Part II

EXPLORING THE VALUE OF THE NEOTROPICAL WATERBIRD CENSUS AS A CONSERVATION AND WILDLIFE MANAGEMENT TOOL

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1. INTRODUCTION

1.1. Background

Waterbirds are useful tools as indicators of the conservation status and health of wetland habitats (Morrison 1986, Kushlan 1993). They are also an important part of our natural heritage and a renewable resource utilized for research, education, and recreation as well as a food resource.

The Neotropical Waterbird Census (NWC) was begun by the International Waterfowl and Wetlands Research Bureau (IWRB, now Wetlands International, WI) in 1990, and since 1991 has been continued by Wetlands for the Americas (now Wetlands International - the Americas). The census was established to provide information on variations in population sizes and distributions of waterbirds in the Neotropics, as part of the International Waterfowl Census (IWC) organized by IWRB.

The objectives of the NWC program are to: 1) contribute reliable data for estimating population sizes of neotropical waterbird species; 2) monitor populations trends and their possible causes; 3) collect baseline data on migration patterns of waterbird species; 4) contribute data in order to characterize neotropical wetlands; 5) identify wetland habitat threats using waterbird species as bio-indicators; and 6) establish a network of volunteers interested in waterbirds and wetland conservation in the Neotropics.

The NWC began in southern South America (Argentina, Chile and Uruguay), with geographical coverage increasingly expanding to the north. In 1991 Brazil and Paraguay joined the Census, followed by Colombia and Peru in 1992, and - in 1995 - by Bolivia and Ecuador. At present the NWC involves almost all South America (except Venezuela, Surinam, Guyana and French Guiana), and since 1990 more than 750 volunteers from nine different countries have participated. These countries include Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru and Uruguay. Taking into consideration the experience of the IWC in Europe and Asia, we expect the overall coverage of the program to increase in the years ahead.

1.2. The NWC as a conservation and wildlife management tool

The strengths of the data collected in these first years include large data sizes, wide geographical coverage, time series generation (repeated sampling), and standard data collection methods.

The enormous amount of information collected will serve as the basis for decisions regarding the future of neotropical waterbird and wetlands conservation. However, this data needs to be carefully analyzed. The exact type of analysis that could be used needs to be determined based on the strengths and limitations of the data.

In this report, we make an initial analysis of the Neotropical Waterbirds Census data (1990-1995), to explore its importance and future possibilities as a tool for wetland and waterbird conservation in the Neotropics.
1.3. Specific analyses proposed

1. To investigate the use of the data to identify sites that could qualify as wetlands of international importance, especially as waterbird habitats, under the Ramsar Convention.

2. To investigate the possibility of mapping the summer and winter distribution of waterbird species based on abundance’s recorded during the censuses.

3. To investigate the use of the data to estimate waterbird population sizes in the Neotropics, based on the Underhill index or other appropriate methods.

2. DATA SOURCES

The specific analyses proposed were compiled using the NWC data from 1990 to 1995. This data is available in two different formats: digital databases and printed reports.

For Argentina, Chile and Uruguay, the first countries to join the program, we used data stored in digital databases. For the rest of the countries (for which databases are not available), we referred to the summary data from the printed reports (1990-1994).

2.1. Databases from Argentina, Chile and Uruguay

First, we worked to standardize the digital data sent by the national coordinators from Argentina, Chile and Uruguay. These databases were developed with different software, producing tables with different file structures. We used the following set of procedures to obtain a controlled database for each country:

1) Verify site codes;
2) Verify species codes;
3) Verify typing mistakes (dates, etc);
4) Delete records with count = 0;
5) Complete missing data (site coordinates, site codes, etc);
6) Standardize table structure: COUNTRY (char/10); SITECODE (char/10); DATE (date/8); YEAR (num/2); SEASON (num/1); SPECIES (char/5); COUNT (num/10); RECORD# (num/9), and SOURCE (char/13).

We merged the verified country databases into a single mega-database ANALISIS.dbf (26,137 records). This database was used as a main source of data in order to carry out the different analyses.

2.1.1. Date selection

A single observation (date) per year and season was selected, so that all sites were sampled equally. The selection was made using the following criteria: a) the date should be within the time window recommended for the census each year, or as close as possible, and b) when multiple count dates exist within this time frame, the selection should be performed randomly.
We use the expressions "austral summer" and "austral winter" for the months of January/February and July/August respectively.

2.1.2. Species selection (for specific analyses 2 and 3)

Only the 10 most common waterbird species were considered in the specific analyses 2 and 3; those with total winter counts for the 1990-1995 period greater than 33,000 birds (see Annex 1 for additional information):

<table>
<thead>
<tr>
<th>Species</th>
<th>Total count</th>
</tr>
</thead>
<tbody>
<tr>
<td>White-faced Ibis (Plegadis chihi)</td>
<td>173,162</td>
</tr>
<tr>
<td>Chilean Flamingo (Phoenicopterus chilensis)</td>
<td>123,053</td>
</tr>
<tr>
<td>Red-gartered Coot (Fulica armillata)</td>
<td>113,787</td>
</tr>
<tr>
<td>White-winged Coot (Fulica leucoptera)</td>
<td>89,018</td>
</tr>
<tr>
<td>Brown-hooded Gull (Larus maculipennis)</td>
<td>79,672</td>
</tr>
<tr>
<td>Kelp Gull (Larus dominicanus)</td>
<td>67,767</td>
</tr>
<tr>
<td>Neotropic Cormorant (Phalacrocorax olivaceus)</td>
<td>67,342</td>
</tr>
<tr>
<td>Black-necked Swan (Cygnus melanocorypha)</td>
<td>63,181</td>
</tr>
<tr>
<td>Coscoroba Swan (Coscoroba coscoroba)</td>
<td>43,069</td>
</tr>
<tr>
<td>Yellow-billed Pintail (Anas georgica)</td>
<td>34,936</td>
</tr>
</tbody>
</table>

3. SPECIFIC ANALYSES

3.1. Investigation of the use of the NWC data to identify sites that could qualify as wetlands of international importance, especially as waterbird habitats, under the Ramsar Convention.

Application of the Ramsar Criteria

We used Ramsar specific Criteria based on waterbirds (Criterions 5 and 6) with the NWC data to identify sites that could qualify as wetlands of international importance (see Annex 2 for additional information).

3.1.1. Criterion No. 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.

Argentina, Chile and Uruguay

We used the ANALISIS.dbf as the source of data. Firstly, we prepared two lists of sites that supported maximum counts greater than 10,000 waterbirds, one for the summer (January/February; Table 1) and the other for winter counts (July; Table 2). Based on these lists and giving special attention to those sites which supported maximum counts greater than 20,000 waterbirds, we identified the following sites that could qualify as wetlands of international importance, some of which were recently included in the Ramsar Convention:
1. **Laguna Mar Chiquita and Bañados del Río Dulce (Argentina)**; includes the following surveyed sites that supported counts greater than 10,000/20,000 waterbirds: Campo de Mare, Ea. La Orihuela and Estuario del Río Segundo (see Tables 1 and 2). *Hemispheric Reserve of the Western Hemisphere Shorebird Reserve Network (WHSRN).*

2. **Laguna Llancanelo (Argentina).** *Ramsar Site (since beginning of 1996).*

3. **Laguna Melincué (Argentina).**

4. **Santuario del Río Cruces (Chile).** *Ramsar Site (designated in July 1981).*

5. **Seno Ultima Esperanza (Chile).**

6. **Bañados del Este (Uruguay);** includes the following surveyed sites that supported counts greater than 10,000 waterbirds: Bañado de las Maravillas, Bañado de los Indios, Laguna de las Nutrias and Laguna Negra/bañado Santa Teresa (see Tables 1 and 2). *Ramsar Site (designated in September 1984).*

Additionally, Table 3 lists other sites from Argentina, Chile and Uruguay, with total counts greater than 5,000 waterbirds.

**Brazil, Colombia, Paraguay and Peru**

To apply the Ramsar specific Criterion No. 5 to Brazil, Colombia, Paraguay and Peru (countries with no databases available), we referred to the NWC printed reports (Carp 1991, Blanco & Canevari 1992, 1993, 1994, 1995).

The following sites could qualify as wetlands of international importance, especially as waterbird habitats (see Table 4 for additional information):

1. **Praia Quintão-Barra Lagoa do Peixe (Brazil).** *International Reserve of the WHSRN.*

2. **Volta da Serra-Sento Sé (Brazil).**

3. **Lago de Sobradinho (Brazil).**

4. **Estuario del Virrilá (Peru).**

5. **Lago Titicaca-Paucarcolla (Peru).**

6. **Reserva Nacional de Paracas (Peru).** *Regional Reserve of the WHSRN.*

**3.1.2. Criterion No. 6:** A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

We used the database ANALISIS.dbf and data on waterbird population estimates from Rose &
Scott (1994). Population estimates using the 1% criteria were only available for 20% of the species recorded.

The following sites could qualify as wetlands of international importance under the Ramsar specific Criterion No. 6 (see Table 5 for more details):

**Argentina**

1. Albufera Mar Chiquita: *Larus atlanticus*
2. Mar del Plata, coasts: *Larus atlanticus*
3. Monte Hermoso, beaches: *Larus atlanticus*
4. Laguna Llanquihue: *Phoenicopterus chilensis*
5. Tramo final Río Dulce: *Phoenicopterus chilensis*
6. Ea. La Orihuela: *Phoenicopterus chilensis*
7. La Rinconada: *Phoenicopterus chilensis andinus*
8. Arroyo San Antonio: *Tringa melanoleuca*
9. Punta Delgado-Golfo San Matías: *Calidris canutus*
10. Puerto San Antonio Este: *Calidris canutus*
11. Lag. Cloacales Artificiales de Trelew: *Larus atlanticus*

**Chile**

1. Desembocadura Río Lluta: *Larus belcheri*
2. Playas al sur de Arica: *Larus belcheri and Larosterna inca*
3. Playa Chipana: *Larus modestus and Sturna lorata*
4. La Portada: *Larus modestus and Larosterna inca*
5. Laguna Meñiques: *Fulica cornuta*
6. Laguna Miscanti: *Fulica cornuta*
7. Pan de Azucar: *Larosterna inca*
8. Bahía de Coquimbo: *Larus modestus*
9. Playa Lagunillas: *Larus modestus*
10. Bahía de Guanaqueros: *Larus modestus*
11. Desembocadura Río Maipo: *Larus modestus*
12. Desembocadura Río Aconcagua: *Pelecanus thagus*
13. Laguna Mantagua: *Larus modestus*
14. Desembocadura Río Reloca: *Larus modestus*
15. Molulco-Compu: *Limosa haemastica*
16. Caulín: *Limosa haemastica*
17. Quilo-Quetalmahue: *Limosa haemastica*

**Uruguay**

1. Laguna Jose Ignacio: *Larus atlanticus*
2. Arroyo Valizas and Laguna Castillos: *Tringa melanoleuca*

The results of the application of the two Ramsar specific Criteria based on waterbirds (Criterions 5 and 6) were summarized in Figure 1.
3.2. Investigation of the possibility of mapping the summer and winter distributions of waterbird species based on abundance's recorded during the censuses.

3.2.1. The mapping procedure

To investigate the possibility of mapping summer and winter distributions of waterbird species using the NWC data, we used the joined database ANALISIS.dbf from Argentina, Chile and Uruguay.

The mapping was restricted to those sites for which geographical coordinates were available (Figure 2 and Annex 3), representing approximately 70% of the total sites surveyed between 1990-1995.

We selected the 10 most common species (see item 2.1.2. for additional information): *Plegadis chihi*, *Phoenicopterus chilensis*, *Fulica armillata*, *Fulica leucoptera*, *Larus maculipennis*, *Larus dominicanus*, *Phalacrocorax olivaceus*, *Cygnus melanocorypha*, *Coscoroba coscoroba* and *Anas georgica*.

We used the software MICROCAM to produce the maps. We mapped the austral summer (January/February) and winter (July) distributions separately, using maximum counts for each season registered at each site.

The resulting maps (Figures 3 to 12) were analyzed taking into account: a) the NWC coverage relating to the species distribution range; b) the habitats frequented (from Canevari et al. 1991); c) the recording of the species out of its known range, and d) seasonal distributional changes (between summer and winter). We included comments on sites with large bird numbers.

We considered the quality of the NWC geographical coverage as being good when the distribution of reported sites was representative of the species known range within the study area, and regular when this distribution was considered incomplete.

3.2.2. Species maps

3.2.2.1. *Plegadis chihi* (White-faced Ibis) - Figure 3

**Habitat:** different types of wetlands (mainly vegetated) and flooded fields.

**NWC coverage:** good

**Distribution range:** summer and winter maps indicate that the species exceeds its known distribution limits (according to Canevari et al. 1991) in the Northeast of Argentina (Narosky & Yzurieta 1987, have registered the species for the area). Another interesting aspect is its scarcity in Chile (summer and winter).

**Seasonal distribution changes:** It is interesting to note the low numbers registered in the east of the Buenos Aires province (Argentina) during the austral summer, compared to the winter season. As ibis frequent mainly shallow and temporal vegetated wetlands; the low abundance
can be related to annual droughts affecting the region during the summer.

**Numbers**: Two areas with large numbers are mentioned: Laguna Mar Chiquita-Bañados del Río Dulce (Cordoba and Santiago del Estero provinces-Argentina), and Bañados del Este (Rocha department-Uruguay).

### 3.2.2.2. *Phoenicopterus chilensis* (Chilean Flamingo) - Figure 4

**Habitat**: mainly salt lakes and lagoons with scarce emergent vegetation; also estuaries and marine mud-coats.

**NWC coverage**: regular. The northwestern region of Argentina (Puna and Prepuna) and the inland Patagonia were poorly covered.

**Distribution range**: no observations.

**Seasonal distribution changes**: the species almost disappears from Chile during the austral summer. This can be related to the movement and congregation of birds to breeding habitats, such as Llancanelo lagoon in Mendoza province (Argentina), where 55,000 flamingos were counted in January 1992.

**Numbers**: Two areas with important numbers stand out from the maps: Laguna Llancanelo (Mendoza province-Argentina), and Laguna Mar Chiquita-Bañados del Río Dulce (Cordoba and Santiago del Estero provinces-Argentina). These wetlands support 11% and 6-14% respectively of the total population estimated for the species (Rose & Scott 1994).

### 3.2.2.3. *Fulica armillata* (Red-gartered Coot) - Figure 5

**Habitat**: lagoons, marshes and other vegetated wetlands.

**NWC coverage**: regular. The northwestern limit of the species distribution in Argentina, as well as inland Patagonia area was poorly covered.

**Distribution range**: the summer and winter maps indicate that the species exceeds its known distribution limits in the central part of Chile (according to Canevari *et al.* 1991), where it was registered in large numbers.

**Seasonal distribution changes**: it is interesting to note the lower numbers observed in northcentral Argentina during the austral summer. In addition, the species almost disappeared from the south of Chile during this period. Because the Red-gartered Coot is not a migratory species, this pattern can be attributed to nesting behavior, when the coot becomes more secretive. The existence of short-distance movements is another reliable possibility that explains the observed changes.

**Numbers**: Significant sites include: Laguna Mar Chiquita-Bañados del Río Dulce (Cordoba and Santiago del Estero provinces-Argentina), and wetlands of the Region 10 of Chile (surroundings of Chiloe island).
3.2.2.4. *Fulica leucoptera* (White-winged Coot) - Figure 6

**Habitat:** lagoons, marshes and other vegetated wetlands.

**NWC coverage:** regular. The northwestern limit of the species distribution in Argentina, as well as the inland Patagonia, was poorly covered.

**Distribution range:** the species exceeds its known distribution limits (according to Canevari *et al.* 1991), in the northcentral part of Chile, both for summer and winter maps.

**Seasonal distribution changes:** it is interesting to point out the lower numbers registered in some regions of Chile during the austral summer, as well as the virtual disappearance of this species from the Bañados del Este (Uruguay) during the same period. As was mentioned for the Red-gartered Coot, this can be related to nesting behavior, when the species becomes less noticeable. The existence of short-distance movements is another possibility that explains the changes observed, given that significant large numbers are registered in Llancanelo lagoon (Mendoza province, Argentina) during the austral winter, yet they are not registered during the summer season.

**Numbers:** Two areas with significant populations were identified: Laguna Mar Chiquita-Bañados del Río Dulce (Cordoba and Santiago del Estero provinces-Argentina), and Laguna Llancanelo (Mendoza province-Argentina).

3.2.2.5. *Larus maculipennis* (Brown-hooded Gull) - Figure 7

**Habitat:** different types of inland and coastal wetlands; from estuaries and marine coasts to marshes, lagoons and rivers, as well as open fields.

**NWC coverage:** good. The northwest of Argentina and inland Patagonia were poorly covered.

**Distribution range:** the winter map indicates that the species exceeds its known distribution limits in the Northeast of Argentina (according to Canevari *et al.* 1991, and Narosky & Yzurieta 1987).

**Seasonal distribution changes:** despite Burger’s (1974) indication that this species remains in the lagoons of Buenos Aires and Santa Fe provinces throughout the year, the austral summer map shows lower numbers registered in the area. Besides this, lower numbers are registered during the austral winter in coastal Patagonia (Argentina), suggesting the existence of migratory habits for the southern populations of the species. In accordance with this, Lizurume *et al.* (1995) observe that this gull makes a seasonal use of Trelew wetlands (northern Patagonia), remaining in the area exclusively during the breeding period (austral summer).

**Numbers:** Two areas with important numbers stand out from the maps: Laguna Mar Chiquita-Bañados del Río Dulce (Cordoba and Santiago del Estero provinces-Argentina), and Bañados del Este (Rocha department-Uruguay).
3.2.2.6. *Larus dominicanus* (Kelp Gull) - Figure 8

**Habitat:** mainly coasts, with different types of beaches. Also harbors and garbage deposits.

**NWC coverage:** good.

**Distribution range:** despite its coastal habits, the maps (especially winter), indicate that the species inhabits inland wetlands in Buenos Aires province (Argentina), also observed by Narosky & Yzurieta (1987). Other authors, like Canevari *et al.* (1991), do not cite the species for this region.

**Seasonal distribution changes:** the species almost disappears from inland wetlands of Buenos Aires province and central Argentina during the austral summer. This suggests that it could become more coastal during this period. Canevari *et al.* (1991) indicate that this gull breeds in the marine coastal areas and southern lakes of Patagonia. Thus, the seasonal differences observed can be related to the reproductive habits of the species.

**Numbers:** no observations.

3.2.2.7. *Phalacrocorax olivaceus* (Neotropic Cormorant) - Figure 9

**Habitat:** fresh-water and brackish wetlands, including estuaries and marine coasts.

**NWC coverage:** good. However, the northwest of Argentina and inland Patagonia were poorly covered.

**Distribution range:** both, the austral summer and winter maps indicate a vast distribution range for this species.

**Seasonal distribution changes:** no significant changes were observed between seasons.

**Numbers:** One area worth mentioning is Laguna Mar Chiquita-Bañados del Río Dulce (Cordoba and Santiago del Estero provinces-Argentina), where in July 1994 42,000 cormorants were counted.

3.2.2.8. *Cygnus melanocorypha* (Black-necked Swan) - Figure 10

**Habitat:** mainly inland fresh-water wetlands and salt lakes, but also coastal areas.

**NWC coverage:** good. However the inland Patagonia was poorly covered.

**Distribution range:** the summer map indicates that the species exceeds its known distribution limits in the northcentral Chile (see Canevari *et al.* 1991).

**Seasonal distribution changes:** during the austral winter counts, larger numbers observed in Chile compared to summer counts, particularly in the Regions 10 and 12. These changes can be related to the migratory habits of the species (Canevari *et al.* 1991). Seasonal changes
registered in Argentina and Uruguay were unimportant. However, the lower numbers registered for nearly all Argentina, especially in Buenos Aires and Cordoba provinces, can be related to the extended drought that took place during the last three years.

**Numbers**: There are three significant areas with important numbers: Laguna Llancanelo (Mendoza province-Argentina), Seno Ultima Esperanza (Region 12-Chile), and the Santuario del Río Cruces and its surroundings (Region 10-Chile).

### 3.2.2.9. *Coscoroba coscoroba* (Coscoroba Swan) - Figure 11

**Habitat**: mainly inland fresh-water wetlands, big salt lakes and estuaries, but also marine coastal areas.

**NWC coverage**: good. Argentina's inland Patagonia was poorly covered.

**Distribution range**: an interesting aspect is the scarcity of this swan in Chile and in the Argentinean Patagonia (both seasons), despite the larger distribution range suggested by Canevari *et al.* (1991) and Narosky & Yzurieta (1987).

**Seasonal distribution changes**: not significant.

**Numbers**: Significant numbers were observed in one location: Laguna Llancanelo (Mendoza province-Argentina).

### 3.2.2.10. *Anas georgica* (Yellow-billed Pintail) - Figure 12

**Habitat**: different wetland habitats, uplands and stubble fields, and less frequently marine coastal areas.

**NWC coverage**: good. Argentina's inland Patagonia was poorly covered.

**Distribution range**: no observations.

**Seasonal distribution changes**: the mainland subspecies of this duck breeds in Argentina from Córdoba, Santa Fe and Buenos Aires provinces, to Tierra del Fuego and the Malvinas islands, migrating in the autumn to Santiago del Estero and the northwest cordillera (Canevari *et al.* 1991). Regarding the maps, seasonal changes observed in certain areas of Chile (south-central regions), Argentina (winter numbers decreasing in Patagonia and increasing in Buenos Aires province) and Uruguay (winter numbers increasing in the Bañados del Este), are indicative of the regional movements previously mentioned. However, data is not yet sufficient to give a clear view of the migratory pattern of this species.

**Numbers**: no observations.
3.3. Investigation of the use of data to estimate waterbird population trends in the Neotropics, based on the Underhill index or other appropriate methods.

3.3.1. The Underhill method

We used the combined data from Argentina, Chile and Uruguay (ANALISIS.dbf), due to the lack of digital databases for the remaining countries.

The Underhill method (Underhill 1989, Underhill & Prys-Jones 1994), appears to be an appropriate tool to study population trends of southern South America waterbird species (Rose 1995). We estimated index numbers following this method, and using the software UINDEX4 (Bell 1995).

UINDEX4 is a comprehensive computer program for estimating population index numbers using the Underhill method. Population index numbers are estimates of relative population size in a given year scaled to be relative to a given "base" year, for which the index number is set to an arbitrary value of 1 or 100. Missing values are imputed according to a simple model of site, year and month factors. Approximate confidence intervals for the year and month factors are estimated using bootstrap samples and sites. They measure the consistency of changes across sites and hence are termed "consistency intervals" (Bell 1995).

The indexing methodology used is fully described by Underhill & Prys-Jones (1994). Here we provided information restricted to the approach adopted in the selection of sites, species and months.

Selection of sites

The database ANALISIS.dbf contains austral winter census data from 415 sites of Argentina (248), Chile (138) and Uruguay (29). Following Underhill & Prys-Jones (1994), we included only those sites that fulfilled the requirements for complete coverage of at least 50% of possible count dates. In our case, we included only sites that have been surveyed for at least 3 years. This resulted in 153 sites being included (37%) out of the 415 available.

Selection of species

We considered only the 10 most common waterbird species as candidates for indexing (see item 2.1.2. for additional information): Plegadis chihi, Phoenicopterus chilensis, Fulica armillata, Fulica leucoptera, Larus maculipennis, Larus dominicanus, Phalacrocorax olivaceus, Cygnus melanocorypha, Coscoroba coscoroba and Anas georgica.

There is evidence of the presence of different populations of Larus maculipennis, Cygnus melanocorypha, Coscoroba coscoroba and Anas georgica inhabiting southern South America. However, the data available is not enough to regard separate populations. In the current analysis, we consider all species as single population species.

Selection of months

The month factor was not relevant for the present analysis, as the NWC is only carried out twice a
We used 1990 as the base year and July as the base month for each series of index numbers presented.

### 3.3.2. Population trends 1990-1995

Population trends from the 10 species considered were categorized into three main groups:

1) **Stable trend** (Figure 14): *Phoenicopterus chilensis*, *Larus maculipennis*, *Larus dominicanus*, *Phalacrocorax olivaceus*, *Cygnus melanocorypha* and *Anas georgica*. Numbers for these species have remained stable during the 1990-1992 period. In particular, the annual population indices of *Phoenicopterus chilensis*, *Larus maculipennis* and *Anas georgica*, have shown great stability over the whole period (1990-1995), with a slow increase in the numbers of *Phoenicopterus chilensis* since 1993. *Larus dominicanus* and *Cygnus melanocorypha* have shown a noticeable decrease in 1993, followed by prompt recovery in 1994-1995. *Phalacrocorax olivaceus* has shown a significant increase between 1992 and 1993, a period of stability (1993-1994), and a decrease since 1994.

2) **Increasing trend** (Figure 15): *Plegadis chihi*, *Fulica armillata* and *Coscoroba coscoroba*. These species have undergone a slow but steady increase during the whole period. In the particular case of *Coscoroba coscoroba*, the numbers have begun to stabilize over the last 3 years (1993-1995).

3) **Decreasing trend** (Figure 15): *Fulica leucoptera*. This coot has shown a significant decreasing trend for the period 1990 and 1995, with a short constant sub-period between 1992 and 1994.

### 3.3.3. Reliability of population indices

The reliability of annual population indices can be assessed from the percentage of imputed values (estimates for missing counts) used in the analysis (Rose 1995). As a general rule, Underhill & Prys-Jones (1994) recommended any set of indices based on more that 20% imputed values should be treated with caution. Table 6 shows that only one of the 10 species considered, the Coscoroba Swan, have less than 20% imputed values for the period 1990-1995 (19.83%). The average imputed values for the group is 29.97%, with a maximum of 44.50% (*Phalacrocorax olivaceus*). In general the percentages of imputed values were lower than those from the Western Palearctic Waterfowl Census 1994 (Rose 1995).

Regarding the period 1991-1994 (Table 6), 40% of the species (*Plegadis chihi*, *Phoenicopterus chilensis*, *Larus maculipennis*, *Larus dominicanus*, *Phalacrocorax olivaceus*, *Cygnus melanocorypha*, and *Anas georgica*) have less than 20% imputed values, while only *Coscoroba coscoroba* has less than 20% imputed values for the period 1990-1995. The average imputed values for the group is 30.82%, with a maximum of 44.50% (*Phalacrocorax olivaceus*). In general the percentages of imputed values were lower than those from the Western Palearctic Waterfowl Census 1994.
chilensis, Cygnus melanocorypha, and Coscoroba coscoroba) have less than 20% imputed values, and another 20% (Fulica armillata and Larus dominicanus) have less than 23% imputed values. The average imputed values for the group during the period 1991-1994 is 21.85%.

The percentages of imputed values observed for the period 1990-1995 were the result of the indexing of two particular years: 1990 and 1995; both of which had had a low geographical coverage (see Table 6). The 1990 - average 44.60% imputed values - was the first year of the NWC program and, as a consequence, a low number of sites were surveyed. On the other hand, the average of imputed values for 1995 is 47.80% (see Table 6). Only data from Chile and central Argentina was available for the analysis for the recently compiled 1995 census.

4. DISCUSSION

Data collected during the first years of the Neotropical Waterbird Census (1990-1995) have significant value for waterbird and wetland habitat conservation. In the following section, we discuss the utility and drawbacks of the NWC data for the three specific analyses proposed.

4.1. Application of the Ramsar Criteria

The NWC program as it is currently carried out provides valuable information for identifying sites that could qualify as wetlands of international importance, especially as waterbird habitats. The analysis was very useful and an excellent starting point for exploring the value of the NWC data in order to:

1) Confirm the value of some existing Ramsar sites for waterbirds, such as the Laguna Llancanelo (Argentina) and the Santuario del Río Cruces (Chile).

2) Confirm the importance of including some recognized waterbird areas into the Ramsar list; such as Laguna Mar Chiquita (Argentina), Lagoa do Peixe (Brazil), and Reserva Nacional de Paracas (Peru), three reserves integrating the Western Hemisphere Shorebird Reserve Network.

3) Identify other waterbird sites that could qualify as wetlands of international importance to be proposed to the Ramsar Convention.

However, when trying to apply the Ramsar specific Criteria based on waterbirds (Criterions 5 and 6), we identify three main difficulties:

1) The delineation of wetland sites.

Recommendation C.4.2. adopted by the Ramsar Convention in 1990, includes the following guideline: ”The specific criteria based on waterfowl numbers will apply to wetlands of varying size in different Contracting Parties. While it is impossible to give precise guidance on the size of an area in which these numbers may occur, wetlands identified as being of international importance under this criteria should form an ecological unit, and may thus be made up of one big area or a group of smaller wetlands”. In the current analysis, the site
information available was not adequate enough to determine if a surveyed site constituted an ecological unit or a smaller part of a larger wetland (large waterbird concentrations are missed as the result of dividing wetlands into small reporting sites). We relied on prior knowledge and telephone confirmations to regard each site as an ecological unit.

2) The fulfilling of the "regularly" requirement.

The "regular use of ..." is a necessary requirement of the Ramsar specific Criteria based on waterbird numbers (Criterions 5 and 6). For the majority of the sites surveyed, the information gathered up until now did not allow for the fulfilling of this requirement.

3) The lack of population estimates for neotropical waterbird species

To apply the Ramsar specific Criterion No. 6 (based on waterbirds numbers), it is necessary to consider the population estimates for the species At present we only have estimates for around 20% of the neotropical waterbird species (Rose & Scott 1994).

4.2. Mapping the summer and winter distributions of waterbirds

The NWC data appears to be an important source of data for the analysis of the distribution and seasonal movements of waterbird species within southern South America. The current analysis constitutes the first attempt and has served to:

1) Detect relevant changes in the abundance of species within their distribution ranges, as well as areas that support high numbers of birds.

2) Identify seasonal changes in the species geographical distribution by comparing the summer and winter maps.

3) Detect records that exceed the distribution limits of the species.

Despite its value, the current set of data shows some limitations for the mapping procedure:

1) Lack of information on geographical coordinates for around 30% of sites surveyed (not included in the current analysis), as well as incorrect information for around 5% of the remaining 70% of sites.

2) Gaps in geographical coverage resulted in the lack of information from vast portions of the mapped region, such as in northwestern Argentina, northern Chile, and inland Patagonia, especially the southern portion.

3) Lack of specific references for an important percentage of birds recorded. Birds not identified at the species level were treated as generic groups - such as coots (Fulica sp.), gulls (Larus sp.), Ducks, etc - , and were eliminated from the calculations.

Insufficient knowledge on southern South America waterbird species (different populations inhabiting the region, etc), as well as the poor and dispersed information about their natural history
and migratory habits, restricts further interpretation of the maps obtained.

**4.3. Waterbird population trends**


This first attempt has been very valuable not only for estimating population trends, but also for suggesting improvements to the data gathering process. However, the current set of data showed some limitations of the indexing process:

1) Gaps in temporal coverage have restricted the number of sites included in the indexing process (only 37% of the sites surveyed in July 1990-1995).

2) Percentages of imputed values for nine of the ten species analyzed (period 1990-1995) were a little higher than the 20% recommended by Underhill & Prys-Jones (1994); but in any case lower than those from the Western Palearctic Waterfowl Census 1994 (Rose 1995).

Since the indexing process has only been taking place for a few years, interpretation of the trends observed should be done with caution.

**4.4. Limitations of the NWC data, and recommendations**

Based on the specific analyses developed, and regarding the preliminary diagnosis (see Blanco & Canevari 1996), we identified these main limitations (including specific recommendations):

1) Gaps in geographical coverage. The coverage of NWC is directly affected by the amount of funding and by the absence of motivated and trained people in vast areas of the Neotropical Region, such as the huge Amazon basin. Many areas that supported large numbers of waterbirds (Pantanal, Chaco, Patagonia, the Beni, etc) are sparsely inhabited with very low numbers of potential NWC volunteers. This has resulted in the absence of information from broad and remote areas of the region considered in the current analyses.

**Recommendation 1:** Secure small funds to assist National Coordinators in covering important and remote wetland areas in their countries. Only by providing small funds for petrol and field expenses will enough information start to build up for these areas.

**Recommendation 2:** Organize regional training workshops to recruit and stimulate volunteer participation.

**Recommendation 3:** Begin the compilation of a "Reduced Sitelist" of wetland areas to represent the Neotropical Region. This list will serve to direct the restricted surveying efforts.
more effectively.

2) Gaps in temporal coverage. The mean temporal coverage (number of times a given site was surveyed during these first years) was lower than expected due to the geographical dispersion of individual surveying efforts. This was a significant issue limiting the comprehensiveness of the trend analysis.

**Recommendation 4:** Continue stressing the importance of visiting the same sites every year to build up information that could serve as a monitoring basis (as information value from a site will increase with the amount of data from it).

3) Heterogeneity of data gathered is higher than expected. NWC data showed great variability in term of reporting approaches, due to differences in geographic locations (different countries), abilities of the volunteers (ornithologists and bird-watchers) and coordination styles in each country. Monval and Pirot (1989) also reported this problem for the Western Paleartic and West Africa.

**Recommendation 5:** Organize an annual workshop for National Coordinators to solve tactical problems at local and national levels, to standardize information gathering and storing, and to enhance communications for working closely together.

4) National databases unavailable or inadequate. More than half of the data collected during the first years were not available for the current analyses (data from Brazil, Colombia, Paraguay and Peru), due to the lack of volunteer time, and/or money to pay a database officer. In addition, not all the available databases had an adequate format for the current analysis.

**Recommendation 6:** Secure funds to hire a database specialist to coordinate the NWC databases activities, to improve the Data Storage Program (PAD), and to continue advising the National Coordinators on data storing and management.

**Recommendation 7:** Secure small funds to help National Coordinators with data entry and processing.

**Recommendation 8:** Promote the use of volunteer time as an option for census data entry.

4.5. Final Considerations

The NWC is a combined effort, which is just beginning to demonstrate its potential for wildlife management and conservation in the Neotropics. The success of the program since its commencement in 1990 was due to the participation of more than 750 volunteers from all over South America, as well as to the invaluable work of the National Coordinators organizing the census in each country.

The objectives proposed in the present analysis were carried out demonstrating the usefulness of the data collected during the first five years. However, when financial problems occur, they indicate that a healthy NWC program requires long term planning in order to keep National Coordinators on
board and volunteers involved.

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