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CHILE´S FRONTIER FORESTS: CONSERVING A GLOBAL TREASURE

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FOREWORD

Chile possesses almost one-third of the world's few remaining large tracts of relatively undisturbed temperate forests— also known as frontier forests. Chile's forests are some of the most impressive in the world, ranging from Chilean palm forests and *Sclerophyllous* forests (composed of tree species adapted to drier climates), in north-central Chile, to prehistoric araucaria forests, temperate rainforests, and alerce forests— the "redwoods of the Andes"—to the South. The alerce cedar is the Southern Hemisphere's largest conifer, and one of the most long-lived species of trees, sometimes living for over 3,000 years. Virtually every type of temperate forest native to the Southern Hemisphere can be found in Chile. These forests are of great ecological and conservation value. They store vast quantities of carbon that contribute to global climate regulation, control flooding, purify water, cycle nutrients and soil, and house an incredible array of species that provide the genetic material for valuable new products and a foundation for the resilience of natural systems.

Chile's frontier forests are being eroded by the skyrocketing global demand for wood and paper products. There has been a dramatic expansion of logging into southern Chile. Over the past 30 years, the Chilean forestry sector has become a driving force in the national economy, with forest exports increasing from approximately US$40 million in 1970 to US$2.2 billion in 2000. These economic incentives together with the current forestry policy in Chile have promoted the establishment of large–scale plantation of pine and eucalyptus, many of which have resulted in the clearing of precious native forest. These plantations provide most of the timber needed for the domestic and export markets. The result is a dramatic loss of biodiversity, soil erosion, and changes in the water level of streams.

While a significant proportion of the native forests are protected as national parks and reserves, natural monuments, and private reserves, most of these protected areas are located in the southern administrative Regions (Regions XI and XII); regions with low human population densities and few forest-related industrial developments. Aside from these protected forests of Regions XI and XII, only a small fraction of native forest in the rest of the country has protected status. This system of protected areas also has a poor representation of the highly diverse forests types of Chile, and reserve size in many regions is inadequate; a degree of protection that does not ensure the continuity of evolutionary processes and the conservation of biodiversity for future generations.

The improvement of Chile's economic stature and an increased awareness of environmental issues has resulted in a more engaged and interested public. The Chilean citizenry is at a point where they are capable of affecting public policy. However, they currently lack updated information regarding forest conditions, their development, and their intrinsic value as a natural resource. If the public is provided with such crucial data, they will be empowered to influence public policy on forest monitoring, protection and management.

For several years now, Chile has been developing legislation to promote the sustainable management of native forests. This legislation, which has not been enacted, generated a national debate regarding forest resources, and has made both the public and policy makers aware of the lack of current information regarding Chile's native forests and their importance. While Chile's economic situation has improved over the last decade, the government lacks adequate tools and financial resources to promote sustainable management, regulate the forest sector, and respond adequately to the short-term management strategies publicized by the timber industry.

This report, ***Chile's Frontier Forests: Conserving a Global Treasure***, is the first Global Forest Watch product to examine the state of native forests in Chile. Launched by the World Resources Institute in 1998, Global Forest Watch (GFW) is a remarkable new alliance that unites non-governmental organizations, universities, scientific researchers, and governments from forested countries around the world. GFW links satellite imagery and aerial photographs with on-the-ground investigation by local groups to assemble powerful information about the condition and threats to the world's remaining large tracts of forests. The Internet is then use as a vehicle to make the information widely available.

GFW seeks to make information available rapidly to an ever wider audience by providing forest information and maps on-line and developing a state-of-the-art Web site (www.globalforestwatch.org) to post results from its multiple field activities in Cameroon, Canada, Chile, Gabon, Indonesia, Russia, the United States, and Venezuela. Reports, maps, and information from credible sources will be available for downloading. Anyone with access to the Internet can consult GFW data and contribute by providing information or views directly on-line. We hope that the array of products and activities will lead to a more constructive dialogue between forest managers and users at the local, national, and international levels.

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KEY FINDINGS

Although native forests still predominate in Chile, less than 45 percent of current forest cover remains as mature native forest.

- Today, about 34 percent of Chile's forests qualify as frontier forest–tracts of at least 5,000 hectares, classified as mature forests or dense timberline forests that are intact or only slightly altered. Only a third of all forest is in relatively undisturbed tracts of at least 10,000 hectares.

- Many frontier forests are in areas with steep slopes or located at high altitudes. As such, they are particularly sensitive to human disturbance. Despite their vulnerability, only 27 percent of frontier forests are protected.

- Fragmented stands of mature native forests (smaller than 5,000 hectares) are, in some regions, the only remaining habitats for a variety of species, such as small, endangered mammals and birds. In many areas of the country, particularly in administrative Regions VI and VII, these fragments represent the only remaining stands of native forests. These remnants constitute an important genetic reservoir for the future restoration of these ecosystems.

- Frontier forests are at greatest risk within:
  – Coastal mountain range forests in administrative Region X, which house 7.5 percent of Chile's remaining frontier forest, but are the least represented in the protected areas systems, even though they house a rich and diverse range of species. The major threats to these forests are non-native plantation developments, inadequate enforcement of regulations, and plans for a new coastal highway.
  – Region VIII, where only 2 percent of native forests remain as frontier forest, of which 80 percent is unprotected. Most of the country's forest industries are concentrated in this region.

- A considerable amount of Chile's native forest has been converted to plantations, most of which are dominated by exotic species, primarily Monterey pine (*Pinus radiata*) and several species of eucalyptus (*Eucalyptus spp.*). Most of the country's timber production comes from these fast-growing plantations, which in large part have been established by clearing native forests.

- Even though Chile has specific forest-protection and management laws, these are partially implemented, and do not constitute an adequate forest management policy framework to assure stewardship and sustainable use of native forests. While currently only a small share of wood products comes from native forests (largely production of wood chips for pulp), this may change, given growing interest in establishing a second oriented strand board (OSB) panel industry, with wood supplied by native forests. In addition there are also two new planned cellulose plants that will place higher demand on land for establishing forestry plantations. A solid forest-management policy for sustainable timber production from native forests would improve the long-term survival of these unique forest systems while addressing wood supply demands.

EXECUTIVE SUMMARY

This document presents the results of activities carried out by the Chilean institutions CODEFF and UACH, which make up the Chile chapter of Global Forest Watch, an initiative of the World Resources Institute. This report describes the state of native forest resources in Chile, and in particular, describes for the first time the extent and distribution of the country's frontier forests (based on 1995 data). Frontier forests in Chile are defined as mature forests or dense timberline forests, of at least 5,000 hectares, that are made up of native species, and are intact or have been only slightly altered[1]. Chile's frontier forests are therefore a subset of Chile's native forests, in turn defined as those composed of native species unique to the region.

Chile's frontier forests constitute a global reserve of biodiversity. They contain a wide array of unique species assemblages, including many tree species that are endemic either to Chile or to the southern cone of South America. These are some of the most productive forests in the world, storing enormous amounts of carbon, which contributes to global climate regulation. While this report focuses mainly on frontier forests, we recognize the importance of smaller patches of native forest (less than 5,000 hectares) for the maintenance of biodiversity and other ecological processes and as a genetic reservoir for future restoration of these outstanding forest ecosystem types. Therefore, the report also highlights the current distribution and state of conservation of these smaller patches of native forests.

This study is based on the digital information generated by the project, "Official Land Register and Evaluation of the Native Vegetative Resources of Chile," carried out for the Chilean government agency responsible for forest management—the Corporación Nacional Forestal (CONAF). These data constitute the most up-to-date information (1995) on forest cover and land use for the country. The GFW-Chile team developed a methodology for delineating frontier forests in Chile based on CONAF's data. Afterwards, a technical advisory committee, made up of experts in the field of forestry and forest ecosystems, revised the proposed methodology and contributed critiques and ideas for its application.

The first part of the report describes the importance of the Chilean forest, both locally and globally. The second part briefly describes the forest industry, its importance in the national economy, and existing legislation affecting forests. Regarding frontier forests, the report presents data concerning their extent, geographic distribution, state of conservation, and degree of representation in the public and private systems of protected areas. The report also provides information about industrial and development projects associated with forest ecosystems. All information is illustrated through maps produced by GFW-Chile.

Results of the analysis show that, in Chile, frontier forests occupy 4.5 million hectares, or approximately 34 percent of all forested land. Approximately 27 percent of these frontier forests are in protected areas, both state- and privately owned. At the regional level, the extent of frontier forests increases as one moves southward through the country. Regions in which most of the development and industrial projects have occurred have fewer frontier forests left. For example, Regions VI and VII have lost all their frontier forests, and only fragments of slightly altered or undisturbed mature native forests remain. Region VIII, where most of the forestry plantations are concentrated, contains only 17,624 hectares of frontier forests, of which 80 percent are unprotected. Region IX has 154,527 hectares of frontier forest, but a large proportion (60.8 percent) is protected. In Region X, 26.6 percent of the large area of frontier forests (1,576,175 ha) is protected; however, the unique rainforests of the region's Coastal Mountain Range are at high risk of fragmentation due to a planned coastal highway. After Region VIII, Region X has the greatest number of forestry plantations and industries in the country. Finally, Region XI and XII are the least disturbed regions, with 1,778,428.3 hectares and 946,930.5 hectares of frontier forest, respectively.

1 The term "frontier forests" as used in this report, is equivalent to "intact forests" as defined and mapped in other contries by the GFW network. GFW-Chile and its Technical Advisory Committee deemed the use of the term "frontier forests" more appropriate, especially as in translates into Spanish, given that the term "frontier forest" allows for slight use of the forest, while "intact" in Spanish excludes any forest use. The definition of frontier forest therefore has been adapted to fit the Chilean context and may differ from earlier uses of the term.

With respect to development activities, as the maps in *Annex I* show, in every region there is a strong inverse relationship between the presence of roads and industrial projects, on the one hand, and the extent of frontier forests on the other.

Using available information, together with the aforementioned, specifically designed methodology, GFW-Chile was able to quantify and determine the distribution of the frontier forests in Chile at the national and regional levels. The characterization of these forests and their unique features drives home the need to produce and maintain a system of updated information that would not only register changes in forest cover over time, but also identify the root causes of these changes and the actors involved.

1. INTRODUCTION

Chile possesses a very important part of the world's temperate forests, i.e., those that grow throughout temperate latitudes. Chile's temperate forests (found between 35°S and 55°S) represent almost one-third of the world's few remaining large tracts of relatively undisturbed temperate forests (Bryant et al., 1997). These forests are of great ecological and conservation value at the national and global levels because of their high degree of endemism and heterogeneity.

With respect to biodiversity, Chile's richest areas are found between Regions VIII and X (i.e., those administrative regions found between the parallels 36°S and 43.5°S). Virtually almost every type of temperate forest native to the Southern Hemisphere can be found in these areas. This same zone, however, is where most of the forest conversion and change is taking place. The driving force behind change in forest cover is the replacement of native forests by forestry plantations of exotic species, a factor that contributes to forest degradation, clearing, and the consequent loss of biodiversity.

In this context, it is Global Forest Watch's mission to support forest conservation as well as sound and sustainable forest management, particularly for the world's remaining large tracts of intact or minimally altered forests (GFW, 1999).

The main objectives of the project covered by this report were:

- To identify and define the limits of existing frontier forests in Chile, including information on conservation status and the activities that threaten these forests.
- To develop a digital database that can be easily accessed and updated to allow for better management, sustainable use, and monitoring of native forests.

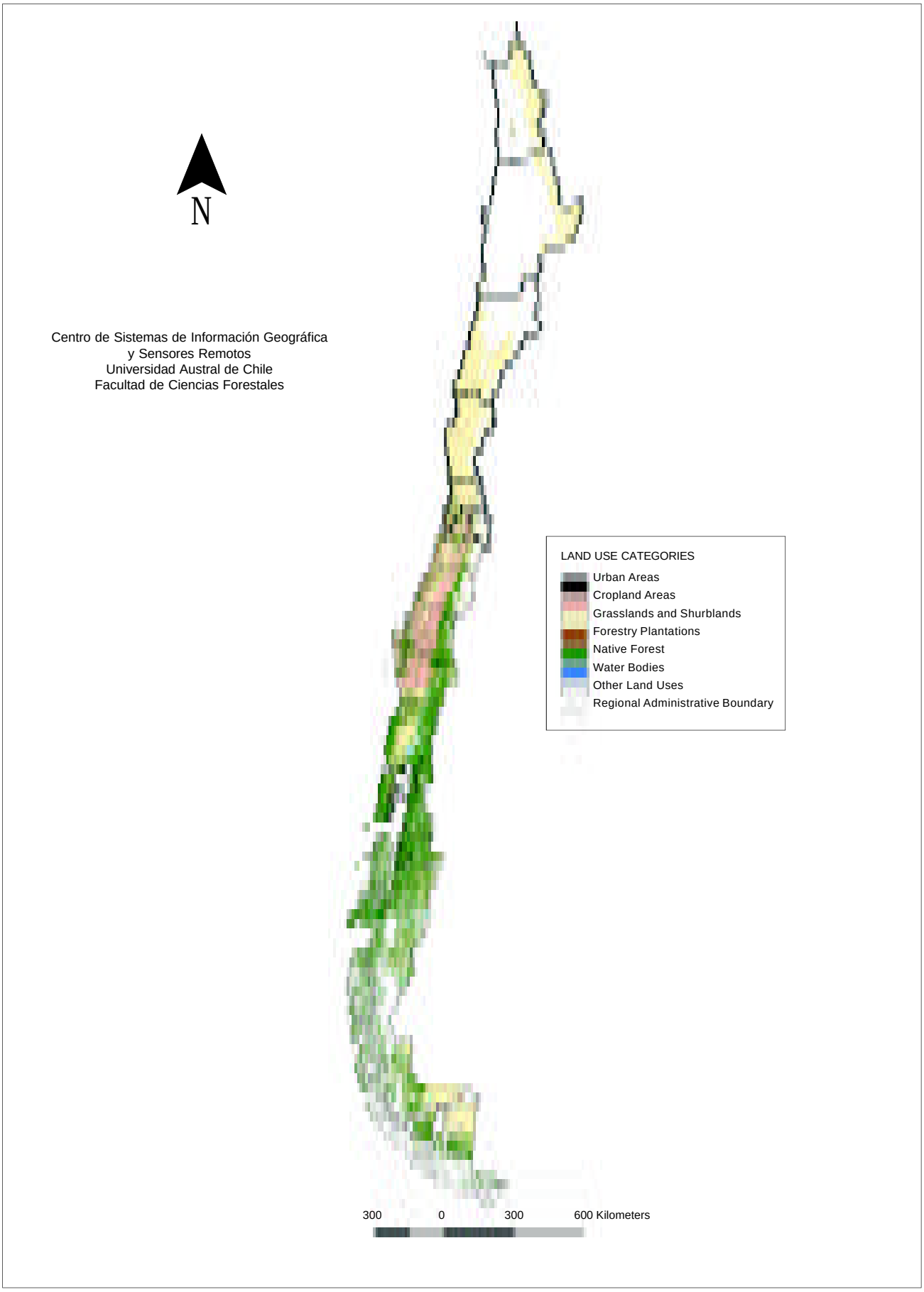
The long-term goal of GFW-Chile is to be able to better monitor the change and evolution of native forests, and in particular frontier forest, by making available improved information on their location, extent, conservation status, management, use, and threats. This information will allow users to detect changes in forest cover early, identify the different activities that are happening in and around frontier forests, and improve the management and sustainable use of this valuable resource.

CHILE is located in the southwestern part of South America, between 17º30'S and 56º30'S. Bordering Chile to the north are Peru and Bolivia, and to the east lies Argentina. Chile's western boundary is its coast, which lies on the Pacific Ocean. Total surface area of the country is 775,000 km^2, including its various islands. Chile is a long, narrow country, with a length of 4,300 km and an average width of 160 km. The country is divided into thirteen administrative regions, distributed from north to south. Region XIII, in the center of de country, corresponds to the metropolitan region of Santiago, Chile's capital, where most of the population of the country is located.

CHILE has an extraordinary diversity of environments, from deserts in the north, to temperate rainforests in the south. The country has three main morphological features: the Coastal Mountain Range, the Andean Mountain Range, and the valley area in between. These three features manifest themselves predominantly as one moves south from the parallel 35ºS, an area occupied by the temperate forests.

CHILE'S GEOGRAPHICAL LOCATION

FIGURE 1. DISTRIBUTION OF DIFFERENT LAND USES AND NATIVE FORESTS IN CHILE



2. CHILE'S FORESTS

2.1. DESCRIPTION OF CHILEAN FORESTS

Chile's temperate forests are largely located between 35°S and 55°S. These forests are classed as *temperate forests* because of their geographical location outside the tropics, and because they experience high rainfall and low temperatures in winter. As one moves south, one can find Chile's temperate rainforests, adapted to wetter and cooler climates. Chile's temperate rainforests are found primarily in Regions IX, X, and south along the coast to Region XI (Donoso, 1979). Similar forests are found in Tasmania, New Zealand and the Pacific Northwest in North America. Chile's temperate rainforests represent about one-quarter of the global total (Wilcox, 1996). Further north, above 37°S, and in the northern reaches of the temperate forests range, one finds Chile's *Sclerophyllous* forests, which are composed of different tree species adapted to drier climates.

Chile has some of the most impressive forests in the world. Among them are the Chilean palm forests (*Jubaea chilensis*) of north-central Chile, which contain the southernmost palms in the world; the *Nothofagus* forests of central and southern Chile, which include a variety of commercially important species for wood and fiber production as well as highly endangered species, like the ruil; the prehistoric araucaria forests (*Araucaria araucana*), an endemic species that can live as long as 1,500 years; and the alerce forests, also an endemic species of impressive height, diameter, and longevity. One of the largest trees found in the Southern Hemisphere, the alerce (*Fitzroya cupressoides*) has the second longest lifespan in the world, with some trees living more than 3,620 years (Lara and Villalba, 1993).

Chile also contains the world's second-largest remaining area of coastal temperate rainforest after the Pacific Northwest coastal rainforest that extends from Northern California to Southeast Alaska (Wilcox, 1996) (see *Box 1* for forest definitions). Experts estimate that the original global extent of these forests was in the order of 30 to 40 million hectares (Weigand et al., 1992). The total area of remaining coastal temperate rainforest is unknown, but researchers believe that, as of 1992, 56 percent had been logged or converted to other land uses (Weigand et al., 1992).

For discussion purposes, this report refers to forest categories and definitions presented in *Box 1*.

BOX 1. FOREST CATEGORIES AND DEFINITIONS

Temperate Forests: Generic term given to forests that grow throughout the temperate latitudes. In Chile, temperate forests are found primarily between 35°S and 55°S (Administrative Regions VI to XII).

Temperate Rainforest: A subset of temperate forests found in areas with high rainfall and where the predominant trees are evergreen species. These forests are found mainly in Regions IX, X, and south along the coast to Region XI (Donoso, 1979). A subset of these forests, the coastal temperate rainforests, are usually found on the western edge of the continent near the ocean and the mountains. These forests are characterized by abundant rainfall throughout the year and the absence of natural fires. In Chile, coastal rainforests are found in a narrow strip along the coastline from Regions IX to XI.

Native Forests: Forests made up of native species unique to the region. Native forest encompass the following forest categories:

- **Mature Forests**: Primary forests, generally heterogeneous in their vertical structure, size of canopy, tree diameter, and age, they feature a shrub-like understory with variable density and a layer of regenerating vegetation.
- **Secondary Forests**: Forests altered either by humans or by a natural disturbance that are regenerating.
- **Mature-Secondary Forests**: In Chile, this particular type of forests is usually the result of intentional forest fires. Most of the vegetative cover has been eliminated and replaced by a mix of young re-growth and the remaining mature trees that were not burned.
- **Sub-alpine or Timberline Forests**: Forests that grow at the limit of the vegetation range. They are characterized by their limited and slow growth due to unfavorable environmental conditions (high altitude, low temperatures, strong winds, aridity, poor drainage, rockiness, thin soil, etc.).
- **Frontier Forests**[1]: Mature forests or dense timberline forests of at least 5,000 hectares that are made up of native species and are intact or minimally altered.

Mixed Forests: Areas of native forest mixed with plantations of exotic species.

Plantations: Areas made up of exotic species that have been planted for harvesting. In Chile, plantations are usually pines or eucalyptus.

1 *The term «frontier forests,» as used in this report, is equivalent to «intact forests» as defined and mapped in other countries by the GFW network. GFW-Chile and its Technical Advisory Committee deemed the use of the term «frontier forests» more appropriate, especially as it translates into Spanish, given that the term «frontier forest» allows for slight use of the forest, while «intact» in Spanish excludes any forest use. The definition of frontier forest therefore has been adapted to fit the Chilean context and may differ from earlier uses of the term.*

However, Chile's rich vegetation and complex biological communities are traditionally categorized into eight vegetative zones and 21 sub-zones (Gajardo, 1983). To provide readers with a general overview of the richness of species and biological communities throughout the country, we include a brief description of Chile's eight vegetative zones in *Box 2*.

As mentioned earlier, Chile's forest types are rich and varied in species composition. If these forest types are classified according to its structure and the dominant species present, one can differentiate 13 forest types, as defined by Donoso (1981). This forest type classification has been incorporated into Chile's national forest legislation, and was the basis for the land register analysis carried out for CONAF (CONAF et al., 1999). This forest classification is presented in *Box 3*. Because forest ecosystems grow and develop in contiguous stands along climatic, latitudinal, and altitudinal gradients, boundaries and transition zones between forest types are not clear-cut, resulting in overlapping forest types in some areas (Donoso, 1981). Ideally the frontier forest analysis carried out in this report would have been done by forest type instead of administrative region; however, the existing data, budget and timeline of the project did not permit this sort of analysis. GFW-Chile hopes to expand the analysis to look at frontier forests by forest type in its continuing program of work.

BOX 2. VEGETATIVE ZONES OF CHILE

Desert: Extending from the limit of Region I to Region IV.

High Andean Plain/Steppe: Found in the Andean Mountain Range, extending from Chile's northern boundary at the borders with Peru and Argentina, to the mountains of Region VII. This zone is characterized by its relative aridity and short growing season.

Scrublands and Dry Sclerophyllous **Forests**: This zone extends across Chile's entire central region and is characterized by a typical Mediterranean climate, which supports dry open canopy forests and shrub-like trees.

Deciduous Forests: The deciduous forest zone extends from 33°S to 41°S, between Chile's Regions V and X, and has a mild temperate climate.

Broadleaf Evergreen Forests: In this zone, the forests are composed of broadleaf evergreen trees with a varied floristic composition that is considered to have been present historically. Gajardo (1983) indicates that most likely, these forests also extended to the coastal mountain chain of central Chile, but they have since disappeared probably due to accelerated human settlements.

Andean-Patagonian Forests: These extend from 37°S to Chile's southern tip, through the densely forested Southern Andean Mountain Range. The vegetative landscape is distinguishable by the presence of the deciduous southern beech or lenga forests (*Nothofagus pumilio*), the most common timberline species in the Andean Mountain Range. The presence of snow is an ecological characteristic of these forests.

Evergreen Forests and Peat Bogs: These occur in mountainous sectors on the western sides of the Patagonian mountains. They are also found on the long narrow band of outer islands that are spread across southern Chile from the island of Chiloé in Region X, all the way to the tip of Chile by Cape Horn (Region XII).

Patagonian Steppe: This corresponds to the vegetation found at the southern tip of South America. It has a broadly homogenous steppe physiognomy, with grasses and short shrubs.

Source: Gajardo, 1993.

BOX 3: CHILE'S FOREST TYPES (FROM NORTH TO SOUTH OF THE COUNTRY)

FOREST TYPE	LOCATION	DOMINANT SPECIES AND KEY ASSOCIATED SPECIES
Sclerophyllous	Coastal Mountain Range: 30º50'S to 36º30'S. Central Valley: 30º50'S to 37º50'S. Andean Mountain Range: 32º00'S to 38º00'S.	Espino (*Acacia caven*), quillay (*Quillaja saponaria*), maitén (*Maytenus boaria*), trevo (*Trevoa trinervis*), guayacán (*Porliera chilensis*), and algarrobo (*Propopis alba*).
Chilean Palm	Isolated Populations starting at 34º30'S.	Chilean palm (*Jubaea chilensis*) with litre (*Litrea caustica*), peumo (*Criptocarya alba*), boldo (*Peumus boldo*), maitén, and espino.
Roble - Hualo	Coastal Mountain Range: 32º50'S to 36º30'S Andean Mountain Range: 34º30'S to 36º50'S.	Roble (*Nothofagus obliqua*), hualo (*Nothofagus glauca*), peumo, maitén, quillay, litre, avellano (*Gevuina avellana*), and radal (*Lomatia hirsuta*).
Cordilleran Cypress	Found in non-contiguous populations in the Andean Mountain Range from 34º35'S to 44º00'S.	Cordilleran cypress (*Austrocedrus chilensis*), peumo, boldo, maitén, and quillay.
Roble-Raulí-Coigue	Andean and Coastal Mountain ranges between 36º30'S and 40º30'S.	Roble, raulí (*Nothofagus alpina*), and coigue (*Nothofagus dombeyi*). These are mainly secondary forests or a mix of these three species with luma (*Amomyrtus luma*) and arrayán (*Luma apiculata*).
Lenga	Found from 36º50'S to 56º00'S and at the altitudinal vegetation limit in the Andean Mountain Range up to at 45º00'S.	Coigue, roble, araucaria (Araucaria araucana), ñirre (*Nothofagus antarctica*), and Magellanic coihue (*Nothogagus betuloides*).
Araucaria	Found in non-contiguous populations in the Coastal Mountain Range from 37º40'S to 38º40'S. Andean Mountain Range: 37º27'S to 40º48'S.	Araucaria, coigue, roble, ñirre, canelo (*Drimys winteri*), and lenga (*Nothofagus pumilio*)
Coigue-Raulí-Tepa	Coastal Mountain Range: 38º00'S to 40º30'S. Andean Mountain Range: 37º00'S to 40º30'S.	Coigue, raulí, tepa (*Laureliopsis philippiana*), trevo, and olivillo (*Aextoxicon punctatum*).
Evergreen	Coastal Mountain Range: 38º30'S to 47º00'S. Andean Mountain Range: 40º30'S to 47º00'S.	Tepa, luma, canelo, and tineo (*Weinmannia trichosperma*).
Alerce	Found in non-contiguous populations in the Coastal Mountain Range from 39º50'S to 41º15'S and in the Andean Mountain Range from 40º00'S to 43º00'S.	Alerce (*Fitzroya cupressoides*), Magellanic coihue, Chiloé coigue (*Nothofagus nitida*), prickly-leafed mañío (*Podocarpus nubigena*), tineo, and Guaitecas cypress (*Pilgerodendron uviferum*).
Guaitecas Cypress	From 40º00'S to 53º00'S.	Guaitecas cypress, Chiloé coigue, prickly-leafed mañío.
Magellanic Coihue	From 47º00'S to 55º30'S.	Lenga, tineo, prickly-leafed mañío, Magellanic coihue, and Guaitecas cypress.

Donoso, 1981

2.1.1 FOREST COVER IN CHILE: A HISTORICAL PERSPECTIVE

Chile's forests began to form following the retreat of continental glaciers more than 10,000 years ago. Evidence suggests that these temperate forests have covered this region of the planet for the last 3,000 years, remaining almost intact until the arrival of the Europeans 450 years ago. Prior to the arrival of the Spanish, the indigenous people of the region had not significantly altered the landscape. The Huilliche[2] people, for example, converted some of the forests of the central valley to agricultural and pasture land; however, as a result of the Spanish conquest, the Huilliche were forced to abandon this zone, allowing the forests to recover (Donoso, 1998). Nevertheless, after the independence from Spain, and the arrival of colonial settlers from Europe around 1860, the 300-year-old forests were again converted, and through intentional forest fires, vast expanses of the central plains' alerce forest (*Fitzroya cupressoides*) were destroyed.

A study by Lara et al. (1999) shows that, in 1550, prior to European colonization, original native forests extending from administrative Regions VII through XI covered an estimated 18.4 million hectares. Today, only 56 percent of this original forest cover remains. Most affected are the *Sclerophyllous* and the *Nothofagus* forest types, with 3 and 30 percent, respectively, of original forest cover remaining. The expanse of grasslands and scrublands, on the other hand, doubled in area, from 2.5 million to 5.5 million hectares (Lara et al., 1999) (*see Figure 2*). It is important to note that, within these regions, new types of land use –such as urban areas, agricultural lands, and forestry plantations– occupy a significant expanse.

2.1.2 CURRENT FOREST COVER IN CHILE

According to the Official Land Register and Evaluation of the Native Vegetative Resources of Chile, carried out for CONAF (Corporación Nacional Forestal), the Chilean government agency responsible for forest management, Chile has 15.6 million hectares of forest cover (CONAF et al., 1999). (*See Table 1* for forest extent and *Box 1* for forest definitions.) Of this area, 13.4 million hectares, or 85.9 percent, is native forest; 2.1 million hectares, or 13.5 percent, is forestry plantations; and 85,744 hectares, or 0.55 percent, is mixed forests. With respect to forest structure, mature forests constitute the largest share of Chile's native forests, representing 44.4 percent. Among forestry plantations, 75.5 percent by surface area are Monterey pine plantations (*Pinus radiata*), with plantations of various eucalyptus species (*Eucalyptus spp.*) accounting for a further 16.8 percent of total plantation area (CONAF et al., 1999).

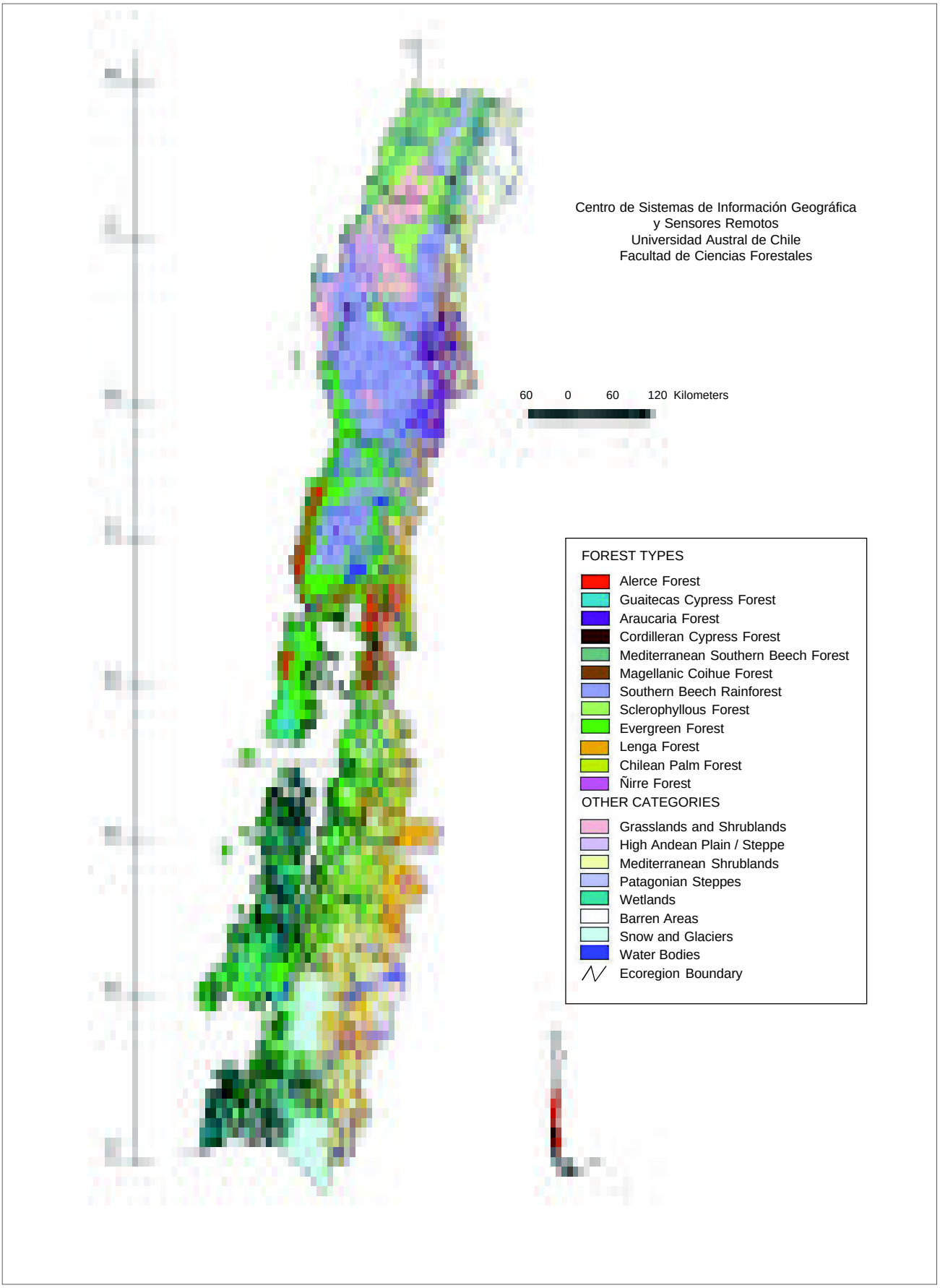
TABLE 1. FOREST COVER IN CHILE

CHILE'S FORESTS	TOTAL SURFACE AREA (HA)	PERCENT OF TOTAL FOREST AREA
NATIVE FOREST		
Mature Forest	5,977,996.3	38.2
Secondary Forest	3,582,427.3	22.9
Mature-Secondary Forest	865,525.3	5.5
Sub-alpine or Timberline Forest	3,017,209.0	19.3
Subtotal	13,443,157.9	85.9
FORESTRY PLANTATIONS	2,118,840.2	13.5
MIXED FOREST	87,744.0	0.6
TOTAL	15,647,742.1	100

Source: CONAF et al., 1999.

2 Indigenous village that populated south-central Chile

FIGURE 2. ESTIMATES OF VEGETATIVE COVER IN 1550 IN REGIONS VII THROUGH XI



Lara et al. (1999)

Native forests are concentrated in the south-central and southern zone of the country. Region XI contains the largest expanse of native forest, with 35.9 percent of all native forest area; the second largest expanse is found in Region X. Region VIII includes the largest expanse of forestry plantations, containing 44.3 percent of total plantation area (*see Figure 1*).

2.2. GLOBAL AND LOCAL SIGNIFICANCE OF CHILE'S FORESTS

At the global level, Chile's forests are a valuable resource, particularly in terms of biodiversity. Though temperate forests are not as species-rich as tropical forests, they remain very important in terms of the size and lifespan of the tree species, the level of productivity, the enormous concentration of biomass and corresponding capacity for carbon storage, and the high degree of endemism. For example, according to Arroyo et al. (1993), 28 of 84 genera (representing 33 percent of woody species) and one family (*Aetoxicaceae*) found in Chile's temperate forests are endemic. In addition to their richness in plant species, Chile's forests, particularly its frontier forests, provide habitat for wild fauna, especially large mammals that require substantial areas of land for their survival. Animal species living in these temperate forests also display a high degree of endemism. These include: 11 species of mammals, 24 species of amphibians, 5 species of reptiles, 13 species of birds, and 13 species of fish.

Chile's temperate forests also possess great ecological and evolutionary value. They are geographically isolated from other tropical and sub-tropical forest formations, including those of Tasmania and New Zealand, which were connected to South America during the Tertiary Period of geologic history (Axelrod et al., 1991).

This geographic isolation has limited the exchange of flora and fauna between Chilean forests and those outside the country, creating marked differences between South American forests and their equivalents in the Northern Hemisphere. Forests of North, Central and northern South America, for example, were connected during the last glacial period, allowing for species exchange between the two continents. Armesto et al. (1995) has demonstrated that many of the characteristics of the southern cone's temperate forests (i.e., forests in the southern part of South America) are the result of this prolonged isolation. The region's climate and topography also have produced extensive heterogeneity of forests, soil types, and patterns of disturbance.

Moreover, temperate forests, and in particular frontier forests, have a crucial role in climate regulation. They are also a fundamental component of the natural landscape, which in Chile is vital for the continued development of a valuable tourist industry.

The global significance of Chile's forests has been recognized by multiple well-known international conservation organizations such as World Wildlife Fund (WWF), Conservation International (CI) and IUCN-The World Conservation Union. WWF for example, has catalogued Chile's temperate forests as one of the top conservation-priority forest ecoregions in the Southern Hemisphere, while CI and IUCN have identified Chile's forests as one of the 25 "hot spots" for biodiversity conservation in the world.

At the local level, native forests are important not only for biodiversity but also as a source of timber, non-timber forest products, and fuel wood for many rural communities, including indigenous communities. In Chile, with the exception of forests in Region XII, most frontier forests are found in fragile areas, such as the upper reaches of watersheds and in areas of steep slopes. In these highly vulnerable areas, forests play a very important role in watershed protection, soil stabilization, and the maintenance of the hydrological and nutrient cycles. Most of the high-latitude forests of Region XII, which are located on moderate slopes and at low elevations, are not considered particularly fragile; however, they too contribute to soil stabilization, provide habitat for species, and are a source of wood, fiber, and other forest products (Franklin personal communication, 2001).

2.2.1 THE NEED FOR CONSERVATION

As mentioned earlier, temperate forests constitute a global reserve of biodiversity. They represent a potential source of unique genetic resources, possessing extraordinary biota that are rich in endemic

species, particularly mono-specific genera and families of plants and animals (i.e., those genera and families with a single species).

Arroyo et al. (1995) estimate that the diversity of Chilean temperate forests encompasses 850 to 900 species of vascular plants. This is a conservative estimate, due in part to the difficulty of identifying some taxa. Moreover, sampling methodologies are usually not uniform across all regions of the country; some areas are sampled more extensively than others. To conserve and maintain native species, Noss (1998), a world-renown conservation biologist, proposes that a large part of the forested region remain untouched, while the remainder is managed for multiple uses, under management practices that are strictly consistent with the natural ecological processes of the region.

Recent findings indicate that a high number of Chile's woody plant species and terrestrial and aquatic vertebrates are threatened with extinction (Armesto et al., 1995). Among the threatened tree species are the southern belloto (*Beilschmiedia berteroana*), the queule (*Gomortega keule*), the ruil (*Nothofagus allessandri*), and the pitao (*Pitavia punctata*). With the exception of the pitao, these species are legally protected in Chile as natural monuments (Wilcox, 1996). No harvesting of such species is permitted; only collection of their dead wood is allowed. The ruil, in particular, is an extremely rare tree whose populations are so highly fragmented that no mature trees exist today (Wilcox, 1996).

Among the threatened terrestrial vertebrates inhabiting Chile's forests are: three feline species (the guiña or austral spotted cat (*Oncifelis guigna*), Geoffroy's cat (*Oncifelis geoffroyi*) and the colocolo or pampas cat (*Oncifelis colocolo*)); one cervid species (the Chilean huemul or South Andean deer (*Hippocamelus bisulcus*)); one otter species (the southern river otter (*Lontra provocax*)); one marsupial species (the long-snout rat-opossum (*Rhyncholestes raphanurus*)); one canid species (the Tierra del Fuego culpeo fox (*Pseudalopex culpaeus lycoides*)); one amphibian (Darwin's frog (*Rhinoderma rufum and Rhinoderma darwini*)); and one bird (the Patagonian Conure (*Cyanoliseus patagonus*)). In addition, there are many other Chilean species vulnerable to extinction, that is, species with declining populations that may become extinct if the causes of their decline persist. There are 26 such species of native flora and 92 species of vertebrates, a large portion of which depend directly or indirectly on forest ecosystems. The principal factors threatening these species are the reduction and fragmentation of native forest, consequent variations in the quality and quantity of water flow in rivers, and microclimatic changes of these habitats due to forest loss.

Results of the analysis carried out by GFW-Chile point to small patches of native forest, many of which are made up of unique species assemblages, that are at risk due to fragmentation caused by development activities (road building, establishment of plantations, etc.). Protecting these last remnants of forests, especially in regions where no frontier forests are left, is a crucial step in ensuring the long-term survival of these ecosystems, and also presents an opportunity for restoration and, eventually, sustainable management.

2.2.2 STATE OF FOREST CONSERVATION IN CHILE

The state of conservation of Chilean forests is a topic of growing concern among the general public as well as national and international conservation organizations. The most recent evaluation shows that only a small portion of forestry activities is adequately managed (Lara et al., 1995). While 29 percent of the total area of native forests is protected through inclusion in the National System of Protected Wildlands (SNASPE), the state's protected areas system (CONAF et al., 1995), forest types are poorly represented and reserve size in many regions inadequate. For example, 84 percent of these protected areas are concentrated in Regions XI and XII, regions with low human population densities and few forest-related industrial developments. Aside from these protected forests of Regions XI and XII, only a small fraction of native forest in the rest of the country has protected status.

In addition, the SNASPE does not include critical areas of native forest that are currently at risk of disappearing or being severely degraded. This is the case, for example, for the coastal forests in Regions VII through X (Armesto et al., 1995). As Simonetti (2000) indicates, only a fraction of national species and ecosystems that need protection are represented in the SNASPE. According to the classification found in Gajardo (1983), Chile has a total of 85 ecosystems and vegetative subregions, of which 19 are not represented in the SNASPE. Some 33

ecosystems have 5 percent or less of their surface area included in the SNASPE. Furthermore, the size of some of the protected areas in the SNASPE seems to be insufficient to maintain viable populations of threatened species. According to CODEFF (1999), despite government efforts, the northern and central zones of the country, the most floristic-rich areas, are poorly represented in the SNASPE. This degree of protection does not ensure the continuity of evolutionary processes.

Because the majority of the forest land is in private hands, its long-term conservation through inclusion under the SNASPE is not the only solution. The government has limited resources to purchase land, and landowners are increasingly placing higher monetary value on their properties. Most of the time, land prices are too high for government purchase. Even if the government prioritized the conservation of these important forest types, active participation from the private sector in the conservation and protection of native forests is also needed and encouraged.

2.2.3 DESTRUCTION AND DEGRADATION OF NATIVE FORESTS

Throughout history various factors have contributed to the current state of degradation of Chile's native forests. One of the first anthropogenic impacts on Chile's forest resources resulted from the clash between the Mapuches and the Spanish. The latter burned vast expanses of native forest to prevent the Mapuches from taking refuge there and attacking the invaders. A 1996 study carried out by CODEFF shows that, following this historic episode of forest destruction, the next major event impacting forest resources took place in the 19th century. Forest land was converted to cropland and pasture, and later cleared for timber production. In 1863, for example, sections of alerce forests were burned in the southern-central zone of Chile for pasture and croplands. This practice of burning native forests continued into the 20th century in southern Chile. Afterwards, in conjunction with the construction of roads and railways, new extractive processes were adopted and have been maintained.

Currently, various authors agree that the two most important disturbances affecting native forests are selective logging and forest clearing, followed by substitution with exotic species. Only a minority of native forest areas are managed for wood production (Lara et al., 1995; Emanuelli, 1996). Selective logging disturbances are most prevalent and, while not causing great reduction in the total area of native forests, do cause severe degradation by altering forest structure and composition. For example, selective logging removes the largest, healthiest trees of highly commercial species, thereby changing the species composition of the forest and the genetic reservoir for these species, as well as altering forest conditions so that other species are also affected. Selective logging directly damages forest soil and vegetation during mechanical removal of large trees. Far more damaging than selective logging is the replacement of native forests with plantations of exotic species, which entails clearing of all existing vegetation and is the primary cause in terms of impact of, usually irreversible, native forest destruction and fragmentation. However, it is important to note that in many instances, selective logging is simply the first step in a process, which often results in the clearing of degraded forests and their replacement with plantations.

Another factor that has negatively affected the forest ecosystem is fire. In the last two decades, an average of 13,660 hectares of native forests have been destroyed each year by fires, almost all caused by humans. In fact, records indicate that less than one percent of fires were of natural origin; 28 percent were set intentionally, 29 percent were related to transportation accidents, and the remainder resulted from undetermined causes (CONAF, 1998).

In 1999, CONAF presented the results of a 4-year monitoring program assessing the changes in the vegetative cover of Region VIII and the northern part of Region X, which account for almost 30 percent of Chile's forests. This monitoring effort showed that native forest area decreased by 25,230 hectares over the course of the study. Of this area, more than 55 percent was replaced by plantations of exotic species (CONAF et al., 1999). The methodology used by CONAF, however, did not allow for an assessment of the degree of degradation caused by selective logging. To be able to detect these changes, a methodology with the highest level of detail is required. The GFW-Chile team is in the process of developing such a methodology in order to obtain more precise information about the state of native forests in Chile.

3. FOREST SECTOR DEVELOPMENT

3.1 EVOLUTION OF THE FOREST SECTOR IN CHILE

Starting in 1974, Chile implemented a national forest management strategy that reduced state involvement in this economic sector. This strategy limited the government's role to three areas: control of legislation affecting the forest sector, promotion of forest-related activities developed by the private sector, and management of protected areas and other land under the National System of Protected Wildlands (SNASPE). Within this framework, two major activities took place:

- A privatization process which transferred the state's forest-related industrial capacity and forest lands to the private sector, and a
- Program of forestry plantation subsidies, which dramatically increased the number of plantations, particularly of Monterey pine. Consequently, the production of pulp or cellulose, one of the primary forest products in Chile, increased as well.

Simultaneously, forest products companies consolidated their investments in the industry. In 1989, two holding companies (Matte Holding and Angelini) controlled an estimated 39.6 percent of the forestry plantations as well as 68.9 percent of forest products exports, the majority of which are destined for the Asian market (Contreras, 1989).

3.2 FORESTS AND LAND TENURE

In the wake of this period of consolidation, two large holding companies currently control most of the forestry plantations in Chile. Empresas CMPC of Matte Holding controls 609,000 hectares of plantations and Angelini controls almost 800,000 hectares, of which 500,000 are forestry plantations. These two companies also own six of the country's eight existing cellulose plants. *Table 2* shows the type and number of the main landowners of Chile's industrial forests.

Some internationally owned companies also control plantations in Chile. For example, Shell Corporation owns 40,000 hectares of forestry plantations through its affiliate Empresa Forestal y Agricola Monteaguila, Forestal Millalemu, which is backed by Swiss capital, owns 80,000 hectares, and Forestal Bio Bio, backed by U.S. capital controls 47,049 hectares. In some cases these plantation-based companies also own land with native forests, for example, Forestal Millalemu owns approximately 40,000 hectares. In addition, there are

TABLE 2. AREA OF FORESTRY PLANTATIONS IN CHILE BY REGION AND BY SIZE OF INDIVIDUAL LANDOWNERS (HECTARES). THIS TABLE EXCLUDES MATTE AND ANGELINI HOLDING COMPANIES.

ADMINISTRATIVE REGION	LARGE AND MEDIUM SIZE LANDOWNERS	SMALL LANDOWNERS	NO INFORMATION ON ON LAND TENURE
IV	1,610	-	58,075
V	34,363	11,518	2,900
VI	59,249	14,403	1,986
VII	178,296	44,462	14,053
VIII	198,150	45,038	29,235
IX	76,622	23,180	3,812
X	46,910	10,029	2,322
XI	5,306	-	-
XII	13	-	-
TOTAL	600,519	148,630	112,383

Source: GFW-Chile.

TABLE 3. KEY COMPANIES WITH NATIVE FOREST HOLDINGS

COMPANY	SURFACE AREA (Ha)	ADMINISRTATIVE REGION
Forestal Savia (formally called Trillium)	103,000	XII
Forestal Mininco	70,000	VIII and IX
Forestal Millalemu	40,000	VIII and IX
Soc. Agrícola Alicahue	20,000	–
Forestal Anchile	20,000	X
Forestal Los Lagos	20,000	X
Soc. Agrícola y Gananadera San Lucas Ltda.	15,728	XII
Inversiones Emasil	10,000	X
Forestal Taquihue	6,700	X
TOTAL	305,428	–

Source: GFW-Chile.

wood processing mills (also owned by both national and international corporations) that do not own land in Chile, but which buy wood from private owners of forest land, both native forests and plantations. Information on these, however, is not readily available. Currently, there is no land tenure registry for areas of native forest. What is known is that 29 percent of native forest land is protected under the SNASPE and that a significant portion of native forest is in the hands of small landowners. However, the exact amount of native forests belonging to small landowners is still unknown. *Table 3* lists the principal large and medium-sized companies that own native forest land.

One indicator of private holdings, is the estimated number of rural production units cited by Peña (1994). These estimates point out that there are 240,000 rural production units in Chile, representing close to 9 million hectares. A rural production unit, or unidad de producción campesina (UPC), is the area available to a rural family for the production of food, either for household consumption or commercial sale. Taking into account these figures as well as research from CODEFF (1992), rural family agriculture administers almost 9 million hectares, of which 2 million are classified by the government as having soils ideal for forest use, but which may or may not actually contain forests stands. Within these 2 million hectares, there are approximately 400,000 hectares of native forest.

In summary, of the 13 million hectares of native forest:

- Two to three percent are owned by the nine large forestry-related companies shown in *Table 3*; and
- An unknown amount is under the control of small landowners. Sample estimates on small land holdings point to 400,000 hectares, out of 9 million in rural production units.

A considerable amount of forest land under the control of small and medium landowners, along with most of the state-owned lands, have been transferred to large companies. Consequently, rural areas have lost population, especially in areas where plantations are predominant. The impact of rural depopulation can be seen in the abandonment of houses, clinics, and schools. Most people migrate to cities or, in some cases, create informal settlements on public land near main roads.

Land tenure issues also arise concerning indigenous communities. These communities have been receiving land titles from the government within the framework of current policies implemented by the National Commission for Indigenous Development (Comisión Nacional de Desarrollo Indígena, or CONADI). Much of this land is forested, and is bought from forest industries with government funds set aside for this purpose. Despite implementation of these policies, there are significant conflicts between the indigenous Mapuche communities and some forestry companies. These conflicts frequently concern lands occupied by forestry plantations, some of which are claimed by indigenous groups as ancestral lands that ended up in the hands of private companies or non-indigenous owners.

3.3 ACTORS INVOLVED

Among the actors involved in the forest sector in Chile are the state (through various state agencies), the forest industry and trade associations, small landowners, and non-governmental organizations (NGOs). The state's main role is to promote the management of native forest and forestry plantations, implement legislation, and administer the SNASPE. The forest industry plays an important role through the ownership and management of extensive forested lands; it has increased the contribution of forest products exports to the country's gross domestic product through the industrialization of the sector (e.g., increasing the number of paper and pulp processing plants). Small landowners hold a significant share of forest land, with its use restricted mostly to fuelwood collection and shelter for livestock during winter months. Finally, the main goals and objectives of many environmental NGOs are to promote forest stewardship, develop conservation plans for natural resources, and serve as catalyst for civil society support of protection of species and ecosystems.

State Agencies

The institutional framework within which the forest sector operates is determined by the Ministry of Finance and the Ministry of Agriculture. The latter administers the state agency in charge of forests (CONAF) and Chile's Forest Institute (INFOR). The National Commission for the Environment (Comisión Nacional del Medio Ambiente, or CONAMA) through its ministry, also has a role with respect to forest use and conservation through the setting and implementation of Chile's environmental norms and regulations.

CONAF: The key mandates of this agency with respect to native forests are: to promote native forest management among small landowners based on the idea that forest sector activities are profitable options; to enforce native forest legislation; and to recover and protect Chile's natural heritage. This agency is represented at both the provincial and regional level.

CONAMA: This government agency is in charge, among other things, on administering Chile's environmental impact assessment system (Sistema de Evaluación de Impacto Ambiental, or SEIA). This system evaluates all infrastructure developments, from industrial projects such as hydroelectric plants and wood-processing mills to large forest management proyects. Based on this evaluation system, CONAMA can impose conditions on the implementation of these projects prior to their approval.

INFOR: The role of this institution is to support public institutions and private-sector entities involved in forest activities. INFOR does this by enhancing information on and developing technologies for the efficient use of forest resources. The work carried out by INFOR addresses three focal areas: (i) improving information on forests resources and land use, (ii) diversifying production options, and (iii) promoting increased domestic consumption and exports of forest products.

Forest Industries, Trade, and Professional Associations

The National Wood Corporation (Corporación Nacional de la Madera, or CORMA): This association brings together forest-sector companies dedicated to improving industrial forest development in Chile. The organization plays a key role as the forest industry's representative in all government-related matters. CORMA has considerable political influence and is led nationally by officials of the largest forestry-plantation companies. It is a national association with representation in all forested regions of the country.

Association of Forest Engineers: This trade association consists exclusively of forest engineers. Its main role is to promote the development and cooperation, protection, progress, prestige, and scientific and technological improvement of association members. It aims to actively contribute to the development of the national community of forest engineers. This trade association also represents the interests of forest engineers in governmental, academic, and other venues linked to the forest sector.

Forests Engineers Association for the Native Forests (Agrupación de Ingenieros Forestales por el Bosque Nativo, or AIFBN): This association was established in response to the increasing concern about and interest in the condition of native forests in Chile. It is a non-profit organization that focuses on promoting the management and conservation of native forests on several levels: political, academic, and in terms of capacity building. To achieve its goals, AIFBN coordinates various efforts carried out by forest

engineers regarding sustainable use of native forests, as well as developing policies, raising awareness and building capacity related to the management and conservation of native forests.

Non-Governmental Organizations (NGOs)

The Chilean environmental NGOs focusing primarily on forest issues are the National Committee for the Defense of Fauna and Flora (CODEFF), the National Network of Ecological Action (RENACE), and Defenders of the Chilean Forest. These organizations work at the political level and with civil society, mostly carrying out education and awareness raising campaigns, monitoring forestry projects and the implementation of pertinent laws and regulations, building capacity among small and medium-size forest landowners, improving the management and conservation of forests, and protecting threatened species and forest ecosystems. Their role to date has been very important in communicating the interests of civil society as it relates to forest issues. In addition to these NGOs, there are also several citizens' groups that participate in specific campaigns dealing with particular forestry projects that affect them.

3.4 FOREST PRODUCTS

3.4.1 EXPORTS OF WOOD PRODUCTS

The forest industry in Chile is an important contributor to the national economy, accounting for more than 10 percent of all Chilean exports. According to the National Forest Institute's latest statistical report (INFOR 2000), principal forest product exports are chemical wood pulp from forestry plantations (39 percent of exports), sawnwood (8.8 percent), and wood chips (3.8 percent). These latter products come from a mix of native forests and forestry plantations.

The following tables present key forest-sector economic indicators, including the value and destination of exports. Figures for export value are presented in millions of $US FOB (free-on-board), i.e., not including insurance or freight costs. These figures reflect the importance of the forest sector in the national economy.

As illustrated in *Tables 4* and *5*, 10 percent of all of Chile's exports are forest products. In 1999 and 2000, more than 60 percent of these exports went to seven countries, with the United States and Japan as leading importers.

3.4.2 NON-WOOD FOREST PRODUCTS

The non-wood forest products category includes all other goods and services that humans derive from forest ecosystems, such as fruits and nuts, wild mushrooms, and medicinal plants (Tacón, 1997). Traditionally, forests have satisfied the needs of their inhabitants with a wide range of products. In Chile, forests provide, among other things, food, medicinal products, fiber, resins, ornamental flowers and foliage, essences, dyes, and forage for livestock. All these resources are intimately linked to the traditional knowledge of the indigenous people and rural communities that live in these forested areas (Smith, 1995). Among the best known traditional non-forest products are wild mushrooms (known in Chile as pinatras, caracuchas, chicharrón del monte, etc.) and fruits and plants (such as the pehuén, chupón, nalca, murta, and others). These traditional products generate significant income through national and international commercial sales, and they form the basis of the subsistence economy of numerous families inhabiting the rural communities of southern Chile (Smith, 1995). (*Table 7*).

TABLE 4. VALUE OF ANNUAL EXPORTS (MILLIONS OF US$ FOB)

YEAR	1997	1998	1999	2000
National Total (all exports)	$US 1,830	$US 1,660	$US 1,955	$US 2,207
Total Forest Products* (as a percent of total exports)	11%	11%	10%	N/A

* Includes all forest products
Source: INFOR, 2000.

TABLE 5. EXPORT VALUE OF WOOD PRODUCTS BY PERIOD ACCORDING TO COUNTRY OF DESTINATION (MILLIONS OF US$ FOB)

COUNTRY OF DESTINATION	JANUARY-JULY 1999	(%)	COUNTRY OF DESTINATION	JANUARY-JULY 2000	(%)
U.S.A	267	24.0	U.S.A	293	20.6
Japan	150	13.6	Japan	186	13.1
China	78	7.0	Belgium	103	7.3
Belgium	62	5.7	China	102	7.2
Argentina	59	5.4	Italy	86	6.1
Republic of Korea	58	5.2	Taiwan	77	5.5
Italy	56	5.1	Republic of Korea	57	4.1
Sub-Total Main Countries	730	66.0	Sub-Total Main Countries	904	63.9
Other Countries	378	34.0	Other Countries	514	36.1
Total	1,108	100.0	Total	1,418	100.0

Source: INFOR, 2000.

TABLE 6. FOREST PRODUCTS

FOREST PRODUCT	UNITS (THOUSANDS)	VOLUME		
		1997	1998	1999
Chemical Pulp	Metric Tons	1,868	1,980	2,064
Mechanical Pulp	Metric Tons	209	185	135
Newsprint	Metric Tons	184	163	225
Other Paper and Paperboard	Metric Tons	430	479	571
Chips and Particles	Cubic Meters	6,032	5,458	5,840
Sawnwood	Cubic Meters	4,661	4,551	5,254
Particle Board	Cubic Meters	424	321	301
Hardboard	Cubic Meters	56	55	75
Medium Density Fiberboard	Cubic Meters	408	362	409
Plywood	Cubic Meters	65	129	166
Veneer Sheets	Cubic Meters	97	104	112

Source: INFOR, 2000.

TABLE 7. VOLUME AND PRICE OF SOME NON-WOOD FOREST PRODUCTS IN 1996

PRODUCT	EXPORTED VOLUME (Metric Tons)	FOB US$
Sweetbriar rose (Rosa eglanteria)	8,363	28,917,309
Soapbark Tree or Quillaia (Quillaja saponaria)	1,224	4,151,161
Wild Mushrooms (Citaría spp., Boletus spp., etc)	5,495	7,689,550
Boldo Leaves* (Peumus boldus)	1,383	810,938
Wicker	850	696,194
American Bamboo (Chusquea spp.)	37	10,528
Hazelnut Oil (Gevuina avellana)	0.3	7,408
TOTAL	17,352.3	42,283,088

* Medicinal evergreen tree native to Chile.
Source: Tacon, 1997.

3.5 LEGISLATIVE FRAMEWORK

3.5.1 OVERVIEW OF FOREST LEGISLATION IN CHILE

Although forest-related legislation dates to colonial times in Chile, the principal piece of legislation concerning forest conservation and protection, the current Forest Law, came into force in 1931. Although the law has since been modified, in practice it is only partially implemented.

BOX 4. PRINCIPAL LAWS RELATED TO THE MANAGEMENT AND PROTECTION OF NATIVE FORESTS IN CHILE

NAME OF LEGISLATION	YEAR
New Compilation. Book VII	Colonial period
Ordinance of New Spain and Laws of the Indies	1855
Civil Code (Article 783)	1871-72
Laws Regulating Logging	1883
Decree 656	1925
Forest Decree 256	1931
Forest Law (Decree 4,363)	1931
Washington Convention of 1940*	1967
Forest Development Law (Law 701)	1974
CITES Convention of 1973	1975
Modification to Forest Development Law 701	1979
Law 18,348 CONAF and Protection of Renewable Natural Resources**	1984
Law 18,362 National System of Protected Wildlands**	1984
Law 19,300 Basic Environmental, Regulation	1993
Law 19,561 (Modification of Law 701)	1998

* Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere.
** These laws have not been enacted.
Source: Lara et al., 1995.

This first piece of conservation-oriented forest legislation, the 1931 Forest Law, had a mandate to protect forests. Its drafting was motivated primarily by the desire to halt destructive processes affecting forests. This is why the 1931 Forest Law sets out norms prohibiting the felling of trees and shrubs in particular areas; provisions regulating the logging, exploitation, and use of forest resources; stipulations prohibiting the use of fire as a means of exploitation in certain forest lands; and regulations regarding the creation of parks and reserves. Nevertheless, the law lacks key elements of modern environmental legislation, i.e., preventive norms and incentives. For instance, there are no incentives to promote the sustainable use of native forests or to participate in timber certification schemes.

The Forest Development Law of 1974 (Law 701) incorporates subsidies for afforestation, that is, for the establishment of commercially viable plantations in lands not covered with vegetation. This law also lists the management plan as a tool to regulate the use of natural resources. Under Law 701, a subsidy is provided based on the area to be reforested, together with a tax exemption for reforested lands. Law 701 specifies that a management plan must be in place prior to the felling or exploitation of native forests or plantations. This law requires preventive measures, such as logging permits and authorizations, as well as sanctions for violations.

Law 701 facilitates the structuring of all forest legislation and specifies the key institutions responsible for their implementation. This law was the key element that allowed for increased plantation-based forest activity. Indeed, this increased forest activity generated explosive growth in the sector, as well as negative environmental and social impacts, especially concerning the substitution of plantations for native forests, and the consequent impact on rural populations in these areas. The creation of plantations was due in part to a misunderstanding of the definition and real value of native forests. Many native trees in secondary forests are considered shrubs without economic value, which allows their elimination and later substitution with exotic forestry species, such as the Monterey pine and the eucalyptus (CODEFF, 1996).

The plantation industry benefits from the fact that in Chile there are no economic and social instruments that encourage the use and protection of native forests and the biological diversity they harbor (CODEFF, 1996).

International Commitments

Chile has committed to several international agreements with environmental implications, some of which apply specifically to forests. Among these commitments are:

Convention on Biological Diversity, signed by Chile in 1992 and ratified in 1994. The objective of this international convention is the conservation of biodiversity, sustainable use of its components, and equitable participation in benefits derived from

biodiversity and genetic resources. With regard to the Convention's implementation in Chile, a national-level conservation strategy, one of the commitments made under this convention, has not been defined yet.

United Nations Framework Convention on Climate Change, signed by Chile in 1994. The objective of this agreement is to stabilize the concentration of greenhouse gases in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system. According to the Convention, such a level should be achieved within a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened, and enable economic development to proceed in a sustainable manner. The implications for forests are related to the potential use of forests as carbon sinks within the framework of establishing the Clean Development Mechanism (CDM). The CDM is a mechanism of the Kyoto Protocol to allow industrialized countries more flexibility in meeting their greenhouse-gas emission-reduction targets, while assisting developing countries in developing more sustainably. Through the CDM, industrialized countries can invest in energy and reforestation projects in developing countries and receive credits for the tons of greenhouse gases avoided or sequestered through the project. The investing country can then use the credits to meet its reduction target or sell them in the carbon market. Although there is interest within the Chilean government in potentially participating in the CDM, NGOs in the country have expressed skepticism about its benefits. This concern derives mainly from the fear that implementation of such a mechanism would promote a new wave of plantation establishment, similar to the one that took place in Chile more than 20 years ago.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), ratified by Chile in 1975. The goal of this convention is to control international trade in endangered fauna and flora. Members of CITES agree to ban the international commercial trade in an agreed-upon list of endangered species and to monitor trade in species that may become endangered. The most endangered species are listed in Appendix I, which requires particularly strict regulations of international trade in these species. Three Chilean tree species have been included in Appendix I: the alerce, the Guaitecas cypress (*Pilgerodendron uviferum*), and the araucaria. The implementation of CITES has proved a useful tool in discouraging international trade in these species.

Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere. This Convention entered into force in Chile in 1968. Its main objective is to preserve areas of extraordinary beauty and native species of fauna and flora on the American continent. The Convention has proven to be a very valuable tool in the conservation of protected wildlands. This success has been due to the fact that each member-country must commit to the maintenance and improvement of protected areas. In Chile, the Convention has been key in the efforts to incorporate new areas and thus increase the ecosystem representation within the SNASPE.

Montreal Process. This international process brings together non-European countries that have temperate and boreal forests. Its main objective is the development of criteria and indicators for the sustainable management of temperate and boreal forests. The Santiago Declaration, signed by Chile in 1995, contains a set of seven agreed-upon, national-level criteria and 67 indicators that can be used for tracking and reporting progress towards sustainable use of resources. Later stages in the Montreal process presume that member countries will adopt national criteria and indicators for forest management under the Montreal process framework. This process is still being developed in Chile. The Montreal Process is not a legally binding agreement.

After reviewing national forest legislation and the international commitments made by Chile, CODEFF (1996) notes that Chilean legislation contains the necessary tools to achieve the objectives set forth in these agreements. However, these objectives are not part of a larger forest policy or conservation and sustainable use strategy; thus, they have limited effect on the conservation of natural resources.

3.5.2 ILLEGAL LOGGING

Illegal logging has affected Chilean native forests throughout history. It is caused in part by a lack of knowledge and understanding of the value and ecological processes in native forest ecosystems among those involved in forest management as well as civil society in general. Another factor is inadequate funding of the government agencies responsible for implementing the relevant norms and regulations. It is illegal to fell trees in forests and plantations without prior authorization from CONAF. This authorization is given once a management plan

–including, among other things, management objectives, a timeline, and specification of logging practices– has been approved.

According to a study carried out by CODEFF (Fernandez, 1993) in 27 administrative districts of Regions IX and X, the main violations concerning illegal logging are:

- Logging without an approved management plan
- Failure to fulfill the obligations set forth in a management plan

CODEFF examined reports against individuals who violated forest regulations between 1989 and March 1993. They found a total of 400 violations, the majority of which were for logging without an approved management plan. In this study, CODEFF points out the disparity in criteria for applying sanctions. This is due in part to judicial discretion in setting penalties, which leaves room for personal and political influences to come into play. The result sometimes is lackluster penalties or dismissal of cases (Wilcox personal communication, 2001). For example, 60 percent of the violations examined went unpunished, while the rest received fines much lower than those recommended by CONAF. The study also highlights the lack of follow-through by the government as prosecutor, indicating that there is no active defense of the public interest as it relates to forests. The study identifies a clear need for more enforcement, stricter penalties, and further assessments of compliance with forest legislation.

The main laws pertaining to native forests deal mostly with promotion of their exploitation (CODEFF, 1996), with the exception of a limited number of norms and regulations that aim to conserve certain species, either by restricting their use or prohibiting their exploitation. This is the case with forests found within protected areas, forests that are excluded because of their critical role in watershed protection and soil stabilization, and certain species of trees that are legally protected as natural monuments. According to CODEFF (1996), current forest legislation in Chile lacks both efficient tools to detect activities (such as illegal logging) that compromise forest conservation and incentives to promote activities that support forest conservation, including forest management and sustainable use.

Many small landowners with native forests, as well as stakeholders interested in the responsible management of these forests have expressed the need for subsidies that promote the sustainable management of native forests in Chile. The government's response to this increased need was to draft a piece of legislation that loosely translates as "Recovery of the native forests and their promotion in forestry." This piece of legislation would provide landowners with subsidies to manage native forests. This legislation would complement the Forest Development Law (Law 701) which already provides subsidies for forestry plantations. Unfortunately the proposed piece of legislation, which was drafted ten years ago, has not been approved, mostly due to lack of consensus among the different stakeholders. In addition, there is a government-led program supported by the German government that promotes the sustainable management of native forests among small landowners. This program counts with subsidies for financing some of the basic work and technical assistance required to set up this type of management. This program has demonstrated the importance of having this initial monetary aid and technical assistance to transform the management of native forests into a profitable activity both economically and environmentally.

BOX 5. ILLEGAL LOGGING OF ALERCE

The alerce is a conifer endemic to Chile, found in the temperate forests of the southern cone, that can reach up to 50 meters in height and 5 meters in diameter. It is the second longest-lived species in the world after *Pinus longeva*. Some alerce trees have been found to be more than 3,600 years old (Lara et al., 1993). The alerce has been declared a natural monument in Chile and since 1973 has been listed in Appendix I of CITES, which prohibits its export. However, these forests are still being exploited and its wood sold commercially, mostly due to the lack of adecuate enforcement of Chile's species protection laws by responsible agencies. In 1550, there were an estimated 617,000 hectares of alerce forests in Chile. Today, less than 50 percent of this area remains (Lara et al., 1999). Since 1987, the illegal logging of alerce has been monitored and investigated by CODEFF and the UACH, primarily with funding from the World Wildlife Fund (WWF). Since monitoring began, 28 reports of illegal logging have been filed. Most of these investigations were carried out in cooperation with CONAF, which officially reported the violations and took the responsible parties to trial. The implementation of sanctions, however, is the responsibility of a judge, who can decide to apply a very small fine or dismiss the case entirely.

4. FRONTIER FOREST IN CHILE

4.1 CHARACTERIZATION AND DESCRIPTION OF THE FRONTIER FORESTS IN CHILE

The great ecological and cultural importance of Chilean frontier forests, on both local and global scales, makes it imperative that there be up-to-date information related to their extent, location, and state of conservation. Until now, this information has been lacking in Chile, creating an urgent need to identify and characterize these forests. This lack of information is what prompted the Global Forest Watch-Chile initiative, which aims to establish a comprehensive database on frontier forests as a means of supporting the conservation and sustainable use of Chile's natural heritage.

Classification of frontier forests was based on GFW's definition and criteria (GFW, 1999), whereby frontier forests are principally characterized by three variables:

Structure: Corresponds to the architecture of the vegetative formation, in this case, of the native forests in Chile, which can be categorized as native mature forests, native secondary forests, mature secondary forests, and native timberline or sub-alpine forests.

Canopy Cover: Corresponds to the surface area of treetops that covers the ground, expressed as a percentage.

Degree of Alteration: Corresponds to the evidence of alterations or interventions within the forest.

Following the global definition of frontier forests, and based on previously defined variables of the methodology developed by the Chilean chapter of GFW, Chile's frontier forests include mature forests and sub-alpine forests.

Mature Forests: Defined as primary forests, generally heterogeneous in their vertical structure, size of canopy, tree diameter, and age, they feature a shrub-like understory with variable density and a layer of regenerating vegetation.

Timberline or Sub-alpine Forests: Adult forests with trees between 2 and 8 meters tall, found principally at higher altitudes where vegetation becomes sparse. They are characterized by their limited and slow growth due to unfavorable environmental conditions (high altitude, low temperatures, strong winds, aridity, poor drainage, rockiness, thin soil, etc.).

Mature forests and sub-alpine forests were classified as frontier forests if they had a canopy cover greater or equal to 50 percent and exhibited either no apparent alteration (NAA) or evidence of only prior moderate or light selective logging (LSL).

TABLE 8. DEGREES OF ALTERATION OF NATIVE FORESTS

DEGREE OF ALTERATION	CODE
No apparent alteration	NAA
Old moderate or light selective logging	L S L

Source: GFW-Chile and CONAF et al., 1999.

Definitions of the degrees of alteration presented in *Table 8*:

NAA: There are no evident signs of human intervention, such as timber extraction or livestock grazing.

LSL: There is evidence of the partial extraction of trees of high commercial interest in one stand, but these extractions were carried out at least 5 years ago, and it is clear that no other activities have taken place since. In these cases, natural regeneration has not been affected to any great extent.

Information on the degree of alteration is available for 61 percent of native forests covered in the project Official Land Register and Evaluation of the Native Vegetative Resources of Chile (CONAF et al., 1999). For those areas of land for which no information on the degree of alteration is available, mature forests were classified as having at least 75 percent canopy cover, while sub-alpine forests had to have a canopy cover of 50 percent or more. *Table 9* presents the attributes of the frontier forests.

TABLE 9. ATTRIBUTES OF FRONTIER FORESTS

STRUCTURE	CANOPY COVER	DEGREE OF ALTERATION
Mature Forest	ž 50%	- No apparent alteration or old moderate or light selective logging
Sub-alpine Forest	ž 50%	- No apparent alteration or old moderate or light selective logging
Mature Forest	ž 75%	No Information*
Sub-alpine Forest	ž 50%	No Information*

*Forest areas about which there is no information on the degree of alteration.
Source: GFW-Chile.

4.2 METHODOLOGY

One of the tools that GFW considers critical in the attainment of its objectives is the production of maps illustrating the extent and condition of Chile's frontier forests, as well as other information that provides an idea of their state of conservation. For this purpose, the GFW-Chile team based its analysis on the database generated by the Official Land Register and Evaluation of the Native Vegetative Resources of Chile (CONAF et al., 1999). This database contains the most recent and complete information (1995) on the forest resources of Chile and has been technically and politically validated.

4.3 FRONTIER FOREST EXTENT

One of the major challenges in determining the extent and location of Chile's frontier forests was defining what minimal surface area of forests fulfilled GFW's definition and criteria for frontier forest (GFW, 1999). After countless discussions among members of the team, in consultation with Chilean biologists, GFW-Chile and the Technical Advisory Committee selected two thresholds to define frontier forests: 5,000 and 10,000 hectares. These randomly-selected patch sizes, reflects the difficulty in defining a basic unit that meets the habitat requirements of the different species of Chilean flora and fauna that live in these forests. Based on the previously stated criteria and the agreed-upon patch sizes, frontier forests in Chile were defined as those continuous forest blocks that have a surface area of at least 5,000 hectares. *Annex I* maps contain two categories of frontier forests, according to the minimum block size, those that have a surface area of at least 5,000 hectares, and those with an area of at least 10,000 hectares. Other forest stands meeting the GFW frontier forest criteria in terms of structure,

BOX 6. OFFICIAL LAND REGISTER AND EVALUATION OF CHILE'S NATIVE VEGETATIVE RESOURCES

The main objective of the land register was to provide basic information about land use and vegetative cover in Chile to facilitate the government's role in environmental and political matters related to the conservation and management of natural resources. Specifically, the land register allowed for the location and characterization of natural vegetative formations, including forestry plantations. The main output of the project is a digital database on Chile's land use, vegetative cover, and other regional information that permits analysis of the extent and other characteristics of Chile's forest ecosystems and forestry resources. The goal is to provide a database, which can be regularly updated, that will be used in the management of forest resources.

The land register used aerial photographs, principally at a scale of 1:20,000, and satellite images for the northern and southern boundaries of Chile. In combination with the aerial photographs, 3,600 days of fieldwork were conducted, gathering observed data for 30 percent of the study units previously identified through the aerial photographs. The information was then digitized using basic cartographic information from the Geographic Military Institute on roads, elevation, rivers and lakes, etc., and thematic maps on a scale of 1:50,000 were produced.

The land register project was an initiative of the Chilean government, carried out through the forestry agency, CONAF, and the Chilean environment agency (Comisión Nacional del Medio Ambiente, or CONAMA). The project took place between 1994 and 1997, relying on financial support from the World Bank. The total cost was US$3.5 million.

To execute the project, a consortium of various universities was formed and headed by the Faculty of Forestry Sciences of the Austral University of Chile. Other members of the consortium include the Catholic University of Temuco, Region IX, and the Catholic University of Chile.

As the principal output of this initiative, the digital database on Chilean land use and vegetative cover, provides the foundation for greater knowledge of the country's natural heritage.

Source: CONAF et al., 1999.

canopy cover, and degree of alteration, but whose surface area is less than 5,000 hectares, are represented in the *Annex I* maps as fragmented old-growth forests. *Table 10* shows the area of frontier forest in each of Chile's administrative regions according to the minimum block size (MBS).

Table 10 shows that in 1995, between 32 and 34 percent of the total area of native forest could be classified as frontier forest. The majority of these are located south of 40°S, in Regions X, XI, and XII. Together, these three regions shelter more than 96 percent of this type of forest.

In the northern regions of Chile (Regions VI, VII, VIII, and IX), there has been a higher degree of forest alteration due to land use changes, selective logging, plantations of exotic species, and forest fires. Therefore, as the maps of these regions show (see *Annex I*), frontier forests are scarce and only small fragments of old-growth native forests can be found there. For example, CONAF et al. (1999) show that, of the total surface area of forests in Regions VII and VIII, native forest consists mostly of secondary forests; more than half of the forest cover is made up of forestry plantations, mostly Monterey pine, which are concentrated in the Coastal Mountain Range.

Regions VI and VII have no remaining frontier forests, even though they contain important fragments of old-growth forests that can play a key role in forest restoration initiatives (*see Map 1*). Region VI has 1,084 hectares of remaining old-growth native forests, in continuous blocks ranging from 6.25 hectares to just under 5,000 hectares. This small area represents only 0.91 percent of all the native forests in this Region. Region VII has 22,575.4 hectares of old-growth forest fragments, which amounts to 6.1 percent of the Region's native forests. In many cases, these fragments are the only remaining parcels of native forest; thus, as the last genetic reservoirs, they are key elements in maintaining the biological diversity of these ecosystems.

TABLE 10. FRONTIER FORESTS BY ADMINISTRATIVE REGION ACCORDING TO MBS

ADMINISTRATIVE REGION	TOTAL NATIVE FOREST * (ha)	FRONTIER FOREST MBS ž 5,000 (ha)	(%)	FRONTIER FOREST MBS ž 10,000 (ha)	(%)
VI	118,064.4	-	-	-	-
VII	369,707.8	-	-	-	-
VIII	785,765.8	17,624.0	2.2	12,112.5	1.5
IX	907,521.0	154,527.0	17.0	111,541.9	12.3
X	3,610,228.0	1,576,175.0	43.6	1,523,406.1	42.2
XI	4,830,711.6	1,778,428.3	36.8	1,716,980.3	35.5
XII	2,625,013.0	946,930.5	36.0	821,185.4	31.3
TOTAL	13,247,011.6	4,473,864.8	33.8	4,185,226.2	31.6

*CONAF's minimum cartographic size was 6.25ha.
Source: GFW-Chile and CONAF et al., 1999.

TABLE 11. AREA OF FRONTIER FORESTS* ACCORDING TO FOREST STRUCTURE BY REGION

ADMINISTRATIVE REGION	MATURE FOREST (Ha)	TIMBERLINE FOREST (Ha)	TOTAL (Ha)
VI	-	-	-
VII	-	-	-
VIII	10,456.9	7,167.4	17,624.3
IX	114,684.9	39,842.2	154,527.1
X	1,209,988.1	366,187.6	1,576,175.7
XI	1,156,032.9	622,395.5	1,778,428.4
XII	655,363.7	291,566.8	946,930.5
TOTAL	3,146,526.5	1,327,159.5	4,473,686.0

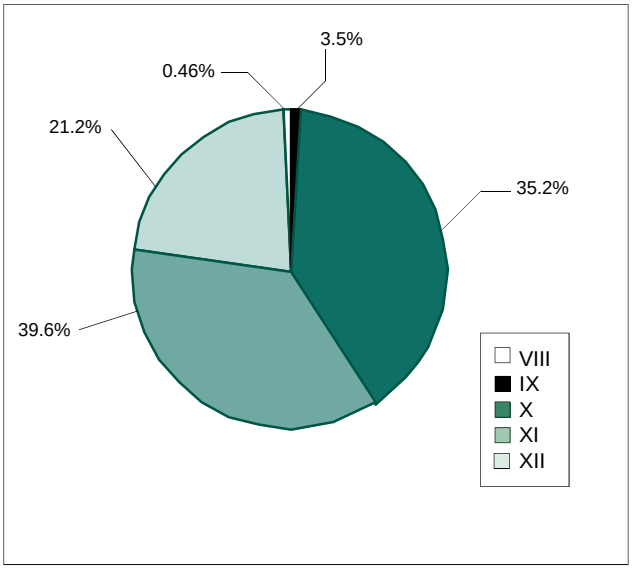
* Forests with a MBS ž 5,000 ha.
Source: GFW-Chile.

The distribution of Chile's frontier forests, illustrated in the maps in *Annex I*, reveal that these forests are located primarily on the western slope of the Andean Mountain Range. The frontier forests of the Coastal Mountain Range are found almost exclusively in Region X, where they occupy an area of 334,300 hectares or 7.5 percent of the total frontier forest of Chile. The frontier forests of the Coastal Mountain Range are one of the most threatened forest areas. Frontier forests in Region X are particularly vulnerable due to their geographic location, which coincides not only with the location of many forestry plantations of exotic species, but also with plans for a new government-sponsored coastal highway which will increase and facilitate the access to these forests (*see Map 4*). These threats emphasize the need to monitor this geographic zone more intensely. GFW Chile has made it a priority to expand monitoring in this Region as part of its next phase of activities.

At the regional level, Region XI has the largest area of frontier forests in the country, with 39.8 percent of forests with an MBS of at least 5,000 hectares, and 41 percent of forests with an MBS of at least 10,000 hectares. In terms of frontier forest extent, the second most important region is Region X, which contains 35.2 percent (MSB ž 5,000 ha) and 36.4 percent (MSB ž 10,000 ha) of the total area of frontier forests in Chile.

It is important to highlight that Region X has the greatest proportion of frontier forests relative to its total native forest area, with almost 50 percent of native forests in Region X considered to be frontier forests.

FIGURE 3. **DISTRIBUTION OF FRONTIER FORESTS BY ADMINISTRATIVE REGION**



Source: GFW-Chile.

4.4 STATUS OF FRONTIER FOREST

4.4.1 FRONTIER FORESTS AND PROTECTED AREAS

The following table provides an overview of the amount of native forests contained in the National System of Protected Wildlands (SNASPE). As the table shows, timberline forests are the most represented within the protected area system.

With respect to frontier forest area contained within the SNASPE and the Network of Private Protected Areas (RAPP), *Table 13* shows a variable distribution depending on the administrative region. This distribution can be explained, in most cases, by the fact that protected areas were first established in areas that were inaccessible at the time and still under the ownership of the Chilean government. This means that

TABLE 12. **AREA OF NATIVE FOREST INCLUDED IN THE SNASPE**

FOREST STRUCTURE	AREA IN SNASPE (Ha)	NATIONAL AREA (Ha)	% SNASPE
MATURE FORESTS	1,812,017.2	5,997,996.3	30.3
SECONDARY FORESTS	551,339.7	3,582,427.3	15.4
MATURE-SECONDARY FORESTS*	154,662.4	865,525.3	17.9
TIMBERLINE FORESTS	1,377,509.9	3,017,209.0	45.7
TOTAL	3,895,529.2	13,443,157.9	29.0

* Corresponds to a mixed forest structure composed of mature forests and secondary forests that are not distinguishable cartographically.

Source: GFW-Chile.

TABLE 13. **REGIONAL DISTRIBUTION OF FRONTIER FORESTS IN THE SNASPE AND RAPP**

ADMINISTRATIVE REGION	AREA (Ha)		Percentage of Regional Frontier Forests Protected	Percentage of Total National Frontier Forests Protected
	Frontier Forest MBS ž 5,000 Ha	Frontier Forests Protected		
VI	-	-	-	-
VII	-	-	-	-
VIII	17,624.0	3,651.2	20.7	0.1
IX	154,527.0	93,976.2	60.8	2.1
X	1,576,175.0	418,725.0	26.6	9.4
XI	1,778,428.3	558,913.8	31.4	12.5
XII	946,930.5	131,600.9	13.9	2.9
Total	4,473,686.0	1,206,867.1	27.0	27.0

Source: GFW-Chile.

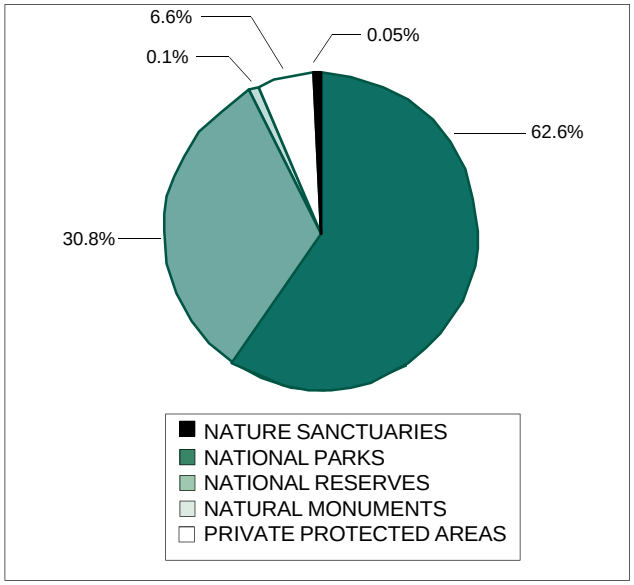
no ecological or ecosystem representation criteria were used to delimit and establish the areas. As a consequence, many forest ecosystem types are not represented in the protected areas system.

Table 13 shows that 1.2 million hectares, or 27 percent of all frontier forests, are publicly or privately protected. At the regional level, Region IX contains the largest proportion of protected frontier forest area, with 60.8 percent of its frontier forests under either the SNASPE or the RAPP. The next most important region in terms of share of frontier forests protected is Region XI, with 31.4 percent. At the national level, the two most important regions are Region XI, with 12.5 percent of the protected national frontier forests, and Region X, with 9.4 percent.

With respect to the types of protected areas containing frontier forests, in the SNASPE, 62.6 percent of frontier forests are found in national parks, 30.8 percent in national reserves, 0.1 percent are protected as natural monuments, and 0.05 percent in nature sanctuaries (*see Figure 4*). An additional 6.6 percent are found in private protected areas (*see Figure 4*).

The northern forest regions (Regions VI and VII) have historically been most altered, leading to highly fragmented forests, the majority of which are not currently protected. These two regions, however, do contain smaller fragments of mature native forest that are undisturbed or minimally altered, and some of these are under protection. For example, Region VI has 1.1 percent of the fragmented native forests protected, and Region VII has 14.8 percent of its

FIGURE 4. **PERCENTAGE OF FRONTIER FORESTS PROTECTED UNDER DIFFERENT SNASPE AND RAPP CATEGORIES**



Source: GFW-Chile.

fragmented native forests protected. Region VIII has a small fraction of 17,624 hectares or 20.7 percent of its frontier forests protected; however, at the national level, this percentage is marginal. These figures all point to the need to extend protection in these northern regions before these last fragments of native forest ecosystems are lost.

According to Lara et al. (1999), based on estimated forest cover in 1550, as of 1997 Regions VII and VIII contained only 28 percent of the original native forests once found in these regions. Most of the forest loss is due to the manner of Chile's colonization. These northern regions provided the needed goods and services, including agricultural land, for the rapid

demographic growth and development experienced in the country. Additional evidence of this is the fact that more than 50 percent of native forests in these regions are secondary forests.

Region X, which contains the richest diversity of broadleaf species within its evergreen forests, is not well represented in the protected areas system. In particular, the forests of the Coastal Mountain Range, which can be seen in *Map 4*, are in urgent need of protection. Although the southernmost regions, Region XI and XII, contain some of the country's largest tracts of protected frontier forests, representation of some of their forests types within the protected areas system is lacking (*see Map 5 and 6*).

BOX 7. **PROTECTED AREA CATEGORIES IN CHILE**

NATIONAL PARK: Areas with unique or representative ecosystems. In general these areas are minimally altered by humans and are capable of sustaining the ecological integrity of the ecosystems they harbor. They contain plant and animal species, the geological formations of special interest for the scientific, educational, or recreational communities.

NATURAL MONUMENT: Small area characterized by the presence of native animal and plant species or unique geological features. These natural features are of outstanding value because of their inherent rarity, representative or aesthetic qualities, or cultural significance.

NATIONAL RESERVE: Areas with natural resources that are particularly susceptible to degradation, or because of their importance for the well being of the local communities.

NATURE SANCTUARY: Marine or terrestrial areas that provide unique possibilities for geological, botanical, zoological, paleontological, or ecological research or that contain natural features of interest to the scientific community and the country.

Source: Law 18.632, 1984.

4.4.2 FRONTIER FORESTS AND ROADS

Inaccessibility has permitted many ecosystems to remain relatively stable and forests are not the exception. Roads and trails can, and often do, represent a real threat to forest conservation. In many rural areas of Chile, fuelwood collection, land clearing, and grazing are putting pressure on remaining forest tracts. All these activities usually take place close to roads, urban centers, and smaller villages. Fuelwood collection and grazing, for example, affect the forest mainly through the removal of smaller trees and understory vegetation, in many cases impeding regeneration.

If a historical review of the development and growth of the country's road network were done, one could probably observe that vegetation, especially forest vegetation, was modified at the same time and at the same pace as the roads were built. Much of the evidence shows that most forests have been directly or indirectly altered by logging and forest fires, the majority of which occur next to new roads. These alterations fragment forest stands close to the roads, and negatively impact the habitat of associated forest species (e.g., pumas, foxes, and pudus[4]). The maps in *Annex I* show that Regions VI, VII, and VIII have the densest road network and the smallest area of native and frontier forests as well as the largest area under forestry plantations.

However, this inverse relationship between roads and intact forests is not always the case. Chile, for example, has areas of degraded forest where no main or secondary roads exist. Nevertheless, these same areas have countless difficult-to-map trails and seasonal paths that allow extractive activities to take place, which in most cases result in forest degradation. Even though the presence of roads and trails facilitates access to the forest, and forest degradation can result, it is important to highlight that the underlying causes for forest fragmentation and clearing resides within the political, economic, educational, and cultural context. If a country has a comprehensive forest policy framework that encourages sustainable management and conservation of resources, adequate enforcement, sound and transparent institutions and legal systems, and an educated and interested public, roads do not need to pose a threat to forest ecosystems.

4.4.3 FRONTIER FORESTS AND DEVELOPMENT ACTIVITIES

Without a doubt, any development project involving the use of forest resources that does not take into account ecological criteria for the maintenance of

4 *Small deer native to Chile*

functioning ecosystems represents a threat to forest conservation. In Chile, the law requires preparation of an environmental impact assessment for the largest infrastructure projects. The maps found in *Annex I* show all the large infrastructure projects that may affect native forest and have submitted an environmental impact assessment approved by the SEIA of the CONAMA, the government agency in charge of the environment. Region VIII contains the largest number of development projects, with a total of eight large-scale projects. In addition to wood extraction projects, other projects presented to the SEIA are mostly hydroelectric dams, roads and highways, gas and oil pipelines, and mineral exploration activities. The latter mostly take place in Regions XI and XII (see *Annex II*).

Most of the forestry industry is concentrated in Region VIII, where 35 percent of the companies are located, followed by Region X, with 29 percent. Identifying the industries' area of influence is crucial in estimating the impact of these activities on forests resources and conservation. These estimates and their cartografphic representation is one of the focus areas in the next phase of activities of GFW-Chile.

4.4.4 ALTERED OR DISTURBED FORESTS

In addition to the frontier forests identified in this study, there are important areas of native forests that, due to their size, structure, or degree of alteration, did not fall under the frontier forests category. The following section presents figures and tables characterizing these forest fragments as of 1995. Most of the alterations to these forests, have resulted in modification of forest structure, canopy cover, or density such that they do not meet the definition of frontier forests set forth by GFW-Chile.

BOX 8. MAIN ALTERATIONS AFFECTING THE NATIVE FOREST IN CHILE

- *Selective logging: Logging method by which some or all of the trees of high commercial value are extracted from a forest stand without following silvicultural criteria. Includes highgrading of largest, healthiest trees.*
- *Forest fire: Alteration caused by fire of anthropogenic origin.*
- *Thinning: extraction of part of the trees in a forest stand following silvicultural criteria.*
- *Clear cut: Forest harvesting method by which all the forest cover is extracted, leaving bare soil that becomes vulnerable to erosion.*

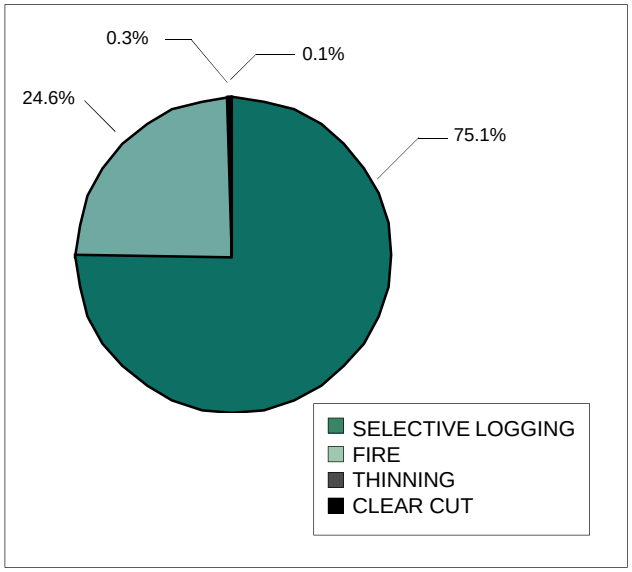
Table 14 shows that central Chile, corresponding to Regions VI and VII, features the highest degree of alteration, while Region XII contains a very small percentage of altered forests.

Selective logging is the most frequent cause of native forest degradation, accounting for 75 percent of degraded forest area. Forest fires are responsible for a further 24.6 percent of degraded forest area. Fires, the majority of them intentionally set, produce major negative impacts on forest ecosystems, destroying more than 13,000 hectares annually over the past two decades.

According to the data collected by CONAF et al. (1999) and presented in *Table 15* clear cutting affects a relatively small area of native forest. It is important to note that these data do not consider the clearing of secondary forests as "clear cut" areas. In CONAF's study, secondary forests with trees measuring less than two meters in height are not considered forests, therefore their clearing is not included in the assessment of types of changes affecting Chile's native forests (Arnold, 1998).

Figure 5 shows the principal types of alteration, in terms of the affected area, seen in the native forests of Chile: selective logging without silvicultural criteria and forests fires.

FIGURE 5. TYPES OF ALTERATION OF NATIVE FORESTS



Source: CONAF et al., 1999.

TABLE 14. **AREA OF ALTERED OR DISTURBED NATIVE FOREST***

ADMINISTRATIVE REGION	AREA OF NATIVE FOREST (Ha)	AREA OF ALTERED FOREST (Ha)	PERCENTAGE OF NATIVE FOREST THAT HAS BEEN ALTERED (%)
VI	118,064.4	58,517.7	49.6
VII	369,707.8	155,886.9	42.2
VIII	785,765.8	146,543.5	18.7
IX	907,521.0	176,575.2	19.7
X	3,610,228.0	688,657.0	19.1
XI	4,830,711.6	949,717.6	19.7
XII	2,625,013.0	109,606.5	4.2
TOTAL	13,247,011.6	2,285,504.4	17.3

*Source: CONAF et al., 1999. Data collection was done between 1995 and 1997, sampled area corresponds to 74% of the total area of native forest.

TABLE 15. **AREA AFFECTED BY THE MAIN TYPES OF CHANGES OCCURRING IN CHILE'S NATIVE FORESTS BASED ON DATA COLLECTED BETWEEN 1995-97**

ADMINISTRATIVE REGION	SELECTIVE LOGGING (Ha)	FIRE (Ha)	THINNING	CLEAR CUT (Ha)	TOTAL AREA (Ha)
VI	56,175.4	2,342.3	-	-	58,517.7
VII	155,144.4	742.5	-	-	155,886.9
VIII	112,847.5	30,968.6	1,563.4	1,164.0	146,543.5
IX	165,038.6	6,773.0	4,467.8	295.8	176,575.2
X	629,679.3	58,833.4	-	144.3	688,657.0
XI	490,200.6	459,517.0	-	-	949,717.6
XII	106,413.6	3,192.9	-	-	109,606.5
TOTAL	1,715,499.4	562,369.7	6,031.2	1,604.1	2,285,504.4

Source: CONAF et al., 1999.

5. CONCLUSIONS

This study shows that a significant share of the native forests in Chile can be classified as frontier forest. Specifically, considering only tracts of 10,000 hectares or more, almost 32 percent of native forests are frontier forests. For tracts of at least 5,000 hectares, 34 percent of native forests can be classified as frontier forests. The definition of a frontier forest should take into account not just size requirements per se, but also additional criteria ensuring that the designated minimum forest tract size is adequate to maintain the ecological processes and biodiversity of Chile's forest ecosystems. Together with its Technical Advisory Committee, GFW-Chile concluded that the minimum patch size plays an important role in analyzing the viability of the various species and populations of flora and fauna. However, the team had difficulty agreeing on a common minimun patch size, and therefore selected two random thresholds (5,000 and 10,000 hectares). Further analysis and discussion on the subject is needed in the Chilean context (see *Annex III* for methodology discussion).

Chile's frontier forests are distributed between 36.5ºS and 54ºS, featuring a wide array of forest types, species compositions, and disturbance regimes. A large percentage of these forested areas is primary forest, dominated by deciduous and evergreen species, with a heterogeneous age structure as well as a scrub-like understory.

Almost all of Chile's frontier forests are found in and around the Andean Mountain Range. In the Coastal Mountain Range, frontier forests are concentrated mostly in Region X, where they constitute only 7.5 percent of the country's frontier forest tracts of at least 5,000 hectares.

Because of the high degree of native forest fragmentation, there is practically no frontier forest left in the northern regions. Regions VI and VII contain only fragments of undisturbed or minimally altered native forests, ranging in size from 6.25 to 5,000 hectares. The combined area of these forest fragments for Region VI, for example, is 1,084 hectares, or 0.91 percent of the region's native forests. For Region VII, the total area of forest cover fragments is 22,575.4 hectares, or 6.10 percent of regional native forests. For these regions, the presence of these forest fragments is crucial, because they represent unique remnants of the original forest cover and have considerable biological and strategic value as genetic reservoirs for maintenance of the ecological and evolutionary processes of these forest ecosystems. This genetic heritage can be the basis for future restoration activities and therefore for the development of sustainable forest management, and economic activity of great importance for the country.

Region VIII contains more than 17,000 hectares of frontier forest, representing 2.2 percent of the native forests in the region. Because of the small proportion of frontier forests left in the region, and given the fact that this region has the highest level of forestry plantation activities, it is very important to monitor changes in land use and forest cover in this area. Conserving the forests of Region VIII is crucial, given that, as in Regions VI and VII, these are the only remaining examples of forests that once covered the central parts of the country. This would entail establishing either public or private protected areas and incorporating forest conservation into management and plantation zoning plans.

Considering only forest tracts of at least 5,000 hectares, almost 27 percent of all frontier forests are included in either a private or public protected areas system. However, representation of frontier forests in the protected areas system is not adequate. For example, those regions with smaller areas of frontier forests (Regions VIII and XII) also have, at the national and regional level, the smallest proportion under protection. The only exception to this trend is Region IX, which is one of the regions with less frontier forests, but almost half of its frontier forests are protected.

It is also important to highlight that, of the fragments of undisturbed or minimally altered forests found in Regions VI and VII, only 1.1 percent and 14.8 percent, respectively, are protected. This points to an urgent need to increase protection of these forest fragments through the establishment of new protected areas and detailed monitoring of changes in land use and forest activities in these regions.

Even though the underliying causes in the fragmentation and clearing of native forest are centered on political, economic and cultural issues, accessibility is an important factor in forest conservation in Chile.

As more forests become accessible, more of them will be affected by fragmentation, making it more challenging to maintain the ecological processes and biodiversity of these ecosystems. In southern Chile, where forests are least accessible (Regions X, XI, and XII), there are also more remaining frontier forests. This points to the need to consider the location and protection of these forests when planning road and infrastructure development in southern Chile.

With respect to the degree of alteration, the forests of Regions VI and VII are considerably more altered than other regions. Region XII has the smallest area of altered forests. The main type of alteration affecting native forests, based on CONAF's data, is selective logging, affecting 75 percent of the total area of altered forests, followed by forest fires, which affects 24 percent. However, it is important to highlight that CONAF's study did not consider the clearing of secondary forests with trees measuring less than two meters in height forest alterations.

After completing this first assessment of the coverage and degree of conservation of native and frontier forests in Chile, GFW-Chile considers it imperative to continue monitoring changes in forest cover and development activities occurring in and around these forests, in order to detect their impacts on forest ecosystems and their biodiversity.

Once the causes and impacts of development activities have been identified, it is necessary to channel efforts toward improving the protection and management of these globally and locally important forests, through policies that ensure their long-term conservation. This would imply an increase in the representation of frontier forests, particularly the forests of the Coastal Mountain Range, in the protected areas system, either public or private.

Because much of the forest cover in Chile is in the hands of private landowners and corporations, it is important to include the private sector and encourage it to play an important role in long-term forest conservation and management. For example, private sector interests have, in certain cases, contributed to the conservation of native forests by purchasing land and setting it aside as a protected or recreation area. The Chilean government also plays a key role in applying and implementing existing legislation, which contains provisions to conserve native and old-growth forests. Ultimately, the government, with support from civil society, has the responsibility to conserve Chile's natural heritage. A new forest legislation in Chile that encourages the management of native forest, and not their conversion to plantations as well as the expansion of the protected areas system to have viable representative samples of all forests types would highly improve the long-term conservation of these forests.

One important trend that seems to be on the rise is the creation of joint ventures among various stakeholders to buy forest land and manage it sustainably, sometimes with wood harvesting, sometimes for other purposes, such as recreation, and sometimes for a combination of both activities.

Because the information used for this study is for 1995, an update on the extent and distribution of frontier forests and their conservation status is urgently needed to obtain a more accurate picture of what is happening on the ground. GFW-Chile recommends an incremental and focused approach, monitoring several regions each year, which we believe would constitute an efficient use of resources and efforts. If this approach were to be taken, it would produce a completely new picture of the condition of Chile's native frontier forests every five years. This type of detailed and focused work at the regional level will allow for improved monitoring and management, particularly in those areas where small, but critical, tracts of mature native forests remain. Specifically, monitoring is urgently needed in Regions VII, VIII, and in the forests of the Coastal Mountain Range in Region X, all of which are highly vulnerable.

This report has outlined the main industrial projects affecting frontier forests as well as the key forestry companies. However, determining the effect of these projects on forests and local communities will only be possible through additional detailed monitoring of these activities. Within this framework, it will be as important to monitor positive as well as negative activities affecting the forest. This will permit mitigation of the damaging effects of detrimental forest activities, encourage development that has positive forest impacts, and avoid future loss of valuable ecosystems.

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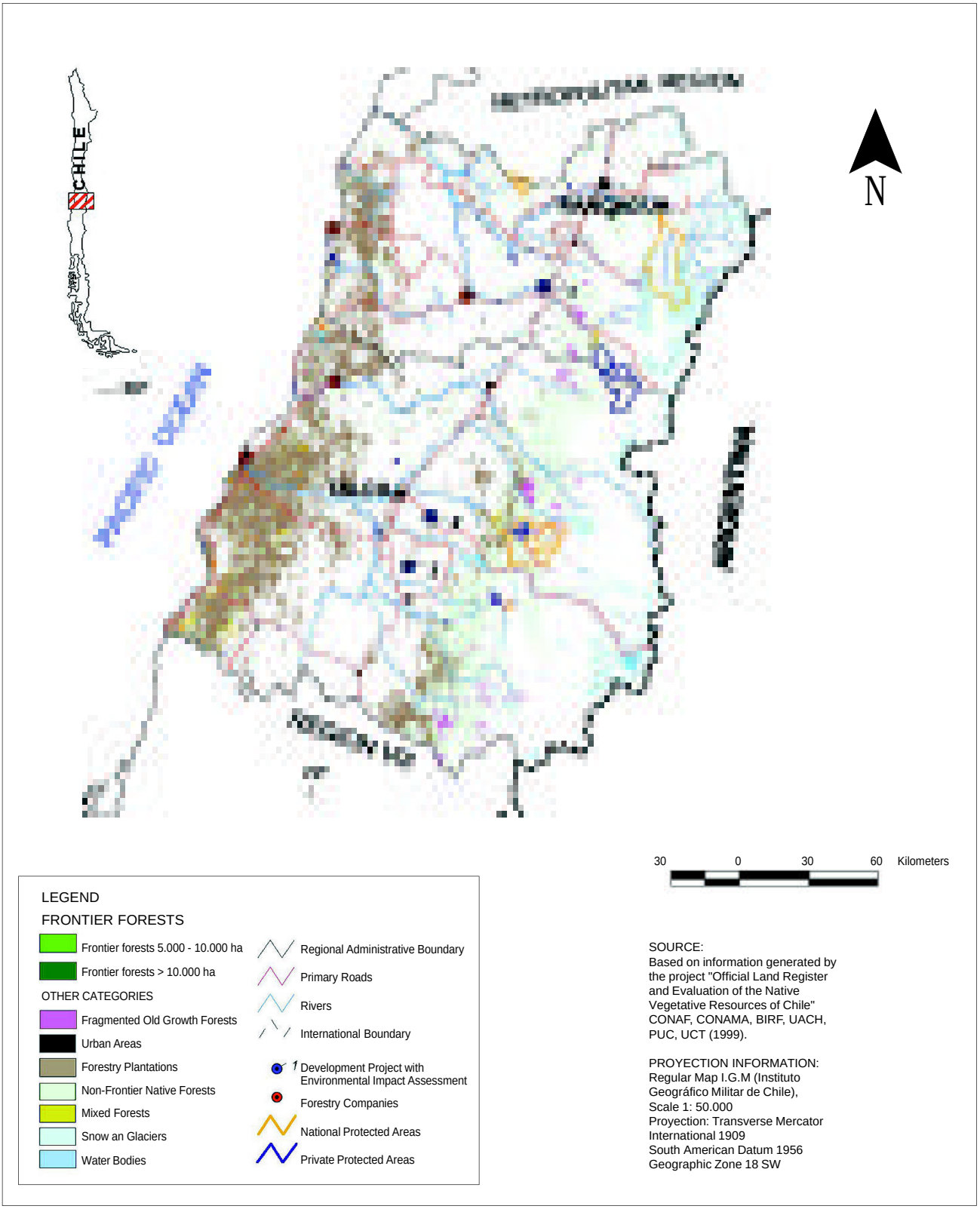
ANNEX

ANNEX I

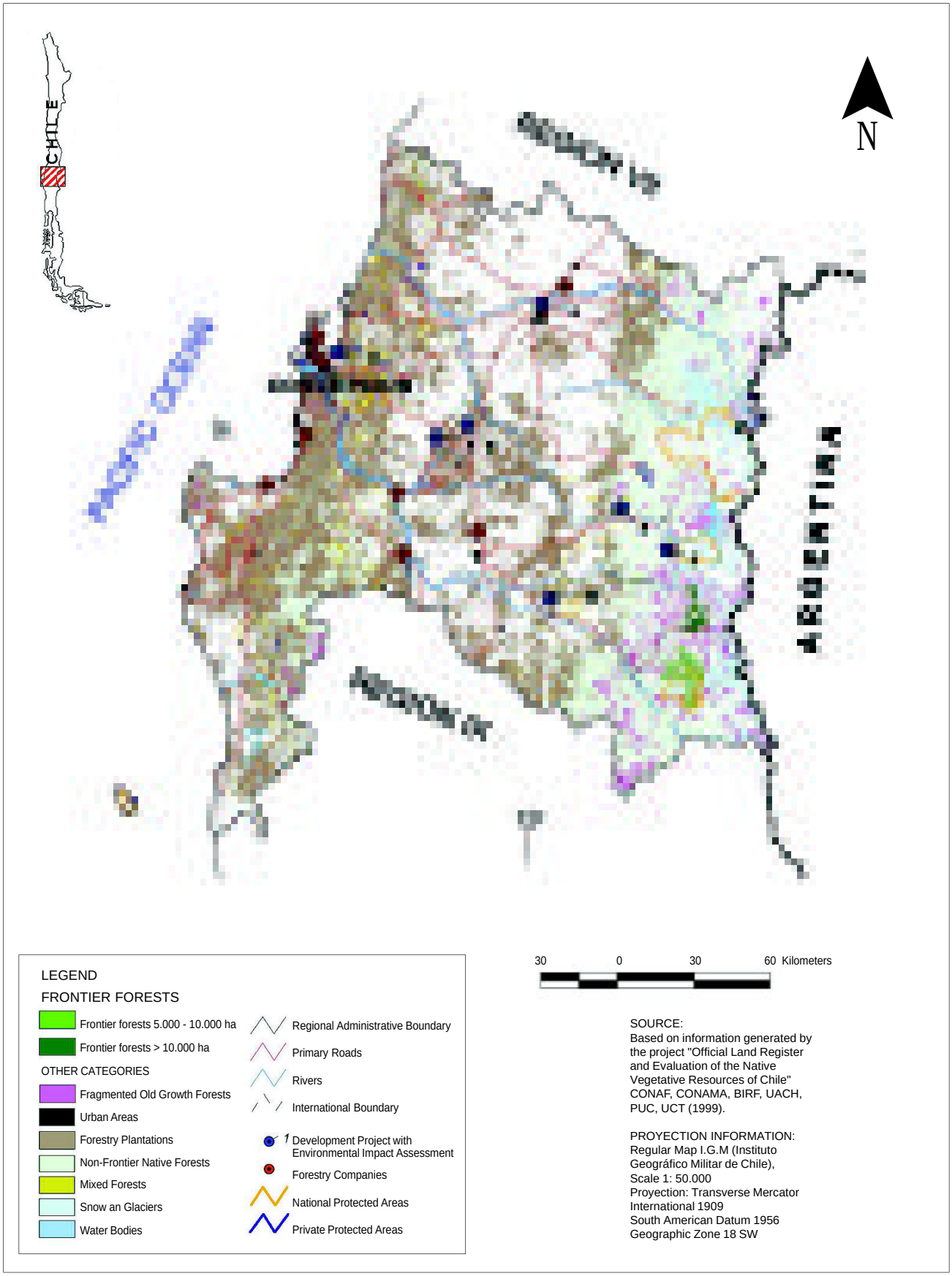
MAPS OF FRONTIER FORESTS, OTHER VEGETATIVE COVER, PROTECTED AREAS, AND FOREST ACTIVITIES BY ADMINISTRATIVE REGION

MAP 1. FRONTIER FORESTS, OTHER VEGETATIVE COVER, PROTECTED AREAS, AND FOREST ACTIVITIES IN ADMINISTRATIVE REGIONS VI AND VII



Produced by Global Forest Wach Chile partners Comité Nacional Pro Defensa de la Fauna y Flora (CODEFF) and Universidad Austral de Chile

MAP 2. FRONTIER FORESTS, OTHER VEGETATIVE COVER, PROTECTED AREAS, AND FOREST ACTIVITIES IN ADMINISTRATIVE REGIONS VIII



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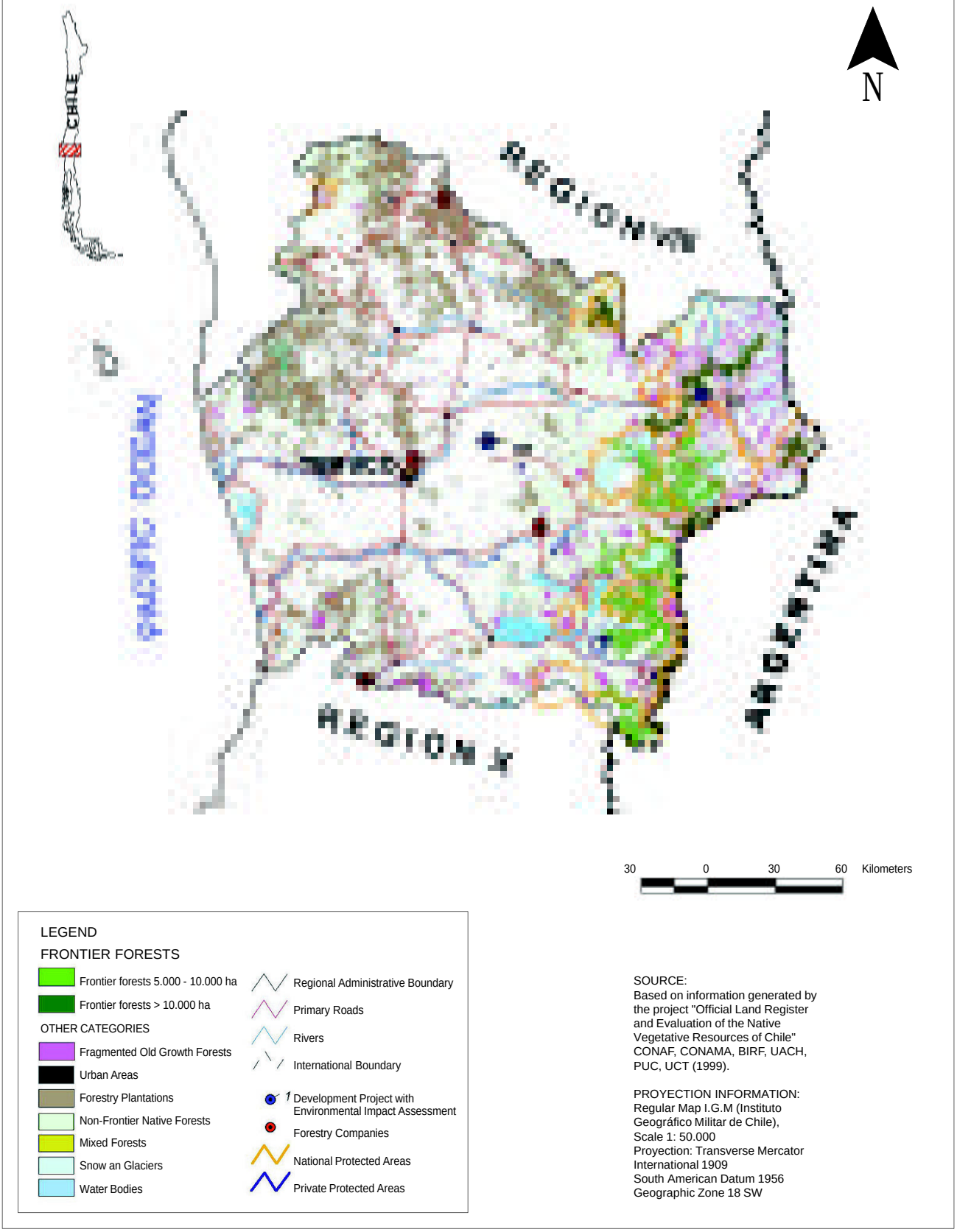
MAP 3. FRONTIER FORESTS, OTHER VEGETATIVE COVER, PROTECTED AREAS, AND FOREST ACTIVITIES IN ADMINISTRATIVE REGIONS IX



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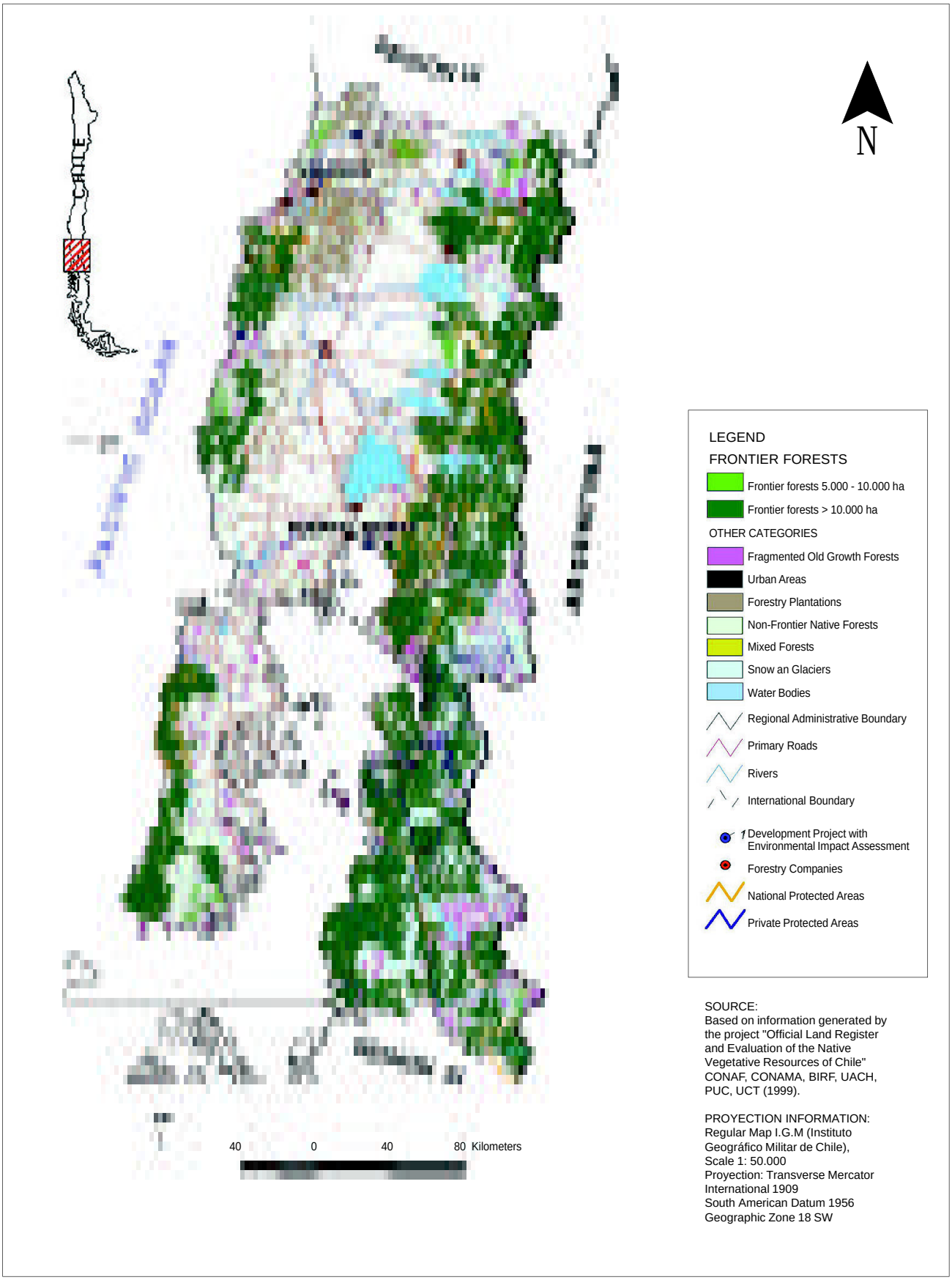
MAP 4. FRONTIER FORESTS, OTHER VEGETATIVE COVER, PROTECTED AREAS, AND FOREST ACTIVITIES IN ADMINISTRATIVE REGIONS X



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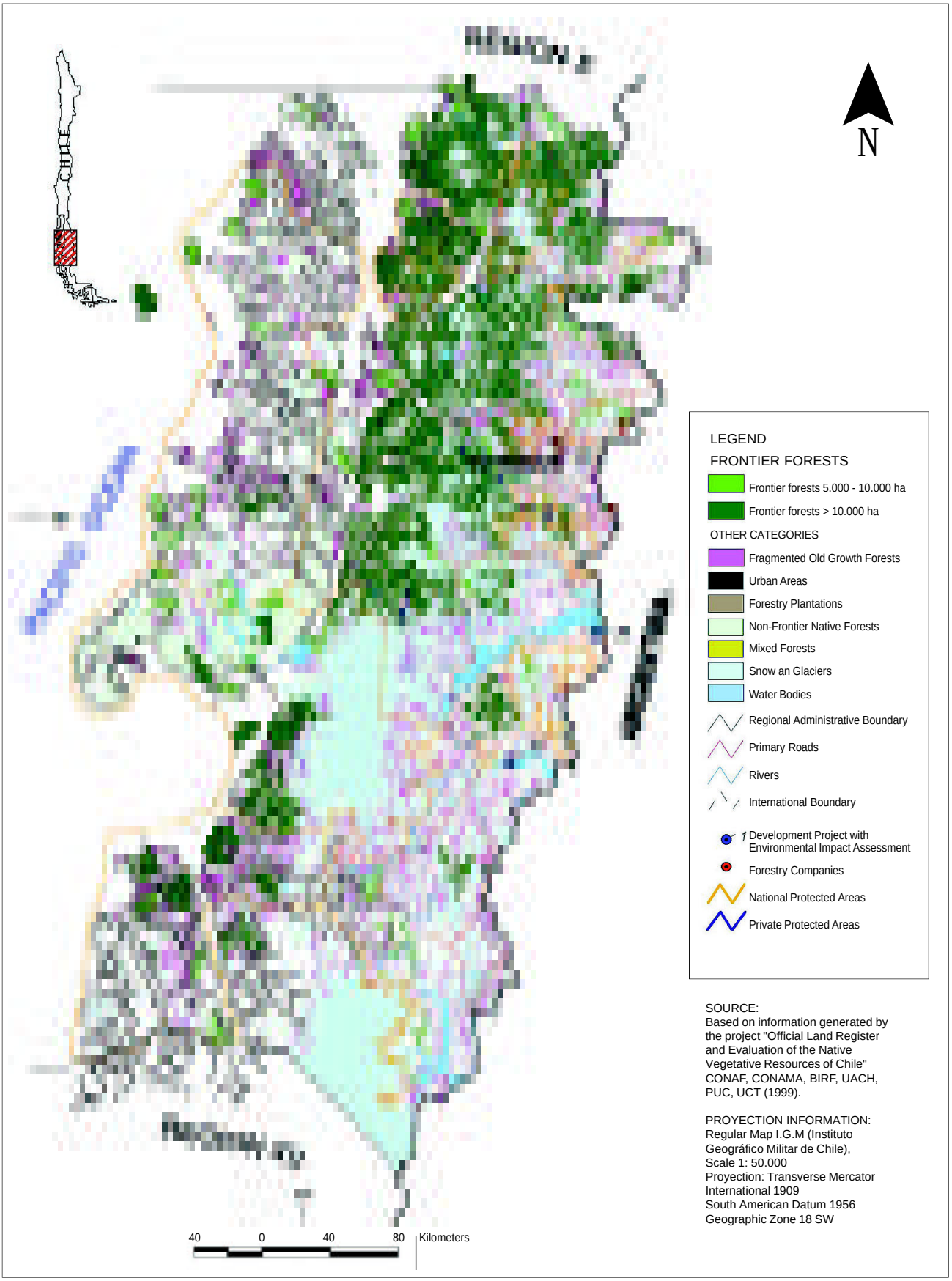
MAP 5. FRONTIER FORESTS, OTHER VEGETATIVE COVER, PROTECTED AREAS, AND FOREST ACTIVITIES IN ADMINISTRATIVE REGIONS XI



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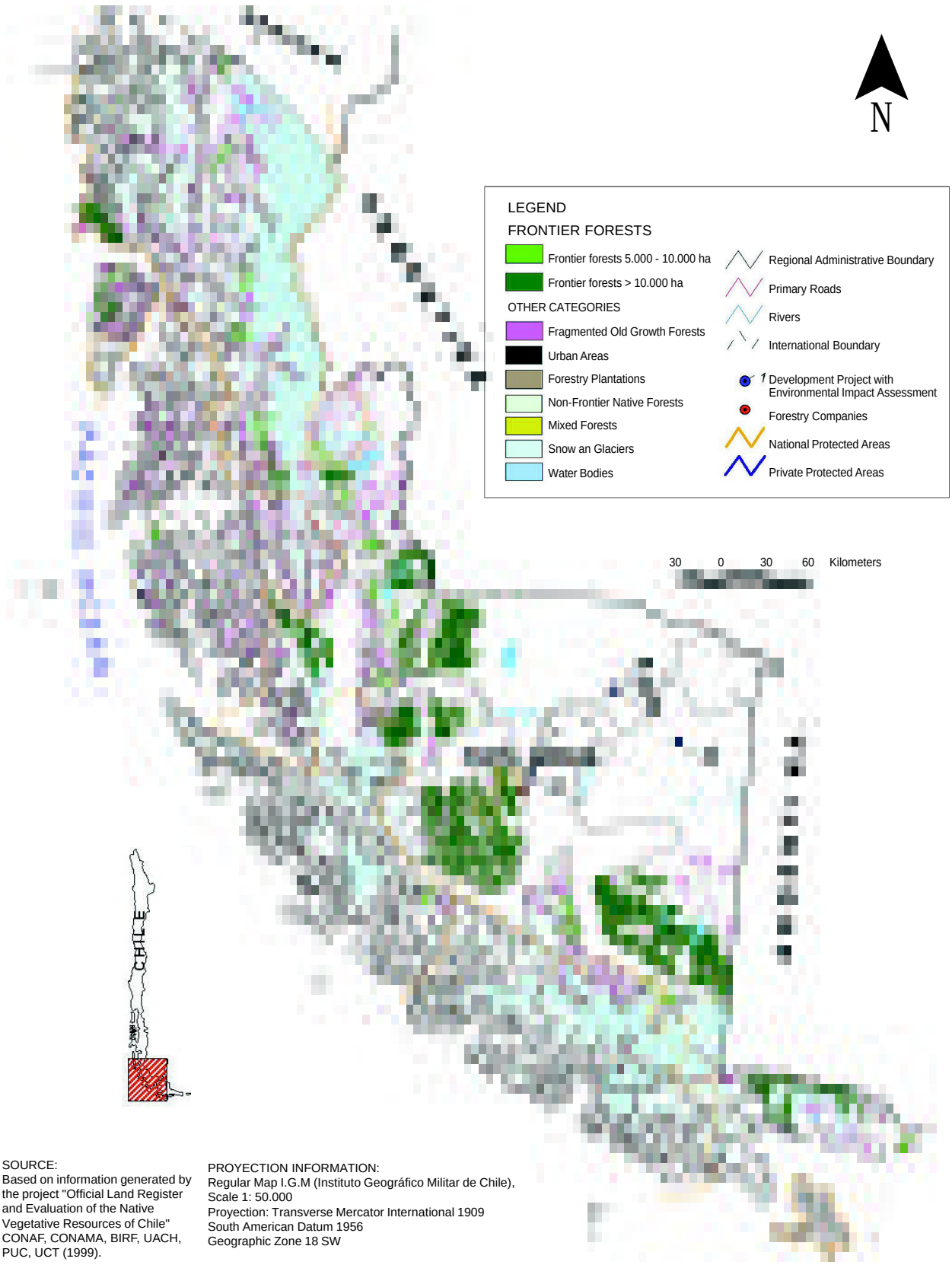
MAP 6. FRONTIER FORESTS, OTHER VEGETATIVE COVER, PROTECTED AREAS, AND FOREST ACTIVITIES IN ADMINISTRATIVE REGIONS XII



SOURCE:
Based on information generated by the project "Official Land Register and Evaluation of the Native Vegetative Resources of Chile" CONAF, CONAMA, BIRF, UACH, PUC, UCT (1999).

PROYECTION INFORMATION:
Regular Map I.G.M (Instituto Geográfico Militar de Chile),
Scale 1: 50.000
Proyection: Transverse Mercator International 1909
South American Datum 1956
Geographic Zone 18 SW

Produced by Global Forest Wach Chile partners Comité Nacional Pro Defensa de la Fauna y Flora (CODEFF) and Universidad Austral de Chile

ANNEX II

LIST OF DEVELOPMENT ACTIVITIES

PROJECT NUMBER	PROJECT NAME	OWNER	ADMINISTRATIVE DISTRICT
REGION VI			
1	Electricity Transmision Lines	Transelec	San Fernando
REGION VII			
2	Loma Alta Hydroelectric Plant	Pehuenche S.A.	San Clemente
3	Paperboard Production Plant	CMPC	Yerbas Buenas
REGION VIII			
4	Electricity Transmision Lines	Transelec	Chillan
5	Transandean Gas Pipeline and Natural Gas Distribution Network	Gasoducto Transandino S.A.	Antuco
6	Transandean Gas Pipeline and Natural Gas Distribution Network	Gasoducto Transandino S.A.	Yumbel
7	Laja Thermoelectric Plant	Energia Verde S.A.	Cabrero
8	Hydroelectric Plants Pehuen- Rucue	Eléctrica Mampil	Santa Barbara
9	Door Molding Processing Plant (FIBRAMOLD S.A.)	Terranova S.A.	Cabrero
10	Ralco Hydroelectric Plant	ENDESA	Quilaco
11	Oil Pipeline San Vicente – Temuco	Soc. Nacional de Oleoductos Ltda.	Concepción
REGION IX			
12	Ralco Hydroelectric Plant	ENDESA	Lonquimay
13	Oil Pipeline San Vicente – Temuco	Soc. Nacional de Oleodcutos Ltda.	Vilcún
REGION X			
14	Valdivia Project (Celulose)	Celulosa Arauco y Constitución	Mariquina
15	Coastal Highway Bahía Mansa- Rio Choroy	Dir. Vialidad Xma Region	San Juan de La Costa
16	Boise-Cascade Chile Project (Wood processing mill) *	Compañia Industrial Pto. Montt	Puerto Montt
REGION XI			
17	Furioso Mining Exploration Activities	CDE Chilean Mining Corporation	Cochrane
18	Patagonia Mining Exploration Project	Aur Resourses Colin Charles Br.	Coihaique
19	Lago Atravesado Hydroelectric Plant	ENDELAYSEN S. A.	Coihaique
20	Beta Raul Mining Exploration	Compañia Minera CDE Fachinal	Chile Chico
REGION XII			
21	Gas Pipeline: Kimiri Aike - Cabo Negro	ENAP	Punta Arenas
22	Gas Pipeline: Kimiri Aike - Cabo Negro	ENAP	San Gregorio
23	Poliducto Catalina Sur - San Gregorio	ENAP	Primavera
24	Poliducto Catalina Sur - San Gregorio	ENAP	San Gregorio
25	Gas Pipeline: Posesión - Cabo Negro	ENAP	San Gregorio

* Project not implemented yet.
Note: The development projects included here are only industrial projects. Forest management projects are shown in the Anex 1 maps, but not listed in this table.

ANNEX III

METHODOLOGY, DATA SETS, AND TECHNICAL NOTES

SOURCE DATA

The main source of information used in this study to determine the location and distribution of frontier forests was the Official Land Register and Evaluation of the Native Vegetative Resources of Chile, carried out for the Chilean Forests Service (Corporación Nacional Forestal - CONAF) during the period 1995-1997 (CONAF et al., 1999).

Topographic Maps:

The Official Land Register and Evaluation of the Native Vegetative Resources of Chile used topographic maps at a scale of 1:50,000 provided by the Military Geographic Institute of Chile (Instituto Geográfico Militar).

Thematic Maps:

The land register project produced 641 native vegetation maps. According to the objectives of CONAF's land register, the country was divided into zones, which were mapped at different scales as follows:

Zone	Scale
Administrative Regions I, II, III, and IV	1:250,000
Administrative Regions V through X	1: 50,000
Administrative Regions XI and XII	1:100,000
Region XII Fiords	1:250,000

The land register was based almost entirely on aerial photographs at varying scales depending on the region. Scales ranged between 1:20,000 and 1:70,000.

The extremes of the country, the desert areas to the North, and the canals and fiords to the South, were mapped based on satellite images at a scale of 1:250,000 and with a 79x79 meter resolution.

The aerial photographs were interpreted visually, for which an entire team was hired and trained. The team also was charged with standardizing the photo-interpretation criteria. Nine categories of land use were established:

Land Use Categories
1. Urban Areas
2. Cropland
3. Grasslands and Shrublands
4. Forests
5. Wetlands
6. Barren Areas
7. Snow and Glaciers
8. Water Bodies
9. Undefined Areas

These 9 land use categories where further divided into several sub-categories. For example, the forest categories was broken down into:

4. Forests
4.1 Forestry Plantations
4.2 Native Forest
4.2.1 Mature Native Forest
4.2.1.1 Dense Mature Native Forest

In addition to classifying the different land use categories and the vegetation density for the different stands identified in the aerial photographs, other attributes also were measured in the field. Fieldwork for the land register consisted of 3,600 days of ground-truthing and data collection. Variables assessed included average tree height, dominant species present, and degree of human-induced alterations on native forest stands. The results of the aerial photograph interpretation (both polygons and stands) were validated with field reconnaissance of 30 percent of the polygons in each of the 641 thematic maps. All of the information was later digitized and entered into a Geographic Information System (GIS) using *PC Arc-Info* software.

METHODOLOGY USED TO IDENTIFY FRONTIER FORESTS

The information from the land register was provided to GFW-Chile by CONAF, which made possible the analysis presented in this report.

Concepts and Definitions

Given the high resolution of the digital information available through CONAF, the GFW-Chile team, in collaboration with its Technical Advisory

Committee, considered appropriate to define frontier forests based on existing attributes that would best convey the pristine or altered condition of the stands of native forests within the Chilean context. There was considerable discussion among the members of the team on what the appropriate minimum patch size that should be; to be considered a frontier forest. GFW-Chile and the Technical Advisory Committee finally selected two thresholds at random to define frontier forests: 5,000 and 10,000 hectares. These randomly-selected patch sizes, reflects the difficulty in defining a basic unit that meets the habitat requirements of the different species of Chilean flora and fauna that live in these forests. Therefore frontier forests were defined as:

- Mature forests or dense timberline forests, of at least 5,000 hectares, that are made up of native species, and are intact or have been only slightly altered[5]. This study also identified those continuous forest blocks of at least 10,000 hectares.

Other types of forest used in this report were defined as:

- Native Forest: Natural ecosystem made up of native species of trees unique to the region. Trees are more than two meters high and the canopy cover is greater than 25 percent (CONAF et al., 1999).
- Mature Forests: Primary forests, generally heterogeneous in their vertical structure, size of canopy, tree diameter, and age, they feature a shrub-like understory with variable density and a layer of regenerating vegetation.
- Secondary Forests: Forests altered either by humans or natural disturbance that are regenerating.
- Mature-Secondary Forests: In Chile, this particular type of forests is usually the result of intentional forest fires. Most of the vegetative cover has been eliminated and replaced by a mix of young re-growth and the remaining mature trees that were not burned.
- Sub-alpine or Timberline Forests: Forests that grow at the altitudinal limit of the vegetation range. They are characterized by their limited and slow growth due to unfavorable environmental conditions (high altitude, low temperatures, strong winds, aridity, poor drainage, rockiness, thin soil, etc.).
- Mixed Forests: Areas of native forest mixed with plantations of exotic species.
- Plantations: Areas made up of exotic species that have been planted for harvesting. In Chile, plantations are usually pines or eucalyptus.

To determine the level of intactness of the forest patches, and therefore their condition, the GFW-Chile team used two attributes presented in CONAF's land register. These include:

- Degree of alteration: Information on the degree of alteration was obtained by gound-truthing, which identified those patches of forests that presented evidence of selective logging, clear-cutting, intentional forests fires, etc. Information on the degree of alteration was available for 61 percent of native forests covered in CONAF's Official Land Register (CONAF et al., 1999). Two categories of degree of alteration were established:

  a) No apparent alteration (NAA): forest stands with no evident signs of human intervention, such as timber extraction or livestock grazing; and

  b) Light selective logging (LSL): forest with evidence of the partial extraction of trees of high commercial interest in one stand, but these extractions were carried out at least 5 years ago, and it is clear that no other activities have taken place since. Natural regeneration has not been affected to any great extent by these alterations.
- Canopy cover: Mature forests and timberline forests were classified as frontier forests if they had a canopy cover greater or equal to 50 percent and exhibited either NAA or evidence of only prior moderate or LSL. Mature forest stands for which no information on the degree of alteration was available were classified as having at least 75 percent canopy cover, while sub-alpine forests had to have a canopy cover of 50 percent or more.

MAPPING METHODOLOGY

Because the digital information on forest and land cover was produced in 641 thematic maps for the entire country, it was necessary to join digital layers of the administrative regions that according to CONAF presented the largest area of native forest

5 The term "frontier forests," as used in this report, is equivalent to "intact forests" as defined and mapped in other coutries by the GFW network. GFW-Chile and its Technical Advisory Committee deemed the use of the term "frontier forests" more appropriate, especially as it translates into Spanish, given that the term "frontier forest"allows for slight use of the forest, while "intact" in Spanish excludes any forest use. The definition of frontier forest therefore has been adapted to fit the Chilean context and may differ from earlier uses of the term.

(Regions VI through XII). All the processing of these thematic layers was done using *ArcView 3.2* software (ESRI, 1996).

After joining these digital layers, the criteria identified to determine frontier forests was applied, producing two sets of polygons: those with areas of frontier forests of at least 5,000 hectares and those with areas of frontier forests of at least 10,000 hectares.

In some instances forest polygons that met all the criteria as frontier forests except for its minimum patch size, were considered frontier forests if they met all of the following criteria:

a) The forest polygon in question is adjoining a high altitude polygon (i.e., mountain tops and ridges with barren soil) that may have been split because of the break in the thematic maps, resulting in one patch of frontier forest being less than 5,000 hectares; and
b) The given forest polygon was adjoining another frontier forest polygon in the next thematic map.

Finally, those patches of mature native forests that did not meet the frontier forest criteria, were classified as fragmented mature forests, and are also presented in the *Annex I* maps.

Because of space limitations and printing costs, only a brief description of the methodology is included in this annex. A detailed methodology paper and additional technical notes will be available on the GFW Web site at http://www.globalforestwatch.org.

ANNEX IV

THE GFW REVIEW PROCESS

A key principle of GFW is the firm belief that access to reliable information, transparency, and accountability are essential for the development of better and sustainable natural resources management. In accordance with this principle, GFW reports include a summary of the major comments received from the GFW-Chile Technical Advisory Committee and other experts during the review process of earlier drafts of the report.

THE REVIEW PROCESS:

This report, the accompanying maps in *Annex I*, and the methodology used in the analysis, underwent a detailed review process involving World Resources Institute and GFW-Chile partners and external reviewers. External reviewers included experts in the field of forest ecology, forest management, and biology; experts from forest-related industries; government representatives; and members of both Chilean and international conservation organizations.

The draft report was sent to 15 external reviewers, including members of the GFW-Chile Technical Advisory Committee; and 9 additional reviewers from WRI and its partner institutions in Chile: Comité Nacional Pro-Defensa de la Fauna y Flora (CODEFF) and the Universidad Austral de Chile (UACH). We received feedback from 22 reviewers, including all but two of the external reviewers.

The reviewers represented an array of stakeholder groups, including:

Academia: Rodrigo Valencia (Universidad Católica de Temuco), Claudio Donoso (Universidad Austral de Chile), Ivan Diaz (Universidad de Chile), Pablo Marquet (Pontificia Universidad Católica de Chile), and Jerry Franklin (University of Washington).

Government: Leonardo Araya (Corporación Nacional Forestal).

Industry: Pablo Ramírez de Arellano (Bioforest, Forestal Arauco) and Gabriel Rodríguez (Forestal Savia).

Conservation organizations: Flavia Liberona (Red Nacional de Acción Ecológica), Margo Burnham (The Nature Conservancy), Jaime Cavelier (World Wildlife Fund), Adrian Newton (UNEP-World Conservation Monitoring Centre) and Ken Wilcox (Osprey Environmental).

Several WRI, CODEFF, and UACH staff also provided input throughout the process by reviewing the methodology and maps, as well as several drafts of the report. Staff members that provided feedback and advice included Franz Arnold, Gerardo Ojeda and César Sepúlveda at CODEFF, Antonio Lara, Cristian Echeverria and Patricio Rutherford at UACH, and Dirk Bryant, Linda Cotton, Tony Janetos, Peter Leimgruber, Ralph Ridder, and Tyson Walker at WRI.

In addition, the GFW-Chile Technical Advisory Committee reviewed the methodology at early stages of the process at a workshop held in Valdivia, Chile, in the first quarter of 2000.

MAJOR REVIEW COMMENTS AND HOW THEY WERE ADDRESSED

Most of the comments received involved suggestions for improving the overall structure, clarity, and flow of the report. Some comments suggested expanding details on some sections to provide the reader not familiar with Chile with a better understanding of Chile's forests resources, related industries, and forest legislation. The majority of the reviewers familiar with Chile's forests, stressed the importance of smaller forest patches and non-frontier forests, particularly the *Sclerophyllous* and *Nothofagus* forests in regions VI-VII. Even though these forests do not meet the frontier forest criteria, and therefore are not the focus of this report, they are unique forest formations, with a high level of endemism and diversity of species that are in urgent need of protection.

Some reviewers suggested new analyses that were impossible to address given our time frame and budget, however, we expect to carry out these suggested analyses during GFW-Chile's next phase of activities.

Listed here is a summary of the major comments received and how they were addressed.

- Review Comment:

Many reviewers felt the forest terminology used in the report was confusing. They suggested clarifying the different types of forests referred to in the report and providing a sense of how much of remaining temperate rainforest is located in Chile relative to other areas of the world.

Response:
To address this issue we included a box with definitions of each forest category used in the report. We also included a more detailed description of Chile's temperate forest types as part of the text in *Section 2: Chile's Forests*. In addition, we included text and several references to information that provides a better understanding of the importance of Chile's temperate forests within the global context.

- Review Comment:

The terminology used for vegetative zones described in Section 2 of the report did not match the forest categories used in the analysis.

Response:
Chile is traditionally divided into "vegetative zones," which are listed in the report. This listing caused some confusion among several reviewers, leading them to believe that the vegetative zones were the base for the frontier forest analysis that followed. The inclusion of the descriptions of the vegetative zones was merely illustrative, to provide the reader with a broader view of the different ecosystems found in the country. To clarify this, we inserted the vegetative zone descriptions in a separate text box, and clearly state that these vegetative zones were not used in the forest analysis that follows.

- Review Comment:

The majority of the reviewers familiar with Chilean forests were concerned that the emphasis on areas larger than 5,000 hectares (frontier forests) plays down the importance of smaller areas where the need for protection is still critical. Several reviewers suggested highlighting the importance of protecting these smaller patches of forest.

Response:
To address these concerns we highlighted throughout the text those forest regions that are more at risk, including smaller patches of native forests in Regions VI and VII. We also stressed the importance of these smaller patches for the conservation of biodiversity and for the potential restoration of these important and rare forest types.

- Review Comment:

Several reviewers did not agree with the author's statement that a significant component of the frontier forests are found on steep slopes or high elevations, and therefore are particularly fragile.

Response:
We clarified this statement, by adding a sentence that excludes those frontier forests in Region XII, which are generally located on moderate slopes and at low elevations, and therefore not necessarily considered "fragile" under appropriate management practices.

- Review Comment:

Some reviewers suggested that the report place more emphasis on the need for new forest legislation in Chile and that the report clarify the lackluster penalties levied in the court system and other problems with the implementation of the current laws.

Response:
These suggestions and clarifications were incorporated throughout the text given the limitations that the GFW mandate imposes on country partners as it relates to making policy recommendations.

- Review Comment:

Several reviewers pointed out that a major limitation of the analysis is that the forest frontier statistics presented in tables in Section 4: Frontier Forests in Chile, were not calculated by forest type, since not all forests are the same and have the same biological, ecological, and cultural values.

Response:
According to several reviewers, in discussing threat and representation one should look at forest ecosystems, rather than analyze results by administrative region. Even though the authors agree with the suggestion of presenting the findings regarding frontier forests by forest type, time constraints and data limitations prevented this from happening in the present report. However, it is envisioned that this type of analysis will be completed during the next phase of the GFW-Chile activities. GFW-Chile is considering publishing these results separately once they are completed.

- Review Comment:

Reviewers pointed out that the rational behind the minimum block size for a "frontier forest" (i.e., 5,000 and 10,000 ha) is lacking. The authors were asked to explain the relationship of these block sizes to biological and ecological variables (i.e., population size of key species, etc.)

Response:
The minimum block sizes of 5,000 and 10,000 hectares were determined by the GFW-Chile team in consultation with the Technical Advisory Committee and biologist familiar with endemic Chilean species of birds and mammals. According to the team assembled for the discussion, the definition of a frontier forest should take into account not just size

requirements per se, but also additional criteria ensuring that the designated minimum forest tract size is adequate to maintain the ecological processes and biodiversity of Chile's forest ecosystems. Because the mammologists and ornithologists in the team could not agree on a minimum patch size that would include all mammal and birds species in Chile, two random cutoff sizes were selected that everyone could agree on (5,000 and 10,000 hectares). This explanation has been incorporated to the document.

• Review Comment:
Several reviewers mentioned that more Chilean species of birds and mammals are listed as endangered than those presented in the report.

Response:
The list of species mentioned as endangered were checked and updated, which resulted in the addition of 5 species.

• Review Comment:
One reviewer suggested including more information regarding hard numbers such as years that trends began/ended, whether rates of change are increasing or decreasing and over what periods, or how much trends affect primary versus secondary forests, etc.

Response:
Even though providing these types of hard numbers is the goal of GFW, given the data available for Chile, basically forest inventory data from 1995, these numbers were not possible to obtain for this report. However, during the upcoming phases of the GFW-Chile work, the team expects to be able to look at trends by forest type, and monitor changes in forest cover throughout time.

• Review Comment:
Several reviewers disagreed with the statement that roads threaten forest conservation and argued that the main issue is the need for a comprehensive forest legislation framework in Chile. One reviewer pointed out, that the past pattern of forest exploitation in specific areas of Chile, such as the Coastal Mountain Range close to city of Valdivia, have never had many roads, and the clearing and burning of the forest has still taken place. According to this particular reviewer, the problem is more a product of the lacking forest policy framework or the hands-off approach to management of forest lands.

Response:
Even though the authors still feel that the plans for the coastal highway in the X Region of Chile threaten the Coastal Mountain Range forests, and therefore have left the statement regarding this issue in the text, they have incorporated the suggestion that a comprehensive policy framework is needed in order to ensure the long-term conservation of these forests.

• Review Comment:
Some reviewers suggested adding an explanation of the five different protected area categories.

Response:
A definition of the level of protection for each protected area category was included in a text box (*see Box 6*).

• Review Comment:
Several reviewers suggested specifying the location by administrative region of the key companies with native forest holdings, listing some foreign-owned companies that have either native forest land or plantations in Chile, as well as stating what percentage of forest products/exports come from native forests vs. plantations.

Response:
These issues were addressed by: (a) including a column in *Table 3: Key companies with native forest holdings,* that specifies the administrative region in which these holdings are located; (b) adding the names and plantation holdings of the main foreign-owned companies in Chile; and (c) stating, when possible, what percentage of forest products comes from plantations versus native forests. Even though the information on land tenure included in this report is not complete, GFW-Chile hopes to continue compiling information during the next phase of activities to ensure a comprehensive picture of the situation of the native forests in Chile.

• Review Comment:
Several reviewers suggested changing the colors for forests regions in the Annex I maps and clarifying the methodology used to create the maps.

Response:
As suggested by reviewers, colors were adapted to tones more in-line with forests (greens, browns, etc.). For space limitations and printing costs only a brief description of the methodology is included in the report. A detailed paper on the methodology and technical notes will be available on the GFW Web site at http://www.globalforestwatch.org.