

Dams and fish passage facilities in the large rivers of Spain: effects on migratory species

By G. G. NICOLA, B. ELVIRA and A. ALMODÓVAR

With 1 table in the text

Abstract

The construction of dams in Spain has steadily increased during this century, with a peak between 1960 and 1990. Today, there are more than 1100 operating large dams. The presence of dams without fish passes in large rivers appears to be a major contributing factor in the decline of native fish, especially of migratory species. In fact, all anadromous and catadromous fish are presently threatened and included in the Spanish Red Data Book. Species such as lamprey, sturgeon, shads and eel are now extinct in wide areas of central Spain, due to the blockage of fish movements caused by dams built in large rivers. As part of an ongoing national project started in 1993, we researched the existence and effectiveness of fish passage facilities at Spanish dams. The main preliminary finding is that fishways are frequently absent in large dams, while fish ladders are the most common type of fish pass used in weirs. Additional mitigating measures to reduce the negative effect of dams on fish populations are also suggested.

Introduction

Stream regulation has exerted more profound and irrevocable effects on the character of the world's rivers than the effects of pollutants (WARD & STANFORD 1979). Dam construction appears to have had a greater impact upon riverine fishes than any other human activity (PETTS 1984). Nowadays, all major rivers in Spain are regulated by more than 1100 dams (MOPTMA 1992). MERMEL (1981) mentioned Spain as one of the countries where dam-building activity greatly increased during the last half of the 1970s. Nevertheless, this tendency changed during the 1980s (GARCIA DE JALON 1987).

Dams are considered to be one of the main negative factors affecting the native Spanish fishes (ELVIRA 1990, 1995, 1996, BLANCO & GONZALEZ 1992). Likewise, dams without some fish passage systems have disastrous effects on migratory fishes because of the "barrier-effect" to upstream and downstream migrations, apart from important changes in the habitat. Thus, all anadromous and catadromous fishes are considered as threatened in the Spanish (BLANCO & GONZALEZ 1992) and Portuguese (SNPRCN 1991) Red Books. This paper deals with the negative effects that dams which block large rivers have on the migratory Iberian fish species, and the consequent reduction of their ranges in Spain.

Methods

As a part of an ongoing national project started in 1993, we looked into the existence and effectiveness of fishways at Spanish dams. For this purpose, we first consulted the available information provided by hydropower developers, national resources agencies and national hydrographic institutions. Field work consisted of visits to dams, evaluating the fish passage facilities installed and other possibilities for those with ineffective devices.

Five Iberian rivers (Douro, Tagus, Guadiana, Guadalquivir and Ebro) were considered to be large rivers (PETTS 1989). Fish species researched were anadromous (*Petromyzon marinus*, *Acipenser sturio*, *Alosa alosa* and *Alosa fallax*), catadromous (*Anguilla anguilla*) as well as species of a representative family of euryhaline fishes (Mugilidae). Past distribution along the main river channels (data derived from MADOZ 1848 and Anonymous 1952), were compared with present ranges known from LOBON-CERVIA et al. (1989) and ALMAÇA (1990) for the Douro, ALMAÇA (1988) and ASSIS (1990) for the Tagus, ALMAÇA (1985, 1988) for the Guadiana, ELVIRA et al. (1991a) and GRANADO-LORENCO (1991) for the Guadalquivir, SOSTOA & LOBON-CERVIA (1989) for the Ebro, ELVIRA et al. (1991b) for *A. sturio* and DOADRIO et al. (1991) for all of Spain.

Results and discussion

Unfortunately, the absence of fish passage facilities at dams is still a common fact in Spain. Fish ladders are the usual structure utilized in weirs and most of these are situated in the north of the country due to the distribution of Atlantic salmon *Salmo salar*. Many of these devices are old and inefficient. Meanwhile, fishways of dams placed along the principal course of Spanish large rivers are scarce (Table 1).

In the River Douro there are five dams on the lower course (Portuguese section) provided with Borland locks. Nevertheless, these sluices seem to be inadequate for upstream migration of fishes (ALMAÇA 1990). The three fish passages (ladders) of the River Tagus are placed on the upper course, while dams without passes on the lower (Portuguese) and middle (Spanish) sections are blocking the migratory movements of fishes. There are no fishways on the seven dams of the principal course of the River Guadiana, but dams are located on the middle and upper course. Thus, some migratory fish are still able to cross the Portuguese and international sections, and reach Spanish waters, where they are finally blocked. Likewise, there is a project to build the Alqueva dam in the lower Portuguese course. If this dam is eventually built, it ought to have efficient fishways to allow fish migrations. The lowest dam of the River Guadalquivir has a fish ladder quite insufficient for upstream fish migration. Finally, in the lower River Ebro there are two dams, supplied with fish ladders and Borland locks respectively. This last system is clearly inadequate (it is always closed) and is a barrier for upstream fish migration.

With regard to the fishes, the sturgeon *Acipenser sturio* is a species in high danger of extinction for several causes, one of them being the dams without fish passes (ELVIRA et al. 1991a). It has nearly disappeared from the Iberian coast and rivers, where solitary specimens are currently found (ELVIRA & ALMODÓVAR 1993). The eel *Anguilla anguilla* was a very abundant fish throughout the large Spanish river basins, but due to dam construction it is presently absent from central Spain. Other migratory fishes (sea lamprey *Petromyzon marinus*, allis shad *Alosa alosa*, and twaite shad *A. fallax*) and euryhaline fishes (mulletts, family Mugilidae) were also common along the large rivers, but are currently declining due to the large dams without adequate

Table 1. Number of dams and fishways on the principal course of Spanish large rivers, together with the distribution in length (km) along the principal course (past, present and percentage decrease) of representative migratory fishes.

Variables and fishes	Rivers: Douro	Tagus	Guadiana	Guadalquivir	Ebro	Means
Dams/Fishways	25/5	19/3	7/-	11/1	30/5	
Length (km)	937	1 120	834	560	928	
Drainage basin (km ²)	98 375	80 629	67 561	56 978	83 093	
Fishes	Past/present	Past/present	Past/present	Past/present	Past/present	Past/present
<i>Petromyzon marinus</i>	495/60	372/170	704/322	358/106	337/117	-66%
<i>Acipenser sturio</i>	207/-	-/-	89/-	318/-	295/-	-100%
<i>Alosa</i> spp.	207/60	372/170	382/322	318/106	295/117	-54%
<i>Anguilla anguilla</i>	832/207	865/170	704/322	483/106	800/117	-74%
Mugilidae	207/60	325/170	89/89	358/106	295/117	-50%

fishways (Table 1). All the species concerned have lost an average of 50 to 100% of their range distribution in length along the Spanish large rivers (Table 1).

In conclusion, new further or alternative fish passage facilities have to be implemented on dams of the Spanish large rivers. Otherwise migratory fishes will continue their present decline and become in grave danger of extinction in the near future.

References

- ALMAÇA, C. (1985): Sobre alguns migradores anfibióticos da bacia do Guadiana. – Congr. sobre o Alentejo, Evora 2: 546–552.
- (1988): Fish and their environment in large European river ecosystems. Tejo and Guadiana. – Sciences de l'eau 7: 3–19.
- (1990): A lampreia e o esturjão na bacia do Douro. – Observatório 1: 377–382.
- Anonymous (1952): Las colecciones de peces de la Sección de Biología de las Aguas Continentales. – Bol. Inst. For. Inv. y Exp. 63: 1–140.
- ASSIS, C. A. (1990): Threats to the survival of anadromous fishes in the River Tagus, Portugal. – J. Fish Biol. 37(Suppl. A): 225–226.
- BLANCO, J. C. & GONZALEZ, J. L. (eds.) (1992): Libro Rojo de los Vertebrados de España. – ICONA, Colección Técnica, Madrid, 714 p.
- DOADRIO, I., ELVIRA, B. & BERNAT, Y. (eds.) (1991): Peces continentales españoles. Inventario y clasificación de zonas fluviales. – ICONA, Colección Técnica, Madrid, 221 p.
- ELVIRA, B. (1990): Iberian endemic freshwater fishes and their conservation status in Spain. – J. Fish Biol. 37(Suppl. A): 231–232.
- (1995): Conservation status of endemic freshwater fish in Spain. – Biol. Conserv. 72: 129–136.
- (1996): Endangered freshwater fish of Spain. – [In:] KIRCHHOFER, A. & HEFTI, D. (eds.): Conservation of Endangered Freshwater Fish in Europe: 55–61. – Birkhäuser, Basel.
- ELVIRA, B. & ALMODOVAR, A. (1993): Notice about the survival of sturgeon (*Acipenser sturio* L., 1758) in the Guadalquivir estuary (S. W. Spain). – Arch. Hydrobiol. 129: 253–255.
- ELVIRA, B., ALMODOVAR, A. & LOBON-CERVIA, J. (1991a): Sturgeon (*Acipenser sturio* L., 1758) in Spain. The population of the River Guadalquivir: a case history and a claim for a restoration programme. – [In:] WILLIOT, P. (ed.): *Acipenser*. – CEMAGREF Publ.: 337–347.
- (1991b): Recorded distribution of sturgeon (*Acipenser sturio* L., 1758) in the Iberian Peninsula and actual status in Spanish waters. – Arch. Hydrobiol. 121: 253–258.
- GARCIA DE JALON, D. (1987): River regulation in Spain. – Regulated Rivers: Research and Management 1: 343–348.
- GRANADO-LORENCIO, C. (1991): The effect of man on the fish fauna of the River Guadalquivir, Spain. – Fisheries Research 12: 91–100.
- LOBON-CERVIA, J., ELVIRA, B. & RINCON, P. A. (1989): Historical changes in the fish fauna of the River Duero basin. – [In:] PETTS, G. E., MÖLLER, H. & ROUX, A. L. (eds.): Historical change of large alluvial rivers: western Europe: 221–232. – John Wiley & Sons, Chichester.
- MADOZ, P. (1848): Diccionario geográfico-estadístico-histórico de España y sus posesiones de ultramar. – Biblioteca Santa Ana, Almadralejo (facsimile of the 3rd. edition, Madrid, 1989–92).
- MERMEL, T. W. (1981): Major dams of the World. – Water, Power and Dam Construction 34: 55–64.
- MOPTMA (1992): Inventario de presas españolas. – Dirección General de Obras Hidráulicas, MOPTMA, Madrid, 58 p.
- PETTS, G. E. (1984): Impounded rivers: perspectives for ecological management. – John Wiley & Sons, Chichester, 326 p.
- (1989): Historical analysis of fluvial hydrosystems. – [In:] PETTS, G. E., MÖLLER, H. & ROUX, A. L. (eds.): Historical change of large alluvial rivers: western Europe: 1–18. – John Wiley & Sons, Chichester.
- SNPRCN (1991): Livro vermelho dos vertebrados de Portugal. Vol. II. Peixes Dulciaquícolas e Migradores. – Secretaria de Estado dos Recursos Naturais, Lisboa, 55 p.

- SOSTOA, A. DE & LOBON-CERVIA, J. (1989): Fish and fisheries of the River Ebro: actual state and recent history. – [In:] PETTS, G. E., MÖLLER, H. & ROUX, A. L. (eds.): Historical change of large alluvial rivers: western Europe: 233–247. – John Wiley & Sons, Chichester.
- WARD, J. V. & STANFORD, J. A. (eds.) (1979): The Ecology of Regulated Streams. – Proc. First Internat. Sympos. on Regulated Streams, Erie, Pennsylvania. Plenum Press, New York, 398 p.

Address of the authors:

G. G. NICOLA, B. ELVIRA, Department of Animal Biology I, Faculty of Biology, University of Madrid, E-28040 Madrid, Spain. A. ALMODÓVAR, Department of Ecology, Agricultural Research Service, Community of Madrid, El Encín, P.O. Box 127, E-28800 Alcalá de Henares, Madrid, Spain.

Corresponding author: B. ELVIRA.