

Information Sheet on Ramsar Wetlands

1. **Date this sheet was completed/updated:** 29 November 1996

2. **Country:** CHILE

3. **Name of wetland:** Soncor Basin

4. **Geographical coordinates:**

23°15' - 23°22'

68°07' - 68°11'

5. **Altitude:** 2,300 metres above sea level

6. **Area:** 5,016 hectares

7. **Overview:**

The Soncor basin is formed by four shallow lakes, no more than 1.5 metres deep, interconnected on the surface and underground and with very productive surface activity. The lakes lie on a layer of crust formed by the constant accumulation of chloride and sulphur crystals produced by a high rate of evaporation in the salt lake. The lakes are hosts to micro fauna and microalgae, a source of food for important species of migratory birdlife such as three species of flamingos, *chorlos* and *playeros*.

8. **Wetland type:**

Permanent saline lakes

9. **Ramsar criteria:**

10. **Map of site included? Please tick yes -or- no**

11. **Name and address of the compiler of this form:**

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12. **Justification of the criteria selected under point 9, on previous page:**

13. **General location:**

Region II of Antofagasta, Province of El Loa, 161 km from Calama and 61 km from San Pedro de Atacama

14. **Physical features:**

Geology and Geomorphology:

The Salar de Atacama consists basically of a large evaporation pan or crust, which can be divided in accordance with its physical and chemical aspects and mineral composition. The crust can vary from several centimetres to approximately 60 metres in depth. There are three types of crust in this sector: a) crusts of chlorides with an intensely broken hard cover, b) sulphate crusts formed primarily of chalk, producing smooth and dry surfaces, and c) crusts of chlorides and sulphates formed by chlorides (halite) and chalk, in which the chalk is powdery.

The most noticeable geomorphological characteristic is the closed tectonic basin, formed by large normal faults and differential movements of blocks in a north-south direction. The salt pan is at an elevation of 2,300 metres above sea level.

It is defined as a dynamic geomorphological unit, subject to climatic variations, evaporation, precipitation, surface runoff, variations in the level of underground water, subsidence and eolian deposition. These factors define a complex model that could be defined as a dynamic saline deposit formed by a clear zonation of detritus and saline layers.

15. **Hydrological values:**

The Salar de Atacama basin has a surface of approximately 156,200 hectares. The hydrological network is formed by a drainage system, which joins a series of small shallow saline lakes creating an area of influence of approximately 5,016 hectares. The Río Burro Muerto, which begins in springs in the middle of the saltpan, supplies water to the lakes of Barros Negros and Chaxas. There are also other lacustrine systems disconnected on the surface from this network, among which is Lake Puilar.

The area of the lakes are: Barros Negros (103 hectares), Burro Muerto (1 hectare), Chaxas (37 hectares) and Puilar (84 hectares). Including smaller ponds, the total area of the lakes is approximately 280 hectares and the depth of the water does not pass 70 centimetres.

The sediment in Barros Negros, Chaxas and the joining channel is black. In Lake Puilar there are sediments ranging in colour from light coffee to pink.

Barros Negros and Chaxas are lakes with well-defined edges, formed by white to clear coffee-coloured crusts, 30 to 40 cm high. Lake Puilar is composed of winding and broken shallow surfaces with crusts around the edges no higher than 30 cm.

According to CORFO (1977), two aquifers have been identified, one free, separated from another confined by an ignimbrite or clay layer. It is replenished in the eastern sector of the Central Cordillera of the Andes and empties primarily onto the eastern edge of the saltpan. It is quite possible that this is also the source of water for the above-mentioned lakes.

Limnology:

Physical and chemical parameters: There are few general descriptions or interpretations of the chemical characteristics of the lakes in the Salar de Atacama. Of relevance are the work of Chong (1970) "Depósitos Salinos en el Norte de Chile y El Salar de Atacama" and some data and research carried out under the project for the conservation of flamingos in northern Chile, which described in general terms the habitat of these species.

The Soncor Basin is classified by Chong as an area in saline efflorescences and crusts forming a band between detritus (alluvial sediments partially cemented with salts on the eastern edges of the saltpan) and a central saline body. This transition zone is composed primarily of halite, with a large band of chalk, anhydride and sodium chloride on the eastern edge, while the western part, the core of the saltpan, is characterized by the presence of ions of Ca^{+2} , Mg^{+2} , Na^{+} K^{+} , Li^{+} , HCO_3^{-} , SO_4^{-2} , Cl^{-} , NO_3^{-} and boron (Parada, 1990).

Parada found high levels of salinity (total solids, 142.23 mg/l) in lake Barros Negros, the most southern of the lakes in the Soncor area. In this lake, there are high levels of sodium and chlorides of 43.32 and 69.84 mg/l respectively, with a neutral pH.

This study carried out chemical and physical analyses of three lakes in the Soncor system, which in general coincide with those observed in the studies mentioned. The following figure shows this situation.

Parameters	Puilar	
	Chaxas	Barros
<u>Negros</u>		
pH		8.03
7.95	7.93	
salinity (ppm)		18
180	180	
total solids (ppm)		96
>190	>190	
NO ₂ (µg-at/l)		0.1
0.1	0.19	
NO ₃ (µg-at/l)		0.1
0.51	0.81	
PO ₄ (µg-at/l)		18.5
30.2	32.8	
O ₂ (ml/l)		6.6
4.14	4.56	

Figure 0 Physical and chemical parameters in the Soncor area

Taking into account that the Soncor system has a constant north-south surface flow, which begins in the tributaries originating in the northeastern side of Lake Puilar and Burro Muerto and continues through lakes Chaxas and Barros Negros, it's possible to identify trends in the concentrations of all of the measured parameters. The positive gradient towards the more southern lakes in the system seen in the parameters of conductivity, nitrites and nitrates is attributable to the interaction of several factors among which are the dilution caused by the presence of the tributaries in the northern part of the system (Lake Puilar) and the permanent dissolution downstream of salts present on the edges of the aquifer. This condition would lead to a greater concentration of salts and nutrients farther from the main tributaries of the system in the northern sector.

This interpretation of the dynamics for the system is probably accentuated by the likely underground communication between Lake Puilar and the Burro Muerto-Chaxas-Barros Negros system.

Chong pointed out that the underground deposits are usually saturated with brine so that, if there is a connection at this level between Lake Puilar and Lake Chaxas, there would no doubt be a factor that would explain the greater concentration of solids and dissolved nutrients in the southern most aquifers.

There is no way to compare similar environments except for the data available for the Salar de Surire in Region I. In this respect, the values found in the Soncor system are in general similar, calling attention to the higher levels of salinity and total solids found in the Barros Negros and Chaxas lakes. This is probably due to the conditions favourable to higher levels of salinity during the day caused by temperatures higher than 40°C (measurements taken in this project).

The pH for the system remains practically homogenous for the three lakes sampled, with high levels of alkalies. This condition is similar to the measurements of Chong and Parada.

The Soncor basin is composed of three interconnected lakes (from north to south: Burro Muerto, Chaxas and Barros Negros), joined by a canal. There is also a more independent lake, probably connected permanently with the other system. During the winter, this condition becomes evident northeast of Lake Chaxas.

It is possible that these lakes are maintained through the continual recharging of underground water from the east that brings water to the saltpan. The total area of these lakes is approximately 3 square kilometres and is no deeper than 1.5 metres.

The following physical and chemical parameters were recorded in September 1995

Sample (mg/l)	Lakes	
	Chaxas	Barros Negros
pH	7.93	7.95
Chlorate	42.117	48.559
Sulphate	7.314	9.259
Sodium	23.457	26.574
Dissolved solids	90.826	110.224

The water in this system can be classified as chlorate-sodium, based on the anion and cation of largest value. This water has an ionic structure of large homogeneity in terms of space and time, with concentrations varying proportionally to salinity. This is greatest in the lakes farthest from the sources of underground water. The pH is alkaline, remaining homogeneous in time and space (CONAF Region II, 1996).

16. Ecological features:

There are three types of habitat in the wetland: shallow lakes of high salinity (over 10,000 total dissolved solids) hosts to Bacillariophyceae microalgae and micro invertebrates such as artemias, copepods, ostracods and quironomide larvae. These form the diet of the three species of flamingos that live in the saltpan (*Phoenicopterus andinus*, *P. chilensis*, *P. jamesi*), *caitías* (*Recurvirostra andina*), *chorlos* (*Charadrius alticola*) and *playeros de baird* (*Calidris bairdii*). Also frequent in this habitat are *patos juarjuales* (*Lophonetta specularoides*) and the Andean gull (*Larus serranus*). Another identifiable habitat corresponds to the shore or intralake area in which are frequently observed processes of decomposition of dissolved organic material in the mud. This area is the preferred area for quironomide larvae, ephemerid flies and gastropods of the genus *Littoridina*. Two species of reptiles in the genus *Liolaemus* feed on these species. Another habitat corresponds to the areas of polygonal cracking that forms on the so-called saline shores, 30 to 50 cm in height. This habitat is not occupied by plant species, being occasionally visited by

chorlos that use the natural cracks as refuge and on the edges of these formations by reptiles for the same purpose.

17. Noteworthy flora:

Classification of vegetation

In general, according to a study entitled "Sistema básico de clasificación de la vegetación nativa chilena" (Gajardo et al., 1983), the area of the pre-puna is located in the ecological province of desert, subregion of Andean desert, represented by the vegetative formation of Salar de Atacama desert.

This vegetative formation covers a large part of the Salar de Atacama and surrounding area and forms a homogenous landscape. There are large areas free of vegetation, especially at the centre of the saltpan, but along the eastern border and towards the south, there are developed steppe communities (Gajardo, 1983).

There are four vegetative associations in the Salar de Atacama Desert (Gajardo, 1983):

Acantholippia punensis - *Franseria meyeniana*
Atriplex atacamensis - *Acantholippia trifida*
Atriplex atacamensis - *Pluchea absinthioides*
Prosopis chilensis - *Geoffroea decorticans*

In the salt marshes of the Salar de Atacama, the association *Atriplex atacamensis* - *Pluchea absinthioides* dominates, with accompanying species *Distichlis spicata* and *Baccharis juncea*.

Vegetation in the reserve

Within the environmental parameters that determine the distribution of species in the Andean wetlands are the salinity characteristic directly related to variations of flora. This means that the greater the percentage of saline deposits, less is the development of vegetation and species diversity. There is also a high correlation between some species that are characteristic of high concentrations of salinity (Faúndez, 1993).

In the formations in the vegas and riparian vegetation of the salt marshes, the distribution of species is strongly influenced by the characteristics of soil moisture and the presence of surface runoff, with characteristic variations depending on the degree of flooding of the soils and distance from surface water.

The vegetation associated with the Soncor wetland is distributed primarily on the eastern side of the lakes, in the eastern part of Salar de Atacama, because flora is almost inexistent around the lakes located toward the centre of the Salar de Atacama (Chaxas - Barros Negros), areas of saturated, flooded and salt deposits in the form of crusts.

Because of this, vegetation is concentrated on the eastern side of the Puillar system of lakes, the part of the Soncor wetland in which it is clearly proven the difference in the dominance and abundance of species, to the degree that the percentage of saturation decreases and distance from the sources of water increases. In this environment, the herbaceous species *Distichlis spicata* (salt grass) grows in isolated areas in a variable-width band beginning approximately 200 metres from the edge of the system of lakes. There are relatively pure patches of this species reaching a cover of approximately 30 to 50 per cent.

Farther away from the area of influence of the lakes, toward the zone on the eastern edge of the Salar de Atacama, there are almost pure communities of the low woody species *brea* (*Pluchea absintioides*) reaching a cover that can exceed 60 per cent. In these areas, *Distichlis spicata* can also be found. In the areas farthest from the water, the low woody species *cachiyuyo* (*Atriplex atacamensis*) grows in the form of bushes up to approximately 1.7 metres high and with crowns of approximately 1.5 metres in diameter. There is also the species *Pluchea absintioides* and *Distichlis spicata*.

The most important other species that can be found in less abundant quantities are: *Nitrophila atacamensis*, *Scirpus acaulis* Phil., *Festuca hypsophylla* Phil., *Juncus balticus* (unco).

According to the study carried out by the University of Chile (Castro et al., 1993) "Identificación y Ubicación de Vegas y Bofedales de las Regiones Primera y Segunda", there are 14 vegas on the edges of the Salar de Atacama, of which only the vega de Carvajal (2 hectares) is located in the area of influence of the Soncor system at a distance of approximately 3 kilometres from the lacustrine systems of the wetland.

Of the species mentioned, none are classified as endangered species from the point of view of conservation status.

Microalgae

The composition of the phytobenthon of the sample obtained from Puillar, Chaxas and Barros Negros in the Soncor system was a total of 16 species. Thirteen of these correspond to microalgae of the Bacillariophyceae family and 3 to the Cyanophyta. There

are similar numbers of species in the three lakes, with Lake Chaxas having 11 species. In general, the samples in the lakes of the system had similar indices of diversity, with the greatest diversity (0.7649) in Lake Chaxas. The greatest abundance was in the sample from Barros Negros which reached 9,199,666 cells per litre. When considering these parameters, the spacial limitations of these samples, which were primarily qualitative, should be taken into account. The species of greatest representativity in the Soncor samples, concerning abundance and presence, were *Navicula* sp.1 and *Surirella ovata* which were common to the three lakes and showed relative abundances between 2,166,666 and 4,466,666 cells per litre.

Given the interconnection between the lakes, it was expected to find a high similarities of phytobethon of the samples. From the point of view of biocenosis, they appear poorly related with similarities that do not exceed 55 per cent. This condition can be attributed to the limitations of the sample, which as mentioned earlier is primarily qualitative. The sample from Lake Puilar with respect to the other lakes in the study appears more distant in the degree of similitude, a fact which can be explained by the differences detected in the chemical characteristics mentioned earlier. This could be because of the existence in Puilar of atypical physical and chemical conditions with respect to the more southern and internal lakes in the Salar de Atacama.

18. Noteworthy fauna:

Following the survey of hydrological and vegetational resources, it was found that two clearly differentiable environments exist in the Soncor wetlands. There is one within the Salar de Atacama, extremely arid and very poor in fauna and flora and limited to saline lakes. The other, less arid, is along the eastern edges and has a rich band of vegetation and permanent sources of underground water with very special habitat.

There is a constant exchange of fauna between the two areas, especially of predators that frequently visit the lakes to feed on young birds and eggs. There are 20 species whose presence is recorded. Of these, only 15 per cent correspond to mammals, and the other 85 per cent correspond to birdlife. At least 5 of these species (1 mammal and 4 birds) have been observed to reproduce in this area or on the edges of the area.

The following table lists the species found in the *Libro Rojo de Vertebrados Terrestres de Chile* (Glade, 1993).

Species of fauna found in the Salar de Tara included in conservation categories

<u>Conservation status</u>	<u>Species</u>
In danger of extinction	<i>Pterocnemia pennata tarpacensis</i>
Vulnerable	<i>Larus serranus</i> <i>Phoenicopterus andinus</i> <i>Phoenicopterus chilensis</i> <i>Phoenicopterus jamesi</i>
Rare	-
Poorly known	<i>Pseudalopex culpaeus</i> <i>Pseudalopex griseus</i>

Mammals of interest

Andean wolf (*Pseudalopex culpaeus*): Its permanent habitat is along the edges of the salt marsh near the sources of freshwater and the strip of vegetation where it probably builds its dens. It visits areas in the wetland to feed on eggs and the young of birds that nest in the saline lakes. There are no estimates of the populations of this species. There appears to be some seasonality in the frequency of sightings and an increase in the presence of *P. culpaeus* toward the summer, the period for nesting by flamingos in the wetland.

Chululo (*Ctenomys fulvus*): It digs galleries in areas dominated by *Festuca* and *Parastrephia*, preferring to eat roots and young vegetation in the transitional area between the vegetational strip and the interior of the saltpan. There are no estimates of this species's population.

Birds of interest

There are three species of flamingos whose habitat is exclusively the saline lakes of wetlands. They feed on microalgae and microinvertebrates in the saline lakes, present primarily in the sedimentary strata of the water. In this strata, highly muddy with abundant organic material and of quite special physical and chemical characteristics, permitting the development of species with a high tolerance for saline conditions and thermic variation.

The flamingos in the Soncor wetlands have a clearly seasonal behaviour as the result of their migratory behaviour mentioned earlier. The numbers of flamingos in Soncor vary between a

minimum of 597 individuals in the month of January 1995 and a maximum of 2731 specimens in September 1995. This variation is related to the optimal conditions that the wetland acquires for the development of reproduction. The largest numbers (September 1994 and September 1995) occurs when pairs of mating birds begin to form, increasing in intensity and numbers involved toward spring and summer. Nonetheless, a survey of species and water surfaces revealed differences from the above generalizations.

The populations of Chilean flamingo in the wetland fluctuate between a general minimum of 105 specimens in the month of January 1995 (data that does not take into account Lake Chaxas) and a average maximum of 830 individuals in May 1995. This species represents an average percentage of 29.38 per cent of the total flamingo population in Soncor for the survey period analyzed.

An analysis of surveys made between September 1994 and September 1995 show that the population of this species increases towards the spring. This can be attributed to the dynamics of migrations in search of conditions propitious for reproduction. Toward the summer, as a result of these same conditions, the numbers of flamingos participating in reproductive activities increase or remain with small variations in the salt flat.

Nonetheless, the figure shows a drop to a minimum during the month of January 1995. It is quite probable that the Chilean flamingo did not find the right conditions for reproduction in the Salar de Atacama and moved on to the area of the Antofagasta puna or other areas such as the Salar de Huasco in Region I. In fact, in that saltpan during the 1994-1995 reproductive period, there was a large population that produced 1,500 chicks of the Chilean flamingo.

This dynamics is the basis for the importance of these wetland on the pre-puna and puna for the reproductive processes of the Chilean flamingo, because this species evaluates the conditions in the wetlands in the Andes in order to choose the best conditions for reproduction.

The population levels of the Andean flamingo varied from a minimum of 207 specimens in May 1995 to a maximum of 1547 specimens in September 1995 (see figure 2 in annex II). It represents an average of 46.15 per cent of the total population and the species with the greatest population during the survey period. The Chaxas and Puilar lakes are of great importance for the Andean flamingo, because the numbers surveyed represent 85 per cent of the total population of this species.

The population of the Andean flamingo, as is the case of the Chilean flamingo, fluctuates according to the dynamics of

migration related to reproduction, with the same drop in population during the month of January. There is no data available, however, to indicate a general movement of the Andean flamingo to habitat on the puna, because no data is available for this area, and during this year there were heavy summer rains. Taking into account the population levels during this year and reproductive activities (the forming of couples) in Barros Negros and Puilar lakes, it is expected that reproduction will be successful in the wetland during 1995-1996.

The population of James's flamingo from September 1994 to September 1995 fluctuated between a minimum of zero specimens in January 1995 (without taking into account Lake Chaxas) and a maximum of 814 specimens in September 1995. This species represents an average of 16 per cent of the total flamingo population in the Soncor Basin for this period. The populations of James's flamingos react to the availability of food in the Soncor wetlands. This species reaches large numbers in Lake Chaxas and Barros Negros (they represent an average of 44 per cent of the total flamingo population), in the winter months, a period during which the lakes on the puna where it usually lives are frozen. As a result, the lowest levels of population are in the summer, when conditions on the puna are more favourable. The presence of this species adds to the importance of the Soncor wetland because it is the wintering area for this species.

The species *Recurvirostra andina (caiti)* which reproduces in the lakes Chaxas and Puilar and the migratory species of *chorlo de la puna* and *playero de Baird* are almost always present in the salt marsh, with an increase in population during the summer.

Micro invertebrates

Surveys of benthic zooplankton in the Barros Negros and Chaxas lakes reveal 8 species, one in the phylum of protozoa, one nematode, 4 crustaceans and 2 insects. The survey found homogeneous levels with regard to the number of species found: Barros Negros Lake with 4 species and Chaxas and Puilar lakes with 3 species. In terms of total populations, Barros Negros and Puilar lakes have populations of more than 0.4 individuals per litre of larvae of the micro invertebrates *Diphera* and *Dyacyclops* spp.

Protozoa are excluded from the previous analysis (with concentration of more than 33,000 specimens per litre) because it is impossible to make comparisons between microscopic specimens with species of copepods and larvae that are much larger. The samples taken in the wetland give a low population and a low number of species. As a result of the dynamics of the saline environments, the numerical populations of the benthic

zooplankton is quite variable and directly correlated with environmental conditions determined by physical and chemical factors.

19. Social and cultural values:

There are no reports of important archaeological sites in this area. The fauna is possibly used by the rural communities in Quebrada Camar and Soncor, about 15 kilometres from the wetland.

The communities around the Salar de Atacama have traditionally gathered flamingo eggs around Barros Negros and Puilar. This activity has almost completely disappeared as the result of the conservation activities begun under the project "Conservation of Flamingos in Northern Chile" carried out by CONAF Region II. Nonetheless, the increase in visitors to the reserve, now more than 10,000 visitors per year, is a source of concern, although visitors are regulated by park wardens of the Los Flamingos National Reserve.

20. Land tenure/ownership of:

At the study site, the land belongs to the government. In the surrounding area, to the north and east the land also belongs to the government (with mining concessions to SOQUIMICH); to the south and the west the land is also owned by the government (with mining concessions to CORFO).

21. Current land use:

Grazing

In addition to the high vegas such as Aguas Calientes, Altar and Quepiaco, the settlement of Toconao uses a series of low vegas that are located in the same Salar de Atacama. The most important vegas are: De Carvajal, Honar, Olar, Potor, Tambillo, Terar and Vilaco. These vegas are used seasonally in the summer by the local inhabitants in Toconao, except Tambillo which is used year round.

The community of Talabre is apparently most closely linked to the vegas as grazing sites, because it has the largest number of llamas (*Lama* spp.) which in 1994 reached 737 animals (SAG, 1994). They also use the low vegas of Tambillo and de Carvajal in the Salar de Atacama.

The species of vegetation most frequently grazed by livestock are *campaya*, *chasquiar*, *chichicón*, *florequilla*, *grama*, *navia*, *ojalar*, *oreja de ratón*, *paja*, *paja blanca*, *paja blanda*, *pasto*

pako, pasto de campo, pasto de semilla, pasto pako, perfilla and unquillo.

The communities of Peine and San Pedro de Atacama do not use wetlands covered under this study. Nonetheless, as reference, the community of Peine has access to the vegas of Agua Delgada, Kapur, Palao, Pular, Puruchare, Silolao, Tarajne, Tilocalar, Tilomonte, Tilopozo and Tulán; while the community of San Pedro uses the vegas of Cejas, Oyape, Purificar and Tebinquiche, all in the Salar de Atacama.

Gathering of plants

Information available on this subject is sparse and covers species of vega and stream vegetation used by the local inhabitants.

<u>Settlement</u>	<u>Species used</u>	<u>Purposes</u>
Camar	<i>Brea</i> and <i>cachiyuyo</i>	Roofing
Peine	<i>Rica-rica</i>	Medication
S.P. de Atacama	<i>Brea</i> and <i>unquillo</i>	Fodder, roofing
Socaire	<i>Paja brava</i>	Roofing, medication
Talabre construction	<i>Catarate, paja</i> and <i>paja grande</i>	Casual
Toconao fuel,	<i>Brea, cachiyuyo, paja</i> and <i>unquillo</i>	Fodder, roofing

The table identifies four types of use for wild plants: fodder, fuel, construction (roofing) and medication. Local inhabitants do not feel that the use of plants has negative effects on the vega. Nonetheless, it should be pointed out that the use of *cachiyuyo* has been greater than its capacity for regeneration. This has led to a considerable decrease in population, especially in the glacial sediments east of the Salar de Atacama.

Extraction of water

In light of the importance of this topic for the development and survival of man and the wetlands, as well as for all of the wildlife in these dry geographic landscapes, it is important to point out that local communities usually have good knowledge of the conditions of good water use, especially those for

agriculture, livestock raising and human consumption; as well as the water used by the companies working in the area.

The following figure gives the use of water in the communities in the Atacama region.

<u>Community Use</u>	<u>Wetland</u>	<u>User</u>
Toconao	Vega Vilaco	
Irrigation	Community	
Human use	Vega Silapeti	Community
Irrigation	Aguas Blancas	Community
Irrigation	Vega Honar	Community
Mining	Salar de Atacama	
	Litio and MINSAL	
Camar use	Nacimiento de Camar	Human
and mining		
Road Contractors	Lagunas del Salar	maintenance
Talabre	Vega Tumbre	
Human use	Community	
Irrigation	Saltar	
Irrigation	Community	
Socaire use	Nacimiento	Human
	Community	
Irrigation	Chorrillo	Community
Irrigation	Quepe	Community
Mining	Salar de Atacama	
	MINSAL and Litio	
Peine	Nacimiento	Irrigation
Community		
Human use		Community
Mining	Vega Tarajne	Litio
San Pedro de Atacama	San Pedro	
Irrigation	Community	
Human		consumption
Community		
	Vilama	
Agriculture	Community	
	Pozo 3 and 5	
Agriculture	Community	
Recreation	Visitors	

Local communities are usually aware of several adverse factors in the *vegas*, either those used by the community or those used by private companies, namely, manifestations of drying that is occurring in these wetlands as the result of a lack of precipitation and in some case the shifting of underground water as the result of earthquakes. Perhaps the only case of a negative impact caused by a mining company is in the *Quepe vega*, used by the *Peine* community, although outside of the study area, because the *Sociedad Chilena del Litio* is extracting water for industrial processing. It is quite certain that water management plays an important role in the conservation of wetlands, whether those used by local communities for grazing or those used for their own needs as well as those of the mining companies and municipal water services.

Mining

The extraction of metallic and non-metallic minerals is having an important impact on the aquatic habitat and wildlife of the areas near the mineral deposits, a situation well perceived by the *Atacama* community.

<u>Community</u>	<u>Wetland</u>
<u>User</u>	<u>Effects</u>
Camar	S.P. de Atacama Litio
--	Vega Poqui
Toconao	
Litio	Loss of natural status
wildlife	Disturbance of
	Noise
	Degradation of the environment
Talabre	--
--	--
Socaire	S.P. de Atacama
Litio	General loss of fauna
	and flora
	Laco
--	--
Peine	Salar de Atacama
Litio	--
S.P. de Atacama	Salar de
Atacama Litio	
Azufrera	

Capture of wildlife

The hunting of wild animals was a common practice of the pre-Hispanic population living in the Andes. This situation continued after the arrival of the Spanish, although the conquerors established a European economic model oriented to the extraction of minerals, which led to the breakdown of the existing social structure, traditional rural activities and the use of dispersed natural resources at various levels of the Andean ecology.

More recently, the hunting of wildlife has persisted, reaching a high point between 1930 and 1950, then gradually declining to the present situation where it is now marginal in the local communities. This is not the case of hunting by external communities, which continue to hunt wild animals ruthlessly.

The following results were obtained from this study and indicate the most frequent species hunted by area, parts and derivatives and season of capture.

<u>Species</u>	<u>Area hunted</u>	<u>Parts</u>	<u>and</u>
<u>derivatives</u>	<u>Period</u>		
Vicuna	1,2,3,5,6	Hair,	fur,
meat	Spring and summer		
Guanaco	1,5,6	Fur,	meat
	Spring and summer		
Fox	1,2,4,5	Fur	
	Year round		
Viscacha	1,2,3,4,5,6	Meat	Spring and summer
Mountain lion	1,2	Fur	Sporadically
Chinchilla	5,6	Fur, meat	Spring and summer
Chululo	2,5	Meat	Spring and summer
Ducks	1,2	Meat	Spring
Condor	1,4	Feathers	Sporadically
Flamingo	1,2,5,6	Feathers	Year round
Ñandu	2	Feathers, meat	Spring and summer
Puna quail	2	Meat	Spring and summer

1) Toconao, 2) Camar, 3) Talabre, 4) Socaire, 5) Peine, 6) S.P. de Atacama

While hunting concerns twelve species, there are conservation problems for at least nine of these (75 per cent). Of special concern are aquatic birdlife and three species of flamingos, which reproduce in the Antofagasta Andean salt flats and later migrate to more benign sites in the Peruvian and Argentine Andes during the fall.

Local inhabitants consider the cause of the decrease in the flamingo populations to be the result of mining activities carried out in the Salar de Atacama, which produces noise and the circulation of heavy trucks and vehicles near the reproduction and feeding sites, as well as the disturbances caused by the increased presence of humans and tourist activities.

It is interesting to note that the community of Peine states that the population of flamingos was much greater in the sixties and seventies. At night, during the spring, it used to be possible to hear hundreds of flamingos, which descended from the mountains to live and nest in places near this town.

Gathering of eggs

The communities admit having collected eggs of at least seven species of birds, which were used for local consumption, except flamingo eggs which were usually sold locally in Calama and S.P. de Atacama. The Salar de Atacama (Barros Negros, Salada, Saladita and Interna) and Tara, are the most important centres for gathering flamingo eggs. At Miscanti and Miñiques lakes, eggs of the *tagua* are gathered and, to a lesser extent, those of ducks and the Andean gull. This information is represented in the following table.

<u>Species</u>	<u>Salar or lake</u>	<u>Town</u>
Flamingo	Salar de Tara	1,2,3,4,6
	Lake Barros Negros	1,2,4,6
	Laguna Salada	5
Tagua cornuda	Lakes Miscanti and Miñiques	3,4
Gull	Lake Miscanti	6
Noonday	Lake Miscanti	2,5
Ducks	Lake Miscanti	2,3,4,6

Lakes in the extreme
southern part of Salar de Atacama

Local inhabitants report that the gathering of wild bird eggs no longer takes place, because of the decrease in bird populations and because of regulations prohibiting this practice. Nevertheless, on the basis of the information provided, this practice was important in the Atacama communities at least until the mid-1980s when the creation of protected wildlife areas and the conservation of wildlife began.

Tourism

Tourism was of little importance and without change until the 1970s when a rapid and steady increase in this activity took place and has remained until the present. The Servicio de Turismo estimates that more than 30,000 persons visited S.P. de Atacama last year, where there are 330 beds in hotels, guest houses and camp grounds, 12 restaurants and 14 tour operators.

The following table indicates the sites visited by tourists, benefits to the local community and the effects of tourism on the wetlands.

<u>Wetlands</u>	<u>Town</u>	<u>Benefits</u>	<u>Negative effects</u>
S.P. de Atacama (Burro Muerto)	1,2,5,6	handicraft services sale of fruit	Disturbance of wildlife Vehicular traffic Creation of garbage
Miscanti and Miñiques	6	handicrafts	Disturbance of wildlife
Salar de Tara	3,4,6	handicrafts	Creation of garbage
Laguna Lejia	4,6	handicrafts	Disturbance of wildlife
Salar Aguas Calientes	5,6	handicrafts	Disturbance of wildlife

In general, local communities consider the benefits of tourism to be very marginal, and few participate in offering services such as accommodation, food and transportation. Their participation is limited to the sale of handicrafts and fruit.

Currently, the most visited salt flats are the Salar de Atacama (Laguna Burro Muerto), the Miscanti and Miñiques lakes, Lejia and the Salar de Tara. Other wetlands visited outside of the range of this study are the Salar de Aguas Calientes II, the vegas of Del Tatio, Jauna, Putana, Tambillo and the El Tatio geyser.

22. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land use and development projects:

Pressure on the use of water resources

Little water is available in the region around Antofagasta and the water that exists varies considerably in magnitude and distribution. Total rainfall and the seasonality of rainfall are extremely variable, leading to conditions of vulnerability and fragility for the environment (University of Chile, 1994).

Over the past few years, in addition to natural common fluctuations in climate, there has been the threat of permanent climate change with uncertain effects on this area. The climate can have seasonal variations and intense dryness that affects these environments. As a result, this affects the conditions of life and the activities of local inhabitants (University of Chile, 1994).

Patterns of rainfall will change to an unknown degree. Based on available information, it is very likely that global warming will intensify dryness instead of attenuating it. Surface runoff and replenishment of underground water will be reduced, leaving less water available for nature and local communities in large areas (University of Chile, 1994).

One of the threatening factors that could cause a major impact on these wetlands is the use of surface or underground water resources. Use has increased in the past ten years. This aspect is of great importance because part of the water resources being used or that is authorized is fossil water.

Most of the demand for water comes from the mining companies that are extracting non-metallic minerals in the saltpans or from the water company for Antofagasta (Empresa Sanitaria de Antofagasta). This affects the Los Flamencos reserve as indicated in the following figure.

Mining activities

Mining activities during the past few years in the pre-puna and puna zones have intensified, with a significant increase in prospecting and extraction for non-metallic and metallic minerals. The following large-scale operations are currently in operation (from north to south).

Among these companies, Mineras Minsal and Sociedad Chilena del Litio are operating in the area near the wetlands chosen for the reserve of Salar de Atacama. Minera Escondida operates in areas near the Salar de Punta Negra and also uses underground water from wells located on the eastern edge of the salt pan in its productive process.

According to information available from public services, it is expected that mining activities will increase in this area in the near future, either because of increases in production levels of the mining companies or because new companies will begin activities. There are several projects for which feasibility studies have been made: Project Lomas Bayas, El Abra, Project Litio-MINSAL are the most important. Another reason why there will probably be an increase in mining activity in the area is the existence of mining claims, especially in Salar de Pujsa. Several companies, including Hunt Oil and the Empresa Nacional de Petroleo, have carried out oil prospecting projects in large parts of the pre-puna and puna area, especially in the Salar

Year	Affected wetland	User
Quantity	Type	(l/s)
1990	Salar de Pujsa	use
	Octavio Brickle H.	
	200	
1991	Soncor	
	Roberto Muñoz	
Communes	exploration	Mining company
	Aguas de Quelana	
	MINSAL	
Calama	exploration	El Abra
1993	Aguas de Quelana	
	Roberto Muñoz	Co delco-
	Chuquibambilla	copper
	Soncor/Quelana	
S.P. María	exploration	Pacana
Chilena	exploration	Sociedad
	Aguas de Quelana	
	MINSAL	
Antofagasta	exploration	Escondida
	Soncor	copper
	S.Q.M.	Zaldivar
	exploration	copper
	Soncor	Autokumpo
	S.Q.M.	copper
	exploration	300
Figure 0	Aguas de Quelana	Mining companies
operating in the	Patricia Muñoz	
	exploration	300
1995	Pujsa	Jorge
Schellman	use	500
	Pujsa	Jorge
Schellman	exploration	600

Figure 0 Requests for water that affect the Los Flamencos reserve de Atacama.

Among the mining activities creating a negative impact on natural resources, the most important is the use of surface or underground water in productive processes. Next in order of importance are the construction of roads for prospecting and production activities that create a direct impact on the soil and changes in the landscape as the result of trash in the surrounding area.

Unregulated tourist activities

The area of the pre-puna and puna offer a variety of attractions of interest to tourists, among which are cultural and archaeological resources, typical fauna and flora and a unique scenery of large volcanoes and high-altitude lakes.

This potential for the development of tourism is exploited by private agencies transporting tourists from the towns of Calama and San Pedro de Atacama to the areas of greatest cultural and natural beauty.

The following table describes the most common tourist itineraries and the wetlands currently visited by the greatest number of tourists.

<u>Itinerary</u>	<u>Wetlands</u>	<u>Total visitors</u>
Salar de Atacama	Soncor	10,000*
Valle de la Luna- Aldea Tulor	-	20,000
Salar de Pujsa- Salar de Tara	Pujsa and Tara	4,000
Miscanti-Miñiques	Miscanti and Miñiques	3,000

*Estimated number of visitors for 1994 (CONAF, Region II)

Minibuses and trucks with a capacity for 6 to 12 persons are usually used for these itineraries without a trained guide. Most of the tourist agencies are located in San Pedro de Atacama; approximately 18 agencies during the tourist season and 10 to 12 permanent agencies.

There is currently no plan for developing tourism for this region that takes into account legal requirements and that lays out regulations for making tourist activities compatible with the conservation of natural resources.

A negative impact on the wetland's natural resources is caused primarily by the creation of garbage, circulation of persons in highly fragile areas (for example in vegas), the gathering of wild flora and changes in the habits and reproduction of wildlife.

The influence of the proximity of persons on the behaviour of wildlife is of special importance in the context of protecting populations of migratory birds of international importance. It

is certain that in the case of flamingos living in the Andean wetlands, the phases of the reproductive cycle namely, courtship, mating, incubation and care for chicks, can be considerably changed by the presence of humans. An interruption of any of these phases can produce irreversible changes in reproductive colonies and a significant decrease in the rate of incorporation of chicks in the adult population.

According to systematic field studies (CONAF, Region II), it is possible to ensure that there are changes in the behaviour of flamingos during reproduction in the presence of persons at distances of approximately 1.5 kilometres, becoming critical at distances of 500 metres. When human presence is permanent or frequent, the probability of abandoning nesting colonies at all stages is significantly higher. More direct activities such as the hunting of adult specimens, circulation among active nests or the gathering of eggs usually produce an immediate interruption of the reproductive phases and the abandoning of resting and nesting sites.

There are sites of confirmed flamingo mating activities that are variants of the present tourist itineraries. These important biological sites are the Soncor wetlands, Laguna Burro Muerto, Laguna Puilar and, to a lesser extent, the Tara wetlands.

Construction of roads

This activity merits mention because of the considerable adverse effects on the environment in this area. Roads are constructed for various reasons, primarily because of activities related to mining and civil engineering constructions for development.

In the case of the Salar de Atacama, there are secondary roads built by the mining companies for prospecting (Empresa Petrolera Northpax) and extraction (Minera MINSAL and Sociedad Chilena de Litio) through which they have easy access to all parts of the Soncor basin and the Aguas de Quelana wetlands.

The main negative impacts on the wetlands caused by the construction of roads are the following:

Increase in the movement of persons affecting the behaviour of wildlife

Creation of access for predators such as the wolf which feed on flamingo eggs and chicks, interrupting reproduction in the phases of nesting and the raising of chicks.

23. Conservation measures taken:

The Soncor basin belongs to the Los Flamencos National Reserve, which was included in the National System of Protected Nature Areas in 1990.

24. Conservation measures proposed but not yet implemented:

In light of the threats in this area there are general measures whose application will favour indistinctly each of the identified subsystems as well as specific priority actions oriented to particular sites.

Strengthening the system of protected wildlife areas

To strengthen the system of protected wildlife areas, the Corporación Nacional Forestal created Los Flamencos National Reserve in 1990, covering 73,986 hectares for the protection of representative environments in the pre-puna and puna. Within the national reserve are the wetlands of Aguas Calientes 1, Lagunas Miscanti and Miñiques, Pujsa, Salar de Tara and part of the Salar de Atacama that form an important area for the biological stability of populations of flamingos.

The main conservation activities in the reserve are:

Patrolling and monitoring of activities incompatible with the purposes of the reserve

Monitoring and providing information to visitors to the Soncor wetlands

Monitoring populations of flamingos in the wetlands of Aguas Calientes 1, Aguas de Quelana, Miñiques, Miscanti, Pujsa and Soncor

Monitoring populations of *tagua cornuda* in the Miscanti and Miñiques wetlands

Providing environmental education activities at the Environmental Information Centre in the town of San Pedro de Atacama

This reserve has an administration and management with headquarters in Toconao (Salar de Atacama), a staff member responsible for planning, supervising and technical control, a staff member responsible for operational planning and three park wardens. There are also a pick-up and two motorcycles.

The present management is insufficient, taking into account the characteristics of the distance between areas that need to be covered. As a result, activities are concentrated almost

exclusively around Soncor, relatively close to the administrative headquarters in Toconao.

The following steps are proposed to strengthen the administration and management of the reserve:

Increase the number of park rangers in order to permit an increase in patrols and the regulation of incompatible activities (gathering of flamingo eggs and registration of visitors)

Obtain financing for the construction of basic accommodations in critical areas in order to increase the range and intensity of inspections especially in Soncor, Tara and the Miñiques and Miscanti lakes

Develop a system for monitoring resources and a data base to increase knowledge of the dynamics of these ecological systems primarily by studying variations of water level in the lakes and fluctuations in populations of migratory birdlife

Establish a system for monitoring the atrophic activities that affect the reserve and propose measures for reducing negative effects on the wetlands, establishing priorities for the building of roads and requests for water use

Improve equipment for research and monitoring programmes

Train professional staff and park rangers on management techniques for resources and environmental education

Promote the development of a management plan by carrying out projects and technical programmes

Encourage the participation of the local community in conservation management, especially in the towns of Camar, Peine, San Pedro de Atacama, Socaire, Talabre and Toconao, involving them into the development of the management plan

Promote the creation of voluntary associations of local inhabitants and institutions that support conservation management

Regulating tourist activities

In order to decrease the negative impact of tourist activities on the wetlands, especially on the flamingo population, the following steps will be taken to promote the development of tourism based on a respect for natural resources and that contributes to conservation management and the promotion of an awareness and environmental-friendly behaviour in tourists:

Development of training courses for tour operators emphasizing ecotourism, the conservation objectives of the nature reserve, planning and management considerations and knowledge of the characteristics of natural resources

Promotion of the development of tourist objectives shared between the National Forest Corporation and tourist agencies, local communities and officials, which should be clearly expressed within the context of a specific development plan for tourism

Formulation and implementation of standards regulating the activities of tourists near the wetlands, especially near the Soncor wetlands, incorporating the active participation of tour operators in planning

Carrying out studies that will create the technical basis for defining regulatory norms for tourist activities, giving priority to determining the tourist capacity of the area of Burro Muerto-Puilar and identification of roads and accessible itineraries for the development of activities of ecotourism and adventure tourism (climbing of volcanoes, hiking in the Andes and bus tours)

Promotion of the development of ecotourism that reinforces the objectives of wetlands conservation

Improvement of access to areas with important scenic value in order to diversify tourist possibilities and to decrease the concentration of visitors in flamingo nesting areas

Development of environmental education programmes

Environmental education activities should be oriented to key groups that can contribute to the management of conservation, among which are local communities and officials, employees of mining companies, tourist agencies and public services. Special attention should be given to groups whose activities represent a threat to wetlands.

The aims of environmental education should promote the creation of an awareness of the importance of wetlands and major environmental problems in order to modify attitudes and increase the participation of individuals in the protection and conservation of wetlands. The public should be informed of the importance of knowledge, methods and standards that make it possible to sufficiently support conservation management and the solving of major problems.

The following specific actions are proposed:

Formulation and implementation of an environmental education programme based on a diagnosis of the expectations, concerns and interests of tourists and local communities and the development of management practices necessary for attracting financing

Creation of environmental education programmes at the CONAF Environmental Education Centre in the town of San Pedro de Atacama

Construction of trails to concentrate visitors and provide information promoting knowledge about the ecological dynamics of the wetlands

Preparation of didactic material emphasizing the ecological importance of the Andean wetlands

Involvement of the private sector in conservation activities

Mining companies working in areas near these wetlands should be involved in the management of conservation activities. It is proposed to develop an agreement for the conservation of wetlands between CONAF and the mining companies working near the Salar de Atacama, taking into account the exchange of information obtained from the environmental programmes of the mining companies and the public sector; financial support for carrying out specific conservation management programmes; and the creation of institutions permitting communication.

Promotion of research activities

The following activities are proposed in order to gather information about the dynamics of the natural resources in the wetlands required for the promotion of conservation and management programmes:

Identification of research needs in specific thematic areas

Promotion of specialization in the natural resources of the Andean region at local universities

Identification of sources of financing for research programmes in management techniques of the flamingo's habitat and bioenergy studies of the flamingo

Provide continuity to the project "Conservation of Flamingos in Northern Chile"

Incorporation of conservation practices for wetlands in the government's environmental management programmes

The government's environmental management is carried out primarily by the Regional Environment Commission (Comisión Regional de Medio Ambiente) (COREMA), which brings together in a technical committee regional and local authorities, representatives of public services in the environmental field and groups of high-level consultants.

The following specific programmes are proposed:

Promotion through COREMA of the importance of conservation in the wetlands of the pre-puna and puna in order to obtain support for conservation management

Incorporation of considerations related to the conservation of Andean wetlands into the regional environmental strategy

Incorporation of measures to mitigate potential impact into development projects carried out near wetlands at the time of evaluation of environmental impact studies by the technical committee of COREMA

25. Current scientific research and facilities:

Scientific research in the Salar de Atacama has been carried out within the framework of Los Flamencos National Reserve, with a large number of studies on the populations of flamingos in the area. CONAF for Region II has begun a programme of monitoring these environments and mining activities in the surrounding areas. This has provided important data about the dynamics of the saltpan's resources, an inventory of species of microalgae and micro invertebrates and physical and chemical conditions. There is also survey and descriptive research on identification of existing fauna.

26. Current conservation education:

There are permanent park wardens that provide accurate and up-to-date information on resources in this area. There is general documentation available and an environmental information centre for this area at 48 km from San Pedro de Atacama.

27. Current recreation and tourism:

Approximately 10,000 tourists visit the wetland annually in organized groups led by formal tourist agencies. These visits increase during the vacation periods of the northern and

southern hemispheres (southern summer and winter). Most of the visitors are foreign adults.

28. Jurisdiction:

II Region de Antofagasta
Ministerio de Agricultura
Secretaria Regional Ministerial de Agricultura
CONAF II Region

29. Management authority:

30. Bibliographical references: