CONSERVATION OF MEDITERRANEAN COASTAL SALINE ECOSYSTEMS: THE PRIVATE SECTOR ROLE IN MAINTAINING ECOLOGICAL FUNCTION

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INTRODUCTION

The wetland definition resulting from the 1971 Ramsar Convention on Wetlands of International Importance was all inclusive without regard for salinity, permanence of innundation, degree of hydrological renewal (lotic versus lentic) or mode of formation (natural versus "artificial")(Navid 1989). Although detailed inventory data are incomplete, the existing wetland area for the Mediterranean Basin has been estimated at 28,500 km^2, divided among coastal lagoons (6,500 km^2), natural lakes and marshes (12,000 km^2) and artificial wetlands/reservoirs (approximately 28,500 km^2) (Pearce & Crivelli 1994).

Of the eleven marine and coastal wetland types recognized by the Ramsar Bureau (1990), five coastal systems are of particular interest in the Mediterranean Basin: estuarine waters; intertidal mud, sand and salt flats; intertidal marshes; brackish to saline lagoons; and freshwater lagoons and marshes in the coastal zone including deltaic systems. Most of the readily accessible of these salt and freshwater systems have been altered profoundly as a result of centuries of sustained utilization by humans for fisheries, agriculture and salt production. Of particular note are salinas (salt pans, salines, saltworks), human-altered coastal systems that have been used for salt production throughout the Mediterranean basin.

Salinas have been critical elements in the economic and cultural development of the region since at least 5,000 BC in Egypt and 2,000 BC in the Near East (Hittites, Hebrews, Phoenicians) (Sadoul et al. 1998). It has always been common practice for salinas to be considered property of the state, thus recognizing the importance that salt production has traditionally played in the economic and political stability of Mediterranean societies.

Salt production underwent a major transformation during the past two centuries. Although mechanization, especially development of high volume pumps, led to an expansion in the overall extent of salinas during the nineteenth century, this trend was reversed in the twentieth century associated with increased efficiency and product quality in emerging large-scale operations and an associated economic failure for small operations (Sadoul et al. 1998). Abandonment of saltworks in small salinas began in the 1930's, but the period of greatest abandonment of operations has been during 1950-1990. In Greece alone, the number of saltworks has declined from 30 to 8 in the last forty years (N. Korovessis, pers. comm.). Of the 165 out of the 168 total salinas operating in 18 Mediterranean nations in 1998, 90 were operational, 64 were inactive and 11 had been modified or eliminated for other purposes. Approximately 77% of the active salinas were found along the northern Mediterranean coast (Spain, Greece, Italy, France and Portugal in decreasing order) and ranged in size from 1-12,000 ha.

SALINAS AS ECOSYSTEMS AND CONSERVATION AREAS

An ecosystem is defined by both structural components (biota) and functional processes (interactions among and between biota and physical/chemical abiotic parameters). Such a definition makes no distinction between natural ecosystems and "artificial" ecosystems developed through self-organization at sites created and possibly maintained as a result of human activities. New ecosystems can and do evolve in landscapes as a result of human activities.

The salinas of the Mediterranean basin are both natural and "artificial", resulting from either human alteration of pre-existing freshwater and saltwater ecosystems or engineered systems created on dry land. Regardless of origin, salinas have developed characteristic foodwebs that change progressively and predictably along a gradient of increasing salinity (Sadoul et al. 1998). Historically, Ramsar has emphasized the importance of structural over functional aspects in their classification of wetlands of international importance and has assigned salinas to the category of man-made wetlands along with reservoirs, stock ponds, aquaculture ponds, excavations, wastewater treatment facilities, canals and flooded fields (Ramsar Convention Bureau 1990). Unfortunately, it is almost implicit in such a classification that man-made wetlands are functionally different from natural wetlands. Ecosystem structural differences do not imply functional dissimilarity. Artificial wetlands can be of equal or even greater value to nature conservation compared with natural systems. Given the degree of human perturbation of most wetlands in the world today, we must increasingly accept the importance of functional over structural values of wetlands in nature conservation.

The importance of Mediterranean salinas as conservation areas is without question. In addition to supporting resident populations, salinas are critical for migratory wading birds, both those continuing to Africa and the estimated 500,000 wintering along the Mediterranean coast (Sadoul et al. 1998). Such ecosystems are of paramount importance for avocets, black-winged stilts, shelducks and flamingoes (Perennou et al. 1996).

ENVIRONMENTAL THREATS TO SALINAS

Approximately one third of total Mediterranean wetlands were drained in the twentieth century for malaria control, agricultural expansion and urban development (Zalidis et al. 1999). Some of the worst estimated losses of wetlands have been in Greece (60%), Spain (60%), Albania (33%) and Tunisia (28%) (Pearce and Crivelli 1994, Zalidis et al. 1999). Additionally, abandonment of saltworks in small salinas began in the 1930's, but accelerated between 1950 and 1990 (Sadoul et al. 1998).

Recognizing the critical importance of salt to local and national economies, salinas throughout the Mediterranean basin have long been considered state property . Greece, for example, nationalized salinas and their saltworks in the 1820's. Thus, even when commercial operations cease, abandoned salinas remain under governmental protection.

Both active saltworks and abandoned/idle salinas are besieged by a variety of point and non-point environmental impacts (Table 1). Based on the extensive survey of Greek wetlands by Zalidis and Mantzavelas (1995), four broad categories of ecosystem impact can be distinguished on the basis of human activity: agricultural, industrial, tourism, and urban and rural local populations.

Agricultural impacts occur both from activities directly along the margin or within the salina (aquaculture, basin infilling, draining for rice cultivation, livestock operations) and a failure to implement best management practices throughout the watershed of the salina to minimize erosion, groundwater extraction, nutrients and pesticides/herbicides. Industrial impacts are associated with new and expanded small and large scale facilities/operations. Often such activities involve basin infilling for site preparation and the development of improved roads to the plant. Unfortunately, groundwater extraction is needed as a dependable source of process water, and the salina is a convenient repository for both wastewater and solid wastes associated with the industry.

Tourism is fast becoming the dominant economy for coastal regions of the Mediterranean basin. Construction is escalating for both single-family seasonal residences and major hotel/resorts and the associated roads and service industry (shops, restaurants) to support them. Sadly, competition to find suitable affordable sites for facilities near the shore has pushed developers into salinas and highly erodable hill slopes. Development has been so rapid in most areas that the local community has not had time to develop sustainable management plans for waste water and solid waste disposal for either transient or permanent populations.

Although legally held in the national trust and administered by local governments, far too many idle and abandoned salinas are being invaded for development. Local populations regard such wetlands to be of little sustainable value, and the potential economic return from draining or infilling salinas greatly outweighs any concern for the national aquatic heritage.

Table 1. Current and projected threats to mediterranean salinas.
Modified from Zalidis and Mantzavelas (1995).

AGRICULTURAL
        AQUACULTURE/FISH FARMS
        BASIN INFILLING
        IRRIGATION SCHEMES & GROUNDWATER EXTRACTION
        NEW/EXPANDED CULTIVATED FIELDS (RICE)
        NEW/EXPANDED LIVESTOCK OPERATIONS
        POINT/NON-POINT SOURCE CONTAMINATION
                NUTRIENTS (NITROGEN & PHOSPHORUS)
                PESTICIDES/HERBICIDES
        WATERSHED EROSION

INDUSTRIAL
        BASIN INFILLING
        GROUNDWATER EXTRACTION
        NEW/EXPANDED SMALL & LARGE OPERATIONS
        ROAD CONSTRUCTION/IMPROVEMENTS
        SOLID WASTE
        SAND EXTRACTION
        WASTEWATER

TOURISM
        BASIN INFILLING
        GROUNDWATER EXTRACTION
        NEW/EXPANDED HOTELS/RESORTS
        NEW/EXPANDED RESTAURANTS/SHOPS
        NEW/EXPANDED SINGLE FAMILY SEASONAL HOMES
        ROAD CONSTRUCTION/IMPROVEMENTS
        SOLID WASTE
        WASTEWATER
        WATERSHED EROSION

URBAN & RURAL LOCAL POPULATIONS
        BASIN INFILLING
        GROUNDWATER EXTRACTION
        ILLEGAL & NON-SUSTAINABLE HUNTING & FISHING
        NEW/EXPANDED PERMANENT RESIDENCES
        ROAD CONSTRUCTION/IMPROVEMENTS
        SOLID WASTE
        WASTEWATER
        WATERSHED EROSION

PUBLIC-PRIVATE PARTNERSHIPS FOR WETLAND CONSERVATION AND MANAGEMENT

It is likely that once they are no longer contributing to the economy, local communities view abandoned saltworks as having little intrinsic value. Local authorities often exercise benign neglect rather than protection for "wastelands", even if such salinas are under legal protection by the national government. Encroachment into salinas for private economic gain is a logical extension of this prevalent attitude.

The private sector can play a major role in informing local communities about both the paramount importance of salinas in nature conservation and unrealized opportunities of such areas as educational sites and possible sustainable economic opportunites through ecotourism and value-added natural products from the wetland. Nongovernmental organizations (NGO's) can be utilized as a viable liaison between the private sector and public to promote meaningful dialogue and subsequent action.

The Pantanal of Brazil is the largest wetland in the world (140,000 km^2), an area approximating 39% of Germany (Por 1995). For the past 200 years, approximately 95% of the Pantanal has been under private ownership as cattle ranches. The Pantanal currently supports an estimated three to eight million cattle, while being recognized as one of the supreme wetland conservation areas in the world. Recognizing that much of what we value as the Pantanal is a direct reflection of 200 years of human manipulation for cattle production, a number of NGOs have been formed by ranchers and others to promote sustainability of this highly integrated duality of purpose, economics and conservation.

Elsewhere, NGOs have been formed by concerned citizens either to promote dialogue between economic and conservation interests where it has been lacking or to fill a void in national governmental structure in the areas of environmental protection and nature conservation. Perhaps the two most successful operations of this type are PROBIDES, organized for the protection of the Banados del Este coastal wetlands in Uruguay, and the Royal Society for the Conservation of Nature (RSCN) for the protection of Wadi Dana and the Azraq Oasis wetland in Jordan. PROBIDES established a close working relationship at the local and national level with rice farmers developing wetlands for agricultural production surrounding conservation core areas of the Banados del Este and were able to develop a water use plan that recognized the hydrological needs of both components and ensured protection of the conservation area. RSCN has been working with local farmers to implement effective irrigation technologies to reduce consumption and protect the Azraq Oasis. Both NGOs are trying to promote economically viable value added products for the local economy based on the sustainably extractable natural resources of the wetlands, while at the same time promoting ecosystem conservation through local and national education programs.

Saltworks should be encouraged to be a major player in developing effective conservation plans for Mediterranean salinas. Salt companies could serve as surrogates for national governments and serve as stewards for environmental manage-

ment. Most salinas are under control of private companies, and there is a strong traditional relationship between the companies and local populations. Thus, the private sector has the unique position of serving in the same capacity as NGOs elsewhere and function as the link between international and national policies and the local community. Without incorporating the local population in mapping the future of Mediterranean salinas, enforcement of mandated policies and regulations for ecosystem management and protection will be ineffective at best.

RESTORATION VERSUS REHABILITATION

During the latter half of the twentieth century, the number of saltworks has declined dramatically, while the average size of individual works has increased. But what is to be the fate of the numerous small saltworks that have been abandoned throughout the Mediterranean basin? These systems are precisely those most vulnerable to sources of direct (infilling, draining) and indirect (wastewater, agricultural contaminants) human encroachment discussed earlier.

Restoration, return to a previous structural and functional state, is one option. But, to what condition would one want to restore abandoned or idle salinas? Conditions of an operating saltwork? A pre-impact natural salina ecosystem? The former is likely not economically feasible, and the latter is problematic given the paucity or absence of pristine salinas to serve as restoration models. Ecosystem restoration of wetlands is contingent on both a return to pre-impact hydrology and water quality and minimization of feedback from the long term memory accruing during the period of system perturbation, the sediments. Even if hydrology and the water quality of incoming water could be returned to a previous state, historical changes in the chemical composition and structure of the inorganic fraction resulting from centuries of human interactions could present formidable obstacles to most restoration schemes. Additional obstacles are associated with recent alterations in land use practices throughout the surrounding watershed, especially erosion, contaminant and nutrient fluxes, and groundwater extraction.

Rehabilitation is the alteration of an ecosystem to a desired functional condition. Restoration places paramount importance on a return to the pre-impact structure, and presumably function, of an ecosystem, while rehabilitation stresses ecosystem functional processes over structural attributes that may not attainable either ecologically or economically. Rehabilitation asks for what purpose the ecosystem is desired, then charts a course to achieve that function.

In addition to their obvious value in conservation, salinas can also serve an important regional function in pollution abatement (Figure 1). It has been common practice for watershed water courses to be re-routed around saltworks to discharge directly into the Mediterranean. Thus, nutrients, chemical contaminants and eroded sediments enter the sea without treatment and can enter saltwork operations through near shore water intake. The negative impact of intake water on salt quality has only become apparent during recent progressive development of watersheds. Once abandoned, simple hydrological alterations to promote sheetflow of incoming waters through the salina rather than bypassing it
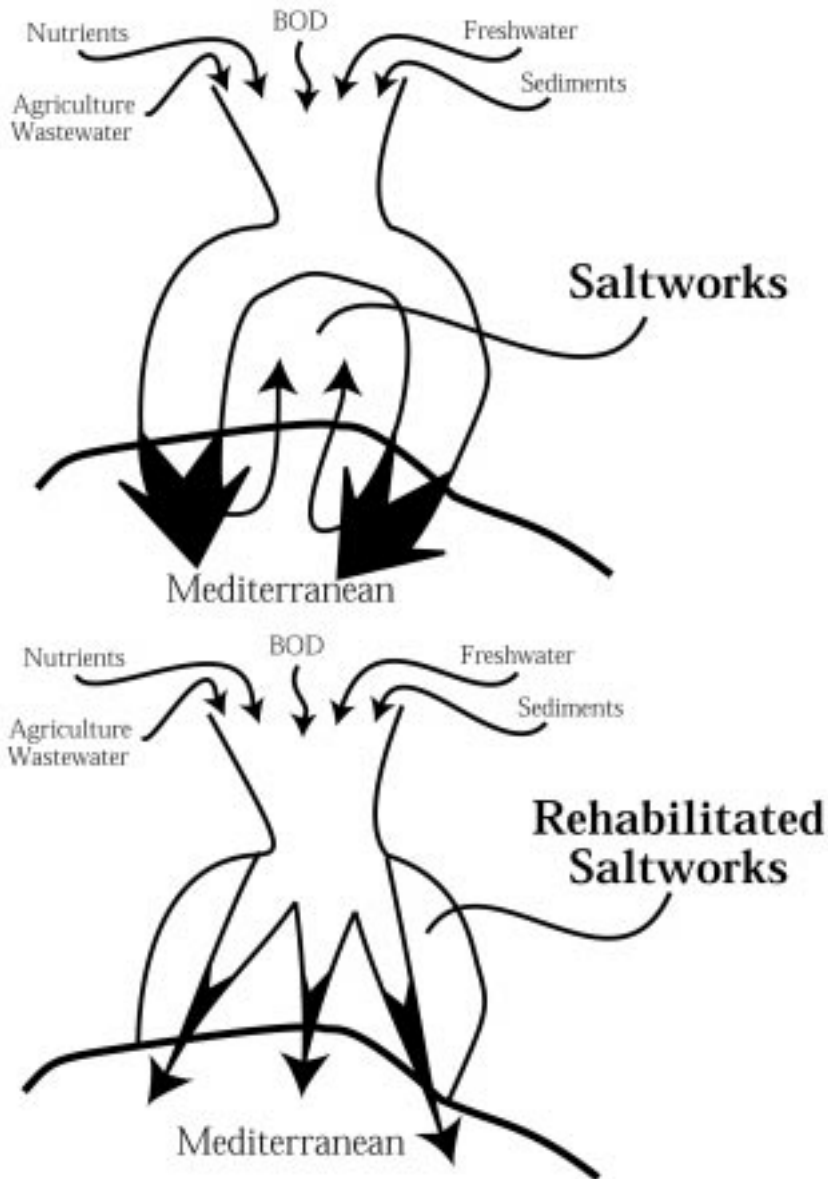
Figure 1. Conceptual scheme for rehabilitating abandoned saltworks to serve
    as treatment systems for watershed discharges.

can be an effective treatment option for chemical and inorganic pollutants prior
to discharge into coastal Mediterranean waters. Such inexpensive engineering
options offer support for sustainable nature conservation by demonstrating
multidimensional benefits to local communities (Crisman et al. 1996).
Zalidis et al. (1999) reviewed the status of rehabilitation efforts for Mediterra-

nean wetlands and stressed the importance of linkages between engineers/scientists and the local community. Any successful rehabilitation effort must first ascertain the purpose or purposes for which the rehabilitated system is intended, then work to incorporate these within a sustainable cost effective management plan. It must be accepted from the beginning that nature conservation does not imply exclusivity over other ecosystem uses.

MANAGEMENT PLANS FOR ACTIVE AND ABANDONED SALINAS

The two fundamental questions upon which the success of all management plans for salinas will be based are: 1) are salinas ecosystems? and 2) what positive and negative impacts do salinas have on the environment? There is an emerging consensus that salinas are ecosystems possessing characteristic structural properties. Our knowledge, however, regarding functional aspects of salinas is poorly lacking, and without detailed knowledge of these, it is difficult to predict how such ecosystems affect the surrounding environment in either a natural or altered state.

There is a great need to determine both positive and negative environmental aspects of salinas in the Mediterranean basin, but that necessitates collection of detailed baseline on the structure and function of salinas, both active and abandoned. Saltworks have been abandoned at an alarming rate in the latter half of the twentieth century, without, for the most part, development of any long term management plan for the site. All abandoned salinas in the Mediterranean should be inventoried and ranked according to both immediacy and intensity of human encroachment and possibilities for nature conservation and sustainable human utilization. Determination of which sites should be considered of paramount importance is essential to distribute the limited funding available for wetland rehabilitation. Once there is a clear idea of the goal of a rehabilitation or management plan, then managers can begin to determine how little water supplement is needed to achieve the precribed goal and when to time such hydrological deliveries seasonally. It is critical in water scarce regions such as the Mediterranean basin that managers know the minimum hydrological requirements for maintanence of wetland ecosystems of a given structure and function.

Basic ecological data are needed also for estimating ecosystem impact resulting from new saltworks and the expansion of existing ones. At present, there is an insufficient database worldwide for evaluating environmental impacts from saltworks such as proposed for a joint Mitsubishi-Mexican government operation in Laguna San Ignacio in northwestern coastal Mexico. Without a strong database, environmental impact assessments will remain more subjective than objective.

Finally, increased attention must be given to how watershed land use affects ecosystem structure and function in salinas. Lake Nakuru is a highly saline lake in the Rift Valley of Kenya. The lake is noted for its flamingo population which numbers in the millions and has contributed significantly to the local economy through ecotourism activities. According to numerous news releases recently (e.g. Gainesville Sun, 5 October 1999), the flamingo population has totally crashed within the past three years to a point where the significance of the site

as both a nature reserve and ecotourism destination is now in jeopardy. It appears that the birds abandoned Lake Nakuru as a result of the collapse of the food web, principally the loss of the alga Spirulina platensis, which has been attributed to both fluctuating salinity levels and increased chemical contamination from the watershed associated with altered land use practices. Although not definitively answered, it is clear that salinas are not as immune from perturbations as once thought, but are ecosystems that are very responsive to human perturbations throughout their watersheds.

The importance of salinas as conservation areas and buffers of terrestrial exports is clear. Effective management plans for abandoned salinas of the Mediterranean basin will be elusive until a cooperative effort among NGOs, governmental units and the private sector is functional and recognizes that salinas can be managed for multiple purposes that are nonexclusive. Above all, the local community must be engaged in this endeavor and see that conservation will produce tangible benefits on a variety of scales.

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