CONSERVATION ISSUES

Protected Areas in Chile: History, Current Status, and Challenges

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ABSTRACT: Natural reserves or protected areas are a keystone of global strategies for biological conservation. With over 18% of its land under protection, Chile faces challenges similar to those in other developing countries. In this paper we describe the history and status of protected areas in Chile, and identify the challenges that the country confronts for improving the conservation and social efficacy of protected areas. Following the modern "pristine" concept of protected areas, Chile created its first protected area in 1907 and the first national park in 1925. Historically, several national and local agencies were in charge of the creation and management of protected areas. In 1984, the national public system of protected areas was created to organize the scattered protected areas around a unified system that seeks to conserve Chilean natural resources. The system has several problems that jeopardize its capability to conserve Chilean biodiversity: insufficient ecosystem representation, inadequate coverage of biodiversity hot-spots, low budgets, and boundary issues. Private protected areas have recently been considered as complementary units to SNASPE. But there are questions about long-term commitment and restriction to development in such areas. The growth of ecotourism may be boosting SNASPE and private reserve initiatives, but it may also threaten the conservation of pristine environments. We propose that protected areas in Chile be part of a comprehensive conservation policy that considers the entire range of natural resources. This policy should also address new ways to conserve biodiversity outside protected area boundaries, bringing both private and public initiatives together.

Áreas Protegidas en Chile: Historia , Estado Actual, y Desafíos

RESUMEN: Las reservas naturales o áreas protegidas son una pieza fundamental de las estrategias globales de conservación biológica. Con más del 18% de su superficie protegida, Chile enfrenta desafíos similares a los de otros países en vías de desarrollo. Este artículo busca entender la historia y estado actual de las áreas protegidas en Chile e identificar los desafíos que este país debe superar para mejorar la eficacia de las áreas protegidas en su rol de conservación y su rol social. Siguiendo el modelo "prístino" de áreas protegidas, Chile creó su primera área protegida en 1907 y el primer Parque Nacional en 1925. Históricamente, varias agencias nacionales y locales estuvieron a cargo de la creación y manejo de las áreas protegidas. En 1984, el Sistema Nacional de Áreas Silvestres Protegidas (SNASPE) fue creado para organizar las áreas protegidas en torno a un sistema unificado que busca la conservación de los recursos naturales de Chile. El SNASPE presenta varios problemas que amenazan su capacidad de conservar la biodiversidad chilena: insuficiente representación de los ecosistemas, inadecuada cobertura de los hot-spots de biodiversidad, limitado presupuesto y problemas en sus límites administrativos. Las áreas protegidas privadas han sido consideradas recientemente como unidades complementarias al SNASPE, sin embargo, dentro de la sociedad chilena ha surgido polémica frente a problemas como el compromiso a largo plazo y la restricción al desarrollo de la tierra. Por otro lado, el crecimiento del ecoturismo puede estar fortaleciendo el SNASPE y las iniciativas privadas de conservación, pero también puede amenazar la conservación de ambientes prístinos. Nosotros proponemos que las áreas protegidas en Chile deberían ser parte de una política integral de conservación que considere la gama completa de recursos naturales. Esta política debería contemplar también, nuevas formas para conservar la biodiversidad fuera de los límites de las áreas protegidas coordinando las iniciativas públicas y privadas de conservación

Index terms: biodiversity conservation, Chile, ecotourism, private reserves, protected areas system

INTRODUCTION

Natural reserves or protected areas are a keystone of global strategies for biological conservation. Humans are modifying the biosphere by altering land use, climate, biogeochemical cycles, and biotic assemblages at unprecedented rates, threatening biodiversity at a global scale (Sala et al. 2000). For terrestrial ecosystems, land use change is the most significant factor threatening biodiversity (Sala et al. 2000). Creation and management of natural reserves may help prevent the loss and fragmentation of natural habitat and thereby diminish the loss of biological diversity (Brandon et al. 1998, Cooperrider et al. 1999). An intensive scientific and political dialogue has surrounded the search for the best or optimal design of reserve systems for biological conservation and the definition of conservation targets (e.g., Kunin 1997, Soulé and Sanjayan 1998, Schwartz 1999, Poiani et al. 2000). In addition to biodiversity and ecological issues, the many social, cultural, and economic con-

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sequences of setting aside land for conservation are being considered during the formulation of natural reserve policies.

Chile faces challenges similar to those of other countries worldwide. Its unique ecosystems, which range from the driest desert in the world to the southernmost temperate rainforests, have a high level of endemism and are considered an international priority for conservation (Biodiversity Support Program et al. 1995). Even though almost 19% of land is protected under the public system of protected areas, the system itself does not ensure protection of biodiversity. Issues such as ecosystem representation, distribution, ecotourism, and land-use planning are being debated to improve the efficacy of Chilean protected areas (Lara et al. 1995).

This paper reviews the history and status of protected areas in Chile and identifies the challenges that this country faces to improve the conservation and social efficacy of protected areas. We review the historical, political, and social context in which protected areas were created. We discuss the current status of the public protected areas system of Chile (SNASPE) and the challenges it faces to improve its function. In addition, we consider the potential benefits and risks of developing private reserves, an increasing trend in Chile. Finally, we outline some of the challenges that both public and private protected confront in trying to achieve conservation goals.

HISTORICAL, POLITICAL, AND SOCIAL CONTEXT OF PROTECTED AREAS IN CHILE

The origins of protected areas can be found in pre-Christian times. For example, the ancient Greek and Indian cultures established reserves to protect unique natural features (Wright and Mattson 1996). In modern Western society, Europeans created the first protected areas during the eighteenth and nineteenth centuries. But the creation of Yellowstone National Park, USA, in 1872 is recognized as the pivotal event in that a natural area was protected on the basis of unique natural attributes. The creation of Yellowstone National Park marked the beginning of the modern view of protected areas, wherein natural systems are strictly protected from human intervention and their use is restricted to recreation and other nonconsumptive activities (Barzetti 1993, McNeely et al. 1994).

The modern "pristine" concept of protected areas was quickly adopted worldwide, being applied now, by some estimates, to over 13,232,275 km^2 in 30,350 protected areas—that is, 8.83% of total land area (Greene and Paine 1997). More conservative estimates say that all protected areas cover only 5% of total land area (Meffe and Carrol 1997). Although protected areas were created sporadically in the first half of the 1900s, during the last four decades their numbers grew exponentially (Greene and Paine 1997). Notwithstanding the apparent success, not all protected areas actually serve "strict" conservation objectives. Several issues such as boundary delimitation, lack of ecological design, poor management, poaching, illegal exploitation, among others, have reduced the effectiveness with which natural reserves conserve ecosystems (McNeely et al. 1994).

In response to the "pristine" model of protected areas, there has been a recent trend toward more holistic and scientific approaches to in situ biodiversity conservation. The influence of social sciences in environmental policy has increased awareness of the social and human dimensions of reserve management. Local communities and inhabitants of protected areas and their surrounding lands are no longer seen as negative elements but as possible collaborators in the conservation work (Barzetti 1993, Colchester 2000).

In conjunction with changes in protected area philosophy, the new discipline of conservation biology has emerged in the last two decades as a response to the need for science-based decision making in protecting biodiversity. New scientific theories and evidence are available to policymakers and managers, and these lead to increases in the efficiency and efficacy of conservation efforts (Meffe and Carroll 1997).

In complex political and social scenarios like those of South America, scientists, policymakers, and managers have not yet agreed on the best model for protected area systems. In most cases, protected areas have been created following isolated conservation efforts and have been limited in size and scope because financial resources are scarce. Few attempts have been made to incorporate protected areas into a regional or national conservation policy (Barzetti 1993, Schwartzman et al. 2000, Sabatini and Rodriguez 2001).

History of Protected Areas in Chile

In the middle of the nineteenth century, the rapid deforestation of south-central Chile, caused by land settlement and consequent agriculture and livestock activities, increased awareness about conservation. First, Claudio Gay, a French naturalist, and later his German colleague Federico Albert (both were government consultants) promoted the creation of protected areas with emphasis on the conservation of forest heritage. However, their proposals were delayed due to conflicts with the commercial sector. The first protected area was not created until 1907, when by Decree of the Ministry of Interior, the Malleco National Reserve was established in south-central Chile. In the period between 1907 and 1927 many new reserves were created, and by 1925 the first national park, Benjamín Vicuña Mackenna, was designated. Nonetheless, it only lasted four years and its boundaries were redefined to form the Villarrica Forest Reserve (Cabeza 1988). The first public protected area that still exists today is Vicente Pérez Rosales, created in 1926 with the purpose of protecting both the scenery and the primary forest of the southern region of Chile (Cabeza 1988).

The creation of protected areas in the early 1900s, as already mentioned, was more of a response to the interest of visionary naturalists in ameliorating deforestation than it was a national policy of conservation. In fact, the first category of protected areas, the "Forest Reserve," and regulatory laws indicate that the protection of natural areas was strongly oriented toward forest production and not to conservation goals

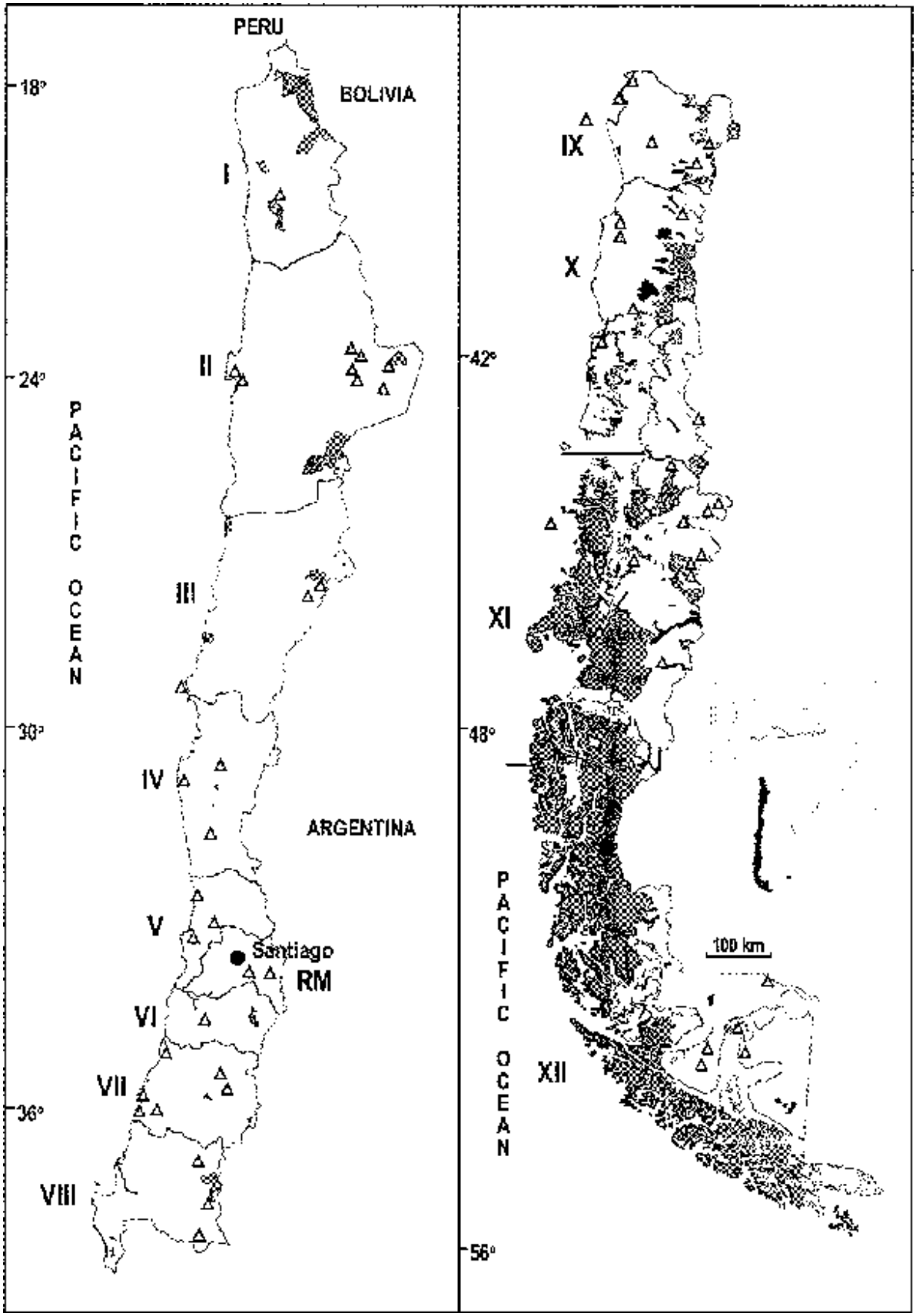

Figure 1. The national public system of protected areas (SNASPE) in continental Chile. Protected areas ≥ 20,000 ha are shown in dark gray, and those < 20,000 ha are represented by open triangles. Regions are numbered from north (I) to south (XII). RM = Metropolitan Region. Protected areas with common boundaries appear as one.

per se. These early protected areas were mostly created in forested areas of south-central Chile (38°–42° S), which now comprise regions IX and X (Figure 1). In addition to forest conservation, aesthetic considerations played a major role in defining protected areas. At that time, concepts like "biodiversity" or "ecosystem processes" were not part of the conservation logic; thus most areas were chosen for their scenic and recreational value.

The fact that the central Mediterranean region of Chile was already extensively disturbed by human activities also favored the conservation of areas in the south-central region (Armesto et al. 1992). By the 1930s, most of central Chile was deforested and almost every fertile valley converted to agriculture. The Coastal Range was particularly affected by soil erosion (Armesto et al. 1992, Bustamante and Pastor 1998). In the 1800s, this region was a major producer of wheat for markets in California and Peru, but the land became less productive and was abandoned at the end of the century. Although central Chile, with its Mediterranean climate and unique biogeography, historically contains the most diverse types of ecosystems in the country (Arroyo et al. 1994), land-use changes, high land value, and population concentration impaired the creation of protected areas in this region. Only high elevations and southern areas were available for conservation purposes. On the other hand, the northern desert region, with distinct ecological and scenic values, was apparently not considered a priority for protection, probably because it lacked forests or other lush vegetation.

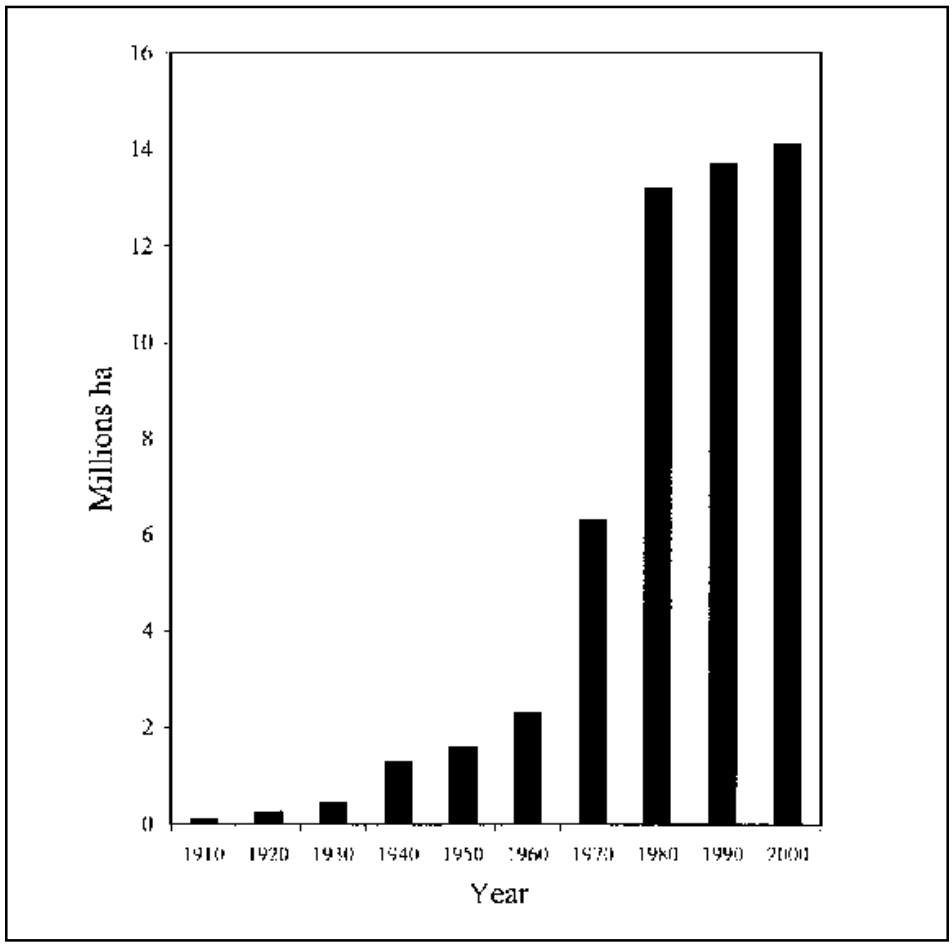

Figure 2. Total area of Chilean protected areas in national public system of protected areas (SNASPE) during the last century (CONAF 2002). Notice the large increases in area during the 1960s and 1970s.

The Chilean government, following the international trend (Sabatini and Rodriguez 2001), was concerned with increasing pressure on natural resources and realized that it needed to preserve samples of the still pristine ecosystems of the country. The total area of protected areas steadily increased from the beginning of the twentieth century to the 1960s, reaching more than 2 million ha (Figure 2). However, major efforts were made in the 1970s and 1980s to increase levels of protection. This second wave of protected area creation was focused in the "wilderness" or frontier regions of the national territory, both in the southern and the northern ends of the country. Low population, low commercial values, and the lack of land claims by private interests made it much easier to declare protected areas in these harsh environments. In contrast to Argentina, a country with which Chile shares a long boundary, geopolitical criteria did not play a major role in the creation of Chilean protected areas (Sabatini and Rodriguez 2001).

Creation of SNASPE

Until the 1970s, several national and local agencies were in charge of the creation and management of protected areas, particularly the Agriculture and Livestock Service (SAG), which was the main government agency responsible for these duties. In the 1970s, the Chilean Forest Service (CONAF) was assigned the administration of all protected areas, with minor exceptions. However, unified legislation on protected areas was not available until 1984.

Decree Law 18,362 of 1984 created the national public system of protected areas: SNASPE. The purpose of the law was to organize the scattered protected areas around a unified conservation system with the common purpose of protecting Chilean natural resources. The SNASPE adopted the framework of the 1978 IUCN protected area categories to comply with international agreements. Four categories of protected areas were defined: Virgin Region Reserves, National Parks, Natural Monuments, and National Reserves (Table 1). In addition, the management of the

Table 1. Protected area categories in the Chilean national public system of protected areas (SNASPE) and their conservation objectives. Numbers are national totals.

Category	Objectives	Number of Units	Area (ha x 1000)	Mean Area (ha x1000)
Virgin Region Reserve	Maintain ecosystems on pristine conditions.	0	0	—
National Park	Preserve samples of natural, cultural and scenic elements and evolutionary processes. Allow education, research and recreation only when not compromising conservation.	31	8718	281
National Reserve	Protect and conserve soil, fauna and flora, and water resources. Promote and develop techniques of rational resource development.	48	5387	112
Natural Monument	Preserve samples of natural, cultural and scenic elements. Allow education, research and recreation only when not compromising conservation.	15	17	1.1

Source: CONAF 2002

system was entirely assigned to CONAF. With the creation of SNASPE, the government tried to promote the definition and legalization of protected area boundaries and the assignment of specific management objectives for each unit in the system, none of which previously had been clear for a large proportion of the protected areas.

One of the major accomplishments of the law was to recognize the protection of ecosystem and evolutionary processes as primary goals for SNASPE (Pauchard 1999). The law establishes that protected areas should maintain "representative samples of the biological diversity of the country" in a way that "ensures the continuity of evolutionary processes, animal migrations, genetic flow patterns and the regulation of the environment" (Law 18,362). Such biological criteria were never mentioned before in Chilean legislation. Furthermore, the law established ecosystems as the primary unit for protection, emphasizing biogeographical diversity and ecosystem representation. For the first time in Chilean history, protected areas were not only an instrument for forest resource protection or for maintaining scenic or recreational services but also a key element in protecting the whole range of natural ecosystems.

Even though scenic and recreational values of protected areas are also recognized in the law, they are implicitly subordinated to conservation objectives. For example, national parks should "preserve samples of natural environments, and cultural and scenic elements," allowing education, research, and recreation only when "compatible" with the conservation goal (Law 18,362). However, the law did not establish mechanisms to specify standards with which these activities should comply.

A new trend in Chile, consolidating in recent years, is the interest in and active establishment of private nature reserves for ecological conservation. The development of this process is significant given the lack of public incentives for the creation of private natural reserves. Today, private reserves are a viable option that complements SNASPE in protecting Chilean natural heritage.

PROTECTED AREAS STATUS: WHERE ARE WE NOW?

Ecosystem Representation and Distribution Problems

At present, Chile has 14.1 million ha of protected areas in the SNASPE (18.7% of Chilean territory). The system includes 31 national parks, 48 national reserves, and 15 natural monuments, with the first two categories encompassing 99.9% of the total area (CONAF 2002; Table 1). Chilean protected areas rank second in Latin America and seventh worldwide in terms of percentage of national coverage (WRI 1990 cited in Cofré and Marquet 1999). Nevertheless, this high percentage is not a good indicator of the quality of the overall system. In fact, 84% of the protected area in SNASPE is located in only 2 of the 13 administrative regions of the country, the southern regions XI and XII, which have nearly half of their area under protection (Table 2, Figure 1). In addition, this area is adjacent to the Argentinean Andes of Patagonia, where 40% of forests are under public protection (Sabatini and Rodriguez 2001). On the other hand, the rest of Chile is left with only 4.4% of area under protection, which is lower than the minimum 5% recommended by international standards (Ormazábal 1986; Table 2).

The "ice and rock" criterion known in the United States wilderness system (Noss and Cooperrider 1994) is also applicable to Chile. Approximately 23% of the total area of SNASPE is covered by ice fields and other land types that are permanently devoid of vegetation with low habitat value (Luebert and Becerra 1998). In addition, 25% of Chilean forests are protected in SNASPE, 82% occurring in only two re-

Table 2. SNASPE status by administrative region in Chile in 2001. Visitor numbers are for the year 2001.

Region	% of Area Protected by SNASPE	SNASPE Area (ha x1000)	Unit Mean Size (ha x1000)	Total Number of Units	Visitors (x1000) per year	Visitors km^{-2}
I	10.8	634	127	5	25.6	4.0
II	2.8	345	86	4	16.2	4.7
III	2.0	149	50	3	11.7	7.9
IV	0.4	15	4	4	31.4	207.1
V	2.7	44	6	7	79.8	179.4
RM [a]	0.8	13	7	2	50.5	383.1
VI	2.8	46	15	3	3.2	6.9
VII	0.6	19	3	7	51.2	274.2
VIII	2.3	84	17	5	8.1	9.6
IX	9.3	297	23	13	90.5	30.5
X	8.9	607	47	13	529.6	87.3
XI	47.8	5210	252 [b]	17 [b]	17.4	0.4
XII	50.5	6661	689 [b]	11 [b]	133.0	1.8
TOTAL	**18.7**	**14124**	**150**	**94**	**1060.5**	**7.5**

Sources: Protected area numbers are based on CONAF 2002. Total SNASPE area by region based on Proyecto CONAF-CONAMA-BIRF 1999.

[a] RM = Metropolitan Region

[b] The Bernardo O'Higgins National Park occupies regions XI and XII; unit mean size and total units were calculated assuming that the park is completely in the XII region.

gions (XI and XII) (Proyecto CONAF-CONAMA-BIRF 1999). Global Forest Watch estimates that 27% of the "frontier forests" (more pristine forests) are under protection, with 6.6% in private reserves and 93.3% in the SNASPE (Neira et al. 2002). Twenty-seven percent of continental waters are also under the SNASPE. However, grasslands and shrublands in the system are only 5% of the total for the country. Finally, 77% of wetland areas are protected, but these are mainly located in extreme southern Chile (Proyecto CONAF-CONAMA-BIRF 1999).

Moreover, most protected areas occupy high elevation environments of the Andes that are under harsh climatic conditions and intense disturbance regimes (Armesto et al. 1998). Therefore there is misrepresentation of not only latitudinal ecological variation but also of elevational ranges. For example, in region IX, 10 protected areas (97.6% of the SNASPE area for that region) are located in the subalpine Andes, but there are only 2 in the Coastal Range (2.3%) and 1 in the Central Valley less than 60 ha in area (0.03%). Even for the regions with temperate forests (regions VII to XII), which are the most represented in the SNASPE, Armesto et al. (1998) found that protected area coverage correlated negatively with species richness and endemism of woody flora and vertebrates. Similarly, in northern Chile, most protected areas are concentrated in high elevation Andean ecosystems, leaving coastal environments minimally protected (Cavieres et al. 2002).

Many authors have recognized that SNASPE geographic distribution and ecosystem representation is insufficient to achieve adequate levels of conservation (Armesto et al. 1992, Villarroel 1992, Lara et al. 1995). By 1996, from the 85 vegetation associations recognized for the country (Gajardo 1995), 19 were completely absent from SNASPE and 27 were represented in less than 5% of its area (Benoit 1996, CONAF 1997). The Mediterranean and temperate ecosystems in central Chile (regions IV to VIII) are the most misrepresented in the system. The number and size of reserves in these regions are extremely small compared to the rest of the country (Table 2). In terms of conservation, these ecosystems sustain a large proportion of Chilean biodiversity, in part due to the high level of endemism in genera and species (Arroyo et al. 1994, Armesto et al. 1998).

In the last 15 years, CONAF has made an important effort to designate new protected areas in poorly represented ecosystems (Benoit 1996). The government has purchased some remnant fragments of central forest and shrub ecosystems. The policy has been to complete the protection of all underrepresented ecosystem types. In this effort, private land donations have also been included in the SNASPE. For example, between 1992 and 1996, 11 new areas were added to SNASPE (CONAF 1997). Despite these efforts the lack of ecosystem representation persists. This is especially true for biodiversity hotspots in central Chile (Armesto et al. 1992, 1998). These ecosystems usually occupy highly productive land that has already been used for agricultural purposes or remains as fragments too dispersed to be designated as protected areas (Armesto et al. 1998).

Ecosystem representation is not the only indicator of biological conservation. Numbers must be analyzed with caution. For example, an ecosystem is considered represented when there is at least one unit, no matter the size, in that ecosystem type. Of course, this definition ignores the ecological diversity within an ecosystem type and the risk of only protecting small areas that may not contain, or may not be able to sustain, the complete variety of species and ecological processes (Meffe and Carroll 1997).

Simonetti and Mella (1997) studied the effect of protected area size and isolation on long-term conservation of large Chil-

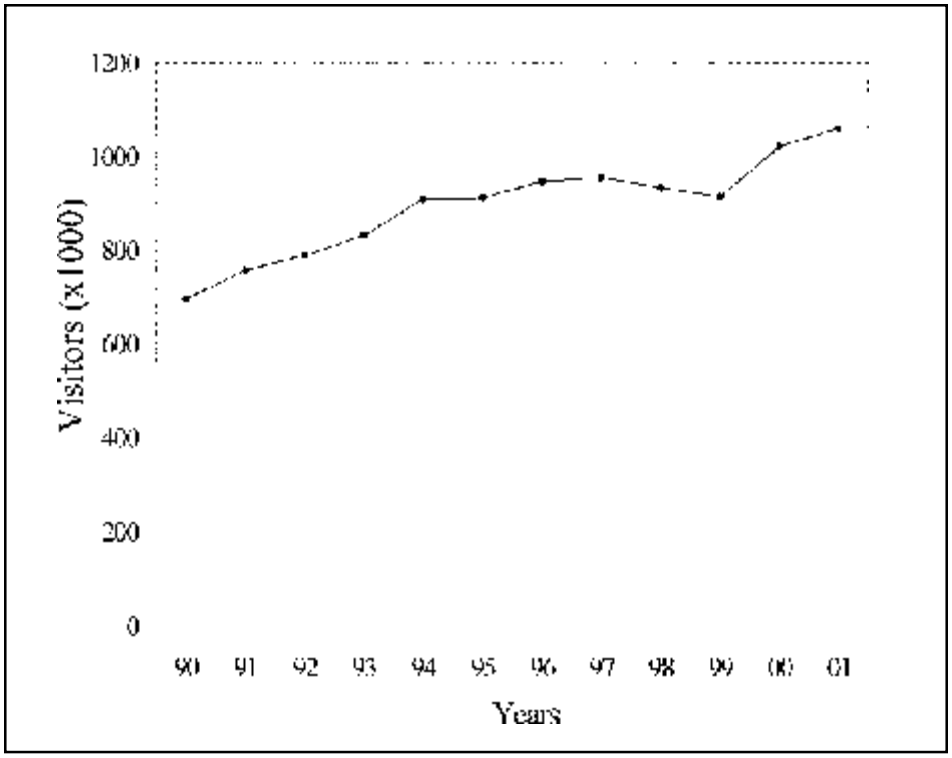

Figure 3. Total number of visitors to SNASPE areas in Chile from 1990 to 2001 (CONAF 2002).

ean mammals. They found that for large mammals, only 45% of the protected areas were large enough to maintain viable populations in the long term. Since the large protected areas are located in the southern end of Chile, they may only conserve a fraction of the intraspecific variation caused by ecological gradients. Furthermore, hotspots of mammal diversity, especially the Andean steppe and the Matorral ecoregions, are poorly covered by SNASPE (Cofré and Marquet 1999). In the case of species with narrow distributions, small protected areas may do little to maintain viable populations of plants and animals. For example, *Nothofagus alesandrii* Esp., an overstory tree, occupies a small number of fragments in the Coastal Range of central Chile. Only 12% (42 ha) of its remaining habitat is protected under SNASPE and thus its existence depends on the other private fragments that are disappearing at a rate of over 8% per year (Bustamante and Pastor 1998).

The inefficacy of SNASPE in protecting biodiversity is exemplified in the reduction of Chilean vertebrate populations (reptiles, amphibians, terrestrial mammals, and freshwater fish) to the point that > 50% of these species are classified as endangered by CONAF (Glade 1988, Iriarte et al. 1992). Considering that data on endangered species has not been updated in 15 years, it is certainly possible that the situation had worsened.

Scarce Resources: Management Implications

As demonstrated internationally, establishing protected areas is a much simpler task than making them functional (McNeely et al. 1994). Even with all of the efforts to improve SNASPE distribution and representation, scarce resources for conservation threaten the capacity of the system to accomplish its objectives (Lara et al. 1995). CONAF has not been able to establish itself as a key component of the national resource management policy. On the other hand, lack of political will has maintained CONAF as a low profile office, mostly dedicated to the promotion of exotic tree plantations and fire control. The Protected Areas Department does not have an adequate budget to improve control and protection activities inside SNASPE units, and the improvement of this situation does not appear to be a priority in public policy. Similar trends have been documented for neighboring Argentina by Sabatini and Rodriguez (2001).

Boundary delineation of protected areas is another common problem in the SNASPE. The decrees by which protected areas were created left many gaps in defining their geographic boundaries. Private owners usually claim areas adjacent to parks, and because of insufficient cartographic and historical records, there have been cases where SNASPE areas have been claimed by private landowners. For example, Villarrica National Park, located in the region IX, has been the focus of several legal land disputes that have ended with the settlement of small landowners in areas previously designated as national park (Adam Burgos, Unidad de Patrimonio Silvestre, CONAF, pers. com.).

Actualization of management plans for protected areas has also been a concern for CONAF. Law 18,362 mandates management plans for each SNASPE unit. These plans should address management objectives, baseline data, and management guidelines. Nevertheless, many protected areas do not have a management plan or the existing plan is obsolete. In recent years, CONAF has pushed the update of management plans, giving priority to those areas with high visitor demand. Data from the new National Inventory of Native Vegetation (Proyecto CONAF-CONAMA-BIRF 1999) will play a major role in improving baseline data for the units. Cooperative agreements with universities and research centers may also be promoted to increase basic knowledge about protected ecosystems. Such agreements have proven to be effective, but difficulties still arise when coordinating such projects to improve related management decisions (e.g., Pauchard et al. 2000).

Ecotourism: An Opportunity or a Threat to SNASPE?

Overall, Chile is considered an important tourist destination in Latin America, both

for traditional and nature tourism. This has led to diversification and expansion in tourist demand in recent years. A fifth of the total number of tourists that arrive in Chile seek an ecotourism experience (Rivas and Villarroel 1995). At present, tourism is among the main sources of foreign income for the country. Compared to more traditional tourism, ecotourism is increasing in importance, with internationally famous destinations such as Torres del Paine National Park and the Atacama Desert. In the period 1985–94, the growth rate of the tourism sector was 16.3%, which was far above the regional average (Rivas and Villarroel 1995) and three times more than the average growth rate for the Americas in the same period. A fifth of that total is associated with nature destinations (Rivas and Villarroel 1995).

Chilean ecotourism offers a diverse and interesting experience for foreign tourists, especially Europeans and North Americans. The SNASPE is a major component of this activity. A large proportion of the forests, glaciers, lakes, and wildlife with high recreational and scenic value are only accessible in protected areas. CONAF estimates that the number of visitors to the SNASPE grew an average of 6% yearly from 1990 to 2000, reaching 1,060,475 in 2001 (CONAF 2002; Figure 3). The growth rate of SNASPE visitation has been larger than the increase in total tourist visitation to Chile, proving that visitors increasingly prefer natural destinations (Rivas and Villarroel 1995).

The ecotourism boom is a potential opportunity for protected areas yet also a threat to their integrity. The potential detrimental effects of increasing tourism in protected areas are well reported worldwide (Ceballos-Lascuráin 1996). Nevertheless, ecotourism may open new opportunities for improving protected area systems and for the development of the adjacent rural communities—a priority in developing countries like Chile. Direct economic benefits may help to enhance protected area management and create new units, as the Costa Rican model has shown (Vaughan and Rodreguez 1997, Pauchard 2000). Indirect economic benefits may also contribute to sustainable development of communities adjacent to protected areas in a shift from an extractive to a service economy (Ceballos-Lascuráin 1996).

In Chile, there are few studies that consider the effects of ecotourism on local development. In the case of Torres del Paine National Park (region XII), ecotourism has had a significant impact in the neighboring town of Puerto Natales. Tourist services began to replace the mining industry as the base for the local economy in the 1980s. The flow of tourists between 1991 and 1995 increased by 109%. By 1996 an estimated one in nine families in Puerto Natales had some annual income related to tourism (Villarroel 1996).

Ecotourism also brings people closer to nature and thereby increases public awareness of the importance of conservation (Ceballos-Lascuráin 1996). However in Chile, the uneven distribution of SNASPE protected areas limits public access. The majority of visitation is concentrated in the south (73% of visits are to regions IX to XII; Table 2). The central regions (regions IV to VIII), where 78% of the Chilean population lives and only 1.3% of the territory is under public protection, has the highest density of visitors per area, but only 19% of the country's recreational visitation (Calcagni et al. 1999, CONAF 2002, Table 2). Just over a million visitors per year to SNASPE translates to < 1 in 15 Chilean citizens that visit at least one park yearly (without subtracting the proportion of foreign visitors). However, steady increases in visitation and ecotourism may increase public awareness (national and international) about SNASPE and its importance in conservation, a factor that may play a major role in rallying social and political support for the maintenance and improvement of Chilean protected areas.

Ecotourism in the SNASPE presents challenges similar to those faced by protected areas in other parts of the world. The risk of oversaturation and loss of natural resource values must be evaluated when making ecotourism decisions in SNASPE (Rivas and Villarroel 1995). Increasing tourist pressure in protected areas could be the beginning of irreversible deterioration. In the last decade, CONAF has strongly promoted private investment for tourism inside protected areas, with emphasis in ecotourism (Lazo 1996). Under the 19.300 Environmental Chilean Law, these projects should pass through the EIA (environmental impact assessment) process. However, this law only assesses the impacts of the construction of new infrastructure and not the indirect impacts produced by increased numbers of visitors. The implementation of this procedure is new for the SNASPE, and only limited pilot studies have been conducted (e.g., Pauchard et al. 2000, 2001). In the future, it is expected that tourist impacts will be considered in management plans for each protected area, including both mitigation and monitoring strategies.

The income generated by ecotourism in the SNASPE (ca. US$ 1.4 million per year) is considered public income and is indirectly transferred to the system. The funding for SNASPE comes from the national budget, reaching ca. US$ 4 million per year. This budget is clearly insufficient (ca. US$ 0.28 ha^{-1}), although it almost triples the direct income produced by visitor entrance and use fees. Recently, CONAF has taken advantage of private investment to improve recreational facilities inside SNASPE. This new scenario has left protected areas open to private investment in order to improve tourism services.

The economic benefits for local communities of an increasing number of visitors to SNASPE units is difficult to assess, but with the exception of specific cases such as Torres del Paine National Park, they appear to be minimal (Villarroel 1996). Big and medium-sized companies, located in strategic tourist cities and run with external capital, tend to gain much of the economic benefits of ecotourism. Even though there are no studies to confirm this hypothesis with respect to Chile, in some documented cases, local communities have expressed their concerns about the limited distribution of tourist income (Villarroel 1996). No plan or policy has been developed to increase local participation in ecotourism services. Small handicraft stores and guiding services are some of the few activities run by local people, as commonly seen in region IX (A. Pauchard, pers.

obs.). A great number of inhabitants of adjacent cities, however, are hired during tourist season, leaving a gap in employment during the off-season (Villarroel 1996). Most of the people living near SNASPE units are rural and in some cases represent indigenous groups (e.g., Clapp 1998). These communities generally have low access to education or adequate training, and even less access to capital for developing their own tourist-oriented businesses.

Boundary Issues: Conflicts with Adjacent Lands

As in the rest of the world, protected areas in Chile are at risk of becoming biological islands (Armesto et al. 1998). At the time of their designation, most protected areas were located in vast natural landscapes with little cross-boundary difference between matrix and core areas. However, "paper boundaries" are becoming real as adjacent areas are developed (Landres et al. 1998). Agriculture, livestock, and logging create a matrix of disturbed conditions, where protected areas remain as isolated remnants of original ecosystems. In extreme latitudes of Chile, some protected areas are still embedded in a matrix of undisturbed land. However, protected areas across most of Chile are increasingly pressured by adjacent land use (Armesto et al. 1998).

The effects of changes in land use and development along protected area boundaries have scarcely being studied in Chile. Nevertheless, land use has been shown to have important effects on reserve integrity worldwide (e.g., Hansen and Rotella 1999, Liu et al. 2001). Armesto et al. (1998) studied the matrix influence in Chilean protected areas in the temperate forest ecoregion. They found that most protected areas are threatened by the influence of the surrounding matrix. However, the conservation of forests outside of protected areas may help to achieve long-term conservation goals (Armesto et al. 1998). At a local scale, Franklin et al. (1999) found that cougars (*Felis concolor* L.) of Torres del Paine National Park (region XII) were in jeopardy from poaching by local livestock producers. However, the conflict has eased because of the shift to ecotourism in adjacent properties and a decrease in the sheep industry.

The isolation and edge effects produced by human activities on adjacent lands may have a wide range of negative consequences on protected areas. Not only do species that are represented in the reserves have to live in smaller fragmented patches, but they also have to deal with matrix effects (Forman 1995). For example, the interface between the human matrix and protected area is the starting point of exotic invasions into natural areas. The endemic flora of Chile may be an easy target for invasions. Arroyo et al. (2000) showed that alien plants represented over 10% of the flora in several Chilean protected areas. Pauchard and Alaback (2002) recorded 39 alien species along roads in Villarrica National Park, south-central Chile, all of which were abundant in disturbed pastures of the park matrix. On the other hand, exotic animals (red deer, *Cervus elaphus* L., and wild pig, *Sus scrofa* L.) have also escaped from local introductions and are invading protected areas of south-central Chile and Argentina (Veblen et al. 1992, Jaksic 1998).

PRIVATE RESERVES

The current deficiencies of the SNASPE—in particular, the low coverage, poor ecosystem representation, and inadequate distribution—suggest that achieving a higher level of conservation will require a major investment and management effort. The low political priority for conservation will make it almost impossible to restructure SNASPE and improve its coverage to reach acceptable levels. However, new conservation strategies that include private cooperation may enhance Chilean conservation efforts and complement the goals of SNASPE.

Private protected areas may become keystones of biodiversity conservation in Chile. Approximately 50% of the total vegetation associations that are underrepresented or absent in SNASPE are on private property (Calcagni et al. 1999). There is a similar trend in the priority sites for conservation designated by the scientific community: all 1.6 million ha represent by these sites are privately owned (Muñoz et al. 1996, CONAF 1997). In addition, private reserves are essential to diminish boundary issues and conserve species with large home ranges (Simonetti and Mella 1997). For example, Povilitis (1998) proposed a "stepping stones" connectivity model using private land to protect the remaining population of huemul deer (*Hippocamelus bisulcus* [Molina]) in the Andes of central Chile. The creation of a significant number of protected areas that started in the early 1990s opens a new opportunity for critical improvement in the conservation of natural areas.

A series of studies by the Center for Research and Environmental Planning (CIPMA) have shown the increasing trend in private reserves (Sepúlveda 1998, 2002; Villarroel et al. 1998; Calcagni et al. 1999; Villarroel 2001). By 1997, there were 25 private reserves over 40 ha in size encompassing approximately 400,000 ha, and currently there are nearly 200 units reaching roughly 500,000 ha. Interestingly, all these initiatives arose spontaneously in the 1990s and were motivated by environmental philanthropy. CODEFF (1999), a grassroots environmental organization, has recorded 104 protected areas without considering a minimum area. In regions V to XII the Network of Private Protected Areas (RAPP) groups 74 properties with a total of 323,542 ha, some of which border SNASPE units (CHIPER 1999). With the support of The Nature Conservancy, the RAPP hopes to promote legal incentives and new alliances for conservation between private and public entities.

It is important to note that the private protected areas of Chile were created in response to the effort of their founders rather than an official policy. Even though in practice no incentives or government recognition have been granted to private reserves, their numbers have risen in recent years. A national policy of private protected areas could boost the creation of private reserves, making them an important tool to complement the conservation goals of SNASPE, especially in areas where land value is extremely high (Villarroel 1992). Private reserves could also open interest-

ing opportunities for conservation research, and these results could be used to improve management strategies in the SNASPE.

Although at present there is no legal entity that recognizes and promotes the creation of private reserves in Chile, the state perceives their importance. Environmental policy, now in force, recognizes the importance of public-private cooperation in improving biodiversity conservation and the role of the state in promoting private reserves. Recently, the National Environmental Commission (CONAMA) activated discussion about regulatory norms within Article 35 of Environmental Law 19,300, which specifically assigns responsibility to the state in promoting and accrediting private protected areas.

Among the most well known private protected areas is Parque Pumalín, owned by the American businessman Douglas Tompkins, former owner of the Sprit clothing company. Pumalin has grown in recent years and currently contains ca. 290,000 ha, making it the largest private reserve in Chile. The park is located in the southern part of the region X (Retamal 2000). This initiative has generated important media attention due to a controversy among environmentalists, local companies, and the government on the multiple implications of this unprecedented conservation effort (CHIPER 1997).

There is no doubt that private reserves will play a major role in biodiversity conservation in Chile. Nonetheless, private investment in protected areas presents a new set of risks. It is unknown whether private capital will flee from conservation investments, especially when some economic crises arise or when alternative uses become more profitable. Private reserves can help in maintaining natural heritage, but regulation is needed.

CHALLENGES TO CHILEAN PROTECTED AREAS

Chilean society needs to establish a policy for the conservation of its natural heritage. Most of the problems discussed here are a product of the lack of a conservation policy that integrates government and private initiatives. Diffuse laws are difficult to enforce and have a minimal effect in protecting Chilean ecosystems. A long-term perspective should be used to discuss the role of protected areas in balancing societal demands for both conservation and economic development.

To develop a policy of sustainability, it is first necessary to have a good understanding of the ecological resources that must be conserved. A national biodiversity assessment, such as other countries have developed (e.g., Costa Rica in Pauchard 2000), would increase our knowledge about natural resources and the priorities for conservation. This deficit is not peculiar to Chile: lack of data has been blamed for limiting conservation efforts throughout Latin America (Cofré and Marquet 1999). A national plan should be coordinated between research institutions and the government, and would require significant financial support. However, without a national assessment, it is impossible to evaluate the efficacy of current protected areas in conserving biodiversity and impossible to design better systems of protection. A series of initiatives have been conducted to determine the priorities for conservation information (e.g., Glade 1988, Benoit 1989, Muñoz et al. 1996). In the same direction, the newly created CASEB (Center for Advanced Studies in Ecology and Biodiversity) is improving the state of biodiversity inventories in the country. The challenge, however, is to coordinate all this information and make it available in the decision-making process.

A major priority for SNASPE is to improve its representation and distribution of protected areas. First, it is necessary to increase the coverage of SNASPE or private reserves to adequately represent the 85 vegetation associations, but also it is necessary to increase this coverage to a 5% minimum for each association (Ormazábal 1986). Other sites recognized by the scientific community as conservation priorities should also be included in SNASPE or other reserve systems (Cavieres et al., in press). Second, in order to achieve a higher recreational and educational use of protected areas, new areas should be created near population centers, improving access for all citizens while controlling for visitation's negative impacts. Furthermore, protected areas provide an excellent forum for environmental education, key to ensuring long-term conservation efforts (e.g. Brewer 2002). Ultimately, it should be recognized that the value of protected areas for a society is directly related to that society's cultural perception of nature (Brandon et al. 1998).

CONAF also needs to improve SNASPE management with updated scientific information. Management plans can be formulated through cooperation with local universities and research institutions that have better access to conservation planning tools and knowledge. Improvement in the management of protected areas is expensive and requires a more reliable funding system than is provided by auto-financing initiatives. In addition, any new legislation should provide for more management categories to increase system flexibility, including the creation of private reserves and incentives to public-private cooperation for conservation.

Rural and indigenous communities should share the benefits and responsibilities of protected areas (Beltrán and Phillips 2000). This may improve social conditions for these marginalized groups while ensuring long-term conservation of natural ecosystems (Barzetti 1993). Local communities should be able to participate in the design and updating of protected area management plans, thereby increasing their involvement in these conservation efforts. In this direction, ecotourism may not be the perfect answer for all conservation problems, but it could be used to bring together private investment and local communities. It can provide a new source of income for rural people and an opportunity for private owners to obtain revenues for protecting their land (Vaughan and Rodreguez 1997). Ecotourism is an interesting model that has proven to be successful in other countries. By providing the right regulatory framework it could open new opportunities for conservation and development in Chile.

Private conservation efforts must be promoted as a keystone element of the nation-

al policy for conservation (Sepúlveda and García 1997). In a free market economy, the private sector is probably one of the last options for protecting some unique ecosystems. It is important to consolidate private initiatives by coordinating public and private efforts. In that direction, it is crucial to approve and empower Article 35 of the Environmental Law 19,300, which recognizes the importance of private reserves and the government role in promoting them. In addition to private reserves, efforts should be made to include lands adjacent to protected areas in landscape-scale management plans. Protected areas in isolation should not be considered the only tool for conservation. Through landscape planning, other areas in the matrix could also play complementary roles in the conservation of biodiversity (Franklin 1993).

Finally, research should be promoted for understanding the complex natural and human interactions in protected areas (Cofré and Marquet 1999). Limited resources for science in Chile have made it impossible to establish a continuous program of wilderness research. Research should be a priority if Chile is to vigorously protect its natural heritage.

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