Chapter 3

A reference list of fish species for a heavily modified transitional water as defined by the Water Framework Directive: the Zeeschelde estuary (Belgium)

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Abstract

A crucial step in the development of a fish-based index for the ecological assessment of water bodies as provided by the European Water Framework Directive is the development of a fish reference. This reference consists of a fish assemblage present in pristine water bodies of the same category. Based on historically reported fish survey data of the Zeeschelde estuary and its tributaries under tidal influence (Belgium), presence/absence reference lists were compiled for different salinity zones. These historical lists were then adjusted using information from recent catches. Inclusion of fish species in the reference lists depended on their natural geographical distribution and ecological demands. Fish species are attributed to guilds (functional groups) and therefore these reference lists contain guild specific information for the different zones within the estuary and its tidal tributaries. The reference corresponds with an ecological status that is referred to as Good or Maximal Ecological Potential (GEP/MEP).

Keywords: ecological potential, estuary, fish, reference list, Zeeschelde, Water Framework Directive, transitional water

This manuscript has been submitted to the Belgian Journal of Zoology

1 Introduction

All transitional waters in Flanders have been identified as heavily modified water bodies as their nature has changed fundamentally as a result of physical anthropogenic alterations. According to Article 4(3) of the European Water Framework Directive (WFD) the principal environmental objective for heavily modified water bodies (HMWB) and artificial water bodies is to obtain a “good ecological potential” (GEP) and “good surface water chemical status” instead of a “good ecological status” as required for natural systems. Similarly, the reference situation in HMWB is referred to as “maximal ecological potential” (MEP) instead of a “pristine status” (EU Water Framework Directive, 2000). According to WFD the MEP biological conditions should reflect, as far as possible, the biological conditions associated with the closest comparable natural pristine water body, given the MEP hydromorphological and associated physico-chemical conditions. Borja and Elliott (2007) consider the MEP as the reference conditions for HMWB. For a HMWB to be classified as attaining GEP status there must be no more than slight changes in the values of the relevant biological quality elements as compared to their values at MEP. The biological potential can be defined once the hydromorphological and physical chemical potentials are described. The different paths of the decision procedure are illustrated in figure 3.1.

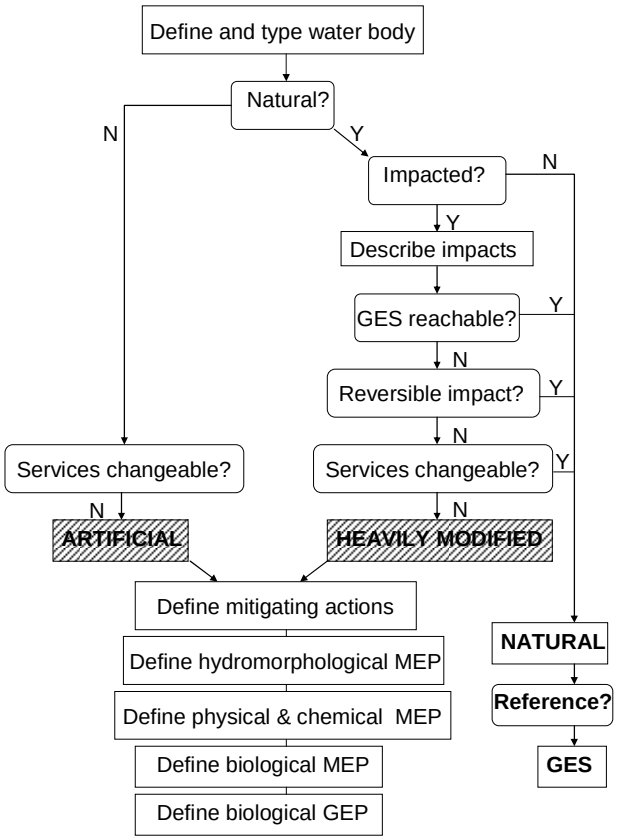

Figure 3.1: Flow diagram: guidelines to describe MEP/GEP adapted from a report of the Dutch Ministry of Transport, Public Works and Water Management (RIZA, 2006). MEP: Maximum Ecological Potential, GEP: Good Ecological Potential and GES: Good Ecological Status.

During an international workshop on the WFD and hydromorphology held in Prague 2005 it was concluded that these biological MEP/GEP conditions can also be defined from the actual status (Kampa & Kranz, 2005). A key difference in this approach is that the GEP is derived directly from the effect of mitigation measures and not indirectly from the specification and prediction of biological quality elements at MEP (Kampa & Laaser, 2009). For the benthos in the Westerschelde, the part of the Schelde estuary that is situated in The Netherlands, Escaravage *et al*. (2004) suggest that when a reference based on historically pristine conditions is absent, the maximum ecological potential has to be based on knowledge of the ecosystem functioning. This concept is further elaborated by Van den Bergh *et al.* (2005) using a scale dependent approach. In particular Escaravage *et al.* (2004) defined MEP/GEP at an ecosystem scale, an ecotope scale and a macrobenthic community scale. For the Zeeschelde, the Belgian part of the Schelde estuary, Brys *et al.* (2005) applied a similar

hierarchical approach to define MEP/GEP conditions for macrobenthic invertebrates and macrophytes on tidal marshes. In addition and according to the Common Implementation Strategy (CIS, 2003a, b) they established the hydromorphological conditions required for these MEP/GEP conditions, but not for fish. For fish we take the habitat needs described in chapter 4 as the MEP/GEP conditions. In that chapter habitat needs in estuaries at a fish guild level are described ensuring a Good Ecological Status. In this chapter we compile a species list for fish that should occur in the Schelde estuary when it reaches GEP or MEP condition. This list will serve to calculate threshold scores for candidate metrics in the process of the development of a fish-based index for the Zeeschelde estuary (Chapter 8).

2 Material and methods

The study area is the Schelde estuary with special interest for the Belgian part, called Zeeschelde, and its tributaries under tidal influence. Jager and Kranenbarg (2004) defined the reference for the Westerschelde, the Dutch part of the estuary to which we add the reference list for the Belgian part of the estuary.

We defined five different zones based on the Venice system (1959, Fig. 3.2): the polyhaline and mesohaline part of River Schelde, the oligohaline part of River Schelde including the River Rupel, the freshwater part of Rivers Schelde and Durme and the freshwater tributaries under tidal influence (Rivers Dijle, Zenne, Nete, Grote Nete, Kleine Nete). Like the estuary all tidal tributaries are heavily modified.

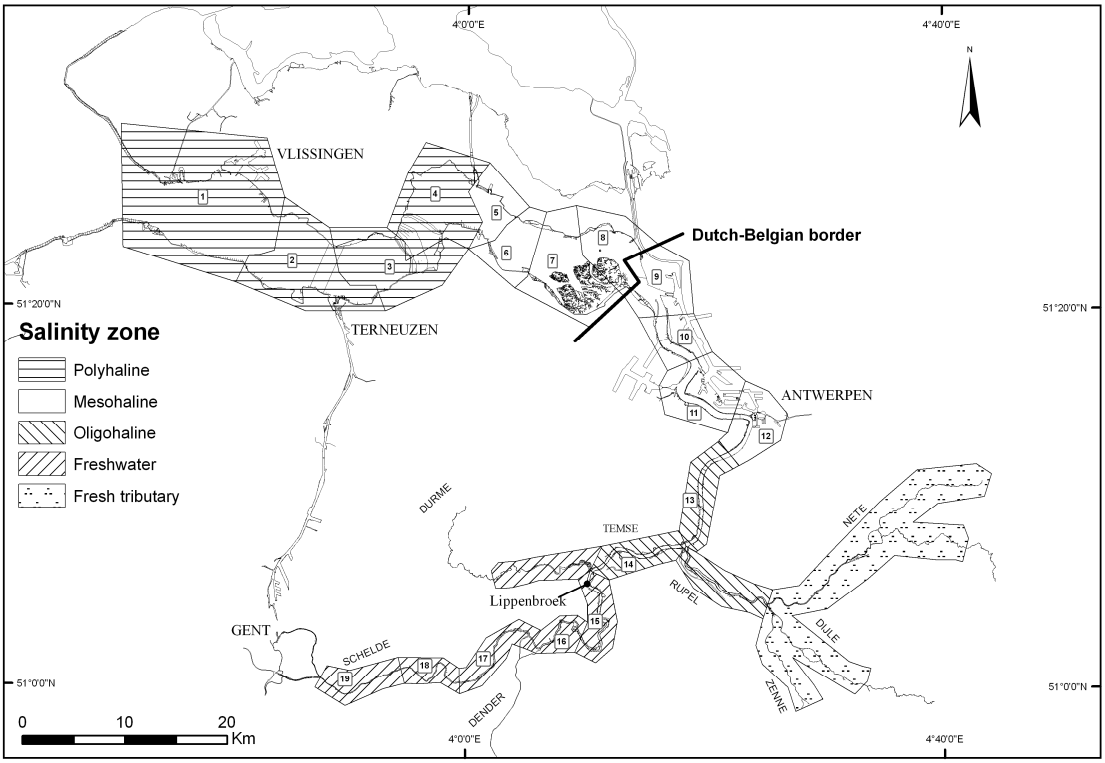

Figure 3.2: Salinity zones and Omes segments (numbers, Hoffmann & Meire, 1997) in the Schelde.

Next we compiled historical records of fish that occurred in each zone of the Zeeschelde in the period 1842 till 1947. This list was then adjusted to a MEP/GEP reference list based on data from recent sampling programmes using fyke nets (1995-2007) and the cooling-water intake screens at the Doel power plant, situated in the mesohaline part of the Schelde estuary (1991-2007). As an additional resource, we used information from peer-reviewed and grey literature reporting on non regular samplings campaigns (Table B, annex). All fish species were assigned to functional groups or guilds according to Elliott *et al*. (2007) and Franco *et al*. (2008) according to their particular niche within their area of interest. First a historical list was made. A species was included in the MEP/GEP lists if historical data indicate its presence in a particular salinity zone or if its habitat needs correspond with the habitat potentials of that particular zone (Breine *et al*., 2001, 2007). In addition, the catch frequency was considered and species that are no more or rarely caught (<5% catch frequency defined by expert judgment) are retained only in the MEP list (Fig. 3.3). Applying other threshold percentages, 1 and 10% respectively, gave only a different result for Crucian carp (*Carassius carassius*) and viviparous blenny (*Zoarces viviparus*); with the 10% threshold these species would only be a MEP species in the freshwater and mesohaline zone respectively. Eurytopic species, i.e.

fishes that are able to tolerate a wide range of conditions, and species tolerant to extreme conditions (e.g. low oxygen concentration) are placed in both lists. The GEP list differs since it should reflect a small anthropogenic impact. These historical MEP/GEP fish record lists were then adjusted following the criteria stipulated by Ramm (1990). We applied three conditions to omit some species from both the MEP and the GEP list even if they previously occurred in a particular zone: 1) they are locally or regionally extirpated, 2) their presence in a particular zone is not an indication of good status (potential) and 3) the zone is not their preferred habitat.

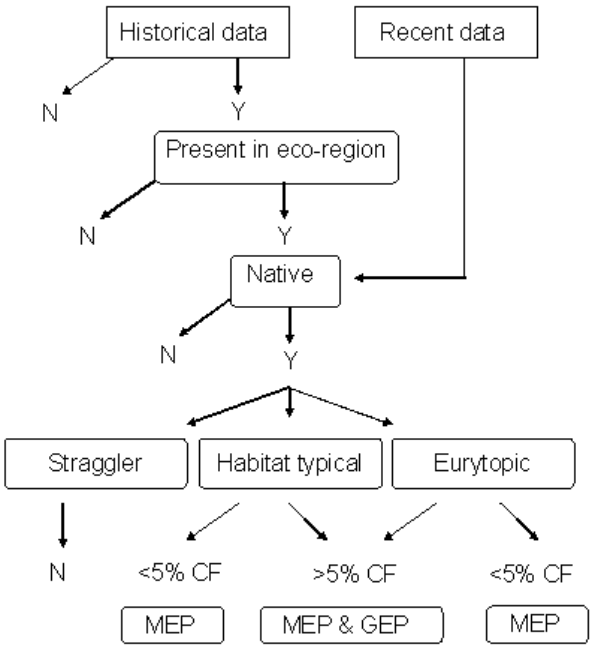

Figure 3.3: Decision tree used to allocate fish species to Maximum Ecological Potential (MEP) and Good Ecological Potential (GEP) list. At each level the answer yes or no indicates the path along the tree. Finally the attribution to the MEP or GEP depends on the catch frequency (CF). The eco-region considered is the North-East Atlantic eco-region.

Stragglers or occasional visitors in a salinity zone are not listed either since they do not depend on the estuary to complete their life cycle (Elliott *et al*., 2007). Nevertheless some observations are interesting e.g. the snake pipefish (*Entelurus aequoreus*) was quite rare in the Zeeschelde but is now captured more frequently at Doel. de Selys-Longchamps (1842) and Poll (1947) stated that the greater weaver (*Trachinus draco*) was common, in contrast with Poll (1945) where it was considered as an irregular guest. This species was never caught in recent surveys in the estuary. All exotic species are omitted since they are indicators of

disturbance (Karr, 1981), with the exception of pike-perch (*Sander lucioperca*) since this species can be considered as naturalised and has a high demand concerning oxygen concentrations (FAO, 1984). Exotic species were defined according to Verreycken *et al*. (2007). Marine species that occur in the North Sea but were never reported in the river are omitted too.

3 Results and discussion

Table C (annex) presents a presence absence reference lists for the different zones in the Zeeschelde. We structured the discussion of these lists using the ecological guild of estuarine usage (Elliott *et al*., 2007; Franco *et al*., 2008). The historical reference was based on available data from de tidal Schelde (de Selys-Longchamps, 1842 and Poll, 1945, 1947). We did not include information from archaeological studies (e.g. Van Neer & Ervynck, 1993, 1994) as anthropogenic impact in the Schelde estuary has been almost continuous since the ninth century; therefore it is scientifically impossible to trace how an unimpaired Schelde estuary would have developed.

3.1 Estuarine species

Estuarine species can complete their life cycle in the estuary. Estuarine resident species are tolerant to widely varying environmental conditions that typically characterize these transitional waters (Elliott *et al*., 2007). However, they are sensitive to the disappearance of specific estuarine habitats such as intertidal mudflats, creeks and marshes and to the accumulation of toxic substances. Therefore an estuary in MEP or in GEP status should accommodate these species. The habitat preferences for estuarine species are not fulfilled in the tributaries. According to Poll (1945, 1947), the common goby (*Pomatoschistus microps*) was quite rare in the Schelde. Common goby and sand goby (*Pomatoschistus minutus*) are at present very common (Guelinckx *et al*., 2008). The common goby is regularly found far upstream, but the freshwater is not its preferred habitat. The sand goby is less common in the freshwater part and is not kept in the freshwater lists. Transparent goby (*Aphia minuta*) is an estuarine species that should normally occur in the Schelde and is regularly caught in the mesohaline zone. This species prefers a polyhaline and mesohaline habitat (van Emmerik, 2003) and is therefore only included in the mesohaline GEP and MEP list, contrary to the list proposed by Jager and Kranenbarg (2004). Straight-nosed pipefish (*Nerophis ophidion*) was only occasionally caught in the Schelde (Poll, 1947) and has never been caught in recent

surveys. This species is not retained in the Westerschelde reference list (Jager & Kranenbarg, 2004) and hence it is not considered as a GEP or MEP species. The greater pipefish (*Syngnathus acus*), Nilsson's pipefish (*Syngnathus rostellatus*) and the viviparous blenny (*Zoarces viviparus*) are estuarine resident species that in the past occurred in the Schelde (de Selys-Longchamps, 1842 and Poll, 1945, 1947). At present they are caught as far upstream as Antwerp. These species avoid freshwater (van Emmerik, 2003) and therefore are included in the mesohaline and oligohaline MEP and GEP lists only. The hooknose (*Agonus cataphractus*) is an estuarine resident species that is reported to be rare in the Schelde (Poll, 1945), which also corresponds with our catch results. Hooknose 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 it was never caught in recent samples. Therefore we exclude this species from the GEP list but included it in the mesohaline MEP list. Striped seasnail (*Liparis liparis*) used to be common in the Schelde (Poll, 1947) preferring poly and mesohaline water. Seasnail was occasionally caught in recent campaigns and is therefore a mesohaline GEP and MEP species. Both seahorse (*Hippocampus guttulatus*) and tadpole fish (*Raniceps raninus*) are absent from the lists. Seahorse was caught nearby the sea (Poll, 1945) and is stated as rare. This species prefers polyhaline water and at present is rarely caught 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 but more common in nearby Dutch coastal waters. Fifteen-spined stickleback (*Spinachia spinachia*) was not reported by de Selys-Longchamps (1842) or by Poll (1945). It was caught only once in Doel and it is not considered as being a GEP or MEP species.

3.2 Diadromous species

Estuaries have a crucial role as migration routes (Able, 2005). According to the season different diadromous species occur in different zones of the estuary. Absence of diadromous species is caused by human impacts, disrupting the connectivity and as a result the estuary is considered not to reach the MEP or GEP status. Thus diadromous species are, when not extirpated in the estuary or nearby estuaries, included in both lists and all zones. If all barriers, physical and chemical, would disappear these species should be able to swim all along the

tributaries (see Table C, annex). The decline of sturgeon (*Acipenser sturio*), Atlantic salmon (*Salmo salar*) and allis shad (*Alosa alosa*) was already described by Poll (1945). Now they are extirpated in the Schelde basin and are not considered as GEP species. However, it is not impossible to restore their required habitat in the Schelde basin and since these species are present in some North-East Atlantic estuaries their return is possible and would indicate a MEP condition. Houting (*Coregonus oxyrhynchus*) was considered as very rare or in danger of extinction by Poll (1945, 1947). At present this species is considered to have disappeared (red list) or to be extinct (International Union for Conservation of Nature and Nature Resources: IUCN) hence it is not in our lists. In addition this species habitat area is also situated more to the north (Maitland, 2000). All the other diadromous species occur in the lists because it can be expected that they will frequent the estuary and tributaries once the habitat conditions improve (Maes *et al*., 2007). The brown trout (*Salmo trutta*) population was already declining in 1945 (Poll, 1945) and now individuals are rarely caught. However, their presence would indicate a MEP status as they are pollution intolerant species. Eel (*Anguilla anguilla*) and flounder (*Platichthys flesus*) were common in the River Schelde (de Selys-Longchamps, 1842 and Poll, 1945). Three-spined stickleback (*Gasterosteus aculeatus*) is known to be a species which is common in all types of waters in Flanders. In the mesohaline zone of the Zeeschelde three types occur (Raeymaekers *et al*., 2007) including the diadromous type. Thinlip mullet (*Liza ramado*) was previously often confounded with thicklip grey mullet (*Chelon labrosus*) a marine seasonal migrant. Poll (1945) stated that the species was abundant nearby the Belgian coast. At present specimens are recorded far upstream Antwerpen. River lamprey (*Lampetra fluviatilis*), twaite shad (*Alosa fallax*) and smelt (*Osmerus eperlanus*) are indicators of good water quality and connectivity as well as good ecological functioning of the estuary (e.g. suitable spawning locations). Sea lamprey (*Petromyzon marinus*) which is abundant according to de Selys-Longchamps (1842) is at present scarce (<5% catch frequency) and is kept in the MEP lists.

3.3 Freshwater species

The freshwater resident species can complete their life cycle in the tidal freshwater part of the estuary. They reproduce, grow up and feed in freshwater, but can also exploit the oligohaline zone evidencing their inclusion in the oligohaline MEP/GEP list too. The Zeeschelde has an important freshwater tidal zone and therefore freshwater species occupy various zones. The spatial distribution is species dependent. Some freshwater species make regular use of

different zones within the 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 to marine stragglers but these enter the estuary from the opposite end. For the tributaries 25 freshwater species are recorded in the MEP list and 16 in the GEP list. The freshwater species ruffe (*Gymnocephalus cernuus*) is mentioned by de Selys-Longchamps (1842) but not by Poll (1945). At present this species is caught in the Zeeschelde all along its salinity gradient. Poll (1945) considers perch (*Perca fluviatilis*) to be very common in the freshwater and brackish reaches of the Zeeschelde up to Zandvliet. Recently perch is caught all over the Zeeschelde. Roach (*Rutilus rutilus*) is less abundant and is not typical for the mesohaline zone, though specimens are captured in Doel and Zandvliet. Roach 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 since it is not its preferred habitat. Though nine spine stickleback is less common than the three-spined stickleback, it is to be found in all tributaries. As already mentioned three-spined stickleback is common in all zones. Bitterling (*Rhodeus sericeus*) is a freshwater species preferring stagnant or slow moving water with plants. Though Poll (1945) did not mention its presence in the Schelde it has been collected in different places in the Zeeschelde. Simoens *et al.* (2006) placed this species in the reference list for fresh tidal water but not for the brackish part of the Schelde. Though the species can tolerate 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 lists. 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 and oligohaline GEP and MEP lists since the mesohaline is not its preferred habitat (Frimodt, 1995). The weatherfish (*Misgurnus fossilis*) is now only caught in the tributaries. De Selys-Longchamps (1842) mentioned its presence in the Schelde and Poll (1942) stated that three specimens were collected in the Schelde. This species should not be present in the mesohaline zone but its presence could be indicative in the other zones. Carp (*Cyprinus carpio*) was 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 our lists since it has an exotic origin and is tolerant to extreme conditions. Species such as white bream (*Blicca bjoerkna*), pike (*Esox lucius*) and rudd (*Scardinius erythrophthalmus*) were mentioned by Poll (1945) to be present in the Schelde. They are still caught in the Zeeschelde and even occasionally in Zandvliet (Guelinckx *et al*., 2008). 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. Ide is a rheophilic B species i.e. some stages of its life history are confined to connected backwaters (van Emmerik, 2003) with a relative high tolerance value (Breine *et al.*, 2007a). Ide is found all along the River Schelde and in most of its tributaries. However, their abundance is underestimated due to confusion with roach. Ide is considered as representative for oligohaline, freshwater and tributaries GEP and MEP lists. Crucian carp (*Carassius carassius*) is kept in the freshwater list since it is occasionally captured (>5% catch frequency) in the Zeeschelde (Simoens *et al.*, 2006). Pike-perch (*Sander lucioperca*) is an exotic freshwater species which is considered as a recent native species in the Netherlands (van Emmerik, 2003). This species can support brackish water and is quite common along the salinity gradient. Pike-perch is sensitive to temperature changes and intolerant to oxygen deficiency and can be used as an indicator for eutrophication (van Emmerik, 2003). The species prefers deeper water than provided by the tributaries and is therefore kept in the GEP lists of the main channel only. 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 rheophilic but not obligate species lives in freshwater but can stand brackish water. Simoens *et al.* (2006) did not consider bullhead a reference species for the Schelde and its tributaries. Buysse *et al*. (2007) caught bullhead in the Nete. This 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 meets the demands of this species, but the morphological characteristics and substrate of the tributaries are not really optimal. We keep it as an indicator for the MEP status in the freshwater zone and tributaries. Burbot (*Lota lota*) is recently reintroduced in the upper Nete. It is possible that within time this species will be caught in the Zeeschelde since Poll (1945) mentioned that it can support mesohaline conditions although the species is not caught yet in the River Schelde. Burbot is retained in the MEP lists since it is an intolerant species. Dace (*Leuciscus leuciscus*) was not mentioned by de Selys-Longchamps (1842) and Poll (1945,

1947) and is only caught in the freshwater tributaries. Because of its rarity and ecological demands this species is included in the MEP lists for tributaries only (Turnpenny *et al*., 2004). 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) mentioned its presence in the Schelde while Poll (1945, 1947) did not. According to Breine *et al.* (2007) bleak has a low pollution tolerance and is therefore only included in the freshwater and tributaries MEP lists. Stone loach (*Barbatula barbatula*) is caught in the freshwater tributaries only, where it indicates a MEP status (<5% CF). de Selys-Longchamps (1842) reported on barbel (*Barbus barbus*) and brook lamprey (*Lampetra planeri*) while Poll (1945) did not. The Zeeschelde is not their habitat. Maes *et al.* (2005) and Breine *et al*. (2007) did not include these two species in their reference lists neither. Barbel is a rheophilic A species preferring fast running water which is not typical for the Schelde tributaries. This species was not caught recently and it was decided not to retain barbel in the lists since the tributaries do not offer the required habitat demands. Brook lamprey is caught in the tributaries and therefore kept in its MEP list. Eurasian minnow (*Phoxinus phoxinus*) is an intolerant species typical for upstream water (Breine *et al*., 2004, 2007), preferring well oxygenated water and gravel substrate (Vostradovsky, 1973). Minnow has never been reported to be caught in the Zeeschelde. European chub (*Leuciscus cephalus*) and gudgeon (*Gobio gobio*) are species reported by de Selys-Longchamps (1842) but not by Poll (1945, 1947). They were caught in the freshwater tributaries (Buysse *et al*., 2007; Breine *et al*., 2007a). European chub is a rheophilic A species typical occurring in creeks and fast flowing rivers (Billard, 1997) and their presence indicates a MEP status. Belica (*Leucaspius delineatus*) is caught occasionally in the freshwater part of the Schelde but was not reported by de Selys-Longchamps (1842) and Poll (1945, 1947). Belica is a stagnophilic species that needs the presence of plants which are not really offered by the Schelde. Therefore this species is included in the tributaries list only. Tench (*Tinca tinca*) has been caught around Antwerpen but is considered a species rather belonging to standing waters and upstream the tributaries (Allen *et al*., 2002).

3.4 Marine migrants

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 in a MEP or GEP status are used by these migrants as feeding areas and refugia. Tributaries do not offer a suitable habitat for marine migrants. Herring (*Clupea harengus*) is an abundant marine juvenile species (Poll, 1945, 1947; Maes, 1997, 2001). Herring swim upstream till the oligohaline zone. Plaice (*Pleuronectes platessa*) was described by Poll (1945) as being very abundant in the Schelde, although adults were rarely caught. The species is now collected in small numbers at Doel and is retained in the mesohaline GEP and MEP lists. Sole (*Solea solea*) penetrated as juveniles quite far into the estuary (Poll, 1945). Poll (1945) mentioned also captures of numerous adults. Sole is now caught in the mesohaline and oligohaline zones and is retained in both GEP and MEP list. Juvenile of the marine species tub gurnard (*Chelidonichthys lucernus*) and whiting (*Merlangius merlangus*) have been reported in the Schelde by de Selys-Longchamps (1842) and Poll (1945, 1947). Also currently mostly juveniles are caught. The oligohaline zone is not their habitat and they are therefore retained only in the mesohaline GEP and MEP lists. At present seabass (*Dicentrarchus labrax*) is one of the most common species caught in the Schelde, which agrees with Poll (1945) who reported 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 that was frequently observed in the Schelde (Poll, 1945, 1947) and is still captured up to Antwerpen. The species is taken into the meso- and oligohaline GEP and MEP lists. Only juveniles of brill (*Scophthalmus rhombus*) are found in the Zeeschelde. This species was 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 now regularly caught in the Zeeschelde. Therefore sand smelt stays in the mesohaline MEP list. Cod (*Gadus morhua*) is an uncommon seasonal migrant, of which only juveniles wander in the estuary. Cod is included in the mesohaline MEP list only. Poll (1947) reported 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 rarely caught and if so only juveniles. Turbot is included in the Dutch list (Jager & Kranenbarg, 2004) but kept in our mesohaline MEP list only. Pollack (*Pollachius pollachius*) was 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). Pollack is not collected in recent fish campaigns in the Zeeschelde and is therefore omitted from our lists. In the past sprat (*Sprattus sprattus*) entered in large numbers the estuary between January and July (de Selys-

Longchamps, 1842 and Poll, 1945, 1947). This species is still 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. According to Poll (1947) anchovy (*Engraulis encrasicolus*) was a seasonal guest from April to August that visited the estuary in large numbers to spawn. At present they are rarely caught upstream Doel. They are retained in the mesohaline MEP and GEP lists. Thicklip grey mullet (*Chelon labrosus*) was considered as rare in the Schelde (Poll, 1947) but is occasionally caught (<5% CF) in recent surveys and is therefore included in the mesohaline MEP list. Garpike (*Belone belone*) was uncommon in the estuary (Poll, 1945). Though it was not caught recently it has a place in the mesohaline MEP list, since it is an indicator of good water quality and 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. This species is in the mesohaline MEP list. The fivebeard rockling (*Ciliata mustela*) was rarely caught in the past (Poll, 1945, 1947) but is now regularly caught in Doel. Grey gurnard (*Eutrigla gurnardus*), sting ray (*Dasyatis pastinaca*) and pilchard (*Sardina pilchardus*) were only encountered occasionally in the estuary (Poll, 1945, 1947). Of them only grey gurnard was caught haphazardly in Doel and none of the three species are withheld in the lists. Small sandeel (*Ammodytes tobianus* or *A. lancea*) was common in the Schelde estuary (Poll, 1945). This species is occasionally caught and is therefore kept in the mesohaline MEP list. Lozano's goby (*Pomatoschistus lozanoi*) is not mentioned in historical reports but is recently regularly caught in the mesohaline zone (Breine *et al*., 2001).

4 Conclusions

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, physical and chemical MEP/GEP are described by Brys *et al*. (2005). Their approach was also used to define the guild specific habitat needs (qualitative) for fish in the Schelde (Chapter 4). If these habitat needs are fulfilled, thanks to restoration and mitigating actions, then we consider the estuary to be in MEP condition for fish. The near fulfilment brings it in the GEP condition. 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 Zeeschelde estuary and its tidal 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 the acceptance of a specific species within the lists. The ecological knowledge of the assessed species is available and sufficient to reduce the risk of mistakes in attribution. The lists proposed should be considered as a starting point to develop quantitative guild lists i.e. include numbers instead of presence/absence information. Attributing threshold values to these quantitative lists will allow expressing the ecological status as an ecological quality ratio (EQR) between 0 and 1. The guild approach facilitates the development of such an 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. Such an evaluation system normally assesses the deviation between a reference condition and the actual condition. Therefore these lists can be used to develop fish-based indices.

Acknowledgments

We are grateful to all people who contributed to the collection of field data.