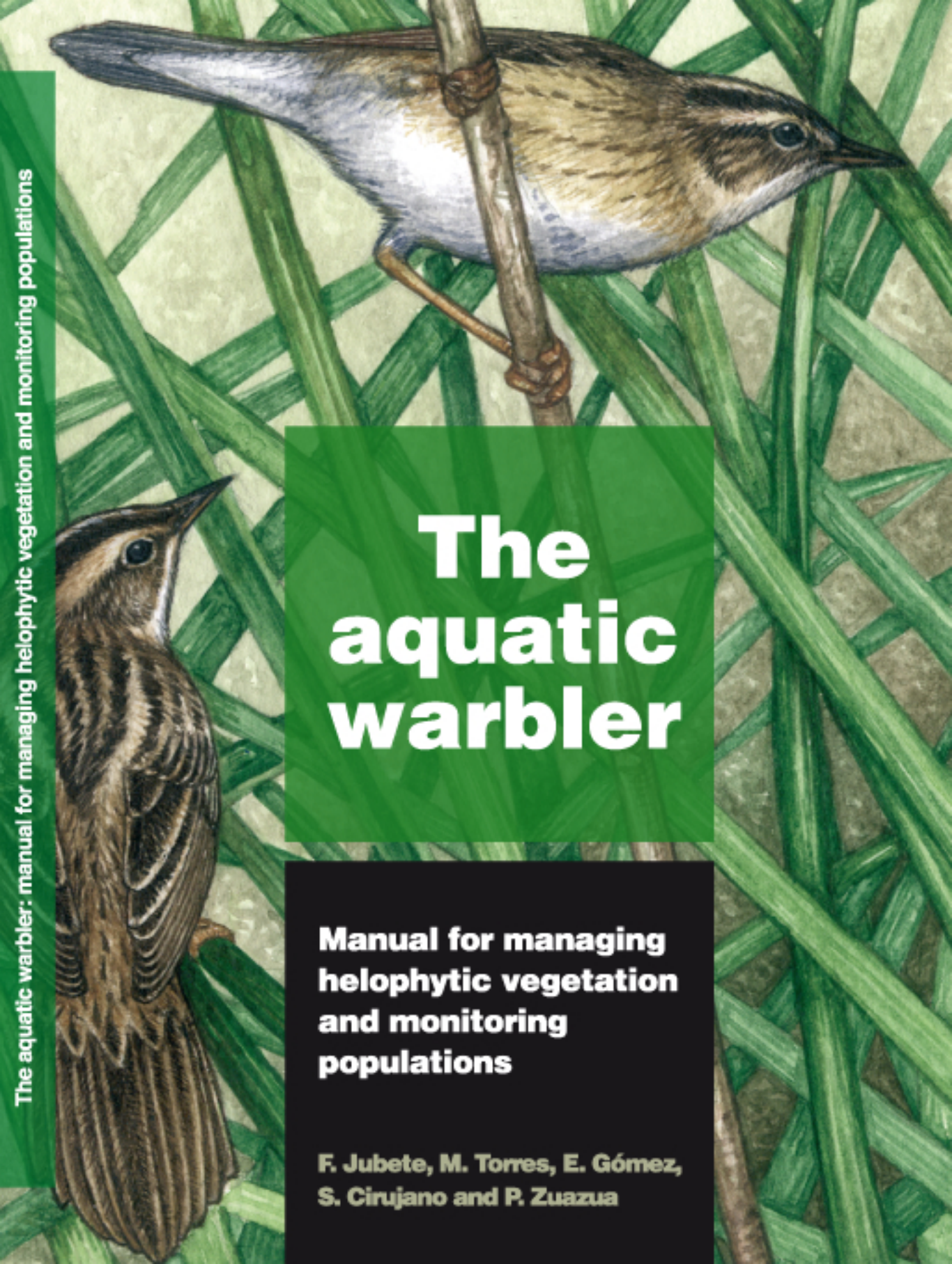

The aquatic warbler

Manual for managing helophytic vegetation and monitoring populations

F. Jubete, M. Torres, E. Gómez, S. Cirujano and P. Zuazua

The aquatic warbler: manual for managing helophytic vegetation and monitoring populations

This book is published within the context of LIFE-Nature Project "Conservation of the aquatic warbler in the Nava-Campos SPA," for which the European Commission provided 75% cofinancing, the Regional Executive of Castile-Leon was the beneficiary, and the Fundación Global Nature and town council of Fuentes de Nava were partners.

Web proyect:
www.carriceríncejudo.org

Recommended bibliographic citation:

Complete work: Jubete, F; M. Torres, E. Gómez, S. Cirujano and P. Zuazua. (eds.) 2006. The aquatic warbler: manual for managing helophytic vegetation and monitoring populations. Fundación Global Nature. 144 pp.

Chapters: González-Villalba, C.; S. Cirujano and M. Sánchez-Rodríguez. 2006. "La Nava wetland" in Jubete, F; M. Torres, E. Gómez, S. Cirujano and P. Zuazua (eds). The aquatic warbler: manual for managing helophytic vegetation and monitoring populations. Fundación Global Nature. 144 pp.

Legal Deposit: P-248/2006
Graphic design and layout: Gráfico Gabinete de Comunicación
Printed by: Graficolor
Translated by: Barbara Thomas

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TABLE OF CONTENTS

Preface

Carlos Fernández Carriedo
Environmental Advisor of the Regional Executive of Castilla y León

The conservation of natural spaces and protected species is one of the mainstays of the policy of the Regional Office of the Environment of the Regional Executive of Castile-Leon.

In our region, the approval of Law 8/91 of 10 May on Natural Spaces marked the beginning of a new stage in the protection of natural areas. This stage has been developed with the current declaration of 20 natural spaces with 539,197 hectares of extension and the proposed declaration of another 26 natural spaces.

Application of Directive 79/409/EEC on wild bird conservation established that each member country of the European Union and all the countries that eventually join the EU would create a network of spaces in which wild birds would be widely represented. As a result, the European Union designated in Castile-Leon a total of 70 areas as Special Protection Areas (SPA), which occupy an area of 1,997,970.62 hectares, 21.20% of the regional territory, and are part of the Natura 2000 Network in Europe.
One of the spaces defined by these legal figures of autonomic and Community conservation is the “North La Nava-Campos SPA.” This natural space has an area of 54,935.88 hectares, of which somewhat more than 300 hectares form La Nava wetland, a pond that was recovered in 1990. La Nava is listed among the Ramsar Convention wetlands due to its international importance. The lands that until recently were grazing lands of the village of Fuentes de Nava have recovered their natural value and now offer refuge to thousands of water birds. One of the more than 220 species of birds detected in La Nava is the aquatic warbler (Acrocephalus paludicola), a small bird whose conservation value has not passed unnoticed by the Regional Office of the Environment.

The aquatic warbler is a high-priority species for conservation in the European Union. La Nava has been shown to be the most important point of passage for

this species in Spain, as a habitat that has the very specific characteristics required by the aquatic warbler. It was precisely the combination of the priority to preserve an endangered species with the need to conserve and manage the habitat of a natural space that stimulated the Regional Office of the Environment to present a LIFE-Nature project to the European Union, a project that was approved in 2002 with a budget of 1,217,240 euros. This LIFE project has made it possible to implement numerous habitat improvement activities in La Nava, public use works, and interesting studies of the species that now have a practical application.

Among the activities of this LIFE project was the publication of this manual, which shares the knowledge gained with different vegetation management methods developed in these four years, as well as study and population localization techniques. We of the Regional Office of the Environment trust that this information will be of interest to managers and students of the aquatic warbler in other Spanish wetlands, thus contributing to the conservation of this small, but not unimportant species, the aquatic warbler.

Introduction

Fernando Jubete
Area Director of the Fundación
Global Nature in Palencia

In recent years there have been visible and important advances in the conservation of many endangered bird species. These projects have targeted mainly species that can be considered "star" species, such as the imperial eagle, Bonelli's eagle, griffon vulture, black vulture, black stork, great bustard and others. The results have been satisfactory in most cases, with populations such as the ospreys of Scotland that have grown from 2 pairs in 1967 to more than 190 pairs in 2005.

The case is very different with less spectacular species in terms of size or behavior or, simply, species that are less attractive because it is difficult to study them. Consequently, British conservationists have been warning us for several years that we are running the risk of dedicating almost all our conservation efforts on "star" species and overlooking other species that also are threatened but do not attract our protection efforts because of their small size. It is paradoxical, but a large part of the species of birds that are currently on the Red List prepared by the British Trust for Ornithology, indicating an unfavorable conservation status, are considered "common" species, such as the house sparrow, skylark, starling or linnet.

One of the avian species in this situation is the aquatic warbler (Acrocephalus paludicola), a bird weighing barely twelve grams, with discrete plumage and habits, which occupies a very specific habitat throughout its biological cycle: low-lying, flooded formations of marsh grass. Not long ago, this warbler was a reproducer found in almost every European country, but in less than a century its populations have diminished considerably and 90% of its population in the world now is concentrated in a few wetlands in just three countries of Eastern Europe: Belarus, Ukraine and Poland.

These are the circumstances that have caused the aquatic warbler to be considered a "flag species," a species whose conservation implies the protection of entire ecosystems and regions. These species have acquired the significance of being living symbols of nature conservation, able to inspire almost automatically feelings of solidarity among all people. The conservation of

the aquatic warbler involves much more than protecting specific zones such as nesting areas. The aquatic warbler stays in nesting areas only three months out of the year, so it is necessary to preserve its autumn and spring migration areas and wintering-over areas to ensure effective conservation.

These are the principles that have inspired the LIFE-Nature project "Conservation of the aquatic warbler in the Nava-Campos SPA." The actions of this project are designed not only to conserve and recover part of the habitat that the species uses in La Nava during the scant time that its autumn migration lasts, but goes still farther to include habitat management measures that can be extrapolated to or applied in other wetlands similar to La Nava.

The same occurs with scientific monitoring work carried out within the framework of this LIFE project, which in addition to obtaining valuable information for the management of the species in La Nava, serves to set general standards that we are convinced will allow this species to be detected and monitored in other wetlands where it is not yet known to be present. This manual offers an organized description of how habitat management and population monitoring were carried out within the context of the LIFE project. The methods used and results are described and evaluated from the vantage points of the cost and effectiveness of each measure and potential problems. This practical manual is dedicated especially to managers of natural spaces and to those involved in the conservation and study of the aquatic warbler or its habitat.

LIFE-Nature Projects

The "Community Program of Policy and Action in Relation to the Environment and Sustainable Development," better known as the Fifth Environment Action Program, began in 1992. The program was the predecessor of the LIFE Program. This program was conceived for the application and development of policy and Community legislation in environmental matters, favoring the integration of the environment in the policies of the European Union. At the same time it also tries to promote new solutions to the environmental problems of the European Union.

The LIFE Program is the financial instrument created to implement the application, update and development of Community policy and legislation in environmental matters. The first stage, approved in 1992, covered the period from 1992 to 1995 and was endowed with 400 million euros. In 1996, a new regulation was approved for the phase from 1996 to 1999, with a budget allocation of 45 million euros. In 2000, a new phase for the 2000–2004 stage was approved, with an initial budget of 640 million euros, although this phase was extended to 2006 and the budget was enhanced by 317 million euros.

The LIFE Program consists of three areas with specific objectives:
- LIFE Nature: was designed to contribute to the application of Directives 79/409/EEC (Bird Directive) and 92/43/EEC (Habitat Directive) and, in particular, to the Natura 2000 Network.
- LIFE Environment: contributes to the development of innovative and comprehensive techniques and methods and to continuing the development of Community environmental policy.
- LIFE Third Countries: contributes to the creation of necessary administrative capacities and structures in the environmental area, and to the development of action policies and programs in environmental matters in countries that are candidates for adherence to the European Union.

Within LIFE Nature, projects are developed in Special Protection Areas for Aves (SPA), Sites of Community Interest (SCI), or in places that harbor high-priority species of the Bird and Habitats Directives. In Spain, a variety of projects have been developed in high-priority habitats like wetlands, steppes or peat bogs. Many animal species have benefited from these funds, including species of birds like the black vulture, Bonelli's eagle, imperial eagle or great bustard, mammals like the brown bear, European mink or bats, amphibians and reptiles like the El Hierro giant lizard or the La Gomera giant lizard, and fish like the Spanish toothcarp (Aphanius iberus) or Valencia toothcarp (Valencia hispanica), to cite just a few of the better known species.

LIFE-Nature Project "Conservation of the aquatic warbler in the Nava-Campos SPA"

Aquatic warbler. | Fernando Jubete.

The idea to present this project arose from the management needs of the habitat of La Nava wetland, one of the most important steppe wetlands of the Iberian Peninsula. In 2000, only ten years had passed since this wetland was recovered, but its dynamism was causing some problems that seriously threatened the health of the enclave. Problems such as excessive growth of helophytic vegetation or the sporadic entry of low quality water were contributing to the rapid degradation of the wetland as a result of an important eutrophication process.

The detection in 1998 of the aquatic warbler (*Acrocephalus paludicola*), a species considered "high-priority" within the regulations of LIFE programs, provided an opportunity to submit a project to benefit this threatened species

LIFE-Nature Project "Conservation of the aquatic warbler in the Nava-Campos SPA"

and, most importantly, could save its principal habitat: meadows of helophytic vegetation, the most extended plant community in La Nava.

Thus, this project had a two-fold objective, to improve the state of conservation of the wetland by habitat management and, in this way, guarantee the conservation of the high-priority species the aquatic warbler.

The LIFE-Nature Project "Conservation of the aquatic warbler in the Nava-Campos SPA" was presented in 2002 by the Regional Executive of Castile-Leon together with the Fundación Global Nature and town council of Fuentes de Nava.

The project approved by the European Commission had a duration of four years, from 2002 to 2006, and a budget of 1,217,240 euros, of which 75% was financed by the European Commission.

La Nava in spring. | Fernando Jubete.

General project objectives and actions

The general objectives of the LIFE project can be summarized by three main points:

1) To increase, monitor, and improve the habitat of the aquatic warbler in La Nava.
2) To increase scientific knowledge of the aquatic warbler and its habitat in La Nava.
3) To create divulgation material on the aquatic warbler and its conservation problems.

Thirty-two different actions were designed to further these objectives, which are summarized below:

1) To increase, monitor and improve the habitat of the aquatic warbler in La Nava:

· Forty hectares of farmland adjacent to La Nava were purchased and planted with native species.
· The area of habitat available for the aquatic warbler was increased by flooding

The great bustard, one of the most representative species of La Nava-Campos SPA. | Carlos M. Martín.

68.4 hectares of the La Güera and El Hoyo (Mazariegos) rangelands.
· A *by-pass* was created in Fuentes de Nava to guarantee the quality of the water entering the wetland.
· The helophytic vegetation of La Nava was managed using four different techniques: mowing, grazing, mechanical removal, and controlled burning.

2) To increase scientific knowledge of the aquatic warbler and its habitat in La Nava:

A scientific banding station was set up for the study of the aquatic warbler during its stays in La Nava. Investigative work consisting in monitoring plant communities and wildlife or radio-tracking studies of the aquatic warbler was developed.

3) To create divulgation material on the aquatic warbler and its conservation problems:

· A DVD showing the results of the project was published.
· A web page on the project was created and maintained (www.carricerincejudo.org).
· Divulgation material (pamphlets, T-shirts, stickers, and pins) was prepared.
· We created a nature trail in La Nava to facilitate public use and provide information on the most representative values of the wetland.
· A manual informing about the results of vegetation management and the preparation of a protocol for searching for the species was published.

It is remarkable that many of the actions of the project are demonstrative in nature, meaning that they are designed to show how to implement actions, such as the management of vegetation, by experimenting with different methods and monitoring the results to ascertain the advantages and disadvantages of each technique used.

Many of the actions of the project are demonstrative

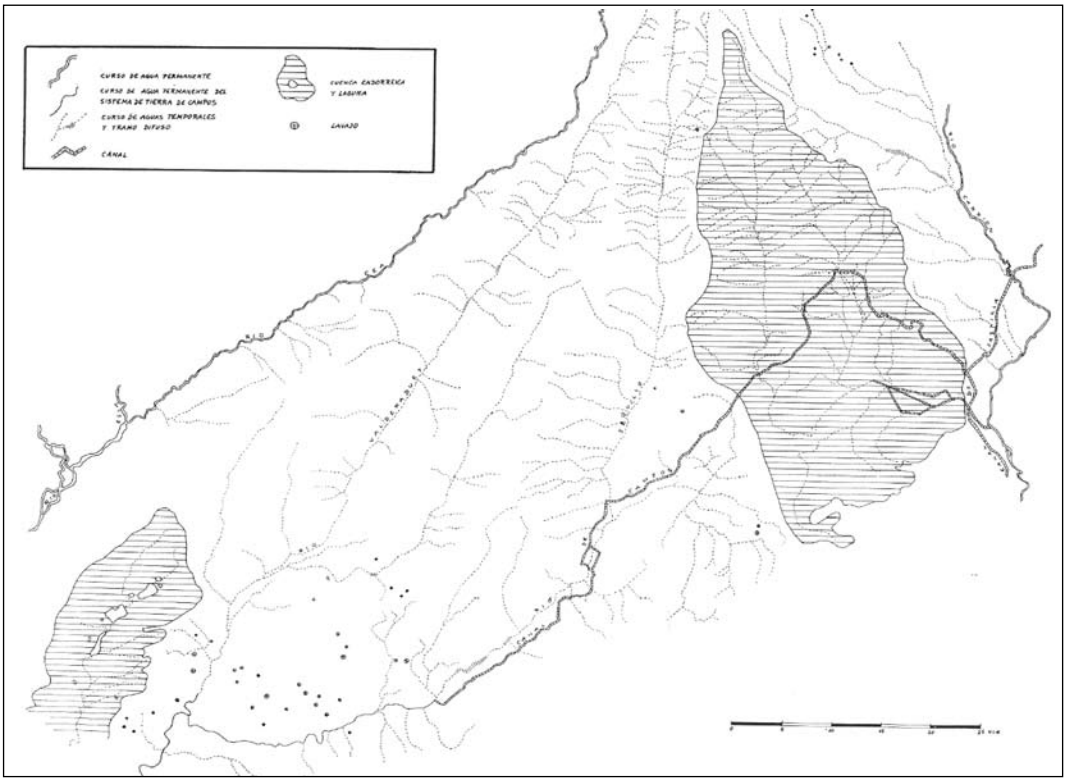
Sunset over La Nava wetlands. | Clara Casanova.

1 La Nava wetlands

Photograph: Antonio Sabater

Carlos González-Villalba
Santos Cirujano
Manuel Sánchez-Rodríguez

1.1. Location. Endorheic catchment area of wetlands



Hydrologic network and endorheic circumstances of Tierra de Campos. The shaded part on the right is the endorheic catchment area of La Nava.| Taken from Plans (1970).

The original La Nava wetlands were located in the province of Palencia, Tierra de Campos, a region dominated by a topography of gently rolling plains with little variation in altitude, ranging from 650 to 850 m asl.

It occupies the southeastern part of this region, a land area of 864 km2.

Therefore, it is a very large catchment area, but it has relatively few water sources because annual rainfall ranges from 400 to 500 mm and falls mainly in winter and spring. Consequently, many of the water courses that feed this catchment area are seasonal and discontinuous.

It has an irregular pentagonal shape, with vertices located approximately in the localities of Palencia, Santa Cecilia del Alcor, Ampudia, Herrín de Campos and Terradillos de los Templarios.

La Nava is one of the main endorheic centers of the Iberian Peninsula

The limit of the endorheic area to the south and southeast is the high plateau of Autilla at the northeastern end of Montes Torozos, which is formed by potic limestone and ranges in altitude from 860 to 874 m asl; the southern edge of the detrital high plateau and high terraces of the Carrión river to the north and northeast, with approximate altitudes of 900 m asl and gently ascending slopes; a series of hills that rise to 840-900 m asl to the west and southwest; and, finally, the Carrión river to the east, where the river basin ends. Consequently, it is an asymmetric catchment area.

Until La Nava wetland was drained by opening the hill that closed the catchment basin, it was considered one of the main and most patent endorheic centers of the Iberian Peninsula and of the sedimentary basin of the Duero river. The origin of the endorheism in this river basin and in La Nava wetland was originated by the formation of a fluvial terrace on the right bank of the Carrión river, a terrace that separated the Valdejinate river basin during the Quaternary. It is thus an example of inversion of the topography.

The floor of this catchment area is a shallow depression that was occupied by the original La Nava wetland; its southeastern end is a little more than seven kilometers from the city of Palencia. Endorheism ended with the drainage works executed in 1968, when this wetland was connected with the Carrión river by a deep drainage ditch, La Nava emissary, which crossed the fluvial terrace and became a tributary of the Carrión.

The point of lowest altitude of the entire river basin is 737.5 m as, which corresponds to the original wetland bottom and is located in the southeastern angle.

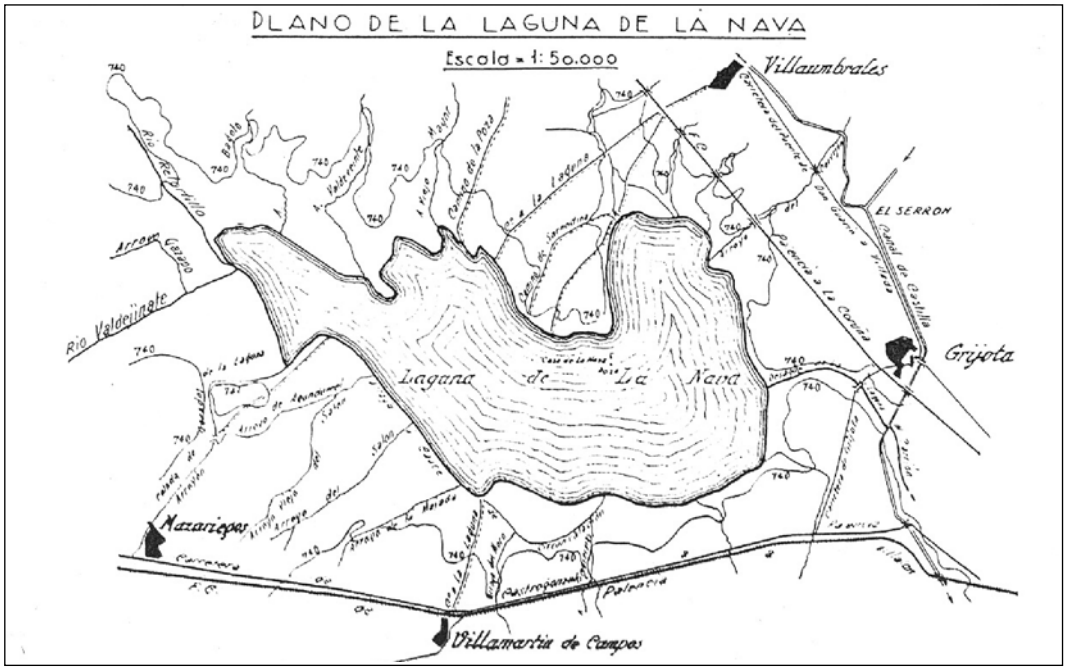
The most important channels are the Valdejinate and Retortillo rivers (tributaries of the Valdejinate), which are now channeled and were responsible for flooding the original La Nava wetland. These channels arise from the southern prolongation of the detrital high plateau. The rest are smaller channels that are much less extensive and have only seasonal flow. All of them carry little water except in especially rainy periods, when the river flow acquires greater volume.

1.2. History

During the floods of February 1993, La Nava emissary temporarily flooded much of the original area of La Nava wetland despite the drainage works. | Fernando Jubete.

La Nava was one of the three major inland wetlands of the Iberian Peninsula, along with La Janda in Cadiz and Antela in Orense. It was located in the region of Tierra de Campos, province of Palencia, close to the northwestern part of the provincial capital. This wetland area also was known as the "Mar de Campos" (Sea of Campos), a descriptive name that local inhabitants used to designate La Nava wetland. This wetland and others were considered unhealthy, a focus of infections and epidemics, and unproductive. This was why its definitive drainage was officially ordered in 1968, culminating a long succession of historical attempts to drain it.

The land occupied originally by the wetland belonged to five towns, the "Five Villages": Grijota, Villaumbrales, Becerril de Campos, Villamartín de Campos and Mazariegos. Another area known as "Cabritones" was located to the northwest of the main body of the wetland, separated by a small earthwork, and belonged to Fuentes de Nava. This area probably was separated from the main body of the wetland in the middle of the nineteenth



Main body of La Nava de Campos. State of the wetland in the early 1940s. | Taken from González Garrido (1941).

century. This second wetland joined the main body of La Nava in years of abundant rainfall, but behaved as a peripheral wetland in other years.

The few existent descriptions of the original wetland are exiguous; Pascual Madoz concisely described it in the Diccionario Geográfico-Estadístico-Histórico de España y Sus Posesiones de Ultramar in 1852, writing: *"... occupying 2,800 obradas of land, which form a large wetland..." "In rainy winters the pond is more than 6 feet deep, whereas in dry winters the land is carpeted with grass." "La Nava produces rich and abundant grass which provides grazing every year for more than 20,000 head of sheep, cows, mules and horses...". "It serves as a refuge, particularly in winter, to an infinite number of water bird species of varied forms, including three types of geese, another three types of ducks, teals, owls with a call that sounds like the lowing of a bull, swifts, curlews and other beautiful birds unknown in other areas of the country."*

1.2. History

The idea of draining La Nava dates back to the time of the Catholic kings, Isabel and Fernando

Its maximum depth must not have been more than 1.8 m, and it had a surface area at the time that it was drained of 2,200 hectares, about 8.3 kilometers long by 3 to 5 kilometers wide. However, in years of abundant rainfall, the surface area could reach 5,000 hectares. During these flood periods, the water level surpasses the closure level of the endorheic catchment area (produced by one of the terraces of the Carrión river, the Grijota terrace), causing water to flow into the catchment area from the wetland to the Carrión river, in the place called "El Tapadero." Apparently, according to Díaz Caneja, author of the drainage project of 1940, the idea of draining La Nava dates back to the time of Isabel y Fernando, with the aim consistently pursued of taking advantage of the lands that flood for farming. There have been numerous successive attempts, that failed for different reasons, such as the lack of economic or technical resources or political problems.

The project signed by Luis Díaz Caneja in 1940 can be considered the definitive project, although it underwent modifications in the course of development. It was based on the construction of a 6-kilometer long channel or main emissary out of "El Tapadero" that opened into the Carrión river and conducted all the tributaries of La Nava into the catchment area of the Valdeginate and Retortillo. This allowed the water to drain. As a complementary measure, plans were made to prolong the emissary through the wetland to collect the waters that flowed into it. It was completed with a network of drainage ditches or primary channels with sufficient capacity to conduct the streams that flow laterally into the wetland into the emissary, as well as secondary channels or drainage ditches to complete drainage of the land between the primary channels.

The purpose of drainage was to allow optimal economic use of this area by transforming it into irrigated land and dividing it up into holdings and granting it to colonists who would farm it using modern farming techniques. This resulted in the creation of an irrigatable land area of 5,000 hectares and the installation of colonists on farms created by the National Institute of Colonization, which led to the appearance of Cascón de la Nava, a colonization town that occupied part of the original wetland.

1.3. Recovery project

Dikes and excavation in La Nava in 1994, which have modeled the present appearance of the wetland. | Fernando Jubete.

The process of partial recovery of this wetland is due to several factors. One factor is general, which is giving rise to the possibility of recovering degraded or lost spaces in different places in the country. Here has been a progressive change in the prevailing mentality of society, which now favors natural or seminatural ecosystems and is increasingly aware of conservation. In addition are the different factors related to the present decadence of rural life and lack of economic productivity of farming and livestock raising in the drained lands (salinity, too much clay in the soil, population aging, and the consequent reduction in the number of livestock farmers). This turned the dream of draining La Nava of the 1940s into the promise of potentially recovering, at least partially, this great wetland in the 1990s.

Nonetheless, drainage of this wetland had and still has serious, practically irreversible problems, at least in the short and intermediate term, particularly of social nature. This is because once the drainage work concluded, the main body of the wetland was transformed into privately owned farmland and a colonization town, Cascón de la Nava. Only some land continued to be

1.3. Recovery project

municipal property, and was dedicated mainly to sheep grazing in these localities.

Among these small grazing lands located in the area of the original Mar de Campos were Fuentes de Nava and La Nava de Cabritones. This land was used for grazing the numerous head of sheep of Fuentes de Nava, which is why it was still flooded periodically by a blanket irrigation system (gravity irrigation) to favor the growth of grass. In these brief periods of flooding, the meadow recovered some of its earlier interest as a refuge for fauna, drawing a large number of aquatic species. This was one of the main reasons why Fernando Jubete, an ornithologist of Palencia, decided to present a project for the partial recovery of this area. Thanks to the support of people in the conservation world like Jose Luis González, Juan Carlos del Olmo, Magdalena Bernues, Jose Jiménez, Luis Mariano González, Bárbara Sotolargo, Antonio Troya and

La Nava meadows in March 1990, when water again flooded La Nava. | Fernando Jubete.

Cosme Morillo, he was able to obtain the necessary funds and reach an agreement with municipal councils so that on 15 March 1990 the waters of the Retortillo river again flooded 60 hectares of La Nava. Various earthworks had to be executed, which consisted basically in annulling the water drainage network of canals and channels that were constructed originally to evacuate water and prevent excessive flooding of grazing lands. The response of fauna to these first steps in recovery was very positive, with numerous species that were then in the migratory prenuptial passage stopping over. Later, the species typical of these ecosystems nested there, resulting in the citation of the reproduction of a pair of black-tailed godwits (Limosa limosa), the third known citation for the peninsula until then.

The success of this first action motivated the development of a more ambitious project, Restoration of La Nava Wetland (Mar de Campos), Palencia ".which was presented in December 1990 in response to a call for proposals by EU Funding for the Environment. This project included:

- Land purchase and leasing
- Restoration work in and around the flooding area
- Management activities (water, control of hunting activity, grazing regime, guards and monitoring)
- Public use (interpretation plan, visitors' schedule, facilities for public use, information material, publicity campaign)

From that moment on, the regional authority, Government of Castile-Leon, assumed the responsibility for managing the project of recovering this part of the original La Nava through the Regional Office of the Environment. Of all the actions carried out, the most important clearly were the actions that involved the regeneration of the wetland catchment area to guarantee sufficient water volume to fill this area, which required different earthworks and management tasks to allow water from the Canal de Castilla and Retortillo river to flow into the wetland area.

The works in the wetland catchment area exclusively affected the flood zone and consisted of closing the drainage ditches, except for those needed to manage the water, and raising an earth mound to guarantee the retention of water within the planned limits. These actions allowed the recovery and flooding of approximately 150 hectares of the grazing lands of La Cogolla, Corralillos and El Prao, thus forming the wetland now present. This surface area was enlarged by approximately 150 hectares with the Cantarranas grazing land, which was flooded temporarily to favor the growth of grass, which later was used by the livestock owners of Fuentes de Nava. This area also was flooded to increase the habitat available for certain species, thus making restoration activities compatible with maintaining an important economic activity in the township.

1.3. The recovery project

Dike construction in La Nava. | Enrique Gómez.

The earthworks in the wetland catchment area affected only the zone to be flooded and consisted of closing the drainage ditches

Aerial photograph of La Cogolla in the summer of 1994. | Fernando Jubete.

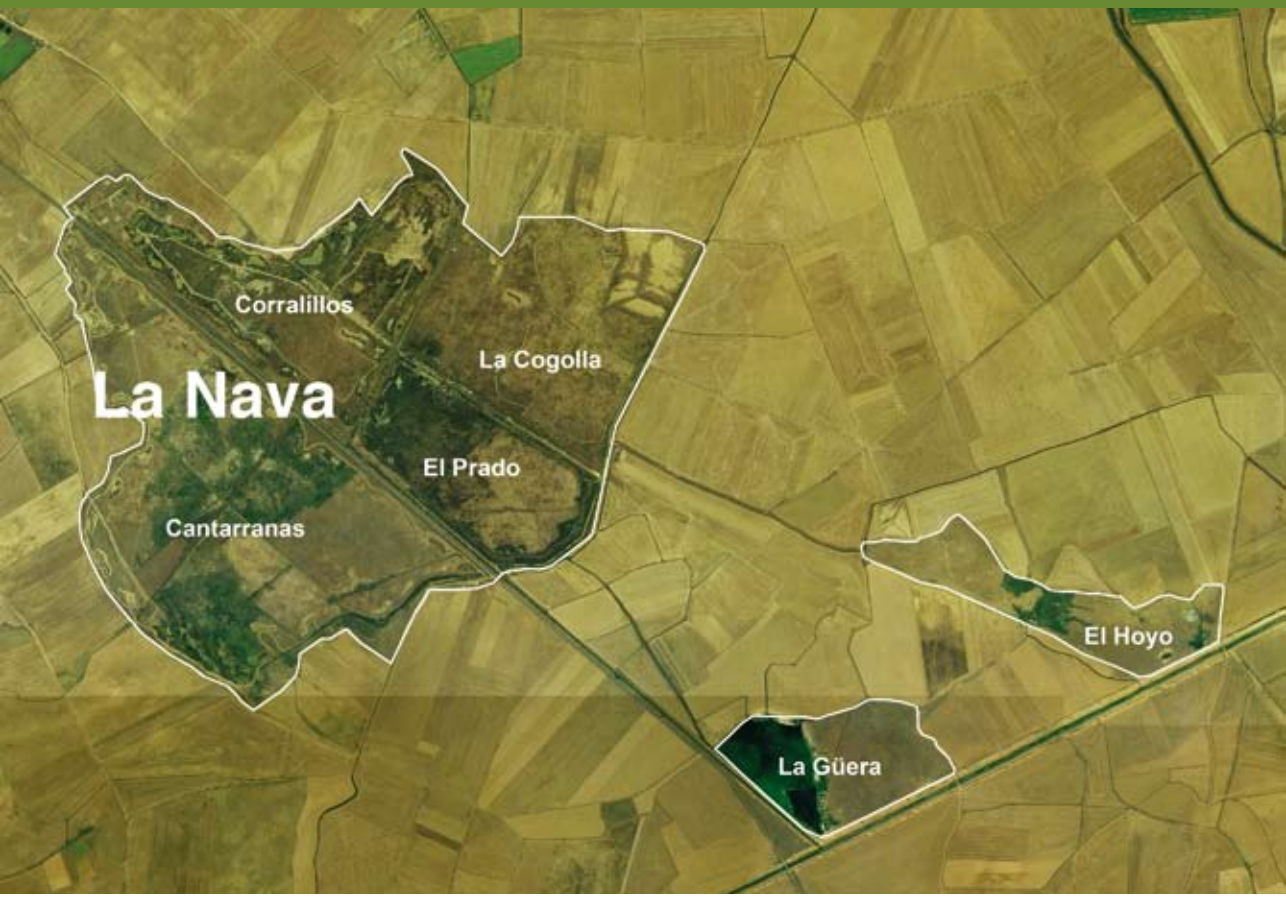
In preparation for carrying out this restoration work, the Regional Office of the Environment of the Regional Executive of Castile-Leon signed a cooperative agreement renewable every four years with the City Council of Fuentes de Nava, in which this Council leased the land for conservation purposes, for use as a wetland.

Later, in July 2003 the agreement for collaboration was signed between the Regional Office of the Environment of the Regional Executive of Castile-Leon and the city council of Mazariegos for the recovery and environmental management of the meadows of La Güera and El Hoyo, as had been done earlier with the city council of Fuentes de Nava for the management of La Nava de Fuentes. This agreement was signed thanks to the development of the LIFE Nature Project "Conservation of the aquatic warbler in the Nava-Campos SPA" to increase the potential habitat of this endangered species. Recovery of these meadows increased by 68.4 hectares the area of the original La Nava wetland.

In the recovery area we attempted, insofar as possible, to imitate the water regime it had under natural conditions, a regimen of flooding and drying typical of a seasonal steppe pond in years of high rainfall, although we always had to work without the benefit of information about the behavior of the original wetland.

The Cantarranas area is flooded temporarily to increase the habitat available for certain species and to allow a use compatible with traditional livestock raising

1.4. Description of the new wetland



Orthophotograph made in the summer months, showing the lands of La Nava, La Güera and El Hoyo without water.

The present La Nava wetland is the consequence of various restoration actions implemented since 1990. The recovered areas have been returned to a state similar to their condition before drainage in the 1960s and are divided into several zones. The main area is the present wetland, La Nava of Fuentes de Nava or Cabritones, which has a surface area of 307.28 hectares in the town of Fuentes de Nava, to which must be added the 68.4 hectares of La Güera and El Hoyo, both floodable meadows located on the left bank of the Valdeginate stream, in the municipality of Mazariegos, and 42 hectares of non-floodable land bordering on these meadows, which now comprises a total surface area of 425 hectares.

Land ownership is completely municipal. Except for the 42 hectares of non-floodable land acquired by the Regional

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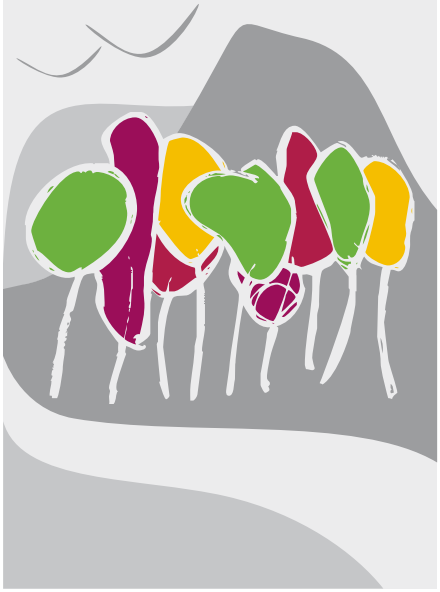


Junta de
Castilla y León

Office of the Environment of the Regional Executive of Castile-Leon, management for the entire area is the responsibility of the Office of Enviroment, through various specific cooperation agreements between this body and the two city councils implicated.

At present, La Nava wetland is a small part, approximately 10% of the original La Nava wetland or Mar de Campos, and it is part of the flood plain of the Retortillo and Valdejinate streams.

As far as the regimen of protection is concerned, La Nava wetland of Fuentes de Nava, with a surface area of 307.28 hectares, was declared a Catalogued Wetland Zone by Decree 194/1994 of 25 August, a form of protection created by article 47 of Act 8/1991 of Natural Spaces of Castile-Leon. Aside from this form of protection, which does not constitute a Protected Natural Space per se, La Nava wetland of Fuentes de Nava is located in the Special Protection Area for birds (SPA) denominated “North Nava-Campos,” which has an extension of 54,936 hectares. In addition, La Nava wetland, together with the land pertaining to La Güera and El Hoyo and the lands between them have been declared a Site of Community Interest (SCI) and will soon form part of the Natura 2000 Network.

This natural space also is included in the Plan of Natural Spaces of Castile-Leon according to Decree 119/2000 of 25 May,

1.4. Description of the new wetland

espacio natural

La Nava y Campos de Palencia

with the name of “Nava and Campos of Palencia” Natural Space, and its Natural Resources Management Plan (PORN, for the Spanish initials) already began with the Order of 17 May 2001, which is currently being written. As an internationally recognized figure of protection, it has been designated “Ramsar Site No. 1260” since 20 December 2002.

Present habitats

The main habitat in this wetland are meadows of emergent aquatic vegetation that cover almost the entire surface and are formed mainly by communities of cyperaceae. This is the habitat with the largest changes in all the wetland, due to the variation in the level of water stored in the wetland during the annual cycle. The habitat changes from a broad stretch of water during winter to a completely green area when the sedges develop in spring and to a yellowish brown zone when the wetland dries out in mid-summer and early autumn. Here is where almost all of the measures designed for vegetation management are implemented actively for conservation purposes.

Aside from this habitat, the wetland contains areas of riparian vegetation located mainly on the outskirts of the wetland and along some of the streams in the area, in addition to areas of aquatic macrophytes. These habitats, although secondary in the surface area that they occupy, diversify the wetland, increasing

Area of La Colada in spring, covered by brass buttons, spikerush and open areas of water. | Fernando Jubete.

the capacity to harbor fauna, and as a reproduction and feeding area for numerous species.

Wetland management

To obtain an exact idea of what La Nava wetland is at present and the processes to which it gives rise, it is necessary to know how it is managed.

Before anything else, wetland zoning should be mentioned because it conditions wetland management. In view of this criterion, the wetland is divided into an area of conservation or biological use and an area of joint use.

The conservation area is formed by the meadows of Corralillos, El Prao and La Cogolla, all located in the lands of Nava de Fuentes or Cabritones in Fuentes de Nava. The area of joint use is composed by the rest of the land pertaining to this wetland, including the meadow of Cantarranas in Nava de Fuentes and the meadows of La Güera and El Hoyo, in Mazariegos, as well as tracts of non-floodable land located between these meadows.

Management of the conservation area focuses mainly on the improvement and suitability of the habitat for present or potential species in the wetland.

1.4. Description of the new wetland

Water management

Water management is the mainstay of this wetland, together with vegetation management. Water management is conditioned directly by the availability of water, which is guaranteed by an authorization of 4 December 1992 of the Presidency of the Duero Hydrographic Confederation to the Regional Office of the Environment of the Regional Executive of Castile-Leon.

The system of introducing water into the wetland is totally artificial because of the social and economic impossibility of recovering the natural system of flooding. Nevertheless, this system is versatile and makes it possible to control the amount of water in the wetland. The water supply mainly through different channels originating in the Canal de Castilla. Water management is differentiated depending on the use of the floodable plot. In addition, there have been successive modifications as experience has accrued over time.

In summary, the area of conservation begins to receive water during the month of October, reaching maximum flood capacity throughout the month of December, receiving a supply in spring with the aim of attaining optimal conditions during the reproduction season. These inflows last approximately until May, when the wetland is allowed to dry out progressively. However, in the area of combined used, management is more dynamic and changing because flooding in this area, aside from aiming to create an appropriate habitat for diverse aquatic species, also seeks to achieve optimal grass growth for sheep, which necessarily entails allowing it to dry out from the end of winter. Later, partial floods keep the grass green in areas. This type of management always shows certain exceptions, which means that in addition to being an optimal place for grazing, it is ideal for certain animal species, as long as this does not affect use by livestock. These exceptions are the maintenance of small meadows that are briefly flooded in summer, which improves the habitat of the aquatic warbler (*Acrocephalus paludicola*) during the postnuptial passage, as well as that of diverse species associated to this type of habitat. Likewise, during winter the area of combined use is partially or totally flooded to increase the habitat available for wintering-over water birds.

Management of vegetation

The handling or management of vegetation in La Nava focuses on controlling the vegetation and creating an optimal structure in the wetland catchment area. The structure considered desirable is one in which free water, emergent vegetation and underwater vegetation coexist, creating areas for feeding, refuge, and nest building for water birds.

Helophytes are strongly dominant in La Nava, notably meadows of *Carex divisa* and others such as *Eleocharis palustris*, which are highly productive. This impedes the development of hydrophytes like *Chara oedophyla* or *Zannichellia obstusifolia*, producing an accumulation of dead plant biomass that favors eutrophication processes in the waters.

This problem, one of the main problems in this wetland, occurs mainly in the area of conservation because flooding is more prolonged and the vegetation is not grazed. Different methods vegetation management are being tried in the conservation area with the aim of preventing or at least reducing this problem.

In addition to the control of vegetation, other actions related to the management of vegetation are carried out, such as replanting the areas around the wetland and along some streams, as well as the land destined to restoration between La Nava de Fuentes and the meadows of El Hoyo and La Güera. This increases the diversity of the environments, diversifies the landscape, minimizes human interference with fauna, reduces the erosion of stream banks, and serves as a buffer zone from the surrounding farmland.

Management of extractive resources

The only activity considered extractive in the wetland is livestock grazing. Much of the relevant material on livestock management of the wetland is already included in the points on water management and vegetation management, because grass and water cannot be dissociated in ecosystems like that of La Nava.

Management of public use

Like all Protected Natural Sites, La Nava is also a tourism, recreational and educational resource. This means that public use has to be organized to facilitate and enhance visits while preventing damage to the fauna and habitats present.

Public use is organized through environmental monitoring, the Visitor Center located in the town of Fuentes de Nava and a series of infrastructures, such as observatories, observation points, parking lots, trails, and information and interpretational signs.

1.4.1. Characterization of waters

An adequate quality of the water feeding La Nava wetland is essential for the conservation of its diversity. The underwater meadows of charophytes (lower part of the photograph) are a good indicator of water quality. Appearance of the wetland in May 1996. | Santos Cirujano.

La Nava wetland is a shallow seasonal wetland that reaches its maximum flood level in early December and then dries out progressively until it is completely dry by the end of July. The fresh water that enters from the Carrepadilla channel contains about 0.3-0.45 g/l of dissolved salts and has a conductivity of 275-650 µS/cm. This water remains in the wetland catchment area and is recharged slightly with the accumulated salts of the sediments. Due to the semiendorheic nature of the wetland, its waters are somewhat saltier than those of the channel and become more concentrated as the depth of the waters decreases with evaporation. In this sense, the waters of La Nava can

be described as slightly saline fresh water, with salinity values that now range approximately between 0.4-1.2 g/l of dissolved salts and exhibit a conductivity of 350-1,500 µS/cm. The somewhat brackish nature of the depression is evident from the appearance of a dusting of white saline efflorescences over some areas of the ground in summer.

Generally speaking, the waters are of mixed type, with sodium-, calcium- and magnesium bicarbonate and chloride. Bicarbonates predominate over chlorides and sulfates are present in smaller amounts. The three cations are present in similar proportions. The concentration of nutrients in water is important for wetland management. By nutrients we mean the essential substances for plant development, e.g., carbon, nitrogen, and phosphorus. It should not be forgotten that marsh vegetation and water are the essential components of seasonal wetlands. Moreover, the development of vegetation is dependent on the amount of nutrients available. The nutrients present in La Nava come mainly from the decomposition of the organic matter that is produced every year in the catchment basin, from the excretions of the fauna that visit or live in the wetland, and from the inflow from the Carrepadilla channel.

Eutrophication is always a problem in wetlands because it leads to a loss of biological diversity. The waters that enter the wetland from the channel are loaded with nutrients, with total phosphorus contents that usually surpass the limit of 0.1 mg/l that defines hypereutrophic waters. Naturally, the nutrient content of the wetland catchment area is even greater, as is salinity. For this reason, the vegetation has to be controlled by eliminating the organic plant matter that accumulates in the catchment area to remove nutrients from the system. This action should be complemented by the installation of an emergent macrophyte green filter to improve the quality of the water that enters from the Carrepadilla.

An important factor in maintaining the ecological balance of the wetland is to control excess nutrients, which contribute to disturbing the development of emergent vegetation

1.4.2. Botanical characterization

Populations of flowering rush, *Butomus umbellatus*. | Santos Cirujano.

La Nava wetland is a seasonal Mediterranean wetland managed by humans insofar as its initial design, water regimen, and the control of emergent vegetation. Successive enlargements of the flooded area since wetland recovery began and different methods used to eliminate excess emergent vegetation have directly influenced the vegetation that colonizes the wetland catchment area. These changes affect the specific composition of the aquatic vegetation and the extension of different types of vegetation, whether underwater or emergent.

In terms of specific composition, the role of water birds in the colonization of this new wetland area should be

***Chara vulgaris* is an alga typical of continental seasonal wetlands that characterizes the subaquatic vegetation of La Nava wetland.** | Santos Cirujano.

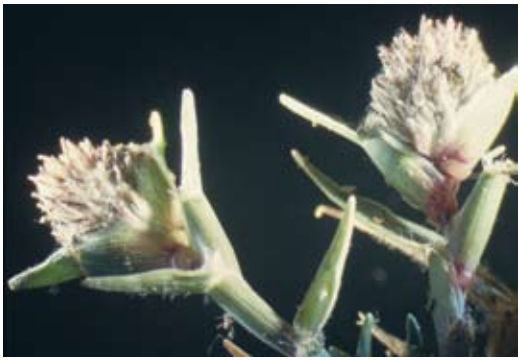
In La Nava wetland, meadows of reeds, spikerush, and saltmarsh bulrush alternate with areas free of emergent vegetation. | Santos Cirujano.

emphasized. Before its recovery in 1990, La Nava was a depression grown over with grass that contained only two small pools for livestock where sheep drank. Some aquatic plants like *Zannichellia obtusifolia* and *Chara vulgaris* var. *oedophylla* were transported to La Nava by birds from distant places, such as the National Park of Doñana. Others, such as *Hippuris vulgaris* or *Utricularia australis*, had to travel less because there are established populations in wetlands of Palencia. The seasonal nature of the wetland and competition with other submerged or emergent plants condition the proliferation or disappearance of some of these plants.

Little by little, the meadow that initially covered this depression was transformed, after repeated periods of flooding, into marshlands dominated by separated sedge (*Carex divisa*), spikerush (*Eleocharis palustris*), or saltmarsh bulrush (*Scirpus maritimus*). In areas of deeper water, cattails (*Typha domingensis* and *Typha latifolia*), common reeds (*Phragmites australis*), and softstem bulrushes (*Scirpus lacustris* subsp. *lacustris*) flourished, and in proximity to channels, extensive populations of flowering rush (*Butomus*

1.4.2. Botanical characterization

Buttercup flowers, *Ranunculus peltatus*, cover the surface in spring. | Santos Cirujano.



***Crypsis schoenoides* is a plant characteristic of autumn praderitas that developed on dried out, cracked land.|** Santos Cirujano.

In autumn, the dry, cracked soil of La Nava is colonized by prostrated plants typical of slightly brackish and nitrified seasonal Mediterranean wetlands. | Santos Cirujano.

umbellatus) arose, one of the most emblematic and pretty plants in this wetland. Finally, in the trails opened in the vegetation, water plantains (*Alisma lanceolatum* and *Alisma plantago-aquatica*) usually appear, taking advantage of a very specific habitat.

The greater or lesser extension of these emergent plant formations also is conditioned by the duration of flooding periods. If flooding is not prolonged, sedge meadows colonize almost the entire catchment area. When flooding increases, these meadows lose their vitality and are displaced, first by spikerush formations and later by saltmarsh bulrush formations. Other, larger emergent plants, such as cattail, common reed and softstem bulrush, occupy a smaller area and are relegated to enclaves where the deepest depression conserves water longest.

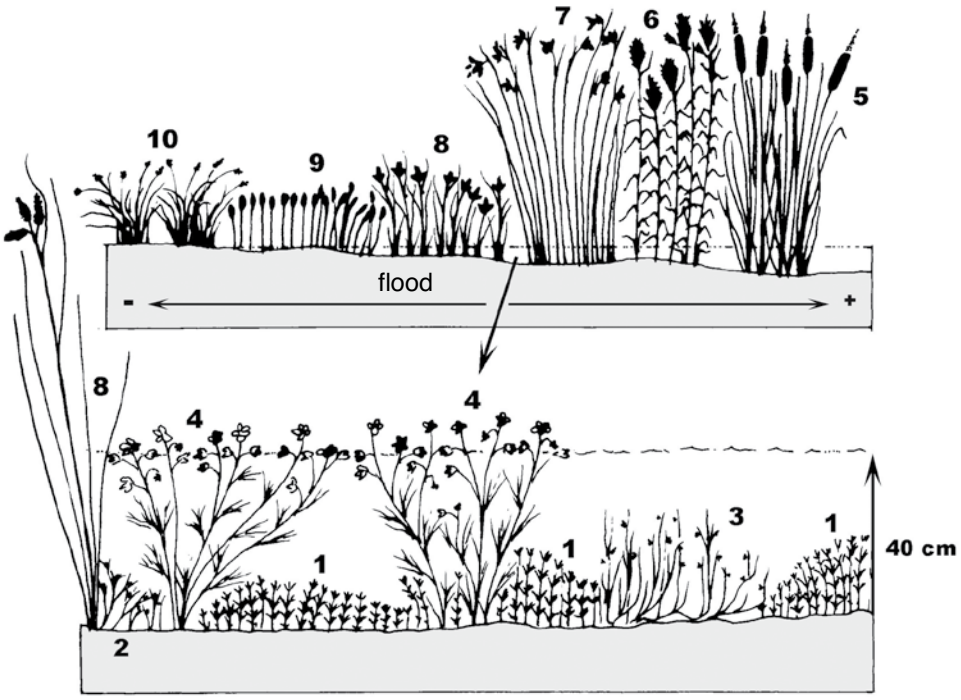
Areas of free water, where no emergent vegetation grows, are colonized by water plants distributed into two strata of vegetation. The first stratum corresponds to underwater meadows of charophytes that cover most of these enclaves, as long as the bottom of the catchment area is not covered by plant debris from previous years. These formations, which range in height from 5 to 10 cm, are constituted by different species and varieties of charophytes (*Chara aspera*, *Chara canescens*, diverse varieties of *Chara vulgaris*, *Tolypella glomerata*, *Nitella flexilis*), which are evolved green algae. The meadows of charophytes are interspersed by more or less extended areas of other submerged aquatic plants, but they already correspond to flowering plants, including different species of *Zannichellia*.

The second stratum of aquatic vegetation is constituted by formations of buttercups (*Ranunculus peltatus*) that colonize large extensions in spring, whose emergent white flowers cover the water surface and give the wetland a characteristic appearance that is typical of this type of shallow seasonal wetlands.

Finally, at the end of the summer, when the wetland is completely dry and the clay bottom of the catchment area begins to crack as the clay retracts, other plants characteristic of saline, slightly nitrified media begin to grow. They are autumn formations typical of large Mediterranean wetlands, where diverse ash-colored, low-growing plants form part (*Crypsis aculeata, Crypsis schoenoides, Lytrum thribracteatum*).

The vegetation closes its cycle awaiting a new period of flooding that will allow the formation to rise again the following year from the rhizomes, seeds and spores that are deposited or buried in the wetland floor, which now and then is enriched by the arrival of a traveling

1.4.2. Botanical characterization



General scheme of the aquatic and emergent vegetation of La Nava wetland. 1, *Chara vulgaris, Chara connivens* y *Chara canescens;* 2, *Nitella flexilis* y *Tolypella glomerata*; 3, *Zannichellia palustris*, 4, *Ranunculus peltatus*; 5, *Typha domingensis;* 6, *Phragmites australis;* 7, *Scirpus lacustris;* 8, *Scirpus maritimus;* 9, *Eleocharis palustris;* 10, *Carex divisa.*

plant that tries its luck in this Palencia wetland. If a botanical emblem were to be chosen for La Nava, without doubt it would be the flowering rush, due to its showy flowers and the fact that the plant is in regression in the Iberian Peninsula, although there are consolidated populations of many units here.

The flowering rush, Butomus umbellatus, botanical emblem of La Nava wetland. | Santos Cirujano.

Changes in the aquatic and emergent flora of the La Nava wetland

Aquatic plants

Algae (Charophytes)	1993	1996	1999	2005
Chara aspera		■	■	■
Chara canescens	■	■	■	■
Chara connivens	■	■	■	
Chara fragilis	■	■	■	
Chara vulgaris var. *longibracteata*	■	■	■	■
Chara vulgaris var. *oedophylla*		■	■	■
Chara vulgaris var. *vulgaris*	■	■	■	■
Chara vulgaris var.contraria			■	
Hippuris vulgaris				■
Nitella flexilis				■
Tolypella glomerata	■	■		■
Utricularia australis				■

Vascular plants	1993	1996	1999	2005
Callitriche brutia	■	■	■	■
Lemna gibba	■	■	■	
Lemna minor	■	■	■	■
Myriophyllum spicatum	■			

Vascular plants (cont.)	1993	1996	1999	2005
Polygonum amphibium	■	■	■	■
Potamogeton crispus	■			
Potamogeton pectinatus	■	■	■	■
Potamogeton pusillus	■	■	■	
Ranunculus peltatus	■	■	■	■
Ranunculus penicillatus			■	
Ranunculus trichophyllus	■	■	■	
Zannichellia obtusifolia			■	
Zannichellia palustris	■	■	■	■
Zannichellia pedunculata	■	■	■	
Zannichellia peltata		■	■	

Mosses	1993	1996	1999	2005
Drepanocladus aduncus	■	■	■	■
Total	**19**	**20**	**22**	**16**

Emergent plants

Vascular plants	1993	1996	1999	2005
Alisma lanceolatum	■	■	■	■
Alisma plantago-aquatica				■
Baldellia ranunculoides	■	■	■	■
Damasonium polyspermum	■	■	■	■
Butomus umbellatus	■	■	■	■
Carex divisa	■	■	■	■
Eleocharis palustris	■	■	■	■
Eleocharis uniglumis	■	■	■	■
Scirpus lacustris subsp. *lacustris*	■	■	■	■
Scirpus maritimus	■	■	■	■
Glyceria declinata	■	■	■	■
Phragmites australis	■	■	■	■
Veronica anagallis-aquatica	■	■	■	■
Sparganium erectum subsp. *neglectum*	■	■	■	■
Typha domingensis	■	■	■	■
Typha latifolia	■	■	■	■
Total	**15**	**15**	**15**	**16**

1.4.3. Invertebrate fauna

Red crayfish (*Procambarus clarkii*), a recently introduced species that has produced major changes in the wetland. | Fernando Jubete.

Before describing the invertebrate fauna of La Nava wetland, it should be noted that this is one of the biotic factors about which information is most deficient and completing this information is a priority. The lack of knowledge is such that there is not even a complete catalogue of this group of fauna, which is fundamental for proper management of the group.

This group of fauna is an essential link in the operation of ecosystems due to its abundance and diversity, as well as its function in the transfer of energy and material through the food chain. This implies indirectly that its conservation and improvement produce a favorable impact on other biological communities like fish and birds.

For these reasons, and their rapid response to variations in biotic and abiotic conditions, aquatic invertebrates are a fundamental component for evaluating the precise state of conservation of an ecosystem, monitoring its status, and as a clear indicator of the suitability or unsuitability of management actions.

Musculium lacustre seems to be increasingly scarce in the Iberian Peninsula

Appearance of various specimens of *Musculium lacustre*, a bivalve with a scant distribution in the Iberian Peninsula. | María Verdugo.

Until now, only a small number of studies of this biological community have been made, all centering on aquatic macroinvertebrates. All were made in the first years of La Nava wetland recovery project and the most recent published data date from 1996.

Thanks to the studies that have been made to date, a total of 45 macroinvertebrate taxa have been detected, distributed in a total of 6 taxonomic classes. Insecta is the largest class, with a total of 28 genera; the presence of the other taxonomic classes is much smaller. The characteristics of the ecosystem, a wetland area with abundant nutrients and organic matter, provide suitable conditions for a greater abundance of the trophic group of collectors-filterers.

Out of all the aquatic macroinvertebrates detected in La Nava, two species bear special mention. One because of its singularity: *Musculium lacustre* is a bivalve that is becoming is becoming increasingly scarce in the Iberian Peninsula and the rest of Europe. The other is the red or Louisiana crayfish (*Procambarus clarkii*), due mainly to two reasons. The first is its capacity to modify its environment, making it a threat to the conservation of submerged vegetation, which can be eliminated completely as a result of its voracity. The other reason is that it is a key element in the food chain of the wetland as one of the most common prey for most of the vertebrate predators in the wetland.

1.4.4. Vertebrate fauna

Band of greylag geese, the birds most characteristic of the wetland in the winter months. | Carlos M. Martín.

La Nava wetland is very important for vertebrate fauna, particularly birds. Of the 281 species of vertebrates in the catalogue of the enclave, 249 are birds (89%), representing almost 50% of all the species present in the Spain, including the islands. The rest of the vertebrate species consist of a total of 17 species of mammals, 6 reptiles, 5 amphibians, and 4 fish.

The species of birds that occupy La Nava vary throughout the year with the change in season and state of the environment. At the beginning of October, the wetland begins to receive water. What were little more than puddles begin to grow and combine to produce a more or less continuous sheet of water with a fairly large area. Growth of the water surface peaks when winter reaches its apogee. Wintering-over birds then put on an amazing spectacle. The cold, quiet days of winter are punctuated by the ruckus created by enormous bands

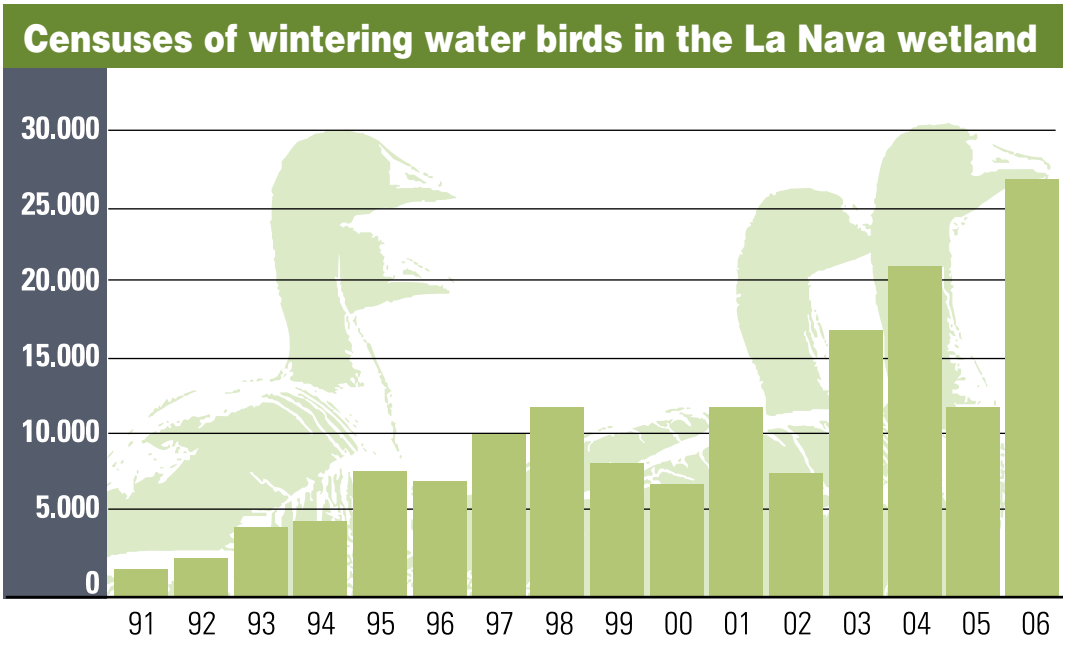
The cold, calm days of winter on the high Castilian plateau are disturbed by the ruckus of enormous bands of geese that winter in the wetland

Archibebe claro. | Carlos M. Martín.

of geese that winter over in the wetland. Most of them are greylag geese (*Anser anser*), although other species of geese are seen often, such as the barnacle goose (*Branta leucopsis*), white-fronted goose (*Anser albifrons*), pink-footed goose (*Anser brachyrhynchus*), and bar-headed goose (*Anser indicus*). These species are accompanied by diverse water birds, the most numerous of which are the mallard (*Anas platyrhynchos*), wigeon (*Anas penelope*), coot (*Fulica atra*), teal (*Anas crecca*), shoveler (*Anas clypeata*), and gadwall (*Anas strepera*). Lapwings (*Vanellus vanellus*) are the most abundant of the waders, although dunlins (*Calidris alpina*), jack snipes (*Gallinago gallinago*), and golden plovers (*Pluvialis apricaria*), among others, also are seen. In winter, several hundred white storks (*Ciconia ciconia*) that do not migrate to Africa also concentrate here. The wetland areas with cattails and reeds receive groups of marsh harriers (*Circus aeruginosus*) that congregate here to sleep. The number of passerines decreases in winter. The harsh climate of the Tierra de Campos wetlands does not allow accessible food resources to exist and few species occupy these areas in winter. In any case, there is no shortage in winter of groups of meadow pipits (Anthus pratensis), water pipits (*Anthus spinoletta*), reed buntings (*Emberiza shoeniclus*), starlings and spotless starlings (*Sturnus vulgaris and Sturnus unicolor*), and Cetti's warblers (*Cettia cetti*).

With the first signs of the end of winter that appear around February, wintering-over birds begin their trip to the north. This originates an incessant movement of birds that initiate their trip northward and others that arrive from the south. At this time, wetland diversity increases

1.4.4. Vertebrate fauna



greatly as the last wintering-over birds and migrating birds come together. The first birds seen are pre-Saharan migrating birds that have wintered over in the south of the Iberian Peninsula or North Africa. As the days advance, trans-Saharan wintering birds begin to appear. In this period the prenuptial passage of the black necked grebe (*Podiceps nigricollis*), avocet (*Recuvirostra avossetta*), plovers (*Charadrius dubius and Charadrius hiaticula*), sandpipers (*Calidris alpina, Calidris minuta, Calidris ferruginea, Calidris canutus*), ruffs (*Philomachus pugnax*), and terns (*Chlidonias niger and Chlidonias hybridus*) is observed. The passerine community increases spectacularly with species that pass in enormous numbers toward their northern breeding areas, such as the sedge warbler (*Acrocephalus schoenobaenus*), grasshopper warbler (*Locustella naevia*), willow warbler (*Phylloscopus trochilus*), and other species of warbler (*Sylvia communis, Sylvia atricapilla, Sylvia borin*, or *Sylvia cantillans*).

As spring advances, the water level of the wetland begins to drop and the wetland is covered with aquatic

The spoonbill is a regular visitor to La Nava. | Carlos M. Martín.

vegetation. The local trees and shrubs, cattail marshes and reedbeds turn green again and the food resources for many species that also find suitable breeding sites also begin to increase. The showy courtship flights of the marsh harriers (*Circus aeruginosus*) begin, purple herons (*Ardea purpurea*) congregate in nesting colonies in the wetland, coots (*Fulica atra*) and mallards (*Anas platyrhynchos*) choose their mates, black-winged stilts (*Himantopus himantopus*) call insistently, and the activity of the birds becomes frenetic. The songs of birds are heard everywhere. We find Savi's warblers (*Locustella luscinioides*) singing from the heights of cattails or softstem bulrushes, bearded tits (*Panurus biarmicus*) flitting through the reeds, and the reed warblers and great reed warblers (*Acrocephalus scirpaceus* and *Acrocephalus arundinaceus*) singing incessantly from the thick marsh vegetation. The penduline tit (*Remiz pendulinus*) constructs its hanging nests

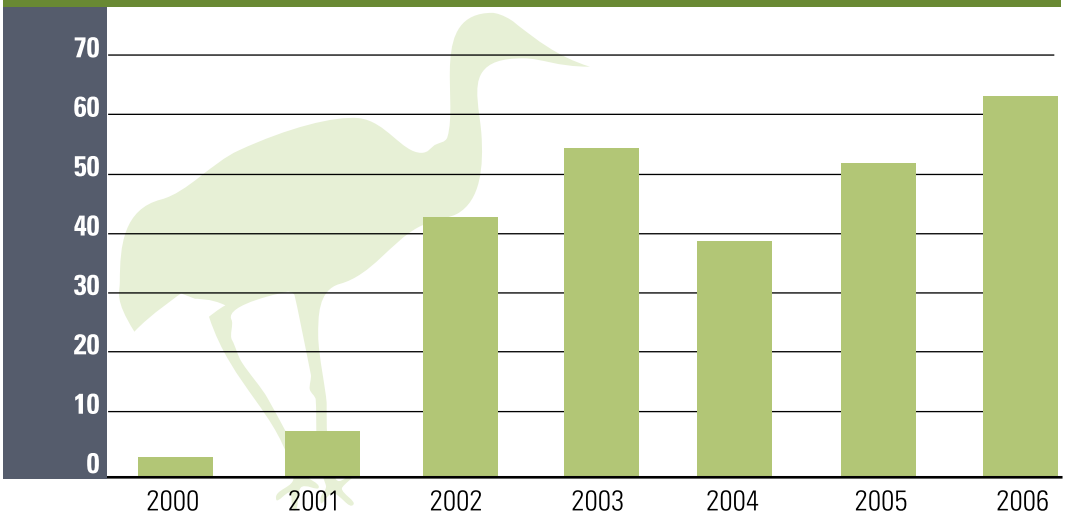
1.4.4. Vertebrate fauna

in the branches, the yellow coloring of the yellow wagtails (*Motacilla flava*) is sighted on the roads and water banks, and an endless procession of colorful birds occupies every corner.

By the end of spring and the arrival of summer, the heat dries out the wetland. Water remains in some canals and puddles that shrink by the moment. The vegetation begins to wither and the mosquitoes, which in other times were the reason why the wetland was drained, allow many species to raise their young. The chicks that hatched in the wetland appear. Young specimens of lapwings, marsh harriers and purple herons begin to be seen. Damp, cool areas of vegetation swarm with life.

Great reed warbler singing from the marsh vegetation where it constructs its nest. | Carlos M. Martín.

Censuses of nesting pairs of purple heron (*Ardea purpurea*) in La Nava wetland



Bearded tit, a singular marsh bird that reproduces in La Nava. | Carlos Zumalacarregui.

During the prenuptial passage, birds travel very quickly because they have to reach breeding areas as soon as possible to occupy the most favorable sites

By mid-summer, the cycle begins to close. The species that flew north begin to appear and now have to return south to spend the winter. This passage is more spread out and not as rushed. During the prenuptial passage, birds travel quickly because they have to reach the breeding areas as soon as possible to secure the best places. During the postnuptial passage, there is no hurry to reach the wintering-over area; the birds can fly more slowly and stop more often. In addition, the contingent of migratory birds is now

1.4.4. Vertebrate fauna

European tree frog. | Enrique Gómez.

much larger because the chicks born in the nesting season form a large part of the population. Thus, even when autumn comes, this process remains active. The rains begin to fall and soon water beings to flow into La Nava. We again encounter a large variety of species that coincide, some arriving and others leaving.

Although birds are undoubtedly the most important group of the wetland, La Nava also has other noteworthy species of vertebrate. It is surprising to find small carnivorous mammals like the ermine (*Mustela erminea*), weasel (*Mustela nivalis*), or european polecat (*Mustela putorius*) in such an open and deforested area. Unfortunately, they have had an aggressive competitor in the recent years, the American mink (*Mustela vison*). Although not strictly bound to the wetland, the steppe areas surrounding the wetland enjoy the

presence of some groups of wolves (*Canis lupus*), which survive in an apparently unfavorable habitat thanks to their extreme adaptability, using food resources like carrion or the cyclical abundance of small rodents. Small mammals also include singular species, like the southern water shrew (*Neomys anomalus*), a shrew of aquatic habits present in the wetland streams.

During the first years of recovery of the wetland, the number of species of amphibians was scant, but some were presence in abundance. This is the case of the Iberian green frog (*Rana perezi*) or the European tree frog (*Hyla arborea*). The introduction of allocthonous species like the red crayfish (*Procambarus clarkii*) has caused a drastic decrease in these species because the crayfish prays on their eggs and larvae.

Reptiles are represented mainly by two species of snakes linked to aquatic environments, the viperine water snake (*Natrix maura*) and the European grass snake (*Natrix natrix*). On the edges of farms, taking advantage of the small fallow areas along roads, other species like the ocellated lizard (*Lacerta lepida*) or the Montpellier snake (*Malpolon monspessulanus*) survive with difficulty.

The community of ichthylogic fauna of the wetland is represented by only four species that are typical of slow-moving waters and are not very demanding with regard to water quality. Of them, three are introduced, the tench (*Tinca tinca*), gudgeon (*Gobio gobio*), and goldfish (*Carassius auratus*); the only native species, which is also endemic to the Iberian Peninsula, is the bermejuela (*Chondrostoma arcasii*).

The presence of small carnivores like the ermine, weasel, or polecat in such an open and deforested area is surprising

2 Experience with managing helophytic vegetation in La Nava wetland

Photograph: Fernando Jubete

Fernando Jubete
Mariano Torres
Enrique Gómez
Santos Cirujano
Pablo Zuazua

2.1. Objectives of vegetation management

Areas of La Cogolla where excess organic matter has led to the disappearance of sedge meadows. | F. Jubete

Wetlands are dynamic, changing ecosystems and La Nava wetland is a good example. The grasslands that grew in the catchment area of the wetland after it was drained in the second half of the twentieth century were flooded again in March 1990. The presence of a constant water level from early autumn until early summer elicited a rapid response from the plants that were adapted to this environment and what had been until recently subhalophilic grasslands became dense meadows of cyperaceae, dominated mainly by two species of spikerush, *Juncus gerardi* and *Carex divisa*. At first, everything seemed to go well. The combination of water and helophytic vegetation attracted many species of birds like ducks or coots, which found food under the water and took refuge in the dense vegetation. Even a threatened species like the aquatic warbler (*Acrocephalus paludicola*) found a perfect habitat here to rest and feed

Sedge meadows in La Nava. | Fernando Jubete

during its autumn migrations.
But wetlands such as La Nava have been subjected for many years to intensive human use and management. As mentioned earlier, up to 20,000 head of cattle grazed in the wetland catchment area in the spring and summer months, thus eliminating much of the vegetation produced by the wetland. Part of the vegetation was harvested to make chairs or baskets and many hectares where cattle did not enter because of the depth of the water were set afire by hunters to force ducks and coots out of hiding so that they could hunt them.

Nevertheless, the new La Nava wetland at first lacked this type of management, so a slow natural succession began that, in the absence of human intervention, would have led to eutrophication of the wetland. *Carex* and *Juncus* meadows contribute a biomass every year of 7 to 10 tons of dry plant material, which, if

not used of, settles on the wetland floor and enters the nutrient cycle in the next season. The results soon were evident. What at first were transparent waters became turbid, with an elevated organic load, conductivity, and oxygen levels well below what is considered normal. Underwater vegetation disappeared because sunlight could not penetrate to the floor of the wetland and plants and algae could not take root because of

The problem with steppe wetlands is that they are scarce in Spain and Europe, which is why there are hardly any previous experiences with vegetation management

Accumulated organic matter on the floor of the wetland, for the most part debris from the decomposition of plant material from other seasons. | Fernando Jubete

the layer of organic matter produced by decomposition of the sedge meadows. Bird species soon accused these changes and the number of pairs of coots, terns, black-winged stilts, and grebes decreased progressively. Even the sedge meadows began to disappear, at first because they were replaced by more hydrophilic species like *Eleocharis* or *Scirpus maritimus*. In some areas, the degree of eutrophication of the wetland caused extensive areas of water in which no vegetation grew to open up and left patches where only decomposition bacteria and green algae were able to survive in the water.

It was obvious that this situation had to be changed, making intense and continued management of the helophytic vegetation formation necessary. The problem is that steppe wetlands, as is the case of La Nava, are scarce in Spain and Europe, which is why hardly any previous experiences with vegetation management exist. For this reason, we decided to try four different methods of managing vegetation: mowing, grazing, mechanical removal, and controlled burning, to evaluate their effects on vegetation and the expense and viability of these methods. The results of these experiences are described below.

2.2. Description of the methods used
2.2.1. Mechanical removal

Mechanical removal or ripping gives good results and is one of the methods most used to control excess helophytic vegetation in wetlands. Basically, it consists of removing the vegetation and first centimeters of soil of the wetland using a caterpillar tractor or bulldozer. This allows the elimination of accumulated plant material as well as plant rhizomes, thus slowing reoccupation. In this sense, the conditions of humidity, land structure, and topography notably influence the effectiveness of this action. In soil like that of La Nava wetland, with a high clay content and an enormous capacity for retaining moisture, the yields of the action can be reduced by up to 30% with respect to what is anticipated because ripping less than 15-20 cm is almost impossible. For that reason, although the initial plan was to perform mechanical removal on 40 hectares to remove only 5 cm of the surface, we finally acted on only 26.5 hectares and removed a deeper layer.

The work was done in summer (August to September), coinciding with the time of no rainfall and a consequent low water level in the wetland. This way, the impact on wetland values is minimal and the work of the bulldozer is more effective.

Specifically, work was carried out on five tracts ranging in size from 0.8 hectares to 11 hectares. The entire amount of dry plant matter eliminated was 180 tons, a mean of almost seven tons of dry plant matter per hectare of land. As has been commented, La Nava is an extraordinarily productive wetland.

Nevertheless mechanical removal as a management tool has a negative aspect: high cost. Between excavation, shovel loading, transportation of the extracted material and its extension, ripping one hectare of land costs 2,900 euros, of which 60% corresponds to transporting earth a maximum distance of only 4 kilometers. However, since this type of work is not done every year, the comparative cost is 414 euros/Ha/year when averaged out over an estimated period of seven years.

In the case of La Nava wetland, the materials removed were deposited and extended over farmland adjacent to the wetland. In some cases, the areas closest to the wetland were located slightly below the maximum water level, leading to flooding and harming farming interests. The 38,000 cubic meters of good quality soil for agricultural use that were extracted using large capacity trucks were extended over this farmland, thus improving the land and limiting the cost of transportation and the entire action.

Mechanical removal work. | Enrique Gómez

El Prao the next year, after the piles of ripped up earth have been removed. | Enrique Gómez .

Appearance of a ripped area in El Prao; piles of earth and plant material that have not been removed are still visible. | Enrique Gómez .

2.2.2. Grazing

Herd of horses used in La Nava for vegetation control. | Fernando Jubete.

The use of herbivores to control helophytic vegetation is a tool that is widely used in many natural spaces. Wetlands are not indifferent to this process and there are many examples in Europe where different species and breeds of large herbivores are used to control vegetation. The review made by Tolhurst (1997) contains a good compendium of actions.

La Nava wetland in its origin was intensively used by livestock. In the middle of the nineteenth century, the historian Pascual Madoz claimed the following about La Nava in his Geographic-Historical-Statistical Dictionary of Spain and Its Overseas Possessions: *La Nava produces rich and abundant grass for the maintenance of more than 20,000 head of sheep, cows, mules, and horses every year; the country is renowned because beautiful and brave colts were raised here in the time of the counts of Castile, who used them as mounts for the cavalry of their armies.*

In Spain there are successful examples of the use of different species of herbivores to control marsh vegetation. Aiguamols Park of l 'Emporda in Girona

uses cows and Camargue horses. The Albufera of Majorca also uses horses and cows, and water buffalos have been introduced for the control of reeds. At the recently recovered Salburua ponds in Vitoria, red deer (*Cervus elaphus*) are being used to control the herbaceous and arbustive vegetation, and they also constitute an attraction for visitors. The National Park of Doñana is another example. In this space of more than 20,000 hectares, several thousand head of bovine, equine, and wild ungulates graze. Application of the measure has resulted in different degrees of success. For instance, the lands of the National Park are subject to overgrazing that threatens helophyte formations. In contrast, on the 10,000 hectares of the Doñana Biological Reserve, which is private land, a balance is maintained in the number of heads of cattle. As a result, this habitat is of high ecological value.

Many of these programs pursue a double goal, being a tool not only for managing the environment but also for the conservation or recovery of native breeds that are in danger of extinction, such as the Camargue horse, retuertero horse (Doñana), marinera cow, and Catalonian donkey (Aiguamols and S'Albufera).

Choice of herbivore species

The first decision that has to be adopted is whether wild or domestic herbivores are going to be used. In the case of wild herbivores, the species most used in Europe are red deer (Cervus elaphus) and fallow deer (Dama dama), whereas the domestic herbivores are mainly cows, horses, sheep, and goats. In some cases, other, more exotic, species are used, such as water buffalo, which can feed in areas of deep water and control species like reeds. Under natural conditions, wild herbivores require large grazing areas, which is only possible in a few European wetlands (for example, the National Park of Doñana or the Camargue). These species are being used in some Spanish wetland areas, but hunting fences have to be erected first to keep the animals from leaving the confines of the wetland and to avoid causing traffic accidents.

As mentioned above, the domestic herbivores most often used for this type of vegetation management are horses, cows, and sheep. Tolhurst (1997) made a detailed study of the advantages and disadvantages of the each of these herbivores, the results of which are summarized below.

2.2.2. Grazing

	Advantages	Disadvantages
 Horses	Good capacity for adapting to different environments and environmental conditions, easily overcoming adverse conditions like climate, food shortages, etc. The effects of grazing yield a good structural diversity Some breeds can tolerate very damp climates without problems and survive in natural spaces that are extensively flooded Some breeds tolerate mosquito bites without problems The treading effect can increase species diversity	Management is more complicated than for other animals and it may be necessary to build facilities for the animals. They tend to return to a wild state Visitor access to areas where public use and vegetation management coincide must be limited to curtail the risk of accidents They require a large amount of drinking water
 Cows	Easy to manage, cows tolerate temporary confinement in stables well They can graze without problems in zones of dense vegetation or flooded wetlands The effects of grazing yield a good structural diversity Some breeds can tolerate very damp climates without problems and survive in natural spaces that are extensively flooded Some breeds tolerate mosquito bites without problems The effect of treading can increase species diversity	They need a complementary food and mineral supply, especially during winter They are classified as Specific Risk Material and the sale, marketing, or elimination of carcasses is subject to strict legislation Females with young can be especially dangerous for people, so they have to be confined to non-public use areas They require a large amount of drinking water
 Sheep	They have an important role as pioneering species in vegetation management They are easily managed and can be moved temporarily to areas where we intend to produce a limited grazing effect Very useful for the control of zones with new-growth arbustive vegetation They can be used in areas where fresh water is not abundant Highly adaptable to variations in temperature Tolerant of the presence of people in grazing areas	In large areas, they graze in small groups, which can make their management difficult and disperse vegetation management Due to the shortness of their limbs, they do not adapt well to areas such as wetlands with high flood levels They are classified as Specific Risk Material and the sale, marketing, or elimination of carcasses is subject to strict legislation Very rainy climates can cause problems physical highs and lows and diseases Their hooves require regular care to prevent excessive growth and control the presence of infections, as well as shearing once a year Short life span

The horses used in La Nava are from the National Park of Doñana. | Fernando Jubete.

The effects of grazing are clearly visible on the right, compared to the ungrazed zone on the left. | Fernando Jubete.

In the case of La Nava (Fuentes de Nava, Palencia), a breed of horse very similar to that which originally existed in the old wetland was chosen. These horses are a Spanish breed that, despite crossbreeding, are highly adaptable to life in damp environments and do not require daily care from the managers of the natural space.

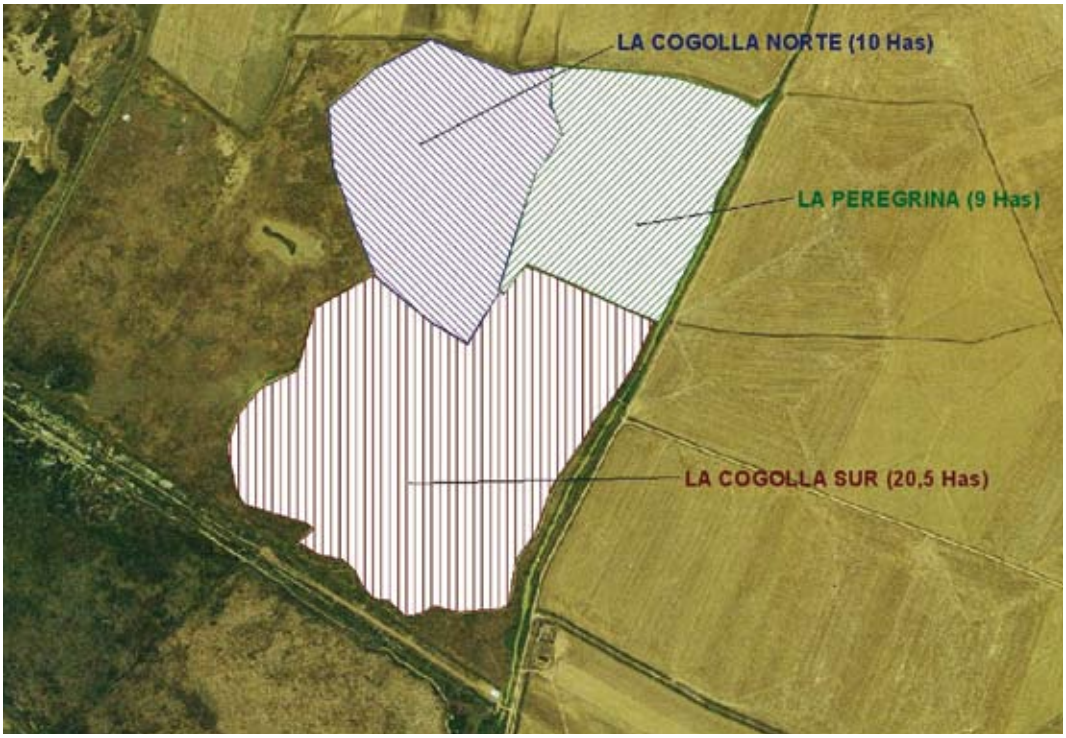
In September 2002, a herd of eight horses, five pregnant adult females and three colts less than one year old, was acquired from the Biological Station of Doñana. These horses had been grazing in semi-freedom in the National Park of Doñana, so the humidity of the environment was similar to La Nava, with periods of flooding from autumn to early summer, and a strong summer drought.

Grazing regimen

Management of the horses has been quite simple. Initially, an area of 9 hectares adjacent to the wetland was fenced with wood posts and barbed wire. This is where the horses are managed when they have to be deparasitized, colts are born, or any other activity has to be carried out. Inside the wetland, 39 hectares has been fenced with acacia wood posts (which is resistant to prolonged dampness) and electric cattle wiring. At first we used plastic tape with three electrical wires, but it has been replaced by wire because the plastic was ineffective and colts broke it several times.

A 30 square-meter corral was built to provide refuge for the animals, but it was not very useful because the animals have used it only a few times. To manage the

2.2.2. Grazing



Name and area of the grazing areas of the horse herd.

animals, a capture corral was built out of wood. In these four years, no veterinary care has been required during births, all of which occurred normally. The only health care that the horses receive is deparasitization once a year.

In general, the herd of horses has grazed freely on the entire land area available, being confined to La Peregrina and La Cogolla-North during winter, from November to February, where they are given a food supplement of forage harvested in La Nava. The winter period coincides with maximum water levels and with the vegetative inactivity period in the wetland, so much of the grazing area cannot be used by the horses. This helps to reduce the introduction of nutrients from excrements in the wetland catchment area because the land where the animals are kept is separate from the wetland.

In summary, we conclude that once the necessary infrastructures were built, an average of 10-12 horses could be grazed on an area of 39 hectares from March to October, whereas in the months of November to March the grazing area was reduced to 9 hectares, although the loss of area was compensated by supplemental feeding, usually with grass cut in the wetland.

The following table offers specific data on the livestock load in La Nava wetland during different periods of the year (expressed in Large Livestock Units, 1 horse = 1 LLU).

Areas grazed by horses and the livestock load in La Nava

Period	Livestock load (LLU/ha)	Area grazed (ha)	Area grazed
1/10/02-31/3/03	1,1	9	La Peregrina
31/3/03-31/3/04	0,8	12,5	La Peregrina y La Cogolla Sur (partialy)
1/4/04-30/11/04	0,3	39	La Peregrina, La Cogolla Norte y La Cogolla Sur
30/11/04-31/1/05	1,4	9	La Peregrina
1/2/05-31/10/05	0,5	39	La Peregrina, La Cogolla Norte y La Cogolla Sur
1/11/05-31/12/05	2,1	9	La Peregrina

These calculations tend to overestimate the livestock load because all existing animals are considered part of the LLU, without distinguishing age classes. The annual average livestock load was 0.3-0.5 LLU/ha during the months of spring, summer and autumn of 2004 and 2005, when the herd was grazing on 39 ha of La Cogolla. The livestock load increased to 1.1-2.1 LLU/ha during the winter months, when the animals were confined to La Peregrina.

This density is similar to that found in other wetlands, for example, in the National Park of Doñana in 1994 the horse density was 0.1 LLU/ha and cow density, 0.1 LLU/ha, to which must be added a large population of sheep and wild ungulates, which makes the livestock load approximately 0.5 LLU/ha.

2.2.2. Grazing

The density of animals in La Nava is similar to that of other wetlands such as the National Park of Doñana

In three Dutch wetland areas where horses and cows are used to manage the vegetation, the animal density ranges from 0.1-0.3 LLU/ha, although many of them also sustain wild herbivores like red deer or fallow deer.

The horses used in La Nava have adapted without problems to the harsh winters of the region. | Fernando Jubete.

2.2.3. Controlled burning

Until the beginning of the present LIFE-Nature project, controlled burning had been the method most often used to control helophytic vegetation since the recovery of La Nava wetland began. Every year in September and October, coinciding with the moment in which the wetland and its vegetation are driest, an area of up to 80 hectares of extraordinarily dense sedge meadow is burned. This practice requires the creation and maintenance of a network of firebreaks more than 8 kilometers long that make it possible to protect the peripheral areas of vegetation that we want to conserve each season.

Nevertheless, although the system has a notable and perfectly acceptable degree of effectiveness from the economic vantage point, its debatable environmental viability forced us to seek alternatives to avoid burning or at least to reduce its use as much as possible.

Vegetation management by controlled burning in La Nava. | Enrique Gómez

2.2.3. Controlled burning

Appearance of El Prao after controlled burning. | Fernando Jubete.

Burning, contrary to appearances, still leaves a large percentage of organic matter as ash in the wetland system and also seems to be very aggressive with the invertebrate populations that are the fundamental food of aquatic warblers and other species that use this wetland ecosystem. In 2002, when the project began, the area of controlled burning reached 80 hectares, but in 2005 burning was no longer used as a control method. The time when an enormous column of smoke could be descried from many kilometers around has past. Burning now is considered a secondary system that should be used only in small areas and whenever there are no other alternatives.

2.2.4. Mowing

Mowing is a method often used to control excess helophytic vegetation in wetlands and it is considered one of the best adapted due to the optimal relation between effectiveness, economic cost, and environmental viability. In effect, in La Nava a minimum of 55% of the plant matter produced by meadows is removed by mowing. The cost, considering mowing, collecting, and packing, is 130 euros/ha/year, making it notably less expensive than other methods of control like mechanical removal.

In La Nava wetland, mowing was hardly used until 2004 and the difficulties that it entails in a wetland such as La Nava are not unappreciable. As an artificial catchment area with an extraordinarily level topography and no major obstacles, the most suitable way to mow is with machinery. Nevertheless, for mowing to be minimally effective with the available technology, the machinery must be used when the vegetation is still green and erect and the ground is dry enough so that the mowers can work without added problems. These special conditions occur only one week out of the year, usually in July. Before this date, the meadow still has a little water and it is impossible to work. Later, when the ground is very dry, the vegetation has withered and fallen, making the work of the combine useless or ineffective. For this reason, mowing requires close monitoring and control of the evolution of the meadow and sufficient planning to ensure that all the necessary tools are available when needed.

Plant matter has to be removed by mowing and this can only be done effectively in July, just before the postnuptial passage of the aquatic warbler through the wetland begins

Nevertheless this system poses a problem that is difficult to resolve a priori. On the one hand, to avoid eutrophication of the water, it is absolutely necessary to remove plant matter by mowing and this only can be done effectively in July, just before the postnuptial passage of the aquatic warbler through the wetland. On the other hand, it is clear from the literature and studies of habitat use by the aquatic warbler in La Nava wetland that this species requires specific conditions of vegetation height and coverage that disappear with mowing.

We are trying to resolve this evident contradiction in the following way: the aquatic warbler apparently needs areas of tall helophytic vegetation (80 cm), in this

2.2.4. Siega

Mowing in La Nava. | Enrique Gómez.

case sedge meadows, with nearby streams of water and helophytic (*Typha sp., Scirpus sp.*) and arbustive (*Salix sp. and Tamarix sp.*) vegetation. Consequently, we do not mow all of the meadow. Each season, only the central parts of the meadow are mowed in the conservation area, leaving a band of vegetation 60 to 100 meters wide along these streams. In addition, in the Cantarranas meadow we have planned a system of rotation about every three years, so that there is always and area of 15 to 20 hectares with the conditions required by the aquatic warbler. On the other hand, in the new meadows of Mazariegos, La Güera, and El Hoyo, sectors of 6 hectares each have been set aside that cannot be mowed or grazed by local cattle. This way the aquatic warbler always finds fairly extensive areas of favorable conditions in the meadows that now form La Nava wetland. It also should be noted that we do not have our own mower. For the last three years, local farmers have been allowed to enter and mow the meadow following the instructions of the manager, in exchange for keeping the bales. They use these bales as food or bedding for

Unmowed area and, in the background, a mowed area in La Nava. | Fernando Jubete.

their animals. In this symbiotic fashion, we remove and control the vegetation at no cost and we also benefit local farmers and livestock owners. It is therefore an optimal system that already has been incorporated into the annual management regimen of the wetland.

In 2004, 40.53 hectares were mowed and in the 2005, 43 hectares were mowed, approximately 14% of the total area of the wetland. In 2005, 178 tons of vegetation was removed from the wetland by mowing, which comes to an average of 4.14 tons/hectare. At present, mowing is the main system for controlling wetland vegetation in areas where regrowth of the meadow the next year does not matter.

3 The aquatic warbler

Photograph: Fernando Jubete

Carlos Zumalacárregui
Fernando Jubete
Mariano Torres

3.1. The aquatic warbler
3.1.1. Description of the species

The aquatic warbler *Acrocephalus paludicola* (Viellot, 1817) is a monotypical species measuring about 12 centimeters long and weighing 14 grams, which belongs to the Sylviidae Family, that is included in the Passeriform Order of the Bird Class.

It is a species with modest plumage, of straw-colored tonality and striped. The only noteworthy feature are three large eyebrows of yellowish ocher color, one on each side of the head and another one on the crown. These characteristic markings give the bird its name in Spanish. The male and female have identical plumage and only slight differences in body size. In contrast, juvenile birds differ from adults because their yellowish tonalities are more marked and the stripes on their flanks are more muted.

The aquatic warbler lives in wetland areas with little flooding where the emergent aquatic vegetation is composed of diverse species of water plants like spikerush, saw grass, or grasses.

Its area of distribution is restricted to eastern and central Europe, between the latitudes 47º and 59º N. At present, only fifty regular breeding areas are known in seven countries, occupying an area of less than 1,000 square kilometers. The main reproduction areas are in Belarus, Ukraine, and Poland, which contain more than 90% of the world population, which was estimated in 2005 at less than 20,000 singing males. It also reproduces in Germany, Hungary, Lithuania and Russia, but to a lesser extent in terms of the number of specimens and distribution area.

During the past twentieth century, the size of the population and area of distribution of this species have experienced a dramatic reduction, mainly due to habitat destruction (more than 40% in the last ten years). This has caused the extinction of the aquatic warbler as a reproducer in many countries of southern and western Europe, such as France, Belgium, Holland, Austria, Italy, Federal Republic of Germany, Yugoslavia, and Czechoslovakia.

On the other hand, in recent years new breeding sites have appeared that are equivalent to more than two thirds of the present population, with important populations in countries like Belarus and smaller nuclei in European Russia and western Siberia. Some reproductive nuclei in Hungary and Poland have experienced a moderate increase in their reproductive population.

The plumage of the aquatic warbler is quite discrete, with the exception of two cream-colored eyebrows and the line of the crown and striped orange rump. | Fernando Jubete.

A young aquatic warbler, showing more intense yellow or orange tones in the plumage color. | Fernando Jubete.

Adult aquatic warbler, with straw-colored plumage and more marked stripes on the flanks and breast. | Fernando Jubete.

3.1.2. General biology

Nesting habitat of the aquatic warbler in Biezbra (Poland). | Fernando Jubete.

This small insectivorous bird lives in a very specific and vulnerable habitat. The habitat consists of open wetland areas with low-growing marsh vegetation and shallow waters 1 to 10 centimeters deep. These areas are called “mires” in English. This type of habitat is found in wetlands and seasonally flooded meadows, where marsh species and helophytic grass of low to medium height of the genera *Carex, Cladium*, or *Molinia* are present. It also is found in degraded helophytic formations of taller species like reeds (*Phragmites australis*). In addition, due to the reproductive strategy that the species develops, the habitat must by highly productive in insects and arachnids, the main source of its food.

During migration and wintering-over, the aquatic warbler also is selective about its habitat needs, which are similar to those of reproductive areas. It is favored by areas of open water with grassy or

Aquatic warbler transporting food in its beak for nestlings. | Alexander Kozulin

marsh vegetation, such as meadows of species of the genera *Carex*, *Juncus*, *Eleocharis*, and *Scirpus* or formations of reed (*Phragmites australis*) and saw grass (*Cladium mariscus*) in both coastal and inland wetlands. However, it is sometimes less selective, visiting other types of vegetation like crops irrigated by flooding (cornfields, lucerne, rice paddies, etc.), or salicornia formations. The aquatic warbler has developed an unusual system of reproduction for a small bird. Its reproductive strategy combines polygyny and promiscuity, which means that males maintain territories where they can mate with several females (polygyny), but at the same time females usually mate with different males (promiscuity). The same clutch often contains descendants of several fathers. It is peculiar to this species that the female alone takes charge of incubating the eggs and raising the chicks because the male completely ignores their care. This strategy seems positive whenever the birds live in very productive and extensive environments because the females need to have a lot of food available and a large territory to do all the work that the male of other species would share.

The nest is located close to the ground, hidden in dense vegetation. The location of the nest usually is selected by the female and is constructed as a cup of grasses, leaves, and spiderwebs that sometimes has grasses arrayed over it like a roof. The size of the clutch ranges from three to six eggs, with an average of five eggs, and more than 50% of the chicks that hatch eventually fly. They usually only have a single clutch, although some pairs can have a second clutch if the habitat conditions are favorable and food resources are available.

Its diet consists of invertebrates, fundamentally diptera (mosquitos), arachnids (spiders), odonata (dragonflies), and lepidoptera (butterflies and moths). These groups make up about 70% of the prey.

3.1.3. Migration and wintering-over areas

The aquatic warbler is a long-distance migratory bird, capable of flying more than 5,000 kilometers from eastern Europe to sub-Saharan Africa, during its seasonal migrations. Its presence has been recorded regularly in Germany, Holland, Belgium, France, United Kingdom, and Spain during its migration between breeding and wintering-over areas. It is a trans-Saharan migrant, and may have a migration route in a loop, meaning that it is more abundant in the western end of Europe during the autumn migration, whereas the eastern route is dominant during the spring migration.

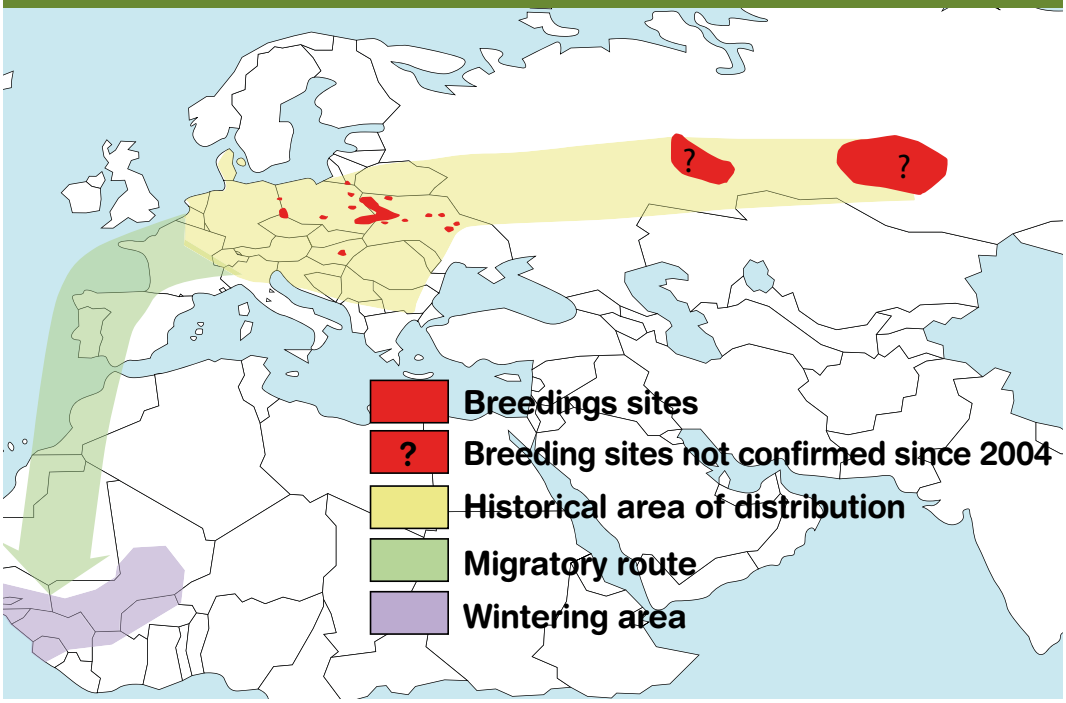
The autumn migration begins when the adults leave the breeding areas in July. The return takes place in two waves: adults, juveniles from the first clutches, and some adult females fly in the first migratory peak, while juveniles from the second clutch and the rest of the adult females migrate in a second smaller peak. Analysis of data on arrival from the resting areas during the autumn

Inland delta of the Niger river in Mali, one of the possible wintering-over areas of the species in Africa. | Carlos Zumalacarregui

passage indicates a single migratory front, passing first through the Baltic coast, along the coasts of the North Sea, and then on to Africa along the Atlantic coast and Iberian Peninsula. The spring migration route is less well-known than the autumn route, but it seems to be a more direct and eastern route than the autumn migration due to the low number of sightings recorded in the countries of western Europe in the spring months. Adults return to the breeding areas at the end of April, increasing in number progressively until the end of May.

The winter quarters are not known at present but, in accordance with the few existing records, the wintering-over areas are located to the south of the Sahara, in the western African continent. The presence of the aquatic warbler in nine African countries is known, but since 1980 sightings have only been recorded in five countries (Egypt, Ghana, Mauritania, Morocco, and Senegal), and in the months of November to January there have been sightings in only four

Map of distribution of the aquatic warbler



3.1.3. Migration and wintering-over areas

countries (Mauritania, Senegal, Mali, and Ghana). All the data analyzed to date seem to indicate that aquatic warbler migrates through northwest Africa in autumn and spring, and in winter is found in wetland areas of the Sahel strip, or the zone of transition between the Sahara desert and tropical western Africa. Some recent data from areas to the south of the Sahara indicate that there may be wintering-over sites in countries like Gambia, Guinea, Sierra Leone, Ivory Coast, Togo, or Benin.

Therefore, the main wintering-over areas of the aquatic warbler in Africa have still not been located, and only a few dozen dispersed sightings indicate its presence at this time in countries of western Africa.

In general, the habitat type and vegetation that the aquatic warbler uses during migration and wintering over in Africa are similar to those of the wetland nesting areas: wet areas with associations of *Carex*, *Juncus*, or *Phragmites*, but also dense grassland, brush, and other types of vegetation that are close to wetland areas.

The meadows of flooded helophytic vegetation in La Nava are the habitat used by the aquatic warbler during postnuptial migration. Fernando Jubete

As in the nesting areas, the loss of habitat in the winter quarters is critical for the long-term survival of the aquatic warbler. The main threats to the species in its wintering-over area derive from the intense human impact on the natural dynamics of the wetlands, fundamentally due to dam construction to regulate watercourses and the intensification of farming, with the development of systems of intensive irrigation. A high livestock load seems to influence the deterioration of these wetland areas due to overgrazing.

Aquatic warbler among the marsh vegetation. | Alexander Kozulin

In fact, things being what they are, the development of field work and research on the areas that can harbor wintering populations of aquatic warbler in Africa is one of the main measures for conserving the species, as indicated in the last modification of the European Action Plan of 2003

The main threats to this species in their wintering-over areas are due to the strong human impact on the natural dynamics of the wetlands

3.1.4. Conservation status

From the biology of the species can be understood directly the causes of the decline that the aquatic warbler has experienced in the last century. The disappearance of fields of bulrushes, which are used by the aquatic warbler throughout its vital cycle, together with the fact that it is a specialist of these aquatic environments and not others, is the main reason behind its poor conservation status.

The main threats to the aquatic warbler in breeding areas are the direct loss of habitat due to the drainage and channeling of wetland areas, changes in farming uses due mainly to the abandonment of traditional livestock practices and the increase in intensive farming, which favor the development of reed formations, shrubs, and arboreal species that are not suitable for the species. Uncontrolled burning during the reproductive period and the deterioration of water quality due to farm or industrial effluents also cause habitat loss in the intermediate term.

Less known are threats to the zones of passage and wintering-over areas, but the degradation and loss of these areas can influence the long-term survival of this small species.

These threats have led to cataloging the aquatic warbler as a globally threatened species (catalogued as Vulnerable on the global scale) and as the most threatened passerine in continental Europe (classified as Endangered in Europe). It is included in Annex I of the Bird Directive, Annex II of the Bern Convention, and Annex II of the Bonn Convention.

In addition, in recent years a European Action Plan has been prepared in which the main threats to the species are analyzed and the conservation priorities to be developed by the countries involved in its management are defined. Also, an international work group has been created in BirdLife International, *the Aquatic Warbler Conservation Team*, to promote the development of monitoring plans and study of different populations of the species and compliance with national and international legislation regulating the conservation of the aquatic warbler.

In Spain, the aquatic warbler is strictly protected. It is included in the National Catalogue of Threatened Species (Royal Decree 439/1990) in the “Of Special Interest” category and is classified as “Vulnerable” in the lastest Red Book of the Birds of Spain according to the criteria of the International Union for the Conservation of Nature (IUCN). Most of the stopover zones that the aquatic warbler uses during its migration through the peninsula are protected, whether by the RAMSAR Catalogue of Wetland areas or the national network of Special Protection Areas (SPAs) for birds. The conservation measures proposed in the last Red Book were to identify the zones used during migratory passage, implement monitoring

Contamination of wetland waters by industrial or agricultural activities contributes to the eutrophication and impoverishment of these ecosystems. | Fernando Jubete.

The construction of drainage channels and overuse of water resources have originated the disappearance of thousands of wetlands in Europe. | F. Jubete.

work, study habitat requirements and use, protect the places used by the species, and to prepare habitat management plans and awareness-raising and environmental education campaigns.

3.2. The aquatic warbler in Spain

Illustration: José M. Onrubia

The aquatic warbler does not breed in Spain and it is not known to have ever reproduced here. This species regularly migrates through Spain between its winter quarters in Africa and nesting areas, during both the prenuptial and postnuptial migrations. Although it has been considered a scarce migrant, the remarkable increase in recorded sightings in recent years seems to indicate that its presence in Spanish territory has passed unnoticed to a great extent. This is not surprising since it is a bird with muted plumage that moves among dense vegetation and is present during the postnuptial passage in the months of August and September, a season in which Mediterranean wetlands do not have water and are not visited often by ornithologists.

The scarcity of citations of this species is mirrored by the mere 102 birds banded in Spain up until 1998. Thus, the only existing work on its migration in Spain was published in 2001 and based on a bibliographic review of citations in Yearbooks, Atlases, and banding catalogs in Spain. On the basis of the available information, the authors of the study described two major migratory fronts for the aquatic warbler, one by the Atlantic coast and another by the Mediterranean coast. The third front described joins the two previous fronts by way of the Ebro valley. The monitoring work of the aquatic warbler in La Nava that began in 2000, and work later initiated in other locations of the peninsular inland suggest the appearance of new and important zones of passage in inland Spain, indicating that the species may have a broader front of migration. In addition to La Nava wetland in Palencia, which groups more than half of the sightings recorded until now in Spain, other important localities are highlighted during the postnuptial passage, like the ponds of Salburúa (Álava), ría de Villaviciosa (Asturias), Valcabado strean (León), or the Cañizar wetland (Teruel). Positive prospections of the species have been made in the wetlands of southern Spain, such as the region of the National Park of Doñana, although the enormous extension of habitat available makes it extremely difficult to detect this small passerine.

As occurs with the known migratory pattern for central and western Europe, the spring passage takes a more eastern route than the autumn passage and is concentrated mainly in the month of April, with extreme observations from mid-March until the second week of May. The postnuptial passage is spread out more in the time between July and October, with most sightings during the month of August, although there are sightings from mid-August until mid-November.

Potential threats to this passerine during migration are the following: destruction or alteration of wetland areas, changes of habitat, and intensification of farming practices.

3.3. The aquatic warbler in La Nava

The first sighting of the aquatic warbler in La Nava occurred on 17 August 1998, when Enrique Gómez, of the Regional Executive of Castile-Leon, observed up to 10 different individuals among the marsh vegetation of the wetland. These sightings were repeated several days that same year, until 22 September.

Later, in 1999, the Fundación Global Nature banded the first specimens of the species, a total of 26 between 18 August and 9 September.

After 2000, the foundation began to carry out banding campaigns constantly during the prenuptial and postnuptial passages, which allowed the capture of 713 specimens, including numerous recoveries of our own bands and of birds bearing foreign bands.

Banding of aquatic warblers *(Acrocephalus paludicola)* in La Nava

Year	F	R	C	E	Total
1999	26	1	0	0	27
2000	187	21	0	2	210
2001	114	18	3	1	136
2002	135	21	2	0	158
2003	43	11	3	2	59
2004	45	3	1	0	49
2005	56	16	2	0	74
	606	**91**	**11**	**5**	**713**

Legend	
F	First banded in La Nava
R	Recaptured in La Nava in the same season
C	Captured in La Nava but banded in previous seasons
E	Foreign-banded bird

The habitat used by the aquatic warbler in La Nava is composed almost exclusively by flooded meadows of medium or low-lying helophytic vegetation consisting of several species of the genera *Carex*, *Juncus*, *Eleocharis*, and *Scirpus*. Aquatic warblers also can be seen in marsh formations of taller vegetation like reeds

Detail of the head of an aquatic warbler. | Fernando Jubete.

(P*hragmites australis*) and cattails (*Typha latifolia* and *Typha domingensis*), as well as arbustive formations of willows (*Salix sp.*) and tamarisks (*Tamarix sp.*) that grow along the margins of streams.

The official logo of the Biological Station of La Nava is the aquatic warbler.

4 Results of the stopover study of the aquatic warbler in La Nava

Photograph: Fernando Jubete

Mariano Torres
Fernando Jubete
Enrique Gómez

4.1. Results of transect analysis

In the LIFE project, we considered different types of monitoring of the aquatic warbler in La Nava wetland using diverse methods with different results. Transect analysis is one of the methods most often used to monitor terrestrial vertebrates and there is a long tradition with this type of studies. Transects are trails that the observer follows while recording sightings of individual specimens within previously established limits of band length and width. For the aquatic warbler, four walking itineraries of variable length were designed, with a 5-meter strip on each side. At greater distances it is assumed that the identification of the bird becomes almost impossible. To increase the probability of contacts with the species, transects were designed to cross all the wetland environments and cover most of their area. To keep the distribution of the birds in the wetland as natural as possible and free of interference by outside agents, during transects the digital calls that were broadcast daily in the banding stations were turned off.

The aquatic warbler is a small bird weighing 15 grams and measuring barely 12 centimeters long. Most of the time it is hidden in the helophytic vegetation so detection is always somewhat difficult. Nevertheless, despite the apparent problems, detecting and identifying the birds is not impossible. On the habitual dates of passage, its habits and behavior can only be confused with that of reed warblers. In this case, thanks to the special morphologic characteristics of the aquatic warbler (plumage) it is relatively simple to distinguish them when they are near the observer. Consequently, it should be noted that they have relatively short escape distances and with attention it is easy to see the birds take off from the ground very close to the census-taker. In these cases, the birds generally seek refuge in the closest stream when they take flight from the meadow after

Transects of the aquatic warbler in La Nava wetland

Number	Meadow	Length(m)
1	Cogolla	886
2	Prao	1.495
3	Corralillos	858
4	Cantarranas	1.641

Flooded sedge meadows in Cantarranas, where transects were made. | Enrique Gómez

detection; they don't hide in another part of the meadow. The bird is often seen perched on the helophytic vegetation of the stream, which is another item of information that helps to confirm the identification. If the observer makes vocal sounds after the escape flight, it is common that the bird will show curiosity and emerge to a visible area of the vegetation. This technique has been used often and it gives extraordinary results in field work.

This work was carried out almost every week in the period of postnuptial passage, from 16 July to 15 October.

4.1. Results of transect analysis

The transect day began half an hour after sunrise and it took about two hours to walk the four routes. All the coordinates of the observations were recorded with a GPS system and several variables were assessed in the area of the observation point to characterize the habitat used:

- Height of vegetation (expressed in centimeters)
- Plant species
- Vegetation coverage (% of ground occupied)
- State of vegetation (green/dry)
- Presence or absence of water on the ground
- Water depth (expressed in centimeters)
- Distance to streams with helophytic vegetation (expressed in meters)
- Water and vegetation management

Altogether, between 2002 and 2005, a total of 24 work days were dedicated and 96 transects were made. Thirteen (54%) of the work days yielded positive results, meaning that at least one bird was observed. Twenty-one transects were positive and 75 were negative.

The habitat was characterized using only the data obtained on the thirteen days in which the presence of aquatic warblers in the wetland was verified because it can only be assured that the birds make a selection of habitat in the wetland on those days.

This method, which has been considered a complement to scientific banding and radio-tracking, has provided information that has been corroborated by radio-tracking data, which is clearly one of the most trustworthy of all the methods used.

The average characteristic of the points where aquatic warblers have been observed in the wetland are the following:

According to the observations made while covering the routes on foot, the aquatic warbler selects areas with the characteristics indicated in the table below. The importance of two variables has been verified. On the one hand, it selects areas with shallow flooding. Thanks to the identification made possible by marking birds with colored bands in the constant effort station, on several

Characteristics of the habitat selected by the aquiatic warbler

Vegetation height	Vegetation coverage	State of vegetation	Distance of stream	Depth of water
48,95 cm.	92,08 %	Verde	<5 m	10,08 cm.

Environmental agent locating aquatic warblers during a transect.| Enrique Gómez

Meadows grazed by sheep in Cantarranas; the lack of water and sparse grass configure an environment that is not inviting for the aquatic warbler. | Enrique Gómez

occasions it has been observed that individuals that had been marked in the banding area when the sector still had some water. When the area later dries out, the birds left to go to another part of the wetland that still had a shallow layer of water. From then on, almost all sightings were made in that environment. On the other hand, it was observed that they need vegetation from several years with different height substrates. The aquatic warbler has been observed mainly in wetland areas with old and annual vegetation where they could feed, as well as in streams with cattails (*Typha sp.*) or reeds (*Phragmites australis*) nearby where they could take shelter at night.

The aquatic warbler has been observed mainly in wetland areas where old and annual vegetation existed and they could feed, as well as in streams with cattails or reeds nearby where they could take shelter at night

4.2. Results of radio-tracking

Study objectives

Radio-tracking studies have been used to increase knowledge about aspects of the biology of many bird species, mainly raptors and other species like galliforms, ducks, cranes, or marine birds. The main problem of using this technology is the size of the transmitter that the bird wears, which is why few projects have applied this technology in small birds.

The successful use of a radio-tracking program with aquatic warblers during the postnuptial migration in Brittany, France, motivated us to undertake similar work in La Nava.

Thus, during 2004 and 2005 twelve aquatic warblers captured in the banding station have been radio-tracked. The goals of this action were:

- To determine more accurately the duration of the stay, foraging area, and the structure of the habitat used by the birds that stop over in the wetland.
- To study the effect of management actions on the species (see the second part of this manual).
- To know the differences in habitat use according to age classes and/or stopover time in the wetland.
- To contrast the results obtained with the other species monitoring actions (banding and transects).

Work methodology

All the radio-tracked birds were fitted for the study with the same model Biotrack PIP® transmitter weighing 0.35 grams. This model was chosen because it is one of lightest on the market.

The transmitter was attached to the tibia in all the individuals with self-degrading surgical tape and it falls off after a few days, thus ensuring that the transmitter is lost once it has ceased to function. This system of fixation was chosen after deciding not to attach the transmitter to the central pair of rectrices because one of the birds to which the transmitter was applied to the tail was lost almost as soon as it was released.

Transmitter used to radio-track the aquatic warbler. | Mariano Torres

Aquatic warbler fitted with a transmitter on the tibia. | Mariano Torres

A methodology of data compilation was designed for this study to enable data to be obtained continuously, more easily and exactly, even in the absence of light. Monitoring was done by teams of two people connected by radiotransmitters, which allowed data to be obtained simultaneously at ten-minute intervals.

Two estimators of foraging area were used for data analysis:

- Minimum Convex Polygon (MCP), which reflects the entire area used by individuals.
- Kernel Density, which minimizes the influence of isolated points, giving a better estimate of the real foraging area.

Results

During the two seasons in which work was done, twelve birds were marked. Four were marked in 2004 and eight in 2005. Sixty-six percent of the radio-tracked birds were adults and the remaining four, juveniles in their first year of life.

Monitoring the birds required 69 days of field work and more than 400 hours of monitoring that materialized as more than 1.000 trackings of individuals.

In 2004, all the birds were radio-tracked during the postnuptial banding campaign. In 2005, one specimen was captured during the prenuptial banding campaign and the rest during the postnuptial

4.2. Results of radio-tracking

Aquatic warbler radio-tracking station. | Fernando Jubete

campaign. The mean time that birds were tracked in the wetland was 6 days for the postnuptial passage (n = 11) and 1 day for the prenuptial passage (n = 1). The two maximum tracking values obtained were 15 and 20 days, both for juveniles. These values were significantly higher than the ones obtained in another stopover area of the species during the autumn passage, Brittany.

The average foraging area obtained with the minimum convex polygon during the postnuptial migration was 9,69 hectares (n = 11). The same value calculated for the kernel area was 7,6 hectares (n = 11), with no significant differences with respect to the results obtained in Brittany.

As discussed in the second part of this manual, throughout the project a series of management actions tending to favor the habitat of the aquatic warbler in La Nava were carried out. One of the objectives of radio-tracking was to analyze how these actions affect the species. The following conclusions can be drawn from the radio-tracked individuals:

· Almost all the specimens were radio-tracked in the Cantarranas meadow, an area that has a flooding level of 10-15 centimeters and helophytic formations, mainly *Carex, Juncus,* and *Eleocharis*, about 30-50 centimeters high when the aquatic warbler is present in La Nava.
·The area of Cantarranas most frequented by the bird has more coverage over the depressions and streams where water accumulates and more coverage by tall helophytic vegetation (*Typha sp*., *Scirpus lacustris, Scirpus maritimus, Phragmites australis*).
· The areas of horse grazing or mechanical removal were not selected positively. However, humidity conditions were unsuitable so we cannot exclude the possibility that these areas might have been used in more favorable circumstances.
· No sheep grazing areas were used that did not have certain levels of humidity, possibly due to the vegetation structure, which was too low and thin. In contrast, they did use areas with levels of flooding and/or surface humidity. It should be noted that sheep grazing requires mechanized

Locations of the aquatic warbler (black points) and areas of intervention in 2004 and 2005 (brown: mechanical removal, gray: horse grazing, green: mowing, yellow: sheep grazing).

mowing periodically because grazing is irregular and the meadow becomes progressively rougher. Consequently, shepherds demand mowing, although the vegetation traditionally has been managed by burning. However, burning is not considered a suitable management method at present.

· Areas that had been mowed and had surface humidity were rarely used by radio-tracked birds. The creation of sufficiently large strips excluded from mowing and the presence of places where water accumulates and tall helophytes develop could improve the capacity to receive the species in these areas.

4.3. Results of banding campaigns

Study objectives

Using a work methodology based on scientific banding by a constant effort station, we tried to obtain information on the phenology, abundance, and use of habitat by the aquatic warbler in La Nava wetland. The general objectives of the study can be summarized in the following points:

- Two annual banding campaigns, one prenuptial and the other postnuptial, covering the entire period of the known migratory passage of this species in the Iberian Peninsula.
- To obtain data on the migratory phenology of the aquatic warbler, including an analysis of the relation between sexes and ages.
- To obtain information on the temporal abundance and an estimate of the number of aquatic warblers that use La Nava wetland each year.
- To obtain information on the physical state of the birds in order to develop hypotheses about the migratory strategy of this passerine.
- To recover birds banded abroad and caught in La Nava, or vice versa, and to obtain information on the migratory routes, nest building sites, and wintering-over places of the aquatic warbler.
- To collect data on the use and quality of the habitat preferred by the aquatic warbler in La Nava, which is vital information for designing management work for the natural space.

Work methodology

Throughout the four years that the aquatic warbler LIFE project lasted, eight banding campaigns were carried out, four during the prenuptial passage and four during the postnuptial passage. The aim of these campaigns was to know the ecology of the species while it stops over in the wetland and its relation with other similar migratory species.

These campaigns were implemented from 1 April to 5 May for the prenuptial passage and from 15 July to 17 October during the postnuptial passage. Campaigns have been carried out in the wetland since 2000 using comparable methodology. The sampling effort is comparable between years because every season mist-nets have been set up in the same place and the methodology has always followed the methodology described by Barlein in the Manual of Field Methods of the *European-African Songbird Migration Project*. Although an important number of mist-nets have been set up in the same places every year, movable nets have been used to detect the presence of the aquatic warbler in certain areas and periods.

To increase the number of captures of aquatic warblers in La Nava, its call was broadcast using mist-nets in the same sites and for as long as the banding station remains active.

Results

During the prenuptial passage, only five aquatic warblers were captured in all the campaigns, 3 birds in 2004 and 2 in 2005. The period of the prenuptial migratory passage, to judge from the dates of capture, is between 10 April and 21 April. This information and the observation of a bird on 20/4/2001 are the only known records during the prenuptial passage for La Nava and the territory of Castile-Leon.

Although the number of captured individuals is small, these results confirm the presence of a more or less constant, although small, prenuptial migratory passage in the western Iberian Peninsula. The postnuptial migration is much more conspicuous and the first captures occur in the second fortnight of July or first days of August, whereas the last captures extend until the end of September:

Peak captures occur from 7 August to 23 August, although interannual variations have been registered that may be due to the climatology or to the habitat conditions present in La Nava each season.

Year	First capture	Last capture
2000	19 July	12 September
2001	26 July	13 September
2002	17 July	29 September
2003	7 August	29 September
2004	28 July	27 September
2005	30 July	30 September

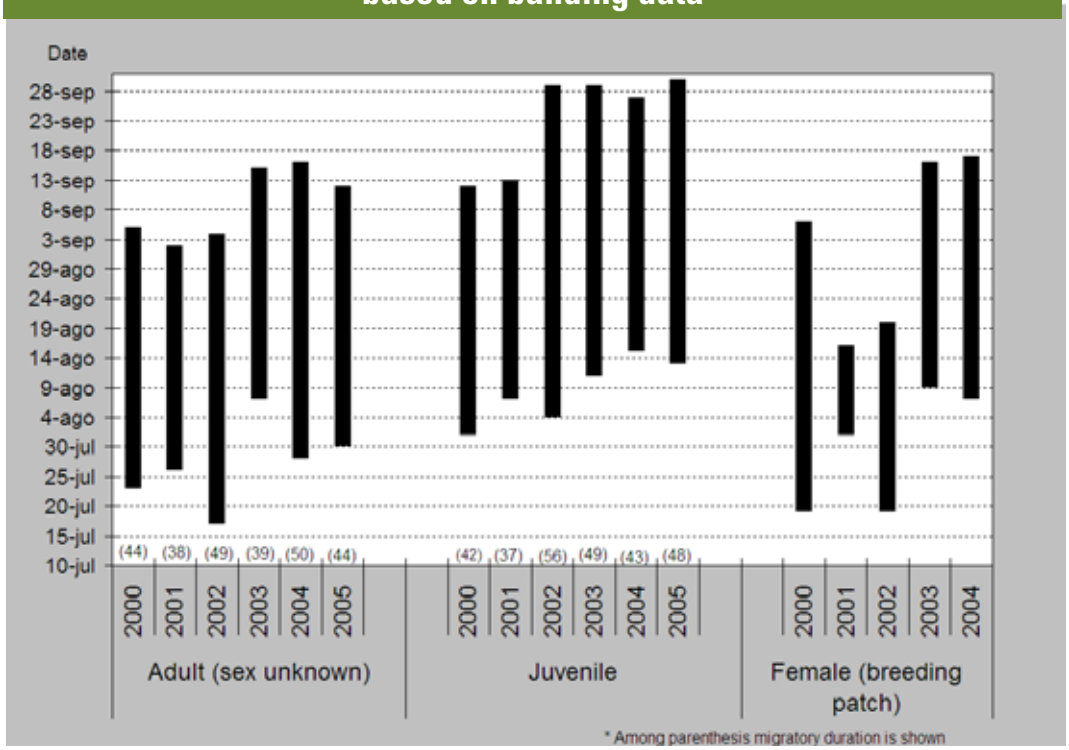
If we extend the focus of the study period to 2000, the phenology obtained from banding data suggests that there has been a progressive delay in the appearance of the species in the wetland.

This was observed in all the age classes analyzed (adults and juveniles) as well as in the adult females, as determined by the presence of remains of the brood patch.

The difference between the earliest and latest values indicates that the species stays in the wetland for an average of 62 days, the known maximum being 73 days in 2002, and the minimum, 53 days in 2005.

4.3. Results of banding campaigns

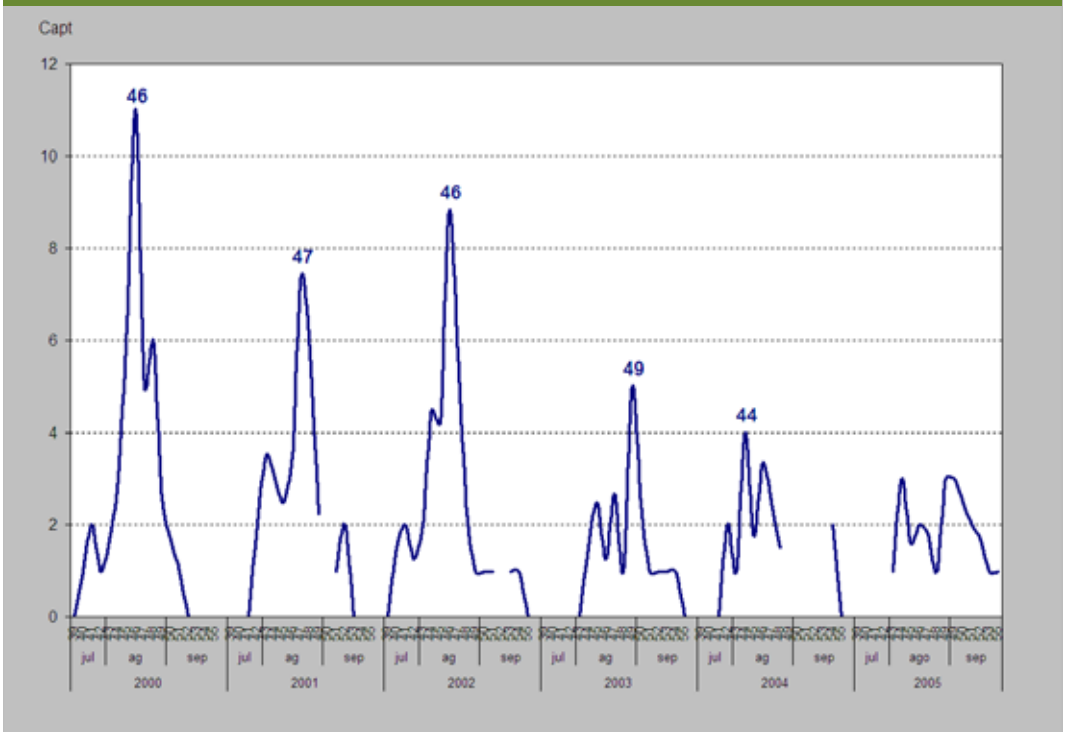
Phenology of the aquatic warbler by age and sex based on banding data



Banding of aquatic warblers by age class and juvenile/adult ratio during the postnuptial passage in La Nava

Data	2000	2001	2002	2003	2004	2005
Adults	63	45	61	17	31	25
Juveniles	126	70	74	26	10	28
Overall total	187	114	135	45	41	53
Juvenile/Adult	2	1,55	1,21	1,52	-	1,12

Fluctuation of total captures by pentades during the 2000-2005 period



The postnuptial phenology of the latest citations can be analyzed only from 2002 because that was the first year that campaigns extended until 17 October. No important differences were observed in the date that the birds left the wetland.

If we compare the interannual evolution in captures, there is a tendency toward fewer captures. Despite notably increasing our efforts from 2002 to 2005 by using additional nets in suitable areas outside the standard area, captures have clearly decreased, especially in 2003 and 2004, with a slight recovery in 2005.

The data collected in the present study indicate some important variations from what has been reported previously about the migration of the aquatic warbler in Spain. Previous studies reported that

4.3. Results of banding campaigns

coastal areas were the most important areas for the migration of this species. The results obtained in La Nava show the importance of the migratory route that crosses the interior of the Iberian Peninsula. In fact, La Nava is currently the most important known postnuptial stopover place of the aquatic warbler, although it cannot be ruled out that there are other, equally important areas in the peninsular inland.

Because this species is threatened world-wide, the reduction in the number of captures may be related to the decline in the population. However, the population has shown a general tendency to stability during the study period. This implies a lack of correlation between the number of captured adults (including males and females) and the number of singing males recorded in nesting areas.

The capture of aquatic warblers in La Nava also has been useful for a research project on the phylogenetic relations of the species. Thanks to this work, we know that out of a total of 46 birds captured in La Nava in the summer of 2000, 86% of the birds came from known populations of Poland, Ukraine, and Belarus.

These three populations do not show tendencies like those shown by the population that stops over in La Nava in any case, which confirms that the variation in results is not related to the evolution of captures. Therefore, the explanation of these data seems to be outside the logical interannual variations in population size.

The following hypotheses can be offered to explain the reduction in the number of captures.

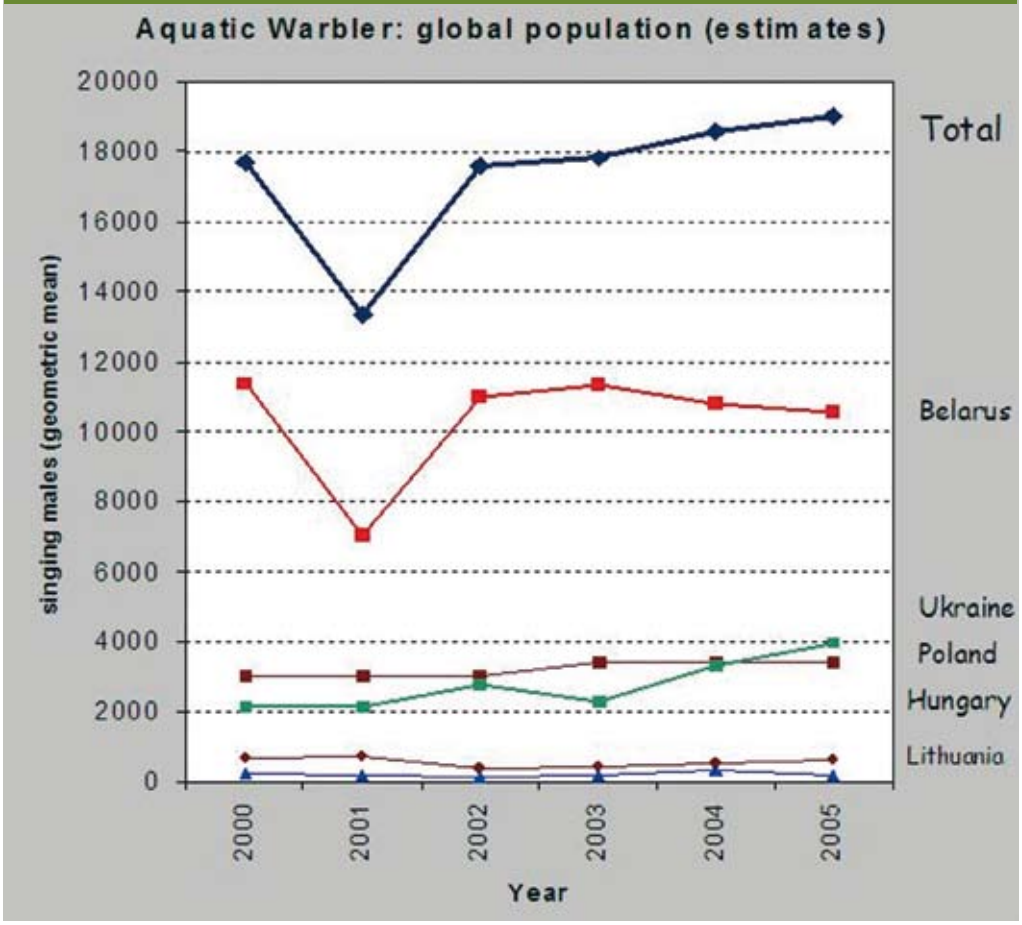
From 2002 to the present, important changes have taken place in the state of the habitat used by the species in La Nava, mainly in the level of flooding of the meadows of helophytic vegetation during the postnuptial passage of the aquatic warbler.

The aquatic warbler is a specialist in a very specific habitat: flooded meadows of helophytic vegetation of low-to-medium height. The presence of this marsh bird is strongly conditioned by the existence of a habitat of optimal quality.

For instance, in 2002 the areas of La Nava where most of the standard nets are positioned, La Colada and El Prado, maintain acceptable levels of flooding until well into August, meaning that the meadows of *Carex* sp., *Juncus* sp., and *Eleocharis* sp. remained unmowed and with a few centimeters of water or moisture within a depth of a few centimeters.

However, in the following years the levels of humidity or flooding were not the

Evolution of the nesting population of aquatic warblers in 2000-2005 (Source: AWCT)



La Nava currently is the most important known site of postnuptial stopovers of the aquatic warbler in Spain

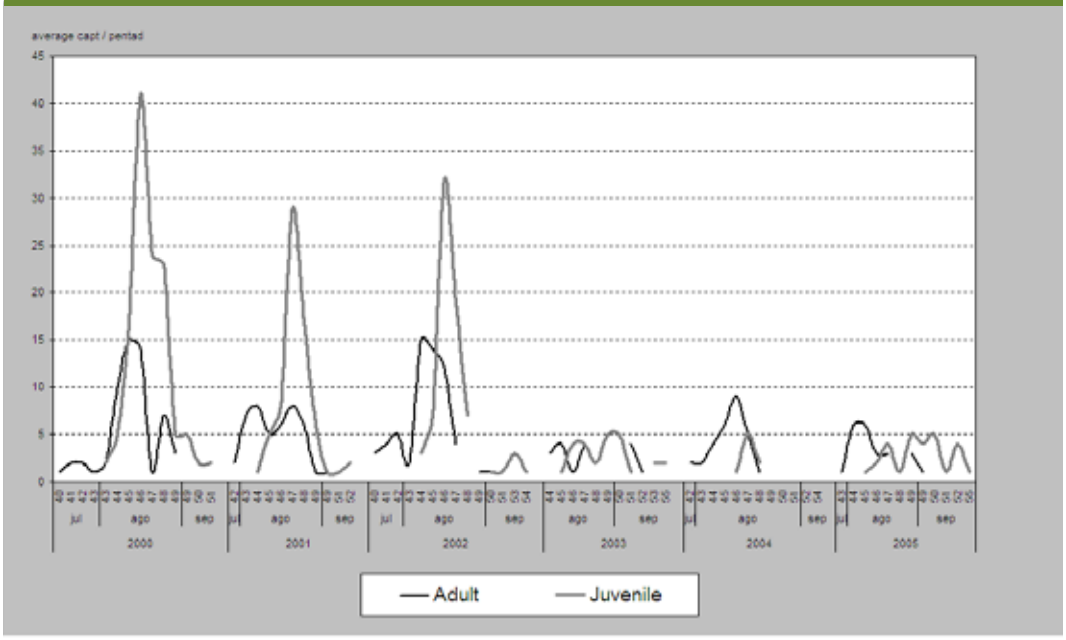
4.3. Results of banding campaigns

Captures of aquatic warblers by years and areas

same in these zones. This is because the area to be mowed to control emergent vegetation must be dry in July, which is why the habitat is unsuitable for the species.

The habitat management actions carried out in the Cantarranas sector allow controlled flooding of areas of meadow and helophytic vegetation in which mowed areas alternate with unmowed areas. This flooding begins at the end of July and continues until October, creating a favorable habitat for many species of water birds, including the aquatic warbler. This situation has caused a displacement of the aquatic warblers present in La Nava that, for want of an optimal habitat in traditional areas, find feeding places in the Cantarranas meadow. These conclusions are supported by

Fluctuation by age of the average number of birds banded in each pentade



the graphic representation of aquatic warbler captures in La Nava by years and areas.

It is evident that as captures in La Cogolla and El Prado decreased markedly until they almost disappeared in 2005, captures increased in the two new sites in Cantarranas where nets were installed after 2003. The new area of habitat generated with this management measure was 15-20 hectares in Cantarranas, to which must be added another 12 hectares in the recently recovered areas of La Güera and El Hoyo in the municipality of Mazariegos.

It is clear that these management measures have benefited the aquatic warbler, but it seems advisable that the traditional areas of La Cogolla, El Prado,

4.3. Results of banding campaigns

Aquatic warbler recoveries in La Nava

and Corralillos should be maintained with shallow flooding during the postnuptial passage of the aquatic warbler, as long as it is compatible with the other objectives of wetland management. The new habitat areas created for the aquatic warbler in the Cantarranas sector are a major improvement in available habitat, but it should not be forgotten that this area is managed as a pasture for the benefit of livestock, and that the formations of helophytic vegetation can be considered suboptimal for the aquatic warbler because many areas do not have vegetation of the height preferred by this species. Likewise, flooding levels in this area are inconstant, with flooding cycles of approximately one month. Later on, they remain dry, reducing the potential habitat quality for aquatic warblers.

Although the data still are limited, the fact is that although the capture effort

Mean flying distance and the flying distances of the 30% heaviest birds and the heaviest bird

has been duplicated in the Cantarranas area, the area most used by the aquatic warbler in recent years, captures remain at thresholds well below those obtained in 2001 and 2002. This may indicate that the species is less abundant during the postnuptial period when El Prado and La Cogolla do not have certain levels of humidity.

If the capture results are analyzed in accordance with the juvenile/adult ratios obtained since 2000, the annual variation in captures by age classes shows a regressive tendency for both adults and juveniles, although juvenile captures have been much more regressive.

As a result of this tendency, the ratio of 2 juveniles/adult of 2000 and 2001 dropped to 1 juvenile/adult between 2003 and 2005. From this information it can be deduced that the reduction

4.3. Results of banding campaigns

Aquatic warbler captured in a mist-net for banding. | Mariano Torres

in captures of juvenile birds may have strongly conditioned the overall reduction in captures.

As there are no data available on the productivity of the species in nesting areas, we cannot know if this variation is related to reproductive productivity, which is a reasonable possibility in view of the results that have been obtained up until now.

On the other hand, the migration of adults and juveniles is clearly differentiated. Adult birds are the first to arrive, reaching a peak number in the first fortnight of August. Juveniles have their migratory peak in the second fortnight of August. The reduction in captures after 2003 has diminished the differences between the two age classes.

The data show that the aquatic warbler is one of the species that has the highest recapture rate in the banding station, with an average recovery rate of 9.6% for adult birds. This finding indicates that migrants are faithful to stopover areas and that it is important to maintain adequate habitat areas on the migratory routes year after year.

Throughout the banding campaigns, several birds banded abroad were recovered. Since 2002, there have been three new recoveries of this species, all of them birds banded in France. Only the recovery that took place in Trunvel (Treogat) corresponds to the same

4.3. Results of banding campaigns

Scientific banding work at La Nava Biological Station. | Mariano Torres

season, with a time interval between banding and recovery of 6 days. The banding area of this last recovery is an important stopover place in France. Birds banded here been recovered in Asturias, Basque Country, and Navarre and the recovery times are very similar, suggesting that northwestern France is an important stopover area for birds coming from the northern Iberian Peninsula.

In addition to the recoveries since 2002, older recoveries in Belarus and Poland should be emphasized.

From the specimens recaptured in the same banding campaign, it is estimated that the aquatic warbler spends two days in the wetland (median of n = 33); this value is an estimator of the minimum time that these birds remain in the wetland. The result coincides

The average stopover of the aquatic warbler in La Nava is estimated to be six days

with the result obtained from radio-marking birds, which indicates that the average stopover is 6 days (median of n = 12), which we consider to be a representative finding.

On the other hand, the difference in weight of the birds between the first and last recovery gives us an estimator of the weight gains of the birds in the wetland: for a stopover of 6 days, the estimated weight gain is 0.8 grams during their stopover in the wetland.

Using the percentage of fat of a bird, a simple estimate can be made of the maximum flight distance that the individuals captured in La Nava could make under standard conditions of altitude and meteorology. These values are only approximations and are subject to many variables that can appear during migration. However, they show that, on the average, birds captured in La Nava could reach the southern Iberian Peninsula in a single flight.

The results offered here are only a fraction of the information generated by banding campaigns in which more than 50,000 birds were captured. More information can be obtained from the general reports on these campaigns, which are available on the web page of the project (www.carricerincejudo.org) or the web page of Fundación Global Nature (www.fundacionglobalnature.org).

During all these banding campaigns, as well as the radio-tracking work, several hundred environmental volunteers from all over Europe and students from various Spanish universities have participated. Without their help, this work could not have been carried out. The project coordinating team would like to thank all of them for their invaluable assistance.

5 Conclusions

Photograph: Fernando Jubete

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5.1. Comparative effectiveness of management methods used to control vegetation in La Nava wetland

The methods traditionally used to control emergent vegetation in seasonal Mediterranean wetlands are controlled burning, grazing by large herbivores, different mowing methods, and mechanical removal by ripping, by order of preference, which owes more to the respective costs of these methods than to their effectiveness.

The choice of one method or another must be dictated by the characteristics of the emergent vegetation of each wetland (the composition and extension of which usually are related to the duration of flooding periods) and the needs of each wetland, or how we want to maintain the wetland. In La Nava wetland, all of these methods have been tried under the premise of keeping some areas free of emergent vegetation so that underwater vegetation could develop, especially charophyte meadows.

La Nava wetland is subject, like most shallow wetlands, to siltation, or progressive filling of the catchment area, and to an increase in eutrophication of the water in the wetland, in this case due to the accumulation of plant matter without decomposing. Given these conditionants, the best method for controlling the vegetation, without considering the problem of financing, is the one that eliminates the largest amount of plant matter and nutrients, slows the appearance of new vegetation, and allows adequate development of underwater vegetation. Each of these methods has advantages and disadvantages and the effectiveness of the different methods of vegetation control must take several criteria into account:

1. Capacity to eliminate plant matter.
2. Capacity to eliminate nutrients.
3. Control of wetland siltation.
4. Capacity to increase biological diversity.
5. Use of debris.
6. Capacity to involve the local population.

The effectiveness of vegetation management in La Nava has been estimated with the data collected in 2003-2006.

Mean dry plant biomass produced annually in the grasslands of La Nava before applying different methods of vegetation control

Area	Method tested	Plant formation	Dry weight kg/m^2	Dry weight tm/ha
La Cogolla	Grazing	Meadows of sedge-spikerush-saltmarh bulrush	0,5804	5,804
Corralillos-El Prao	Burning, ripping, or mowing	Meadows of spikerush-saltmarsh bulrush	0,634	6,634

Controlled burning of vegetation

The burning of emergent vegetation when it is dry is a method traditionally used to control excessive development of the aerial parts of the plant. It is cheap and easy. The most noteworthy disadvantages are the production of CO_2 and the need to construct firebreaks that last for years, giving the catchment area an artificial appearance. There are no data that indicate its influence on the biocenosis of small animals, although in areas where the aquatic warbler is present in Eastern Europe and such practices have been carried out, important reductions in invertebrate productivity have been observed. A period of three to five years is needed for an ecosystem to recover its productivity. The vegetation regenerates the next year. By burning, 80-85% of the plant matter of La Nava meadows is eliminated (since ashes and plant remains are left), as well as 90-95% of the carbon, 80-85% of the nitrogen, and 30-35 % of the phosphorus produced by the vegetation in a year.

Grazing with horses

Horses have been used mainly in large spaces, where the meadows provide food for cattle throughout the year. They require certain facilities and fairly continuous attention if we aim to delimit the grazing areas. The intensity of grazing on meadows is influenced by the duration of the flooding period, being less intense in land that remains flooded for more time. An important aspect is the production of feces and urine, which contribute to recycling nutrients and part of the plant matter. The vegetation regenerates the next year. Horse grazing eliminates 25-70% of the plant matter from the meadows of La Nava, which is equivalent to 30-75% of the carbon, 20-60% of the nitrogen, and 25-70% of the phosphorus produced by the vegetation in a year.

Consumption and inputs of horses* grazing in La Nava wetland

Mean annual consumption of dry matter	2.920 Kg
Average nº. of bowel movements a year	1.725
Dry weight of feces in a year	779,27 Kg
Mean annual urine volume	1.825 l

*(400-450 weight).

Carbon, nitrogen, and phosphorus content of plant samples and horse excrements*

Sample	C	N	P
Grazed meadows	42,77	1,08	0,14
Horse excrement	39,89	1,13	0,13
Horse urine	-	1,5	-

*Expressed as % of dry matter.

5.1. Comparative effectiveness of management methods used to control vegetation in La Nava wetland

Formation of cattails, reeds, and spikerush in La Nava. | Fernando Jubete

Horses, in contrast with bovines, have incisors on both jaws, which allow them to graze forage almost to ground level. They are not very selective herbivores about the plant matter that they consume. This has been verified in La Nava, where the areas chosen for grazing have shown an important reduction in plant biomass in terms of the density and height of the plants. Horses have grazed on almost all the species present in the wetland catchment area, from large helophytes like the cattail (*Typha* sp.) or saltmarsh bulrush (*Scirpus maritimus*) to the vegetation of the marginal subhalophilic meadows, which is composed by species like *Pucinellia fasciculata, Hordeum hystrix, Hordeum marinum, Polypogon maritimus, Plantago maritima, Juncus gerardi*, or *Spergularia media*. When food is scarce, it will even consume coriaceous plants, some as unappetizing as the

Populations of invertebrates can disappear almost entirely for several years in the areas affected by burning. | Ignacio Rodríguez

European meadow rush (*Juncus inflexus*), or even branches and leaves of bushes.

Another effect of grazing considered positive is the stirring up and elimination of dead plant matter that is deposited in layers or flakes on the floor of the wetland. It would take several years for this organic matter to be digested by mineralization or decomposition in the wetland, but thanks to treading, much of it is stirred up and scattered by the wind, or its elimination is facilitated by being dragged through the water when the catchment area fills. Area of La Cogolla that were dense meadows of spikerush before the introduction of horses now have thinner formations of this species, in addition to formations of macrophytes like *Chara* or *Zanichellia*.

A final positive effect of grazing is the diversification of the vegetation structure, which favors the coexistence of areas of sedge with small areas of open water. Some species groups, like waders, passerines, spoonbills, or storks, now are seen more often in the grazed areas of La Cogolla. The presence of horse excrements in these areas of shallow water is also attractive for many of these species because they are the food source of invertebrates that decompose organic matter and also serve as prey for numerous species of birds. However, from the vantage point of water eutrophication, this not so positive.

Mowing

Mechanical or manual mowing is another method frequently used to eliminate vegetation. This is a very different method with regard to objectives and results if compared with mechanical removal. In the first place, we are not seeking a durable persistence for several seasons of extensions of open water free of helophytic vegetation. Quite to the contrary, since rhizomes are not eliminated, this method allows the same

5.1. Comparative effectiveness of management methods used to control vegetation in La Nava wetland

Horses grazing in La Nava. | Fernando Jubete

sedge meadow to sprout again the next season. Siltation does not decrease because we do not remove centimeters of soil, and it is less valuable for increasing the biological diversity of the wetland. In mowed areas, meadows of underwater vegetation, considered bioindicators of a high quality system, do not appear, in contrast with what occurs with mechanical removal. Therefore, what we really obtain with this method is the control and reduction of part of the plant matter produced by the wetland, which is not taken up by a system already saturated with nutrients. It must be remembered that the main objective of grazing was to reduce the eutrophication of the wetland by controlling sedge meadows, not the total elimination of these meadows, which are the main habitat of the aquatic warbler.

In mowed areas, the meadows of underwater vegetation that are seen after mechanical removal do not appear

The effectiveness of this method depends on several factors, among them, the stiffness or resistance of the stems of the plants that we propose to mow. In the case of La Nava, the meadows consist mainly of spikerush-saltmarsh bulrush (*Eleocharis palustris-Scirpus maritimus*), which have stems that bend easily. For this reason, the mower squashes part of the vegetation, which then cannot be removed. However, it is a method of elimination that is interesting for La Nava because the material removed is used as fodder and bedding for livestock. Mowing eliminates 50-55% of the plant matter and an equivalent proportion of the carbon, nitrogen, and phosphorus that the vegetation produces in a year.

On the other hand, mowing and grazing have another aspect that, although not strictly ecological, is no less important. In both cases, we secure the engagement and participation of the local population in wetland management. This is an appreciable social benefit that any manager should look for in a natural space.

With regard to the results that this method, or mechanical removal, has on the bird population of the wetland, it is extraordinarily difficult to draw conclusions about cause and effect. It has not been possible to confirm that a given species or family of birds has benefited directly from mowing. As mentioned, mowing does not change the appearance of the wetland landscape; it does not leave an area of open water and the meadow sprouts again the following spring. It is known, however, that by removing biomass in summer, we help to reduce the eutrophication of the entire wetland and thus favor the regeneration of sedge meadows that otherwise would be smothered by excess plant debris that the system cannot decompose. This is a benefit of remarkable importance.

Ripping

This is the method used least often to eliminate vegetation due to its expense, but it has been shown to be the most effective measure for controlling helophytic vegetation in wetlands. Using mechanical ripping to remove vegetation, we can create areas of water that remain free of emergent vegetation for several years. This favors the design of an ecosystem in which areas occupied by helophytic vegetation, where birds can construct

5.1. Comparative effectiveness of management methods used to control vegetation in La Nava wetland

their nests and take refuge, coexist with areas of open water, where underwater vegetation develops and the invertebrates on which they feed can live.

With this action, several problems are address, such as the total elimination of vegetation and the elimination of a goodly part of the nutrients that are deposited on the floor of the wetland. It also helps to increase the depth of the catchment area, thus counteracting siltation. If the depth of ripping is chosen properly, we also remove the roots and rhizomes of emergent plants (which usually are located in the upper 8 cm of soil in La Nava), which is why the regeneration of this type of vegetation is delayed by years. Regeneration depends on the characteristics of the substrate and duration of the flooding period, and it must be studied properly to define the effectiveness of this management method. Based on information obtained from previous experiences, it can be effective for up to five to seven years. Although there may be some recolonization by helophytes in the year after mechanical removal, as occurred with cattails in La Nava, it is more common that these areas are colonized by underwater meadows of charophytes and *Zannichellia*. These formations of aquatic macrophytes fix the upper layer of the soil, keeping the water transparent and producing abundant oxygen, which enhances the biotic potential of the ecosystem. The presence of these submerged formations is an indicator of the "good health" of a wetland.

Mechanical removal acts on several problems, such as the total elimination of vegetation and the elimination of much of the nutrients

Underwater vegetation colonized the ripped areas after the first flood and it is estimated that regeneration (referred to as dry biomass produced per square meter) was 56.4% in the first year and 100% in the second year. Mechanical removal eliminates 100% of the vegetation and nutrients produced by emergent vegetation in a year.

Among the advantages of mechanical removal is the control of siltation, which is especially important in shallow wetlands like La Nava. Use of the sediments removed on adjacent farmland has been discussed earlier, together with the elimination of nutrients, which is important for reducing the eutrophication of the wetland. Mechanical removal is undoubtedly the system that has

The meadow of La Cogolla in August. | Fernando Jubete

contributed most to changing the appearance and landscape of La Nava wetland, as well as to diversifying the ecosystem and reducing eutrophication of its waters.

From the vantage point of fauna, it has been observed that where the vegetation has been ripped out, the total number of spoonbills (*Platalea leucorodia*) has increased, as well as the duration of their presence in the wetland and the number of sightings. It also favors the presence and reproduction of species that almost had disappeared as reproducers due to the densification of sedge meadows. This is the case of black-winged stilts (*Himantopus himantopus*), pied avocets (*Recurvirostra avosetta*), great crested grebes (*Podiceps cristatus*), and black necked grebes (*Podiceps nigricollis*).

5.1. Comparative effectiveness of management methods used to control vegetation in La Nava wetland

Conclusions

The advantages and disadvantages of each method of control of emergent vegetation have been discussed. In the following tables we compare the effectiveness of the four methods tried in La Nava. The most efficient method was mechanical removal, which made it possible to maintain areas of open water for years. Underwater vegetation developed in these areas from the first year. Mowing and grazing are management methods that can be used in areas where we want to maintain a continuous meadow with a controlled annual output of plant biomass. Burning, while it eliminates most of the plant biomass, is not as effective in eliminating phosphorus and should be ruled out as a control method because of its disadvantages whenever one of the other three methods described can be used.

Comparative elimination of plant matter* by the four methods tested in La Nava wetland

Ripping	Burning	Mowing	Grazing
100	80-85	50-55	25-70

*** Expressed as %.**

Comparative elimination of main nutrients* by the four methods tested in La Nava wetland

Nutrients	Method tested			
	Ripping	Burning	Mowing	Grazing
Carbon	100	90-95	50-55	30-75
Nitrogen	100	80-85	50-55	20-60
Phosphorus	100	30-35	50-55	25-70

*** Expressed as %.**

	Advantages	Disadvantages
 **Mecanical removal**	Elimination of 100% of the vegetation. Durable action lasting several years. Controls wetland siltation.	Expensive. Work must be done during dry periods of the wetland. It is necessary to have a place near the wetland to deposit the material removed.
 **Grazing**	Medium economic cost of the measure, which requires an initial investment to purchase cattle and build facilities. Versatility in the application of the measure, which can intensify or diminish the effect of vegetation control depending on the breed chosen, livestock load, and grazing period. Availability of a wide variety of domestic cattle breeds or wild species that can be adapted to the management needs of each natural space. Partial elimination of wetland sediments by treading. Diversification of the vegetation structure. The local population can be engaged in the implementation of the measure.	Continued management of animals. Only a partial reduction of siltation. The presence of herbivores inevitably entails nutrient input in the form of excrements that enter the wetland cycle.
 **Mowing**	Control and reduction of approximately 50% of the plant biomass. The local population can be engaged in the implementation of the measure. It seems to be an effective measure for maintaining sedge communities.	The measure has to be repeated annually. It does not reduce siltation problems definitively. It does not favor the appearance of underwater vegetation.
 **Controlled burning**	Elimination of 80-85% of vegetation. Application of the measure is inexpensive.	Creation of a network of firebreaks and/or adoption of measures to prevent the propagation of fire. Partial elimination of plant biomass. Elimination of microfauna and microflora from the edaphic level of the soil. Intensely affects vertebrate species with low mobility, such as amphibians, reptiles, or invertebrates. Temporality of the measure, which can only be carried out in summer, when the vegetation is totally dry. Produces CO_2.

5.2. Search and monitoring protocol of the aquatic warbler during migratory passage

5.2.1. Choice of habitat-based areas

The aquatic warbler is a selective marsh species in terms of habitat selection, a specialization that is not limited only to the reproductive period, but extends throughout all the stages of its biological cycle, including migration and wintering-over. La Nava has a variety of marsh habitats, but the largest captures have occurred in areas where the surrounding habitat consisted of meadows of helophytic vegetation of low to medium bearing and superficial or edaphic humidity present. The vegetation is composed by various species, such as *Carex* sp., *Juncus* sp., *Eleocharis* sp., or *Scirpus maritimus*, with a smaller proportion of areas of larger helophytes (*Phragmites australis, Typha* sp., *Scirpus lacustris, Butomus umbelatus*) or arbustive vegetation (*Salix* sp. or *Tamarix* sp).

In the absence of this habitat, the aquatic warbler also has been detected in coastal salt marshes or dense reed formations.

The interest of certain crops that have a morphology similar to sedge and flooding cycles that result in the presence of water or humidity at the time of migratory passage is unknown. Examples of such crops are rice paddies and certain meadows irrigated by flooding.

Analysis of the sightings to date in Spain and our own experience in La Nava wetland enabled the preparation of the following table to characterize the habitat preferences of the aquatic warbler during its migratory flights through the Iberian Peninsula.

	Vegetation	Flood level
Optimal	Meadows of low-to-medium height helophytic vegetation: *Carex, Juncus, Scirpus maritimus, Molinia, Cladium mariscus.* Sparse or degraded reedbeds (*Phragmites australis*) of low-to-medium height.	5-50 centimeters of water. In the absence of water, there should be edaphic humidity very close to the surface.
Sub-optimal	Well conserved spots of Phragmites australis, *Typha* sp. or *Scirpus lacustris*. A greater density and lower vegetation height that are less interesting for the species.	These areas are characterized by a flood level of more than 50 centimeters.
Occasional	Crops like corn, rice paddies, or alfalfa (its presence in this type of habitat may be limited exclusively to short periods for feeding).	Occasionally present during crop irrigation.

In recent years, numerous prospections have been made that have allowed the location of new areas where the aquatic warbler is present in Spain. Even so, new areas of the Iberian Peninsula have to be prospected to identify the most important areas for the aquatic warbler during migration. Although the primary aim is to guarantee its protection, the presence of this threatened species can also become an interesting attraction and increase the value of the wetlands where it is present.

The aquatic warbler is a species that migrates along an extended front, although there is a clear concentration of sightings in the western half of the Iberian Peninsula during the postnuptial passage. This may be due to the absence of favorable habitats along the Mediterranean coast, where high, dense reedbeds (*Phragmites australis*) are abundant, a habitat that we have already described as not the most suitable for the aquatic warbler.

Although successful prospections already have been made of the Cantabrian coastal wetlands, it is necessary to make prospections in new areas where the species almost certainly passes. The situation is similar in the Atlantic coast wetlands.

The wetland areas of the peninsular inland seem to offer one of the best habitats for this small passerine. Meadows of spikerush, although they are becoming progressively more scarce, still exist in many provinces of the communities of Castile-Leon, Castile-La Mancha, and Aragon, where there should be more prospection work in search of the species. Natural spaces like the Tablas de Daimiel National Park have vast extensions of apparently favorable habitat for the species to settle.

The peninsular south also has numerous wetlands that meet the conditions of a favorable habitat for the aquatic warbler. Doñana National Park alone has hundreds of hectares of low-growing saltmarsh bulrush and helophytic vegetation, although the total absence of water during the months of migration may mean that the state of the habitat is not completely optimal. Even so, the numerous channels and fluvial courses have suitable plant formations for the species.

The presence of various citations in the Canary Island archipelago is significant, which can be explained by the use of a migratory route along the North African coastal wetlands, with some birds that stop over in the Canary Islands when they stray from their route.
The Balearic Islands have several wetlands of quality for the species, especially S'Albufera of Majorca, where work in search of the species during the prenuptial passage should intensify, as in other Mediterranean coastal wetlands.

5.2.2. Phenology of the species search

Helophytic formations of low height that are flooded in summer, the perfect habitat for the aquatic warbler to stop over. | Fernando Jubete

The known prenuptial phenology for the species in the Iberian Peninsula is from early March to late April, with a more intense passage along the Mediterranean coast.

The daily prenuptial banding campaign has demonstrated that the presence of the aquatic warbler, although scant, is more frequent than expected in the central part of the peninsula.

The greater availability of stopover habitats in spring, when the wetlands have more water, can make it difficult to locate and monitor the population.

The return passage to the wintering-over areas after migrating through the Iberian Peninsula takes place from early August to late October.

Aquatic warbler captured in a mist-net for banding. | Mariano Torres.

In La Nava wetland, located in the northern part of the Iberian Peninsula, there have been sightings from July to late October, which may indicate that some birds may remain in the southern part of the peninsula, even in the month of November. In fact, there are a few records from that month of the year.

The migratory passage of adults and juveniles differs in date. The migratory phenology of the adult birds is between 20 July and 15 September. In the case of juveniles, the period of passage centers on August and September, with peaks in the middle of August. Considering all the age groups, the peak number of captures takes place in mid-August and there is a residual passage in October.

Recommended search dates for the aquatic warbler in the Iberian Peninsula

	Adults	First year
Prenuptial passage	March and April	-
Postnuptial passage	20 July to 15 September	August and September

5.2.3. Sampling methods

Mist-net positioned in a stream in La Nava; at the base of the net is a battery-run device to play calls. | Ignacio Rodríguez.

Routes

Transects are a very useful tool for detecting the presence of the aquatic warbler and obtaining data on the relative density or abundance of the species.

It is advisable, if not essential, that the people who make this type of transects become familiar with the species previously so that they know its call, form of flight, and how to differentiate it from other similar species with the same habitats, such as reed warblers (*Acrocephalus schoenobaenus*) or grasshopper warblers (*Locustella naevia*). The transect itineraries should be covered early in the day, coinciding with the period of maximum activity of the species. The strip delimited for the route should be no more than 10 meters wide; at a greater distance it is not likely that the birds will be correctly identified or that they will take flight as the observer passes, so bands should be no more than 5 to 7 meters wide. The routes should be made whenever possible by the same person.

The transects in La Nava were made with the aid of a GPS to locate the exact points of contact with the species. In addition, a series of simple data were recorded that allowed the habitat to be characterized. These data are:

- Plant species
- Vegetation height
- Vegetation coverage
- State of vegetation (green/dry)
- Presence of water on the ground
- Depth of water
- Distance to streams with helophytic vegetation
- Water and vegetation management of the plot

It is recommended that transect routes be made in August and the first fortnight of September, coinciding with known peaks of presence of the aquatic warbler.

Aquatic warbler with colored bands to facilitate identification at a distance. | Fernando Jubete.

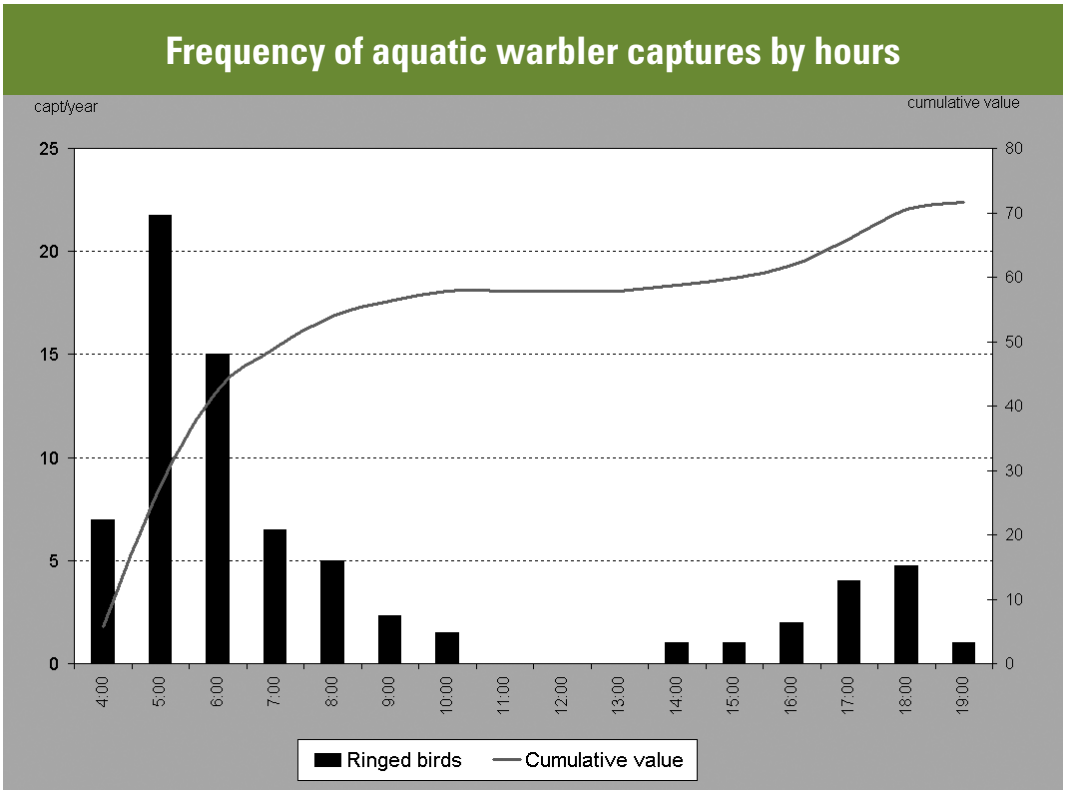
Banding

Monitoring of the aquatic warbler in La Nava has been very effective for investigating the migration.

The methodology that gives the best results is that established in constant effort banding stations. In these stations, mist-nets are set up in specific sites according to previously planned study period that is repeated every season. Possible variations of habitat in some wetland areas due to habitat management and the natural evolution can make it necessary to set up movable nets that can be positioned in favorable areas, always trying to avoid interference with the operation of the fixed nets and allowing a response to abrupt changes in habitat.

The capture nets should be positioned in areas near these habitats or, if possible, inside them. The uniformity of these habitats makes it advisable to install nets taking advantage of the presence of canals

5.2.3. Sampling methods



with a little taller marsh vegetation or linear arbustive formations, places where the aquatic warblers go to rest and where nets can be camouflaged better. In La Nava we have successfully positioned mist-nets with only three bodies in the middle of extensive meadows of low-lying vegetation.

The capture nets should be positioned in areas nears these habitats or, if possible, inside them. The uniformity of these habitats makes it advisable to install nets taking advantage of the presence of canals with a little taller marsh vegetation or linear arbustive formations, places where the aquatic warblers go to rest and where nets can be camouflaged better. In La Nava we have successfully positioned mist-nets with only three bodies in the middle of extensive meadows of low-lying vegetation.

In nesting areas in eastern Europe, aquatic warblers are captured individually. Once a singing male or a bird is detected alighted on vegetation the net is placed near that point, with several observers facing the net, looking toward the bird. In the migration areas, they have experimented with a variation in this method that consists of "confronting" the birds near the net (almost always nets with a recorder to broadcast calls) when the nets are checked.

Mist-nets (the capture method most often used) have limited effectiveness in open settings so we propose the use of polyester nets (70/10 denier), with a smaller bag volume and less visibility for areas of low coverage, which have been very effective in captures.

It must be remembered that the areas where the nets are set up usually are flooded, so it is very important to make sure that the height of the nets is sufficient to guarantee that no bird will come in contact with the water.

The use of digital calls to detect birds and increase the number of captures has been very effective. Calls should be broadcast only during the daylight hours with the aim of attracting the birds previously settled in the wetland to the nets. In contrast, as indicated in the Action Plan of the species, the use of calls in nocturnal hours is not recommended, because this is the time when aquatic warblers migrate, which can detain the migration of aquatic warblers and cause the birds to settle in unfavorable areas.

The best moments for sampling are the first and last hours of the day, when the intensity of the light affects the nets less and the birds are more active.

The combination of banding and radio-tracking has shown that stopovers last six days. These results imply that for a minimum follow-up of the migration of the aquatic warbler, at least one visit every five days is advisable.

In Spain, like other European countries, has a program of marking with colored bands that can help to know the movements of the species. The codes generated allow the participating country to be identified and, in the case of Spain, the year of capture and locality of capture of the three participating banding areas: La Nava (Palencia), Salburua (Álava), and Brazo de la Torre (Seville). In the case of La Nava, the bands also allow us to know the age class of the specimen (adult or juvenile). More information on the countries participating in this program and the combinations of colors assigned to each country can be found on the web page http://www.cr-birding.be. If a bird is observed that is bearing a combination of colored bands, the data can be sent to the following address, where the observer will be informed of the year, locality, and history of the bird's banding.

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Photograph: Enrique Gómez

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