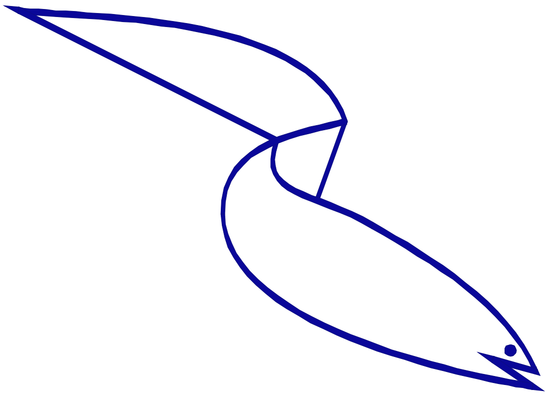
MINISTRY OF RURAL DEVELOPMENT AND FOOD
GENERAL DIRECTORATE OF FISHERIES
DIRECTORATE OF AQUACULTURE AND INLAND WATERS

Hellenic Eel Management Plan



In accordance with
COUNCIL REGULATION (EC) No 1100/2007

MINISTRY OF RURAL DEVELOPMENT AND FOOD
DIRECTORATE OF AQUACULTURE AND INLAND WATERS

UNIVERSITY OF PATRAS
DEPARTMENT OF BIOLOGY

TECHNOLOGICAL EDUCATIONAL INSTITUTE OF EPIRUS

TECHNOLOGICAL EDUCATIONAL INSTITUTE OF MESOLONGHI

PREFECTURE OF AITOLOAKARNANIA
FISHERIES DIRECTION

Athens 2009

The present Eel Management Plan is the product of a specific working group defined by the General Directorate of Fisheries of the Ministry of Rural Development and Food (MRDF, Des. No. 147800). The group was composed by:

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Acronyms and abbreviations

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora

DCR: (EC Reg. 1563/2000 (EC Reg. 199/2008 and EC Reg. 655/2008

EMP: Eel Management Plan

EMU: Eel Management Unit

GCTD: Greek Commission for the Treat of the Desertation

ICES: International Council for the Exploration of the Sea

MD: Ministry of Development

MEPPW: Ministry for the Environment, Planning and Public Works

MRDF: Ministry of Rular Development and Food

NSSH: National Statistical Services of Hellas (Greece)

OECD: Organisation for Economic Co-operation and Development ???

SHPP: Small Hydro Power Plant

WD: Water District

WFD: Water Framework Directive 2000/60/EC

Contents

1. INTRODUCTION

The Advice from the International Council for the Exploration of the Sea (ICES) clearly demonstrates that the stock of the European eel, *Anguilla anguilla*, is outside safe biological limits. For that reason the Council Regulation No 1100/2007/EC obliges Member States to take measures and develop national management plans in order to increase the percentage of escapements to the sea of at least 40% of the silver eel that would have been migrate in the absence of anthropogenic influences.

The continue declining of both eel rercruitment and landings, observed in all European waters, makes the adoption of management measures urgent. The spatial and temporal characteristics of the eel life-history suggest that the equitable contribution of all concerned countries is necessary for the eel recovery.

It is also critical to point out that in order to fulfill the targets of the Council Regulation No 1100/2007/EC, the management schemes adopted by each Member State could be specific to each country respecting the differences in geomorphology, ecosystem structure, fisheries and other human activities.

The elements provided by the Greek eel fisheries landings confirm the above-mentioned declining trends. In fact, despite the local and regional heterogeneity eel production is considerably lower than during early and mid 80's. In most of the Greek freshwaters systems (lakes and rivers) fishery activities are limited and not well organized. In contrast, in most of these systems, especially in low altitudes areas, human impacts were highly intensive especially those related with the irrigation and drainage systems. The majority of the data landings that have been recorded in all Greek systems are provided by the lagoon fisheries. The traditional exploitation of the lagoons is characterized by rather stable fishing effort and thus the observed declining trends reflect decrease in abundance. The exploitation of the young stages is not allowed, except in particular cases requiring a special license limited in space and time. Several rather qualitative indices suggest that both environmental degradation and fishing are responsible for this decline.

The local character of the eel fisheries and the fact that eel is not the main target species in the lagoon fisheries make the management of the fishing effort a complex task. In addition, the decrease of eel landings in the lagoons will directly affect the landings of the other species caught in the traditional fixed barrier traps. For that reason, an extended dialogue with the professional fishermen was necessary in order to enhance the flexibility of the suggested measures and the structure of the management plan.

The urgent need of the eel recovery should lead to immediate measures accompanied by mid and long term actions focused on the reduction of both natural and fishing mortality and the improvement of the seaward migration of adult eels. A synthesis of qualitative and the few quantitative data have been used for the design and implementation of the Eel Management Plan and this information will be presented in the following paragraphs.

The Hellenic ecosystems are close to the eastern limit of the geographic distribution of the species. Moreover they are heterogeneous even at mesoscale. The total annual precipitation increases from east to west and from south to north. A clear increasing trend in total precipitation is also observed with altitude. Consequently, the availability of water resources varies in different regions of Greece. Moreover, the main characteristic of Greek rivers is their torrential flow that is caused by the uneven seasonal rainfall distribution, the mountainous terrain with large slopes and the erosion of the ground due to inadequate forestry. Thus the lowland (less than 200m altitude) are probably crucial for the eel population.

These geographical differences which are followed by differences in eel exploitation and landings suggest the definition of Eel Management Units in order to prioritize and focus the actions aiming in the improvement of the situation of the European eel population.

2. DEFINITION AND DESCRIPTION OF THE EEL MANAGEMENT UNITS

The following paragraphs resume the main characteristics affecting the distribution and abundance of eel in inland and coastal waters. The main climatic characteristics of the entire country will be presented because great differences exist over the country in precipitation, water discharge and dryness and these parameters affect the characteristics of eel ecosystems. Then, the existing Water Districts and their main characteristics will be presented followed by the spatial distribution of lakes and rivers. Special reference will be made to the coastal lagoons as the majority of the eel landings is provided by the lagoon exploitation. Finally the location and spatial extend of the main Authorities involved in water and eel management will be presented. The definition of the Eel Management Units (EMU) will be based on a synthesis of all these elements.

MAIN CLIMATIC CHARACTERISTICS

The distribution of precipitation, dryness and water discharge show a great heterogeneity over the country (Figures 2.1-2.3). The main aspects can be resumed as follows: the total annual precipitation increases from east to west and from south to north. A clear increasing trend in total precipitation is also observed with altitude. In fact this pattern is the result of the main geomorphological characteristics of the country which is mainly marked by the mountain range of Pindos followed by the mountain ranges of Peloponissos and Crete. Consequently, the availability of water resources varies in different regions of Greece.

The mean annual value of atmospheric precipitation is about 700 mm, half of which is lost due to evaporation. In the northwestern part the mean annual precipitation is about 1000 mm in the coastal regions and increases to more than 1400 mm in the higher altitudes of the mountain chain of Pindos. These values decrease slightly towards the southwestern regions. The rainfall height decreases on the eastern side of these mountain ranges. The mean annual rainfall height in the flat areas of Central Macedonia, Thessaly, Eastern Sterea–Western Evia, Cyclades and Eastern Crete is 400–600 mm. However, in the mountainous areas of these regions total rainfall is greater. In coastal areas of Eastern Macedonia and Thrace the rainfall is relatively low (400–600 mm) and increases towards the interior (1.000–1.400 mm), as reaching the mountains (Kotoulas 1996). About 85–90% of fresh water reserves are surface waters, while groundwater reserves constitute 10–15%. These elements reveal three main zones (Figure. 2.4).

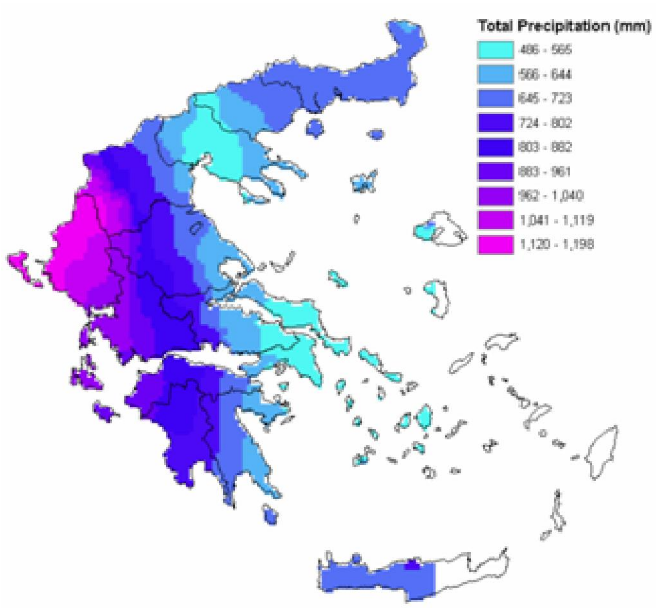


Figure. 2. 1. Distribution of total precipitation (from Mimikou 2005)

Figure. 2. 2. Dryness index (from Mimikou 2005)

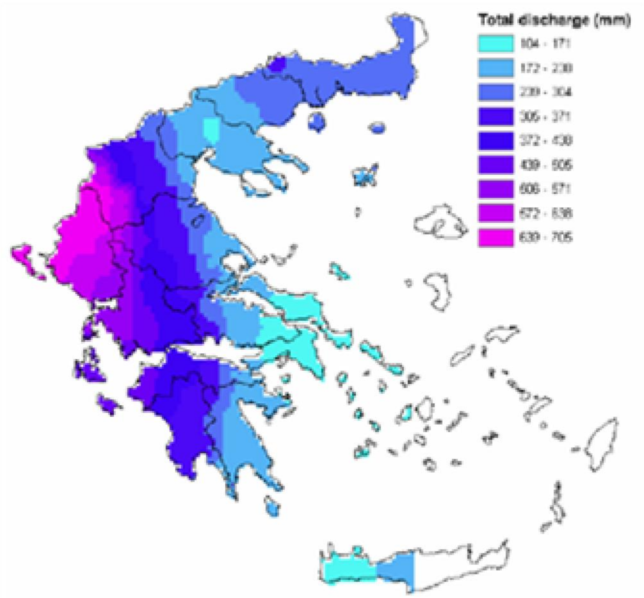


Figure. 2. 3. Runoff Distribution (from Mimikou 2005)

Figure. 2. 4. Hydrogeological zonation of Greece

DESCRIPTION OF THE WATER DISTRICTS

The entire country has been partitioned for water management issues to 14 Water Districts with quite similar hydrological and hydro-geological conditions. The main aspects of the 14 Water Districts are summarized in Table 2. 1 and they appear in the Figure. 2.5.

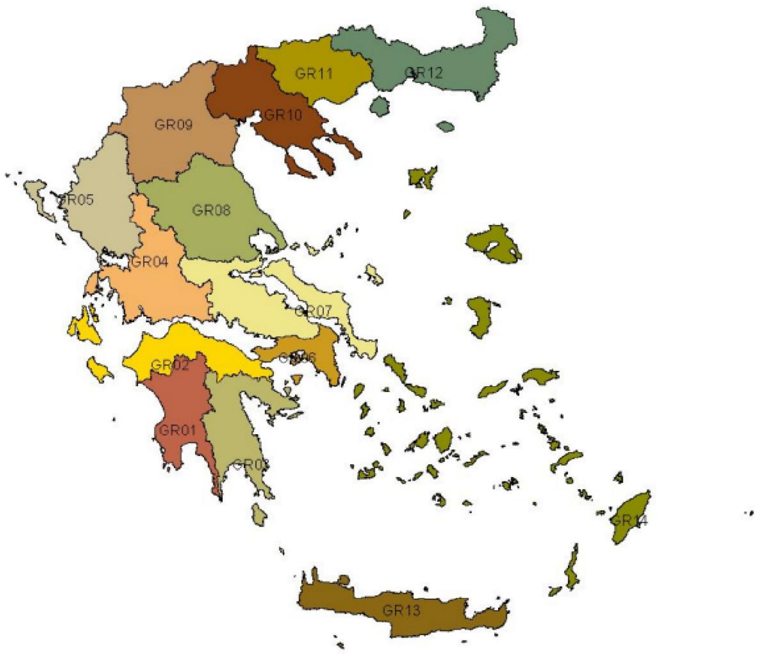


Figure. 2. 5 . Hellenic Water Districts

Table 2.1. The Water Districts of Greece, their relation to the spatial extend of the Prefectures and their main river basins and catchment areas.

Number	Name of W.D.	Area (km²)	Prefectures	Main river basins and catchment areas of lakes	Population (Census 2001)
01	West Peloponnesos	7301	**Messinia**, major parts of the Prefectures of **Ilia** (53%) and Arkadia (48%) and smaller parts of the Prefectures of Achaia (17.2%) and Lakonia (6.1%).	Alfios river, Pamisos river, Nedas river, Aris river, Lousios river, Ladonas river	331180
02	North Peloponnesos	7310	Kefallinia and Zakinthos, major parts of the Prefectures of **Achaia** (82.8%) and **Korinthia** (83%) and smaller parts of the Prefecture of Ilia (46.9%) and Argolida (7.6%).	Pinios Ilias river and Vergas river	615288
03	East Peloponnesos	8477	Lakonia (94.3%), Argolida (92.4%), Arkadia (51.6%) and smaller parts of the Prefecture of Attiki (17.9%) and Korinthia (4.2%).	river basin of Evrotas river.	288285
04	West Sterea Ellada	10199	Evritania and Lefkada, major parts of Aitoloakarnania (98%) and Fokida (58%) and smaller parts of Karditsa (19%), Trikala (20%) and Arta (15%).	Acheloos river, Evinos river and Mornos river. Lakes Trichonida, Lisimachia, Amvrakia, Ozerou, Voulkaria and Mornou	312516
05	Epirus	10026	Thesprotia, Kerkyra, Preveza, major parts of the Prefectures of Ioannina (98.9%) and Arta (85.5%) and smaller parts of Kastoria (12.4%), Grevena (7.2%) and Aitoloakarnania (1.6%).	Aoos river, Louros river, Kalamas river, Sarantaporos river, Voidomatis river, Acherontas river and Arachthos river.	464093

				Lake Pamvotida	
06	Attica	3207	Attica (74.9%) and smaller parts of the Prefectures of Voiotia (1.4%), Korinthia (12.9%) and Kiklades (0.7%).	Catchment area of lake Marathona.	3737959
07	East Sterea Ellada	12341	Evoia, major parts of Fthiotida (83.1%), Voiotia (98.5%) and Fokida (41.9%) and smaller of Magnisia (14.9%) and Attica (7.2%).	Voiotikos Kifissos river Sperchios river and Asopos river. Lakes Iliki and Paralimni	577955
08	Thessaly	13377	Larisa (98%), Magnisia (85%), Trikala (79%) and Karditsa (82%) and smaller parts of Fthiotida (17%), Pieria (7%) and Grevena (7%).	Pinios river. Lithaios river, Titarisios river, Skamnias river. Lake Plastira	750445
09	West Macedonia	13440	Florina and Kozani, major parts of the Prefectures of Grevena (85.5%), Imathia (74.3%), Kastoria (87.6%), Pieria (92.6%) and Pella (66.9%) and smaller parts Ioannina (1.1%), Larisa (1.8%) and Trikala (1.2%).	Aliakmonas river and river basin of Soulou stream. Lakes Chimaditida, Kastoria, Mikri Prespa, Megali Prespa, Petron, Vegoritida and Zazari	596891
10	Central Macedonia	10389	Chalkidiki, major parts of the Prefectures of Thessaloniki (92.7%) and Kilkis (96.1%) and smaller parts Imathia (25.7%), Pella (33.1%) and Serres (0.8%). The main river basins of Water District (10) are: river basin of Axios river and river basin of Ligkos river. Furthermore lakes Doirani, Lagkada and Volvi are significant water bodies located in the Water District (10).	Axios river and Ligkos river. Lakes Doirani, Lagkada and Volvi	1362190
11	East Macedonia	7280	Serres (99.2%), Drama (54.2%) and Kavala (52%) and smaller parts of the Prefectures of Thessaloniki (7.3%) and Kilkis (3.9%).	Strimonas river, Aggitis river, Marmaras river Poria river.	412732
12	Thace	11177	Evros, Rodopi and Xanthi and major parts of the Prefectures of Drama (45.8%) and Kavala (48%)	Nestos river, Lissos river, Vozvozis river, Kompsatos river, Kosinthos river and Fonias river.	404182
13	Crete	8335	Iraklio, Chania, Rethymno and Lasithi.	Kourtaliotis river, Spilianos river, Geropotamos river and Anapodari river.	601131
14	Aegean Islands	9103	Dodekannisa, Lesvos, Samos, Chios and the major part of the Prefecture of Kiklades.	No major rivers are present in the District. Some minor river basins exist in the islands of Rhodes and Samos	508807

Figures 2.6 and 2.7 present the main rivers and lakes and the limits of the Water Districts. These figures reveal clearly the north-south and west-east gradients described in the previous paragraph.

The main characteristic of Greek rivers is their torrential flow that is caused by:

- the uneven seasonal rainfall distribution,
- the mountainous terrain with large slopes
- the erosion of the ground due to inadequate forestry.

Figure 2.6. Rivers per Hellenic Water District

Figure 2. 7. Lakes per Hellenic Water District

A great seasonal fluctuation characterizes the rivers' flow. The ratio between minimum and maximum flow varies from 1:200 up to 1:700. The total number of main rivers in Greece is 40; 13 of them perform a flow of more than 3 m^3 sec^{-1} during the summer period; and 6 of them are originating in neighboring countries. The length of the large rivers in Greece ranges from 70 to 300km (Ministry of Rural Development and Food, 2006). It should also be noticed that important water inflow from neighboring countries exists at the Water Districts 10, 11 and 12 mainly by the rivers Axios, Strimonas, Nestos and Evros and the management of these flows is based on intergovernmental agreements with Former Yugoslav Republic of Macedonia, Bulgaria and Turkey (Polyzos and Sofios 2005).

European Mediterranean catchments, especially those in Greece, are marked by high spatial differences in morphologic, climatic, hydrographic, petrographic and vegetative features. They vary also at the pollution level (Skoulikidis et al., 1998, Skoulikidis, 2000). As a result, river and stream habitat, hydrochemical regime and biocommunity structure, vary considerably along their courses (Skoulikidis, 2000). In addition, research on ecological quality assessment is limited and geographically restricted and classification systems are absent. Hence, the assessment of the ecological quality of Greek is a complex task and needs a special approach respecting the local and regional characteristics Economou et al., 2007 .

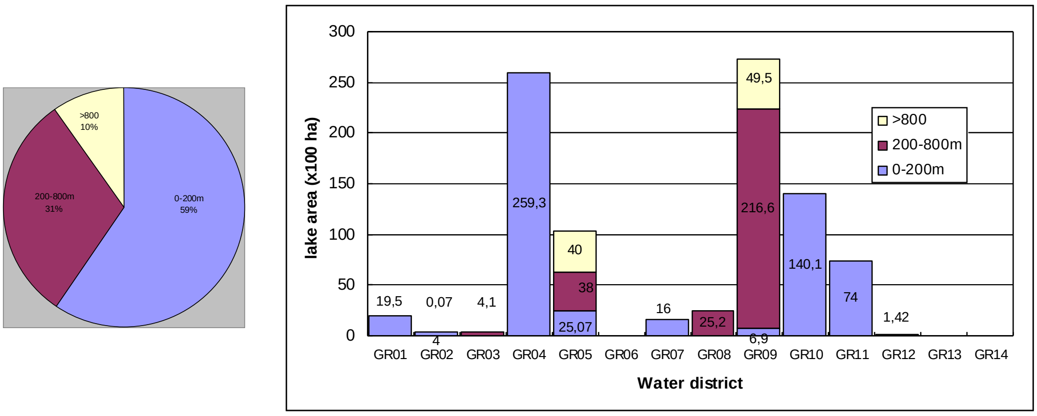


Figure. 2. 8. Percentage of lake area as a function of altitude and lake area per water district (data source: Anonymous, 2001a)

Similar seasonal fluctuations characterize the lakes and storage basins. Lakes, reservoirs and storage basins do not usually contain the same amount of water all year long. They depend strongly on the rainfall and several are linked to rivers. Usually the reservoirs collect water during the winter, but in the summer most of the water is used and evaporated and both the water level and its quality declines drastically. Consequently, the water level and the size of these lakes are rather variable. The distribution of lakes per Water District and in relation to altitude is presented in figure 2.8. About 59% of the Greek lakes is located lowlands (<200m altitude) while a great part of the lakes is concentrated in Water Districts 4 (25930 ha), 10 (14000 ha) and 11(7400 ha). On the other hand, highland lakes are concentrated in WD 9, 5 and 8 (Figure. 2.8).

Several elements suggest that the biological diversity of both natural and artificial lakes increases with the size as a result of a higher diversity of habitats. The presence of eel has been recorded at both natural and artificial lakes as well as at lowland and highland lakes (Figure. 2.9)

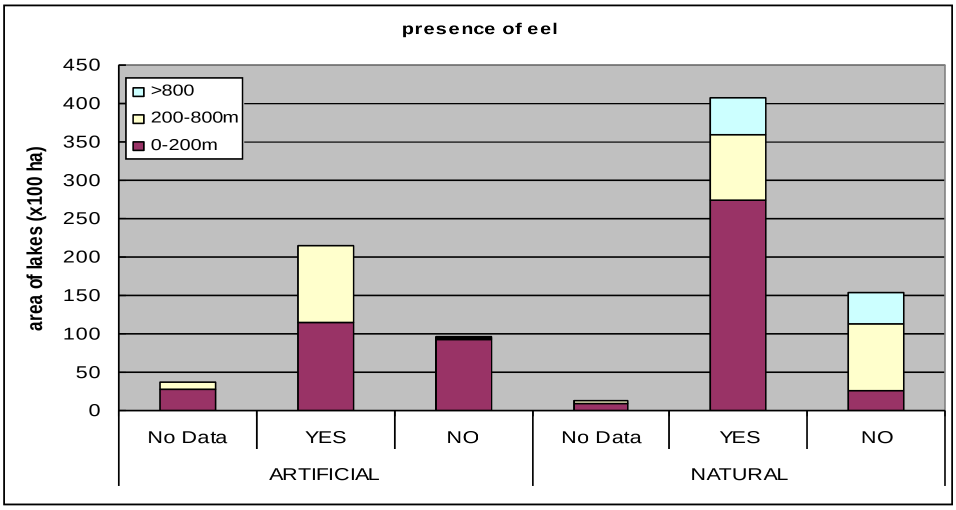


Figure. 2. 9. Presence of eel at natural and artificial lakes by altitude class (data source: Anonymous, 2001a)

It is also important to point out that 65% of the total natural lakes surface of the country was lost during the 20th century

An important aspect for the functioning of the Hellenic water ecosystems is the extended irrigation. The total extent of irrigated regions, which has been increased over 40% in the last 15 years, corresponds to one third of the total cultivated area of Greece (Figure. 2.10). Since the 1960 approximately 20,000–30,000ha have been transformed in irrigated areas each year. This number has been stabilised to 10,000 ha during the last five years (OECD and Greek MEPPW 2006). The irrigated land in Greece indicated a high increase during the last 50 years due to land reclamation works (Sofios et al. 2008). Figure 2.11 shows clearly that the irrigated part of the total cultivated area is considerably higher and increases more rapidly than the other European countries.

Figure. 2.10. Distribution of Rural water demand (from Mimikou 2005)

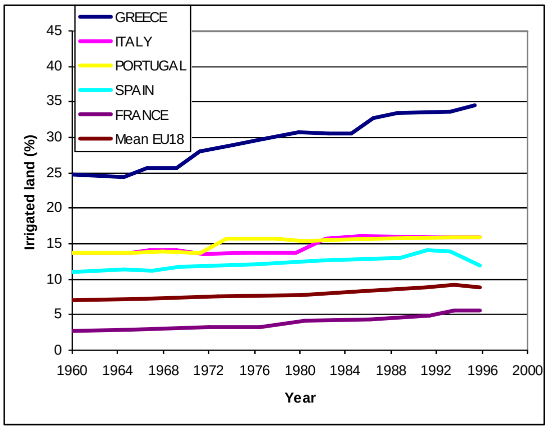


Figure. 2. 11. Irrigated part of the total cultivated area of the country (Source: FAO, Aquastat)

The percentage of irrigated agricultural land was increased to 32% and 60% of the lowland surface is irrigated (GCTD:Greek Commission for the Treat of the Desertation). Despite the importance of the irrigation, the effectiveness of the irrigated systems is rather low.

All the aspects linked to irrigating and drainage systems are considered as critical for the eel and consequently for the present management plan. The concerned zones are considered as priorities and specific actions will be planned.

The HWater bodies are considered to have an acceptable quality (Figure. 2.12). However, it should be noted that this estimate is more based on the relatively limited pressures (medium level of industrial activities) and less on systematic recordings of the water bodies quality.

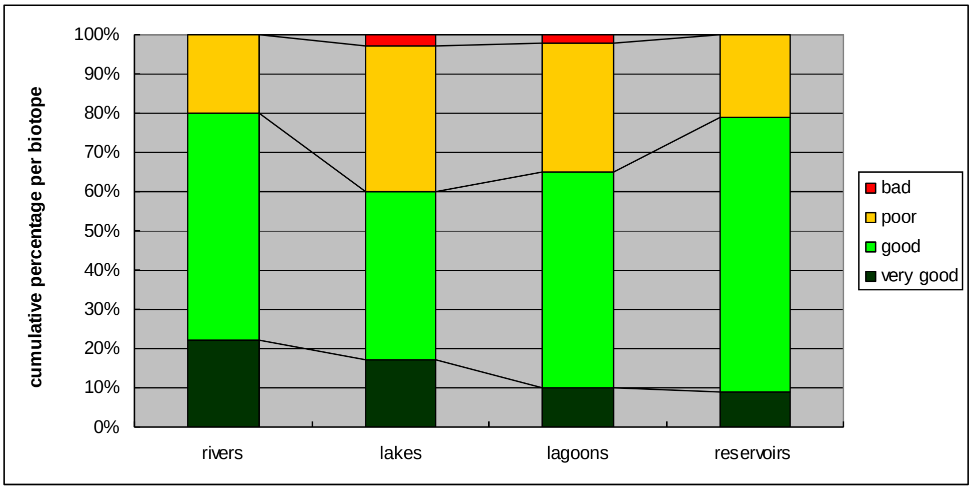


Figure. 2. 12. Water bodies quality assessment (source: Tsouni et al. 2001)

The characterization of the water quality as "acceptable" is based to a large extent on the criteria concerning the uses of the water bodies (for example drinking water, irrigation, fish rearing) and less on criteria that are related to the habitats structure and functioning and their general environmental condition, criteria which in any case have not been studied yet extensively and they are included in the WFD targets. Few elements exist on the distribution of fishes in inland waters in past decades. A global study of the situation in 80's is provided by Economidis (1991).

The evaluation is based on the criteria of the current legislation and more specifically on the criteria related to water use for human consumption (the stricter, in terms of quality standards) and eutrophication aspects linked to urban wastewater or pollution caused by agricultural sources.

In most cases, surface water coming from rivers and lakes can be used for the production of drinking water after appropriate treatment. River Pamisos and Soulou stream are an exception, due to man induced pollution and Rivers Alphios and Pineios of Ilia due to high sulphur concentration. The quality of the waters of rivers Pinios Thessalias, Axios, Strimonas and Evros although remaining within acceptable limits requires further investigation. It is however worth mentioning that the level of toxic substances in surface waters is very low (Figure. 2.13). This is attributed partly to the limited industrial activity level and also to the fact that these activities produce conventional rather than toxic pollution loads.

The following 5 lakes are registered as sensitive recipients according to the provisions of 91/271/EC Directive, Vistonida, Volvi, Lagada, Mitrikou, and Petron. Moreover any discharge of treated or untreated waste water in the lakes Marathona, Stamata, Iliki and Palalimni is forbidden.

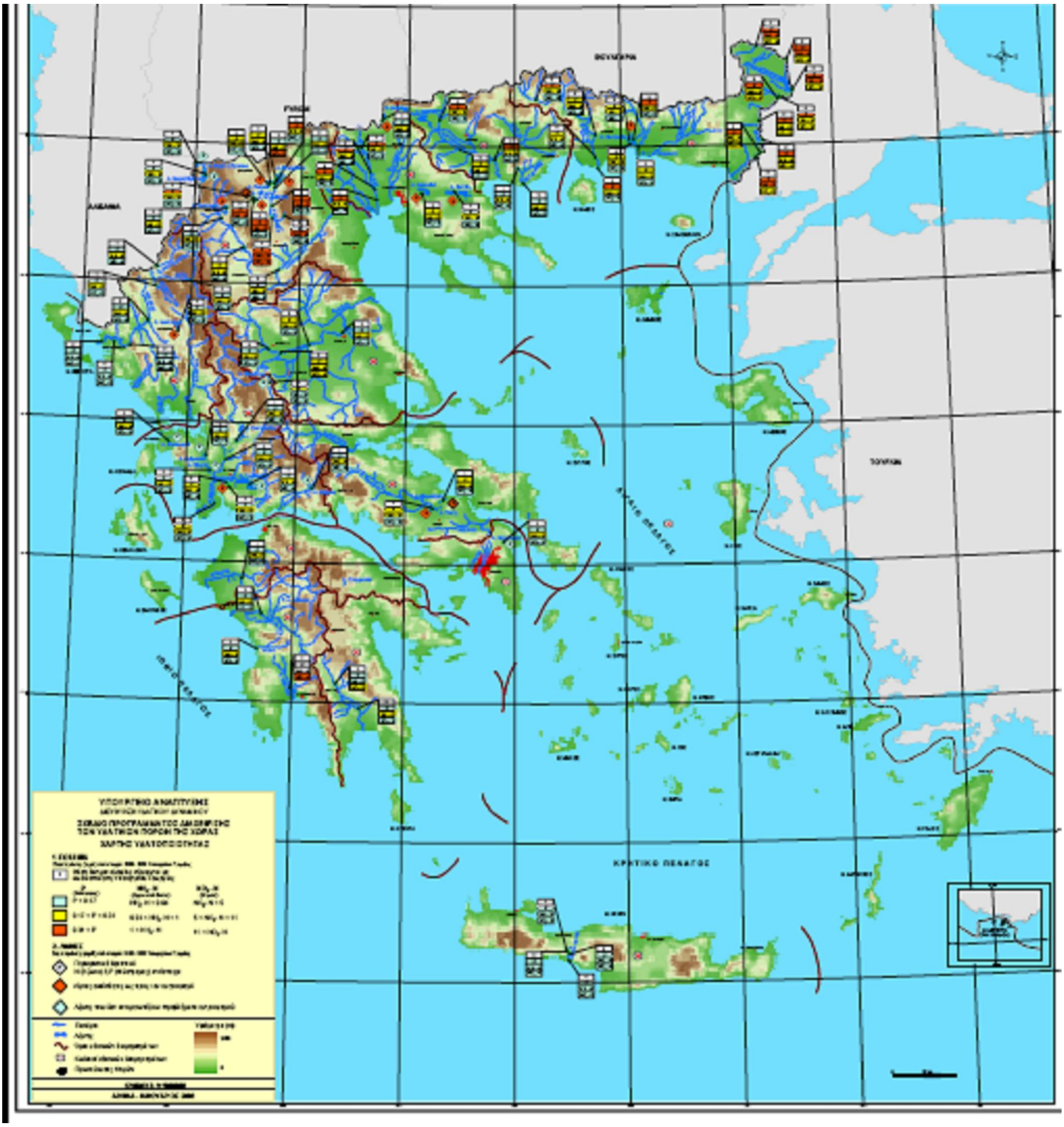


Figure. 2. 13. Characterisation of the surface waters quality (source: MD)

Greece presents an extreme Mediterranean Hydrologic profile (non continuous flow is one important factor), and the characterization of the water ecosystems quality need the combination of existing parameters and the improvisation of new ones including the particular aspects of these ecosystems. Normally this will be done in the context of the WFD.

The above mentioned aspects of the Greek inland waters are very important for the eel distribution, abundance and movements and they will be considered in the management approaches developed in the next paragraphs.

DESCRIPTION OF THE LAGOONS

Small and large wetlands and wetlands clusters constitute the wetland resources of Greece. Their extent is 2x105 ha while their total number exceeds 400. In Greece, 12 river deltas, 75 marshes, 56 lakes, 25 reservoirs, 76 lagoons, 17 springs, 42 estuary systems and 91 rivers have been recorded as wetlands (Papazafeiriou et al. 2000, Anonymous 2001b). Special reference has to be made to the lagoons as the vast majority of the eel catches are provided by the traditional fixed barrier traps of the lagoon fisheries. The surface of 76 Greek lagoons was estimated at about 34511 ha (Anonymous 2001b) and their spatial distribution is presented in Figure. 2.14. It is obvious that the majority of them are located along the west coast of the country in the Water Districts 4 and 5 representing respectively 41.2% and 27.9% of the total lagoon surface of the country. Important lagoons exist also in the Water Districts 11 and 12 (23.9% of the total surface) (Figure. 2.14).

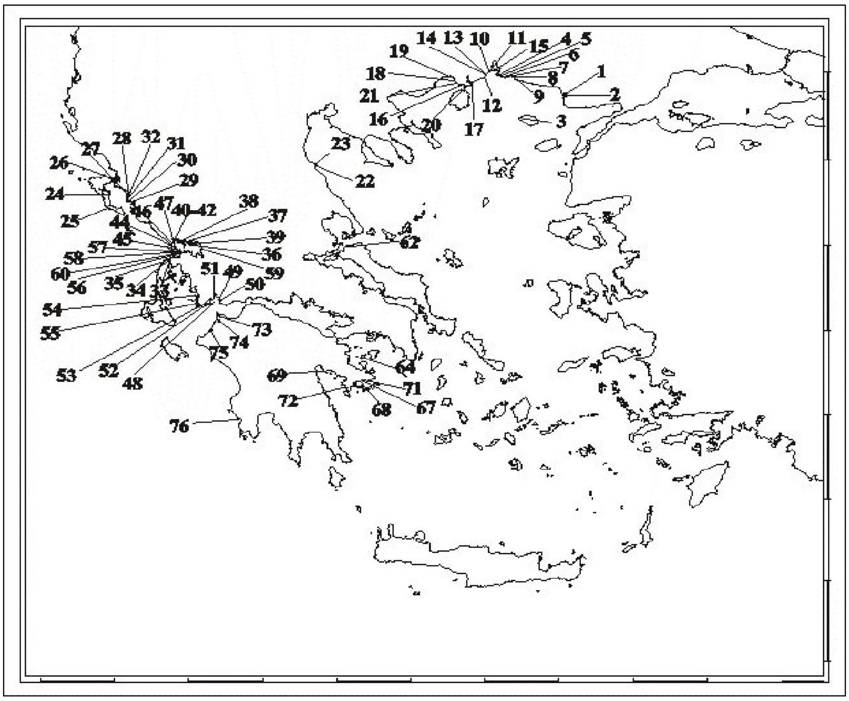


Figure. 2. 14 Geographical distribution of the Greek lagoons (Source:Anonymous 2001b)

They have a limited depth, with a mean value of less than one meter (only 2 lagoons have a mean depth greater than 2m), and only 27% of them have a maximum depth greater than 2.5m. These features make them rather fluctuating and instable. Their limited inertia explains the fragile character of these ecosystems. Despite their fragile character, a growing concentration of different activities affecting their characteristics was recorded mainly due to their attractive position in protected areas of the coastal zone, the specific landscapes and their increased productivity. The analysis revealed that the pressure developed on these ecosystems, affecting their nature, is more limited in the lagoons with well-established and productive fisheries. On the contrary, the total surface and the environmental quality of lagoons with no fishing activity decrease rapidly. From this point of view the development and maintenance of lagoon fisheries could be an interesting mean for the conservation of the lagoons since the local communities exploiting the fisheries protect the lagoons from the development of antagonistic activities. In contrast, the efforts made for the increase of the fish production lead to the multiplication of enhancement trials using fish from the numerous fish farms, especially for the sea bream. The results are obvious in the landing time series of several lagoons. The negative aspects of these practices have not been evaluated.

The particular character of these ecosystems and the pronounced traditional character of the human societies linked to the lagoons (75% of the fishermen followed the profession of their ancestor) limit the flow of information on the functioning, the dynamics of these ecosystems and the needs of these communities. Despite the important investments made by the General Secretariat of Research and Development representing 2.5 million € for the period 1995-99 and founds from other Ministries, regional and local authorities, for a mean annual fish production representing less than 5 million €, there is a remarkable lack of information. Sporadic measurements of hydrological parameters exist for only 48% of the lagoons. For 57% of the Greek lagoons less than 5 study reports and publications can be found (for 21% of the lagoons there were no recorded elements). The recent development of a central database appears as a very efficient tool for the monitoring and the management of these important but fragile coastal ecosystems.

Important fishing activities are developed in the majority of the Greek lagoons. The fishery exploitation is based on traditional and/or modern fixed barrier fish traps. These are permanent entrapment devises and the catches are based on the species-specific inshore-offshore seasonal or ontogenic fish migrations. This element is of crucial importance because the fishing effort can be considered rather constant and thus the fish landings from the lagoons reflect changes in both the abundance and the composition of the fish communities. More over, for the majority of the lagoon fishes, their seasonal presence in the lagoons is part of their life cycle pattern and thus year to year landing fluctuations reflect mainly changes in their population abundance.

For several lagoons, 20 to 30 years landings time series were analyzed and the results show clear decreasing trends with different patterns: stable decreasing trends, drastic changes occurred during short time periods without obvious restoration (accidents) and increased interannual fluctuations. The continuous trends characterizing the landings of Mugilidae and Sparidae, are due to both the degradation of the physical environment and the increased fishing pressure. The accidental changes, very pronounced in the eel landings, can be linked to both regional and large-scale changes occurred in the natural ecosystems.

Based on the elements of Anonymous (2001b), in Greek lagoons are employed about 750 fishermen belonging to Cooperatives and the same number approximately operate individually. It is should be noted that these numbers are significantly lower than in 80's and this is due to the marked decrease of the landings after 1990.

The linkage of the transitional waters with the inland water systems is of great importance for the management of eel because the main eel exploitation is carried out in the lagoons during the seaward migration of the silver eels and consequently inland ecosystems and the exploitation of the lagoons should be considered in parallel in the context of the Eel Management Units.

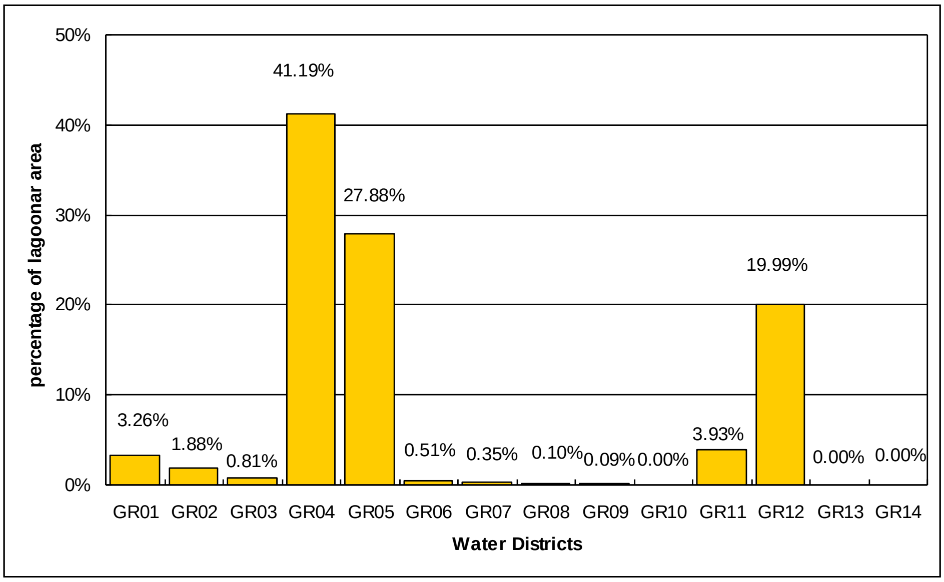


Figure. 2. 15. Percentage of total lagoon area per Water District.

From the recorded data (Anonymous 2001b) it appears that 50% of the Greek lagoons do not receive identified freshwater discharges, 33% receives the seasonal freshwater influence from the constructed drainage channels or torrents and 17% receives directly or indirectly the freshwater influence from rivers, lakes and salt marshes. In 80% of the Greek lagoons the water management is problematic due to human impacts independent of the fisheries. In addition, the fact that 73% of the lagoons is of closed-type and anthropogenic changes can affect the migration processes of diadromous species. The lagoons of this last category are located in the WD 4, 5, 11 and 12 and thus they represent an important lagoon surface. The improvement of eel migration through these lagoons can in term complete or replace direct measures concerning the fisheries. It should be noticed also that 75% of the wetlands surface of the country was lost during the 20th century.

COMPETENT AUTHORITIES

In Greece the structure of the water management schemes is based on the public administration at National and regional level. A National Committee of Water was established by the Law 3199/2000. The duties of the commission include the policy-making and management of water, the monitor and control of the implementation and the approval of national programs for the protection and management of the water potential of Greece. The national programs are proposed by the Minister of Environment, Planning and Public Works and the opinion of National Water Council.

The functional management takes place at the Prefecture level, with local Normative Decisions, defining the terms for water resources protection and determining the condition frames for the publication of licences for the construction of water works and permissions of water use per category.

The management structures were never well organized. Specifically, at the regional basis the fact that the limits of Water Districts often does not match the limits of the prefectures leads to frequent conflicts (Figure 2.16 and Table 2.1). These differences constitutes an important cause of frictions for the implementation of Law 1739/87, due to the fact that this law takes into account the ‘‘Authority of Management’’ (Regional Service of Water Resources) and does not consider the established administrative structures.

The greatest part of the used water capacity concerns surface water. Moreover, a contribution of water from neighbouring countries is marked at the WD 10–12. According to intergovernmental agreements with Former Yugoslav Republic of Macedonia, Bulgaria and Turkey, Greece receives significant water quantities from the rivers Axios, Strimonas, Nestos and Evros (Polyzos and Sofios 2005).

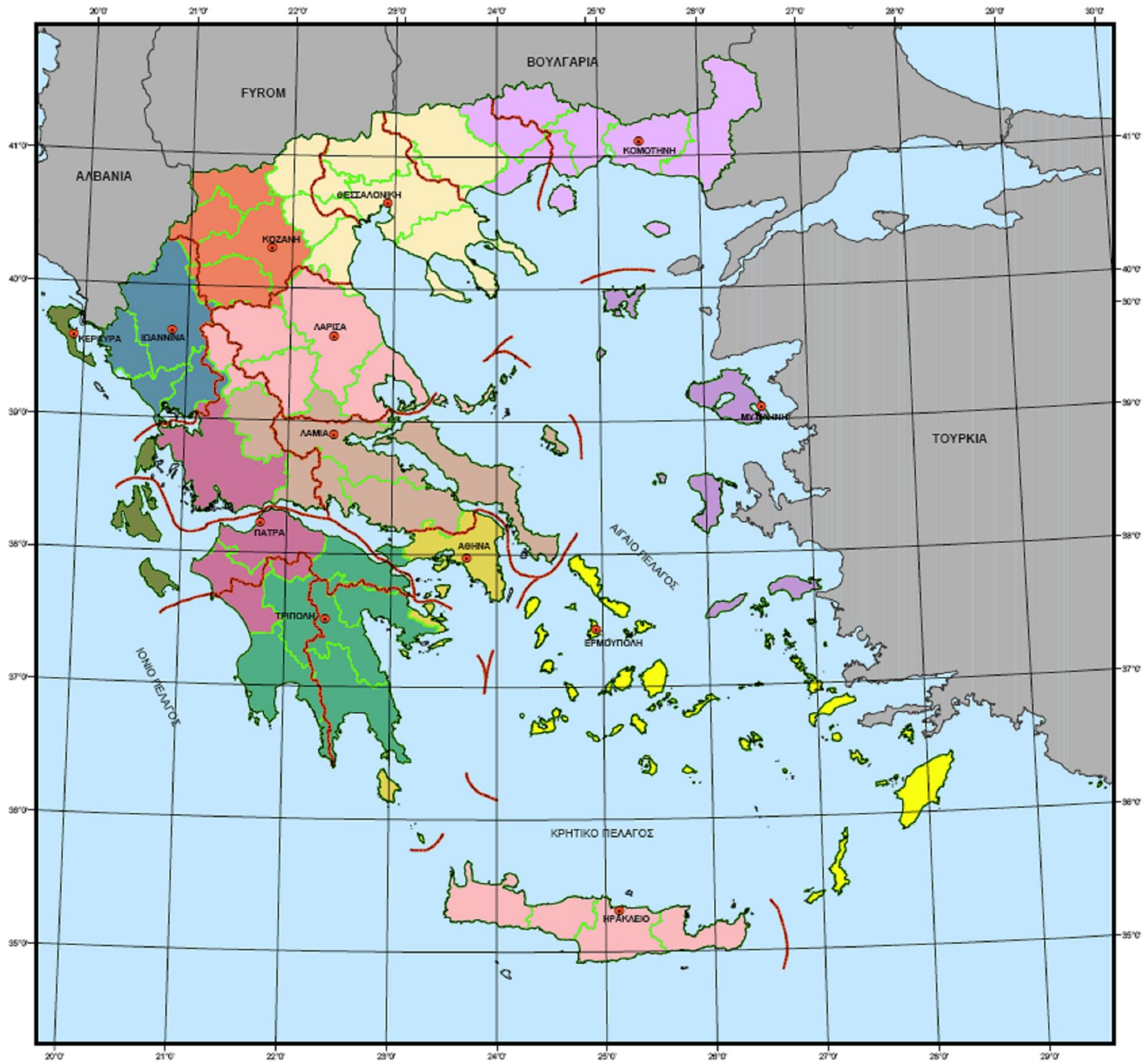


Figure. 2. 16. The limits of Water Districts (Red lines) and the Greek Prefectures (green lines) (source Ministry of Development)

In the rural sector the management of water resources concerns mainly the activities of irrigation, the infrastructures in the livestock—farming, the fishery of internal waters and the agricultural industry. The forests, which constitute important areas of water supply, are included in the framework of activities. According to Law 1739/87, the Ministry of Rural Development and Food, which is the responsible authority for the rural sector, has the responsibility for the application of measures and actions satisfying the cultivation needs in water, as well as other agricultural needs for the sustainable development of the countryside.

Moreover, the following administrations are involved in the management of the coastal, transitional and inland ecosystems and especially the fishing activities.

The responsible administrations for the implementation of Greek legislation is the Ministry of Rural Development and Food and the Ministry for the Environment, Physical Planning and Public works.

The responsible administration for safeguarding is the local Sea Customs for the sea and estuarine areas, the Police Departments for the lakes and rivers.

Each Region has the responsibility of leasing lagoons and coastal areas, monitoring and implementing the current law for the above mentioned systems, assisted by the local Fisheries Directions of the Prefectures.

The majority of freshwater systems, lagoons and natural lakes belong to the public domain. For freshwater systems, fishery period starts the 1st of March and ends in the last day of February of the next year.

More specifically, the Hellenic lagoons belong to the following owners:

Table 2.2. The number of lagoons and the corresponding surface per owner type.

Owner	Lagoons	Surface (ha)
Ministry of Mercantile Marine	1	4.500
Public	63	298.426
In Conflict	2	7.800
Church	4	3.760
Private	2	2.700
Local municipalities	3	7.900
Total	75	325.286

The fisheries exploitation is defined by the article 35 of the Law No 420/70. According to the paragraph 11 of the article 19 (3208/2003) the decision for the leasing of the public natural systems (lagoons, lakes) is decided by the General Secretary of the Region and it includes the general context, the specific conditions and the technical aspects for the leasing. The same decisions define the rules for the fishery exploitation in addition to the current fishing law.

DEFINITION OF THE EEL MANAGEMENT UNITS

Following the above presented elements concerning the climatic, hydrogeological, geomorphological and administrative aspects the definition of four Eel Management Units (EMU) is proposed (Table 2.3, Fig. 2.17). This definition respect both the physical and the operational aspects included in the eel management structures. As it will be presented in the next paragraphs the retained definition considers some aspects of the eel exploitation which discriminate and characterize the EMU.

Table 2.2. The proposed Eel Management Units (EMU) of Greece and the Prefectures and the number of Regions included to each one.

EMU	Name	Prefectures	Regions
1	North Western Greece	Aitoloakarnania, Arta, Preveza, Lefkada, Ioannina, Thesprotia, Kerkyra	3
2	Western Peloponnesos	Achaia, Ilia, Messinia, Zakynthos, Kefalonia	2
3	East Macedonia - Thrace	Evros, Rodopi, Kavala, Xanthi	1
4	Central Greece – Aegean Islands	The rest of the country (35 Prefectures)	8

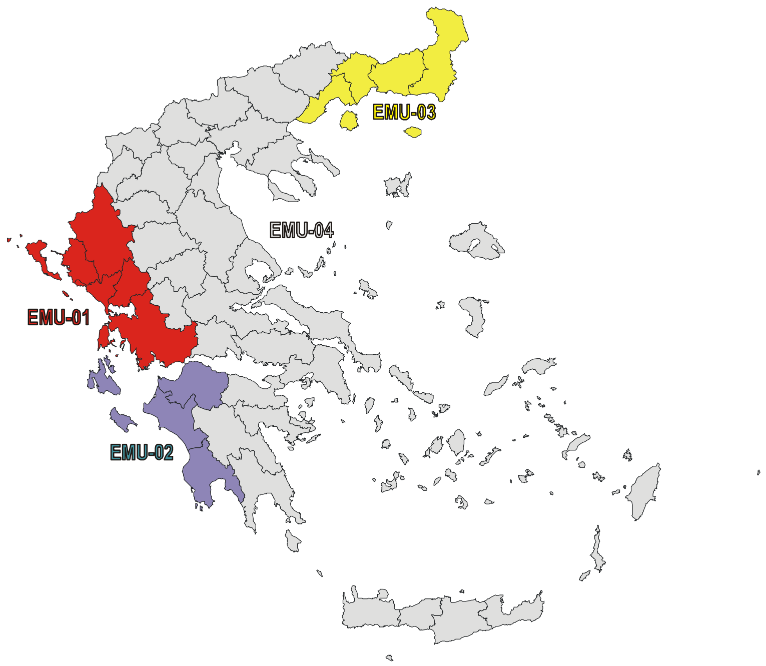


Figure. 2.17. Map of proposed Eel Management Units of Greece

The relative importance of the EMU's for the eel stock gradually decreases from EMU-01 to EMU-04 as it is revealed from the landings of the lagoons (Figure. 2.18) and the lakes (Figure. 2. 19). Despite the considerable decrease of the EMU-01 landings (Fig. 2.18), the unit remains the most important eel producer. The landings of the EMU-04 are almost zero. It is interesting to point out that the landings of the EMU-02 increased during the period 1997-2000. The same decreasing pattern is observed in the lakes landings (Fig. 2.19) but in this case the production of EMU-02 and EMU-03 are negligible.

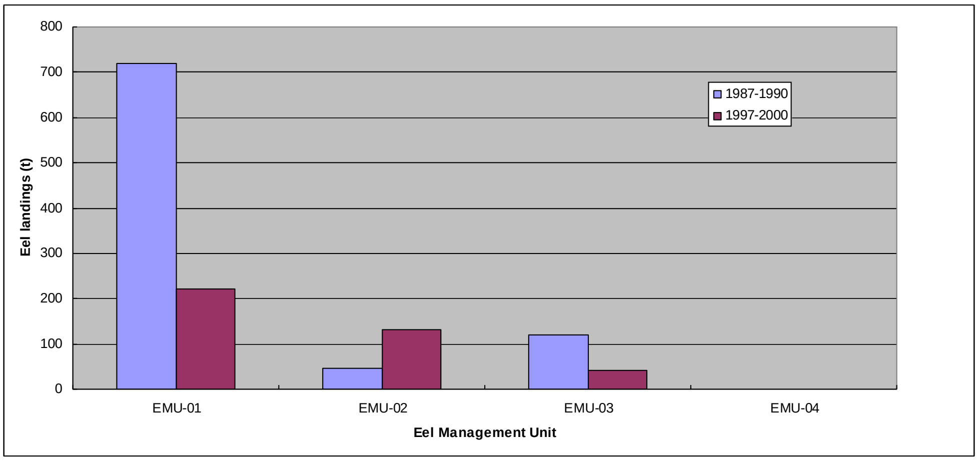


Figure. 2. 18. Sum of lagoon eel landings per Eel Management Unit of Greece for two periods.

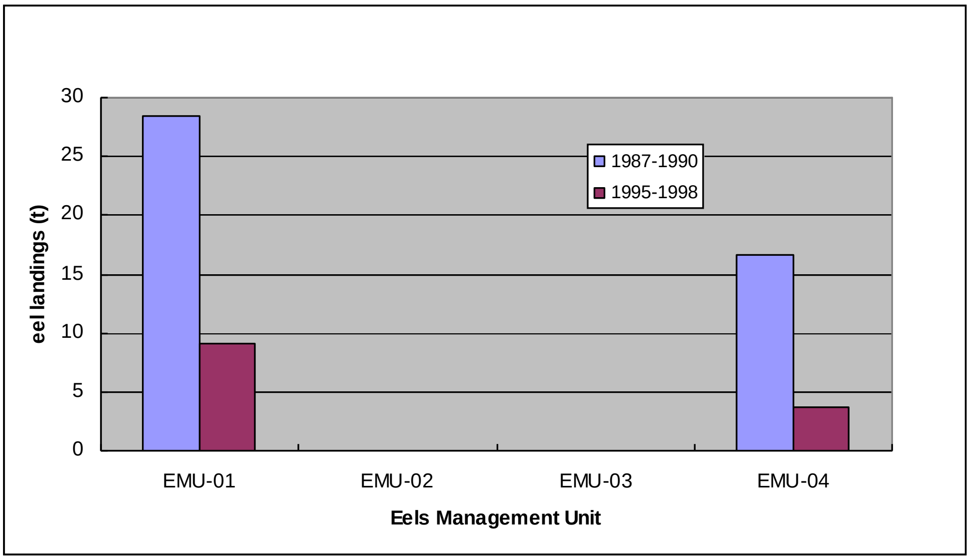


Figure. 2. 19. Sum of lake eel landings per Eel Management Unit of Greece for two periods

Rivers, Lakes and dams

In Greece they have been recorded 91 rivers representing 4268 km with deltas covering approximately 723 km^2. No professional fishing activity was observed in rivers (except some rivers like Evros) despite the reported presence of eel. In several cases illegal fishing activities have been observed.

Scientific elements report the presence of eel in the majority of rivers but in a database concerning the Hellenic inland waters (Anonymous 2001a) only in few rivers the presence of eels were recorded (Almopos, Axios, Acheloos, Galikos, Edesaios). A possible cause of this disagreement is the absence of systematic and organized fishing activities. The particular characteristics of the Hellenic rivers (torrential character, large slopes) limits the local presence of significant eel numbers. In the cases where rivers are connected with natural lakes both eel abundance and fishing activities are more pronounced.

From the total number of Greek rivers, about 15% are directly connected with 23 lakes having a total surface of 550 km^2 and they are located from the sea level up to 1350 m of altitude. Most of these lakes are dam reservoirs (15) with total surface of 350 km^2 and the remaining 8 are natural systems with total surface of 180 km^2. From these 8 natural lakes 3 representing 67% of the total surface of these category belong to Acheloos river system and they are located 14 to 24 m above the sea level. In four natural lakes that are located up to 31 m above the sea level the presence of eel was reported. For the remaining low altitude lakes no fishing activity was recorded. All these lakes are in EMU-01 and EMU-02.

From the 16 most important artificial lakes linked to 11 rivers, 3 of them covering 33% of the total surface of this group, belong to the system of Acheloos river which is connected with the largest lagoonal system in Greece, the Mesolognhi-Etoliko lagoons. Two additional dam lakes, covering 47% of the total surface of this group, are linked with Arachthos river which is related with the lagoons of Amvrakikos gulf. All the above-mentioned systems belong to EMU-01. In addition, these dam lakes are used electric power and irrigating systems. The presence of eel has been reported in six of the 14 dam lakes that are dispersed in various altitudes and regions.

Special care should be given to the influence of hydropower constructions on the eel spatial distribution. The number of large dams are relatively low in Greece (less than 50) and in any case considerably lower than in the other European countries. But much more attention should be devoted to the rapid increase of the number of small private hydropower systems. Despite the environmental protection previsions conditioning their construction and functioning no special reference to eel was made. Additional structures facilitating the upward and downward eel movements should be added to the majority of them. This action should be considered in the EMP as a direct measure especially in the most important EMUs.

3. THE PRESENT SITUATION OF THE EEL STOCK

TYPES OF EXPLOITATION

Lagoons

The most important type of Mediterranean lagoon exploitation is the use of fixed barrier traps catching fishes during their seasonal or ontogenic offshore migration. Barrier traps (V-shape traps) are passive, fixed gears and are part of the fence installed at the interface between the lagoon and the sea (for more details see Ardizzone et al., 1988). The traps are covered by a nylon or PVC net (mesh size 30 mm; hanging ratio 0.7). The size selectivity of the fish barrier traps follows a classic sigmoid curve. The traditional barrier fish traps used to be wooden installations, consisting of wooden sticks hammered into the lakebed sustaining a net of reeds. Most of these installations were replaced after 1980 with cement installations (modern barrier fish trap) copied from the Italian "vallicultura" capture systems (Figure 3. 1).

The analysis of the monthly landings of the Messolonghi-Aitoliko lagoons (EMU-01) showed that 92% of the total annual eel catches were recorded between November and January (Katselis et al., 2003). This clear seasonal character of the fixed barrier trap fisheries in the lagoons is confirmed in Figure 3.2. Moreover, this figure shows a clear decreasing trend during the period 1988-98.

Figure 3. 1 Traditional (above) and mondern (below) barrier fish traps installated in Greek lagoons (Source: Koutrakis et al., 2007)

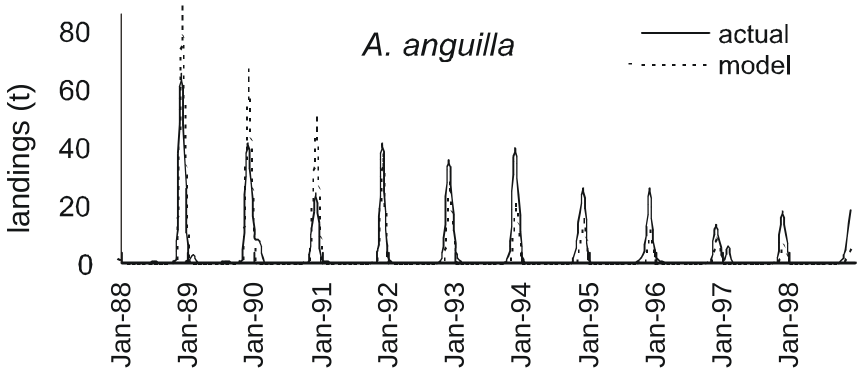


Figure 3. 2 Recorded monthly landings of the eel in the Messolonghi Etoliko lagoons during the period 1988-1998 and the estimates produced by the harmonic regression model (Source: Katselis et al., 2003)

A more detailed analysis by Akovitiotis et al. (2003) showed that the bulk of catches is recorded in few days under particular environmental conditions (mainly low atmospheric pressure and stormy weather (Figure 3.3)).

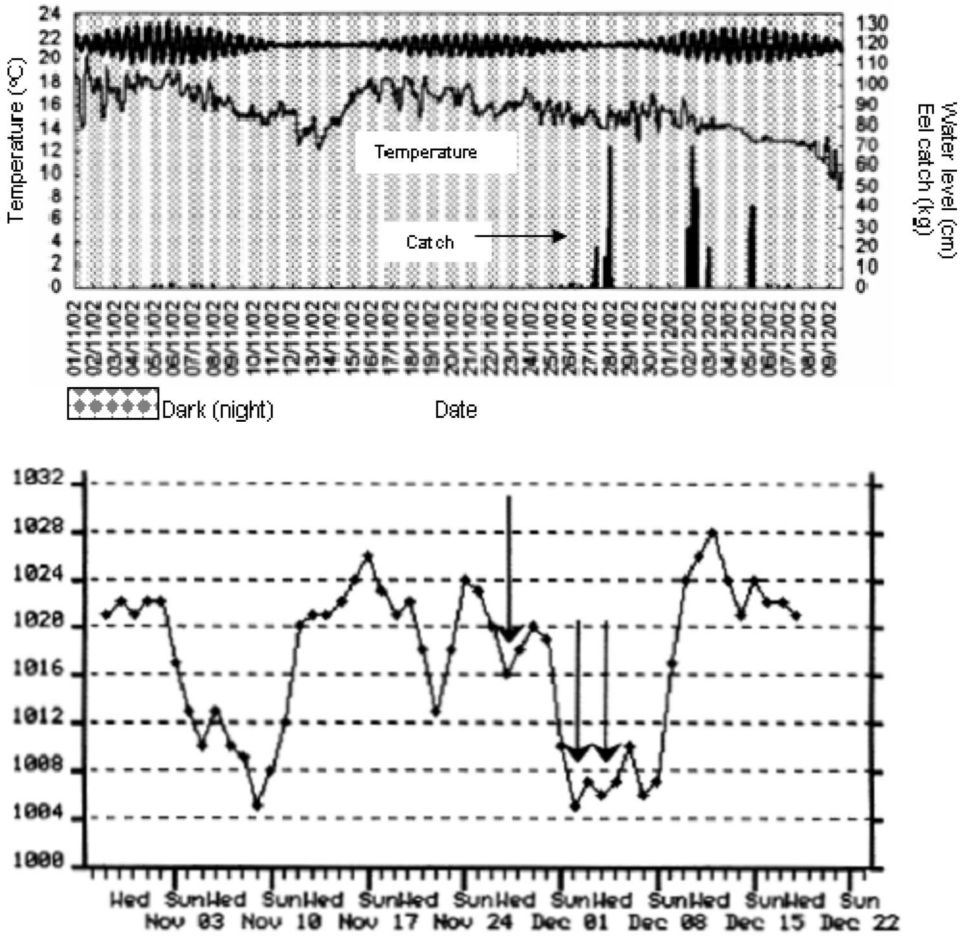


Figure 3. 3 Daily eel landings in the Buka lagoon (W. Greece) during the period November to December 2002 in relation to water temperature, water level (tide) and atmospheric pressure. Arrows indicate massive eel catches. (Source: Akovitiotis et al., 2003)

Individual fishermen

In several areas of the EMU-01 individually operating fishermen (often from the coast) target eel with catches varying from 200 kg to 1000 kg per period (Koutsikopoulos et al., 2001). The number of fishers remain unknown and their spatial distribution and their gears also. Individually operating fishers exist also in lagoons, lakes and deltas of EMU-02 but no elements exist on their activity. The same information exist for EMU-03 and finally the few elements for EMU-04 suggest that the intense eel fishing activities in some rivers stopped at the late 70's as a result of the severe degradation of the corresponding ecosystems.

The spatial distribution of eel is extended over a wide range of ecosystems, from the coastal waters to small and large systems in inland and isolated waters. From this perspective, the monitoring and the evaluation of the fishing activity and landings is a difficult task, especially in the case that sporadic professional and/or recreational fishers caught this species in different systems. In addition, a significant number of those fishers caught eels for selling them illegally. It is also worthy to point out that in the Greek fishing legislation recreational fishers are allowed to catch eels using only fishing line from the land and without the use of a vessel.

The so-called independent fishers that fish inside the Greek lagoons are allowed only in 8.3% of them, using nets and longlines, irrespectively from the species caught. The lagoons with legal independent fishing activity are all recorded in EMU-01, representing 50% of the total surface of the Greek lagoons and belong all to the most important deltas of Acheloos and Arachthos systems. The independent eel fishery is carried out using eel traps, fyke nets, lights, spears, longlines and other localized traditional fishing gears.

In 14 Hellenic lagoons (covering 10% of the total surface of the lagoons) the illegal fishing activity is almost zero, in 30 the fishery activity is medium (covering the 29.7%) and in 26 the fishing activity is intense (covering 60.3% of the total surface). These elements are provided by rather qualitative elements on the activity. The quantification and the detailed description of these fisheries is urgent and special actions will be planned in the context of the EMP.

The information presented above for the legal and illegal fishery in the Greek lagoons is referring to the total fishing activity. No elements exist on eel specific fishing actions Thus, it is important to:

(a) define the eel catches in those fisheries,

(b) identify the different gears used in each area for catching eels

(c) estimate the contribution of eel landings in the income of the legal fishery. The above findings will help to suggest more specialized and acceptable measures limiting the eel fishing mortality.

Generally, given the lack of detailed data and the existing knowledge, eel can be considered as target species locally and for specific time periods. In few cases the eel fishing is observed all year round catching both yellow and silver eels. Both legal and illegal or recreational fisheries supply local markets. Their size and character have to be estimated before the establishment of measures limiting these activities.

Recreational fisheries

There are no quantitative data available for recreational fishing for eel in Greece. Some scarce, disperse and rather qualitative information on this activity exist. This activity is local and has a seasonal character. In lakes and coastal lagoons is more frequent, but no information on the level of catches exist. Given the relatively high price of the eel and/or the local traditions, an effort should be firstly made to quantify these fisheries before the decision of specific measures limiting them.

Aquaculture

Eel aquaculture in Greece has been developed from the late of 80's (Fig. 3.4). Aquaculture production data, which are provided by the Ministry of Rural Development and Food, have shown that until 1997 the mean production reached 166 tons (123.9 SD), whereas afterwards a three-fold increase was marked (mean production 538 tons, 109.6 SD). The market size is larger than 130 g (up to 220 g) however it is variable, in accordance to the market demands. The Hellenic farmers are supplied by glass eel or elvers mainly from the Great Britain and/or France. During the period from 2002 to 2007 an approximate number of $17x10^6$ individuals of elvers have been imported to the Greek eel farming (source: MRDF).

In the context of the EMP the supply of the farms with elvers fished in specific ecosystems of the country can be examined. The main idea is to collect elvers in high natural mortality ecosystems and rear them. A part of the produced eels in well identified health conditions will be used to enhance specific ecosystems communicating with the sea.

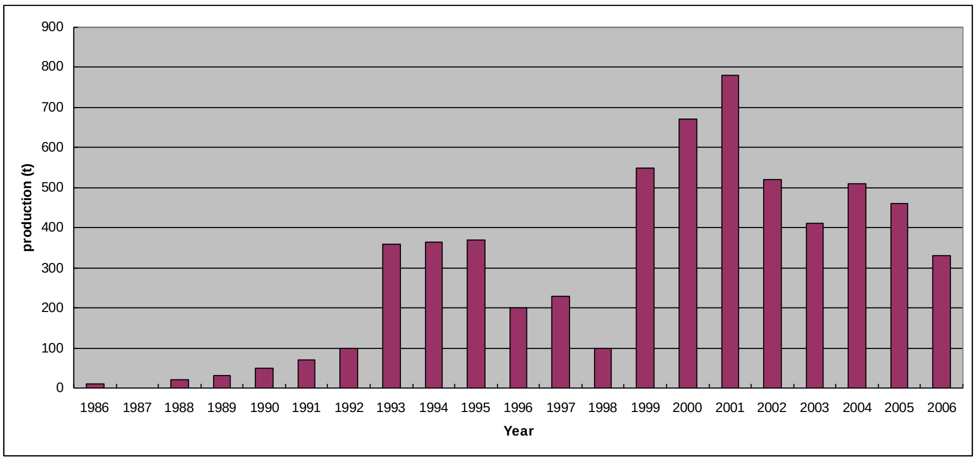


Figure 3.4. Aquaculture production of eel in Greece

LANDINGS

Total eel landings

Significant differences on the annual total eel production (landings and aquaculture) were noted among the various sources; MRDF, National Statistical Service of Hellas (NSSH), FAO. The production data provided from MRDF indicated that the annual total eel production (landings and aquaculture) ranged from 300 t, in 1980, to 1000 t in 2001 (Figure.3.5). The trends of these two sources are different, a decreasing one for the fisheries and an increasing for the aquaculture.

On the other hand, the production data provided from NSSH and FAO indicated that the annual total eel production (landings and aquaculture) ranged from 4 t, in 1989, to 45 t in 1991 (Figure. 3.6), but these data include only the landings from inland and sea waters. It should be noted that no decreasing trend is present in these series. Moreover, the FAO data suggest that the vast majority of the catches are provided by the regions of the Aegean Sea. This is rather strange if we consider the climatic and geo-hydrological elements presented in previous paragraphs.

In any case, all sources can be considered as imprecise and biased and the landings are underestimated due to the misreported or/and non declared production as well as due to the illegal fishery.

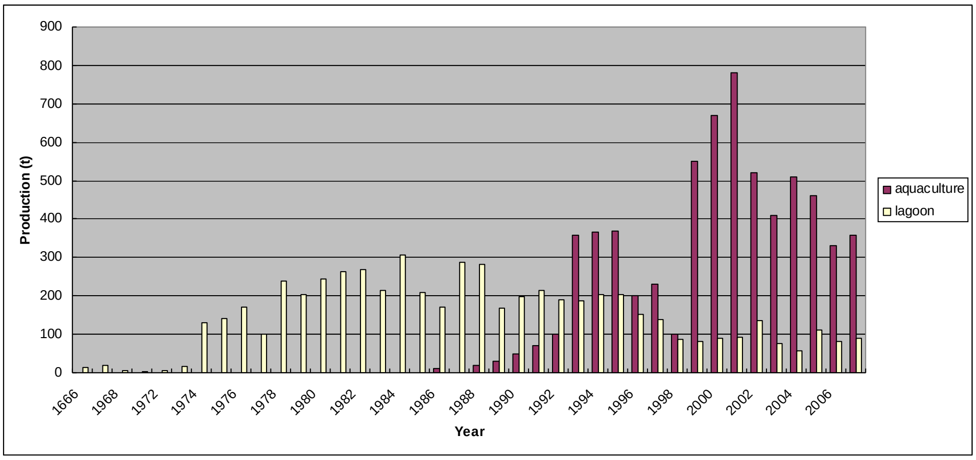


Figure 3. 5 Annual production of eels from lagoon landings and aquaculture (Source: Ministry of Rular Develoment and Food of Greece).

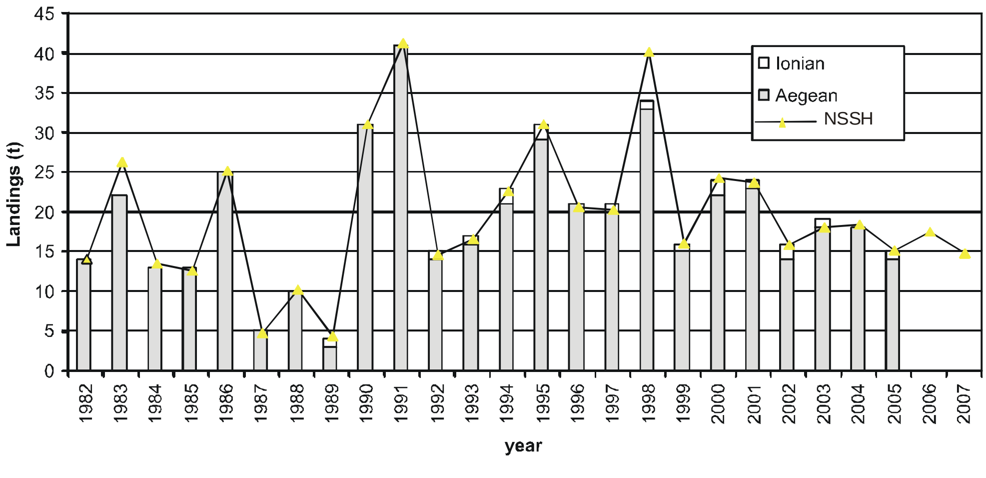


Figure 3. 6 Annual landings eels from inland and sea waters (Sources: National Statistical Service of Hellas (NSSH) and FAO).

In the context of the EMP a unique, specific and well designed reporting system will be developed. An effort will be also made to analyse carefully the past data in order to use them as reference points.

Landings per Water District

Figure 3.7 presents the annual landings of eel per Water District. It is clear that the most productive are the WDs 5, 12 and 4. Also, the highest annual productions were observed during the period from 1970 to 1990. After this period a significant decreasing trend marks the majority of the WDs. Some exceptions are also observed in low production Water Districts (WD 1 and 2).

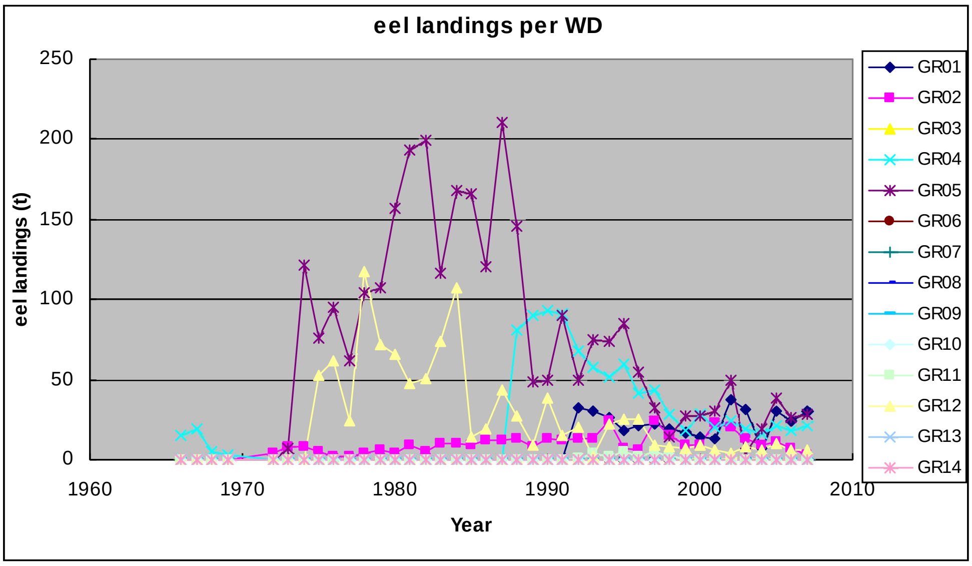


Figure 3. 7 Landings of eels from lagoons per Water Districts of Greece.

The same results are obvious in the time related changes of the annual productivity of the WDs (landings/surface). Indeed, the mean annual eel productivity of the lagoons in the WD 1 and 2 increased from 10 kg/ha during the period before 1980 to 25 kg/ha after 1990. On the other hand, the productivity of other WDs dropped from 10 kg/ha during the period before 1985 to lower than 5kg/ha during the period after 1990 (Figure. 3.8). These differences are interesting (if they are not produced by misreporting) and they will be examined in the context of the EMP.

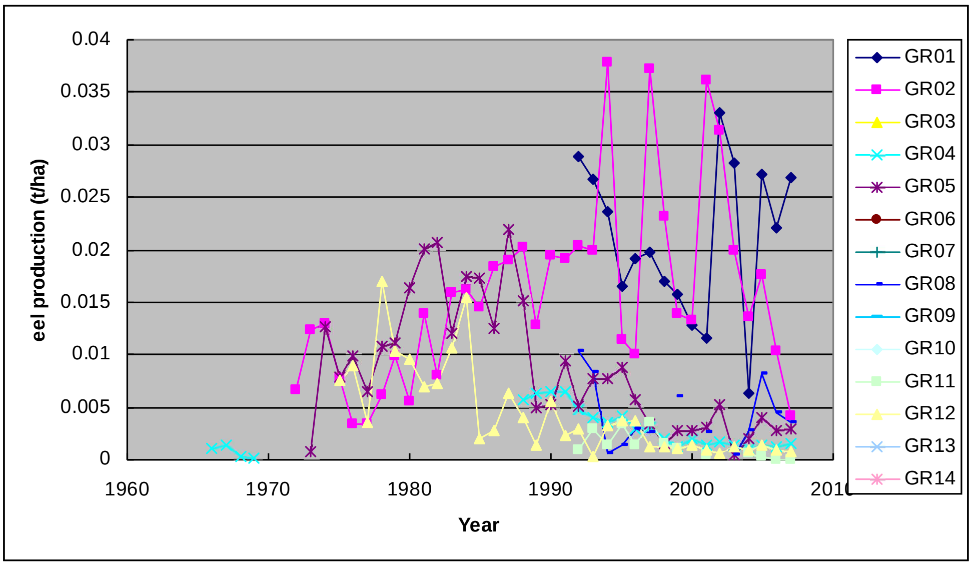


Figure 3. 8 Lagoon's productivity (landings/surface) of eel per Water District of Greece.

Landings per EMU

Figure 3.9 shows clearly that the landings of the EMU-01 are considerably large. The maximum annual landings ranged from 110 to 220 t/yr during the period 1980-1990. For the second important unit (EMU-02), the maximum annual landings have been recorded during the period 1976-1985 (50-100t/yr), while after this period the landings decreased and the last years they ranged from 10 to 20 t/yr.

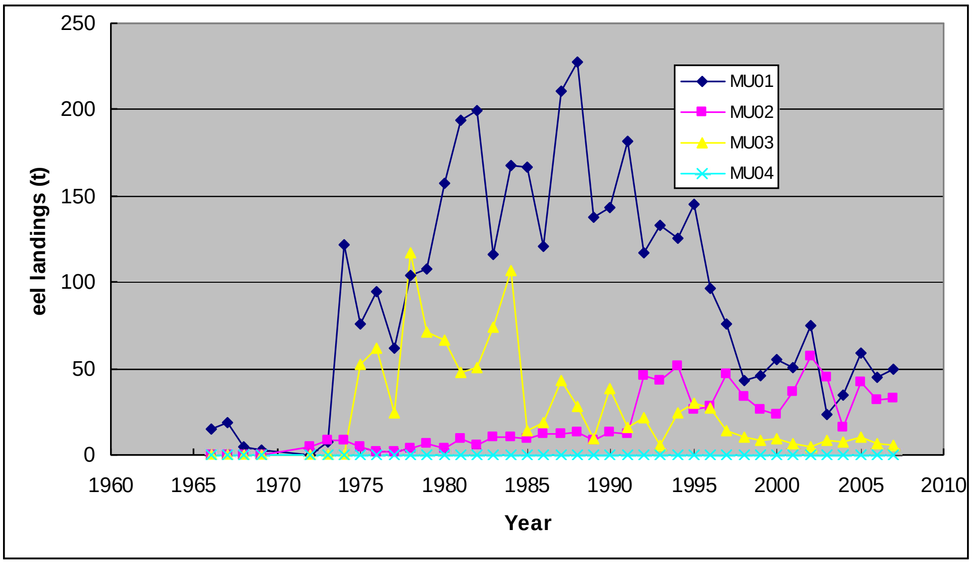


Figure 3. 9 . Lagoon eel landings per Eel Management Unit of Greece.

The available landings from lakes showed also a clear decrease of eel production between the periods 1987-1990 and 1995-1998 at both EMU-01 and EMU-04 (Figure 3.10). In the figure it is also clear that the majority of the catches are realized in low altitude lakes.

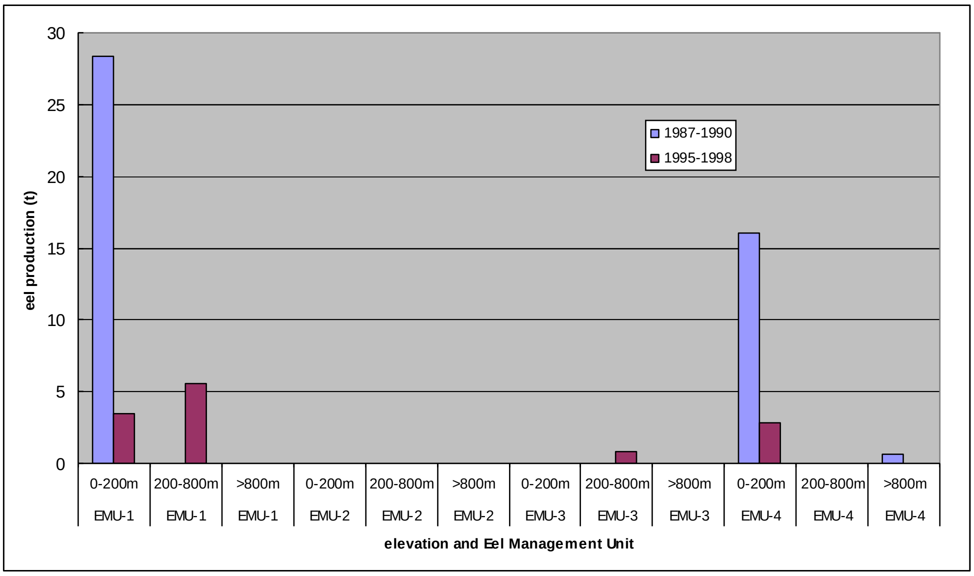


Figure 3. 10. Sum of eel landings from lakes per Eel Management Unit of Greece and altitude of the lake during the periods 1987 to 1990 and 1995 to 1998.

The decreasing trends are obvious on the annual lagoon landings of the EMU-01 and EMU-03 after 1990 while the annual lagoon eel landings of the EMU-02 showed a noticeable increase. The mean eel annual production of lagoons of the EMU-01 and EMU-04 decreased from 10 kg/ha during the period before 1980 to 2.4 kg/ha the last years. On the other hand, the eel annual production of lagoons of the EMU-02 increased from 10 kg/ha during the period before 1985 to 20-25kg/ha during the period after 1990 (Figure. 3.11).

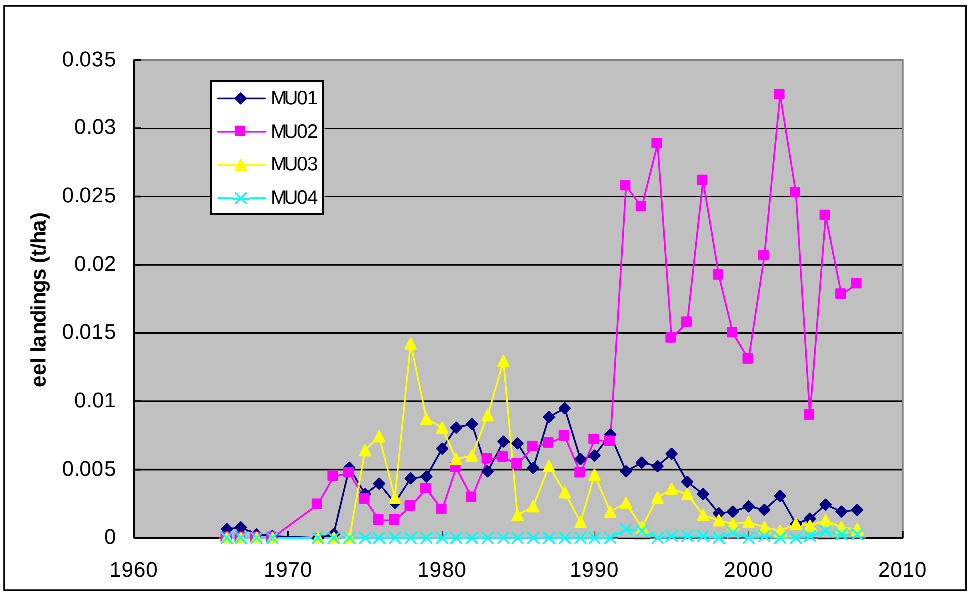


Figure 3. 11 Lagoon's eel production (landings/surface) per Eel Management Unit of Greece.

QUALITY OF DATA

In Greece, despite the economic importance of the species, the available biological data are scarce and limited. No element on recreational fisheries and few scarce and localised elements for the individually operating fishers exist. More over no trend on the evolution of these two categories is available.

The eel production data were gathered from all official Greek authorities. Analysis of these data showed that the existing time series are insufficient, heterogeneous and usually contradicting whereas there is almost entirely absent information concerning individual fishermen. Reliable information is difficult to obtain even in cases of leased areas, such as lagoons, in which the leasing enterprises are obliged to declare their annual production. The development and the application of the EMP will greatly improve these aspects by defining one central information source.

Despite the fact that the presence of eel is reported in the majority of rivers only few records of eel fisheries in rivers is detected. This could be linked to the fact that in several cases eel fishing in rivers is limited, rather occasional and opportunistic. It seems that close to the deltas the fishing pressure increases but no elements are available.

The exploitation pattern showed a pronounced regional character with great heterogeneity (more intensive in transitional and less in inland and sea waters). The Greek eel fishery seems to be based on silver eel stage and showed a clear temporal pattern (November-February).

A significant decrease in eel production was observed after the 80's. The same decreasing trend of eel production had also been observed in regions of western Europe, a fact that could signify that the Greek eel stock followed the pattern of changes of the European eel stock.

RECRUITMENT

Informations on recruitment of the European eel in the eastern Mediterranean are scarce and limited despite the increasing state of anxiety for the future of the stock. The glass eel entrance in Greek inland waters as well as their biological characteristics (biometry and pigmentation stages), were studied in two coastal systems along the western Greece (Ionian Sea): at the Sagiada marsh in the delta area of Kalamas river and at the mouth of Alfios river, from 1998 to 2000 and from 2001 to 2002. The two sites have different geomorphological and environmental features allowing a between sites comparison Zompola, 2008 .

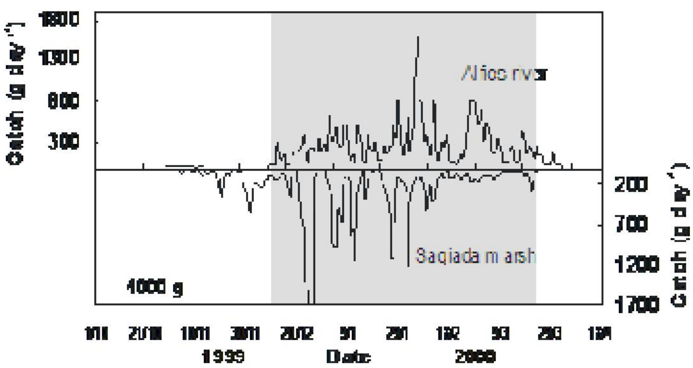


Figure 3. 12 Time series of daily glass eel catches in Alfios river and Sagiada marsh. The dark area marks the period retained for the statistical analysis (14th December 1999 to 3rd April 2000) (Source: Zompola et al., 2008).

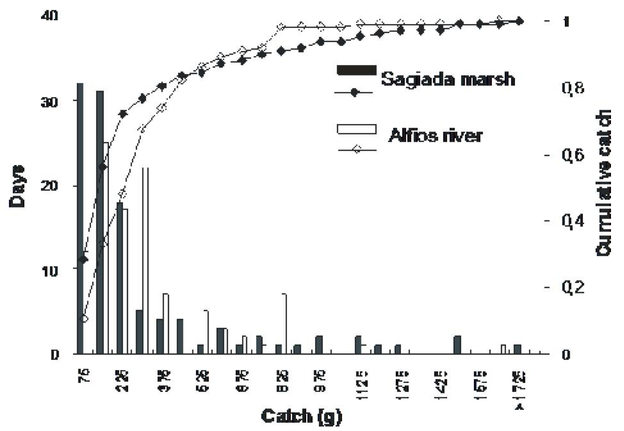


Figure 3. 13 Frequency (days) and cumulative distributions of glass eel catches (in weight classes of 75 g) in the Sagiada marsh and Alfios river

The main period of the glass eel entrance was from December to March (80% of catches) (Figure. 3.12-3.13) and the migration pattern was similar to those observed along the Atlantic coast of southwestern Europe, despite the greater distance of Greek coast from the suggested spawning grounds (Sargasso Sea).

However, the temporal pattern was characterized by short term fluctuations. The majority of the catches were recorded from mid November until late March in Sagiada, while in Alfios about one month later, from mid December to mid April. These differences were attributed to the specific local environmental parameters (marsh vs river). The data analysis showed that glass eel short-term freshwater migration consisted of waves with periods from 5 to 40 days and was correlated with environmental factors such as water temperature, atmospheric pressure, rainfall and moonlight (Zompola et al. 2008).

The results of this study showed that glass eel size (mean length: 6,02 cm ± 0,34 and mean weight: 0,19 g ± 0,05) was smaller compared to those reported for the Atlantic coast, but similar to those reported for the Mediterranean. Mean total length and weight showed high variation and also a decreasing trend over the season (up to 5% and 45 % respectively). Temporal changes were observed in the pigmentation stages of the glass eels showing a progressive increase of more pigmented individuals throughout the season, similar to those observed for the Atlantic coast. In contrary, glass eels of VB stage (‘true’ glass eel) consisted a small percentage (<30%) of glass eel catches in Greek coast in comparison to southwestern Europe where dominated (>80%) during their major ascent in estuaries indicating delayed ascent in Greek inland water after the eel metamorphosis.

Unfortunately this is the only detailed study covering the entire period of presence of glass eels in inland waters and no comparison with past data is possible.

ENVIRONMENTAL ASPECTS

The relative importance of eels in the catches as well as their landings has been changed as a result of anthropogenic modifications of the main biotopes (irrigation, water management, land management). For example the species composition of Messolonghi-Aitoliko landings showed long-term changes (Figure. 3.14).

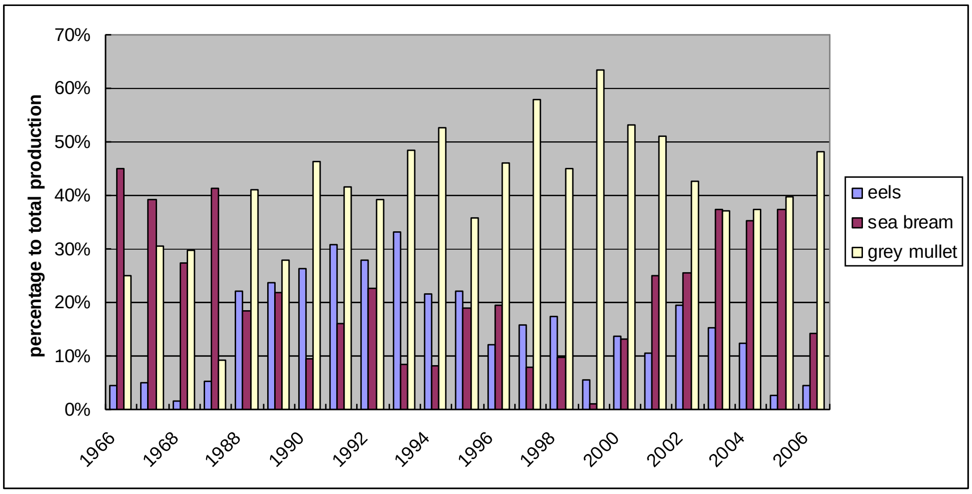


Figure 3. 14 Percentage of eels, sea bream and grey mullets on the total annual

production of Mesolonghi-Aitoliko lagoons complex during the period 1966 to 2007.

The figure 3.14 shows a decreasing relative importance of the eel in the lagoon landings after the mid 90's. An increase of eel contribution was observed in 2002 landings. These fluctuations are linked to anthropogenic changes in the geomorphology of the lagoons and the functioning of the irrigation and drainage systems. A detailed analysis of these fluctuation in relation to the environmental changes will be carried out in the context of the EMP.

Anoxic problems exist all over the country (lakes, lagoons). Massive fish mortalities due to anoxic conditions in Aitoliko lagoon (W.Greece) were recorded in 1992, 1994 and 1997 (Leonardos & Sinis, 1997). During these years a strong decrease in the species diversity was observed (Figure 3.15).

After these accidents, eel dominated the landings (Figure 3.16). This species inhabits the inland ecosystems around the lagoon (natural and artificial irrigation and drainage channels covering the entire cultivated region) so it was not seriously affected by the anoxic conditions occurring in the lagoon.

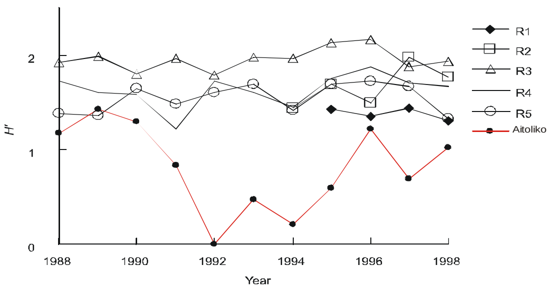


Figure 3. 15 Shannon -Wiener diversity index (H') of the annual fishery landings, in the six regions of the Messolonghi Etoliko lagoons (Red line Aitoliko lagoon). (Source:Katselis et ., 2003).

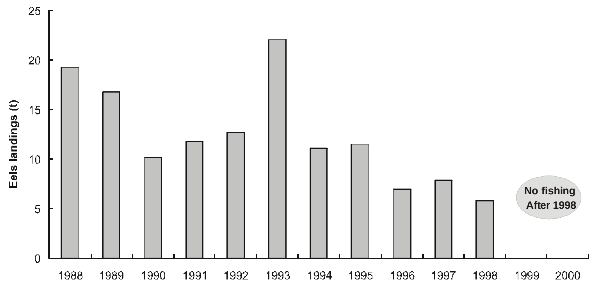


Figure 3. 16 Eel landings from Aitoliko lagoon (W. Greece).

50 years ago the whole estuarine system (Lisimachia – Trichonida lakes, Mesolonghi – Etolikon lagoons, the Acheloos – Evinos rivers and the adjacent Ionian Sea) was an open – type rare system in which many anthropogenic changes occurred. The direct communication with the open sea has been disrupted either due to large extended anthropogenetic effects (e.g.., dams, pumping systems) or due to non-recorded impacts from many small irrigation systems (Figure 3.17) which disrupted the direct communication with the open sea (Ionian Sea). In the map of figure 3.17 it appears that the surface of the irrigation systems around the lakes and the lagoons is greater than the surface of these ecosystems. The consequences of these effects are related with the limitation of the migratory movements of many species towards and from the Ionian Sea. The photos presented below (Fig. 3.17) show clearly that the fish survival in the extended drainage and irrigation channels around the Mesolonghi-Etoliko lagoons is very low. The

extend of the mortalities are not known but the position and the scale of these systems suggest that massive mortalities of all eel stages are expected.

Figure 3. 17 Anthropogenic changes (irrigation systems) on Messolonghi-Aitoliko lagoons complex neighbor area.

OBSTRUCTIONS TO MIGRATION

The complex life cycle of eel marked by large scale migrations through different ecosystems increases the vulnerability of the population to the physical changes occurring on the migration routes. One of the main problems is the development of structures like dams and pumping stations making large areas inaccessible for the species. The same structures affect also the seaward migration decreasing thus the size of the spawning stock. Different types of structures affect the eel migration efficiency in Greece.

A special study to estimate the mortality levels and/or the decrease of the eel dispersal rates will be made in the context of the EMP in order to define precisely the measures to decrease the negative influence of these structures.

Dams

Different types of dams exist all over the country: Hydropower, Irrigation, Water supply, Flood control, Ground water recharge and some others. Depending on the size and position of the dams the upward or downward eel migration probability can be reduced to zero. The number of the irrigation dams increased rapidly the last decades mainly due to the particular geomorphological and climatic characteristics of Greece (see chapter 2). Figure 3.18 shows the temporal evolution of the number and the surface of the reservoirs of the dams.

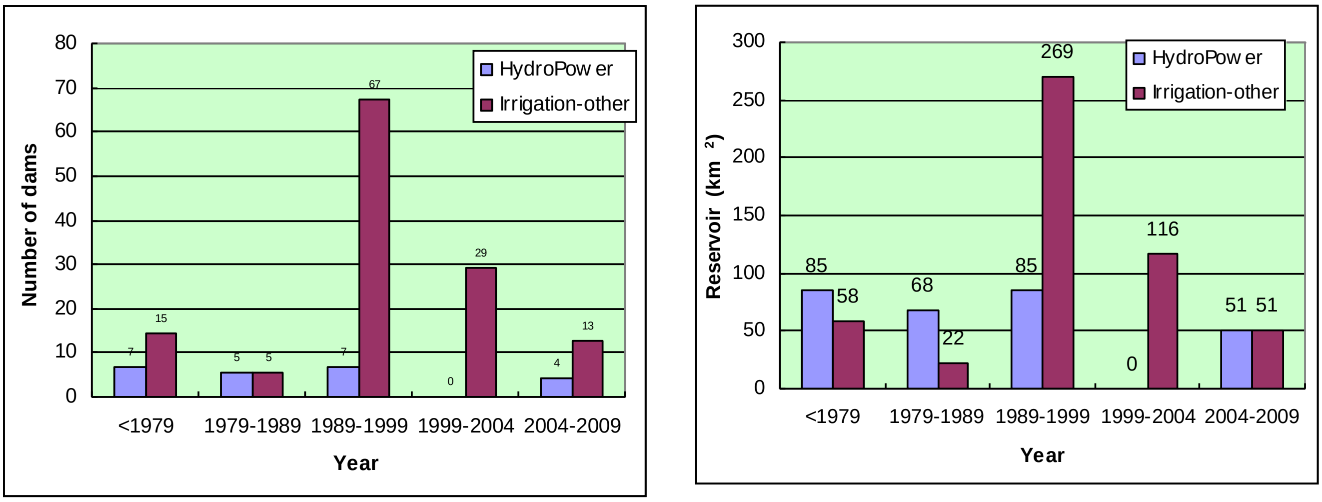


Fig. 3.18. Number (left) of dams and reservoir surface (right) per decade and type of dum.

An important increase of both the number and the surface of the reservoirs was observed in the 90's. The importance of the irrigation and other dams is also obvious. The rapid increase of the number of dams during the last decades coincides with the marked decrease of the eel landings but no analytic elements are available at present to evaluate the possible linkage.

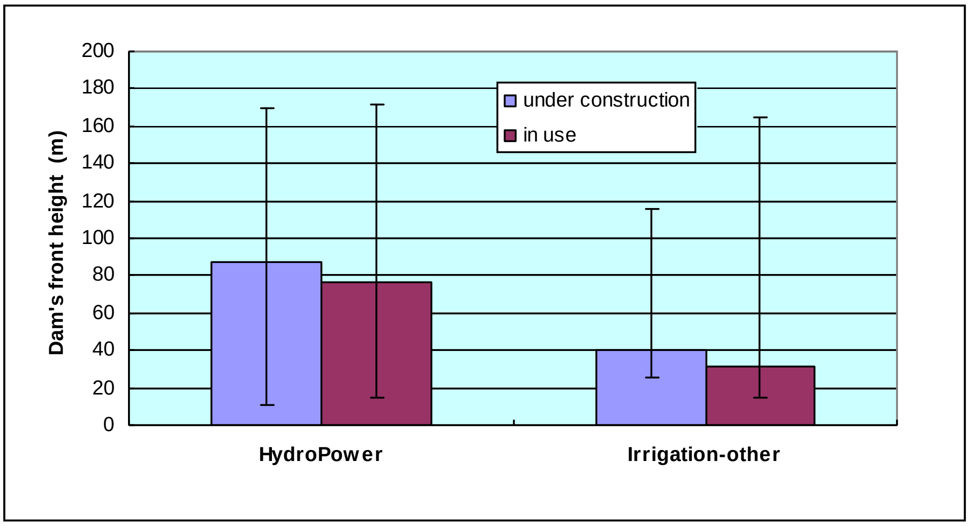


Fig. 3.19. Mean and sd of dam's front height by category.

Another important element is presented in figure 3.19. The mean front height of the large hydropower dams is about 80 m making the construction of bypasses or specific eel passes rather difficult. The mean height of the other dams is much lower offering a possibility to install devices or structures improving the fish movements.

Moreover no elements exist on the mortality generated by the hydropower plant turbines.

Small HydroPower Plants

The introduction and improvement of the relevant Hellenic legislation during the last decade produced a dynamic investing interest for Small HydroPower Plants (SHPP). Their number increased exponentially (fig. 3.20) and this trend seems to be maintained for the next years. Naturally the SHPP are mainly located far from the coast and in areas receiving important precipitations (fig. 3.21). Their number is or will soon reach 800 and their distribution by EMU is presented in figure 3.22. No special reference or element on their impact on eel survival and migration exists.

In the context of the Eeel Management Plan an effort should be made to evaluate their impact.

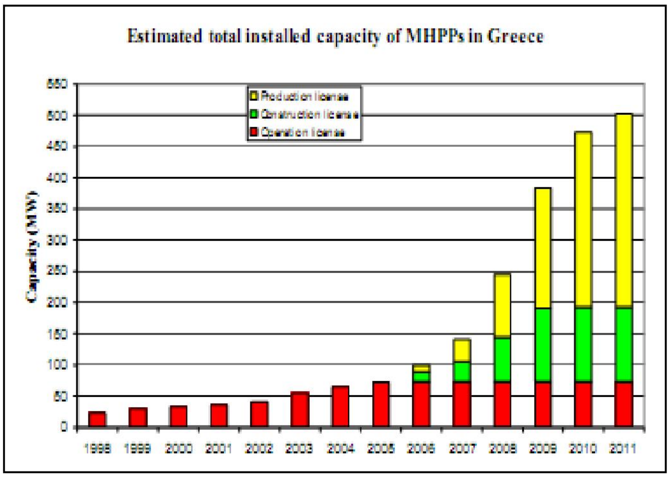


Fig. 3.20. Capacity of Small Hydropower Plants in early 2006 and future trends (from Douridas 2006).

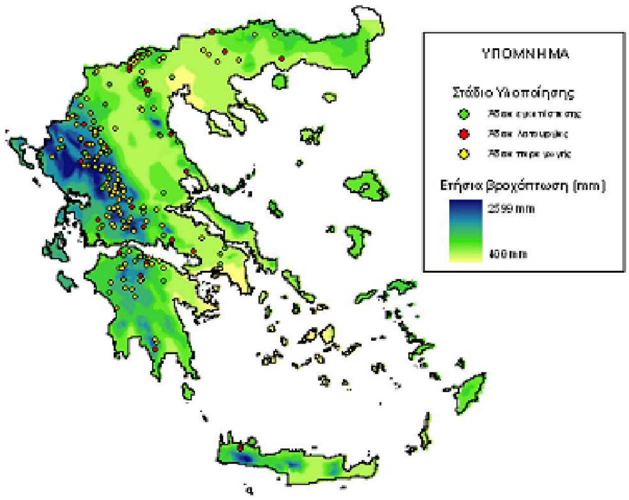


Fig 3.21. Geographical distribution of the Small Hydropower Plants in Greece (the background colors of the map indicate the total precipitation, from Douridas 2006).

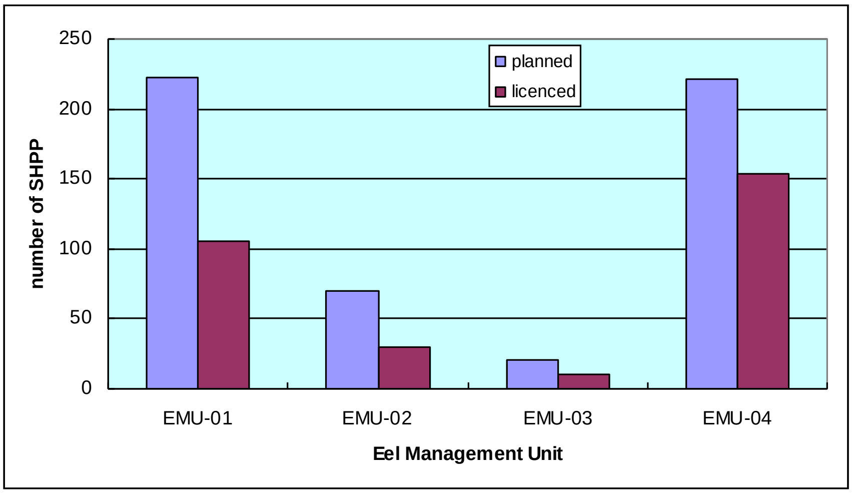


Fig. 3.22. Distribution of the Small HydroPower Plants per EMU. The distribution is based the position of the SHPP relatively to the river cathment and the EMU geographical limits.

Large Pumping Stations

In several large lagoons large pumping stations to control the water level in the irrigation and drainage channels around the lagoon are installed since the early 70's. An example was presented and discussed in the previous paragraph (fig. 3.17).

The three main negative consequences of their functioning on eel are:

- Changes in the geomorphology of the area leading mainly in the isolation of the humid zones around the lagoons.
- The freshwater supply attract the glass eels during their inland migration and frequently they are trapped in restricted areas during the pause of the discharge (their functioning is occasional) generating high mortalities.
- Mortalities generated during the passage of young and adult eels through the turbines.
- Occasional trapping of eels in the drainage or irrigation channels with very low water quality.

4. RESTOCKING

The present legislation clearly proscribe the fishing and commercialization of eels shorter than 30 cm (RD/142 art. 4/1971). Fishing activities targeting individuals less than 30 cm are allowed with a specific authorization only for restocking purposes (RD/142 art. 1/1971).

Some scarce, empirical and small scale attempts were realized aiming the improvement of local fisheries. Glass eels were used in the lake Pamvotida and the Kalama's delta and young reared eels were introduced in the lake Pamvotida and at the area of the estuary of W. Greece rivers Economidis, 1991 and Economidis et al., 2000 . There are no elements concerning the number of eels, their characteristics and also no elements exist about the results of these experiments. Only one, indirect, reference on eel-restocking was found (Ragias, 1997) suggesting that the introduction of the non indigenous parasite of the eel swim bladder *Anguillicola crassus* in the area of Xanthi (Thrace, EMU3) was probably caused by a release of reared juvenile eels.

Suggested actions

1. Both in case of restocking and also for specific protection measures an hierarchical inventory of coastal and principally lowland ecosystems provided through the development of a typology based on their hydrological profile and on the possibilities to act for their restoration should be produced.

2. Detection and description of glass eel concentration areas with high mortalities and low dispersion possibilities. The irrigation pumping points or selected dams are such systems and the transplantation of these individuals to more favorable ecosystems should be studied.

3. Analysis of the possibility to use eels from farms for restocking. Definition of biological safe processes. In several cases enhancement with farmed eels were carried out (Wickström et al.,1996; Pedersen,1998) but several questions remain about the future use of this approach (ICES, 2008). The

fragile points concern the use of eels bought from distant regions increasing thus the risk of new pathogens introduction to natural ecosystems. Another point is related to the fact that usually individuals with slow growth rates are provided by the farms and no clear elements on their future development (sex definition, survival, growth) exist. Finally questions related on their trophic behaviour in the nature exist. A specific experiment in an isolated lake and after a careful sanitization of the young eels can provide interesting elements about the possibility to use slow growers in restocking actions.

4. A pilot enhancement study in selected ecosystems of the EMU-01 (Western Greece) and the observation of their evolution (mark-recapture, size, sex ratio) is suggested. The enhancement will respect all the points raised by Cowx (1999). Technical aspects concerning the densities as a function of age size and the characteristics of the receiving ecosystems like the existing eel densities (Daverat & Tomas, 2006) will follow the suggestions of Wickström et al. (1996).

The surface of artificial lakes of Greece is about 30000 ha and represents about 50% of the surface of natural lakes. Considering the mean productivity of the artificial lakes a quantity of 200 kg of glass eels (considering the mean individual weight of Greek and W. European glass eels) will be necessary to carry out enhancement actions to all of them.

The restocking actions will be supported by the eel farms and by the users of natural resources affecting the eel survival and migration (power palnts, irrigation dams and similar structures).

It is proposed that 10% of the imported glass eels for rearing to be used in stocking actions in selected ecosystems mainly of the EMU1 in order to monitor their development. Given the last activity of the farms 1 t of glass eel is imported each year. This means that 100 kg representing about 300,000 individuals will be available for restocking. The same biomass representing 400,000 individuals of local glass eels is expected to be transferred from high mortality locations to favourable ecosystems in EMU1, 2 and 3. More specifically, glass eels from the irrigation channels and the pumping stations of the Messolonghi-Etoliko lagoons will be transferred to selected ecosystems of the rivers Acheloos and Kalamas (EMU1). After the establishment of the technical protocols this quantity will be increased to 400 kg representing about 1.5 millions of individuals. Considering that the experimental fishing in two locations of EMU1 and 2 provided about 100 kg of glass eels in one sampling period (October to March, Zompola et al., 2008) the above quantities can be achieved.

After the selection and definition of the favourable ecosystems for restocking additional measures such as the total prohibition of use of fishing gears targeting eel and the control of any activity affecting the survival and the seaward migration of eel will be taken.

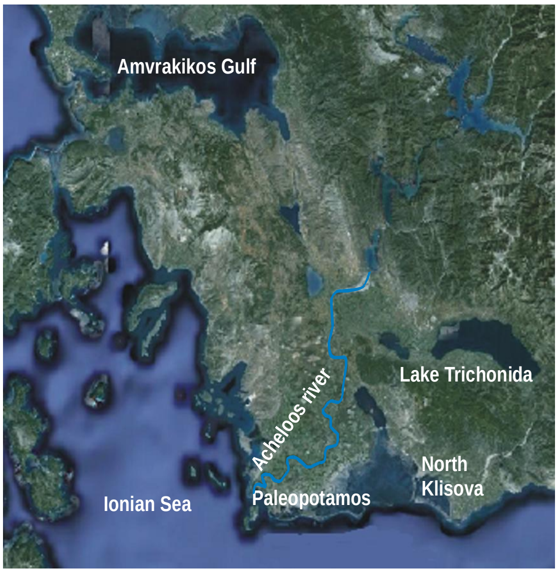
Two main sources of young eels for restocking purposes are: 10% of the imported quantities by the rearing farms and the transfer of eels from high mortality locations to favourable ecosystems.

A small scale pilot restocking will be carried out in 2010 in the area of Messolonghi in order to develop and adjust zootechnical and administrative aspects and three types of restocking actions will be carried out in 2011 during the first phase of the plan.

1. Restocking in exploited lagoons. The purpose is to observe an increase of the catches and consequently the release of silver eels to the sea. The approximate generation time for eel in such lagoons around the Mediterranean is 5-7 years. This restocking should start at the latest in 2011. The use of exploited lagoons for restocking actions is based on the fact that these lagoons are controlled by the cooperatives, the free access is limited and the biological sampling is easy in the barrier traps. The locations of North Klisova and Paleopotamos, both of them belonging to the Messolonghi-Etoliko lagoons complex (EMU1) are selected because they had high eel yields in the past.

2. Restocking in non exploited lagoons of Katafourko in the Amvrakikos Gulf and the isolated and non used lagoon of the Messolonghi salines (EMU1). Total prohibition of fishing will be imposed in 2011 and experimental fishing will be used to follow the restocked eels. This action will complete the first one.

3. Restocking in deltas and channels with free communication with the sea. Eels from high mortality locations will be transferred in these ecosystems and pilot actions for the improvement of the water quality and the migration efficiency (towards the river and the sea) of the irrigation and drainage channels of the areas will be realised. The irrigation and drainage system close the delta of the Acheloos river will be selected as it is one of the most expanded channel systems of the country communicating with the lagoons of Messolonghi-Etoliko (representing 42% of the surface of the Hellenic lagoons) and also with the lakes Trichonida and Lysimachia (18% of the Hellenic natural lakes).



5. MONITORING

RECRUITMENT MONITORING

Few elements on glass eel distribution and abundance along the Greek coastal and transitional waters exist. There is only one systematic study covering an entire season along the Western coast (Zompola et al. 2008). In the context of the EMP at least one point for systematic monitoring along the Western coast (EMU-01 or EMU-02) should be defined. Given the spatial heterogeneity of the Greek ecosystems and the site specific fluctuations detected by Zompola et al. (2008) a second monitoring point is suggested (subject to funding). The decision about the position and the sampling protocol will be defined in 2011 after the analysis of the existing eel data and the typology of the different ecosystems based on environmental and eel relevant data. In any case a closed and rather "undisturbed and stable" ecosystem will be selected in order to obtain meaningful time series. At the beginning annual surveys will be carried out and in the future a lower frequency will be examined.

EEL MARKET MONITORING & TRACEABILITY OF EELS

The vast majority of the eel landings are exported to other European countries. In any case the CITES requirements will be respected and the monitoring of these quantities will be realized by the combination of data provided by central authorities (customs) and data from the fishery sector (mainly fish wharfs).

The fact that the majority of the catches are exported will facilitate the traceability of the eels. In fact the bulk of eel catches are provided by fishermen cooperatives. They pass through the regional fish wharfs. Also major regional commercial firms develop their own detailed traceability systems for eel export.

Local markets also exist. They have a rather local and seasonal character and their survey can be combined with the monitoring of fishing activities of individual fishermen. They are controlled by the commerce related administration.

All live eel imported to Greece for rearing or restocking must be accompanied by a relevant proof of origin certificate in compliance with national and international trade legislation.

A traceability system will be put in place for transplantation of eels (individuals captured in low quality, high mortality sites) in favorable ecosystems. Health conditions and limited distances will be respected.

MEASURES FOR PRICE CONTROL OF EELS UNDER 12 CM

The RD/142/1971 states clearly that fishing and commercialization of eels less than 30 cm is totally prohibited. Thus there is no fishing of glass eels and young yellow eels in Greece so it is not necessary to ensure price control, as required by Article 7(5) of the Regulation No. 1100/2007. Fishing activities targeting individuals less than 30 cm is allowed with a specific authorization only for restocking purposes (RD/142 art. 1/1971).

MONITORING FISHING EFFORT AND BIOLOGICAL DATA FROM EEL FISHERIES

The bulk of eel landings are provided by the fixed barrier traps of lagoon fisheries in which fishermen cooperatives are involved. Individually operating fishermen around lagoons and in lakes catch also eels (in rivers and deltas fishing will be prohibited). Catches are also reported from coastal areas mainly from static gears used in small scale fisheries but few are also provided by seinners and trawlers.

The catches of lagoon fisheries are by far the more important but this is probably due to the fact that individual fishers are not declaring their catches. For the lagoon fisheries, at least for the barrier traps the fishing effort is rather stable. The reporting of the catches will be improved and the biological sampling is easy. Considering the lack of past biological elements, a more important sampling effort than the one suggested in the context of the DCR is necessary for the first period of application of the EMP.

The recording system of the fishing effort and catches of the individual fishers is much more complex to establish. There are only scarce and rather qualitative elements and the establishment of an efficient sampling protocol is not possible. It is proposed that in 2009 and 2010 the development of a specific study leading to a typology of the individual fishermen, their fishing tactics and their catches by EMU will be realised.

At the present state almost all the elements concerning eel are provided by the fisheries. In the future, the design and implementation of fishery independent surveys will improve the estimates of crucial parameters. These actions include experimental fishing in lagoons of the EMU1 to 3 (EMU1: Eastern Klisova, Delta of Acheloos, Delta of Kalamas, EMU2: Kotychi, EMU3: Vistonida). The surveys will collect elements on biomass estimates, age/size structures. The surveys will start in winter 2010 and should continue as long as necessary to collect all relevant data.

6. TARGETS

The achievement of the European eel recovery is based on the improvement of both the survival probability and the reproductive migration of the adult individuals. The complex life cycle of the species and the disperse character of the population inevitably increase the diversity of the targets, measures and proposed actions over the European countries. This diversity is due to the heterogeneity characterizing the eel ecosystems, the related anthropogenic actions, the amount of knowledge and several socio-economic aspects. In any case, the urgency of eel recovery needs the realistic definition of priorities and actions maximizing the expected results.

As it is already presented, Greece is located close to the eastern limit of the species distribution and the main climatic and geomorphological characteristics of the country have a strong influence on the distribution and abundance of the species. These elements have also a strong influence on anthropogenic actions affecting the eel stock. These actions concern both direct and indirect decrease of survival and offshore migration of the species.

Several elements presented above are important for the Eel Management in Greece. These elements concern:

Silver eel compose the vast majority of eel catches because there is a global prohibition of fishing and commercialization of eels shorter than 30 cm (RD/142/1971). Fishing activities targeting individuals less than 30 cm are allowed with a specific authorization only for restocking purposes (RD/142 art. 1/1971).

- Eel is not a clear target species in the majority of the fishing activities but in some cases represents an important resource. This is especially true in few lagoons.
- Only 20% of the surface of the ecosystems in which presence of eel is reported is exploited (HCMR 2008).
- The main catches are provided by fisheries in transitional waters which are under complex administration and exploitation regimes.

- Very few and rather qualitative elements exist on the fishing activities in inland waters.
- Very few and poor quality elements, both in space and time, exist on fishing methods, effort and catches. Few and short time series exist.
- Almost no elements exist on the structure of the eel stock (age/size distribution, sex ratio, condition factor, diseases).
- Few and local elements exist on glass eel abundance and seasonal dynamics and no elements on temporal trends of recruitment.
- After mid 80's a global decrease of the eel landings is recorded but this is not observed all over the country. Moreover, the decreasing trends are also present in the landings of the main species of the lagoon fisheries.
- The climatic and hydrogeological characteristics of the country present important particularities which influence the eel distribution and dynamics and point out the importance of the coastal and lowland ecosystems.
- The water use and the continuously growing irrigation systems represent probably a major source of eel mortality or migration restriction. No elements on the subject exist.
- Due to the ecosystem particularities the direct transfer and application from NW Europe of technical devices and methods increasing eel dispersal is doubtful or not applicable.
- The administration involved in the water management is complex and not efficient. This is partially true for the eel fisheries

ESCAPEMENT

The context

As it was mentioned above, the quantity, diversity and quality of data concerning the biology, ecology and exploitation of eel in Greece are extremely limited. Only one peer-reviewed article exists and it concerns the ecology of glass eel. No systematic data from inland fisheries can be found. No specific reference to eel exist in the environmental studies accompanying the dams, the extended irrigation channels, the small hydropower plants and all the structures affecting the eel ecosystems. Moreover, no recruitment estimates and monitoring exist and no systematic data from the coastal small scale fisheries can be found. In this context the definition of the present escapement levels and consequently a realistic estimate of the target escapement suggested by the regulation EC no 1100/2007 is almost impossible.

Despite the fact that Moriarty and Dekker (1997) more than ten years ago pointed out the paucity of data across Europe on silver eel escapement and, in particular, on levels of "pristine" productivity in terms of silver eel biomass per unit area, no useful information to achieve even rough estimates exists in Greece. There are no elements on length, age composition, sex ratio, mortality and growth rates. No information exists on eel densities per biotope and no studies exist on predation or escapement. In addition, the particularities of the Hellenic ecosystems (discussed in chapter 2) and the geographic position (close to the easternmost limit of the species distribution) make the comparison with other areas difficult. The “extreme” environmental conditions marked by the uneven and largely fluctuating precipitations can be responsible for carrying capacity and upsteam colonization limitations but these aspects remain simple speculations.

In the EU regulation, in Article 2, Establishment of Eel Management Plans, it states that the target level of escapement shall be determined, taking into account the data available for each eel river basin, in one or more of the following three ways:

(a) use of data collected in the most appropriate period prior to 1980, provided these are available in sufficient quantity and quality;

(b) habitat-based assessment of potential eel production, in the absence of anthropogenic mortality factors;

(c) with reference to the ecology and hydrography of similar river systems.

The lagoon fisheries are mainly based on fixed barrier traps on the lagoon – sea interface. The eels are caught during their seaward migration mainly observed between late October and January. The lagoon catches have two advantages: 1) the fishing effort remains stable (except in case of changes in infrastructures which were observed mostly in 70’s) and 2) the eel landings from the lagoons are composed from the eels living in the transitional waters and also those entering the lagoon during their migration from the surrounding freshwater ecosystems. Thus the area concerned by these catches can be considerably larger than the strict lagoon surface and the production per unit of lagoon surface is affected by the freshwater area linked or communicating with the lagoons.

The analysis of the elements presented by Anonymous (2001b) shows that 65.4% of the total Hellenic lagoon surface is linked to surface freshwater systems (table 6.1). The nature, quality and scale of these systems should be studied during the first phase of the EMP and their impact on the eel lagoons productivity have to be evaluated. Several of these elements normally are the subject of the Water Management structures but as it was stated in chapter 2 these structures were never well organized both at regional and national level. Recently decided major changes in the context of WFD will improve this situation and the EMP will benefit from these aspects. The actions foreseen in the context of the implementation of the WFD will be compatible with the actions foreseen in the EMP and with the fulfillment of the EMP's targets.

Table 6.1. The lagoons surface per E.M.U. and Prefecture and the available time series of landings

Freshwater systems linked to lagoons	Part of the total Lagoons surface
Drainage-irrigation channels	28.0%
Drainage-marshes	8.8%
Marshes	3.0%
River-Marshes	3.4%
River	7.4%
Lake	14.8%
No link with surface freshwater system	31.2%

In 80% of the Greek lagoons the water management is problematic due to human impacts independent of the fisheries. In addition, 73% of the lagoons is of closed-type with limited sea-lagoon interface and consequently anthropogenic changes can affect the migration processes of diadromous species.

In this context, an additional inter-lagoon variance in the eel catches per unit of space and time (fishery productivity) is introduced but as the surface of the freshwater ecosystems linked to the lagoons remains unknown only the lagoon surface will be used to the following analysis In any case, the extend of the surface water systems linked to the lagoons affects two elements. The first one is the variance estimates as the vast majority of the eels from these systems pass through the lagoons during their offshore migration, increasing the landings of some lagoons. The second element is the quantity of eels escaping from open ecosystems (freshwater or transitional ecosystems communicating without obstacles with the sea). In fact, a part of the silver eel biomass of the freshwater systems is captured by the lagoon fisheries. Unfortunately, no data on silver eel escapement or at least eel biomass in freshwater ecosystems exist.

The data

The main data are provided by the lagoon fisheries. The lagoons are leased by fishermen cooperatives and the leasing cost is a function of the total earnings. In the hiring contracts between the Hellenic state and the fishing cooperatives the lowest annual landing of a specific lagoon is stipulated and consequently the lowest annual earnings are also defined (law 2040/92 art.9). The estimates of these quantities are based on the landings of the previous recent years. These quantities will be decreased in order to take into account the eel releases to the open sea, following the action 1 of the EMP (chapter 7, “immediate actions”). In this way, the measure becomes economically attractive suggesting an increase in the quality of the declared landings. Moreover, actions aiming to increase both the public and the fishers awareness about the critical state of the eel population and the need to urgently take measures to preserve the stock will be carried out resulting in the active involvement of fishing cooperatives to the EMP. Gradually, the central administration will modify the legal context of the lagoons leasing in order to increase the efficiency of the EMP and more generally the sustainability of the lagoons exploitation.

Commonly the data are compiled by the fisheries administration at the Prefecture level (NUTS 3). Several lagoons can exist in a Prefecture and often the between lagoon variance is ignored (pooled data). A second aspect concerns the length of the time series. Few Prefectures have elements from the early 70’s and most of them provide elements since 1988. Thus estimates of the eel state before 1980 is extremely risky and even for early 80’s a lot of simplifications and assumptions are needed. A second point concerns the surface of the lagoons. A study compiling the Hellenic lagoon fisheries Anonymous 2001b) revealed that important differences in the recorded lagoons surface can exist (reaching in some cases 40%) depending on the information source and the time period. The following table presents the lagoons surface per E.M.U. and Prefecture and the time series of landings.

Table 6.2. The lagoons surface per E.M.U. and Prefecture and the available time series of landings.

EMU	Prefecture	ha	time series
1	Preveza	340	1980-2007
1	Arta	7910	1974-2007
1	Etoloakarnania	15580	1988-2007
1	Thesprotia	1120	1990-1996
1	Kerkyra	960	1973-1996
1	Lefkada	870	1992-2007
Total	**26780**		
2	Achaia	330	1972-2007
2	Ilia	700	1992-2007
2	Messinia	450	2004-2007
Total	**1480**		
3	Xanthi	5110	1975-2007
3	Kavala	1350	1992-2007
3	Evros	970	1992-2008
3	Rodopi	1180	1992-2009
Total	**8610**		
4	Larissa	37	1992-2010
Total Lagoon surface (ha)		**36907**	

These elements confirm the scarcity and heterogeneity of the available data and also show clearly that EMU 1 includes 72.6% of the Hellenic lagoons surface and naturally special attention should be devoted to this unit.

The bulk (80-100% depending on the location) of lagoon eel landings are provided by the fixed barrier traps located and covering the entire lagoon – sea interface and the fishes are trapped during their ontogenic and/or seasonal offshore migration. Thus the fishing effort is rather stable in time (as far as the technical characteristics of the traps remain unchanged) and the annual fluctuations of the landings follow the species abundance changes in the lagoons.

As it was presented in previous chapters both the mean level and the temporal patterns are Unit specific but it is also obvious that after mid 80’s EMU1 provides the vast majority of landings (figure 6.1). The last decade, the Hellenic lagoon landings are provided by EMU1 and EMU2. In any case, special attention will be devoted these two EMUs in the eel management context.

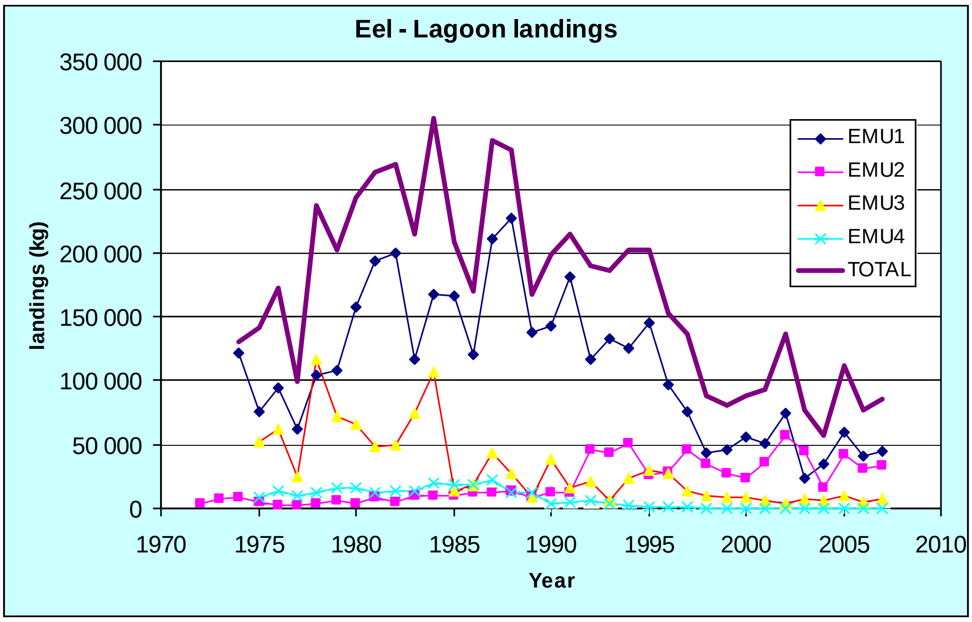


Figure 6.1. Time series of eel landings from the lagoon fisheries grouped by Eel Management Unit (source Ministry of Rural Development and Food).

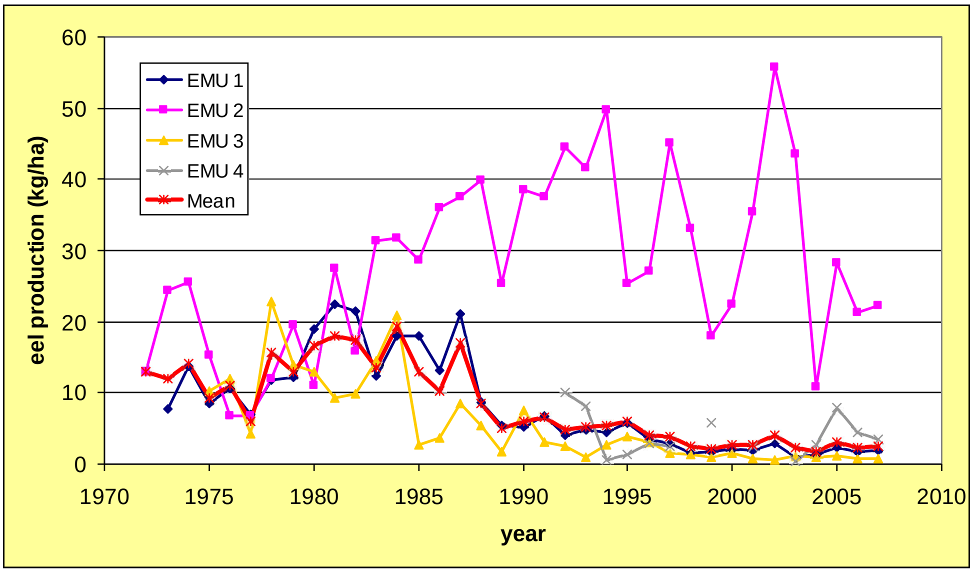
The time series of the eel landings in the EMU1 is marked by a relatively rapid increase during the period 1974-1985 despite the overall recruitment decrease after the 70's (no recruitment data from Greece, it is suggested that the general European pattern is valid for this area). This period is followed by a continuous decreasing trend. Both administrative and technical changes occurred in early 80's. The traditional hand-made wooden barrier traps were replaced by new reinforced concrete, permanent and larger (presented in figure 3.1). The increase in the efficiency of the new traps can explain the differences in the mean level of catches between late 70's and late 80's. We can consider that the increase in catches are based on eels normally escaping during the first period. The second reason leading to this increase is the fact that the time series of the landings are not synchronous (table 6.2) and the gradual incorporation of landings to the EMUs production inevitably produce this increasing trend

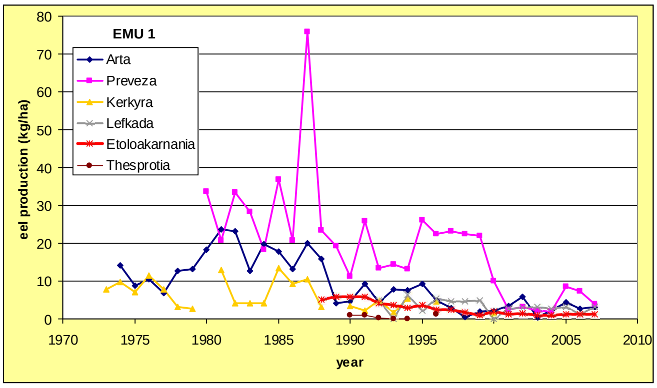
Similar patterns are partially observed in EMU3 (Northeastern Greece) with a different timing due to the fact that changes in fishing infrastructures occurred earlier (mid and late 60's). Unfortunately, no data from this early period exist.

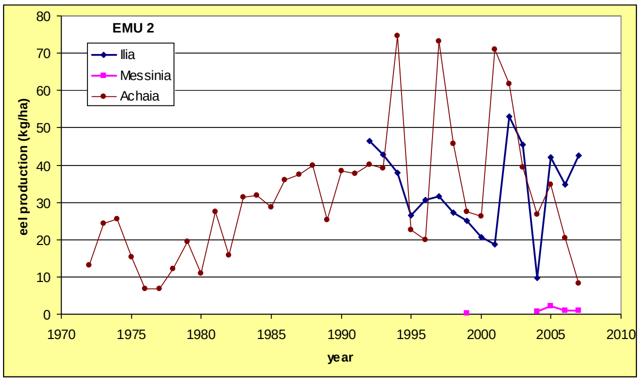
From table 6.2 it is clear that landings from few lagoons are available for the early 80's. In order to estimate the total catches during this period the eel lagoon yield productivity (kg ha^{-1} year^{-1}) will be mainly used. Due to the lack of data in early 80's in several prefectures the assumption that the productivity during this period was 20% higher than the maximum observed in the concerned Prefecture was made. A weighted mean based on the relative surface of the lagoons was computed and this value was then used to estimate total landings (abundance) in 1980.

Figure 6.2 shows the time related changes of eel productivity by E.M.U. and the corresponding overall mean values. In order to present the inter-

Prefecture variability of the available landings the time series of the lagoon eel productivity for E.M.U. 1 to 3 are presented in figure 6.2. This variability inevitably decreases the precision of the estimates. It should be noted that the lagoons of Etoloakarnania represent 42.2% of the total lagoon surface and unfortunately the first available data for the area appear in 1988.







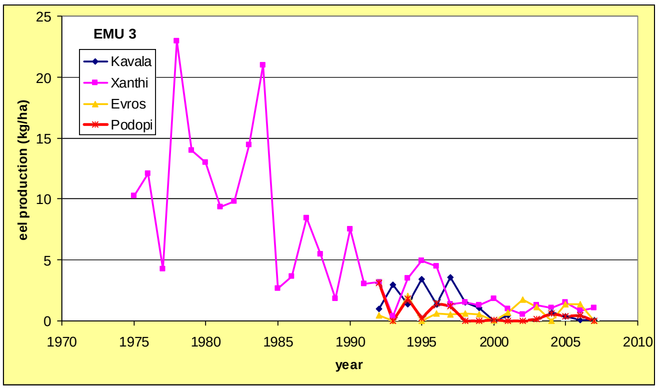


Figure 6.2. Time related changes in the lagoon eel productivity (kg ha^{-1} $year^{-1}$) by E.M.U. and by Prefecture for the most important management units.

The target

Using the above mentioned method based on these data and assumptions the mean annual fisheries productivity for 1980 is estimated to 11.41 kg ha^{-1} $year^{-1}$ and the total lagoon eel catches for the same year are estimated to

421018.6 kg (S.E. 305986.2). The large standard error accompanying this estimate is mainly due to the huge spatial variability characterizing the eel landings. The estimated quantity is considerably larger than the total eel landings recorded during the same period (fig. 6.1) and this is due to the partial reporting of eel catches during the early 80's. The estimated mean fisheries productivity is considerably lower than the mean presented in figure 6.2. This is due to the lack of data from the Etoloakarnania lagoons before 1988. These lagoons have a limited eel productivity (figure 6.2) but they have an important relative weight as they represent 42.2% of the surface of the Hellenic lagoons.

The low productivity of the lagoons of Etoloakarnania is mainly due to the important relative weight of the Central Lagoon the surface of which is about 8000 ha representing 51% of the total lagoon surface of the Prefecture. The Central Lagoon is an open-type lagoon with a very long sea-lagoon front and it has a pronounced marine character (salinity varying between 32 and 37 units) contrary to the rest of the lagoons which are closed and the presence of freshwater is pronounced (salinity range 12-29). These elements can explain partially the reduced eel productivity of this lagoon affecting the productivity of the entire Prefecture. The comparison of the mean eel productivity of the 6 lagoons composing the Messolonghi-Etoliko lagoon complex, over the period 1995-98 confirms this suggestion (Central Lagoon o.8, Klisova 1.6, Tholi 10.7, Paliopotamos 14.2, Diavlos 5.8 and Poros 5.0 kg ha^{-1} $year^{-1}$). Moreover, the eel productivity of the lagoons of Etoloakarnania, based on the landings presented by the cooperatives, decreases because of the catches of fishermen not belonging to the cooperatives but operating in the lagoons of Diavlos, Klisova and Central Lagoon (free fishing is allowed only in these 3 Hellenic lagoons, estimated quantities are presented in the table below). Finally, the low productivity of the Central Lagoon is also due to the increased escapement of fishes because the infrastructures isolating the lagoon from the sea (about 15-20 km of fragile traditional reed barriers till the last decade) are frequently damaged especially in winter (official records exist). This is not the case of the closed-type lagoons.

The estimated mean value of 11.41 kg ha^{-1} $year^{-1}$ for the early 80's is slightly lower but comparable to the yield of the fishery in the Valli di Comacchio (northern Italy, 10400 ha) which has always been dominated by *Anguilla anguilla*, representing up to 90% of fishery yield in mass. This fishery provided approximately l5 kg ha^{-1} $year^{-1}$ until the mid 1970s and then declined to the current level of 6 kg ha^{-1} $year^{-1}$ (De Leo and Gatto 1996 and 2001). Rossi (1979) states that mean value of 19.3 kg ha^{-1} $year^{-1}$ was recorded during the period 1963-73. Moreover the system (geomorphology, hydrology, climate) of the Northern Adriatic (latitude 45°N) is different from the conditions characterizing the Hellenic lagoons located at a mean latitude of 38°30'N (Ravagnan 1981). The mean annual value of atmospheric precipitation is about 700 mm in Greece and in Italy is about 40% higher. The conditions of the Hellenic lagoons are closer to the Albanian ones which in late 80's had a mean fishery productivity of about 10 kg ha^{-1} $year^{-1}$ (Peja et al. 1996).

In addition to the above mentioned quantities, experts' contribution (due to the lack of data) is included to estimate other eel catches. All these data are used to estimate pristine silver eel escapement. The potentially escaping quantity, with zero fishing mortality will be close to the maximum estimated catches because the lagoon fisheries, representing the bulk of the catches, they operate on the lagoon-sea interface, they are mainly based on silver eel catches during their offshore migration and the exploitation pattern remained unchanged since the mid 80's. The following table 6.3 resumes these elements.

Table 6.3. Estimates of eel catches (in t) from different fishing activities during the 80's.

Estimated Lagoon Landings for 1980	421.02
Fyke net lagoon catches 1983-1988 (EMU1)	33.65
Recreational fisheries 1985-1990	15.00
Deltas & coastal traps (EMU1) 1989	17.00
Lakes (EMU1&4) 1987-1990	45.00
Sea fisheries 1982-1986	17.50
Total	549.17
40% escapement target	219.67

These elements are based on known fishing activities and a quantity of eels escaping from "free" ecosystems (ecosystems communicating with the sea with no fishing activities) have to be added but no elements concerning these quantities exist . An effort during the first phase of the EMP will be done to fill this gap. Nevertheless, their contribution to the total seems limited but this assumption should be verified. In fact, as it was presented above only 31% of the lagoon surface is not linked to natural or artificial freshwater ecosystems. This means that a part of the silver eel biomass of the freshwater systems is captured by the lagoon fisheries. Experimental fishing and mark-recapture experiments in selected ecosystems (exploited and unexploited lagoons, lakes, rivers) of EMU1 will be carried out in 2010 and 2011 in order to fill the existing gap concerning the escapement from "open ecosystems".

Illegal fishing and non reported catches also exist but no estimates of these catches can be found. Illegal fishing in the lagoons seems limited as the majority are surveyed and controlled by the cooperatives. No elements exist for the other eel ecosystems. Unreported catches also exist. The amount of non reported catches, at least for the lagoons, is suggested to be lower than for the other fish species and also lower than the estimated levels for the western European countries. In fact, the majority of the catches is collected during few weeks in winter and is exported abroad and for the international transport official documents are needed. In any case, during the first phase of the EMP an effort will made to reduce the non reported catches and to estimate their past level and these quantities will be reconsidered in the update of the target quantities.

The contribution of the EMUs to this global escapement target will be proportional to their past and present production. From the above presented elements only the lagoon and sea fisheries landings are official data (provided by the MRDF and NSSH). The rest of the elements are rough estimates based on the experience of the scientists of the team developing the present

EMP. They should be verified during the first period of the EMP application and the target quantities should be adjusted.

These “rough” estimates of the escaping quantities in early 80’s concern mainly the transitional waters and the freshwater and humid ecosystems linked to them. No elements of the current escapement exist and no indirect estimate can be made. Moreover, no elements for the inland eel and its past and present escapement probabilities from lakes, rivers and reservoirs exist and this is mainly due to the occasional and generally low fishing activity targeting eel. Only 20% of the ecosystems were eel presence is reported are exploited. The absence of systematic and extended inland eel fisheries suggests that the population abundance is relatively low. The few available elements presented in chapter 2 (figures 2.18 and 2.19) show that the eel landings from lakes (natural and artificial) is 10 times lower than the lagoon catches but the time related changes show the same decreasing pattern. Moreover, the rapid development of the number of Small Hydropower Plants as well as larger dams for hydropower, irrigation, water supply, flood control and groundwater recharge reduce the migration capabilities but at the same time increase the available surface of freshwater ecosystems in a country where their extend is limited. No elements on the possible impact of these structures on the pristine eel escapement can be derived at present. This gap will be covered during the first period of application of the EMP and more complete and realistic estimates will be presented during its reconsideration. In any case, the fact that the fisheries are mainly concentrated in and around the lagoons and the fact that the obstacles in the migration routes are located far from the coast, in relatively high altitudes, means that a large amount of humid ecosystems communicating with the sea are still available in lowlands and after the reduction of their surface in the 50-60’s their surface is stabilized. The contribution of these surfaces to the eel escapement is unknown and an effort will be made to be evaluated during the first period of the EMP. Moreover these ecosystems will be focused in the restocking actions.

Current potential escapement

Assuming these aspects and the recent catches presented in table 6.4, it appears that recent (2005-2007) lagoon catches represent 42% of the proposed escaping target of 219.67 t and this quantity is larger than the estimated total eel catches (145.26 t).

Table 6.4. Estimates of eel catches (in t) from different fishing activities during the recent period.

Mean Lagoon Landings 2005-2007	91.27
Fyke net lagoon catches 2005-2007 (EMU1)	9.66
Recreational fisheries 2005-2007	8.00
Deltas & coastal traps (EMU1) 2000	8.50
Lakes (EMU1&4) 1995-1998	12.00
Sea fisheries 2005-2007	15.83
Total	145.26

The present escapement is limited to the seaward migration of eels from “open ecosystems”. This corresponds to the non exploited ecosystems mentioned earlier. Unfortunately the amount of escaping eels remains unknown. No elements are available. We can refer to the lagoon catches as "potential escapement" because the majority of these catches is made at the lagoon – sea interface during the seaward migration and thus if the eels are released from the traps no other obstacles to the sea exist.

The above mentioned quantities suffer also by the fact that the concerned periods are influenced by the global decreasing eel recruitment after 1970. Whatever the obvious weaknesses of this simplistic approach, it offers a reference point at the present state. *The main advantage of the presented data is that they concern mainly catches in transitional and coastal waters and no additional anthropogenic mortality is expected.* These estimates should be seriously examined, completed and re-evaluated during the first period of the Eel Management processes. The target quantity should also include other anthropogenic negative aspects. As it was presented, important natural mortalities are expected in the irrigation channels and drainage systems around the lagoons but no estimates exist and moreover no comparison with previous decades. Reconsideration of both the target quantity and the different components of the eel mortality will be presented during the reevaluation of the EMP.

7. MEASURES

The Greek Eel Management Plan will include a time period for detailed older data collection and a parallel effort to analyse the nature of the available data, mainly from the lagoon fisheries, in order to understand both the between lagoon differences and the observed trends compared to the anthropogenic changes made in the EMU areas. The absence of decreasing trends in the landings of the EMU-02 should be investigated carefully.

These remarks make the estimation of the escapement levels very difficult and show clearly that the improvement of knowledge in parallel with direct measures for the decrease of the mortality and increase of the sea escapement are necessary.

The main targets of the EMP are:

- Reduce direct fishing mortality
- Establish an efficient recording system
- Reduce natural mortality
- Improve the efficiency of eel migrations

To achieve these targets both short and mean to long term measures and actions should be designed and carried out.

In the context of the Greek case the short term actions include the following aspects.

IMMEDIATE ACTIONS

These actions and measures will take place the first year of the EMP. As it was stated no quantitative biological and fishery elements (size/age distribution, CPUE, fishers, fishing days) concerning the eel fisheries exist. An effort will be made to evaluate the positive contribution of the proposed actions through a dedicated study based on questionnaires and experimental fishing.

1.Direct release of the eel from lagoon fisheries

This will be achieved by releasing into the coastal waters 30% of the lagoon catches provided by the fish traps. This measure is realistic because the elements presented in the previous paragraphs show that 70% of the annual catches are recorded in few days around December. Eels are maintained alive in cages in the lagoons till their final sale and they are exported to Western European countries. Thus the release of 30% of these silver eel catches to the open sea presents no difficulties. This fraction will be reconsidered as soon as the first controlled data concerning the fishing mortality will be available and technical and administrational problems will be resolved. These technical and administrative issues will be resolved before the end of 2010.

Migrating silver eel are caught only during a few nights per month, when there is no moon. These are normally kept for 1 to 2 months before Christmas and then transported to Italy once a large enough amount of eel has been collected. Given that keeping migrating eel in cages even for a short period of time may cause them to change their migration behaviour, 30% of the eels caught during each fishing night should be released within 72 hours of capture.

As a result, the eels caught at the fishing traps will remain in captivity in specific stocking places existing in the lagoons for three days maximum and the release will be controlled and certified by the local fisheries administration, coast guard authorities and representatives of the fishermen cooperatives. This action will contribute to the escapement of 23.8 t in 2010, considering the mean lagoon landings of 2006-7 decreased by 5% due to the reduced recruitment. The quantities by EMU are EMU1: 12.9 t (54.2%), EMU2: 9.2 t (38.6%) and EMU3: 1.7 t (7.1%). These quantities will be adjusted on the base of the real catches and they will be released between November 2010 and January 2011 respecting the technical details presented above.

The financial, technical and administrative aspects of both the releasing process, the sampling protocols, the certification and the definition of the quantities to be released by cooperative they are defined in a specific inter-ministerial decision covering the main aspects of the EMP.

2.Prohibition of fyke net fishing in the lagoons

Immediate prohibition of the fyke nets fishing in the lagoons and in the coastal zone in the Amvrakikos Gulf where specific places are leased by fishermen cooperatives. This will allow the increase of the eel quantities in the barrier traps and consequently an increased escapement through the release of 30% of the catches mentioned above. Few elements exist on the importance of the activity of individual fishers in the lagoons. A rough estimate of the Mesolonghi-Etoliko lagoons (EMU1) shows that 25% of the total catches are provided by fishermen operating alone in the lagoons with fyke nets, longlines and harpoons. The majority of the catches are made by the fyke nets. A quantitative estimate of the contribution of this measure all over the country is necessary. This action only for the EMU1 will provide 2.9 t to escapement.

3.Prohibition of eel fishing in rivers

Immediate complete prohibition of eel fishing in rivers and deltas during the main migration period of silver eel (November to January). This action will provide 8.5 t to escapement.

4.Prohibition of the recreational eel fishing

Immediate complete prohibition of the recreational eel fishing The few available elements show that seasonally and locally this activity is quite common and important, especially around lagoons, deltas and artificial water systems. No quantitative elements on the number of fishers, the gears used and individual catches exist and this gap should be filled in order to estimate the positive impact of this and the above mentioned measure. A rough estimate based on the experience of the scientists involved in the composition of the EMP suggests that 8.0 t will be added to the overall escapement.

5.Maintenance of free fish movements through the Dimikos channel

Trichonida is the largest lake in Greece. The lake is located in EMU1 (the most productive unit) and is direct linked with the lake Lysimachia representing as a whole about 11000 ha (18% of the natural lakes surface, or 30% of the total lagoon surface). The only communication with the Ionian Sea free of technical obstructions is through the overflow channel of Dimikos linking the lakes with the river Acheloos. It is of crucial importance to prohibit immediately the development of any structure or activity preventing the free fish movements.

6.Restocking actions

During the first period of application of the EMP a clearly designed and controlled restocking action will be realized. The priority is to transfer eels from low quality and low dispersion regions to open and favourable ecosystems. The choice of the sites in the most productive zone (EMU1) will be based on the results of the two previous actions. The main scope of this action is to define the technical aspects of both the collection and transfer and also to establish the monitoring protocols. Fishing activities targeting individuals less than 30 cm are allowed with a specific authorization only for restocking purposes (RD/142 art. 1/1971).

The restocking actions will be supported by the eel farms and by the users of natural resources affecting the eel survival and migration (power palnts, irrigation dams and similar structures). It is proposed that 10% of the imported glass eels for rearing to be used in stocking actions in selected ecosystems mainly of the EMU1 in order to monitor their development. Given the last activity of the farms 1 t of glass eel is imported each year. This means that 100 kg representing about 300,000 individuals will be available for restocking. The same biomass representing 400,000 individuals of local glass eels is expected to be transferred from high mortality locations to favourable ecosystems in EMU1, 2 and 3. More specifically, glass eels from the irrigation channels and the pumping stations of the Messolonghi-Etoliko lagoons will be transferred to selected ecosystems of the rivers Acheloos and Kalamas (EMU1). After the establishment of the technical protocols this quantity will be increased to 400 kg representing about 1.5 millions of individuals.

These actions will be completed in the selected ecosystems for restocking by additional measures concerning the fishing activities (ban of fishing gears targeting the species such as fyke nets, fixed traps) and limitation and control of all actions affecting migration routes and water quality. The pilot actions planned (nature, location, time) are presented in details in chapter 4 ("restocking") and technical elements will be decided on the base of the site specificities.

SHORT TERM ACTIONS

These actions will be realised during the first period of application of the EMP and their conclusions will be used to reconsider the EMP before 2012.

7.Define a consistent and operational reporting system

Three points characterise the present situation: the majority of the catches are provided by fishermen cooperatives exploiting the lagoons and they are not considered by the National Statistical Service of Greece, the catches of individual fishermen, the number of which remains unknown, their catches are not reported, as the previously presented elements suggest, and no elements on the recreational fisheries exist. Consequently it is necessary to organize an effective reporting system. The particular status of the lagoon fisheries (cooperatives having in the majority of the cases the exploitation of the lagoons) makes the direct access to landings difficult. The fact that the proposed action presented in the previous paragraph will decrease the hiring cost for the cooperatives will improve the quality of the data. Moreover, the vast majority of the landings are exported to European countries and the combination of direct observations and the elements recorded by custom authorities will lead to the homogenisation and improvement of the data quality.

For the individual fishermen no special eel licence or specific limitations exist. After the specific actions planned for the first two years of the EMP estimates of their number and activity by EMU will be available. The need of special measures will be examined on the basis of these elements.

At present, the immediate prohibition of the eel recreational fishing is planned as well as the prohibition of eel fishing in rivers during the main silver eel migration period (actions 3&4). As no quantitative elements concerning these two fisheries exist an effort to evaluate the contribution of these measures to the escapement target should be made by the analysis of specific elements based on questionnaires concerning the past fishing activities over the EMUs. In 2010, these questionnaires will be addressed to local competent authorities (fisheries departments, coast guards), individual fishers, fishermen representatives, traders and retailers.

The main authorities involved in the data recording system will be the Fisheries Departments of the Prefectures in each EMU. The central administration will be in charge of centralizing and communicating the elements from custom authorities and CITES related processes.

Finally, the Eel Committees will be in contact with the authorities in charge of the DCR in order to complete and homogenize the eel concerning elements including fishing effort, landings and biological parameters (age/size distribution, sex ratio, growth, condition, etc.).

Illegal fishing and non reported catches also exist but at present no estimates of these catches exist. The following actions have been decided.

1. Cross checking by the Central Eel Committee of the following elements:

a) Data from the regional CITES administrations having the responsibility to control the trading, transport and distribution of eel

b) Data from the fish wharfs concerning the first vending of eels.

c) Data collection and compilation of the four EMUs .

d) The inventory sheets submitted to the Prefecture’s Fisheries Directions by the rearing farms, firms and fisheries cooperatives located in marine, transitional and freshwater ecosystems

2. Enforcement of the controls and enactment of additional sanctions for the defaulters of the measures defined by the EMP

Finally, for the recreational fisheries, prohibited by the EMP, a specific survey based on experimental fishing and specific questionnaires will be carried out in 2010 in order to evaluate their importance and consequently the contribution of this prohibition to the EMP targets.

8.Additional decrease of the fishing mortality

Reconsideration of the RD/805/1968 defining the technical characteristics of the fishing gears used by professional fishermen and the definition of closed seasons are planned. These measures will be based on new data (no size distribution or selectivity information is available) and they will proposed by 2011.

The level of 30% direct release of the lagoon eel catches will be re-evaluated considering ecological, economic and social aspects aiming to increase this level to 70% gradually.

9.A typology of the obstruction to migration structures

Summarized elements of structures decreasing the eel upward and downward migration rates were presented in section 3. The rapid increase of the number of these structures, the diversity of their physical and functional characteristics and the heterogeneity of the ecosystems in which are located and the large number of the responsible administrations oblige the development of a common database containing elements related to the eel management priorities. Following this, a study leading to a typology of these structures and the eel related actions relevant to each type should carried out. This study will be supported by public and private companies installed or using the specific ecosystems. An hierarchical list of priority actions contributing to the eel restoration effort will be established.

10.Evaluate the quality of ecosystems using elements relevant to eel

This actions aims the establishment of an extended hierarchical list of favourable and unfavourable eel ecosystems mainly based on the eel survival and the escapement probabilities. As it was presented in the previous paragraphs, the quantity and quality of water varies considerably in several types of ecosystems (both natural and artificial). The example of the massive fish mortalities observed in the irrigation channels around the Messolonghi lagoons confirm the fact that several destructive eel traps exist close to the coastal areas. The evaluation of their impact is a priority and special studies will be carried out during the first phase of the EMP.

11.Establish specific indices to evaluate the management effectiveness

As it was explained earlier, eel is not a target species for a specific fishery. This, along with the complex life cycle of the species which involves several administrations explain the low level of knowledge available for the Greek eel fisheries and the eel itself. In this context it is difficult to evaluate the impact of any action and also to compare the results with the desired targets. The actions proposed for the first period of the EMP will improve our knowledge on several aspects of the fishery and the ecosystem. An effort will be made during the first year to design some approaches to overcome the problem and this will be discussed with specialists in other countries.

12.Raising awareness of the state of the stock

A first action concerned the involvement of lagoon fishing cooperatives to the definition of the short term measures included in the present EMP. This effort should be continued with the staff of local and regional administration involved in fisheries and water management. Moreover, special linkages with the different water resource users have to be developed in order to involve them actively to the Eel Recovery actions. Finally, an effort should be made to inform the wider public on eel as a species in serious decline and especially the recreational fishers in order to accept the future measures.

13.Typology and effectiveness of technical actions to open migration routes

The particularities of the Hellenic ecosystems (torrential character of the rivers, large slopes, high altitudes, seasonal fluctuations) make the direct transfer and application of technical structures improving the eel migration from NW European countries to the Hellenic ecosystems rather difficult. Moreover, the mean main height of the dams makes the development of technical structures to assist the migration very difficult. An evaluation of the feasibility and efficiency of the different structures and methods is necessary.

The accomplishment of this action will be supported by public and private companies installed or using the specific ecosystems.

14.Re-evaluation of the target and escaping quantities

In the previous chapters it appeared that serious knowledge gaps affect the quality of the estimates of the reference quantities. New elements are necessary to revise and complete the existing data in order to obtain more precise estimates of the reference target, the sources of mortality and/or decrease of migration probabilities, the quantities escaping at present and the time interval for the attainment of the targets. The majority of these aspects and the related actions were presented in specific paragraphs above. Experimental fishing and mark-recapture experiments in selected ecosystems of EMU1 will be carried out in 2010 and 2011.

15.Design and establishment of a fishery independent eel monitoring

At the present state, almost all the elements concerning eel are provided by the fisheries. As severe fisheries restrictions can be decided in the future a fishery independent eel monitoring system is necessary. During the first phase of the management plan the design and implementation of fishery independent surveys in the EMU 1 will improve the estimates of the spatial patterns, abundance indices, demographic parameters and other crucial elements concerning the eel population and the performance of the management measures.

MID AND LONG TERM ACTIONS

Mid and long term actions include the improvement of the up and downward migration at barriers and restocking actions. The rapid increase of dams and small hydropower plants (section 3) suggests that their involvement in the restoration of the eel population becomes crucial. The development of technical interventions and the financial support of restocking actions should be decided and established. Based on the typology of the structures and the ecosystems the contribution of each one to the eel restoration effort will be decided.

The status and future of the eel fisheries will be continuously re-examined following the elements provided by the monitoring actions and specific studies. As it was presented previously the gradual increase of the release from the lagoons to up to 70% of the catches in combination with the transfer of early stages from “death traps” to open to the sea and safe environments will considerably increase the silver eel escapement.

A pilot action of collection and transfer of glass eels trapped in the drainage pumping stations of the Messolonghi-Etoliko lagoons will be carried out in winter 2010 and early spring 2011 aiming to the transfer of 70 kg of glass eels representing 250000-300000 individuals. They will be transferred to the locations presented in chapter 4 (“restocking”). The contribution to the eel escapement of this action will be considered after the experimental monitoring of these restocking actions. The experimental monitoring should start in 2011 or earlier, and should last at least 3 eel generations in order to accumulate as much relevant data as possible.

The interest for restocking actions will also be evaluated following the elements presented in the corresponding paragraph previously. Moreover the improvement of water quality in transitional and inland ecosystems will be covered by actions planned in the context of the Water Directive.

During the first phase of the management plan the design and implementation of fishery independent surveys in the EMU 1 will be realized. At mid term this monitoring will be applied to selected ecosystems of the EMU 2 and 3.

TIMETABLE OF THE EMP

The observed differences both in the physical aspects of the Management Units and their recorded eel landings suggest the application of different measures and the development of specific actions in the four management units.

The suggested measures will certainly contribute to the increase of silver eel escapement since the first year of application. The recovery of the European eel may depend on the improvement of factors included in the present plan but for the short and probably mid term (scale of decade) will certainly be governed by the recruitment levels. The effectiveness of the measures depends on the proportional contribution of all the countries over the distribution area of the European eel. All the studies agree that several eel generations are necessary before obvious recovery can be observed. At this level another difficulty is introduced by the heterogeneity of the growth and maturation rates characterising the different ecosystems. The age for seaward migration can vary up to three times as a function of environmental conditions. In our case is expected to be short mainly due to the higher mean temperatures and thus the benefits of the management measures will be more rapid. Unfortunately, no elements exist on the mean age of the migrating silver eels in Greece and thus the temporal dynamics of population under this management regime cannot be easily explored. In any case, the time scales to recovery (several decades) suggest that the careful observation and analysis of the situation, the effective management and the establishment of adaptive management plans is of crucial importance.

The following table resumes the proposed actions by Management Unit and year till the next consideration of the management plan.

	EMU-01			EMU-02			EMU-03			EMU-04		
	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Release 30% of the lagoon catches in the open sea	þ	þ	þ	þ	þ	þ	þ	þ	þ	þ	þ	þ
Prohibition of fyke nets in the lagoons	þ			þ			þ			þ		
Prohibition of eel fishing in rivers	þ			þ			þ			þ		
Prohibition of eel recreational fishing	þ			þ			þ			þ		
Maintenance of free fish movements through the Dimikos channel	þ											
A consistent reporting system for the fishing effort and landings	þ	þ	þ	þ	þ	þ	þ	þ	þ	þ	þ	þ
Additional decrease of fishing mortality			þ			þ			þ			þ
A typology of obstruction to migration structures		þ			þ			þ			þ	
Develop an ecosystem typology based on eel survival and migration		þ	þ		þ	þ		þ	þ			
Restocking actions		þ	þ									
Establish specific indices for the evaluation of the management effectiveness			þ			þ			þ			þ
Raising awareness of the state of the stock	þ	þ		þ	þ		þ	þ		þ	þ	
Typology and effectiveness of technical actions to open migration routes			þ									
Design and implementation of fishery independent monitoring system		þ	þ		þ	þ		þ	þ			

From the analysis of the presented elements and the proposed actions and measures it is obvious that a set of specific studies are necessary in order to fill the existing knowledge gap in several aspects concerning biological, ecological, fishery and technical elements. Priority will be accorded to studies providing estimates of the impact of the proposed actions and measures (measures 2, 3, 4, 8) and to those providing the fundamental elements for the development of actions improving the survival, migration and escapement of eel (9, 10, 13). These specific studies will be started immediately.

Mid (2012-2018) and long term actions include the maintenance of fishing mortality in low levels, the improvement of the up and downward migration at barriers and larger restocking actions. The development of technical interventions to improve the migration probabilities and larger restocking actions in open to the sea non fished clearly defined ecosystems will be carried out with the financial support of the state, the users of the water resources and ecosystems and the European Union. Finally, the implementation of a fishery independent monitoring system in selected ecosystems will be established.

ATTAINMENT OF THE 40% ESCAPEMENT TARGET.

According to the study of Astrom and Dekker (2007), a zero anthropogenic mortality should result in recovery of recruitment within approximately 90 years. Assuming the average European anthropogenic mortality is reduced to a comparable level the escapement biomass target will be achieved in a comparable time scale. The long-term contribution of the Hellenic Eel Management Plan depends on the increase in natural recruitment. In any case the Hellenic contribution is limited and this is due to the limited extend of the eel ecosystems and the particular geomorphological and climatological characteristics of the area. Following the study of the above mentioned authors a 85% reduction of anthropogenic mortality is estimated necessary to prevent continued decline from the current extremely low recruitment but no recovery can be achieved.

The proposed direct measures will reduce the fisheries mortality to 67.8% of the present level and they will lead to the additional escapement of 46.8 t of silver eels. Unfortunately both the present level of escapement and the mortality sources other than fishing are unknown and the contribution of the proposed measures to reach the goal depend strongly on them. The proposed actions is a first reduction and a detailed observation of the fishing activities will provide the elements necessary for the improvement of the fisheries mortality reduction. This decrease will be accompanied by restocking actions but their contribution to the escapement will be recorded later (5 to 10 years).

As no elements on other mortality sources than fishing exist it is difficult to evaluate the contribution of the proposed actions to the escapement target. The transfer of young eels from “death traps” existing around the lagoons to favourable ecosystems will contribute to the eel stock much more than the contribution of the eel farms restocking actions. The advantage of the Hellenic ecosystems is that the age to maturity is considerably lower than in the Northern ecosystems (no data are available but some preliminary observations suggest 5 to 10 years) and thus the contribution of the restocking actions will be observed earlier. In any case these measures will be reconsidered as the first elements of the proposed above proposed actions will be available. In any case, the planned restocking actions are expected to add about 20 t to the escaping eels after a period of 5 to 10 years and these individuals are expected to compensate part of the future decrease due to the present reduced recruitment. The projected further decrease of the fishing mortality by 2012 (release of up to 70% of the lagoon catches and fishing prohibition in the restocking ecosystems) in combination with a restocking activity two times the proposed now will permit to reach escaping levels higher than the critical level necessary to reverse the decreasing recruitment trend. Considering the relatively short time to maturation (to be verified) this could be reached in 5 to 8 generations (35 to 60 years). With no elements on the anthropogenic mortality other than fishing and with no estimates of the present escapement the estimate of the future temporal trends remains risky. Assuming that the same trends will be observed all over the European stock and the improvement of environmental aspects (migration, water quality) the 40% target is expected to be achieved in 15 to 20 generations (100 – 140 years). Naturally, these perspectives depend on the behaviour of the entire eel population.

7. CONTROL AND ENFORCEMENT

The establishment, control and enforcement of the measures of the EMP are under the responsibility of the General Directorate of Fisheries of the MRDF. The operational phase of the EMP in Greece will start in 2009.

The establishment of an Eel Committee in each Management Unit will also take place in 2009. Fishermen representatives, farmers, local and regional administration mainly from Prefecture's Fisheries Directions and scientists will be included in these structures. At this first phase of the EMP development, small efficient structures will be defined. The involvement of other partners will be examined during the reconsideration of the EMP.

The enforcement of the proposed measures is the responsibility of the competent local and regional authorities depending on the location (sea-lagoon, inland waters). The fisheries directions of the Prefectures will be in charge to control and certify the actions concerning the release of eels from the lagoon fisheries to the open sea (in collaboration with the coast guard services and the fishermen cooperatives) as well as the transfer and restocking actions. Additional parameters (size-age distributions, length – weight relationships, sex ratio) will be recorded by measurements and readings on samples from these catches. These elements will be reported through the certification processes of the local and regional fisheries Directions. The data will be centralized by the Eel Committee and their analysis will lead to escapement estimates which they will be compared to the escapement target.

The Eel Management Committees ensure the coordination of pilot actions and the information flow between the different administrations involved in the water and fisheries management. These structures will be in direct contact with the General Fisheries Directorate of the Ministry of Rural Development and Food and the Central Eel Committee. These committees will coordinate all the proposed actions and they will concentrate all the elements in the context of the Eel Management Plan. The resources necessary for the application and further development of the Eel

Management Plan will be provided by the mainly involved Hellenic Ministries and the main water resource users (Power Plants, irrigation and water supply). In addition to the centrally provided resources regional and local support by concerned administrations, agencies and users is expected. These resources will be used in conjunction of support of the European Fisheries Fund (EFF) in the context of Measures of common interest to protect and develop aquatic flora and fauna.

8. RECONSIDERATION OF THE EEL MANAGEMENT PLAN

The first phase of the Greek Eel Management Plan incorporates a number of direct actions and initiatives (direct release of silver eels from lagoons to the sea, decrease of fishing mortality, restocking and transfer actions), management tools and development projects focusing on strengthening the quality and quantity of data relevant to eel. As it was discussed in the previous paragraphs, the quantity and quality of the available information is extremely low and thus the first period of development of the EMP will mainly consist in a considerable improvement of this aspect. This will be done through the analysis of the existing data and the new information through the specific actions presented above. So a sequential approach and a dynamic character should be accepted for the EMP. The main concerned authority expects that this first phase will provide more detailed information on fishing activities, eel mortality and the definition of crucial environmental aspects and thus the modification of the EMP will be considered in 2012.

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