
The Rain Forests
of Home:
An Atlas of
People and Place

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Part 1: Natural Forests and Native Languages of the Coastal Temperate Rain Forest

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An Interrain Publication

FOREWORD

People and place - indigenous cultures and an extraordinarily rich forest and marine bioregion - developed together in the coastal temperate rain forests of North America in the millennia following the most recent Ice Age. The unusual diversity and abundance of fish, shellfish, wildlife, and forest resources that characterize this bioregion supported one of the densest populations of non-agricultural peoples known anywhere on earth. Native languages proliferated and distinct cultures arose up and down the coast partly in response to the local variations in resource abundance.

The south-to-north sweep of the western industrial economy that followed settlement has diminished both indigenous cultural and ecological integrity. Languages, art, and an irreplaceable legacy of cultural knowledge of the environment have been lost as fast or faster than plant and animal species. Today both Native and non-Native coastal communities, and the ecosystems that sustain them, face new challenges. The relationship between people and place, once synergistic, is now at risk.

Forest cover, the defining feature of the coastal temperate rain forest and a principal focus of this report, is one of many features of regional interest. Conservation of the environmental resource base is an important objective, but not the only concern of coastal residents. A bioregional information system based on the integrative capacity of computerized geographic information systems (GIS) and incorporating social, economic, and cultural - as well as ecological -information would enable further exploration of the links between livelihood and landscape. This effort will start us down the path to restoring a sustainable relationship between people and place.

People live in places with distinct histories and opportunities. A regional picture serves them only if it is accessible to them, and only if it relates in a meaningful way to the local particularities that shape their lives. The information age has the potential to strengthen the nexus that connects each locality with its region. As local detail accumulates, data from the community level can be used to update and refine regional knowledge. Over time, participation in gathering, sharing, and considering such information can help bring a bioregional community into being.

The Rain Forests of Home reports the first results of an effort to assemble such a bioregional portrait. It presents information on forest cover and indigenous languages as first proxies for forest integrity and cultural diversity throughout the entire North American coastal temperate rain forest bioregion, summarized in maps produced by a GIS. This report offers the first comprehensive picture of the rain forests of home, one that reconciles scientific definitions and administrative boundaries with the natural watershed boundaries of the coastal landscape. The holistic perspective that it provides can help identify opportunities and priorities for conservation-based development.

This bioregional atlas will be updated and enriched periodically as part of an array of print, CD-ROM, and on-line products and services designed to map and describe patterns of change in the coastal temperate rain forests of North America. Known as Interrain, this strategy aims to help communities capture the power of the information age and harness the forces of change to their advantage.

The approach to understanding the coastal temperate rain forest of North America exemplified by Interrain offers residents of other bioregions an example and an impetus for gathering new information. It establishes the first strand in a web linking people who live in, or are concerned with, the rain forests of continental margins. It offers a context - bioregional understanding - in which conservation and development can support one another.

This work seeks to increase the likelihood that contemporary civilization will, like the First Nations of the Northwest Coast, enter a relationship with nature marked by deliberate reciprocity. We still have much to learn about permanence from the cultures that have nurtured, and outlasted, the longest-lived trees of these rain forests of home.

ACKNOWLEDGEMENTS

Five years ago, Spencer Beebe and Silvio Olivieri laid the groundwork for the research that ties at the heart of The Rain Forests of Home. Beebe, then Vice President of Conservation International's North American Program, sought data to understand patterns of change in the coastal temperate rain forests of the Pacific Northwest. Olivieri, head of Conservation International's Conservation Planning and Technical Cooperation Department, and Edward Backus, Director of CI's Regional Conservation Analysis Program, joined Beebe in an effort to outline the parameters of a GIS analysis of the remaining coastal temperate rain forests of North America.

Conservation International's Andrew Mitchell, supported by consultant Randall Hagenstein, compiled the database and analyzed and cross-referenced the data, building on information contributed by a host of state, federal, and nongovernmental organizations throughout the region. The project expanded over time to incorporate other institutions as well, including Ecotrust (established by Beebe as an independent organization in 1991) and Pacific GIS (founded by Backus and Hagenstein in 1993). Conservation International staff, and subsequently staff at Pacific GIS, completed the digital maps that form the basis of the bioregional view presented in this report. Ecotrust's Science Director, Peter Schoonmaker, guided the subsequent analysis of forest cover data.

This atlas was made possible by the advice, encouragement, and support of many people. Paul Alaback, Jerry Franklin, Andy MacKinnon, Jim Pojar, and James Weigand were invaluable in helping us to define and describe this forest type. They also reviewed several early drafts of the bioregional maps. We are grateful for their continuing interest in this project.

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We are indebted to all who contributed to this effort. Final responsibility for the content of this atlas rests solely with its authors and publishers.

COASTAL TEMPERATE RAIN FORESTS

The coastal rain forests of temperate latitudes are a study in contrasts. Separated, in some cases, by more than fifteen thousand kilometers, coastal temperate rain forests around the world possess remarkable ecological similarities. Home to large and long-lived trees, as well as some of the most productive timberlands and coastal fisheries on earth, they also shelter resource-dependent communities faced with rising unemployment and uncertainty. Containing few metropolitan centers, they support some of the world's most significant experiments in conservation-based development.

Recognition of the uniqueness of the coastal rain forests of the temperate zone is quite recent. Although scientists have recognized temperate rain forests for over fifty years, the term "coastal" temperate rain forest has a scientific currency of less than a decade. But knowledge of these forests and interest in the bioregions where they stand are growing rapidly. (See Sidebar: A Review of Past and Current Research.)

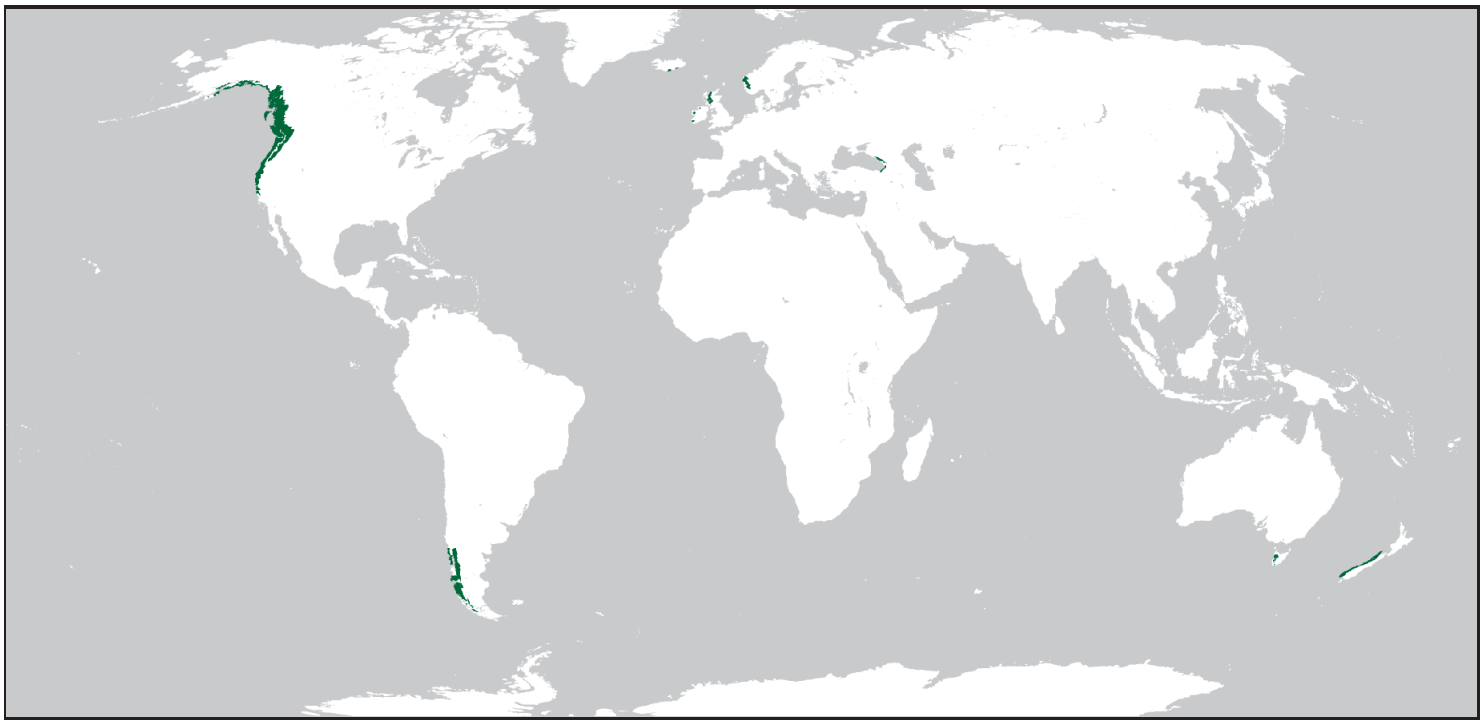
Once found on every continent except Africa and Antarctica (See Map 1), coastal temperate rain forests have been modified throughout much of their range. Nonetheless, the relatively small extent that remains contains large contiguous blocks of natural forest still substantially free of human influence. In addition to the obvious significance these forests hold for conservation and scientific research, they can help us to understand the relationships and connections that our economic activities must respect to achieve true sustainability.

Along rugged coastlines in both hemispheres, forests possess striking similarities in structure and ecosystem function, despite wide variation in species composition and history. These forests, standing for the most part in watersheds that empty directly into saltwater, are shaped by the cycling of water between the land and sea. In a 1990 survey, ecologists Paul Alaback and James Weigand proposed four features to distinguish coastal rain forests from other temperate forest types: proximity to oceans, the presence of coastal mountains, cooler summer temperatures, and high rainfall levels with significant precipitation occurring in all seasons (Weigand 1990). These conditions lead to a unique set of dynamic links between terrestrial and marine ecosystems. In effect, the high tide line does not bound the coastal rain forest ecosystem. The forest influences the abundance and distribution of coastal sea life, and a number of animal species return the favor by carrying marine nutrients back into coastal watersheds.

Worldwide, coastal temperate rain forests are scarce. Only thirty to forty million hectares (2-3 percent) of the world's estimated 1.3 billion hectares of temperate forest can be classified as coastal temperate rain forest, scarcely one-thousandth of the earth's land surface. Tropical rain forests once covered roughly forty times more land. Though both forest types have been drastically reduced, at least 36 hectares of tropical rain forest currently stand for every intact hectare of coastal temperate rain forest.

Tropical rain forests contain a diversity of plant and animal species vastly disproportionate to the area they occupy -perhaps 60 percent or more of all life forms. Coastal temperate rain forests contain a similarly disproportionate share of biological production. They accumulate and store more organic matter than any other forest type (including tropical forests) - as much as 500-2000 metric tons of wood, foliate, leaf litter, moss, other living plants, and soil per hectare. Some individual trees in temperate rain forests have grown for two millennia and surpass six meters in diameter. The adjacent waters are productive as well. The upwelling zones and cold-water currents that bathe the edges of coastal temperate rain forests account for a substantial share of the biological production of the oceans. The productivity of these marine ecosystems is enhanced by the nutrients and organic debris washed out of coastal watersheds.

The largest contiguous coastal temperate rain forest traces the northwestern maritime margin of North America, from Kodiak Island in Alaska south through British Columbia and the U.S. Pacific Northwest to California's "fogbelt" redwoods. (See Figure 1.) Elsewhere in the north, Norway contains small fragments of coastal rain forest, and scientists speculate that Japan may have some areas of rain forest as well (not shown on Map 1). The forests formerly found along the west coasts of Ireland and Scotland, parts of Iceland, and in a



Map 1. *Original Global Distribution of Coastal Temperate Rain Forests*

narrow crescent along the eastern shore of the Black Sea are long gone. Chile contains the Southern Hemisphere's largest remaining coastal temperate rain forest. Significant areas of coastal rain forest also stand on the west coast of New Zealand's South Island and on the Australian island of Tasmania, where broadleaved rain forests harbor the most ancient constituents of the Australian flora.

Throughout that original range, the fecundity and relatively mild maritime climates of coastal temperate rain forests have invited heavy exploitation. Coastal rain forests were among the first landscapes logged when Euro-Americans settled North America's Pacific Coast in the l850's. Clearcut logging of old-growth conifers remains widespread in this region today, and many rain forest valleys are industrial tree farms from which trees have already been harvested three times. Monocultural plantations of introduced tree species have also replaced large areas of the native forests of southern coastal Chile and New Zealand, and heavy logging continues in their natural forests. The once-extensive coastal rain forests of the Scottish Highlands are gone, replaced by non-forested heaths and plantations of introduced Sitka spruce and lodgepole pine.

Industrial exploitation of the lands and waters of the coastal temperate rain forest has meant secure profits for a relative handful of corporate enterprises but insecure livelihoods for thousands of residents. Communities dependent on logging, mills, and coastal fisheries have seen their prosperity wax and wane with the boom-and-bust cycles typical of raw materials economies. In virtually every stretch of the eight thousand kilometer coastline that supports these forests around the world, residents are seeking to diversify local economies and to capture more of the value of the raw materials harvested and exported from the rain forest fringe.

The growing importance of recreation, tourism, and environmental services in the economies of many coastal areas, and the recognition that conventional resource extraction depletes natural capital, are forcing a reappraisal of resource-based industries and the landscapes they leave behind. New insights into the interdependence of land and sea in the coastal rain forest zone offer further challenges to traditional management practices. The connections between forestry and fisheries offer an obvious example: logging's true contribution to local economies is exaggerated by the extent to which associated road building alters flows of nutrients and sediment and thereby reduces the production of coastal fisheries. The research that can guide communities seeking to understand such tradeoffs is in its infancy.

A REVIEW OF PAST AND CURRENT RESEARCH

Temperate rain forests have been recognized as a distinct biome throughout the 20th century, although ecologists have not used the term uniformly. Most vegetation classification schemes use vegetation structure (and, secondarily, unique fauna) to define biomes, but temperate rain forests can be structurally similar to nearby forest types. Temperate rain forests are also difficult to define floristically because they share species with warmer and drier forest types. Nevertheless, temperate rain forests have been included in most world vegetation maps and classifications (Koppen 1918, Kuchler 1949, Holderidge et al. 1971, de Laubenfels 1975, Udvardy 1975, Whittaker 1975, and Archibold 1995). (See Figure 2.) Several of these schemes, which define temperate rain forests primarily with climatic variables, are in close agreement.

Alaback's (1991) definition for temperate rain forests of North America is widely recognized and most useful for this analysis: over 1400 millimeters annual precipitation, cool summers stemming from an equable year-round climate, mean annual temperature between 4 and 12 degrees Celsius, and infrequent fire except in the redwood fogbelt. Kellogg (1992) used an approximation of this definition to create the first map of coastal temperate rain forest distribution.

Alaback (1991, 1995) has synthesized information to distinguish four zones of coastal temperate rain forest in North America. Other ecologists have mapped rain forest vegetation for parts of the region. These classifications, though fragmented by jurisdictional boundaries, reflect real taxonomic and environmental differences. Viereck et al. (1992) recognize a coastal forest type in Alaska. Pojar et al. (1991) propose that the coastal western hemlock zone defines the coastal temperate rain forest zone for British Columbia. In Oregon and Washington, Alaback's definition of coastal temperate rain forest includes all of Franklin and Dyrness's (1988) Sitka spruce zone and part of their western hemlock zone. For northern California, Barbour and Major (1977) recognize coastal redwood and mixed conifer-hardwood vegetation types in the area identified in this report as coastal temperate rain forest.

Mapping vegetation and the environmental status of the North American coastal temperate rain forest has been a patchwork affair. Morrison (1988) produced a seminal database of remaining old growth in the national forests of Washington, Oregon, and California, some of which contain significant areas of coastal temperate rain forest. Remaining old-growth vegetation has also been mapped for Vancouver Island, Haida Gwaii (the Queen Charlotte Islands), mainland British Columbia, and southeastern Alaska, with information on mid-century status included for comparison of the two Canadian islands (Sierra Club of British Columbia 1992, Broadhead 1995, Finch and Phipps 1993, MacKinnon and Eng 1995). Vegetation age and type have been mapped for Oregon's Coast Range using Landsat Thematic Mapper (TM) data as part of the Coastal Landscape Analysis and Modeling Study at Oregon State University. Ongoing research in that study aims to integrate social and economic information with forest cover and other environmental data (Spies, personal communication, 1995). Noss (1992) also focused on the Oregon Coast Range for a conservation plan that proposed reserves, corridors, buffers, and matrix areas based on rare species and habitats. Finally; the Forest Ecosystem Management Assessment Team (FEMAT) produced maps of vegetation and ecosystem status, and proposed options for management on federal lands in Washington, Oregon, and northern California.

National agencies have produced topographic maps that permit delineation of watersheds. State and provincial agencies and other organizations have used these maps for administrative purposes, especially for water and fisheries management (e.g., Oregon Trout's healthy salmonid stocks report [Huntington et al. 1994]). Individual initiatives have mapped vegetation and other environmental variables for single watersheds (e.g., Applegate, Lookout Creek, Carnation Creek, and the upper Willapa River). This report presents the first bioregional map of vegetation and ecosystem condition overlaid on a watershed template for the entire North American coastal temperate rain forest.

-P.K.S.

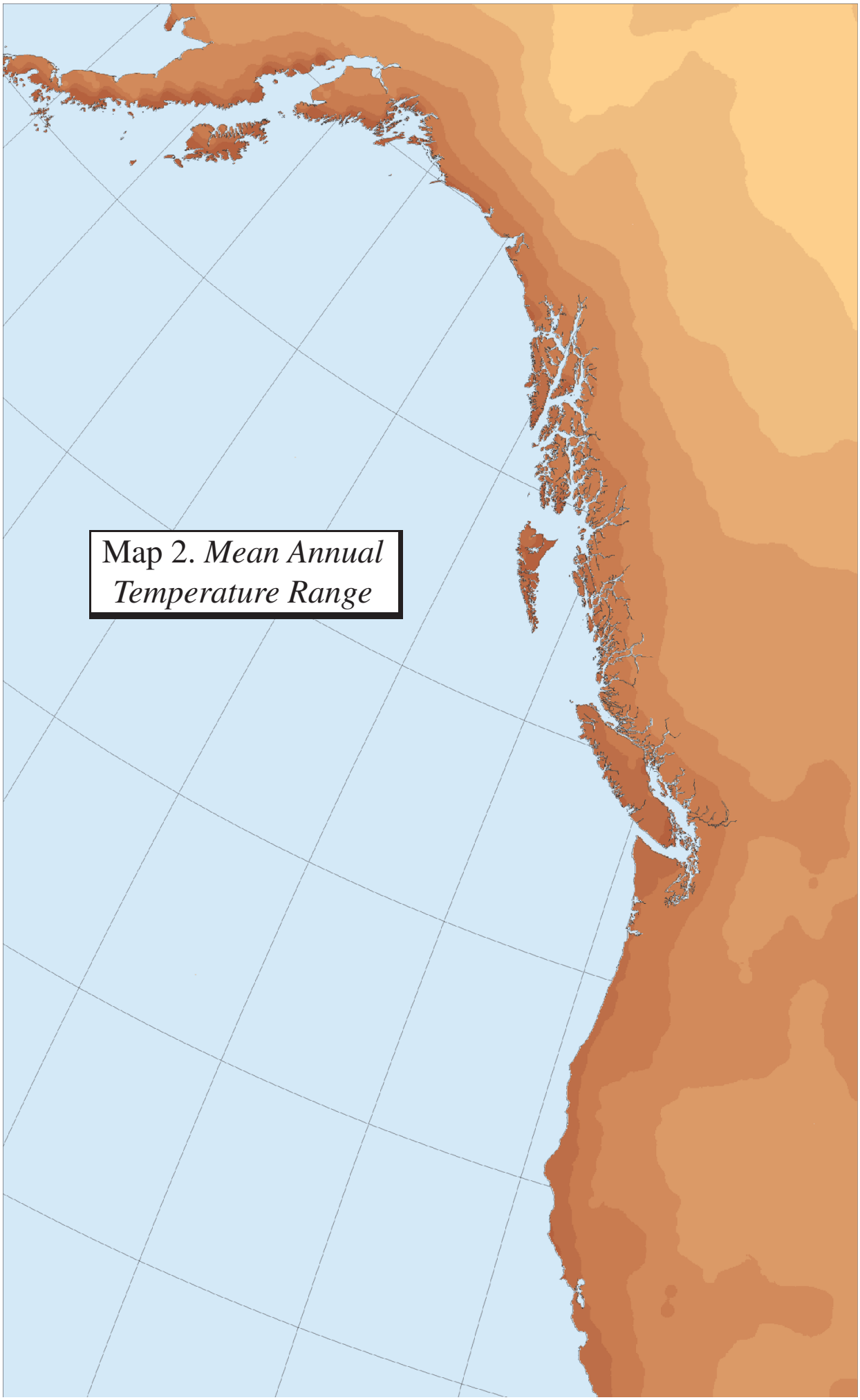
THE RAIN FORESTS OF HOME

The coastal temperate rain forests of North America occupy a place of central importance in the global future of this forest type. Originally covering some 25 million hectares, the narrow band of coastal forests between Alaska and northern California occupied slightly more land than all the other stands of coastal temperate rain forest combined. Topography and climate provide clues to their original distribution along the Pacific Coast of North America. (See Maps 2, 3, and 4.)

These rain forests have sustained human communities for at least five millennia, certainly longer than western red cedar has been dominant in coastal forests. Ecosystem and society developed simultaneously in the wake of the Ice Age: the forest and the sea shaped the coastal First Nations, and their resource use practices influenced the landscapes that European explorers would regard as "pristine." Perhaps nowhere else in the temperate zone were people and place more inextricably bound.

In many obvious ways, and probably in many more yet undiscovered, the thin band of coastal forest interlaced with ocean is utterly unlike the far more extensive interior forests that begin just a few hundred kilometers inland. It is more luxuriant: abundant rainfall and fog throughout the year, the absence of catastrophic fire, and a nearly snow-free climate promote rapid tree growth, while frequent fog sustains a heavy and diverse crop of mosses and lichens in the forest canopy.

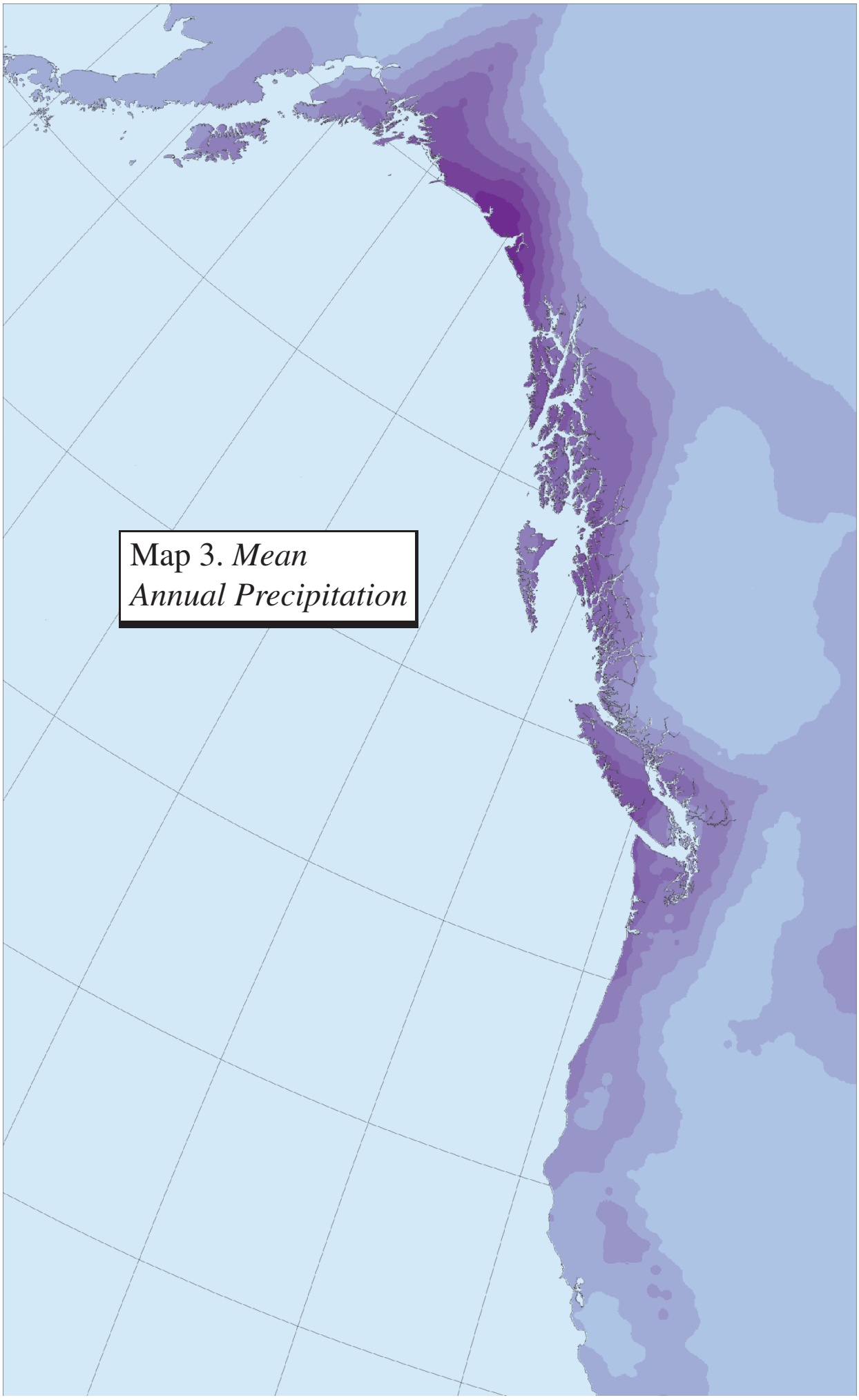
These forests rarely burn, especially north of Vancouver Island. Large-scale fires are less frequent in coastal rain forests than in most other temperate forest types, and less probable than in other conifer forests. As a result, landscape-scale disturbances (other than industrial clearcuts and catastrophic blow-downs in young even-aged stands) seldom occur here, while more localized disturbances, including wind-throws and landslides, create a multitude of smaller openings in which young trees germinate and grow. The resulting forest stands include vigorous trees of all ages, as well as many dead and dying trees. This diversity of tree ages and sizes creates a wide variety of microhabitats for other plants and animals.



Map 2. *Mean Annual Temperature Range*

Here the defining pattern of more temperate areas along the coast can be clearly seen, compared to the more extreme seasonal temperature variations inland. The darker colors mark areas with a smaller annual temperature range, and the lighter colors, those with a larger range.

The coastal rain forest region receives much more precipitation - up to 2000 mm a year - than areas further inland, as shown by the darker bands of purple along the coast.



Map 3. *Mean Annual Precipitation*

Intricate networks of streams, wetlands, and estuaries lace through coastal rain forest watersheds, creating habitats for freshwater and anadromous fish, for wildlife dependent on aquatic habitats, and for plants adapted to wet conditions. These riparian habitats create natural corridors for animal movement, and the streams that shape them distribute nutrients throughout the landscape. The unique plant and animal communities found both above and below ground in riparian zones contribute elements of biodiversity found only in coastal forests. The watersheds that surround these rivers and streams form important ecological units that integrate the distribution of fish and animals, the flows of energy and water, and the movement of materials.

North America's coastal rain forests contain more than 30 tree species and about 250 species of birds and mammals. The diversity in these groups, though not exceptional by global standards, includes species that better embody the interdependence of land and sea than perhaps any others. No living things demonstrate more dramatically the reciprocity of forest and sea than the seven species of Pacific salmon and trout that range widely in the North Pacific while they grow to maturity, then return to their natal coastal rain forest streams to spawn. Avian counterparts of the salmonids, the birds known as alcids (the murres, puffins, and their kin) have equally extraordinary life histories. The marbled murrelet spends its days at sea feeding on capelin, smelt, and small shellfish, returning to shore at nightfall to nest on moss platforms on the upper branches of old-growth trees. The common murres and other burrow-nesting alcids range the open ocean, only coming ashore to breed in sizable colonies at the forest's seaward edge or on offshore islands. Such creatures weave land and sea into a coherent whole - a whole recorded in the myths and teaching tales of Native peoples.

Map 4. *Physiography of the Northwest Coast*

The coastal temperate rain forest ecosystem extends from the continental shelf to the crest of the coastal mountains. This map shows the bathymetry and topography of the Northwest Coast.

FIRST NATIONS OF THE COASTAL TEMPERATE RAIN FOREST

When European explorers and fur traders first visited the coast, they encountered one of the highest densities of First Nations settlements found anywhere on the North American continent. Several hundred thousand First Nations people knew the forested valleys and shores as home, occupying thousands of villages and seasonal camps. More than sixty distinct languages were spoken by peoples living between the Kodiak Archipelago of Alaska and San Francisco Bay. This linguistic diversity, far greater than that of the continental interior, surely reflects the ecological complexity of the sustaining coastal lands and waters. Only in a few other places in the world did comparably advanced societies arise on a foundation of natural abundance, rather than farming or herding.

The geography of languages only begins to explore the cultural diversity, the reciprocal accommodation of people and landscape, that blossomed along this coastline. First Nations people were organized far less into discrete "tribes" than into a network of local and village groups for which few contemporary counterparts exist. Some groups based their economic and spiritual lives on pursuit and capture of marine mammals, others on the gathered bounty of tidelands and estuaries, still others on salmon or the mammals of upland forests. Many participated in trading networks extending throughout and beyond the region. Many individuals were multilingual, thanks to parentage, marriage, or economic necessity.

Languages, though not necessarily synonymous with distinct cultures, express a bond between people and place that offers perhaps the closest human counterpart to the adaptive "fit" of genetically distinct salmon stocks to their ancestral coastal streams. Oral traditions, particularly the names and stories unique to a local group, also articulate a highly intimate, and evanescent, understanding of place: "If much of a people's knowledge about the natural world is encoded in their indigenous language, the same knowledge cannot easily be imparted in another foreign language which has not developed a specific vocabulary to describe local conditions, biota, and land management practices" (Nabhan and St Antoine 1993).

Table 1. First Nation Language Groups: Historical and Current Status

Approximate Region	Number of Language Groups	Historical Population	Current Status
Southeastern Alaska2	3	~15,000	Spoken by <10: 1 Spoken by >100: 2
British Columbia	18	81,000	Extinct: 1 Spoken by <10: 4 Spoken by 10-100: 7 Spoken by >100: 5 Status unknown: 1
Washington	16	45,000	Extinct:7 Spoken by <10: 7 Spoken by 10-100: 1 Spoken by >100: 1
Oregon	15	42,000	Extinct: 11 Spoken by <10: 1 Status unknown: 3
California	16	51,000	Extinct: 7 Spoken by <10: 5 Spoken by 1Q-100: 4
Total Rain Forest	68	234,000	Extinct: 26 Spoken by <10: 18 Spoken by 10-100: 12 Spoken by >100: 8 Status unknown: 4


Spokenby >100
Spokenby 10-100
Spokenby <10
Extinct
Unknown
Lambert Azimuthal
Equal Area Projection
1:9,250,000
Map
Language Group
1 Alutiq
2 Eyak
3 Tlingit
4 Haida
5 Gitskan, Nishga
6 Coast Tsimshian and Southern Tsimshian
7 Haisla
8 Bella Coola
9 Heiltsuk
10 Oowekyala
11 Kwakiutl (Kwakwala)
12 Comox
13 Sechelt
14 Pentlatch
15 Nootka
16 Squamish
17 Halkomelem
18 Nitinaht
19 Songhees Saanich, Lummi, Samish, Clallam
20 Makah
21 Quileute
22 Nooksack
23 Lushootseed Salish
24 Chemakum
25 Twana
26 Quinault
27 Lower Chehalis
28 Upper Chehalis
29 Lower Chinook, Clatsap
30 Kwalioqua
31 Cowlitz
32 Cathlamet
33 Clatskanie
34 Kiksht
35 Central Kalapuya
36 Yonkalla
37 Tualatin
38 Tillamook
39 Alsea
40 Siuslaw
41 Hanis
42 Miluk (Coos)
43 Takelma
44 Upper Umpqua
45 Galice-Applegate
46 Tututni
47 Chetco Tolowa
48 Karok
49 Yurok
50 Hupa, Chilula, Whilkut
51 Wiyot
52 Mattole
53 Wailaki, Sinkyone, Lassik
54 Cahto
55 Yuki
56 Pomo
57 Wappo
Map 5. First Nations Language Groups of the Coastal Temperate Rain Forest: Current Status
50¡
45¡
40¡
35¡
135¡
130¡
125¡
The language groups shown on this map do not represent the bound-

As Franz Boas and other early ethnographers who worked among the people of the Northwest Coast found, First Nations languages arose from a worldview almost unimaginable to the European mind. The Kwak'w'ala place names Boas recorded near the northern end of Vancouver Island (Boas 1934, cited by Stafford 1986) expressed events more than features; to the speakers of Kwak'w'ala, like many of the coastal First Nations, places became memorable and nameable through the experiences that occurred in them. Each such name was pregnant with a story, one told to amuse, to instruct, to caution, or to reassure. Through the stories passed among villages and across generations arose a kind of local knowledge that has been nearly lost from the bioregion.

There is no denying the extent of indigenous cultural erosion that European settlement, the ensuing pressures for cultural assimilation, and instances of outright genocide, caused. Forty-four of 68 language groups believed to have been spoken at the time of European exploration are today extinct or spoken by fewer than ten individuals. (See Map 5 and Table 1.) The losses have been heaviest in the southern part of the coastal temperate rain forest region: twenty-five of 47 languages spoken in northern California, Oregon, and Washington are extinct, while only one of the 21 languages spoken in coastal British Columbia and southeastern Alaska is extinct (though five are spoken by fewer than ten people). The pattern of language extinction follows a path from south to north reflecting the time and intensity of European settlement. Overall, the numbers of fluent speakers of Native languages in the region have declined by more than 99 percent, and all of the languages along the Northwest Coast are in essence endangered since all or nearly all of their surviving speakers are elderly.

After a century and a half of European settlement and industrial resource exploitation, First Nations populations are a fraction of their former size, native forests are smaller, and the more recent, non-Native immigrants who live in and visit the coastal zone number in the millions. But, in Tennyson's words, "though much has been taken, much abides." With remarkable tenacity, many First Nations have sustained the integrity of their traditions in the face of overwhelming pressure. Efforts to revive Native languages on the verge of disappearance, and to revitalize the cultural and territorial identity they express, have taken root up and down the coast. A promising path to restoration begins with stories told in the old words, in the old ways and leads back to the places that spawned them.

ASSESSING THE STATUS OF LANGUAGE GROUPS

Determining the status of Native language groups is fraught with difficulties of many kinds. The first is that setting boundaries around language "groups," individual languages, and dialects is inevitably an arbitrary effort. Wayne Suttles, who recently mapped the language groups of the Northwest Coast, took pains to point out the different meanings and implications of the terms "languages, " "related languages," "language families," and the hypothetical "language phyla." The true diversity of languages within a region is not fully captured by any particular method of distinguishing them.

The contemporary status of Native languages is bound up in the history of particular villages and tribes - their territorial status, the nature of recognition granted them by the governments of Canada or the United States, and the various tribal amalgamations that have taken place since the coast was settled by people of European descent. It is by no means surprising that this history and its consequences should have rendered the interpretation of language status considerably more difficult.

The language groups represented in *Map 5* are those identified and mapped by anthropologists Wayne Suttles (1985) and Michael Krauss (1982). In some cases the groups shown are themselves amalgamations of several adjacent languages. The estimates of historical populations of native speakers summarized in *Table I* (roughly indicating populations at the time of European exploration and first contact) are from various volumes of *Handbook of North American Indians* (Sturtevant 1990).

The assignment of language groups to categories of current status in *Table I* (Extinct, Spoken by <10, etc.) was based on estimates for the number of fluent speakers of each language group in 1994 by Professors Jay Powell of the University of British Columbia and Michael Krauss of the Alaska Native Language Center of the University of Alaska, Fairbanks (for groups north of California) and by Professors Leanne Hinton and Yolanda Montijo of the University of California, Berkeley (for groups in California). In the few cases where two authorities differed on the status of a particular language group, the authors of this report chose the more precise assessment, or erred on the side of over-, rather than underestimating the number of speakers. We are, of course, responsible for any errors of assignment that resulted.

Estimating the total number of language speakers alone can be misleading. A better way to approach this type of analysis is to compare the number of speakers to the total population, and more importantly, to categorize the number of speakers by age group. Michael Krauss has collected much of this information for the northern portion of the rain forest region, and any future analyses should incorporate this data and methodology.

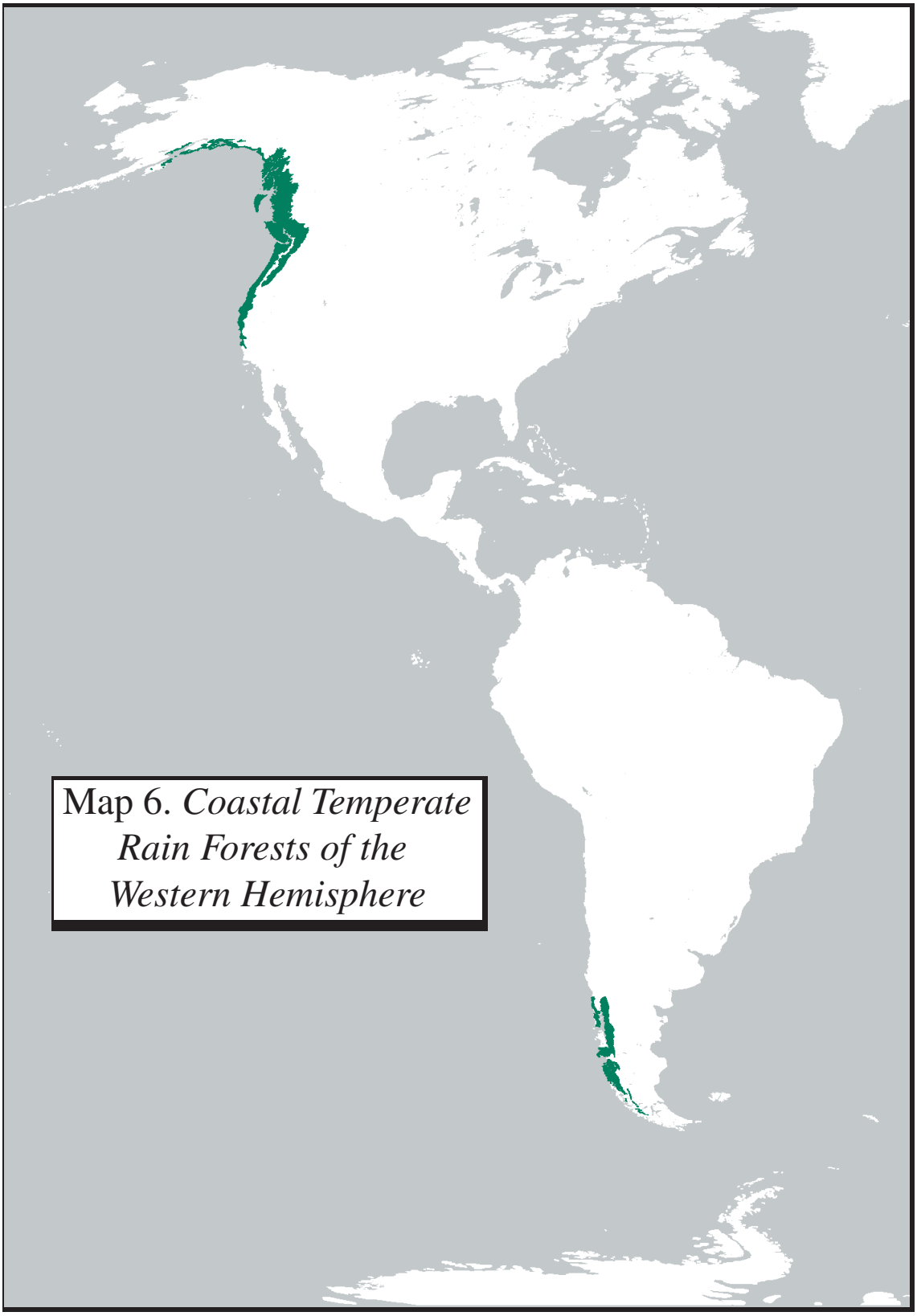
The status of language groups is not static. Some still spoken in 1994 may now be extinct, and some then considered extinct, or nearly so are being "reawakened" (to use the term favored by Native language advocate Vi Hilbert of the Upper Skagit Tribe in Washington state) through painstaking tribal efforts. But the overall pattern of loss has not yet been reversed, and as Richard and Nora Marks Dauenhauer of the Sealaska Heritage Foundation have written (1992), "if a Native American language dies, there is no place on earth one can travel to learn it."
-E.C.W.

STATE OF THE COASTAL TEMPERATE RAIN FOREST OVERVIEW

North America's coastal temperate rain forest bioregion contains some of the best examples of forest unmodified by industry, and some of the only examples of fully intact forested coastal watersheds sustaining a full spectrum of native species, left in the world. Many of these areas survive because of the concern and perseverance of conservationists and Native communities; they are protected as parks, wilderness areas, or First Nations territories. Many, however, persist less by intent than by default: industrialized resource extraction has not yet reached them.

A regional picture of the North American coastal rain forest can do more than identify conservation opportunities in such pristine areas. It can also bring knowledge of natural forests to bear on the economic challenges facing coastal communities -Native and non-Native alike- that depend on resource-based livelihoods in heavily modified landscapes. Scientists and resource managers throughout the region are keenly interested in understanding ecological patterns at the landscape and regional scale. Conservationists seek clear guidance as they identify gaps in the protection of natural systems and set priorities for preservation and restoration. Residents want a sense that their livelihoods and their families have a future. The bioregional portrait presented in the following maps is intended to help all three.

This analysis of forest cover consists of three parts: an estimation of the original (pre-European settlement) distribution of coastal temperate rain forests; an appraisal of the present-day status of coastal temperate rain forests; and an assessment of the condition of forest cover within major watersheds of the coastal temperate rain forest region. Data for the development of the GIS database and analyses were collected in digital or map form from a variety of public and private sources, and integrated in the GIS. For more information about the data sets used in this analysis.



From the global to the regional. A closer look at the coastal temperate rain forests of North America.

Map 7. *Original Distribution of the Coastal Temperate Rain Forest*

ORIGINAL DISTRIBUTION

The forests along the western coast of North America from the redwoods in California to Alaska's Kodiak Island contain approximately half of the remaining worldwide distribution of coastal temperate rain forest. Alaback (1991, 1995) distinguishes four coastal rain forest zones in North America based on temperature and precipitation distribution, which are the primary determinants of the distribution of plants and animals. *Map 7* shows the probable pre-European settlement distribution of conifer forests and associated vegetation types (bogs, muskegs, and high-elevation areas) that make up the North American coastal temperate rain forest.

Several sets of climate data (precipitation and temperature) and elevation information, augmented by land cover data, were combined to estimate the original extent of coastal temperate rain forest in the United States portion of the bioregion. For British Columbia, the coastal western hemlock biogeoclimatic zone provided a preferred indication of original distribution. The coast redwood range, a drier zone of coastal temperate rain forest, was also mapped using information on the major vegetation zones of California. The subpolar, perhumid, and seasonal rain forest zones distinguished within the coastal temperate rain forest were delimited based on the expert knowledge of several leading ecologists.

Highlights:

-Changes in climate and physiography from north to south change the character of the forest. The rugged relief of the far north creates a steep climatic gradient that confines the forest to a narrow coastal strip. The fjord-like character of southeastern Alaska and the central British Columbia coast expands the width of the forest zone, as the rain forest follows branching channels inland. From Vancouver Island south, the forest is not confined to fjords, but a marked orographic effect from the Coast and Cascade ranges limits its interior extent. At its southern extent, the zone narrows again, confined to the fog belt not by mountains but by moisture.

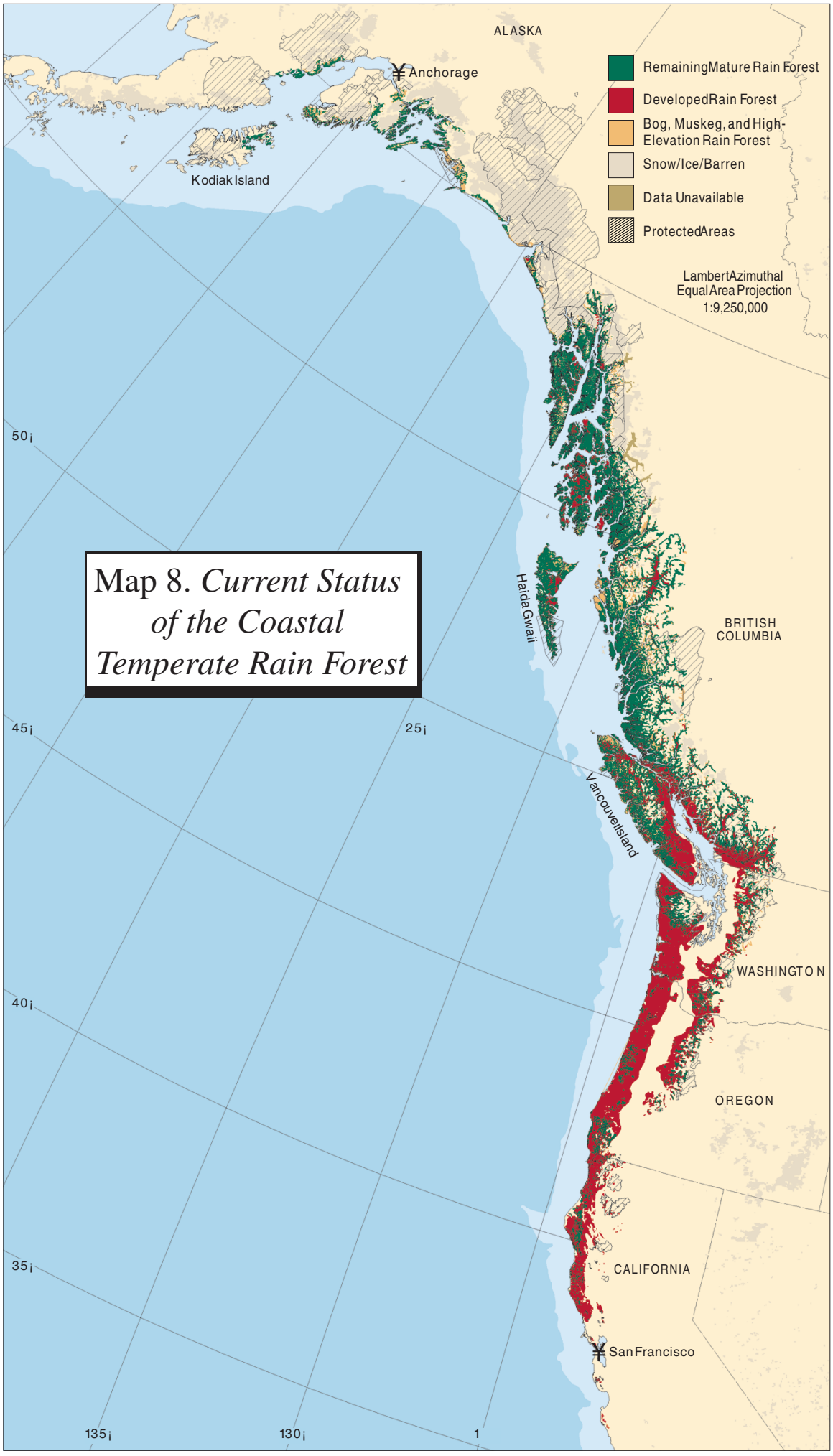
-Each zone supports distinct associations of dominant species. Sitka spruce and western and mountain hemlock dominate the subpolar zone. Sitka spruce, western red cedar, and western hemlock characterize the perhumid zone. Douglas-fir joins these species as a dominant in the seasonal zone. Coast redwood distinguishes the redwood zone.

ESTIMATING ORIGINAL DISTRIBUTION

Different methods were used throughout the range of coastal temperate rain forest to delineate probable original extent, depending on information availability. (The fact that different data sets and methodologies were used is most apparent at the British Columbia/Washington border.) For British Columbia, the coastal western hemlock zone from the Ministry of Forest's biogeoclimatic zone classification (a scheme based on factors including vegetation, climate, and soil type) was used to determine the temperate rain forest zone. The coast redwood zone was also mapped, based on a data layer of vegetation cover types of California.

Outside British Columbia and California, areas having at least 1400 millimeters average annual precipitation (identified using data from several state agencies) were combined with areas having a mean annual temperature range of less than 22 degrees Celsius (derived from the International Institute for Applied Systems Analysis global spatial data set of mean monthly temperatures) to distinguish temperate from wet boreal forests. The combined data set, showing wet temperate areas, was then filtered with elevation data (from the Digital Chart of the World) to exclude areas above 3,000 feet, which would be snow-dominated during the winter. Areas of permanent snow and ice at the northern end of the range and non-forest areas (barren, shrub-dominated, and rock) were filtered out using generalized land cover data (based on the Normalized Difference in Vegetation Index [INDVI] data set from the Advanced Very High Resolution Radiometer [AVHRR] satellite sensor).

The resulting data layer, combined with the coastal western hemlock biogeoclimatic zone data for British Columbia and the redwood zone for California, represents the probable pre-European settlement distribution of coastal temperate rain forest.
-A.P.M.


ALASKA
Anchorage
Kodiak Island
RemainingMature Rain Forest
DevelopedRain Forest
Bog, Muskeg, and High-Elevation Rain Forest
Snow/Ice/Barren
Data Unavailable
ProtectedAreas
LambertAzimuthal Equal Area Projection
1:9,250,000
50¡
Map 8. Current Status of the Coastal Temperate Rain Forest
Haida Gwaii
BRITISH COLUMBIA
45¡
25¡
Vancouverlsland
WASHINGTON
40¡
OREGON
35¡
CALIFORNIA
San Francisco
135¡
130¡
1

CURRENT FOREST STATUS

North America's coastal rain forests contain some of the world's most valuable commercial timber lands. They have been heavily harvested, particularly in the southern third of the bioregion. In *Map 8*, mature coastal forests that have not been extensively logged or disturbed by other development appear green. The red areas are those classified as "developed." Other areas within the bioregion, shown in gold, consist of undisturbed bog, muskeg, and high-elevation rain forest. The boundaries of existing protected areas larger than 250 hectares within the coastal temperate rain forest bioregion are also shown in relation to mature forest and other land cover classes.

To determine the extent of remaining natural forest, analysts created a region-wide "human development" layer, depicting areas of forest affected by logging, farming, or urban development. Undeveloped areas within the bioregion were mapped by subtracting areas affected by human activity from the map of original distribution. An overlay of areas of remaining mature forest (compiled from various sources), when superimposed on the map of undeveloped areas, distinguished forested from non-forested undeveloped habitat. Protected areas (provincial, state, and national parks, wilderness areas, etc. that conformed to the World Conservation Union [IUCN] definition of "protection") were also aggregated from various sources and mapped.

The information on this map is not static, but rather changes from year to year as more forest is harvested or protected. Some areas shown on this map as remaining mature forest may in fact now be logged, and others may have been protected.

Highlights:

-Overall, 44 percent of the North American coastal temperate rain forest has been developed. The main impact of development is evident from Vancouver Island south.

-Two factors -accessibility and value- have determined the pattern of development. Low-elevation valleys proved easier to log, and the natural predominance of Douglas-fir in the seasonal rain forest zone and redwood in northern California historically provided high-quality lumber.

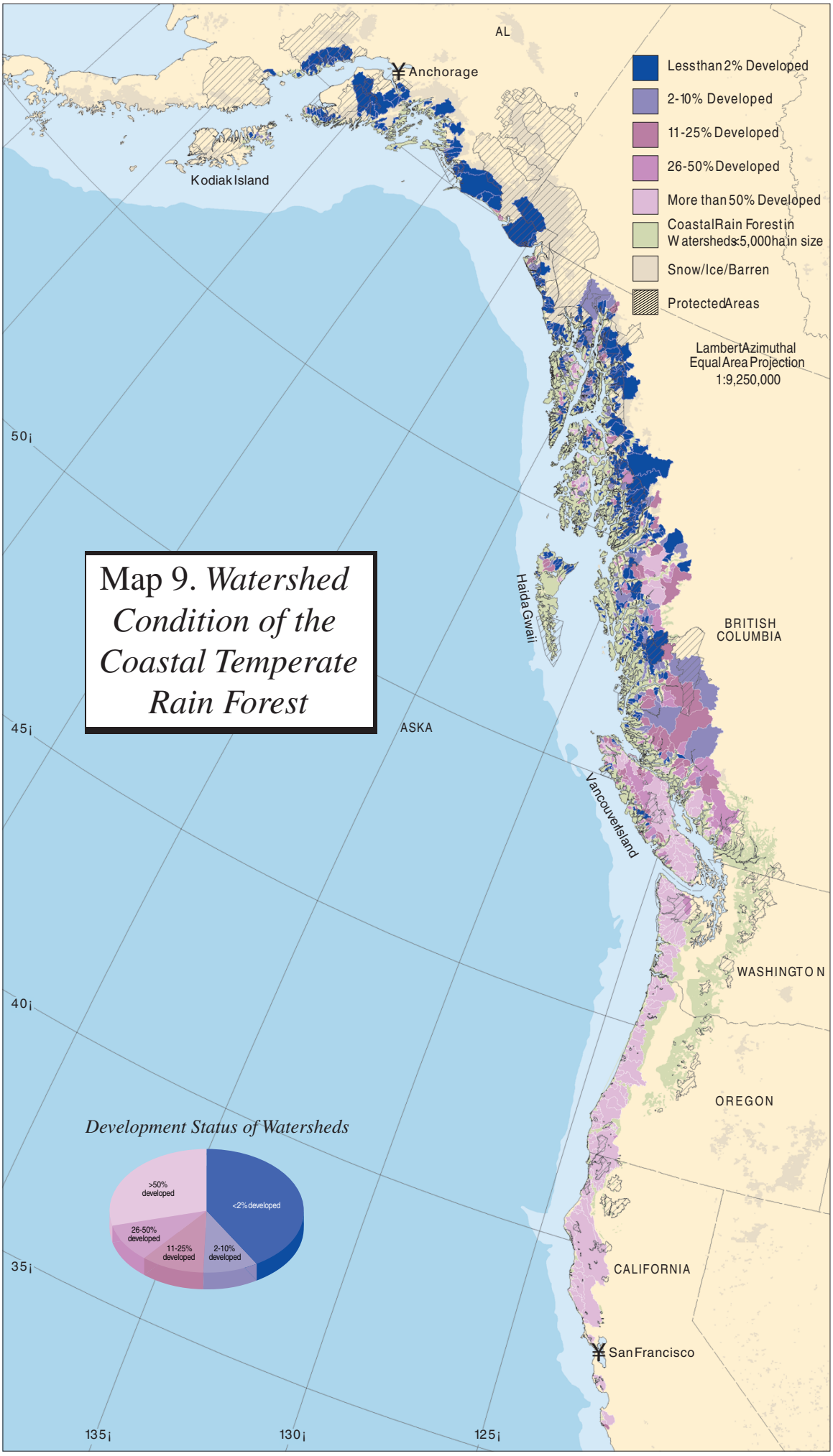
-Sixteen percent of the coastal temperate rain forest bioregion is protected. Over two-thirds of the protected coastal temperate rain forest is forest of the subpolar and perhumid zones in Alaska; comparatively little forest in the seasonal zone or the bioregion's southern extent is protected. Many of these protected areas are situated in alpine or other non-forested regions.

-The most important opportunities to protect large contiguous areas of coastal temperate rain forest are in Alaska and northwestern British Columbia, while restoration efforts will characterize conservation in the lower forty-eight.

DETERMINGING CURRENT FOREST STATUS

Analysts determined the extent of remaining undeveloped forest by subtracting a GIS layer representing areas primarily affected by human activity from the layer of original forest distribution. The "human development" layer was assembled from sources giving some indication of areas primarily affected by farming, logging, or urban development. These sources included forest and vegetation classification data sets as well as more general land use land cover data sets.

Similarly, contiguous areas of remaining mature forest were compiled in the GIS from a number of forest classification data sets for specific areas within the region, mainly at the state or provincial level. Analysts selected the data sets that offered the widest coverage for each given area, and those that best distinguished managed from unmanaged forest. Where necessary, auxiliary data sets were added to complete the geographic coverage. Again, analysts extracted from each data set just those areas indicating mature or old-growth forest (or some surrogate measure of this condition), on the assumption that these areas best represented undeveloped forest. Analysts recognized that some very old second growth might be included and areas of undeveloped forest may have been omitted. In Alaska, the non-forest undeveloped areas were taken from satellite imagery and GIS databases that distinguish forest from non-forest types. Remaining mature forest areas included those classified as forests but not shown in databases of harvested areas.
-A.P.M.


AL
Anchorage
Kodiak Island
Less than 2% Developed
2-10% Developed
11-25% Developed
26-50% Developed
More than 50% Developed
Coastal Rain Forest in Watersheds <5,000 ha in size
Snow/Ice/Barren
Protected Areas
Lambert Azimuthal Equal Area Projection
1:9,250,000
Map 9. Watershed Condition of the Coastal Temperate Rain Forest
Haida Gwaii
BRITISH COLUMBIA
ASKA
Vancouver Island
WASHINGTON
OREGON
CALIFORNIA
San Francisco
50¡
45¡
40¡
35¡
135¡
130¡
125¡
Development Status of Watersheds
<2% developed
2-10% developed
11-25% developed
26-50% developed
>50% developed

WATERSHED CONDITION

Top conservation priorities for the coastal temperate rain forest bioregion include the protection and stewardship of large contiguous blocks of undeveloped land and water. Watersheds form a logical unit of analysis to identify such priority areas: the flow of water through a drainage basin integrates distribution of fish populations, flows of energy, and movement of materials. The analysis illustrated by *Map 9* is based on a methodology developed by Keith Moore (1991) as part of an inventory of coastal watersheds in British Columbia.

The level of disturbance within the rain forest within primary coastal watersheds larger than 5,000 hectares is shown in relation to protected areas. Approximately 41 percent of the forested watersheds included in this analysis remain undeveloped. None of these largely pristine coastal temperate rain forest watersheds occurs outside of British Columbia and Alaska.

The analysis of watershed condition combined the human development layer with the boundaries of major watersheds within the region. Given the known area of coastal temperate rain forest in each watershed and the amount converted by human development within each, the portion affected by human activities was readily calculated as a percentage.

Highlights:

-Forty-one percent of the forested watersheds included in this analysis (343 of 827 watersheds) remain in a largely undeveloped condition, all of them in the more northern parts of the bioregion. These watersheds encompass roughly 3 million hectares of rain forest.

-Only 11 of 46 watersheds larger than 100,000 hectares remain intact. Five are in Alaska: one on the Kenai Peninsula (the coastal temperate rain forest area is undeveloped, although the lower watershed has been settled), one in Prince William Sound, two in the Copper River Delta, and one on Icy Bay. These Alaska watersheds are somewhat anomalous, as much of the area is rock and ice, with a narrow strip of rain forest along the coast. Nonetheless, they are ecologically important as representative of this rare subpolar coastal temperate rain forest zone.

-Six of the intact watersheds larger than 100,000 hectares are found in British Columbia: the Whiting, and the contiguous Unuk, Iskut, and Chickamin Leduc watersheds on the Alaska/British Columbia border, and the Cranberry and Kitlope watersheds on the north coast.

-South of the Canadian border, only the Elwha River in Washington, Taylor Creek in Oregon, and the Big Sur River in California are less than 50 percent developed.

-Of the 15 watersheds containing more than 100,000 hectares of rain forest, only the Wannock (8 percent developed) and the Nimpkish (46 percent developed) in British Columbia are less than 50 percent developed.

-From Vancouver Island north, a substantial number of the coastal temperate rain forest watersheds are smaller than 5,000 hectares in size, and therefore not included in this analysis. They are nonetheless important, and any future analysis should include watersheds 1,000 hectares and larger.

ANALYZING WATERSHED CONDITION

The analysis of watershed condition applied a definition of major coastal watersheds developed by Moore (1991) which includes all watersheds greater than 5,000 hectares having their terminus in salt water and encompassing the area from terminus to height of land. The lower limit of 5,000 hectares, though somewhat arbitrary, has been used as an appropriate minimum size for functional wilderness areas (Wilderness Advisory Committee 1986). Moore's definition was modified for those few major rivers extending inland through the coast ranges and flowing from headwaters in the interior valleys or the Cascades. Rather than delineating large watersheds which contain a small amount of coastal temperate rain forest relative to their full extent as single units, analysts delineated second-order streams (those flowing into the major river) for the portion of these watersheds within the coastal temperate rain forest zone.

The GIS was used to calculate the amount of coastal temperate rain forest in each watershed. The human development layer was then overlaid with the water-shed boundaries to calculate the amount of developed coastal temperate rain forest area within each watershed. This figure, divided by the total area of coastal temperate rain forest in each watershed, determined the percentage affected by human activity. Five development classes were distinguished according to the extent of human impact.
-A.P.M.

THE RESEARCH CHALLANGE

LIMITS OF THE PRESENT ANALYSIS

While providing a reasonably accurate first approximation of the status of coastal temperate rain forest in the region, this study was limited by the type and availability of data. Two key elements of the analysis, the determination of original distribution of coastal temperate rain forests and the present extent of undeveloped forests, used data that provide indirect, rather than direct, measures of forest cover.

The distribution of forest ecosystems, results from the complex interactions of numerous factors. A combination of available moisture and mild temperatures is the primary determinant of the distribution of coastal temperate rain forests (Alaback 1991). An area receiving less rainfall but experiencing cooler year-round temperatures might provide growth conditions roughly comparable to another area receiving more rainfall but experiencing higher temperatures. Under ideal circumstances, the necessary preconditions would be observed directly, through physical measurements of soil moisture or evapotranspiration.

Unfortunately, such data are not collected on a regular basis. In the absence of direct physical measurements, available precipitation and temperature data sets, combined with auxiliary data sets including land cover and elevation, served as surrogate measures of environmental conditions. (British Columbia's data set -the coastal western hemlock zone - provides a better measure of the conditions of interest, since its classification scheme uses the distribution of vegetation, which integrates a host of climatic factors). Future studies can refine the distribution based on additional, more direct measures of environmental conditions.

One goal of this analysis was to determine the amount of remaining natural forest of any age (i.e., not just old growth) within the coastal temperate rain forest zone. It relied on existing data sets describing forest cover for various areas within the region. These data sets record timber age and size. crown closure, or specific indicators of old-growth habitat. They do not distinguish forest regrowth after logging from regrowth after natural disturbance. Studies of old-growth forests have also indicated the difficulty of distinguishing old growth from older second-growth forests, making the distinction between never-logged forests and very old regrowth on logged areas somewhat arbitrary. (This is not an issue in British Columbia or Alaska, where logging activity is more recent.)

This analysis assumed that areas not specifically classified as mature or old-growth forest had been logged. While some of these areas may in fact be younger forests resulting from natural (windthrow or landslides) rather than industrial disturbance, this would not significantly affect the results of this study. Fire is common only on southern Vancouver Island and in the more southern portions of the North American coastal temperate rain forest. Conversely, some areas included as mature forest have likely been logged at some time, but may effectively be functioning as natural forests. Future studies that incorporate new data sets can provide a more accurate assessment of natural forests.

Two types of information, though beyond the scope of this analysis, are important from a conservation perspective. Distribution of key coastal species (salmon, the anadromous smelt known as eulachon, and marbled murrelets, among others) would indicate key watersheds for conservation and provide valuable information for management plans. Additional information on land ownership is indispensable for development of an overall stewardship strategy for the bioregion.
-A.P.M.

PRIORITIES FOR FUTURE RESEARCH

This analysis, based on the best regional-scale data available, provides a valid region-wide picture of the status of coastal temperate rain forests. There is room to improve both data and methods, especially to support local-level analyses, as well as to update the rapidly changing status of critical areas within the bioregion. Specifically:

Consistent application of a comprehensive definition of this forest type would better delineate the coastal temperate rain forest bioregion.

- Better data on evapotranspiration, soil moisture, or growing season degree-days would strengthen the analysis. Such data would support more sophisticated models of the original distribution of coastal temperate rain forests.

- Stepping the elevation criteria for coastal temperate rain forest along a south-to-north gradient would provide a more accurate picture of forest area (This has already been done for the coastal western hemlock biogeoclimatic zone in British Columbia.)

- More detailed and timely analysis of forest condition using images collected by satellites, particularly for areas outside national parks and national and provincial forests, is an urgent need. Improved means of distinguishing natural forests (at any age) from managed forests should be a goal of such analysis. (The Sierra Club of British Columbia is working on this type of analysis for the British Columbia coast.)

- Coastal streams flowing from watersheds smaller than 5,000 hectares are especially common from the mid-coast of British Columbia north through the Gulf of Alaska. The exclusion of such areas from the analysis by no means represents a conclusion about their potential importance to regional conservation. Future analyses should delineate these watersheds.

- The adequacy of protected areas within the region could be better assessed by indicating the levels of protection achieved by existing parks and other legally protected areas. An improved data set containing up-to-date information on new protected areas, revised boundaries, and altered legal status would improve the analysis.

- Delineating key vegetation types within the coastal temperate rain forest zone (e.g. wetlands, peatlands, riparian, and subalpine types) and structural classifications would help to capture the interactions between forest and wildlife.

-A.P.M.