



Ramsar Advisory Mission N°95

Doñana, Spain (2020)

(Ramsar Site N°234)

Ramsar Advisory Missions

The Ramsar Convention on Wetlands requires its Parties to designate key sites as Wetlands of International Importance ('Ramsar Sites'). Parties commit to maintain the ecological character of designated sites. However, Ramsar Sites can face a variety of challenges, including human developments in different sectors, water management issues, invasive alien species and climate change. Ramsar Advisory Missions (RAMs) help Parties and site managers respond to threats to the ecological character of Ramsar Sites. They are a means by which the Convention provides technical advice for the management and conservation of listed sites whose ecological character has changed, is changing or is likely to change as a result of technological developments, pollution or other human interference (Resolution XIII.11). RAMs may be conducted jointly with other multilateral agreements or agencies. Advantages of joint missions include increased efficiency from the perspective of the Party, when international institutions are working together at a practical level, and increased authority and impact of mission findings and recommendations.

Joint Mission to Doñana by the UNESCO World Heritage Centre, IUCN and Ramsar

Doñana National Park (50,720 ha) was designated by the Spanish Government for inclusion in the Ramsar List when the Kingdom of Spain deposited its instrument of accession to the Convention with UNESCO on 4 May 1982. In 1990, Ramsar COP4 considered Doñana as one of the most important Ramsar Sites in Europe and noted the many positive measures taken for its protection. In spite of these measures, there was still a risk because of water abstraction for agriculture and tourist development, among other problems (Recommendation 4.9.1). This resulted in the inclusion of Doñana on 4 July 1990 in the newly established 'Montreux Record' of Ramsar Sites where changes in ecological character have occurred, are occurring or are likely to occur, because of technological developments, pollution or other human interference (referring to Article 3.2 of the Convention). Subsequent to the pollution created in the Guadiamar river valley by the toxic mine spill at Aznalcóllar in 1998, a specific RAM was undertaken in 2002 (N°51) to assess the restoration measures. Based on this restoration programme, in April 2007, the Ramsar Site was extended to cover 111,645 ha with the inclusion of the Doñana Nature Park surrounding the National Park. RAM N°51 was followed up by a first mission undertaken jointly by the Convention on Wetlands, IUCN and the World Heritage Centre in 2011 (RAM N°70), and a second one in 2015. On 3 September 2019, Spain invited UNESCO to undertake a joint World Heritage Centre-IUCN-Ramsar Reactive Monitoring Mission. The joint mission took place 25-28 February 2020 and presents its detailed analysis and recommendations in this report, approved by the Spanish World Heritage and Ramsar Convention authorities.

The Conclusions and Recommendations by the mission are detailed on pages 47-51.

**Report on the joint UNESCO/IUCN/Ramsar Reactive Monitoring mission to
Doñana National Park, Spain
25 to 28 February 2020**



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January 2021

EXECUTIVE SUMMARY AND LIST OF RECOMMENDATIONS

Doñana National Park was inscribed on the UNESCO World Heritage List in 1994 for its great diversity of biotopes, especially lagoons, marshlands, fixed and mobile dunes, scrub woodland and matorral^a. It is a wintering site for hundreds of thousands of birds. The World Heritage property is also part of a Biosphere Reserve and Ramsar Site.

About 170,000 people live in the vicinity of the National Park. The Park provides income to local communities via (eco)tourism and as the setting for the El Rocío pilgrimage. About forty percent of all jobs in the region derive from agriculture activities (production of olives, fruit trees, rice, and berries). A high percentage of the red fruits consumed in Europe (strawberries, blueberries, raspberries, blackberries) are produced on the sun-drenched irrigated sandy soils near Doñana. These agricultural activities and other human uses require an enormous amount of groundwater, almost 100 hm³ per year. About forty percent of all the water that infiltrates into the aquifer units around Doñana (predominantly from rain) is used for human use through groundwater abstraction. This abstraction currently exceeds sustainable limits, putting strain on the aquifers, and in 2020 the Spanish Authorities declared some aquifers officially overexploited. This has given rise to fears that the Outstanding Universal Value (OUV) of the property is in danger from lack of water. In this context a Reactive Monitoring Mission, organized jointly between the UNESCO World Heritage Centre, IUCN and the Secretariat of the Ramsar Convention on Wetlands, took place from 25 to 28 February 2020, upon the invitation of Spain.

The mission would like to commend the considerable conservation success that has been achieved over the years. The protected area grew considerably in the last four decades, the Iberian lynx was saved from the brink of extinction, thousands of hectares of introduced eucalyptus -a ferocious water consumer- have been removed to restore the original ecosystem, 5000 hectares of marshes have been restored through the Doñana 2005 project, the Mimbrales estate was purchased for 50 million euros thereby acquiring the water rights of almost 7 hm³, and there is a constructive cooperation between the Park, the Participation Council and most parties involved.

Following field visits, analysis of material provided and meetings with authorities, the Park, non-governmental organisations (NGO), businesses, scientists and other stakeholders, the mission team concludes that the values for which the property has been inscribed under the World Heritage and Ramsar Conventions are still present. The mission team heard concerns about potential threats to the state of conservation of the World Heritage property, including those from water abstraction outside the property, climate change, and potential development and infrastructure projects in the property's vicinity.

The mission team reviewed the principal literature available on the hydrological system of Doñana, which is critical to the functioning of the property, including the connectivity of the detritic aquifer and the marshes. The mission did not find documented scientific evidence of negative impacts from groundwater abstraction from the detritic aquifer on the OUV of the property, and limited impacts of abstraction from the coastal dune aquifer. Moreover, the reduction in groundwater abstraction to sustainable levels being pursued by the Confederación Hidrográfica del Guadalquivir (CHG), should further reduce any potential threat. The considerable resources that the State Party has already dedicated to the conservation and restoration of the property are recognized. On the other hand, whilst there is a lack of evidence of significant interactions between the detritic aquifer and the marshes, hydrological independence has not been proven either. Hence, the mission team recommends further research is of the utmost importance to clarify the wider eco-hydrological dynamics of Doñana.

^a<http://whc.unesco.org/en/list/685>

In light of this scientific uncertainty, and since aquifers associated with the wider Doñana ecosystem remain below Good Status, it is recommended the State Party urgently continues the implementation of conservation efforts including the prescribed water management measures, to ensure the recovery of these aquifers, and to eliminate any possible related risk to the OUV of the property. There is also a need to report differently on the hydrological context because the mission team considers that the water levels in the detritic aquifer, used previously on its own as a metric, is not the best indicator of potential danger to the OUV. Appropriate indicators are therefore required that link the hydrology to the ecological response of the property.

Climate change poses a potentially greater future risk, but is highly uncertain, so also requires further research. The mission team considers that this overall level of scientific uncertainty is unacceptable for an iconic World Heritage site such as the Doñana National Park. After all, State Parties to the World Heritage Convention have pledged to do all they can “to the utmost of its own resources” to conserve and transmit the world’s natural heritage to future generations.^b

The Covid-19 pandemic has underlined the importance of a diversified economy for the resilience of local communities. For the Doñana region, the resilience of both people and ecosystems depend on a healthy water balance. Especially in light of likely possible climate change impacts on a sensitive ecosystem, more resources should be dedicated to building resilience and climate adaptation measures.

The mission proposes the following recommendations to the State Party:

Main recommendations:

Recommendation 1

To eliminate any possible risk to the OUV of the marshes and groundwater-fed ecotones derived from groundwater extraction from the Almonte-Marismas detritic aquifer (Doñana aquifer), and given the crucial role of the CHG in achieving Good Status of the aquifer by 2027, consistent with a precautionary management approach, the mission recommends to:

- increase the resources available to the CHG, including recent technologies, to strengthen monitoring, surveillance and enforcement to ensure the accelerated and urgent closure of all illegal wells and illegally irrigated farmland;
- continue the urgent implementation of the Special Management Plan of the Irrigation Zones located to the North of the Forest Crown of Doñana, in its current form, in close cooperation with all key stakeholders, to ensure the recovery of the aquifers to Good Status as soon as possible, and by no later than 2027;
- ensure that any substitution of groundwater by surface water is directed to those areas most in need, and that any substitution is carefully managed and considered in the context of any possible impacts on the OUV of the property as per the *Operational Guidelines* of the World Heritage Convention, including through EIAs, as required;
- ensure that projects including water transfers, dam extensions, and licenced groundwater abstraction have no negative impact on the OUV of the property, by undertaking appropriate EIAs in line with the IUCN World Heritage Advice Note on Environmental Assessment^c;

^bUNESCO. 1972. Art. 4, Convention Concerning the Protection of the World Cultural and Natural Heritage , adopted by the General Conference, Paris, 16 November 1972. <http://whc.unesco.org/en/conventiontext/>

^cIUCN World Heritage advice note on Environmental Assessment (November 2013) <https://www.iucn.org/theme/world-heritage/resources/iucn-policies-world-heritage/environmental-assessment>

- encourage, incentivize and provide financial support if needed for the adoption of sustainable agriculture practices (especially concerning drip irrigation and reduction in use of single-use plastics) by farmers of the Doñana area.

Recommendation 2

To eliminate any possible risk to the OUV in the coastal dunes, consistent with a precautionary management approach, the mission recommends relocating as soon as possible, and within three years, the most eastern wells that provide water for the Matalascañas tourist resort (well 9 and 10), as already proposed in the draft Hydrological Plan 2021-2027.

Recommendation 3

Although there is a basic understanding of the hydrology of the region, some uncertainty remains concerning possible impacts of water use in the vicinity of the property. Consequently, an increased research effort is urgently required to understand the relationship between the hydrology and ecology of the area, as this is essential to underpin sound management. The mission therefore recommends that future research should include a focus on defining the water requirements of the property to maintain its OUV. This necessitates quantification of relationships between the ecological features that define the OUV and hydrological components (*e.g.* rainfall, evaporation, river flows and groundwater levels). Construction of an eco-hydrological model of the World Heritage property based on the results of the research, and consideration of the possible need of a buffer zone, including the surrounding catchment basin (covering the Ramsar Site and EU Natura 2000 area), would allow the impacts of various scenarios to be defined, including abstraction of groundwater, removal of trees, building of dams and climate change. The model should incorporate appropriate indicators linking the hydrology to the ecological response of the property. A detailed list of recommended research topics can be found in the mission report (Chapter 3.3.8).

Recommendation 4

Taking into account the likely possible impacts from climate change on the values of the property, the mission recommends the creation of a strategic plan that defines conceptually:

- The extent to which a reduction in water consumption is required in response to climate change impacts to conserve and protect the OUV of the property (in case further studies would reveal close linkages between the detritic aquifers and the OUV);
- The extent to which alterations to the OUV and ecological character of the wetland ecosystem due to climate change can be expected, along with any adaptation and mitigation measures that can be implemented to maintain the conditions of integrity of the property and increase its resilience.

Recommendation 5

To facilitate the reporting and analysis of the state of conservation of the property's OUV in the coming decades, the mission recommends:

- The State Party finalizes the rSOUV as soon as possible, in consultation with IUCN;
- The State Party develops a clear set of fixed indicators to monitor the state of conservation of the OUV through an integrated catchment-wide management approach that allows for the identification, monitoring and management of threats within and beyond the boundaries of the property, and to report on those indicators in future state of conservation reports;

Recommendation 6

Noting that the mission did not receive any additional information on a Strategic Environmental Assessment (SEA) of the Guadalquivir river basin, it recalls the 2017 Committee Decision as follows^d: “Requests furthermore, the State Party to present an updated SEA for the Guadalquivir River Basin to ensure that it includes a specific chapter on the OUV of the property, and submit it to the World Heritage Centre.”

Recommendation 7

Because the State Party’s commitment to abandon the deep dredging project of the Guadalquivir River cannot be considered ‘permanent’ or ‘unequivocal’ whilst a reference to any deep dredging remains in the new Guadalquivir Basin Hydrological Plan, the mission team recommends that the State Party continues honouring its previously made commitments and removes this project from the revised Guadalquivir Basin Hydrological Plan (2021-2027).

Recommendation 8

Noting that the mission did not receive any additional information on the status of the potential reopening of the Aznalcóllar mine, it recalls the 2019 Committee Decision^e: “Further recalling the need for great caution with regards to re-opening the former Aznalcóllar mine, and urges the State Party to ensure that systematic risk preparedness and emergency action plans take into account the property and to submit these analyses for review by IUCN, as soon as they become available and before a decision on re-opening the mine is made”.

Recommendation 9

Noting that the mission did not receive any additional information on the status of the gas storage projects, consistent with a precautionary management approach the mission recommends that systematic monitoring of the possible impacts and risk assessments of Rincon-2 and Marismas-3 on the hydrology and OUV is put in place, and that a summary of those findings is included in future state of conservation reports. The mission also recommends for the State Party to ensure that the individual and cumulative impacts on the property’s OUV of any development or infrastructure project in or near the property are thoroughly assessed in conformity with IUCN’s World Heritage Advice Note on Environmental Assessment.

Recommendation 10

To maintain the integrity of the property, and consistent with a precautionary management approach, the mission recommends to establish an official World Heritage buffer zone around the property that includes the Natural Park (Ramsar Site), Natura 2000 sites and other established protected areas in the immediate water catchment of the property which underpin the OUV of the property.

Other recommendations:

Recommendation 11

The mission notes that varying perspectives regarding the status of the ecosystems of the property and Doñana Natural Space exist. It therefore recommends that actions are taken to ensure the availability of current scientific data to inform decision making, and to organise regular meetings of all stakeholders to present, share and discuss scientific knowledge and different perceptions of the eco-hydrological status, trends and possible futures in and around the property. This could result in closer agreement on the issues and solutions.

^d<http://whc.unesco.org/en/soc/3556>

^e<http://whc.unesco.org/en/soc/3909>

Recommendation 12

Further studies are required to determine the level of threat from pollutants or water of different quality imported to the system from other river basins. This includes both historical determinands such as nutrients from agricultural fertilizers and new pollutants such as pharmaceuticals. Evidence is required on impacts of ecological functioning, threshold levels of pollutants and how they might accumulate through the food chain.

Recommendation 13

Recalling recommendation 11 of the 2011 Reactive Monitoring Mission, recommends the State Party prepare a consolidated proposal for the establishment of a Marine Protected Area (MPA) adjacent to the property, which also considers the potential OUV of the marine ecosystem and possibility to extend the existing property to include this MPA.

Recommendation 14

Participation and education of young people is key to continue encouraging and enabling the future stewards of the property and Doñana Natural Space, and the mission therefore recommends to expand the educational activities in schools nearby the property, including by exploring to join the UNESCO Associated Schools (ASPNet), to continue involving the youth of Doñana and strengthen education activities on sustainable development and the OUV of the Park.

Recommendation 15

To promote a culture of peace through intercultural dialogue, and increase management effectiveness through the exchange of conservation best practices (especially in the field of bird monitoring and building resilience of wetlands in the face of climate change), the mission recommends the State Party to strengthen international cooperation with other World Heritage and Ramsar sites (*e.g.* Danube Delta, Everglades National Park, Wadden Sea, Banc d'Arguin National Park), Biosphere Reserves and Ramsar Sites (Carmargue/Delta du Rhone), and protected areas in general whose ecosystem is linked with, or very similar to the Doñana National Park, especially on the East Atlantic Flyway.

ACKNOWLEDGEMENTS

The mission team acknowledges the excellent support from the Doñana Natural Space (Espacio Natural Doñana) team, in terms of logistical arrangements, provision of high-quality information and the English-Spanish translation. We also thank the members of the Spanish delegation (Junta de Andalucía, Autonomous Regional Administration; Ministry of Ecological Transition and Demographic Challenge, Autonomous Organisation of National Parks, Guadalquivir Hydrographic Confederation; Ministry of Education, Culture and Sports, Sub-Directorate for Heritage Protection; and Ministry of Foreign Affairs, European Union and Cooperation, Coordination Unit for Cultural and Scientific Relations) for joining the mission and contributing to the provision of relevant information.

We are grateful to all the people who set aside time to speak to us and share their valuable insights including NGOs, scientists from Spanish universities, local community representatives and others (full list available in the Annexes). The mission team equally thanks the IUCN World Heritage Programme for its advice and review.

Finally, we salute all individuals living in the surrounding area of Doñana who are taking actions to ensure that future generations can continue to enjoy the World Heritage and Ramsar values of Doñana.

The mission highlights also the benefits of joint missions between UNESCO, IUCN and the Ramsar Convention on Wetlands, avoiding the duplication of efforts and allowing the alignment of recommendations wherever possible and appropriate.

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ABBREVIATIONS

| | |
|--------|---|
| CHG | Confederación Hidrográfica del Guadalquivir (Guadalquivir Hydrographical Confederation) |
| COM | World Heritage Committee session |
| EIA | Environmental Impact Assessment |
| HIA | Heritage Impact Assessment |
| IUCN | International Union for Conservation of Nature |
| MPA | Marine Protected Area |
| OUV | Outstanding Universal Value |
| rSOUV | Retrospective Statement of Outstanding Universal Value |
| SEA | Strategic Environmental Assessment |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| WFD | European Union Water Framework Directive |

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1. BACKGROUND TO THE MISSION

1.1 Inscription history

The World Heritage property (property) of “Doñana National Park” (Spain) was inscribed on the World Heritage List as a natural property under criteria (vii), (ix), and (x) during the 18th session of the World Heritage Committee (hereafter referred to as “the Committee”) in 1994 (**CONF 003/16**). An extension of the property to bring its boundaries in line with the extended National Park as proposed by the State Party was approved by the Committee in 2005 (**29 COM 8B.16**).

1.2 Inscription criteria and World Heritage values

In 1994, the Committee inscribed this property as “an exceptional example of a large Mediterranean wetland with diverse habitats such as marshes, forests, pristine beaches, dunes and lagoons, which supports high faunal diversity, particularly large numbers of migratory birds of the palearctic region.”^f

The description of OUV as below is based on the 1994 IUCN Evaluation Report at the time of nomination for inscription.^g The State Party should be encouraged to finalize as soon as possible the retrospective Statement of Outstanding Universal Value, in collaboration with IUCN (see also Chapter 3.3.11).^h

Criterion (vii): Numerous authors have commented on the exceptional beauty, solitude and unspoilt nature of Doñana, particularly its vast flat expanses of wilderness containing diverse habitats (marshes, forests, beaches, dunes, lagoons). Its 38 km long beach is completely pristine, and it possesses spectacular colonies of nesting birds.ⁱ

Criterion (ix): The marshes of the Guadalquivir River constitute an example of geological processes during the Pleistocene. Doñana contains the last marshes of the Guadalquivir unaltered by agriculture or development. The marshes result from a subsidence of the continental plate in the Upper Miocene and Lower Pliocene, which caused a depression later filled by fluvial and aeolian deposits. Deposition of a coastal sand bar and mobile dunes continue today. These dunes, among the largest in continental Europe, advance at speeds of 4-6 m per year. Primary and secondary successional stages are evident in the vegetation of the area.

Criterion (x): The Park has high fauna diversity, notably an avifauna consisting of 360 species of breeding and migratory birds. It contains breeding populations of several globally threatened animal (marbled teal, white-headed duck, Imperial eagle, and Iberian lynx) and plant species. It is an important wintering site for wildfowl, receiving hundreds of thousands of migratory ducks and geese every year. Doñana includes one of the last large stretches of undeveloped pristine coastline in Spain, and its largest wetland.

The 1994 IUCN Evaluation Report also concludes with: “In sum, its outstanding universal values are based on two features:

^f<http://whc.unesco.org/en/decisions/3193>

^g<https://whc.unesco.org/document/154023>

^h<https://www.iucn.org/sites/dev/files/import/downloads/whouven.pdf>

ⁱ Noting that the spectacular colonies of nesting birds are located in the marshes and not the beaches, it is recommended that the State Party takes this into consideration as part of the finalisation of the rSOUV.

- Its high diversity of habitats: beaches, coastal dunes, marshes, water courses, ponds, Mediterranean scrub, pine, juniper, and cork oak/olive woodlands, and the interactions among them; (criterion ii)^j
- Its high ornithological values with habitat for five endangered breeding species, as one of the largest heronries in the Mediterranean, for supporting over one half million wintering waterfowl. And as a critical link in the migration route for palearctic waders; (criterion iii and iv)^k

1.3 Integrity issues raised by IUCN and the Committee at time of inscription

At the time of inscription, the Committee alerted the State Party to the “continuing threats to the integrity of the site arising from hydrological projects and encouraged them in their ongoing efforts to restore disturbed parts of the Park”.^k IUCN in its 1994 Evaluation Report stated that the conditions of integrity for all three of the criteria were met but noted that the main concern for the conservation of the property would be to ensure its long-term hydrological integrity.^l

1.4 Examination of the state of conservation by the Committee

The property has been subject to numerous state of conservation reports and the key issues identified by the Committee are highlighted as follows:

Condition of the aquifers around the property

In 2011 (**35 COM 7B.27**) the Committee took note of the conclusions of the 2011 Reactive Monitoring Mission that the OUV of the property could be threatened by the over-abstraction of the “Doñana aquifer” (here meaning the Almonte-Marismas detritic aquifer, see chapter 3.2 for details). In 2013 (**37 COM 7B.27**) the Committee considered that the property could meet the conditions for inscription on the List of World Heritage in Danger in the near future if the issue of over-extraction of the Doñana aquifer was not addressed. In 2014 (**38 COM 7B.79**) the Committee expressed its utmost concern for: 1) the continued decline in the condition of the Doñana aquifer; 2) reported plans to increase water use for irrigation of rice paddies upstream of the property; 3) proposal to legalise illegal water use under the revised Strawberry Plan; 4) dam construction on the Guadiamar River; and 5) absence of a plan of action to address unsustainably high water extraction. In 2015 (**39 COM 7B.26**) the Committee requested that regular monitoring of the Doñana aquifer be ensured. In 2017 (**41 COM 7B.9**) and 2019 (**43 COM 7B.20**) the Committee recalled that the continued declining condition of the Doñana aquifer, if not reversed, could represent a potential danger to the OUV, and thus could merit inscription of the property on the List of World Heritage in Danger. In 2019 the Committee expressed its deep concern that the status of the Almonte-Marismas aquifer within the property remains at “pre-alert” and “alert” levels, and that the current method and level of groundwater abstraction in a significant part of the Almonte-Marismas aquifer, if sustained, would ultimately compromise the terrestrial ecosystem. The Committee also expressed its concern about the infringement decision issued by the European Commission regarding the Habitats and Water Framework Directives (see Chapter 3.3.3).

Regional land-use

In 2002 (**26COM 21B.21**), the Committee urged the State Party to prioritise integrated regional land-use planning to minimise impacts related to irrigation and road design, construction and management around the property. In 2011 the State Party was requested to ensure the implementation of the Special Management Plan of the Irrigation Zones located to the North of the

^jCriteria (ii), (iii) and (iv) are now criteria (ix), (vii) and (x) respectively.

^k<http://whc.unesco.org/en/decisions/3193>

^l<http://whc.unesco.org/document/154023>

Forest Crown of Doñana. In 2013 the Committee requested the State Party to approve and implement the plan without further delay, and in 2017 to expedite the full implementation of the plan. In 2019 the Committee noted the continued inspections and a reduction of irrigable agricultural land in connection to the implementation of the Extraction Plan and Special Irrigation Plan (SIP).

Strategic Environmental Assessment of the Guadalquivir River Basin

In 2014, the Committee requested for a Strategic Environmental Assessment (SEA) to be undertaken to prepare revised plans and actions for water management and use in the river basin, which will provide long-term protection of the OUV of the property. In 2017 a specific chapter on the OUV of the property was requested to be included in the SEA. In 2019 the Committee expressed its appreciation that the Hydrological Plan for the 2021-2027 period will include a chapter on the OUV and also requested the State Party to submit the draft chapter including revised plans for water management and use in the river basin, based on an SEA that takes into account the OUV of the property and covers water supply scenarios, agricultural, industrial and commercial development, for review by IUCN.

Transfer of water and Agrio dam

In 2014 the Committee expressed its utmost concern about the reported plans to construct a dam on the Guadiamar River. In 2017 it noted that enlargement of the Agrio dam on the Guadiamar River is still at a conceptual stage and that the cumulative impacts from these projects on the OUV of the property should be assessed in the framework of the SEA. In 2019 the Committee noted the plans to quadruple the transfer of water from the Tinto-Odiel-Piedras basin to the Guadalquivir basin, and requested the State Party to submit an Environmental Impact Assessment (EIA), including an analysis of any potential positive and negative impacts on the OUV of the property.

Aznalcóllar mine

Following a toxic spill of the Aznalcóllar mine in 1998, the Committee requested the State Party to carry out EIAs for each step should the mine be reopened (**22 COM VII.25/24**), and in 1999 expressed its concerns over the decision to reopen the mine (**23 COM X.B.26**), a plan which was later abandoned. In 2015 the Committee noted with utmost concern the reopening of the site while in 2017 it noted that a research project for the mine has been authorized, but that there was no mining project to date. In 2018 the State Party submitted the project documentation to the World Heritage Centre together with its State Party report. In 2015 and 2019 the Committee urged the State Party to ensure that systematic risk preparedness and emergency action plans take into account the property.

Gas extraction and storage

In 2013 and 2014, the Committee urged the State Party to ensure that impacts on the property's OUV from gas exploitation and storage projects in Doñana's vicinity are thoroughly assessed to consider the potential impact on the OUV of the property through EIA processes, including adherence to IUCN's World Heritage Advice Note on Environmental Assessment. In 2013 the Committee reiterated concerns regarding the potential cumulative impacts of a number of threats to the OUV of the property including the potential impacts from hydrocarbon projects in the vicinity of the property, and considered that if these issues are not addressed, the property could meet the conditions for inscription on the List of World Heritage in Danger. In 2017 the decision not to authorize the gas and storage projects in Marismas Oriental was welcomed, while the urgent submission of EIAs for the gas extraction projects at Aznalcázar and Marismas Occidental, comprising specific assessments of impacts on the OUV of the property, including its conditions of integrity, was requested. In 2019 the Committee noted with concern that the EIA for the Marismas Occidental and Aznalcázar projects located in close proximity of the property recognized impacts

from the additional fragmentation of the property's upstream areas, potentially adding pressure on habitats, as well as surface and groundwater flows.

Dredging of the Guadalquivir River

The Committee urged the State Party not to authorise the dredging of the Guadalquivir River (2011), not to permit any deepening dredging in the Lower Guadalquivir River (2013), and to make a permanent commitment to not permit plans for deepening dredging in the Guadalquivir River (2014,2015). In 2013 the Committee considered the possible deepening dredging of the Guadalquivir estuary as a possible trigger for inscription on the List of World Heritage in Danger. In 2017 the Committee welcomed the State Party's commitment not to authorize the dredging project to deepen the Guadalquivir River and took note of the State Party's statement to remove this project from the Guadalquivir Basin Hydrological Plan when it is next revised.

1.5 Doñana – a Wetland of International Importance (Ramsar Site)

Doñana National Park (50,720 ha) was designated by the Spanish Government for inclusion in the List of Wetlands of International Importance when the Kingdom of Spain deposited its instrument of accession to the Convention on Wetlands with UNESCO on 4 May 1982. In 1990, Ramsar COP4 considered Doñana as one of the most important Ramsar Sites in Europe and noted the many positive measures taken by the Spanish authorities for its protection. It noted that, in spite of these measures, there was still a risk because of water abstraction for agriculture and tourist development, among other problems. COP4 listed four recommendations, the first stressing that the authorities “a) ensure that the basin-wide water resources Master Plan being prepared by the Guadalquivir Basin Authority (CHG) will examine the Almonte-Marismas aquifer, the irrigation scheme, as well as tourist and urban demands for water, in order to meet the Doñana National Park's water requirements and to maintain its ecological character;” ([Recommendation 4.9.1](#)). This Recommendation resulted in the inclusion of Doñana National Park on 4 July 1990 in the newly established “Montreux Record”, i.e. a record of Ramsar sites where changes in ecological character have occurred, are occurring or are likely to occur, because of technological developments, pollution or other human interference (referring to Article 3.2 of the Convention).

Subsequent to the landscape-scale pollution created in the Guadiamar river valley (upstream of the National Park) by the toxic mine spill at Aznalcóllar in 1998, a specific Ramsar Advisory Mission was undertaken in 2002 (N°51) to assess the restoration measures being implemented through the programme Doñana 2005. Based on this restoration programme, in April 2007, the Ramsar Site (N°234) was extended to cover 111,645 ha with the inclusion of the Doñana Nature Park surrounding the National Park. Since then the Ramsar Site covers the Doñana Natural Space, combining the National and the Nature Park. It contains representative, rare and unique Mediterranean examples of natural and near-natural wetland types (Criterion 1) such as a vast coastal marshland complex, separated from the ocean by an extensive dune system and subject to seasonal variations in water level and salinity. Its vegetation includes aquatic species, salt-tolerant plants, stone pine *Pinus pinea* forest, and grassland. The Ramsar Site supports vulnerable, endangered and critically endangered species and ecological communities (Criterion 2) and plant and animal populations important for maintaining the Mediterranean biological diversity (Criterion 3). The Site is of importance for numerous species at a critical stage in their life cycles (Criterion 4) and regularly supports more than 20,000 breeding, staging or wintering waterbirds (Criterion 5), including more than 1% of the individuals of several flyway populations of migratory waterbirds (Criterion 6).

Human activities in the Doñana Natural Space are more diverse than in the National Park only and include nature conservation, research, charcoal production, bee keeping, wood gathering, fishing, livestock grazing, aquaculture, farming and increasingly nature tourism (bird watching, horse riding,

and traditional pilgrimages). The impact of mass tourism and intensive irrigated agriculture in the Natural Space, and even more so in its surrounding area are still concerning. Development of tourism, agriculture, and transport are factors influencing management of this vast complex.

The Ramsar Advisory Mission N°51 in 2002 was followed up by a first Mission undertaken jointly by the Convention on Wetlands, IUCN and the World Heritage Centre in 2011 (Ramsar Advisory Mission N°70) , and a second one in 2015. In spite of several measures undertaken as a result of these Missions, the Ramsar Site (including the National and the Nature Park) is still included in 2021 in the Montreux Record for the reasons already addressed in 1990.

1.6 Justification of the mission

The Committee at its 43rd session (Baku, 2019) in Decision **43 COM 7B.20** requested the State Party to invite a joint World Heritage Centre/IUCN Reactive Monitoring Mission to the property, to be conducted jointly with the Secretariat of the Ramsar Convention if possible, to assess the potential impacts of current and future developments and water management on the OUV of the property, and to review the implementation of the recommendations of previous missions.

The mission team visited Doñana from 24 to 28 February 2020. Terms of Reference of the mission, full programme and a list of people met during the mission are included in the Annexes of this report. Following the visit, the mission team consulted a wide range of national and international experts, ecologists, hydrologists and NGOs with regard to knowledge relating to the State of conservation of the property. A search was also undertaken for scientific evidence using international databases including Web of Science and Google Scholar, and experts from Spain and other countries provided additional papers and reports. In total, 374 publications were reviewed and relevant scientific evidence was distilled and included in this mission report (see Annex V). This constitutes the knowledge base on which the mission team's conclusions and recommendations are based.

2. NATIONAL POLICY FOR THE PRESERVATION AND MANAGEMENT OF THE WORLD HERITAGE PROPERTY

2.1 Protected area/national legislation

The legal framework specific to the protection and management of Doñana National Park is provided by the following laws and regulations:

- Law 91 of 28 December 1978 which established the Doñana National Park;
- Special Plan for Doñana National Park of 1986;
- Law 2 of 18 July 1989 which established the inventory of natural protected spaces of Andalucía and additional measure towards their protection;
- Law 8 of 27 October 1999 on the Doñana Natural Space;
- Law 30 of 3 December 2014 which established overall regulations for the Network of National Parks of Spain;
- Decree 142 of 2 August 2016 which increased the territorial scope of the Doñana National Park and approved the Natural Resources Management Plan and the Master Plan for the Use and Management of the Doñana Natural Space.

In addition, the natural property is protected by the following laws and legal provisions:

- Coastal zone law 22/1988;

- Decree 24/2007 (No 25, of 30 January 2007) which declares the Sierra Nevada Natural Area and regulates the management and participation bodies of the Doñana and Sierra Nevada Natural Areas al Space;
- Law 42/2007 (No 299, of 14 December 2007) on Natural Heritage and Biodiversity;
- Law 1803/1999 (No 209, of 1 September 1999) on the Plan Director;
- Royal Decree 389/2016 (of October 22) which approves the Master Plan of the Network of National Parks;
- Habitat Directive (92/43/CEE) of 1992;
- Declaration of Zone of Special Protection of Birds (ZEPA);
- Agreement of the Council of Ministers of 1982, which authorizes the inclusion of the site into the list of wetlands of international importance of the Ramsar Convention (1971) - Boletín Oficial del Estado (BOE) nº 199, de 20 de agosto de 1982.^m

2.2 Institutional framework and management structure

The responsible body for the implementation of the 1972 World Heritage Convention in Spain is the Spanish Ministry of Culture. For the 1971 Convention on Wetlands it is the Ministry for the Ecological Transition and Demographic Challenge. All planning and management activities are implemented at the regional level by the Government of Andalucía in coordination with the national authorities. The administration and management of the Doñana Natural Area is carried out by the regional administration through the Management Team. This team is structured around two main areas: (1) Conservation and (2) Management, and both areas are directed and coordinated by the Director of the Doñana Natural Space. There is also an advisory body called the Doñana Natural Space Participation Council, which is made up of the President, Vice President, Secretary and the Members representing the Administration of the Junta de Andalucía, the State Administration and the Local Administration, organizations and social and economic agents and the scientific community. The form of appointment of the members and the number of the members is determined by regulation.

2.3 Response to the recognition of values under other international treaties and programmes

In addition to its status as a World Heritage and Ramsar site, Doñana was established in 1980 as a Biosphere Reserve under the UNESCO Man and the Biosphere Programme. The Biosphere Reserve includes the National Park (core zone), the Natural Park (buffer zone) and wider catchment area (transition zone).ⁿThe Biosphere Reserve is located between two hydrographic boundaries, the Gadiana and the Guadalquivir.

In addition, in September 1985 the Council of Europe granted the National Park the European Diploma for Protected Area Management, which has been renewed in 1990, 1995, 2000 and 2010.^o Furthermore, in 1988, the National Park was declared a “Special Protection Area” under the EU Birds Directive 79/409, which implies that it is also part of the Natura 2000 Network established by the EU Birds Directive and EU Habitat Directive 92/43.

^mAdapted from the 2015 Reactive Monitoring mission report. <http://whc.unesco.org/document/136601>

ⁿ<https://en.unesco.org/biosphere/eu-na/Doñana>.

^o<https://www.coe.int/en/web/bern-convention/-/Doñana-national-park>

3. IDENTIFICATION AND ASSESSMENT OF ISSUES / THREATS

3.1 Management effectiveness

Although management effectiveness was not a particular focus of this Reactive Monitoring Mission, the mission team reiterates the conclusion from the 2015 Reactive Monitoring Mission that the management of the property is considered effective and supported by adequate human and financial resources. Since 2015, the Doñana Natural Space (which includes the property) is inscribed on the IUCN Green List of Protected and Conserved Areas (IUCN Green List). Areas on this list are certified by IUCN as being effectively managed and fairly governed, with long-term positive impact on people and nature. Every five years, they are evaluated against a set of demanding criteria defined by the IUCN Green List Standard. These criteria include the quality of protection of natural values and the effectiveness of actions against threats.^p The 2020 IUCN World Heritage Outlook for the property considered that *“In general protection and management of the World Heritage site is effective or even highly effective. The Park has strong collaboration with authorities that address threats originating from outside the property, including conflict over water use with the agricultural sector, but it is not within their control, and therefore requires greater regional and national collaboration to address this issue. Other aspects of park management including replanting of previously degraded areas, tourist management, education and research, are highly effective.”*^q

A highly qualified team of people managing the property are guided by the findings of scientific research implemented by the Doñana Biological Station. In 2018, 247 people worked for the Doñana Natural Space, including 136 regular staff and 111 project staff. In 2018, the total budget amounted to 14 million euros, of which about half was allocated to each of the Doñana National Park (the property) and the Doñana Natural Park. The budget has remained generally stable over the past decade.^r The excellent cooperation of the Park with a variety of stakeholders, (expressed by stakeholders during mission), including through the Participation Council, is commendable and instrumental for the long-term conservation of the property.

3.2 Overview of the hydrology of the Doñana National Park^s

Water is the essential element that determines the characteristics of the Doñana ecosystem (García Novo & Marín Cabrera, 2006). The property lies on the right bank of the Guadalquivir River estuary and hosts a wide variety of ecotones of international importance (Williams *et al.*, 2001). At a broad scale there are two key wetland systems: the marshes of the alluvial plain of the Guadiamar River, to which other streams from the west contribute (MU/UM yellow in Fig. 1) and the ponds^t

^p<https://www.iucn.org/theme/protected-areas/our-work/iucn-green-list-protected-and-conserved-areas/iucn-green-list-areas>

^q<https://worldheritageoutlook.iucn.org/explore-sites/wdpaid/61611>

^rMemoria de actividades y resultados 2018. Espacio Natural Doñana.

<http://www.juntadeandalucia.es/medioambiente/site/portalweb/menuitem.7e1cf46ddf59bb227a9ebe205510e1ca/?vgnnextoid=b74590a683924510VgnVCM2000000624e50aRCRD&vgnnextchannel=a250ee9b421f4310VgnVCM2000000624e50aRCRD&rating=5>

^s More information about the process for developing this text and a full list of consulted references can be found in Annex V

^t In English, the word ‘lagoon’ usually refers to a shallow coastal lake connected to the sea (eg. The Venice lagoon), whilst ‘pond’ or ‘pool’ is more often used for small inland freshwater bodies, such as in dunes. The word ‘pond’ is used in most scientific papers on Doñana in English. In Spanish a ‘laguna’ may refer to several different types of wetlands including floodplain marshes or dune ponds. The mission therefore used ‘pond’ or specifically ‘dune pond’ in its own analysis for small water bodies in the coastal dunes of Doñana, except when citing previous documents (such as from IUCN or WHC) that use the term ‘lagoon’.

occupying depressions in the aeolian coastal dunes (EU/UE green in Fig. 1). The property is underlain by two aquifer zones: the unconfined aquifer in the sandy substrates of the dunes (EU/UE green) and the confined detritic aquifer^u (DU/UD and UA yellow) under the impermeable sediments of the marshes (MU/UM white/light grey) (Custodio, 1995, de Castro Ochoa & Muñoz-Reinoso, 1997; Manzano *et al.*, 2013)^v.

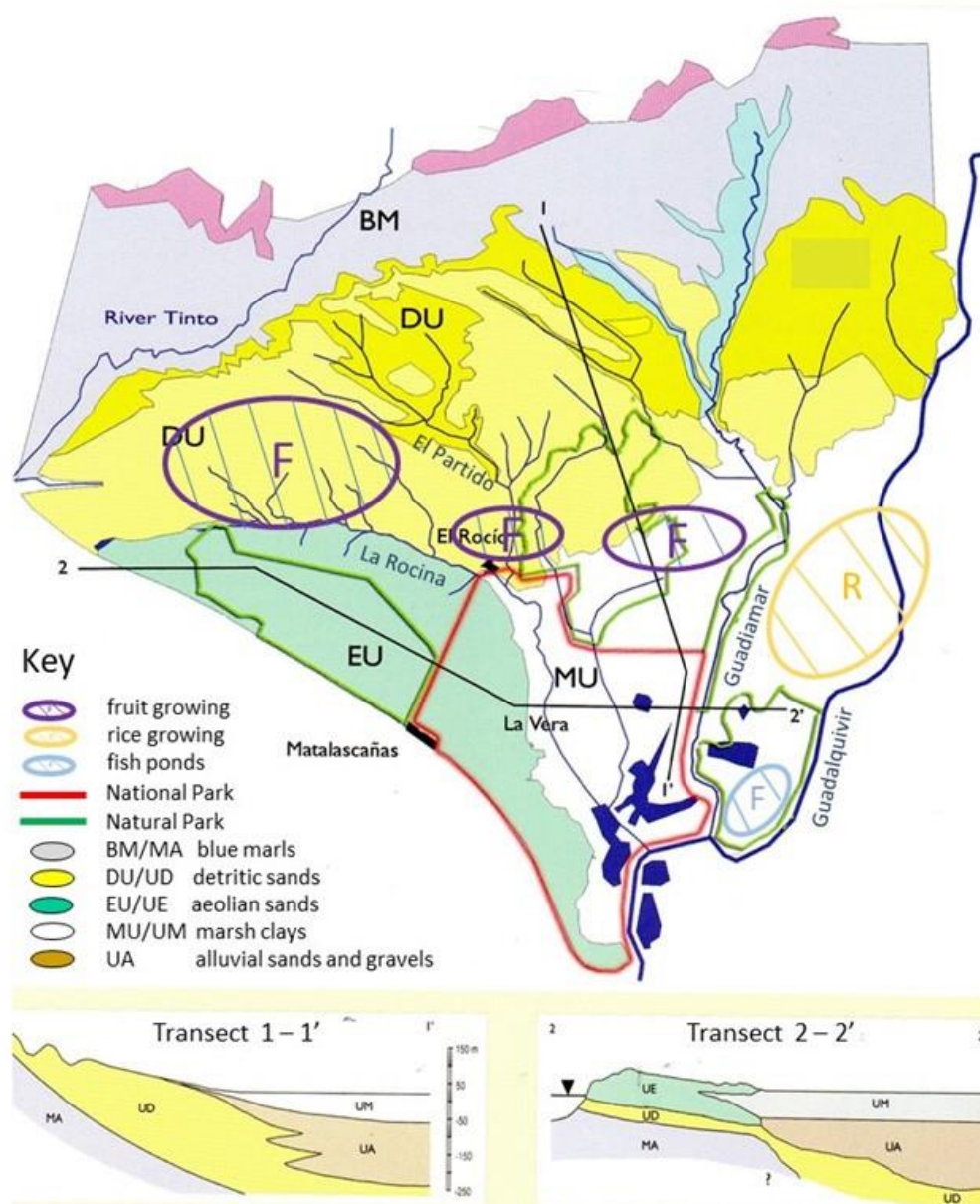


Figure 1. Map showing major rivers, surface geology, fruit and rice growing areas and fish ponds. Transects showing geological strata (after García Novo & Marín Cabrera, 2006). The World Heritage property is depicted by the red line (Doñana National Park). The Ramsar Site includes in addition the areas delineated with green lines (Natural Park).

^uA detritic aquifer is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials ('detritus' such as gravel, sand, or silt)

^vA confined aquifer is an aquifer below the land surface that is covered by impermeable material so that there is no movement of water between the aquifer and the surface where the covering exists.

Understanding of the structure and hydrological function of the aquifer units around Doñana is essential to defining any threats to the OUV of the property. Some past reports have referred to the “Doñana aquifer” (meaning the Almonte-Marismas detritic aquifer, cf. below). It is important to recognise the different aquifer units and their juxtapositions as shown in Fig. 1 and Fig. 2.

In 2016 the aquifers around Doñana were divided into five units to allow for more detailed analysis of what is in fact a complex geological “lasagna” of different aquifers and sub aquifers, each of which has different hydrological characteristics. The five units include the confined Almonte-Marismas detritic aquifer, which is composed of four underground water bodies: La Rocina, Almonte, Marismas, Marismas de Doñana (see Fig.2 and chapter 3.2.2), and the separate unconfined dune aquifer (Manto Eólico Litoral de Doñana) (see Fig. 2 and chapter 3.2.3).

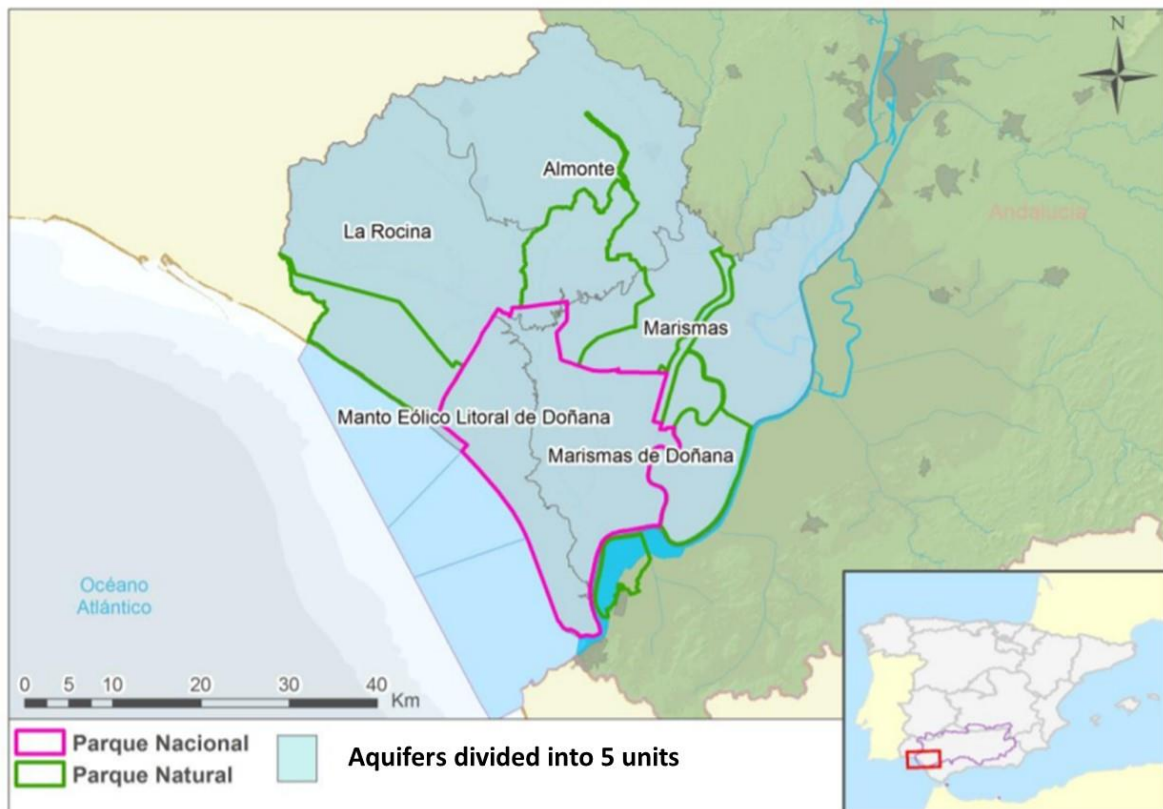


Figure 2. Map showing the five aquifer units (grey) associated with Doñana National Park (the property) (purple line) and Doñana Natural Park (Ramsar) (green line). Four underground water bodies make up the Almonte-Marismas detritic aquifer (La Rocina, Almonte, Marismas, Marismas de Doñana), the fifth unit is the unconfined dune aquifer (Manto Eólico Litoral de Doñana). After CHG, Draft Hydrological Plan 2021-2027

3.2.1 The marshes

The marshes (*marismas* in Spanish) are a key element of the OUV of the property. The government states that, in winter and spring, inundation of the marshes supports over 300 bird species, including a large number of aquatic birds that usually reach 500,000 individuals in the winter census. These include ducks and numerous shorebirds *e.g.* black-tailed godwits *Limosa limosa* (Kloskowski *et al.*, 2009). In summer, virtually the whole of this ecosystem dries out (Suso & Llamas, 1993). The permanently inundated aquaculture fishponds at Veta la Palma provide a vital refuge for waterbirds during the dry season (Kloskowski *et al.*, 2009, Walton *et al.*, 2015), usually not exceeding 200,000 birds. Flooded rice-growing areas provide an additional food source outside

of the protected areas (Toral *et al.*, 2012). Hydrological dynamics, including flood duration and connection between water bodies, largely determine the high biodiversity of the marshes, particularly invertebrate community structure (Alcorlo *et al.*, 2014) with 224 phytoplanktonic taxa (Reyes *et al.*, 2008) and biological processes, such as large seasonal and interannual production of the greenhouse gases CO₂, CH₄ and N₂O (Tortosa *et al.*, 2011). Climate change has resulted in northward shifts of overwintering areas for some birds, such as greylag goose *Anser anser* (Ramo, *et al.* 2015).

The marshes are an estuarine floodplain of Quaternary impermeable clay, which separates them hydrologically from underlying aquifers (hence the underlying aquifer is called 'confined'). The marshes depend predominantly on surface flows (Green *et al.*, 2017) and can be classified as a flood-pulse system (Junk *et al.*, 1989). Water levels and extent of inundation are determined by direct rainfall and, more importantly by high surface flows arriving rapidly after winter rainfall from the rivers upstream (Olías *et al.*, 2008). Figure 3 shows that the flooded area has fluctuated each year since 1984 in response to variations in winter rainfall, but there is no trend evident during this period.

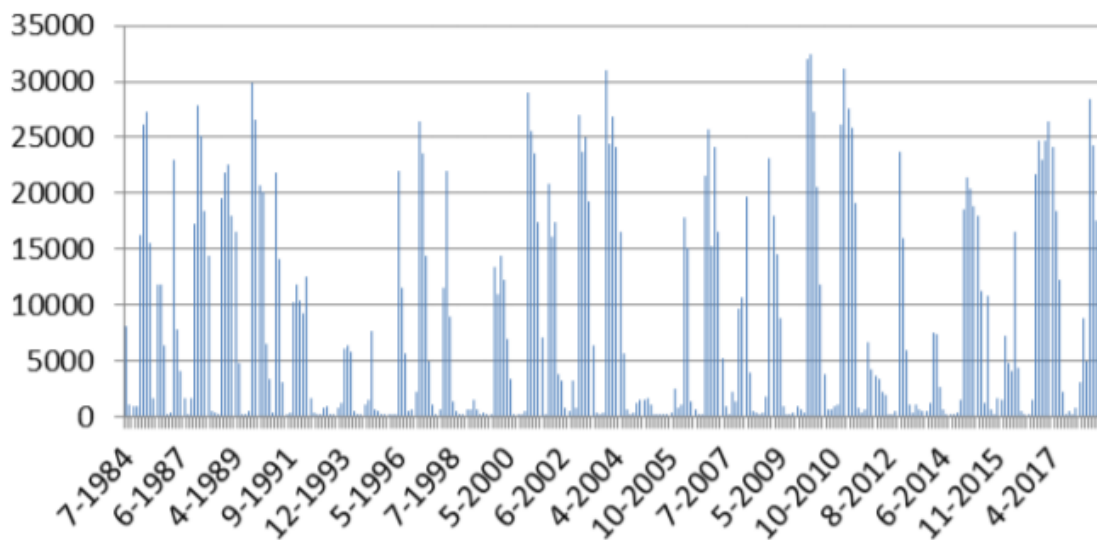


Figure 3: Total flooded surface area (ha) in the Doñana marshes from 1984 to 2018. Source: EBD-CSIC.

The maximum flooding in recent years was in February 2010 during which 97% of the marshland (34 200 ha) was covered by surface water (Huertas *et al.*, 2017). After direct rainfall, the principal water source is the Guadiamar River, an affluent of the Guadalquivir River (Kohfahl *et al.*, 2019a), the flow of which can often exceed 20 hm³ per month in winter, but this drops to around 0.1 hm³ per month in late summer. The government reports that, in the 1960s, prior to the designation of the National Park, the connection between the upper and mid reaches of Guadiamar basin and the marshes was severed by embankments and became non-functional, and water was diverted to an old oxbow lake (El "Brazo de La Torre") and then directly to the Guadalquivir river, bypassing the marshes, which were left with an effective basin of only 490 km². Water levels were kept high by the embankments (La "Montaña del Río"). This lasted 50 years and was partially reversed in 2015, when the Hydrographical Confederation of the Guadalquivir (CHG), as part of Doñana 2005 programme, opened several connections between the channel and the marshes in the property. This permits inundation of the marshes during normal floods (around 26 hm³ per month) which have increased flood habitat. The openings have also reconnected the marshes with high tides. These management actions have been important for restoring and incorporating into the property

an area of 2700 ha in 2004 that was previously arable land, when the marshes were hydrologically disconnected to prevent flooding (Díaz-Delgado *et al.*, 2016).

Historically (1942-1975), direct rainfall onto the property was around 315 hm³ per year^w - providing around 65% of the total water input^x - and annual stream flows from the Guadiamar River, which drains a catchment of 1185 km², has averaged 173 hm³ per year (Arambarri *et al.*, 1996) – providing about 35% of the total water input. According to data provided by the Guadalquivir Hydrographical Confederation (CHG) (Cifuentes Sánchez, *pers. comm*) flows in the Guadiamar River were lower between 1967 and 2017, with an average of 74 hm³ per year, and lower still from 1979 to 1991 due to lower rainfall (with droughts in 1989-1990 and 1991-1992).

Construction in 1977 of the Agrio dam (capacity 21 hm³) in the headwaters may have had a minor effect but, in the mission's view, could not have caused this recorded reduction. However, there are proposals to raise the dam by 10 m to provide an additional 20 hm³ of water storage for irrigation to offset groundwater abstraction. Any potential impact on flows in the Guadiamar, would first need to be assessed employing international best practice prior to any decisions being taken regarding dam expansion. Smaller quantities, around 12 hm³ per year, flow into the property from other streams, such as the La Rocina and El Partido streams. Climate projections for the Mediterranean region include an increased risk of drought and floods (IPCC, 2018), which would augment the extremes of inundation and drying in the marshes.

The southern extreme of the marshes, where the Guadiamar River joins the Guadalquivir estuary, can be inundated by brackish water at high tide. There is thus a gradient of fresh to brackish marshes from north to south. The interface between fresh and brackish water may migrate upstream if freshwater flows are reduced especially during very high tides and under west wind conditions (Arambarri *et al.*, 1996). In the late 1960s embankments were built to separate Doñana from the estuary, which reduced the area of marine flooding. Parts of the embankments were removed by the CHG in 2015, as part of the Doñana 2005 project which involved an investment of 110 million euros.

Summary: The hydrology and ecology of the marshes is dominated by winter flooding resulting from rainfall and surface flows from the Guadiamar River. The area of inundation varies naturally from year to year in response to rainfall and there has been no obvious major trend since 1984. The detritic aquifer is confined under clay strata and does not influence flooding of the marshes. Potential threats to sufficient inundation of the ecosystem come from increasing the size of the Agrio dam (a potential risk which would need to be first assessed through appropriate impact assessment processes) and climate change (though potentially increased storage could offset lower rainfall in some years). The potential ecological impact of raising the dam on the OUV needs to be assessed prior to any decision being taken regarding its possible expansion. The annual recording of the area and duration of marsh inundation from satellite images needs to continue.

3.2.2 The marshes and the Almonte-Marismas detritic aquifer (Doñana aquifer)

The marshes and surrounding inland area are underlain by the Almonte-Marismas detritic aquifer (or Doñana aquifer), composed of four underground water units as depicted in Figure 2: La Rocina, Almonte, Marismas, Marismas de Doñana. Importantly, the Manto Eólico Litoral de Doñana is a separate unit within the aeolian mantel (cf. below 3.2.3). The detritic aquifer is composed of alluvial and aeolian deltaic deposits from the Pliocene-Quaternary age (Salvany and Custodio, 1995), which

^w1 hm³ = 1 million m³

^xThis water budget calculation does not include inflows from small streams, such as the La Rocina and El Partido, whose contribution are relatively minor.

are highly heterogeneous in character with strata of sand, gravel and marl (Fig 1. DU/UD and UA yellow; Naranjo-Fernández *et al.*, 2019). Monthly recharge to the aquifer is between 21 and 91% of rainfall (Naranjo-Fernández *et al.*, 2020a). Water has been abstracted from the aquifer for agriculture, such as for growing strawberries (now covering 6000 ha in the western area), fruits, cotton, rice, and orchards (see Fig. 1). The area has been suffering a dry period since 2011, but even taking low rainfall into account some aquifer water levels are lower than during the great drought of the mid-1990s, though others are higher (Trick and Custodio, 1998; UPC, 1999; Lozano, 2004, Juárez *et al.*, 2012). This has given rise to fears that the water supply to Doñana, and hence its ecosystem, is at risk due to abstraction (WWF, 2019; WWF, 2020). The European Commission started to investigate the situation in 2009, and in 2014 it began procedures to sanction the Spanish Government due to the infringements in groundwater management in Doñana under the Water Framework Directive (WFD). CHG has recorded water levels in a very dense network of 292 piezometers with some data going back before 1974. Six types of hydrodynamic behaviour were obtained that depended on soil uses and hydrogeological characteristics (Naranjo-Fernández *et al.*, 2020b). In many piezometers, groundwater levels are consistent with rainfall, but in others levels were found to be low and declining (de Stefano *et al.*, 2015). In 2020 the CHG declared that three of the four groundwater bodies that share the aquifer to the north of the property – La Rocina, Almonte and Marismas - are at risk of failing to achieve Good Status (see 3.3.3.1 for details). Furthermore, climate change projections suggest significant reductions in recharge to the aquifer - 25-55% less for La Rocina and 43-68% less for Marismas (Guardiola-Albert & Jackson, 2011) - which could lead to reduced groundwater levels in the future and cause additional negative impacts.

Whilst groundwater level data show a decline in some parts of the detritic aquifer, the mission team did not find any published evidence on direct links between this aquifer and the marshes. The detritic aquifer outcrops in the north but inclines to the south beneath the marshes (Suso & Llamas, 1993, cf. Fig. 1). The marshes are formed of plastic clays of very low permeability (Salvany *et al.*, 2011) up to 100 m thick (Suso & Llamas, 1993). It has been speculated that some groundwater could up-well directly onto the marshes through the clay (Manzano *et al.*, 2013), but the mission considers that this is extremely unlikely and no evidence has been put forward that this actually occurs; indeed the aquifer is defined in publications as ‘confined’. The Guadiamar River, which feeds the marshes, runs in its upper reaches over impermeable slate materials. In its middle reaches the river runs over the detritic aquifer and along its left bank there is a contribution to flow from groundwater, measured at about 30 l s^{-1} (IGME, undated). This flow is insignificant (< 1%) in winter and spring when Guadiamar flows are on average $3500\text{-}6700 \text{ l s}^{-1}$, which controls flooding of the marshes. The maximum contribution detritic groundwater can make to Guadiamar flows is about 25% in late summer, assuming the groundwater flow is at 30 l s^{-1} and river flow is at its lowest (on average 126 l s^{-1}) in September. However, at this time the marshes are normally already dry.

In most groundwater-fed systems, the presence of an aquifer dampens and delays the response of river flow to rainfall, reducing peaks but sustaining flows later in the year. This is because of the time taken for rainwater to percolate through to the aquifer and then to the river (Chiverton *et al.*, 2015). Hence, groundwater-fed streams in the property probably have their highest discharge some months after the winter flood-pulse (July-September). The area of Doñana marsh inundation varies from year to year broadly according to winter rainfall. As noted above, river flow depletion due to groundwater abstraction is likely to manifest itself only in summer when it could hasten drying, however, no evidence of this effect was found.

Some groundwater discharges as springs along the contact between the clays of the marshes and the sand dunes producing important ecotones, particularly groundwater-fed phreatophyte forests (Manzano, *pers comm*). These temporarily saturated marshy areas, called La Vera, support hygrophilic meadows, cork oaks and ferns which provide nesting habitat for many birds. CHG’s draft hydrological plan indicates that a localised water table depression (of around 10m) to the east of El

Rocio has degraded parts of the north ecotone, which is situated partly inside and partly outside the property, but no published scientific reports about any ecological impacts of this water table depression on the OUV were found by the mission team to substantiate this. The ecotone west, located completely within the property, is unimpacted; here the water table has remained constant over the past 40 years and the closure of the Mimbrales Estate ensures that a similar water table depression is unlikely to form. Assessment of impacts on the OUV of the property itself should include behaviour of species using both the north ecotone outside the property and habitats within the property, since these species could be negatively affected by degradation outside the property. No reports of such behaviour were found by the mission team. Additionally, degradation of the north ecotone due to groundwater abstraction could be seen as an indicator of potential implications of high groundwater use for other similar systems.

Some small rivers that flow into the marshes, such as the La Rocina and El Partido, are mainly fed by rainfall but are also partially fed by the detritic aquifer. Flow in these rivers can provide water for large fauna during the long dry summers. Water flowing in the La Rocina River feeds the El Rocio floodplain marshes. Recorded flows in the La Rocina River declined during 1970-1974 probably resulting from local groundwater abstraction (Yagüe and Llamas, 1984) and forest encroachment. The latter impact may have been more important as there was some recovery of the aquifer in 1996-7 due partly to removal of eucalyptus trees in the main recharge area (Manzano, 2002). Generally, La Rocina flows were lower post 2004 than pre 2004 in times of similar low rainfall conditions, possibly due to lower groundwater levels in the detritic aquifer. However, no reports of negative ecological impacts were found. Furthermore, satellite images show that the extent of flooding of the El Rocio floodplain marsh has not been reduced (Diaz-Delgado *et al.*, 2016), suggesting that lowering of flows has not depleted the marshes. A possible explanation is that the creation of a depositional fan of sandy sediments from El Partido tributary stream has dammed the surface inflow waters isolating the El Rocio marshes and producing a compensatory area of inundation (García-Novo *et al.*, 2007).

Summary: In recent years, there has been great concern that groundwater abstraction from the detritic aquifer has altered inundation of the marshes in winter and spring. However, the mission team did not find published scientific evidence to unequivocally support this assertion. There have been variations in inundation extent since 1984, but no clear trend is evident. Abstraction may have the potential to reduce water flows to the marshes in summer, however given that the marshes are usually dry at this time, further research is required to assess the level of risk this creates to the marshes and the OUV of the property. The groundwater-fed ecotones on the margins of the marshes are theoretically at risk because they are the sole ecotones that directly depend on groundwater from the detritic aquifers that are heavily exploited upstream. The north ecotone, which lies partially within the property, has reportedly suffered from a groundwater level reduction of 10m, though this needs to be substantiated. In contrast, the west ecotone (which corresponds with La Vera, an iconic ecosystem between the marshes and the sand dunes that is a key component of the OUV) within the property has not been impacted as the water level has remained fairly constant for 40 years.

Whilst there is a lack of evidence of significant interactions between the detritic aquifer and the marshes, hydrological independence has not been proven and would be difficult to demonstrate. Hence their relationship - and the potential impact of aquifer condition on the OUV of the property - remains somewhat uncertain. It is therefore essential that further research is undertaken to clarify the wider eco-hydrological dynamics of Doñana and its natural water supplies (evaporation, rainfall, river flows, groundwaters). The mission team considers that this level of scientific uncertainty is unacceptable for an iconic World Heritage site such as the Doñana National Park. In light of this scientific uncertainty, and the fact that aquifers associated with the wider Doñana ecosystem remain below Good Status, it is recommended the State Party continues its conservation efforts to

address threats of alterations to the eco-hydrological system in the vicinity of the property. This would entail protecting the marshes and the groundwater-fed ecotones by closing wells and/or reducing abstraction to a sustainable level; this is already being actioned to comply with the WFD (see 3.3.3.2 below), so the threat is being addressed. It is also noted that the recovery of the detritic aquifer may take many decades due to long residence times. Climate change may become a bigger risk in the future. Further studies of rainfall, recharge and links between the detritic aquifer, stream flow, ecotones and marshes are essential to developing management strategies that mitigate climate change effects on the property and guarantee optimal conditions for groundwater resources in the future (Naranjo-Fernández *et al.* 2020c). This needs to be completed before the new Spanish Water Resources Management Plans (2021–2027) are finalised (Naranjo-Fernández *et al.* 2020b).

3.2.3 The dunes

The area between the marshes and the sea is a large aeolian mantel (the Doñana-El Abalario Litoral Aeolian Mantel, or Manto Eólico Litoral de Doñana in Fig. 2), within which there are active and inactive coastal dune systems. The aeolian sands (Fig. 1 EU/UE) are 20-25 m thick, underlain by alluvial and litoral sands (30 – 60 m thick) and these overlay the detritic aquifer (Salvany and Custodio, 1995). Parts of the dune became fixed following pine afforestation in the mid-eighteenth century, which supported ponds that appeared around the year 1550 when conditions became wetter (Manzano *et al.* 2019). The dune pools are rich in wildlife (Williams *et al.*, 2001, Blanco *et al.*, 2013). More than 124 taxa of macroinvertebrates (Díaz-Paniagua *et al.*, 2010) and at least 55 hydrophytes species have been recorded, plus several endemic zooplankton species. Eight of the 11 amphibian species of this area require temporary ponds for breeding. Some bird species such as Marbled Teal are known to breed in the pools, although they predominantly prefer the marshes (CMAOT, 2018). Numerous microbes, such as *Acidobacteria* that breakdown organic matter (Zimmermann *et al.*, 2012) are important components of the system. Natural inundation and drying of the dune ponds are crucial to support this biodiversity (Florencio *et al.*, 2020), such as zooplankton (Serrano & Fahd, 2005). Most of the dune ponds are temporary and are fed from direct rainfall and groundwater. In permanent ponds, such as Santa Olalla, around 20% of the total water inflows to the dune ponds comes from rainfall and 80% (Fernández-Ayuso *et al.*, 2018) from the Quaternary aeolian sand aquifer in the dunes (Sacks *et al.* 1992). The aquifer is recharged by local winter rainfall (Molano-Leno *et al.*, 2018) with 64% finding its way into the aquifer (Kohfahl *et al.*, 2019b), but rainfall has decreased generally in recent years. The aeolian aquifer sits on top of the detritic aquifer, but there is no evidence of connection between the two, with the possible exception of minor interaction near Charco del Toro.

Abstraction of water to supply the town of Matalascañas (especially in the summer when 90,000 tourists arrive) comes from a set of seven wells up to 150 m deep, taking water from both the aeolian dune aquifer and the much deeper underlying detritic aquifer. These wells have a maximum extraction limit of 2.75 hm³ per year. Some near-by dune ponds, such as Charco del Toro, appear to have been affected by the pumping (Manzano *et al.* 2005), with changes in their hydroperiods (Bustamante *et al.*, 2016) i.e. drying-out faster and for longer and more often than in the past and with an increased dependency on direct rainfall, putting wetland habitats at risk (Díaz-Paniagua & Aragonés, 2015). This trend does not coincide with a decreasing trend in rainfall and the greatest changes in hydroperiod have been reported in the ponds located near, <1 km, to the pumping area and least in the ponds at a further distance, around 5.6 km (Serrano & Serrano, 1996; Dimitriou *et al.*, 2017). Some dune ponds appear now to be recharging the aquifer by downward percolation of water rather than being supported by it through upward aquifer discharge (Cifuentes Sánchez, *pers. comm*). In other ponds, such as Santa Olalla, no resulting damage has been identified (Fernández-Ayuso *et al.*, 2019). Non-native forests planted in the dunes have high evaporative demand and the current action of replacing them with native vegetation should help raise water-table levels (Trick

& Custodio, 2004). Lowering of the aquifer has changed the acidity of some ponds, which can affect amphibian breeding (Serrano *et al.*, 2016) changing the relative abundance of major solutes in shallow groundwater around some wetlands (e.g., Charco del Toro), which could impact vegetation and microorganism (Manzano, *pers comm*), and has negatively impacted woody vegetation (Antunes *et al.*, 2018) although pine tree mortality has also been linked to the droughts of 1979–83 (Muñoz-Reinoso & Castro, 2005).

To address environmental concerns regarding water abstraction, plans have been put forward to close wells nearer the impacted ponds and to transfer water from Huelva for public supply. This should remedy the impact of pumping on dune ponds currently affected, but levels may take several decades to recover. New investigations are required to measure if the re-location of wells is sufficient for the recovery of pond's water level regimes. Temperature increases and the expansion in the dunes of pine trees (that use more water than short vegetation) over recent decades may have contributed to changes in some ponds. In contrast the past hydroperiod of other ponds has persisted. Future climate change is likely to reduce rainfall and lower aquifer recharge rates, thus altering pond hydroperiods.

Summary: The dune aquifer is separate from the detritic aquifer with little evidence of interactions. The dune pond ecosystems, which are dependent on the dune aquifer, located near pumped wells have experienced alteration and remain at risk. This should be remedied in the short term by the planned closures or relocation of these wells, but climate change may become a bigger risk in the future. Further studies are required to increase knowledge of links between the aeolian aquifer, the dune ponds and their ecosystem. Monitoring of the groundwater response to vegetation management and closing wells is required.

3.3 Positive or negative developments in the conservation of the property since the last report to the Committee

3.3.1 Hydrological dynamics and water management

It is clear that parts of the Almonte-Marismas detritic aquifer are seriously depleted due to overexploitation of water as fully recognised by CHG. It is also clear that the area of inundation of the marshes and some dune ponds have been low in some recent years, as specified in scientific papers. However, as specified in more detail in chapter 3.2, available evidence is that the hydrological connection between the detritic aquifer and either the winter inundation of the marshes or natural variations in the dune ponds is at best very minor and not sufficiently strong for detritic aquifer abstraction to have caused these alterations. Changes in marsh hydroperiod have been caused predominantly by variations in rainfall; whilst changes in pond hydroperiod are caused by variations in rainfall and local abstraction from the dune aquifer. Further research is required to assess the level of risk of abstraction on water flows to the marshes in summer. To confirm, or update, the mission's understanding of the hydrological relationship between the detritic aquifer and the marshes - and hence the OUV of the property, it is essential that further research is undertaken to clarify the wider eco-hydrological dynamics of Doñana and its natural water supplies (evaporation, rainfall, river flows, groundwaters).

Marsh inundation depends primarily on flood-pulse flows in the Guadiamar River, which are driven predominantly by winter rainfall. The detritic aquifer may play a secondary role in sustaining flows from the La Rocina, El Partido and some other small rivers that provide water to the marshes in the summer. This could lead to premature drying that may negatively impact the marshes, however evidence to support this hypothesis was lacking. Other changes including the geomorphology of the marshes may have mitigated this effect. This lack of clear understanding demonstrates the urgent need for further research. Meanwhile, adopting a precautionary management approach would

entail reducing abstraction from the detritic aquifer to sustainable levels to protect the OUV of the property, which is consistent with actions already underway (see 3.3.3.2 below).

The groundwater-fed ecotones along the margin of the marshes are potentially at risk because they are dependent on groundwater discharging from the detritic aquifer, according to current scientific understanding. The north ecotone has reportedly been degraded by water abstraction. Whilst this ecotone is both within and outside of the property, it may affect the attributes that constitute the OUV, though this has not been reported.^y In addition, the response of the north ecotone may provide an indicator of what may happen to similar systems within the property. The west ecotone is part of the OUV but not impacted and water table levels have been constant for 40 years. Recovery of the detritic aquifer should result in restoration of the north ecotone.

The hydroperiod of the dune ponds is determined predominantly by the aeolian sand aquifer in the dunes, which is recharged by rainfall. Some dune ponds have been significantly affected by lowering of groundwater levels in the aeolian aquifer due to changes in rainfall and to pumping for public water supply to Matalascañas. Well relocation projects within the dune aquifer are being drafted to address this problem. The mission considers that since there is no evidence of a general strong connection between the sand aquifer and the detritic aquifer, the latter does not have a significant role in determining pond hydrology.

Overall, the evidence, to date, does not support the view that the Doñana National Park is at high risk from abstraction from the detritic aquifer, but uncertainty in knowledge of ecohydrological processes, particularly the interaction between aquifers underlying the National Park and its surroundings (including the Natural Park) and with rivers and their floodplains means that a low risk remains. Consistent with a precautionary management approach, the mission team considers it key that:

- 1) To eliminate all possible hydrological risks to the OUV of the property, the detritic aquifer needs to recover to Good Status^z and local declines in the aeolian aquifer need to be reversed by stopping all illegal pumping, allowing only sustainable pumping, relocating wells and bringing surface water from neighbouring rivers (as a last resort). All actions should be completed as soon as possible. However, full recovery of the aquifers may take several decades due to legal constraints and long residence times in the groundwater system, so the risk may remain in place for some time.
- 2) A reorientation of research or review of available data to fully understand the hydrological dynamics of the property and its surroundings in relation to OUV (or reference ecosystems outside the property that can act as an indicator of those within). A greater risk comes from current variations in rainfall and likely future changes in climate with projected higher temperatures, lower and more variable rainfall and elevated sea levels that may reduce river flows and recharge to aquifers.

3.3.2 European Union Water Framework Directive

^yProperties convey their OUV through certain attributes. Attributes include the physical elements of the property, and may include the relationships between physical elements, essence, meaning, and at times related processes, that need to be protected and managed in order to sustain OUV. The Statement of OUV needs to make reference to the attributes of the property that are important in conveying OUV. <https://www.iucn.org/sites/dev/files/import/downloads/whouven.pdf>

^zGood Ecological Status (GES) is the WFD default objective for all water bodies and is defined as a slight variation from undisturbed conditions.

As a European Union Member State, the State Party is required to reach good qualitative and quantitative status for all its water bodies, both surface and groundwater, according to the European Water Framework Directive (hereafter referred to as “WFD”). The three hydrological planning cycles for the Guadalquivir River Basin (2009-2015, 2016-2021, 2022-2027) are developed in the framework of the WFD.

In 2016, the European Commission distributed a reasoned opinion in which it urged the State Party to step up nature protection in the Doñana area.^{aa} In 2019, the European Commission referred Spain to the Court of Justice of the EU over a failure to take adequate measures to protect the groundwater bodies that feed the Doñana Wetlands, as required by the WFD.^{bb} The European Commission’s 2019 decision was due to a “sharp decline in groundwater levels which has made the water-dependent habitats in Natura 2000 sites extremely vulnerable to the area's periodic dry periods.”^{cc} The 2nd Hydrological Plan (2016-2021) also acknowledges the negative trend of riparian biodiversity due to aquifer overexploitation in the zone ‘ES6150009 - Doñana Norte y Oeste’.

However, the Natura 2000 sites are slightly more extensive than both the Doñana National Park and Doñana Natural Park, and the zone ‘ES6150009 - Doñana Norte y Oeste’ is located outside of the World Heritage property and Ramsar Site.^{dd} The reported impacts of groundwater abstraction on the groundwater-fed ecotones (zone ‘ES6150009- Doñana Norte y Oeste’ and the small wet ecotone to the east of El Rocio) concern specific riparian ecosystems whose decline may provide an indicator of how ecosystems within the property may respond and species may require use of habitats in both systems. However, the reported negative trends in biodiversity in Natura 2000 sites also need to be considered in the context of potential impacts on the OUV of the property. This would require a comparison of the detailed Natura 2000 habitats with the description of the OUV and its attributes. For example, habitat type 9330, *Quercus suber* forests (cork oak) might be of particular importance in view of evaluating the state of conservation of the property.

In December 2020, the Advocate General of the Court of Justice of the EU stated that “the excessive abstraction of groundwater in the Andalusian Doñana natural area infringes EU law.”^{ee} Concerning the infringement of the Habitats Directive, the issue at heart is a lack of scientific understanding of the effects of groundwater abstraction on the protected areas concerned, as highlighted also in this report. This again indicates the urgent need for research on relationships between biodiversity, OUV and the supporting hydrological environment. Since the area of application of both the World Heritage property, Ramsar Site and Natura 2000 sites are all different; and because of the lack of scientific evidence that the OUV of the Doñana National Park is at high risk from abstraction from the detritic aquifer, the mission team considers the legal protection regime provided by the WFD, based on a functional water catchment approach should help to develop unified policies for the World Heritage property (National Park), Ramsar Site (National and Natural Park) and EU Natura 2000 site, with slightly different administrative procedures.

The legal implications of the WFD and the substantial efforts that the State Party will have to undertake to achieve Good Status of the detritic aquifers should further reduce any possible hydrological risk to Doñana of abstraction from its underlying aquifers, but this will require sustained actions over many decades. The mission team therefore underlines the importance of achieving Good Status of the detritic aquifer by 2027.

^{aa}https://ec.europa.eu/commission/presscorner/detail/EN/MEMO_16_1452

^{bb}https://ec.europa.eu/commission/presscorner/detail/en/IP_19_466

^{cc}https://ec.europa.eu/commission/presscorner/detail/en/IP_19_466

^{dd}<https://natura2000.eea.europa.eu/>

^{ee}<https://curia.europa.eu/jcms/upload/docs/application/pdf/2020-12/cp200152en.pdf>

3.3.3 Groundwater abstraction in the Almonte-Marismas aquifer (Doñana aquifer)

To comply with the WFD, abstraction from the Almonte-Marismas detritic aquifer is being reduced as part of a CHG plan (Berbel *et al.*, 2012) that combines five measures:

- 1) Stopping illegal abstraction
- 2) Reducing the area of groundwater-irrigated land
- 3) Adjusting legal abstraction during dry periods
- 4) Enhancing control with water agents, telecontrol of water meters and remote sensing of land use, and
- 5) Providing surface water from dams (*e.g.* Agrio in the Guadimar) and other catchments (such as the Guadiana River) for irrigation to replace groundwater.

The first four measures are regulated through the Special Management Plan of the Irrigation Zones located to the North of the Forest Crown of Doñana^{ff} (sometimes also called the Strawberry Plan or Special Irrigation Plan, hereafter referred to as “the Plan”). The 15-year Plan was approved in 2014 and aims to combine economic development (especially agriculture and tourism) with the protection of the exceptional natural values of Doñana and the rational use of water. It foresees 57 million euros of expenses. The Plan covers an area of about 9,000 ha of farmland (about 14 percent of the total surface area covered by the Plan), of which about 6,000 ha are located in the Guadalquivir basin. The Plan foresees, among others, in annual water extraction limits for certain water bodies (based on the condition of the aquifer) at large and proportional individual water irrigation quota based on water rights, as specified in annually adjustable Extraction Plans.^{gg} From 2014 to 2020, the CHG has processed numerous cases to regularize almost all lands covered by the Plan. For example, in July 2020, about 500 wells representing 6.4hm³ for 1,414 ha were regularized, making these henceforth subject to the Extraction Plan and remotely controlled water meters operated by the CHG. The finalization of the regularization is a big step forward, because the CHG now finally has the ability to adjust water abstraction limits during dry periods for virtually all the wells in the area subject to the Plan. It also means that data on the extraction of water from the aquifer is more centralized. The mission considers the continued and urgent implementation of the Plan in its current form essential to eliminate any potential risk to the OUV, as soon as possible and at the latest by 2027 in accordance with the requirements of the WFD.

Wells and farmland not included under the Plan are considered illegal, and no additional lands can be converted to farmland.^{hh} Some sources have estimated that there are more than 1,000 unauthorized wells, 1,700 suspicious irrigation ponds, and 3,000 hectares of illegal farms.ⁱⁱ Authorities are tracking illegal wells and farms through remote sensing and field inspections, after which illegal wells are closed. Closing the first wells involved a 7-year practical, administrative and legal process. Since 2015, almost 500 wells have been closed, and the process is still ongoing. Authorities also sanctioned the illegal conversion of 375 ha of forest area to farmland. While the slow process in closing all illegal wells and farmland is regrettable, it is also acknowledged that legal proceedings can take some years to come to conclusion. The mission considers the continued and urgent closure of all illegal wells and farmland essential to eliminate any potential risk to the OUV at the latest by 2027.

^{ff}Plan Especial de Ordenación de las Zonas de Regadío ubicadas al norte de la Corona Forestal de Doñana (PEOCFD)

^{gg}Plan de Extracciones

^{hh}So-called ‘Non-SAP’ Suelos Agrícolas Regables

ⁱⁱ<https://wwf.panda.org/?286470/Spains-warrants-UNESCO-in-danger-listing>

The mission had the opportunity to visit a strawberry farm which has received several awards and certificates for its organic production methods. Through the use of sensors and probes, the farm was able to determine at what moment in the day strawberry plants typically absorb water, allowing for a targeted drip irrigation system which leads to a substantial reduction in water use. The farm also uses biodegradable plastic to cover its fruit products. The mission commends these type of sustainable agriculture practices and recommends that all farmers in the Doñana area are encouraged and incentivized to adopt such practices.

The substitution of groundwater by surface water from dams (*e.g.* Agrío in the Guadiamar) and other catchments (such as the Guadiana River) for irrigation is an essential component of the governments' plan to restore the aquifers to Good Status. Some 5 hm³ per year have already been provided to offset groundwater abstraction and an additional 19,99 hm³ per year (originating from the Tinto-Odiel-Piedras basin) was approved in 2018. The latter will necessitate new infrastructure (pipelines and dams), which comes at a considerable cost. The raising of the Agrío dam, thereby increasing the capacity from the current 40 hm³ to 60 hm³ is considered essential for achieving Good Status, however the mission notes that no EIA has been made available yet for evaluation. The mission considers that surface water transferred from other catchments with impounded rivers (such as the Guadiana River) could provide a substitute for groundwater, if it is directed to those areas most in need, but the water may be of a different quality and the additional water abstraction may produce negative effects in the source catchment. Both these potential solutions need to be carefully managed and considered in the context of any possible impacts on the OUV of the property as per the *Operational Guidelines* of the World Heritage Convention, including through EIAs, or a wider SEA, as required.

In conjunction with the Plan, the authorities have several other tools and hydrological planning instruments at their disposal to remove pressures on the detritic aquifers. In the past, thousands of hectares of introduced eucalyptus -a ferocious water consumer- have been removed to restore the original ecosystem. The mission was informed that to date a significant percentage of the planted eucalyptus trees have been removed.

In July 2020 the CHG declared that three of the five water bodies in Doñana (La Rocina, Almonte and Marismas, cf. Figure 2) are "at risk of not reaching good status", acknowledging their overexploitation.^{jj} This declaration has the legal consequence that it obliges the development of an action plan for the recovery of the underground water bodies, the development of the Extraction Plan which aims to improve the condition of the water bodies, and the creation of communities of groundwater users who will have to decide jointly with the CHG on both plans. The annually adjustable Extraction Plans will have to be adapted based on meteorological conditions and piezometric data.

Authorities can also purchase farms, thereby recovering the associated water extraction rights. For example in 2015, the government bought the Mimbrales farm (one of the region's largest farms covering almost 1,000 ha and the only farm directly adjacent to the property) for 50 million euros, thereby recovering 6.8 hm³.

The mission team had an opportunity to review the draft Hydrological Plan for the period 2021-2027 (ie. the chapter specifically concerning the property), which was available online and open for comments from January until July 2020.^{kk} The draft Hydrological Plan includes a specific chapter on

^{jj}<https://www.chguadalquivir.es/-/tres-de-las-cinco-masas-de-agua-del-entorno-de-Doñana-declaradas-en-riesgo-de-no-alcanzar-el-buen-estado-cuantitativo->

^{kk}<https://www.chguadalquivir.es/demarcacion-hidrografica-guadalquivir>

Doñana and the property. It also proposes a trend scenario and two scenarios to achieve Good Status of the Doñana aquifer, which would come at a cost ranging from 100 to 500 million euros.

The mission team felt reassured by the commitment of the various authorities involved and proposed actions to achieve Good Status by 2027. The current goal of the CHG is to recover the level prior to 2000, before the last agricultural expansion. The mission team appreciates that the legal and administrative procedures for closing wells and monitoring legal and illegal well abstraction mean that achieving sustainable abstraction levels by 2027 will be challenging. However, the longer it takes the higher the likelihood is of environment damage. Hence, it is recommended that the State Party provides any necessary support to speed-up implementation. Achievement of Good Status is in the interests of abstractors as it ensures protection of future water resources in the aquifer. The WFD also requires that aquifer levels are sufficient to maintain surface waters and ecosystems dependent on groundwater. Thus, recovery of the detritic aquifers to Good Status should further reduce any potential hydrological risk to Doñana of abstraction from its underlying aquifers, but this will require sustained actions over many decades.

Recommendation 1

To eliminate any possible risk to the OUV of the marshes and groundwater-fed ecotones derived from groundwater extraction from the detritic aquifer (Almonte-Marismas or Doñana aquifer), and given the crucial role of the CHG in achieving Good Status of the aquifer by 2027, consistent with a precautionary management approach, the mission recommends to:

- increase the resources available to the CHG, including recent technologies, to strengthen monitoring, surveillance and enforcement to ensure the accelerated and urgent closure of all illegal wells and illegally irrigated farmland;
- continue the urgent implementation of the Special Management Plan of the Irrigation Zones located to the North of the Forest Crown of Doñana, in its current form, in close cooperation with all key stakeholders, to ensure the recovery of the aquifers to Good Status as soon as possible, and by no later than 2027;
- ensure that any substitution of groundwater by surface water is directed to those areas most in need, and that any substitution is carefully managed and considered in the context of any possible impacts on the OUV of the property as per the *Operational Guidelines* of the World Heritage Convention, including through EIAs, as required.
- ensure that projects including water transfers, dam extensions, and licenced groundwater abstraction have no impact on the OUV of the property, by undertaking appropriate EIAs and SEAs in line with the IUCN World Heritage Advice Note on Environmental Assessment¹¹.
- encourage, incentivise and provide financial support if needed for the adoption of sustainable agriculture practices (especially concerning drip irrigation and reduction in use of single-use plastics) by farmers of the Doñana area.

Recommendation 2

To eliminate any possible risk to the OUV in the coastal dunes, consistent with a precautionary management approach, the mission recommends relocating as soon as possible, and within three years, the most eastern wells that provide water for the Matalascañas tourist resort (well 9 and 10), as already proposed in the draft Hydrological Plan 2021-2027.

3.3.4 Water quality

¹¹IUCN World Heritage advice note on Environmental Assessment (November 2013) <https://www.iucn.org/theme/world-heritage/resources/iucn-policies-world-heritage/environmental-assessment>

The quality of water feeding the property is generally good, but there are signs of pollution from agriculture, nitrate fertilizers and pesticides (Paredes *et al.*, 2020). The La Rocina groundwater body is the only one that has been declared as at risk of not achieving good water quality status by CHG because of some high nitrate readings. At the Soto Grande wetland the most probable polluting mechanism is leaching by local rainfall of agricultural nitrate fertilizer N from the sediments of the Soto's alluvial fan over several decades (Manzano *et al.*, 2016). There is an increasing risk from untreated domestic wastewater entering the system containing pharmaceuticals such as ibuprofen, naproxen, salicylic acid, propranolol, caffeine and gemfibrozil (Camacho-Muñoz *et al.*, 2010). This might be augmented by importing water with different quality characteristics from other river basins (Mediavilla, *pers comm*). Imported water comes from the Andevalo-Chanzadams, whose basin is sparsely populated and not intensively cultivated, so its quality is good. In agricultural or urban zones, nitrates and sulphates are present in the upper layers of the detritic aquifer (Olías *et al.*, 2008) as are naturally occurring radio nuclides (Bolívar *et al.*, 2008).

The aeolian aquifer is considered to be in Good Status by CHG, with nitrate levels at 5.6 mg/l. which is well below the threat threshold of 25 mg/l.

Recommendation12

Further studies are required to determine the level of threat from pollutants or water of different quality imported to the system from other river basins. This includes both historical determinands such as nutrients from agricultural fertilizers and new pollutants such as pharmaceuticals. Evidence is required on impacts of ecological functioning, threshold levels of pollutants and how they might accumulate through the food chain.

3.3.5 Strategic Environmental Assessment of the Guadalquivir River Basin

In its 2019 state of conservation report, the State Party informed the Committee that “A Strategic Environmental Assessment (SEA) of the Guadalquivir river basin will be conducted for the next Hydrological Planning Cycle under the European Union Water Framework Directive. The consultation and public information period for the third cycle of the hydrological planning process (2021-2027) started in October 2018. The new Hydrological Plan for this cycle will incorporate a specific chapter on the Outstanding Universal Value (OUV) of the property.” No additional information was provided during the mission since the new Hydrological Plan was still being drafted, but the State Party assured again that the new Hydrological Plan will include a specific chapter on the OUV in the SEA.

Recommendation6

Noting that the mission did not receive any additional information on a Strategic Environmental Assessment (SEA) of the Guadalquivir river basin, it recalls the 2017 Committee Decision as follows^{mm}: “Requests furthermore, the State Party to present an updated SEA for the Guadalquivir River Basin to ensure that it includes a specific chapter on the OUV of the property, and submit it to the World Heritage Centre.”

3.3.6 Dredging to deepen the Guadalquivir River

In 2013 the Committee considered the possible deepening dredging of the Guadalquivir estuary as a possible trigger for inscription on the List of World Heritage in Danger. A key recommendation from the 2015 Reactive Monitoring Mission was to make a permanent and unequivocal commitment to abandon plans for the deepening of the Guadalquivir River. In 2016 and 2017, the State Party informed the Committee it had abandoned the deep dredging project of the

^{mm}<http://whc.unesco.org/en/soc/3556>

Guadalquivir River. During the mission it was confirmed that the project has not been authorized or executed, and that a reference to any deep dredging will be removed from the new Guadalquivir Basin Hydrological Plan (2021-2027). As the new Guadalquivir Basin Hydrological Plan is not yet available, the State Party should be requested to ensure this commitment is implemented.

Recommendation 7

Because the State Party's commitment to abandon the deep dredging project of the Guadalquivir River cannot be considered 'permanent' or 'unequivocal' whilst a reference to any deep dredging remains in the new Guadalquivir Basin Hydrological Plan, the mission team recommends that the State Party continues honouring its previously made commitments and removes this project from the revised Guadalquivir Basin Hydrological Plan (2021-2027).

3.3.7 Current and future development projects

3.3.7.1 Mining and gas storage projects

The following extractive development projects were discussed during the mission: Aznalcóllar mine, Marismas Occidental, Marismas Oriental, Aznalcázar gas storage, and the Saladillo Project. No new information was submitted by the State Party and no field visits to the actual sites took place.

Aznalcóllar mine

The mine has been a divisive topic ever since the environmental disaster in 1998, when the burst of the Los Frailes holding pool resulted in an ecological disaster downstream. Although the main toxic flow was diverted away from the property, the property was indirectly affected. Although the property is located 60 km downstream of the mine location, about 5 hm³ of degraded sludge and water from the Agrio and Guadiamar Rivers which was contaminated with heavy metals eventually reached the property (flowing through the Ramsar Site) (Giró *et al.*, 2002). Whilst the mine has the potential to provide increased jobs in a region with high unemployment, the potential environmental risk of further accidents, as well as the substantial water use required by mining operations in an area where aquifers are already negatively impacted, must be carefully considered. In February 2018 an application for a Unified Environmental Authorisation (Autorización Ambiental Unificada) was submitted for approval by the regional government.ⁿⁿ In its 2019 state of conservation report to the Committee, submitted to the World Heritage Centre in November 2018, the State Party shared the project's EIA for the Los Frailes mining project and indicated that the IUCN World Heritage Advice Note on Environmental Assessment was expected to be incorporated. In response, the Committee urged the State Party to prepare a clear risk preparedness plan and rapid emergency response capacities and to submit these analyses for review by IUCN, as soon as they become available and before a decision on re-opening the mine is made.^{oo}

The former mine area currently includes two former mining pits which are filled with water: the Aznalcóllar mining pit and the Los Frailes mining pit. The project under evaluation involves the reopening of the latter and would involve three phases as outlined in the EIA:

- 1) 14-21 months to empty the water currently in the Los Frailes mining pit which contains relatively few mineral contaminants (contrary to the Aznalcóllar mining pit), such as for example Zinc (13.8 mg/l), Nitrates (3 mg/l), Fluoride (1.2 mg/l) and Aluminium (0.10 mg/l). The almost 15hm³ of water would, after treatment, be diverted to the Agrio river;
- 2) 3 years to construct the underground mine galleries;

ⁿⁿDevelopment projects usually require two approval phases: approval of an EIA by the Federal Ministry for Environment, followed by a Unified Environmental Authorisation (Autorización Ambiental Unificada) by the regional government.

^{oo}<http://whc.unesco.org/en/soc/3909>

- 3) 17 years of exploitation, with an annual amount of 0.75 hm³ of water which would be diverted to the Agrio river (removal of water which infiltrates in the mine).

The EIA considers two ways in which the project could potentially impact the property. In terms of hydrology, there is a risk posed by the continuous flow of treated wastewater from the mine which would eventually find its way to the marshes and Guadalquivir River, both during the construction and exploitation phase. The risk is given the lowest value on the risk scale because of the small amounts of continuous inflow, its dilution, unperceivable chemical alteration of the water because only treated water is released in the Agrio River, and because of the continuous monitoring of the quantity and quality of the discharge (regulated by various Spanish environmental and regulatory mechanisms). Secondly, during the exploitation phase, the EIA also considers the risk of atmospheric contamination (CO, PM, NO).^{pp} This risk is also given the lowest value on the risk scale because any air leaving the plant is filtered. How much water would have to be extracted annually (either from groundwater abstraction or from the Agrio dam) during the exploitation phase is unclear. In terms of habitat, the EIA identifies a potential impact because of the ecological corridor just next to the mine area which links to the Guadiamar River, the floodplain of which was recently restored thanks to substantial investments through the Corredor Verde del Guadiamar project, and which eventually links to the possible dispersal territory of the Iberian lynx as recognized by the regional plan for the recovery of the Iberian lynx. Overall, the risk on the OUV of the property according to the EIA would appear low in terms of habitat destruction inside the property, but the mission team considers the risk of habitat destruction of the recently restored floodplain (and lynx dispersal corridor) inside the Ramsar Site (Nature Park) to be high.^{qq}

The project is currently still in the evaluation phase. During the mission no additional information was provided regarding the risk preparedness plans, the mission therefore recommends to recall the latest Committee decision.

Gas storage projects

The region of Doñana is one of the few areas in Southern Spain which would be geologically suited for gas storage, and it has been subsequently designated as a strategic gas storage location by the State Party. In 2005, the decision was made to re-use existing depleted gas deposits as gas storage facilities. Four former gas extraction and potential gas storage projects located 3 to 25km from the property have since then been considered: Marismas Occidental, Marismas Oriental, Aznalcázar, and Saladillo (see Fig. 4). The four projects combined would involve 14 extraction points linked together by a 70-km network of tubes to transport the gas, most of which already exists. Five new drilling holes were foreseen, of which three are located in the Natural Park. All drilling holes and tubes are located outside the property. Of the four projects, two have been subject to an Environmental Impact Statement and one is currently in operation, Marismas Occidental.^{rr} For the other two which are partially located in the Natural Park adjacent to the World Heritage property, authorization has been requested and denied for Marismas Oriental, while for Saladillo no application has been made yet for final authorisation. The Marismas Oriental project received a negative Unified Environmental Authorisation (i.e. did not receive approval) from the Junta de Andalucía in 2016, on the grounds that the proposed project was incompatible with the regulations specified in the Natural Resources Management Plan (*Plan de Ordenación de los Recursos Naturales* in Spanish), which applies to the Natural Park. In January 2020 media reported that the High Court of Justice of Andalucía (*Tribunal Superior de Justicia de Andalucía* in Spanish) dismissed the appeal

^{pp}CO (carbon monoxide), NO (nitrogen monoxide), PM (particulate matter).

^{qq}See also <https://www.ramsar.org/document/ramsar-advisory-mission-report-51-spain-2002>

^{rr}https://www.boe.es/diario_boe/txt.php?id=BOE-A-2010-15005 and https://www.boe.es/diario_boe/txt.php?id=BOE-A-2016-2626

of the energy company against the 2016 decision from the Junta de Andalucía.⁵⁵ Since the two boreholes of the Saladillo project are also located within the Natural Park, it could be expected that the same logic will be followed and that this project would also be denied on the same grounds for which Marismas Oriental was not approved. It remains to be seen if the gas storage project will remain operational if two or three of the four sub-projects do not proceed, thereby reducing its financial profitability.

Proyecto de gas en Doñana



Figure 4. Overview of the four gas storage projects and their current status. Source: EL PAÍS, 14 January 2020. The two drilling holes currently operational (Marismas-3 and Rincon-2) are encircled.

With regards to Marismas Occidental which is operational since 2016, no new information was provided during the mission and no impacts on the OUV of the property have been reported to the mission team. As mentioned in the 2010 EIA, most impacts were expected to take place during the construction phase and drilling of the two boreholes (Marismas-3 and Rincon-2), which took place in 2016. The EIA considered several impacts including fragmentation of the property's upstream habitats, as well as surface and groundwater flows but rated them all as of low concern and proposed several mitigation measures. The mission would like to underline that every EIA identifies impacts, but that there is only reason for concern if those impacts are rated as important, or considered to be significant, and if proposed mitigation measures are not sufficient to mitigate the impacts. The risk of fragmentation of the property's upstream habitats refers to a temporary risk because of the construction of a ditch of max 0.80m wide and installation of a 5km underground pipeline to connect Marsimas-3 with Rincon-2. During construction phase (digging of the trench and placing the pipeline) the affected area is 10m wide because of the equipment materiel, ditch and moved soil. A proposed mitigation measure was that an animal expert verifies the ditches before the pipe is placed and helps to release animals that might have been trapped in the ditches. Once the pipeline is installed, the ditches are filled. The EIA specified that the area is already highly impacted by human alterations (in fact almost the entire affected area is under agricultural exploitation) and that the animals living there are rather generalist species associated with degraded lands. Increased acoustic and light disturbances would be mitigated by avoiding construction during breeding season and using special lights to limit light pollution. The impact on

⁵⁵https://elpais.com/sociedad/2020/01/14/actualidad/1578999733_420786.html Accessed 12 August 2020

surface water flows refers to the increased turbidity of surface waters as a result of the digging of the ditch and installation of the pipeline. To mitigate this risk, the works on the crossing of the Laguna de los Reyes stream should be executed during the dry season, after the necessary permits had been granted. An important consideration regarding impacts during the operation phase is that gas extraction requires water and generates wastewater. The wastewater generated by this project is collected in an evaporation basin.

The mission team notes the lack of documentation of the exploitation of the gas storage projects. On a general note, although the drilling is targeted at geological layers below the detritic aquifer, there is potential for seismic activities and accidents related to such projects to produce gas intrusions into associated aquifers. The mission recommends the authorities to provide further information on how such risks are evaluated and can be avoided, monitored and remediated, should seismic fractions appear or accidents occur despite the precautionary measures and monitoring put in place, as recommended by the CHG in the EIA.

Cumulative impacts

Concerns have been raised by NGOs that the cumulative impacts of the four separate gas storage projects are not adequately assessed. While gas extraction has happened in the vicinity of the Doñana National Park since the 1980s, no negative impacts on the OUV of the property have been reported so far. However, the drilling of new bore holes and plans to store gas rather than extract gas could involve a risk of increased seismic activity, as indicated by two reports released in 2017 by the Ministry of Economy, Industry and Competition.^{tt} Geologists also pointed out that no real evaluation of the risk of increased seismic activity had been carried out, and that the gas extraction of Marismas Occidental should have been halted until such an evaluation has been conducted. It is important that any potential risks and risk avoidance methods, as well as responses in case of potential gas intrusions into relevant aquifers for the property are adequately considered, to avoid negative changes on the OUV of the property.

Recommendation 8

Noting that the mission did not receive any additional information on the status of the potential reopening of the Aznalcóllar mine, it recalls the 2019 Committee Decision^{uu}: “Further recalling the need for great caution with regards to re-opening the former Aznalcóllar mine, and urges the State Party to ensure that systematic risk preparedness and emergency action plans take into account the property and to submit these analyses for review by IUCN, as soon as they become available and before a decision on re-opening the mine is made”.

Recommendation 9

Noting that the mission did not receive any additional information on the status of the gas storage projects, consistent with a precautionary management approach the mission recommends that systematic monitoring of the possible impacts and risk assessments of Rincon-2 and Marismas-3 on the hydrology and OUV is put in place, and that a summary of those findings is included in future state of conservation reports. The mission also recommends for the State Party to ensure that the individual and cumulative impacts on the property’s OUV of any development or infrastructure project in or near the property are thoroughly assessed in conformity with IUCN’s World Heritage Advice Note on Environmental Assessment.

^{tt}<https://www.publico.es/ciencias/Doñana-csic-pide-gobierno-detener-gasoducto-Doñana-riesgo-sismico.html>

<http://www.juntadeandalucia.es/presidencia/portavoz/medioambienteobsoleto/131109/junta/inicia/acciones/legales/paralizar/proyecto/almacenamiento/gas/Doñana>

^{uu}<http://whc.unesco.org/en/soc/3909>

3.3.8 Research activities

It is the occurrence of wet, saturated or inundated conditions, either permanently or temporarily, that makes wetlands function differently than terrestrial or fully aquatic habitats. The hydrological regime of the Doñana National Park is crucial in determining the ecological features and processes that define the OUV and ecological character of the property. In return, ecological changes such as the removal of eucalyptus trees and expansion of pines, can change the hydrological cycle. Alterations to the hydrological regime may also result from impoundment of rivers and groundwater abstraction for irrigated agriculture and public supply or changes to the climate. The WFD requires that aquifer levels are sufficient to maintain ecosystems dependent on groundwater. Recent research has expanded knowledge of the links between hydrology and ecology, but further work is essential to underpin sound management of the property for the future. More research should also be targeted to the La Vera ecotone as this is a key ecosystem from the point of view of OUV which is largely fed by groundwater.

Hydrology research topics which should be prioritized from the point of view of the OUV include:

- Clarify the linkages between the aeolian aquifer, the dune ponds and their ecosystem to understand better the difference between human and natural pressures.
- Monitor the groundwater response to the reduction of vegetation density and closure of the most easterly wells that supply Matalascañas.
- Clarify the degree of hydrological interaction between marshes, ponds, rivers and aquifers to better understand summer conditions, when the groundwater-fed streams have their highest discharge.
- Increase understanding of the links between surface and groundwaters and the marsh, ponds and ecotone ecosystems (with particular focus to the La Vera ecotone) that can underpin future management of the property.
- Study the potential ecological impact of raising the Agrio dam on the OUV (*e.g.* reduced waterflow which could impact the hydroperiod).
- Continue to record the area and duration of marsh inundation annually from satellite images.
- Calculate the water requirements of the property to maintain its OUV, and the potential deterioration of the ecosystem that would result from not meeting these needs. For biological reasons (bird nesting, fish spawning), this will also have to take into account minimum water levels requested during specific parts of the year and a modelling of such annual fluctuations. Also calculate the sources of water (direct rainfall, surface water, groundwater), how these meet the water requirements naturally and what effect changes to water supply (caused by abstraction, climate change or habitat management) could have on the ecosystem. This could start from the already existing water table for the Doñana Natural Space, which estimates the annual recharge at 250 hm³ per year (of which almost 100 hm³ is abstracted through drilling).
- Increase studies of rainfall, recharge and links between the detritic aquifer, stream flow, ecotones and marshes. These are essential to develop management strategies that mitigate climate change effects on the property and guarantee optimal conditions for groundwater resources in the future.
- Construct an eco-hydrological model of the property based on the results of the research above which would allow the impacts of various scenarios to be defined, including abstraction of groundwater, removal of trees, building of dams and climate change. Such a model could underpin environmental assessments. This analysis should also provide conclusions about iconic species for which ample data is available, such as specific waterbird species depending on flooded marshes for breeding, wintering or stop-over on

migration, and mammals depending on ecotone habitats (and their vegetation and food resources) that in turn depend on sufficient water levels.

This research would provide a tool to underpin environmental assessments by providing knowledge of the hydrological interaction between marshes, dune ponds, rivers and aquifers. These studies will also help to understand in how far the human water footprint surrounding the property needs to be reduced to increase the resilience of the property in light of climate change, or if climate change by itself will have deteriorating impacts on the OUV which require substantial investments to avoid a deterioration or loss of certain values.

It would also be useful to undertake an economic value study of the property which could provide the Park with data to demonstrate the added value of a well-preserved protected area to the local economy and wellbeing of local communities.

The above research questions may be addressed at least partially by re-analysis of past scientific results or data-mining, without the need for substantial new research because there is already a substantial amount of scientific data and monitoring available for the property.

The property has a wide range of stakeholders (including Park authorities, local government, NGOs and scientists) with, in some cases, different perspectives and perceptions. This has led to disagreements over the status, trends and possible futures of the ecosystems in and around the property. It is anticipated that closer agreement on the issues and solutions could be achieved by holding a scientifically based meeting of all stakeholders to present, share and discuss available knowledge of the property.

Recommendation 3

Although there is a basic understanding of the hydrology of the region, some uncertainty remains concerning possible impacts of water use in the vicinity of the property. Consequently, an increased research effort is urgently required to understand the relationship between the hydrology and ecology of the area, as this is essential to underpin sound management. The mission therefore recommends that future research should include a focus on defining the water requirements of the property to maintain its OUV. This necessitates quantification of relationships between the ecological features that define the OUV and hydrological components (*e.g.* rainfall, evaporation, river flows and groundwater levels). Construction of an eco-hydrological model of the World Heritage property based on the results of the research, and consideration of the possible need of a buffer zone, including the surrounding catchment basin (covering the Ramsar Site and EU Natura 2000 area), would allow the impacts of various scenarios to be defined, including abstraction of groundwater, removal of trees, building of dams and climate change. The model should incorporate appropriate indicators linking the hydrology to the ecological response of the property. A detailed list of recommended research topics can be found in the mission report (Chapter 3.3.8).

Recommendation 11

The mission notes that varying perspectives regarding the status of the ecosystems of the property and Doñana Natural Space exist. It therefore recommends that actions are taken to ensure the availability of current scientific data to inform decision making, and to organise regular meetings of all stakeholders to present, share and discuss scientific knowledge and different perceptions of the eco-hydrological status, trends and possible futures in and around the property. This could result in closer agreement on the issues and solutions.

3.3.9 Climate Change

The European Environment Agency has stated that countries of the Mediterranean have experienced decreased precipitation and increased temperature over past decades and this trend is projected to worsen. Projections from the Spanish Meteorological Agency show that under various AR5-IPCC RCP emission scenarios the amount of rain in the Guadalquivir Basin could decrease by ten to twenty percent by 2100.^{wv} Evapotranspiration rates could decrease by ten to thirty percent, on an annual basis, by 2100.^{ww} Recent research suggests that a decline in species, such as zooplankton, has been related to long-term reduction of wet period length of temporary freshwater ponds within the Doñana National Park. Species of shrews, mice and rats have been declining with increasing temperatures and lighter rainfall. Diving birds and vegetation gleaners are likely to decline in future climate scenarios, while many small wading birds will benefit from changing conditions. Resident species and those that breed in this wetland may be more negatively impacted than those using this area for wintering or stopover.

The sixth recommendation from the 2015 Reactive Monitoring Mission focused on the potential impacts from climate change on the OUV of the property and the need to define adaptation and mitigation measures required to maintain the conditions of integrity of the property, particularly in the processes associated with the long-term hydrological regime of the property.

While the importance of assessing climate change impacts was underlined on several occasions during the mission, an assessment of the potential impacts from climate change on the OUV of the property and a suite of adaptation and mitigation measures was not provided. Climate change is also the only threat for which the risk is considered high for all seven conservation priorities of the Doñana Natural Space, as specified in its 2016 Management Plan. The mission considers that it would be worthwhile to prepare a long-term plan, in a similar fashion as for example Australia has done for the Great Barrier Reef with its Reef 2050 Plan, which includes a resilience assessment and reflects on how climate change might impact the OUV in coming decades.

It is to be noted that climate change impacts on rainfall are the main threat for the hydrological balance of the marshes upon which the ornithological values of the property so much depend. Climate change also risks changing the behaviour of migratory birds. In this way, species such as the white stork or the black stork (in danger of local extinction) are showing a shortening of their migratory trips, settling during wintering in increasingly northern areas in temperate latitudes to reach winter optimum in areas closer to their breeding areas. Increased temperature and evaporation, coupled with reduced groundwater-fed ecotones could perhaps also increase the likelihood of fires. In 2017 a major fire destroyed 10,300 ha of forest just outside the property in the Natural Park, in an area considered a key habitat for the Iberian lynx.^{xx yy}

The mission team was informed about the national programme to closely monitor global change in the Spanish National Parks.^{zz} Unfortunately, Doñana is not yet part of this programme, but has the potential to be included and provide indicators for its particular types of wetland ecosystems that are not covered by other coastal National Parks participating in the programme. Also, it might be

^{wv}http://www.aemet.es/es/serviciosclimaticos/cambio_climat/result_graficos?w=0&opc1=guar&opc2=P&opc3=Anual&opc4=0&opc6=0

^{ww}http://www.aemet.es/es/serviciosclimaticos/cambio_climat/result_graficos?w=2&opc1=guar&opc2=Ev&opc4=0&opc6=0&opc3=Anual

^{xx}<https://www.sciencedirect.com/science/article/abs/pii/S0048969719317711>

^{yy}<https://andaluciainformacion.es/huelva/939098/donana-afronta-en-2021-un-ano-clave-para-la-restauracion-tras-el-fuego-de-2017/>

^{zz}https://www.miteco.gob.es/es/red-parques-nacionales/red-seguimiento/observar-cambio-global_tcm30-442805.pdf

helpful to include Doñana as a specific case study to illustrate concrete adaptation and mitigation measures for the regional climate change strategy of the government of Andalucía.^{aaa}

Recommendation 4

Taking into account the likely possible impacts from climate change on the values of the property, the mission recommends the creation of a strategic plan that defines conceptually:

- The extent to which a reduction in water consumption is required in response to climate change impacts to conserve and protect the OUV of the property (in case further studies would reveal close linkages between the detritic aquifers and the OUV);
- The extent to which alterations to the OUV and ecological character of the wetland ecosystem due to climate change can be expected, along with any adaptation and mitigation measures that can be implemented to maintain the conditions of integrity of the property and increase its resilience.

3.3.10 Stakeholder participation

The Doñana National Park can only be effectively managed when all stakeholders are involved in a participatory and inclusive manner. While the mission team had seen disturbing news articles on local protests that prevented the local authorities from closing illegal wells in 2019, the statements from all interviewed persons were encouraging in that nobody questioned for example the necessity to close all illegal wells. Excellent collaboration between the Park and the different entities and stakeholders was highlighted throughout the mission. The Participation Council of the Doñana Natural Space^{bbb}, in which all stakeholders are represented, plays an important role in bringing different views together, which is commendable.

Participation and education of young people is key to continue encouraging and enabling tomorrow's decision-makers to participate in the conservation of the property. The mission team would like to highlight the opportunities of the region's natural heritage and related ecosystem services for job creation and for providing young people with opportunities to build a future in Doñana. The mission recommends that local schools explore the option to join the UNESCO Associated Schools (ASPNet) so they can benefit from already existing tools on sustainable development and World Heritage.

Recommendation 14

Participation and education of young people is key to continue encouraging and enabling the future stewards of the property and Doñana Natural Space, and the mission therefore recommends to expand the educational activities in schools near the property, including by exploring to join the UNESCO Associated Schools (ASPNet), to continue involving the youth of Doñana and strengthen education activities on sustainable development and the OUV of the Park.

3.3.11 International cooperation

The World Heritage Convention is founded on the premise of international cooperation. Managers and staff from different World Heritage sites have confronted every imaginable conservation challenge and have developed leading-edge solutions. Sharing knowledge and lessons learned among World Heritage properties with similar ecosystems can therefore avoid repetition and

^{aaa}<http://www.juntadeandalucia.es/medioambiente/site/porta/web/menuitem.7e1cf46ddf59bb227a9ebe205510e1ca/?vgnnextoid=ef1cbc2b0ec34010VgnVCM1000000624e50aRCRD&vgnnextchannel=6efa659a15255310VgnVCM1000001325e50aRCRD>

^{bbb}<https://www.juntadeandalucia.es/organismos/agriculturaganaderiapescaydesarrollosostenible/consejeria/organos-colegiados/62199.html>

facilitate the exchange of best practices. International cooperation is particularly relevant for the Doñana National Park because its ecosystem is intimately connected with other parts of the world. The thousands of birds that winter in Doñana also spend some part of their life in other World Heritage properties, Biosphere Reserves, Ramsar Sites, and protected areas. International cooperation under the banner of World Heritage thus provides several interesting opportunities, from joint bird monitoring campaigns to cultural diplomacy.

Recommendation 15

To promote a culture of peace through intercultural dialogue, and increase management effectiveness through the exchange of conservation best practices (especially in the field of bird monitoring and building resilience of wetlands in the face of climate change), the mission recommends the State Party to strengthen international cooperation with other World Heritage and Ramsar sites (*e.g.* Danube Delta, Everglades National Park, Wadden Sea, Banc d'Arguin National Park), Biosphere Reserves and Ramsar Sites (Carmargue/Delta du Rhone), and protected areas in general whose ecosystem is linked with, or very similar to the Doñana National Park, especially on the East Atlantic Flyway.

3.3.12 Marine extension

The 2011 Reactive Monitoring Mission recommended to establish a large Marine Protected Area (MPA) adjacent to the Doñana National Park and to consider the possibility to expand the World Heritage property with a marine component. It was also noted that the coastal zone of the Doñana National Park has a very high number of marine species and valuable ecosystem and a marine extension could be beneficial for the property and enhance its protection.

While the mission team did not have the objective to look into specific marine issues, as an MPA has not yet been established, it is recommended to reiterate the recommendation already made in 2011.

Recommendation 13

Recalling recommendation 11 of the 2011 Reactive Monitoring Mission, recommends the State Party prepare a consolidated proposal for the establishment of a Marine Protected Area (MPA) adjacent to the property, which also considers the potential OUV of the marine ecosystem and possibility to extend the existing property to include this MPA.

3.3.13 Indicators to monitor the state of conservation

A property's OUV is the justification for its inscription on the World Heritage List and should also be the basis for ongoing site management and monitoring. For many natural World Heritage properties that are already protected areas, this will entail an additional layer of planning and management activity focused solely on the OUV.

What complicates a thorough analysis of the OUV of the Doñana National Park is that the property is one of the few sites inscribed on the World Heritage List before 2007 which does not yet have a retrospective Statement of OUV (rSOUV) (see Chapter 1.2). This means that the OUV that was agreed by the Committee at the time of inscription has not been articulated in an agreed format.

Because the OUV is the ultimate benchmark against which any decision by the Committee should be taken, the mission recommends that the State Party finalize the rSOUV as soon as possible, in consultation with IUCN. This exercise might have to take into consideration that the ecological importance of certain attributes of OUV, such as distribution of key species, might have changed since the time of inscription in 1994. For example, although at the time of nomination the property

was a refuge for the Iberian lynx, its habitat has increasingly extended and currently seems to lie more beyond the property than in the property (see Fig. 5). There might currently also be more information available on the ecological linkages between the property and the protected areas surrounding the property (Natural Park, Natura 2000 site) than there was at the time of inscription.

There is also no agreed set of key indicators to monitor the state of conservation of the OUV. This is only required to be included in the template for Nomination Dossiers from 2005 onwards, while the property was inscribed on the World Heritage List in 1994. While the Doñana Natural Space has plentiful data and a set of indicators, concerning OUV the situation is less clearly articulated. For this reason, it is advisable to agree on a set of indicators to clearly monitor the state of conservation of the OUV of the property.

In addition, because the human water footprint surrounding the property is expected to remain high, and given that water availability is likely to decrease due to future climate change, a thorough monitoring of the OUV will become even more important in the future. The values and management of Doñana will continue to be looked at under a magnifying glass by several national and international entities. The area is also subject to several monitoring mechanisms that come with its multiple designations (UNESCO World Heritage Convention, Ramsar Convention, Biosphere Reserve, Natura 2000, Bern Convention, National Park, Natural Park, etc.).

The mission therefore recommends the development of a clear set of fixed indicators to monitor the state of conservation of the OUV in the coming decades. This would greatly facilitate the State Party's different reporting obligations and should be relatively easy to compile given that many datasets are already available. Progress on these indicators should be reported to the Committee through the state of conservation monitoring process.

There is also a need to report differently on the hydrology context because the mission considers that the condition of water levels in the detritic aquifer, used previously, is, on its own, not the best indicator of potential danger to the OUV. An appropriate indicator is required that links the hydrology to the ecological response. A distinction should be made between the depletion of the detritic aquifer affecting the Doñana Natural area -mainly the Natural Park and Ramsar Site, and the dune aquifer affecting directly the National Park, Ramsar Site and property.

The mission notes that the conservation status of the Doñana Natural Space is evaluated every six years by the CCMA (*Consejería Competente en materia de Medio Ambiente* in Spanish). The last evaluation was done in 2016 and the next one is foreseen for 2022. For example, the 2016 Management Plan includes a summary table of the seven conservation objectives, their indicators, initial value, targeted value, and source of information. Objective 5 "Maintain or restore the favourable conservation status of waterbirds" has as indicator "Conservation status of waterbirds", starts from a favourable/unfavourable value, aims to reach a favourable value, which will be verified by the CCMA. This evaluation does not provide sufficient detail to monitor the OUV, for which specific indicators should be determined and monitored.

The mission suggests the below key indicators, which might need to be updated once the rSOUV is finalized and for which the current condition, desired condition and source of verification should be determined.

Integrity indicators

- Pluviometric analysis (annual precipitation, historic comparison)
- Piezometric trends of the 14 water bodies (one map with the respective graphs and trends)
- Depth of water table map of the Doñana area

- Water balance table or simple eco-hydrological model that shows how much water enters the system (by direct rainfall or from rivers or aquifer discharge) and leaves the system naturally (such as outflow to the sea) and which is extracted for human use.

Rationale: Water is the essential element that determines the characteristics of the Doñana ecosystem.

Ecological indicators

- Conservation status of the different ecotones of the property (to be determined how many of the 36 habitat types of European importance found in the Doñana Natural Space are relevant for the OUV)
- Concentrations and distribution of nutrients in waterbird ecosystems (marshes and ponds)
- Concentrations and distribution of salinity in the marshes
- Water quality of the marshes
- Hydroperiod of the marshes and ponds
- Abundance, diversity and distribution of waterbirds, including those that are threatened
- Abundance and distribution of wintering waterfowl
- Abundance and distribution of Imperial eagle
- Abundance and distribution of Iberian lynx

Rationale: it is generally accepted that the property's OUV is determined primarily by the high diversity of habitats, the marshes unaltered by agriculture or development, the high diversity of avifauna, breeding populations of threatened species, a critical stopover habitat and wintering site for migratory birds.

Management effectiveness indicators

- Catchment-wide support for the conservation of the OUV of the property
- Delivery of necessary financial resources

Rationale: the conservation of the property can only be ensured in the long-term if the pressures emanating outside the property are carefully managed.

Recommendation 5

To facilitate the effective reporting and analysis of the state of conservation of the property's OUV in the coming decades, the mission recommends:

- The State Party finalize the rSOUV as soon as possible, in consultation with IUCN;
- The State Party develop a clear set of fixed indicators to monitor the state of conservation of the OUV through an integrated catchment-wide management approach that allows for the identification, monitoring and management of threats within and beyond the boundaries of the property, and to report on those indicators in future state of conservation reports;

3.3.14 Buffer zone

The Operational Guidelines for the Implementation of the World Heritage Convention specify that "Wherever necessary for the proper protection of the property, an adequate buffer zone should be provided."^{ccc} For the Doñana National Park it is clear that what happens outside of the property may also have an impact on the OUV, especially concerning migratory species or groundwater-dependent ecosystems. The mission team notes that while the property currently has no official

^{ccc}whc.unesco.org/en/guidelines/ Art. 103

World Heritage buffer zone, the surrounding Natural Park (and Ramsar site) and Biosphere Reserve might de facto already serve as a buffer zone. Both the National Park (the property) and Natural Park are also already managed by the same management entity (the Doñana Natural Space).

However, important attributes of the OUV seem to be located outside of the property. The Iberian lynx is increasingly found outside of the property thanks to the State Party's conservation efforts (see Fig. 5). Several species of waterfowl are regularly observed outside of the property, both resident and migratory bird species, for example in the Natura 2000 zone 'ES6150009 - Doñana Norte y Oeste'.^{ddd} The Veta la Palma fish farm, a permanent artificially inundated island outside the property but subject to the environmental regulations of the Natural Park, likely provides the largest habitat for waterbirds during dry periods. The State Party also proposed a visit to this area during the mission, underlining its importance. So while areas such as the Doñana Norte y Oeste may be located outside of the World Heritage property and Ramsar site, they seem to be important secondary areas for the resident and migratory waterbird populations, which underpin the OUV of the property and therefore the degradation of these areas could impact the OUV of the property. A buffer zone could also increase the resilience of a sensitive ecosystem in light of anticipated climate change impacts and other external development pressures.

Recommendation 10

To maintain the integrity of the property, and consistent with a precautionary management approach, the mission recommends to establish an official World Heritage buffer zone around the property that includes the Natural Park (Ramsar Site), Natura 2000 sites and other established protected areas in the immediate water catchment of the property, which underpin the OUV of the property.

4. ASSESSMENT OF THE STATE OF CONSERVATION OF THE PROPERTY

4.1 Assessment of the values, on the basis of which the property was inscribed on the World Heritage List, and associated conditions of integrity

The property was inscribed on the World Heritage List for criteria (vii), (ix), and (x). A thorough assessment of the OUV is hindered by the lack of a detailed description of OUV for the property (see Chapters 1.2 and 3.3.11).

Criterion vii

In terms of exceptional beauty, solitude and unspoilt nature, the mission team observed first-hand that the flat expanses of wilderness containing diverse habitats such as marshes, forests, dunes and ponds are intact. However, some ponds near the Matalascañas settlement, such as Charco del Toro, have seen a change in hydroperiod, notably drying-out faster and for longer and more often than in the past and with an increased dependency on direct rainfall, putting wetland habitats at risk. There are two possible causes for these changes that may have acted in combination: variations in rainfall and pumping of the dune aquifer for local water supply. The planned relocation of two water pumps (see recommendation 2) is expected to remove any potential human-induced impact that has contributed to alteration to the hydroperiod of the dune ponds. While any potential impact of groundwater abstraction in the detritic aquifer on the OUV is likely to be seen first in the 'La Vera' groundwater-fed ecotone, there is currently a paucity of evidence of a negative ecological impact. The purchase of the Las Mimbrales estate, thereby recovering 7hm³ of water rights, was timely as it might have been the biggest potential threat to the La Vera ecotone. To the east of El Rocio lies a small wet ecotone 'Ecotone norte' similar to La Vera but without the characteristic oak trees

^{ddd}[N2K ES6150009 dataforms \(europa.eu\)](https://natura2000.ec.europa.eu/)

‘pajareras’ and dune association. This groundwater-fed ecotone has likely been impacted already by groundwater abstraction outside the property because it is just next to a known depression of the water table and the water table in some parts of that ecotone have decreased by 10 meters since the 1970s. This may negatively impact the OUV if certain attributes depend on the north ecotone, though no such impact has been reported. In addition, it may provide an indicator of response of this type of system to lowered groundwater levels.

Criterion ix

In terms of ongoing ecological and biological processes, the marshes, mainly fed by surface water, have fluctuated naturally from year to year in their extent (see Figure 3) but there is no evidence of a long-term decline. The restoration project Doñana 2005, restoring the original flow of water from Guadamar River to an old distributary of the Guadalquivir delta, thereby restoring water balance for the eastern part of the marshes, is commendable (cf. Ramsar Advisory Mission in 2002). The signature of Doñana 2005 in hydroperiod data is expected to be more clearly visible in future data (see more information in chapter 3.2). It is to be noted that the Doñana marshes as inscribed on the World Heritage List are a relict of an ecosystem which used to be far more extensive until human activities (irrigation, dams, dikes) altered most of the Guadalquivir River marshes. The mobile dunes are also still intact.

Criterion x

Regarding criterion x (habitats for in-situ conservation including threatened species), the property is still a safe haven for numerous plant and animal species, including fish, amphibians, reptiles and mammals, although many of these are not the primary reason why the property was inscribed on the World Heritage List. While certain species currently have an improved conservation status compared to 40 years ago (herons, ibis, booted eagle), others are in a more negative state especially rabbits (the main food resource for the endemic endangered Iberian Lynx), reptiles, small mammals and dragonflies. The decreased hydroperiod of some temporary ponds likely also had an impact on certain amphibians.

Over 360 bird species (migratory and sedentary) were mentioned in 1994, although current estimates seem to go up to ‘over 300’. It is unclear if this is the result of a different way of counting or if the property has seen a decreasing number of species. Species of particular importance (as mentioned specifically in the OUV description from the 1994 IUCN Evaluation Report) are:

- Marbled teal (*Marmaronetta angustirostris*)^{eee}
 - o This bird is still threatened, as was already the case at the time of nomination, and currently listed as ‘vulnerable’ on the IUCN Red List.^{fff} In 1994 an estimated 400 individuals were reported (note that 1994 was an exceptionally dry year). The State Party reported 25 and 16 breeding pairs in 2017 and 2018, the highest numbers in

^{eee}It is to be noted that for the 1994 numbers it is not clear what exactly was measured. For example the 1994 nomination file mentions ‘imperial eagle (30)’ while it is not clear if this refers to individuals, breeding pairs or numbers specifically for the property or the region at large. Data from the Junta de Andalucía indicates there were 29 imperial eagle pairs in 1994 for all of Andalucía. It is not clear if the 1994 numbers on marbled teal and white-headed duck apply to wintering or residing individuals.

^{fff}<https://www.iucnredlist.org/species/22680339/110054350>

5 years.^{ggg} The marshes of the Guadalquivir and wetlands near Alicante are their preferred habitat.^{hhh}

- White-headed Duck (*Oxyuraleucocephala*)
 - o This bird is still threatened, as was already the case at the time of nomination and is currently listed as 'endangered' on the IUCN Red List.ⁱⁱⁱ In 1994 an estimated 70 individuals were reported (note that 1994 was an exceptionally dry year). The 2016 Management Plan notes that Veta la Palma is the main refuge for this species. The State Party reported in 2017 that 449 specimens were observed in the Veta la Palma farm, an absolute record, and that 17 breeding pairs were spotted in the property.^{jjj}
- Iberian Imperial eagle (*Aquila adalberti*)
 - o This bird is no longer threatened, as was the case at the time of nomination, but is currently listed as 'vulnerable' on the IUCN Red List.^{kkk} In 1994 an estimated 30 individuals were reported. Other data shows that, after a decrease to 4 breeding pairs in Doñana in 2005, for the last years the number has stabilized to 10, about the same as during the time of inscription. Doñana and Andalucía have special programs in place for many years to support the recovery of the Iberian Imperial eagle population. Electricity supply lines have been upgraded to avoid eagles landing on the towers and being killed by electric shock. For Andalucía as a whole, the number of new births increased from 59 in 2002 to 144 in 2019.^{lll}
- Iberian Lynx (*Lynx pardinus*)
 - o The iconic small cat was already threatened at the time of nomination and is currently listed as 'endangered' on the IUCN Red List.^{mmm} In 1994 an estimated 40 individuals were reported. The number of reported lynxes in the property rose from 41 in 2002 to 88 in 2011. The recovery of the lynx is an important conservation success story, with numbers for Andalucía going up from 94 in 2002 to 450 in 2018.ⁿⁿⁿ The recovery is attributed to the special action plan, creation of biological corridors, and fences along major roads to avoid road kills.
- Waterfowl: the property still receives hundreds of thousands of migratory ducks and geese every year.
 - o The overall number of aquatic birds seems to have remained stable around 500,000 between 2002 and 2015, with a recent record of over 600,000 counted birds in

^{ggg}Realización de censos de aves en la comarca de de Doñana. Invernada 2018. http://www.juntadeandalucia.es/medioambiente/portal_web/servicios_generales/doc_tecnicos/publicaciones_renpa/2018_05_end_memorias_anuales/memorias_anuales/2018_apartados/Anexo_2_Censos_Aves_2018.pdf

^{hhh}<https://seo.org/ave/cerceta-pardilla/>

ⁱⁱⁱ<https://www.iucnredlist.org/species/22679814/119403602>

^{jjj} 2018 state of conservation Report. <http://whc.unesco.org/document/171075>

^{kkk}<https://www.iucnredlist.org/species/22696042/152593918>

^{lll}http://www.juntadeandalucia.es/medioambiente/portal_web/web/temas_ambientales/biodiversidad/0_conservacion_biodiversidad/planes_conservacion_recuperacion/plan_recuperacion_aguila_imperial/ficha_aguila_imperial_2019.pdf

^{mmm}<https://www.iucnredlist.org/species/12520/174111773>

ⁿⁿⁿ<https://www.lavanguardia.com/natural/20190105/453933569443/lince-iberico-recuperacion-biodiversidad-numero-ejemplares-aumento-datos-especie.html>

2019.^{ooo} ^{ppp} ^{qqq} However the number of certain bird species has decreased, triggering BirdLife International to declare the Doñana area as an IBA in Danger in 2016.^{rrr} For example the rise in Doñana's duck population can be attributed to four species only (*Anas clypeata*, *Anas acuta*, *Anas crecca* and *Nettarufina*) while four other species show a negative trend (*Aythya nyroca*, *Anas platyrhynchos*, *Marecastrepera*, and *Anas penelope*). For some species, these negative trends have been attributed to higher temperatures in Northern Europe, so that birds do not longer need to go as far south as before to find an agreeable place to pass the winter. The negative trends cannot be attributed to a reduced hydroperiod because the inundated marsh area has remained constant.^{sss}

Overall the numbers and diversity of water birds visiting and breeding in the property indicate that the values that underpin the OUV are in a good condition. Bird censuses need to be carefully interpreted due to a seasonal variability which is typical for wetlands. However negative trends for specific bird species need to be carefully monitored to allow for appropriate management actions.

The well documented decline of the local European rabbit (*Oryctolagus cuniculus*) population is a reason for concern. The appearance of the Myxomatosis virus in the 1950s and Rabbit haemorrhagic disease in following decades has almost decimated the original rabbit population in the Iberian Peninsula. In 2019 the European rabbit was categorised as 'endangered' on the IUCN Red List.^{ttt} Rabbits are a key prey for several species including the endangered Iberian lynx and Iberian Imperial eagle. In its 1994 Evaluation Report, IUCN noted that a distinctive feature of Doñana is the relative high density of rabbits which are the basis of a predation system upon which 43 species in part depend. The rabbit is highlighted as one of the eight conservation priorities in the management plan of the Doñana Natural Space, which also highlights the important role of a healthy rabbit population for the recovery of the Iberian lynx and Iberian Imperial eagle. Management authorities actively monitor and support the rabbit population, including through reintroductions, with the objective of increasing rabbit density. So far, the dwindled rabbit numbers have not yet had an apparent impact on the population of Iberian lynx and Imperial eagle, but continued monitoring is required to assess if these iconic species could change diet or if their further recovery will reach a maximum threshold based on rabbit density.

Integrity of the property

With migratory birds constituting a major component of the property's OUV, the integrity of the property is an important consideration.^{uuu} Over half of the property's bird species are migrants

^{ooo} Doñana Biological Research Station:

http://icts.ebd.csic.es/documents/20181/235665/1.1.2_1_Esp+y+Pob_censos+terrestres_left.png/46928880-a68e-47a2-8329-10fdf19b6494?t=1511431598000

^{ppp} Junta de Andalucía.

<http://www.juntadeandalucia.es/medioambiente/site/portalweb/menuitem.30d4b35a97db5c61716f2b105510e1ca/?vgnnextoid=8d0abaf0d6db8610VgnVCM100000341de50aRCRD&vgnnextchannel=2229b8f8606b8210VgnVCM10000055011eacRCRD>

^{qqq} 2020 state of conservation Report. <http://whc.unesco.org/document/185771>

^{rrr} <http://datazone.birdlife.org/site/factsheet/guadalquivir-marshes-iba-spain/details>

^{sss} <http://www.juntadeandalucia.es/medioambiente/site/portalweb/menuitem.30d4b35a97db5c61716f2b105510e1ca/?vgnnextoid=1d4f43b0954ab510VgnVCM2000000624e50aRCRD&vgnnextchannel=8ee2db02de34c510VgnVCM1000001325e50aRCRD&vgnnextfmt=portalwebSinMenu>

^{ttt} <https://www.iucnredlist.org/species/41291/170619657>

^{uuu} The integrity of a World Heritage site is defined as a measure of the wholeness and intactness of the site and its natural features. Specifically, a site needs to 1) include all elements necessary to express its OUV, 2)

which spend part of their life elsewhere along the Eastern Atlantic Flyway. This means that the conservation of the OUV depends on adequate protection measures taken outside the property, including by other States Parties. Closer to the property, for example, on the easterly boundaries of the property lies the Veta la Palma fish farm, a permanent artificially inundated island. The farm includes 3,200 ha of permanently flooded lands all year round which makes it likely Doñana's largest habitat for waterbirds during dry periods. While the marshes of the property dry up during prolonged droughts, the Veta la Palma farm remains permanently flooded thanks to its water pumps. This farm is under private concession but subject to environmental regulations of the Natural Park. The continued sustainable operation of the farm and surrounding rice fields is considered critical as more erratic rainy periods could make the marshes a less reliable spot for annual breeding of waterbirds.

The regional government has several plans in place to protect species of OUV in the wider area of Andalucía, such as for lynx, imperial eagle and waterbirds.

Although at the time of nomination the property was a refuge for the Iberian lynx, its habitat has increasingly extended and currently lies more beyond the property than in the property (see Fig. 5). Monitoring programs should continue to track lynx distribution and pay particular attention to the evolution of groundwater-fed ecotones upon which the lynx might depend.

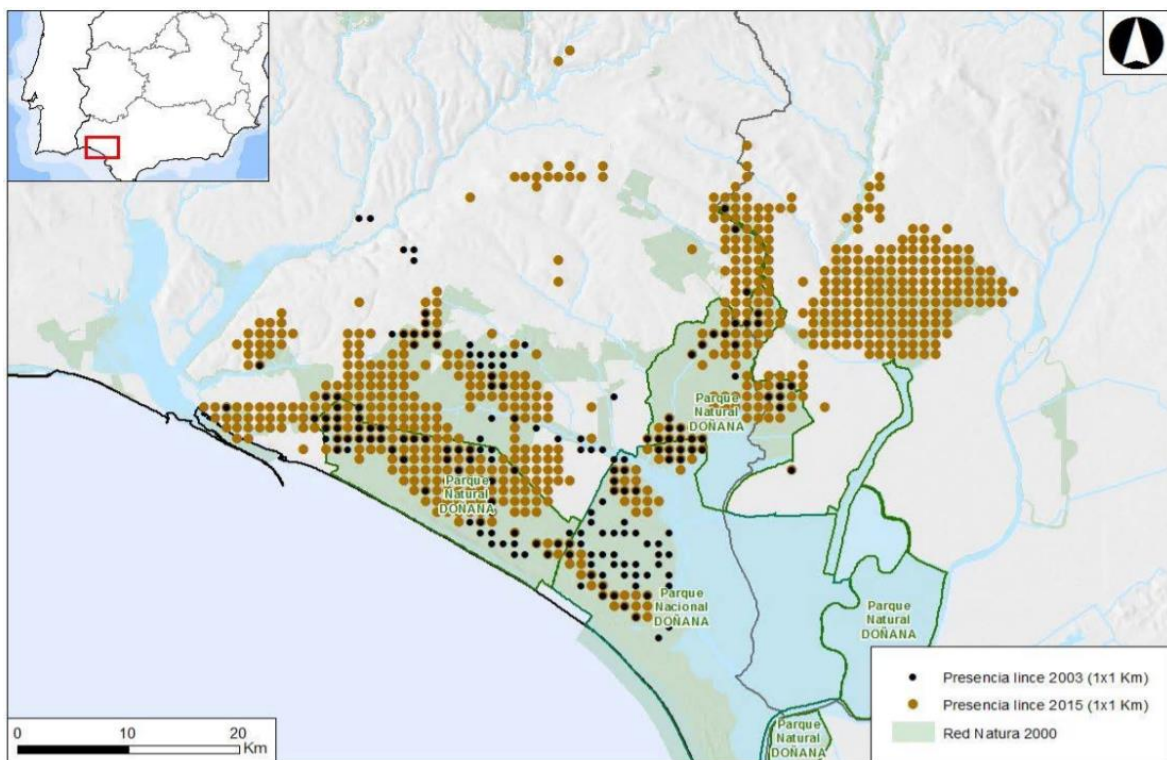


Figure 5. Presence of the Iberian lynx in 2003 and 2015. Source: 2016 state of conservation Report. <http://whc.unesco.org/document/155122>

The hydrodynamics of Doñana at large are considered very important for the property. However the mission notes that there has been a lot of confusion about the different aquifer units and the hydrological relationship between these units and the property, especially regarding to what degree water abstraction from the detritic aquifer outside the Doñana National Park relates to the

be of adequate size to ensure the complete representation of the features and processes that underpin its OUV, and 3) be relatively intact, i.e. free from adverse effects of development and/or neglect.

OUV of the property. Previous Reactive Monitoring Missions and Committee decisions have argued that the continued decline of the detritic aquifer, if not reversed, could represent a potential danger to the OUV of the property, and thus warrant inscription on the List of World Heritage in Danger.

Because of the specific geological and hydrological conditions, the mission considers that it is important to consider separately the marshes and temporary dune ponds of the Doñana National Park. As explained in more depth in Chapter 3.2, the mission team failed to find sufficient substantial scientific evidence to support a strong hydrological connection between the detritic aquifer and either the winter inundation of the marshes or natural variations in the dune ponds. The winter situation is of particular importance for the OUV because its value as a wintering site for waterfowl. This means that groundwater abstraction in the detritic aquifer (Almonte-Marismas or Doñana aquifer) has potentially little impact on the key ornithological values of the property, which are driven primarily by rain and surface water during winter. However there remains some uncertainty concerning the supply of groundwater to the marshes and fringing ecotones during the summer. Hence the level of current and future risk is highly uncertain. While lower water tables might have already had an impact on the biodiversity of certain specific habitats in the Doñana Natural Space (especially riparian and groundwater-fed ecotones), no reports about negative impacts of those changes on the OUV or its attributes have been put forward.

However, consistent with a precautionary management approach, and bearing in mind the importance of specific habitats for the Iberian lynx and Imperial eagle which lie outside the property, the mission considers it important that the Doñana aquifer reaches Good Status by 2027.

In conclusion, following field visits, analysis of material provided and meetings with authorities, the Park, NGOs, businesses, scientists and other stakeholders, the mission team concludes that the values for which the property has been inscribed under the World Heritage and Ramsar Conventions are still present. However, concerns about the state of conservation of the World Heritage property remain, including the potential impact of water abstraction outside the property, climate change, and potential development and infrastructure projects in the property's vicinity. The considerable resources which the State Party has already dedicated to the conservation and restoration of the property are recognized, but the mission recommends the State Party to increase and urgently continue the implementation of water management measures and conservation efforts to ensure that the OUV of the property can be transmitted to future generations.

4.2 Review any follow-up measures to previous decisions of the Committee on the state of conservation of the property and measures which the State Party plans to take to protect the outstanding universal value of the property

The recommendations from the 2015 Reactive Monitoring Mission for the Doñana National Park have been mostly addressed. Issues that still require attention have been integrated in the new recommendations of this 2020 mission. A detailed overview of the status of the 2015 recommendations is available in Annex VI.

In line with Decisions **43 COM 7B.20** and **41 COM 7B.9** the State Party was requested to share the below information with the World Heritage Centre and IUCN once available. Where these requests remain outstanding they have been reiterated in the new recommendations of this report.

- the updated SEA for the Guadalquivir River Basin which includes a specific chapter on the OUV of the property;
- the draft chapter of the 2021-2027 Hydrological Plan including revised plans for water management and use in the river basin based on a Strategic Environmental Assessment (SEA) that takes into account the OUV of the property and covers water supply scenarios,

agricultural, industrial and commercial development, in line with Decisions **38 COM 7B.79** and **41 COM 7B.9**, for review by IUCN;

- the outcomes of the infringement proceedings of the European Directives;
- the EIA of the water transfer plans from the Tinto-Odiel-Piedras basin to the Guadalquivir basin;
- the analyses on the clear risk preparedness plan and rapid emergency response capacities for the Aznalcóllar mine before a decision on re-opening the mine is made, for review by IUCN.

5. CONCLUSIONS AND RECOMMENDATIONS

Doñana National Park was inscribed on the UNESCO World Heritage List in 1994 for its great diversity of biotopes, especially ponds, marshlands, fixed and mobile dunes, scrub woodland and matorral^{vv}. It is a wintering site for hundreds of thousands of birds. The World Heritage property is also part of a Biosphere Reserve and Ramsar Site.

About 170,000 people live in the vicinity of the National Park. The Park provides income to local communities via (eco)tourism and as the setting for the El Rocío pilgrimage. About forty percent of all jobs in the region derive from agriculture activities (production of olives, almonds, rice, meat, and berries). A high percentage of the red fruits consumed in Europe (strawberries, blueberries, raspberries, blackberries) are produced on the sun-drenched irrigated sandy soils near Doñana. These agricultural activities and other human uses require an enormous amount of groundwater, almost 100 hm³ per year. About forty percent of all the water that infiltrates into the aquifer units around Doñana (predominantly from rain) is used for human use through groundwater abstraction. This abstraction currently exceeds sustainable limits, putting strain on the aquifers, and in 2020 the Spanish Authorities declared some aquifers officially overexploited. This has given rise to fears that the Outstanding Universal Value (OUV) of the property is in danger from lack of water. In this context a Reactive Monitoring Mission, organized jointly between the UNESCO World Heritage Centre, IUCN and the Secretariat of the Ramsar Convention on Wetlands, took place from 25 to 28 February 2020, upon the invitation of Spain.

The mission would like to commend the considerable conservation success that has been achieved over the years. The protected area grew considerably in the last four decades, the Iberian lynx was saved from the brink of extinction, thousands of hectares of introduced eucalyptus -a ferocious water consumer- have been removed to restore the original ecosystem, 5000 hectares of marshes have been restored through the Doñana 2005 project, the Mimbres estate was purchased for 50 million euros thereby acquiring the water rights of almost 7 hm³, and there is a constructive cooperation between the Park, the Participation Council and most parties involved.

Following field visits, analysis of material provided and meetings with authorities, the Park, non-governmental organisations (NGO), businesses, scientists and other stakeholders, the mission team concludes that the values for which the property has been inscribed under the World Heritage and Ramsar Conventions are still present. The mission team heard concerns about potential threats to the state of conservation of the World Heritage property, including those from water abstraction outside the property, climate change, and potential development and infrastructure projects in the property's vicinity.

The mission team reviewed the principal literature available on the hydrological system of Doñana, which is critical to the functioning of the property, including the connectivity of the detritic aquifer and the marshes. The mission did not find documented scientific evidence of negative impacts from

^{vv}<http://whc.unesco.org/en/list/685>

groundwater abstraction from the detritic aquifer on the OUV of the property, and limited impacts of abstraction from the coastal dune aquifer. Moreover, the reduction in groundwater abstraction to sustainable levels being pursued by the Confederación Hidrográfica del Guadalquivir (CHG), should further reduce any potential threat. The considerable resources that the State Party has already dedicated to the conservation and restoration of the property are recognized. On the other hand, whilst there is a lack of evidence of significant interactions between the detritic aquifer and the marshes, hydrological independence has not been proven either. Hence, the mission team recommends further research is of the utmost importance to clarify the wider eco-hydrological dynamics of Doñana.

In light of this scientific uncertainty, and since aquifers associated with the wider Doñana ecosystem remain below Good Status, it is recommended the State Party urgently continues the implementation of conservation efforts including the prescribed water management measures, to ensure the recovery of these aquifers and to eliminate any possible related risk to the OUV of the property. There is also a need to report differently on the hydrological context because the mission team considers that the water levels in the detritic aquifer, used previously on its own as a metric, is not the best indicator of potential danger to the OUV. An appropriate indicator is therefore required that links the hydrology to the ecological response of the property.

Climate change poses a potentially greater future risk, but is highly uncertain, so also requires further research. The mission team considers that this overall level of scientific uncertainty is unacceptable for an iconic World Heritage site such as the Doñana National Park. After all, States Parties to the World Heritage Convention have pledged to do all they can “to the utmost of its own resources” to conserve and transmit the world’s natural heritage to future generations.^{www}

The Covid-19 pandemic has underlined the importance of a diversified economy for the resilience of local communities. For the Doñana region, the resilience of both people and ecosystems depend on a healthy water balance. Especially in light of likely possible climate change impacts on a sensitive ecosystem, more resources should be dedicated to building resilience and climate adaptation measures.

The mission proposes the following recommendations to the State Party:

Main recommendations:

Recommendation 1

To eliminate any possible risk to the OUV of the marshes and groundwater-fed ecotones derived from groundwater extraction from the Almonte-Marismas detritic aquifer (Doñana aquifer), and given the crucial role of the CHG in achieving Good Status of the aquifer by 2027, consistent with a precautionary management approach, the mission recommends to:

- increase the resources available to the CHG, including recent technologies, to strengthen monitoring, surveillance and enforcement to ensure the accelerated and urgent closure of all illegal wells and illegally irrigated farmland;
- continue the urgent implementation of the Special Management Plan of the Irrigation Zones located to the North of the Forest Crown of Doñana, in its current form, in close cooperation with all key stakeholders, to ensure the recovery of the aquifers to Good Status as soon as possible, and by no later than 2027;
- ensure that any substitution of groundwater by surface water is directed to those areas most in need, and that any substitution is carefully managed and considered in the context

^{www}UNESCO. 1972. Art. 4, Convention Concerning the Protection of the World Cultural and Natural Heritage, adopted by the General Conference, Paris, 16 November 1972. <http://whc.unesco.org/en/conventiontext/>

of any possible impacts on the OUV of the property as per the *Operational Guidelines* of the World Heritage Convention, including through EIAs, as required;

- ensure that projects including water transfers, dam extensions, and licenced groundwater abstraction have no negative impact on the OUV of the property, by undertaking appropriate EIAs in line with the IUCN World Heritage Advice Note on Environmental Assessment^{xxx};
- encourage, incentivize and provide financial support if needed for the adoption of sustainable agriculture practices (especially concerning drip irrigation and reduction in use of single-use plastics) by farmers of the Doñana area.

Recommendation 2

To eliminate any possible risk to the OUV in the coastal dunes, consistent with a precautionary management approach, the mission recommends relocating as soon as possible, and within three years, the most eastern wells that provide water for the Matalascañas tourist resort (well 9 and 10), as already proposed in the draft Hydrological Plan 2021-2027.

Recommendation 3

Although there is a basic understanding of the hydrology of the region, some uncertainty remains concerning possible impacts of water use in the vicinity of the property. Consequently, an increased research effort is urgently required to understand the relationship between the hydrology and ecology of the area, as this is essential to underpin sound management. The mission therefore recommends that future research should include a focus on defining the water requirements of the property to maintain its OUV. This necessitates quantification of relationships between the ecological features that define the OUV and hydrological components (*e.g.* rainfall, evaporation, river flows and groundwater levels). Construction of an eco-hydrological model of the World Heritage property based on the results of the research, and consideration of the possible need of a buffer zone, including the surrounding catchment basin (covering the Ramsar Site and EU Natura 2000 area), would allow the impacts of various scenarios to be defined, including abstraction of groundwater, removal of trees, building of dams and climate change. The model should incorporate appropriate indicators linking the hydrology to the ecological response of the property. A detailed list of recommended research topics can be found in the mission report (Chapter 3.3.8).

Recommendation 4

Taking into account the likely possible impacts from climate change on the values of the property, the mission recommends the creation of a strategic plan that defines conceptually:

- The extent to which a reduction in water consumption is required in response to climate change impacts to conserve and protect the OUV of the property (in case further studies would reveal close linkages between the detritic aquifers and the OUV);
- The extent to which alterations to the OUV and ecological character of the wetland ecosystem due to climate change can be expected, along with any adaptation and mitigation measures that can be implemented to maintain the conditions of integrity of the property and increase its resilience.

Recommendation 5

To facilitate the reporting and analysis of the state of conservation of the property's OUV in the coming decades, the mission recommends:

- The State Party finalizes the rSOUV as soon as possible, in consultation with IUCN;

^{xxx}IUCN World Heritage advice note on Environmental Assessment (November 2013) <https://www.iucn.org/theme/world-heritage/resources/iucn-policies-world-heritage/environmental-assessment>

- The State Party develops a clear set of fixed indicators to monitor the state of conservation of the OUV through an integrated catchment-wide management approach that allows for the identification, monitoring and management of threats within and beyond the boundaries of the property, and to report on those indicators in future state of conservation reports;

Recommendation 6

Noting that the mission did not receive any additional information on a Strategic Environmental Assessment (SEA) of the Guadalquivir river basin, it recalls the 2017 Committee Decision as follows^{yy}: “Requests furthermore, the State Party to present an updated SEA for the Guadalquivir River Basin to ensure that it includes a specific chapter on the OUV of the property, and submit it to the World Heritage Centre.”

Recommendation 7

Because the State Party’s commitment to abandon the deep dredging project of the Guadalquivir River cannot be considered ‘permanent’ or ‘unequivocal’ whilst a reference to any deep dredging remains in the new Guadalquivir Basin Hydrological Plan, the mission team recommends that the State Party continues honouring its previously made commitments and removes this project from the revised Guadalquivir Basin Hydrological Plan (2021-2027).

Recommendation 8

Noting that the mission did not receive any additional information on the status of the potential reopening of the Aznalcóllar mine, it recalls the 2019 Committee Decision^{zz}: “Further recalling the need for great caution with regards to re-opening the former Aznalcóllar mine, and urges the State Party to ensure that systematic risk preparedness and emergency action plans take into account the property and to submit these analyses for review by IUCN, as soon as they become available and before a decision on re-opening the mine is made”.

Recommendation 9

Noting that the mission did not receive any additional information on the status of the gas storage projects, consistent with a precautionary management approach the mission recommends that systematic monitoring of the possible impacts and risk assessments of Rincon-2 and Marismas-3 on the hydrology and OUV is put in place, and that a summary of those findings is included in future state of conservation reports. The mission also recommends for the State Party to ensure that the individual and cumulative impacts on the property’s OUV of any development or infrastructure project in or near the property are thoroughly assessed in conformity with IUCN’s World Heritage Advice Note on Environmental Assessment.

Recommendation 10

To maintain the integrity of the property, and consistent with a precautionary management approach, the mission recommends to establish an official World Heritage buffer zone around the property that includes the Natural Park (Ramsar Site), Natura 2000 sites and other established protected areas in the immediate water catchment of the property which underpin the OUV of the property.

Other recommendations:

Recommendation 11

^{yy}<http://whc.unesco.org/en/soc/3556>

^{zz}<http://whc.unesco.org/en/soc/3909>

The mission notes that varying perspectives regarding the status of the ecosystems of the property and Doñana Natural Space exist. It therefore recommends that actions are taken to ensure the availability of current scientific data to inform decision making, and to organise regular meetings of all stakeholders to present, share and discuss scientific knowledge and different perceptions of the eco-hydrological status, trends and possible futures in and around the property. This could result in closer agreement on the issues and solutions.

Recommendation 12

Further studies are required to determine the level of threat from pollutants or water of different quality imported to the system from other river basins. This includes both historical determinands such as nutrients from agricultural fertilizers and new pollutants such as pharmaceuticals. Evidence is required on impacts of ecological functioning, threshold levels of pollutants and how they might accumulate through the food chain.

Recommendation 13

Recalling recommendation 11 of the 2011 Reactive Monitoring Mission, recommends the State Party prepare a consolidated proposal for the establishment of a Marine Protected Area (MPA) adjacent to the property, which also considers the potential OUV of the marine ecosystem and possibility to extend the existing property to include this MPA.

Recommendation 14

Participation and education of young people is key to continue encouraging and enabling the future stewards of the property and Doñana Natural Space, and the mission therefore recommends to expand the educational activities in schools nearby the property, including by exploring to join the UNESCO Associated Schools (ASPNet), to continue involving the youth of Doñana and strengthen education activities on sustainable development and the OUV of the Park.

Recommendation 15

To promote a culture of peace through intercultural dialogue, and increase management effectiveness through the exchange of conservation best practices (especially in the field of bird monitoring and building resilience of wetlands in the face of climate change), the mission recommends the State Party to strengthen international cooperation with other World Heritage and Ramsar sites (*e.g.* Danube Delta, Everglades National Park, Wadden Sea, Banc d'Arguin National Park), Biosphere Reserves and Ramsar Sites (Carmargue/Delta du Rhone), and protected areas in general whose ecosystem is linked with, or very similar to the Doñana National Park, especially on the East Atlantic Flyway.

Annex I: Terms of Reference

TERMS OF REFERENCE

Joint WHC/IUCN/Ramsar Reactive Monitoring Mission
Doñana National Park (Spain)

At its 43rd session (Baku, June-July 2019), the World Heritage Committee requested the State Party of Spain to invite a joint World Heritage Centre/IUCN Reactive Monitoring Mission to the Doñana National Park World Heritage property (Spain), to be conducted jointly with the Secretariat of the Ramsar Convention. The mission's objectives are to assess the potential impacts of current and future developments and water management on the Outstanding Universal Value (OUV) of the property, and to review the implementation of the recommendations of previous missions (see Decision 43 COM 7B.20, Annex 1).

In line with these overarching objectives this Reactive Monitoring Mission will

- 1) Assess the potential impacts of current and future developments, which have the potential to individually and cumulatively impact on the OUV of the property, taking into account the
 - ii. Impacts of the Marisma Occidental and Aznalcázar gas extraction and storage projects located in close proximity of the property, including fragmentation of the property's upstream habitats, as well as surface and groundwater flows, as recognised in the project's Environmental Impact statements;
 - iii. Potential re-opening of the former Aznalcázar mine, which if it proceeds should ensure systematic risk preparedness and emergency action plans which take into account impacts on the property;
 - iv. The planned four-fold increase in the transfer of water from the Tinto-Odiel-Piedras basin to the Guadalquivir basin;
 - v. Groundwater abstraction in the Almonte-Marismas aquifer.
- 2) Assess current and future hydrological dynamics and water management in relation to the OUV of the property, taking into account the
 - i. Planned Hydrological Plan for the 2021-2027 period and the related Strategic Environmental Assessment (SEA) with respect to Decisions **38 COM 7B.79** and **41 COM 7B.9**;
 - ii. Current Extraction Plan (EP), Special Irrigation Plan (SIP) and the Guadalquivir Hydrographic Confederation reports on the status of the Doñana aquifer;
 - iii. Wider European Union legislative frameworks including the Water Framework and Habitats Directives, specifically any reported breaches of these Directives including the infringement proceedings launched by the European Commission.
- 3) Review progress with the implementation of the recommendations of the 2015 IUCN Reactive Monitoring Mission;
- 4) Evaluate any other relevant issues that may negatively impact on the OUV of the property, including its conditions of integrity and protection and management, in line with paragraph 173 of the Operational Guidelines.

The mission shall also consider the interrelated aspects of issues noted between points a. to g. given the relevance of the Habitats and Water Framework Directives for the legal protection of the OUV of the property, the mission should also take into consideration the impacts on OUV of the infringement proceedings launched by the European Commission regarding these two Directives.

The State Party should facilitate necessary field visits to key locations inside the property and its wider catchment area. To enable the mission's preparation, the State Party should, as soon as possible, and preferably no later than one month prior to the mission, provide the World Heritage Centre, IUCN and the Ramsar Secretariat with any relevant updates, including documents that have become available since the latest state of conservation report submitted by the State Party in November 2018, in line with a. to g. and Decision 43 COM 7B.20 (Annex 1), and including the most recent version of the management plan of the property and the Special Management Plan of the Irrigation Zones. Additional information may be requested during the mission as required.

The mission should hold consultations with all relevant stakeholders, including representatives of the Spanish authorities at national, autonomous community and local levels, including representatives of the Ministry of Agriculture, Food and Environment, the Junta de Andalucía, the local government, Guadalquivir Hydrographic Confederation, and the Doñana Biological Station. In addition, the mission should hold consultations with relevant scientists, NGOs, farmers' organizations and relevant industries.

Based on the results of the above-mentioned reviews, assessments and discussions with the representatives of the States Parties and other stakeholders, the mission will prepare a concise report on the findings and recommendations following the site visit, in line with the attached Reactive Monitoring Mission report format (see Annex 2). The mission's recommendations to the World Heritage Committee should have the objective of providing guidance to the State Party to ensure the ongoing conservation of the property's OUV. It should be noted that recommendations will be provided in the mission report and not during the mission.

Annex II: Itinerary and programme

JOINT WORLD HERITAGE CENTRE/IUCN REACTIVE MONITORING MISSION JOINTLY WITH THE SECRETARIAT OF THE RAMSAR CONVENTION TO THE WORLD HERITAGE SITE “DOÑANA NATIONAL PARK” (SPAIN)

25 – 28 FEBRUARY 2020

PROGRAM

During the sessions, the different matters dealt with by the Committee Decision will be explained with the participation of the Park management team and the different administrations and all the stakeholders usually requested as conservation NGOs, EBDs, municipalities, businesses, agricultural organizations, and others.

Day zero. Monday 24th February 2020

Arrival of the members of the Mission in Sevilla and transfer to Hotel El Toruño (El Rocío).

Day one. Tuesday 25th February 2020 (Venue: El Acebuche Park Offices)

Morning session

9:00h. Institutional welcome of the Secretary General of Environment, Water and Climate Change and Director General of Natural Environment, Biodiversity and Protected Areas of the Regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development of the Junta de Andalucía.

9:30h. First working session with the technicians responsible for managing the Natural Area of Doñana

- Communication of the organizational aspects of the Mission, explanation of the programmed participation and detailed clarification of the planned treatment of the issues proposed by the Decision of the UNESCO World Heritage Committee meeting in Baku. (Juan Pedro Castellano (Director, Doñana Natural Space), Javier Rubio (National Parks- Ministry for the Ecological Transition and Demographic Challenge) and Laura de Miguel (Ministry of Culture and Sport)).
- Territorial framework of the property, location and time scale of risks and threats. The Outstanding Universal Value of Doñana (Juan Pedro Castellano).

10:00 h. **Content block 1.** Various issues mentioned or demanded by the Mission. (30 minutes).

Objective: Provide a brief description of the key issues and how each will be addressed through the discussion during the program or the documents that will be provided.

- Presentation of the issues mentioned in the latest Decision
- Dredging
- Huelva Cádiz Highway
- Aznalcóllar Mine
- Re-growth of the Rio Agrio dam
- Gas project evaluations
- Open procedure in the EU Court of Justice

- Introduction to water management in Doñana, which will be widely discussed in the program

10:30 h. Coffee break

11:00 h. Biological and geological research

- Doñana Biological Station (Eloy Revilla)
- IGME (Geological and Mining Institute of Spain) (Carlos Mediavilla or Juan José Durán)
- Pablo de Olavide University (Miguel Rodríguez)

12:00 h. Conservation organizations with continued presence in Doñana

- WWF (Eva Hernandez, Juan José Carmona, Ana Bernal Arlandi)
- Ecologistas en Acción (Juan Romero)
- SEO (Carlos Davila)

13:00 h. Working session with the President of the Participation Council, Mr. Miguel Delibes de Castro.

14: 00 h. Lunch

Afternoon session

16:00 h Block of contents requested by the Mission. The water in Doñana. Surface water. Marsh and lagoons (Management Team of Doñana and Hydrographic Confederation of the Guadalquivir).

- The marshland. Flood dynamics and evolution of the territory and the hydroperiod.
- The lagoons. Framework, situation and detail analysis

16:30 h Block of contents requested by the Mission. The underground waters.

- Groundwater characterization
- Diagnosis, planning and measures

17:00 h. Coffee break

17:30 h. Continuation of the block. The underground waters

- Execution of measures and detailed explanation with consistent data of the measures adopted and those to be adopted.
- Forecasts and new planning framework.

18:00 h Block of contents requested by the Mission. Agriculture and water uses.

- Agriculture in the Doñana environment. (José Juan Chans). (15 minutes).
- Actions carried out and programmed by the competent administration for the management of land uses.
- Special Irrigation Management Plan located north of the Doñana Forest Crown. (Antonio Agúndez) Ministry of Agriculture, Livestock, Fisheries and Sustainable Development. (15 minutes)
- Effects on control over groundwater consumption. Substitution of deposits. (CHG). (15 minutes).

19:00 h Transfer to El Rocío.

Day two. Wednesday 26th February 2020 (Venue: El Acebuche Park Offices)

Morning session

9:30 h Continuation block of contents demanded by the Mission. Agriculture and water uses.

- Agriculture in the Doñana environment. (José Juan Chans). (15 minutes).
- Actions carried out and programmed by the competent administration for the management of land uses.
 - Special Irrigation Management Plan located north of the Doñana Forest Crown. (Antonio Agúndez) Ministry of Agriculture, Livestock, Fisheries and Sustainable Development. (15 minutes)
 - Effects on control over groundwater consumption. Substitution of deposits. (CHG). (15 minutes).

10:30 h. Meeting with Mayors of municipalities that contribute territory to the National Park. (It is intended to provide the vision of local authorities and communities regarding the reality of Doñana and the problems being discussed).

- Mayor of Almonte
- Mayor of Aznalcázar
- Mayor of Hinojos (excused)

11:30 h Coffee break

12:00 h. Meetings with business and agricultural organizations, and representatives of the farmers

- ASAJA (Emilio Vieira)
- UPA (Manuel Piedra)
- Business Representative Participation Council (Pedro Roldán Cabrera)

14:30 h. Lunch

Afternoon session

16: 30 h. Visit crop area Plan Almonte Marismas - Matalagrana

19:00 h. Transfer to El Rocío

Day three. Thursday 27th February 2020

Morning session

9:00 h. Visit to the National Park and surroundings, with special attention to the areas related to matters of interest to the mission.

El Rocío – La Vera – Lagunas – Marisma – Guadalquivir River – marshland restoration (Doñana 2005).

14:00 h. Lunch during the visit

Afternoon session

16:00 h. Montaña del Río – Caracoles (Travieso) – Isla Mayor – Veta la Palma (transformed marsh) – Coto del Rey – El Rocío.

Day four. Friday 28th February 2020 (Venue: El Acebuche Park Offices)

Morning session

9:00 h. Visit of the Breeding Center and Iberian lynx observatory.

10:00 h. Working session of the visiting members of the mission (separately).

11:00 h. Coffee break

11:30 h. Wrap up session with the Doñana Natural Space Management Team, National Parks and Ministry of Culture

- Monitoring and evaluation of the conservation status of Doñana. With special attention to matters of interest to the mission and the values that motivated the inclusion of the site in the World Heritage List and in the Ramsar List. (40 minutes).
- Main conclusions and contents of the next Spanish State of conservation report for UNESCO and Ramsar and exchange of opinions. (40 minutes).

13:30 h Lunch

16:00 h transfer to Seville

Annex III: Composition of mission team and list of people met

Mission team:

- Mike Acreman, IUCN.
- Tobias Salathe, Ramsar Convention.
- Robbert Casier, UNESCO World Heritage Centre.

Technical staff from the State Party participating in the Mission:

Managing team of the World Heritage Site:

- Juan Pedro Castellano. Director of the Natural Space of Doñana (National Park and Natural Park of Doñana. Regional Ministry of Agriculture, Livestock, Fishing and Sustainable Development, Government of Andalusia
- Isabel Redondo. Curator of the Natural Space of Doñana. Regional Ministry of Agriculture, Livestock, Fishing and Sustainable Development, Government of Andalusia
- José Juan Chans. Manger of the Natural Space of Doñana. Regional Ministry of Agriculture, Livestock, Fishing and Sustainable Development, Government of Andalusia

Other members of the State Party delegation:

- Laura de Miguel Riera. Head of World Heritage Service. Ministry of Culture and Sport
- Javier Rubio. C.T. National Parks. Ministry for the Ecological Transition and Demographic Challenge
- Milagros Pérez. Technical counsellor. General Directorate for Natural Environment, Biodiversity and Protected Spaces
- Victor Cifuentes. Head of the Office for Planning, Hydrographic Confederation of the river Guadalquivir
- Inés Manrique Ecuero. AECID. Ministry of Foreign Affairs, European Union and Cooperation

Biological Station of Doñana:

- Eloy Revilla Sánchez, Director
- Javier Bustamante
- Carmen Díaz

Pablo de Olavide University:

- Miguel Rodríguez Rodríguez

Geologic and Mining Institute of Spain:

- Carlos Mediavilla Laso, Head of the Projects Office, Seville

NGO's:

- Juan José Carmona Moreno, WWF
- Eva Hernández Herrero, WWF
- Juan Romero Romero, Ecologistas en Acción

President of the Participation Council in the Natural Space of Doñana:

- Miguel Delibes de Castro

Hydrographic Confederation of the Guadalquivir river:

- Victor Cifuentes. Head of the Office for Planning, Hydrographic Confederation of the river Guadalquivir
- Alejandro Rodríguez González, Comisario de Aguas
- Emilio Rodríguez Merino

Mayors of Municipalities with territory in the National Park:

- Rocío del Mar Castellano Domínguez, Mayor of Almonte
- Manuela Cabello González, Mayor of Aznalcázar

Business and agricultural organizations:

- Pedro Roldán Cabrera. Representative of Entrepreneurs, Participation Council of Doñana.
- Emilio Vieira Jiménez-Ontiveros, Agriculture Association of Young Farmers
- Pedro Báñez, Community of Irrigators El Condado.

Visitto Veta la Palma:

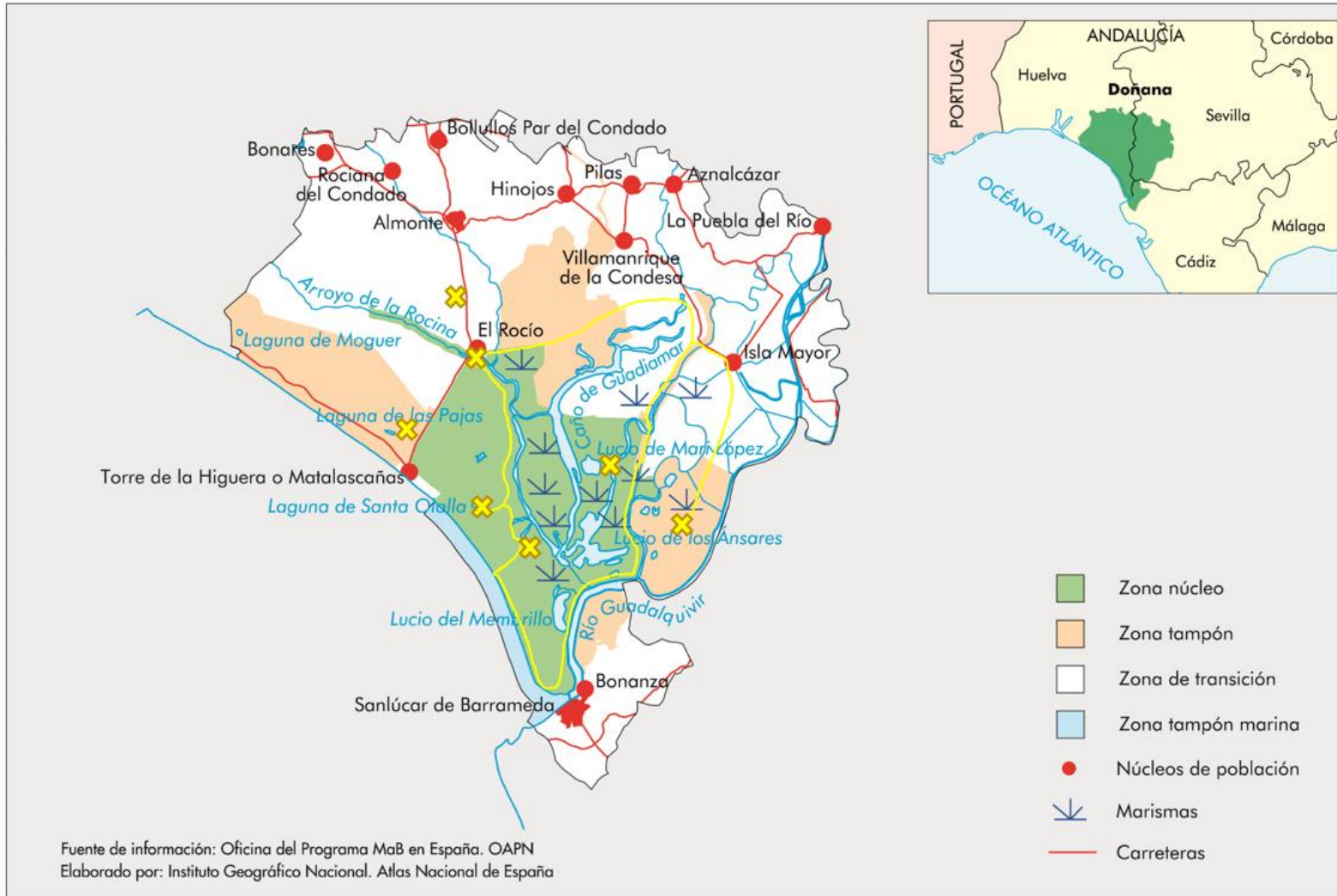
- Miguel Medialdea

Visit to the farm “Flor de Doñana”:

- Juan Maria Rodríguez

Annex IV: Map of areas visited by the mission team.

Map adapted from UNESCO's Man and Biosphere Programme. Yellow line and crosses indicate areas that were visited during the mission.



Annex V: The process for developing chapter 3.2 (Overview of the hydrology of the Doñana National Park)

Given the importance of hydrology to the property and the differing views of stakeholders, a detailed scientific approach was taken to developing best available knowledge, summary findings and recommendations. Searches were undertaken of international databases including Web of Science and Google Scholar; these returned 374 publications related to the eco-hydrology of Doñana. From these 64 publications were found to include knowledge relevant to the study and a further 9 publications were provided by experts and interested organisations, along with data and additional experience, in particular Victor Juan Cifuentes Sánchez, Confederación Hidrográfica del Guadalquivir and Teresa Gil, WWF-Spain. Salient information was extracted from the 73 publications (listed below Annex VI) and draft text produced, which was independently peer-reviewed by three experts: notably Dr Marisol Manzano, Universidad Politécnica de Cartagena, but also Dr Carolina Guardiola Albert, Instituto Geológico y Minero de España and Prof Esperanza Montero González, Complutense University of Madrid.

Publications, reports, data, personal knowledge and comments on draft text were kindly provided by experts: especially Dr Marisol Manzano, Universidad Politécnica de Cartagena, Spain, and Victor Juan Cifuentes Sánchez, Confederación Hidrográfica del Guadalquivir, Spain, and also Dr Carolina Guardiola Albert, Instituto Geológico y Minero de España, Spain; Prof Esperanza Montero González, Complutense University of Madrid and Teresa Gil, WWF-Spain.

Annex VI: References

Aguilera, H., Guardiola-Albert, C., Naranjo-Fernández, N. & Kohfahl, C. 2019 Towards flexible groundwater-level prediction for adaptive water management using Facebook's Prophet forecasting approach, *Hydrological Sciences Journal*, DOI: 10.1080/02626667.2019.1651933

Alcorlo, P., Jimenez, S. & Baltanas, A. 2014 Assessing the patterns of the invertebrate community in the marshes of Doñana National Park (SW Spain) in relation to environmental factors *Limnetica*, 33, 1, 189-204

Antunes, C., Chozas, S., West, J., Zunzunegui, M., Cruz Diaz Barradas, M., Vieira, S. & Máguas, C. 2018 Groundwater drawdown drives ecophysiological adjustments of woody vegetation in a semi-arid coastal ecosystem *Global Change Biology*, 24, 10, 4894-4908

Arambarri, P., Cabrera, F. & Gonzalez-Quesada, R. 1996. Quality evaluation of the surface waters entering the Doñana National Park (SW Spain) *Science of the Total Environment* 191, 185-196

Berbel, J., Kolberg, S. & Martin-Ortega, J. 2012 Assessment of the Draft Hydrological Basin Plan of the Guadalquivir River Basin (Spain) *International Journal of Water Resources Development* 28, 1, 43-55 DOI: 10.1080/07900627.2012.640875

Blanco, S., Álvarez-Blanco, I., Cejudo-Figueiras, C., Recio Espejo, J.M., Borja Barrera, C., Bécares, E., Díaz del Olmo, F. & Cámara Artigas, F. 2013 The diatom flora in temporary ponds of Doñana National Park (southwest Spain): five new taxa. *Nordic Journal of Biology* 31, 4 489-499

Bolivar, J. P.; Olias, M.; Gonzalez-Garcia, F.; et al. 2008 Concentrations and activity ratios of uranium isotopes in groundwater from Doñana National Park, South of Spain Proceedings 8th International Symposium on Natural Radiation Environment. Buzios, Brazil October 2007

Bustamante, J., Aragonés, D. & Afán, I. 2016 Effect of Protection Level in the Hydroperiod of Water Bodies on Doñana's Aeolian Sands *Remote Sensing*, 8, 867; doi:10.3390/rs8100867

Camacho-Muñoz, M.D., Santos, J.L., Aparicio, I. & Alonso, E. 2010 Presence of pharmaceutically active compounds in Doñana Park (Spain) main watersheds. *Journal of Hazardous Materials* 177, 1–3, 1159-1162 doi.org/10.1016/j.jhazmat.2010.01.030

Chiverton, A., Hannaford, J., Holman, I., Corstanje, R., Prudhomme, C., Bloomfield, J. & Hess, T. 2015 Which catchment characteristics control the temporal dependence structure of daily river flows? *Hydrological Processes* 29, 1353–1369

CMAOT (Consejería de Medio Ambiente y Ordenación). 2018. Realización de censos de aves en la comarca de de Doñana. Invernada 2018. http://www.juntadeandalucia.es/medioambiente/portal_web/servicios_generales/doc_tecnicos/publicaciones_renpa/2018_05_end_memorias_anuales/memorias_anuales/2018_apartados/Anexo_2_Censos_Aves_2018.pdf

Custodio, E. 1995 Comportamiento y papel de las aguas subterráneas en Doñana: Consecuencia de las extracciones. VI Simposio de Hidrogeología, Sevilla. XX, 281-310.

de Castro Ochoa, F. & Muñoz Reinoso, J.C. 1997 Model of long-term water-table dynamics at Doñana National Park *WaterResearch*31, 10, 2586-2596

de Miguel, R. J., Oliva-Paterna, F.J., Gálvez-Bravo, L. & Fernández-Delgado, C. 2014 Fish composition in the Guadiamar River basin after one of the worst mining spills in Europe *Limnetica*, 33, 2, 375-384 doi: 10.23818/limn.33.29

de Stefano, L., Fornes, J.M., Lopez-Getac, J.A. & Villarroya, F. 2015 Groundwater use in Spain: an overview in light of the EU Water Framework Directive. *International Journal of Water Resources Development*, 31, 4, 640–656, doi: /10.1080/07900627.2014.938260

Díaz-Delgado, R., Aragonés, D., Afán, I. & Bustamante, J. 2016 Long-Term Monitoring of the Flooding Regime and Hydroperiod of Doñana Marshes with Landsat Time Series (1974–2014) *Remote Sensing*, 8, 775; doi:10.3390/rs8090775

Díaz-Paniagua, C., Fernández-Zamudio, R. & Florencio, M. 2010 Temporary ponds from Doñana National Park: a system of natural habitats for the preservation of aquatic flora and fauna Proceedings of the 3rd European Pond Workshop, Valencia, Spain 2008 *Limnetica*, 29, 1, 41-58

Díaz-Paniagua, C. & Aragonés, D. 2015 Permanent and temporary ponds in Doñana National Park (SW Spain) are threatened by desiccation *Limnetica*, 34, 2, 407-424

Dimitriou, E., Moussoulis, E., Díaz-Paniagua, C. & Serrano, L. 2017 Hydrodynamic numerical modelling of the water level decline in four temporary ponds of the Doñana National Park (SW Spain) *Journal of Arid Environments*, 147, 90e102

Fernández-Ayuso, A., Rodríguez-Rodríguez, M. & Benavente, J. 2018 Assessment of the hydrological status of Doñana dune ponds: a natural World Heritage Site under threat *Hydrological Sciences Journal* 63, 15-16 2048-2059

Fernández-Ayuso, A., Aguilera, H., Guardiola-Albert, C., Rodríguez-Rodríguez, M., Heredia, J. & Naranjo-Fernández, N. 2019 Unraveling the Hydrological Behavior of a Coastal Pond in Doñana National Park (Southwest Spain). *Groundwater* 57, 6 895-906 doi.org/10.1111/gwat.12906

Florencio, M., Serrano, L., Siljestrom, P., Fernández-Zamudio, R., García-Murillo, P. & Díaz-Paniagua, C. 2014 The influence of geomorphology on the composition of aquatic flora and fauna within a temporary pond network *Limnetica*, 33, 2 327-340

Florencio, M., Fernandez-Zamudio, R., Lozano, M. & Diaz-Paniagua, C. 2020 Interannual variation in filling season affects zooplankton diversity in Mediterranean temporary ponds *Hydrobiologia* DOI: 10.1007/s10750-019-04163-3

García Novo, F. & Marín Cabrera, C. 2006 *Doñana Water and Biosphere*. UNESCO - MaB (Man and Biosphere Programme), Doñana 2005 Project. Junta de Andalucía (Consejería de Medio Ambiente) Confederación Hidrográfica del Guadalquivir, Spanish Ministry of the Environment, Madrid.

García-Novo, F., García, J.C.E., Carotenuto, L., Sevilla, D.G. & Faso, R.P.F.L. 2007 The restoration of El Partido streamwatershed (Doñana Natural Park): A multiscale, interdisciplinary approach. *Ecological Engineering* 30, 122–130.

Giró, F., Costa, L. & Salathé, T. 2002 Sitio Ramsar Doñana, España, reporte Mision Ramsar de Asesoramiento No 51.

Gómez-Ortiz, D., Martín-Crespo, T., Martín-Velázquez, S., Martínez-Pagán, P., Higuera, H. & Manzano, M. 2010. Application of ground penetrating radar (GPR) to delineate clay layers in wetlands. A case study in the Soto Grande and Soto Chico watercourses, Doñana (SW Spain). *Journal of Applied Geophysics*, 72: 107-113.

Green, A.J., et al., 2017. Creating a safe operating space for wetlands in a changing climate. *Frontiers in Ecology and the Environment*, 15, 99–107. doi:10.1002/fee.1459

Guardiola-Albert, C., Jackson, C.R. 2011 Potential Impacts of Climate Change on Groundwater Supplies to the Doñana Wetland, Spain. *Wetlands* 31, 907. doi.org/10.1007/s13157-011-0205-4

Hernández, L.M., Gómara, B., Fernández, M., Jiménez, B., González, M.J., Baos, R., Hiraldo, F., Ferrer, M., Benito, V., Suñer, M.A., Devesa, V., Muñoz, O., & Montoro, R. 1999 Accumulation of heavy metals and As in wetland birds in the area around Doñana National Park affected by the Aznalcollar toxic spill *Science of The Total Environment* 242, 1–3, 6, 293-308 [https://doi.org/10.1016/S0048-9697\(99\)00397-6](https://doi.org/10.1016/S0048-9697(99)00397-6)

Higuera, H., Manzano, M., Custodio, E., Juárez, I., Puig, R. & Aravena, R. 2011. Isotopic assessment of the impact of agriculture on the hydrology of the aquifer and wetlands at the Doñana Ramsar site, SW Spain. *Geophysical Research Abstracts* 13: 6789.

Huertas, I. E., Flecha, S., Figuerola, J., Costas, E. & Morris, E.P. 2017 Effect of hydroperiod on CO2 fluxes at the airwater interface in the Mediterranean coastal wetlands of Doñana, *J. Geophys. Res. Biogeosci.*, 122, 1615–1631, doi:10.1002/2017JG003793.

IGME undated Identificación y caracterización de la interrelación que se presenta entre aguas subterráneas, cursos fluviales, descarga por manantiales, zonas húmedas y otros ecosistemas naturales de especial interés hídrico. 051.050 Aljarafe http://info.igme.es/SidPDF/147000/994/147994_0000005.pdf

IPCC 2018 Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty

Junk, W.J., Bayley, P.B. & Sparks, R.E. 1989 The flood pulse concept in river-floodplain systems. *Canadian Journal of Fish and Aquatic Sciences*, 106, 110-127

Kloskowski, J., Green, A.J., Polak, M., Bustamante, J., Krogulec, J., 2009. Complementary use of natural and artificial wetlands by waterbirds wintering in Doñana, south-west Spain. *Aquatic Conservation*. 19, 815–826. <http://dx.doi.org/10.1002/aqc.1027>.

Kohfahl, C., Molano-Leno, L., Guardiola, C., Manzano, M., Ruiz, F., Naranjo-Fernández, N., Rebollo, A., Martínez, D., Martínez, A., Heredia, J., Custodio, E., Vanderlinden, K., Horacio Higuera, J. & Giráldez, V. 2019a. Monitoring and current research of groundwater resources and recharge in the Doñana Natural area (SE Spain). *Boletín Geológico y Minero*, 130 (4): 661-690 DOI: 10.21701/bolgeomin.130.4.005

Kohfahl, C., Molano-Leno, L., Martínez, G., Vanderlinden, K., Guardiola-Albert, C. & Moreno, L. 2019b Determining groundwater recharge and vapor flow in dune sediments using a weighable precision meteorological lysimeter *Science of the Total Environment*, 656, 550–557

Lozano, E. 2004. Las aguas subterráneas en los Cotos de Doñana y su relación con las lagunas. [Groundwater in the Cotos of Doñana and its relationship with lagoons]. PhD. Technical University of Catalonia.

Manzano, M. 2002 The impact of localised groundwater abstractions on the Doñana wetlands. Presentation to Ramsar COP-8 Valencia, November 2002.

Manzano, M., Custodio, E., Mediavilla, C. & Montes, C. 2005. Effects of localised intensive aquifer exploitation on the Doñana wetlands (SW Spain). In: Sahuquillo, A., Capilla, J., Martínez-Cortina, L. & Sánchez Vila, X. (eds) *Groundwater intensive use* International Association of Hydrogeologists, Selected Papers on Hydrogeology 7: 209-219.

Manzano, M.; Custodio, E.; Iglesias, M.; Lozano, E. 2008. Groundwater baseline composition and geochemical controls in the Doñana aquifer system (SW Spain). In : Natural Groundwater Quality. Editor: W.M. Edmunds y P. Shand. Blackwell. 216-232. ISBN: 978-14051-5675-2

Manzano, M.; Custodio, E.; Montes, C. & Mediavilla, C. 2009. Groundwater quality and quantity assessment through a dedicated monitoring network. The Doñana aquifer experience (SW Spain). In: Groundwater monitoring. Ph. Quevauviller, A.M. Fouillac, J. Grath & R. Ward (eds). John Wiley and Sons, Ltd. 273-287. ISBN: 978-0-470-77809-8.

Manzano, M., Custodio, E., Eburne, L. & Higuera, H. 2013 Relationship between wetlands and the Doñana coastal aquifer (SW Spain). In: Ribeiro, L. *et al.* (eds) *Groundwater and ecosystems*. International Association of Hydrogeologists. Taylor & Francis, London

Manzano, M., Higuera, H., Custodio, E., Puig, R. & Soler, A. 2016. Existence and transport processes of agricultural NO₃ and SO₄ in surface water and groundwater of La Rocina-Mimbrales-La Vera, Doñana (SW Spain). CD: HIDROGEOLOGÍA EMERGENTE. Aniversario 50 CIHS 2016. Nuevos campos

en la investigación y el desarrollo sostenible de las aguas subterráneas. Editado por: Fundación Centro Internacional de Hidrología Subterránea. ISBN 978-84-921469-2-5. Póster 22.

Manzano, S., Carrión, J.S., García-Murillo, P. *et al.* 2019 When dynamism is the baseline: long-term ecology of a Mediterranean seasonal wetland in the Doñana National Park (Southwestern Europe). *Biodiversity Conservation* 28, 501–522.

Molano-Leno L. *et al.* 2018 Investigating the Impact of Climate Change on Groundwater Recharge Using a High Precision Meteo Lysimeter in a Dune Belt of the Doñana National Park. In: Calvache M., Duque C., Pulido-Velazquez D. (eds) *Groundwater and Global Change in the Western Mediterranean Area*. Environmental Earth Sciences. Springer, Cham

Muñoz-Reinoso, J.C. & de Castro, F.J. 2005 Application of a statistical water-table model reveals connections between dunes and vegetation at Doñana *Journal of Arid Environments* 60, 663–679

Muñoz-Reinoso, J.C. 2001 Vegetation changes and groundwater abstraction in SW Doñana, Spain *Journal of Hydrology* 242, 197-209

Naranjo-Fernández, N., Guardiola-Albert, C., Montero-González, E. 2019 Applying 3D Geostatistical Simulation to Improve the Groundwater Management Modelling of Sedimentary Aquifers: The Case of Doñana (Southwest Spain) *Water*, 11, 39; doi:10.3390/w11010039

Naranjo-Fernández, N., Guardiola-Albert, C., Aguilera, H., Serrano-Hidalgo, C., Rodríguez-Rodríguez, M., Fernández-Ayuso, A., Ruiz-Bermudo, F. & Montero-González, E. 2020a Relevance of spatio-temporal rainfall variability regarding groundwater management challenges under global change: case study in Doñana (SW Spain) *Stochastic Environmental Research and Risk Assessment* doi.org/10.1007/s00477-020-01771-7

Naranjo-Fernández, N., Guardiola-Albert, C., Aguilera, H., Serrano-Hidalgo, C., & Montero-González, E. 2020b Clustering Groundwater Level Time Series of the Exploited Almonte-Marismas Aquifer in Southwest Spain *Water*, 12, 1063. doi:10.3390/w12041063

Naranjo-Fernández, N., Guardiola-Albert, C., Aguilera, H. *et al.* 2020c Relevance of spatio-temporal rainfall variability regarding groundwater management challenges under global change: case study in Doñana (SW Spain). *Stoch Environ Res Risk Assess.* doi.org/10.1007/s00477-020-01771-7

Olías, M., González, F., Cerón, J.C. *et al.* 2008 Water quality and distribution of trace elements in the Doñana aquifer (SW Spain). *Environmental Geology*, 55, 1555–1568 doi.org/10.1007/s00254-007-1106-y

Pain, D.J., Meharg, A., Sinclair, G., Powell, N., Finnier, J., Williams, R. & Hilton, G. 2003 Levels of cadmium and zinc in plants following the toxic spill from a pyrite mine, Aznalcollar, Spain. *Ambio*, 32, 1, 52-57

Paredes, I., Otero, N., Soler, A., Green, A.J. & Soto, D.X. 2020 Agricultural and urban delivered nitrate pollution input to Mediterranean temporary freshwaters *Agriculture, Ecosystems and Environment* 294, 106859

Pinto-Bazurco, J.F. 2020 *The Precautionary Principle* IISD Earth Negotiations Bulletin.

Ramírez, F., Rodríguez, C., Seoane, J., Figuerola, J., & Bustamante, J. 2018 How will climate change affect endangered Mediterranean waterbirds? *PLoS ONE* 13, 2: e0192702. Doi: /10.1371/journal.pone.0192702

Ramo, C., Amat, J.A., Nilsson, L., Schricke, V., Rodríguez-Alonso, M., Gómez-Crespo, E., *et al.* 2015. Latitudinal-Related Variation in Wintering Population Trends of Greylag Geese (*AnserAnser*) along the Atlantic Flyway: A Response to Climate Change? *PLoS ONE*, e0140181. doi:10.1371/journal.pone.0140181

Reyes, I., Casco, M.A., Toja, J. *et al.* 2008 Hydrological complexity supports high phytoplankton richness in the Doñana marshland (SW Spain). *Hydrobiologia* 614, 47–54 doi.org/10.1007/s10750-008-9535-5

Riba, I., DelValls, T.A., Forja, J.M. *et al.* 2003 Evaluating the Heavy Metal Contamination in Sediments from the Guadalquivir Estuary after the Aznalcóllar Mining Spill (SW Spain): A Multivariate Analysis Approach. *Environ Monit Assess* 77, 191–207. doi.org/10.1023/A:1015828020313

Sacks, L.A., Herman, J.S., Konikow, L.F. and Vela, A.L. 1992. Seasonal dynamics of groundwater-lake interactions at Doñana National Park, Spain. *Journal of Hydrology*, 136, 123-154.

Salvany, J.M.; Custodio, E. 1995. Características litoestratigráficas de los depósitos plio-cuaternarios del bajo Guadalquivir en el área de Doñana: implicaciones hidrogeológicas. *Rev. Soc. Geol. España*, 8, 1-2, 21-31. (In Spanish, but with English abstract and detailed geological sections).

Salvany, J.M., Cruz-Larrasoña, J., Mediavilla, C. & Rebollo, A. 2011 Chronology and tectono-sedimentary evolution of the Upper Pliocene to Quaternary deposits of the lower Guadalquivir foreland basin, SW Spain. *Sediment. Geol.* 241, 22–39.

Santoro, S., Sanchez-Suarez, C., Rouco, C., Javier Palomo, L., Carmen Fernandez, M., Kufner, M.B. & Moreno, S 2017 Long-term data from a small mammal community reveal loss of diversity and potential effects of local climate change *Zoology*, 63 5 515-523 DOI: 10.1093/cz/zow109

Serrano, L. & Fahd, K. 2005 Zooplankton communities across a hydroperiod gradient of temporary ponds in the Doñana National Park (SW Spain) *Wetlands* 25, 101–111

Serrano, L. & Serrano, L. 1996 Influence of Groundwater Exploitation for Urban Water Supply on Temporary Ponds from the Doñana National Park (SW Spain) *Journal of Environmental Management* 46, 229–238

Serrano, L., Díaz-Paniagua, C. Gómez-Rodríguez, C. Florencio, M., Marchand, M.-A., Roelofs, J.G.M. & Lucassen, E.C.H.E.T. 2016 Susceptibility to acidification of groundwater-dependent wetlands affected by water level declines, and potential risk to an early-breeding amphibian species *Science of the Total Environment*, 571, 1253–1261

Trick, T. & Custodio, E. 2004 Hydrodynamic characteristics of the western Doñana Region (area of El Abalarío), Huelva, Spain *Hydrogeology Journal*, 12, 321–335

Toral, G.M., Stillman, R.A., Santoro, S. & Figuerola, J. 2012 The importance of rice fields for glossy ibis (*Plegadis falcinellus*): Management recommendations derived from an individual-based model *Biological Conservation* 148, 1, 19-27

Tortosa, G., Correa, D., Sánchez-Raya, A.-J., Delgado, A., Sánchez-Monedero, M.A. & Bedmar, E.J. 2011 Effects of nitrate contamination and seasonal variation on the denitrification and greenhouse gas production in La Rocina Stream (Doñana National Park, SW Spain) *Ecological Engineering*, 37, 4, 539-548

UPC. 1999. Modelo regional de flujo subterráneo del sistema acuífero Almonte-Marismas y su entorno. Grupo de Hidrología Subterránea, Universidad Politécnica de Cataluña. Realizado para: Instituto Geológico y Minero de España. 144 pp + annex. (Unpublished).

Walton, M.E.M., Vilas, C., Coccia, C., Green A.J, Cañavate, J.P., Prieto, A., van Bergeijk, S.A., Medialdea, J.M., Kennedy H., King J. & Le Vay, L. 2015 The effect of water management on extensive aquaculture food webs in the reconstructed wetlands of the Doñana Natural Park, Southern Spain *Aquaculture* 448, 451–463

Williams, P., Biggs, J., Fox, G., Nicolet, P., and Whitefield, M. 2001. History, origins and importance of temporary ponds. *Freshwater Forum*, 17 (1) 7-15.

WWF 2019 Doñana, an aquifer on red alert Analysis of the “Report on the status of aquifers in the Doñana area. Hydrological year 2017-2018” by the Guadalquivir Hydrographic Confederation. WWF Spain.

WWF 2020 A lost decade. Report on the status of the Doñana aquifer July 2020. WWF Spain.

Yagüe, A. & Llamas, M.R. 1984. Simulación del flujo subterráneo del sistema acuífero del estuario del Guadalquivir en un perfil vertical. Primer Congreso Español de Geología. Tomo i. Segovia, pp. 435-451.

Zimmermann, J., Portillo, M.C., Serrano, L. *et al.* 2012 *Acidobacteria* in Freshwater Ponds at Doñana National Park, Spain. *MicrobEcol* 63, 844–855 doi.org/10.1007/s00248-011-9988-3

Annex VII: Progress with the implementation of the recommendations of the 2015 IUCN Reactive Monitoring Mission

| Recommendations made in the 2015 IUCN Reactive Monitoring Mission | Progress with implementation | New recommendation in the current report |
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| <p>Recommendation 1: Prepare a detailed implementation plan for the “Special Management Plan of the Irrigation Zones located to the North of the Forest Crown of Doñana” as soon as possible in a participatory manner to obtain the consensus and commitment of all key stakeholders including managers of Doñana National Park. Implementation should ensure the ecological needs for the conservation of Doñana are met whilst providing options to address social conflicts potentially arising from it, as noted in the IUCN mission report</p> | <p>Completed</p> | <p>Recommendation 1: To eliminate any possible risk to the OUV of the marshes and groundwater-fed ecotones derived from groundwater extraction from the Almonte-Marismas detritic aquifer (Doñana aquifer), and given the crucial role of the CHG in achieving Good Status of the aquifer by 2027, consistent with a precautionary management approach, the mission recommends to:</p> <ul style="list-style-type: none"> - increase the resources available to the CHG, including recent technologies, to strengthen monitoring, surveillance and enforcement to ensure the accelerated and urgent closure of all illegal wells and illegally irrigated farmland; - continue the urgent implementation of the Special Management Plan of the Irrigation Zones located to the North of the Forest Crown of Doñana, in its current form, in close cooperation with all key stakeholders, to ensure the recovery of the aquifers to Good Status as soon as possible, and by no later than 2027; - ensure that any substitution of groundwater by surface water is directed to those areas most in need, and that any substitution is carefully managed and considered in the context of any possible impacts on the OUV of the property as per the <i>Operational Guidelines</i> of the World Heritage Convention, including through EIAs, as required; - ensure that projects including water transfers, dam extensions, and licenced groundwater abstraction have no |

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| | | <p>negative impact on the OUV of the property, by undertaking appropriate EIAs in line with the IUCN World Heritage Advice Note on Environmental Assessment⁷⁹;</p> <ul style="list-style-type: none"> - encourage, incentivize and provide financial support if needed for the adoption of sustainable agriculture practices (especially concerning drip irrigation and reduction in use of single-use plastics) by farmers of the Doñana area. |
| <p>Recommendation 2: In line with Decision 38 COM 7B.79 of the World Heritage Committee, and responding to the decision of the Supreme Court of Spain on the matter, requests the State Party to urgently make a permanent and unequivocal commitment to abandon plans for the deepening of the Guadalquivir River. An absence of such a commitment should be seen as a trigger to inscribe the property in the List of World Heritage in Danger.</p> | <p>Ongoing. The State Party made a commitment not to allow the deep dredging project of the Guadalquivir River, but the removal of any reference to deep dredging from the new Guadalquivir Basin Hydrological Plan (2021-2027) is not yet available.</p> | <p>Recommendation 7: Because the State Party's commitment to abandon the deep dredging project of the Guadalquivir River cannot be considered 'permanent' or 'unequivocal' whilst a reference to any deep dredging remains in the new Guadalquivir Basin Hydrological Plan, the mission team recommends that the State Party continues honouring its previously made commitments and removes this project from the revised Guadalquivir Basin Hydrological Plan (2021-2027).</p> |
| <p>Recommendation 3: In line with Decision 38 COM 7B.79, and following the decision by the regional government of Junta de Andalucía to suspend issuing a Unified Environmental Authorization for gas extraction and storage projects proposed in the vicinity of the property, until an Environmental Impact Assessment with a detailed evaluation of the possible individual and cumulative impacts is prepared, urges the</p> | <p>Completed.</p> | <p>Recommendation 9: Noting that the mission did not receive any additional information on the status of the gas storage projects, consistent with a precautionary management approach the mission recommends that systematic monitoring of the possible impacts and risk assessments of Rincon-2 and Marismas-3 on the hydrology and OUV is put in place, and that a summary of those findings is included in future state of conservation reports. The mission also recommends for the State Party to ensure that the</p> |

⁷⁹IUCN World Heritage advice note on Environmental Assessment (November 2013) <https://www.iucn.org/theme/world-heritage/resources/iucn-policies-world-heritage/environmental-assessment>

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| <p>State Party to ensure that the potential impacts on the Outstanding Universal Value, including the integrity of the property, are thoroughly assessed in conformity with IUCN’s World Heritage Advice Note on Environmental Assessment.</p> | | <p>individual and cumulative impacts on the property’s OUV of any development or infrastructure project in or near the property are thoroughly assessed in conformity with IUCN’s World Heritage Advice Note on Environmental Assessment.</p> |
| <p>Recommendation 4: Noting with utmost concern the decision to re-open the Aznalcóllar mine, the State Party should ensure that potential impacts on the Outstanding Universal Value, including the integrity of the property are thoroughly assessed prior to any recommencement of operations, in line with IUCN’s World Heritage Advice Note on Environmental Assessment, and ensure that no impacts to the property arise from the use of water by the mine, and that a clear risk preparedness plan and associated resources are in place to enable a rapid response in case of any accidents.</p> | <p>Ongoing. The reopening of the Aznalcóllar mine is still in an evaluation phase and possible impacts are being evaluated according to the IUCN World Heritage Advice Note on Environmental Assessment.</p> <p>A clear risk preparedness plan and associated resources is not yet in place.</p> | <p>Recommendation 8: Noting that the mission did not receive any additional information on the status of the potential reopening of the Aznalcóllar mine, it recalls the 2019 Committee Decision⁸⁰: “Further recalling the need for great caution with regards to re-opening the former Aznalcóllar mine, and urges the State Party to ensure that systematic risk preparedness and emergency action plans take into account the property and to submit these analyses for review by IUCN, as soon as they become available and before a decision on re-opening the mine is made”.</p> |
| <p>Recommendation 5: Expand the research activities taking place in Doñana by the Doñana Biological Station to better assess the status and trends of ecosystem and the key attributes of the Outstanding Universal Value, including the integrity of the property, and assure the necessary resources to support this research are provided.</p> | <p>It is unclear what indicators should be used to evaluate the ‘expansion’ of research activities. The mission was not able to evaluate progress in this recommendation.</p> | <p>Recommendation 3: Although there is a basic understanding of the hydrology of the region, some uncertainty remains concerning possible impacts of water use in the vicinity of the property. Consequently, an increased research effort is urgently required to understand the relationship between the hydrology and ecology of the area, as this is essential to underpin sound management. The mission therefore recommends that future research should include a focus on defining the water requirements of the property to maintain its OUV. This necessitates quantification of relationships between the ecological features that define the OUV</p> |

⁸⁰<http://whc.unesco.org/en/soc/3909>

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| | | and hydrological components (e.g. rainfall, evaporation, river flows and groundwater levels). Construction of an eco-hydrological model of the World Heritage property based on the results of the research, and consideration of the possible need of a buffer zone, including the surrounding catchment basin (covering the Ramsar Site and EU Natura 2000 area), would allow the impacts of various scenarios to be defined, including abstraction of groundwater, removal of trees, building of dams and climate change. The model should incorporate appropriate indicators linking the hydrology to the ecological response of the property. A detailed list of recommended research topics can be found in the mission report (Chapter 3.3.8). |
| <p>Recommendation 6: Assess the potential impacts from climate change on the Outstanding Universal Value of the property and define adaptation and mitigation measures required to maintain the conditions of integrity of the property, particularly in the processes associated with the long-term hydrological regime of the property.</p> | Not yet started. | <p>Recommendation 4: Taking into account the likely possible impacts from climate change on the values of the property, the mission recommends the creation of a strategic plan that defines conceptually:</p> <ul style="list-style-type: none"> - The extent to which a reduction in water consumption is required in response to climate change impacts to conserve and protect the OUV of the property (in case further studies would reveal close linkages between the detritic aquifers and the OUV); - The extent to which alterations to the OUV and ecological character of the wetland ecosystem due to climate change can be expected, along with any adaptation and mitigation measures that can be implemented to maintain the conditions of integrity of the property and increase its resilience. |
| <p>Recommendation 7: In line with Decision 38 COM 7B.79 of the World Heritage Committee, prepare a Strategic Environmental Assessment</p> | Ongoing | <p>Recommendation 6: Noting that the mission did not receive any additional information on a Strategic Environmental Assessment (SEA) of the Guadalquivir river basin, it recalls the 2017 Committee</p> |

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| <p>of the Guadalquivir River Basin, particularly in relation to water supply scenarios, and agricultural, industrial and commercial development, to enable the State Party to identify key measures to strengthen planning, regulation and implementation of development projects located outside of the property to avoid impacts to its OUV including the integrity of the property. Such assessment has the potential to facilitate preparing regular updates on the state of conservation of the property.</p> | | <p>Decision as follows⁸¹: “Requests furthermore, the State Party to present an updated SEA for the Guadalquivir River Basin to ensure that it includes a specific chapter on the OUV of the property, and submit it to the World Heritage Centre.”</p> |
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⁸¹<http://whc.unesco.org/en/soc/3556>