

Introduced and translocated fish species in the inland waters of Greece

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Abstract Over the last 7 decades, 23 exotic fish species have been introduced into the inland waters of Greece. Some introductions were deliberately planned to take advantage of particular ecological or economic qualities of the species concerned. These include rainbow trout, *Oncorhynchus mykiss* (Walbaum), Pacific salmon, *Oncorhynchus* sp., vendace, *Coregonus lavaretus* (L.), grass carp, *Ctenopharyngodon idella* (Valenciennes), and silver carp, *Hypophthalmichthys molitrix* (Valenciennes). Other introductions, such as that of pumpkinseed, *Lepomis gibbosus* (L.), and false rasbora, *Pseudorasbora parva* (Temminck & Schlegel), were unintentional. Further transfers were made of species between various basins within the country, including common carp, *Cyprinus carpio* L., tench, *Tinca tinca* (L.), crucian carp, *Carassius auratus gibelio* (Bloch), bitterling, *Rhodeus amarus* (Bloch), and Aristotle's catfish, *Silurus aristotelis* Garman. Some species have become fully acclimatized and have built up important populations. In other cases, the transfers and introductions have had considerable negative impacts, particularly where introduced species have outcompeted native forms, as in the cases of the mosquito fish, *Gambusia affinis* (Baird & Girard), versus Greek toothcarp, *Valencia letourneuxi* (Sauvage), in the western Greek marshes, and of Aristotle's catfish versus the wels, *Silurus glanis* L., in Lake Volvi.

KEYWORDS: Greece, inland waters, introductions.

Introduction

The introduction of exotic species and the translocation of native species from one drainage system to another in the same country are widely accepted methods for enhancement of many natural waters around the world (Cowx 1998). Some species, such as carp, *Cyprinus carpio* L., and rainbow trout, *Oncorhynchus mykiss* (Walbaum), having been assumed to have little environmental impact, have proved to be helpful for increasing fishery production, especially in

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new water bodies (i.e. reservoirs), or natural waters with poor fish community and/or low fish productivity. Apart from these intentional introductions, many exotic species often appear in natural waters where these fish were unknown before. This could be the result of accidents, such as the careless release of live specimens from home aquaria or escapes from nearby aquaculture units, the negligent transfer of fertilized eggs of unknown species during stocking, the opening of channels, or undocumented stocking (Cowx 1998). Recent investigations and practices have shown that these last actions are harmful to native species in many cases, especially when they are endemic. In Greece, a total of 23 primary or primary-like exotic fish species have been introduced as eggs, fry or fingerlings for different purposes over the last 7 decades. Some of these fish have been used only in closed systems (e.g. as ornamental species or for intensive aquaculture), while others have been released into the open inland waters of the country. Additionally, 15 native species have been translocated from their original system to elsewhere in the Greece.

The aim of the present paper is to describe all these introduced species, and to annotate their ecological and economic influence, if any.

Materials and methods

The introduction of exotic fish species into Greek fresh waters (rivers and lakes) as a management tool commenced in the 1920s (Livadas & Sfagos 1940, Stephonidis 1950). Additionally, recent information was collected by official Greek authorities [e.g. the Ministry of Agriculture, the Fishery Service and their departmental bureau, Municipal Enterprises, and Lake Pamvotis Hatchery (DELI)] and other organizations involved with this matter. A large number of specimens were also collected by staff of the Laboratory of Ichthyology, School of Biology, Aristotle University, Thessaloniki, Greece, and the samples were deposited in its collection.

The classification and nomenclature follow Berg (1948), Lee, Gilbert, Hocutt, Jenkins, McAllister & Stauffer (1980), Daget, Gosse & van de Audernaerde (1986) and Kottelat (1997).

Results

In the following section, the available information about introduced and translocated species is given (see also Table 1). The localities referred to in the text are shown in Figure 1.

Introduced species – Acipenseridae

Acipenser baeri Brandt, 1869: This species was introduced as eggs from Russia in 1997 into the Lake Pamvotis Hatchery (DELI) for rearing in closed systems. It is also regarded as an ornamental species.

Acipenser gueldenstaedtii Brandt & Ratzeburg, 1833: This species was introduced as eggs from Russia in 1997 into the Lake Pamvotis Hatchery (DELI) for the same purposes as the above species.

Table 1. Introduced and translocated fish species in Greece

Species	Native	Introduced	Translocated	Hatchery close systems	Free water releasing	Acclimatization	Origin
Acipenseridae							
<i>Acipenser baeri</i>		+		+			Asiatic
<i>Acipenser gueldenstaedtii</i>		+		+			Euro-asiatic
<i>Acipenser ruthenus</i>		+		+			Euro-asiatic
Polyodontidae							
<i>Polyodon spathula</i>		+		+			American
Salmonidae							
<i>Oncorhynchus kisutch</i>		+		+	+	Doubtful	American
<i>Oncorhynchus mykiss</i>		+		+	+	Unsuccessful	American
<i>Salmo salar</i>		+		+			European
<i>Salmo trutta</i>	+		+	+	+	Successful	European
<i>Salvelinus fontinalis</i>		+		+	+	Doubtful	American
Coregonidae							
<i>Coregonus lavaretus</i>		+		+	+	Successful problematic	European
Esocidae							
<i>Esox lucius</i>	+		+		+	Successful	European
Cyprinidae							
<i>Hypophthalmichthys nobilis</i>		+		+	+	Doubtful	Asiatic
<i>Carassius auratus</i>		+		+	+	Expected successful	Asiatic
<i>Carassius auratus gibelio</i>	+		+		+	Successful	European
<i>Ctenopharyngodon idella</i>		+		+	+	Doubtful	Asiatic
<i>Cyprinus carpio</i>	+	+	+	+	+	Successful	Euro-asiatic
<i>Hypophthalmichthys molitrix</i>		+		+	+	Doubtful	Asiatic
<i>Ladigesocypris ghigii</i>	+		+		+	Successful	Endemic
<i>Parabramis pekinensis</i>		+			+	Unsuccessful	Asiatic
<i>Pseudorasbora parva</i>		+			+	Successful	Asiatic
<i>Rhodeus amarus</i>	+		+		+	Doubtful	European
<i>Tinca tinca</i>	+	+	+		+	Successful	European
Siluridae							
<i>Silurus aristotelis</i>	+		+		+	Successful	Endemic
<i>Silurus glanis</i>	+	+		+	+	Successful	European
Clariidae							
<i>Clarias gariepinus</i>		+		+			African
Anguillidae							
<i>Anguilla anguilla</i>	+	+	+		+	Marine origin	European
Poeciliidae							
<i>Gambusia affinis</i>		+			+	Successful	American
Mugilidae							
<i>Mugil anguilla</i>	+	+	+		+	Marine origin	European
<i>Liza ramada</i>	+		+		+	Marine origin	European
Atherinidae							
<i>Atherina boyeri</i>	+		+		+	Expected successful	European
Gobiidae							
<i>Knipowitschia caucasica</i>	+		+		+	Successful	European
Centracanthidae							
<i>Lepomis gibbosus</i>		+			+	Successful	American
Cichlidae							
<i>Tilapia</i> sp. (hatchery stocks)		+		+	+	Expected unsuccessful	African
Percidae							
<i>Perca fluviatilis</i>	+		+		+	Successful	European

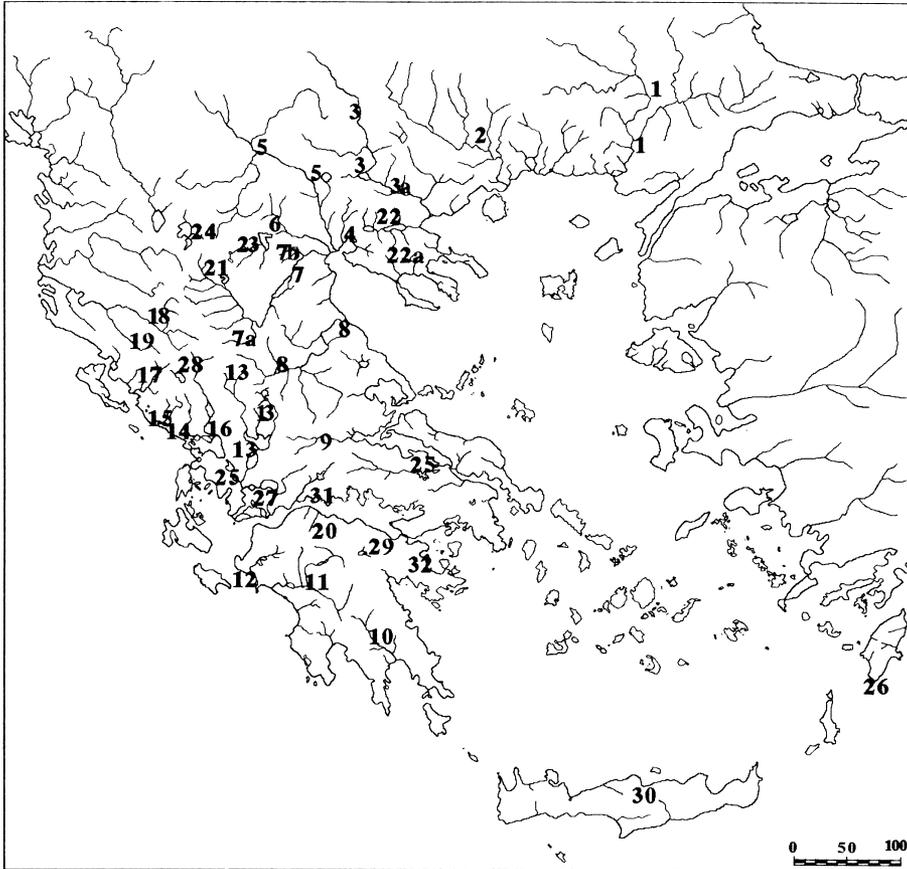


Figure 1. Map of Greece showing water drainage (scale in kilometres): (1) Evros River; (2) Nestos River and tributaries; (3) Strymon River (Kerkini dam-lake); (3a) Serres Town; (4) Gallikos River (near Thessaloniki); (5) Axios River (Lake Doirani); (6) Loudias-Edessaos River (Agras dam-lake and Edessa state hatchery); (7) Aliakmon River (Polyphyto, Sfikia and Asomaton dam-lakes); (7a) Venetikos River tributary; (7b) Tripotamos River and Arapitsa River tributaries; (8) Pineios River (Thessaly and Karditsa fish farms); (9) Spercheiros River (Lamia fish farms); (10) Evrolas River; (11) Alpheios River (Ladonas dam-lake); (12) Pineios River (Peloponnese and Ileia fish farms near Varda); (13) Acheloos (Aitolia, Tavropos dam-lake and Kremasta dam-lake forest hatcheries); (14) Louros River (state hatchery); (15) Aheron River; (16) Arachthos River (Arta hatcheries and fish farms); (17) Kalamas River; (18) Aoo River; (19) Voidomatis River; (20) Vouraiikos River (Kalavrita fish farm); (21) Kastoria Lake; (22) Koroneia Lake and Volvi Lake; (22a) Halkidiki Lake; (23) Vegoritits Lake (Petron, Heimaditis and Zazari); (24) Mikri Lake and Megali Prespa Lake; (25) Yliki Lake and Paralimni Lake; (26) Apolakkia dam-lake (Rodos); (27) Trichonis Lake (see also lakes Lysimacheia, Ozeros and Amvrakia); (28) Pamvotis Lake (DELI hatchery); (29) Stymphalia Lake; (30) Irakleio Lake (fish farm); (31) Riopesca Lake hatchery (Managouli and Phokis); and (32) Epidavros Lake (fish farm).

Acipenser ruthenus L., 1758: This species was introduced from Hungary in 1995 and 1996 into the Lake Pamvotis Hatchery (DELI) for the same purposes as the above two species. It is also reared in HELPA, a private fish farm in Neochori Arta.

Polyodontidae

Polyodon spathula (Walbaum, 1792): This species was introduced from Hungary in 1995 and from the USA in 1997 into the Lake Pamvotis Hatchery (DELI) for rearing in closed systems or as an ornamental fish.

Salmonidae

Oncorhynchus kisutch (Walbaum, 1792): This species was introduced as eggs from Canada into the Edessa state hatchery. Live specimens were released into Lake Vegoritis (Macedonia) and the Tavropos Reservoir (Thessaly) during the 1980s. It has also been used in some fish farms at Gorgopotamos (near Lamia) and in cage aquaculture in Lake Vegoritis.

Oncorhynchus mykiss (Walbaum, 1792): This species was initially introduced as eggs from Switzerland in the early 1950s, and the fingerlings were dispersed widely, mainly by state hatcheries at Louros and Edessa, into many rivers and oligotrophic lakes. However, only small populations, which have resulted from recent stocking, still live in some rivers and lakes. This species is also used in many intensive fish-farms and live specimens frequently escape to nearby open waters from these establishments. The species is of great economic importance to fish-farms, but not for enhancing fish production in natural waters.

Salmo salar L., 1758: This species was introduced after 1985 as eggs from Sweden for rearing into the Edessa state hatchery, and in some closed fish farms in central Greece (Gorgopotamos Lamia, Karditsa), the Peloponnese (Kalavrita) and Crete (Irakleion).

Salvelinus fontinalis (Mitchill, 1814): The eggs of this species were introduced into the Edessa state hatchery for incubation, and fingerlings were released in Lake Vegoritis (Macedonia) and the Tavropos Reservoir (Thessaly) during the 1980s. It is also used in aquaculture.

Coregonidae

Coregonus lavaretus (L., 1758): This species was introduced as eggs from Switzerland during the 1950s, and adapted in Lake Vegoritis (Macedonia) and later in the Tavropos Reservoir (Thessaly). Poor natural reproduction led to the repeated introduction of fingerlings from the Edessa state hatchery. However, the species can be considered useful for stocking appropriate natural waters because of its economic value and neutral ecological behaviour.

Cyprinidae

Carassius auratus (L., 1758): This species was introduced from China into the Lake Pamvotis Hatchery (DELI), where it was bred in close systems as an ornamental fish. However, during the stocking of *C. carpio* and *Ctenopharygodon idella* (Valenciennes) fry and/or fingerlings in Lake Lysimacheia, some were released accidentally and seem to have acclimatized there since this incident.

Ctenopharygodon idella (Valenciennes, 1844): This species was introduced into the Lake Pamvotis Hatchery (DELI) during the 1980s (Economidis 1991), and from there, into lakes Pamvotis, Lysimacheia (Aitolia) and Yliki-Paralimni (Beotia), the Appolakia (Rhodes island) and Ladonas reservoirs, and the rivers Alpheios (Peloponnese near Megalopolis) and Evros (Thrace near Tycheron and Soufli). In the 1990s, another introduction was made into Lake Lysimacheia, and in 1989, the Kandilas stream. It has made a similar ecological contribution to *Hypophthalmichthys nobilis* (Richardson).

Cyprinus carpio L., 1758: Although this species is considered to be native to Greece (Thessaly, Macedonia and Thrace), fingerlings from Italy (var. *specularis*) were initially introduced in lakes Pamvotis and Yliki (Stephanidis 1939a, b), and then to other lakes in the western part of the country (e.g. Amvrakia, Ozeros, Lysimacheia, Trichonis and Stymphalia). Other introductions and translocations have been made repeatedly since the 1950s in many natural lakes and reservoirs, and low parts of rivers, with fry and/or fingerlings from acclimatized or wild populations, including those from Israel, which were introduced in the 1980s. During the late 1980s and the 1990s, further introductions with fry or fingerlings belonging to the central European race (Hungary) were also made by the Lake Pamvotis Hatchery (DELI) into many natural lakes (e.g. Pamvotis, Kastoria, Vegoritida, Petron, Zazari, Heimaditis, Mikri Prespa, Koroneia, Volvi, Amvrakia, Trichonis, Lysimacheia and Yliki), reservoirs (e.g. Tavropos, Ladonas, Asomaton, Sfikia and Agras), and rivers or streams [e.g. Evros, Aliakmon, Tripotamos, Arapitsa, Alpheios of Peloponnese catchment (near Megalopolis) and Pineios of Thessaly]. It is almost impossible to be certain where wild, introduced or mixed populations are living. However, apart from the obvious massive hybridization of the wild race, which led to genetical pollution, these stockings have helped enhance the fish production of lakes, mainly where the fish community is poor (reservoirs) or the population of the species is decreasing as a result of overfishing.

Hypophthalmichthys molitrix (Valenciennes, 1844): The species was introduced to Bulgaria during the 1960s and escaped into the Greek parts of the rivers Evros and Strymon (Kerkini Reservoir), where specimens appeared in the 1970s (Economidis 1991). Brood stock was also used at the Lake Pamvotis Hatchery (DELI) in the early 1990s for artificial reproduction, and the rearing of fry or fingerlings. It has also been used for stocking in Lake Pamvotis, the Tavropos and Ladonas reservoirs, the River Alpheios of the Peloponnese catchment (near Megalopolis), and Lake Yliki-Paralimni (Beotia). This species has a role in the treatment of eutrophic aquatic ecosystems.

Hypophthalmichthys nobilis (Richardson, 1845): This species was introduced to the Lake Pamvotis Hatchery (DELI) during the early 1990s, and from there, to Pamvotis itself and Lake Yliki-Paralimni (Beotia). It makes a contribution to the ecological balance of eutrophic lentic ecosystems such as Lake Pamvotis.

Parabramis pekinensis (Basilewsky, 1855): This species was introduced into Lake Mikri Prespa by Albania in 1959 (Rakaj 1995). It is doubtful if it is acclimatized since captures have been very scarce.

Pseudorasbora parva (Temminck & Schlegel, 1842): This species was introduced accidentally in many European drainages including northern Greece. It is found in Lake Prespa and the River Aliakmon (Bianco 1988), and in the rivers Loudias and Axios, and Lake Koroneia (Economidis 1991). Field observation has shown that this species is in competition with fry of the riverine cyprinid fish for food.

Tinca tinca (L., 1758): This species was native to Greece (Thessaly, central Macedonia and Thrace). However, in 1926, live specimens were translocated from the River Loudias to Lake Kastoria (Athanasopoulos & Pellegrin 1934), and in 1929, other specimens were introduced from Italy in Lake Pamvotis (Stephanidis 1939b). After the 1950s, many repeated translocations and/or introductions were made in different natural lakes and reservoirs, and the lower parts of rivers. Recently, stocking with fingerlings of this species was undertaken in Lake Pamvotis and some tributaries of the River Aliakmon. The species shows a rather neutral ecological character and contributes to the enhancement of fish production in lakes.

Siluridae

Silurus glanis L., 1758: This species is native to Greece (Thessaly, Macedonia and Thrace). However, after introductions from Hungary in 1993, 1995 and 1996 by the Lake Pamvotis Hatchery (DELI), fry or fingerlings were released into the lake itself and the River Alpheios of the Peloponnese catchment (near Megalopolis). The species is also reared at some fish-farms (Naupaktos monastery) following the introduction of fingerlings from Holland.

Clariidae

Clarias gariepinus (Burchell, 1822): This species was introduced from Holland in 1993 and 1994 by a private hatchery and fish-farm near Neochori Arta (Epeiros). After 1996, rearing was stopped. No information is available about living specimens escaping.

Anguillidae

Anguilla anguilla (L., 1758): This species was widely distributed in the estuaries, rivers and lakes of Greece. However, elvers from France, England and Denmark were introduced after

1987 in many fish farms (Arta, Thessaloniki, Serres, Pella, Halkidiki and Phokis). In 1992, an introduction of elvers was also realized in Lake Pamvotis and further stockings have been made each year with elvers collected near the mouths of western Greek rivers. These stockings were made to reinforce the population in lakes after a decrease in the upstream movement of elvers.

Poeciliidae

Gambusia affinis (Baird & Girard, 1853): This species was introduced repeatedly from 1927 to 1937 from Italy and France by the Greek Ministry of Public Health for the biological control of mosquito larvae and was dispersed in almost all still waters (Livadas & Sfagos 1940). It is widely distributed in all marshes, including those of the islands. The species competes with *Valencia letourneuxi* (Sauvage), an endemic species in western Greece, especially in small and restricted habitats where these two species live sympatrically. This competition is expressed by aggressiveness which results in the erosion of the fins of the latter (Economidis unpublished data).

Centracanthidae

Lepomis gibbosus (L., 1758): This species was introduced accidentally in some areas of central Macedonia. It is found in the rivers Axios, Loudias and Gallikos, and reported in the rivers Strymon (Kerkini) and Evros, probably after the release of fry or fingerlings by the Bulgarians. Important populations have developed in all systems.

Cichlidae

Tilapia spp. (hatchery stocks): Undetermined species of hatchery stocks (possibly *Oreochromis niloticus* (L.) hybrids) have been introduced repeatedly from Israel and Scotland (Institute of Aquaculture, University of Stirling, Stirling) since the early 1980s in some fish-farms in Varda and Epidaurus (Peloponnese), Arta (Epeiros), and in the Naupaktos monastery (Aitolia and Sterea Ellas). Live specimens have been released into the naturally hot waters of Thermopyles (near Lamia) and the Kremasta Reservoir (River Acheloos drainage). The acclimatization of this species to the cold natural waters of the latter is expected to be unsuccessful.

Translocated species – Salmonidae

Salmo trutta L., 1758: Repeated stockings, with fry or fingerlings of this species reared in the Louros state hatchery, have been made since the early 1980s in many rivers including the Louros, Voidomatis and Aaos to enhance threatened natural populations. Translocations of fish from wild populations, which were incubated and reared in some Acheloos forestry hatcheries, were also made during the late 1970s into some tributaries of the River Nestos (i.e. the Arkoudorema and Diavolorema), and repeatedly from 1992 until 1995 into the Venetikos, a tributary of the River

Aliakmon (far away from the normal distribution of these genetically different stocks). The first of these unnecessary and harmful translocations has been detected genetically because the intruders breed with the wild local trout populations and gene transfer (genetic pollution) is taking place (Apostolidis, Triantaphyllidis, Kouvatsi, Economidis & Tsakalidis 1999).

Esocidae

Esox lucius L., 1758: This species is native to Thessaly, Macedonia and Thrace. It was translocated to Lake Kastoria during the 1930s (Stephanidis 1950).

Cyprinidae

Carassius auratus gibelio (Bloch, 1783): This species is considered to be native to the north-eastern part of the country (East Macedonia and Thrace), especially in Kerkini Reservoir. However, there is evidence that it could have been introduced even there. Since the 1950s, many translocations have been made in other natural lakes and reservoirs, and therefore, the fish is now present in almost all still and lowland running waters.

Ladigesocypris ghigii (Gianferrari, 1927): This species is endemic to the island of Rhodes, where it has been reported in streams near Kalavarda and Koskinou. During the last 70 years, many successful transplantations to other waters on the island have been made.

Rhodeus amarus (Bloch, 1782): This species is native to Thessaly, Macedonia and Thrace. It was introduced accidentally into Lake Ozeros (Akarnania) (Economidis 1991). There is no information about the acclimatization of this species in the lake.

Siluridae

Silurus aristotelis Garman, 1890: This species is endemic to Greece, exclusively in the River Acheloos catchment. It was initially introduced into Lake Pamvotis during the 1960s or earlier, and into Lake Volvi (Macedonia) in 1986 (Economidis 1991). In the latter case, the introduced species has restored an exploited population which had competed with the native population of European wels (*S. glanis*), leading to its extinction.

Mugilidae

Mugil cephalus L., 1758: In 1995 and 1996, this marine fish was used for stocking lakes Koroneia, Volvi, Amvrakia and Pamvotis with wild fry or fingerlings reared in the private hatchery at Riopesca (near Naupaktos). Almost at the same time, fingerlings were introduced from Israel into a private fish-farm in Psathotopi near Arta (Epeiros).

Liza ramada (Risso, 1810): Like *Mugil cephalus* L., this species has been used for stocking lakes with wild fingerlings.

Atherinidae

Atherina boyeri Risso, 1810: Recently (1997), initiatives have been undertaken to stock the Tavropos Reservoir from Lake Trichonis with this species (Economidis, Vasileiou, Michaloudi & Bobori, 1999).

Gobiidae

Knipowitschia caucasica (Kawrajsky, 1899): This species may have been accidentally transferred to Lake Trichonis, and perhaps, to Lake Pamvotis and other lakes as well (Economidis & Miller 1990).

Percidae

Perca fluviatilis L., 1758: This species was introduced into Lake Kastoria, possibly from Lake Koroneia, in the early 1930s, where it became acclimatized after some years (Stephanidis 1950). As a predator, it caused a decline in the herbivorous cyprinids, leading to an increase of aquatic plants and the prevalence of mosquitoes. Specimens from Lake Doirani were also released into Lake Volvi in 1986 and into Lake Kerkini (River Strymon) in 1988, where native populations of the species are found.

Discussion

The deliberate introduction of exotic fish species and the small-scale translocation of native ones are disputable actions for freshwater fishery management. However, in the past, such actions were common and only consider the quality of the fish species as food or as a biological control. This is still true to some extent. Such actions often resulted in a serious disturbance of the natural equilibrium and the normal cycles in the ecosystem. On the other hand, a young aquatic ecosystem, such as a newly constructed reservoir, often needs the establishment of an artificial fish community by means of the introduction of suitable species. In such a case, it is prudent to use native species. Nevertheless, several exotic fish species can be considered, especially when these have been proven to be planktonic and/or benthic feeders, and there is no proven impact on the native species or ecosystem. The same actions are also necessary for some disturbed (eutrophic) or impoverished communities. In any case, a fundamental study of the ecological functioning of the system and the anticipated ecological impact of the introduction is required beforehand (Cowx 1997). On the other hand, the introduction of exotic species may also result from dispersion when large scale public works, such as opening channels or constructing ditches for new irrigation systems, link existing aquatic systems. Other species can also appear after being released as part of a stock enhancement exercise for a different species or from aquaria when these fish are unwanted.

With regard to the wilful introduction and translocation of fish species in Greece, some apparently undesirable disturbances have been observed. The most noticeable have been caused by the perch, *P. fluviatilis*, and mosquito fish, *G. affinis*, (see above). Closely related

disturbances have been caused by Aristotle's catfish, *S. aristotelis*, which was carelessly introduced into Lake Volvi where the native population of European wels, *S. glanis*, lived, and the release of fingerlings of the River Acheloos wild trout species, *S. trutta*, into some tributaries of the rivers Nestos and Aliakmon. The full acclimatization in Greek waters of the accidentally transferred exotic sunfish, *L. gibosus*, and false rasbora, *P. parva*, have also been harmful for native species.

However, in many other cases, the introduction of exotic species and the translocation of native fish have been beneficial. The most important introductions have been of common carp, *C. carpio*, and tench, *T. tinca*, which have contributed to the enhancement of fish production in some lakes where a fish fauna was lacking or impoverished. The same is also true for the Asiatic carps (i.e. *Ctenopharyngodon* and *Hypophthalmichthys*), especially in hypertrophic lakes (i.e. Lake Pamvotis), and rainbow trout, *O. mykiss*. The introduction of the other American salmonids has been of little importance. Finally, the introduction of fingerlings of some marine species (e.g. mullet, *Mugil* spp.) is expected to be beneficial for the management of fish populations in lakes and no obvious ecological trouble has been predicted.

Besides the introduction of live specimens in the natural waters of Greece, there is increased activity in rearing economically important fish in closed systems. Despite taking precautions to prevent the escape of species into free waters, this possibility cannot be excluded. Therefore, any such management should be directed towards preventing this scenario.

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