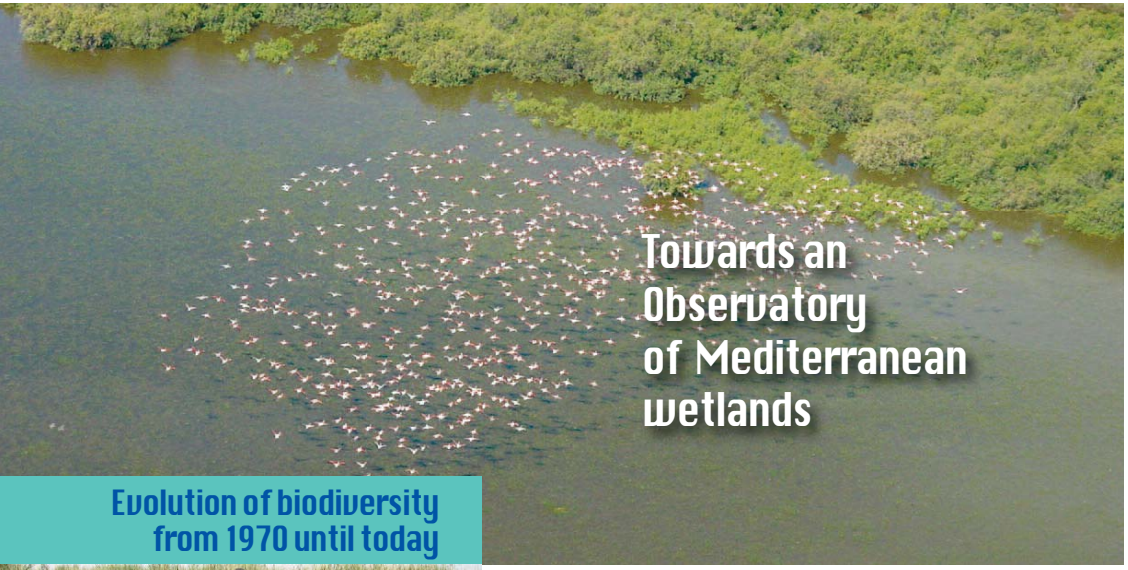


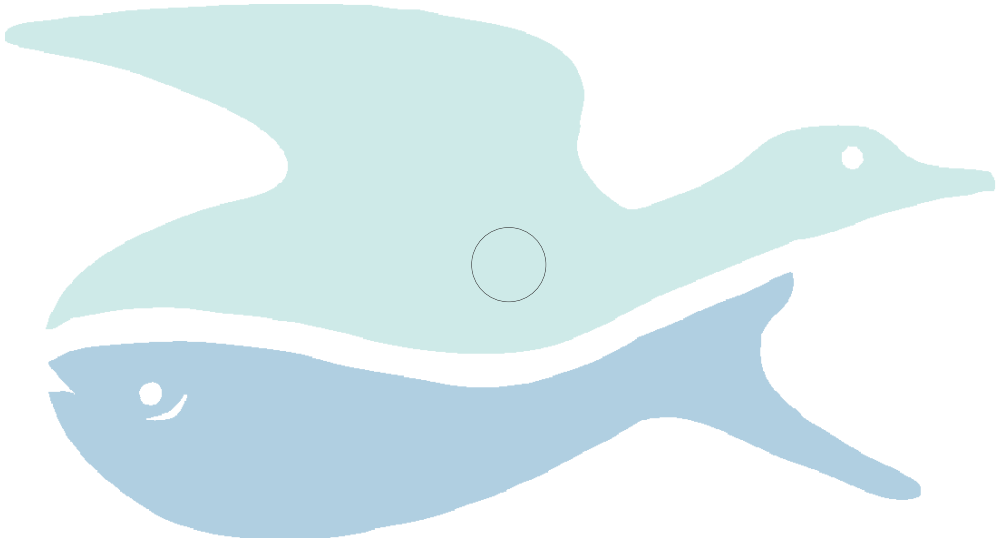
Towards an Observatory of Mediterranean wetlands

Evolution of biodiversity from 1970 until today

TOUR DU VALAT

MedWet

FULL REPORT



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For more than 50 years, the Tour du Valat, a public-benefit Foundation, has been developing multidisciplinary research programmes on the functioning of Mediterranean wetlands. Its teams have dedicated themselves to "halting the loss and degradation of these habitats and their natural resources, restoring them and promoting their rational use".

The author, Thomas Galewski, Doctor of Evolutionary and Ecological Biology, works on an Observatory of Mediterranean wetlands project at the Tour du Valat. By training and personal interest, he is especially concerned by the state of conservation of biodiversity in these habitats.

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PREFACE

S. ARDUES

Wetlands. The ecosystem that contributes the most to the development of humanity is also that which is destroyed the most relentlessly and at an unprecedented pace. What a fatal irony! In the Mediterranean, world biodiversity hotspot, this reality is taking on particular meaning faced with the increasing scarcity of water resources and the huge and constantly growing pressures it is sustaining.

Since 1991, the MedWet Initiative has catalysed forces and federated political support to provide concrete responses to these challenges. Yet the situation is more urgent than ever. Resolute, concerted and targeted action must be taken. But for this action to be appropriate and effective, it must be based on in-depth, up-to-date and scientifically validated knowledge concerning the state of the wetlands and their evolution. That is the ambition of the Observatory of Mediterranean wetlands: to develop our knowledge of the state and evolutionary trends of these habitats via a broad network, share information, provide guidance for action and contribute to public policies.

By proposing an evaluation of the state of the biodiversity of the Mediterranean Basin wetlands and their evolution since 1970, this brochure presents an important initial contribution to this "Observatory", which is currently taking form. This study, based on huge amounts of scientific data, has been produced using the Living Planet Index, developed by the WWF, applied to Mediterranean wetlands.

Its messages are clear:

- *Mediterranean wetlands and their biodiversity are threatened, especially in the east of the Basin where numerous vertebrate populations are in decline.*
- *Information is sketchy, fragmentary and uneven in quality; whole areas of wetland biodiversity are not being monitored and may disappear in a context of total indifference.*
- *But there is hope. The measures set up 30 years ago in the west of the Mediterranean Basin for the protection and management of certain threatened species are now bearing fruit.*

The deterioration of wetlands is not ineluctable. It's up to us to take up the challenge!

Jean Jalbert
Director General of the Tour du Valat

Mediterranean wetlands, an ecosystem in danger

Marshes, lakes, ponds, lagoons, estuaries, peat bogs, alluvial valleys, pools, streams... these many names denote one abundant life source. For time immemorial, these habitats have provided man with vital resources and services - water, food, plants, animals, a wide range of materials and access routes - which are fundamental to social, economic and cultural activities. These habitats have structured the landscapes of the Mediterranean Basin, determined the location of human settlements and enabled the development of the "hydraulic civilisations" at the origin of the flowering of the Mediterranean, cradle of civilisations. A subtle and dynamic balance became established over the thousands of years during which man was able to exploit these resources without endangering them.

Yet, in spite of the services that they give the community, and despite the value they represent, Mediterranean wetlands have long been considered hostile to man. And when technology made it possible to throw off natural constraints, they were "cleaned", drained and filled in. Their global surface area has been in constant decline. Now most of these wetlands are threatened by water management measures, pollution, climatic disturbances and the introduction of new species. It is estimated that about half of Mediterranean wetlands have been destroyed in the last hundred years ... and all projections show that these pressures are set to increase in the coming decades.

J. JALBERT

A threatened lagoon

Landfill and pollution in a lagoon in Morocco.

MedWet, pioneer in regional mobilisation for wetlands

Over the last 50 years, and especially since the adoption of the Ramsar Convention on Wetlands in 1971, awareness-raising on the importance of these ecosystems has constantly increased. Following the Grado Conference in 1991, the MedWet Initiative was launched with the primary goal of contributing to the conservation and rational use of Mediterranean wetlands. This long-term collective action, led by the Mediterranean Committee for Wetlands (MedWet/Com), brings together 25 countries, 3 international conventions, the European Union, the UNDP, and 7 NGOs and scientific centres. In 1997, MedWet became the first regional initiative under the aegis of the Ramsar Convention. Since then, it has been recognised as a model of regional co-operation that has inspired many other initiatives around the world.

MedWet is currently establishing a new strategic vision and an updated work plan. But faced with the scale of the challenges and the swiftness of change, it must regularly revise its agenda in order to target its actions better and maintain its technical and political pertinence.

The Observatory of Mediterranean wetlands: mobilising knowledge and clarifying decisions

In order to respond to these challenges, in keeping with MedWet's pioneering spirit, some years ago the idea of an "Observatory of Mediterranean wetlands" was born. The objective: to supply decision-makers, first in line the Mediterranean Wetlands Committee, with regularly updated summary information based on the best scientific knowledge. Thus mobilised, decision-makers will be able to adapt strategies and take appropriate action.

This implies developing a huge technical and scientific partnership; collecting, processing and summarising information on the state of wetland evolution and afterwards diffusing it in a suitable form. This Observatory, which is designed to be an integral part of the MedWet strategic planning process, is taking shape under the impetus of the Tour du Valat. Many scientific and technical organisations are working together on this system or have undertaken to do so. Several studies calling on the skills of various organisations have been launched.

This is shown in the following chapters, which are a summary of the studies carried out in this partnership, about which there is a detailed report contained in the CD-Rom that come with this brochure.

The evolution of wetland biodiversity: the Living Planet Index

The Mediterranean wetlands are among the hotspots of world biodiversity. They are home to communities of original species, characterised both by a high rate of endemism - 64% of Mediterranean amphibians are found only in these biotopes - and by their adaptation to unpredictable climatic conditions. Subjected to enormous anthropogenic pressures, the Mediterranean region has already seen the vast majority of its wetlands disappear, mainly during the 20th century, and the situation could continue to deteriorate in the coming decades. It is thus a matter of urgency to gather all available data in order to draw up an initial assessment of the recent evolution of the biodiversity of these key biotopes, and then to set up the appropriate conservation actions.

Since 1998, the Living Planet Index has been the reference index used by the World Wide Fund for Nature (WWF) to measure the state of conservation of world ecosystems. This index is based on the trends collected from 1970 to the present, concerning thousands of vertebrate populations around the world. In collaboration with WWF International and the Zoological Society of London (ZSL), we applied this methodology to the wetlands of the Mediterranean region alone. We have thereby been able to gather together the trends of more than 1400 populations representing 301 species of birds, mammals, amphibians, reptiles and fish monitored in the wetlands of a region extending from Morocco to Turkey and encompassing the countries encircling the Black Sea (figure 1).

TOUROVALAT

Research programme
Monitoring of European Pond Terrapin populations in the Camargue.

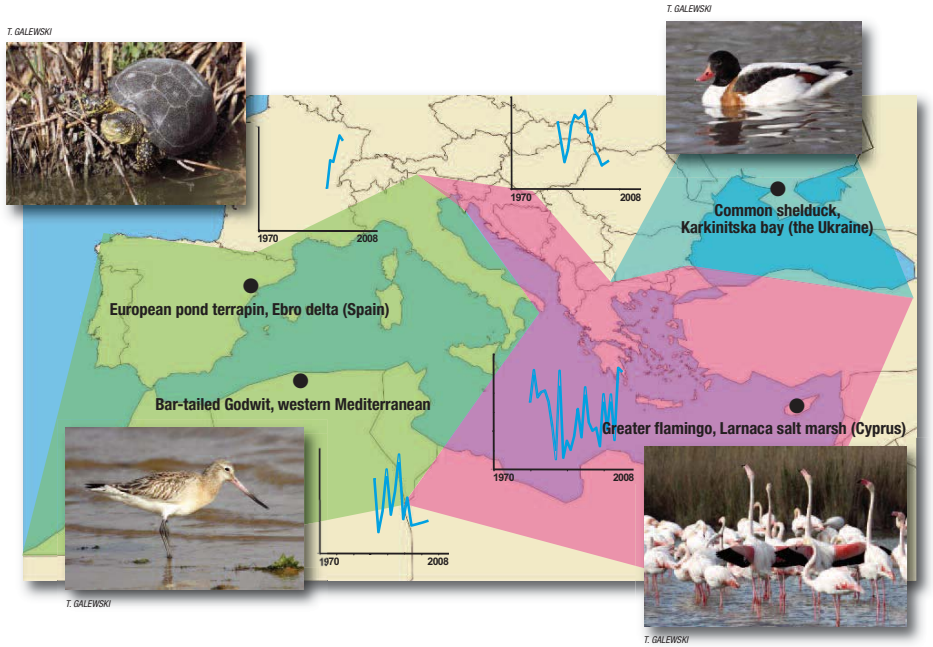


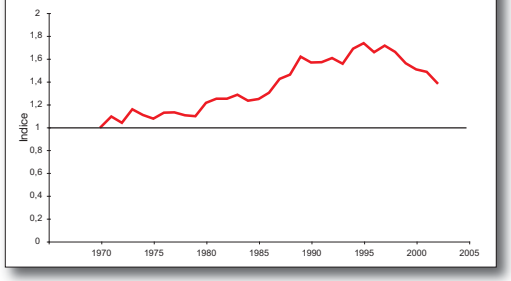
Figure 1:
Examples of some populations included in the calculation of the Living Planet Index for Mediterranean wetlands.
The coloured areas indicate the limits of the geographical area studied, which can be subdivided into three sub-regions: west-Mediterranean (Portugal, Spain, France, Italy, Malta, Morocco, Algeria, Tunisia) in green, east-Mediterranean (Slovenia, Croatia, Serbia, Montenegro, Albania, Macedonia, Greece, Turkey, Cyprus, Syria, Israel, Lebanon, Jordan, Egypt, Libya) in red and the Black Sea (Bulgaria, Romania, Moldavia, Ukraine, Russia, Georgia) in blue.

Recent evolution globally favourable for water birds

The Living Planet Index - for all species combined - of the Mediterranean wetlands shows an increase of 38% from 1970 to 2002[1] (figure 2). This indicates that the species monitored have increased their population by one third overall. This initial result is therefore good news, suggesting that the loss of biodiversity has come to a halt. However, this optimistic observation applies essentially to water birds. Most of the monitoring efforts having been applied to gregarious water birds, which are easier to count, the other groups of vertebrates (amphibians, reptiles, fish and mammals) are under-represented in the database upon which the Living Planet Index is based (figure 3). Even though the low number of populations monitored does not allow precise interpretation of recent evolution at the Mediterranean Basin scale, the biodiversity index of fish, reptiles, amphibians and mammals suggests a decline, as is observed elsewhere in the world. Since birds seem to be more resistant to anthropogenic pressures, better knowledge of the trends of the other taxonomic groups is now seen as essential.

As birds represent major social and economic concerns, they have been the first to benefit from conservation measures. The Birds Directive (1979), applied within the European Union, made it possible to register a large number of species on the protected species list, bringing an end to persecution campaigns against fish-eating birds (grebes, herons, cormorants). Likewise, the demand for more rational hunting practices - no hunting during the pre-breeding migration and nesting periods - together with the adoption of specific management measures have by and large enabled water bird populations to be maintained.

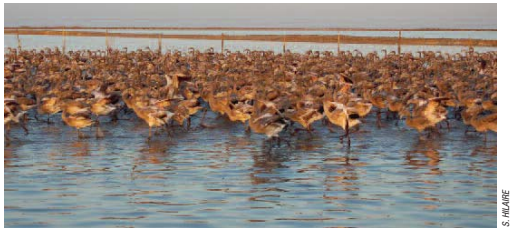
Figure 2: Living Planet Index of the Mediterranean wetlands



[1] *It should be noted that the Mediterranean and Black Sea data for the last few years are too incomplete to obtain a trend after 2002..*

Greater Flamingo

The protection of the main flamingo colonies allowed a strong increase of the species within the Mediterranean basin.

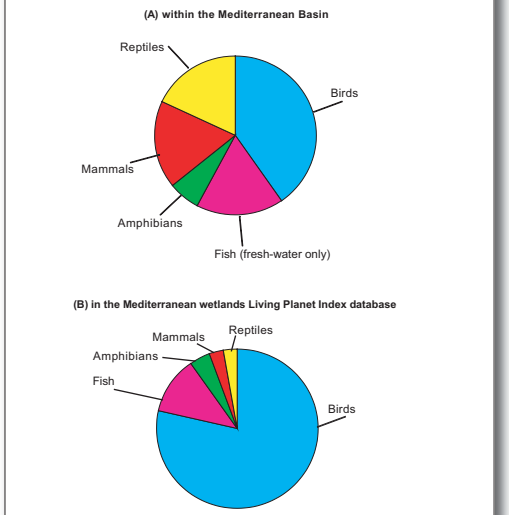


S. INLARIE

It's true that, from the 1970s, the increase in scientific knowledge and the media coverage of environmental problems have totally transformed our perception of nature. Considered up to then as insalubrious habitats, wetlands have started to be perceived as zones rich in natural resources that must be managed sustainably (Ramsar Convention, EU Habitats Directive...). Paradoxically, whilst many wetlands have been drained or destroyed, regional planning has also resulted in the creation of many artificial wetlands managed for agricultural or aquacultural purposes (dammed reservoirs, rice fields, fish-farming ponds).

Generally home to scarcer biodiversity than equivalent natural areas, they nonetheless represent interesting surrogate habitats for opportunistic species.

Figure 3: Relative abundance of various classes of vertebrates (in number of species)within the Mediterranean Basin



Contrasting trends between the Western Mediterranean and the entire Eastern Mediterranean / Black Sea area

To refine this initial analysis, indices have been calculated independently for three Mediterranean sub-regions that differ in terms of their bio-geographical and socio-economic history (figure 1). Biodiversity has evolved very differently in the western and eastern parts of the Mediterranean Basin (figure 4). Whilst the species tied to wetlands indicate an increase surpassing 150% in the early 21st century in the west, they show a decline of 30 to 40% elsewhere. This negative trend did not occur at the same time in the two regions: the decrease in the index can be seen from the early 1980s in the Black Sea, whilst it occurs only from the middle of the 1990s, although very rapidly, in the Eastern Mediterranean.

These opposing trends between west and east can be found in the indices obtained for three orders of birds, which form the main contingents of water birds that reproduce and winter in the Mediterranean region (figure 5). The Charadriiformes - gulls, terns and shorebirds - and Ciconiiformes - herons, ibises and storks - have experienced a veritable demographic explosion in the Western-Mediterranean in the past 40 years, with their nesting populations increasing tenfold! This observation can be explained by the reinforcement of populations of species that have long been present there (Little Egret, Yellow-Legged Gull) but also and above all through the massive establishment of species that until recently were limited to the eastern part of the Mediterranean Basin (Great Egret, Mediterranean Gull). Although less spectacular, the Anseriformes - swans, geese and ducks - have also experienced an increase in their index, mainly due to the rapid growth of several, once rarer species (Common Shelduck, Greylag Goose) rather than the development of duck populations.

Figure 4: Living Planet Indices for the Western Mediterranean, Eastern Mediterranean and Black Sea, 1970-2008

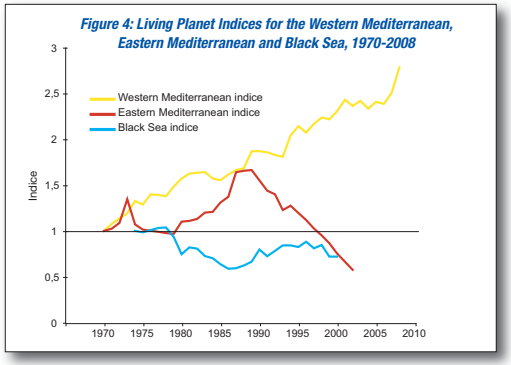
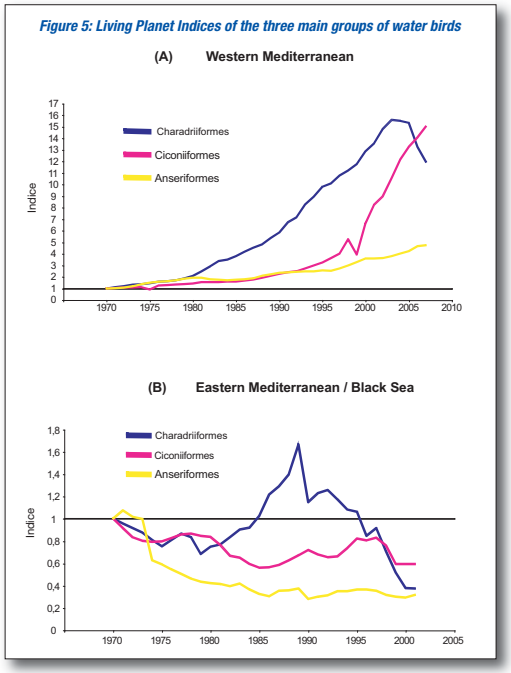


Figure 5: Living Planet Indices of the three main groups of water birds



The situation is much less favourable in the Eastern Mediterranean / Black Sea areas, where a fall in the index ranging from 40 to 70% can be seen for the groups of birds studied. For example, several species whose strongholds had up to then been in the east of the Mediterranean region saw their populations considerably reduced at the end of the 20th century: Gull-Billed Tern, Glossy Ibis, Marbled Teal....

Marbled Teal

The Marbled Teal, a threatened species, is continuously declining in its eastern strongholds.

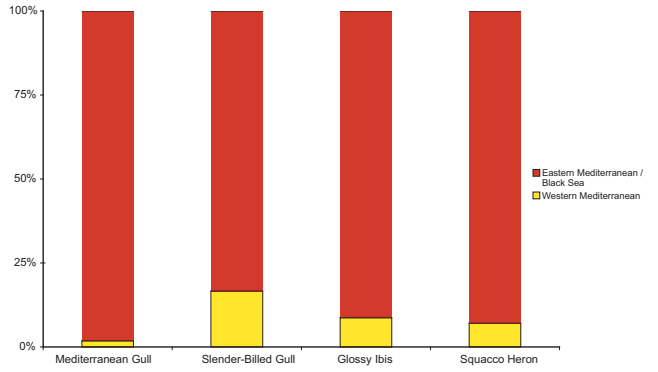
F. VEYRUNES

The causes of the increase in the west and decline in the east

How can such differing trends between the west and east of the Mediterranean region be explained? Some of the countries of the west-Mediterranean having undergone development earlier, the great drainage operations of the wetlands there took place prior to the 1980s. Later, realisation of the value of these habitats, together with an effective protection of the last natural areas, allowed a partial recovery of the animal populations that were probably at their minimal level in 1970. With regard to certain groups of birds in an especially positive phase, such as herons or gulls, the hypothesis of a transfer of eastern populations towards the west of the Mediterranean Basin can be made. The filling in of marshes, overgrazing and the pollution of the Black Sea, which all increased at the end of the last century, may have been the reasons for some of the eastern populations having taken up new nesting areas. But it's also plausible that the west-Mediterranean region has become more favourable to the establishment of these new species. The banning of some particularly dangerous pesticides (DDT) in the 1970s in the more developed countries probably helped the return of species situated at the top of the food chain. However, the increase in populations of opportunistic species such as herons and gulls is not necessarily synonymous with a better state of conservation of the natural habitat. These birds have been able to take advantage of the eutrophication of aquatic habitats, which have become more productive, and/or of discards from trawling, as seen by the demographic explosion of Audouin's Gull in the Ebro Delta (Spain).

On the other hand, the decline observed in the east-Mediterranean / Black Sea area can be connected to more belated economic development of this region. Combined with strong human demographic growth, this results in increasingly drastic pressure on water resources. The rapid development of agriculture, manufacturing industry and tourism is leading to the disappearance and deterioration of many wetlands, and the species that depend on them are regressing. Finally, the negative trend observed in the east of the study zone is all the more worrying, as this region is home to most of the reproducer populations of many species of waterfowl, to the extent that a decrease in these populations was probably not compensated by the growth rate, even if strong, recorded in the west of the Mediterranean Basin (figure 6).

Figure 6: Comparison of the current populations of the Western Mediterranean versus Eastern Mediterranean / Black Sea for four species having transferred their nesting area towards the west



M. THIBAULT

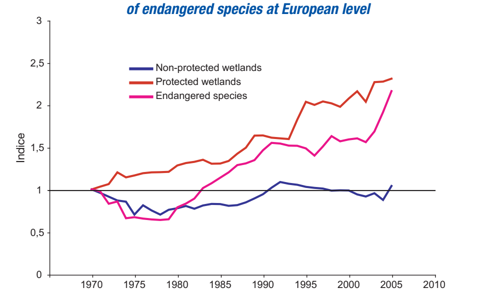
Glossy Ibis

The Glossy Ibis, a threatened species, is spreading strongly in the west of the Mediterranean Basin, but its major strongholds are still confined to the east of the region, where it is in decline.

Conservation efforts bearing fruit

The International Ramsar Convention (1971), the MedWet Initiative (1991), the Barcelona Convention (1976) and its protocol on specially protected areas and biological diversity (1999), and the Agreement on the Conservation of African-Eurasian Migratory Water birds (AEWA, 1999) have all been effective driving forces in identifying and protecting wetlands of major importance in the Mediterranean. Here as well, protecting the important sites is easier in certain advantaged countries, which are broadly equipped with protection policies for natural areas (France, Italy, Spain), than in the majority of countries of the east and south of the Mediterranean region. Even though the level of protection can vary considerably among different wetlands, vertebrate communities are clearly benefiting from the change in status of their habitats. For example, the indices obtained independently for protected and unprotected sites do not show the same trend, as the biodiversity of the latter is not increasing (figure 7).

Figure 7: Living Planet Index of protected and non-protected wetlands, and of species registered on the lists of endangered species at European level



The establishment of lists of threatened species that should benefit from priority actions for their conservation has also visibly had a positive impact on their dynamics. Figure 7 shows an index calculated solely for the populations belonging to species classified as vulnerable or in danger of extinction on the red list of the IUCN or the SPEC (Species of European Concern) list of Birdlife. We can see that the decline of these species reversed from 1980. Their index now shows an increase higher than that of the Living Planet Index, all species combined (figure 2). The species considered endangered benefit more often than not from specific conservation actions that result, among other things, in the restoration of favourable ecological conditions and in reintroduction operations (Majorcan Midwife Toad, Crested Coot, Purple Swamphen)
The situation is undoubtedly much more of a problem for the freshwater fish endemic to the Mediterranean Basin, which, in addition to having to deal with the deterioration of their habitat (pollution, drainage, construction of hydraulic dams), are faced with the introduction of a growing number of species of non-native fish that are potential competitors or predators. It is within this group that we note the extinction of seven endemic species over the last few decades.

Purple Swamphen

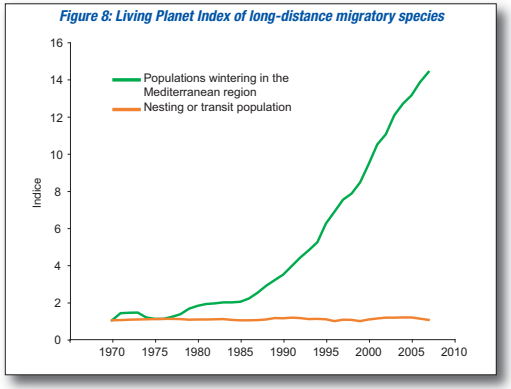
The Purple Swamphen is limited to a few wetland zones in Morocco, Spain, Sardinia, Turkey and Algeria. Following reintroduction operations, the species is gradually in the process of resettling regions from which it had disappeared for more than a century (Catalonia, Southern France).

T. GALEWSKI

What future for the biodiversity of Mediterranean wetlands and their monitoring?

How will the biodiversity of Mediterranean wetlands evolve over the next century, especially in the current context of climate change? An initial consequence of these changes can already be seen regarding long-distance migratory birds, which usually spend the winter in sub-Saharan Africa after having reproduced in the Palaearctic. For these species, the populations wintering in the Mediterranean region, and which therefore do not cross the Sahara, have increased by a factor of 14 since 1970 (figure 8).

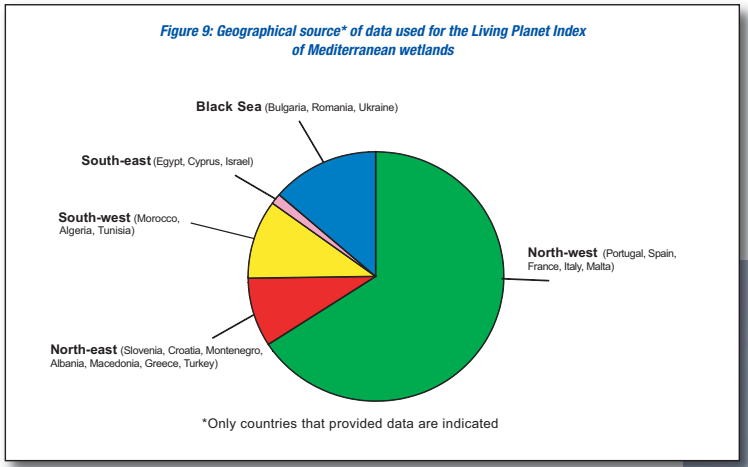
Figure 8: Living Planet Index of long-distance migratory species



Long-distance migratory species are nonetheless not in a positive phase, as the index of their populations are nesting or on migratory stopover did not increase over the same period. For example, some partial migrators have become sedentary (Little Egret), whilst some populations of central or northern Europe now winter in the Mediterranean, which had previously been only a rest area on their migratory path (Little Ringed Plover, Squacco Heron). The importance of the Mediterranean wetlands could increase in the future, especially if the deterioration of Sahelian African aquatic ecosystems continues at its current pace.

In order to measure and anticipate such changes, the long-term monitoring of populations must be continued and developed. The setting up of a Living Planet Index for Mediterranean wetlands has made it possible to draw up an initial assessment of such needs. The first observation is that there is too little accessible data from the east and south of the Mediterranean region (figure 9).

Figure 9: Geographical source of data used for the Living Planet Index of Mediterranean wetlands*



*Only countries that provided data are indicated

European White Stork

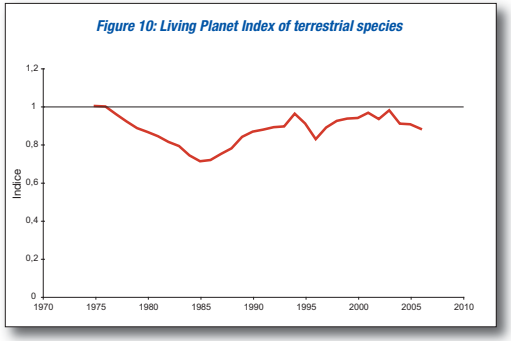
Still considered as a great trans-Saharan traveller, the European White Stork has nonetheless become a common winter sight in the wetlands of the Mediterranean Basin.

T. GALEWSKI

Yet that is where the situation seems to be the most worrying at the present time. The development of biodiversity monitoring, accompanied by the centralisation and publication of results, will be a priority for all countries so that an assessment of the state of conservation of wetlands can be drawn up at any time. The second observation is that the monitoring of populations concerns essentially birds, to the detriment of other classes of vertebrates. As we have seen, birds seem to adapt rather well to the transformation of their biotopes and are not always good indicators of the qualitative evolution of their habitats. The monitoring of other organisms - amphibians, fish or odonata - in closer contact with the aquatic habitat should thus be reinforced. Finally, it should be noted that the species occupying land habitats adjacent to wetlands are generally seldom considered in monitoring studies. Some of them are nonetheless specific to habitats that are generally above water level but directly associated with wetlands (riverine woodlands, saline grasslands with salicornia, alluvial plains) The limited data available suggests a reduction in biodiversity in these habitats (figure 10), a direct consequence of the conversion of these spaces into agricultural and urban zones.

With its simple methodology, the Living Planet Index is proving an efficient tool for rapidly measuring the state of conservation of a natural area on a continual basis, from a global to a very local scale, such as that of a park or reserve (see the example of the Camargue, page 22). In addition to showing the results of conservation efforts that have already been made, this index demonstrates the uneven nature of the available information in order to orient new monitoring programmes. Despite their possible limits or biases, such tools are indispensables for informing the general public and decision-makers about the evolution of biodiversity. It could be to the advantage of the Observatory of Mediterranean wetlands and the local observatories to be based on such integrated indicators as the Living Planet Index.

Figure 10: Living Planet Index of terrestrial species



T. GALEWSKI

Western Green Lizard

Terrestrial species are seldom taken into account in the monitoring programmes.

Technical note on the calculation of the "Living Planet Index"

The data used for calculating the index come from various sources published in scientific journals, the activity reports of protected areas or the websites of NGOs. These data are generally species counts or population estimations for a given site (for example a park or reserve), or a larger geographical area (a country or bio-geographical area). The time series used must be represented by at least two measurements (generally more) between 1970 and 2008, in order to determine a trend between these two points.

For a single population, the measurements can come from different sources, on the condition that the methodologies used are comparable. Plants and invertebrates are not taken into account because there are too few time series available.

During the analysis, the same weight is given to each species, so that, for the species for which data coming from several populations exist, an average of the different trends is calculated. As for the index itself, it reflects the average trend observed for all species. For example, a 100% increase in the index means that, on average during the period considered, the population of a species doubled. Obviously, this is only an average trend, with some species possibly having declined and others having increased at a rate above or below 100%.

Before the Living Planet Index is calculated, the species are distinguished according to their geographical location: Western Mediterranean or Eastern Mediterranean / Black Sea. If the data were not grouped this way, the index would then be dominated by Western Mediterranean species and not be representative of overall biodiversity. An index was calculated for each of these two batches of data. The Living Planet Index of Mediterranean wetlands is the mathematical average of these two indices.

Focus on the Camargue (France)

Before flowing into the sea on the north shore of the Mediterranean, the Rhône forms a huge 140,000-hectare delta, the Camargue. It is a wetland of international significance, whose fauna and flora benefit from many monitoring programmes, some of which date back more than 50 years. The abundance of data available today concerning the Camargue makes it possible to follow and understand the evolution of biodiversity at a local level.

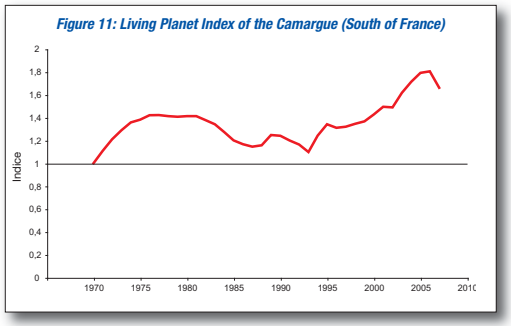
The "Camargue" Living Planet Index shows a globally positive trend, with a 65% increase in the index from 1970 to 2007 (figure 11).

T. GALEWSKI

Stripeless-Tree-Frog
New monitoring programmes will soon supply information on the evolution of amphibian populations in the Camargue

This result ties in with the positive dynamic observed throughout the western region of the Mediterranean Basin. However, a finer analysis, produced in function of major types of ecosystems or groups of species, makes it possible to examine more carefully and qualify the biodiversity trend in the Camargue.

Figure 11: Living Planet Index of the Camargue (South of France)

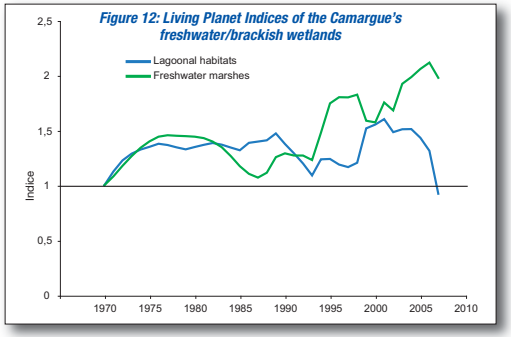


Increase in freshwater populations

The species using the Camargue's freshwater aquatic habitats are mainly linked to marshes of fluvio-lacustrine origin and some to the artificially flooded habitats that have partially replaced them (rice fields, irrigation canals).

These are the species that are experiencing the strongest expansion, nearly 100% over a 37-year period (figure 12). The origin of their dynamism can partially be found in the increase of surface area of the protected wetlands in the Camargue and in their protective management, together with the adoption of water and hunting management of the marshes. In order to keep the habitats attractive for waterfowl, most of the hunting marshes are intensively managed and kept flooded all year. The maintenance of abundant and stable resources over time has benefited some of the animal communities, especially water birds. Thus, despite significant catches (estimated at 150,000 ducks and coots each year), the Camargue remains a wintering area of foremost importance for these birds, with populations that fluctuate, but are apparently stable in the long term (figure 13). Ciconiiforme populations, especially herons, have sharply increased, perhaps helped by the appearance of a new and very abundant food resource: the Louisiana Crayfish. But this evolution has probably contributed to reducing the uniqueness of the Camargue marshes, notably by affecting the populations of species adapted to summer drought, though with little impact on the overall index.

Figure 12: Living Planet Indices of the Camargue's freshwater/brackish wetlands



T. GALEWSKI

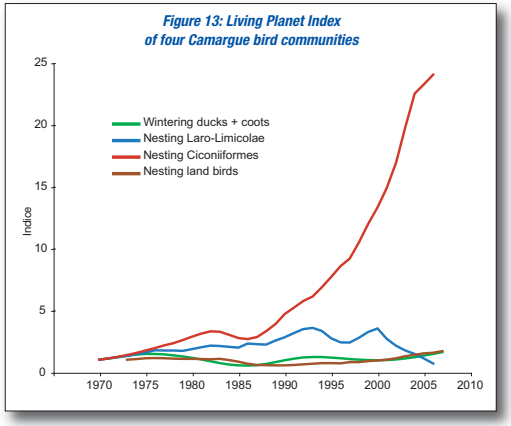
Gadwall
The freshwater marshes of the Camargue are of international importance for the Gadwall.

Recent conservation problems for the laguno-marine Camargue

After continuing at a high level since the middle of the 1970s, the index for the Camargue brackish habitat (lagoonal and saline meres) is currently decreasing (figure 12).

An example of the difficulties encountered by the communities inhabiting these habitats is illustrated by nesting Laro-Limicolae. These birds (gulls, terns and waders) are a major feature of the whole laguno-marine Camargue during the breeding season. They form large multi-species colonies on the islets of lagoons and salinas. Their index shows that the positive dynamics characterising this group in the second half of the 20th century have reversed recently. Initially, the expansion of the salinas from 1953 to 1973 created new food and reproduction zones that favoured the Laro-Limicolae populations. Furthermore, immigration from the Black Sea may have also played a role in the colonisation of the region by two hitherto rare species: the Mediterranean Gull and the Slender-Billed Gull. The dyking up of the salinas has nevertheless led to a stabilisation of the habitat and blocked the process of renewing small islets, making them gradually less favourable for breeding. This stabilisation of the habitat has favoured the Yellow-Legged Gull, a large predatory species, which tends to prevent other species of Laro-Limicolae from settling. These latter have thus been forced to occupy poorer quality sites (dykes and even recently freshwater marshes), which are more accessible to land predators. After a long period of poor breeding success, the populations of Laro-Limicolae as a whole - with the exception of the Yellow-Legged Gull - are thus now on the decrease.

Figure 13: Living Planet Index of four Camargue bird communities



Unknown trends for terrestrial communities

Faced with the abundance of aquatic species, terrestrial communities have been relatively little monitored in the Camargue. It is above all land nesting birds that are regularly counted in several protected zones, without our being sure that these local trends reflect those of the whole region. The fact that a rather stable index (figure 13) has been obtained must therefore be interpreted with caution.

This stability could nevertheless reflect the existence of a contrasting trend between open habitats (saline scrub, grasslands, dry agricultural lands) and closed habitats (woodlands, bushy areas). The destruction of the original biotopes and the intensification of agriculture, which have speeded up over recent decades, have reduced the carrying capacity for a whole range of avifauna that was once characteristic of the Camargue.

On the other hand, after having been reduced to negligible surface areas, woodland is now in a growth phrase in the Camargue. The consequences of these changes in land-use can now be seen by direct comparison of the lists of breeding species from the 1970s and the 2000s. Some open habitat species, namely macro-insectivore species and those associated with low-intensive cultivated countryside, have disappeared (such as the Common Scops Owl and Lesser Grey Shrike). On the other hand, forest species or those taking advantage of changes in agricultural production have found favourable conditions for settlement (such as the Wood Pigeon and the Common Buzzard).

Yellow-Legged Gull

Once rare, the Yellow-Legged Gull underwent a steep increase in population during the 20th century, to the extent that it now represents a threat to several species of colonial water birds.

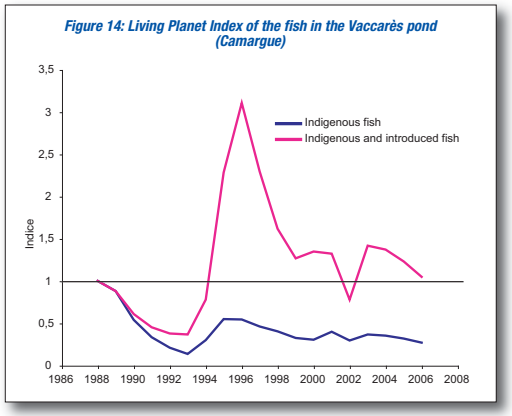
T. GALEWSKI

Populations sensitive to climatic variations

A drop in the Camargue Living Planet Index can be seen from the mid-1980s to 1993. This apparent drop in biodiversity could be due to various causes, but mainly of climatic origin. For example, the index of freshwater wetlands is in net decline between 1985 and 1988, as is the Ciconiiforme index. These decreases coincide with a series of harsh winters, marked especially by cold snaps on a scale unusual in the south of Europe in January-February 1985 and 1987. Sedentary Mediterranean-type species were especially affected by the periods of prolonged frost, because their food resources were made inaccessible. Several years were required for populations to recover to equivalent levels to those of the period prior to these cold snaps (Cattle Egret).

Concerning the index for brackish wetlands, there was a significant decline between 1988 and 1993. This evolution can be found in the fish population of the Vaccarès pond (figure 14), the cornerstone of the Camargue laguno-marine system. The exceptional rise in water level of the Rhône in autumn 1993, followed by wet winters (1994-1997), led to a very significant rise in the water level of the pond, as well as a significant drop in salinity. This situation lasted several years, particularly due to considerable agricultural wastewater discharges. These unusual conditions benefited the growth of the Vaccarès fish population, in particular numerous freshwater species, thus explaining the increase in the index during those years. However, more precise analysis shows that the species non-native to the Camargue - all of which are freshwater species - responded very strongly to this modification of the habitat.

Figure 14: Living Planet Index of the fish in the Vaccarès pond (Camargue)



J. ROCHE

The Living Planet Index: a tool for local management?

Analysis of the evolution of Camargue vertebrate populations over the last 40 years shows the extent to which they are sensitive to variations in land-use by man and to abrupt climatic variations. The recent setting up of new monitoring programmes - on amphibians, bats and land birds, whose data can be included in an indictor such as the Living Planet Index - will enable us to go even further in the analysis and interpretation of trends. However, it's important that these efforts continue in the long term and deal with the entire delta, including the unprotected areas, which are subject to greater anthropogenic pressures.

Fishing in the Vaccarès

The drop in salinity of the Vaccarès pond has furthered the establishment of largely non-native freshwater fish.

The deterioration of wetlands is not ineluctable.

It's up to us to take up the challenge!

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