Wetlands of Chile: Biodiversity, Endemism, and Conservation Challenges

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Abstract

Chile has various types of wetlands throughout its territory, their biological diversity is low, but it concentrates high endemism (52% accounts for vascular plants, continental fish account for 55%, and amphibians account for

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65%). Towards the northern end of the country, endorheic (landlocked) basins are located in a hydrological network that has developed as a result of the geology of the Andes, here the Andean wetlands are unique and microbial biodiversity is unique. Towards the south of Chile, meadows, coastal wetlands, swamp, lacustrine (lakes, ponds), estuaries, forested wetlands (marshy wetlands, hualves) increase in abundance. The coastal wetlands types are principality tidal flats and marshes, lagoons, and estuarine waters. Other unique wetlands type are the peatlands, which are principally found in Chile and Argentina in South America. Chile currently does not have historical trends data for its aquatic environments and how pressures have acted on their quantity, quality, and morphological structure. The Ministry of Environment has proposed a standardized Wetland Environmental Monitoring System that is integrated and complementary to the National Inventory of Wetlands. The objective is to use the wetlands as indicators of the environmental condition of basins.

Keywords
High endemism · Andean wetlands · Coastal wetlands · Peatlands · Pressures · Environmental monitoring system · National inventory

Introduction

Chile is an elongated but relatively narrow country averaging approximately 180 km wide extending between 18° S and 56° S, a distance of approximately 4,300 km. The Pacific Ocean borders the territory on the west and, the Andean Mountain Range, with altitudes up to 6,900 m above sea level (Ojos del Salado, Atacama region) on the east. Within this area are described eight climatic zones, the most extreme zones are in the north, the hyper-arid desert zone and arid steppes occur on the highlands, and towards the southernmost end are the cold hyper humid and semi-arid steppe in Patagonia. Climate and geography result in the development of various types of wetlands. Thus, important hotspots of biodiversity are recognized in Chile (Cowling et al. 1996; Arroyo et al. 2006). Although Chile has low diversity, it concentrates high endemism; for example, 52% accounts for vascular plants, continental fish account for 55%, and amphibians account for 65% (CONAMA 2008; MMA 2016).

Watersheds in the Mediterranean zone in the northernmost end of Chile are water deficient (Banco Mundial 2011), but wetlands are an exception to the rule. Southwards, wetlands are increasingly frequent and diverse, and the human population is concentrated around headwaters, at the mouths of rivers, at the margins of lakes, ponds, estuaries, and creeks. Changes in population settlement patterns have redefined the natural dynamics of these ecosystems; changes in weather patterns pose additional challenges to preserve these ecosystems.

Main Types of Wetlands in Chile and Their Location

Towards the northern end of the country, endorheic (landlocked) basins are located in a hydrological network that has developed as a result of the geology of the Andes. Salt flat-type wetlands, Andean ponds, meadows, and highland wetlands predominate in the Puna area. The interdependence between wetlands and the aquifers that feed these systems is narrow and fragile. The biogeographic isolation of this area has favored the existence of endemic species. For example, the diversity of fish only reaches 44 species in Chile, 81% of which are endemic (Vila et al. 1999; Habit et al. 2006) and is a low number when compared to other biogeographic regions of the world.

Southward towards central Chile between 27° S and 31° S, the climatic conditions change and the environments are no longer dominated by high radiation and evaporative processes. Andean wetlands and meadows begin to predominate as salt flats and highland wetlands disappear. Transverse valley systems, ritronic and potamon habitats, and seasonal wetlands (creeks and estuaries) appear.

Towards the south of Chile, rivers are flowing, vegetation increases, and soils are oversaturated. Meadows, coastal wetlands, swamp, lacustrine (lakes, ponds), estuaries, forested wetlands (marshy wetlands, hualves), nonforested wetlands, and peatlands increase in abundance. Peatlands have their greatest expression in the southernmost region of Chile, between 39° S and 56° S (regions of Los Lagos and Magallanes).

Based on the national register of wetlands, their area is estimated to not exceed 2%. However, this is an underestimate as it excludes wetlands on oceanic islands and those (including peatlands and meadows) in Chile's southernmost area (regions of Aysen and Magallanes: see Fig. 1). An overview of wetland types in Chile and their most representative environments are presented in Table 1.

With the exception of coral reefs, tundra, and karst, all the wetlands described in the Ramsar classification system are found in Chile (see Ramsar Convention Secretariat 2010 – Annex 1). In Chile we can find various types of wetlands, some of which have been characterized by Hauenstein et al. (2004) and in some cases, their names are due to denominations given by indigenous communities, below are some descriptions;

Hualves: Rain forests vegetated with native woody Myrtaceae such as temu *Blepharocalyx cruckshanksii*, pitra *Myrceugenia exsucca*, chequén *Luma Chequén*, and tepu *Tepualia stipularis* on waterlogged poorly drained soils. These wetlands are the habitat of the huillín or river otter *Lontra provocax* and meadow shrimp *Parastacus nicoletti*. These wetlands are primarily located in grabens, creek beds, or gullies with poorly drained soils (Varela 1981; Ramírez et al. 1983; Castro 1987; San Martín et al. 1988; Solervicens and Elgueta 1994) in the central depression coastal range (Ramírez and Añazco 1982; San Martín et al. 1988) and on the island of Chiloé (41° 00′–42° 30′S).

Ñadis: Systems with thin soils, saturated or flooded only in winter. They have a waterproof layer of "fierrillo" between the organic soil and gravel substrate. Located in the central depression of south central Chile, these wetlands have poor plant and animal diversity.

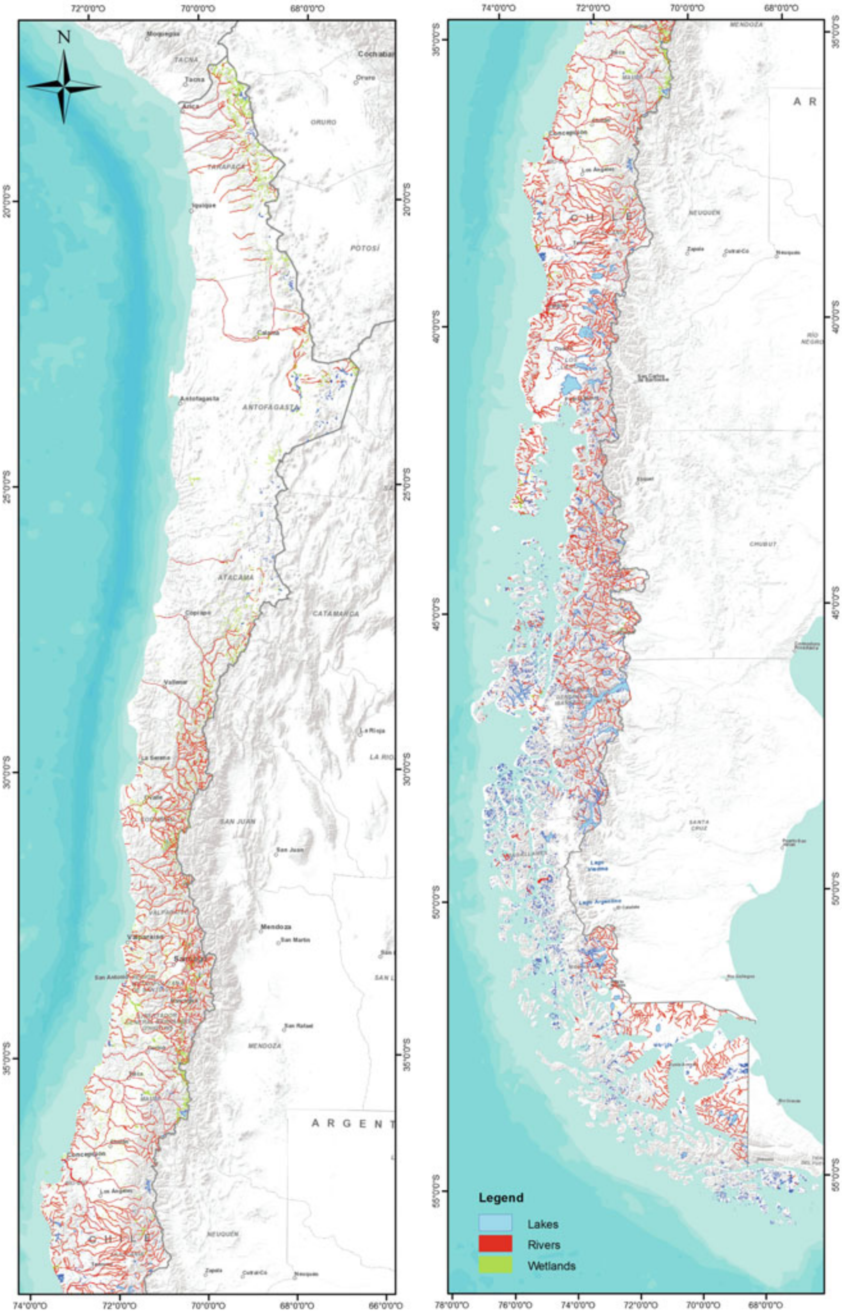

Fig. 1 Cadastre rivers, lakes and wetlands, excluding peatlands, meadows and saline pastures of Los Lagos, Aysen and Magallanes regions (Source: Ministerio de Medio Ambiente 2014 based upon MMA 2012, with permission)

Table 1 Predominant wetland ecotypes (CONAMA 2006) and some examples where they can be found

Ecotypes	Common name	Some locations in Chile
Coastal wetlands	Coastal lakes, salines lagoons, intertidal marshes, estuarine waters, intertidal salt	Lago Budi (saline coastal lake), Ramsar Site Laguna Conchalí (lagoons), Laguna Cahuil (saline lagoons and estuarine), Ramsar Site El Yali (coastal freshwater lagoons and saline lagoons), Humedal Tubul-Raqui (marshal, estuarine), Estuary del río Queule (estuarine waters), Putemún (intertidal marshes)
Inland wetlands	salar, "bofedal," "Puquios"	Salar de Atacama (salar and saline lagoons), Sitio Ramsar Surire (salar and saline lagoons), Sitio Ramsar Sistema hidrológico Soncor (saline lagoons), Salar de Huasco, Sitio Ramsar Negro Francisco and Santa Rosa (saline lagoons and salar, Andean prairie)
	Hualves, pitranto, ñadi, swamp	Wetlands of the central depression between the Maule and Araucanía (primarily) and the coastal area of Araucanía (Queule and Moncul). (forested wetlands, swamps, permanent rivers)
	Mallín, turberas (peatlands, bogs, fens), "pomponales"	Parque Karukinka, Tierra del Fuego (peatlands), Parque Nacional Chiloé (peatlands), Parque Tantauco (peatlands, bogs)
	River, lakes, streams	Río Lluta (river), Lago Chungará (andean lake), in Ramsar Site Parque Andino Juncal (rivers and streams, bogs), estero Tongoy (stream), Lago Lleu-Lleu (permanent lake)

Albúferas: Brackish lagoons, located in the coastal area, with seasonal connectivity to the sea. They are highly eutrophic, due to the salt loads coming from the sea. A representative example is the lagoon of the estuary El Yali, Valparaíso Region.

Andean Wetlands

Andean wetlands are widely distributed on the Andes Mountain Range, being prominent in the Andean highland area and Andean steppe (Fig. 2). Andean wetlands are usually located above 3,000 m asl, while high Andean wetlands typically occur around 2,300 m asl (MMA et al. 2011a). The Puna Seca is a bioregion associated with the Andean highlands characterized by intense cold, dryness, and daily temperature fluctuations, mainly endorheic basins, vegetation types defined as azonal hydric, and can include halophytes (Ahumada and Faundez 2009). These types of wetlands are flooded or partially flooded and have a strong balance with groundwater (aquifers).

Fig. 2 A peatland (bog) in Parque Nevado Tres Cruces that lies in the northern end of the southern Andean steppe, Atacama Region, and includes Laguna Santa Rosa and Laguna del Negro Francisco designated as Ramsar wetlands of international importance (Photo Credit: A. Figueroa © Rights remain with the author)

Wetlands as freshwater lakes and ponds (glacial, volcanic, and tectonic), hot springs, and geysers also occur in Puna Seca. Associated with these lakes and ponds are dense stands of flooded or semi-flooded sedges. In the subregion of the Mediterranean Andes and the Cordillera de la Araucanía (from the Biobio region to the northern region of Los Lagos), wetlands occupy the higher parts of the Cordillera de los Andes and Nahuelbuta interspersed among evergreen coniferous *Araucaria sp.* and southern beech *Nothofagu*s *sp.* forests and steppes characterized by the genera *Festuca*, *Juncus*, *Carex*, and *Eleocharis*.

These type of wetlands (meadows, sedges, bogs) are supplied almost exclusively by groundwater and there exists a functional relationship between riparian or edge vegetation (azonal vegetation) and water courses and other bodies of water. Biological communities can be distinguished between those occurring in low salinity ecosystems (macrophytic vegetation, birds, fish, and amphibians), high salinity ecosystems (communities of flamingos, benthic microalgae, and bacteria), and ecosystems dominated by hydrophytic vegetation.

Andean wetlands are fragile ecosystems with high species endemism. Their high fragility is associated with changes in rainfall patterns and also with anthropogenic causes, such as drainage activities, overgrazing, or disturbance in the water regime. For wetlands in the dry Puna, sustained water extraction kills meadows and wetlands. Reduced flows also negatively affect the habitats of fish, amphibians, and birds.

Andean wetlands are rich in species, in response to the spatial heterogeneity, local factors that occur in different basins (e.g., water, soil, water quality), and the phenomena of geographic isolation. In general, the biological composition of wetlands is specific constituting biodiversity concentration areas in the highland region ("hot spot"). The fish fauna of Andean wetlands is endemic; it has primitive characteristics and is of great ecological significance (Arratia 1982; Vila et al. 1999, 2006). This is the case for the genus *Orestias* with six endemic species present only in the Andean wetlands (from 3,000 to 4,500 m. in altitude). Birds are another important group that depend upon Andean wetlands. Chilean flamingo *Phoenicopterus chilensis*, Andean flamingo *P. andinus*, James's flamingo *P. jamesi*, and other migratory bird species use the salt flats and lagoons for reproduction and feeding.

A remnant microbial world was recently recognized in Argentina and Chile salt mines of the Andean otherwise known to occur in certain parts of the world, e.g., Australia (Shark Bay); Mexico (Cuatro Ciénagas), and USA (The Bahamas-Yellowstone) (Farías and Conteras 2013). Among these microbial groups are distinguished cyanobacteria, microbialites, stromatolites, evaporates, and a variety the nomenclature of which varies according to its structure and composition. In general, they correspond to the microorganisms that gave life to the planet. This demands precision in terms of water resources management, particularly in endorheic basins, and agreements to limit activities in areas of ecological importance and scientific interest.

Coastal Wetlands and Forest

These wetlands are located along the continental coast and on the oceanic islands, including Chiloé Island. There are mainly three types of coastal wetlands in Chile: tidal flats and marshes, lagoons, and estuarine waters. The estuaries are numerous and occur south of latitude 35°S (subhumid zone in Maule and Biobio Regions); south of latitude 40°S, estuaries become large deltas and are characteristic southern fjords.

In the northern part of Chile are rivers with low flows, small streams, and coastal lakes. The largest estuaries located to the south of Mataquito River (Maule Region) input nutrients and sediments that benefit coastal zone productivity (Stuardo and Valdovinos 1989) and supports activities like an inshore fishery and salt works. Especially important are forested wetlands of the coastal zone between the Imperial and Toltén Rivers. In this area these forested wetlands (wooded swamps) are known locally as "hualves" (mapudungun language, Ferriere 1982) or "pitrantos," they do not receive salinity from the tides but have daily influence of these. Several authors have described the importance of these wetlands, its origin, and its vegetal composition (Ramírez et al. 1995; Hauenstein et al. 2004, 2014; Peña-Cortés et al. 2011). Principal genera in these wooded swamps include *Myrceugenia, Blepharocalyx, Luma*, and *Tepualia* and are described as having a canopy cover between 18 and

20 m in height (Ramírez et al. 1995; Correa-Araneda et al. 2011). These wetlands are the favored habitat for hullín, (*Lontra provocax*, Thomas 1908), birds as torcaza (*Araucaria Patagioenas*, Lesson) and crow swamp (Plegadis chihi, Veillot) as well as amphibians.

Coastal wetlands are under pressure by development activities in adjacent basins, particularly the central Chilean zone where most of the population lives and most of the industrial activities occur (with the exception of mining which takes place in the north of Chile). The farming activity exerts some pressure on coastal systems which extends into the river flood zones, especially near estuarine wetlands. The high input loading of nitrogen and phosphorus with the application of pesticides and herbicides negatively impacts water quality, the fishery, and marine and freshwater biodiversity.

Nutrient levels and chlorophyll "a" concentrations used to determine the trophic status indicates there is a progressive decline in the general environmental condition of coastal wetlands. In 2011 and 2013, the 68 monitored coastal systems all showed either a tendency towards eutrophication or hypereutrophication (MMA 2011b, 2012). About the Biobío Region 11 systems were evaluated and 72% were in a bad conservation state. For the coastal zone, between the Andalién and Biobío Rivers, the conservation status of 83% of 12 evaluated systems was classified bad or very bad (MMA 2011c). Chilean coasts are however also exposed to dramatic and mostly irreversible natural changes caused by earthquakes and tsunamis that produce changes in the morphology and ecological characteristics of wetlands (e.g., coastal zones and wetlands of Valdivia and Cruces Rivers, Queule River Estuary, Tubul – Raqui Estuary).

In addition, the mouths of rivers and marshes are modified by opening of the terminal bars. Summer tourism can also impact these coastal wetlands if it has not been planned. To ensure continued enjoyment and pleasant visitation of coastal wetlands by many people, coastal wetlands need protection along with appropriate access infrastructure for visitors and educational information.

Chilean Peatlands

South American peatlands are principally found in Chile and Argentina, and the largest proportion of these is in the humid zones of Patagonia where regional climate patterns favor the development of these cold temperate wetlands (Roig and Roig 2004). Although Chile does not have a detailed land registry for peatlands, the largest proportion of peatlands are distributed in the administrative regions of Los Lagos south to Magallanes and particularly south of 45°S (Lappalainen 1966). Joosten and Clarke (2002) estimated Chile's peatlands at no more than 10,470 km^2, while other publications consider peatland covering between 10,684 km^2 (Luebert and Pliscoff 2006) to 21,000 km^2 (1.4–2.8% of the national territory). The two southernmost provinces of Tierra del Fuego and Chilean Antarctica in the Region of Magallanes have approximately 4,900 km^2 of peatland, respectively (Ruiz and Doberty 2005). Karukinka Natural Park at nearly

Fig. 3 Peatlands in Karukinka Natural Park. Magallanes Region, Chile (Photo credit: Carlos Silva-Quintas © Rights remain with photographer)

2,800 km^2 is the largest privately owned protected area in southern Magallanes and contains significant areas of peat (Fig. 3), while Chiloé National Park and the private Tantauco Park on Chiloé Island (Los Lagos Region) have only minor areas of peat. Bernardo O'Higgins National Park within both the Aysén and Magallanes regions is the largest of the protected areas in Chile at 35,259 km^2 and peat is one of the predominant vegetation types.

Peatlands provide habitat to a diverse group of species including amphibians (e.g., marbled wood frog *Batrachyla antartandica*), birds (e.g., white-tufted grebe *Rollandia rolland*, silvery grebe *Podiceps occipitalis*, magellan goose Caiquén *Cholephaga picta*), and mammals (e.g., guanaco *Lama guanicoe*). The beaver *Castor canadensis* is however an introduced species that negatively impacts peatlands, particularly in Magallanes and Tierra del Fuego, with the construction of dams from slow growing native trees and shrubs. The dams flood wide areas resulting in changes in basin hydrology, habitats, and peatlands (Baldini et al. 2008).

Peatlands are also being negatively affected by human activities, particularly by a growing peat harvesting industry (Domínguez 2013). Although there are a number of legal standards respecting the use of inlands wetlands, an assessment by Möller and Muñoz-Pedreros (2014) concluded peatlands had among the lowest legal measures for their protection. Harvesting of this resource has a number of ecological and social consequences including the disruption of *Sphagnum* ecosystems, changes in water storage capacity affecting water supply to rural communities, exhaustion of the moss and impoverishment of the producers, carbon cycle impacts, landscape erosion, and loss of biodiversity (Zegers et al. 2006; Diaz and Delano 2012).

The National Inventory and the Environmental Tracking of Wetlands in Chile

Approaches, Goals, and Challenges

Beginning in 2011 work has been proceeding on developing a national inventory of wetlands. The first step in this undertaking was development of a national land register from which the locations and area of the different watercourses and bodies of water existing in the country could be determined (Table 2). However, full coverage has not yet been completed using the available tools and methodology for some areas and types of wetlands, such as the peatlands in Patagonia (discussed below). Although there is information for these areas included in the Forest Cadastre (CONAF – CONAMA 1999; CONAF-UACH 2011), it must be revised. The current information of the locations of Chilean aquatic ecosystems (rivers, lakes and wetlands) now is available in mapping (see Fig. 1) and an estimate of their coverage (Table 2). The detailed information for eventual consolidation in the national inventory is still underway. The national inventory is the means to implement an environmental monitoring system of wetlands and support the territorial planning at country level. The National Cadastre of wetlands is a first step.

Wetlands as Indicators of the Environmental Condition

Chile currently does not have historical trends data for its aquatic environments and how pressures have acted on their quantity, quality, and morphological structure. A monitoring and evaluation program (Early Warning System) is a prerequisite for assessing the health of aquatic systems and determining whether or not a wetland has suffered changes in its ecological character. A standardized Wetland Environmental Monitoring System integrated and complementary to the National Inventory of Wetlands and Environmental Monitoring project (MMA 2011c, 2012) is proposed for this purpose. Applying a basin approach, wetlands will be selected to collect basin and class/ecotype specific information on condition indicators, forcing factors, and threats in order to ascertain wetland environmental and ecologic condition (CONAMA 2006). Spatiotemporal considerations include where and when to measure condition indicators and anthropogenic activity specific to each wetland, i.e., defining the most sensitive area and period for each wetland (dependent on geographical location and wetland ecotype), included in the monitoring and assessment program. Pilot projects are underway in wetlands including Sitio Ramsar Laguna Negro Francisco and Sta. Rosa and The Yali National Reserve.

Conservation for Sustainable Use Within and Outside Protected Areas

Several aspects have driven the development of projects that improve the knowledge and management of the environment: the progressive request for natural spaces, the loss and alteration of wetlands, the growing use of hydric resources, and some deficiencies of regulatory instruments to protect wetland ecosystems. This improvement involves local governments, communities, and private systems through participatory environmental management and environmental monitoring of wetlands inside and outside of protected areas; two current examples of which occur in Greater Island of Chiloé and Nevado Tres Cruces National Park and Sitio Ramsar Negro Francisco, respectively.

Participatory Environmental Management on Greater Island Chiloé

The island is located between latitudes 42°–43° S and has a diversity of wetlands: marshlands, lakes, rivers, and peatlands. Towards the eastern coast of Chiloé are intertidal wetlands and salt marshes used by migratory birds and diverse fauna of invertebrates. More than the 30% of the population of the whimbrel *Numenius phaeopus* and Hudsonian godwit *Limosa haemastica* arrive every year after travelling over 14,000 km from the arctic to these coastal wetlands, making this one of the most important areas for these species in South America. Chiloé wetlands are also the habitat for the Chilean flamingo *Phoenicopterus chilensis* (Fig. 4), chorlon chilean (rufous-chested plover) *Charadrius modestus*, and the small churrete (grey-cheeked cinclodes) *Cinclodes oustaleti.*

Peatlands vegetated with Sphagnum, grasses (gramineas), and “pulvinadas” (dense, compact, and hard cushion-shaped plants, e.g., *Donatia fascicularis, Astelia pumila, Caltha dioneifolia*) are very common, the latter having recently developed over the last 100–200 years by anthropogenic processes. The vegetation in some areas corresponds to: Totora azul marsh (*Scirpo-cotuletum coronopifoliae*), Seliera marsh (*Puccinellia-Sellerietum radicantae*), and Llinto marsh (*Sarcocornio Spartinetum densiflorae*).

A project of participatory management has been developed for 11 coastal areas that involves four local governments and communities. Management plans for these 11 coastal area wetlands contain local developmental proposals that consider resource sustainability, agriculture, and wetland recovery and protection. The stakeholders define the priorities and conservation interests. The management proposal is presented before the local government in order for them to identify changes in the territorial planning and to develop agreements for land use restrictions in fragile areas and degraded zones. Sustainable tourism of coastal wetlands will be promoted using guides, interpretative tables, and signposts.

Fig. 4 Chilean flamingo *Phoenicopterus chilensis* (Photo credit: Roberto Villablanca)

Ramsar Sites in Chile, Brief Overview

Chile has 12 Ramsar sites covering an area of 359,989 ha. Eight of these are Andean wetlands (Table 3) and four are coastal (Table 4), with the exception of Lomas Bay, the second southernmost Ramsar site in the world after Argentina's Atlantic Coast Reserve of Tierra del Fuego, which includes the intertidal flats of Bahía Lomas.

The first site designated was the Santuary Carlos Anwandter (4,877 ha). It is a fluvial wetland with a marked marine influence due to the daily fluctuations of the tides and freshwater flows and affected by major natural and anthropogenic events. Located in the region of Los Rios, this wetland originated from the earthquake that hit Chile in 1960.

Since 1981, public interest in the protection of wetlands has increased. Two examples of private conservation in Chile are: Andino Juncal Park and Laguna Conchalí. Andino Juncal Park was nominated by a private owner who proposed 13,796 ha of private land be included within the boundaries of a Ramsar site for the purposes of preservation, education, and research. This is a symbolic action, considering the mining activity of our Cordillera and neighboring areas to Juncal, where glaciers, Andean prairie, streams, and watershed (header basin) are protected. Laguna Conchalí is managed by a mining company. This 52 ha site is an example of passive recovery and community education.

The remaining Ramsar sites are within the National System of Protected Areas. The demands made by society to improve the conditions of their environment have attracted increasing interest in the conservation of wetlands and in designation of Ramsar sites as a protective measure.

Table 2 Identified area of wetlands, rivers, and lakes by region

Región	Lakes (km^2)	Rivers (km^2)	Wetlands (km^2)	Total (km^2)	Total (ha.)
Arica y Parinacota	56	34	196	286	28,600
Tarapacá	12	14	11	137	13,700
Antofagasta	167	76	166	409	40,900
Atacama	87	12	78	177	17,700
Coquimbo	9	10	140	159	15,900
Valparaíso	15	27	24	66	6,600
Región Metropolitana	22	61	49	132	13,200
O'Higgins	6	4	101	111	11,100
Maule	115	171	138	424	42,400
Biobío	176	283	64	522	52,200
Araucanía	561	176	82	819	81,900
Los Ríos	1,050	230	13	1,293	129,300
Los Lagos*	178	232	2,036	2,446	244,600
Aysén	4,000	329	113	4,442	444,200
Magallanes Y Antártica Chilena	2,700	180	6	2,886	288,600
*Isla Grande de Chiloé	130	49	116	295	29,500
TOTAL	**9,284**	**1,887**	**3,433**	**14,604**	**1,460,400**

*Chiloé Island is part of the Los Lagos Region
Source: Ministerio de Medio Ambiente, Chile (2012)

Table 3 Andean Ramsar Sites in Chile

Ramsar Sites High Andean	Area (ha)
Laguna del Negro Francisco y Laguna Santa Rosa	62,460
Salar de Surire	15,858
Salar de Tara	96,439
Salar del Huasco	6,000
Salar de Aguas Calientes IV	15,529
Salar de Pujsa	17,397
Parque Andino Juncal	13,796
Sistema hidrologico de Soncor del Salar de Atacama	67,133

Table 4 Coastal Ramsar Sites in Chile

Ramsar Sites Coastal	Area (ha)
Laguna Conchalí	34
Reserva Nacional El Yali	520
Santuario de la Naturaleza Carlos Anwandter	4,877
Bahía Lomas	59,946

Disturbances and Threats to Wetland Ecosystems

The relationship between wetland ecosystems and people is close as much of the population is located on the coastline or the banks and mouths of rivers or estuaries from which natural resources are extracted, e.g., seafood, fish, and even salt. Wetlands are used as navigation routes and as tourist attractions. The same pattern is repeated for wetlands in the interior of the country, concentrating on the edges of rivers, estuaries, lakes, or ponds. Along with the increase in population and human activities is however alterations in the ecological integrity of wetlands with changes affecting water quality and the loss of wetlands and their biodiversity. Habitats are modified along with the landscape, thereby changing riparian and terrestrial vegetation types. Space is opened for exotic species, and habitats for fish species are lost or become isolated.

Moreover, the increased and growing demand for water extracted from aquifers and natural waterways exceeds recharge. Wetlands are also being affected by other factors including the removal of native forest, soil drainage, construction of coastal roads, or changes to the dynamics of the terminal bar connecting coastal lagoons and estuaries to the sea. Coupled with changes in rainfall patterns and retreating glaciers feeding streams and lakes in much of the Chilean territory, a complex scenario is established for the maintenance of fragile ecosystems.

The systematic fragmentation of bodies of water, rivers, and estuaries to consolidate city real estate development extends into rural areas and develops a landscape where wetlands are surrounded by people. However, in planning urban spaces the inclusion of wetlands and the goods and services they provide is not considered as a contribution to human welfare. For example, in the city of Concepcion, regional capital of the region of Biobío, the expansion and development of real estate projects has “made” more ponds. These become wetlands embedded in an urban matrix. Their viability is however not assured, because the fragmentation modifies the natural waterways and the hydrographic network (MMA 2010a). Heavy rains maintain the wetlands, but their environmental condition deteriorates.

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