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Freshwater fish introductions in Spain: facts and figures at the beginning of the 21st century

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Twenty-five introduced fish species are established in Spanish fresh waters. Most of the introductions took place after 1900, with a significant exponential increase during the second half of the 20th century (15 species introduced from 1949). Major stocking efforts in Spanish waters have been suspended, but recently some species have been released by anglers or are suspected to be escapes from fish farms. Stream regulation is considered to be one of the main negative factors affecting river ecosystems in Spain, but many of the aliens adapt well to these altered habitats. Competition between native and exotic fishes is certain to occur to some degree, but there is little quantitative information. Fish conservation and fishery management must not be based on the ' introduce anything ' sentiment that has developed over more than a century. Information, education and public awareness are critical components of any effort to prevent the spread of introduced fish species.

Key words: alien; conservation; exotics; invasions; management; Spain.

INTRODUCTION

Biological invasions have caused considerable disruption to native ecosystems around the world (Rainbow, 1998; Williamson, 1999; Mooney & Hobbs, 2000). Elton (1958) seems to have been the first to review the ecological consequences of introduced species. Both the introductions of alien species and the loss of natural habitats are the main factors responsible for the extinction of animal species in the last centuries. Aquatic ecosystems disturbed by human activities seem to be particularly vulnerable to these invasions (Welcomme, 1992; Moyle & Light, 1996; Claudi & Leach, 1999).

Among vertebrates, introductions of freshwater fish species have been among the most numerous. Consequently, introduction of exotic freshwater fishes is one of the main threats to the survival and genetic integrity of native fishes around the world (Bruton, 1995; Moyle, 1997; Cowx, 1998; Gido & Brown, 1999). Moyle *et al.* (1987) have labelled the impact of introduced fishes on native species as the ' Frankenstein effect ' because the consequences of introductions tend to be negative in unpredictable ways.

There are *c.* 40 exotic fish species introduced in Europe, and many more have been translocated among European countries (Holcík, 1991; Welcomme, 1991; Cowx, 1997; Kottelat, 1997; B. Elvira, pers. obs.). In Spain, acclimatization of exotic freshwater fishes in rivers is probably one of the most important negative factors affecting the survival of the native (mostly endemic) species (Elvira, 1990,

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TABLE I. Exotic species acclimatized in Spain, including date and purpose of introduction

Species	Date of introduction	Purpose of introduction
Cyprinus carpio	17th century	Ornament
Carassius auratus	17th century	Ornament
Gobio gobio	Late 19th century	Aquaculture (farm escape)
Oncorhynchus mykiss	Late 19th century	Angling
Salvelinus fontinalis	Late 19th century	Angling
Rutilus rutilus	1910–1913	' Improvement ' of wild stocks
Scardinius erythrophthalmus	1910–1913	' Improvement ' of wild stocks
Ameiurus melas	1910–1913	' Improvement ' of wild stocks
Lepomis gibbosus	1910–1913	' Improvement ' of wild stocks
Gambusia holbrooki	1921	Mosquito control (malaria)
Esox lucius	1949	Angling
Micropterus salmoides	1955	Angling
Hucho hucho	1968	Angling
Fundulus heteroclitus	1970–1973	Aquarists (release)?
Silurus glanis	1974	Angling
Perca fluviatilis	1970–1979	Angling
Stizostedion lucioperca	1970–1979	Angling
Oncorhynchus kisutch	1983–1984?	Aquaculture (farm escape)
Cichlasoma facetum	1980–1986?	Aquarists (release)?
Alburnus alburnus	1992	Angling (forage species)
Acipenser baerii	1995	Aquaculture (farm escape)
Abramis bjoerkna	1995	Angling (forage species)
Ictalurus punctatus	1995	Aquaculture (farm escape)
Aphanius fasciatus	1997	Aquarists (release)
Poecilia reticulata	2000	Aquarists (release)

1995*a*, *b*, *c*, 1996, 1997, 1998, 2001). The aim of this paper is to review the current status of freshwater fish introductions in Spain. Recent changes are described and the impact of alien species on native fishes is analysed. Likewise, several guidelines and recommendations are provided.

MATERIALS AND METHODS

Data of introductions refer to continental Spain, and are new or reported formerly by Doadrio *et al.* (1991), Elvira (1995*a*, *b*, 1997, 1998, 2001, pers. obs.) and Doadrio (2001) where references are listed. Statistica software package (Version 5.1) was used to estimate the parameters of the exponential function.

FISH INTRODUCTIONS IN SPAIN

Twenty-five exotic species have become established in Spanish freshwater ecosystems (Table I). They represent *c.* 30% of the current freshwater fish fauna list. Neighbouring countries also show a similar level of disturbance, but proportional to the size of their respective territories: 12 exotic species in Portugal (Almaça, 1995), 23 in Greece (Economidis *et al.*, 2000), 25 in Italy

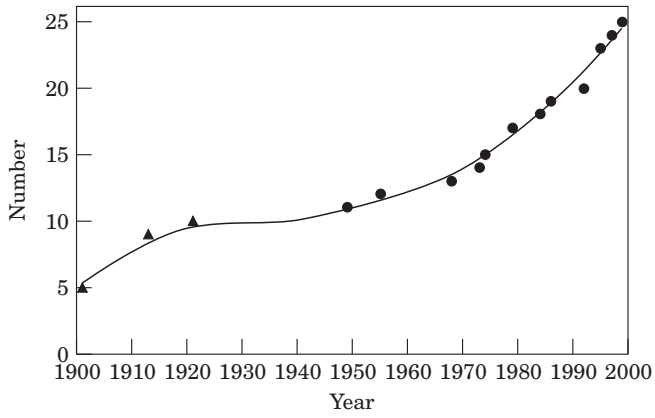

FIG. 1. Accumulative number of exotic fish species acclimatized in Spain during the first (▲) and second half (●) of the 20th century (exponential fit to the latter half of the century: $y=7{\cdot}522\text{e-}14^{(0{\cdot}017x)}$; $r^2=0.92$; $P<0.001$; $n=12$).

(Bianco, 1998) and 26 in France (Keith & Allardi, 1998). Introductions are also a noteworthy cause of disturbance in other areas of the Mediterranean region (Crivelli, 1995; B. Elvira, pers. obs.).

Most of the exotic fish species were introduced into Spanish waters during the 20th century and many of them were stocked for sport fishing. Similarly, the number of aliens show a significant exponential rate of increase during the latter half of that century (Fig. 1). White bream *Abramis bjoerkna* (L.) is one of the most recently acclimatized species, reported in the Ebro River basin in 1995, and a little later in several places in eastern and south-eastern Spain. Two other exotic species have been found in Spain from 1995, the Siberian sturgeon *Acipenser baerii* Brandt in the Ebro, Douro, Guadalquivir (Elvira & Almodóvar, 1999) and Júcar basins, and the channel catfish *Ictalurus punctatus* (Rafinesque) in the Ebro River. The last acclimatized species seem to be the Mediterranean toothcarp *Aphanius fasciatus* (Valenciennes), found in the Ebro delta since 1997, and the guppy *Poecilia reticulata* Peters, apparently established in the Mijares River (eastern Spain) in 2000.

Conversely, some introductions seem to have failed. For instance, a pilot study of stocking was carried out with the grass carp *Ctenopharyngodon idella* (Valenciennes) in south-eastern Spain during the nineties, but its current survival is unknown. Furthermore, one specimen of the oscar cichlid *Astronotus ocellatus* (Agassiz) was found in 1996 in the Guadalquivir River, and some isolated specimens of red piranha, *Pygocentrus nattereri* Kner, in Spanish open waters in 1997. The acclimatization of these two species in the Iberian Peninsula also seems unlikely.

ORIGIN OF INTRODUCTIONS

Alien fishes have been introduced for a variety of reasons in Spain: ornament, sport, aquaculture, biological control and by accident (Table I). In some cases fish introductions were carried out for more than one reason. The first stockings

were administrative decisions for sport fishing; the last official introduction of a new fish species was the huchen *Hucho hucho* (L.) in 1968. Later, during the last 30 years, new species have been released mainly by anglers or aquarists. Recent introductions have been made by private individuals or have resulted from escapes into the wild.

There are a number of pressures that currently increase the potential for unwanted impacts from introduced fishes. One of these is the large number of fish hobbyists, and the habit of selling or exchanging specimens or releasing them in public waters. Likewise, there is an increasing interest by anglers for new species, hatchery support of existing populations, and in angling opportunities where none existed previously. Baitfish are still commonly used, and ongoing transfer of them from one area to another occurs. Another problem is the escape of species transferred or imported for aquaculture.

Often the introduction of one species produces the need to introduce further species. Following introduction of major predators into fish communities which are not adapted to heavy predation, the decline in native species is such that it has often been assumed to be necessary to introduce a forage species more closely adapted for life with the predators. In fact, the introduction and spread of major predators, such as the pike *Esox lucius* L., largemouth bass *Micropterus salmoides* (Lacépède), wels catfish *Silurus glanis* L., European perch *Perca fluviatilis* L., zander *Stizostedion lucioperca* (L.), created the need to introduce and spread forage species, such as gudgeon *Gobio gobio* (L.), roach *Rutilus rutilus* (L.), rudd *Scardinius erythrophthalmus* (L.), pumpkinseed *Lepomis gibbosus* (L.), bleak *Alburnus alburnus* (L.), and white bream which are more closely adapted to survive alongside the predator.

A range of reasons are cited for introducing fish species for the ' improvement ' of wild stocks. The major motivation is to introduce some element that is perceived as lacking from the fauna of a water body. This is usually termed to fill a ' vacant niche ' or some variant of this. Although not strictly in line with the niche concept, which sees the niche as a property of the organism, the idea of a vacant niche is used to describe the perception that there are resources within a water body which are not being used efficiently for lack of a suitable species. It usually applies in Spain to new habitats such as reservoirs or regulated rivers, where the native fauna lacks elements competent to establish themselves in the new water body.

Fortunately, translocation of native fishes is an unusual practice in Spain, where only a few species have been locally stocked in other basins outside their ranges. Artificial connections among river basins may be an important factor for translocations (Balon *et al.*, 1986), but large connections among Spanish river basins are still uncommon. The most relevant one, the Tagus-Segura transfer, caused the arrival of the goldfish *Carassius auratus* (L.), the gudgeon and the Tagus nase *Chondrostoma polylepis* Steindachner into the Segura River basin. This river connection is also responsible for the arrival of *C. polylepis* and calandino chub *Squalius alburnoides* (Steindachner) into the Júcar basin, and the bermejuela nase *Chondrostoma arcasii* (Steindachner) into the Guadiana basin. In addition, several other native species have been translocated by humans: *Phoxinus phoxinus* (L.) in northern Spain and Douro River basin, *Barbatula barbatula* (L.) in the Douro River basin, *Cobitis paludica* (de Buen) in the Nalón

and Douro River basins, and *Chondrostoma miegii* Steindachner in the Tagus River basin.

ECOLOGICAL IMPACTS OF NATURALIZED FISHES

Alien species may affect indigenous species by competing for resources, preying on native fauna, transferring pathogens, or significantly altering habitat. The impact of most introductions of fishes in Spain is still unknown. Particularly with naturalized fishes, it is often difficult, or in some cases almost impossible, to assign individual causes to specific impacts accurately, because frequently more than one is involved.

Many of the exotic species are large fish predators originally absent from the Iberian fauna, mainly wels catfish, pike, European perch, zander and largemouth bass. Their occurrence in Spanish waters can negatively affect native species such small minnows and loaches. Likewise, successful introductions of eastern mosquitofish *Gambusia holbrooki* (Baird & Girard), mummichog *Fundulus heteroclitus* (L.) and Mediterranean toothcarp *Aphanius fasciatus* are a potential threat by competition for the endemic toothcarps, *Aphanius iberus* (Valenciennes) and *Valencia hispanica* (Valenciennes). The introduction of a non-indigenous species may work synergistically with other factors, such as water diversion or pollution, to alter the population and distribution of native species. The factors are often cumulative and complementary. For example, habitat degradation may make a species more vulnerable to the introduction of non-native species.

Studies of interactions between alien and native fish fauna are still scarce. Evidence for exotic fish predation on native fishes includes some feeding studies based on stomach content analyses. Rincón *et al.* (1990) researched the negative effects of pike introduction on the native fish assemblages in the Duero River basin. Pike also was the main cause of extinction of native fish fauna in the National Park of Daimiel (Elvira & Barrachina, 1996) and in the Natural Park of the Ruidera Lakes (Almodóvar & Elvira, 1994; Elvira *et al.*, 1996). A similar case, but on a lower scale, could happen with the largemouth bass (Nicola *et al.*, 1996).

Hybridization between released and resident fishes involves genetic risks which vary with the genetic characteristics of each population, the proportion of stocked to resident individuals and the potential for introgression following hybridization. Likewise, many years of stocking practices with allochthonous brown trout *Salmo trutta* L. produced different levels of introgression in Spanish wild populations of brown trout (García-Marín & Pla, 1996; Cagigas *et al.*, 1999; García-Marín *et al.*, 1999). In particular, Machordom *et al.* (1999, 2000) have found a current high level of introgression in brown trout populations in central Spain after many years of stocking with allochthonous specimens.

Many fish communities are currently highly disturbed by the spread of aliens. In fact, the exotic species are now dominant in number and biomass in middle-upper river sections of the Tagus (Elvira *et al.*, 1998) and the Guadiana (Almodóvar & Elvira, 1994; Elvira & Barrachina, 1996), in the Banyoles Lake (García-Berthou & Moreno-Amich, 2000), and in the south-eastern Pyrenees watershed (Aparicio *et al.*, 2000). Likewise, eventual impact of introduced fishes

on other communities are still poorly known, but Braña *et al.* (1996) described the negative effect of stocked salmonids (*Salmo*, *Salvelinus*, *Oncorhynchus*) on amphibian (*Chioglossa*, *Salamandra*, *Triturus*, *Alytes*, *Bufo*, *Rana*) survival in mountain lakes of northern Spain.

PREVENTION AND PUBLIC AWARENESS

Potential risks related to intentional introductions of non-native species are reduced by careful consideration of an introduction before it occurs. As a means of evaluating proposed introductions, a number of protocols have been developed. Examples of protocols that may serve as guidelines for satisfactorily addressing environmental concerns include EIFAC (Turner, 1988), ICES (FAO, 1995) and IUCN (IUCN, 2000).

Education may be the most effective means of reducing the risk associated with specific introduction pathways, e.g. aquarium and baitfish releases. This education is not solely the responsibility of public administrations, either financially or otherwise. The case of baitfish introductions illustrates how education has the potential to reduce the risk of introductions. To deal with such a problem, the most appropriate measure may be to seek an improvement in angler ethics through an educational programme to help anglers understand why the release of live baitfish can be costly and environmentally unsound. End users can be reached by providing educational materials through pet stores for aquarium organisms and with fishing licenses in the case of baitfish.

Information and education are critical components of any effort to prevent the spread of the introduced fish species in Spain. To prevent the negative effects of fish nuisance species, pathways of introduction and dispersal must be interrupted. A very important tool to do this is education to change behaviour, ensuring that all aquaculture workers, bait dealers, commercial fishing operators, aquarium hobbyists and anglers take preventative action. An additional relevant objective is to inform and to educate user groups and decision-makers on the environmental negative impacts of introduced species, and to involve policy makers on the need for significant increased funding to mitigate these impacts.

Many data on fish introductions compiled here are the result of many years of field work made by several teams of Spanish ichthyologists. Our warmest thanks and dedication to all of them.

References

Almaça, C. (1995). *Fish Species and Varieties Introduced into Portuguese Inland Waters*. Lisboa: Publicaçoes Avulsas do Museu Bocage.

Almodóvar, A. & Elvira, B. (1994). Further data on the fish fauna catalogue of the Natural Park of Ruidera Lakes (Guadiana river basin, central Spain). *Verhandlungen der Internationalen Vereinigung für Theoretische und Angewandte Limnologie* **25,** 2173–2177.

Aparicio, E., Vargas, M. J., Olmo, J. M. & de Sostoa, A. (2000). Decline of native freshwater fishes in a Mediterranean watershed on the Iberian Peninsula: a quantitative asessment. *Environmental Biology of Fishes* **30,** 359–368.

Balon, E. K., Crawford, S. S. & Lelek, A. (1986). Fish communities of the upper Danube River (Germany, Austria) prior to the new Rhein-Main-Donau connection. *Environmental Biology of Fishes* **15,** 243–271.

Bianco, P. G. (1998). Freshwater fish transfers in Italy: history, local changes in fish fauna and a prediction on the future of native populations. In *Stocking and Introduction of Fish* (Cowx, I. G., ed.), pp. 167–185. Oxford: Fishing News Books.

Braña, F., Frechilla, L. & Orizaola, G. (1996). Effect of introduced fish on amphibian assemblages in mountain lakes of northern Spain. *Herpetological Journal* **6,** 145–148.

Bruton, M. N. (1995). Have fishes had their chips? The dilemma of threatened fishes. *Environmental Biology of Fishes* **43,** 1–27.

Cagigas, M. E., Vázquez, E., Blanco, G. & Sánchez, J. A. (1999). Genetic effect of introduced hatchery stocks on indigenous brown trout (*Salmo trutta* L.) populations in Spain. *Ecology of Freshwater Fish* **8,** 141–150.

Claudi, R. & Leach, J. H. (Eds) (1999). *Nonindigenous Fresh Water Organisms: Vectors, Biology, and Impacts*. Boca Raton, FL: Lewis Publishers.

Cowx, I. G. (1997). Introduction of fish species into European fresh waters: Economic successes or ecological disasters? *Bulletin Francais de la Pêche et de la Pisciculture* **344–345,** 57–77.

Cowx, I. G. (1998). *Stocking and Introduction of Fish*. Oxford: Fishing News Books.

Crivelli, A. J. (1995). Are fish introductions a threat to endemic freshwater fishes in the northern Mediterranean region? *Biological Conservation* **72,** 311–319.

Doadrio, I. (2001). *Atlas y Libro Rojo de los Peces Continentales de España*. Madrid: Dirección General de Conservación de la Naturaleza.

Doadrio, I., Elvira, B. & Bernat, Y. (1991). *Peces Continentales Españoles. Inventario y Clasificación de Zonas Fluviales*. Madrid: Colección Técnica, ICONA.

Economidis, P. S., Dimitriou, E., Pagoni, R., Michaloudi, E. & Natsis, L. (2000). Introduced and translocated fish species in the inland waters of Greece. *Fisheries Management and Ecology* **7,** 239–250.

Elton, C. S. (1958). *The Ecology of Invasions by Animals and Plants*. London: Methuen.

Elvira, B. (1990). Iberian endemic freshwater fishes and their conservation status in Spain. *Journal of Fish Biology* **37**(Suppl. A), 231–232.

Elvira, B. (1995*a*). Freshwater fishes introduced in Spain and relationships with autochthonous species. In *Protection of Aquatic Biodiversity, Proceedings of the World Fisheries Congress, Theme 3* (Philipp, D. P., Epifanio, J. M., Marsden, J. E. & Claussen, J. E., eds), pp. 262–265. New Delhi: Oxford and IBH Publishing.

Elvira, B. (1995*b*). Native and exotic freshwater fishes in Spanish river basins. *Freshwater Biology* **33,** 103–108.

Elvira, B. (1995*c*). Conservation status of endemic freshwater fish in Spain. *Biological Conservation* **72,** 129–136.

Elvira, B. (1996). Endangered freshwater fish of Spain. In *Conservation of Endangered Freshwater Fish in Europe* (Kirchhofer, A. & Hefti, D., eds), pp. 55–61. Basel: Birkhäuser Verlag.

Elvira, B. (1997). Impacto y control de los peces exóticos introducidos en España. In *Conservación, Recuperación y Gestión de la Ictiofauna Continental Ibérica,* **1** (Granado-Lorencio, C., ed.), pp. 139–151. Sevilla: Publicaciones de la Estación de Ecología Acuática.

Elvira, B. (1998). Impact of introduced fish on the native freshwater fish fauna of Spain. In *Stocking and Introduction of Fish* (Cowx, I. G., ed.), pp. 186–190. Oxford: Fishing News Books.

Elvira, B. (2001). Peces exóticos introducidos en España. In *Atlas y Libro Rojo de los Peces Continentales de España* (Doadrio, I., ed.), pp. 267–272. Madrid: Dirección General de Conservación de la Naturaleza.

Elvira, B. & Almodóvar, A. (1999). A morphological study of native sturgeon Acipenser sturio in Spain, and recent records of exotic Siberian sturgeon *A. baerii. Journal of Applied Ichthyology* **15,** 278–279.

Elvira, B. & Barrachina, P. (1996). Peces. In *Las Tablas de Daimiel. Ecología Acuática y Sociedad* (Álvarez-Cobelas, M. & Cirujano, S., eds), pp. 171–185. Madrid: Colección Técnica, Organismo Autónomo Parques Nacionales.

Elvira, B., Nicola, G. G. & Almodóvar, A. (1996). Pike and red swamp crayfish: a new case on predator-prey relationship between aliens in central Spain. *Journal of Fish Biology* **48,** 437–446. doi:10.1006.jfbi.1996.0043.

Elvira, B., Almodóvar, A. & Nicola, G. G. (1998). Fish communities of the middle-upper Tagus river (central Spain): a story of river regulation and exotic introductions. *Polskie Archiwum Hydrobiologii* **45,** 165–171.

FAO. (1995). ICES code of practice on the introductions and transfers of marine organisms 1994. In *FAO. Precautionary Approach to Fisheries, Part 1. Guidelines on the Precautionary Approach to Capture Fisheries and Species Introductions*. FAO Fisheries Technical Paper **350**, pp. 35–40. Rome: FAO.

García-Berthou, E. & Moreno-Amich, R. (2000). Introduction of exotic fish into a Mediterranean lake over a 90-year period. *Archiv für Hydrobiologie* **149,** 271–284.

García-Marín, J. L. & Pla, C. (1996). Origins and relationships of native populations of *Salmo trutta* (brown trout) in Spain. *Heredity* **77,** 313–323.

García-Marín, J. L., Sanz, N. & Pla, C. (1999). Erosion of the native genetic resources of brown trout in Spain. *Ecology of Freshwater Fish* **8,** 151–158.

Gido, K. B. & Brown, J. H. (1999). Invasion of North American drainages by alien fish species. *Freshwater Biology* **42,** 387–399.

Holcík, J. (1991). Fish introductions in Europe with particular reference to its central and eastern part. *Canadian Journal of Fisheries and Aquatic Sciences* **48**(Suppl. 1), 13–23.

IUCN. (2000). *IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species*. Gland: SSC Invasive Species Specialist Group, IUCN.

Keith, P. & Allardi, J. (1998). The introduced freshwater fish of France: status, impacts and management. In *Stocking and Introduction of Fish* (Cowx, I. G., ed.), pp. 153–166. Oxford: Fishing News Books.

Kottelat, M. (1997). European freshwater fishes. *Biologia* **52**(Suppl. 5), 1–271.

Machordom, A., García-Marín, J. L., Sanz, N., Almodóvar, A. & Pla, C. (1999). Allozyme diversity in brown trout (*Salmo trutta*) from Central Spain: genetic consequences of restocking. *Freshwater Biology* **41,** 707–717.

Machordom, A., Suárez, J., Almodóvar, A. & Bautista, J. M. (2000). Mitochondrial haplotype variation and phylogeography of Iberian brown trout populations. *Molecular Ecology* **9,** 1325–1338.

Mooney, H. A. & Hobbs, R. J. (2000). *Invasive Species in a Changing World*. Washington D.C.: Island Press.

Moyle, P. B. (1997). The importance of an historical perspective: fish introductions. *Fisheries* **22,** 14.

Moyle, P. B. & Light, T. (1996). Fish invasions in California: do abiotic factors determine success? *Ecology* **77,** 1666–1670.

Moyle, P. B., Li, H. W. & Barton, B. (1987). The Frankenstein effect: impact of introduced fishes on native fishes of North America. In *The Role of Fish Culture in Fisheries Management* (Stroud, R. H., ed.), pp. 415–426. Bethesda: American Fisheries Society.

Nicola, G. G., Almodóvar, A. & Elvira, B. (1996). The diet of introduced largemouth bass, *Micropterus salmoides*, in the Natural Park of the Ruidera Lakes, central Spain. *Polskie Archiwum Hydrobiologii* **43,** 179–184.

Rainbow, P. (1998). Impacts of invasions by alien species. *Journal of Zoology* **246,** 247–248.

Rincón, P. A., Velasco, J. C., González-Sánchez, N. & Pollo, C. (1990). Fish assemblages in small streams in western Spain: The influence of an introduced predator. *Archiv für Hydrobiologie* **118,** 81–91.

Turner, G. E. (1988). Codes of practice and manual of procedures for consideration of introductions and transfers of marine and freshwater organisms. *FAO, EIFAC/ CECPI Occasional Paper* **23,** 1–44.

Welcomme, R. L. (1991). International introductions of freshwater fish species into Europe. *Finnish Fisheries Research* **12,** 11–18.
Welcomme, R. L. (1992). A history of international introductions of inland aquatic species. *ICES Marine Science Symposium* **194,** 3–14.
Williamson, M. (1999). Invasions. *Ecography* **22,** 5–12.