Bird Conservation Plan for the Colorado River Delta
Baja California and Sonora, Mexico

Version 1.0
February 2004

BIRD CONSERVATION PLAN FOR THE COLORADO RIVER DELTA

This plan was developed with the kind support provided by:
National Fish and Wildlife Foundation
Sonoran Joint Venture
North American Wetlands Conservation Council
Dirección General de Vida Silvestre – Secretaría de Medio Ambiente y Recursos Naturales
Reserva de la Biosfera del Alto Golfo de California y Delta del Río Colorado
Instituto del Medio Ambiente y Desarrollo Sustentable del Estado de Sonora
Centro de Investigación en Alimentación y Desarrollo
Point Reyes Bird Observatory
Consejo Nacional de Ciencia y Tecnología
Asociación Ecológica de Usuarios de los Ríos Hardy y Colorado, A.C.
Environmental Defense
Environmental Research Laboratory, University of Arizona
Sonoran Institute
Ejido Luis Encinas Johnson
Pronatura Noroeste

We thank the following persons for their support, participation, and encouragement to develop this plan: Daniel W. Anderson, Juan Carlos Barrera, Carol Beardmore, Mark Briggs, Jose Juan Butrón Gonzales, Mauricio Butrón González, Juan Butrón Mendez, Alejandra Calvo Fonseca, José Campoy Favela, Raquel Castro, Steve Cornelius, Miguel Cruz, Roy Churchwell, Richard Ericsson, Richard Felger, Jaqueline García Hernández, Kimball Garrett, Geoff Geupel, Edward Glenn, Eduardo Gómez Limón, Onésimo Gonzalez, Sacha Heath, Miriam Lara Flores, Steve Latta, William Mannan, Chris McCreedy, Eric Mellink, Robert Mesta, Kathy Molina, Javier Mosqueda, Pamela Nagler, Eduardo Palacios, Eduardo Peters, Jennifer Pitt, Norma Ramos, Juan Rivera, Martha Román Rodríguez, Gerardo Sánchez Bon, William Shaw, Sam Spiller, José Trejo, Carlos Valdés-Casillas, Pablo Valle, Charles van Riper, and Francisco Zamora.

Recommended citation:
Hinojosa-Huerta, O., H. Iturribarría-Rojas, Y. Carrillo-Guerrero, M. de la Garza-Treviño, and E. Zamora-Hernández. 2004. Bird Conservation Plan for the Colorado River Delta. Pronatura Noroeste, Dirección de Conservación Sonora. San Luis Río Colorado, Sonora, México.

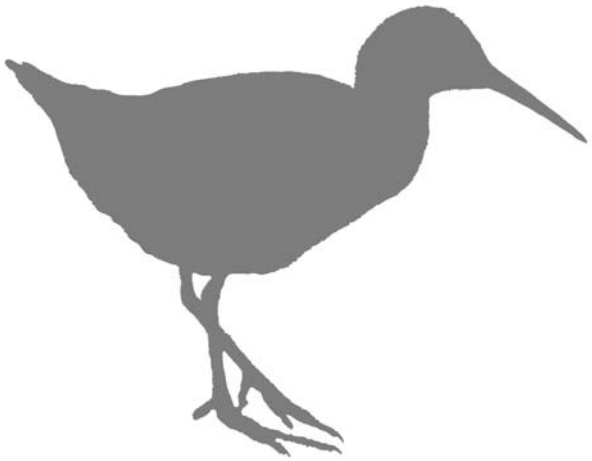
For further information about the plan, please contact:
Osvel Hinojosa-Huerta
Director of Conservation in Sonora
Pronatura Noroeste
Ave. Jalisco 903, Colonia Sonora
San Luis Río Colorado, Sonora, México. 83440
T/f (653)5356738
Email: osvel@email.arizona.edu

February 2004

Bird Conservation Plan for the Colorado River Delta
Baja California and Sonora, México

Version 1.0

February 2004



Osvel Hinojosa-Huerta
Helena Iturribarría-Rojas
Yamilett Carrillo-Guerrero
Meredith de la Garza Treviño
Enrique Zamora-Hernández

Pronatura Sonora
San Luis Río Colorado, Sonora, México

With the Support of the National Fish and Wildlife Foundation

INDEX

BIRD CONSERVATION PLAN FOR THE COLORADO RIVER DELTA

EXECUTIVE SUMMARY

This Bird Conservation Plan (BCP) is a joint effort among agencies, government, and stakeholders that have been working towards the conservation of the Colorado River delta. The general guidelines of the BCP include protecting all bird species, helping species at risk, maintaining common birds common, and basing all actions on collaborative, voluntary efforts for the benefit of birds, their habitats, and people, regardless of political boundaries

Specific objectives of the BCP are to: 1) recover populations of birds that have been extirpated or are in reduced numbers, 2) maintain populations of common birds, and 3) maintain the ecological integrity of the system that provides invaluable functions and services to a diversity of life.

The major components in the process of achieving the Plan included: 1) compilation of existing information, 2) analysis of information gaps, 3) data collection, 4) definition of conservation targets and management recommendations, and 5) definition of recommendations for implementation.

Seven conservation targets, which included a total of 56 focal species, were selected for the Plan: Marshbirds, Colonial Waterbirds, Riparian Birds, Migratory Landbirds, Migratory Waterbirds, Saltgrass Bird Community, and Marine Zone Bird Community.

The criteria for the selection of conservation targets and focal species included their population and habitat status, current threats, endemism, and considerations to cover a wide range of ecological requirements, and to develop effective biological indicators of the system's health.

Analysis of the focal species revealed that:

- Fresh water is the major requirement for the recovery and long term conservation of birds and their habitats in the delta.
- Loss of appropriate habitat structure and size has extirpated or greatly reduced breeding populations of several bird species.
- Recent floods and restoration efforts have recovered part of the wetland and riparian areas, increasing the population of threatened or endangered species.
- There is an urgent need to evaluate population size and trends of many species, as well as the effect of lack of freshwater influx in the Upper Gulf of California and its birds.

Major management recommendations for the Bird Conservation Plan include:

- Secure water sources for the wetlands of the Colorado River delta, including the riparian areas, the marshes at the Ciénega, El Doctor and Hardy River, and the tidal and marine zone.
- Exclude cattle from sensitive areas.
- Establish legal protection mechanisms for the important bird sites in the delta.
- Restore cottonwood-willow forests and mesquite terraces along the floodplain of the Colorado River.

In the process, we also identified eight strategic lines of action for the implementation of the Plan:

1. Collaborate with and enhance the work of the Upper Gulf of California and Colorado River Delta Biosphere Reserve
2. Protect the Colorado River floodplain
3. Develop a Management Plan with the National Water Commission for the floodplain of the Colorado River
4. Purchase water rights to secure flows to the wetland and riparian areas
5. Expand the community-based conservation projects
6. Implement restoration project at priority sites
7. Develop a Program of Environmental Education
8. Develop an outreach and communications program

This is only the first version of the BCP. The plan will be updated as further information about the status and trends of birds and habitat types becomes available, as well with the information resulting from the evaluation of the implementation strategies.

BIRD CONSERVATION PLAN FOR THE COLORADO RIVER DELTA

I - INTRODUCTION

The process of defining conservation priorities has become a critical requirement to achieve recovery objectives for many bird species and their habitats (Dunn et al. 1999, Carter et al. 2000). This need has become more evident as we have realized that bird populations across North America have suffered population declines over the last century (Kushlan et al. 2002, Rich et al. 2003). Causes for these declines are related to the dramatic rate at which habitat has been destroyed, diminishing the area and quality of breeding grounds, wintering areas, and migratory stopover sites (Weller 1988, North American Bird Conservation Initiative 2000).

Wetland and riparian areas have been more susceptible to the effects of increased human activities (National Research Council 1995). In western North America, the patterns are shocking: wetland loss in the California Central Valley is estimated at 95% (Zedler 1988), and loss along the U.S. Pacific coast has been 50% (Helmers 1992).

This trend has been particularly critical in the Sonoran Desert, where the struggle for water between human uses and the environment has dried up most of the riparian forests and wetlands (Brown 1985). The Lower Colorado River is a clear example, as its delta has lost more than 80% of wetland area over the last 80 years (Valdés-Casillas et al. 1998).

Worldwide, loss of wetland and riparian areas is often related to water management practices (Lemly et al. 2000), and this certainly is the case in the Colorado Basin (Lemly 1994, Morrison et al. 1996), where water diversions for human activities have negatively impacted the delta region (Glenn et al. 1996). Nevertheless, agricultural runoff, sporadic flood flows, and their interaction with the tidal regime from the Upper Gulf of California have restored and maintained part of these wetlands, showing that environmentally sound water management could help restore and conserve some avian habitats (Glenn et al. 2001, Zamora-Arroyo et al. 2001).

The interest in restoring the Colorado River delta has been increasing on both sides of the border (Valdés-Casillas et al. 1998, Pitt 2001). Opportunities for restoration have been identified (Briggs and Cornelius 1998, Luecke et al. 1999, Glenn et al. 2001) and these ideas have been discussed in public forums incorporating environmental considerations into the political, social, and economic framework (Varady et al. 2001).

This process has resulted in a binational consensus among stakeholders, agencies, environmental groups, and academia on the importance of developing and implementing a binational conservation/restoration program, based on robust scientific information, which would consider water requirements for wildlife conservation. This was the basis for the development of a Bird Conservation Plan for the Colorado River Delta, which is only the next step in this long term process to ensure the permanence of birds and their habitats in this region.

The Bird Conservation Plan

The BCP for the delta was developed under an existing framework of institutions working toward the conservation of this ecosystem, optimizing the existing constituency among government agencies and stakeholders. The foundation of the plan is to build up a collaborative, non-confrontational approach for bird conservation on a landscape basis, focused on an iterative course of action to update the status of birds, the conservation recommendations, and the strategies for their implementation.

The process of constructing the plan not only included an analysis and generation of scientific information, but also the analysis of threats, the definition of conservation goals, and the definition of management guidelines.

The overall vision of this BCP is to establish criteria for the long-term conservation of avian communities in the Colorado River delta, that will: 1) recover populations of birds that have been extirpated or are in very reduced numbers, 2) maintain the populations of common birds, and 3) maintain the ecological integrity of the system that provides invaluable functions and services to a diversity of life. This process was focused on the generation of guidelines for floodplain activities, management of water flows, and management of agricultural drains, as well as in the identification of priority areas for avian conservation and ecological restoration.

This is only the first version of the BCP. The plan will be updated as further information about the status and trends of birds and habitat types becomes available, as well with the information resulting from the evaluation of the implementation strategies.

The Colorado River Delta

The Colorado River delta has long been recognized as one of the richest regions for wildlife in the southwestern United States and northwestern México (Sykes 1937, Leopold 1953, Glenn et al. 2001). Located in the western edge of the Sonoran Desert, at the common border of the Mexican states of Baja California and Sonora, the delta is surrounded by the driest biomes of the ecoregion.

Prior to the dam era, the cottonwood (*Populus fremontii*) – willow (*Salix gooddingii*) forest was very common in the Colorado River delta, extending over tens of thousands of hectares throughout the Mexicali Valley (Sykes 1937). Thick mesquite bosque (*Prosopis pubescens* and *P. glandulosa*) dominated the upland terraces, in association with arroweed (*Pluchea sericea*) and quail bush (*Atriplex lentiformis*; Mearns 1907). Oxbows, backwaters, and seepage were common, and provided for vast extensions of marshlands (Sykes 1937).

Eighty years later, only 3,000 ha of cottonwood-willow remain, regenerated after excess flows reached the delta, and maintained with "administrative losses" from the irrigation systems (Glenn et al. 2001). The extent of mesquite bosque has been largely diminished, as upland areas have been cleared for agriculture development (Valdés-Casillas et al.1998). Marshlands have been reduced as well, although in a lesser extent (Glenn et al. 1996).

The root causes of ecological decline in the delta are the fundamental changes in water and sediment movement brought on by impoundments and diversions along the river. These have significantly impacted the local avifauna. Ten species of breeding birds and fourteen species that use this area as stopover or wintering ground have required a status of legal protection under Mexican laws (Endangered, Threatened, or Special Protection; Diario Oficial de la Federación [DOF] 2002; Table 1).

Populations of many species have declined regionally, and some have been extirpated locally, including populations of five breeding and two wintering species (Hinojosa-Huerta et al. in press[a]; Table 1). Most affected have been riparian-obligate breeders, waterfowl, and some marshbirds.

Despite these changes, many species still thrive in the region and the Colorado River delta remains one of the best opportunities for biodiversity conservation along the border. Its importance for the conservation of birds has been recognized both nationally and internationally.

In México, a portion of the these wetlands are protected by the Upper Gulf of California and Colorado River Delta Biosphere Reserve (SEMARNAP 1995). The delta is also an Important Bird Area in México (AICA), and a priority site for the conservation of biodiversity as decreed by the National Commission on Biodiversity (CONABIO; Cervantes et al. 1999). This ecosystem has as well been recognized as a wetland of international importance by the Ramsar Convention (Ramsar Convention Bureau 1998), and is part of the Western Hemisphere Shorebird Reserves Network (WHSRN 1993).

Between 1993 and 2003, 353 bird species have been detected in the Colorado delta (Hinojosa-Huerta et al. in press[b], Patten et al. 2001). The delta provides habitat for migratory and wintering waterbirds and for neotropical migrant landbirds (DOF 2002, García-Hernández et al. 2001a, Mellink and Ferreira-Bartrina 2000). Nearly 200,000 shorebirds and 60,000 ducks and geese use the delta wetlands as wintering grounds or for stopover habitat during migration (Morrison et al. 1992, Mellink et al. 1997), and at least 110 species of neotropical migratory landbirds visit the delta during their migratory movements (Patten et al. 2001).

Figure 1. Wetlands of the Colorado River delta, Baja California and Sonora, México

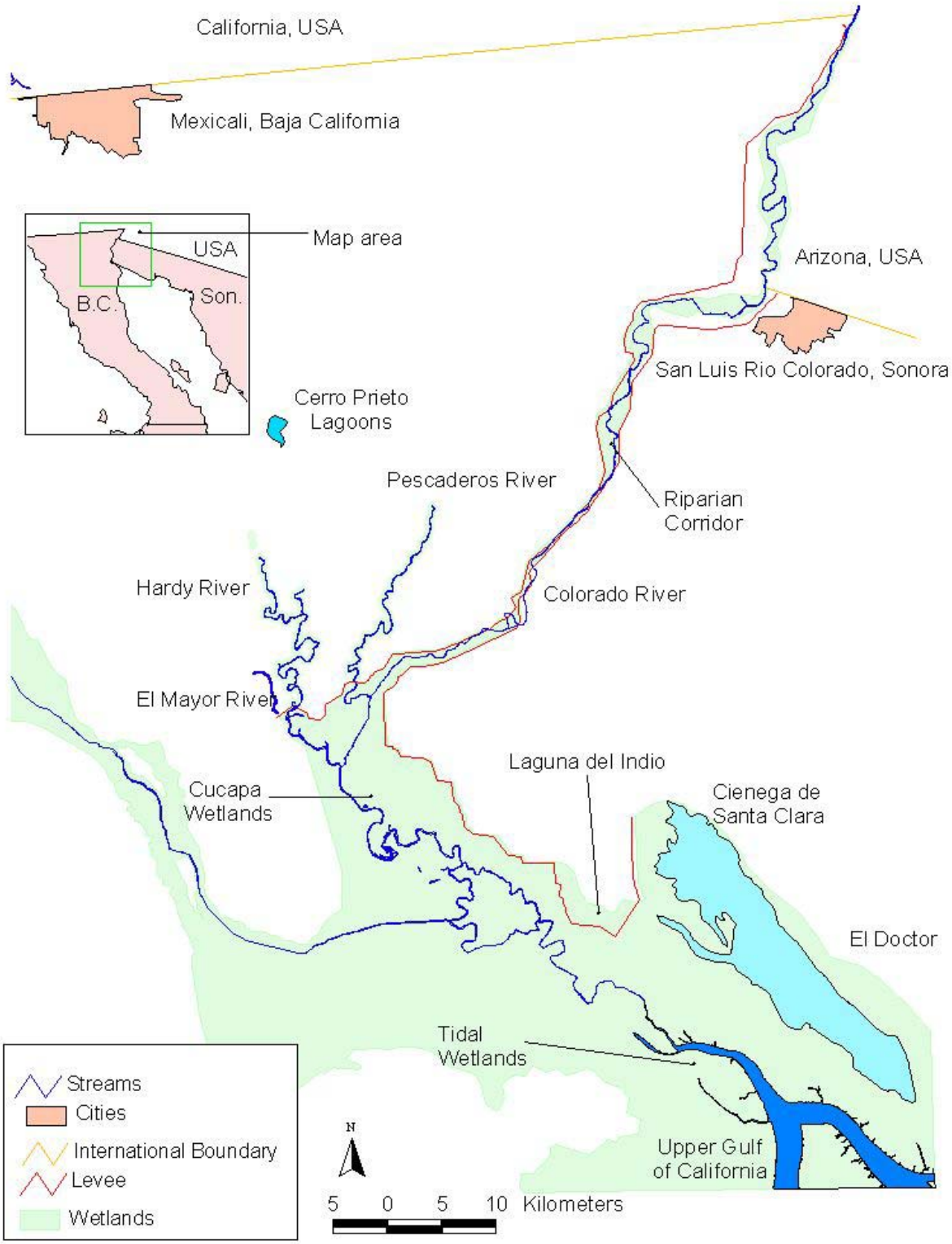


Table 1. Bird species under a protection category in México or of conservation concern in the Colorado River delta. Four codes are given for each species: **Protection Category** in México (SP – Special Protection, TH – Threatened, EN – Endangered, NP – No Protection), **Breeding Status** (NB – Non-breeding, BR – Breeding), **Relative Abundance** (EX – Extirpated, CA – Casual, RA – Rare, UN – Uncommon, CO – Common), and **Temporal Presence** (WI – Winter, SP – Spring, SU – Summer, PE – Perennial). Abundance categories follow Patten et al. (2001).

Species	Protection Category	Breeding Status	Relative Abundance	Temporal Presence
Least Grebe	SP	NB	CA	SU
Laysan Albatross	TH	NB	RA	SP
Black Storm-Petrel	TH	NB	CO	PE
Least Storm-Petrel	TH	NB	CO	PE
Reddish Egret	SP	BR	RA	SU
Roseate Spoonbill[1]	NP	NB	EX	WI
Fulvous Whistling-Duck[1]	NP	BR	EX	SU
Brant	TH	NB	UN	WI
Bald Eagle[2]	EN	NB	UN	WI
Sharp-shinned Hawk	SP	NB	UN	WI
Cooper's Hawk	SP	NB	UN	WI
Harris' Hawk	SP	NB	UN	WI
Red-shouldered Hawk	SP	NB	CA	WI
Swainson's Hawk	SP	NB	UN	WI
Ferruginous Hawk	SP	NB	RA	WI
Peregrine Falcon	SP	NB	UN	WI
Prairie Falcon	SP	NB	RA	WI
California Black Rail	EN	BR	RA	PE
Yuma Clapper Rail[2,3]	TH	BR	CO	PE
Virginia Rail	SP	BR	CO	PE
Sandhill Crane[1]	NP	NB	EX	WI
Snowy Plover[2]	TH	BR	UN	SU
Heermann's Gull	SP	NB	CO	PE
Gull-billed Tern[1]	NP	BR	CO	PE
Elegant Tern	SP	BR	RA	SU
Least Tern[2]	SP	BR	UN	SU
Yellow-billed Cuckoo[1]	NP	BR	UN	SU
Western Screech-Owl[1]	NP	BR	RA	SU
Short-eared Owl	SP	NB	RA	WI
Gilded Flicker[1]	NP	BR	EX	SU
Southwestern Willow Flycatcher[1,2,4]	NP	BR	EX	SU
Bell's Vireo[1]	NP	BR	RA	SU
Lucy's Warbler[1,4]	NP	BR	EX	SU
Summer Tanager[1,4]	NP	BR	EX	SU
Large-billed Savannah Sparrow[3]	SP	BR	CO	SU

[1] Species not under a protection category, but has experienced sharp population declines in the region.
[2] Species also under federal protection in the U.S.
[3] Species endemic to the Colorado River delta.
[4] Breeding population has been extirpated, but still present as transient.

II – THE PROCESS

The major components in the process of achieving the BCP included: 1) compilation of existing information, 2) analysis of information gaps, 3) data collection, 4) analysis of the information, 5) definition of conservation targets and management recommendations, and 6) definition of recommendations for implementation.

Compilation of Information

This component included the compilation and analysis of geographic material, scientific papers, gray literature, field notes, and information from personal interviews with biologists and residents. This yielded a collection of over 100 papers related to birds and their conservation in the Colorado River delta.

All of the reviewed material contributed to a better understanding of the delta system, but several of these papers were basic for the definition of the status of birds or as a baseline of the historic avifauna of the delta. These include the work of Grinell (1928), Rosenberg et al. (1991), Russell and Monson (1998), and Patten et al. (2001), as well as the numerous papers published by Eric Mellink and Eduardo Palacios. In terms of changes in the landscape and vegetation, important benchmarks were the work of Sykes (1937) and Glenn et al. (1996, 2001).

Analysis of Information Gaps

The second step was an analysis of gaps in the existing information of the birds in the Colorado River delta, which we conducted based on the compiled information. The major gaps identified were:

- A comprehensive summary of the status of birds in the whole region, incorporating data from the Sonora and Baja California portion.
- Population estimates and trends, in particular for those species already recognized as critical in the delta.
- The general condition of the riparian birds and their habitats, as well as the effects of river changes on their populations

- An assessment of the use of the delta as a stopover site by migratory landbirds.
- The status of the birds that now depend upon the agricultural fields of the Mexicali Valley.

Data Collection

This assessment provided the basis for the design of the field studies to collect data. This component included several activities: 1) assessment of the birds of the floodplain of the Colorado River, with monthly point counts at 240 survey stations during 15 months and a MAPS station (DeSante et al. 2003), 2) marshbird (call-response) surveys following the Standardized Protocols to Monitor Marshbirds in North America (Conway 2002) , 3) determination of abundance, species composition, and habitat use of landbirds during spring migration, with intensive mist-netting, 4) assessment of birds in the agricultural lands, in particular Burrowing Owls (Iturribarría-Rojas 2002), and 5) compilation of noteworthy bird records to update the status of birds.

Analysis

The collected information was integrated in a relational database, and in the Geographic Information System of the Colorado River delta. This information has been used to continuously update the status of birds and to prepare an annotated checklist. The data has been analyzed to produce population estimates and trends when possible, as well to define the condition of birds in the different habitat types and ecozones of the delta.

Definition of Conservation Targets, Focal Species, and Management Recommendations

Bird Conservation Targets were selected in order to define the management recommendations for the conservation of birds and their habitats. The targets were defined as bird groups with similar habitat requirements, thus sharing similar pressures and needs. Besides a complete list of species that conforms each group, we also defined focal species within each target, in order to further refine the habitat management implications and facilitate monitoring and evaluation efforts.

A preliminary list of conservation targets was prepared, based on existing information of the status of birds and habitat types in the Colorado River delta. Emphasis was placed on bird groups whose habitats have been deteriorated in the delta, and which included endangered and threatened species or whose populations in the region have declined drastically. Bird groups with species whose breeding populations have been extirpated and might be recovered with restoration efforts were also considered.

A list of focal species was selected for each group, considering the most representative birds which might cover the habitat needs of all the species within the group, and function as indicators in monitoring efforts. Focal birds also included key species within the delta ecosystem, as well as endemics and those that require special attention due their status (endangered or threatened).

The preliminary list was analyzed and discussed by an expert panel to define a final list of targets and species. This process was part of the Workshop to Identify Conservation Priorities in the Colorado River Delta, held in Tijuana, Baja California on October 14-17, 2002. The panel included expertise in different topics of ornithology and bird conservation (see Appendix A for list of participants). The discussions and final selections were based on the purpose of guiding conservation and restoration efforts in the Colorado River delta, and providing insight of the role of the delta ecosystem at the regional and hemispheric scales.

The analysis was continued to the selection of a network of priority sites in the Colorado River delta that, with proper management, could ensure the long-term persistence of the delta avifauna, including rare and common species, their habitats, and the ecological processes that maintains the integrity of the ecosystem.

This analysis also yielded the following products: 1) restoration potential of priority conservation sites, 2) assessment of the quantity, quality, and timing of water flows required to support each of the identified sites and habitat types, and 3) a state-of-knowledge and gap analysis identifying priority research needs and resources required to implement them. This information was integrated in the management recommendations for each of the conservation targets.

Finally, all this information was put together in this Bird Conservation Plan, that was further reviewed by the participants in the workshop, as well as ngo's, government agencies, and academia (Appendix B).

III - ECOZONES OF THE COLORADO RIVER DELTA

The Colorado delta is undoubtedly an altered environment, and restoration to its original state is practically impossible. Nevertheless it remains an oasis of life in the middle of the desert. The actual delta supports a rich avifauna thanks to the resilience of this ecosystem and non-conventional water sources, such as administrative losses, agricultural drainage, and municipal discharges. Some areas maintain a larger number of species and individuals, but each habitat type supports a characteristic avian community of its own.

The delta ecosystem covers 169,000 ha and supports an array of contrasting ecozones, ranging from the harsh desert to the productive wetlands (Fig.2, Table 2). For the BCP, we did not considered the open desert areas, rocky mountains, urban zones, and dry flats of the region.

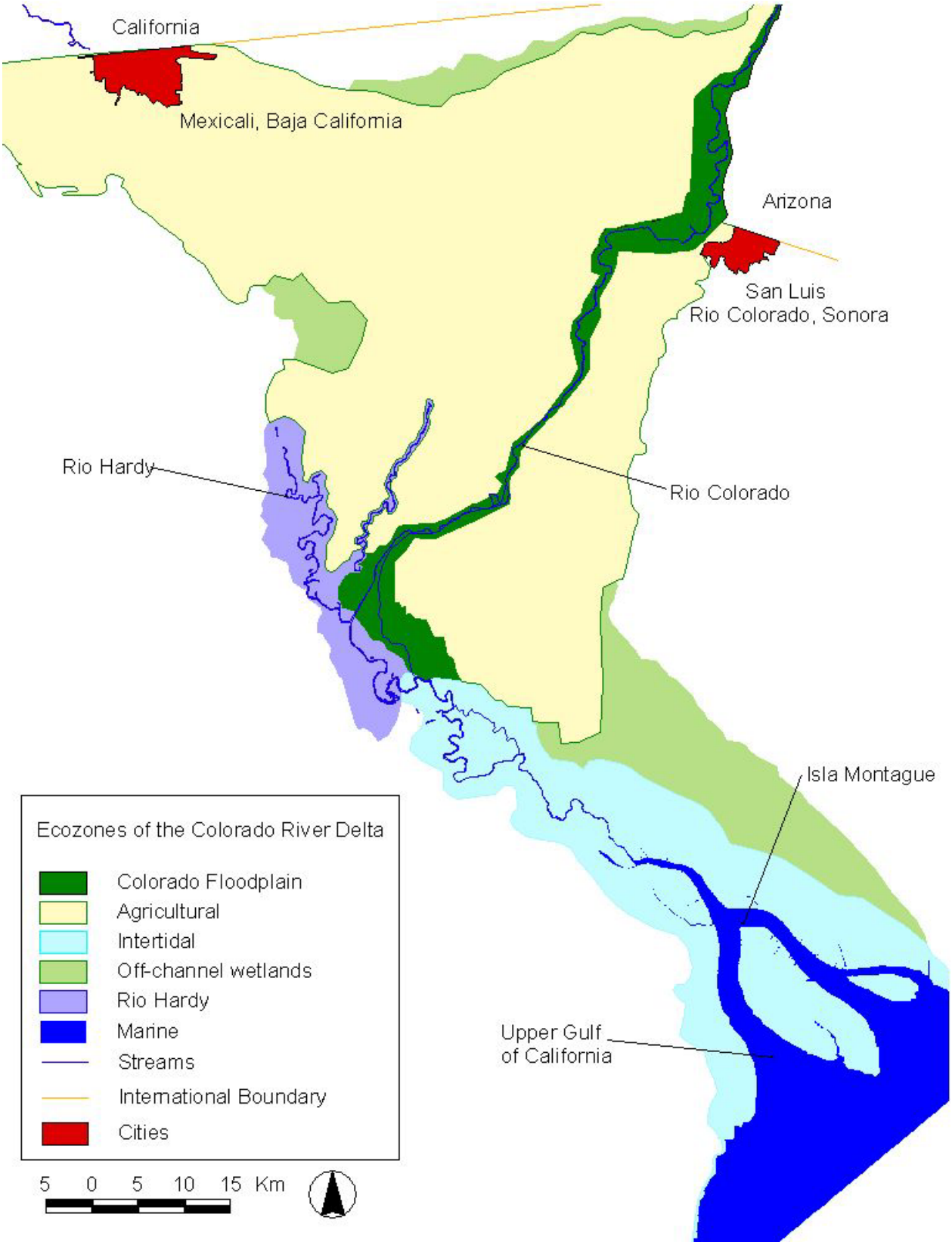
The major ecozones in the Colorado River delta included in the plan are:

- The Colorado River floodplain
- The Wetlands of the Hardy River
- Off-channel Wetlands
- The Intertidal and Marine Zone
- Agricultural Areas

Table 2. Ecozones of the Colorado River delta, México.

Ecozone	Hectares	Included Areas	Habitat Types	Main Threats
Colorado Floodplain	20,000	Colorado River, from Morelos dam to the confluence with the Hardy River	Cottonwood-willow-saltcedar riparian forests	Lack of instream flow and pulse floods
Hardy River	16,000	Hardy and Pescaderos Basin, from Cerro Prieto to the confluence with the Colorado River	Open water canals and saltcedar-cattail marshes	Reduced flow and increased salinity
Off-channel Wetlands	23,450	Cienega de Santa Clara, El Doctor, Cerro Prieto, Laguna del Indio, and Andrade Mesa Wetlands	Cattail marshes, mudflats and lagoons	Unreliable water sources and cattle grazing
Intertidal and Marine Zone	110,000	Confluence of Hardy-Colorado to El Golfo de Santa Clara and San Felipe	Mudflats, saltgrass, and open marine areas	Lack of freshwater inflows and sediments
Agricultural Areas	208,000	Mexicali Agricultural Valley	Agricultural fields, levees, and drains	Contaminants and habitat loss due to agricultural expansion

Figure 2. Ecozones of the Colorado River delta, México.



Major Threats

As in other delta ecosystems worldwide, insufficient and unreliable water supplies and poor water quality are the ultimate causes of environmental degradation in the Colorado River delta, intensified in this particular case for its location in an arid ecoregion.

The use of the river's water is governed by a complex set of legal and administrative agreements known collectively as the Law of the River (Luecke et al. 1999). This group of agreements gives the lowest priority to uses such as maintaining a flow in the river to support plants, fish, and wildlife, and it doesn't consider water allocation to maintain the delta's ecological health in the Mexican side of the river.

Lower basin states in the U.S. are now using their full entitlement of water from the river and are working to secure access to additional supplies (Cornelius et al. 2004). The environment in the Mexican portion of the Colorado River depends almost entirely on "administrative losses" (Zamora-Arroyo et al. 2001), and plans are to further channelize the river, in order to avoid flooding. In the United States, criteria for retaining surplus water for human use are being revised. To date, little or no water reaches the Gulf of California.

Most of the present delta vegetation has been enhanced and maintained by flood releases over the last 20 years (Glenn et al. 1996), restoring in part the willow-cottonwood stands. However, lack of yearly flooding regime inhibits riverbank salt washing and augments the tidal influence, causing soil salinity to increase. This allows invasive exotic plants, such as saltcedar (*Tamarix ramosissima*), to colonize vast areas, decreasing habitat value.

Some native bird species have expanded their range and increased their populations in western North America in relation to increased human activities. Most notorious have been Red-winged Blackbirds (*Agelaius phoeniceus*) and Brown-headed Cowbirds (*Molothrus ater*). The effect of the expansion of these species has not been evaluated in the Colorado River delta. However, the impacts of cowbirds have been carefully evaluated in other riparian areas of the Sonoran Desert, showing that habitat fragmentation and intensified farming practices have increased the nest parasitism success of cowbirds, causing population declines in riparian-dependant songbirds (Robinson 1999, Averill-Murray et al. 1999, Powell and Steidl 2000).

COLORADO RIVER FLOODPLAIN

During the years of intense floods in the 1980s, the National Water Commission (CNA) constructed protection levees on each side of the Colorado River banks to prevent flooding of agricultural lands (CNA 1997). The levees surround the main stream of the Colorado River as well as a major part of the Hardy River Basin. Besides of functioning as a flood control structure, the levees have worked for salinity control, and they have also been the delimitation margins between human developed areas and natural areas. It is important to mention that the river is not perennial, it only flows when surplus water is released from the United States.

Plant cover in the corridor varies in density, species composition, and habitat value according to its position in the flood plain. In general, the average vegetation cover for the floodplain is 70.45%, of which 88% is comprised by shrubs and trees (Table 3). Native plants average a cover of 33.71%, while exotic plants cover 36.74%. Cottonwood and willow trees cover 7.84% of the floodplain, while saltcedar covers 34.73%. Other common trees are honey mesquite (*Prosopis glandulosa*) and screwbean mesquite (*Prosopis pubescens*). Saltcedar is the most common shrub; followed by arroweed, seep willow (*Baccharis salicifolia*), and saltbush (*Atriplex* spp). Cattail (*Typha domengensis*) is the dominant emergent species, but common reed (*Phragmytes australis*) and bulrush (*Scirpus* spp.) are also present.

Three different sections can be distinguished in the floodplain during its progression from Morelos Dam towards the Gulf of California (Fig. 3), with important changes in vegetation structure, species composition, hydrology, and water quality.

From north to south, the first section of the corridor is the 25 km stretch of the river that divides Arizona from Baja California, starting at Morelos Dam and ending at San Luis Río Colorado. This segment has been identified as one of the few areas that support significant extensions of native riparian trees in the Lower Colorado Basin (Hinojosa-Huerta et al. 2003) yet, there are nearly 3,000 ha of agricultural fields within the levees (Carrillo-Guerrero 2001). The first 10 km south of Morelos Dam are narrow and contain 170 ha of dense thickets of willow, most of which are under 4 m in height with older plants reaching 8-15 m. Although cottonwood trees are also found along this reach, they appear only as isolated individuals. The next 15 km stretch is much wider and less heavily vegetated, but still supports significant stands of trees in local areas. Data from bird surveys (Hinojosa-Huerta et al. 2003) show that willows and cottonwoods cover

around 30% of the total ground area, saltcedar has an average cover of 23.75%, while mesquite trees are very rare (only 0.79% of the cover), shrubs other than saltcedar cover 12.55% and are dominated by arroweed, seep willow, and saltbush. Another noteworthy feature of the vegetation is the presence of emergent vegetation within the river (approximately 12 ha).

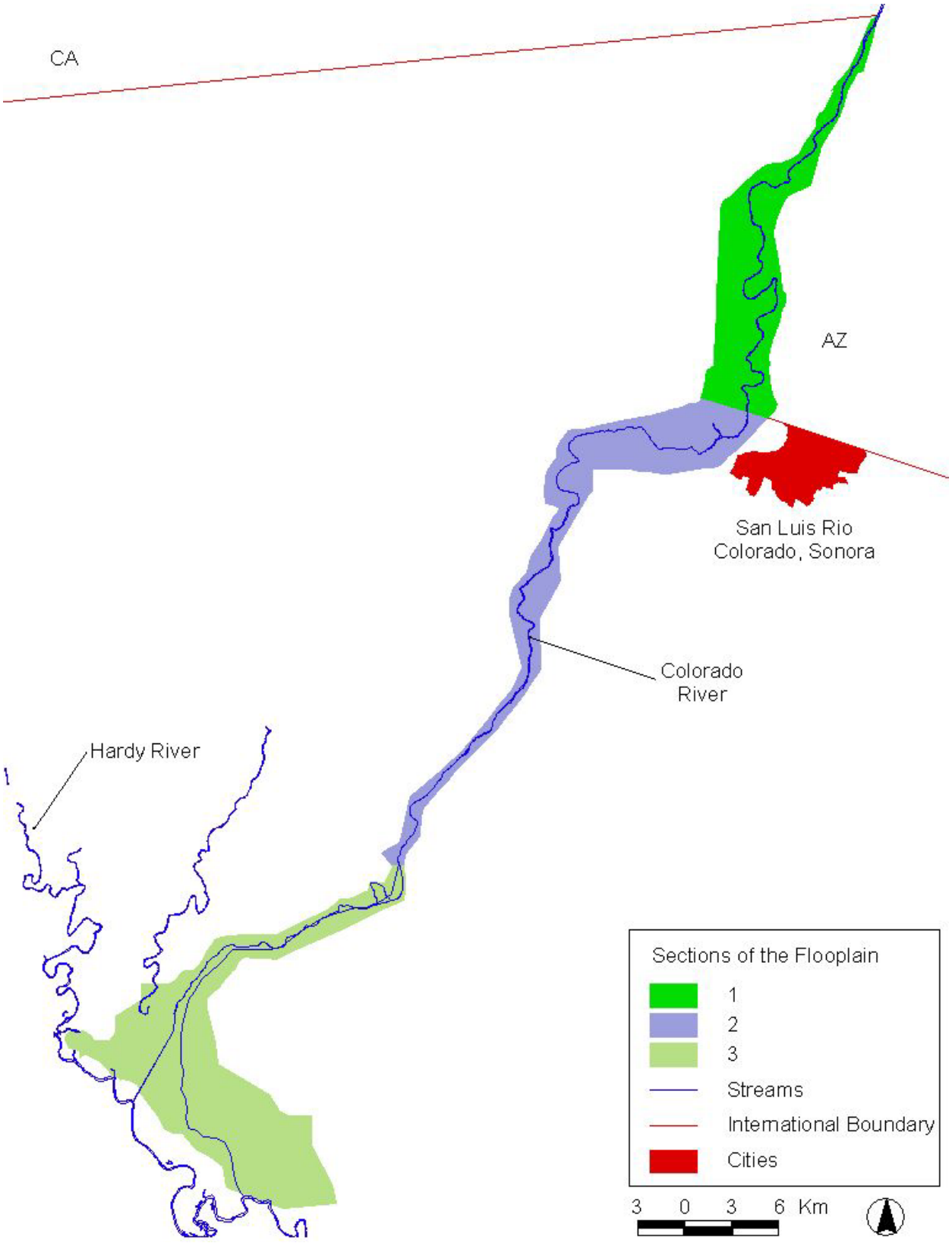
The second zone goes from San Luis Río Colorado to the railroad bridge around Colonias Nuevas. The composition and general diversity of this stretch is similar to the south portion of the first zone, although here cottonwood dominates with a mid and understory dominated by willow and saltcedar. The largest trees are up to 15 m in height.

The third portion ends with the last stands of cottonwoods and willows. Although numerous pockets of cottonwood and willow are still found along the main river channel, they constitute a lower portion of those existing in the upper stretches of the river. Over 70% of this zone is dominated by a mixture of saltcedar, mesquite, and significant numbers of large saltbush plants.

Table 3. Average cover and height (in meters) of vegetation strata in the floodplain of the Colorado River in México. Confidence intervals (95%) are given in parenthesis. Depth is provided for water (in centimeters).

Strata	Avg. Cover	Avg. Height
Trees	27.55 (24.82 - 30.28)	4.63 (4.45 - 4.85)
Shrubs	35.04 (32.35 - 37.72)	1.72 (1.68 - 1.76)
Emergent	5.40 (4.32 - 6.49)	2.06 (1.94 - 2.18)
Herbs	1.93 (1.43 - 2.43)	0.39 (0.31 - 0.47)
Forbs	0.52 (0.16 - 0.87)	0.12 (0.09 - 0.154)
Water	5.65 (4.59 - 6.71)	34.04 (28.76 - 39.32)
Bare Soil	23.89 (21.46 - 26.32)	-

Figure 3. Sections of the Colorado River Floodplain in México.



Threats to the Colorado River Floodplain

The main threat to the floodplain is probably the lack of vision at the river as another user that needs water allocation. The riparian areas have been drastically reduced all along the Lower Colorado River, due to river impoundment, diversions, and agricultural activities. This has led to the regulation of river flows and lack of over bank flooding, causing dramatic ecological degradation, including population declines in riparian birds and other wildlife.

The natural flood regime helped wash the riverbank salts and helped germinate native trees (Levine and Stromberg 2001). Now the soil is saltier and saltcedar, in association with native halophytes, has replaced the native forest, in some parts even growing in homogeneous stands.

Human induced fires are a constant threat in the floodplain. Fires have been extensive across the corridor, in particular during the summer of 2001. Fires also change plant species composition; exotic invasive species out compete native trees in the establishment stage due to their salt and drought tolerance.

HARDY RIVER

The wetland system of the Hardy River is located on the western side of the Colorado River delta, at the southern portion of the Mexicali Valley. This river travels through 26 km, joining the Colorado River downstream. This area was covered by extensive areas of riparian vegetation, surrounded by dense forests of mesquite (Valdés-Casillas et al. 1998).

The Hardy is now a channel fed by agricultural return flows, and this corridor also includes Pescaderos River (also fed by agricultural drainage) and part of the confluence area with the Colorado River, so it flows continually. The size and habitat quality of these wetlands have varied drastically over the last decades, in relation to the amount and quality of water they receive.

Wetlands of the Hardy River became apparent after the 1930's floods in the delta, when a sandbar 35 km upstream from the Upper Gulf of California, blocked the exit of water from the western delta (Glenn et al. 1996). By 1937, Hoover Dam was completed and Lake Mead began to fill. In 1964 Glen Canyon Dam was built and Lake Powell began to fill. Even though no flood water reached the delta for 35 years, a large wetland area of about 18,200 hectares was formed

north of the sandbar, supporting large areas of emergent and riparian vegetation (Glenn et al. 1996). After the major flooding on the Colorado in 1983, and until 1989, when México received surplus water through the Colorado River, the Hardy Wetlands grew to some 66,400 hectares. After that, the wetlands shrunk to approximately 1,200 hectares, in part because in 1987 the floods destroyed the sandbar, and the wetlands began to be drained (Glenn et al. 1996).

Considering all remaining wetlands in the Colorado River delta, the Hardy Complex is one of the most important, as it provides a wintering area for migratory birds, including waterfowl and shorebirds. This is the only extensive brackish wetland in the delta that has been historically supported by Mexican water, and if proper management strategies are implemented, it represents the largest area subject to potential restoration and habitat improvement in the Colorado River delta. Potential additional water could be allocated to the Hardy from new wastewater treatment plants in Mexicali.

Below the junction of the Colorado and the Hardy Rivers, the flow is perennial. It carries agricultural return flows from the agricultural valley, and is influenced by tides, hence the water and river banks are saline (Glen et al. 1996). The river divides into numerous braided channels, with the area between them dominated by saltcedar. In addition, the emergent plants like common reed and cattail grow along the river canal and banks (Glenn et al. 2001).

Threats to the Hardy River

Being one of the last portions of the Colorado River basin, the Hardy River has been used as a recipient of drainage water. The Mexicali Valley has 17 agricultural drains (3 primary and 14 secondary drains), which flow directly into the Hardy River system. They carry an annual volume of 6.33×10^7 m^3 (CNA 1997), with a total of 70,000 tons of fertilizers/year and 400,000 liters of insecticides/year (Dirección General de Ecología 1995). The average salinity of the drains is of 3 ppm (CNA 1997), which is not tolerable by most of the native riparian vegetation.

Most of the land surrounding the northern edge of the Hardy Wetlands has been targeted for agricultural use. Extensive marshes have been desiccated; instead, flat saline plains remain, and many riparian areas have been occupied by saltcedar, that has taken advantage of a modified floodplain that is not suitable for native species.

Selenium affects water quality in the Hardy wetlands. Selenium is dissolved by irrigation water, and then evaporation increases its concentration in both water and sediments. The highest concentrations in the delta are found in the Hardy confluence (García-Hernández et al. 2001b). Selenium levels often are higher than the U.S. EPA and Mexican official permitted levels.

OFF-CHANNEL WETLANDS

The off-channel wetlands include the Ciénega de Santa Clara, El Doctor, Laguna del Indio, the Andrade Mesa Wetlands, and the Cerro Prieto ponds. These are freshwater and brackish wetlands in the Colorado River delta apart from the floodplain, related to wastewater discharge points, seepage, artesian springs, and tidal influenced areas (Briggs and Cornelius 1997). These areas are a critical component of the Lower Colorado River and delta system and are dominated mostly by soft-stemmed emergent plants such as cattails, bulrushes (*Scirpus americanus*), and reeds (Felger 2000).

Ciénega de Santa Clara

The Ciénega de Santa Clara is the largest marsh in the Sonoran Desert, encompassing about 5,800 ha of cattail dominated areas interspersed with open lagoons, and over 12,000 ha of shallow pools and mudflats that extends towards the Upper Gulf of California (Glenn et al. 1992, Zengel et al. 1995). The Ciénega is maintained by discharge of agricultural waste water from the Welton-Mohawk Irrigation District via the main outlet drain extension (MODE) canal and local agricultural drain water (Glenn et al. 1996).

The Ciénega is home to the largest population of Yuma Clapper Rails (*Rallus longirostris yumanensis*; Hinojosa-Huerta et al. 2001a) and a major portion of the population of the desert pupfish (*Cyprinodon macularius*; Zengel and Glenn 1996). It is a major stopover for migratory waterfowl on the Pacific Flyway, and support different human activities such as ecotourism, hunting, and fishing. In 1993, the Ciénega was included in the Upper Gulf of California and Colorado River Delta Biosphere Reserve (SEMARNAP 1995).

Threats to the Ciénega

There are plans to divert the water from the Welton-Mohawk canal to the Yuma Desalting Plant in Arizona, and sell the treated water for urban, industrial, or agricultural uses (Pitt et al. 2003). This is the main threat to the Ciénega. The Welton-Mohawk canal was created as a temporal answer to the salinity problems between the United States and México, until the completion of the Desalting Plant. In the meantime, this brackish water discharge created the Ciénega as we know it.

At date, the Yuma Desalting Plant is not working, but budget has been approved to upgrade the plant and prepare it for operation (Pitt et al. 2003). If the plant operates, it would divert the agricultural wastewater flows from the Ciénega and replace them with concentrated brine. This would greatly reduce the coverage of emergent vegetation in the Ciénega, impacting wildlife as well as local residents.

Selenium concentrations in drain water entering the Ciénega are 2.5 times higher than those in water at Imperial Dam in the United States (García-Hernández et al. 2000). However, samples of sediments, plants, and fish showed concentrations not considered hazardous for wildlife or humans (García-Hernández et al. 2001b).

El Doctor Wetlands

El Doctor wetlands extend along the escarpment that separates the Sonoran Desert Mesa with the Colorado River delta floodplain, covering about 750 ha of marsh, microphyll woodland, saltflats, and open water areas, fed by natural springs (Ezcurra et al. 1988). These wetlands support 22 species of plants, including mesquite and saltcedar stands (Glenn et al. 2001) surrounded by dune vegetation dominated by creosote bush. This wetland serves as a critical stopover for neotropical migratory landbirds.

Threats to El Doctor

These wetlands have been impacted by ground water pumping in the San Luis Mesa and in nearby areas. This has reduced the available water and increased salinity, favoring the establishment of the invasive and exotic saltcedar.

The presence of cattle also has caused a severe impact at El Doctor, damaging emergent vegetation and limiting recruitment of native trees.

Laguna del Indio Wetlands

The Laguna del Indio is a brackish marshland located in the southeastern side of the delta, within the boundary of the Biosphere Reserve. It is dominated by saltcedar, cattails and other emergent hydrophytes in areas flooded with agricultural drainage water (Briggs et al. 2002). It occupies an area of approximately 100 ha.

Threats to El Indio

Laguna del Indio is a final reservoir for agricultural drainage in the eastern side of the Mexicali Valley. Restoration efforts have favored the establishment of emergent vegetation over saltcedar and the maintenance of open water areas (Briggs et al. 2002), but there is still a critical need to manage water flows and quality to limit the growth of saltcedar. On the other hand, with water shortages in the region, there are plans to use part of this water for several local human uses.

Andrade Mesa Wetlands

The Andrade Mesa Wetlands currently supports a unique set of wetlands in México that combine characteristics of freshwater and saltwater marshes with dunes between lagoons. There are at least six wetland groups extending over 6,200 ha along the U.S.-México border supported by seepage from the All-American Canal (Hinojosa-Huerta et al. 2002a). This area is a depression in the dunes where seepage water surfaces, and they support three habitat types: 1) marshes, consisting of open water and emergent vegetation; 2) playas, consisting of dry lakebeds vegetated with saltgrass; and 3) vegetated dunes, colonized by phreatophytic shrubs, mostly honey mesquite, creosote bush (*Larrea tridentate*) and saltcedar; and different halophytes like arroweed and chenopod shrubs (*Sueada torreyana, Allenrolfea occidentalis,* and *Atriplex canescens*; Hinojosa-Huerta et al. 2002a).

Threats to the Andrade Mesa Wetlands

Farmers in the Mexicali Valley pump water in the border region that seeps from the All-American Canal. This groundwater is also the source that maintains these wetlands. Recently, Nevada and California have proposed the lining of the All American Canal in California. This action would substantially capture water that now recharges the aquifer and will cut off the flow to over half of these wetlands (Hinojosa-Huerta et al. 2002a).

Cerro Prieto Ponds

The Cerro Prieto Geothermal Ponds are located in the western Mexicali Valley, north of the Hardy River. Cerro Prieto is a complex of levees that contain water pumped from geothermal wells for electricity generation. There are also several water impoundments, sometimes creating small islands, generally bare, but in some cases heavily vegetated with the halophytic shrub *Allenrolfea occidentalis*, providing nesting ground for several species of colonial waterbirds and other birds (Molina and Garret 2001). This place is probably a link between the other Lower Colorado breeding sites (Montague Island) and the Salton Sea for these colonial waterbirds.

Threats to Cerro Prieto

The ponds are fed with residual water from the geothermal facility, containing significant amounts of minerals and heavy metals at which wildlife is exposed. Breeding birds nest in the ground, thus operations in the Geothermal Plant may destroy nests or potential breeding spots.

INTERTIDAL AND MARINE ZONES

The intertidal and marine zones are at the very end of the Colorado River, where freshwater shortages have been more severe. Yet, this area also supports a rich avifauna as well as important fisheries. All of this zone is part of the Biosphere Reserve.

Intertidal Zone

The intertidal area experiences one of the largest tidal ranges in the world (up to 10 meters), an ebb that extends the estuary 56 km upstream, spreading over thousands of hectares (Glenn et al.

2001). This zone also includes Montague and Pelicano Islands, at the mouth of the river. These islands have been formed with silt deposited by the Colorado River at the very end of its delta.

Palmer's saltgrass (*Distichlis palmerii*), endemic to this region, is the dominant plant on the banks of the river and on Montague Island (Felger 2000). This zone is poorly vegetated, as the high tide inundates and deposits mud in the banks (Glenn et al. 2001). As such, it is one of the most important concentration sites for wintering shorebirds in the continent, as well as a critical breeding ground for colonial waterbirds (Mellink et al. 1996, Peresbarbosa and Mellink 2001).

Threats to the Intertidal Zone

Lack of freshwater flow from the river inhibits reproduction and germination of the saltgrass. On a broader scale, this has impacted the whole aquatic food chain (Rodríguez et al. 2001). The impoundments have also blocked the flow of sediment. The loss of sediments in the delta due to tidal currents and wave action is now much greater than the accretion of sediments by river transport. The net effect is that the delta has entered a destructive phase (Alles 2003).

The Marine Zone

Shallow and turbid waters characterize the marine portion of the delta (60% of the Upper Gulf has 200 m in depth or less). This zone has a high concentration of nutrients and photosynthetic pigments, being highly productive due the high dynamism of currents and tides (Álvarez-Borrego et al. 1975). Despite the changes and impacts caused by the reduction of freshwater influx, this zone is still very productive, sustaining several commercial fisheries.

This area provides important foraging areas for waterbirds that breed in the central Gulf of California, as well as for many that breed in the delta and Salton Sea. It also provides habitat for the endangered Vaquita (*Phocoena sinus*) and Totoaba (*Totoaba macdonaldi*; Glenn et al. 2001).

Threats to the Marine Zone

The reduced inflows of freshwater has not affected primary productivity, but it has drastically changed the salinity of this zone. When freshwater reaches this region, salinity ranges in the 26-

32 ppt (Valdés-Casillas et al. 1998, Lavín and Sánchez 1999) whereas during the now common periods of limited freshwater, salinity ranges in the 35-45 ppt (Glenn et al. 2001). This change in salinity has profoundly altered the circulation in the Upper Gulf, that used to be driven by the influx of freshwater, extending its effects 60 km south of the river mouth (Carbajal et al. 1997). Nowadays, circulations are driven by the evaporation of marine water, with limited mixing, characteristic of a negative estuary (Lavín et al. 1998).

The sediment load and the river born nutrients that used to sustain the diverse and productive marine life at this region are now being trapped in the dams along the Colorado River. This has resulted in tremendous impacts, that we are just beginning to understand, including a drastic reduction in densities of bivalve mollusks, in particular of the endemic Colorado delta clam (*Mulinia coloradoensis*; Kowaleski et al. 2000, Rodriguez et al. 2001), and the reduction in shrimp catches (Galindo-Bect et al. 2000).

However, the full extent of this impacts on other organisms, including birds, is still unknown. It is also unclear what are the requirements, in terms of freshwater quantity, to restore the intertidal and marine zones of the Colorado River delta.

AGRICULTURAL AREAS

Much of the upper delta has been converted to farmland; levees and channels have changed the landscape. The Mexicali Valley has become the most important agricultural area in Baja California and one of the largest in the country. The valley comprises 208,000 ha of farmland, most of which is cultivated with wheat, alfalfa, and cotton (Ayuntamiento de Mexicali 2002).

The history of the Mexicali Valley is related directly to the development of agriculture in the region. In 1892, the Colorado River Irrigation Company began using the Colorado River water for agricultural purposes. However, it was not until early in the 20th century when the first human settlements were established in the northern part of the municipality (Sánchez-Ramírez 1990).

In response to the agricultural crisis of the 1960s, the Mexican government began the rehabilitation of the Mexicali Irrigation District (Ortega-Villa 1991). This effort resulted in a 15% increase of land available for agriculture (Ortega-Villa 1991). During the last two decades,

actions have focused in maintaining existing infrastructure, repairing the damages caused by floods, and preparing the riverbed and levees in order to minimize flood damages (CNA 1997).

Even though the Mexicali Valley is an artificial environment, there are various species of wildlife that have benefited from these changes. This has been possible in part because agricultural activities have not been heavily industrialized, and wildlife habitat has been maintained at the edges of the fields and along agricultural drains.

Threats to Wildlife at the Agricultural Areas

The major threat in this zone is that almost all of the considerations for management are directed to the optimization of agricultural yield, setting aside the potential benefits that this agrosystem can provide to wildlife and alternative economic uses, such as hunting and ecotourism. In this sense, the existing benefits for birds in the farmlands could be reduced if management practices are geared towards industrialization of agriculture in this region.

As in most agricultural systems, the risk of contamination from pesticides is present. This has started to be evaluated, and apparently the risk is low (García-Hernández 2004), but further monitoring is required.

IV - CONSERVATION TARGETS AND FOCAL SPECIES

The conservation targets are the centerpiece of the BCP, as they set the guidelines for the definition of conservation priorities, and their focal species help to provide the details for the management recommendations.

Seven bird groups were included in the list of conservation targets, with a selection of 56 focal species, covering a wide range of habitat requirements. The final list of targets include:

- Marshbirds
- Colonial Waterbirds
- Riparian Birds
- Migratory Landbirds
- Migratory Waterbirds
- Saltgrass Bird Community
- Marine Zone Bird Community

MARSHBIRDS

This conservation target include species from two families: Rallidae and Ardeidae (Table 4). These birds strongly depend upon the emergent vegetation of freshwater and brackish marshes. The focal species for this conservation target are: Yuma Clapper Rail, California Black Rail (*Laterallus jamaicensis coturniculus*), Least Bittern (*Ixobrychus exilis*), and Virginia Rail (*Rallus limicola*).

The overall goal for this target is maintaining a dynamic system of marsh areas in the Colorado River delta that secures the preservation of these birds. Specific goals include conserving existing marshlands (Ciénega de Santa Clara and El Doctor), restore or enhance degraded areas (Hardy and Colorado rivers), limit the expansion of saltcedar, and protect the marshes from cattle.

From this species, the Yuma Clapper Rail is endemic to the Lower Colorado River and its delta, and is listed as Endangered in the U.S. and Threatened in México (Eddleman and Conway 1998, DOF 2002). The California Black Rail is listed as Endangered in México and in California, and is a candidate species to be listed in the United States (California Department of Fish and Game 1999, DOF 2002).

Table 4. Conservation targets and focal species of the Colorado River delta.

	México Status	US Status	Relative Abundance	Breeding Status	Habitat Status & Trend	Continental Assessments
Marshbirds						
Least Bittern	NP	NP	CO	BR	CO→	NWCP-NR
Yuma Clapper Rail	TH	EN	CO	BR	CO→	NWCP-NR
Virginia Rail	SP	NP	CO	BR	UN→	NWCP-NR
California Black Rail	EN	CS	RA	BR	EN ↓	NWCP-NR
Nesting Waterbirds						
Snowy Egret	NP	NP	CO	BR	UN ↓	NWCP-HC
Snowy Plover	TH	EN	RA	BR	TH ↓	SHCP - HI
Gull-billed Tern	NP	CS	UN	BR	UN→	NWCP-HC
Black Skimmer	NP	NP	UN	BR	UN→	NWCP-HC
Riparian Birds						
Fulvous Whistling-Duck	NP	NP	EX	HB	NE -	NAWMP-NT
Yellow-billed Cuckoo	NP	CS	RA	BR	EN ↑	LCP-NC
Southwestern Willow Flycatcher	NP	EN	EX	HB	NE -	LCP-TH&D
Vermillion Flycatcher	NP	NP	UN	BR	UN ↑	LCP-NC
Bell's Vireo	NP	NP	RA	BR	NE -	LCP-TH&D
Crissal Thrasher	NP	NP	UN	BR	CO ↑	LCP-P&R
Lucy's Warbler	NP	NP	EX	HB	NE -	LCP-RR
Yellow-breasted Chat	NP	NP	RA	BR	UN ↑	LCP-NC
Song Sparrow	NP	NP	CO	BR	CO ↑	LCP-NC
Brown-headed Cowbird	NP	NP	CO	BR	CO ↑	LCP-NC
Bullock's Oriole	NP	NP	UN	BR	UN ↑	LCP-NC
Migratory Landbirds						
Rufous Hummingbird	NP	NP	RA	NB	TH ↓	LCP-TH&D
Pacific-slope Flycatcher	NP	NP	CO	NB	UN ↓	LCP-P&R
Warbling Vireo	NP	NP	CO	NB	UN ↓	LCP-NC
Swainson's Thrush	NP	NP	CO	NB	UN ↓	LCP-NC
Wilson's Warbler	NP	NP	CO	NB	UN ↓	LCP-NC
Western Tanager	NP	NP	CO	NB	UN ↓	LCP-NC
Saltgrass Avian Community						
Large-billed Savannah Sparrow	SP	NP	UN	BR	TH ↓	LCP-NC
Marine Zone Avian Community						
Eared Grebe	NP	NP	CO	NB	CO→	NWCP-MC
Black Storm-Petrel	TH	NP	CO	PB	CO→	NWCP-HC
Brown Pelican	NP	EN	CO	NB	CO→	NWCP-MC
Migratory Waterbirds						
Snow Goose	NP	NP	CO	NB	UN ↓	NAWMP-IN
American Wigeon	NP	NP	CO	NB	UN ↓	NAWMP-IN
Cinnamon Teal	NP	NP	CO	BR	UN ↓	NAWMP-IN
Northern Shoveler	NP	NP	CO	NB	UN ↓	NAWMP-IN
Black-bellied Plover	NP	NP	UN	NB	UN→	SHCP - MC
Whimbrel	NP	NP	CO	NB	CO→	SHCP - HC
Sanderling	NP	NP	CO	NB	UN ?	SHCP - HC
Western Sandpiper	NP	NP	CO	NB	CO ↓	SHCP - HC
Short-billed Dowitcher	NP	NP	CO	NB	CO ↓	SHCP - HC
Common Snipe	NP	NP	UN	NB	TH ↓	SHCP - MC

México Status: EN-Endangered, TH-Threatened, SP-Special Protection, NP-Not Protected. **US Status**: EN-Endangered, TH-Threatened, CS-Candidate Species to be Listed. **Relative Abundance**: CO-Common, UN-Uncommon, RA-Rare, EX-Extirpated. **Breeding Status**: BR-Breeder, HB-Historic Breeder, NB-Non-Breeder. **Habitat Status**: CO-Common, UN-Uncommon, TH-Threatened, NE-Non-Existent. **Habitat Trend**: ↑-Increasing, ↓-Declining, → - Stable. **Continental Assessments**: NWCP-North American Waterbirds Conservation Plan, LCP-North American Landbirds Conservation Plan, NAWMP-North American Waterfowl Management Plan, SHCP-U.S. Shorebirds Conservation Plan, NR-Not Yet Rated, HC-High Concern, HI-Highly Imperiled, NT-No Trend Available, NC-No Concern, TH&D-Threatened and Declining, RR – Range Restricted, P&R-Requires Long-term Planning and Responsibility, MC-Medium Concern, IN-Trend Increasing.

Populations of marshbirds have declined in North America during the last decades (Eddleman et al. 1988). This has been the case in the delta, where much habitat has been lost or degraded. Nevertheless, the status of marshbirds in the delta is in fairly good condition, especially due to the existence of the Ciénega de Santa Clara and El Doctor wetlands, which together provide about 6,300 ha of habitat for this birds. In particular, the Ciénega maintains about 70% of the total population of the Yuma Clapper Rail, with a population estimate of 4,850 individuals in 2003 (Hinojosa-Huerta 2003). On the other hand, the California Black Rail is in very reduced numbers, with an estimate of less than 50 pairs in the delta (Hinojosa-Huerta et al. 2001b, 2003). The contrast is based on the specific habitat requirements of the two species: while the Clapper Rail inhabits cattail stands, with brackish water (3-8 ppt of salinity), and variable water depths (0-70 cm; Eddleman 1989), the Black Rail prefers bulrush stands, with freshwater (0-3.5 ppt of salinity), and very shallow (<5 cm) and stable water levels (Flores and Eddleman 1995).

The drastic difference in status between these two marshbirds is a good example of the importance of maintaining a diversity of marsh habitat types, and in monitoring several focal species in order to secure the preservation of the diversity of bird life.

The maintenance of dynamism in the marshes and management to maintain stands of emergent vegetation of different ages is one of the major conservation actions for this target. This is critical in particular for the preservation of Yuma Clapper Rails. Between 1999 and 2002, the species had a population decline of 52% (Hinojosa-Huerta et al. 2003). This trend was related to the senescence of cattail stands in the Ciénega de Santa Clara. From 2002 to 2003, fluctuations in the direction of water flows created patches of mixed ages of cattails. During the breeding season of 2003, the Clapper Rail counts increased 40%, compared with counts in 2001 and 2002.

Restoration is also a critical part of the conservation of marshbirds, in particular for the expansion of available habitat, and for maintaining a healthy metapopulation system of these species in the Lower Colorado and delta. Current projects have shown that restoration is feasible. In the mainstem of the Colorado River, marshes have regenerated in response to instream flows. This marshes were soon colonized by Clapper Rails, Black Rails, Virginia Rails, and Least Bitterns. In the Hardy River, community projects have restored about 40 ha of marshes, which has resulted in a four fold increase in the density of Yuma Clapper Rails there (Hinojosa-Huerta et al. in press[a]).

Management Recommendations for Marshbirds

- Secure water for the Ciénega de Santa Clara, at least at current flow and quality.
- Maintain salinity levels of water sources for marshlands at least at 3.2 ppt., but preferably lower.
- Exclude cattle from El Doctor and the eastern side of the Ciénega de Santa Clara.
- Limit groundwater extractions in the San Luis Mesa and nearby El Doctor, to protect the water sources for these wetlands.
- Manage cattail stands to avoid marsh senescence in the Ciénega (>6 or 7 years old), either with water flows, controlled fires, or clearing vegetation.
- Enhance marshes in the Hardy River: 1) by managing agricultural runoff with dikes, to flood a larger area in the floodplain, and 2) by increasing the water flow through the Hardy River.
- Enhance marshes in the Colorado River, by maintaining a constant instream flow and restoring water access to backwaters and secondary streams.
- Optimize the potential for marsh maintenance with agricultural drainage water, especially at Laguna del Indio and the eastern drains of the Mexicali Valley, by avoiding extended periods of desiccation and avoiding extreme fluctuations in water flows and salinity.

Information Needs for Marshbirds

- Determine population trends.
- Evaluate the risk of contaminants.
- Evaluate the effect of restoration and management activities on the populations of marshbirds.
- Determine the exact sources of groundwater maintaining El Doctor wetlands, and the effect of groundwater pumping at the San Luis Mesa on these wetlands.
- Determine the groundwater dynamics that maintain the Andrade Mesa wetlands, evaluate the potential effects of lining the All-American Canal, and identify alternatives to protect these wetlands.

NESTING WATERBIRDS

This conservation target include the waterbird species that breed in aggregations (colonies or semi-colonies) in the Colorado River delta. This include 14 species from three families: Ardeidae, Charadriidae, and Laridae. Major breeding sites for these birds are Montague Island, Cerro Prieto ponds, and the saltflats of El Doctor and Ciénega de Santa Clara (Mellink et al. 1996, Molina and Garrett 2001, Peresbarbosa and Mellink 2001). There are also important heronries at some drains in the Mexicali Valley (Mellink et al. 2002). The focal species for this target are: Snowy Egret (*Egretta thula*), Snowy Plover (*Charadrius alexandrinus*), Gull-billed Tern (*Sterna nilotica*), and Black Skimmer (*Rhynchops niger*; Table 4).

The goal for the conservation target is to maintain suitable nesting, roosting, and foraging sites for these species in the Colorado River delta. One of the major conservation objectives is to protect the highly localized aggregation sites, and protect the colonies from predators and human disturbance.

The breeding waterbirds of the Colorado River delta are fairly well known, in particular their status and relative abundance (Patten et al. 2001, Peresbarbosa and Mellink 2001). Yet, there is little information on their population dynamics and trends, which are critical to effectively protect these birds. Equally important is determining the factors influencing their productivity and survivorship, which is necessary to adequately amend any activities harming them.

Aquatic habitat types in the delta have been decimated, and populations of waterbirds have been reduced accordingly. However many species, including most herons and egrets, are still common or fairly common, as large wetland areas have been maintained. Other species are not as common, and require specific conservation measures.

Populations of the western subspecies of the Gull-billed Tern appear to be declining, and the species is under consideration to be listed as Endangered in the United States (Parnell et al. 1995). The Least Tern (*Sterna antillarum*) is under Special Protection in México, as its populations have been reduced across the Gulf of California (Palacios and Mellink 1996). Western populations of Snowy Plovers have also declined drastically, and is listed as Threatened in México and Endangered in the United States (Powell 1998, DOF 2002). The Reddish Egret (*Egretta rufescens*) is a rare breeder in the delta, with just a few pairs (Mellink et al. 2002), and is under Special Protection in México (DOF 2002).

Management Recommendations for Nesting Waterbirds

- Continue the protection of Montague Island as the core zone of the Biosphere Reserve, restricting human disturbance during the breeding season.
- Exclude cattle from nesting sites at El Doctor and Ciénega de Santa Clara.
- Protect and secure the permanence of the sediment islands at the evaporation ponds of Cerro Prieto where waterbirds nest; restrict human disturbance during breeding season.
- Protect the heronries in the Mexicali Valley (Hardy River, Ejido Cucapá Indígena, and Ejido Oaxaca) from human disturbance and destruction.
- Protect and enhance wetland areas that provide foraging, roosting, and dispersal sites for the waterbirds in the Colorado River delta.

Information needs for Nesting Waterbirds

- Determine population trends.
- Determine the major factors affecting productivity and survivorship.
- Determine the effect of lack of freshwater on the breeding success and abundance of waterbirds at the intertidal and marine zones of the Colorado River delta.
- Determine if artificial nesting platforms or mounds could improve breeding success of waterbirds at Montague Island.
- Determine if increasing the amount of available sediment islands at Cerro Prieto could improve productivity and population numbers of waterbirds.
- Evaluate the risk of contaminants on the populations of waterbirds.
- Evaluate the effect and value of agricultural areas on the populations of waterbirds.

RIPARIAN BIRDS

This conservation target includes the birds that breed in the riparian areas, with a special emphasis on those species that are riparian-obligate nesters. The selected species encompass a wide variety of habitat types, from mature cottonwood-willow forests, to mesquite woodlands, and young stands of colonizing willow, seep willow, and arroweed. The purpose of this selection was to provide the basis to restore and maintain a diverse and ecologically functional riparian system in the delta.

The goal for this target is to protect the habitat of these birds: in particular the cottonwood and willow forests, but also the mesquite woodlands that occupy the terraces in the floodplain. It is important to maintain foliage diversity and species heterogeneity in the floodplain of the Colorado River, as well as the maintenance of both connectivity and large blocks of habitat. The target area includes the floodplain of the river delimited by the levee system that traverses the Mexicali Valley, starting in the north at Morelos Dam, and extending down to the confluence of the Hardy and Colorado Rivers.

Focal species for this target include 11 birds from 8 families (Table 4). This list includes species that were common breeding residents in the Colorado River in México, but that are now extirpated, such as the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) and the Fulvous Whistling Duck (*Dendrocygna bicolor*). It also includes some species that are now rare or occasional breeders in this region, such as Yellow-billed Cuckoos (*Coccyzus americanus*). In the list are also species that have returned or have increased their numbers in response to revegetation of the floodplain, and some species that have remained common, but that their population fluctuations indicate the health of the system.

One species, the Brown-headed Cowbird, was included in the group in order to track disturbances in the floodplain and any impacts this species might cause on other riparian birds.

Brown-headed Cowbirds have expanded their range and increased their populations in western North America in relation to increased human activities. Along riparian areas of the Sonoran Desert, habitat fragmentation and intensified farming practices have increased the nest parasitism success of cowbirds, causing population declines in riparian-dependant songbirds, such as Willow Flycatchers and Bell's Vireos (*Vireo bellii*; Sogge et al. 1997, Averill-Murray et al. 1999, Powell and Steidl 2000).

The group of riparian birds is the conservation target with less information available. The status of many of these species is just being determined, and for some is still unclear. As with other targets, there is no information on population trends, productivity, survivorship, and the factors influencing these parameters.

On the other hand, this is the conservation target that has probably been under higher pressure, as riparian areas were almost non-existent for several decades in the delta, and these systems require freshwater as a source, one of the most desired commodities on the region. Furthermore, this stretch of the Colorado River lies outside the limits of the Biosphere Reserve, and thus does not have any protection. A similar situation occurs for its species: while it is the target with the highest number of extirpated species (6 extirpated; 3 in very reduced numbers), there are no riparian birds that breed or used to breed in the delta that have legal protection in México, and only one is listed in the United States (the Southwestern Willow Flycatcher).

Yet, the conservation and restoration opportunities are enormous. After almost 20 years of continuous desiccation (1960-1979), the floodplain has been revegetated in response to pulse floods that occurred during 1983-1986, 1993-1994 and 1997-1999 and a modest but continuous instream flow during the last 3 years. Near 3,000 ha of cottonwood-willow association have been reestablished in the 20,000 ha floodplain, and now there are numerous breeding species that are common in the floodplain, including Abert's Towhees (*Pipilo aberti*), Song Sparrows (*Melospiza melodia*), Crissal Thrashers (*Toxostoma crissale*), Ash-throated Flycatchers (*Myiarchus cinerascens*), and Bullock's Orioles (*Icterus bullockii*). Some species have reestablished in the area recently in response to the revegetation, and now are uncommon, but regular breeders, including Ospreys (*Pandion haliaeetus*), Vermillion Flycatchers (*Pyrocephalus rubinus*), Yellow-breasted Chats (*Icteria virens*), and Lesser Goldfinches (*Carduelis psaltria*). This shows that proper management can reestablish the functions of the riparian corridor, and hopefully, with the adequate conservation measures, the extirpated species might return to the delta.

A 15-year drought is expected for the Colorado River basin, which would mean an extended desiccation again of the Colorado floodplain in México. This would cause the loss of the restored cottonwood-willow areas, and an impact for the avifauna regionally. Therefore, is now even more critical to implement conservation measures to protect the riparian corridor of the Colorado delta.

Management Recommendations for Riparian Birds

- Designate the floodplain of the Colorado River in México under a protection category within the National System of Protected Areas (SINANP).
- Allocate a continuous instream flow (2-3 m^3/s) and a larger pulse flood every 4 or 5 years (100 m^3/s) to facilitate the propagation of new trees and maintain the floodplain dynamics.
- Limit management practices in the floodplain that damages riparian vegetation, including vegetation clearings, river canalization, and blocking of secondary streams and backwaters.
- Control human induced fires in the floodplain.
- Restrict groundwater pumping within 100 m of the floodplain.
- Limit logging and collection of fire wood in the floodplain.
- Control solid waste in and around the floodplain.
- Restore mesquite terraces.
- Enhance and protect priority sites
- Control sediments that build up on the main stem and block secondary streams.

Information Needs for Riparian Birds

- Clarify the status of Fulvous Whistling Duck, Western Screech Owl (*Otus kennicottii*), Gilded Flicker (*Colaptes chrysoides*), Willow Flycatcher, Bell's Vireo, Lucy's Warbler (*Vermivora luciae*), Yellow Warbler (*Dendroica petechia*), and Summer Tanager (*Piranga rubra*).
- Determine the abundance of the breeding population of the focal species, in particular.
- Determine population trends.
- Determine breeding success, productivity, and survivorship; and the factors influencing them.
- Determine the response of the avian community to long-term restoration and water flows.
- Determine the effect of fire on the riparian birds.
- Evaluate the impacts of cattle (goats) grazing in the floodplain.

MIGRATORY LANDBIRDS

This conservation target includes the species of landbirds that breed in the United States and Canada, winter in southern México and Central America, and for which the delta is an important stopover site during their migration. The goal for this target is to maintain a continuous mosaic of riparian corridors, desert shrubs, and microphyll woodlands that are used by these birds during their spring migration, across the Gran Desierto, Upper Gulf Region, and Colorado River delta. This goal also benefits fall migrants and wintering species. Many of the migratory landbirds are also benefited by the goals and management recommendations for the riparian birds.

The focal species of this target include 6 birds from 6 families (Table 4). Likewise riparian birds, this selection included a variety of birds to encompass different habitat requirements. However, emphasis was made on the most common migrants, in order to have a sufficient sample size during monitoring efforts to yield significant results on their trends and survivorship.

The status as migrants of many of these birds is fairly well known, in particular the species composition, their relative abundance, distribution, and seasonality. The detailed studies and accounts of birds conducted on nearby areas, such as the Salton Sea and the Lower Colorado River (Rosenberg et al. 1991, Patten et al. 2001) have also provided solid background on the status as migrants of many of these species. However, there are no long-term data, and the effects of the changes in the delta on these species is unclear, as historical records do not provide a detailed baseline of the status of the migrant landbirds previous to the construction of dams.

It is likely that the habitat degradation and loss in the Colorado River delta was one of the many factors causing declines in populations of many of these birds, as the quality of stopover sites in migration routes has been identified as one of the most critical parameters defining the status and population trends of neotropical migratory landbirds (Hutto 2000).

This is particularly important in this region, as migratory landbirds have to fly along the coast of Sonora on their northbound migration, with the Gulf of California on one side, and the open desert on the other. A critical stopover site in this journey is El Doctor. These wetlands are the only large patch of vegetation (>1 ha) in at least 150 miles to the south, east, and west. As such, El Doctor is a concentration spot funneling migratory landbirds north along the coast of Sonora, by providing much needed cover, freshwater, and food.

Thousands of migratory landbirds from over 80 species concentrate every spring at El Doctor, showing the importance of the desert oases as stopover sites. Many of these birds continue north following the corridor of the Colorado River, while others move west, migrating through central and coastal California.

The species of migratory landbirds moving through the delta are not protected in México. However, El Doctor is included in the core zone of the Biosphere Reserve, bringing protection to one of the most important sites. This type of protection should also be granted to other important stopover sites north and south of El Doctor, such as the Colorado River.

Management Recommendations for Migratory Landbirds

- Protect critical stopover sites, either by a designation status or by means of other conservation tools, such as conservation easements.
- Maintain migration corridors along the coast with "stepping stones" stopover sites, and along the natural corridors of the Colorado, Hardy, and Sonoyta Rivers.
- Exclude cattle from El Doctor.
- Limit groundwater extractions that could impact stopover sites, in particular in desert areas, such as El Doctor and Río Sonoyta.
- Control the expansion of saltcedar, and restore areas with native trees, in particular honey and screwbean mesquite.

Information Needs for Migratory Landbirds

- Determine the trends of landbirds migrating through the delta.
- Determine stopover length, weight changes, survivorship and habitat preferences.
- Determine breeding and wintering sites of birds that migrate through the delta.
- Determine how habitat degradation and restoration efforts affect *en route* survivorship, overall survivorship, productivity, and population numbers of these birds.

SALTGRASS AVIAN COMMUNITY

This conservation target includes the birds that depend upon or that commonly use the saltgrass areas of the delta, in particular the endemic Palmer's saltgrass. This grass covers the banks of the river near its confluence with the Upper Gulf and an important area of Montague Island (Glenn et al. 2001). The goal is to maintain the remnant areas of this saltgrass in the delta.

A wide variety of birds use this area, providing food and nesting material where no other vegetation grows. Birds in this area include geese, ducks, shorebirds, herons and egrets, gulls and terns, and the Large-billed Savannah Sparrow (*Passerculus sandwichensis rostratus*), endemic to this region, an obligate resident of the saltgrass areas, and a bird under Special Protection in México (DOF 2002). This sparrow was selected as the only focal species for this conservation target, as its conservation secures the preservation of the saltgrass areas for the benefit of other wildlife.

The Palmer's saltgrass can live with saltwater, but it requires freshwater to reproduce and germinate (Felger 2000). Thus, its cover area has been greatly diminished. The populations of the Large-billed Savannah Sparrow have been reduced as well, as witnessed in coastal California, where it winters (Unitt 1984) and in the breeding grounds (Mellink and Ferreira-Bartrina 2000). However, its current abundance and trends are not known. Although the whole area covered by the saltgrass is protected by the Biosphere Reserve, its major problem originates upstream.

Management Recommendations for the Saltgrass Avian Community

- Continue the protection as part of the core zone of the Biosphere Reserve
- Allocate freshwater, at least every 4 or 5 years, that could reach that area and propagate the saltgrass. The recommended pulse floods to maintain the riparian system could help this purpose.

Information needs for the Saltgrass Avian Community

- Trends in coverage of Palmer's saltgrass and its relation with freshwater flows.
- Abundance and population trend of the Large-billed Savannah Sparrow.
- The effect of fluctuations of freshwater flows on the Large-billed Savannah Sparrow.

MARINE ZONE AVIAN COMMUNITY

This conservation target includes the species of birds that depend upon the open marine areas of the Upper Gulf of California, in particular as feeding, post-breeding dispersal, and wintering sites. The goal of this target is to maintain the productive food web in these marine areas that sustains a diversity of birds and other wildlife.

The focal species for this group includes three species: Eared Grebe (*Podiceps nigricollis*), Black Storm-Petrel (*Oceanodroma melania*), and Brown Pelican (*Pelecanus occidentalis*). All of these species are common non-breeding visitors to this region (Patten et al. 2001, Hinojosa-Huerta et al. in press[b]), and their population fluctuations could be used as an indicator of the health of these marine areas. Some of the nesting waterbirds use the marine zone for feeding, and would be benefited with conservation efforts as well.

Although marine zones are included either as part of the core or buffer zones of the Biosphere Reserve, there are several threats to birdlife in these areas, but the information on their scale and impacts is limited. In particular, commercial fisheries could be causing an impact on the populations of marine birds, as well the reduction of freshwater flows.

Management Recommendations for the Marine Zone Avian Community

It is difficult to recommend management guidelines for the benefit of birds in this zone, due the limited knowledge of the threats and their effects on birds. An increase in freshwater flows in the area could enhance the food web, but this is still the topic of scientific debate, and the amount of water that would be required to have an effect on this area is unknown.

Information needs for the Marine Zone Avian Community

- Determine population trends of focal species.
- Determine the effect of reduced freshwater flows on the populations of marine birds and their food sources.
- Determine the effect of fisheries on the populations of marine birds and their food sources.

MIGRATORY WATERBIRDS

This group includes the species of waterbirds that spend the winter or stop during their migration in the Colorado River delta. The emphasis is on those species of waterfowl and shorebirds that occur in the delta in the hundreds of thousands of individuals every year. The goal of this target is ensure that the delta wetlands will continue to provide habitat for these species.

The focal species for this target include 10 birds from 3 families: Anatidae, Charadriidae, and Scolopacidae (Table 4). The focal species were selected to cover the major aquatic habitat types in the delta, as well as to include the most representative species of the group.

At the continental level, populations of migratory waterbirds have declined due to wetland loss, and their habitats are threatened and still declining (Kushlan et al. 2002). Wetland loss in the delta has impacted drastically the abundance of wintering waterfowl in the region. Hundreds of thousands of ducks and geese from at least 26 species used to visit the region in winter (Kramer and Migoya 1989), but habitat for wintering waterfowl has been reduced to a minimum of a few thousand hectares during the dry years (Glenn et al. 1996). Recent counts from aerial winter surveys estimate about 50,000 individuals during wet years (1993-1994) and just over 4,000 individuals during dry years (1995-1996) (U.S. Fish and Wildlife Service 1993 to 1996). Wetlands at critical sites has been restored and maintained, especially at the Ciénega de Santa Clara and Hardy River, providing over 8,000 ha of habitat for waterfowl, which now support tens of thousands of wintering individuals every winter (Hinojosa-Huerta et al. in press[b]).

Given the cumulative impacts on these species, the Colorado River delta represents a major opportunity for the conservation and recuperation of these species. This is particularly important for shorebirds, especially at the mouth of the Colorado River and the Ciénega de Santa Clara. Over 150,000 shorebirds from 32 species visit the delta every year (Mellink et al. 1997, Morrison et al. 1992). For this reason, the delta is part of the Western Hemisphere Shorebird Reserves Network (1993) and also a Wetland of International Importance in the Ramsar Convention (1998). The western populations of American White Pelicans (*Pelecanus erythrorhynchos*) also depend strongly on the Colorado River delta during winter and migration (Patten et al. 2001). Overall, the Colorado River delta is a critical piece of the Pacific Flyway, necessary for the conservation of waterbird populations across Western North America (Anderson et al. 2003).

Management Recommendations for Migratory Waterbirds

Many of the recommendations are covered in other groups, as they basically require what has been the most limiting factor in the delta: water. The recommendations are:

- Secure water for the Ciénega de Santa Clara, at least at current flow and quality.
- Limit the grow of cattail, preventing the closure of open water areas.
- Enhance wetlands in the Hardy River: 1) by managing agricultural runoff with dikes, to flood a larger area in the floodplain, and 2) by increasing the water flow through the Hardy River.
- Enhance wetland areas in the Colorado River, by maintaining a constant instream flow and restoring water access to backwaters and secondary streams.
- Optimize the potential for wetland maintenance of agricultural drainage water, especially at Laguna del Indio and the eastern drains of the Mexicali Valley, by avoiding extended periods of desiccation and avoiding extreme fluctuations in water flows and salinity.
- Limit the expansion of extensive shrimp farms in the intertidal zone of the delta.
- Regulate and control hunting of waterfowl, to prevent any impacts on the population of these species.

Information needs for Migratory Waterbirds

- Determine population trends.
- Evaluate the effect of restoration efforts on the abundance of wintering waterbirds.
- Evaluate the effect of freshwater on the wintering shorebirds of the delta, especially at the intertidal areas.
- Determine stay length and survivorship of wintering and migrant waterbirds in the delta.
- Determine the sustainable number of individuals (waterfowl) that can be hunted every winter in the delta.

V – STRATEGIES FOR IMPLEMENTATION

The general guidelines for the development and implementation of the Conservation Plan are based on the principles of Partners in Flight (Rich et al. 2003), which include protecting all bird species, helping the species at risk, maintaining common birds common, and basing all actions on collaborative, voluntary efforts for the benefit of birds, their habitats, and people, regardless of political boundaries

With the premises of those guidelines, and with the purpose of achieving the goals for the conservation targets, we identified eight lines for action in the Colorado River delta:

1. Collaborate with and enhance the work of the Biosphere Reserve
2. Provide legal protection to the Colorado River floodplain
3. Develop a Management Plan with CNA for the floodplain of the Colorado River
4. Secure freshwater flows to wetland and riparian areas
5. Expand the community-based projects
6. Implement restoration project at priority sites
7. Develop a Program of Environmental Education
8. Develop an outreach and communications program

1 – Collaborate with the Biosphere Reserve

The declaration of the Upper Gulf of California and Colorado River Delta Biosphere Reserve in 1993 by the Mexican Government has been one of the major landmarks for the conservation of the delta ecosystem and a clear statement of the commitment of México for the protection of biodiversity in this region.

The main challenges that the Reserve has faced in the ten years of operation have been lack of adequate funding and understaffing, which have limited the monitoring and enforcement activities. Nevertheless, the Reserve has been effective in protecting the wetland areas, in particular the Ciénega de Santa Clara, and the associated species, such as the Yuma Clapper Rail. Major opportunities to collaborate with the efforts of the Reserve for bird conservation include the implementation of a joint monitoring plan (see Appendix C), which could help evaluate and guide the activities of the reserve, under the framework of adaptive management.

Another area for cooperative efforts is the implementation of a comprehensive outreach and environmental education program for the communities within the reserve, with the objectives of 1) developing alternative economic activities, such as nature tourism, under a framework of sustainable development and conservation of natural resources; 2) reducing the pressures in these areas, such as cattle grazing and over fishing; and 3) increasing the understanding within local communities of the linkages between the ecosystem health and the health of their communities, as well as the importance of the Colorado River delta at a regional and continental scale.

2 – Protect the Floodplain

The Biosphere Reserve is mostly marine, and it protects only a small portion of the Colorado River floodplain. As such, the Hardy River and the riparian forests of the Colorado River were left out the reserve and without protection. Land tenure in this area is federal, and is managed by the National Water Commission (CNA), but there is no mandate to protect or implement conservation actions. Furthermore, the area is being managed only under considerations for drainage of the Mexicali Valley and the prevention of floods, with dredging and vegetation clearings occurring periodically.

A major step to change this situation is to establish protection for the riparian corridors of the Hardy and Colorado rivers within the National System of Natural Protected Areas, with the implementation of a conservation mandate over the federal agencies for these rivers.

3 – Develop a Plan with CNA

The legal protection of the area is only one of the steps for the conservation of the Colorado River in México. A major activity required in this long-term process is the development and implementation of a management plan for the floodplain, in coordination with the National Water Commission, the agency in charge of this area.

The plan should be formulated in a participatory manner with the input of local communities, and in the framework of adaptive management, in constant coordination with the monitoring efforts. The plan should address the environmental needs of the area, without jeopardizing the mandates for flood control that the CNA needs to meet. It should also specify the water needs for the

environment and set guidelines to protect the riparian vegetation, as well as the secondary streams and backwaters. Finally, the plan must also identify and protect or restore the required processes that maintain the health of the riparian system, in particular the processes that maintain the geomorphologic dynamism of the floodplain, securing its ecologic functionality in the long term.

4 – Secure freshwater flows

Together with the legal protection and the management plan, securing an environmental instream flow is one of the priority actions to accomplish the goals of the Bird Conservation Plan for the Colorado River delta.

A secure allocation of water for the river has been identified as the critical factor limiting the restoration of the delta (Zamora-Arroyo et al. 2001). The required maintenance water is a continuous flow of about 2 m^3/s (4 X 10^7 m^3/year; Glenn et al. 2001). At this time, additional water transfers between the United-States and México are not allowed under the existing International Treaty (Cornelius et al. 2004), and water for environmental purposes needs to be identified in México. Cooperative efforts between foundations, environmental ngo's and government agencies should be developed for the purchase of the required water and implementing the delivery to the required areas.

It is important to acknowledge that this maintenance flow requires to be complemented with a larger pulse flood every 4-5 years at 80-120 m^3/s (3 X 10^8 m^3/year), to foster recruitment of native plants, wash salts, and rework sediments in the floodplain (Glenn et al. 2001, Zamora-Arroyo et al. 2001). However, to achieve this goal will require a greater involvement of the governments of México and United States, as well as the participation of the stakeholders of water rights in the Lower Colorado Basin.

5 – Expand the Community-based Projects

The long-term success of restoration efforts is linked to the support of local communities (Little 1994). In this sense, the Colorado River delta provide one of the greatest opportunities for restoration in the Sonoran Desert. As local communities are strongly connected to wetland

resources, they are committed to the long-term conservation of these resources, and they have joined efforts to form a local organization to achieve these goals (Carrillo-Guerrero 2002).

One of the major milestones towards these goals has been the incorporation of local communities in the process, in particular through the representation of the Ecological Association of Users of the Hardy and Colorado Rivers (AEURHYC). The organization was formed in 1998 by different sectors of the communities of the Hardy River to work together toward the restoration of the Colorado River delta. The association includes fishermen, farmers, the Cucapá tribe, aquaculturists, and the tourist sector. In particular, they call for 1) a modification of the 1944 Treaty between México and the United States to identify the delta ecosystem as an official "user" of Colorado River water, 2) the designation of all delta wetlands under a protection status, and 3) the implementation of community-based restoration projects (AEURHYC 2001).

Community support for wetland conservation also extends to farmers and landowners located close to the riparian areas. These farmers have shown their interest in maintaining native riparian vegetation, allotting water for the environment, protecting the Colorado River floodplain with a conservation designation, and in participating in active restoration projects by leasing land and water (Carrillo-Guerrero 2002). These community activities show that long-term restoration and conservation projects for wetlands can be implemented successfully in the Colorado River delta.

A major target for the future is to expand or develop similar groups to AEURHYC in other areas of the delta, that could improve the participation of local communities and multiply their reach in supporting the restoration of the Colorado River delta.

6 – Implement Restoration Projects

Three restoration projects are currently being implemented in the delta by a diverse group of local communities, environmental groups, government agencies, universities, and research institutions from the U.S. and México. Each one of these projects has different specific objectives and is focused on a different type of ecosystem. A riparian/mesquite restoration project is being developed by a binational team of environmental and scientific institutions in the northern area of the Hardy River, in coordination with eight local tourist camps. South from there, the Ecological Association of Users of the Hardy and Colorado Rivers has been working on the restoration of

marsh wetlands in the Hardy River. Finally, restoration activities have continued at the Laguna del Indio, in the eastern part of the delta since 1998, in coordination with an ejido.

The common goal is to reestablish some of the ecological functions of the Colorado River delta, through a more efficient and environmental use of the available water, which allows for the conservation of biodiversity and the preservation of social and cultural values of the region.

It is important to continue with these efforts, and expand them into the cottonwood-willow areas. It is also important to optimize the community interest that is already in place, as well as coordinate the *on the ground* restoration projects with the larger restoration effort in the delta and the allocation of instream water.

7 – Develop a Program for Environmental Education

Environmental Education (EE) is one of the best positive approaches for the conservation of birds and their habitats, as it is preventive and proactive. If properly articulated, environmental education can facilitate the implementation of conservation initiatives in the long term. The EE program for the Colorado River delta will be designed under the guidelines of: 1) providing the communities with the opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment, and 2) creating new patterns of behavior of individuals, groups, and society as a whole towards the environment.

The EE program in the delta should develop local awareness of the importance of the Colorado River delta for the conservation of biodiversity, and reduce the local threats to this ecosystem, such as wildfires, wood cutting, illegal hunting, open trash areas, cattle grazing, and agricultural expansion.

A major part of the program should be based on a cooperative effort between ngo's and the Secretaría de Educación Pública (Ministry of Education), to implement EE activities in public schools across the Colorado River delta. As such, the program will be defined as civil education for improved community and environmental ethics.

8 – Develop an Outreach and Communications Program

This strategic line is devised as an enhancement of the community-based initiatives and the environmental education program, but more importantly, is targeted towards reaching a broader audience with the message of the restoration of the Colorado River delta.

The program should target the public in the cities of Mexicali and San Luis, that have not been involved as strongly as rural communities. In particular, it is important to reach out local governments and special interest groups that can support the conservation initiatives in the delta, including universities and education groups, different citizens' councils such as the Colorado River Watershed Council (Consejo de Cuenca del Río Colorado), and Citizens' Council of the Colorado River (Consejo Ciudadano del Río Colorado), and private groups such as the Tourism Council and the Fisheries Council.

A critical aspect of developing such a program is to increase the awareness of the importance of the Colorado River delta and the issues happening in this region at a broader scale, in particular at a national level in México, and regionally across the border. In this sense, the development of a media campaign will be one of the major targets.

VI - REFERENCES

Asociación Ecológica de Usuarios de los Ríos Hardy y Colorado, A.C. (AEURHYC). 2001. Plan Estratégico de AEURHYC. Mexicali, Baja California, México.

Alles D.L. 2003. Geology of the Salton Trough. Department of Biology, Western Washington University, Bellingham, WA. http://fire.biol.wwu.edu/trent/alles/GeologySaltonTrough.pdf

Alvarez Borrego, S., B.P. Flores Baéz, and L.A. Galindo Bect. 1975. Hidrología del Alto Golfo de California II. Condiciones durante invierno, primavera y verano. Ciencias Marinas 2: 21–36.

Anderson, D.W., E. Palacios, E. Mellink, and C. Valdés-Casillas. 2003. Migratory bird conservation and ecological health in the Colorado River delta Region. Pp. 1091-1109 in Rapport, D. J., editor. Managing for Healthy Ecosystems. CRC Press, Boca Raton, FL.

American Ornithologists' Union. 1998. Check-list of North American Birds, 7th edition. American Ornithologists' Union, Washington, D.C.

Averill-Murray, A., S. Lynn, and M.L. Morrison. 1999. Cowbird parasitism of Arizona Bell's Vireos (*Vireo bellii arizonae*) in a desert riparian landscape: implications for cowbird management and riparian restoration. Studies in Avian Biology 18: 109-120.

Audubon, J.W. 1906. Audubon's western journal, 1849-1850. AH Clark, Cleveland.

Ayuntamiento de Mexicali. 2002. Anuario Estadístico Municipal 2002. XVII Ayuntamiento de Mexicali, Mexicali Baja California.

Bancroft, G. 1922. Some winter birds of the Colorado delta. Condor 24:98.

Bancroft, G. 1926. The faunal areas of Baja California del Norte. Condor 28:209–215.

Bancroft, G. 1927. Notes on the breeding coastal and insular birds of central lower California. Condor 29:188-195.

Bates, J.M. 1992. Frugivory on Bursera microphylla (Burseraceae) by wintering Gray Vireos (*Vireo vicinior*, Vireonidae) in the coastal deserts of Sonora, Mexico. The Southwestern Naturalist 37:252-258.

Briggs, M. K. and S. Cornelius. 1998. Opportunities for ecological improvement along the lower Colorado River and delta. Wetlands 18:513-529.

Briggs, M. K., M. Lara-Flores, M. de la Garza, O. Hinojosa-Huerta, Y. Carrillo Guerrero, E. P. Glenn, V. Gerhart, D. Radtke, and M. Román. 2002. La Mosqueda and El Indio: restoring wetland and riparian plant communities on abandoned farmlands in the Colorado River delta. Progress Report to the North American Wetlands Conservation Council, Pronatura Sonora, Guaymas, Sonora.

Brown, D. E. 1985. Arizona wetlands and waterfowl. University of Arizona Press, Tucson, AZ.

California Department of Fish and Game. 1999. Birds in the List of Special Animals; dated June 1999. http://www.dfg.ca.gov/endangered/birds.html.

Carbajal, N., A. Sousa and R. Durazo. 1997. A numerical model of the ex-ROFI of the Colorado River. Journal of Marine Systems 12: 17–33.

Cardiff, E.A. 1961. Two new species of birds for California and notes on species of the Imperial Valley and Salton Sea area of California. Condor 63:183.

Carrillo-Guerrero, Y. 2002. Wetland restoration in private and ejido land in the Colorado River delta, México. M.S. Thesis, School of Renewable Natural Resources, University of Arizona, Tucson, AZ.

Carter, M. F., W. C. Hunter, D. N. Pashley, and K. V. Rosenberg. 2000. Setting conservation priorities for landbirds in the United States: The Partners in Flight Approach. Auk 117:541-548.

Cervantes, M., M.J. Román, y E. Mellink. 1999. AICA: NO-17 Delta del Río Colorado. En: Benítez, H., C. Arizmendi, y L. Márquez. Base de datos de las AICAS. CIPAMEX, CONABIO, FMCN y CCA. (http://www.conabio.gob.mx. México).

Cervantes-Sanchez, J. and E. Mellink. 2001. Nesting of Brandt's Cormorants in the northern Gulf of California. Western Birds 32:134-135.

Conway, C. 2002. Standardized Protocols for Monitoring Marshbirds in North America. Arizona Cooperative Fish and Wildlife Research Unit, United States Geological Survey and School of Renewable Natural Resources., University of Arizona, Tucson, AZ.

Comisión Nacional del Agua (CNA). 1997. Problemática del Río Colorado. Comisión Nacional del Agua, Gerencia Regional de la Península de Baja California, Mexicali, Baja California.

Cornelius, S., P. Culp, J. Pitt, and F. Zamora. 2004. Recent developments on the Colorado River: implications for Mexico. Southwest Hydrology 3: 14-15.

Daniels, B.E., D.R. Willick, and T. E. Wurster. 1993. Observation of a Bendire's Thrasher from northeast Baja California. Euphonia 1:42-43.

De Sante, D. F., K. M. Burton, P. Velez, and D. Frohelich. 2003. MAPS Manual 2003 Protocol. The Institute for bird populations, Point Reyes Station, CA.

Diario Oficial de la Federación (DOF). 2002. Norma Oficial Mexicana NOM-059-ECOL-2001, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Secretaría de Medio Ambiente y Recursos Naturales. México, D.F. Marzo 6, 2002.

Dirección General de Ecología.1995. Plan de Ordenamiento Ecológico del Estado de Baja California. Gobierno del Estado de Baja California, Mexicali, Baja California.

Dunn, E., D.J.T. Hussell, and D.A. Welsh. 1999. Priority-setting tool applied to Canada's landbirds based on concern and responsibility for species. Conservation Biology 13:1404-1415.

Dunning, B. 1988. An unusual concentration of boobies in the northern Gulf of California. Aves Mexicanas 1:1-2.

Eddleman, W.R., F.L. Knopf, B. Meanley, F.A. Reid, and R. Zembal. 1988. Conservation of North American rallids. Wilson Bulletin 100:458-475.

Eddleman, W. R. 1989. Biology of the Yuma clapper rail in the southwestern U.S. and northwestern Mexico. Final Report. Intra-Agency Agreement No. 4-AA-30-02060, U.S. Bureau Of Reclamation, Yuma Projects Office, Yuma, AZ.

Eddleman, W.R. and C.J. Conway. 1998. Clapper Rail (*Rallus longirostris*). In A. Poole and F. Gill, editors. The Birds of North America, 340. The Birds of North America, Inc., Philadelphia.

Escalante, P., A.M. Sada, and J.R. Gil. 1996. Listado de nombres comunes de las aves de México. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México, D.F.

Ezcurra, E., R.S. Felger, A.D. Russell, and M. Equihua. 1988. Freshwater islands in a desert sand sea: the hydrology, flora, and phytogeography of the Gran Desierto Oases of northwestern Mexico. Desert Plants 9:35-44, 55-63.

Flores, R. E. and W.R. Eddleman. 1995. California Black Rail use of habitat in southwestern Arizona. Journal of Wildlife Management 59:357-363.

Felger, R.S. 2000. Flora of the Gran Desierto and Rio Colorado of Northwestern Mexico. The University of Arizona Press, Tucson, AZ.

Galindo-Bect, M., E. Glenn, H. Page, K. Fitzsimmons, L. Galindo-Bect, J. Hernandez-Ayon, and R. Petty. 2000. Penaeid shrimp landings in the upper Gulf of California in relation to Colorado River freshwater discharge. Fishery Bulletin 98: 222–225.

García-Hernández, J. 2004. Water quality in the Colorado River delta. Southwest Hydrology 3: 18-19.

García-Hernández, J., O. Hinojosa-Huerta, V. Gerhart, Y. Carrillo-Guerrero, and E.P. Glenn. 2001a. Willow Flycatcher (*Empidonax traillii*) surveys in the Colorado River delta wetlands: implications for management. Journal of Arid Environments 49: 161-169.

García-Hernández, J., K.A. King, A.L. Velasco, E. Shumilin, M.A. Mora, and E.P. Glenn. 2001b. Selenium, selected inorganic elements, and organochlorine pesticides in bottom material and biota from the Colorado River delta. Journal of Arid Environments 49: 65-90.

García-Hernández, J., E.P. Glenn, J. Artiola, and D.J. Baumgartner.2000. Bioaccumulation of selenium (Se) in the Cienega de Santa Clara Wetland, Sonora, Mexico. Ecotoxicology and Environmental Safety 45:298-304.

Glenn, E.P., F. Zamora-Arroyo, P.L. Nagler, M. Briggs, W. Shaw, and K. Flessa. 2001. Ecology and conservation biology of the Colorado River delta, Mexico. Journal of Arid Environments 49:5-15.

Glenn, E., C. Lee, R. Felger, and S. Zengel. 1996. Effects of water management on the wetlands of the Colorado River delta, Mexico. Conservation Biology 10:1175-1186.

Glenn, E. P., R. Felger, A. Burquez, and D. Turner. 1992. Ciénega de Santa Clara: endangered wetlands in the Colorado River delta, México. Natural Resources Journal 32:817-824.

Grinnell, J. 1928. A distributional summation of the ornithology of Lower California. University of California Publications in Zoology 32:1–300.

Grinnell, J. 1926. Occurrence of the Roseate Spoonbill in the Colorado Delta. Condor 28:102.

Groschupf, K., B.T. Brown, and R.R. Johnson. 1988. An annotated checklist of the birds of Organ Pipe Cactus National Monument, Arizona. Southwest Parks and Monuments Association, Tucson.

Helmers, D. L. 1992. Shorebird management manual. Western Hemisphere Shorebird Reserve Network, Manomet, MA.

Hinojosa-Huerta, O., M. Briggs, Y. Carrillo-Guerrero, E.P. Glenn, M. Lara-Flores, M. Román-Rodríguez. In press (a). Community-based restoration of desert wetlands: the case of the Colorado River delta. Proceedings of the Third International Conference of Partners in Flight: International Bird Conservation, Asilomar, CA.

Hinojosa-Huerta O., J. García-Hernández, Y. Carrillo-Guerrero, and E. Zamora-Hernández. In press (b). Hovering over the Alto Golfo: status and conservation of birds from the Rio Colorado to the Gran Desierto. Dry Borders-Journal of the Southwest.

Hinojosa-Huerta, O., Y. Carrillo-Guerrero, S. DeStefano, W. Shaw, and C. Valdés-Casillas. 2004. Waterbird communities and associated wetlands of the Colorado River Delta, Mexico. Studies in Avian Biology 27: 52-60.

Hinojosa-Huerta, O., H. Iturribarría-Rojas, and E. Zamora-Hernández. 2003a. Status of the Yuma Clapper Rails and California Black Rail in the Colorado River delta. Report to the Sonoran Joint Venture, Pronatura Sonora, San Luis Río Colorado, Sonora.

Hinojosa-Huerta O., P. Nagler, R. Romo, E. Glenn, and E. Mellink, 2003b. Rapid Ecological Assessment of the Limitrophe Zone of the Colorado River. Final Report to Environmental Defense, Pronatura Sonora, San Luis Río Colorado, Sonora.

Hinojosa-Huerta, O., P.L. Nagler, Y. Carrillo-Guerrero, E. Zamora-Hernández, J. García-Hernández, F. Zamora-Arroyo, K. Gillion, and E.P. Glenn. 2002a. Andrade Mesa wetlands of the All-American Canal. Natural Resources Journal 42:899-914.

Hinojosa-Huerta, O., J. García-Hernández, and W. Shaw. 2002b. Report on the surveys for Willow Flycatchers in the Colorado River delta, Mexico. School of Renewable Natural Resources, University of Arizona, Tucson.

Hinojosa-Huerta, O., S. DeStefano, and W. Shaw. 2001a. Abundance and distribution of the Yuma Clapper Rail (Rallus longirostris yumanensis) in the Colorado River delta, Mexico. Journal of Arid Environments 49:171-182.

Hinojosa-Huerta, O., W. Shaw, and S. DeStefano. 2001b. Detections of California Black Rails in the Colorado River delta, Mexico. Western Birds 32:228-232.

Huey, L.M. 1927. Birds recorded in spring at San Felipe, northeastern Lower California, Mexico, with the description of a new woodpecker from that locality. Transactions of the San Diego Society of Natural History 5:13-40.

Hughes, J.M. 1999. Yellow-billed Cuckoo (Coccyzus americanus). In A. Poole and F. Gill, editors. The Birds of North America, No. 418. The Birds of North America, Inc., Philadelphia.

Hutto, R.L. 2000. On the importance of en route periods to the conservation of migratory landbirds. Studies in Avian Biology 20:109-114.

Iturribarría-Rojas, H. 2002. Estimación de abundancia y afinidad de habitat del Tecolote Llanero (*Athene cunicularia hypugea*) en el Valle de Mexicali, Baja California y Sonora, México. Senior Thesis, Facultad de Ciencias Químicas y Biológicas, Universidad Autónoma de Guadalajara, Guadalajara, Jalisco.

Kaufman, K. and J. Witzeman. 1979. A Harlequin Duck reaches Sonora, Mexico. Continental Birdlife 1:16-17.

Kowalewski, M., G. Serrano, K. Flessa, and G. Goodfriend. 2000. Dead delta's former productivity: two trillion shells at the mouth of the Colorado River. Geology 28: 1059–1062.

Kramer, G.W. and R. Migoya. 1989. The pacific coast of Mexico. Pp. 507-528, In Habitat Management for Migrating and Wintering Waterfowl in North America, L.M. Smith, R.L. Pederson, and R.M. Kaminski, editors. Texas Tech University Press, Lubbock.

Kushlan, J. A., M. J. Steinkamp, K. Parsons, J. Capp, M. A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliott, R. M. Ervin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird Conservation for the Americas, Version 1. North American Waterbird Conservation Initiative. Washington, DC. USA.

Lavín, M.F. and S. Sánchez. 1999. On how the Colorado River affected the hydrography of the upper Gulf of California. Continental Shelf Research 19: 1545–1560.

Lavín, M.F., V.M. Godínez and L.G. Alvarez. 1998. Inverse-estuarine features of the upper Gulf of California. Estuarine, Coastal and Shelf Science 47: 769–795.

Levine C. M. and J. L. Stromberg. 2001. Effects of flooding on native and exotic plant seedlings: implication for restoring Southwestern riparian forests by manipulating water and sediment flows. Journal of Arid Environments 49: 111-131.

Leopold, A. 1953. Round River. Oxford University Press, New York.

Leopold, A. 1989. A Sand County Almanac. Oxford University Press, New York.

Lemly, A.D. 1994. Irrigated agriculture and freshwater wetlands: a struggle for coexistence in the western United States. Wetlands Ecology and Management 3:3-15.

Lemly, A. D., R. T. Kingsford, and J. R. Thompson. 2000. Irrigated agriculture and wildlife conservation: conflict on a global scale. Environmental Management 25:485-512.

Little, P. 1994. The link between local participation and improved conservation: a review of issues and experiences. Pp. 347-372 *in* D. Western and M. Wright (*editors*). Natural Connections: Perspectives in community-based conservation. Island Press, Washington, D.C.

Luecke, D. F., J. Pitt, C. Congdon, E. Glenn, C. Valdés-Casillas, and M. Briggs. 1999. A delta once more. Environmental Defense Fund, Boulder, CO.

Mearns, E. A. 1907. Mammals of the Mexican boundary of the United States. Bulletin of the United States National Museum 56.

Mellink, E., J.A. Castillo-Guerrero, and A. de la Cerda. 2002. Noteworthy waterbird records in the delta of the Río Colorado, Mexico, 2002. Western Birds 33:249-253.

Mellink, E. and V. Ferreira-Bartrina. 2000. On the wildlife of wetlands of the Mexican portion of the Río Colorado delta. Bulletin of the Southern California Academy of Sciences 99:115-127.

Mellink, E., E. Palacios, and S. Gonzalez. 1997. Non-breeding waterbirds of the Delta of the Río Colorado, Mexico. Journal of Field Ornithology 68:113-123.

Mellink, E., E. Palacios, and S. Gonzalez. 1996. Notes on nesting birds of the Cienega de Santa Clara saltflat, Northwestern Sonora, Mexico. Western Birds 27:202-203.

Mellink, E. and A.M. Rea. 1994. Taxonomic status of the California Gnatcatchers of northwestern Baja California, Mexico. Western Birds 25:50-62.

Miller, A.H., H. Friedman, L. Griscom, and R.T. Moore. 1957. Distributional check-list of the birds of Mexico, part 2. Pacific Coast Avifauna 33.

Molina, K.C. and K.L. Garrett. 2001. Breeding birds of the Cerro Prieto geothermal ponds. Monographs of Field Ornithology 3:23-28.

Mora, M.A. 1997. Feeding flights of Cattle Egrets nesting in an agricultural ecosystem. The Southwestern Naturalist 42:52-58.

Morrison, J., S. Postel, and P. Gleick. 1996. The sustainable use of water in the Lower Colorado River basin. Pacific Institute, Oakland, CA.

Morrison, R.I.G., R.K. Ross, and M.M. Torres. 1992. Aerial surveys of Neartic shorebirds wintering in Mexico: some preliminary results. Progress Note, Canadian Wildlife Service.

Murphy, R.C. 1917. Natural history observations from the Mexican portion of the Colorado Desert, with a note on the Lower Californian Pronghorn and a list of the birds. Abstract Proceedings of the Linnean Society of New York 28:43-101.

National Audubon Society. 2002. The Christmas Bird Count Historical Results (Online). Available http://www.audubon.org/bird/cbc (February 21, 2002).

National Research Council. 1995. Wetlands: characteristics and boundaries. National Academy Press, Washington, D.C.

Newcomer, M.W. and G.K. Silber. 1989. Sightings of Laysan Albatross in the northern Gulf of California. Western Birds 21:139-140.

North American Bird Conservation Initiative. 2000. North American Bird Conservation Initiative: Bird Conservation Region Descriptions. U.S. Fish and Wildlife Service Washington, DC.

Ortega-Villa, M. 1991. Mexicali, Una Historia. Universidad Autónoma de Baja California, Dirección General de Extensión Universitaria, Mexicali, Baja California.

Palacios E., D.W. Anderson, E. Mellink and S. Gonzalez-Guzman. 2000. Distribution and abundance of Burrowing Owls on the Peninsula and Islands of Baja California. Western Birds 31: 89-96.

Palacios, E. & E. Mellink. 1992. Breeding bird records from Montague Island, northern Gulf of California. Western Birds 23:41-44.

Palacios, E. and E. Mellink. 1993. Additional breeding bird records from Montague Island, northern Gulf of California. Western Birds 24:259-262.

Palacios, E. and E. Mellink. 1996. Status of the Least Tern in the Gulf of California. Journal of Field Ornithology 67:48-58.

Parnell, J.F., R.M. Erwin, and K.C. Molina. 1995. Gull-billed Tern. In A. Poole and F. Gill, editors. The Birds of North America, 140. The Birds of North America, Inc., Philadelphia.

Patten, M.A., E. Mellink, H. Gómez de Silva, and T.E. Wurster. 2001. Status and taxonomy of the Colorado Desert avifauna of Baja California. Monographs in Field Ornithology 3:29-63.

Patten, M.A., K. Radamaker, and T.E. Wurster. 1993. Noteworthy observations from northeastern Baja California. Western Birds 24:89-93.

Peresbarbosa, E. and E. Mellink. 1994. More records of breeding birds from Montague Island, northern Gulf of California. Western Birds 25:201-202.

Peresbarbosa, E. and E. Mellink. 2001. Nesting waterbirds of Isla Montague, northern Gulf of California, Mexico: loss of eggs due to predation and flooding, 1993-1994. Waterbirds 24: 265-271.

Pitt, J., C.W. Fitzer, and L. Force. 2003. New water for the Colorado River: economic and environmental considerations for replacing the bypass flow. Water Law Review 6: 68-86.

Pitt, J. 2001. Can we restore the Colorado River delta? Journal of Arid Environments 49: 211-220.

Powell, A.N. 1998. Western Snowy Plovers and California Least Terns. In M.J. Mac, P.A. Opler, C.E. Puckett-Haecker, and P.D. Doran, editors. Status and Trends of the Nation's Biological Resources. United States Geological Survey, Reston.

Powell, B.F. and R.J. Steidl. 2000. Nesting habitat and reproductive success of southwestern riparian birds. The Condor 102:823-831.

Price, W.W. 1899. Some winter birds of the lower Colorado Valley. Bulletin of the Cooper Ornithological Club 1:89–93.

Pyle, P. 1997. Identification Guide to North American Birds, Part I. Slate Creek Press, Bolinas.

Ralph, C.J., G.R. Geupel, P. Pyle, T. E. Martin, D.F. DeSante, and B. Mila. 1996. Manual de métodos de campo para el monitoreo de aves terrestres. General Technical Report PSW-GTR-159. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, Albany, CA.

Ramsar Convention Bureau. 1998. Internet Home Page (revised on 02/98). http://www.iucn.org/themes/ramsar/about_infopack-2e.htm

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. Demarest, E. H. Dunn, W. C. Hunter, E. Iñigo-Elias, J. A. Kennedy, A. Martell, A. Panjabi, D. N. Pashley, K. V. Rosenberg, C. Rustay, S. Wendt and T. Will. 2003. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithololgy. Ithaca, NY.

Robinson, S. 1999. Cowbird ecology: factors affecting the abundance and distribution of cowbirds. Studies in Avian Biology 18: 4-9.

Rodriguez, C.A., K.W. Flessa, and D.L. Dettman. 2001. Effects of upstream diversion of Colorado River water on the estuarine bivalve mollusc *Mulinia coloradoensis*. Conservation Biology 15: 249–258.

Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the Lower Colorado River Valley. The University of Arizona Press, Tucson.

Ruiz-Campos, G., and M. Rodríguez-Meraz. 1997. Composición taxonómica y ecológica de la avifauna de los ríos El Mayor y Hardy, y áreas adyacentes, en el Valle de Mexicali, Baja California, México. Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología 68:291-315.

Russell, S.M. and D.W. Lamm. 1978. Notes on the distribution of birds in Sonora, Mexico. Wilson Bulletin 90:123-131.

Russell, S. M. and G. Monson. 1998. The Birds of Sonora. The University of Arizona Press, Tucson.

Sánchez-Ramírez, O. 1990. Crónica Agrícola del Valle de Mexicali. Universidad Autónoma de Baja California, Mexicali, Baja California.

Saunders, G.B. and D.C. Saunders. 1981. Waterfowl and their wintering grounds in Mexico, 1937-1964. U.S. Fish and Wildlife Service, Resource Publication 138, Washington, DC.

SEMARNAP. 1995. Programa de Manejo Reserva de la Biosfera del Alto Golfo de California y Delta del Río Colorado. Secretaria del Medio Ambiente, Recursos Naturales y Pesca, Publicacion Especial 1, México D.F.

Simon, D. and W.F. Simon. 1974. A Yellow-billed Loon in Baja California, Mexico. Western Birds 5:23.

Sogge, M.K., R.M. Marshall, S.J. Sferra, and T.J. Tibbitts. 1997. A Southwestern Willow Flycatcher natural history summary and survey protocol. USGS Colorado Plateau Research Station, Northern Arizona University, Flagstaff, AZ.

Stone, W. and S.N. Rhoads. 1905. On a collection of birds and mammals from the Colorado delta, Lower California. Proceedings of the Academy of Natural Sciences of Philadelphia 57:676-690.

Sykes, G. 1937. The Colorado Delta. American Geographical Society Special Publication 19.

Unitt, P. 1984. The birds of San Diego County. San Diego Society of Natural History Memoirs 13.

Unitt, P. 1987. *Empidonax traillii extimus*: an endangered subspecies. Western Birds 18: 137-162.

U.S. Fish and Wildlife Service. 1993 to 1996. Winter waterfowl survey in Mexico. United States Department of the Interior, Fish and Wildlife Service, Portland, OR.

U.S. Fish and Wildlife Service. 2001. Endangered and threatened wildlife and plants; 12-month finding for a petition to list the Yellow-billed Cuckoo (*Coccyzus americanus*) in the western continental United States. Federal Register: July 25, 2001 (Volume 66, Number 143).

Valdés-Casillas, C., E.P. Glenn, O. Hinojosa-Huerta, Y. Carrillo-Guerrero, J. García-Hernández, F. Zamora-Arroyo, M. Muñoz-Viveros, M. Briggs, C. Lee, E. Chavarría-Correa, J. Riley, D. Baumgartner, and C. Condon. 1998. Wetland management and restoration in the Colorado River delta: the first steps. Special Publication of CECARENA-ITESM Campus Guaymas and North American Wetland Conservation Council, Guaymas.

van Riper III, C., J. Hart, C. Olson, C. O'Brien, A. Banks, M. Lomow, and K. Covert. 1999. Use of the Mexico Colorado River delta region by neotropical migrant landbirds. Report to Cooperators. USGS Biological Resources Division, Colorado Plateau Research Station, Northern Arizona University, Flagstaff, AZ.

van Rossem, A.J. 1945. A distributional survey of the birds of Sonora, Mexico. Louisiana State University, Occasional Papers of the Museum of Zoology 21.

van Rossem, A.J. and M. Hachisuka. 1937. A further report on birds from Sonora, Mexico, with description of two new races. Transactions of the San Diego Society of Natural History 8:321-336.

Varady, R.G., K.B. Hankins, A. Kaus, E. Young, and R. Merideth. 2001. ...to the Sea of Cortés: nature, water, culture, and livelihood in the Lower Colorado River basin and delta – an overview of issues, policies, and approaches to environmental restoration. Journal of Arid Environments 49: 195-210.

Weller, M. W. 1988. Issues and approaches in assessing cumulative impacts on waterbird habitat in wetlands. Environmental Management 12:695-701.

Western Hemisphere Shorebird Reserve Network. 1993. Western Hemisphere Reserve Network Site Profiles. WA publication No. 4, Wetlands for the Americas, Manomet and Buenos Aires.

Wilbur, S.R. 1987. Birds of Baja California. University of California Press, Berkeley.

Wurster, T.E. and K. Radamaker. 1992. Semipalmated Sandpiper records for Baja California. Euphonia 1:37-38.

Zamora-Arroyo, F., P.L. Nagler, M. Briggs, D. Radtke, H. Rodríguez, J. García, C. Valdés, A. Huete, and E.P Glenn. 2001. Regeneration of native trees in response to flood releases from the United States into the delta of the Colorado River, Mexico. Journal of Arid Environments 49: 49-64.

Zengel, S. and E. Glenn. 1996. Presence of the endangered Desert Pupfish (*Cyprinodon macularius*, Cyprinidontidae) in Cienega de Santa Clara, Mexico, following an extensive marsh dry-down. The Southwestern Naturalist 41:73-78.

Zengel, S., V. Mertetsky, E. Glenn, R. Felger, and D. Ortiz. 1995. Cienega de Santa Clara, a remnant wetland in the Rio Colorado delta (Mexico): vegetation distribution and the effects of water flow reduction. Ecological Engineering 4:19-36.

Zedler, J. 1988. Salt marsh restoration: lessons from California. Pp. 123-138 in J. Cairns, editor. Rehabilitating damaged ecosystems, volume 1. CRC press, Boca Raton, FL.

Appendix A. Participants in the development of the Bird Conservation Plan for the Colorado River Delta.

Name	Institution	Origin
Daniel W. Anderson	University of California at Davis	Davis, CA
Horacio de la Cueva	CICESE	Ensenada, Baja California
Eric Mellink	CICESE	Ensenada, Baja California
Steve Latta	Point Reyes Bird Observatory (PRBO)	Stinson Beach, CA
Kimball Garrett	Los Angeles Natural History Museum	Los Angeles, CA
Kathy Molina	Los Angeles Natural History Museum	Los Angeles, CA
Robert Mesta	Sonoran Joint Venture	Tucson, AZ
Eduardo Palacios	CICESE	La Paz, Baja California Sur
Jennifer Pitt	Environmental Defense	Boulder, CO
Ray Stendell	Salton Sea Science Office	El Centro, CA
Enrique Zamora Hernandez	Pronatura Sonora	San Luis Río Colorado, Sonora
Helena Iturribarria Rojas	Pronatura Sonora	San Luis Río Colorado, Sonora
Chris McCreedy	Point Reyes Bird Observatory (PRBO)	Stinson Beach, CA
Jaqueline Garcia Hernandez	CIAD	Guaymas, Sonora
Alejandra Calvo Fonseca	IMADES	San Luis Río Colorado, Sonora
Martha Roman Rodriguez	IMADES	San Luis Río Colorado, Sonora
Yamilett Carrillo-Guerrero	Pronatura Sonora	San Luis Río Colorado, Sonora
Jose Campoy Favela	RBAGDC, SEMARNAT	San Luis Río Colorado, Sonora
Miriam Lara Flores	AEURHYC	Mexicali, Baja California
Michael Vamstad	AEURHYC	Mexicali, Baja California
Francisco Zamora	Sonoran Institute	Tucson, AZ
Steve Cornelius	Sonoran Institute	Tucson, AZ
Juan Butron Mendez	Ejido Johnson	San Luis Río Colorado, Sonora
Jose Juan Butron Gonzales	Ejido Johnson	San Luis Río Colorado, Sonora
Onesimo Gonzales	Comunidad Cucapa	Mexicali, Baja California
Javier Mosqueda	Campo Mosqueda	Mexicali, Baja California
Edward Glenn	University of Arizona	Tucson, AZ
Pamela Nagler	University of Arizona	Tucson, AZ
William Shaw	University of Arizona	Tucson, AZ
Osvel Hinojosa-Huerta	Pronatura Sonora	San Luis Río Colorado, Sonora
Charles van Riper	U.S. Geological Survey	Tucson, AZ
Sam Spiller	U.S. Fish and Wildlife Service	Phoenix, AZ
Mark Briggs	Riparian Ecologist	Tucson, AZ
Eduardo Peters	Instituto Nacional de Ecologia, SEMARNAT	México, D.F.
Juan Carlos Barrera	Pronatura Noroeste	Hermosillo, Sonora
Carlos Valdes-Casillas	Commission for Environmental Cooperation	Montreal, Canada
Jose Trejo	Comision Nacional del Agua	Mexicali, Baja California
Juan Rivera	CIAD	Guaymas, Sonora
Gerardo Sanchez Bon	CIAD	Guaymas, Sonora

CICESE	Centro de Investigacion Cientifica y Educacion Superior de Ensenada
CIAD	Centro de Investigacion en Alimentacion y Desarrollo
IMADES	Instituto del Medio Ambiente y Desarrollo Sustentable del Estado de Sonora
AEURHYC	Asociacion Ecologica de Usuarios de los Rios Hardy y Colorado
RBAGDC	Reserva de la Biosfera del Alto Golfo de California y Delta del Río Colorado
SEMARNAT	Secretaria de Medio Ambiente y Recursos Naturales

APPENDIX B

ANNOTATED CHECKLIST OF FOCAL SPECIES

This checklist summarizes current knowledge on the status of the focal species in the Colorado River delta. The species are listed for each conservation target. The checklist within each target follows the taxonomic nomenclature and order of the latest edition of the Check-list of North American Birds (American Ornithologists' Union 1998). Names in Spanish follow Escalante et al. (1996).

Designations for abundance and temporal status of birds are based on the categories used by Patten et al. (2001) and Russell & Monson (1998). The designations for abundance are: 1) common - frequently encountered and/or in large numbers; 2) fairly common - encountered in modest numbers; 3) uncommon - present in the area, but found infrequently; 4) rare – seen only on occasion, but range lies within the region; 5) casual – out of usual range, but could be expected every other year; 6) accidental – away from the normal range and not normally expected. Designations for temporal occurrence are: 1) resident – occurs during most of the year; 2) visitor – spends a few weeks to a few months in the region; 3) transient – migrant birds that spend a short time (usually a few days) in the region; 4) vagrant – birds that have wandered off their usual range, and occur sporadically in the region.

Conservation targets were selected to define the management recommendations for the plan. The targets were defined as bird groups with similar habitat requirements, thus sharing similar pressures and needs. We also defined focal species within each target, in order to further refine the habitat management implications and facilitate monitoring and evaluation efforts.

The list of conservation targets was prepared based on existing information of the status of birds and habitat types in the delta. Emphasis was placed on bird groups whose habitats have been deteriorated, and which included endangered and threatened species or whose populations in the region have declined drastically. Bird groups with species whose breeding populations have been extirpated and might be recovered with restoration efforts were also considered.

The list of focal species was selected considering the birds which might cover the habitat needs of all the species within the group and function as indicators in monitoring efforts. Focal birds also included key species within the delta, as well as endemics and those that require special attention due their status (endangered or threatened).

MARSHBIRDS

ARDEIDAE

Least Bittern (*Ixobrychus exilis*) – Garcita de Tular. Common breeding resident at the Ciénega de Santa Clara; uncommon at the Hardy and Colorado rivers, and Andrade Mesa wetlands (Hinojosa-Huerta et al. 2002a).

RALLIDAE

California Black Rail (*Laterallus jamaicensis coturniculus*) – Ralito Negro, Polluela Negra. Rare breeding resident at Ciénega de Santa Clara and El Doctor, with less than 50 pairs (Hinojosa-Huerta et al. 2001b, 2003). Subspecies listed as endangered in México (DOF 2002) and as a priority taxon for conservation in the U.S. (California Department of Fish and Game 1999). Single birds detected at Laguna del Indio (May 25, 2001), Hardy River (May 30, 2001), Colorado River (June 9, 2002), and a canal at Ejido Luis Encinas Johnson (June 13, 2002).

Yuma Clapper Rail (*Rallus longirostris yumanensis*) – Palmoteador de Yuma, Rascón Picudo de Arizona. Common breeding resident at Ciénega de Santa Clara, with an estimated population of over 4,850 individuals (Hinojosa-Huerta et al. 2001a, 2003). Uncommon at other wetland sites, including Hardy River, El Mayor River, El Doctor, the Colorado mainstem, All-American Canal marshes and throughout agricultural drains in the Mexicali Valley. Subspecies endemic to Lower Colorado River and Delta, listed as threatened in México (DOF 2002) and endangered in the U.S. (Eddleman and Conway 1998).

Virginia Rail (*Rallus limicola*) - Rascón Limícola. Common breeding resident at Ciénega de Santa Clara and El Doctor, with numbers augmented by winter visitors. Rare breeder at the Hardy and Colorado rivers. Species under special protection in México (DOF 2002).

NESTING WATERBIRDS

ARDEIDAE

Snowy Egret (*Egretta thula*) - Garza Nivéa. Common breeding resident at Montague Island, Cerro Prieto ponds (Molina and Garrett 2001, Palacios and Mellink 1992), and heronries in cottonwood and saltcedar trees in the Mexicali Valley (Mellink et al. 2002). Common visitor throughout the Colorado delta and coastal wetlands.

CHARADRIIDAE

Snowy Plover (*Charadrius alexandrinus nivosus*) – Chorlito Nivéo. Uncommon breeding resident at El Doctor saltflats, Ciénega de Santa Clara, and Cerro Prieto ponds. Western populations have declined since the 1920s (Powell 1998), and is listed as threatened in México (DOF 2002) and Endangered in the U.S. (Powell 1998).

LARIDAE

Gull-billed Tern (*Sterna nilotica vanrossemi*) – Gallito piquigrueso. Status of western subspecies *vanrossemi* uncertain, but probably in declining numbers and is under consideration to be listed as Endangered in the U.S. (Parnell et al. 1995). Common breeder at Montague Island and Cerro Prieto ponds. Common visitors to the Colorado mainstem, Hardy River, canals, and drains as foragers. These colonies, along with the Salton Sea population, are the stronghold in their northern range (Molina and Garrett 2001).

Black Skimmer (*Rhynchops niger*) - Rayador Americano. Common breeder at Montague Island (Peresbarbosa and Mellink 2001) and Cerro Prieto (Molina and Garrett 2001). Fairly common transient and winter visitor along the coast, especially at El Golfo de Santa Clara and Puerto Peñasco.

RIPARIAN BIRDS

ANATIDAE

Fulvous Whistling-Duck (*Dendrocygna bicolor*) - Pijiji Canelo. Former breeding resident at the Colorado River (Bancroft 1922, van Rossem 1945), but no recent records. Post-breeding visitors from breeding grounds at Imperial Valley might occur in the Colorado floodplain and Mexicali Valley (Patten et al. 2001).

CUCULIDAE

Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) - Cuco Piquiamarillo. Western populations have declined drastically (Hughes 1999), and the subspecies has been almost extirpated from the Colorado delta. Recent records during breeding season (1 pair in July 1995 – Patten et al. 2001; 1 bird in June 2000, 2 pairs in July 2001, 2 singing males in June 2002, and 6 singing males in 2003 - YCG, OHH, HIR, and EZH) suggest that cuckoos might nest in the restored riparian patches of the Colorado River. The western subspecies is under consideration to be listed as Endangered in the U.S (U.S. Fish and Wildlife Service 2001).

TYRANNIDAE

Willow Flycatcher (*Empidonax traillii*) - Mosquero Saucero, Papamoscas Saucero. The endangered subspecies *E. t. extimus* formerly bred along the Colorado and Hardy rivers (Unitt 1987). No breeding activity has been detected since 1928, despite extensive surveys being conducted from 1998-2003 (García-Hernández et al. 2001a, Hinojosa-Huerta et al. 2002b).

Vermilion Flycatcher (*Pyrocephalus rubinus flammeus*) – Brasita, Mosquero Cardenal, Pájaro Bule, Chapaturrín. Fairly common breeding resident along riparian areas of the Colorado River, Hardy River, and Laguna del Indio. Apparently was almost extirpated as a breeder in the Colorado delta (Patten et al. 2001) but the local population has increased, most likely associated with revegetation of riparian areas in response to instream flows.

VIREONIDAE

Bell's Vireo (*Vireo bellii*) - Vireo de Bell. Formerly was a common breeder along the Colorado River (Rosenberg et al. 1991), now a rare breeder in the remnant riparian patches of the region. Uncommon spring transient throughout the delta.

MIMIDAE

Crissal Thrasher (*Toxostoma crissale*) - Cuitlacoche Crisal. Fairly common breeding resident at the Colorado River.

PARULIDAE

Lucy's Warbler (*Vermivora luciae*) - Chipe de Lucy. Formerly a common breeder throughout the delta (Russell and Monson 1998), but no recent records. Rare transient through the Colorado floodplain and El Doctor.

Yellow-breasted Chat (*Icteria virens*) - Gritón Pechiamarillo. Uncommon breeder along the Colorado River. Uncommon spring and fall transient.

EMBERIZIDAE

Song Sparrow (*Melospiza melodia*) - Gorrión Cantor. Common breeding resident in the delta.

ICTERIDAE

Brown-headed Cowbird (*Molothus ater*) - Vaquero Cabecicafé. Common breeding resident throughout the delta. Populations have increased with farming activity in the region.

Bullock's Oriole (*Icterus bullockii*) - Bolsero de Bullock. Common breeder along the Colorado River. Common transient through Puerto Peñasco, Sonoyta River, and El Doctor.

MIGRATORY LANDBIRDS

TROCHILIDAE

Rufous Hummingbird (*Selasphorus rufus*) - Zumbador Rufo. Uncommon spring and rare fall transient through the coast, Pinacate, and Colorado delta.

TYRANNIDAE

Pacific Slope Flycatcher (*Empidonax difficilis*) - Mosquero Occidental. The most abundant migrant flycatcher through the delta. Abundant at El Doctor from mid-March to mid-May.

VIREONIDAE

Warbling Vireo (*Vireo gilvus*) - Vireo Gorgojeador. Very abundant fall and spring transient at El Doctor, Colorado River, and Sonoyta River.

TURDIDAE

Swainson's Thrush (*Catharus ustulatus*) - Zorzalito de Swainson. Common spring and uncommon fall transient through El Doctor, Colorado River, and coastal desertscrub.

PARULIDAE

Wilson's Warbler (*Wilsonia pusilla*) - Chipe de Wilson. Common spring and fall transient through coastal desertscrub, El Doctor, Sonoyta River, and Colorado River.

THRAUPIDAE

Western Tanager (*Piranga ludoviciana*) - Tángara Occidental. Common spring and fall transient through coastal desertscrub, El Doctor, Sonoyta River, and Colorado River.

SALTGRASS AVIAN COMMUNITY

EMBERIZIDAE

Savannah Sparrow (*Passerculus sandwichensis*) - Gorrión Sabanero. The Large-billed Savannah Sparrow (*P. s. rostratus*) is a common breeder at Montague Island, Cerro Prieto, Ciénega de Santa Clara, El Doctor, and coastal salt marshes, although is threatened and declining (Mellink and Ferreira-Bartrina 2000). The subspecies is under special protection in México (DOF 2002).

MARINE ZONE AVIAN COMMUNITY

PODICIPEDIDAE

Eared Grebe (*Podiceps nigricollis*) - Zambullidor Orejudo. Common winter visitor. Uncommon non-breeder summer resident at Ciénega de Santa Clara and Cerro Prieto.

HYDROBATIDAE

Black Storm-Petrel (*Oceanodroma melania*) - Paiño Negro. Common resident in the Gulf, probably breeds at Rocas Consag (Bancroft 1927, Patten et al. 2001). Common close to the shore during summer, but rare during other seasons. Protected as threatened in México (DOF 2002).

PELECANIDAE

Brown Pelican (*Pelecanus occidentales*) Pelícano Café. Common perennial visitor in the coast and marine areas as a non-breeder. Inland it is an uncommon summer visitor; rare during winter.

MIGRATORY WATERBIRDS

ANATIDAE

Snow Goose (*Chen caerulescens*) - Ganso Blanco. Fairly common winter visitor at Ciénega de Santa Clara and adjacent agricultural fields, although formerly much more abundant.

American Wigeon (*Anas americana*) - Pato Chalcuán. Fairly common winter visitor and casual summer visitor in the Colorado delta; common transient through the coast.

Cinnamon Teal (*Anas cyanoptera*) - Cerceta Castaña. Fairly common winter visitor at Ciénega de Santa Clara and common transient through the region.

Northern Shoveler (*Anas clypeata*) - Pato Cucharón Norteño. Common winter visitor at Ciénega de Santa Clara and Hardy River. Rare non-breeding summer visitor.

CHARADRIIDAE

Black-bellied Plover (*Pluvialis squatarola*) - Chorlo Gris. Common transient and winter visitor, and uncommon summer visitor at Ciénega de Santa Clara, El Doctor, and the coast.

SCOLOPACIDAE

Whimbrel (*Numenius phaeopus*) - Zarapito Trinador. Common winter visitor and transient in the Mexicali Valley, Colorado delta, and coastal areas..

Sanderling (*Calidris alba*) - Playero Blanco. Common transient and winter visitor along the coast, less abundant at Colorado delta.

Western Sandpiper (*Calidris mauri*) - Playerito Occidental. Common transient and winter visitor through the Colorado delta and coastal areas.

Short-billed Dowitcher (*Limnodromus griseus*) - Costurero Piquicorto. Common winter visitor and spring transient, fairly common fall transient. Most numerous at Ciénega de Santa Clara.

Common Snipe (*Gallinago gallinago*) - Agachona Común. Uncommon transient and winter visitor at Colorado delta and coastal wetlands.

APPENDIX C
MONITORING PROGRAM FOR BIRDS IN THE COLORADO RIVER DELTA

Effective assessment tools of management strategies are required in order to protect birds and their habitats. Robust long-term monitoring programs provide critical information on changes in bird populations and habitat features that can guide conservation efforts. In the Colorado River delta, recent pulse floods and agricultural drainage water has restored wetland and riparian areas. Effective management of these areas and their water sources can provide and maintain critical habitat for hundreds of bird species, many of which are of special concern, including Yuma Clapper Rail, Yellow-billed Cuckoo, Bell's Vireo, Gull-billed Tern, and Willow Flycatcher.

The monitoring program in the delta is designed to provide the required information to guide the management and restoration activities of the Upper Gulf of California and Colorado River Delta Biosphere Reserve, as well as guiding restoration activities and the management of the Colorado River floodplain.

The program will help us understand which management activities and impacts have an effect on bird populations and will help us develop strategies to detect, counteract, and prevent population declines at the local level as well as in a regional scale, by participating and sharing information with continental monitoring efforts.

Objectives

Specific objectives of project are:

- Detect significant trends in bird populations in the delta region; in particular the focal species of the BCP.
- Monitor vital rates (productivity and survivorship) of riparian songbirds.
- Associate trends (if any) to changes in habitat features and management activities.
- Provide the data for the long-term evaluation of the effectiveness of the conservation, management, and restoration strategies.
- Contribute this information to regional and continental analyses of bird population trends.
- Develop a strong community participation in the monitoring efforts.

The Monitoring Program

The monitoring program occurs year-round, but is more intense during spring and summer. Major monitoring activities include: point counts in the floodplain; call-response surveys for marshbirds; bird banding for breeding, wintering, and migrant landbirds; transect to count migratory waterbirds; and breeding counts of colonial waterbirds.

Point Counts

The objectives of this component are to: 1) detect population trends of birds in this area, in particular riparian birds, 2) assess the long-term response of birds (avian diversity, abundance, and community structure) to habitat characteristics, vegetation regeneration, and river flows, and 3) assess the response of avian communities to wetland and riparian restoration projects in the delta. The data to accomplish these objectives is being obtained through point count based bird surveys. Data on the habitat features is being obtained through field measurements (following methods by Ralph et al. 1996 and Ohmart and Anderson 1986), and analysis of satellite images and aerial pictures. Data on instream flows is being obtained from the International Boundaries and Water Commission.

Study areas

Field activities of this component are carried out in the floodplain of the Colorado River in México, starting at San Luis Río Colorado, Sonora, and down to the area of the confluence of the Hardy and Colorado Rivers (Fig. A). The floodplain traverses the Mexicali Valley as the river flows toward the Gulf of California, and is surrounded by flood control levees on each margin. The total area is 20,000 ha, and extends for 120 river kilometers. This encompass the main stem of the Colorado, secondary streams, backwater lagoons, and the portion of the major agricultural drains that are within the floodplain.

The northern portions of this area supports the largest stands of native riparian trees (cottonwoods and willows) in the Lower Colorado Basin, covering 4,000 ha. This vegetation has been regenerated with instream flows during the last 20 years (Zamora-Arroyo et al. 2001). The southern stretches are dominated by saltcedar, although emergent vegetation is common along the streams and drains.

Bird Surveys

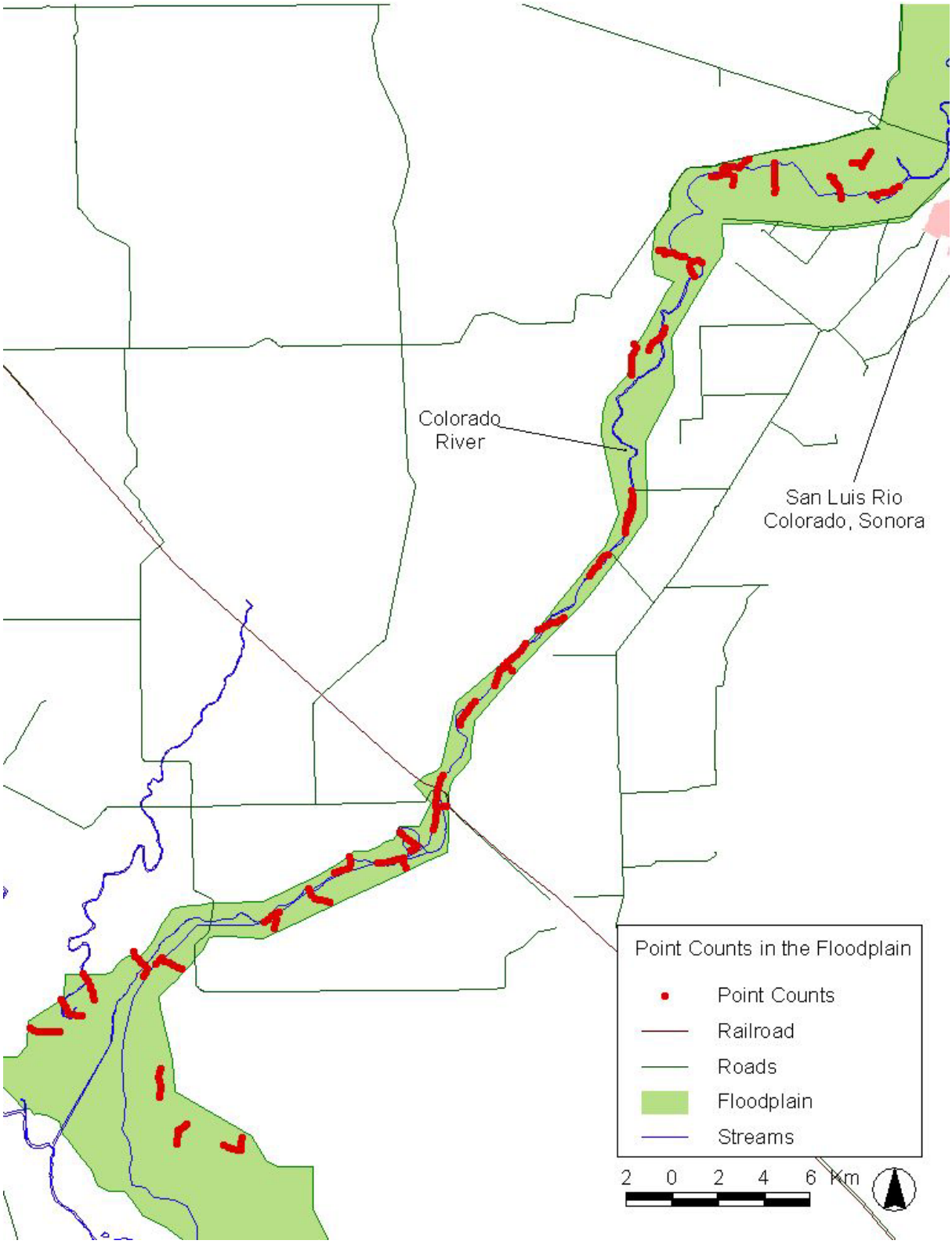
Survey procedures follow the methods described by Ralph et al. (1996) for variable circular plot point counts. These surveys for the monitoring plan should be conducted four times per year (January, April, July, and October) on 18 transects randomly distributed along the floodplain (Fig. A). Each transect is composed of 8 point counts, and extends for 1.6 km, starting at the levee, and moving toward the main channel of the river. Transects are run by teams of two biologists, starting at sunrise and until no later than 4 hours after sunrise. At each point count station we count all birds heard or seen within a 5 min period, estimating distance to the observer (using four categories: <25 m, 25-50 m, >50 m, and flyovers) and annotating the time at which it was detected (using 2 categories: 0-3 min and 4-5 min).

Baseline for these surveys was conducted between May 2002 and July 2003, with point counts conducted monthly at 30 transects (same 18 plus other 12).

Habitat Surveys

Field surveys to measure the habitat features at the transects should be conducted once every year during the summer (June – September). The general procedures for recording habitat measurements follow Ralph et al. (1996). At each station we estimate the percent coverage, and the minimum, maximum, and average height of each of the following strata: trees (vegetation >3 m in height), shrubs (0.5 – 3 m), herbs (0.1 – 0.5 m), forbs (< 0.1 m), emergent plants, bare soil, and open water. We then categorize each strata by estimating the percent coverage and average height of each plant species within a stratum. We also measure the diameter at breast height (dbh) of five individuals from each species present at the tree stratum. For open water, we record type (primary or secondary stream, drain, irrigation canal, or lagoon), depth, and width. Finally, we assign a category of vegetation community and type of vegetation structure to each of the survey stations, following the methods of Ohmart and Anderson (1986).

Figure A. Point counts in the floodplain of the Colorado River, México



Bird Banding

The objectives of the program of mist netting and bird banding in the Colorado River delta are to: 1) monitor the use of the Colorado River delta by migratory landbirds, 2) collect information on survivorship and productivity of landbird species, and 3) collect information on the wintering survivorship of migratory landbirds in the delta. These objectives will be accomplished with three different banding protocols.

Our general banding procedures follow methods described by Ralph et al. (1996). We band all captured birds except endangered species or injured individuals, which are released immediately. Identification, aging, and sexing of captured birds follow Pyle (1997). We record morphology measurements (wing length and tail length) and body condition (weight, body fat, feather wear, and feather molt) following Ralph et al. (1996). We start the operation of the nets (12 X 2.6 m, 36 mm mesh size) ± 30 min of sunrise, except during unfavorable wind conditions (wind speed >10 kph), excessive heat (temperature > 40 C) or cold (temperature < 5 C).

All the data is integrated using Band Manager and MAPSPROG, and shared with the Bird Banding Laboratory of the USGS and the Institute for Bird Populations.

MAPS

The MAPS program (Monitoring Avian Productivity and Survivorship; DeSante 2002) is targeted towards monitoring the breeding birds. This protocol is being implemented across North America, and is intended to determine local and regional patterns of survivorship and productivity of these birds, and the factors that influence them.

In the delta, we are operating a MAPS station since 2002 in a riparian area. The procedures follow the established protocol of the program (DeSante 2002), which consists of the operation of 10 nets for 6 hours every day, once every 10 day period, from May 1 trough August 10, for a total of 600 net hours. The location of the MAPS site is indicated on Figure B.

MoSI

The implementation of the MoSI program (Monitoreo de Sobrevivencia Invernal; DeSante 2003) is targeted towards monitoring wintering survivorship of landbirds. This protocol is also being implemented at a continental scale, but mainly in wintering grounds of landbirds across Latin America. In the delta, we are implementing the MoSI protocol starting in 2003, with a station at

El Doctor and another at the Colorado River. The general procedure consists in the operation of 16 nets for 10 hours each day, during 3 pulses (December, January, and March), each consisting of three consecutive banding days. The location of the MoSI sites is indicated on Figure B.

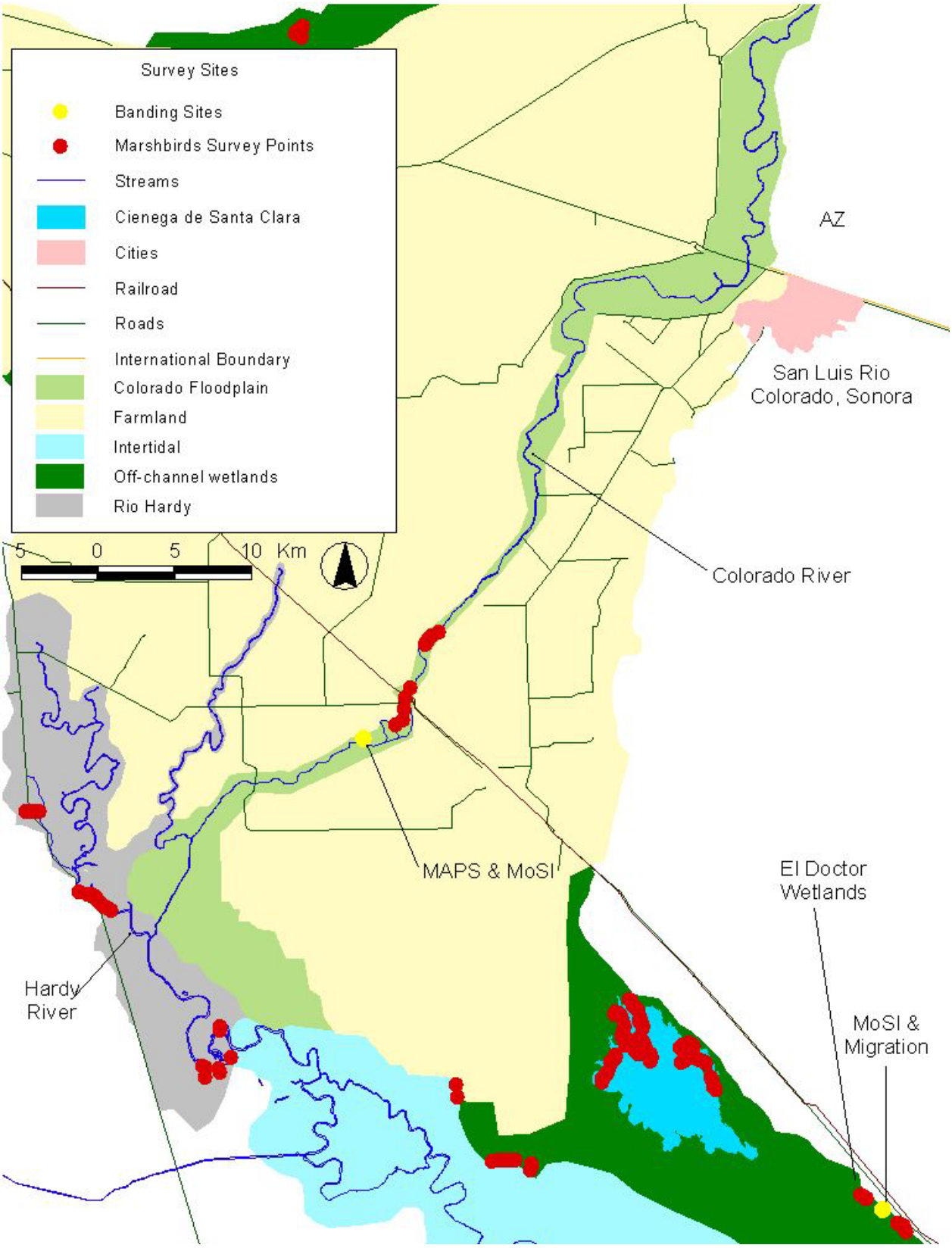
Migration

Beside MAPS and MoSI, we also conduct bird banding to monitor the patterns of use of the Colorado River delta by migratory landbirds, and to determine population trends, species composition and abundance, temporality, stopover length, and habitat quality of the delta as a stopover site. For these purposes, we operate 6 mist nets at El Doctor for 5 hours each day, between March 10 and June 10, at least three days in every 10 day period. The location of the site is indicated on Figure B. Habitat measurement and complementary information is collected following the MAPS protocol.

Marshbird Surveys

The objective of the marshbird surveys in the Colorado River delta is to detect changes in population trends and distribution of secretive marshbirds. The main focus is the Ciénega de Santa Clara. Other target wetland areas include Hardy River, Laguna del Indio, El Doctor, and Andrade Mesa Wetlands (Fig. B). Surveys are performed twice each year, during the early breeding season (March 15-March 25) and during the late breeding season (May 15 – May 25). The procedures for field surveys follow the Standardized North American Marshbirds Monitoring Protocols (Conway 2002). In general, the protocol consists of call-response surveys, in which taped vocalizations are broadcasted to elicit the response of the targeted marshbirds. At each survey point, the surveyors record the number of responding birds of each species during a 5-minute passive period prior to broadcasting recorded calls, and during a period in which pre-recorded vocalizations are broadcast into the marsh. The particular segment of the survey in which each bird vocalizes is also recorded, in order to assess the effectiveness of the protocol and estimate detection probability. The distance of each bird to the surveyors is estimated, and also if each vocalization heard is a new bird for that point or is an individual that vocalized previously. Surveys start at sunrise and continue no later than 1030 h. Survey stations are variable distance circular plots located 200 m apart, and grouped in transects, with 5 to 10 stations per transect.

Figure B. Marshbird survey points and banding sites in the Colorado River delta.



The transects are surveyed in teams of at least two persons and are run by canoe and by foot. The broadcast sequence includes calls of the primary marshbird species that are expected breeders in the study area and is broadcasted using a portable CD player. The sequence of marshbirds vocalizations is: Black Rail, Least Bittern, Sora, Virginia Rail, Clapper Rail, and American Bittern. This sequence was arranged to play vocalization of the most intrusive species last, in order to avoid inhibiting responses from less intrusive species.

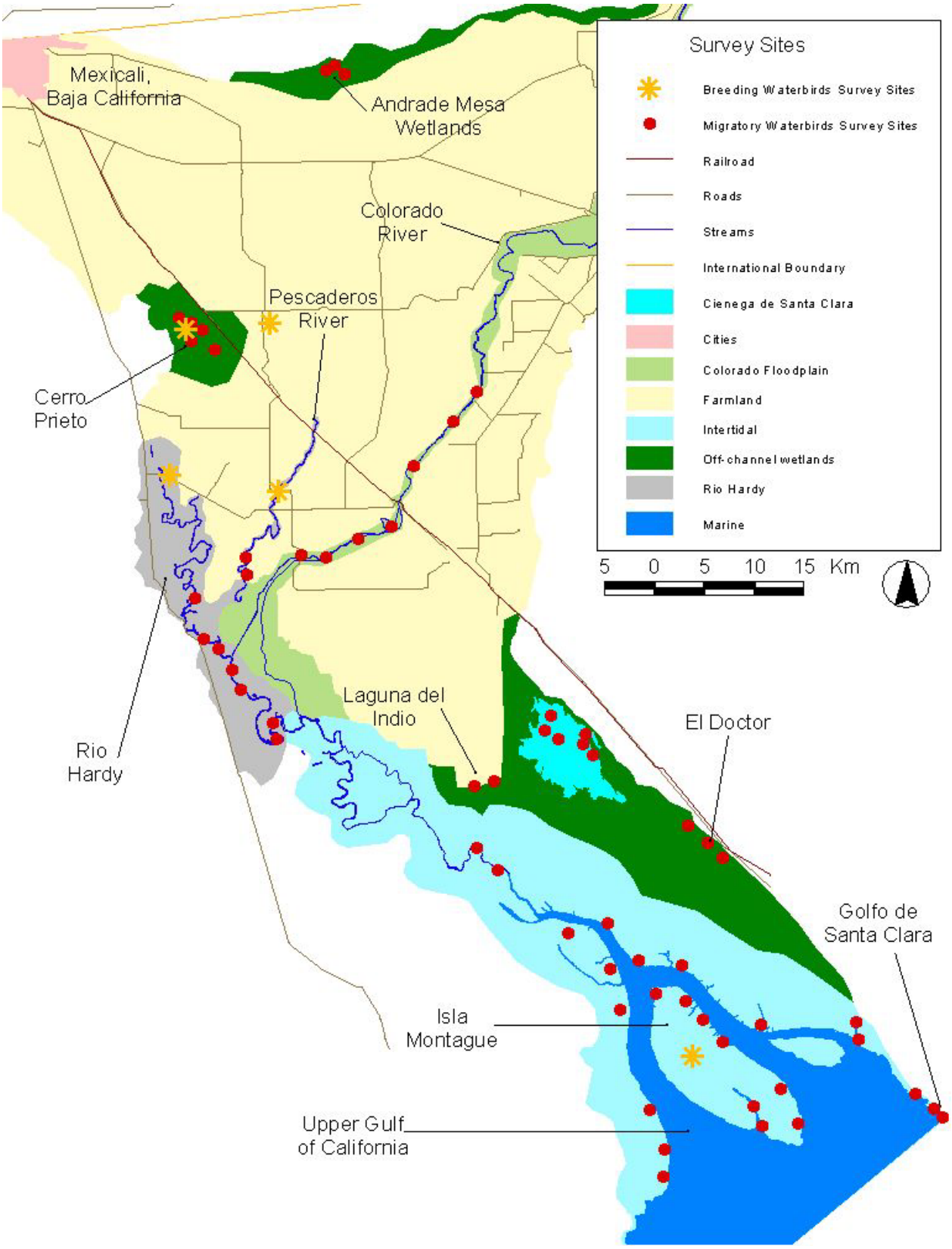
Migratory Waterbirds

The objective of surveys for migratory waterbirds is to detect trends in the abundance and species richness of wintering and staging waterbirds in the Colorado River delta.

Survey procedures follow the methods described by Ralph et al. (1996) for variable circular plot point counts. The surveys should be conducted at least two times per year (January and early March). The counts for waterbirds are done at 60 random points across the wetlands of the Colorado River delta (Fig. C). The points are conducted by teams of two biologists, starting at sunrise and continuing throughout the day. At each point count station we count all birds heard or seen within a 20 min period, estimating distance to the observer (using eight categories: <25 m, 25-50, 50-100, 100-150, 150-200, 200-250, >250 and flyovers) and annotating the time at which it was detected (divided in five min segments).

Field surveys to measure the habitat features at the transects should be conducted once every year in the winter (Dec-Feb). At each station we estimate the percent coverage, and the minimum, maximum, and average height of each of the following strata: trees (vegetation >3 m in height), shrubs (0.5 – 3 m), herbs (0.1 – 0.5 m), forbs (< 0.1 m), emergent plants, bare soil, and open water. We then categorize each strata by estimating the percent coverage and average height of each plant species within a stratum. For open water, we record type (primary or secondary stream, drain, irrigation canal, or lagoon), depth, and width. Finally, we assign a category of vegetation community and type of vegetation structure to each of the survey stations, following the methods of Ohmart and Anderson (1986).

Figure C. Survey sites for migratory and breeding waterbirds in the Colorado River delta.



Colonial Waterbirds

The objective of this component is to detect population changes on the breeding waterbirds in the Colorado River delta, in particular on the colonial or semi-colonial species.

The general procedure is to conduct counts of individuals and active nests during the breeding season (April – June), at least twice per breeding season. The counts are conducted at the major aggregation areas, including Cerro Prieto Ponds, Montague Island, and heronries of the Hardy River and Mexicali Valley (Fig C). Counts are conducted by two observers, starting at sunrise, and continuing during the day, and are conducted at a distance that would not cause disturbance to the colonies (>50 m). Habitat features at the aggregation sites are estimated visually, following the procedures described in the Point Counts section..

Data management, analysis, and reporting

All data is being integrated into relational databases in MS ACCESS (one for each component). Bird banding data is integrated using Band Manager and MAPSPROG. Statistical analysis will be conducted using JMP IN and MONITOR, particularly to estimate trends, their significance, and statistical power. This information will be used to generate an annual report of the status of the avifauna of the Colorado River delta, and used as the evaluation of management and restoration activities in the framework of adaptive management. The report will be distributed among the involved institutions in the Colorado River delta efforts, and submitted for publication to a scientific journal.