Information Sheet on Ramsar Wetlands

Translation of original Information sheet by Charles Akin (August 2000)

1. **Date this sheet was completed/updated**: 4 August 1998

2. **Country**: Bolivia

3. **Name of wetland**: Lake Titicaca

4. **Geographical coordinates**: (The lake surface is between 15 13'-16 35' South latitude and 68 33'- 70 02' West longitude.) (Wirrmann 1992)

   15 10' - 17 10' South latitude
   68 20' - 69 25' West longitude

5. **Altitude**: 3,809 to 4,200 metres above sea level

6. **Area**: Approximately 800,000 hectares (The total surface proposed, which includes part of the water basin, covers approximately 800,000 hectares and includes 3,792 square kilometres (379,200 hectares) that correspond to the surface of Lake Titicaca in Bolivia. The total surface of the lake is 8,562 square kilometres.)

7. **Overview**: Lake Titicaca is an endorheic lacustrine system of tectonic origin, located at 3,800 metres above sea level in the central Andes between Bolivia and Peru. Depth of the lake reaches 281 metres. The ichthyofauna includes more than half of the currently identified species in the genus *Orestias* (23 species of which are endemic) and large populations of waterfowl, including one endemic species. The lake has been the centre of the development of important Andean cultures, forming an important area of economic activity in the past and the present. Currently, the population is formed by Aymara-speaking rural farmers, who depend rather heavily on the use of the lake's resources.

8. **Wetland type**: Continental M, N, O, U

9. **Ramsar criteria**: 1c, 2a, 2b, 2d, 3a, 3b, 3c, 4a

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**:

1c Because of its large volume of water and extensive surface, the lake acts as a regulator of the local microclimate and promotes production (by reducing the risk of frosts and increasing precipitation). It is a basic regulator in local water dynamics. Products from the lake, such as fish and forage (macrophytes) for livestock, are important in the economy of the population living around the lake. The lake has been the centre of the development of the most important Andean cultures, which have created unique technology still applied or being studied for use.

2a, b, d The lake has a specific fauna and flora, including an important portion of endemic species of fish, several invertebrates and one bird species. The presence of subspecies of limited distribution and populations confined to the lake are important factors in the conservation of genetic diversity. In addition, all of the species in the genus *Orestias* are considered to be vulnerable, and two species are endangered (both endemic to the lake). One species is considered extinct.

3a, c The lake is characterised by an important population of waterfowl that includes about 40 species constantly represented. There is one endemic species (most of the population of the lake) and several highly differentiated subspecies of restricted distribution in the high-Andean systems.

4a It has 28 species (66 per cent of the known total) of fish in the genus *Orestias*, of which 23 are endemic to the lake, contributing to the basic biodiversity of the high-Andean region.

13. **General location**:

Lake Titicaca is located in central western Bolivia, approximately 40 kilometres in a straight line (about 43 kilometres by road) northwest of the cities of La Paz and El Alto, in part of the department of La Paz. The current population of the two cities together is estimated to be 1,300,000 inhabitants. There are several towns nearby with populations between 500 and 1000 inhabitants (Carabuco, Copacabana, Desaguadero, Escoma and Tiwanacu) and two urban centres with populations between 2,000 and 5,000 inhabitants (Achacachi and Ancoraimes).

The limits of the proposed area are: in the west, the border with Peru from 15 10' to 17 00' South latitude; in the south, all of the subbasin of the Río Llinkhi and Río Desaguadero up to the area of Aguallamaya, the subbasin of the Río Jachajahuira and the basin of the Río Tiwanacu up to the headwaters in the Serranía de Machaca; to the east, a line going north from the headwaters of the Río Tiwanacu to the base of the last foothills of the western flank of the Eastern Cordillera at an altitude of 4,200 metres and following this elevation up to the town of Carabuco; to the north, it includes all of the drainage basin of the Río Suchez up to the limit with the Area Natural de Manejo Integrado Apolobamba, the conservation unit that forms part of the Sistema Nacional de Areas Protegidas de Bolivia (SNAP) (See map).

14. **Physical features**:

Geology and geomorphology

The current lake basin on the Altiplano is the result of the evolution of the former systems begun in the lower Pleistocene with the transition from a more or less moderate climate to a cold climate. The presence and size of the lakes is directly related to the recession of the glaciers at the beginning of the interglacial period (Lavenu 1992 in Dejoux and Iltis 1992). During the Quaternary, there was considerable reduction in the lake areas, deformation that fractured the base of the mountains of the Eastern cordillera and distensive north-south neotectonic activity. The tectonic depression now occupied by the present Lake Titicaca was created during the lower Pleistocene after the Cabana lacustrian phase and before the Bolivian phase (Lavenu 1992 in Dejoux and Iltis 1992).

In the early Pleistocene, there was the Mataro lacustrian phase at 140 metres above the current level, and in the middle Pleistocene there was Lake Cabana with a water level 90 metres above the present level. The landscape of the altiplano was once dominated by these two large lakes, which extended to the south up to the present salt flats (Wirrmann et al. 1992 in Dejoux and Iltis 1992). Later, with the retreat of the Sorata glaciation, occurred the Ballivian stage with a paleo lake that was 50 metres above the current level. Lacustrian terraces located 15 metres above the current level are attributed to the Minchin phase (upper Pleistocene between 27,000 to 21,000 B.P.). The last lacustrian event in the Pleistocene (approximately 10,500 B.P.) corresponds to the Tauca stage that gave rise to a paleo lake slightly larger than the present Lake Titicaca (Wirrmann et al. 1992 in Dejoux and Iltis 1992).

Lake Titicaca is oriented NNW-SSE. It is divided into two subbasins (the larger lake and the smaller lake) joined at the Tiquina straits with a maximum width of approximately 850 metres and a depth of 20 metres. The shores are poorly defined in the northern and western parts of the lake at the mouths of rivers that form flood areas. In contrast, the eastern shore is much better defined because it follows a fault. The lake's greatest length is 178 kilometres and maximum width is 69 kilometres in the larger lake and 41 kilometres in the smaller lake. Its surface covers 8,562 square kilometres (856,200 hectares). The larger lake has an average depth of 135 metres and occasional depths of more than 200 metres. In general, the shore is very steep. The smaller lake has an average depth of 9 metres, and almost 56 per cent of it is less than 5 metres deep. The deepest part is 41 metres deep in the Chua trench. The shores are usually gradual (Boulange and Aquize Jaen 1981).

Origin: The present lacustrian system of the Altiplano is the result of the evolution of the former systems that began in the lower Pleistocene with the transition towards the end of the Pliocene from a temperate to a cold climate. From the early Quaternary, the Altiplano has always been occupied by lakes, although not always of the same area.

Hydrology (including seasonal water balance, inflow and outflow): Precipitation provides 880 mm (7.47 x 10^9 cubic metres/year) and the contribution of rivers is 1002 mm (8.51 x 10^9 cubic metres/year). Precipitation represents 47 per cent of the contributions to the lake, while the rivers contribute 53 per cent of the inflow. Evaporation removes 1628 mm (13.8 x 10^9 cubic metres/year), while the Desaguadero drains only 160 mm (1.36 x 10^9 cubic metres/year). Evaporation represents 91 per cent of the losses and the Desaguadero river only 9 per cent.

Hydrological balance: Taking into account the values for the terrestrial part of the basin, total precipitation in the basin is 43.6 x 10^9 cubic metres/year. A volume of 0.80 x 10^9 cubic metres/year is accumulated. A total of 41.4 x 109 cubic metres/year is lost through evaporation (96.8 per cent) and only 1.36 x 10^9 cubic metres/year is drained by the Desaguadero (3.2 per cent).

Physical and chemical characteristics

Temperature: The average monthly surface temperature recorded in the larger lake varies between 11.25 C (August) and 14.35 C (March). The annual average is 13.0 C (Iltis et al. 1992 in Dejoux and Iltis 1992). The smaller lake shows little thermic variation; a cold period from May to October (<8 C in July) alternating with a warmer period from December to January (about 14 C) (Lazzaro 1981). The smaller lake is colder than the larger lake in winter and is warmer in summer (Iltis et al. 1992 in Dejoux and Iltis 1992). In the larger lake, a warming of the surface water occurs in October and spreads to deeper layers, creating a thermocline in December, which remains until May and then disappears between June and September.

Dissolved O_2: The main factors controlling the concentration of dissolved oxygen are atmospheric pressure and temperature. Saturation under these conditions is approximately 7 mg/l (Iltis et al. 1992 in Dejoux and Iltis 1992). In the smaller lake, surface water has surface concentrations close to equilibrium year round (>95 per cent saturation). In the deepest part (Chua trench), during summer stratification the hypolimnion contains only 1-2 mg/l with anoxia on the bottom (Lazzaro 1981). The vertical profiles of oxygen in the larger lake indicate a relative deficit in the hypolimnion during the stratification period (Iltis et al. 1992 in Dejoux and Iltis 1992).

Transparency: In the smaller lake, the extreme values of transparency recorded are 1.2 and 9 metres (Lazzaro 1981) with less transparency in summer-autumn and more in winter. Except in the deepest areas of the smaller lake (Chua trench), the euphotic area is frequently limited to the bottom. In the larger lake, there are values between 4.5 and 10.5 metres (Richardson et al. 1977) and between 7.5 and 18.5 metres (Iltis 1987).

pH: The values of pH at the surface are relatively stable. In the smaller lake, Lazzaro (1981) reported values between 8.55 and 8.65 with extremes of 8.06 and 9.38. In the greater lake, values of 8.5 in the period of isothermia were reported and 8.6 in the period of stratification (Richardson et al. 1977). Values recorded in the Bolivian part of the lake are between 8.48 in December and 8.20 in February.

Dissolved salts: An estimate of salinity can be obtained through measurement of conductivity. In the smaller lake, conductivity is an average of 1343 S/cm in April (Iltis 1987) and in the larger lake, the average recorded in December was 1501 S/cm. As in the case of temperature, the averages measured in the subbasin vary markedly. In the smaller lake, dissolution is greater than in the larger lake during the rainy season and concentrations are more accentuated in the dry season (Iltis 1987). Concentrations of dissolved salts reported for Lake Titicaca vary between 1.2 g/l (Lazzaro 1981) and 0.78 g/l (Richardson et al. 1977).

Chemical composition of the water: The water has chloride sodium sulphate. The cations are classified in the following order: Na>Ca>Mg>K. With respect to Ca, the values registered by several authors is around 65 mg/l. Na between 168 and 261 mg/l; Mg was recorded at values between 18 and 41 mg/l; and K between 4 and 21.7 mg/l. Sulphate is between 244 and 339 mg/l. As for silica, concentrations vary between 0.2 and 2.6 mg/l with an average of 1.8 mg/l (Iltis et al. 1992 in Dejoux and Iltis 1992).

The concentrations of dissolved inorganic nitrogen (DIN = NO_3- + NO_2- + NH_4^+) are often low in Lake Titicaca in relation to the quantities of reactive soluble phosphorous (RSP). Both nitrate and ammonium are usually below the limits of detection (3.5 and 2.5 g/l in the larger lake during periods of stratification and overturn respectively. The relationship of DIN to RSP gives an indication of the deficiency of nutritive salts. This value is usually well below 10:1, which results in a sharp limitation in nitrogen (Wurtsbaugh et al. 1992 in Dejoux and Iltis 1992).

Among the trace elements found are boron, cobalt, nickel and vanadium (Iltis et al. 1992 in Dejoux and Iltis 1992).

Depth, fluctuations and permanence: The larger lake has an average depth of 135 metres and nearly 27.5 per cent is more than 200 metres deep. The greatest depth recorded is 281 metres. The smaller lake has an average depth of 9 metres, and approximately 56 per cent has less than 5 metres. The deepest part of the smaller lake is 41 metres in the Chua trench. The annual maximum depth is usually in April at the end of the rainy season. The minimum is usually in December just before the rains. For the period 1914-1989, the range between years of water level was 6.37 with a minimum of -3.72 in 1943 and a maximum of 2.65 metres in 1986 in relation to the zero on the limnimetric scale (3,809.93 metres). The annual cycle varies between 1.80 metres in 1986 and 0.04 metres in 1983 (Roche et al. 1992 in Dejoux and Iltis 1992).

The importance of the exchange of water in the lake in relation to its volume can be expressed by two parameters: the annual average rate of renovation of the lake water and the average time of permanence of water in the lake. For all of the lake, an average rate of renovation of 1.80 per cent has been calculated: 1.55 for the larger lake and 22.5 for the smaller lake. The length of permanence for the whole lake is 55.5 years: 63.5 years for the larger lake and 4.4 years for the smaller lake (Carmuze and Aquize Jaen 1981).

Surface of the water basin: The surface of the water basin is 57,340 square kilometres of which 8,562 square kilometres correspond to the lake surface (Boulange and Aquize Jaen 1981).

Climate: In the areas of altitude below 4000 metres, average annual temperature varies between 7 and 10 C and average annual temperature below zero is at about 5100 metres. Around the lake, the average annual temperature is greater than 8 C (Roche et al. 1992 in Dejoux and Iltis 1992). The minimum average monthly temperature occurs in July (1.8 C at on the shore of the lake, while the maximum average monthly temperature is 15.3 (Roche et al 1992 in Dejoux and Iltis 1992). Precipitation curves are in general concentric around the lake, at the centre of which there is precipitation of 1000 mm. Rain tends to decrease when the distance from the lake increases, reaching minimums of 500-600 in parts of the basin. The rains are concentrated in January and extend from December until March. The dry season is concentrated in June and lasts from May to August. Two periods of transition separate these two periods (Roche et al. 1992 in Dejoux and Iltis 1992).

15. **Hydrological values**:

Local thermic regulation: The large volume of water creates more favourable local microclimates in the area of influence near the lake and reduces the frequency of frosts.

Control of flooding and water regulation: Lake Titicaca concentrates the greatest amount of surface water on the northern Altiplano. Through absorbtion in the water basin of large amounts of water from the rainy season from the cordillera, it controls flooding in the lower parts of the basin (Río Desaguadero and central Altiplano). The volumes accumulated during the rainy period represent a continuous contribution during the dry season.

16. **Ecological features**:

The subbasin of Lake Titicaca in Bolivia is included in the ecological regions of the semi-humid high-Andean area and the semi-humid puna. To a lesser extent, some of the rivers toward the southwest of the subbasin begin in the ecoregion of the semiarid high-Andean area.

The semi-humid high-Andean area forms part of the high-Andean geographical region. It is located in the eastern cordillera between 4200 and 5000 metres, occupying former plateaus, glacial valleys and abrupt escarps or rock outcroppings (Ribera 1992). The region is considered to be extremely oligothermic with frosts at night during most of the year. At higher elevations, the moist and cool Amazon winds create frequent precipitation. Descending toward the lake, the masses of cold air heat up, decreasing their relative humidity and generating relatively less precipitation (500-700 mm). Vegetation is characterized by low grasses, in which hard Gramineae such as *Calamagrostis* spp., *Festuca dolicophylla* and *Stipa ichu*, rosette plants, creeping plants and compact tufts dominate. In areas that remain flooded year round there are *bofedales* in which the dominant vegetation of *pulvínulos* such as *Distichia muscoides, Oxychloe andina* and *Plantago tubulosa* and other Juncaceae (Ribera 1992).

The high-Andean arid and semiarid area is distributed in the western cordillera, occupying high plateaux and mountain slopes in a range of altitude similar to the semihumid area. The predominant vegetation is low grass with rosette species in clumps and hard Gramineae. Frequent shrubs are *Baccharis* spp. and *Parastrephia* spp., and there are also *bofedales* (Ribera 1992).

The semihumid puna covers the northern part of the intercorrilleran plateau known physiographically as the Altiplano. The altitude ranges between 3800 and 4200 metres (Ribera 1992). The soils are usually poor and lack organic horizons (Beck 1988). The climate is characterized by stressed conditions and an average precipitation with maxima recorded in January-February (18-21 C) and minima in June-August (-5 C near the lake). Precipitation is concentrated in the months of December to March, and there is a dry period between May and August that extends with a transition period from September to November. Precipitation is greatest in the larger lake, at 800 mm, 700-800 mm in the northeastern part of the lake (mainly in Peru), from 500 to 700 mm in the southeast of the subbasin. There is an area of low precipitation at the base of the eastern cordillera.

The vegetation is a cover of hard Gramineae arranged in clumps (*Stipa ichu* and *Festuca* spp.) and low resinous shrubs (*Baccharis* spp. and *Parastrephia* spp.). There are microclimates in the foothills where there are *Satureja boliviensis, Calceolaria* spp. and *Mutisia ledifolia*. The structure and composition of the vegetation has been drastically changed by centuries of grazing (Ribera 1992).

The subbasin of Lake Titicaca proposed as a Ramsar site includes fluvial aquatic systems, several marshes (*bofedales*) and most importantly Lake Titicaca, which represents about half of the proposed area.

The rivers begin mainly in the eastern slope. They are usually seasonal or permanent river systems with unconsolidated beds formed by rocks and pebbles in the higher parts and by gravel or sand in the lower parts and banks of consolidated material (less well defined in some places) of the same general material, with mainly Gramineae. The most important river is the Suchez whose upper course is protected in the Reserva Nacional de Fauna Ulla Ulla and is included in the proposed area as part of the Ramsar site. The aquatic vegetation is limited to a few species that are found mainly in the slower parts of the river, where specimens of *Orestias* are also found. There is little macro vertebrate fauna and invertebrates. Among the species of fish found are also species of *Trichomycterus*. Species of ducks are found in the rivers, and at the mouths of the rivers there is a larger number of species including some of the most characteristic of the lake.

The *bofedales* are permanent marsh systems characterized by the presence of vegetation in clumps formed primarily by species of *Oxychloe* and *Distichia*. Among the clumps, streams and small ponds of different area are found, in which abundant aquatic vegetation grows, and there are species of *Orestias*. Several species of birds, mainly aquatic but also terrestrial are found in the system.

In the lake, there is a well-defined shore area, which extends up to a depth of approximately 15 metres, with emersed vegetation (*tortora*) up to a depth of 5 metres. In this area are concentrated most of the species of *Orestias* in Lake Titicaca and an important population of several species of waterfowl. There is also a large deep-water surface in which are found two species of *Orestias* and which is now occupied by the pejerrey (*Basilichthys bonariensis*) and a trout (*Oncorhynchus mykiss*). The deeper parts of Lake Titicaca are very poorly known, although there are records of invertebrates up to 150 metres or more and at least two species of *Orestias* are known that are considered characteristic species of the deep water.

17. **Noteworthy flora**:

The flora of the lake is characterised by the juxtaposition of species with very diverse geographic distribution. Some (*Elodea potamogeton, Lilaeopsis andina, Myriophyllum elatinoides*, and *Schoenoplectus tatora*) are characteristic species of the high-Andean plateaux. Others such as the cosmopolitan *Hydrocotyle ranunculoides, Lemna gibba, Ranunculus trichophyllus, Ruppia maritima* and *Zannichellia palustris* are more widely distributed.

The vegetation appears to be an emersed belt of *tortora* (*Schoenoplectus tatora*), which grows close to the shore between 2 and 4.5 metres. This species is found primarily in shallow bays, associated with a vegetative belt that forms a basic habitat for most of the species of *Orestias*. *Totora* is also a important resource used as forage for livestock and managed by the community. Until a few years ago, it was widely used for the construction of rafts and in some parts for the roofs of houses.

18. **Noteworthy fauna**:
Lake Titicaca stands out because of the presence of species in the genus *Orestias* endemic to the Altiplano. There are currently 27 species identified, of which 23 are endemic to the lake. Among the most important species are the *humanto* (*O. cuvieri*) considered to be extinct and the *boga* (*O. pentlandii*) considered to be endangered. Among the endemic species are *O. ispi* which is important in fisheries and *O. albus, O. crawfordii, O. gilsoni, O. mulleri, O. tchernavini*.

The herpetofauna is marked by the presence of the *rana del lago* (*Telmatobius culeus*) endemic to Lake Titicaca and characteristic because of its strictly aquatic habits and its size. This species has been introduced into trade for production of frog legs.

A total of 94 species of birds have been recorded of which 36 (38 per cent) are waterfowl. There are many populations of Rallidae, such as *Fulica ardesiaca*, and ducks (*A. cyanoptera, A. flavirostris, A. georgica, A. puna* and *Oxyura jamaicensis*). One Podicipedidae, *Rollandia microptera*, is endemic to the lake. There are now large concentrations of flamingos (mainly *Phoenicopterus chilensis*) because of the drying of Lake Poopó farther south, and there are seasonal concentrations of *Steganopus tricolor*, a migratory species.

19. **Social and cultural values**:

The lake is one of the most important centres for cultural development in South America. The first records of human presence on the subcontinent (the Viscachanense culture) was in Viscachani, which now forms part of the Desaguadero subbasin (the only outlet from the lake) and was probably associated with earlier stages of the lakes of the Altiplano.

The lake has been the centre of the Chiripa and Pucara cultures which led to the Tiwanacu culture, which has left important traces of land use and technological development. Later, it was part of the area of influence of the Inca culture.

Furthermore, it is a basic element of the mythologies of the main Andean cultures and has played a role as an important religious centre with temples built on the islands of Luna and Sol. While many of these traditions have now been lost because of the effect of acculturation introduced by colonisation, the lake is an important cosmogonic centre for the Andean cultures.

The lake is important economically because of its fisheries, based on the *pejerrey* (*Basilichthys bonariensis*, an introduced species) and on species in the endemic genus *Orestias*, which is an important resource for several sectors of the urban population of the city of La Paz, the most important city in Bolivia.

20. **Land tenure/ownership of**:

The system of land holding of the Inca and pre-Inca cultures was replaced during the colonial period and during a large part of the republican period by a system of latifundia in which the rural farmer was mainly free labour. Beginning in 1952 with the agrarian reform, there was an intensive restructuration that directly affected land holdings. In general, there is now a mixed regime of private property with areas of communal property, where use is carried out in accordance with a participatory programme. The main problem in the areas near the lake is the transition towards a minifundist regime, which has led to marked reduction in the productive surfaces per family. The regime for communal use also includes areas of reeds along the shores of the lake.

21. **Current land use**:

This area corresponds to one of the areas of greatest population density in Bolivia. Density in the eastern part of the lake reaches 20-30 inhabitants per square kilometre. To the southwest, it is less with 10-20 inhabitants per square kilometre. Human settlements includes settlements with populations between 500 and 1000 inhabitants (Carabuco, Desaguadero, Escoma and Tiwanacu) and two urban centres with populations between 2000 and 5000 inhabitants (Achacachi and Ancoraimes).

Agriculture is the basis for economic activity. The main products are potatoes, oca, barley, beans and quinua. These products are used for subsistence and trade, primarily in La Paz. An important complementary activity is the raising of livestock, primarily cows and sheep that play the role of economic reserve, although there is trade in meat and milk, for La Paz and local use.

Another complementary activity for part of the population is fishing. It plays a secondary role after agriculture and the raising of livestock, but can represent an important subsistence resource for shore populations. There is commercial fishing, based primarily on the *pejerrey* and native species of *Orestias*. The main market is the city of La Paz, but it also plays an important role in the regional economy.

This area has become important as one of the most important areas for tourist activities in Bolivia. Tourism is monopolised by tourist companies in La Paz, but there is an effect on local populations.

Mining was carried out in areas near the lake in the past, but this activity has now decreased considerably. One important aspect is the increase in the mining of gold that can affect several areas such as Suchez, which has been proposed for inclusion in the Ramsar site.

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

The area closest to the city of La Paz, although land ownership and the size of holdings has not changed much, is being transformed into residential areas through the building of week-end houses for the people of La Paz. Although it can promote conservation, it creates problems such as waste and local contamination from domestic waste. Mention should be made of improvement in the La Paz-Copacabana highway up to the border with Peru and which extends to the Desaguadero, forming part of the continental highway plan. This highway can promote development of tourism and increase trade with Peru. The project is tied to the improvement of secondary roads in support of regional development. Increased tourism, given a lack of infrastructure, can generate other problems. With the expansion of the road network, access with be improved to other parts of the lake. At least locally there will be an increase in transportation on the lake, primarily using outboard motor boats.

The lake has been and is an important transportation link. Sail boats have been replaced with outboard motor boats, whose impact on the environment should be taken into account. Among the development projects, the most important is the bilateral programme for the regulation of the water in Lake Titicaca. The idea is to build sluices for regulating the volume of the lake in order to control the water level downstream in the basin of the Poopó outlet. This project includes water management in other parts of the basin.

Domestic contamination is a problem mainly in the shallow bays of the lake. The main problem now is the bay of Puno in Peru, but small-scale domestic pollution exists in several parts, primarily in areas near important population centres.

The shore of the lake has been an important area for agriculture and the raising of livestock for several centuries and as a result the vegetation has been highly disturbed, formed basically by replacement communities and very reduced areas of original vegetation, mainly in the most distant parts and the higher parts of the area proposed as a Ramsar site.

The introduction of more efficient means of fishing, primarily gill nets, and the greater availability of these materials have given place to an increase and greater efficiency for fishing in Lake Titicaca. This has been probably one of the main problems causing the disappearance of *humanto* (*Orestias cuvieri*) and reduction of the population of other species such as *boga* (*O. pentlandii*) and now *carache* (*O. agassii*). The introduction of exotic species (trout and *pejerrey*) although not to the extend claimed, has been a factor in the reduction of populations primarily through the introduction of disease.

23. **Conservation measures taken**:

No conservation measures have been taken. Present management practices include primarily intensive agriculture with rotation of crops and fallow periods. The practices are based on local tradition. In several areas, experimental programmes have been set up to reintroduce former technologies for use in flooded areas. Fishing is regulated although regulations are based on inadequate knowledge, and enforcement is very difficult.

24. **Conservation measures proposed but not yet implemented**:

A series of studies have been made for implementation of a bilateral management plan for the protection and prevention of flooding and use of resources in Lake Titicaca, Río Desaguadero, Lake Poopó and the Coipasa salt flats, under the Programa Especial del Lago Titicaca (PELT). Part of this plan is the proposal the establishment of a protected area that includes mainly the Rio Llinkhi subbasin. The work and the importance of its implementation have been endorsed by several bilateral agreements and, in some cases, are being evaluated for implementation.

25. **Current scientific research and facilities**:

At the national level, Lake Titicaca probably forms one of the areas of greatest scientific activity. After the first survey made by Pentland at the beginning of the nineteenth century, several expeditions have taken place (Agassiz 1875; Créqui-Monfort 1903; Percy Sladen 1937), which obtained collections of fauna and flora and information on the lake and its basin. At the beginning of the 1970s, work was begun by IMARPE in the Puno, the Universidad de San Andrés and ORSTOM in the smaller lake and the Bolivian part of the larger lake. Important work has been carried out under the bilateral project between Peru and Bolivia (PELT).

The lake is relatively close to the city of La Paz and is readily accessible from many points. The Universidad de San Andrés (UMSA) has the infrastructure, including boats and trained staff for carrying out research. On the shores of Lake Titicaca, within the prefecture of La Paz, is the Centro de Desarrollo Pesquero del Altiplano (CDPTA) with excellent infrastructure and equipment for work on limnology and fisheries.

26. **Current conservation education**:

There are no specific programmes in this field. Nonetheless, proposed educational reforms have included the question of conservation in the programmes of the national urban and rural education systems.

27. **Current recreation and tourism**:

The lake is probably the most important tourist centre in Bolivia. Its proximity to the city of La Paz and nearness to the tourist circuits in southern Peru promote tourism. Domestic tourism is also very important, primarily for the residents of La Paz and tends to increase above all through the increase in week-end houses, primarily for residents of La Paz. Tourism is characterised by seasonality with the high season in the winter months (May-September).

28. **Jurisdiction**:
The lake and the area proposed for the Ramsar site are totally in the Department of La Paz. In accordance with the current process of decentralisation being carried out in Bolivia, the lake is under the jurisdiction of the prefecture of the department of La Paz. It also forms part of the jurisdiction of five provinces: Camacho, Ingavi, Los Andes, Maco Kapac and Omasuyos. The provincial authority is represented by the subprefect who lives in the provincial capital.

The administrative management is the responsibility of the departmental secretariats in the departmental prefecture. The Secretaría de Agricultura y Ganadería is responsible for the questions concerning agriculture and livestock and the Secretaría de Desarrollo Pesquero for the fishing sector. Tourist activities are the responsibility of the Secretaría de Turismo. The prefecture also includes in its structure a Secretaría de Medio Ambiente y Conservación.

29. **Management authority**:

1. Considering that the area is not included in the Sistema Nacional de Areas Protegidas, the management is the responsibility of the departmental prefecture, through the secretariats that form part of its structure. Within this structure, the Secretaría de Medio Ambiente y Conservación is the specific agency responsible for conservation and coordination with other sectors. Nonetheless, the Ministerio de Desarrollo Sostenible y Planificación (MDSyP) is directly responsible at the national level for coordination of sectoral processes and departmental planning. The ministry coordinates the activities of the prefectures and oversees PELT, which is a decentralised institution responsible for the preparation of the Plan Director Global Binacional de Protección-Prevención de Inundaciones y Aprovechamiento de los Recursos del Lago Titicaca, Rio Desaguadero, Lago Poopó y Salar de Coipasa. The Ministerio de Desarrollo Sostenible y Planificación through the Dirección Nacional de Areas Protegidas is responsible for management of the protected areas at the national level.

30. **Bibliographical references**: