

ARTIGO / ARTÍCULO / ARTICLE

Odonatological study in the Doñana area (SW Andalusia, Spain) in years with low rainfall

Joaquín Márquez-Rodríguez^{1,4}, José David Duque-González²
& Manuel Ferreras-Romero³

¹ Laboratorio de Zoología. Facultad de Ciencias Experimentales. Universidad Pablo de Olavide. A-376, Km 1.
E-41013 Sevilla (SPAIN). e-mail: jmarrod1@admon.upo.es

² Plaza de España, 6. E-41720 Los Palacios y Villafranca (Sevilla, SPAIN). e-mail: josedavidduquegonzalez@gmail.com

³ c/ Gerona, 9. E-41003 Sevilla (SPAIN). e-mail: mferrerasrsp@gmail.com

⁴ Corresponding author.

Abstract: The records of Odonata obtained in Doñana (SW Andalusia, Spain) in two consecutive years are presented. In 2005, the driest year of the last five decades, only eight species were recorded. Both years, 2005-2006, *Ischnura graellsii* (Rambur, 1842) was the most abundant species. Most common anisopterans were thermophilic species with a wide distribution in the African continent.

Key words: Odonata, termophilic species, man-made wetlands, Doñana, Andalusia, Spain.

Resumen: Estudio odonatológico en el área de Doñana (SO de Andalucía, España) en años con escasas precipitaciones. En este estudio se presentan los registros de Odonata obtenidos en Doñana (SO de Andalucía, España) en dos años consecutivos. En 2005, el año más seco de las cinco últimas décadas, sólo fueron registradas ocho especies. La especie más abundante ambos años, 2005-2006, fue *Ischnura graellsii* (Rambur, 1842). Los anisópteros más frecuentes fueron especies de carácter termófilo y con amplia distribución en el continente africano.

Palabras clave: Odonatos, especies termófilas, humedales artificiales, Doñana, Andalucía, España.

Recibido: 1 de octubre de 2024

Publicado on-line: 12 de octubre de 2024

Aceptado: 6 de octubre de 2024

Introduction

Wetlands are important aquatic habitats that contribute to the conservation of a large number of species (Díaz-Paniagua & Aragónés, 2015). Listed as a Ramsar and an UNESCO World Heritage Site, the Doñana National Park (SW Spain) is one of the most important wetlands in Europe (Green et al., 2018). Within its more than 54,000 ha, Doñana holds a natural, protected network of more than 3,000 Mediterranean temporary ponds (Díaz-Paniagua et al., 2010), which harbour highly biodiverse communities of aquatic fauna and vegetation, including rare and globally threatened species (Díaz-Paniagua & Aragónés, 2015). Most of these ponds are fed by groundwater, relying on the annual fluctuations of the water table of an aquifer five times larger than the National Park (Manzano et al., 2009).

The present study was focused on four types of small lagoons existing in the Doñana area. Several of these observations were carried out the year 2005, when only 169.8 mm of rainfall were recorded in Doñana, the lowest value in the entire historical series, whilst the following year rainfall was up to three times higher (Morente, 2024).

Material and methods

This study was conducted within protected areas of Doñana: Biological Reserve, National Park, and Natural Park (Seville and Huelva provinces) (Fig. 2). In the springs of 2005 and 2006, eight marsh lagoons ("lucios"), two more peridunes and three more located in conifer forest, as well as four man-made wetlands, were visited looking for the presence of Odonata adults (Table 1). Most localities were visited twice each spring, though the sites 15, 16 and 17 were only sampled in 2006. A total of 51 samplings were carried out. Species were identified according to Dijkstra & Lewington (2006), using binoculars or collecting the specimen by hand net and releasing them in the same place few minutes behind. Likewise, all papers including faunistic data on Odonata from Doñana have been reviewed.

Results

In this paper are presented 1,610 records of adult odonates belonging to ten species, four of them zygopterans. *Ischnura graellsii* (Rambur, 1842) was the most abundant species. The most frequently collected anisopteran was *Sympetrum fonscolombii* (Selys, 1840). Eight and ten species were recorded in 2005 and 2006, respectively. Species found in 2006 not observed in the previous year were *Lestes virens* (Charpentier, 1825) and *Orthetrum trinacria* (Selys, 1841). Exuviae of four species were also collected: *I. graellsii*. (loc. 5 and 8), *Anax ephippiger* (Burmeister, 1839) (loc. 5), *Orthetrum cancellatum* (Linnaeus, 1758) (loc. 5), and *S. fonscolombii* (loc. 5).

In a small lagoon maintained with artificial water contributions (loc. 5, Acebuche) it was seen the greatest number of species, nine, seven each year. Only in this site were recorded *Paragomphus genei* (Selys, 1841) and *O. trinacria* (1 male only). Likewise, it was used by the migratory species *A. ephippiger* to complete there its life cycle in spring, as exuviae were found elsewhere. In the remaining artificial wetlands, at Cerrado Garrido (loc. 7) six species were seen, and at Boca y Perchel (loc. 6) and Vuelta de la Arena (loc. 11) only three and two, respectively.

In the two peridune lagoons were seen seven species, six each year. Conifer forest lagoons were extremely poor: three species were only recorded (Table 2). In the set of eight "lucios" visited, only six species were seen. Five and four of them were recorded at Bolín (loc. 4) and Palacio (loc. 3), respectively. In the remaining "lucios" almost only *I. graellsii* was observed. Most localities pertaining to this type of habitat, very characteristic of this area and highly conditioned by the absence of rainfalls (Fig. 1), were very poor in species in the years in which this study was carried out.

Presence of *I. graellsii* was highly constant, 75% or more in all habitat types. Likewise, it was the most abundant species, between 63 and 97% of records (Table 3). Constancy of *S. fonscolombii* was higher than 40% in peridune and forest lagoons, as soon as artificial wetlands. Significative presence of *Sympetrum fusca* (Vander Linden, 1820) in several man-made wetlands, and *Crocothemis erythraea* (Brullé, 1832) in the peridune lagoons were recorded. In this last habitat, *Enallagma cyathigerum* (Charpentier, 1849) and *O. cancellatum* several times were observed too.

Discussion

Since 1959, a total of 43 species have been reported in Doñana (Boudot et al., 2009), although the citation of *Lestes sponsa* (Hansmann, 1823) by Aguesse (1962) was questioned by Ferreras-Romero & Soler-Andrés (1979) and more recently by Díaz-Paniagua et al. (2014). According to Weihrauch & Weihrauch (2003), *Brachytron pratense* (Müller, 1764), species that was repeatedly cited in ponds from the Doñana area in the last third of the 20th century, seems to have disappeared too. On the other hand, the abundance of *Lestes macrostigma* (Eversmann, 1836), emblematic species for this area, is

highly variable in Doñana. It shows strong populations in some years, but virtually disappearing the next one and vice versa (Ferreras-Romero & Soler-Andrés, 1979; Montes *et al.*, 1982; Ferreras-Romero *et al.*, 2005; Díaz-Paniagua *et al.*, 2010; Muñoz & Ferreras-Romero, 2011).

Only 25 species of odonates are currently detected in the Doñana area (Díaz-Paniagua *et al.*, 2010), ten of which were observed during the springs of 2005 and 2006. Four anisopterans collected in the present study are thermophilic species characteristic of arid habitats. It is noticeable that Acebuche lagoon, a locality artificially flooded, was the richer in species, nine. Three artificial wetlands proved to be aquatic environments visited by the migratory species *A. ephippiger*. Natural habitats with more species richness were the two peridune lagoons, Dulce and Santa Olalla, with seven and five species, respectively, and Bolín "lucio", five species.

Those years with great rain irregularity by scarcity of rainfall, the development of aquatic stages (larval, mainly) of several species will be negatively affected (Ferreras-Romero, 1988). An analysis by De Felipe *et al.* (2023) has found that 59% of ponds in Doñana dried out completely between 1985 and 2018, and that expansion of greenhouses since 1995 had a statistically significant impact on desiccation rates. A new analysis by Green *et al.* (2024) supports the conclusion that groundwater abstraction has been causing extensive ecological damage to Doñana ecosystems for decades.

In current years, as a consequence of the repeated scarcity of rainfall, the habitats created by artificial flooding have not received external water supplies and the two peridune lagoons, traditionally called "permanent", have been completely dried out in the summers from 2022 to 2024, for the first time since their hydrology was known. If the main drivers of the presence/absence of superficial water in the Doñana area, global climate change and groundwater abstractions for intensive agricultural purposes, irreversibly alter its hydrological dynamics, the odonatological biodiversity will likely suffer a progressive impoverishment, which will have effects even in the Doñana Biological Reserve.

Acknowledgements

Sincere thanks to Jochen Fründ, for his help in the field works of 2005.

Bibliography

- Aguesse, P. 1962. Quelques Odonates du Coto de Doñana. *Archivos del Instituto de Aclimatación de Almería*, **11**: 9-12.
- Boudot, J.P., Kalkman, V.J., Azpilicueta Amorín, M., Bogdanović, T., Cordero Rivera, A., Degabriele, G., Domangest, J.L., Ferreira, S., Garrigós, B., Jović, M., Kotarac, M., Lopau, W., Marinov, M., Mihoković, N., Riservato, E., Samraoui, B. & Schneider, W. 2009. *Atlas of the Odonata of the Mediterranean and North Africa. Libellula*, supplement 9: 1-256.
- De Felipe, M., Aragonés, D. & Díaz-Paniagua, C. 2023. Thirty-four years of Landsat monitoring reveal long-term effects of groundwater abstractions on a World Heritage Site wetland. *Science of The Total Environment*, **880**: 163329.
- Díaz-Paniagua, C. & Aragonés, D. 2015. Permanent and temporary ponds in Doñana National Park (SW Spain) are threatened by desiccation. *Limnetica*, **34**: 407-424.
- Díaz-Paniagua, C., Fernández-Zamudio, R., Florencio, M., García-Murillo, P., Gómez-Rodríguez, C., Portheault, A., Serrano, L. & Siljeström, P. 2010. Temporary ponds from Doñana National Park: a system of natural habitats for the preservation of aquatic flora and fauna. *Limnetica*, **29**: 41-58.
- Díaz-Paniagua, C., Martín-Franquelo, R., de los Reyes, L., Fernández-Díaz, P. & Prunier, F. 2014. The dragonflies of Doñana: 1959-2013. *Boletín Rola*, **4**: 5-15.

Dijkstra, K.-D.B. & Lewington, R. 2006. *Field guide to the dragonflies of Britain and Europe*. British Wildlife Publishing, Dorset, 320 pp.

Ferreras-Romero, M. 1988. La fauna odonatológica de la cuenca del embalse del río Bembezar (Sierra Morena) en un periodo de pluviometría irregular (1982-1983). *Stvdia Oecologica*, **5**: 303-314.

Ferreras-Romero, M. & Soler-Andrés, A. 1979. Odonatos de las marismas del bajo Guadalquivir, aspectos faunísticos. *Boletín de la Asociación española de Entomología*, **3**: 213-218.

Ferreras-Romero, M., Fründ, J. & Márquez-Rodríguez, J. 2005. Sobre la situación de *Lestes macrostigma* (Eversmann, 1836) (Insecta: Odonata) en el área de Doñana (Andalucía, sur de España). *Boletín de la Asociación española de Entomología*, **29**: 41-50.

Green, A.J., Bustamante, J., Janss, G.F.E., Fernández-Zamudio, R. & Díaz-Paniagua, C. 2018. Doñana wetlands (Spain), pp. 1123-1136. In: Finlayson, C., Milton, G., Prentice, R. & Davidson, N. (eds.). *The Wetland Book II. Distribution, Description and Conservation*. Springer, Dordrecht, Netherlands, 2027 pp.

Green, A.J., Guardiola-Albert, C., Bravo-Utrera, M.A., Bustamante, J., Camacho, A., Camacho, C., Contreras-Arribas, E., Espinar, J.L., Gil-Gil, T., Gomez-Mestre, I., Heredia-Díaz, J., Kohfahl, C., Negro, J.J., Olías, M., Revilla, E., Rodríguez-González, P.M., Rodríguez-Rodríguez, M., Ruíz-Bermudo, F., Santamaría, L., Schmidt, G., Serrano-Reina, J.A. & Díaz-Delgado, R. 2024. Groundwater abstraction has caused extensive ecological damage to the Doñana World Heritage Site, Spain. *Wetlands*, **44**: 20.

Manzano, M., Custodio, E., Higueras, H., Puig, R. & Soler, A. 2009. Influencia de la gestión del acuífero sobre los humedales del manto eólico de Doñana. *Boletín Geológico y Minero*, **120**: 377-392.

Montes, C., Ramírez Díaz, L. & Soler, A.G. 1982. Variación estacional de las taxocenosis de Odonatos, Coleópteros y Heterópteros acuáticos en algunos ecosistemas del bajo Guadalquivir (SW España) durante un ciclo anual. *Anales de la Universidad de Murcia (Ciencias)*, **38**: 19-100.

Morente, A. 2024. Diez gráficos para entender a las claras la agonía que sufre Doñana. Eldiario.es. Available online at: https://www.eldiario.es/andalucia/huelva/diez-graficos-entender-claras-agonia-sufre-donana_1_10901012.html. [Accessed: 19/02/2024]

Muñoz, J.D. & Ferreras-Romero, M. 2011. Abundante presencia de *Lestes macrostigma* (Eversmann, 1836) (Odonata, Lestidae) en el área de Doñana (sur de España) en 2010. *Boletín de la Asociación española de Entomología*, **35**: 281-287.

Weihrauch, F. & Weihrauch, S. 2003. Spring Odonata records from Alentejo (Portugal), Andalusia and Extremadura (Spain). *Opuscula zoologica fluminensis*, **207**: 1-18.

Table 1. - Doñana area localities sampled from 30/03/2005 to 27/04/2005, and from 10/05/2006 to 28/06/2006. The protection category of the area where it is situated each locality is shown.

Tabla 1. - Localidades de Doñana muestreadas del 30/03/2005 al 27/04/2005, y del 10/05/2006 al 28/06/2006. Se indica la categoría de protección de la zona en que se encuentra cada localidad.

Code	Localities	Type	Conservation status
1	Laguna de Santa Olalla	peridune lagoon	Biological Reserve
2	Laguna Dulce	peridune lagoon	Biological Reserve
3	Lucio de Palacio	marsh lagoon	Biological Reserve
4	Lucio del Bolín	marsh lagoon	Biological Reserve
5	Laguna del Acebuche	artificial wetland	National Park
6	Lagunas de La Boca y El Perchel	artificial wetland	National Park
7	Cerrado Garrido (FAO)	artificial wetland	National Park
8	Lucio del Lobo	marsh lagoon	National Park
9	Lucio del Aro	marsh lagoon	National Park
10	Lucio de Mari López	marsh lagoon	Natural Park
11	Charcas de Vuelta de la Arena	artificial wetland	Natural Park
12	Laguna de la Anguilla	forest lagoon	Natural Park
13	Laguna del Rincón	forest lagoon	Natural Park
14	Laguna de la Lengua	forest lagoon	Natural Park
15	Lucio del Cangrejo Grande	marsh lagoon	National Park
16	Lucio del Cangrejo Chico	marsh lagoon	National Park
17	Lucio de Vetas Altas	marsh lagoon	National Park

Table 2. - Localities of Doñana area where each Odonata species was recorded the years 2005 and 2006. Exuviae records are included.

Tabla 2. - Localidades del área de Doñana donde las distintas especies de odonatos fueron registradas en los años 2005 y 2006. Están incluidos los registros de exuvias.

Species	2005	2006
<i>Lestes virens</i>		2, 3, 4, 5, 13
<i>Sympetrum fusca</i>	2, 5, 6, 7	7
<i>Enallagma cyathigerum</i>	1	1, 2
<i>Ischnura graellsii</i>	1, 2, 3, 5, 6, 7, 8, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17
<i>Anax ephippiger</i>	5, 6, 7, 10	5
<i>Paragomphus genei</i>	5	5
<i>Orthetrum trinacria</i>		5
<i>Orthetrum cancellatum</i>	1, 5, 7	1, 2
<i>Crocothemis erythraea</i>	2, 5, 7	1, 2, 3, 4, 5, 7
<i>Sympetrum fonscolombii</i>	2, 5, 7, 8	1, 2, 3, 4, 5, 7, 8, 11, 12, 13, 14, 15

Table 3. - Values of constancy and frequency of the Odonata species in each habitat types studied in Doñana area: peridune lagoons, man-made wetlands, forest lagoons, and "lucios". Constancy: percentage of visits in which the species was observed in each type of habitat. Exuviae records are included. N, number of visits. Frequency: percentage of records of the species with respect to the total (n) obtained in each type of habitat.

Tabla 3. - Constancias y frecuencias de las especies de Odonata en cada tipo de hábitat estudiado en Doñana: lagunas peridunares, humedales artificiales, lagunas forestales y "lucios". Constancia: porcentaje de visitas en que la especie fue observada en cada tipo de hábitat. Los registros de exuvias están incluidos. N, número de visitas. Frecuencia: porcentaje de registros de la especie respecto al total (n) obtenido en cada tipo de hábitat.

	Constancy (%)				Frequency (%)			
	Peridune N = 8	Man-made N = 16	Forest N = 9	"Lucios" N = 18	Peridune n = 271	Man-made n = 631	Forest n = 247	"Lucios" n = 434
<i>Lestes virens</i>	12.5	6.2	11.1	11.1	3.32	1.90	0.81	1.84
<i>Sympetrum fusca</i>	12.5	43.7	-	5.5	11.44	22.82	-	2.76
<i>Enallagma cyathigerum</i>	37.5	-	-	-	4.06	-	-	-
<i>Ischnura graellsii</i>	75.0	100.0	77.8	77.8	69.37	63.07	97.16	89.86
<i>Anax ephippiger</i>	-	25.0	-	5.5	-	2.22	-	0.23
<i>Paragomphus genei</i>	-	12.5	-	-	-	0.32	-	-
<i>Orthetrum trinacria</i>	-	6.2	-	-	-	0.16	-	-
<i>Orthetrum cancellatum</i>	37.5	12.5	-	-	1.47	0.63	-	-
<i>Crocothemis erythraea</i>	62.5	37.5	-	11.1	5.53	2.53	-	0.46
<i>Sympetrum fonscolombii</i>	62.5	43.7	44.4	27.8	4.80	6.34	2.02	4.84



Fig. 1. - View of the sampling point Lucio del Aro on June 28, 2006.

Fig. 1. - Vista del punto de muestreo Lucio del Aro el 28 de junio de 2006.

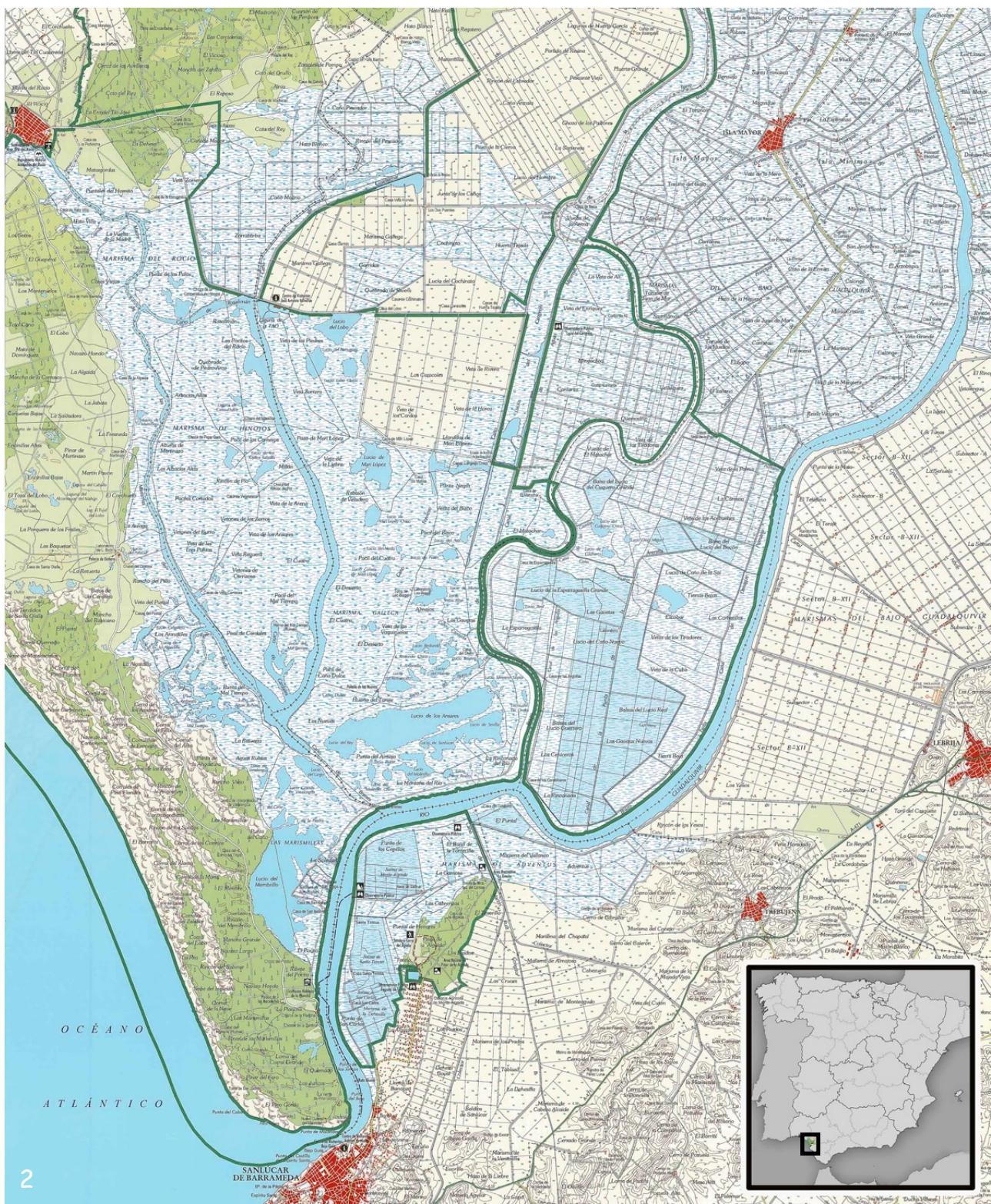


Fig. 2. - Location of the area of Doñana (Andalusia, S Spain).

Fig. 2.- Localización del área de Doñana (Andalucía, S de España).