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Abstract

Distribution records (historical, contemporary) for native and non-native freshwater fish species from 105 hydrographic basin areas were compiled and analysed in order to develop a nation-wide inventory (including transboundary river basins). Overall, 162 species, including diadromous and euryhaline, with documented occurrence records in freshwaters, and taxa of unclarified taxonomic status, are accommodated in the distributional compilation. An annotated checklist summarises the confirmed ichthyofauna of Greek freshwaters (161 species); a provisional supplementary list contains species recorded in brackish waters (55 species). In comparison to the last published (1991) checklist of freshwater fish of Greece, the present checklist shows an increase in species number of 53% (56 species). This increase has resulted mainly from taxonomic re-evaluations of existing taxa on the basis of new information and adoption of a new systematic concept. The current trend, as reflected in recent ichthyological publications, is towards abandonment of the biological species concept (BSC) and adoption of the phylogenetic species concept (PSC) for the delineation of species boundaries. The practical implications of the change in species concept on biodiversity conservation and watershed management are discussed. An overview of the composition and characteristics of the freshwater fish fauna of Greece is provided, especially with regard to the native and introduced status of species, and the spatial patterns of species richness and endemism. This systematic inventory may assist in efforts to develop nation-wide surface water bioassessment tools within the demands of the Water Framework Directive (WFD); it may further promote biodiversity conservation and biologically-orientated fishery management approaches.

Keywords: Freshwater ichthyofauna; Fish distribution; River basin area; Endemism; Biodiversity; Greece.

Introduction

Freshwater fish represent an important component of the aquatic ecosystem and are highly valued for their economic, social and aesthetic importance. Fish are already involved in environmental policies as biodiversity and ecological quality indicators (KESTEMONT *et al.,* 2000; SCHMUTZ *et al.,* 2007) and they have been used successfully in biogeographical studies (BĂNĂRESCU, 2004), ecoregion delineations (HAWKES *et al.,* 1986; ABELL *et al.,* 2002), conservation evaluations (MOYLE & RANDALL, 1998) and assessments of ecologically acceptable water regime management (JOWETT, 1997). Greece has diverse inland water resources and hosts one of the richest freshwater ichthyofaunas in Europe. The number of species occurring in Greek waters is still an issue of active investigation. The last published checklist of the freshwater fish of Greece contains 105 native and introduced species (including euryhaline) plus five of doubtful occurrence (ECONOMIDIS, 1991). A recent re-evaluation gives 135 species, of which 89 are native exclusively freshwater, and 54 are endemic to the country or to the southern Balkans (BOBORI & ECONOMIDIS, 2006). However, a complete nation-wide inventory of fish occurrences by river basin has never been published.

A review of publications concerning the freshwater fish of Greece was recently undertaken with the scope of assessing the utility of available ichthyological information for the implementation of the EU Water Framework Directive (ECONOMOU *et al.,* 2004a). One of the outcomes of this review is that there has been a change in the thematic focus of ichthyological research over the past decades, from distributional surveys and taxonomic work based on morphology, to studies of fish physiology, ecology, biology and genetics. This change had a negative side-effect on the availability of fish distributional data. Large-scale distributional survey work was abandoned in favour of regional or local scientific investigations, often focusing on single species or single areas. It is characteristic that most of the information used to produce the checklist of freshwater fish of Greece published by ECONOMIDIS (1991) was derived from his earlier published catalogue of fish (ECONOMIDIS, 1973), which is based on results of investigations undertaken before the 1970s.

According to the aforementioned review (ECONOMOU *et al.,* 2004a) valuable ichthyological information exists for large rivers and lakes, however, the fish fauna of small aquatic systems has been poorly investigated. For some areas no information at all could be found, whereas for other areas there are data shortages for most, except the larger water bodies. An associated problem is that the distribution of alien fish is poorly known since species introductions or translocations are rarely announced, and when they are, the data are not always accessible. Quite often, information on the occurrence of non-native species can be obtained only from grey literature or local authorities. A risk of misreporting and misidentification is inevitably inherent in this approach as the taxonomy of the introduced species is not often verified by experts. Moreover, much of the available information on species distributions is spread out in various, often obscure, publications which are not readily accessible to the scientific community, especially to non Greek-speaking scientists. This holds particularly true for dissertation theses, works published in older or local journals, national conference proceedings and project reports. It is obvious that a synthesis and compilation of relevant information is required to facilitate knowledge access and sharing.

Deficiencies in distributional data availability, coupled with taxonomic ambiguities, have a negative impact on scientific research and management applications dependent on fish data. For example, planning for biodiversity conservation in Greece is often hindered by lack of knowledge of the distributional ranges of endangered species and vagueness in ichthyological nomenclature. These problems reflect the fact that the list of protected fish species for Greece included in the Annexes of the Habitats Directive (92/43/EC) contains species listed under invalid names, while many really threatened species are not listed. Recent taxonomic revisions undertaken on a European scale and the application of new criteria for defining species (KOTTELAT, 1997; KOTTELAT & FREYHOFF, 2007a) have attempted to resolve problems related to nomenclature and systematics but at the same time they have complicated the ichthyological faunal list of Greece by renaming and 'splitting' many species. Thus, much confusion may be generated among environmental managers and non-specialist users of ichthyological data, as some species appear under new names, several new species have emerged, and the distributional ranges of many species are not clearly defined. This again reiterates the need for a systematic treatment of existing fish distributional records to produce hydrographic basin area compilations incorporating these changes.

The aim of the present work is to develop an updated and, to the degree that it is possible, complete inventory of the distribution of freshwater fish over Greek territory. Using a combination of data sources and historic or contemporary accounts, we compiled lists of the freshwater fish occurring in 105 Greek hydrographic basin areas and we characterized their provenance status (i.e. native or introduced in each basin area). The hydrographic basin area was chosen as the spatial unit for this inventory because of its relevance to biogeography. Indeed, no single factor is more important in explaining large-scale distributional patterns of freshwater fish than hydrographic basin limits (GILBERT, 1980). River basins have long been considered as the operational unit for the biogeographical analysis of fish throughout the world (e.g. ABELL *et al.,* 2002; HIGGINS *et al.,* 2005; THIEME *et al.,* 2005; REYJOL *et al.,* 2006). This is because both primary and many secondary freshwater fish are freshwater-obligate organisms that cannot readily disperse across terrestrial boundaries or marine areas. Effectively, the freshwater fish populations within hydrological basins are reproductively isolated entities adapted to their basin-scale ecosystems. River basins often exhibit a distinct fish composition and can be seen as 'biogeographical islands' containing a specific pool of species (HUGUENY, 1989). This island-like character also renders the basin area an appropriate scale for studies of endemism and speciation (PETER, 2006).

The main product of this work is a hydrographic basin area-based compilation of fish that live in the freshwaters of Greece. These data may assist in understanding regional assemblage structure and other faunistic attributes of relevance to biogeography. In addition, the data are of potential utility in resource and environmental management, especially with regard to ecological quality assessments, biodiversity conservation and fishery exploitation.

From the perspective of ecological quality assessment, interest is centered on the successful implementation of the EU Water Framework Directive 2000/60/EC (WFD). The WFD establishes an ecosystem-based policy framework for water management and protection in Europe at the river basin scale. The Directive demands, among others, that the member states should develop monitoring programmes and ecological status classification systems within river basin districts using fish and other organisms as biological indicators. An important requirement for the establishment of the monitoring programmes is that reliable information on freshwater fish assemblages for each river basin area is available, both for the characterization of the undisturbed, type-specific 'reference conditions' and for the selection of the appropriate biological metrics with which to measure ecological degradation (ECONOMOU, 2002; ECONOMOU *et al.,* 2003).

With regard to biodiversity conservation, the emphasis is on identifying areas hosting species in need of protection according to the EU Habitats Directive (92/43/EC). Incomplete and/or inaccessible information on fish species' distributions has hindered the timely evaluation of areas of high conservation value and their inclusion in the NATURA 2000 protected-area framework. This is unfortunate, as Greece is one of Europe's biodiversity hotspots in terms of freshwater fish endemism (MAITLAND & CRIVELLI, 1996). The country has already lost nearly 75% of its natural wetland areas during the last century (OECD, 2000) and many aquatic ecosystems are threatened even in designated protected-areas. Data show that several fish populations have become threatened or extirpated (ECONOMIDIS, 1995, 1999, 2002; ECONOMIDIS *et al.,* 1996; ECONOMOU *et al.,* 1999; STOUMBOUDI *et al.,* 2002; PERDIKARIS *et al.,* 2005) and many more may face threats in the near future due to escalating pressures upon surface freshwater resources. Organization of the ichthyological information on a basin area scale provides a practical approach for the evaluation of conservation priorities and the design of restoration measures. Knowledge of fish distributions may also facilitate the monitoring of changes in the fish faunas in relation to climatic change.

Lastly, freshwater fishing has a strong socio-economic dimension, especially in rural areas, where alternative employment possibilities are limited or highly seasonal. The freshwater fisheries' resources are threatened by destructive or illegal fishing and, increasingly in recent years, by the uncontrolled introduction of alien species (CRIVELLI *et al.,* 1997; ECONOMIDIS *et al.,* 2000a; ECONOMOU *et al.,* 2001a). The present compilation may provide policy-relevant information on the distribution status of native, exotic and translocated species that may help in designing biologically-based fisheries management.

Study Area

Greece's land area (132 000 km^2) supports remarkably varied inland water features. The country has a highly fragmented geography and various parts of the territory have very different environmental conditions and biogeographical histories. 65.4% of the land exceeds 200 m in altitude (CATSADORAKIS, 2003). The coastal morphology both on the continent and on the islands is diverse but it usually consists of a highly fragmented, narrow coastal zone with a varied relief. The most extensive lowland areas exist in northern Greece where relatively large alluvial plains are drained by the rivers Evros, Nestos, Strymon, Axios and Aliakmon.

In terms of inland water aquatic biota, Greece is at a biological crossroads among Mediterranean, temperate European, Danubian-Black Sea, and Anatolian influences (BĂNĂRESCU, 2004). Although the biotic influences due to the country's geography are unique, important biogeographic barriers criss-cross the country and create even more heterogeneity. Long mountain chains, climatic rain-shadows, wide marine gulfs and deep seas that were not drained due to sea level lowering at the glacial maxima, create inland water isolation which has remained rather stable for millennia. More geographic idiosyncrasies are created by the country's geological fragmentation and dynamics, its extensive coastline (16000 km), and a variety of climatic zones. Climatically, Greece maintains remarkable extremes ranging from high-rainfall mountains receiving 2400 mm precipitation per year (Central Pindos), to seasonally semi-arid areas (southern Attiki) receiving less than 400 mm. Rain-shadow areas in the southeast mainland and the Cyclades islands create pockets of seasonally arid conditions with high evapotranspiration rates and a long summer drought. Unlike most European countries Greece's inland aquatic ecosystems are strongly characterized by geographical isolation, both spatially as small river basin areas, and temporally as long-standing relatively stable waterbodies which created biotic refugia when much of the continent was being affected by the Pleistocene glaciations (SKOULIKIDIS *et al.,* 1998; PERISSORATIS & CONISPOLIATIS, 2003).

A proper classification of Greece's surface water systems has never been completed and the variety of aquatic ecosystems and habitat types is certainly immense. These water features range from large transboundary rivers, medium and small perennial and intermittent streams to small endorheic karstic streams, spring systems, inland lakes, coastal lagoons, swamps and marshes. Water features have been poorly inventoried for their aquatic biota and little published information exists on regional and local scale species distributions; data for invertebrates and lower vertebrates is especially lacking (LEGAKIS, 2004). Until recently, formal inventory procedures have catalogued only the large wetland sites; one such compilation lists 378 wetland sites covering approximately 2000 km^2 in the entire country (ZALIDIS & MANTZAVELAS, 1994). Unfortunately, these published catalogues of sites are a poor and incomplete representation of the total number of aquatic sites in the country (e.g. CATSADORAKIS & PARAGAMIAN, 2006). In a recent regional-based survey, CATSADORAKIS & PARAGAMIAN (2007) describe 352 wetland areas solely in the Aegean islands (excluding Crete).

Profile of Greek hydrographic basins

It has been recently stated that limnology and freshwater ecology in the Mediterranean should not be based on temperate European paradigms, patterns and generalizations (ALVAREZ-COBELAS *et al.,* 2005). Greek river basins differ markedly from most temperate European ones.

They usually comprise isolated hydrographic basins, characterized by short, steep fluvial systems that exhibit very erosive behavior, flashy, irregular flow regimes and are influenced by varied geographical, geological and climatic conditions. Most rivers run through narrow mountain valleys and descend abruptly to the coast, usually lacking extensive lowland sections and floodplain habitats. There are only eight large rivers in the country (with drainage areas larger than 6000 km^2), including five transboundary ones (SKOULIKIDIS *et al.,* 1998). The number of smaller rivers or streams with perennial flowing segments is certainly in the hundreds; a complete inventory of all hydrographic basin delineations does not exist, despite attempts in the recent past (e.g. NTUA, 1994). 'Lowland' fluvial habitat conditions are mainly encountered in the plateaus and inland plains of the larger rivers, which create unique biotic assemblages since their access to the river's main stem may be blocked by gorges or other natural barriers including karstic phenomena. The deltas of Greek rivers are often extensive, although they are not affected by estuarine tidal regimes (TSIOURIS & GERAKIS, 1991).

Most lakes in Greece are located within river basins or have a historic relation with their wider river basins. Some of the older lakes have a unique history of isolation and are centers of endemism (e.g. Lakes Prespa, Vegoritis, Pamvotis, Doirani) (FROGLEY *et al.,* 2001; GRIFFITHS *et al.,* 2002; FROGLEY & PREECE, 2004; ALBRECHT *et al.,* 2007). Although 56 major natural lakes have been described (ZALIDIS & MANTZAVELAS, 1994; ZACHARIAS *et al.,* 2002), Greece has many smaller lentic bodies, such as various wetlands, ponds and coastal lagoons; the number of these small water features is certainly in the thousands. Some of these water features are associated with lowland rivers and lowland or plateau lake-swamp environments. In contrast, many small karstic spring-fed lentic systems especially in the limestone-dominated southern and western parts of the country are often totally isolated from other surface-flowing waters in the wider landscape.

Methods

Our inventory approach takes the following steps: a) selection of adequately-studied hydrographic basin areas (and other 'isolated' aquatic sites); b) compilation of fish species occurrence for each area; and, c) compilation of a provisional annotated freshwater fish species checklist and a supplementary list of species recorded in transitional waters.

Definition of studied basin areas

The basic geographical unit to assemble our distributional compilation is defined as the hydrographic basin area. Only basin areas where documented fish species occurrences have led to a 'near-complete' ichthyofauna list are included in the compilation. The size of each basin area was retrieved largely from the Hydroscope database of the National Technical University of Athens (NTUA, 1994). This geo-database delineates 737 river basins and 'wider river basin areas' in Greece. The NTUA delineations do not include some of the smaller hydrographic basin areas we provide data for; their area was roughly estimated by us from maps (Table 1). Each hydrographic basin area was categorized into one of six general biogeographical units, these roughly follow

Table 1
Hydrographic basins for which fish data are presented in this study. Basins are numbered according to their position on the map (see Fig. 1). For each basin the biogeographical region, the basin surface area and the included water bodies are given.

No	Name Given	Biogeo-graphical Area	Estimated Area (km^{2})	Included water bodies
1	Evros	North Aegean	53000	Evros R. (Maritsa, Meric), Loutros R., Delta and lagoons.
2	Avas	North Aegean	249	Avas R. (also known as Potamos R.)
3	Filiouri	North Aegean	2107	Filiouris R., Bospos R., Mitrikou (or Ismarida) L.; adjacent coastal lagoons and Maronia R.
4	Kompsatos	North Aegean	596	Kompsatos R.
5	Vistonis	North Aegean	3200	Vistonis L., Porto Lagos Lagoons.
6	Kossinthos	North Aegean	435	Kossinthos R.
7	Laspias	North Aegean	138	Laspias (or Laspopotamos) R., Avdira wetlands and surrounding wetlands and lagoons.
8	Nestos	North Aegean	6200	Nestos (Mesta) R., reservoirs, Delta wetlands and lagoons.
9	Marmaras	North Aegean	235	Marmaras R.
10	Nevrokopi	North Aegean	473	Streams in Nevrokopi basin.
11	Strymon	North Aegean	17000	Strymon (Struma) R., Kerkini L., reservoirs.
12	Ladopotamos	North Aegean	25	Ladopotamos, Agion Oros Peninsula.
13	Mavrolakas	North Aegean	80	Mavrolakas R.
14	Asprolakas	North Aegean	91	Asprolakas R.
15	Rihios	North Aegean	2090	Rihios R.
16	Volvi	North Aegean	1903	Volvi L., Koronia (or Aghiou Vassileiou or Lagada) L., tributary streams.
17	Doirani	North Aegean	420	Doriani (Dorjan) L. (within the broader basin of the Axios R.), Megalo Rema and other tributaries.
18	Axios	North Aegean	22250	Axios (Vardar) R., reservoirs.
19	Anthemountas	North Aegean	428	Anthemountas R.
20	Gallikos	North Aegean	1022	Gallikos (or Echedoros) R.
21	Loudias	North Aegean	1409	Loudias R.
22	Vegoritis	North Aegean	752	Vegoritis L., Cheimaditis L., Petron L., Zazari L., tributary streams.
23	Kastoria	North Aegean	264	Kastoria (or Orestias) L. (within the broader basin of the Aliakmon R.), tributary streams.
24	Aliakmon	North Aegean	8677	Alkiakmon R., Almopeos R., Tripotamos R., reservoirs, Delta wetlands.
25	Mavroneri	North Aegean	815	Mavroneri (or Itamos) R.
26	Pinios The	North Aegean	9500	Thessalian Pinios R.
27	Prespa	South Adriatic	1383	Mikri and Megali Prespa L. (within the broader basin of the Drin R.), Ag. Germanos R.
28	Aoos	South Adriatic	6710	Aoos (Vjose) R. and reservoir near Metsovo.
29	Kalamas	Ionian	1831	Kalamas (or Thyamis) R.
30	Zaravina	Ionian	13	Zaravina L.
31	Pamvotis	Ionian	330	Pamvotis (or Ioannina) L.
32	Paramythia	Ionian	138	Small Lakes of Paramythia (basin of Margaritiou).
33	Kalodiki	Ionian	69	Kalodiki L.

(continued)

Table 1 (continued)

No	Name Given	Biogeo-graphical Area	Estimated Area (km^2)	Included water bodies
34	Acheron	Ionian	752	Acheron R and coastal wetlands.
35	Ziros	Ionian	10	Ziros L.
36	Louros	Ionian	983	Louros R.
37	Arachthos	Ionian	2009	Arachthos R., reservoirs and Delta.
38	Vouvos	Ionian	205	Vouvos R. (Kombotiou R. basin).
39	Vlychos	Ionian	45	Vlychos spring and Myrtari Lagoon.
40	Voulkaria	Ionian	74	Voulkaria L.
41	Astakos	Ionian	80	Astakos R.
42	Acheloos	Ionian	6329	Acheloos R., Agios Dimitrios (Lesini) R., lakes, reservoirs, Delta and lagoons.
43	Evinos	Ionian	1112	Evinos R. and reservoir.
44	Mornos	Ionian	998	Mornos R., reservoir, Delta wetlands and Gouvos Spring.
45	Kerkyra	Ionian	Insular drainages	Kerkyra (Corfu) Island water features.
46	Lefkas	Ionian	Insular drainages	Lefkas Island water features.
47	Assopos Pel	Ionian	286	Assopos (Peloponnese) R.
48	Dervenios	Ionian	65	Dervenios R.
49	Krios	Ionian	130	Krios R.
50	Krathis	Ionian	155	Krathis R.
51	Vouraikos	Ionian	273	Vouraikos R.
52	Keronitis	Ionian	98	Keronitis R.
53	Selinous	Ionian	373	Selinous R.
54	Meganitis	Ionian	107	Meganitis R.
55	Phoenix	Ionian	97	Phoenix R.
56	Volinaios	Ionian	55	Volinaios R.
57	Glafkos	Ionian	142	Glafkos R.
58	Piros	Ionian	577	Piros R.
59	Tsivlos	Ionian	10	Tsivlos L. (within the Krathis R. basin).
60	Prokopos	Ionian	280	Prokopos Lagoon, Lamia Swamp and adjacent springs and streams.
61	Kotychi	Ionian	266	Kotychi Lagoon and Vergas R.
62	Pinios Pel	Ionian	868	Peloponnesian Pinios R. and reservoir.
63	Alfios	Ionian	3658	Alfios R. and reservoir in the Ladon tributary.
64	Neda	Ionian	287	Neda R.
65	Yiannousagas	Ionian	48	Yiannousagas R. and adjacent Yalova Lagoon.
66	Peristeras	Ionian	184	Peristeras (or Kalo Nero or Miras) R.
67	SW Messinia	Ionian	N/A	Streams of SW Messinia, south of Kyparissia.
68	Pamissos	Ionian	728	Pamissos R. and Aris tributary.
69	Kandila	Ionian	216	Kandila spring and former wetlands.
70	Feneos	Ionian	233	Doxa reservoir in Feneos Plateau and streams.
71	Stymphalia	Ionian	216	Stymphalia L.
72	Taka	Ionian	102	Taka L.
73	Evrotas	Ionian	1738	Evrotas R.

(continued)

Table 1 (continued)

No	Name Given	Biogeo-graphical Area	Estimated Area (km$^{2)}$	Included water bodies
74	Vassilopotamos	Ionian	14	Vassilopotamos canals within the Evrotas Delta Area.
75	Smynous	Ionian	192	Smynous (or Arniotiko) R.
76	Ardeli	Ionian	78	Ardeli (or Ardelolaggado) R.
77	Lerni	East Peloponnese	20	Lerni Spring.
78	Kato Almyri	East Peloponnese	N/A	Kato Almyri Spring.
79	Erassinos Arg.	East Peloponnese	22	Erassinos R. (in Argolis)
80	Vouliagmeni	Attiko-Beotia	N/A	Vouliagmeni Karstic Lake, Attiki.
81	Erassinos Vra.	Attiko-Beotia	25	Erassinos R. (in Vravron, Attiki).
82	Rafina	Attiko-Beotia	90	Rafina (Megalo Rema) R.
83	Kato Souli	Attiko-Beotia	40	Kato Souli (or Schinias Marathon) Wetland.
84	Marathon	Attiko-Beotia	114	Marathon reservoir, Charadros stream and other tributaties.
85	Kifissos Att	Attiko-Beotia	420	Attikos Kifissos R. (in Attiki).
86	Assopos Beo	Attiko-Beotia	724	Beotian Assopos R.
87	Kifissos Beo	Attiko-Beotia	1958	Beotian Kifissos R. (in Beotia).
88	Yliki	Attiko-Beotia	494	Yliki L. and Paralimni L.
89	Thermopyles	Attiko-Beotia	71	Thermopyles Springs.
90	Sperchios	Attiko-Beotia	1828	Sperchios R., Gorgopotamos and other tributaries, Delta wetlands.
91	Cholorema	Attiko-Beotia	192	Cholorema R. (Pagasitikos Gulf).
92	Kireas	Attiko-Beotia	441	Kireas-Nileas R. (Kirinthos), Euboea.
93	Manikiotiko	Attiko-Beotia	158	Manikiotiko (or Monodriotiko) R., Euboea.
94	Dystos	Attiko-Beotia	57	Dystos L., Euboea.
95	Rigia	Attiko-Beotia	29	Rigia & Lala river, Karystos plain, Euboea.
96	Samothraki	Aegean islands	Insular drainages	Samothraki Island water features.
97	Lesvos	Aegean islands	Insular drainages	Lesvos Island water features.
98	Samos	Aegean islands	Insular drainages	Samos Island water features.
99	Rhodos	Aegean islands	Insular drainages	Rhodos Island water features.
100	Almyros	Aegean islands	20	Heraklion Almyros spring and stream, Crete.
101	Koutsoulidis	Aegean islands	578	Koutsoulidis R. (Yeropotamos Basin); including Zaros reservoir, Crete.
102	Kourtaliotis	Aegean islands	109	Kourtaliotis R., Crete.
103	Kourna	Aegean islands	20	Kourna L and adjacent water features, Crete.
104	Agia	Aegean islands	166	Agia reservoir within the Platanias basin, Crete.
105	Tavronitis	Aegean islands	131	Tavronitis R., Crete.

BĂNĂRESCU (2004): 1) Northern Aegean (includes both the Thrace and Macedonia-Thessaly zoogeographic regions), 2) Southern Adriatic (represented here by the Aoos R. and the Lake Prespa), 3) Ionian (includes the Ionian islands and nearly all of the Peloponnese except the eastern part 4) East Peloponnese (rain-shadow coastal area only), 5) Attiko-Beotia (includes Euboea and Fthiotis in eastern central Greece), and 6) Aegean islands (includes Crete).

The hydrographic basin areas cited are defined by the traditional watershed boundaries of the entire catchment, taking into account hydrographic idiosyncrasies and historical drainage connections. In this context, lakes with a present or past connection to large rivers were usually incorporated into the wider river basin area. This also includes small rivers lying in the vicinity of the deltaic depositional zone of larger rivers. For instance, the Acheloos R. basin area is defined here to include the drainages of the natural lakes Trichonis, Lyssimachia, Ozeros and Amvrakia; the artificial reservoirs Kremasta, Kastraki, Stratos and Tavropos; the entire deltaic wetland area, including the small Aghios Dimitrios (or Yeroporos) R. with which the Acheloos R. had a direct connection before the draining of the deltaic Lake Meliti. The hydrographic basin areas of hydrologically isolated lakes are considered to contain the drainages of associated smaller lakes, as well as the drainages of rivers discharging into them. For example, the hydrographic basin area of Lake Vegoritis contains the watershed of Lakes Vegoritis, Cheimaditis, Zazaris and Petron and all streams discharging into these lakes. Expert judgment based on criteria of geographical distinctiveness and surface hydrological connectedness was used to define the areal extent of the hydrographic basin area unit considered in this inventory. In certain cases (14 basin areas), several exceptions and violations to the use of traditionally defined hydrographic basin areas were made:

a. Certain older lakes or lake groups within major river catchments are included as 'isolated' water features, despite present or past drainage connections with wider river basins (e.g. Lakes Kastoria, Doirani and Pamvotis). In a few instances even very small lakes, semi-isolated spring-fed wetlands, and other karstic surface waterbodies are delineated in isolation, either because they represent unique geological features or they have other surface water attributes which are worthy of particular conservation interest (e.g. Lakes Tsivlos, Vouliagmeni and Zaravina, Kato Almiri Spring).
b. Some assemblages of separate small stream basins on the mainland and on the islands are incorporated into single artificially defined 'basin areas'. This is done in cases where complete information on species composition for each separate stream basin is lacking, but incidental records among the group of proximate basins is considered adequate to warrant the wider areas' inclusion (i.e. SW Messinia includes several small streams south of Kyparissia-Messini, Peloponnese). In some other cases, surface hydrology is complicated and semi-connected wetland conditions or artificial canals blur watershed boundaries; hence nearby streams and wetlands are included (e.g. coastal wetland and isolated canal features such as the Laspias-Avdira wetlands near Xanthi, Thrace). In the case of small islands, the entire network of an island's inland water features is presented as an artificially defined 'hydrographic basin' area. This treatment is of course provisional and was followed simply because in most insular systems ichthyological research is still inadequate. Only for

two of the largest Aegean islands (Crete and Euboea) are specific river basin area compilations provided.

Compilation of fish species occurrence for each area

We compiled a species-hydrographic basin area dataset hosting the freshwater fish species occurring in Greece and, in the case of transboundary rivers, in neighbouring southern Balkan countries (Albania, Bulgaria, FYR Macedonia, Turkey-in-Europe). This compilation is based on an extensive bibliographic study that began in 2003 (ECONOMOU *et al.,* 2004a, 2006). Unpublished survey data from HCMR field surveys were also utilized when the available material was collected through the participation of the authors in field sampling projects. The authors have been involved in wide-ranging site-based sampling surveys particularly in western, northwestern and southern Greece (including 73 of the presented hydrographic basins areas); much of this work remains unpublished in refereed journals (ECONOMOU *et al.,* 1999, 2004a, 2007; ZOGARIS *et al.,* 2004, 2006).

Attention was paid to documenting and ascertaining the quality of each particular record for each basin area. The occurrence of a species in a basin area had to be provided by at least one reliable source (publication, technical report) or to have been confirmed by the authors during field surveys. Some information was received from competent ichthyologists through personal communications. On some occasions substantiated uncertainty of the quality of an accepted record is provided with a question mark notation beside the record.

Fish systematic taxonomy was based on KOTTELAT & FREYHOF (2007a), and all relevant publications up to mid 2007. KOTTELAT & FREYHOF (2007a) provide a major revision of taxonomic units in Europe and include information on the distribution of the taxa occurring in Greece. Some of the taxa described are not given separate species status while distributional information for some species is vague or incomplete. For the sake of consistency and practical policy-relevant applications, we adopt the taxonomic changes given by KOTTELAT & FREYHOF (2007a) and we critically comment on particular difficulties in the taxonomy and distribution of certain taxa in the checklist (Appendix I). In some cases we carefully document divergence in certain taxa distributions from that presented by the above authors.

The following species inclusion and nomenclature premises were made:

a. All species, native or introduced, that spend their entire lives or a significant portion of their life-cycle in freshwaters were considered in the basin area distributional compilation, i.e. primary freshwater species (intolerant to saltwater) and secondary freshwater species (species that now live exclusively in freshwater but were once able to tolerate saltwater). Diadromous species and euryhaline species for which adequate distributional data exist are included, but so-called 'sporadic species' or marine stragglers that seem indifferent to salinity or have a definite marine life-history, are not included. Information is largely lacking in order to confirm the regular presence of certain marine species in freshwaters, although proof of several marine species' residence in brackish transitional waters exists (e.g. KOUTRAKIS *et al.,* 2000).

b. Certain euryhaline species known to be regularly present in freshwaters but for which consistent records are missing are excluded from the distributional compilation. However, these species are placed within the summary checklist of freshwater fish in the appendix and should be considered as important elements of the freshwater fauna.
c. Valid species names are given but in some instances tentative operational taxa names are given for species that present identification problems, strictly following KOTTELAT & FREYHOFF (2007a). In addition, in five isolated cases, we provide only our own operational name for unidentified species known only to genus level (i.e. two *Eudontomyzon* spp., *Knipowitschia* sp. *Squalius* sp1, *Squalius* sp2). This is not a diversion from any accepted taxonomy, but it is required to show the presence of an unidentified species in a particular basin area.
d. Species of undefined taxonomic status are included with a notation to indicate taxonomic uncertainty. For example, KOTTELAT & FREYHOF (2007a) provide the controversial taxon *Salmo* sp. Louros and we include this poorly described taxon in our compilation, but with a notation to show 'doubtful taxonomic status'. Furthermore there are several instances where KOTTELAT & FREYHOFF (2007a) refer to species occupying particular hydrographic basins but give no information on presumably the same or closely related fish that exist in nearby basins. In such cases of uncertainty we have used available distributional data and expert judgment to assign these fish to a specific taxon. We used the acronym 'cf' (Latin for confer) between the genus name and the species name to show that the species in question is similar to a named species but there is uncertainty about its taxonomic status, or that this species may represent a distinct unnamed species. Our overall objective was to produce an operational and complete distributional compilation of the freshwater fish of Greece rather than a taxonomically more accurate but incomplete distributional account.
e. Notations are given where uncertainty exists about the native or introduced status of a population and where the population is presumed extirpated or possibly extirpated.

Annotated freshwater species checklist (in Appendix)

A critical assessment of the ichthyological data assists in the production of an updated checklist of species known to inhabit freshwaters in Greece. As previously mentioned, certain migratory and transient marine species regularly present in freshwaters are included but most marine species are excluded, since evidence is lacking on how frequent these species are in the freshwater parts of the basin areas. This checklist is still a preliminary contribution for use in practical conservation-relevant applications. Sweeping taxonomic name changes have drastically altered previously given names and abolished the use of sub-species names, so a practical updated list linking the previous and the current taxonomy is needed to clarify confusion. In this respect, notation on previous species names and new additions to Greece's species list are given. For conservation purposes the level of 'endemicity' of each species according to the scale of the Greek territory is summarized. Endnotes present special taxonomic problems and distributional uncertainties. It must be made clear that in some cases the available data is often of poor quality and uncertainties exist; consequently, unreliable records and poorly validated taxonomic problems are inevitable. The checklist provides notes concerning our professional opinion on these difficulties.

Supplementary list of species recorded in transitional waters (in Appendix)

A separate supplementary list of species recorded in transitional waterbodies is also attempted (this includes river mouths, coastal lagoons and the brackish reaches of lowland rivers). This is certainly a very rough provisional contribution needing further research. References are given for each species that is included in the list. This list does not include species cited in the aforementioned checklist of freshwater species; therefore, many freshwater species that have been recorded in transitional waterbodies are not included. This supplementary list attempts to provide a more complete picture of the hydrographic basin-based species assemblage, since transitional waters are definitely a part of the river basin area unit. Some of these species are potential candidates for inclusion in the freshwater checklist when further evidence is gathered.

Results

Hydrographic basin areas considered in the survey

Table 1 lists the hydrographic basin areas considered in this study along with their main synonyms, the waterbodies included in each area and the estimated total surface area. The basin areas are arranged numerically according to their position on the orientation map of Greece which is given in Figure 1. Most of the basin areas covered in this survey lie on the western, more humid side of the country (50 areas). Northern Greece covers a very large region with the predominance of large or very large hydrographic basins (26 areas). Relatively few basins from the drier rain-shadow parts of the country (Central-Eastern Greece, Eastern Peloponnese, the Aegean islands) are accommodated in the dataset, reflecting both the scarcity of larger perennial waterbodies and poor sampling effort (29 areas).

Composition and characteristics of the ichthyofauna of Greece

All species known from freshwaters, native or introduced, are recorded in the checklist of the freshwater fish fauna of Greece (Appendix I). The supplementary list of other euryhaline and marine species that have been recorded in the published literature from transitional brackish waters is provided in Appendix II.

The distributional compilation of species occurrence data in 105 hydrographic basin areas is presented in Tables 2-6. The compilation includes all species contained in the checklist, plus seven species that have been reported from sections of transboundary rivers outside Greek territory; however, it excludes 9 euryhaline species contained in the checklist for which the distributional accounts in freshwaters are incomplete. Among these, mugilids (five species) have a widespread occurrence in estuaries and lowland sections of rivers but their presence is not regularly

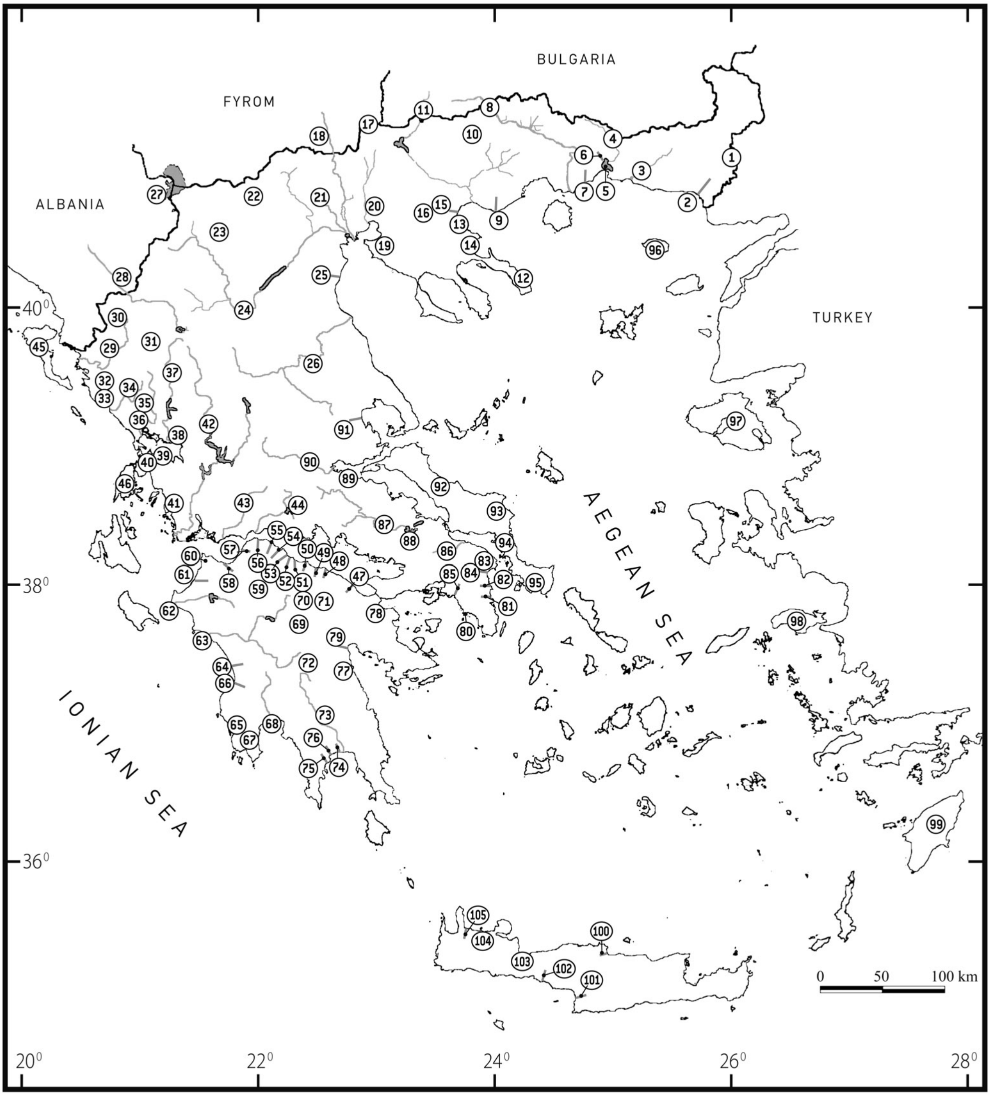


Fig.1: Map of Greece showing the location of the hydrographic basin areas considered in the ichthyofaunal distributional compilation.

reported or given at species level. The same holds for *Atherina boyeri,* which is commonly found in coastal lagoons, estuaries and the lower reaches of rivers. Notably, there are records of three landlocked sandsmelt populations in Greece, in Lakes Voulkaria, Kourna and Trichonis respectively (LEONARDOS, 2001; TIGILIS, 2001; ECONOMOU *et al.,* 2001b). Two more species excluded from the compilation are *Dicentrarchus labrax* and *Zosterissesor ophiocephalus,* which are not a frequent target of faunistic investigations, and their occurrence in transitional and adjoining freshwater waterbodies often goes unreported.

Table 2
Fish faunistic lists for the hydrographic basins of Northern Greece. The position of the basins is shown in Figure 1.

	Evros	Avas	Filiouri	Kompsatos	Vistonis	Kossinthos	Laspias	Nestos	Marmaras	Nevrokopi	Strymon	Ladopotamos	Mavrolakas	Asprolakas	Rihios	Volvi	Doirani	Axios	Anthemountas	Gallikos	Loudias	Vegoritis	Kastoria	Aliakmon	Mavroneri	Pinios The
Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Abramis brama	1		2								1					1										
Acipenser gueldenstaedtii	2																									
Acipenser stellatus	1[b,c]										2[b,c]															
Acipenser sturio	1[c]				1[c]			1[c]			1[c]															1[c]
Alburnoides bipunctatus	(1)						1	1	1		1							1			1			1	1	1
Alburnus alburnus	1[a]							1[a]																		
Alburnus macedonicus																	1									
Alburnus sp. Volvi											1				1	1										
Alburnus thessalicus											(1)[a]							1			1	1		1		1
Alburnus vistonicus			1	1	1	1																				
Alburnus volviticus																1										
Alosa fallax	1		1		1			1			1										1?					1
Alosa macedonica																1										
Alosa vistonica					1																					
Anguilla anguilla	1	1?	1	1?	1	1	1?	1	1		1	1			1	1	1[c]	1		1	1	1	1	1	1	1
Aphanius fasciatus	1		1		1		1	1			1							1								
Aspius aspius	1										1				1		1									
Barbatula barbatula	(1?)[a,b,c]							(2)										1						1		
Barbus balcanicus																	1	1	1	1	1	1		1	1	
Barbus cyclolepis	1	1	1	1	1	1																				
Barbus macedonicus																		1			1			1		1
Barbus sperchiensis																										1
Barbus strumicae								1	1	1	1		1	1	1	1										
Carassius auratus												2														

(continued)

Table 2 (continued)

	Evros	Avas	Filiouri	Kompsatos	Vistonis	Kossinthos	Laspias	Nestos	Marmaras	Nevrokopi	Strymon	Ladopotamos	Mavrolakas	Asprolakas	Rihios	Volvi	Doirani	Axios	Anthemountas	Gallikos	Loudias	Vegoritis	Kastoria	Aliakmon	Mavroneri	Pinios The
Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Carassius carassius	1										2															
Carassius gibelio	1[b]		2	1?[b]	2			2			1[b]					2	2	2		2	2	2	2	2		2
Chondrostoma vardarense	1		1					1			1						1	1			1			1		1
Cobitis puncticulata	1																									
Cobitis punctilineata											1															
Cobitis stephanidisi																										1
Cobitis strumicae	1	1	1	1	1	1	1	1			1				1	1										
Cobitis vardarensis																	1	1	1	1	1			1	1	1
Coregonus cf. *albula*								(2)[a]																		
Coregonus cf. *lavaretus*																						2[a]		2[a]		
Coregonus cf. *peled*								(2)[a]																		
Ctenopharyngodon idella	2																						2	2		
Cyprinus carpio	1		1	1	1	1	1	1			1				1	1	1	1		1	1	1	1	1	2[b]	1
Esox lucius	1							(1)			1				1	1	1	1			1	1[b]	2	1		1
Eudontomyzon hellenicus											1															
Eudontomyzon sp.																								1[a]		
Gambusia holbrooki	2		2?		2	2		2			2				2	2	2	2		2	2	(2?)		2	2	
Gasterosteus gymnourus			1	1	1	1												1			1			1	1?	1
Gobio bulgaricus	1	1	1	1	1	1	1	1			1						1	1		1		1	1	1		
Gobio feraeensis																										1
Huso huso	2[b,c]																									
Hypophthalmichthys molitrix	2										2													2		
Ictalurus punctatus	(2)																									
Ictiobus sp.	(2)																									
Knipowitschia caucasica	1		1		1	1	1	1			1				1	1		1			1			1	1	

(continued)

Table 2 (continued)

	Evros	Avas	Filiouri	Kompsatos	Vistonis	Kossinthos	Laspias	Nestos	Marmaras	Nevrokopi	Strymon	Ladopotamos	Mavrolakas	Asprolakas	Rihios	Volvi	Doirani	Axios	Anthemountas	Gallikos	Loudias	Vegoritis	Kastoria	Aliakmon	Mavroneri	Pinios The
Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Knipowitschia thessala																										1
Lepomis gibbosus	2							2			2							2		2	2		2	2		
Leucaspius delineatus	1		1		1	1		1			1				1											
Misgurnus fossilis	(2?)							(2?)			(2)															
Oncorhynchus kisutch																						2				
Oncorhynchus mykiss	2							2			2							2				2		2	2	
Oxynoemacheilus bureschi					1		1	1		1	1							1								
Pachychilon macedonicum																	1	1		1	1	1?		1	1	1
Perca fluviatilis	1							2			1					1[c]	1	1			1		2	1		1
Petroleuciscus borysthenicus	1		1	1?	1	1?					1				1	1										
Petromyzon marinus					1																					
Phoxinus cf. *phoxinus*	(1)[a]		1[a]					1[a]	1[a]									1[a]			1[a]			1[a]		
Phoxinus strymonicus											1															
Proterorhinus semillunaris	1										1															
Pseudorasbora parva	2							2			2					2		2			2			2		
Pungitius platygaster																		1			1			1		
Rhodeus amarus	1	1	1	1	1	1	1	1	1		1				1	1										
Rhodeus meridionalis																	1	1		1	1	1		1	1	1
Romanogobio elimeius																		1			1			1		1
Rutilus rutilus	1		1	1	1	1		1			1				1	1	1	1			1	1	1	1		1
Sabanejewia balcanica	1		1														1[a]	1		1	1			1	1	1
Salaria fluviatilis				1	1	1			1						1	1	1	1			1			1		1
Salmo cf. *macedonicus*	1[a]							1[a]			1[a]							(1)								
Salmo farioides								2																2		
Salmo pelagonicus																		1						1		1[a,c]

(continued)

Table 2 (continued)

	Evros	Avas	Filiouri	Kompsatos	Vistonis	Kossinthos	Laspias	Nestos	Marmaras	Nevrokopi	Strymon	Ladopotamos	Mavrolakas	Asprolakas	Rihios	Volvi	Doirani	Axios	Anthemountas	Gallikos	Loudias	Vegoritis	Kastoria	Aliakmon	Mavroneri	Pinios The
Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Salmo cf. *trutta*																						2[a]				
Salvelinus fontinalis	2																					2				
Sander lucioperca	1										2															
Scardinius erythrophthalmus	1		1		1			1			1					1	1	1			1?	1	1	1		1
Silurus aristotelis																2										
Silurus glanis	1				1?			(1?)			1				1	1	1	1			1	1	1	1		1
Squalius orpheus	1	1	1	1	1	1	1	1	1		1				1[a]	1[a]										
Squalius vardarensis																	1	1	1	1	1	1[a]	1	1	1	1
Tinca tinca	1				1			1			1					1	1[c]	1			1	1[b]	2	1		1
Vimba melanops	1							1			1				1	1		1			1			1		1
Zingel balcanicus																		1								
SUM	**47**	**6**	**22**	**13**	**25**	**15**	**10**	**35**	**7**	**2**	**42**	**2**	**1**	**1**	**17**	**25**	**20**	**37**	**3**	**12**	**30**	**20**	**13**	**38**	**13**	**29**

1 = Native, confirmed presence in river basin;
1? = Presumably native, reported but unconfirmed presence;
2 = Introduced to the basin;
2? = Reported but unconfirmed introduction.
The above symbols placed in parenthesis indicate occurrence only in sections of transboundary rivers outside the Greek territory.
Notations are further given where taxonomic and native status uncertainty exists or where the population may be presumed extirpated, as follows:
[a]: Doubtful taxonomic status of population;
[b]: Doubts on native or introduced status;
[c]: Extirpated or possibly extirpated population.

Table 3
Fish faunistic lists for the hydrographic basins of Western Greece. The position of the basins is shown in Figure 1.

	Prespa	Aoos	Kalamas	Zaravina	Pamvotis	Paramythia	Kalodiki	Acheron	Ziros	Louros	Arachthos	Vouvos	Vlychos	Voulkaria	Astakos	Acheloos	Evinos	Mornos	Kerkyra	Lefkas
Number	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**
Acipenser baeri		2			2															
Acipenser gueldenstaedtii		2			2															
Acipenser naccarii		(1)[c]	1[b,c]																	
Acipenser ruthenus					2															
Acipenser sturio		(1)[c]														1?[c]				
Alburnoides bipunctatus		1						1?												
Alburnoides prespensis	1																			
Alburnus belvica	1																			
Alburnus cf. *scoranza*		1[a]																		
Alosa fallax		(1)	1							1?	1?					1				
Anguilla anguilla	1	1	1	1?	1		1	1		1	1	1	1	1		1	1	1	1	1
Aphanius fasciatus		(1)	1					1		1	1		1			1	1		1	
Barbus peloponnesius			1	1				1		1?	1					1	1	1		
Barbus prespensis	1																			
Barbus rebeli		1																		
Carassius auratus	2?[a]				2											2				
Carassius gibelio	2		2	2	2					2						2				
Chondrostoma prespensis	1																			
Chondrostoma vardarense		1																		
Clarias gariepinus											2									
Cobitis arachthosensis											1[a]									
Cobitis hellenica			1[a]		2[a]					1[a]										
Cobitis meridionalis	1																			
Cobitis ohridana		1																		

(continued)

Table 3 (continued)

	Prespa	Aoos	Kalamas	Zaravina	Pamvotis	Paramythia	Kalodiki	Acheron	Ziros	Louros	Arachthos	Vouvos	Vlychos	Voulkaria	Astakos	Acheloos	Evinos	Mornos	Kerkyra	Lefkas
Number	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**
Cobitis trichonica																1				
Coregonus cf. *lavaretus*																2[a]				
Ctenopharyngodon idella	2				2				2?							2				
Cyprinus carpio	1	(2?)	2	2	2		2			2	2			2		2				
Economidichthys pygmaeus			1		2			1		1	1		1		1	1	1	1		1
Economidichthys trichonis																1				
Esox lucius	2																			
Eudontomyzon sp. Louros										1[a]										
Gambusia holbrooki	2	(2)	2		2			2		2	2		2	2	2	2	2?		2	2
Gasterosteus gymnourus								1		1										
Gobio cf. *skadarensis*		1[a]																		
Hypophthalmichthys molitrix	2				2											2				
Hypophthalmichhtys nobilis					2															
Ictalurus punctatus											2?									
Knipowitschia goerneri																			1[c]	
Knipowitschia milleri								1												
Knipowitschia sp.			1		2					1	1?		1	1		1	1	1?		
Lampetra sp.		(1)																		
Lepomis gibbosus	2															2				
Luciobarbus albanicus			1	1	1				1[b]	1	1	1		1?		1	1	1		
Micropterus salmoides																2				
Oncorhynchus kisutch																2				
Oncorhynchus mykiss	2	2	2					2		2	2					2	2			
Oreochromis niloticus											2?					2				
Oxynoemacheilus pindus		1																		

(continued)

Table 3 (continued)

	Prespa	Aoos	Kalamas	Zaravina	Pamvotis	Paramythia	Kalodiki	Acheron	Ziros	Louros	Arachthos	Vouvos	Vlychos	Voulkaria	Astakos	Acheloos	Evinos	Mornos	Kerkyra	Lefkas
Number	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**
Pachychilon pictum		1																		
Parabramis pekinensis	2																			
Pelasgus epiroticus				1?[a]	1			1[a]		1?[a,c]										
Pelasgus prespensis	1																			
Pelasgus stymphalicus					2[a]								1	1	1	1	1	1		1[a]
Pelasgus thesproticus			1			1		1		1	1								1	
Perca fluviatilis																2				
Petromyzon marinus										1										
Poecilia sp.		(2?)																		
Polyodon spathula					2?															
Pseudorasbora parva	2										2					2				
Rhodeus amarus	1[a]															2[a]				
Rutilus ohridanus		(1)[a]																		
Rutilus panosi					2					1?[a,c]						1				
Rutilus prespensis	1																			
Salaria economidisi																1				
Salaria fluviatilis			1					1								1	1	1	1	
Salmo dentex		1[a]																		
Salmo farioides		1	1	1[c]							1					1	1	1		
Salmo letnica	2																			
Salmo peristericus	1																			
Salmo sp. Louros										1[a]										
Salvelinus fontinalis																2				
Scardinius acarnanicus									2[a,b]							1				
Silurus aristotelis					2											1				

(continued)

Table 3 (continued)

	Prespa	Aoos	Kalamas	Zaravina	Pamvotis	Paramythia	Kalodiki	Acheron	Ziros	Louros	Arachthos	Vouvos	Vlychos	Voulkaria	Astakos	Acheloos	Evinos	Mornos	Kerkyra	Lefkas
Number	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**
Silurus glanis	2				2											2				
Squalius cf. *peloponnensis*			1[a]					1[a]	1?[a,b]	1[a]	1[a]	1[a]		1[a]					1[a]	
Squalius pamvoticus					1															
Squalius prespensis	1																			
Squalius sp. Aoos		1																		
Squalius sp. Evinos																1[a]	1[a]	1[a]		
Telestes pleurobipunctatus			1	1				1	1[b]	1	1		1			1	1		1	
Tinca tinca	2		2	2	2									2		2			2	
Tropidophoxinellus hellenicus																1				
Valencia letourneuxi			1					1		1	1		1		1	1		1	1[c]	1[c]
SUM	**25**	**24**	**20**	**9**	**23**	**1**	**2**	**15**	**5**	**22**	**20**	**3**	**8**	**8**	**4**	**39**	**13**	**10**	**10**	**5**

Notes as in Table 2

Table 4
Fish faunistic lists for the hydrographic basins of the Peloponnese. The position of the basins is shown in Figure 1.

	Assopos Pel	Dervenios	Krios	Krathis	Vouraikos	Keronitis	Selinous	Meganitis	Phoenix	Volinaios	Glafkos	Piros	Tsivlos	Prokopos	Kotychi	Pinios Pel	Alfios	Neda	Yiannousagas	Peristeras	SW Messinia	Pamissos	Kandila	Feneos	Stymphalia	Taka	Evrotas	Vassilopotamos	Smynous	Adreli	Lerni	Kato Almyri	Erassinos Arg
Number	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**
Acipenser sturio																	1?[c]																
Anguilla anguilla			1?	1	1		1	1				1		1	1	1	1	1	1	1	1	1					1	1	1	1	1?	1	1
Aphanius almiriensis																																1	
Aphanius fasciatus														1	1				1														
Barbus peloponnesius			1?		1	1	1	1	1?	1	1	1			1	1	1	1	1	1	1	1											
Carassius gibelio																	2					2?											
Ctenopharyngodon idella																2	2						2										
Cyprinus carpio													2			2	2					2?		2	2	2							
Gambusia holbrooki													2	2	2	2	2					2	2			2	2	2			2		2
Gasterosteus gymnourus																						1									1		
Hypophthalmichthys molitrix																	2						2										
Knipowitschia sp.														1		1	1																
Leponis gibbosus																	2?																
Luciobarbus albanicus																1						2?											
Oncorhynchus kisutch																	2																
Oncorhynchus mykiss		2		2									2				2						2				2						
Pelasgus laconicus																	1										1	1	1[a]	1[a]			
Pelasgus stymphalicus													2	1	1	1	1			1	1	1	1	1	1	1					1[a]		1[a]
Perca fluviatilis																	2?																
Petromyzon marinus																	1?																
Salaria fluviatilis			1?	1	1		1?					1				1	1	1		1		1					1	1			1		
Salmo farioides																	1																
Salmo cf. *trutta*																	2																
Silurus glanis																	2																
Squalius cf. *peloponnensis*	1[c]			1	1		1					1	1[b]		1	1	1	1[c]	1[a]	1[a]	1[a]	1			2[a]								

(continued)

Table 4 (continued)

	Assopos Pel	Dervenios	Krios	Krathis	Vouraikos	Keronitis	Selinous	Meganitis	Phoenix	Volinaios	Glafkos	Piros	Tsivlos	Prokopos	Kotychi	Pinios Pel	Alfios	Neda	Yiannousagas	Peristeras	SW Messinia	Pamissos	Kandila	Feneos	Stymphalia	Taka	Evrotas	Vassilopotamos	Smynous	Adreli	Lerni	Kato Almyri	Erassinos Arg
Number	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**
Squalius keadicus																											1	1					
Squalius moreoticus																									1[c]								
Telestes pleurobipunctatus															1	1	1																
Tinca tinca																						2?											
Tropidophoxinellus hellenicus																1																	
Tropidophoxinellus spartiaticus																		1	1	1	1	1					1	1					
Valencia letourneuxi																1	1[c]																
SUM	**1**	**1**	**3**	**4**	**4**	**1**	**4**	**2**	**1**	**1**	**1**	**4**	**5**	**5**	**7**	**13**	**22**	**5**	**5**	**6**	**5**	**12**	**5**	**2**	**4**	**3**	**7**	**6**	**2**	**2**	**5**	**2**	**3**

Notes as in Table 2

Table 5
Fish faunistic lists for the hydrographic basins of Central-Eastern Greece.
The position of the basins is shown in Figure 1.

	Vouliagmeni	Erassinos Vra	Rafina	Kato Souli	Marathon	Kifissos Att	Assopos Beo	Kifissos Beo	Yliki	Thermopyles	Sperchios	Cholorema	Kireas	Manikiotiko	Dystos	Rigia
Number	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**
Alburnoides bipunctatus											1[a]					
Anguilla anguilla	1	1	1	1		1	1	1	1		1		1	1		1
Aphanius fasciatus											1					
Barbus euboicus														1		
Barbus sperchiensis											1	1	1			
Carassius gibelio								2	2							
Ctenopharyngodon idella								2?	2							
Cyprinus carpio					2			2	2						2	
Gambusia holbrooki		2		2	2	2		2			2				2	2
Gasterosteus gymnourus											1					
Hypophthalmichthys molitrix									2							
Hypophthalmichthys nobilis									2							
Knipowitschia caucasica											1					1
Luciobarbus graecus								1	1		1					
Oncorhynchus kisutch											2					
Oncorhynchus mykiss								2			2[a]					
Oreochromis niloticus										2						
Pelasgus marathonicus		1[c]		1	1	1	1[c]	1	1		1	1				
Poecilia cf. *latipinna*	2[a]															
Pungitius hellenicus											1					
Rutilus sp. Sperchios											1					
Rutilus ylikiensis								1	1							
Salaria fluviatilis											1					
Salmo salar											2?					
Scardinius erythrophthalmus												1[a]				
Scardinius graecus								1	1							
Silurus glanis											1?[b]					
Squalius sp.1							1[c]									
Squalius sp. Evia													1[a]	1		
Squalius vardarensis											1[a]	1[a]				
Telestes beoticus							1[c]	1	1							
SUM	**2**	**3**	**1**	**3**	**3**	**3**	**4**	**11**	**11**	**1**	**17**	**4**	**3**	**3**	**2**	**3**

Notes as in Table 2

The distributional compilation indicates the presence of 162 species (including doubtful occurrences) in 105 basin areas. Of these species, 155 have been recorded from hydrographic basins within the Greek territory. Five of the species present in the North Aegean region, all introduced, do not occur in Greece and are known only

Table 6
Fish faunistic lists for the hydrographic basins of the Aegean Islands.
The position of the basins is shown in Figure 1.

	Samothraki	Lesvos	Samos	Rhodos	Almyros	Koutsoulidis	Kourtaliotis	Kouna	Agia	Tavronitis
Number	**96**	**97**	**98**	**99**	**100**	**101**	**102**	**103**	**104**	**105**
Alosa fallax										1
Anguilla anguilla	1	1	1	1	1			1	1	1?
Aphanius fasciatus		1	1							
Barbus pergamonensis		1								
Carassius auratus								2?[a]		
Carassius gibelio								2		
Ctenopharyngodon idella				2		2				
Cyprinus carpio		2?		2						
Gambusia holbrooki		2	2	2	2?	2		2	2	2
Hypophthalmichthys molitrix				2		2				
Knipowitschia caucasica	1	1	1							
Ladigesocypris ghigii				1						
Oncorhynchus kisutch					2					
Oncorhynchus mykiss					2	2	2	2		
Oxynoemacheilus theophilii		1								
Petroleuciscus smyrnaeus		1								
Salaria fluviatilis		1		1				1		
Salmo salar							2			
Squalius cf. *cii*		1								
Squalius sp.2			1							
SUM	**2**	**10**	**5**	**7**	**4**	**4**	**2**	**6**	**2**	**3**

Notes as in Table 2

from Bulgarian sections of the rivers Evros, Strymon and Nestos (*Coregonus albula, C. peled, Ictalurus punctatus, Misgurnus fossilis, Ictiobus* sp.). Some characteristics of the fish assemblages in the designated biogeographic regions are summarised in Table 7a. The North Aegean region has the highest (85 species) and the East Peloponnese region has the lowest (6 species) species richness. The total number of native species with confirmed occurrence in the examined basins is 130. 25 species were invariably assigned as introduced in all areas of their occurrence; these are referred to as aliens to the country (another two species were reported but their presence requires confirmation). Ten of these aliens have been established through natural reproduction; the presence of the remaining 14 species in the wild depends on stocking and aquaculture escapes. Finally, 19 species have native populations in Greece but are introduced in one or more hydrographic basins outside their native range. These species are referred to as translocated, though there are instances

Table 7a
Summary data of the ichthyofauna of Greece.
Fish occurrences in the hydrographic basin areas included in the distributional compilation.

Attributes	Designated regions						All regions
	North Aegean[1]	South Adriatic[2]	Ionian[3]	East Peloponnese[4]	Attiko-Beotia[5]	Aegean Islands	
Number of basins areas	26	2	48	3	16	10	105
Number of fish taxa (species)	85	45	65	6	31	20	162
Species within Greek territory (confirmed occurrences)	80	37	61	6	29	19	155
Species recorded only in neighbouring countries (confirmed occurrences)	5	6	-	-	-	-	7
Native species (confirmed occurrences)*	65	29	37	5	19	11	130
Introduced species (confirmed occurrences)**	20	14	24	1	10	8	25
Regional endemics (confined to the biogeographic region)	29	18	28	1	9	1	86
Proportion of regional endemics to the native fish fauna of the region (in %)	44.6	62.1	75.7	20.0	47.4	9.1	66.1
Average basin area species richness (confirmed occurrences)	18.0	23.0	6.9	3.0	4.4	4.2	9.1
Average basin area native species richness (confirmed occurrences)	14.0	15.0	4.8	2.3	3.1	2.3	6.9

* Species recorded as native in at least one basin area of the biogeographic region.
** Species always recorded as introduced in the region.

[1]: Northern Greece, from Evros R. to Pinios Thessaly R.; Table 2.
[2]: Prespa L. and Aoos R.; Table 3.
[3]: Western Greece, from Kalamas R. to Evrotas R.; Tables 3 (mainland western Greece and Epirus) and Table 4 (Peloponnese).
[4]: The eastern coasts of Peloponnese (Kato Almyri Spring, Erassinos R., Lerni Spring); Table 4.
[5]: Central Eastern Greece, from Cholorema R. to Vouliagmeni L. including Euboea Island; Table 5.

Table 7b: Summary data of the ichthyofauna of Greece.
Fish contained in the checklist of freshwater fish species (Appendix I)
and the supplementary list of transitional water species (Appendix II).

Attributes	Number
Total number of fish species confirmed in freshwaters (Appendix I)	161
Typical freshwater species (do not readily enter seawater conditions) (Appendix I)	138
Brackish water or marine species that spend part of their lives in freshwater conditions (Appendix I)	23
Number of Greek endemics (species confined exclusively to Greece) (Appendix I)	47
Number of Balkan endemics (species with a distribution restricted south of the Danube R.) (Appendix I)	28
Number of "near endemic" species (species found along the frontiers of Greece) (Appendix I)	14
Total number of fish species recorded in transitional waters but not confirmed as residents of freshwaters (Appendix II)	55
Total number of fish species recorded in fresh and transitional waters (Appendices I+II)	216

where the introduced specimens were imported from abroad, rather than being translocated from another Greek basin.

Taking into account the distributional ranges of the native species, 86 species are recorded as regional endemics (their distribution is confined to only one biogeographical region). Some endemics are known from single or very few basin areas. This category of range-restricted endemics includes species of high conservation priority, such as *Aphanius almiriensis, Alosa vistonica, Barbus euboicus, Cobitis stephanidisi, Eudontomyzon hellenicus, Pungitius hellenicus* and *Squalius keadicus.* A number of species have a distribution confined to the frontiers of Greece with neighbouring countries (Lake Doiraini: one species; Lake Prespa: nine species). All regional endemics of the East Peloponnese, Attiko-Beotia and Aegean Islands are entirely within Greek territory. The Ionian region has the highest endemicity level (75.7%) and the Aegean Islands the lowest (9.1%).

Table 7b summarises the fish data appearing in Appendices I and II. The total number of fish species recorded in the fresh and transitional waters of Greece is 216. The checklist of freshwater fish species (Appendix I) contains 161 species that live in freshwaters, arranged in 28 families. Of these, the family Cyprinidae strongly dominates with 80 species that comprise 49% of the total number of species. Another five families (Acipenseridae, Cobitidae, Salmonidae, Mugilidae, and Gobidae) are represented by 5 or more species. Twelve families are represented by single species. Judging from spatial occurrence information, 139 taxa are provisionally classified as typically freshwater species (recorded primarily from freshwaters) and 23 are classified as euryhaline species with a confirmed presence in freshwaters. The supplementary list (Appendix II) contains 55 species with a recorded presence in transitional waters, arranged in 22 families.

Table 8 shows the ten native and the ten introduced species with the highest frequency of occurrence in the examined basins. Of the native species, *Anguilla anguilla* is the most widespread, reported from 74 basins, followed by *Salaria fluviatilis,* which is known from 32 basins. First in the list of introduced species are *Gambusia holbrooki,* with confirmed occurrence in 52 basins and *Oncorhynchus mykiss,* with occurrence in 27 basin areas. The latter species has not yet been reported as reproducing in Greece and its occurrence depends on stocking programmes and aquaculture escapes. Two alien species, *Pseudorasbora parva* and *Lepomis gibbosus,* are highly invasive and their distributional range is expanding.

A comparison of fish assemblage composition among the six defined biogeographical regions reveals that only 15 native species, of the 130 native species recorded, have joint presence in two or more regions (see Table 9). Seven of these species (*Aphanius fasciatus, Knipowitschia caucasica, Salaria fluviatilis, Anguilla anguilla, Alosa falax, Gasterosteus gymnurus* and *Petromyzon marinus*) are secondary freshwater or peripheral fish with presumed ability to utilise the marine route for their dispersal. One species, *Cyprinus carpio,* with paired presence in the Adriatic region (Lake Prespa) and the North East Aegean regions has been ommitted because its native status in Lake Prespa is not certain. The high degree of faunistic dissimilarity among regions can only partly be attributed to the fine-level taxonomy adopted in this study. The most probable reason of the dissimilarity is the presence

Table 8
The most widespread native and introduced fish species in Greek freshwaters (ranked from 1-10). Introduced species highlighted in grey are recorded as translocated and may occur as native in some hydrographic basins.

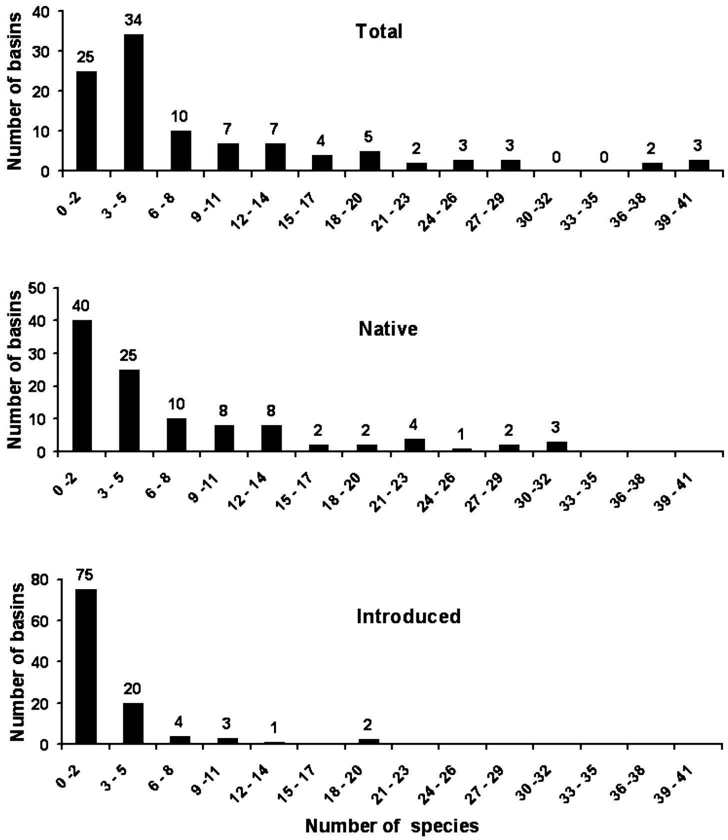
Top 10 Native species			Top 10 Introduced species		
Species	**Catchments**	**%**	**Species**	**Catchments**	**%**
Anguilla anguilla	74	70.5	*Gambusia holbrooki*	52	49.5
Salaria fluviatilis	32	30.5	*Oncorhynchus mykiss*	27	25.7
Squalius cf. *peloponnensis*	21	20.0	*Carassius gibelio*	20	19.1
Barbus peloponnesius	21	20.0	*Cyprinus carpio*	18	17.1
Aphanius fasciatus	21	20.0	*Ctenopharyngodon idella*	11	11.4
Pelasgus stymphalicus	20	19.1	*Hypophthalmichthys molitrix*	10	10.5
Cyprinus carpio	19	18.1	*Lepomis gibbosus*	10	10.5
Knipowitschia caucasica	18	17.1	*Pseudorasbora parva*	10	10.5
Rutilus rutilus	16	15.2	*Tinca tinca*	7	6.7
Gobio bulgaricus	15	14.3	*Oncorhynchus kisutch*	5	4.8

of geographic barriers preventing faunal exchanges among regions.

Fish species richness and endemism

Hydrographic basin area species richness (number of fish species per area) is generally low in Greece. The number of native freshwater fish species per area varied from 0 to 32 (Evros) and that of introduced species varied from 0 to 18 (Pamvotis and Acheloos). Only 53 hydrographic basins, mostly small, had no record of introduced species. The areas with the highest total basin richness (number of native and introduced species) are Evros (41), Strymon (40), Acheloos (38) and Aliakmon (38). Figure 2 shows the distribution of richness in the basin areas examined, where richness was calculated separately for native, introduced and all species. More than half of the examined basin areas (59) host up to five species, with only five basin areas hosting more than 35 species. If only the native species are considered, the number of basin areas hosting up to five species rises to 65. Only ten basin areas host more than 20 native species. Basin area species richness is determined by a multiplicity of factors representing local and regional scales. Local influences on species richness include factors determining habitat diversity and environmental stability, such as basin surface area, discharge level and variability, mean elevation and slope, presence of lakes or floodplains in the basin, etc. Here we restrict ourselves to the examination of the relationship between basin native species richness and basin surface area (see Fig. 3). Despite the high scatter of points, the data show a clear increase of richness with basin area. The small size of most basins explains, at least partly, the low average richness in Greek waterbodies.

On the regional scale, basin area species richness reflects the pool of species that occur in a biogeographic region, as determined by a combination of historical factors and contemporary environmental influences. Other conditions being equal (e.g. when basins of similar size are compared), basin species richness is associated with regional species richness (defined as the number of fish species known to occur within a



biogeographic region). Inspection of the data shows that the basins in the North Aegean contain on average more species than basins of similar size in the other regions. This is largely a reflection of the richer ichthyofauna in the North Aegean region in comparison to other regions (see Fig. 4). The regional species richness is particularly low in the Aegean islands, which are comprised of very small insular basins. Low annual precipitation and the frequent occurrence of prolonged droughts may have contributed to species extinctions and the depauperation of the local fish communities.

Figure 5 shows the spatial distribution of fish endemicity. Within Greece endemicity is very high (47 species found exclusively in Greece; or 35% of its native fish fauna). In some basin areas (e.g. Acheloos, Evrotas, Beotian Kifissos), the proportion of endemic fish exceeds 75% of the total number of native fish. The general trend is towards an increase of the proportion of endemics westwards and southwards. This trend is opposite to that

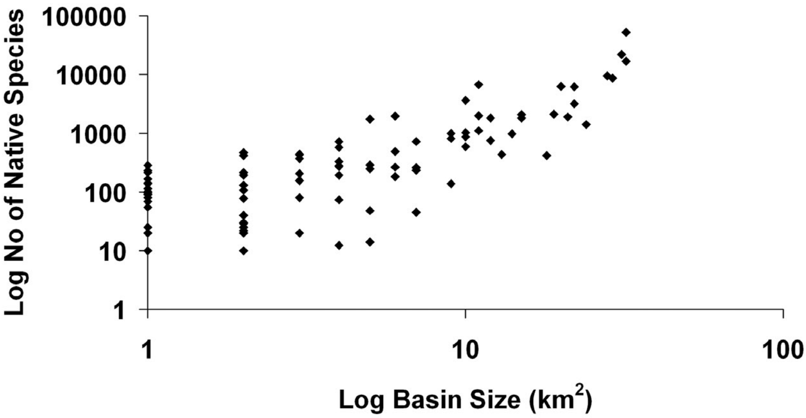


Fig. 3: Relationship between hydrographic basin surface area (km^2) and native species richness.

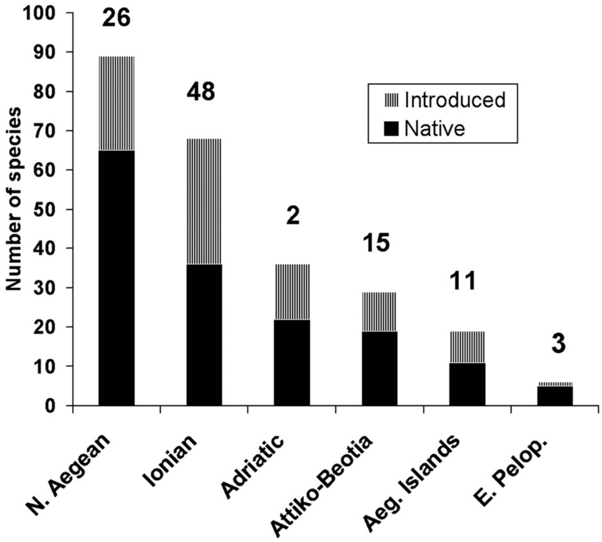


Fig. 4: Regional species richness (native, introduced and total fish species) for the six designated biogeographical regions. Figures above columns indicate number of basin areas.

of species richness, which increases eastwards and northwards. Another 14 species (10.3%) are considered 'near-endemic' since they inhabit isolated waters on the borders of Greece (Prespa and Doirani) or their range extends slightly beyond the Greek territory (specifically in the Butrint basin in Albania). Finally 28 species (20.6%) have a wider distribution in the Balkan Peninsula south of the Danube, considered here as Balkan endemics.

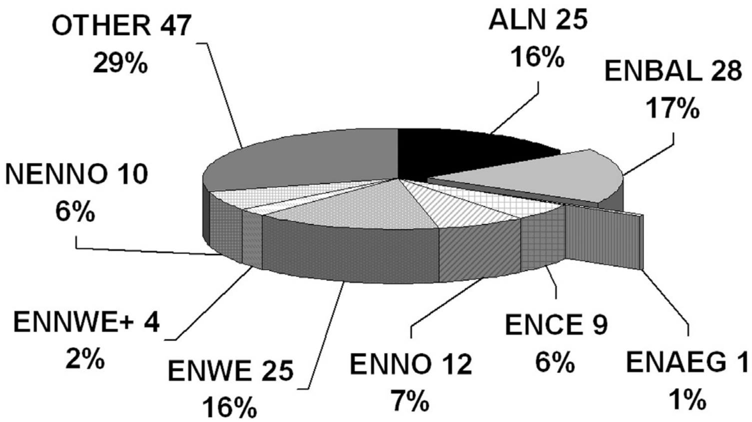


Fig. 5: Endemicity of the fish fauna relative to the territorial boundaries of Greece. Endemics confined to Greece include 47 species (ENWE, ENNO, ENCE, ENAEG). 'Near-endemics' include 14 species (NENNO, ENWE+). 28 species are restricted to the Balkans (ENBAL). See Appendix I - Legend for codes descriptions.

Discussion

Sources of bias in compiling the basin area species lists and checklists – data availability, knowledge gaps and unmet needs

The freshwater fish of Greece have been studied for more than 150 years. Historical ichthyological information and early records of commercial catches (e.g. VALENCIENNES, 1844; HELDREICH, 1878; APOSTOLIDIS, 1883, 1892; ATHANASSOPOULOS, 1917, 1923, 1925; KOLLER, 1927) provide a sound basis for ascertaining the native distribution of many species. However, the distribution of some species is still insufficiently known and their native or introduced status in some waterbodies is uncertain.

Despite the relatively large number of publications dealing with freshwater fish (ECONOMOU *et al.,* 2004a), few only provide complete fish faunistic lists in individual drainages (e.g. KATTOULAS, 1972; ECONOMIDIS *et al.,* 1981; ECONOMIDIS & SINIS, 1982; KOKKINAKIS *et al.,* 1999; TIGILIS, 2000; KOUTRAKIS *et al.,* 2000; DAOULAS *et al.,* 2001; ECONOMOU *et al.,* 2001b, 2004b; TACHOS, 2003; KOKKINAKIS, 2006; STOUMBOUDI *et al.,* 2006; LEONARDOS *et al.,* 2007) or describe the distributional ranges of species and species groups (e.g. ECONOMIDIS, 1989; ECONOMOU, 2000; ECONOMIDIS *et al.,* 2000b; BOBORI *et al.,* 2001; DAOULAS, 2003; KALOGIANNI *et al.,* 2006). An even smaller number of publications take a synthetic approach to fish distribution treating all species and/or compiling basin-specific species lists over wide geographical areas (STEPHANIDIS, 1939, 1950, 1971; ECONOMIDIS, 1974; DAGET & ECONOMIDIS, 1975; ECONOMOU *et al.,* 1999, 2001a; ECONOMIDIS *et al.,* 2001; BARBIERI *et al.,* 2002). Two of the aforementioned works, namely the thesis dissertations of STEPHANIDIS (1939) and ECONO-

MIDIS (1974), deserve special mention for comprehensive taxonomic work and detailed accounts of species occurrences in a large number of freshwater bodies. A catalogue of the fish of Greece produced by ECONOMIDIS (1973) forms a landmark in the ichthyological research of Greece for reporting all freshwater fish occurrences known at that time. A popularized check-list was later published by the same author (ECONOMIDIS, 1991).

It is inevitable that some of our basin area's fish compilations may have errors of omission. It is remarkable that with few exceptions many smaller isolated aquatic sites, especially along Greece's Aegean coastline and its islands, have never been properly surveyed for fish. For example, our compilation provides data for only eight islands although wetland habitats exist on a very large number of Greek islands. In a recent inventory of wetland sites (CATSADORAKIS & PARAGAMIAN, 2007), fish presence was recorded in 72 of 352 small wetlands in the Aegean islands; unfortunately, however, these fish were rarely identified to species level. A stark example of the extent of the unexplored areas is given by the extent of wetland exploration on the large island of Euboea (3.685 Km^2), which hosts a unique freshwater fish fauna that includes two local endemics. CATSADORAKIS & PARAGAMIAN (2007) provide descriptions of 39 wetlands on Euboea and they note that this number is far from a complete inventory; we compiled ichthyofaunal data of only four Euboean wetlands, two of which are not listed in the aforementioned inventory. The number of wetlands on Euboea is certainly very large, and sadly we have only the slightest knowledge of freshwater fish distributions on this island.

Another problem with our dataset – that again addresses unmet data needs – is the unresolved issue of each basin area's fish assemblage completeness. The data provided here sometimes refer to very large basin areas, thus much local information has been amalgamated, and important site-specific data is not presented (i.e. fish assemblages along a particular river segment). We are almost certain that some species, especially introduced ones, are missing from even the larger river basin area accounts in our dataset. Also, some smaller river basins, such as the Acheron, Kalamas, Kireas, and Lerna, do not yet have complete species lists. This is either because sampling efforts have been few or the sampling conditions are especially difficult due to deep-water, non-wadeable reaches which have never been surveyed with appropriate tools (i.e. boat-based electrofishing, multi-mesh gill-nets etc). Lastly, there has been no recent sampling in some basin areas. For example, the most reliable account of the Mornos R. fish dates back to 1972 (KATTOULAS, 1972) and is based on data obtained with old-fashioned sampling techniques that may have been ineffective for small-bodied species likely to occur in the lower parts of the river. In addition, this investigation took place before the huge wave of alien species' introductions that occurred from the 1970's through the 1990's. Thus, the apparent absence of introduced species in this system may reflect lack of recent faunistic information.

Apart from these distributional ambiguities, there are also problems with occurrence records of some species appearing in old publications but are not verified by recent surveys. For example, we decided to note our doubt for the occurrence of *Alburnoides bipunctatus* in the Acheron R., despite the fact that its presence in this river has been mentioned by STEPHANIDIS (1939) on the basis of a single specimen collection. This species has not been found in the Acheron R. since then and, more importantly, it is absent from all other river basins of the Ionian region, which substantiates our doubt. However, the Acheron R. is far too deep to be sampled efficiently with conventional sampling techniques, so the presence of *A. bipunctatus* in this river cannot be excluded with certainty. On similar grounds, we decided to express doubt for the occurrence of *Barbus peloponnesius* in the Louros R., mentioned in older surveys, because this species is persistently absent in the collections of extensive recent surveys.

In addition, the bibliography is rife with ambiguities concerning site-specific information that would be of use to practical management and conservation applications (ECONOMOU *et al.,* 2006). Difficulties in 'deciphering' locality information from the bibliography are widespread and they may also be a major reason for potential errors. There is even difficulty with interpreting the basin-specific location of data for many species. For example, ECONOMIDIS (1991) mention the existence of *Pseudophoxinus* (now *Pelasgus*) *stymphalicus* on the island of Euboea without giving specific locality information. Other survey compilations have also encountered difficulty with unconfirmed or erroneous identifications of fish (MAURAKIS *et al.,* 2003). Unfortunately it is very difficult to verify distributional information, and errors can easily creep into a dataset if the inventoried data are not confirmed with recent field observations. This shows that more field work is needed to confirm and monitor the presence of species in many river basins or sites.

Moreover, there are unresolved taxonomic issues with respect to the identity of some populations. Due to the difficulties in resolving taxonomy rapidly, many past records of occurrence are difficult to substantiate. For example, the species *Pseudophoxinus stymphalicus* has recently been split to five species under the new genus name *Pelasgus* (see KOTTELAT & FREYHOFF, 2007b). All previous published records referring to the nominate species *P. stymphalicus* are difficult to be included in a geographical compilation because the distributional limits of the newly described taxa are not yet completely defined. Are the specimens from the eastern coast of the Peloponnese *P. stymphalicus, P. laconicus* or *P. marathonicus*? Also, what is the translocated *Pelasgus* species in Lake Pamvotis? Challenging problems with the systematics and the distribution of many species remain to be resolved, such as confirming the taxonomic validity of some unnamed and undescribed taxa within the genera *Squalius* and *Alburnus* for which morphological characters alone do not allow reliable identification. Molecular studies have greatly contributed to unraveling the genetic and the underlying phylogenetic relationships of some species. Ongoing genetic work and other biological investigations within the next few years should focus on sorting relationships in taxa with disjunct or fragmented distributions.

Finally, there is a lack of published site-based ichthyofaunal surveys on transitional waters. This is a serious problem because a large number of species use estuarine areas, rivermouths, lagoons and brackish waters in deltas as rearing areas or seasonally as transient habitats. Our bibliographic search showed that many species have been recorded in transitional waters but many surprising records of marine species need verification (including marine stragglers such as *Epinephelus aeneus, Scorpaena scrofa* and *Gaidropsarus mediterraneaus*). We must reiterate the provisional and tentative nature of our supplementary list of species recorded in brackish waters since 36 (56%) of the species that we present had been submitted by a single published bibliographic reference. On the other hand, our list contains several species which possibly enter freshwaters regularly. In fact, some species in this list were located in the lists of 'freshwater' species by ECONOMIDIS (1991) and BOBORI & ECONOMIDIS (2006). Pending accurate detailed information on these and other species' residence in freshwaters we retain them only within this provisional supplementary list.

The current ichthyological picture of Greece

The last published annotated checklist of the freshwater fish of Greece contained 105 species, including introduced, diadromous and euryhaline species with a regular presence in freshwaters, and also five species of doubtful occurrence (ECONOMIDIS, 1991). Since then the list of species has expanded considerably as several species have been recently described (e.g. KOTTELAT, 2004; KOTTELAT & BARBIERI, 2004; ECONOMIDIS, 2005; KOTTELAT & ECONOMIDIS, 2006; BOGUTSKAYA & ILIADOU, 2006; STOUMBOUDI *et al.,* 2006; KOTTELAT, 2007; KOTTELAT *et al.,* 2007). Some more taxa were named and designated as species by KOTTELAT & FREYHOFF (2007a) mostly on the basis of morphological data. Molecular data have contributed to some taxonomic clarification, especially when morphological differences of diagnostic importance could not be established. For instance, KOTTELAT & FREYHOFF (2007) utilized evidence of genetic distinctiveness provided by BOHLEN *et al.* (2006) to establish *Rhodeus meridionalis* that otherwise would not be easily recognized as a distinct species on the basis of classical features such as morphology. Another cause of this increase of species number has been the introduction of several alien species to many waterbodies for aquaculture and fishery enhancement (e.g. CRIVELLI *et al.,* 1997; ECONOMIDIS *et al.,* 2000a; LEONARDOS *et al.,* 2007).

The present checklist of the freshwater fish of Greece (Appendix I) compiles the fish data in a standardized way comparable to ECONOMIDIS (1991), i.e. it includes introduced, diadromous and some euryhaline species. In total, the checklist contains 161 species, of which 14 are of unclarified taxonomic status and are given provisional or generic names. The great increase in species numbers (56 species, 53%) since 1991 has resulted mainly from taxonomic re-evaluations of existing taxa, rather than from the genuine discovery of new species. In fact, most of the new species contained in the checklist were known as biological entities in 1991 but were recognized as subspecies or were lumped with their closely related species.

The apparent tendency towards species splitting is in accordance with the currently prevailing trend towards adoption of the Phylogenetic Species Concept (PSC) over the older Biological Species Concept (BSC). KOTTELAT (1997) has strongly advocated the use of the PSC (considered as equivalent to the Evolutionary Species Concept) for species recognition and employed this concept in a first revision of the systematics and nomenclature of the European freshwater fish. This revision resulted in a great increase in the number of species in Europe with well over a hundred more species than previously recognised. Recently KOTTELAT & FREYHOFF (2007a) produced a handbook that further revises the systematics of European freshwater fish. This second revision has radically changed the ichthyofaunal list of Greece by introducing new names for species and genera and raising many populations and subspecies to species rank. In fact, 29 species from Greek freshwaters (18%) are 'new' since the ECONOMIDIS (1991) checklist was published. With the demise of the subspecies unit, many subspecific taxa have been lost while others have been awarded species status. Overall, only 41% (67 species) of the species names given in the present list are identical to those used by ECONOMIDIS (1991).

Judging from trends in recent taxonomic publications, the new species concept is accepted by several taxonomists working with Greek freshwater fish and is likely to become the dominant concept guiding fish systematics in the future (MILLER, 1998). The changes of species names and the emergence of new species may create problems to users of the fish data who do not have a background in systematics. We have attempted to resolve some of the anticipated problems by quoting in the checklist of freshwater species (in Appendix I) the previous species names and indicating new additions. Given that both the checklist and the distributional compilation are based on the taxonomy proposed by KOTTELAT & FREYHOFF (2007a), we consider it important to clarify the meaning of species under the two species concepts and to explore what impact the acceptance of the PSC might have on the users of fish data. We shall begin with the definition of species and the criteria used to delineate species boundaries under the two species concepts, namely the BSC and the PSC. We shall also discuss the strengths and weaknesses of the two concepts and the potential implications of the change in species concept on the uses (and users) of fish data. Next, we shall provide an overview of the distributional status of the freshwater fish of Greece, particularly with respect to regional patterns of richness and endemism. Last, we shall examine some policy-relevant implications of the fish dataset presented in this paper and we shall explore areas of research and management priority.

Species concepts - distinctiveness criteria and utility relative to the needs of users

How to define 'species' is one of the most fundamental and controversial issues in biology (KULLANDER, 1999; BARTON, 2001; MAYDEN, 2002; REYDON, 2005). More than 20 species concepts have been put forward (MAYDEN, 2002) and considerable debate still exists about their theoretical basis, applicability, and consequences for studies of ecology and biodiversity (MAYR, 1996; HENDRY *et al.,* 2002; ISAAC *et al.,* 2005; AGAPOW & SLUYS, 2005). We confine ourselves to a brief presentation of the two prevailing species concepts, the BSC and the PSC, focusing on topics of relevance to biodiversity conservation and watershed management from a fish-based perspective. More detailed presentations and arguments in favour or against their conceptual and methodological basis can be found in the aforementioned publications and also in KOTTELAT (1997), TURNER (1999), CRANDALL *et al.* (2000), RUFFING *et al.* (2002) and AGAPOW *et al.* (2004).

Both the BSC and the PSC seek to partition the natural variability observed in biological communities into distinguishable components (species) but differ over the partitioning criteria and the characters used to delineate species boundaries. The BSC emphasizes reproductive compatibility among individuals within and among populations and defines a species as 'a group of interbreeding natural populations which is reproductively isolated from other such groups' (MAYR, 1940). This definition is straightforward and provides one definitive criterion for assessing distinctness of species – inability to interbreed. Different species maintain their genetic integrity because gene flow between species is prevented by reproductive isolation. One of the major criticisms of this concept is that interbreeding capacity can only be assessed in sympatry (MAYDEN & WOOD, 1995). In organisms with disjunct distributions the interbreeding criterion becomes non-operational, since there is no practical way to test whether individuals belonging to allopatric populations would be able to mate and produce viable and fertile offspring. Due to the inability of assessing reproductive isolation in allopatric taxa, the distinctiveness of species is usually inferred indirectly, e.g. from observation of morphology and distribution. Traditionally, species have been defined by morphological traits under the assumption that morphological variation reflects genetic variation which, when sufficiently high, may cause reproductive isolation. The conceptual problem inherent in this assumption is that morphological changes produced by variation and selection do not necessary correlate with the genetic changes that produce reproductive incompatibility. Eventually, genetically distinct taxa may look very similar and, contrarily, large morphological differences may exist between very closely-related taxa. The BSC has also been criticised for its difficulty in dealing with introgressive hybridization and its inability to cope with asexual reproduction (TURNER, 1999).

The PSC emphasises membership in a unique genealogical (phylogenetic) lineage and defines a species as 'the smallest diagnosable cluster of individual organisms within which there is a parental pattern of ancestry and descent' (CRACRAFT, 1983). Under this concept, criteria for species distinctiveness are monophyly (all members of a group are descended from a single common ancestor) and autapomorphy (presence of genetically-based characteristics shared by all members of the group and not found in other groups). Subspecies do not exist according to the PSC. In comparison to the BSC, the criteria employed to delineate species are more functional and testable – for example, the problematic notion of having to demonstrate reproductive isolation is avoided, while the existence of phenetic dissimilarity is not a prerequisite for considering genetically distinct taxa as separate species. Major advantages of the PSC are its potential to handle asexual organisms and to delineate and classify allopatric taxa. Main grounds for criticism are the difficulty in demonstrating monophyly, the tendency of PSC applications to produce excessive 'splitting' of species, the recognition of species irrespective of the degree of phenotypic or genetic divergence between evolutionary lines, and the absence of standardised approaches for selecting traits and/or determining levels of trait discreteness needed for diagnosing species-level differences. In fact, two groups would qualify for the status of separate species simply on the basis of differences in any single character, morphological or genetic, provided that all individuals within a group share one evolutionary lineage. Questions may therefore arise as to which traits are appropriate for establishing species, whether species can be delimited on the basis of genetic differences alone, and how much difference in the selected trait(s) is enough for distinguishing species.

Another problem associated with the PSC is how to deal with genetic introgression, given the tendency of freshwater fish to hybridise even at the generic level (SMITH, 1993). For instance, how will a taxon formerly characterised as a distinct species be defined and named if extensive introgressive hybridisation has occurred due to repeated stockings? In a strict application of the PSC, hybrid populations cannot be classified as belonging to any species because they are polyphyletic at the species level. In practical applications of the PSC, it is left to the taxonomists to evaluate evidence for the monophyly of lineages and to decide whether or not the phyletic integrity of the taxon has been disrupted by stocking beyond acceptable limits. A last issue of concern relates to phenotypic plasticity. Many fish display remarkable morphological variation, and it is rarely clear what portion of this variation is based on inheritable genetic variation and what portion reflects local environmental features. Although plasticity may posses adaptive value and be under some genetic control (BAMBER & HENDERSON, 1988; JENNINGS & BEVERTON, 1991; SWAIN *et al.,* 1991), an extensive expression of plasticity may mislead taxonomic identifications. Caution is therefore warranted when interpreting the results of comparisons of allopatric populations, especially when: (a) taxa from contrasting environments show trait differences that correlate with environmental differences; (b) the comparisons involve a limited number of individuals and few characters; and (c) the examined traits show slight differences and/or overlapping values. Again, it is left to competent taxonomists to judge if the kind, amount and direction of observed differences in species traits permit discrimination in species-level identifications.

Overall, application of the BSC encounters methodological difficulties, particularly with regard to demonstrating reproductive isolation in allopatric populations. The PSC is equally vulnerable to various methodological difficulties, such as sample data variability and reliability on statistical grounds, and problems in assessing phylogenetic lineages. It is also open to criticism for the objectivity with which the species-discrimination criteria can be chosen or applied. Taxonomies based on the BSC contain few and often ambiguously defined species. However, these taxonomies tend to maintain their stability over time, because persistent and multiple-character differences must be demonstrated before altering the taxonomic status of taxa. By contrast, taxonomies based on the PSC usually contain more species and are sensitive to revisions and changes, because the species are more loosely and variously defined.

LEE & WOLSAN (2002) attempted to reconcile the apparently contradictory views concerning the conceptual framework and operational applicability of the two concepts, arguing that the BSC refers explicitly to synchronic species, while the PSC refers explicitly to diachronic lineages. Therefore a biological species (synchronic species) and a phylogenetic species (diachronic lineage) are ontologically distinct entities. The authors proposed that it might be appropriate to use the term species solely for a synchronic, integrated assemblage of organisms, as defined by the BSC, and to apply the term lineage for a diachronic, non-integrated assemblage which is the historical product of past evolution. Nonetheless, most authors perceive species as both synchronic and diachronic entities. Inevitably, the conflict over the merits and practicability of the BSC and the PSC will continue to persist. In Greece, a trend towards acceptance of the PSC is evident in almost all recent publications. Below we shall discuss the consequences of this trend for some applied biological disciplines. After all, an important factor to be considered in systematics is how useful a species concept is relative to the needs of the users of fish data.

Taxonomic standardisation and species lists. Many users of fish data (e.g. fisheries managers and administrative officers involved in commercial catch statistics or regional development programmes) are not interested in taxonomy per se but on the applications of taxonomy. For these users, one of the more serious implications of adopting the PSC is that the fish species lists are large, differ among basin areas and must change constantly. An additional difficulty arises when the species contained in the lists have been defined under different species concepts and with a mixture of criteria. This may also be a cause of instability since any re-evaluation of taxa defined and named under the BSC may result in the definition of new species and names under the PSC. Such taxonomic changes may have a disturbing effect on most users of fish data, who would like to see the species list remaining constant rather than changing each time a taxonomic study is undertaken.

Biodiversity conservation. The freshwater fish fauna of Greece is characterized by a high level of endemism, which leads to a concomitant need for a conservation focus. Given the high number of species in need of protection and the relatively poor resources available for biodiversity conservation, biologists and environmental managers are faced with the problem of deciding which taxa warrant special protection using criteria such as the magnitude of the extinction threat, ecological value or role in the ecosystem and biological distinctiveness. Assessing 'biological distinctness' is a challenging issue with biodiversity conservation. Several authors have argued that the PSC may promote conservation efforts better than other concepts (e.g. KOTTELAT, 1997; GOLDSTEIN *et al.*, 2000). On the one hand, the PSC allows the recognition of genetically distinct populations as evolutionarily significant units regardless of morphological similarity or the ability to interbreed. On the other hand, the taxonomic identification of vulnerable populations makes them a clear target for conservation effort on political grounds. Indeed, policy-makers recognize and give more value to 'distinct' named species than to lower taxonomic categories. For example, the *Aphanius* population inhabiting the spring of Kato Almiri (NE Peloponnese) is more likely to be strictly protected than other *Aphanius* populations, simply because it has been given the name *A. almiriensis.* Opponents of this view consider that adoption of the PSC may have little effect on conservation. Reasons invoked include the species-centred waste of limited resources and the difficulty of deciding what should be conserved, given the proliferation of species under this concept; and, also the huge bureaucratic processes triggered to update conservation policies (e.g. GARNETT & CHRISTIDIS, 2007). Taking position, we recognise that the PSC has various operational limitations, such as the problem of handling hybridisations, and also that taxonomic classifications are unstable. However, we take into account that (a) many freshwater fish populations in Greece have a long history of isolation, often dating back to the Miocene, and thus may represent unique genetic units, deserving immediate management consideration; (b) only 'species' have high prominence under the national and the EU conservation legislations, and (c) many sites harbouring threatened fish populations or species (some until recently recognized only as subspecies) have not been incorporated in officially designated protected-areas (e.g. under the NATURA 2000 framework). On these grounds, we consider that the PSC may better assist in efforts for conserving Greek freshwater fish, despite its various limitations.

Ecological quality assessments. Today one of the most active areas of ichthyological research in Greece is the use of ichthyological indicators for the assessment of the ecological status of freshwater waterbodies, in accordance with the provisions of the EU Water Framework Directive 2000/60. The principle behind the application of fish-based bioassessment methodologies is that freshwater fish assemblages reflect structural and functional aspects of aquatic ecosystems. Therefore, the important issue for applying such methodologies is not the genetic discreteness of taxa, but rather their ecological properties and ability to diagnose ecological degradation. Many closely related taxa that are recognised as separate species under the PSC exhibit a similar range of ecological characteristics and tolerances to a variety of anthropogenenic disturbances (ECONOMOU *et al.,* 2007). For example, all *Squalius* species inhabiting Greek freshwaters in Western Greece have similar ecological requirements with respect to rheophily and habitat use. Likewise, all *Salmo* species of Greece exhibit similar requirements with respect to habitat, thermal tolerance and oxygen demands. Therefore, in ichthyological research aimed at ecological quality assessments, high-level classifications based on the BSC are more meaningful than the less inclusive fine-level classifications based on the PSC.

In conclusion, it appears no species concept can fulfil all of the different requirements posed by the various disciplines and applications. Each has its strengths and weaknesses and may work better in some situations, while the other may apply better in other situations. Given the different demands of potential users of fish data, a possible solution is to use standardised lists of species incorporating finer and coarser taxonomies suitable for different applications, so that studies based on such lists can at least be consistent. Nevertheless, caution is needed in applications of the PSC concept in species descriptions; otherwise the taxonomy will become unmanageable and vulnerable to disruptive changes.

Distribution pattern of native freshwater fish

Ancient arrivals, travel routes and barriers to dispersal

Two major and perhaps non-exclusive explanations have been proposed for the arrival and dispersion of freshwater fish in the Balkans. One postulates that Euro-Siberian and Palaearctic species reached the area during Oligocene and Miocene times through river captures (ECONOMIDIS & BĂNĂRESCU, 1991). A second wave of arrivals of central European and Danubian species that intruded into the area from the Danube and the Black Sea during Pliocene or Pleistocene times is also postulated by the above authors. The alternative hypothesis holds that colonisation of freshwater species around the circum-Mediterranean may have occurred during a short period of the late Miocene when the Mediterranean dried up completely and then was partially refilled with freshwater from the Paratethys (BIANCO, 1990). It seems that no single explanation can account for the diversity of the Balkan ichthyofauna, and of the Greek ichthyofauna in particular (BĂNĂRESCU, 2004). Different species may have arrived in different times and through different pathways, and may have experienced various degrees fragmentation and isolation (ZARDOYA *et al.,* 1999). Isolation, combined with complex climatic events, promoted speciation and produced a great variety of endemic taxa. During periods of intense tectonism and marine regression secondary contacts of previously isolated populations may have occurred, resulting to hybridization and genetic introgression (e.g. DURAND *et al.,* 2003). The following vicariant and dispersal events have been proposed to account for the structural diversity and high degree of endemicity of the Greek ichthyofauna (see ECONOMIDIS, 1974; ECONOMIDIS & BĂNĂRESCU, 1991; ZARDOYA *et al.,* 1999; DURAND *et al.,* 2003; BĂNĂRESCU, 2004; BOBORI & ECONOMIDIS, 2006; SKOULIKIDIS *et al.,* 2008): (a) the gradual uplift of the Alps and the Balkan Mountains from late Oligocene to the end of the Miocene isolated the Balkan drainages preventing faunal exchanges with the rest of Europe; (b) the rise of the Pindos mountain range created a northwest-southeast barrier for fish range expansions, while the rise of the Mount Othrys cut the connections of the rivers of central-eastern Greece from those of northern Greece; (c) at the Pliocene–Pleistocene boundary, a communication of the NW Aegean drainages with the Danube R. was temporarily established through a river-capture involving the Morava R. and the Axios R.; (d) at about the same time, a similar communication of the Adriatic drainages with the Danube R. was established through a river capture involving the Ohrid-Drim-Skadar system in the area of Kosovo; (e) also in Plio-Pleistocene times, intrusion of Black Sea waters (then a freshwater lake) into the Mediterranean through the former Aegeopotamos R. permitted dispersal of Black Sea freshwater fish to the NE Aegean drainages; and (e) sea-level regressions at the glacial maxima of the Pleistocene had a homogenising effect on fish assemblages allowing dispersal among neighbouring river basins.

During the Pleistocene glaciations the Greek rivers remained free of ice, serving as refugia for the preservation of ancestral elements of the European ichthyofauna, which were eradicated from most other parts of Europe. In the post-glacial times, the Greek rivers did not contribute to the recolonization of the European rivers with freshwater fish; consequently, the fish faunas of the Greek rivers have retained their unique endemic forms which thus represent distinct taxononomic entities different from the ones in the rest of Europe.

Regional fish assemblages and endemicity patterns

The present-day fish composition has been determined by a combination of vicariant and dispersion events and faunal relaxation by extinction episodes. The uplift of the Pindic Cordillera in the Middle Miocene (DERMITZAKIS & PAPANIKOLAOU, 1981) acted as a major factor for the faunal divergence of the western and eastern Greece. Consequently, two major aquatic biogeographical divisions are unanimously recognised, defined with different names by various authors, and referred to here as the Aegean and the Ionian divisions. However, opinions differ over the number of minor divisions and their boundaries (STEPHANIDIS, 1939; BIANCO, 1986, 1990; ECONOMIDIS & BĂNĂRESCU, 1991; MAURAKIS & ECONOMIDIS, 2001; MAURAKIS *et al.,* 2001). ECONOMIDIS & BĂNĂRESCU (1991) distinguished four main ichthyogeographic divisions (regions) in the Balkans of which three encompass the Greek territory: the Ponto-Aegean (containing the subdivisions Thracian-East Macedonia and Macedonia-Thessaly), the Attiko-Beotia, and the South Adriatic-Ionian. BĂNĂRESCU (2004) retained this ichthyogeographic scheme with some slight modifications, e.g. he charted the East Peloponnese as a separate entity.

The fish distributional data presented in the present paper corroborate the above biogeographical separation of Greece indicating the presence of characteristic endemics in each region (Appendix I) and a low degree of faunistic similarity among regions (Table 9). Species richness and endemicity levels also differ among biogeographic regions. The western, central and southern parts of Greece (Ionian and Attiko-Beotia regions) hold an old and long-isolated ichthyofauna, and present low species richness but a high degree of endemicity. The northern and eastern parts of the country present higher richness and lower endemism, most probably because these parts are in great proximity to the dispersal areas of the Danube and the Black Sea. Species depauperation in East Peloponnese and the Aegean Islands makes faunistic comparisons difficult and particularly challenging. Nonetheless, the data indicate a faunistic distinctness of the Aegean region that most likely has its explanation in independent origins of species. So far it has been difficult to determine the faunistic relationships of the East Peloponnese with the other regions because only few, poorly studied fish are present in this region. A general difficulty in performing biologically relevant comparisons among regions is that many areas in central and south-eastern Greece and in the Aegean Islands are in a bioclimatic semi-arid zone, where few species have survived prolonged drought episodes or recent human water abstraction impacts.

The North Aegean basins harbour many species with Black Sea and Danubian affinities (BĂNĂRESCU, 2004). Despite many common faunistic elements over the entire North Aegean region (e.g. *Scardinius erythrophalmus, Rutilus rutilus, Silurus glanis*) the Thracian rivers (eastwards of the Strymon R.) and the Macedonian-Thessalian rivers show ichthyological distinctiveness that would justify their placement in different ichthyogeographic regions. As pointed out by ECONOMI-

Table 9
Faunistic similarities among biogeographical regions
(fish species with joint presence in more than two regions).

Fish species	North Aegean	Attiko-Beotia	Ionian	South Adriatic	East Peloponnese	Aegean Islands
Alburnoides bipunctatus	X	X		X		
Alosa fallax	X		X			X
Anguilla anguilla	X	X	X	X	X	X
Aphanius fasciatus	X	X	X			X
Barbus sperchiensis	X	X				
Chondrostoma vardarense	X			X		
Gasterosteus gymnourus	X	X	X		X	
Knipowitschia caucasica	X	X				X
Pelasgus stymphalicus			X		X	
Petromyzon marinus	X		X			
Rhodeus amarus	X			X		
Salaria fluviatilis	X	X	X		X	X
Salmo farioides			X	X		
Scardinius erythrophthalmus	X	X				
Squalius vardarensis	X	X				

DIS & BĂNĂRESCU (1991) most fish occurring in the Thracian rivers are inhabitants of still or slow-flowing waters and may have reached the area chiefly from the Black Sea during its freshwater phase. Nonetheless, dispersal opportunities have existed at least since the Miocene (SAKINÇ & YALTIRAK, 2005). *Barbus strumicae* and *Squalius orpheus* are two of the most characteristic endemics of the Thracian ichthyofauna.

The fish inhabiting the Macedonian and Thessalian rivers show distant affinities with Danubian fish and may have entered the area via the Axios R. in Plio-Pleistocene times, as previously discussed. Indeed, several species endemic to this area (e.g. *Cobitis vardarensis, Squalius vardarensis, Pachychilon macedonicum, Rhodeus meridionalis* and *Zingel balcanicus*) have sister group relationships with Danubian fish species. However, the first arrivals might have occurred quite earlier, as it seems that the area had hydrological contact with the former Paratethys Sea in Miocene times (e.g. SONNENFELD, 2005). All Macedonian-Thessalian rivers show remarkable faunistic similarities, as expected, given that these rivers were connected during the last glacial maximum (LYKOUSIS *et al.,* 2005).

The Ionian region is considered as one of the most isolated zoogeographic units in Europe, since it is blocked from the rest of the Balkans by mountain ranges. This region contains unique endemics that are often confined to one or few drainages (TSIGENOPOULOS & KARAKOUSIS, 1996; BARBIERI *et al.,* 2002; KETMAIER *et al.,* 2003; MILLER *et al.,* 2004a; ECONOMOU *et al.,* 2004c). Species of some genera (e.g. *Squalius, Scardinius* and *Barbus*) show deep genetic divergence from their counterparts in the Balkans and the rest of Europe and often have a basal or almost basal position in phylogenetic reconstructions (DOADRIO & CARMONA, 1998; KETMAIER *et al.,* 1998, 2003; DURAND *et al.,* 1999a, 1999b; TSIGENOPOULOS & BERREBI, 2000; TSIGENOPOULOS *et al.,* 2002). The distinctness and ancient origin of the Ionian ichthyofauna is further indicated by (a) the presence of endemic genera (*Tropidophoxinellus* and *Economidichthys*) (BIANCO *et al.,* 1987; STEPHANIDIS, 1974) and (b) the absence of widespread European genera that are typically present in other Balkan regions (*Chondrostoma, Barbatula, Gobio, Alburnus, Alburnoides, Phoxinus, Cottus* and *Rhodeus*). Interestingly, some Ionian species show much closer relationships to Iberian species than to species inhabiting other Balkan regions (DOADRIO & CARMONA, 1998; ZARDOYA *et al.,* 1999; PERDICES *et al.,* 1996; SANJUR *et al.,* 2003). Geological events that have contributed to isolation and speciation in the Ionian region include: the early isolation of the southern part of Peloponnese by mountain barriers and deep seas; the separation of the Peloponnese by the opening of the Corinthian Gulf during the early part of the Late Pliocene; the progressive uplift of the Ionian islands throughout the Pliocene; and the entrance of seawater in the Patraikos Gulf during the Holocene. The existence of paleo-lakes in Epirus, Acarnania, Arcadia and Laconia allowed the maintenance of old fish lineages. The confluence of the Epirus rivers, and the similar confluences of the Acarnanian rivers, permitted faunal exchanges in the Pleistocene.

The breadth of fish diversity in the Ionian region is easily underestimated if one counts only the number of species present. A larger and yet poorly explored amount of diversity exists below the species level, and is represented by unique phenotypes and genetic profiles often showing a north-south clination. For instance, the present-day distribution of *Squalius keadicus* is restricted to Laconia (Evrotas and Vassilopotamos Rivers). However, there is evidence from genetic studies that the historic range of this species was wider and included rivers of south-west Peloponnese from which it was extirpated by introgression with new *Squalius* invaders (DURAND *et al.,* 2000).

The Attiko-Beotia region is a diverse area which seems to be a true 'genetic crossroad', as species have presumably emigrated in both from the north, west and east, however they have been isolated long enough to show differentiation and speciation. The rivers of this region share few only species with the North Aegean and the Ionian rivers (Table 9) and are inhabited by a depauperate freshwater fish fauna that includes distinctive endemics. The fluvio-lacustrines *Luciobarbus graecus, Scardinius graecus* and *Rutilus ylikiensis* are confined in the Kifissos R. system and are probably remnants of the ichthyofauna of the ancient lake Kopais, now drained. Several species of the Attiko-Beotia region (of the genera *Luciobarbus, Rutilus, Pelasgus, Telestes* and *Scardinius*) have sister species in the Ionian region, which may reflect the past hydrological connection of the Sperchios basin with the Amvrakikos Gulf in Miocene times. Today's ichthyofauna is only a relict of the past. An unclarified cyprinid, identified as a *Squalius* taxon, geographically isolated from other *Squalius* taxa, inhabited the Beotian Assopos (STEPHANIDIS, 1974). This species presumably disappeared before it was scientifically studied and similar extinctions may have occurred in rivers of Attiki and Euboea, which have been severely impacted by human activities.

Although the knowledge of the Aegean island's fish fauna is still incomplete, the available evidence suggests that the eastern islands show faunal affinities with Asia Minor. A distinctive endemic in this region is *Ladigesocypris ghigii,* inhabiting streams of Rhodes Island, which has lost its connection with Anatolia in the Pliocene (DERMITZAKIS, 1990). By contrast, other eastern Aegean islands, including Lesvos and Samos, remained connected to Anatolia until Pleistocene times, and fish colonisations from the mainland, especially during marine regressions, were possible. The ichthyofauna of the East Peloponnese is extremely depauperate and not yet properly studied. In the 1990s an *Aphanius* population was discovered in the Kato Almiri spring (ECONOMOU *et al.,* 1997). This population was provisionally assigned to *A. fasciatus,* though the authors noted its morphological and behavioural distinctiveness from the latter species. Later, this taxon was described as *A. almiriensis* (KOTTELAT *et al.,* 2007). Whereas in the 1990s this species was moderately abundant, recent investigations have failed to show its persistence in the site.

It is safe to conclude that the remarkable diversity of the fish assemblages among biogeographic regions has a historical explanation (vicariance and isolation). It is interesting that many cases of shared species presences indicated in Table 9 concern secondary freshwater or peripheral fish with the ability to utilise the marine route for their dispersal (*Aphanius fasciatus, Knipowitschia caucasica, Salaria fluviatilis, Anguilla anguilla, Alosa falax, Gasterosteus gymnurus and Petromyzon marinus*). This is especially the case in the Aegean Island region, where all species shared with other regions are peripheral or secondary freshwater species.

Species richness and species – area relationships

High species richness generally correlates negatively with the degree of endemicity, except in the Aegean Islands and the East Peloponnese, where fish faunal depauperation does not permit meaningful comparisons. This is particularly true when the fish faunas of the Ionian and the North Aegean regions are compared. Lower richness in the Ionian region (Table 7a; Fig. 4) may have a historical explanation: the Ionian fish faunas have probably remained isolated since the Miocene, and therefore may have been subjected to extinction processes for a longer time than the North Aegean fish faunas, which had Pliocene or more recent contacts with the Danubian and Black Sea faunas. However, this explanation should be considered with caution because the low species richness in the Ionian hydrographic basins may be due to ecological or physiographic factors. Our data show an increase of species richness with increasing basin size (see Fig. 3), confirming long-standing generalisations that more species exist in larger basins, either because such basins contain a wider array of habitat configurations, or because the probability of extinction is more likely in small basins (REYJOL *et al.,* 2006). Given the positive correlation between species richness and basin size, a logical explanation of the lower richness of the Ionian basins is that their size is much smaller than the size of the North Aegean basins. However, local ecological conditions and landscape features often disrupt the richness-basin area correlation. For instance, the spring-fed Louros R. hosts a larger number of species (14 species) than the adjacent and much larger nivo-pluvial Arachthos R. (11 species). Presumably, hydrological stability and the presence of more extensive floodplain habitats in the former river have resulted in a greater availability of habitat types and/or higher ability of species to persist in the long term.

That both explanations may hold is not controversial. Richness may depend on both demographic processes (colonisation and extinction events) and ecological or physiographic factors. When basins of similar size are compared, those of the Ionian region contain fewer species than basins of the North Aegean region, suggesting that historical factors and demographic processes had an important structuring effect on regional fish assemblages. Within regions, however, physiographic factors, such as basin size and relief, may better explain the observed richness patterns. For instance, most rivers of North Peloponnese are small and have high slope, lacking floodplains; these rivers host only one or two fish species that are tolerant to flashy and erosive stream conditions. The depauperation of the fish faunas of East Peloponnese and the Aegean Islands can similarly be attributed to small basin size. Their isolated fish communities are particularly vulnerable to repeated drying episodes, and many historical extirpations may have taken place.

Policy relevant implications of the survey

River basin area management and WFD application

As previously expressed, ecosystem health assessment and monitoring is one aspect of aquatic conservation where fish play an important role as biological indicators. Greece is lagging very much behind in the application of the WFD assessment scheme and an important reason is the information deficit on the organisms to be used as biotic quality elements (ECONOMOU *et al.,* 2006). As of late 2007, Greece had not yet delineated river basin areas or constituent waterbodies, so even the basic geographic framework for ecological quality assessments is still missing. The river basin area distributions provided here can contribute to bioassessment tool development in various ways, e.g. by enabling the characterisation of historical reference conditions and the selection of appropriate metrics. They also reveal two kinds of difficulties in building robust fish-based bioassessment indices. The first kind relates to the faunistic idiosyncrasies and heterogeneity that characterised the Greek hydrographic basins (low basin species richness, high degree of endemicity, and varied basin-specific taxa assemblages). Such aspects of the ichthyofaunal assemblages are characteristic of the highly heterogeneous Mediterranean-climate environmental conditions (GASITH & RESH, 1999; FERREIRA *et al.,* 2007) and, among others, restrict the number of potential metrics or prevent the application of a common metric system over wide areas. The second kind of difficulties arises from taxonomic uncertainties, insufficient knowledge of the species' distributions, and the wide tolerance of many native species to varying environmental conditions. The adoption of the phylogenetic species concept (PSC) has exacerbated the problems of reference conditions and metric development because the application of a finer taxonomy generates an 'apparent' increase of the biological heterogeneity among hydrographic basins. However, bearing in mind that phylogenetically closely related species are more likely to be ecologically similar, a solution to these problems is to identify ecologically-equivalent species that respond to ecological degradation in a similar manner. Base-line research projects for fish assemblage community ecology is vital for establishing and standardising lists of ecologically-similar species.

Species conservation

Species entities are basic units in biodiversity research and conservation applications. Experience has shown that the more 'distinct' a species is, in relation to other species, the greater the priority is given to its protection (MAITLAND, 2004). At the Mediterranean scale the number of threatened species is very large and encompasses about 56% of the endemic fish; this is one of the highest proportional assessments of threatened species worldwide (see SMITH & DARWELL, 2006; PETER, 2006). The distributional ranges of species are a key issue for the assessment of their vulnerability and the design of protective measures. In Greece, little work has been done to systematically document the distributions of endemic species; most studies provide anecdotal accounts of species ranges and are not quantitative with respect to abundance or density (ECONOMIDIS, 1995). Problems of this kind have impeded conservation efforts. As a consequence, conservation priorities are usually based on fish assemblage data available at the national level (i.e. check-lists) or regional level (i.e. protected-areas), rather than on detailed basin area-based fish compilations. Therefore, it is not surprising that many endangered fish species are still not given appropriate legal protection, e.g. they are not present in Annex II of the Habitats Directive. Besides, with the recent name changes, we are faced with a remarkable number of localized endemic species as well as of taxa of unclear taxonomy. Our basin survey identifies a large number of range-restricted species that need conservation attention. For some species complete distributional data are provided that can assist in conservation reassessments. For a number of other species, however, the survey indicates gaps in the knowledge of their distribution and/or problems with their taxonomic status. Distributional surveys and taxonomic work are essential for planning conservation-orientated research.

Habitat conservation

While it is widely accepted that saving the sites where vulnerable species live is a very important aspect for their conservation, current legislation does not include satisfactory provisions for sites and aquatic habitat types. For example, the Habitats Directive does not provide adequate descriptions or classifications of the array of aquatic habitat types which exist in inland freshwaters, since mostly terrestrial habitat types are listed and targeted for conservation (DIMOPOULOS *et al.,* 2005). This is unfortunate, because it is well known that freshwater habitats belong to the world's most threatened ecosystems (SMITH & DARWELL, 2006). These important weaknesses in current legislative coverage or enforcement of protection of aquatic habitats and their biota have resulted in the 'exclusion' of many small and highly vulnerable sites from the existing protected-area network of Greece. Our basin-based compilation of fish distributions indicates the occurrence of basins containing potentially important evolutionary units. However, the compilation does not detail the exact limits of the geographic distribution of each unit within basins. Further analyses and screening of site-specific data will be required to ensure the preservation of independent genetic pools and to highlight unmet conservation gaps on a nation-wide scale.

Fishery management

Inland waters fisheries are facing significant problems due to mismanagement, water quality problems and the effects of invasive alien fish species (CRIVELLI *et al.,* 1997; LEONARDOS *et al.,* 2007). Destructive fishing practices lead to damaged fish habitat and less fish, and species introductions and translocations cause genetic pollution, representing a major reason of the degradation of native gene pools. Misinformed fishermen and fisheries managers are definitely the largest cause of alien fish species spread in Greece (ECONOMIDIS *et al.,* 2000a). In planning and enforcing fisheries management policies, it is important that reliable data on the composition of fish assemblages and the native ranges of species are available. The present dataset provides baseline ichthyological information that may help to track the spread of alien species and to report vital ichthyological data in a standaridised manner. However, commercial and sport fishing have major economic and political implications that also need to be taken into account in the watershed management plans. While it is clear that holistic approaches covering social, economic, environmental and technical aspects should be used to promote fishery management, biodiversity issues should not be sacrificed for the sake of development; the conservation value of species and habitats should be given at least as much importance as economic and social factors.

Biogeography

Since freshwater fish are restricted to pathways offered by hydrogeographic systems, their distribution largely reflects historical patterns of drainage connections (e.g. VARGAS *et al.,* 1998; REYJOL *et al.,* 2006). Moreover, fish do have better documented distributional information than do most other freshwater-obligate organisms in Greece (i.e. invertebrates, amphibians); therefore, they are capable of supporting biogeographical analyses (LEGAKIS, 2004). The influence of historic drivers determining fish distribution is especially important in the species extinction-invasion process. Many biogeographic applications can be developed when a complete inventory of fish species occurring in the hydrographic basins of Greece will be created (for instance, assessing the relative importance of historical factors and physiographic or hydrological characteristics in determining basin area fish assemblages). We acknowledge that our database still needs verification and completion; nevertheless it is a first step in developing a nation-wide basin-based inventory that can be used for conservation-relevant biogeographical research.

Research and management priorities

Below we summarize five imperative actions with respect to conservation-relevant ichthyological research in Greece:

1. *Fish distributional surveys.* Our distributional data clearly suggest that conservation and management programmes should refer to the geographic ranges of each taxonomic unit to ensure the preservation of independent genetic pools. Distributional data are also critical for the implementation of the WFD (establishment of reference conditions, metric selection, site-based index development), the Habitats Directive (site protection and monitoring, populations reporting, conservation management) and basic environmental impact assessment. Likewise, fisheries management should be seen as a conservation issue that needs planning and enforcement on the basis of distributional and information assemblage structure. Ichthyological research is especially needed in small water features such as springs, wetlands and coastal lagoons, as well as in deep sections of large rivers, which have not been adequately sampled. An important initiative to integrate the aforementioned needs would involve a coordinated atlas project for freshwater fish in Greece.

2. *Fish taxonomy - genetic research.* Taxonomy and conservation must come together; and taxonomists who are motivated by conservation action must strive to produce reliable standardized taxonomic units. Obviously, genetic research is critical in taxonomy. A community of taxonomists must develop and a forum should be created in order to help establish the validity of taxa (CRIVELLI & MAITLAND, 1995). Genetic variation in any species being conserved or managed is very important to monitor. Without this basic research it is impossible to effectively manage species, populations or communities of fish. Some isolated populations are poorly studied, and yet they may represent cryptic endemic species that may be worth protecting as significant evolutionary units (e.g. *Alburnoides bipunctatus* in the Sperchios R. and various *Knipowitschia* populations in western and central-eastern Greece). Particular attention is needed in the boundary areas between species where genetically distinct units can occur. For example, the progress of recent *Squalius peloponnensis* populations and the colonization of new aquatic systems might have taken place in successive waves. Perhaps in some systems of southern Peloponnese (e.g. in the SW Messinia streams or in the montane plateau of the Lousios R.) the new invaders found old local *Squalius* stocks and either eliminated them or mated with them. Similar hybridisation zones may exist in the boundaries of species belonging to the genera *Salmo* and *Pelasgus.*

3. *Aquatic habitat inventory.* Habitat loss is the most important conservation problem for fish species, and this is especially acute in seasonally-semi-arid environments where many small watersheds are vulnerable to human pressures. Greece and the western Balkans have one of the largest concentrations of range-restricted species; many species are restricted to one or two river basin areas – some are confined to certain river segments or special habitat types (spring-fed wetlands, lakes, ponds etc). Coordinated efforts are needed to document aquatic habitats in an inventory and to create wide-ranging campaigns for their preservation and restoration. As stated by CRIVELLI & MAITLAND (1995), the conservation of freshwater habitats is more important than that of individual species; but to conserve these effectively we need: a) a list of all aquatic habitat areas, b) priority ranking and conservation evaluation of the habitat areas, c) conservation management plans for sites and the fish species accommodated within them.

4. *Alien species control.* Alien species are widely considered as the second most important threat to aquatic biodiversity after habitat loss. Awareness and enforcement of the control of the spread of introduced species is critical for conservation. We have provided evidence that 25 alien species have been introduced to Greece of which some are spreading fast, seriously impacting the natural biota. Translocation of fish among basins is an equally serious problem, since they are usually performed without any concern for the evolutionary history of the species (for trout species: see APOSTOLIDIS *et al.,* 1999). The impact of translocations on genetic diversity may exceed the impact of alien species introductions due to the high possibility of introgressive hybridization between populations or closely related species. In the light of the recorded human effect on the distribution of the different species, it is desirable that both the donor populations and the indigenous populations in the recipient areas would be genetically screened before any introduction. Public awareness of this problem is extremely important. A research priority is to identify areas hosting unaffected remnant indigenous fish stocks that can be preserved and used as a population source for rehabilitation projects.

5. *River basin management plans.* A multi-tiered approach to biota and habitat protection must be incorporated in river basin management plans. Integrated and holistic planning is needed to co-ordinate water resource exploitation, conservation and restoration in basins; however, at this scale, biodiversity is not often given appropriate consideration. Indeed, as already stated, traditional protected-areas often disregard fish and other elements of the aquatic biota. It is therefore important to promote legal protection schemes and special management initiatives to keep aquatic habitats in existence (APERGHIS & GAETHLICH, 2006). Carefully sited protected-areas are needed in order to cover linear aquatic features or focus on relatively small sites and threatened population refuges (e.g. MOYLE & YOSHIYAMA, 1994). Micro-reserves may be effective as a short-term direct protective measure.

Conclusion

Hydrographic basin areas are of high relevance to current water policy and conservation. Such areas have well defined boundaries (watershed limits) and are becoming important for effective aquatic ecosystem monitoring, assessment, reporting and management. In this work, a basin area survey method was employed to compile the best-available distributional assemblage data for freshwater fish in Greece. Our work is a preliminary but wide-ranging attempt that may help to identify: (a) unmet needs in our understanding of freshwater species' distributions in Greece, (b) problems with the species' recent taxonomic changes, and (c) basic gaps in science-based conservation work on threatened species. Indeed, one of the major obstacles in effectively assessing the conservation status of fish, their habitat needs, and the anthropogenic pressures they may face, is the large gap in knowledge of their geographical distributions.

A coordinated effort is needed to promote field ichthyology as a scientific enterprise that is directly useful to nature conservation. There is still poor baseline knowledge of Greece's inland water aquatic ecosystems. The number of different aquatic habitat areas in Greece is large; as geographic entities, aquatic habitat sites certainly number in the thousands. We have very little information for many of the smaller more isolated ones, and the quality of the information for many parts of the larger river basin areas is also poor. Reviews from other inland water assessments from the Mediterranean have similarly depicted the problem of important gaps in the inventory of ecosystems and their aquatic biota (ALVAREZ-COBELAS *et al.,* 2005), so this is not a problem unique to Greece. However, the ichthyofauna of Greece is especially rich in many range-restricted species and needs immediate attention. Particular problems concern conservation-relevant aspects of its taxonomy, biology and ecology. Important problems also exist with information management and dissemination. This work also underlines the urgent need for building site-based inventories of fish assemblages in this country.

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Appendix I. Annotated Checklist of Freshwater Fishes of Greece.

1	2	3	4	5	6
	Name	**Authority**	**Previous Nomenclature**	**Freshwater**	**Endemic**
	Petromyzonidae				
1	*Eudontomyzon hellenicus*[1]	Vladykov, Renaud, Kott & Economidis, 1982	NO CHANGE	1	ENNO
2	*Eudontomyzon* sp. *Louros*[2]	Undescribed	*Eudontomyzon hellenicus*	1	(ENWE)
3	*Petromyzon marinus*	Linnaeus, 1758	NO CHANGE	0	OTHER
	Acipenseridae				
4	*Acipenser baeri*	Brandt, 1869	NO CHANGE	(1)	ALN
5	*Acipenser gueldenstaedtii*	Brandt & Ratzeburg, 1833	NO CHANGE	0	ALN
6	*Acipenser naccarii*	Bonaparte, 1836	NO CHANGE	0	OTHER
7	*Acipenser ruthenus*	Linnaeus, 1758	NO CHANGE	(1)	ALN
8	*Acipenser stellatus*[3]	Pallas, 1771	NO CHANGE	0	OTHER
9	*Acipenser sturio*	Linnaeus, 1758	NO CHANGE	0	OTHER
10	*Huso huso*[4]	(Linnaeus, 1758)	NO CHANGE	0	(ALN)
	Polyodontidae				
11	*Polyodon spathula*	(Walbaum, 1792)	NEW	1	ALN
	Anguillidae				
12	*Anguilla anguilla*	(Linnaeus, 1758)	NO CHANGE	0	OTHER
	Clupeidae				
13	*Alosa fallax*	(La Cepède, 1803)	*Alosa fallax nilotica*	0	OTHER
14	*Alosa macedonica*	(Vinciguerra, 1921)	*Alosa (Caspialosa) macedonica*	1	ENNO
15	*Alosa vistonica*	Economidis & Sinis, 1986	*Alosa (Caspialosa) caspia vistonica*	0	ENNO
	Cyprinidae				
16	*Abramis brama*	(Linnaeus, 1758)	NO CHANGE	1	OTHER
17	*Alburnoides bipunctatus*	(Bloch, 1782)	NO CHANGE	1	OTHER
18	*Alburnoides prespensis*	(Karaman, 1924)	*Alburnoides bipunctatus prespensis*	1	NENNO
19	*Alburnus alburnus*	(Linnaeus, 1758)	*Alburnus alburnus thessalicus, Alburnus alburnus macedonicus*	1	OTHER
20	*Alburnus belvica*	Karaman, 1924	*Chalcalburnus belvica*	1	NENNO
21	*Alburnus* cf. *scoranza*[5]	Bonaparte, 1845	NEW	1	ENBAL

(continued)

Appendix I (continued)

1	2	3	4	5	6
	Name	**Authority**	**Previous Nomenclature**	**Freshwater**	**Endemic**
22	*Alburnus macedonicus*	Karaman, 1928	*Alburnus alburnus macedonicus*	1	NENNO
23	*Alburnus* sp. Volvi[6]	In K&F2007	NEW	1	(ENNO)
24	*Alburnus thessalicus*[7]	Stephanidis, 1950	*Alburnus alburnus thessalicus*	1	ENBAL
25	*Alburnus vistonicus*	Freyhof & Kottelat, 2007	*Chalcalburnus chalcoides macedonicus*	1	ENNO
26	*Alburnus volviticus*	Freyhof & Kottelat, 2007	*Chalcalburnus chalcoides macedonicus*	1	ENNO
27	*Aspius aspius*	(Linnaeus, 1758)	NO CHANGE	1	OTHER
28	*Barbus balcanicus*[8]	Kotlií k, Tsigenopoulos, Ráb & Berrebi, 2002	*Barbus peloponnesius petenyi*	1	OTHER
29	*Barbus cyclolepis*	Heckel, 1837	*Barbus cyclolepis cyclolepis*	1	ENBAL
30	*Barbus euboicus*	Stephanidis, 1950	NO CHANGE	1	ENCE
31	*Barbus macedonicus*	Karaman, 1928	*Barbus barbus macedonicus, Barbus barbus thessalicus*	1	ENBAL
32	*Barbus peloponnesius*[9]	Valenciennes, 1842	*Barbus peloponnesius peloponnesius*	1	(ENWE)
33	*Barbus pergamonensis*	Karaman, 1971	NEW	1	OTHER
34	*Barbus prespensis*	Karaman, 1924	NO CHANGE	1	NENNO
35	*Barbus rebeli*	Koller, 1926	*Barbus peloponnesius rebeli*	1	ENBAL
36	*Barbus sperchiensis*[10]	Stephanidis, 1950	*Barbus cyclolepis sperchiensis, Barbus cyclolepis cholorematicus*	1	ENNO
37	*Barbus strumicae*	Karaman, 1955	*Barbus cyclolepis strumicae*	1	ENBAL
38	*Carassius auratus*[11]	(Linnaeus, 1758)	NEW	1	ALN
39	*Carassius carassius*	(Linnaeus, 1758)	NO CHANGE	1	OTHER
40	*Carassius gibelio*[12]	(Bloch, 1782)	*Carassius auratus gibelio*	1	OTHER
41	*Chondrostoma prespensis*	Karaman, 1924	NO CHANGE	1	NENNO
42	*Chondrostoma vardarense*	Karaman, 1928	*Chondrostoma vardarensis*	1	ENBAL
43	*Ctenopharyngodon idella*	(Valenciennes, 1844)	NO CHANGE	1	ALN
44	*Cyprinus carpio*[13]	Linnaeus, 1758	NO CHANGE	1	OTHER
45	*Gobio bulgaricus*	Drensky, 1926	*Gobio gobio bulgaricus, Gobio gobio balcanicus*	1	ENBAL
46	*Gobio* cf. *skadarensis*[14]	Karaman, 1936	NEW	1	ENBAL
47	*Gobio feraeensis*	Stephanidis, 1973	*Gobio gobio feraensis*	1	ENNO
48	*Hypophthalmichthys molitrix*	(Valenciennes, 1844)	NO CHANGE	1	ALN

(continued)

Appendix I (continued)

1	2	3	4	5	6
	Name	**Authority**	**Previous Nomenclature**	**Freshwater**	**Endemic**
49	*Hypophthalmichthys nobilis*	(Richardson, 1845)	NO CHANGE	1	ALN
50	*Ladigesocypris ghigii*	(Gianferrari, 1927)	*Ladigesocypris ghigii ghigii*	1	ENAEG
51	*Leucaspius delineatus*	(Heckel, 1843)	NO CHANGE	1	OTHER
52	*Luciobarbus albanicus*	(Steindachner, 1870)	*Barbus albanicus*	1	ENWE
53	*Luciobarbus graecus*	(Steindachner, 1896)	*Barbus graecus*	1	ENCE
54	*Pachychilon macedonicum*	(Steindachner, 1892)	*Rutilus macedonicus*	1	ENBAL
55	*Pachychilon pictum*	(Heckel & Kner, 1858)	*Pachychilon pictus*	1	ENBAL
56	*Parabramis pekinensis*	(Basilewsky, 1855)	NO CHANGE	1	ALN
57	*Pelasgus epiroticus*	(Steindachner, 1896)	*Paraphoxinus epiroticus epiroticus*	1	ENWE
58	*Pelasgus laconicus*	(Kottelat & Barbieri, 2004)	NEW	1	ENWE
59	*Pelasgus marathonicus*	(Vinciguerra, 1921)	*Pseudophoxinus stymphalicus marathonicus*	1	ENCE
60	*Pelasgus prespensis*	(Karaman, 1924)	*Paraphoxinus epiroticus prespensis*	1	NENNO
61	*Pelasgus stymphalicus*	(Valenciennes, 1844)	*Pseudophoxinus stymphalicus stymphalicus*	1	ENWE
62	*Pelasgus thesproticus*	(Stephanidis, 1939)	*Pseudophoxinus stymphalicus thesproticus*	1	ENWE+
63	*Petroleuciscus borysthenicus*	(Kessler, 1859)	*Leuciscus borysthenicus*	1	OTHER
64	*Petroleuciscus smyrnaeus*	(Boulenger, 1896)	NEW	1	OTHER
65	*Phoxinus* cf. *phoxinus*[15]	(Linnaeus, 1758)	*Phoxinus phoxinus*	1	OTHER
66	*Phoxinus strymonicus*	Kottelat, 2007	*Phoxinus phoxinus*	1	(ENNO)
67	*Pseudorasbora parva*	(Temminck & Schlegel, 1846)	NO CHANGE	1	ALN
68	*Rhodeus amarus*	(Bloch, 1782)	*Rhodeus sericeus amarus*	1	OTHER
69	*Rhodeus meridionalis*	Karaman, 1924	*Rhodeus sericeus amarus*	1	ENBAL
70	*Romanogobio elimeius*[16]	(Kattoulas, Stephanidis & Economidis, 1973)	*Gobio uranoscopus elimeius*	1	ENBAL
71	*Rutilus panosi*	Bogutskaya & Iliadou, 2006	*Rutilus ylikiensis*	1	ENWE
72	*Rutilus prespensis*	(Karaman, 1924)	*Rutilus ohridanus prespensis*	1	NENNO
73	*Rutilus rutilus*	(Linnaeus, 1758)	*Rutilus rutilus mariza, Rutilus rutilus dojranensis, Rutilus rutilus vegoriticus*	1	OTHER
74	*Rutilus* sp. Sperchios[17]	In K&F2007	NEW	1	ENCE
75	*Rutilus ylikiensis*	Economidis, 1991	NO CHANGE	1	ENCE

(continued)

Appendix I (continued)

1	2	3	4	5	6
	Name	**Authority**	**Previous Nomenclature**	**Freshwater**	**Endemic**
76	*Scardinius acarnanicus*	Economidis, 1991	NO CHANGE	1	ENWE
77	*Scardinius erythrophthalmus*	(Linnaeus, 1758)	NO CHANGE	1	OTHER
78	*Scardinius graecus*	Stephanidis, 1937	NO CHANGE	1	ENCE
79	*Squalius* cf. *cii*[18]	(Richardson, 1856)	NEW	1	OTHER
80	*Squalius peloponnensis*[19]	(Valenciennes, 1844)	*Leuciscus cephalus peloponnensis*	1	ENWE
81	*Squalius keadicus*	(Stephanidis, 1971)	*Leuciscus keadicus*	1	ENWE
82	*Squalius moreoticus*[20]	(Stephanidis, 1971)	NEW	1	ENWE
83	*Squalius orpheus*	Kottelat & Economidis, 2006	*Leuciscus cephalus macedonicus*	1	ENBAL
84	*Squalius pamvoticus*[21]	(Stephanidis, 1939)	NEW	1	ENWE
85	*Squalius prespensis*	(Fowler, 1977)	NEW	1	NENNO
86	*Squalius* sp. Aoos	In K&F2007	*Leuciscus cephalus vardarensis*	1	ENBAL
87	*Squalius* sp. Evia[22]	In K&F2007	NEW	1	ENCE
88	*Squalius* sp. Evinos[23]	In K&F2007	*Leuciscus cephalus albus, Leuciscus "svallize"*	1	ENWE
89	*Squalius vardarensis*	Karaman, 1928	*Leuciscus cephalus vardarensis*	1	ENBAL
90	*Telestes beoticus*	(Stephanidis, 1939)	*Pseudophoxinus beoticus*	1	ENCE
91	*Telestes pleurobipunctatus*	(Stephanidis, 1939)	*Phoxinellus pleurobipunctatus*	1	ENWE+
92	*Tinca tinca*	(Linnaeus, 1758)	NO CHANGE	1	OTHER
93	*Tropidophoxinellus hellenicus*	(Stephanidis, 1939)	NO CHANGE	1	ENWE
94	*Tropidophoxinellus spartiaticus*	(Schmidt-Ries, 1943)	NO CHANGE	1	ENWE
95	*Vimba melanops*	(Heckel, 1837)	NO CHANGE	1	ENBAL
	Cobitidae				
96	*Cobitis arachthosensis*	Economidis & Nalbant, 1997	NO CHANGE	1	ENWE
97	*Cobitis hellenica*	Economidis & Nalbant, 1997	NO CHANGE	1	ENWE
98	*Cobitis meridionalis*	Karaman, 1924	NO CHANGE	1	NENNO
99	*Cobitis ohridana*	Karaman, 1928	NEW	1	ENBAL
100	*Cobitis puncticulata*	Erk'akan, Atalay-Ekmekçi & Nalbant, 1998	NEW	1	OTHER
101	*Cobitis punctilineata*	Economidis & Nalbant, 1997	NO CHANGE	1	ENNO
102	*Cobitis stephanidisi*	Economidis & Nalbant, 1997	NO CHANGE	1	ENNO

(continued)

Appendix I (continued)

1	2	3	4	5	6
	Name	**Authority**	**Previous Nomenclature**	**Freshwater**	**Endemic**
103	*Cobitis strumicae*	Karaman, 1955	NO CHANGE	1	ENBAL
104	*Cobitis trichonica*	Stephanidis, 1974	NO CHANGE	1	ENWE
105	*Cobitis vardarensis*	Karaman, 1928	NO CHANGE	1	ENBAL
106	*Sabanejewia balcanica*	(Karaman, 1922)	*Sabanejewia aurata balcanica*	1	ENBAL
	Nemacheilidae				
107	*Barbatula barbatula*	(Linnaeus, 1758)	*Orthrias barbatulus*	1	OTHER
108	*Oxynoemacheilus bureschi*	(Drensky, 1928)	*Orthrias brandti bureschi*	1	ENBAL
109	*Oxynoemacheilus pindus*	(Economidis, 2005)	*Orthrias pindus*	1	ENBAL
110	*Oxynoemacheilus theophilii*	Stoumboudi, Kottelat & Barbieri, 2006	NEW	1	OTHER
	Ictaluridae				
111	*Ictalurus punctatus*	(Rafinesque, 1818)	NEW	1	ALN
	Siluridae				
112	*Silurus aristotelis*	Garman, 1890	NO CHANGE	1	ENWE
113	*Silurus glanis*	Linnaeus, 1758	NO CHANGE	1	OTHER
	Clariidae				
114	*Clarias gariepinus*	(Burchell, 1822)	NEW	1	ALN
	Esocidae				
115	*Esox lucius*	Linnaeus, 1758	NO CHANGE	1	OTHER
	Coregonidae				
116	*Coregonus* cf. *lavaretus*[24]	(Linnaeus, 1758)	*Coregonus lavaretus*	1	ALN
	Salmonidae				
117	*Oncorhynchus kisutch*	(Walbaum, 1792)	NO CHANGE	1	ALN
118	*Oncorhynchus mykiss*	(Walbaum, 1792)	NO CHANGE	1	ALN
119	*Salmo dentex*[25]	Heckel, 1852	*Salmo trutta dentex*	1	ENBAL
120	*Salmo farioides*[26]	(Karaman, 1938)	*Salmo trutta macrostigma, Salmo trutta dentex*	1	ENBAL
121	*Salmo letnica*	(Karaman, 1924)	NEW	1	ALN
122	*Salmo cf. macedonicus*[27]	(Karaman, 1924)	*Salmo trutta macedonicus*	1	ENBAL
123	*Salmo pelagonicus*	Karaman, 1938	*Salmo trutta pelagonicus*	1	ENBAL
124	*Salmo pestericus*	Karaman, 1938	*Salmo trutta pestericus*	1	NENNO

(continued)

Appendix I (continued)

1	2	3	4	5	6
	Name	**Authority**	**Previous Nomenclature**	**Freshwater**	**Endemic**
125	*Salmo salar*	Linnaeus, 1758	NEW	1	ALN
126	*Salmo* sp. Louros[28]	In K&F2007	NEW	1	ENWE
127	*Salmo* cf. *trutta*[29]	Linnaeus, 1758	NEW	1	ALN
128	*Salvelinus fontinalis*	(Mitchill, 1814)	NO CHANGE	1	ALN
	Mugilidae				
129	*Chelon labrosus*	Risso, 1827	NO CHANGE	0	OTHER
130	*Liza aurata*	(Risso, 1810)	NO CHANGE	0	OTHER
131	*Liza ramada*	(Risso, 1827)	NO CHANGE	0	OTHER
132	*Liza saliens*	(Risso, 1810)	NO CHANGE	0	OTHER
133	*Mugil cephalus*	Linnaeus, 1758	NO CHANGE	0	OTHER
	Atherinidae				
134	*Atherina boyeri*[30]	Risso, 1810	NO CHANGE	0	OTHER
	Valenciidae				
135	*Valencia letourneuxi*	(Sauvage, 1880)	NO CHANGE	(1)	ENWE+
	Poeciliidae				
136	*Gambusia holbrooki*[31]	Girard, 1859	*Gambusia affinis*	(1)	ALN
137	*Poecilia* cf. *latipinna*[32]	Lesuer, 1821	NEW	1	ALN
	Cyprinodontidae				
138	*Aphanius almiriensis*	Kottelat, Barbieri & Stoumboudi, 2007	NEW	0	ENWE
139	*Aphanius fasciatus*	(Valenciennes, 1821)	NO CHANGE	0	OTHER
	Gasterosteidae				
140	*Gasterosteus gymnourus*	Cuvier, 1829	*Gasterosteus aculeatus*	0	OTHER
141	*Pungitius hellenicus*	Stephanidis, 1971	NO CHANGE	1	ENCE
142	*Pungitius platygaster*	(Kessler, 1859)	NO CHANGE	(1)	OTHER
	Moronidae				
143	*Dicentrarchus labrax*	(Linnaeus, 1758)	NO CHANGE	0	OTHER
	Syngnathidae[33]				
144	*Syngnathus abaster*	Risso, 1827	NO CHANGE	0	OTHER

(continued)

Appendix I (continued)

1	2	3	4	5	6
	Name	**Authority**	**Previous Nomenclature**	**Freshwater**	**Endemic**
	Centrarchidae				
145	*Lepomis gibbosus*	(Linnaeus, 1758)	NO CHANGE	(1)	ALN
146	*Micropterus salmoides*	(La Cepède, 1802)	NEW	(1)	ALN
	Percidae				
147	*Perca fluviatilis*	Linnaeus, 1758	NO CHANGE	1	OTHER
148	*Sander lucioperca*	(Linnaeus, 1758)	*Stizostedion lucioperca*	1	OTHER
149	*Zingel balcanicus*[34]	(Karaman, 1936)	*Zingel streber balcanicus*	1	ENBAL
	Cichlidae				
150	*Oreochromis niloticus*	(Linnaeus, 1758)	NEW	(1)	ALN
	Blenniidae				
151	*Salaria economidisi*	Kottelat, 2004	NEW	1	ENWE
152	*Salaria fluviatilis*	(Asso, 1801)	NO CHANGE	(0)	OTHER
	Gobiidae				
153	*Economidichthys pygmaeus*	(Holly, 1929)	NO CHANGE	(1)	ENWE+
154	*Economidichthys trichonis*	Economidis & Miller, 1990	NO CHANGE	1	ENWE
155	*Knipowitschia caucasica*[35]	(Berg, 1916)	NO CHANGE	(1)	OTHER
156	*Knipowitschia goerneri*	Ahnelt, 1991	NEW	(1)	ENWE
157	*Knipowitschia milleri*	(Ahnelt & Bianco 1990)	NO CHANGE	(1)	ENWE
158	*Knipowitschia thessala*	(Vinciguerra, 1921)	NO CHANGE	(1)	ENNO
159	*Proterorhinus semillunaris*	(Heckel, 1837)	*Proterorhinus marmoratus*	1	OTHER
160	*Zosterisessor ophiocephalus*	(Pallas, 1814)	NO CHANGE	0	OTHER
	Pleuronectidae				
161	*Platichthys flesus*	(Linnaeus, 1758)	NO CHANGE	0	OTHER

LEGEND

Column 1: Species annotation. All species with valid name as well as undescribed operational taxa names are numbered and considered as separate taxonomic units.
Column 2: Scientific Name. Valid scientific name or operational taxonomic unit names are given.
Column 3: Authority. Species author and date are given. Undescribed taxa are given only if provided by KOTTELAT & FREYHOF (2007a) (hereby referred as K&F 2007) with one exception (*Eudontomyzon* sp. Louros, an operational name provided by this study).

Column 4: Previous Nomenclature. Subspecies replacement names and notation on changes with respect to ECONOMIDIS (1991) are as follows: NO CHANGE: No recent name changes (i.e. species names retained as given by ECONOMIDIS, 1991); NEW: New additions to the Greek freshwater fish checklist, not included in ECONOMIDIS (1991) under the current taxon name.

Column 5: "Freshwater residence". Fish known to be restricted to freshwaters in Greece are distinguished from species spending a part of their lives in the sea or in waters with high salinity. Typically freshwater species that usually do not readily enter seawater conditions are denoted with 1; Euryhaline species, brackish water or marine species that are tolerant of or spend part of their lives in freshwater conditions are denoted with 0. Where uncertainty exists on the behaviour of these fish in Greece a provisional designation is given in parentheses.

Column 6: Endemicity: level of endemic status at the national scale, i.e. restricted distributional range or endemic status relative to the territorial boundaries of Greece.

ENWE: Endemic to Western Greece and/or the Peloponnese.
ENWE+: "Near-endemic" to Western Greece; i.e. restricted to Greece, but a small fraction of global population extends into the southern part of Albania.
ENCE: Endemic to Central Eastern Greece, i.e. the Attiko-Beotia region (south of Pagasiticos Gulf, including Fthiotis, Beotia, Attiki and Euboea).
ENNO: Endemic to Northern Greece; including Thessaly, but not the Pagasiticos Gulf (additionally two species that reach Attiko-Beotia region are included).
NENNO: "Near-endemic" to Northern Greece; global populations restricted to Greece's transboundary lakes (i.e. Prespa or Doirani).
ENBAL: Endemic to the Balkans (i.e. south of the Danube R.).
ENAEG: Endemic to the Aegean Islands.
OTHER: Species with other distribution patterns; this includes widespread species, and species having a localized population only in Asia Minor and the adjacent Greek islands.
ALN: Alien species; there is no substantiated evidence that the species is native within the Greek territory.
Where doubts exist a provisional status is given in parentheses.

CRITICAL COMMENTS ON CHECK-LIST

[1] *Eudontomyzon hellenicus* refers only to the populations in the Strymon R. An unidentified Eudontomyzon species has also been recorded from the Almopeos tributary of the Aliakmon R. but it remains undescribed (ECONOMIDIS & BĂNĂRESCU, 1991).

[2] *Eudontomyzon* sp. Louros is not a valid taxa described for the Greek freshwater ichthyofauna (not referred to by an operational name by K&F 2007). The *Eudontomyzon* in the Louros basin is given this provisional name here since its distribution in Greece is extremely localized and this taxon has been known to differ morphologically from *E. hellenicus* for several years now (ECONOMIDIS, 1995). K&F 2007 remark that the population from Louros "either belongs to *E. stankokaramani* or represents a distinct, unnamed species".

[3] *Acipenser stellatus* is considered as extirpated in the Aegean basins (K&F 2007), documentation of its past presence is evident in older publications (PAPACONSTANTINOU, 1988). Recent occurrences of the species in the Evros R. seem to be from stocking or escapes from Bulgaria (APOSTOLOU, pers. comm.; KOUTRAKIS & ECONOMIDIS, 2006).

[4] *Huso huso* is now considered as an alien species in Greece since all populations are from stocking and/or escapees from fish farms (KOUTRAKIS & ECONOMIDIS, 2006). Unfortunately we cannot confirm the possible existence of natural populations of this sturgeon (or even its transient occurrence) in the northern Aegean in the past; although the species may possibly have existed up

until the 19th or early 20th centuries. A few unconfirmed records in the Aegean are reported in earlier accounts (ONDRIAS, 1971; ECONOMIDIS, 1973; PAPACONSTANTINOU, 1988) but these have later been regarded as extremely doubtful (KOUTRAKIS & ECONOMIDIS, 2006).

5 The existence of *Alburnus scoranza* is undocumented in Greece. A species regarded as *Alburnus alburnus* was detected within the Greek part of the Aoos (ECONOMOU *et al.,* 2007) and is tentatively given the provisional operational name *A.* cf. *scoranza* here, since the only *Alburnus* species in the immediate vicinity and within the Southern Adriatic biogeographic region is *A. scoranza* (K&F 2007).

6 *Alburnus* sp. Volvi is an unnamed taxon very similar to *Alburnus alburnus.* Specimens only from L. Volvi and L. Kerkini (Strymon basin) were collected in a first provisional description (FREYHOF & KOTTELAT, 2007a).

7 *Alburnus thessalicus* belongs to the *Alburnus alburnus* complex with four taxa in Greece (*A. thessalicus, A. macedonicus, A.* sp. Volvi, *A. alburnus*) (K&F 2007). These taxa share many characteristics and may be difficult to identify in the field.

8 *Barbus balcanicus* populations in the lower Axios were formerly considered as both *Barbus peloponnesius petenyi* and *Barbus cyclolepis;* difficulty of identification of these fish on morphological grounds is noted in K&F 2007, but the species can be distinguished using molecular markers (KOTLÍK *et al.,* 2002).

9 *Barbus peloponnesius* is not recorded in Albania following K&F 2007, but there is recent evidence of its existence in the extreme southern part of the country (MARKOVA *et al.,* 2007).

10 *Barbus sperchiensis* has isolated populations in the Sperchios valley and in Northern Euboea (formerly considered *Barbus cyclolepis sperchiensis*), the Pagasiticos Gulf's Cholorema basin (formerly considered *B. cyclolepis cholorematicus*) and in Thessaly (formerly considered *Barbus cyclolepis strumicae*) (ECONOMIDS & BOGUTSKAYA, 2003). This unusual distribution straddles a biogeographic boundary and includes insular populations on Euboea Island.

11 *Carassius auratus* is frequently confused in the literature with *Carassius gibelio*, which was formerly treated as "a wild feral form of *C. auratus*" (K&F 2007). The taxonomic entity of *Carassius auratus* (the goldfish) is not present as an independent taxonomic unit in ECONOMIDIS (1991) although it is present in BOBORI & ECONOMIDIS (2006).

12 The status of *Carassius gibelio* with respect to its being native in Greece is still unresolved and controversial; we adopt its status "as probably native" only in the Strymon and the Evros following ECONOMIDIS (1991). There is considerable doubt as to this species native status in southeast Europe, although populations have long been naturalized.

13 The status of *Cyprinus carpio* with respect to its being native to Greece is unclear; natural populations have probably been established and are naturalized for centuries. We adopt this species status as "native" in Thessaly, Macedonia, and Thrace according to ECONOMIDIS (1991).

14 The existence of *Gobio skadarensis* is undocumented in Greece. The species

found inhabiting the Aoos (ECONOMOU *et al.,* 2007) is tentatively given the operational name *Gobio* cf. *skadarensis* in this list since the only known *Gobio* sp. in the immediate vicinity and in the South Adriatic biogeographic region is *Gobio skadarensis,* previously referred to as *Gobio gobio albanicus* (Š ANDA *et al.,* 2005).

[15] *Phoxinus phoxinus* was until recently the only species in this genus in Greece. K&F 2007 present a new *Phoxinus* species in the Strymon (*Phoxinus strymonicus*), but no classification is provided for the *Phoxinus* populations of Aliakmon, Loudias, Nestos, Filiouris and Evros; although they state that "*Phoxinus* populations in the Loudias and Filiouris drainages are possibly conspecific". The aforementioned authors do not give *Phoxinus phoxinus* as inhabiting any area in the southern Balkan river basins or in Greece. Pending an accurate description of the unclassified populations we propose the fish not in the type locality river (Strymon) be provisionally termed *Phoxinus* cf. *phoxinus*.

[16] *Romanogobio elimeius* may possibly include a very similar-looking rheophilic gudgeon called *Romanogobio kessleri banarescui* (ECONOMIDIS, 1991); K&F 2007 were "unable to dististinguish *R. banarescui* and *R. stankovi* from *R. elimeius* on the basis of the available literature and material and therefore tentatively treat them as synonyms".

[17] *Rutilus* sp. Sperchios was observed in the lower Sperchios in the late '90s but was never described. Only two small-sized specimens were collected in 1997 (K&F 2007); this taxon needs immediate study.

[18] *Squalius* cii was first proposed as a tentative name for the *Squalius* of Lesbos (STOUMBOUDI *et al.,* 2006) although K&F 2007 refers to this population as *Squalius* cf. *cii.* Unidentified Leucisinae called "*Leuciscus cephalus*" (BIANCO, 1990) also exist on Samos.

[19] The identity of the *Squalius* in the Ionian river basins is controversial and unresolved. Formerly these chubs were given as *Leuciscus cephalus* but it is certain that the chubs west of the Pindos are different species. In the distributional compilation we refer to nearly all "Ionian chubs" by the provisional operational name *Squalius* cf. *peloponnensis* although we do give the specific three taxa proposed by K&F 2007 in the specific recorded basins. Despite considerable amount of genetic work (IMSIRIDOU *et al.,* 1997, 1998, 2000; DOADRIO & CARMONA, 1998, 2003; SANJUR *et al.,* 2003; ZARDOYA *et al.,* 1999; DURAND *et al.,* 1999b, 2000), further taxonomic research involving populations from northern and south-western Peloponnese as well as from the Epirus rivers is needed to resolve the problem of *Squalius* species distinction in the Ionian basins.

[20] *Squalius moreoticus* described as *Leuciscus cephalus moreoticus* by STEPHANIDIS (1939) was originally considered as being confined to Lake Stymphalia. K&F 2007 give a wider distribution for this taxon (i.e. including Vouraikos R. in the northern Peloponnese). We tentatively limit the *S. moreoticus* distribution to the aforementioned lake but its current status is undefined, as the originally described taxon may be extirpated or even extinct. The lake completely dried-out in the early 1990s and the present population hosted in the lake may have been introduced from another basin – as purported by

local fisherman.

[21] *Squalius pamvoticus* was described by STEPHANIDIS (1939) as *Leuciscus cambeda* var. *pamvoticus* presumably confined to Lake Pamvotis. K&F 2007 give a wider distribution for this taxon, including nearly all the rivers of Epirus (except Aoos). Care is needed in the classification of populations in the rivers of Epirus; and pending further taxonomic evidence we treat the Epirus river taxa as *Squalius* cf. *peloponnensis* (STEPHANIDIS, 1939 considered these populations as *Leuciscus cephalus peloponnensis*). The taxonomy and distribution of *Squalius pamvoticus* needs immediate attention.

[22] *Squalius* sp. Evia was previously considered as a distinct form of *Leuciscus cephalus vardarensis.* This taxon name is provisionally given for specimens from the Manikiotikos R. on Euboea island. The classification of *Squalius* populations in the streams of northern Euboea remains unresolved (although we tentatively place the fish from the Kireas R. under this taxon name in the distributional accounts). Evia should be spelled Euboea, the anglicised classical rendition often used in the scientific bibliography.

[23] *Squalius* sp. Evinos was proposed as a tentative taxonomic unit by K&F 2007 for *Squalius* populations inhabiting Mornos, Evinos and Acheloos. This taxon is morphologically very similar to some populations of *Squalius peloponnensis.*

[24] *Coregonus* cf. *lavaretus* requires identification due to recent taxonomic changes in K&F 2007.

[25] *Salmo dentex* is mentioned as inhabiting Aoos (and possibility Alfios) in K&F2007. This species' existence in Greece needs confirmation.

[26] *Salmo farioides* is now formally considered as the dominant trout of western Greece, a different taxon from populations east of the Pindos. The population of the Alfios (Peloponnese) are isolated and in need of conservation-relevant taxonomic confirmation (K&F2007).

[27] *Salmo macedonicus* is not recorded as a species inhabiting the Greek territory in K&F 2007. These authors do not give distributional information or the identity of trout in the Strymon, Nestos or Evros; however, in previous works the taxon *S. trutta macedonicus* has been described in these areas (KARAMAN, 1927). We use the tentative name of *S.* cf. *macedonicus* to refer to the fish inhabiting the aforementioned basins. Confirmation of this taxon's presence and its distribution in Greece is needed.

[28] *Salmo* sp. Louros is one of the most surprising new "taxa" described from the Louros R. DELLING (2003) refers to this fish as *Salmo louroensis* a name not accepted by K&F 2007.

[29] Varieties of farmed *Salmo trutta* from European hatcheries have been introduced into Greek waters particularly near fish-farming units.

[30] The systematic status of *Atherina boyeri* populations has been recently questioned. Molecular data (KLOSSA-KILIA *et al.,* 2007) reveal deep genetic divergence between marine populations of *Atherina boyeri* and those living in lagoons and lakes, possibly indicating the existence of cryptic or sibling species.

[31] *Gambusia holbrooki* has replaced former claims of *Gambusia affinis* in Greece. K&F 2007 state that there is no confirmed record of *G. affinis* in Europe.

[32] *Poecilia* cf. *latipinna* has tentatively been identified as the alien aquarium escapee which is abundant in Vouliagmeni L., Attiki (KOUTSIKOS pers. comm.); formerly this species was described as *Poecilia sphenops* (CHINTIROGLOU *et al.,* 1996).

[33] The marine family Syngnanthidae is poorly documented in freshwaters in Greece. BOBORI & ECONOMIDIS (2006) provide five species of this family in their freshwater fish fauna list. Pending new information that confirms that these species actually reside for long periods in freshwaters we retain only *Sygnathus abaster* in this list, as did ECONOMIDIS (1991).

[34] To our knowledge *Zingel balcanicus* has not yet been collected within the Greek territory but records are from very near the border in FYR Macedonia. This species is difficult to collect and it is assumed that it is almost definitely present in Greek waters, probably as far as Axioupolis, as stated by K&F2007. The species is also included within the freshwater fish faunal list of BOBORI & ECONOMIDIS (2006).

[35] The *Knipowitschia* population in the lower Evinos R. was formally referred to as *Knipowitschia panizzae* (AHNELT & BIANCO, 1991) but this is unconfirmed; perhaps an unidentified taxon (or taxa) of *Knipowitschia* exists in several areas of western Greece (MILLER *et al.,* 2004b).