

Restoration actions and monitoring at a Mediterranean river floodplain wetland: the Amvrakikos case-study

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ABSTRACT

Wetland restoration in order to benefit ecological integrity, biodiversity and threatened species is a vital part of managing internationally important wetlands that have undergone anthropogenic degradation. The restoration of desired conditions and resources for biodiversity may require long-term planning and research and can be an expensive undertaking. This work describes the rationale and development of a wetland restoration project at the Amvrakikos Wetland, one of Greece's largest Ramsar sites. Recommendations are made on the need to develop an indicator-based system to monitor the effects of restoration infrastructure that was recently constructed at the Louros river floodplain and Rodia Swamp. An adaptive management approach is promoted which sees restoration also as a learning process in order to develop in-country know-how for appropriate management of a complex wetland protected-area.

INTRODUCTION

Ecological restoration projects in Mediterranean wetlands have a very recent history. Although the network of Greece's proposed protected areas includes 11 Ramsar wetlands of international importance, most Greek wetlands suffer from severe anthropogenic pressures (Zalidis and Mantzavelas, 1996). Only a very few, small-scale and isolated examples of restoration projects in riverine wetlands exist. This presentation describes the establishment of one of the largest river-wetland restoration infrastructures in Greece, at the Amvrakikos wetland. Recommendations for practical indicator-based monitoring to inform and guide management actions are made.

STUDY AREA

The study site is situated in the Amvrakikos Wetland in Epirus (Western Greece) and focuses on the Louros river floodplain and its adjacent Rodia Swamp (2700 ha), the largest reed-dominated swamp in Greece. This diverse wetland area is located on the northwest shores of the Amvrakikos Gulf, a large semi-enclosed embayment with a remarkable

double-delta wetland between the rivers Louros and Arachthos.

The Louros river is a medium-sized spring-fed river on calcareous substrate with a drainage basin covering 980 km² and a total river length of approximately 80 km. The average river flow is 24.8 m³/s; low flows in July are 11.8 m³/s. The lower part of the river exhibits remarkable biodiversity. In this lowland river the artificial flood protection embankments are far from the river's banks creating a wide regularly-flooded riparian plain, called here the Louros flood-zone. The native biocommunities of the former floodplain-swamp were retained within the Louros' flood-zone, which maintains a width of 300 to 400 m for approximately 9 kilometers. This embanked riverside area floods with river water from November to May, creating unique lentic conditions next to the river; these conditions should be quite similar to conditions that existed in parts of the floodplain-swamp system before the embankments were built.

The river's existing flood-zone was embanked in the late '60s. The river embankment completely disrupted natural river flooding of the adjacent Rodia Swamp and associated deltaic lagoons. This and associated water abstraction works seem to be the key cause of remarkable increases in salinity in the swamp and the rapid degradation of its renowned

freshwater reed-swamp vegetation. Since the 1970s the swamp's varied reed and riparian woodland communities have deteriorated, water salinities increased with documented declines in wetland biodiversity and biological productivity (Sziij 1981).

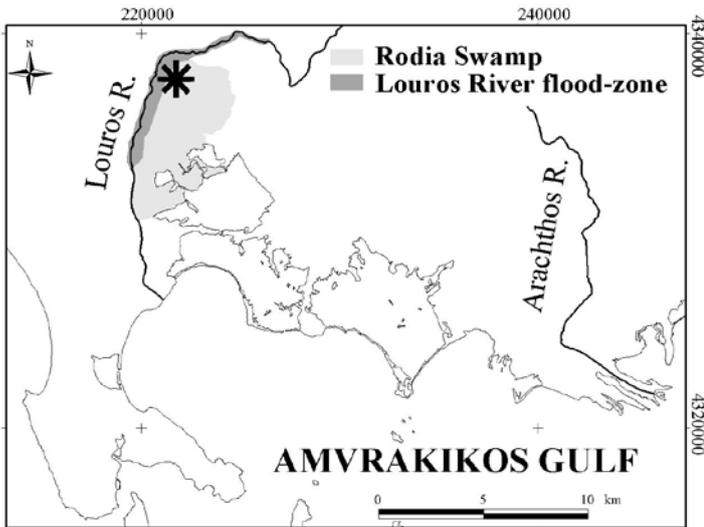


Figure 1. Study area. Location of the Louros / Rodia Swamp restoration project is shown with an asterisk*.

METHODS

Despite limited hydrological data, proposals to restore the connection between the Louros and Rodia Swamp have been proposed since the '1980s and the local communities have also shown support (Sziij 1981, Oikos LTD 2003). This specific action was undertaken within the framework of an EU Life-Nature project entitled "Conservation management of Amvrakikos Wetlands B4-3200/99/006475".

Ecological Restoration Paradigm

The approach chosen for restoration is one founded on habitat rehabilitation and water management of particular freshwater aquatic and semi-aquatic wetlands which are scarce and threatened in Amvrakikos. Priority is given to the conservation of biodiversity and the restoration of natural structure and functioning, aspects of ecological integrity (Angermier & Karr 1994). Restoration should aim at creating self-sufficient and naturally functioning systems (White & Walker 1997); and, at Amvrakikos it should accommodate small-scale fisheries and other traditional land-uses. Finally our approach is also viewed as a means to increase understanding of the ecosystem and test management concepts through an adaptive management procedure (Walters 1997).

Specific Aims

The restoration work is based primarily on biodiversity rehabilitation, with the following aims: 1) to restore freshwater flood pulses from the river into Ro-

dia Swamp, without negative impacts to the river, its flood-zone or the downstream coastal lagoons; 2) to enable control of water pulses with sluices; 3) to enable an implementation of a freshwater flooding regime which will re-establish natural plant communities and support freshwater-dependent species including threatened bird species, in particular threatened waterbirds such as *Aythya nyroca* and *Botaurus stellaris*; 4) to provide potential ability to manage water resources for future rehabilitation regimes and human-uses in its associated coastal lagoons.

RESULTS & DISCUSSION

The need for restoration

Freshwater marshes, riparian woods and water meadows are the most threatened wetland habitats at the Amvrakikos and biodiversity and ecological integrity have suffered from their loss and degradation (Oikos LTD 2003). Through air photo analysis, it is evident that 63% of the wetlands of the deltaic plain have been drained since 1945; and at least 80% of these consisted of inland freshwater wetlands. Most freshwater wetlands were replaced primarily by cultivated land, whose areal cover has increased by 59% since 1945 (Zogaris et. al. in prep.). The remaining wetlands have suffered from salinization which has also been proved to be a reason for degradation of reed-swamp structure in Rodia Swamp (Lawrie 2002, Oikos LTD 2003). Recent high dam developments (1981,1999) have severely disrupted the natural hydrological regime on the Arachthos river and plans are underway for more surface water abstraction adjacent to the Louros (Oikos LTD 2003).

Infrastructure development

Restoration focused on establishing a re-distribution of freshwater from the Louros river to the riverine-deltaic Rodia Swamp, known to have suffered from hydrologic degradation and salinization. A simple sluice-canal system was constructed in the heart of the floodplain-swamp wetlands, 13 Km upstream from the Louros river's outlet to the sea. The main infrastructure consists of two large sluices and two canals through the swamp, each 1000 meters long (6 m. wide, 1,5 m. deep), which can transport water directly from the river to the swamp without draining the river's flood-zone. The canals were constructed with the use of an IHC Beaver 300 cutter dredger. Dredged material (14.600 m³) was piled into islet-like heaps next the canals. The works cost 210.000.00 euros in total (97.000.00 for dredging works and 113.000.00 for sluices, embankment bridge, and other infrastructure). Infrastructure work began in October 2002 and was successfully com-

pleted on July 1st 2003. Even during low summer flows river water drains from the river bed to the canals in the swamp's basin without the use of pumps.

Only proximate results of the projects success are evident upon a rapid assessment immediately after works were completed: A) The canals can transport approximately 134000 m³/day of water from the river to the swamp. This maximum amount (maintained with both sluices wide-open) represents 13.2% of the rivers discharge during its lowest summer flows and proved that it can effectively increase water levels in nearly all parts of the swamp basin, as it did in July 2003. B) Regeneration of the canals with freshwater helophytes and aquatic plants was very rapid and certain freshwater species have expanded into former seasonally brackish reed-swamp; C) Large numbers of birds, including specialized species used the canals immediately after their construction. At least 9 species of fish were recorded in the new canals and these including rheophilic cyprinids presumably from the river's floodplain. These preliminary indications, provide evidence that the restoration infrastructure can be an important tool for rehabilitation if it is employed in appropriate water management. It is not yet possible to assess the success of the project since long-term monitoring has not taken place; and a water management plan has not been completed or implemented.

INDICATORS FOR MONITORING

An indicator-based approach to monitoring is promoted to strive for effectiveness and efficiency and support demands of the protected area as guided by the Habitats Directive (92/43/EC), the Birds Directive (79/409/EC) and the Water Framework Directive or WFD (2000/60/EC). The project must strive to develop a monitoring scheme that will identify and use 'key signals' that indicate: a) the trends of species and biotic community changes (biodiversity conservation-based monitoring) and, b) the degree of anthropogenic impacts and ecological quality status (water-based monitoring as defined in the WFD).

Monitoring hydrology and abiotic parameters

A specific hydrogeological study for the restoration area does not exist. Water volumes in the various sectors of the swamp are difficult to measure due to the irregular wetland terrain. A study of the hydrology of the floodplain-swamp will enable the channeling of water to various water body units since the two canals go to different directions. We recommend a thorough hydrological study of the area including the history of hydromorphological change in the vicinity. This will be a baseline for reference

condition development (Walker & White 1997, Jungwirth 2000). Spatially-based site knowledge and modeling should be used in building a hydrological management scheme which could incorporate type-specific reference conditions to guide assessments (Smakhtin & Piyunkarage 2003). Lastly, chemical and physico-chemical water parameters should be monitored regularly since they directly support bio-indicator assessments.

Monitoring wetland vegetation

The recent Life-Nature project conducted important base-line work with wetland macrophytes. Wetland vegetation communities, both aquatic and riparian are good indicators because they can be easily sampled and mapped over large areas in order to give an assessment at the scale of the water body, not only for distinct sampling sites within the waterbody. Plant growth is influenced by factors that can be proved to be linked to human pressures, such as changes in sediments, nutrients, turbidity, wetland drainage, salinity etc. Research is needed to establish the cause and effect between human pressures and the plant indicators. It is well known that the quality, quantity and changes in water regime influences distribution and robustness of the plant communities, but identifying underlying pressures or combinations of pressures is not straightforward (Orfanidis et.al. 2003). Correlations can be used initially to provide hints, but ecological research is needed to confirm impacts and the effectiveness of indices used (Lawrie 2002). Nonetheless relatively simple approaches such as detailed vegetation mapping through the use of high-quality satellite images is an important beginning for creating baseline monitoring and at least this should be pursued at Amvrakikos.

Monitoring Fish

Fish are known to be good long-term indicators of ecological change and along with aquatic macrophytes constitute a biological quality element promoted specifically in the WFD. Although very little ichthyological work has been conducted in the area, recent surveys show that at least 24 species (19 native) are known to inhabit the river and swamp; furthermore at least 9 of the natives are endemic taxa (species or subspecies) unique to Western Greece and southern Albania. These species include threatened and local endemics of outstanding conservation concern.

Monitoring fish populations has many varied approaches in Europe but methods have not been standardized for large rivers or in brackish wetlands (Jungwirth et. al. 2000). The fish-based monitoring proposed for Amvrakikos should include two principle approaches: a) monitor fish to inform water management since fish provide integrated information on aquatic habitat qualities, biodiversity,

wetland productivity and other aspects which are of conservation management interest; and b) attempt to use fish to build an index for monitoring aquatic ecosystem change based on establishing type-specific reference conditions (sensu the WFD guidance for ecological quality assessment). In brackish waters fish are easily monitored using multi-mesh nets or fyke nets while in freshwaters electrofishing has become the standard method for sampling in Europe. Experience in monitoring fish in deep non-wadable rivers such as the Louros or in extensive swamps is very limited in Greece and inroads should be attempted at Amvrakikos.

Monitoring Birds

Threatened bird species have been the focus of monitoring at Amvrakikos for nearly 20 years (Zogaris et.al. 2003). There are well-documented relationships between the number, size and quality of aquatic habitats with bird species richness, population density and community structure (Weller 1995). As elements of a policy-relevant biodiversity monitoring tool, birds of conservation interest can promote specific habitat rehabilitation actions; furthermore, birds have been successfully utilized for protected area zonation at Amvrakikos (Pergantis 1989).

Due to their great mobility, birds show more flexibility in their site and habitat relationships than do plants or fish, but because they are dependent on water, food and cover resources they are sensitive to ecosystem changes and can react to landscape scale changes. In order to include birds in an effective and efficient monitoring, surveying methods should be made very specific. Since birds are an important biodiversity component at Amvrakikos we recommend basic targets at the Louros-Rodia restoration: 1) breeding waterbird communities: simple repeatable methods such as point counts are effective for breeding bird communities and establish species-habitat relations; 2) *Cicconiformes*: large colonies of heron-like wading birds in Rodia swamp have particular need for adjacent wetland resources; 3) habitat specialized species: certain waterbird species have specialized requirements and may function as specific indicators. Finally, habitat specialized “flagship species” such as Bittern *Botaurus stellaris* and Ferruginous Duck *Aythya nyroca* as well as other threatened species should be included in monitoring within restoration project monitoring.

CONCLUSION

Amvrakikos could represent an example of a “show-piece” Ramsar Site for Greece since due to its large size and diversity it presents challenging conservation and research potential that could be met through

developing synergy with integrated restoration actions. Carefully planned monitoring must become a priority within restoration projects; and monitoring should be incorporated within the protected-areas management as soon as possible.

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