lake Quinault but the area with high to very high density values was much smaller than for Quinault residents.

Breaking down the dataset into the six residential zones clarifies that the pattern observed in the overall composite map is primarily a combination of the Forks/North Central pattern and the Quinault/Grays Harbor pattern. As noted earlier, this pattern is likely partly the result of differences in mapping styles east side and west side residents and a reflection of differences in the types of values attached to meaningful places by east side and west side residents.

Table 7 reveals important differences in the types of activities mapped by residents of the six zip code zones. Recreational values dominated in the Grays Harbor, South Hood, Forks, and North Central zones. For North Hood residents, aesthetics (22.1 percent of mapped sites) topped the list, followed closely by recreation (18.6 percent of mapped sites). Economic activity sites were dominant in Quinault, followed by home, with recreation a close third.

Table 7— Top four primary values for each zip code zone

Top four primary values	Percent of primary values (within zip code zone)	Top four primary values	Percent of primary values (within zip code zone)
North Hood		**Quinault**	
Aesthetic	22.1	Economic	42.2
Recreation	18.6	Home	18.2
Home	11.0	Recreation	16.6
Heritage	8.3	Social	3.7
South Hood		**Forks**	
Recreation	37.9	Recreation	56.5
Aesthetic	14.3	Economics	16.3
Heritage	7.1	Heritage	8.7
Home	6.6	Home	7.6
Grays Harbor		**North Central**	
Recreation	45.5	Recreation	35.4
Aesthetic	20.2	Aesthetic	16.8
Economic	13.1	Economic	13.3
Home	7.1	Environ. Quality	7.1

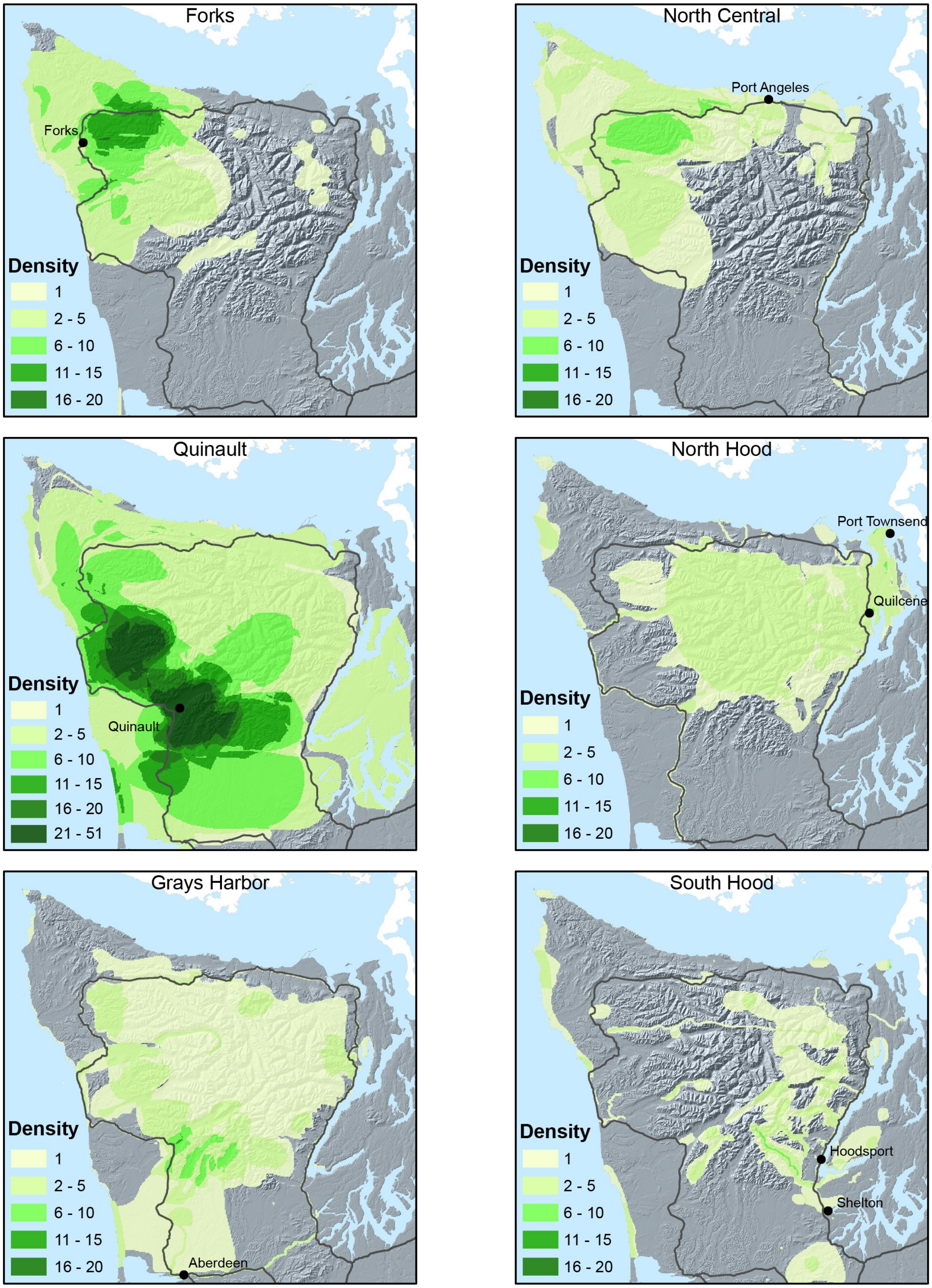

Figure 26—Zip code zone density maps for meaningful places; counts per one-sixteenth square mile

Differences in Outdoor Activity Sites by Zip Code Zone

The composite activity density maps (fig. 28) for the six residential zones revealed a "stay close to home" pattern similar to that for meaningful places. Activity concentrations for residents of South and North Hood tended to be much more linear than those in the other four zip code zones. This pattern likely reflects the importance of Hood Canal to eastside residents and greater use of the park's interior which is accessible only along major river valleys. None of the zip code groups had very extensive areas of high density values for activities within the park's interior. However, it is striking that virtually no activity sites were mapped in the park's core by residents of the Forks and Grays Harbor zones. A breakdown of the frequency of places mapped for activity categories (fig. 27) revealed substantial differences across the peninsula. Non-motorized recreation was by far the most common activity mapped by residents in the eastern and northern zones. Although recreation was an important activity for west side residents, the percent of sites mapped was more evenly distributed across categories. For Quinault zone residents, economic activities were the most frequently mapped category.

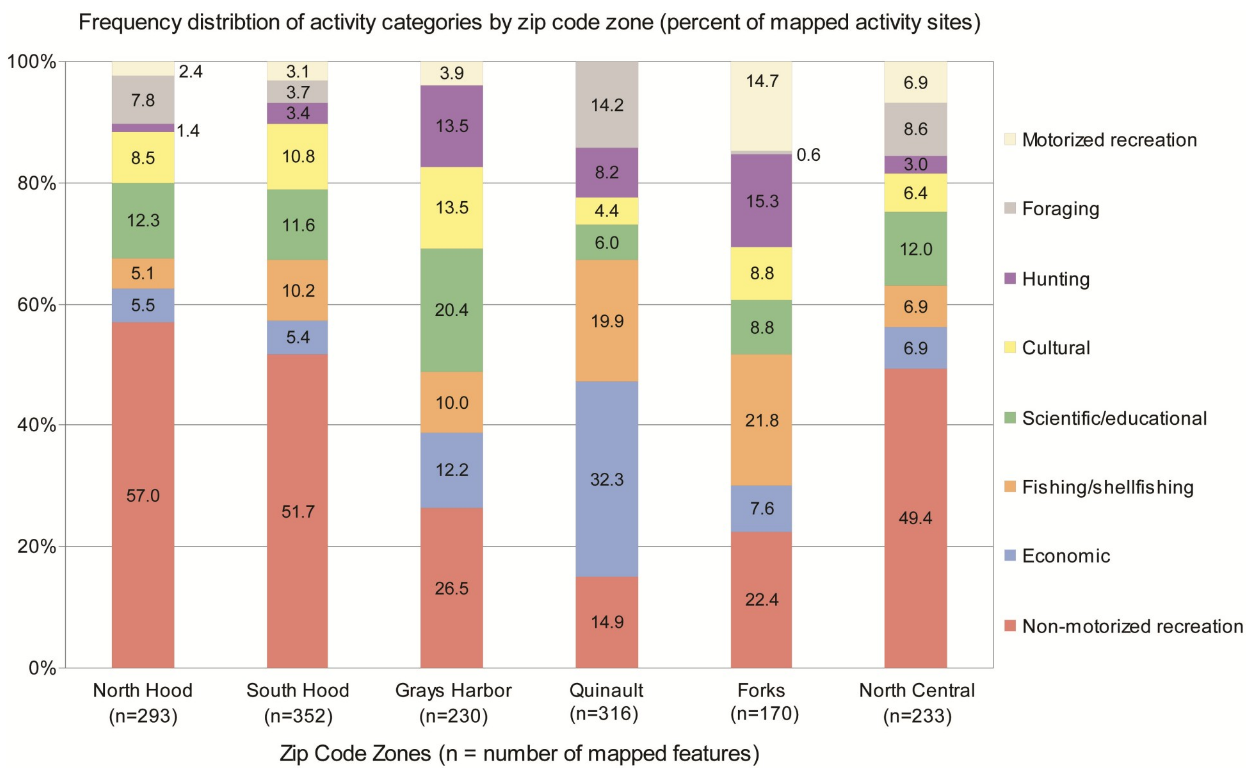

Figure 27—Activity categories by zip code zone

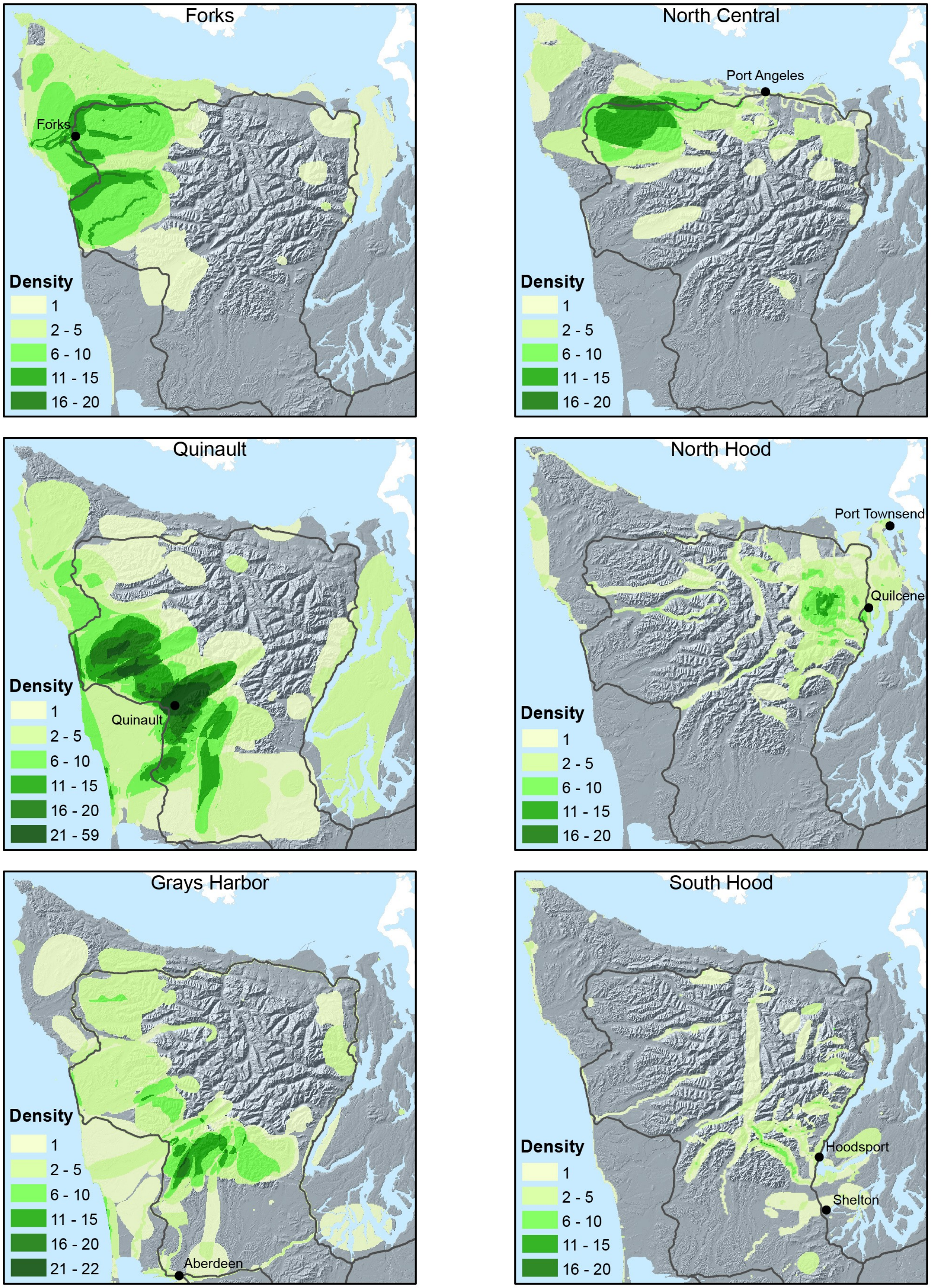

Figure 28—Zip code zone density maps for activity sites; counts per one-sixteenth square mile.

Exploring Values Diversity for Zip Code Zones

Knowing where areas of high values diversity exist for different communities can be helpful in identifying sites that are likely to be more complex to manage and where local tensions may exist over management objectives or between user groups. Values and activity diversity maps for the zip code groupings are tools for gaining better understanding of sub-regional differences.

The maps for residents in Quinault and Forks showed extensive areas with high values diversity (fig. 29). For Quinault residents, the zone of high values diversity was centered around Lake Quinault and the upper reaches of the Quinault river; for Forks residents, high values density areas followed the Sol Duc and Hoh rivers. The North Central map revealed an extensive zone of moderately high values diversity in the Sol Duc river valley between Pleasant Lake (north of Forks) and Lake Crescent (west of Port Angeles), with a small area of high values diversity by Lake Crescent itself. Small areas of high diversity in the western peninsula may be a function of the tendency by west side residents to use much larger polygons, creating greater likelihood for overlaps. The maps for North Hood, South Hood, and Grays Harbor residents had only a few very small and scattered areas with high values diversity.

Exploring Activities Diversity for Zip Code Zones

Areas with high activities diversity at the sub-regional level are likely to be more complex to manage than areas with low activities diversity or, if the activities are incompatible, to be the focus of local user group conflicts. Zip code zone activity diversity maps (fig. 30) show that four of the zip code zones (Grays Harbor, Quinault, Forks, and North Central) had fairly extensive areas with high to very high activity diversity. Areas characterized by high diversity for Quinault were located around Lake Quinault; for Grays Harbor, high diversity areas were found in areas south of the national forest, as well as around Lake Quinault. Among Forks residents, high activity diversity spots included the Sol Duc and Hoh river valleys and the Highway 101 corridor west of Port Angeles. For North Central zone, areas with high activity diversity were found in the mountains and river valleys east of Forks.

Areas characterized by high diversity of activities were less prevalent in North and South Hood. The smaller percent of area with overlapping activities in these two zip code zones could be due to a more homogenous set of uses for the area. However, it could also be a function of the differences in mapping styles. As noted earlier, east side residents were less likely to draw large polygons than the west side residents. As a result, the opportunity for overlap is reduced for those zip code zones.

The activities diversity maps for North and South Hood indicate that for both zones, the Hood Canal is a “hot spot” of diversity. The small size of polygons and greater use of lines and points among the east side residents results in a narrow hot spot band that is less visible than the larger diversity hotspots on the west side of the peninsula where residents tended to use map large polygons for their activities. This differed from the values diversity results, which showed low values diversity along Hood Canal for North Hood residents, but a range from moderately low to high values diversity for South Hood residents.

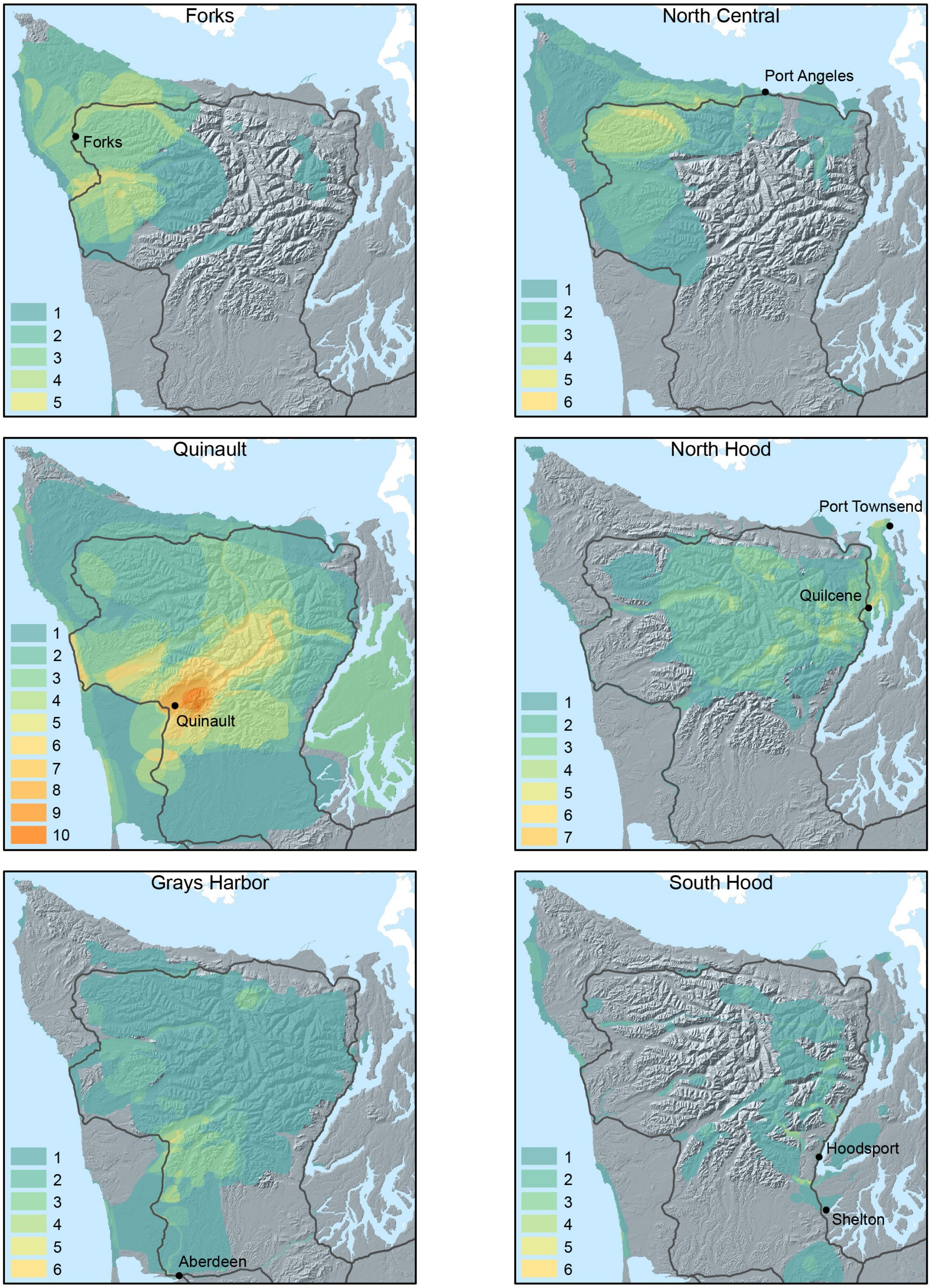

Fig 29—Values diversity by zip code zone; number of different values per grid cell.

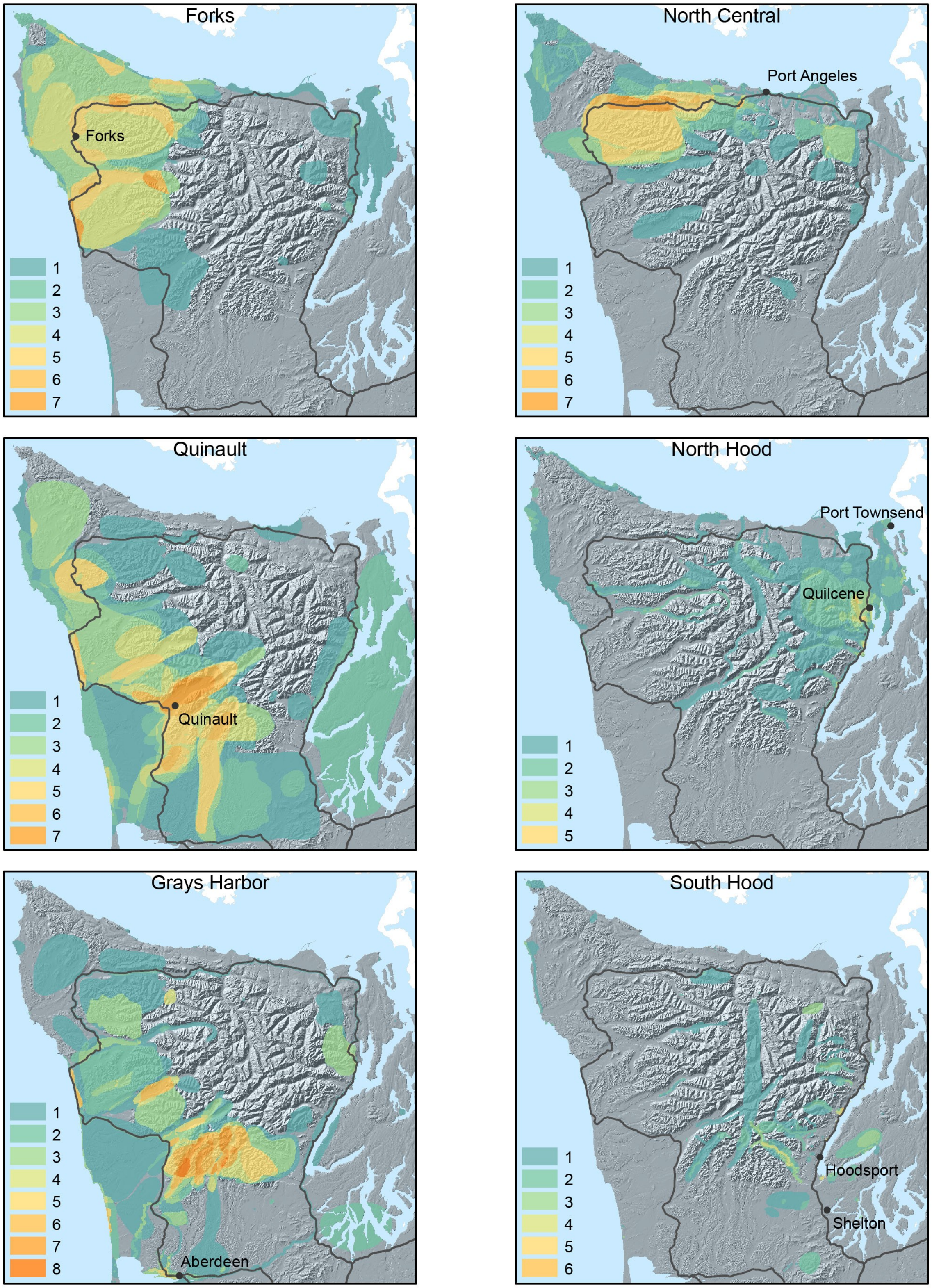

Figure 30—Zip code zone diversity maps for outdoor activities; number of activity sites per grid cell.

Section 5—Integration with Other Data Layers

This section explores the extent to which locations of meaningful places and activity sites vary depending on factors such as land ownership type, vegetation type, steepness of terrain, and distance to roads.

Land Ownership Frequency Ratio Analysis

We explored the relationship between land ownership and meaningful places and activity sites by calculating frequency ratios to see whether high density values for meaningful places and activities were distributed randomly across the five major landownership categories. These categories included national park, other federal lands, state, tribal, and private. On the Olympic Peninsula, the U.S. Forest Service manages the majority of federal land located outside the park's boundaries. Consequently, for all practical purposes the category "other Federal land" serves as a proxy for the Olympic National Forest. The only other federal holdings of any significance are lands managed by the U.S. Fish and Wildlife Service.

The frequency ratios of meaningful place and activity densities for the five ownership categories were calculated in three steps. For each ownership category we first calculated the percent of the total number of grid cells with density values within the top 25 percent. Next we calculated the percent of total area covered by each land ownership category. Then we divided the percent of total grid cells by the percent of total area for each type of ownership. This final figure is the frequency ratio, and is useful for determining whether meaningful places or activity sites are disproportionately present in (or absent from) each of the land ownership categories.

A frequency ratio of less than 1 indicates a negative correlation between high density values and the ownership category. Ownership categories with negative correlations have fewer high density values than one would expect given the amount of area in that type of ownership. A frequency ratio of greater than 1 indicates a positive correlation. Ownership categories with positive correlations have more high density values than one would expect given the area in that type of ownership. A frequency ratio of 1 or that is very close to 1 indicates no correlation. If there is no correlation, then the observed percent of high density values in that ownership type is what would be expected given the amount of area in that ownership category.

Table 8—Thresholds for determining correlation for frequency ratios

Frequency ratio	Correlation
Greater than 1.50	Positive
1.26 to 1.50	Weak positive
.75 to 1.25	None
.5 to .74	Weak negative
Less than .5	Negative

The frequency ratio calculations for the top 25% of density values for meaningful places and activity sites for the five major land ownership categories are displayed in Tables 9 and 10. Table 9 indicates that high density values for meaningful places are disproportionately present on national forest and state lands. The positive correlation for national forest lands, however, is stronger than for state lands.

Although the frequency ratio for the national park was positive, it was only marginally so and the correlation is very weak. The correlation for tribal and private lands was negative, indicating that relatively few people marked meaningful places on those lands relative to the percent of land in those ownership categories. The results for activity site density are similar, except that the association between state ownership and the top 25% of density values for activity sites is somewhat stronger.

Table 9—Frequency ratio of top quartile of meaningful place density values by ownership category

Landowner	Percent total area	Percent total occurrence	Frequency ratio	Correlation
National Park	0.20	0.23	1.15	None
Other Federal	0.15	0.34	2.22	Positive
State	0.12	0.17	1.42	Weak positive
Tribal	0.05	0.02	0.28	Negative
Private	0.47	0.24	0.51	Weak negative

Table 10—Frequency ratio of top quartile of activity density values by ownership type

Landowner	Percent total area	Percent total occurrence	Frequency ratio	Correlation
National Park	0.20	0.17	0.83	None
Other Federal	0.15	0.33	2.13	Positive
State	0.12	0.19	1.61	Positive
Tribal	0.05	0.01	0.24	Negative
Private	0.47	0.30	0.64	Weak negative

Vegetation Frequency Ratio Analysis

Frequency ratio analyses can be used to explore whether meaningful places or activities are more likely to be found in some vegetation types rather than others. High densities of meaningful places are found disproportionately in areas where the dominant vegetation is silver fir, and are also positively correlated, albeit more weakly, with western hemlock (table 11). They are least likely to be associated with woodland-prairie mosaic (which tends to be farmland), along shorelines, and in areas with permanent ice and snow cover.

Table 12 shows frequency ratios for dense activity sites in the 11 vegetation categories. The pattern is similar to that identified for meaningful places, with dense values for activities being associated disproportionately with silver fir, and to a lesser extent with western hemlock.

Table 11—Frequency ratio of top quartile of meaningful place density values by vegetation type

Vegetation	Percent total area	Percent total occurrences	Frequency ratio	Correlation
Shoreline	0.01	<0.01	0.06	Negative
Woodland/Prairie	0.03	<0.01	0.00	Negative
Sitka Spruce	0.16	0.19	1.19	None
Puget Sound Doug-fir	0.20	<0.01	0.01	Negative
Olympic Doug-fir	0.04	0.01	0.13	Negative
Western Hemlock	0.37	0.52	1.41	Weak positive
Silver Fir	0.10	0.22	2.20	Positive
Subalpine Fir	0.01	<.01	0.45	Negative
Mountain Hemlock	0.05	0.04	0.97	None
Alpine/ Parkland	0.04	0.02	0.39	Negative
Permanent Ice/Snow	0.00	<0.01	0.07	Negative

Table 12—Frequency ratio of top quartile of activity density values by vegetation type

Vegetation	Percent total area	Percent total occurrences	Frequency ratio	Correlation
Shoreline	0.01	0.0014	0.10	Negative
Woodland/Prairie	0.03	0.0001	0.00	Negative
Sitka Spruce	0.16	0.1965	1.23	None
Puget Sound Doug-Fir	0.20	0.0080	0.04	Negative
Olympic Doug-fir	0.04	0.0096	0.26	Negative
Western Hemlock	0.37	0.5440	1.47	Weak Positive
Silver Fir	0.10	0.2043	2.04	Positive
Subalpine Fir	0.01	0.0061	0.69	Weak negative
Mountain Hemlock	0.05	0.0200	0.44	Negative
Alpine/ Parkland	0.04	0.0102	0.27	Negative
Permanent Ice/Snow	0.00	0.0000	0.00	Negative

One possible conclusion from the frequency ratio analyses for vegetation is that people tend to value places and do outdoor activities in areas where silver fir, western hemlock and Sitka spruce predominate. However, it is also possible that those vegetation types are disproportionately located in lands that are publicly owned, and which are therefore more likely to be accessible to a larger number of people. To test for this, we ran a frequency ratio analysis to see how vegetation types were correlated with ownership. Silver fir was disproportionately located in the Olympic National Park and the Olympic National Forest, while western hemlock was disproportionately found on federal and state lands (table 13). These results suggest that land ownership type rather than vegetation type is the explanatory factor for the observed patterning of meaningful places and activity sites.

Table 13—Frequency ratio of vegetation type by ownership type

Vegetation Type	National Park	Federal (other than park)	State	Tribal	Private
Shoreline	0.02	0.10	0.31	1.43	1.85
Woodland Prairie Mosaic	0.00	0.00	0.21	0.32	2.04
Sitka Spruce	0.31	0.07	0.93	5.74	1.12
Puget Sound Doug-Fir	0.00	0.05	0.92	0.14	1.86
Olympic Doug-Fir	1.23	3.57	1.20	0.00	0.16
Western Hemlock	0.61	1.27	1.50	0.39	1.04
Silver Fir	2.77	2.33	0.71	0.17	0.00
Subalpine Fir	3.17	2.42	0.00	0.00	0.00
Mountain Hemlock	4.35	0.85	0.02	0.00	0.00
Alpine Parkland	4.48	0.68	0.00	0.00	0.00
Permanent Ice/Snow	5.00	0.00	0.00	0.00	0.00

Terrain Roughness Frequency Ratio Analysis

We expected that both activity site and meaningful place density would be affected by terrain roughness. However, we anticipated that the relationships might be complex as terrain roughness could be both a barrier and a draw. The steep terrain and lack of roads makes much of the Peninsula inaccessible for many people. However, the rugged terrain results in some very spectacular views and visitors may be drawn to hard-to-reach viewpoints. Moreover, rugged terrain is a draw for some outdoor activities, such as mountain climbing or backpacking. We conducted a frequency ratio analysis similar to that used for the vegetation and ownership analyses to explore how terrain roughness is related to meaningful place and activity site density. Appendix D describes how terrain roughness was defined and calculated.

Tables 14 and 15 show that high densities for meaningful places were positively correlated with moderate to high terrain roughness. High density values for activities were positively correlated with places characterized by moderate to moderate high terrain roughness, but were not correlated with high terrain roughness.

These results suggest that while participants value very steep areas, they spend more time in moderate to moderately rough terrain. This pattern is illustrated in figure 31.

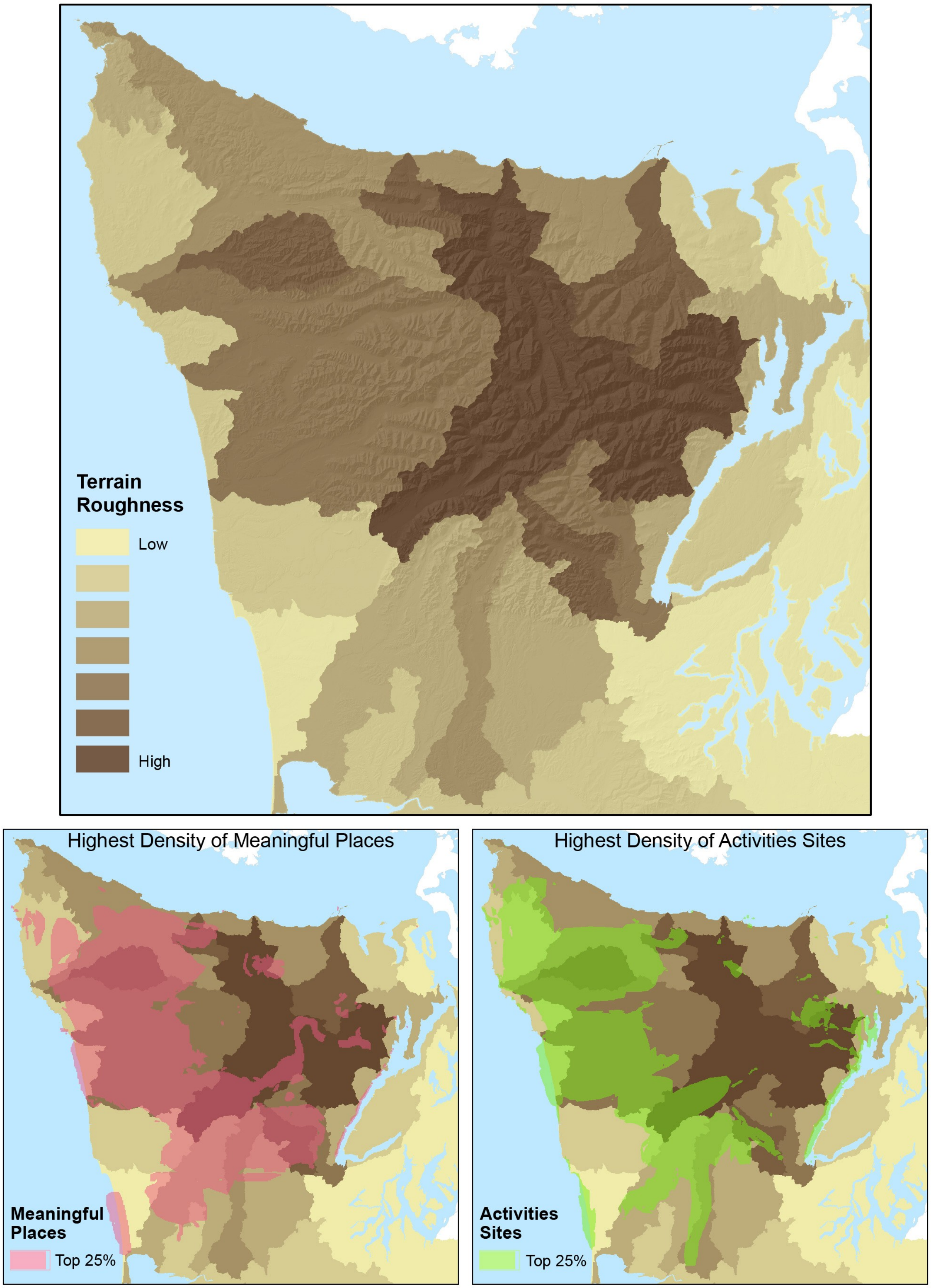

Figure 31— Terrain roughness and meaningful place and activity site density

High density values for meaningful places extended into the Olympic National Park's interior, much of which is very steep. By contrast, high density values for activities only extended a short way into the park. The terrain roughness and meaningful places/activity site density analyses are similar to the vegetation analyses in that land ownership category may be an intervening factor. The majority of the roughest terrain on the peninsula is located in designated wilderness where certain activities, such as motorized recreation and logging, are prohibited. The less rough terrain is primarily in private or tribal ownership and thus is likely to be less accessible than the rougher terrain on public lands. The frequency analyses for terrain roughness were performed for all values and activities but would likely yield different results if they were conducted for specific values or activities.

Table 14—Frequency ratio of top quartile of meaningful place density by terrain roughness

Roughness (range in elevation in meters)	Percent total area	Percent total occurrences	Frequency ratio	Correlation
0 - 8.85	0.47	0.32	0.69	Weak negative
8.85 - 22.13	0.24	0.24	0.99	None
22.13 - 38.72	0.17	0.26	1.48	Weak positive
38.72 - 59.74	0.09	0.15	1.60	Positive
59.74 - 282.09	0.02	0.03	1.36	Weak positive

Table 15—Frequency ratio of top quartile of activity density by terrain roughness

Roughness (range in elevation in meters)	Percent total area	Percent total occurrences	Frequency ratio	Correlation
0 - 8.85	0.47	0.36	0.77	None
8.85 - 22.13	0.24	0.26	1.07	None
22.13 - 38.72	0.17	0.23	1.35	Weak positive
38.72 - 59.74	0.09	0.12	1.32	Weak positive
59.74 - 282.09	0.02	0.02	1.01	None

Proximity to Roads Analysis

One of the most important physical features of the Olympic Peninsula is the extensive network of roads surrounding the large roadless wilderness of Olympic National Park and adjacent Forest Service wilderness areas. As figure 34 shows, these roads vary from US 101, the main highway that nearly circles the peninsula, to paved access roads for the national park, to the myriad of roads on USFS and DNR land, built primarily for timber extraction but now important for recreation access as well.

A clear visual association between peninsula roads and areas of high density of meaningful places/activities is apparent, and even more evident in the maps of diversity of values and activities. To test the relationship between density of meaningful places and distance from roads, two regression models were created. For both models, density of meaningful places was the dependent variable and distance from roads was the explanatory variable. Only Class 1, 2, and 3 roads as shown in figure 35 were used for this analysis. Euclidean distance from roads was calculated and then those values spatially joined to the grid cells of density values.

An Ordinary Least Squares (OLS) regression for the entire Olympic peninsula proved to be a poor fit. This model exhibited large spatial variation within the study area, indicating that a Geographically Weighted Regression (GWR) might be the more appropriate model. GWR fits a linear regression equation to every feature in the dataset, in this case each grid cell.

While the GWR model explains much of the dependent variable with a high Adjusted R squared value and had mean residual values much lower than the OLS model, the model proved not to be a good fit. At this regional scale of analysis, the only areas that are not close to a road are the designated wilderness of the national park and national forest. Areas of value and activity may be more likely to be related to land management boundaries than to proximity to roads.

Figure 32—Road network on the Olympic Peninsula

Section 6—Conclusion

Major patterns identified through human ecology mapping

Importance of recreation at the regional level: Our study highlights the overriding importance of the Olympic Peninsula as a recreational landscape for workshop participants. Recreation was by far the most common primary value associated with meaningful places. Participants overwhelmingly mapped recreational activities, even though we explicitly stated during the workshops that any outdoor activities could be mapped. Moreover, recreation dominates residents' interactions with the local landscape if subsistence activities such as hunting, fishing, and foraging are included in the recreation category. For the majority of participants, outdoor activities tended to involve non-motorized forms of recreation, such as hiking, camping, biking, or bird-watching.

Importance of public lands: The regional analyses also highlight the importance of public lands for Olympic Peninsula residents. High density values for meaningful places and activities are strongly correlated with public lands, most notably lands located along the western front of the Olympic range that are managed by the Olympic National Forest or Washington Department of Natural Resources. These lands are located on less steep terrain and are more readily accessible by road than public lands on the Olympics' eastern front or at their core.

Distinct differences exist between east and west side residents' activity patterns: The zip code zone density maps, as well as the activity and values charts, point to significant differences between residents on the east and west side of the Olympic Peninsula. The Grays Harbor and Quinault zones' activity density maps have considerable overlap, as do the maps for the Forks and North Central zones. Additionally, the activity density maps for all four of those zones overlap in the northern watersheds. Neither the North Hood and South Hood zones' activity locations overlap much with the four west side zones, but they do overlap considerably with each other. There is an east/west side division relative to the spatial extent of meaningful places (irrespective of the values attached to them), but the pattern is less distinct than for activities. The east-west difference is even more apparent in the charts and figures comparing the zip code zones by activity category and value type.

Residents value places and do things close to home: The zip code zone density maps indicate that Olympic Peninsula residents had a strong tendency to value places near their homes. Participants had an even greater tendency to do outdoor activities relatively close to home. However, some important differences were found across the peninsula. Activity sites mapped by east side participants (North Hood and South Hood) showed a more dispersed pattern than that shown on the westside density maps, all of which tended to have one or more very large areas with very dense values located within the zip code zone boundaries.

Human ecology mapping applications

Identifying general patterns at a regional scale: The human ecology mapping approach tested on the Olympic Peninsula is particularly useful for identifying general patterns among participants in the distribution and intensity of meaningful places and the values attached to them. It also is helpful for discerning general patterns in the locations of outdoor activity sites and the types of activities associated with them. As such, the data is most suited for regional level planning. The scale of the map used in the workshops was not conducive to producing data precise enough for use in sub-regional or site-level planning.

Exploring differences in patterns among subgroups: The inclusion of questions aimed at soliciting data about participants' demographic characteristics enabled us to explore how differences in meaningful place and activity locations were linked to demographic characteristics. Although our sub-group analyses focused on gender and place of residence, comparisons could also be developed based on age group and length of residence on the peninsula. We did not include age and length of residence analyses as space was limited and the patterns across categories did not differ substantially. Gathering data about ethnicity, income, and level of education would permit even more detailed understanding of differences among sub-groups.

Locating places where conflicts exist or that have potential for conflict: The diversity analyses provide a starting point for identifying areas characterized by a large number of overlapping values or activities. Such areas are likely to be focal points for conflicts among user groups or stakeholders. The contested areas linked to the Wild Olympics campaign, for example, show up quite clearly as hot spots on both the values and activity diversity maps in this atlas. A comparison of the individual value or activity density maps is a quick way to get a rough sense of what values or activities are likely to be in conflict at hot spot locations.

Key lessons learned

The values people map represent a snapshot at a particular point in time: In all situations, human ecology mapping elicits values that are important to the participants at the time of the mapping session. Both previous and current tensions over natural resources are likely to influence what values people choose to map and how they choose to map them. In situations where tensions are particularly intense, the influence of such tensions on what people map is clear. More often, however, these tensions are much more subtle. It is tempting—but misguided—to conclude that data produced in contexts where resource conflicts are less visible are of better quality than data produced in situations where they are overt. The fact that differences occur over time in the types or locations of values mapped does not invalidate the data but rather points to the importance of gathering longitudinal data about cultural values. It also highlights the importance of understanding how tensions over resources can affect who participates in mapping, their mapping styles, and the resulting patterns that appear on values and activity density maps.

Use the right map at the right scale: "Plant the right tree in the right place" is the guiding principle for urban foresters. "Use the right map at the right scale" is an equivalent guiding principle for human ecology mapping. However, following this principle is challenging as what the right map is depends on who is doing the mapping and what the intended goals are. For example, the more features included on the map, the easier it will be for the mapper to identify key locations. However, what features are included on the map can also influence what people map. Features that are labeled may more readily be mapped than those that are not. Understanding who the mappers are, how familiar they are with the area represented on the map, and their familiarity with how to interpret maps are all critical elements in creating the "right" map. The right scale is equally critical. If the goal is regional planning, then mapping at the regional scale is adequate. But if the goal is site-level planning, then a map at a much different scale is required.

Study design considerations

Sample size and sampling strategy: A question that audience members have raised when we've presented preliminary findings of this study is whether a sample size of 169 is adequate given the size of the population on the Olympic Peninsula. In answering this question, we note that what constitutes an adequate sample size varies depending on the structure and the goals of the study, as well as on the variability in the study population. The primary goal of our study was to develop and test a qualitative method for collecting spatial data for cultural values and outdoor activities. A sample size of 169 is well within expectations for this type of an approach. The number of participants in qualitative values mapping studies in the US has ranged from as few as 37 on the Kootenai National Forest (Cacciapaglia et al. 2012) to as many as 90 in the Palouse region of eastern Washington (Donovan et al. 2009). The number of participants in random sample quantitative values mapping studies (typically implemented through either mail or internet surveys) in the United States has varied from as low as 179 on the Mount Hood National Forest in western Oregon to as high as 344 on the Deschutes and Ochoco National Forests in central Oregon (Brown and Reed 2009). From the standpoint of having enough data for meaningful spatial analysis, Brown and Pullar (2012) recommend a minimum of 25 respondents irrespective of the overall population size for polygon-based mapping and 300 or more for point-based methods.

Of much greater concern than the number of participants, however, is whether a sufficiently diverse set of people are included in the mapping workshops. Key segments of the resident population, including motorized recreationalists, commercial nontimber forest products harvesters, tribal members, and Latino residents were absent in many of the community workshops. Given that we engaged in an intensive outreach campaign for all of the workshops, including working through community leaders, the consistent absence of key sub-groups suggests that methods other than the public workshop format are needed for reaching those groups. Examples of approaches that could be used are discussed in the section on next steps.

Seasonality of mapping: A second question that has been raised is whether the time of the year that the mapping workshops take place is likely to affect the values and activities mapped. For example, all of our workshops took place in late summer or fall before any major snowfalls. In all of the workshops, very few participants mapped winter sports activities. One conclusion is that participants might have mapped snow-based activities if the workshops had been held in the winter. However, the link between seasonality and the activities or values mapped is unclear since the Olympic Peninsula is by no means a hot spot for winter sports. Indeed, we would have been surprised to see a large number of people mapping such activities. Avid winter sports enthusiasts on the peninsula are likely to go to the Cascades, which are relatively close, have many more easily accessible activity sites, and far better snow conditions for winter sports than the Olympic Mountains. Nonetheless, in areas where there are strong differences in activities over the course of the year, it would be worthwhile to investigate how seasonality affects the locations and types of values or activities that participants map.

Next steps

The human ecology mapping project described in this atlas provides insights about the places Olympic Peninsula residents value and why they value them. It also provides information about the types of outdoor activities that are important to residents and identifies the general locations where they tend to do them. Missing from this picture, however, are the perspectives and experiences of non-resident visitors. Also missing are the perspectives of people who never visit the peninsula but who nonetheless consider it a meaningful place and attach values to it. The values of non-residents, whether visitors or not, are important to capture given that they greatly outnumber residents and that their views are likely to influence the debates about how state trust lands, the Olympic National Forest, and the Olympic National Park should be managed. Additionally, as noted on the previous page, a number of important subgroups of the resident population were absent from the workshops. To reach out to a more diverse set of stakeholders, we have taken the following steps.

Targeted focus groups: In 2011, we tested a targeted focus group approach with Latino residents in the southeastern Olympic Peninsula (Biedenweg et al. in review). Based on the success of that effort, we plan to organize other targeted stakeholder meetings to see how that approach works for reaching groups that might be reluctant to participate in general public workshops and to see how the two approaches compare in terms of cost-effectiveness and the time needed to implement them.

Mapping visitor perspectives: As a first step in collecting data from visitors, in summer 2012 two of our team members tested a face-to-face survey approach at trail heads, visitor centers, ferries, and other venues where visitors to the peninsula can be readily interviewed. Our initial impressions were that the approach was an effective way to obtain data from both visitors and residents. Once the data have been processed, we will be able to tell whether the data gathered from residents through this method differs substantially from that gathered through the public workshop approach.

Web-based mapping: Finally, to reach people who never visit the peninsula, and to expand the participation of visitors and residents, in 2013, we are exploring the feasibility of using an open source mapping program to gather meaningful place and activities data. Our intention is to adapt the mapping process to a web-based environment so as to expand the number of people who can potentially contribute data about meaningful places and activity sites on the Olympic Peninsula.

Each of these approaches implemented on its own produces data that while sound, is inevitably partial to a particular set or sets of stakeholders. Rather than relying on one single method, a much more robust set of cultural values data is produced when multiple approaches are used simultaneously. Testing and refining this suite of methods is a critical first step toward developing a set of practical tools that planners can draw upon to integrate cultural values data into ecosystem planning processes.

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Data layers used in creating maps

Precipitation—PRISM Climate Group 30 year average (1971-2000)
Elevation—United States Geological Survey, National Elevation Dataset 30m Digital Elevation Model
Land Ownership—Bureau of Land Management/Oregon and Washington, Surface Management Ownership polygons

Appendix A: Workshop Format

The human ecology mapping project employed a facilitated participatory mapping workshop design using hardcopy 3' x 3' base maps of the Olympic Peninsula. The base maps included numerous labeled features (such as roads, rivers, beaches, towns, mountain peaks, and jurisdictional boundaries) and an underlying hillshade showing topography. Lessons learned in the first workshop in Quilcene indicated that a base map at the regional level – especially for a region as geographically complex as the Olympic Peninsula – required a high number of labeled features in order for participants to easily locate the areas they wished to map.

Eight mapping workshops were conducted in towns located throughout the Peninsula. A wide variety of recruitment strategies were employed to reach a broad spectrum of community residents. Participants were assigned to a table (ideally about four persons per table) on which was a base map of the peninsula overlaid with a clear sheet of mylar. Participants drew features directly on this mylar. The use of mylar sheets reduced the number of maps used from about 40-50 to eight, saving on printing costs. The mylars were cleaned after digital scanning and reused in subsequent workshops.

Each participant was given a collated worksheet packet for recording location names, values and activities related to that location, qualitative data about the mapped sites, and a demographic data sheet (Appendix F). Conversations between participants at a table occurred throughout the exercise, though each participant mapped individually. During the exercise, several facilitators were available to assist participants in clarifying the instructions or in locating features on the base map. Gazetteers were available at each table and were used to locate features not easily identifiable on the regional base map.

The workshops consisted of two mapping exercises – Meaningful Places and Activities – lasting about 20-30 minutes each. In the Meaningful Places exercise, participants were asked to locate on the base map and draw on the mylar (using points, lines or polygons) a maximum of five places that had particular meaning for them and to assign one primary value to each place from a list provided. Participants could also attach as many secondary values to the location as they wished. The values list was slightly modified from a well-tested landscape values typology (Brown and Reed, 2009) in order to create an acceptable level of standardization for compilation and analysis of the data. Participants were asked to choose a primary value so that a single value could be attached to that location and used for mapping purposes.

In the Activities exercise, participants were asked to identify three outdoor activities they enjoyed on the peninsula and to draw on the mylar (again using points, lines or polygons) up to five locations where they did that activity. Participants were provided with a list of possible activities as a prompt (Table 3), but were not required to choose from this list. A list of all the activities identified by participants was compiled at the conclusion of the project and subsequently categorized into eight clusters of related activities to facilitate data aggregation, mapping, and spatial analysis.

Appendix B—Data Collection

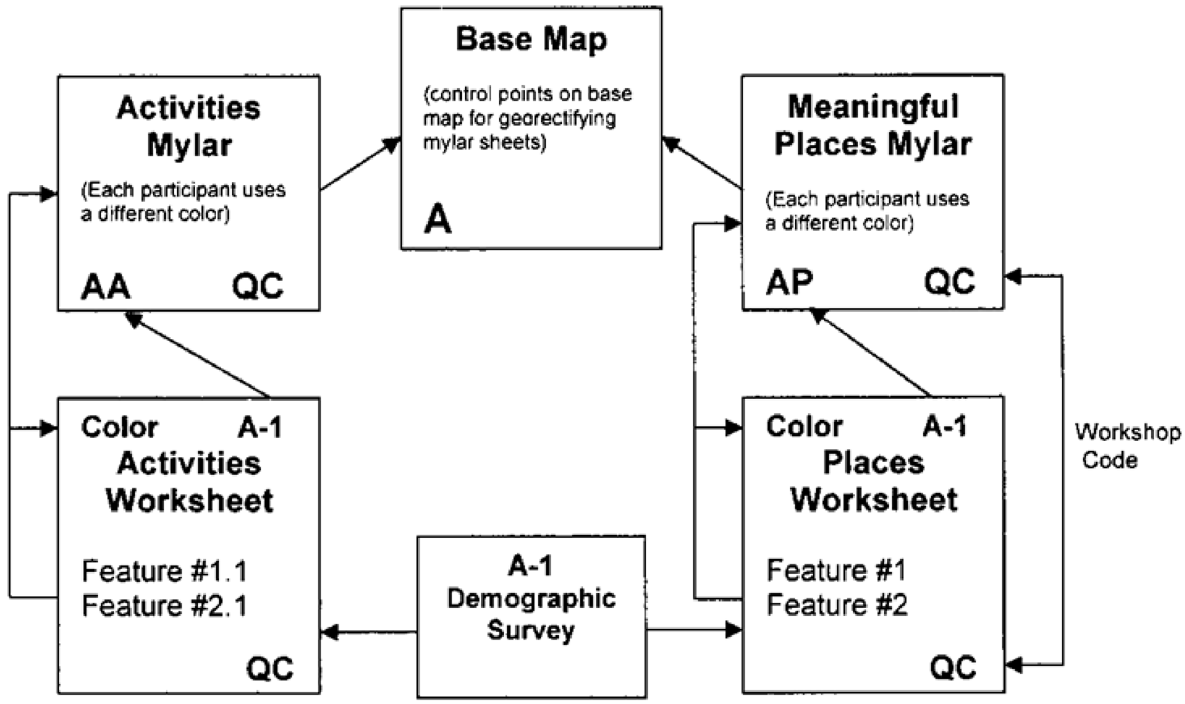
Because the data collected in this project is intended for both land managers and public dissemination, care was taken to preserve the confidentiality of workshop participants. Only basic demographic information was gathered (residential zip code, birth year, number of years living on the peninsula, and occupation). A coding system was developed that, when concatenated, provided a unique identifier for each mapped feature that preserved participant confidentiality while offering a means to trace each feature back to a workshop, base map, exercise and worksheet for quality control purposes. The schematic and explanatory text in figure 33 illustrates the coding system.

Each workshop was assigned a letter code. The base maps were also assigned a letter code (from A-E) representing each table. The mylar sheets for each exercise were associated with a particular workshop and table through these letter codes and an additional letter signifying “A” for the Activities exercise and “P” for the Meaningful Places exercise. The combination of these letter codes allowed each mylar sheet (when removed from the base map) to be easily traced back to a particular workshop, base map and mapping exercise.

The participant worksheet packets were also labeled with the letter code corresponding to the workshop and a table, with an additional sequential number identifying a unique participant (1-7). This provided a unique identifier for each participant. These identifying codes were prepared by facilitators in advance of the workshop. Upon arrival, participants were given a coded worksheet packet and asked to go to the table indicated on the packet. In the interest of simplicity, the only coding participants were asked to do was label their map features with the number corresponding to the description they provided on their worksheet.

Since multiple participants were at a table and drawing on the same mylar sheet (with no differentiating labeling instructions), each participant at the table was asked to choose a unique color marking pen and indicate this color on their worksheet packet. The color was used to associate features drawn on the mylar with the correct worksheet during the data processing stage. Concatenating all the code segments created the unique feature identifier used to join the digitized map elements with the descriptive data provided on the worksheets.

Figure 33—Coding system used to link mapped features to worksheet data



Unique Workshop Code: Quilcene = QC

Unique Participant ID: Workshop Code + Worksheet Number that includes a table assignment and participant number (QC-A1)

Unique Feature ID: Combination of Participant ID, Mylar Code and Feature Label

Example: QC-A1-AA-1.1 This code indicates that the mapped feature is he first feature in the Activities exercise drawn by Participant 1 at Table A in the Quilcene workshop.

Appendix C—Data Processing

The attribute table. Data from the participant worksheets were transcribed into a digital spreadsheet. Columns in the spreadsheet contained the unique codes for the workshop, mylar, worksheet and feature labels and were used for various sorting purposes and concatenated for the unique feature ID. Other columns recorded all information participants listed on their worksheets including location names, primary and secondary values, activities, and any other descriptive text. Each location listed in the worksheet became a record in the table. Demographic data on the participant was also appended to each of the feature records. Data from the Meaningful Places and Activities exercises were stored in separate spreadsheets.

Scanning and digitizing. The Olympic Peninsula base map contained eight "control points." After a mylar was attached to the base map, these control points were immediately transferred to the mylar. The mylar, once removed from the base map, had no defining landscape features (only generalized points, lines and polygons drawn by participants). Thus, it was imperative that these control points were transferred to the associated mylar when it was attached to the base map used in a mapping exercise. Otherwise, it would have been extremely difficult (if not impossible) to georectify the mylar properly.

Completed mylars were scanned as TIF files and georectified with GIS software using the control points and the GIS layout of the base map. Features on the mylars were manually digitized and assigned a unique feature ID based on the associated worksheet (as described above). The use of an automated vectorization tool was not possible due to the propensity for overlapping polygons and the numerous labels drawn on the mylar. Information written on the worksheet, such as a location name, provided confirmation and cues for each digitized feature.

Points, lines and polygons. Because of their geometric incompatibility, features drawn as points, lines or polygons had to be initially digitized and saved in separate databases. To combine the different feature types it was necessary to create a small buffer around the points and lines (100 ft.) thus creating polygons. Once all the features were digitized (and buffered if necessary), all the data was merged into an Activities and a Meaningful Places database, the polygons were slightly smoothed to remove digitizing anomalies, and joined to the attribute table using the feature ID. Once combined, the databases were ready for the various spatial analysis operations illustrated in this atlas.

On average, each mylar required approximately 1-1/2 hours for complete processing, or roughly 64—72 hours total for the eight workshops.

Appendix D—Analysis Techniques

Density analysis

Density was calculated by spatially joining the datasets to a quarter-mile grid. First a quarter-mile fishnet was created and converted to polygons. The values and activities were subset by category and individually spatially joined with the grid polygons. We also experimented with calculating density by overlaying the unaltered polygon shapes and counting up the number of overlapping polygons for each polygon sliver created through the overlay. This was accomplished through a union of the data with itself and then dissolving by area. The buffers around the point data were randomly modified to make the union followed by dissolve process possible. The union created 19 million polygons and the dissolve took 6 hours. The result of the alternate processing method produced very similar patterns to the grid method. Given that the results were similar and the alternate method was much more computationally intensive, we used the grid cell method to do the density analyses.

Diversity analysis

Values and activity diversity were calculated using a technique similar to that used for the density maps. The individual categories of values or activities were joined to a quarter-mile grid. The grid features were then converted to a raster based on the join count. Each raster was reclassified so that any raster cell with a value greater than '0' became '1', and any raster cell with a value less than '1' became '0'. This creates a binomial dataset with presence or absence for each value/activity. To calculate the diversity, all the values/activities layers were summed using the raster calculator to get the number of values/activities for each cell.

Frequency ratio analysis

The frequency ratios of meaningful places and activities densities for the five ownership categories were calculated in three steps. For each ownership category we first calculated the percent of the total number of grid cells with density values within the top 25 percent. We used the top quartile rather than all values and activities because we were interested in identifying the patterns of dense concentrations of values or activity sites. Next we calculated the percent of total area covered by each land ownership category. Then we divided the percent of total grid cells by the percent of total area for each type of ownership. This final figure is the frequency ratio, and is useful for determining whether meaningful places or activity sites are disproportionately present in (or absent from) each of the land ownership categories.

A frequency ratio of less than 1 indicates a negative correlation between high density values and the ownership category. Ownership categories with negative correlations have fewer high density values than one would expect given the amount of area in that type of ownership. A frequency ratio of greater than 1 indicates a positive correlation. Ownership categories with positive correlations have more high density values than one would expect given the area in that type of ownership. A frequency ratio of 1 or that is very close to 1 indicates no correlation. If there is no correlation, then the observed percent of high density values in that ownership type is what would be expected given the amount of area in that ownership category.

Appendix D (continued)

Terrain roughness analysis

Terrain roughness was calculated as the range in elevation values in the neighborhood surrounding each cell in a 30m DEM. A 3 by 3 cell neighborhood was used for the calculations. We used Jenks natural breaks (5 classes) to create the terrain roughness categories. The maps show the mean roughness of each fourth field watershed, a unit chosen because it best illustrates the difference between the east side and west sides of the Olympic peninsula. A watershed is an area in which all the surface waters flow to the same location. A fourth field watershed is the smallest subdivision in the US Geological Survey's watershed classification system. Fourth field watersheds are also called subbasins.

Appendix E — Workshop Instructions and Protocol

Facilitator Instructions

Human Ecology Mapping Project Poster

Example Confidentiality Statement

Demographic Survey

Activities Worksheet

Activities List

Meaningful Places Worksheet

Landscape Values List

Exit Survey