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Environmental management of Burullus Protectorate (Egypt), with special reference to fisheries.

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ABSTRACT

One of the main values of the Protected Area is its role in conserving the biodiversity resources found within its boundaries. Burullus Protectorate encompasses a wide array of habitats in a relatively small area that supports an equally diverse fauna and flora. During the last two decades Lake Burullus has become more dulcitude and eutrophic ecosystem, owing to the remarkable increase in the amount of discharging agricultural drainage water, loaded with nutrients, into the lake via the southern drains. The change in the lake level has become positive all over the year; that means water in the lake is in continuous movement toward the sea, and the Mediterranean water never enters into the lake. Decreasing salinity and nutrients loading led to a significant influence on biodiversity and abundance of aquatic fauna in Lake Burullus, where sensitive and many marine species have disappeared completely. In fish community, six marine species have disappeared from the catch during the last five years, while tilapia dominated the fishery of the lake during the last decade. A detailed site diagnosis study has been done during 2002/2003 and a management plan has been proposed depending on accurate evaluation and operational projects have been implemented and followed up till 2011 to restore the ecological status of the protected area and diversity of species. The present article is concerned with management of fisheries.

1. INTRODUCTION

Burullus Protected Area is located on the Mediterranean coast of the northern Delta of Egypt, in a central position between the two branches of the Nile. The protected area is bordered from the north by the Mediterranean Sea (encompassing approximatly 50km of shoreline), from the south by agricultural lands of the northern Delta, from the west by longitude 30°33”E, and from the east by by longitude 31°07”E (Fig.1).

Burullus Protectorate is an internationally important wetland for wintering water birds. Consequently, Bird Life International has designated it as an Important Bird Area (IBA). It is also a Ramsar site, which means that Egypt has a legally binding obligation to protect and rehabilitate Burullus wetland.

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More importantly, Burullus Protected Area encompasses representative samples of a diversity of wetland and terrestrial habitat types, which support a wide range of species of indigenous fauna and flora.

In addition, it provides protection to several globally endangered and endemic species and their habitats. So, Burullus became an important component of the Protected Area Network of Egypt, contributing in a significant way to the representation of Mediterranean coastal habitats, landscapes and biodiversity in this network.

Burullus wetland receives most of its water from main five southern drains and another one at the northeastern side, besides a canal from the Rosetta Nile branch, situated at the western side (Brimbal Canal). It is also connected to the Mediterranean Sea at its northeastern side through a narrow opening referred to as Boghaz El-Borg. The occurrence of brackish and saline waters resulted in a large number and a big variety of invertebrates and fish species inhabiting the Lake during seventies and early eighties. However, the lake became very different from what it was several decades ago before discharging massive quantities of agricultural fertilizers and drainage water loaded with nutrients into the lake from vast areas nearby. This led to increasing of eutrophication, deterioration of this important ecosystem and decreasing or disappearance of many of high-valued marine fish species.

In 2002 a research team began a detailed site diagnosis study upon Burullus protected area through Med Wet Coast project (EEAA), aiming to know the main threats and problems at Burullus Protected Area and to identify the constitutive elements of the ecobiological value that are important for its conservation and its sustainable utilization and establishment of a management program. Many operational projects of this management plan have been implemented to improve and manage aquatic fauna diversity, especially fisheries. The Unit of Environmental Research & Studies at Ain Shams University began in 2007 to follow up changes in the aquatic biodiversity after implementing these projects.

So, the present investigation is aiming to spot the light on the changes in aquatic communities' structure and diversity of Burullus Protected Area, before and after implementing the management operational program, with special reference to fisheries.

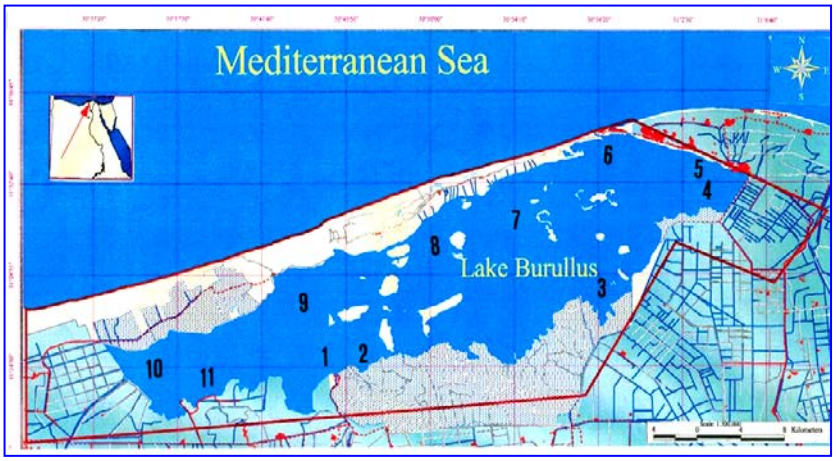

Fig. 1: Map of Lake Burullus showing the location of sampling sites (Shaltout and Khalil, 2005).

2. Methodology

2.1 Area of the study

The main component of the Protected Area is Burullus wetland, which is a shallow (depth ranges between 50-210 cm), brackish coastal lagoon with an irregular elongate shape, extending approximately parallel to the Mediterranean coast. Currently, the Lake covers an area of about 410 km^2 with a maximum length of about 47 km and an average width of 14 km. There are some 50 islands scattered throughout the lake with a total area of 0.7 km^2. These islands are paleogeographic relicts of deltaic features such as beach ridges, dunes and former riverbanks. The lake is separated from the sea by a broad, dune-covered sand barrier, which varies in width between 500 meters in the east to five kilometres in the west.

Bughaz El Burullus, located in the northeast corner of the lake, is the only direct connection between Lake Burullus and the Mediterranean. Salinity in the lake decreases towards the south and west as the distance from the Bughaz increases, becoming fresh near the outflows of drains and canals flowing into the lake from the south. Consequently, salt marshes and mudflats dominate the north shores of the lake; while the southern shore is bordered by an extensive fringe of reed swamps (mainly Phragmites australis), which currently covers over 25% of the lake area. Lake Burullus has abundant submerged vegetation dominated by Potamogeton pectinatus, which is densest in the southern portion of the lake.

2.2 Site diagnosis study

A detailed descriptive investigation has been done during the period from 2001 to 2003, aiming to know the main threats and problems at Burullus Protected Area and to identify the constitutive elements of the ecobiological value that are important for its conservation and its sustainable utilization and establishment of a management program. Flora, mammals, herpetofauna, birds, plankton, aquatic bottom fauna and fisheries have been studied to species or genera level, and the ecological status was identified for most taxa.

For fisheries, that we are concern in the present study, the database describing the present state of the open fishery was systematically collected during the period from spring 2001 to spring 2002.Visiting of ports was conducted on a quarterly basis, and a proportion of the returning fishing vessels were sampled. Sampling was conducted in a random manner with respect to boat size and type. The boat captain was interviewed and the following items of information obtained: Home port, normal fishing patter (average number of days fished per week; number of days per fishing trip), name of fishing area for the present trip, total fishing time (in hours) for the present trip, crew size (number of adults and children), fishing gear (number, type, dimensions and mesh size) and fish catch (for each species and size composition). Fish production data of the Lake during the period from 2003 to 2008 was obtained from the yearly statistics book of GAFRD (2010).

Many operational projects have been implemented to enhance, rehabilitate and manage fisheries in Burullus wetland:

- Clearing and dredging of the lake-inlet.
- Regulation of the mesh of the fishing gears, through a project aiming to exchange of illegal nets with legal ones.
- Management of extensive growth of macrophytes (Phragmites australis) beds in the lake to increase the open fishing area and to facilitate circulation of water between different regions of the Lake.
- Removal of solid wastes from the wetland sides.
- Raising environmental awareness of fishermen.
- Lab and field training of protectorate rangers for monitoring programs of water quality of the Lake.

3. RESULTS AND DISCUSSION

Establishment and management of a protected area in a heavily utilized and inhabited setting such as that of Burullus is very challenging. Biodiversity and nature conservation objectives must be skillfully

reconciled with the needs and aspirations of the local inhabitants. The Protected Area management must find and develop new and innovative ways to maximize benefits on all sides.

One of the main steps for establishing a management plan is to identify the constitutive elements of the ecobiological value that are important for its conservation and its sustainable utilization.

3.1 Main Values of Burullus Protected Area:

The site diagnosis study revealed that, besides playing an important role in biodiversity conservation, Burullus Protected Area plays an important role in maintaining environmental quality and has the potential of diversifying land use along this section of the Mediterranean coast. The Protected Area is an important fishery and contains excellent resources for education, research, tourism and recreation; including several archeological sites and a traditional rural and fishing community.

3.1.1Biodiversity conservation

One of the main values of the Protected Area is its role in conserving the biodiversity resources (species and habitats) found within its boundaries.

Burullus Protected Area encompasses a wide array of habitats in a relatively small area; ranging from marine waters, to coastal dunes, to mudflats, to saltmarshes, to freshwater swamps. This diversity of habitats supports an equally diverse fauna and flora. More significantly, these habitats are some of the best representatives of their kind remaining in Egypt and the entire eastern Mediterranean basin as a whole, supporting many unique taxa that have very limited representation elsewhere on a global level. In addition the Protected Area supports internationally important numbers of globally endangered species of birds, and is an internationally important wetland and wintering ground for waterbirds. The main taxonomic attributes of Burullus Protected Area are summarized in Table 1.

Table 1: Summary of known taxonomic composition, and number of threatened and endemic species in Burullus Protected Area.

Taxa	No. of species	Threatened spp.	Endemic spp.
Flora	197	3	3
Invertebrates	147	5	0
Fish	32	3	0
Herpetofauna	22	3	1
Avifauna	250 (43 breeding)	4	0
Mammals	15	3	1
Total	**663**	**21**	**5**

3.1.2 Representation of biodiversity in the Protected Area Network of Egypt

One of the main objectives of the Protected Area Network of Egypt is to have proportional representation of the countries' natural habitats. Burullus Protected Area contributes significantly towards this objective, as it encompasses habitat types not or little represented in the rest of the Protected Area Network.

Another important objective is to maximize taxonomic representation within the Protected Area Network. Burullus contributes many key biological elements (particularly endemic and localized taxa), which otherwise would be missing from the Network.

3.1.3 Role of the Protected Area as a regional land use planning tool

The Protected Area can consolidate all aspects of management of Lake Burullus and

attempt to develop a comprehensive management mechanism that incorporates all stakeholders. This framework is badly needed in a situation like that of Lake Burullus, where there are numerous interest groups, often with conflicting objectives. The Protected Area management can serve to synchronize and coordinate amongst them.

From another perspective, protected areas have proven to be one of the most effective land use planning tools in Egypt. Such an effective tool is needed particularly to control unplanned development.

3.1.4 Importance as a fishery

Fish production of Lake Burullus accounts for about 40.6 % of the northern Delta lakes. In 2012 the gross fish production was about 52,076 kg (GAFRD, 2012), and the productivity per hectare has been estimated at around 1240 kg. The Protected Area would seek to maintain and restore environmental quality, which ensures optimal fish production.

3.1.5. Ecotourism

The Protected Area can have a major role in promoting alternative and new tourist activities in the Delta region. The natural landscape of Burullus, combined with rich biodiversity and cultural heritage are the main tourism resources to be promoted. Thus, the maintenance of landscape qualities and natural conditions is essential to attract the ecotourism and adventurers. The establishment of appropriate visitor facilities and targeted management schemes could launch the Protected Area as a new alternative ecotourism destination.

3.1.6. Recreation

Thousands of local tourists already visit the region annually for recreational purposes; the Protected Area will work to preserve the environmental quality of the area and its natural values, which attract these visitors. The Protected Area can create added attractions by establishing visitor facilities and promoting new and innovative activities.

3.1.7. Development of local communities

One of the objectives of Protected Areas is to help maximize benefits to local communities from the natural resources in a sustainable manner. Interests of the local population inhabiting areas inside and immediately adjacent to the Protected Area should be integrated in management and conservation efforts, in order to optimize the local community benefits from the natural resources of the area in a wise and sustainable fashion.

3.1.8. Maintenance of cultural heritage

The Protected Area helps in protection of the archeological sites of the area, minimizing disturbance, and securing them from haphazard activities. It also maintains the archeological remains in their original natural setting, rendering them much more appealing for visitors. The local inhabitants also have a rich and colorful traditional culture, which forms an important and integral part of the region's landscape. One of the objectives of Protected Areas is to nourish and maintain this local cultural heritage.

3.1.9. Maintenance of environmental quality

As a major wetland receiving huge amounts of contaminated and nutrient rich water, Lake Burullus acts as a vast water treatment facility, absorbing and fixing contaminants and improving water quality, before its eventual release into the Mediterranean. The Protected Area will play an important role in maintaining the natural functions of the lake so that it can continue to perform its role in the maintenance of environmental quality. The controls imposed by the protected area status will establish limits to future polluting activities and act as a buffer around the lake to maintain and restore environmental quality in the Lake essential to develop a high quality fishery the primary economic activity in the region.

3.1.10. Importance for scientific research and education

The intrinsic value of the Protected Area for scientific research and education is very high. The many rare and localized biodiversity components, in addition to

various natural phenomena as well as unexplored cultural heritage sites make this a particularly rich site from the scientific point of view.

3.1.11. Fulfilling Egypt's international obligations

The establishment and management of Burullus Protected Area contribute in a very significant way towards fulfilling some of Egypt's important international obligations, most importantly Ramsar, CMS and AEWA.

3.2. Main Threats and Problems at Burullus P A

3.2.1. Root causes

Root causes for biodiversity and environmental erosion in Burullus Protected Area are not very different from those in the rest of Egypt, being compounded further by the low productivity and relatively poor resource base of the region. With the expanding population there is more intensive shortsighted demands on natural resources. This is contributing further to environmental degradation of Lake Burullus, and the loss of natural habitats and native species. The main root causes can be summarized as follows.

Lack of management planning

The lack of planning is a chronic national problem, which has a negative effect on most activities in the country. One of the notable byproducts of this is the rudimentary land use planning system in Egypt, which is manifested in wasteful and confused natural resources utilization patterns. Without careful, proactive and target-driven management and planning, further degradation of the Protected Area will undoubtedly ensue. This situation is compounded further in Lake Burullus as a result of the overlapping (and perhaps incompatible) interests, jurisdictions and responsibilities of the various stakeholders.

Low awareness of environmental and conservation issues

The low awareness of environmental issues and their importance, combined with a limited understanding of the role of protected areas and their value (at both local and national levels) are some of the basic factors, which hinder the proper management of protected areas and threaten their integrity on the long run.

Large continually growing population

The large and growing human population inhabiting most parts of the Protected Area is one of the main root causes, manifested in mounting pressures on natural resources, pollution, disturbance, etc. However, this population is an integral part of the Protected Area, which utilized its resources long before the area was encompassed under the auspices of Law 102/1983, and must be incorporated in a significant way in any future management planning for the Protected Area.

3.2.2 Symptomatic issues

Habitat loss

Habitat loss is probably the most serious problem in Burullus Protected Area today. There are several factors contributing to loss of habitats, most importantly conversion of lands into agriculture and urbanization. The most valuable habitats being lost are wetlands and sand dunes.

Lake Burullus covered 588 km² in 1913. It is estimated that more than 40% of the open water area and 85% of marsh areas have been lost during the past 50 years, largely a result of on-going drainage and reclamation of the Lake's eastern, western and southern margins; and the proliferation of emergent and submeregent vegetation.

Habitat degradation

Unlike habitat loss, degradation is not obvious but is often a low-key process, which slowly alters ecological properties of habitats in a complex manner. Many factors contribute to habitat degradation in Lake Burullus.

Local fishermen complain that the combination of occasional siltation and closure of the Bughaz El Burullus and increased drainage water leads to the reduction of the salinity of the lake and the expansion of reed swamps, reducing the open water areas and hence fishing opportunities. The intentional spreading of the invasive floating Water Hyacinth Eichhornia crassipes by fishermen over areas of the open water as a procedure for catching

fishes may negatively affect all biota of the lake, specially micro-and macroflora because it reduces the amount of sunlight reaching lake waters.

Over-grazing and over-crowding of domestic animals on the islands severely affects the native flora and vegetation as well as the fauna in these areas. Similar overgrazing is experienced in the sand dune habitats of the sand bar.

3. 2.3. Pollution and waste disposal

Agricultural drainage

Despite being the least polluted of the northern Delta lakes, agricultural drainage water with increasing quantities of fertiliser and pesticide loads are being released into Burullus, contributing significantly to the eutrophication and pollution of the lake.

Municipal wastewater

Untreated wastewater from Baltim and the villages neighboring Lake Burullus is directly released into the Lake. This has led to the rapid eutrophication of parts of the Lake and further promoted the growth of extensive *Phragmites australis* beds. Also, the drainage of toxic and industrial wastes into the lagoon eradicated some sensitive fish stocks and tainted the water; even some of the fishermen suffered from skin diseases.

Solid waste dumping

Solid waste is one of the main sources of environmental pollution associated with human settlements in Egypt today. Currently, there are no mechanisms or facilities to deal with solid waste in the region, to the extent that waste generated at the existing visitor facilities is disposed of in-situ, in an ad-hoc fashion.

3.2.4 Excessive and illegal fishing practices

Hoshas are an illegal but widely practiced method of fish catching is in Lake Burullus. This fishing procedure harvests all sizes of fish, which certainly negatively affects the fish production of the Lake. Collection of fish fry and fingerlings directly from Bughaz El Burullus by illegal gangs to provide stock to fish farms, which are established on the southern shore of the Lake and elsewhere, is a highly destructive practice.

3. 2. 5. Disturbance to wildlife

The large number of fishermen on the lake cause continuous disturbance to wintering waterbirds, forcing them to utilise less optimal habitats or sites (for example the open sea). This probably leads to high mortality and abandonment of the area altogether.

3. 2. 6. Hunting

Although it is illegal to hunt or collect any species of wild fauna or flora in any protected area in Egypt, hunting, particularly of migratory birds still takes place almost on an annual basis within Burullus Protected Area. There are also indications that commercial animal collectors are active in the region, collecting small mammals and reptiles for the pet trade. Waterbird catching is widely practised on the lake in winter. While Quail nets, shot guns and lime are used along the sand bar to catch thousands of migrants in the autumn.

3.3 MANAGEMENT OBJECTIVES

Burullus Protected Area is unique amongst Egypt's protected areas because it is home to a substantial human population. For this reason its management is especially challenging and should not be conducted in isolation from the local inhabitants. Management objectives of Burullus Protected Area must take into consideration the fact that it is a fully utilized wetland with many human activities taking place. The Protected Area management should seek to optimize its benefits to the local community, and in the mean time fulfill its role in biodiversity preservation. Maintenance of environmental quality, ecological equilibrium and the promotion of sustainable development practices should be balanced with wilderness preservation and biodiversity maintenance objectives.

The ideal or "principal" long-term objectives have been proposed after accurate field diagnosis and thorough evaluation:

1. to restore ecological and landscape values which have been lost or damaged,

2. to maintain and enhance the ecological and landscape values of the site,
3. to conserve El Burullus resources through sustainable management,
4. to improve socio-economic opportunities for local people, and
5. to develop public awareness for nature conservation.

3.4 Operational objectives

The principal objectives define the direction that the management programme will take, but not the detail. To achieve each objective, a number of measures and tasks are required. Each of these needs its own "operational objective" to ensure that it complies with the general tenure of the plan, that the outcome or result can be assessed and that it relates directly to one or more of the principal objectives. Once the operational objectives have been determined, a series of measures or "projects" can be developed in order to achieve them. Thus there is a step-wise progression in devising a management programme from principal to operational objective and on to identification of projects or measures.

Taking into account the values of the site, its needs and the constraints, the following operational objectives have been identified. Some are related to more than one principal objective, but they are arranged in relation to the principal objective to which they most closely correspond.

3.4.1 Restore ecological and landscape values which have been lost or damaged

1. Restore salinity level
2. Initiate a network for monitoring water quantity and quality
3. Treat water for re-use
4. Monitor climate changes

3.4.2 Maintain and enhance the ecological and landscape values of the site

1. Propose a scheme of zonation
2. Take in situ measures of species conservation
3. Initiate ex situ conservation measures
4. Establish a system of data management
5. Monitor species diversity
6. Initiate a programme of research

3.4.3 Conserve El Burullus resources through sustainable management

1. Improve the situation of law enforcement
2. Revise legislative and institutional aspects
3. Sustainable use of fish resources
4. Sustainable use of reed growth

3.4.4 Improve socio-economic opportunities for local people

1. Initiate capacity-building schemes
2. Develop eco-tourism
3. Fund raising

3.4.5 Develop public awareness and respect for nature conservation

1. Raise level of public awareness
2. Initiate publicity programmes

Fish and fisheries

The occurrence of brackish and saline waters resulted in a large number and a big variety of fish species inhabiting the Lake during seventies and early eighties. Approximately 32 species were recorded in the Lake during these periods (Libosvarsky *et al*., 1971). During 2003 the field survey showed that the diversity of fishes declined from 32 species to 18 ones. All the species, which have disappeared, are of marine origin.

Following the different years of the survey, it was found that the total production of the lake increased gradually from 7349 tons in 1963 to its maximum of 55,000 tons in 1999. As far as the main groups of fishes are concerned, a gradual decrease in the mullet catch was recorded from about 44.7% in 1963 to 17% in 2000 of the total catch. This was accompanied by an increase of tilapia production from 42.8% in 1963 to 72% in 1992, and then decreased to about 62% in 2000. The shift was more pronounced during the eighties. The

production of marine fishes, such as *Johnius hololepidotus* and *Dicenlrarchus labrax* decreased greatly.

All these findings confirm an increased predominance of freshwater components in the fish stock of the lake reflecting thus the changes of the lake underwent in the water supply, mostly from drains, and reducing salinity of water, especially in the eastern part of the lake in association with the new huge drains constructed at that area.

Main threats to fisheries of Lake Burullus

1- **Neglecting of clearing and dredging the lake-inlet** (to the Mediterranean) is the first complaint of fishermen.

2- **Illegal capture of small fishes and fry** directly from the only existing inlet by illegal operating gangs to provide fish farms that established on the southern shore of the lake.

3- **Using illegal fishing gears** with small meshes leads to catching non-commercial sizes, which are finally dried up and used in feed industry. This certainly affects negatively upon the net fish production of the lake.

4- **Hydrological and water balance** studies revealed that the drainage water has dominated the Lake ecosystem, and the water inflows into the Lake are always greater than outflows. That means water in the Lake is in a continuous movement toward the sea, and salinity has been reduced in the lake, which undoubtedly is reflected upon the disappearance of marine fish species in the lake.

5- Pollution and waste disposal

Agricultural drainage and untreated wastewater from Baltim and the villages neighboring Lake Burullus is directly released into the Lake. This has led to the rapid eutrophication of parts of the Lake and further promoted the growth of extensive *Phragmites australis* beds. Also, the drainage of toxic and industrial wastes into the lagoon eradicated some sensitive fish stocks and tainted the water.

6- The low awareness of environmental issues as well as management planning and their importance, combined with a limited understanding of the role of protected areas and their value (at both local and national levels) are some of the basic factors, which hinder the proper fisheries management of Lake Burullus and threaten their integrity on the long run.

Fisheries management

It is essential for the preparation of the fisheries management plan that it includes the interests of Governmental as well as other national agencies; Conservation Organizations and development agencies. A supplementary participation of local people in management efforts is needed, because when the local inhabitants feel part of development and progression, then the conservation organizations can be sure that the protection and management of the wetland is guaranteed. Therefore, wide steps should be taken into the direction of understanding of the management and protection of natural resources and habitats.

Operational Objectives

-Raising environmental awareness of fishermen.

-Management of extensive growth of macrophytes (*Phragmites australis*) beds in the lake to increase the open fishing area and to facilitate circulation of water between different regions of the Lake.

-Clearing and dredging of the lake-inlet to facilitate entering of salt water, as fishery management of mullet and marine fishes is based on raising salinity of Lake water and regulating of a closed fishing season.

- Monitoring the wetland water level and quality.

- Removal of solid wastes from wetland sides.

- Illegal fishery practices should be banned at some areas in some periods, even by enforcing law to achieve this objective.

- Regulation of the mesh of the fishing gears.

- At the initial stage of the management and monitoring process a baseline data needs to be established, to serve as a starting point against which subsequent monitoring results are compared. Some of the results of the current site diagnosis could be used as a basis for the Burullus baseline data.

Action plan and projects

Many operational projects have been implemented to enhance, rehabilitate and manage fisheries in Burullus wetland:

- Clearing and dredging of the lake-inlet for increasing salinity; and this is implemented annually by GAFRD; and the last operation was in 2012. The results of this action were very impressive in 2006, where the production of marine species has increased significantly (Fig. 2).
- Regulation of the mesh of the fishing gears, through a project aiming to exchange of illegal nets with legal ones. This project has been done through non-governmental organization, and it was very successful.
- Management of extensive growth of macrophytes (*Phragmites australis*) beds in the lake to increase the open fishing area and to facilitate circulation of water between different regions of the Lake. The cooperative Union in the region has supervised this project and the fishermen implemented it in many regions of the lake. The results were wonderful and the open area of fishin increased by 23%.
- Removal of solid wastes from the wetland sides.
- Raising environmental awareness of fishermen through many lectures and meetings with them. Also, a workshop was conducted with local religious men to train them how to convince fishermen to conserve the protected area and fisheries in the lake.
- Lab and field training of protectorate rangers for monitoring programs of water quality of the Lake.

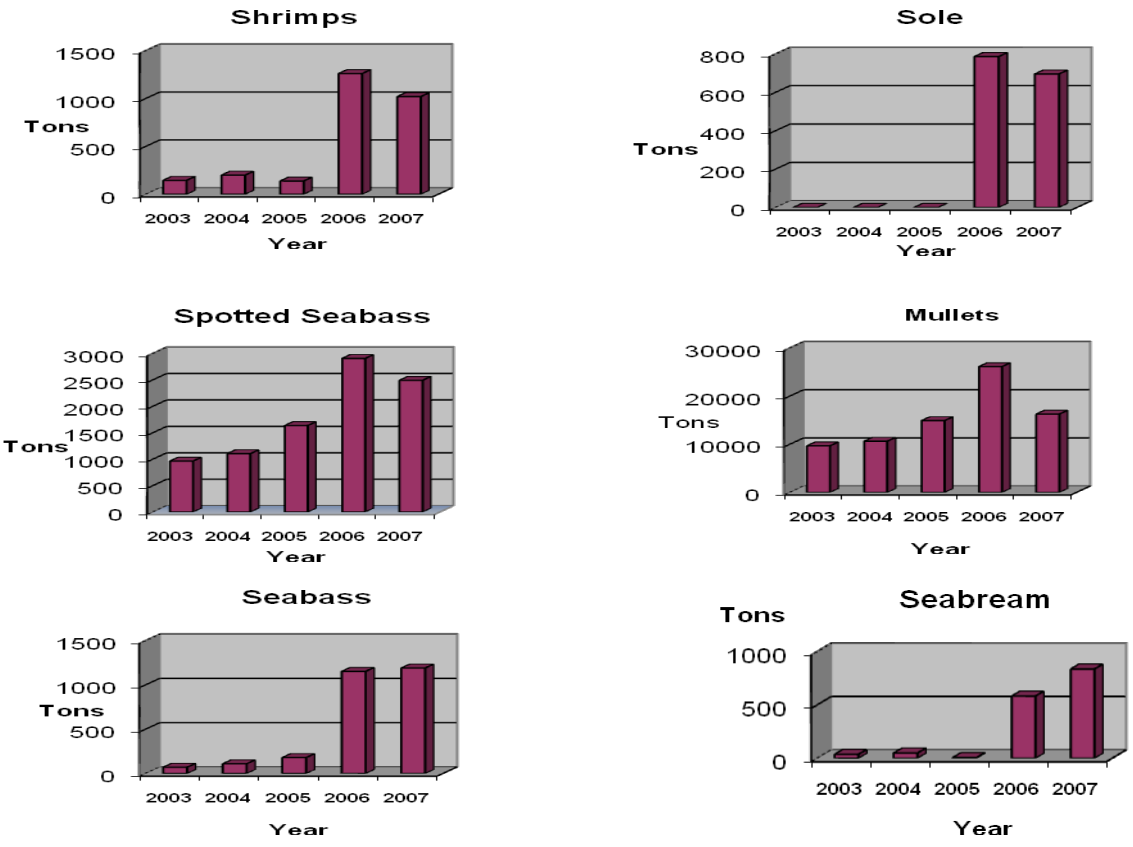

Fig. 2: Increasing of marine species production after management actions

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