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HARBASINS: Harmonised River Basin Strategies North Sea

Estuarine Ecosystem Functioning and Health

A reference list of fish species for a heavily modified estuary and its tributaries: the River Schelde

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Colofon

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1. References for the River Schelde main channel

1.1 Introduction

The European Water Framework Directive (WFD, EU Water Framework Directive, 2000) has several objectives. These objectives concern the protection of groundwater, inland surface waters, transitional waters and coastal waters. The main aim is to achieve a good ecological status by 2015. Apart from natural waters the WFD also considers artificial and heavily modified water bodies. According to Article 4(3) of the Water Framework Directive the principal environmental objective for heavily modified water bodies (HMWB) and for artificial water bodies are a “good ecological potential” (GEP) instead of a "good ecological status" (GES) and a “maximal ecological potential” (MEP) instead of a “pristine status”. Definitions for these GEP and MEP are vague and allow a certain freedom of interpretation. For a HMWB the values of the relevant biological quality elements at maximal ecological potential (MEP), reflect, as far as possible given the MEP hydromorphological and associated physical and chemical conditions, those of the closest comparable pristine surface water body type. In other words a water body at MEP is close to a pristine situation. Borja & Elliott (2007) state that the MEP is considered as the reference conditions for HMWB. As a consequence the MEP biological conditions should reflect the biological conditions associated with the closest comparable natural water body type at reference conditions. For a HMWB to be classified as being at GEP there must be no more than slight changes in the values of the relevant biological quality elements as compared to their values at MEP. Or the WFD defines the GEP as a reduction of the MEP status which is open to different interpretations. Borja & Elliott (2007) define it as the potential to be in GES if only the stressor was removed. Thus to define a GEP we need to know the pristine conditions and the effects caused by removing the stressors. Elliott *et al.* (2006) describe for the marine environment the links between the physical and chemical attributes for the water column and substratum. If one of these links is broken than the fundamental ecological niches are not maintained and the system enters the GEP status (Borja & Elliott, 2007). Knowing the interlinked nature of the different elements is essential especially in the scope of restoration. But even than there is always a fraction of uncertainty considering the (quantitative) result of mitigating actions and therefore one can not guarantee an mediate effect (e.g. return of a species) once a restoration action has been fulfilled. In the Netherlands RIZA produced a report with guidelines to describe MEP/GEP in artificial water bodies (RIZA, 2006). The biological potential can be defined once the hydromorphological and physical chemical potentials are described (Fig. 1). But here again the difference between MEP and GEP is not precise. During an international workshop on the WFD and hydromorphology held in Prague 2005 it was decided that these biological MEP/GEP conditions also can be defined from the actual status (Kampa & Kranz, 2005). These conditions should be concretised in terms of species and species groups. The authors propose to adopt a habitat approach which is a conceptual ecological model that differentiates between processes, patterns and species. In a first step the habitat that will result from a mitigating action is determined and this will in a second step define which species that can occur in the habitat. E.g. if according to an action no plants will be created than the limnophylic species should not occur in the MEP/GEP. For the Westerschelde Escaravage *et al.* (2004) state that in the absence of historical or spatial comprehensive frames or reference, the maximum ecological potential has to be based on knowledge dealing with the ecosystem functioning. This concept is worked out in detail by Van den Bergh *et al.* (2003). In their scale dependent approach they defined MEP/GEP at an ecosystem scale, an ecotope scale and

a macrobenthic community scale. At the ecosystem scale primary production was used to define the status of the Westerschelde. MEP/GEP habitat conditions were defined at the ecotope level allowing them to define the number of species for MEP/GEP and a list of species that have a probability of >90%, 90->50% and less than 50% to occur as a function of the sample strategy. Finally the macrofauna biomass and density were defined for MEP status and the bad status.

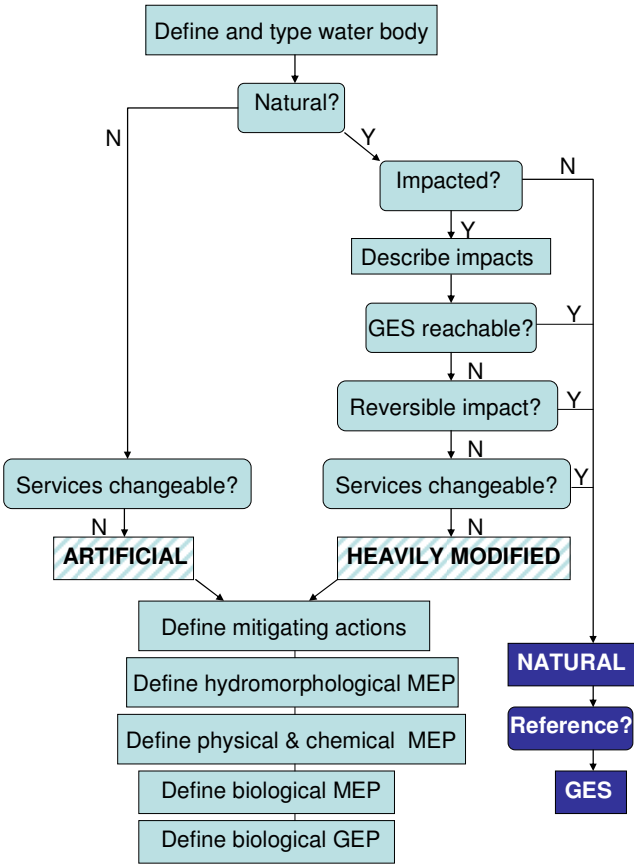

Figure 1: Flow diagram: guidelines to describe MEP/GEP adapted from RIZA (2006)

For the Zeeschelde Brys *et al.*(2005) applied a hierarchical approach to define MEP/GEP conditions. These authors defined the MEP/GEP in the frame of the ecosystem functioning with respect to different scales: ecosystem, water body, habitat for macrophytes, macrobenthos and phytoplankton. In addition and according to CIS (2003a,b) they established the hydromorphological conditions required for MEP/GEP. For fish we take the MEP/GEP conditions as the habitat needs described by Breine et al. (2008). In this report we compose a species list for fish that should occur in the Schelde when in GEP or MEP condition.

1.2. Methodology

In the Schelde we defined five different zones based on the Venice system. We did not differentiate between the freshwater zone with short and long retention time (Fig. 2).

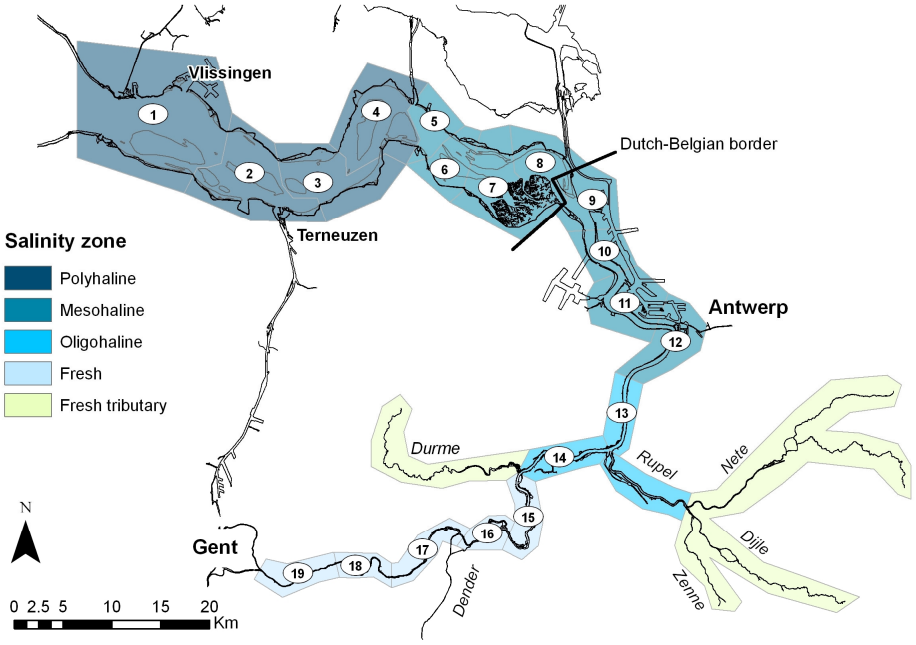

Figure 2: Salinity zones and Omes segments (numbers, Hoffmann & Meire, 1979) in the Schelde

To compile a presence absence list for these zones we combined data from recent sampling programmes using fyke nets (1995-2007) and the cooling-water intake at Doel (1991-2007) with published information from peer-reviewed and grey literature (Table 1). A reference list for the Westerschelde (Jager & Kranenbarg, 2004) and data from a fish monitoring campaign in the Westerschelde (Hostens, 2000) were checked also.

Table 1 References used for fish in the mainstream according to salinity zone

Salinity zone	Literature
Polyhaline	Hostens, 2000 Jager & Kranenbarg, 2004
Mesohaline	de Selys-Longchamps, 1842 Poll, 1945, 1947 Van Damme *et al.*, 1999 Breine *et al.*, 2001 Adriaenssens *et al.*, 2002 Breine *et al.*, 2007a
Oligohaline	Vrielynck *et al.*, 2003 Maes *et al.,* 2005 Simoens *et al.,* 2006 Breine *et al.*, 2007a
Freshwater	Van den Bogaerde, 1825 Vrielynck *et al.*, 2003 Maes *et al.*, 2005 Simoens *et al.*, 2006

We adopted the reference list from Jager & Kranenbarg (2004) as the presence absence list for the polyhaline zone (Table 2). The authors did not differentiate for the polyhaline Schelde in between GEP and MEP.
To allocate species to the lists the species were grouped into habitat guilds according to (Elliott & Hemingway, 2002). All exotic species are omitted with the exception of one since this species can be considered as naturalised. Exotic species were defined according to Verreycken *et al*. (2007). Marine adventitious species are omitted from the list since they only appear irregularly in the Schelde estuary. Marine species that occur in the North Sea but were never reported in the river are omitted too.

1.3. Results

An overview of the lists is given below in table 2. This table also includes the MEP and GEP lists.

Table 2: Historical and recent presence (1) - absence (0) fish data for the tidal River Schelde and GEP and MEP lists for the mesohaline, oligohaline and freshwater zones. Fishes are grouped according to guilds (Elliott & Hemingway, 2002). For each data source it is indicated whether the study deals with the polyhaline (P), mesohaline (M), oligohaline (O) or freshwater (F) zone of the Zeeschelde. Empty cells means no data available; italics stands for few catches or records; * no longer in Schelde; ** exotic species

Scientific name	(M–O) de Selys-Longchamps, 1842	(M–O) Poll, 1945	(M–O) Poll, 1947	(M–O–F) Breine *et al.*, 2001	(F) Maes *et al.*, 2005	(M-0) (Simoens *et al.*, 2006)	(F) (Simoens *et al.*, 2006)	(M-O) Breine *et al.*, 2007a	(M) surveys cooling-water Doel 1991-2007	(M) fyke nets surveys, 1995-2006	(O) fyke nets surveys, 2005-2007	(F) fyke nets surveys, 2005-2007	(P-M) Jager & Kranenbarg, 2004	GEP Mesohaline zone	GEP Oligohaline zone	GEP Freshwater zone	MEP Mesohaline zone	MEP Oligohaline zone	MEP Freshwater zone	Guild
Salmo trutta		*1*	*1*	1	0	0	0	1		1	1		**1**	**1**	**1**	**1**	**1**	**1**	**1**	D
Platichthys flesus	1	1	1	1	1	1	1	1	1	1	1	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	D
Liza ramado		1	1	1	1	1	1	1	1	1	1	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	D
Alosa fallax	1	1	1	1	0	1	1	1	1	1	1	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	D
Anguilla anguilla	1	1	1	1	1	1	1	1	1	1	1	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	D
Lampetra fluviatilis	1	1	1	1	1	1	1	1	1	1	1	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	D
Osmerus eperlanus	1	1	1	1	1	1	1	1	1	1	1	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	D
Petromyzon marinus	1	*1*	*1*	1	0	1	1	1					**1**	**1**	**1**	**1**	**1**	**1**	**1**	D
Acipenser sturio	1	*1*	*1*	1	0	0	0						**1**	**0**	**0**	**0**	**0**	**0**	**0**	D*
Salmo salar	1	*1*	*1*	1	0	0	0	1		1			**1**	**0**	**0**	**0**	**0**	**0**	**0**	D*
Alosa alosa	1	*1*	*1*	1	0	0	0	*1*					**1**	**0**	**0**	**0**	**0**	**0**	**0**	D*
Pholis gunnellus		1	1			0	0						**1**	**0**	**0**	**0**	**1**	**0**	**0**	ER
Pomatoschistus microps		1	1	1		1	1	1	1	1	1	1	**1**	**1**	**1**	**0**	**1**	**1**	**1**	ER
Pomatoschistus minutus	1	1	1	1		1	1	1	1	1	1	*1*	**1**	**1**	**1**	**0**	**1**	**1**	**0**	ER
Aphia minuta		1	1	1		1	0	1	1				**1**	**1**	**0**	**0**	**1**	**0**	**0**	ER
Nerophis ophidion			*1*			0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	ER
Syngnathus acus	1	1	1	1		0	0	1	1	1	1		**1**	**1**	**1**	**0**	**1**	**1**	**0**	ER
Agonus cataphractus		1	1	1		0	0	1	*1*	1			**1**	**0**	**0**	**0**	**1**	**0**	**0**	ER
Hippocampus guttulatus			*1*	1		0	0	1					**0**	**0**	**0**	**0**	**0**	**0**	**0**	ER
Syngnathus rostellatus	1	1	1	1		0	0	1	1				**1**	**1**	**1**	**0**	**1**	**1**	**0**	ER
Zoarces viviparus	1	1	1	1		1	0	1	1	1	1		**1**	**1**	**1**	**0**	**1**	**1**	**0**	ER
Liparis liparis		1	1	1		0	0	1	1	1			**1**	**1**	**0**	**0**	**1**	**0**	**0**	ER
Raniceps raninus	1					0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	ER
Myoxocephalus scorpius		1	1	1		0	0	1	1	1			**1**	**1**	**1**	**0**	**1**	**1**	**0**	ER

Spinachia spinachia		0	0			0	0		*1*				**0**	**0**	**0**	**0**	**0**	**0**	**0**	ER
Coregonus oxyrhynchus	1	*1*	*1*		0	0	0						**1**	**0**	**0**	**0**	**0**	**0**	**0**	ER*
Alburnus alburnus	1	0				0	0	1			*1*		**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Perca fluviatilis	1	1		1	1	1	1	1	1	1	1	1	**0**	**1**	**1**	**1**	**1**	**1**	**1**	FW
Barbus barbus	1	0				0	1						**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Lampetra planeri	1					0	0					1	**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Barbatula barbatula	1	0				0	1					1	**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Rhodeus sericeus		0				0	1	1	1	1	1	1	**0**	**0**	**1**	**1**	**0**	**1**	**1**	FW
Rutilus rutilus	1	1		1	1	1	1	1	1	1	1	1	**0**	**1**	**1**	**1**	**0**	**1**	**1**	FW
Abramis brama	1	1		1	1	1	1	1	1	1	1	1	**0**	**0**	**1**	**1**	**0**	**1**	**1**	FW
Phoxinus phoxinus		0				0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Silurus glanis					0	0	0					1	**0**	**0**	**0**	**1**	**0**	**0**	**0**	FW
Misgurnus fossilis	1	*1*		1		1	1	1					**0**	**0**	**1**	**1**	**0**	**1**	**1**	FW
Cyprinus carpio	1	1		1		0	0	1	1		1	1	**0**	**0**	**0**	**1**	**0**	**0**	**1**	FW
Cobitis taenia	1	0				0	1						**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Blicca bjoerkna		1				1	1	1	1	1	1	1	**0**	**0**	**1**	**1**	**0**	**1**	**1**	FW
Leuciscus cephalus	1	0				0	1					1	**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Carassius carassius		0				0	1	1	*1*			1	**0**	**0**	**0**	**1**	**0**	**0**	**1**	FW
Lota lota	1	0				0	0							**0**	**0**	**0**	**1**	**1**	**1**	FW
Gymnocephalus cernuus	1	0		1	1	1	1	1	1	1	1	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	FW
Scardinius erythrophthalmus	1	1		1		1	1	1	1		1	1	**0**	**0**	**1**	**1**	**0**	**1**	**1**	FW
Cottus gobio	1	*1*				0	0	1	*1*	1		1	**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Leuciscus leuciscus	1	0				0	0		*1*			1	**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Esox lucius	1	1		1	0	1	1	1		1	*1*	1	**0**	**0**	**1**	**1**	**0**	**1**	**1**	FW
Pungitius pungitius	1	*1*		1	1	1	1	1	1	1	1	1	**0**	**0**	**1**	**1**	**0**	**1**	**1**	FW
Leucaspius delineatus						0	0	1			*1*	1	**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Leuciscus idus		0			1	0	1	1	1	1	1		**0**	**0**	**1**	**1**	**0**	**1**	**1**	FW
Gobio gobio	1	0				0	1					1	**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Tinca tinca	1	0				0	1		*1*		*1*		**0**	**0**	**0**	**0**	**0**	**0**	**0**	FW
Sander lucioperca		*1*		1	1	0	0	1	1	1	1	1	**0**	**1**	**1**	**1**	**0**	**0**	**0**	FW**
Gasterosteus aculeatus	1	1	1	1	1	1	1	1	1	1	1	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	FW/D
Entelurus aequoreus			*1*			0	0		1				**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Balistes carolinensis		0	*1*			0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Conger conger	1	*1*	*1*	1		0	0	1					**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Trisopterus minutus			*1*			0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Trigloporus lastoviza			*1*			0	0							**0**	**0**	**0**	**0**	**0**	**0**	MA
Trachinus draco	1	*1*	1			0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Hyperoplus lanceolatus	1	*1*		1		0	0	1					**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Hippoglossus hippoglossus			*1*			0	0							**0**	**0**	**0**	**0**	**0**	**0**	MA
Scyliorhinus canicula	1	*1*	*1*			0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Glyptocephalus cynoglossus			*1*			0	0							**0**	**0**	**0**	**0**	**0**	**0**	MA
Trachurus trachurus		*1*	1	1		0	0		1	1	1		**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Scyliorhinus stellaris		*1*	*1*			0	0							**0**	**0**	**0**	**0**	**0**	**0**	MA
Echiichthys vipera		1	1	1		0	0	1	1		*1*		**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Ammodytes tobianus	1	1	1	1		0	0	1	1		*1*		**1**	**0**	**0**	**0**	**1**	**0**	**0**	MA
Ctenolabrus rupestris			*1*			0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Hippocampus hippocampus	1	*1*				0	0		1				**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Crystallogobius linearis			*1*			0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Crenilabrus melops		0	*1*			0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Pomatoschistus lozanoi				1		0	0	1	1	1			**0**	**0**	**0**	**0**	**1**	**0**	**0**	MA
Scomber scombrus		*1*	*1*			0	0						**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Scomberesox saurus		*1*	*1*			0	0	1					**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA

Mullus surmuletus			0		0	0	1	1	1		**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Callionymus lyra	1	*1*	*1*	1	0	0	1	*1*			**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Melanogrammus aeglefinus	1	*1*	*1*		0	0					**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Arnoglossus laterna		1	*1*	1	0	0	1				**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Raja clavata	1	*1*	1	1	0	0	1				**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Rhinonemus cimbrius		0	*1*		0	0					**0**	**0**	**0**	**0**	**0**	**0**	**0**	MA
Xiphias gladius		*1*			0	0						**0**	**0**	**0**	**0**	**0**	**0**	MA
Scophthalmus rhombus	1	*1*	*1*	1	1	0	1		1		**1**	**0**	**0**	**0**	**1**	**0**	**0**	MJ
Atherina presbyter		0			0	0	1	1	1	1	**0**	**0**	**0**	**0**	**1**	**0**	**0**	MJ
Clupea harengus	1	1	1	1	1	1	1	1	1	1	**1**	**1**	**1**	**0**	**1**	**1**	**0**	MJ
Gadus morhua	1	*1*	*1*	1	0	0	1	1	1		**1**	**0**	**0**	**0**	**1**	**0**	**0**	MJ
Pollachius pollachius			*1*		0	0		*1*			**0**	**0**	**0**	**0**	**0**	**0**	**0**	MJ
Chelidonichthys lucernus	1	1	1	1	0	0	1	1	1	*1*	**1**	**1**	**0**	**0**	**1**	**0**	**0**	MJ
Limanda limanda		*1*	0	1	0	0	1	1	1		**1**	**0**	**0**	**0**	**1**	**0**	**0**	MJ
Pleuronectes platessa	1	1	1	1	1	1	1	1	1		**1**	**1**	**0**	**0**	**1**	**0**	**0**	MJ
Trisopterus luscus	1	1	1	1	0	0	1	1	1	1	**1**	**1**	**1**	**0**	**1**	**1**	**0**	MJ
Psetta maxima	1	*1*	1	1	1	1	1				**1**	**0**	**0**	**0**	**1**	**0**	**0**	MJ
Solea solea	1	1	1	1	1	1	1	1	1	1	**1**	**1**	**0**	**0**	**1**	**1**	**0**	MJ
Merlangius merlangus	1	*1*	1	1	0	0	1	1	1	*1*	**1**	**1**	**0**	**0**	**1**	**0**	**0**	MJ
Dicentrarchus labrax		1	1	1	0	0	1	1	1	1	**1**	**1**	**1**	**0**	**1**	**1**	**0**	MJ
Engraulis encrasicolus	1	1	1	1	1	1	1	1	1		**1**	**1**	**0**	**0**	**1**	**0**	**0**	MS
Chelon labrosus		0	*1*		0	0				*1*	**1**	**0**	**0**	**0**	**1**	**0**	**0**	MS
Belone belone	1	*1*	*1*	1	1	1	1				**1**	**0**	**0**	**0**	**1**	**0**	**0**	MS
Eutrigla gurnardus		*1*			0	0		*1*			**0**	**0**	**0**	**0**	**0**	**0**	**0**	MS
Dasyatis pastinaca			*1*		0	0					**1**	**0**	**0**	**0**	**0**	**0**	**0**	MS
Sardina pilchardus		0	*1*		0	0					**0**	**0**	**0**	**0**	**0**	**0**	**0**	MS
Cyclopterus lumpus		*1*	*1*	1	0	0	1	1			**1**	**0**	**0**	**0**	**1**	**0**	**0**	MS
Sprattus sprattus	1	1	1	1	1	1	1	1	1		**1**	**1**	**1**	**0**	**1**	**1**	**0**	MS
Ciliata mustela		*1*	*1*		1	0	1	1	1	*1*	**1**	**0**	**0**	**0**	**1**	**0**	**0**	MS

D: Diadromous species; ER: Estuarine resident species; FW: Freshwater species; MA: Marine adventitious species; MJ: Marine juvenile migrant species; MS: Marine seasonal migrant species

1.3.1. Diadromous species

Diadromy obliges fish to migrate between marine waters and brackish and freshwater area for spawning (McDowall, 1988). Therefore estuaries have an important role as migration routes (Able, 2005). According to the season different diadromous species occur in different zones of the estuary. Absence of diadromous species are caused by human impacts disrupting the connectivity and as a result the estuary is considered not to reach the MEP/GEP status. Thus diadromous species are, if not extinct, included in both lists.

Three diadromous species are no more present in the Schelde and their decline was already described by Poll (1945). Sturgeon (*Acipenser sturio*), Atlantic salmon (*Salmo salar*) and allis shad (Alosa alosa) are extinct in the Schelde and even though they are included in the Westerschelde reference (Jager & Kranenbarg, 2004) species are not considered as GEP or MEP species in the other zones. The brown trout (*Salmo trutta*) population was already declining in 1945 (Poll, 1945) and is now rarely caught. Diadromous species such as eel (*Anguilla anguilla*) and flounder (*Platichthys flesus*) were common in the River Schelde (de Selys-Longchamps, 1842 and Poll, 1945). At present the eel population is decreasing but

flounder is still very common. Three-spined stickleback (*Gasterosteus aculeatus*) is known to be a species which is common in all types of waters and that is very resistant to quality degradation of its environment. Thinlip mullet (*Liza ramado*) was previously often confounded with thicklip grey mullet (*Chelon labrosus*) a marine seasonal migrant. Poll (1945) states that the species was abundant nearby the Belgian coast. At present specimens were collected near the mouth of the River Durme. River lamprey (*Lampetra fluviatilis*) is an indicator of good water quality and connectivity and good ecological functioning of the estuary (e.g. suitable spawning locations). The same applies for the twaite shad (*Alosa fallax*) and smelt (*Osmerus eperlanus*). Sea lamprey (*Petromyzon marinus*) abundant according to de Selys-Longchamps (1842) is at present scarce.

1.3.2. Estuarine Resident species

Estuarine Resident species complete their complete life cycle within the salt to brackish estuary. Estuarine resident species are euryoecious (i.e. wide tolerances to several environmental variables) and have the ability to tolerate the spatially and temporally widely varying conditions found within Estuaries (Elliott *et al*., 2007). However, they are sensitive to the disappearance of specific habitat such as intertidal mudflats, creeks and marshes, accumulation of toxic substances. Therefore their presence in an estuary, excluding the freshwater zone, is necessary to reach the MEP/GEP status.

According to Poll (1945, 1947), the common goby (*Pomatoschistus microps*) was quite rare in the Schelde, while it was probably confused with sand goby (*Pomatoschistus minutus*). Common goby and sand goby are at present very common. The common goby is regularly found far upstream but the freshwater is not its preferred habitat. The sand goby on the other hand, is less common in the freshwater part. This species is therefore omitted from the freshwater lists. Transparent goby (*Aphia minuta*) is an estuarine resident species that should normally occur in the Schelde and is regularly caught in Doel. It prefers a polyhaline and mesohaline habitat (van Emmerik, 2003) and is therefore only included in the mesohaline GEP and MEP list and polyhaline list although Jager & Kranenbarg (2004) did not consider it as a reference species for this zone. Straight-nosed pipefish (*Nerophis ophidion*) is only occasionally caught in the Schelde (Poll, 1947). It was never caught in recent surveys and it is also not retained in the Westerschelde reference list (Jager & Kranenbarg, 2004). It is therefore not considered as a GEP or MEP species. The greater pipefish (*Syngnathus acus*) and the viviparous blenny (*Zoarces viviparus*) are estuarine resident species that occurred in the Schelde (de Selys-Longchamps, 1842 and Poll, 1945, 1947). At present it is even caught in Antwerp but not further upstream. They avoid freshwater (van Emmerik, 2003) and therefore it is included in the mesohaline and oligohaline MEP and GEP lists. Nilsson's pipefish (*Syngnathus rostellatus*) was also common and caught even as far as Antwerpen (Poll, 1945, 1947) from April onwards. This species also avoids the freshwater reaches and is included in the mesohaline and oligohaline MEP and GEP lists. The hooknose (*Agonus cataphractus*) is an estuarine resident species that is reported to be rare in the Schelde (Poll, 1945) which corresponds with our catch results. It is therefore retained only in the mesohaline MEP and the polyhaline lists. Bull rout (*Myoxocephalus scorpius*) was quite common in the Schelde estuary (Poll, 1945) and is still caught from time to time. This species is included in both meso- and oligohaline GEP and MEP lists. Butterfish (*Pholis gunnellus*) is included in the reference list for the Westerschelde (Jager & Kranenbarg, 2004). Poll (1945) stated that the species was present but not caught. The species was never caught recently and therefore it

is not included in the GEP but in the mesohaline MEP list. Striped seasnail (*Liparis liparis*) used to be common in the Schelde (Poll, 1947) preferring poly and mesohaline water. It was occasionally caught in recent campaigns. It is a mesohaline GEP and MEP species. Both seahorse (*Hippocampus guttulatus*) and tadpole fish (*Raniceps raninus*) are not in the lists. Seahorse was caught nearby the sea (Poll, 1945) and is stated as rare. It prefers polyhaline water and there are no records of recent catches in the Zeeschelde. The presence in the Schelde of tadpole fish has been recorded for the first time in 1943 (Poll, 1945) and this species is believed to be very rare in the estuary and more common in nearby Dutch coastal waters. Fifteen-spined stickleback (*Spinachia spinachia*) is not reported by de Selys-Longchamps (1842) or by Poll (1945). It was only caught once in Doel and it is not considered as being a GEP or MEP species. These last three species are also not in the Westerschelde reference. Houting (*Coregonus oxyrhynchus*) is considered as very rare or in danger of extinction by Poll (1945, 1947). At present this species occurs in the Westerschelde reference (Jager & Kranenbarg, 2004) but is considered to have disappeared (red list) or to be extinct (International Union for Conservation of Nature and Nature Resources: IUCN). This species is therefore not in our lists. We believe that the species habitat area is more to the north.

1.3.3. Freshwater species

The freshwater resident species occur in the freshwater part of the estuary during their complete life cycle. They reproduce, grow up and feed in freshwater, but can also be found in the oligohaline zone. Reason why some occur in the oligohaline MEP/GEP list too. The Schelde has an important freshwater tidal zone and therefore freshwater species occur in its different zones. The spreading is species dependant and some freshwater species have a well-defined and regular use of estuaries, whether for seasonal migrations, nursery or feeding migrations, reproductive migrations through the estuary or the use of the estuary as a refuge (Elliott *et al*., 2007). Freshwater stragglers are considered species that occupy the mesohaline zone irregularly and only for a short time. Elliott *et al*. (2007) consider them analogous as marine stragglers but these enter the estuary from the opposite ends.

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The freshwater species ruffe (*Gymnocephalus cernuus*) is mentioned by de Selys-Longchamps (1842) but not by Poll (1945). It is a reference species in the Westerschelde (Jager & Kranenbarg, 2004) and at present it is caught from Zandvliet until the sluice in Merelbeke. It is therefore kept in all lists. Perch (*Perca fluviatilis*) is also a species that is found all over the Zeeschelde. Also perch (*Perca fluviatilis*) is a species that is caught all over the Zeeschelde. Poll (1945) considers the species to be very common in the freshwater and brackish reaches of the Zeeschelde up to Zandvliet. Therefore also this freshwater species is included in all lists. Roach (*Rutilus rutilus*), another freshwater species, is less abundant and is not typical for the mesohaline zone, though specimens are captured in Doel and Zandvliet. It is a tolerant species and its presence is justified in all GEP lists but not in the mesohaline MEP list. Bream (*Abramis brama*) and nine-spined stickleback (*Pungitius pungitius*) are typical lowland freshwater species with a tolerance for brackish water. They are opportunistic species that are caught all over the river Schelde. These species are not typical for mesohaline water and are therefore omitted from the mesohaline GEP and MEP lists. Bitterling (*Rhodeus sericeus*) is a freshwater species preferring stagnant or slow moving water with plants. Though Poll (1945) does not mention its presence in the Schelde it has been collected in different places between Zandvliet and Merelbeke. Simoens *et al.* (2006) place this species in

the reference list for fresh tidal water but not for the brackish part of the Schelde. Though the species can stand brackish water it is not relevant to put it in the mesohaline MEP or GEP list, but it remains in the oligohaline and freshwater MEP and GEP. Wels catfish (*Silurus glanis*) is now frequently caught all along the tidal freshwater Schelde. Though this species can support brackish water it is kept only in the freshwater GEP list. It does not belong in the MEP list since its presence is due to escape from upstream located ponds. The weatherfish (*Misgurnus fossilis*) is only caught in the River Nete. de Selys-Longchamps (1842) mentions its presence in the Schelde and Poll (1942) states that three specimens were collected. This species should not be present in the mesohaline zone but its presence could be indicative in the other zones. Carp (*Cyprinus carpio*) is reported by de Selys-Longchamps (1842) and Poll (1945) and is still caught in the freshwater and oligohaline zones. The species does not occur in Simoens *et al*. (2006) reference list since the authors took it as an exotic species. Here it is included in the freshwater GEP and MEP lists. Species such as white bream (*Blicca bjoerkna*), pike (*Esox lucius*) and rudd (*Scardinius erythrophthalmus*) are mentioned by Poll (1945) to be present in the Schelde. They are still caught in the Zeeschelde and even occasionally in Zandvliet. These freshwater species are no part of the mesohaline fish population but can occur in the oligohaline zone. Therefore all three of them are kept in the oligohaline and freshwater GEP and MEP lists. Ide (*Leuciscus idus*) is a species that is also encountered frequently in the oligohaline zone. It is considered as representative for oligohaline and freshwater GEP and MEP lists. Crucian carp (*Carassius carassius*) is a freshwater species which is occasionally captured in the River Schelde. Simoens *et al.* (2006) keep it in their freshwater reference and also here. Pike-perch (*Sander lucioperca*) is an exotic freshwater species. van Emmerik (2003) considers it as a recent native species. This species should not be in our waters and is therefore omitted from the MEP list. On the other hand it can support brackish water and is quite common along the salinity gradient. It is sensitive to temperature changes and intolerant to oxygen deficiency and can be used as an indicator for eutrophication. It is therefore allowed in the GEP lists. Bullhead (*Cottus gobio*) has been reported to be present over the salinity gradient (de Selys-Longchamps, 1842 and Poll, 1945, 1947) and was also recently caught in Zandvliet. This species lives in freshwater but can stand brackish water. It is rheophilic but not obligate. Simoens *et al.* (2006) do not consider it a reference species for the Schelde nor for its tributaries. It is not be taken as a GEP nor MEP species for the Schelde. Burbot (*Lota lota*) is recently reintroduced in the upper Nete. It is possible that within time this species will be caught in the Schelde since Poll (1945) mentioned that although the species is not caught yet in the River Schelde it can support mesohaline conditions. It is retained in the MEP lists since it is an intolerant species. Dace (*Leuciscus leuciscus*) is not mentioned by de Selys-Longchamps (1842) and Poll (1945, 1947) and is only caught in the freshwater tributaries. This species is not in the lists for the River Schelde. The same reasoning applies for spined loach (*Cobitis taenia*) frequently caught in the River Nete but not found in the main channel. Bleak (*Alburnus alburnus*) is a freshwater species that is occasionally fished in the freshwater part of the main river and in the River Nete. de Selys-Longchamps (1842) mentions its presence in the Schelde while Poll (1945, 1947) does not. This species is not included in the GEP or MEP list. Stone loach (*Barbatula barbatula*) is caught in the freshwater tributaries only. de Selys-Longchamps (1842) reports on barbel (*Barbus barbus*) and brook lamprey (*Lampetra planeri*) while Poll (1945) does not. The Zeeschelde is not their habitat. Maes *et al*. (2005) and Breine *et a*l. (2007a) do not include these species in their reference list neither. Eurasian minnow (*Phoxinus phoxinus*) has never been reported to be caught in the Zeeschelde. European chub (*Leuciscus cephalus*) gudgeon (*Gobio gobio*) are species reported by de Selys-Longchamps (1842) but not by Poll

(1945, 1947). They were caught in the freshwater tributaries and are therefore included in their GEP or MEP lists only. Belica (*Leucaspius delineatus*) is caught occasionally in the freshwater part of the River Schelde but has not been reported by de Selys-Longchamps (1842) and Poll (1945, 1947). It is as stagnophilic species that needs the presence of plants which are not really offered by the Schelde. Therefore it is not included in our lists. Tench (*Tinca tinca*) has been caught around Antwerpen but is considered a species rather belonging to standing waters (eventually upstream the tributaries).

1.3.4. Marine Adventitious species

Normally the estuary is not considered as a crucial environment for marine adventitious species. Elliott *et al*. (2007) prefer to use the term marine stragglers to denote a low-level of presence in the estuary. Some of these species are kept in the list for reasons given below.

Small sandeel (*Ammodytes tobianus* or *A. lancea*) is common in the Schelde estuary (Poll, 1945). As a marine adventitious species it is occasionally caught and is therefore kept in the mesohaline MEP list. It is also in the Westerschelde reference (Jager & Kranenbarg, 2004). Another marine adventitious species that is not mentioned in historical reports but that is regularly caught now in the mesohaline zone is Lozano's goby (*Pomatoschistus lozanoi*). These are the only marine adventitious species included in the lists since it is assumed they frequent the estuary for a reason. Still some observations are interesting e.g. the snake pipefish (*Entelurus aequoreus*) was quite rare but is now captured more frequently. de Selys-Longchamps (1842) and Poll (1947) state that the greater weaver (*Trachinus draco*) is common, in contrast with Poll (1945) where it is considered as an irregular guest. It is not included in the Westerschelde reference list (Jager & Kranenbarg, 2004) nor was it ever caught in recent surveys.

1.3.5. Marine Juvenile species

Elliott *et al*. (2007) no longer distinguish between marine seasonal migrants and marine juvenile migrants since larval and 0+ juvenile migrations into estuaries tend to be seasonal for many marine species. But anyway estuaries are used by these migrants as feeding and refugia areas. Therefore their presence in particular zones is needed to reach the MEP/GEP status.

Herring (*Clupea harengus*) is an abundant marine juvenile species (Poll, 1945, 1947, Maes, 1997, 2001). It swims upstream till the oligohaline zone. Plaice (*Pleuronectes platessa*) is described by Poll (1945) as being very abundant in the Schelde. Adults are rarely caught. It is now collected in small numbers at Doel. This species is retained in the mesohaline GEP and MEP lists. Sole (*Solea solea*) penetrates as juveniles quite far into the estuary (Poll, 1945). Poll (1945) mentions also captures of numerous adults. For the GEP list species should occur in the mesohaline zone and also in the oligohaline for the MEP list. Tub gurnard (*Chelidonichthys lucernus*) and (*Merlangius merlangus*) are marine juvenile species that have been reported in the Schelde by de Selys-Longchamps (1842) and Poll (1945, 1947). At present mostly juveniles are caught. Jager & Kranenbarg (2004) consider it as reference species in the Westerschelde. They are rarely caught in the oligohaline zone and therefore are retained only in the mesohaline GEP and MEP lists. One of the most common species is the European seabass (*Dicentrarchus labrax*) which agrees with Poll (1945) who reports important quantities of juveniles. This species figures in the GEP and MEP lists of meso- and

oligohaline waters. Pouting (*Trisopterus luscus*) is a marine juvenile species frequently observed in the Schelde (Poll, 1945, 1947). It is still captured up to Antwerpen. The species is taken into the meso- and oligohaline GEP and MEP lists. Of brill (*Scophthalmus rhombus*) only juveniles are found in the Zeeschelde. This species is not common according to Poll (1945). Consequently, it is only included in the mesohaline MEP list. Sand smelt (*Atherina presbyter*) was reported to be quite abundant in Belgian coastal waters (Poll, 1947) and is regularly caught in the Zeeschelde. Therefore it stays in the mesohaline MEP list. Cod (*Gadus morhua*) is an uncommon seasonal migrant, of which only juveniles wander in the estuary. It is included in the mesohaline MEP list only. Poll (1947) reports the occasional presence of the marine juvenile migrant dab (*Limanda limanda*). In recent surveys this species is rarely caught and is therefore taken in the mesohaline MEP list only. Turbot (*Psetta maxima*) is caught rarely and only juveniles, which corresponds with its classification in the guild of marine juvenile species. It is included in the Dutch list (Jager & Kranenbarg, 2004) and kept in the mesohaline MEP list only. Pollack (*Pollachius pollachius*) is described as being rare in Belgian coastal waters (Poll, 1947) and there are no records of it from de Selys-Longchamps (1842) and Poll (1945). It is not in the Westerschelde reference (Jager & Kranenbarg, 2004) nor is it collected in recent fish campaigns in the Zeeschelde. It was therefore decided to omit it from our lists.

1.3.6. Marine Seasonal migrants

These species migration towards the mesohaline zone is seasonal and representatives should therefore be found within the estuary.

Sprat (*Sprattus sprattus*) enters in large numbers the estuary between January and July (de Selys-Longchamps, 1842 and Poll, 1945, 1947). This species is often caught and is also a reference species for the Westerschelde (Jager & Kranenbarg, 2004). It is taken into the meso- and oligohaline GEP and MEP lists. Anchovy (*Engraulis encrasicolus*) is a seasonal guest from April to August that visits the estuary in large numbers to spawn (Poll, 1947). At present they are rarely caught upstream Doel. They are in the mesohaline MEP and GEP lists. Thicklip grey mullet (*Chelon labrosus*) is included in the reference list for the Westerschelde (Jager & Kranenbarg, 2004). The species is considered as rare in the Schelde (Poll, 1947) and is occasionally caught in recent surveys. It is therefore included in the mesohaline MEP list. Garpike (*Belone belone*) is uncommon in the estuary (Poll, 1945). Though it was not caught recently it has a place in the mesohaline MEP list since it is also a reference species for the Westerschelde (Jager & Kranenbarg, 2004). The lumpsucker (*Cyclopterus lumpus*) was rarely caught (Poll, 1945, 1947) and this is still the case. It is in the mesohaline MEP lists. A similar reasoning was done for the fivebeard rockling (*Ciliata mustela*). Three more species were only encountered occasionally (Poll, 1945, 1947). Grey gurnard (*Eutrigla gurnardus*) was caught haphazardly in Doel but no specimens of sting ray (*Dasyatis pastinaca*) and pilchard (*Sardina pilchardus*). None of the three species are withheld in the lists.

2. References for the River Schelde tributaries

2.1. Introduction

The Zeeschelde has tributaries which are grouped into different water bodies (Simoens *et al*., 2006). We differentiate according to figure 2: The tidal Rivers Dijle and Zenne are grouped together and they join the tidal Rivers Nete (Grote and Kleine Nete) to form the River Rupel (oligohaline). Finally there is the River Durme that enters the Zeeschelde upstream the mouth of the River Rupel. All rivers are heavily modified and the River Zenne is a particular case since it has a history of severe pollution. Since March 2007 the Zenne is being treated and this should result in a better water quality.

2.2. Methodology

A similar approach as described above is applied. As already mentioned above Simoens *et al.* (2006) describes for these tributaries a MEP. They are based on literature review mainly from reports. For the River Rupel and Durme presence absence data were combined from Vrielynck *et al*. (2003) and Breine & Van Thuyne (2004, 2005). For the Rivers Nete authors consulted Vrielynck *et al*. (2003), Van Thuyne & Breine (2003a), Van Liefferinghe *et al*. (2000, 2005) and Yseboodt & Meire (1999). For the Rivers Dijle and Zenne Vrielynck *et al*. (2003) and Van Thuyne & Breine (2003b) were used. Similar as for the Zeeschelde a table is drawn and fish data were updated if new data were available (Table 2). As such information from Maes *et al*. (2005) is included. From Breine *et al.* (2001) only freshwater species are maintained. For the Rivers Rupel and Durme information from Breine *et al*. (2005, 2006, 2007b) is included. For the Rivers Nete and Dijle data from Buysse et al. (2007) and personal communications are added. For the GEP a fish assemblage slightly different for the MEP is accepted since it should reflect a small anthropogenic impact.

2.3. Results

The results are given in table 3 below.

Table 3: Historical and recent presence (1) - absence (0) fish data for the River Schelde tributaries under tidal influence and GEP and MEP lists. Fishes are grouped according to estuarine use guilds (Elliott & Hemingway, 2002). Empty cells means no data available; italics stands for few catches or records; * no longer in Schelde or tributaries; abbreviations see table 2

Scientific name	Breine *et al.*, 2001	Tidal Freshwater Maes *et al.*, 2005	Tidal Rivers Nete (Simoens *et al.*, 2006)	Tidal rivers Dijle & Zenne (Simoens *et al.*, 2006)	Durme (Simoens *et al.*, 2006)	River Rupel (Simoens *et al.*, 2006)	River Durme (Breine *et al.*, 2005-2007)	River Rupel (Breine *et al.*, 2005-2007)	River Nete (Buyse *et al.*, 2007) & PC	River Dijle (Buyse *et al.*, 2007) & PC	GEP	MEP	Guild
Salmo trutta	1	0	0	0	0	0					**0**	**1**	D
Platichthys flesus	1	1	1	1	1	1	1	0	1		**1**	**1**	D
Liza ramada	1	1	0	0	0	1					**1**	**1**	D
Alosa fallax	1	0	1	0	1	1					**1**	**1**	D
Anguilla anguilla	1	1	1	1	1	1	1	1	1	1	**1**	**1**	D
Lampetra fluviatilis	1	1	0	0	0	1			*1*	0	**0**	**1**	D
Osmerus eperlanus	1	1	1	0	0	1	1	0	0	0	**1**	**1**	D
Petromyzon marinus	1	0	0	0	0	1					**0**	**1**	D
Acipenser sturio	1	0	0	0	0	0					**0**	**0**	D*
Salmo salar	1	0	0	0	0	0					**0**	**0**	D*
Alosa alosa	1	0	0	0	0	0					**0**	**0**	D*
Perca fluviatilis	1	1	0	0	0	1	1	1	1	1	**1**	**1**	FW
Gymnocephalus cernuus	1	1	1	0	0	1	1	1			**1**	**1**	FW
Rutilus rutilus	1	1	1	1	1	1	1	1	1	1	**1**	**1**	FW
Rhodeus sericeus			0	0	0	1	1	1	1	*1*	**1**	**1**	FW
Abramis brama	1	1	0	0	0	1	1	1	1	1	**1**	**1**	FW
Misgurnus fossilis	1		1	1	1	1			*1*		**1**	**1**	FW
Blicca bjoerkna			1	1	1	1	1	1	1	1	**1**	**1**	FW
Scardinius erythrophthalmus	1		1	1	1	1	1	1	*1*	*1*	**1**	**1**	FW
Esox lucius	1	0	1	1	1	1			1	0	**1**	**1**	FW
Pungitius pungitius	1	1	1	0	0	1	0	1	*1*		**1**	**1**	FW
Leuciscus idus		1	0	0	0	1	1	1	*1*	0	**1**	**1**	FW
Cyprinus carpio	1		1	0	0	0	1	1	1	*1*	**1**	**1**	FW
Carassius carassius			0	0	0	1	*1*	0			**1**	**0**	FW
Silurus glanis		0	1	0	1	0	0	1	1	*1*	**1**	**1**	FW
Alburnus alburnus			1	1	1	0	1	0	*1*	0	**0**	**1**	FW
Barbus barbus			1	1	0	1					**0**	**0**	FW

Lampetra planeri			0	1	1	0					**0**	**0**	FW
Barbatula barbatula			0	0	0	1			1		**0**	**0**	FW
Phoxinus phoxinus			1	1	1	0					**0**	**0**	FW
Cobitis taenia			1	1	1	1			1		**1**	**1**	FW
Leuciscus cephalus			0	0	0	1	*1*	0	1	0	**0**	**1**	FW
Lota lota			0	0	0	0					**0**	**1**	FW
Cottus gobio			1	1	1	0			1		**0**	**0**	FW
Leuciscus leuciscus			1	1	1	0			1		**0**	**1**	FW
Leucaspius delineatus			0	1	1	0	1	0			**0**	**0**	FW
Tinca tinca			1	1	1	1			*1*	1	**1**	**1**	FW
Gobio gobio			1	1	1	1			1	*1*	**1**	**1**	FW
Gasterosteus aculeatus	1	1	0	0	0	1	1	1	1	1	**1**	**1**	FW/D
Pomatoschistus microps	1			0	1	1	1	1	0	0	**0**	**1**	ER

2.3.1. Diadromous species

Diadromous species should occur in the MEP/GEP lists since their presence indicates that the transfer between the different zones and habitats is possible.

The GEP and MEP lists for this group are the same for all tributaries. If all barriers, physical and chemical, disappeared these species should be able to swim all along these rivers. Disappeared species are not included in the lists. There are no records of brown trout in the tributaries. Its decline has been reported by Poll (1945). The species can be absent from the GEP but its presence would indicate a MEP. Flounder is common in the Schelde and caught in all tributaries. Therefore it appears in both lists. Thinlip mullet is now caught nearby the River Durme. This species spawns at sea and adults enter the estuary its presence is indicative for a GEP and MEP. Twaite shad and smelt are MEP species according to Simoens *et al.* (2006) and are regularly caught in different tributaries. They are both GEP and MEP species. Eel is found all along the tributaries especially creeks are its habitat. It is in both lists. Sea lamprey is rare in the Schelde and no catch data in the tributaries are known. River lamprey is more common. As already mentioned they are intolerant species and are therefore good indicators of water quality and they are kept in the MEP list only because of their high ecological demands.

2.3.2. Estuarine Resident species

The habitat preferences for estuarine species is not fulfilled in the tributaries. However Common goby (*Pomatoschistus microps*) is common in some of the tributaries (Durme and Rupel) and is the only estuarine resident species that is kept in the MEP list. Occasionally other estuarine resident species can be sampled in it but these species are not retained in the GEP or MEP lists.

2.3.3. Freshwater species

A GEP and MEP list for the different water bodies can be made. There are morphological differences but if we consider historical data and recent data then the differences between them are minimal and were mostly the result of chemical habitat quality differences. For the Rivers Nete and Durme 24 freshwater species are recorded the others have records for 21 species. Exotic freshwater species are omitted from the lists. Pikeperch which is kept as a

GEP species for the Schelde is no longer kept as a GEP species since it prefers deeper water than normally is provided by the tributaries. This species is rarely caught in the tributaries. From all freshwater species in the list only burbot is not been caught yet. It is considered as a MEP species since its high habitat demands. The following species' presence has been recorded recently or previously: perch, roach, bitterling, bream, weatherfish, white bream, rudd, pike, carp, wels catfish, spined loach, tench, gudgeon and three-spined stickleback. They are all retained in both lists. To allocate the remaining freshwater species habitat demands and tolerance values (Breine et al., 2001, 2007a) were considered as well as the catch frequency. Species with high or specific habitat demands and rarely caught are retained in the MEP list only. Eurytopic and tolerant species are placed in both lists. Rudd is present in all but one tributary. It is caught al along the Schelde and therefore can move into all tributaries. It is an eurytopic species that can tolerate some degradation of the environment (Billard, 1997) and is therefore kept in both GEP and MEP. Ide is a rheophilic B species (van Emmerik, 2003) with a relative high tolerance value (Breine *et al*., 2007a). It is found all along the River Schelde and in most of its tributaries. Its abundance is underestimated due to confusion with roach. It is kept in both lists. Bleak is found in all but one MEP list presented by Simoens *et al*. (2006). As already mentioned above the species is occasionally fished in the freshwater part of the main river and in the River Nete. According to Breine *et al*. (2007a) species has a low tolerance it is therefore included in the MEP list only. Barbel is a rheophilic A species which is not typical for the Schelde tributaries. It was not caught recently and though Simoens *et al*. (2006) consider it as a MEP species for some tributaries it was decided not to retain this species in the lists since the tributaries do not offer this species the required habitat demands. Eurasian minnow is an intolerant species typical for upstream water (Breine *et al*., 2004, 2007a) preferring well oxygenated water and gravel substrate (Vostradovsky, 1973). The species has never been reported in the Schelde and has not been caught during recent surveys and is thus omitted from the lists. Chub have been reported in the Schelde (de Selys-Longchamps 1842) and was collected in the River Nete (Buysse *et al*., 2007) and once in the Durme (Breine *et al*., 2007b). European chub is a rheophilic A species typical occurring in creeks and fast flowing rivers (Billard, 1997) and to obtain a GEP its presence is not necessary but it can indicate a MEP. Bullhead is not in the reference of Breine *et al*. (2007a) or Maes *et al*. (2005) but Simoens *et al*. (2006) add it to the MEP lists of all tributaries except the River Rupel. Buysse *et al*. (2007) caught it in the Nete. This rheophilic and intolerant species has a low range of acceptable habitats (Grandmottet, 1983) and prefers a hard substrate with gravel and stones. At present only the River Nete has a water quality that needs the demands of this species but the morphological characteristics and substrate of the tributaries are not really optimal for this species. As a consequence the species is not retained in the lists. The same logic is applied for stone-loach. Belica is a stagnophilic and limnophilic species with a moderate tolerance (Breine *et al*., 2007a) occasionally caught in the tributaries (Simoens *et al*., 2006). Habitat conditions such as shallow water and weeds in quite places are not offered for this species and therefore it is not included in the lists. Dace is retained in all tributaries MEP lists, except for the River Rupel (Simoens *et al*., 2006). The reason why this species is not in the latter list is probably due that the River Rupel here is joined with a freshwater part of the River Schelde. This rheophilic species is occasionally caught in the Nete (Buysse et al., 2007, unpublished data). According to van Emmerik (2003) this species can support a salinity gradient from freshwater to salt still it is not mentioned by de Selys-Longchamps (1842) and Poll (1945, 1947) and it is not caught in the main channel probably because dace is intolerant to oxygen deficiencies (Turnpenny *et al*., 2004). Because of its rarity and ecological demands this species is included in the MEP list only. The only record in

the River Schelde of brook lamprey an intolerant rheophilic species with high oxygen demands is from de Selys-Longchamps (1842) and was once caught also in the freshwater part. However it has not been reported in the tributaries which are not considered as being a suitable habitat from which it follows that this species is excluded from the lists. Crucian carp a tolerant species, but less than carp, is caught in the freshwater part of the River Schelde and in the River Durme. Theoretical this species could inhabit all tributaries. Its presence can indicate a good GEP but is not needed to obtain a MEP. Though nine-spined stickleback is less common than the three-spined stickleback it is to be found in all tributaries. The species is present in both lists.

Tributaries do not offer a suitable habitat for marine adventitious species, marine juvenile and marine seasonal migrants. These species are omitted from the lists.

3. Conclusion

To assess the ecological status of heavily modified transitional waters the European Water Framework Directive requires definitions of Maximal and Good ecological potential (MEP/GEP) and the design of classification tools for specified biological quality elements. The hydromorphological and physical chemical MEP/GEP status is described by Brys *et al.*(2005). Their approach was also used to define the guild specific habitat needs (qualitative) for fish in the Schelde (Breine *et al.*, 2008). If these habitat needs are fulfilled, thanks to mitigating actions, than we consider the estuary to be in MEP condition for fish. The near fulfilment brings it in the GEP status. Based on a literature review in combination with recent fish catch data we were able to make guild specific qualitative MEP/GEP lists for the different zones within the Schelde estuary and its tributaries. For each fish species the relevance of its presence in each salinity zone was examined. The geographical spreading and ecological demands were assessed and were decisive for its acceptance within the lists. The ecological knowledge of the assessed species is available and sufficient to reduce the risk of making mistakes in attribution.
The lists proposed here should be considered as a starting point from where quantitative guild lists can be developed. Attributing threshold values to these quantitative lists will allow to define the ecological status expressed as an ecological quality ratio (EQR) between 0 and 1. The guild approach facilitates the development of the assessment tool. We are aware that by grouping fish into guilds particular information can be lost. On the other hand the guild approach is widely used and accepted to develop robust assessment tools for the ecological status of surface waters. There are different approaches to develop a fish-based qualitative indicator for the status in the estuary. Such an evaluation system normally assesses the deviation between a reference condition and the actual condition. In the absence of reference we have to develop another approach. Different approaches are discussed in another document (Breine *et al.*, in prep).

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