A strategy to enhance migratory fish species in the Weser River Basin according to the aims of the European Water Framework Directive

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Keywords: Weser, river morphology, migratory fish, hydro power, EU-WFD

1 Introduction

The Water Framework Directive (WFD) has revolutionised water resources management in Europe over the last decade by adjusting the sustainable use of water not only to the supply of human needs but also to the ecological integrity of surface water. With the river basin management plans that were published in December 2009 and adopted in most of the European river basin districts, this new broad integrative approach has reached another milestone. River-basin management plans comprise an overview of the river basin, an analysis of pressures and impacts, a cadastre of protected areas, the assessment of water bodies, strategies and objectives to reduce the effects of significant water management issues and a summary of the programme of measures.

But the ambitious objective to achieve a good ecological status or to develop a good ecological potential failed by more than 80% of surface water bodies as indicated by biological quality components like fishes, macrophytes or macrozoobenthos in the Weser River Basin (FGG Weser 2009). Long-distance migratory fish species account for about 20 % of all fish species whereas potamodromous species constitute up to 40% of the fish community in potamal and epipotamal river stretches in the Weser River Basin (FGG Weser 2006). Most of the migratory species are in bad conditions due to low quality of spawning habitats and a high density of obstacles cutting the river continuity (Pusch et al. 2009).

In the Weser River Basin the hydromorphological structures of the surface waters have been subject to significant changes during the 19th and 20th century, caused not only by measures of navigation, hydropower or flood defence, but also for agriculture and urban development as in other large European Rivers (Tockner et al. 2009). Modifications in the river-channel morphology as well as in hydrological dynamics have strong impacts on the ecological conditions especially on the quality, suitability and availability of habitats for aquatic organism (Carling & Petts 1992; Poff et al. 1999) and particularly on fish fauna (e.g. Bischoff 2002, Schiemer et al. 2001).

Therefore a strategy for the improvement of river continuity both at regional and river basin scale has to be developed in close cooperation with the authorities of water resource management and all the affected stakeholders to answer the following questions:

- Which are the migratory fish species (diadromous and potamodromous) of concern in the Weser River- Basin?
- Where are sufficient and adequate spawning and juvenile habitat areas?
- What are the migration routes and is their continuity disrupted by dams?
- How can priorities of measures set in the future?
- What is the way to share problems and management issues with the main affected stakeholders?

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2 The Weser approach

Since 1996 in the Weser River Basin the idea of enhancing existing populations of migratory fish species has been realized. In 2003 the Ministries of Environment competent for the Weser River Basin (River Basin Commission Weser) decided to develop a fundamental strategy as a basis for the basin wide objectives in implementing the WFD. Concrete environmental objectives regarding migratory fish species have been identified, and priorities of measures and areas have been derived considering specific ecological demands of diadromous and potamodromous species as well as the cost effectiveness of measures.

The River Basin Commission Weser has decided to develop an approach to deal with this task at different levels – at a river basin scale focusing on the supra-regional migration routes and at regional or local scale concentrating on continuity as well as on the spawning and nursery habitats in small streams and rivers. In a first step native migratory fish species have been selected (Tab. 1) analysing historical data about spawning areas and fisheries activities and defining a reference of fish fauna for each water body separately.

Table 1. *List of target migratory fish species of the Weser River Basin*

species	scientific name	migration type	mobility
river lamprey	*Lampetra fluviatilis*	anadromous	long distance
sea lamprey	*Petromyzon marinus*	anadromous	long distance
twaite shad	*Alosa fallax*	anadromous	long distance
Salmon lachs	*Salmo salar*	anadromous	long distance
sea trout	*Salmo trutta f. trutta*	anadromous	long distance
smelt	*Osmerus eperlanus*	anadromous	medium distance
Three spine stickleback	*Gasterosteus aculeatus*	anadromous	medium distance
Barbel	*Barbus barbus*	potamodromous	medium distance
Ide	*Leuciscus idus*	potamodromous	medium distance
Vimba	*Vimba vimba*	potamodromous	medium distance
Burbot	*Lota lota*	potamodromous	long distance
Eel	*Anguilla anguilla*	catadromous	long distance

In a second step, tributaries which provide suitable and accessible spawning and nursery habitats and which contribute to an ecological network of habitats of diadromous species and populations of potamodromous species have been identified. The migration routes in between were identified and classified in supra-regional routes (Weser and the lower parts of Werra and Fulda) and routes of regional importance. Fig. 1 presents the maximum setting of migration routes in the Weser River Basin; it encompasses all target species and approximately 1,900 km including 212 obstructions.

In a third step the function of fish passes was evaluated by technical criteria (DWA 2006) and need for action was classified for each obstacle separately. Additionally, improvements including cost estimates of each construction for better continuity were recommended. Availability of spawning nursery habitats was estimated with respect to the expected efficiency of fish pass function.

In a last step the relevance of each obstacle was estimated by criteria for anadromous, catadromous and potamodromous species separately (Tab. 2). Priorities of measures have been identified for each obstruction with respect to the ecological relevance and the need for action to improve fish migration. Priorities were classified in four categories and for up- and downstream migration separately.

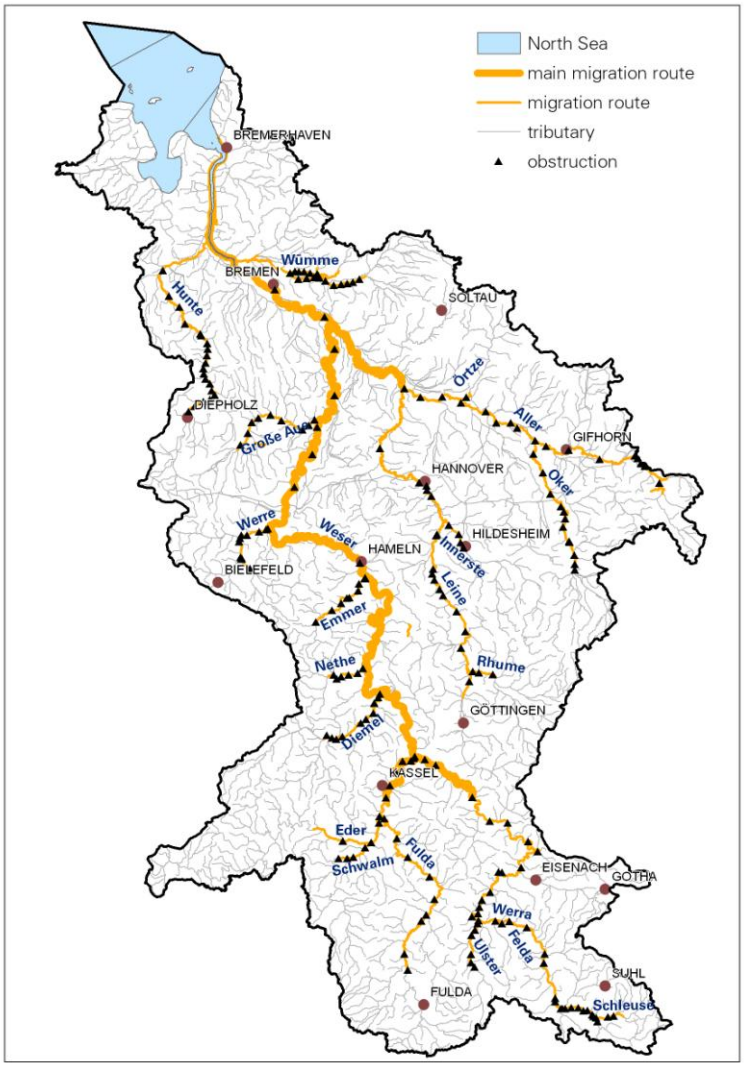

Figure 1. *Migration routes of basin wide interest in the Weser River Basin*

Table 2. *Criteria for assessing the relevance of each obstruction for the different migratory fish species*

	anadromous	**catadromous**	**potamodromous**
Potential of habitat network	Dimension and accessibility of potentially appropriate spawning and juvenile habitat areas upstream of the obstruction	Dimension of potential eel habitats upstream of the obstruction	Dimension of potential appropriate spawning and juvenile habitats Distance to the next reproductive population (stream effect)
Potential damages of downstream migration	Potential effects of damages at downstream migration caused by turbines	Potential effects of damages at downstream migration caused by turbines	-
Relevant assessment due to the EU-WFD	-	Part of the reference community in the water body upstream	Part of the reference community in the water body upstream

	anadromous	catadromous	potamodromous
			Comparison between current population status and reference conditions
Requirements due to the Natura 2000 Directive	Number and position of the Natura 2000 areas with anadromous fish species in the Weser River Basin	-	-

„-" criteria has no relevance for this fish species

From the river basin management point of view a separate process for the main migration route has been established to discuss the restoration of continuity with the hydropower companies, the administration for shipways, the association for fishery and the Federal States in charge with the water resource management issues. A small core working group has been installed supported by special surveys to answer questions on technical feasibility and cost effectiveness and to discuss different strategies of solutions. By combining all information a strategy has been elaborated by the head office of the Weser River Basin Commission to be adjusted to the requirements of the members of the core working group. This strategy contains elements to optimise the up- and downstream continuity in a three phase system (Tab. 3).

Table 3. *Weser River Basin fish strategy. Overview of measures regarding the necessities of each location and time schedule*

Schwerpunkt	location	status quo			Phase 1				Phase 2				Phase 3			
		fish ecological priority			measures	fish ecological priority			measures	fish ecological priority			measures	fish ecological priority		
		fish protection	down-stream	upstream		fish protection	down-stream	upstream		fish protection	down-stream	upstream		fish protection	down-stream	upstream
Schwerpunkt Weser	Langwedel				Turbine management and bypass,; optimisation of fishladder											
	Dörverden				Turbine management				Fishladder and Bypass							
	Drakenburg												Fishladder; Bypass and Turbine management			
	Landesbergen								Fishladder							
	Schlüsselburg				Fishladder and Turbine management											
	Petershagen								Fishladder and Turbine management							
	Hameln												Fishladder; fine screen			
Schwerpunkt Werra	Hann. Münden				Fishladder											
	Letzter Heller				Fishladder											
	Hedemünden				fine screen and fishladder											
	Bad Sooden-Allendorf				fine screen and fishladder											
Schwerpunkt Fulda	Hann. Münden				fine screen and fishladder											
	Bonaforth												Fishladder			
	Wilhelmshausen												Fishladder			
	Wahnhausen								Fishladder							
	KS Voigtsche Mühle								fine screen and fishladder							
	KS Neue Mühle								fine screen and fishladder							

Priority 1 2 3 4

implemented

3 Outlook and Conclusions

The procedure described has been the basis for the identification of relevant areas and possible measures at the main obstacles in the supra-regional migration routes with respect to fish ecological demands concerning continuous passage of corridors and connectivity of habitats. The associated costs of potential measures have been estimated about 100 M€ and, hence, the technical feasibility assessed. Looking at ecological benefits and cost effectiveness priority measures have to be derived. Results and experiences from regional projects as well as already available data are taken into account and are being looked at from a river basin wide perspective.

Fish ecological priorities and the cost effectiveness analysis will provide the basis for a priority list of measures. The objectives are identified in an iterative process analogue to the set priorities at a river basin wide scale. These objectives will have an effect on local and regional objectives and, hence, a top-down and bottom-up process of information and negotiation is necessary, between the administration in charge with water resource management issues and the different stakeholder groups in the entire Weser River Basin. Such participatory procedures have been proven very successful and lower in costs than traditional top-down procedures.

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