Description of references and metrics for fish in rivers in the Netherlands

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1. INTRODUCTION

Reference conditions and metrics for fish in the Netherlands were developed more or simultaneously with the FAME. As a consequence we could not use the output of FAME in that stage. In 2005 though a validation exercise was conducted using FIDES for the small and medium-sized rivers. This was necessary, because the Netherlands lack reference sites, and it was possible because surrounding countries do have reference sites with quite similar fish communities as found in Dutch rivers. The choice of metrics also shows a strong comparison with the FAME project. We do, however, not (yet) use absolute abundance in our metrics as will be shown in the following. The reason is that sampling in the past had insufficiently been standardised and a poor registration of the effort. Further standardisation as well as an improved recording of the effort applied will quite surely allow the use of absolute abundances in the future.

The general approach is based on the ecological characteristics of individual fish species in combination with predefined river types. This river typology is in the Netherlands used for all biological quality elements. Per quality element types may be combined in case there is little difference between their communities. For assessment the fish species are grouped into guilds. The guilds used comprise degree of rheophily, migration and general sensitivity to habitat degradation.

Table 1 Description of river types. R8 has a tidal influence of 0,3 –1,9 m; n.a. = not applicable

KRW descriptor type	name	Slope m/km	Flow velocity cm/s	Geology >50%	width m	catchment km^2
R4	Permanent slow-flowing headwater on sandy soil	< 1	< 50	silicious	0-3	0-10
R5	Slow-flowing middle/lower course on sandy soil	< 1	< 50	silicious	3-8	10-100
R6	Slow-flowing rivulet on sandy/clayey soil	< 1	< 50	silicious	8-25	100-200
R7	Slow-flowing river on sandy/clayey soil	< 1	< 50	silicious	> 25	> 200
R8	Freshwater tidal river on sandy/clayey soil	< 1	< 50	silicious	> 25	> 200
R10	Slow-flowing middle/lower course on calcareous soil	< 1	< 50	calcareous	3-8	10-100
R12	Slow-flowing middle/lower course on peaty soil	< 1	< 50	organic	3-8	10-100
R14	Fast-flowing middle/lower course on sandy soil	> 1	> 50	silicious	3-8	10-100
R15	Fast-flowing rivulet on siliceous soil	> 1	> 50	silicious	8-25	100-200
R16	Fast-flowing middle/lower course on sandy or gravel soil	> 1	> 50	silicious	> 25	> 200
R18	Fast-flowing middle/lower course on calcareous soil	> 1	> 50	calcareous	3-8	10-100

2. DESCRIPTION OF RIVER TYPES

In the Netherlands 18 river types are distinguished. For eleven river types the references fish community and metrics has been defined (Table 1). No substantial difference has been found between R5 and R10 and between R14 and R18. They

were combined and thus in total nine different reference fish communities have been identified.

Remark: for comparison with other member states we thus need a characterisation of the river based on these hydromorphological criteria (Table 1). Since there is an overlap with the environmental criteria used in the FAME project it will probably not be too difficult to filter on the basis on the FAME criteria. This has to be confirmed where is concerns the level of resolution.

Other river types for which no references and metrics have been defined are:
- Intermittent spring (R1)
- Permanent spring (R2)
- Intermittent slow-flowing headwater on sandy soil (R3)
- Slow-flowing headwater on calcareous soil (R9)
- Slow-flowing headwater on peaty soil (R11)
- Fast-flowing headwater on sandy soil (R13)
- Fast-flowing headwater on calcareous soil (R17)

3. SPECIES COMPOSITION

The present insights indicate that judgement should make use of an IBI having several metrics that are sensitive to relevant pressures. Basic principle for the choice of fish-based indicators is the sensitivity of the various ecological guilds to the degree of human intervention in aquatic ecosystems. The various species represented in the guilds make specific use of habitats within a river and are thus sensitive to specific pressures. When defining metrics, large rivers are dealt with separately next to small and medium-sized rivers.

For the species composition the following parameters are used for small and medium-sized rivers (Table 2, Table 3):
- Number of characteristic rheophilic species
- Number of characteristic eurotopic species
- Number of species that migrate regionally or to the sea
- Number of species sensitive to habitat destruction

For large rivers are used (Table 4):
- Number indigenous diadromous species
- Number indigenous rheophilic species
- Number indigenous limnophilic species

Table 2 Species characteristics. Small and medium-size rivers: E = eurytopic; H = habitat sensitive; M = migration regional/sea; R = rheophilic. Large rivers: D = diadromous; L = limnophilic; R = rheophilic. The guild column is used for the metrics concerning relative abundance. Per river type the species are given that are considered to be characteristic for that particular type. This is used for the metrics concerning species composition. The river types R11, R13 and R17 are not further addressed due to low species richness.

Species	Small and medium-sized rivers									Large Rivers			
	Guild	R4 R9	R5 R10	R6	R11	R12	R13 R17	R14 R18	R15	Guild	R7	R8	R16
Abramis brama	EM												
Acipenser sturio	RMH									RD	RD	RD	RD
Alburnoides bipunctatus	RH									R			R
Alburnus alburnus	E			E					E	R	R	R	R
Alosa alosa	RMH									RD	RD	RD	RD
Alosa fallax	RMH									D		D	
Anguilla anguilla	EMH		EMH	EMH		EMH		EMH	EMH	D	D	D	D
Aspius aspius	EMH												
Barbatulus barbutula	RH	RH	RH	RH	RH	RH	RH	RH	RH	R			R
Barbus barbus	RMH								RMH	R	R	R	R
Blicca bjoerkna	E												
Carassius carassius	H									L	L	L	L
Carassius gibelio	E												
Cobitis taenia	EH		EH	EH		EH				R	R	R	R
Condrostoma nasus	RMH								RMH	R	R	R	R
Coregonus laveratus	EMH												
Coregonus oxyrinchus	MH									RD	RD	RD	RD
Cottus gobio	RH						RH	RH	RH	R	R	R	R
Cyprinus carpio	EH												
Esox lucius	EH		EH	EH		EH							
Gasterosteus aculeatus	E	E	E	E	E	E	E	E	E	D	D	D	
Gobio gobio	RH	RH	RH	RH		RH		RH	RH	R	R	R	R
Gymnocephalus cernuus	E												
Lampetra fluviatilis	RMH			RMH					RMH	RD	RD	RD	RD
Lampetra planeri	RMH	RMH	RMH	RMH				RMH					
Leucaspius delineatus	H		H	H		H		H	H	L	L	L	L
Leuciscus cephalus	RMH		RMH	RMH				RMH	RMH	R	R	R	R
Leuciscus idus	RMH			RMH					RMH	R	R	R	R
Leuciscus leuciscus	RH		RH	RH				RH	RH	R	R	R	R
Lota lota	EMH									R	R	R	R
Misgurnus fossilis	H									L	L	L	L
Osmerus eperlanus	H									D		D	
Perca fluviatilis	E		E	E		E		E	E				
Petromyzon marinus	RMH									RD	RD	RD	RD
Phoxinus phoxinus	RH						RH	RH	RH	R			R
Platichthys flesus	MH									D	D	D	
Pungitius pungitius	H	H	H		H	H							
Rhodeus sericeus	H									L	L	L	L
Rutilus rutilus	E		E	E		E		E	E				
Salmo salar	RMH									RD	RD	RD	RD
Salmo trutta fario	RH									R			R
Salmo trutta trutta	RMH									RD	RD	RD	RD
Sander lucioperca	EH												
Scardinius erythrophthalmus	H									L	L	L	L
Silurus glanis	EH												
Thymallus thymallus	RMH												
Tinca tinca	H									L	L	L	L
Total number of characteristic species			5	13	15	3	10	4	12	16		26	28	28

Table 3 Metric boundaries for the species composition in small and medium-sized rivers.

Guild	EQR	R4	R5 R10	R6	R12	R14 R18	R15
Rheophilic	0,1			1		1	1
	0,2		1	2		2	2
	0,3	1		3		3	3
	0,4		2	4		4	4
	0,5				1		5
	0,6		3	5		5	6
	0,7	2					7
	0,8		4	6		6	8
	0,9						9
	1,0	3	5	7	2	7	10
Eurytopic	0,1		1	1	1		
	0,2		2	2	2	1	1
	0,3			3			
	0,4		3	4	3		2
	0,5					2	
	0,6		4	5	4		3
	0,7						
	0,8		5	6	5	3	4
	0,9						
	1,0	1	6	7	6	4	5
Migration regional/sea	0,1						1
	0,2			1			2
	0,3		1			1	
	0,4			2			3
	0,5				1		
	0,6			3			4
	0,7		2			2	
	0,8			4			5
	0,9						
	1,0	1	3	5	2	3	6
Habitat sensitive	0,1		1	1-2	1	1	1-2
	0,2	1	2	3	2	2	3-4
	0,3		3	4	3	3	5
	0,4		4	5	4	4	6
	0,5	2	5	6		5	7
	0,6		6	7	5	6	8
	0,7		7	8		7	9
	0,8	3	8	9	6	8	10
	0,9		9	10			11
	1,0	4	10	11	7	9	12

Table 4 Metric boundaries for the species composition in large rivers. Per type and metric is given the minimum number of species that gives the EQR score.

Guild	EQR	R7	R8	R16
Rheophilic	0,3	10	10	14
	0,5	12	12	16
	0,7	15	15	19
	0,9	17	17	21
Diadromous	0,3	3	5	1
	0,5	5	7	3
	0,7	8	10	6
	0,9	10	12	8
Limnophilic	0,3	1	1	1
	0,5	2	2	2
	0,7	4	4	4
	0,9	6	6	6

For all these metrics the number of species that is regarded as being characteristic is enumerated. For each river type the EQR can be derived from the number of species per guild.

4. ABUNDANCE

For the metric abundance the following parameters are used in small and medium-size rivers (Table 5):

- Relative abundance (%) of rheophilic species
- Relative abundance (%) of eurytopic species
- Relative abundance (%) of species that migrate regionally or to the sea
- Relative abundance (%) of species sensitive to habitat destruction

For large rivers are used (Table 6)

- Relative abundance (%) of rheophilic species
- Relative abundance (%) of limnophilic species

Table 5 Metric boundaries for relative abundance of various guilds in small and medium-sized rivers. Relative is expressed as the numerical percent of the total number of specimens observed. Within one class scores change linearly. Abundances outside the lower or upper boundaries are classified as either 0 or 1.

Guild	EQR	R4	R5, R10	R6	R11	R12	R14 R18	R15
Rheophilic	0,0	0	0	0	0	0	0	0
	0,2	10	10	10	10	10	30	30
	0,4	30	30	30	30	30	70	70
	0,6	70	65	65	70	65	85	85
	0,8	80	75	75	80	75	90	90
	1,0	90	85	85	90	85	95	95
Eurytopic	0,0	90	100	100	90	100	100	100
	0,2	60	90	90	60	90	80	80
	0,4	40	40	40	40	40	30	30
	0,6	20	20	20	20	20	20	20
	0,8	10	10	10	10	10	10	10
	1,0	5	5	5	5	5	5	5
Migration regional/sea	0,0	0	5	5	0	5	0	0

Guild	EQR	R4	R5, R10	R6	R11	R12	R14 R18	R15
	0,2	5	20	20	5	20	5	5
	0,4	10	30	30	10	30	10	10
	0,6	15	40	50	15	40	15	15
	0,8	20	50	70	20	50	55	55
	1,0	90	90	90	90	90	90	90
Habitat sensitive	0,0	10	0	0	10	0	0	0
	0,2	30	20	20	30	20	40	40
	0,4	50	60	60	50	60	75	75
	0,6	85	90	90	85	90	85	85
	0,8	95	95	95	95	95	95	95
	1,0	100	100	100	100	100	100	100

Table 6 Metric boundaries for the relative abundance of rheophilic and limnophilic guild as percent of the total number of specimens in large rivers. Per type and metric the minimum relative abundance is given that gives the EQR score.

Guild	EQR	R7	R8	R16
Rheophilic	0,3	10.0	5.0	20.0
	0,5	20.0	15.0	30.0
	0,7	30.0	25.0	40.0
	0,9	40.0	35.0	50.0
Limnophilic	0,3	1.0	1.0	0.1
	0,5	5.0	5.0	1.0
	0,7	10.0	10.0	3.0
	0,9	15.0	15.0	5.0

For abundance data of all species are used including that are not considered characteristic e.g. the abundance of all rheophilic species. The abundance of a certain guild is expressed relative to the total abundance. Per river type boundaries are defined. Within one boundary class the score changes linearly. Values exceeding the upper boundary of the high state are classified as 1.

The class boundaries are when possible based on ecological relevant boundaries (transitions in fish communities). The class boundaries for small and medium-sized rivers are derived using FIDES and a subsequent validation on the Netherlands dataset. In individual cases expert judgment has been judged to fit the boundaries to the local situation in the Netherlands. Further explanation can be found in Klinge et al. 2004 (in Dutch)

By a low number of species there is a substantial chance that the metric for abundance does give an unreliable estimate of the fish community. Therefore a minimum number of 10 fish is required to apply the abundance metric. The number of fish caught of course depends on the effort applied. It is therefore a prerequisite that for future sampling effort such as the length of the reach sampled should be recorded to be able to relate effort to the minimum number of fish caught.

5. AGE COMPOSITION

The metric age composition does not make part of the assessment of small and medium-sized rivers. Too few data are available on age determination. Data on length composition are available though, but have so far not been used. We do not expect that either age or size composition will add any discriminative power to the assessment of the ecological state that uses a five-class system.

Also for the large rivers (R7, R8 en R16) there is no metric for age composition. In an earlier version abundance of 0-group rheophilic fish was proposed as a metric for age composition. Due to methodological uncertainties it has been left out.

6. FINAL JUDGEMENT

Small and medium-size rivers (R4, R5, R6, R10, R12, R14, R18):

To determine of the final score the individual scores for species composition and abundance are calculated separately as follows:

EQR = [(rheophilic + eurytopic)/2 + (migration regional/sea) + (habitat sensitive)]/3

The motivation to average the scores for rheophilic and eurytopic is because characteristics species of these guilds together yield one image of the total number of characteristics species. The relative abundances of these two guilds are thus interdependent.

Subsequently the arithmetic mean of the score for species compositon and abundance gives the final score for the EQR for fish in small and medium-sized rivers.

EQR = (EQR species composition + EQR abundance)/2

Large rivers (R7, R8, R16):

For the calculation of the ecological state in large rivers the same weight has been given to species composition and abundance.

EQR = [(species score diadromy+rheophily +limnophily)/3 + (abundance score rheophily+limnophily)/2]/2

7. MONITORING

The score especially those for the species composition depends on the sampling methodology. The monitoring has to be performed according to the Netherlands Handbook on fish monitoring and assessment (STOWA, 2003 (in Dutch)). The presented assessment method is tuned to the sampling effort this handbook applies. The standardised sampling is not exhaustive to record every species in the system i.e. the method is adequate for a proper quantitative monitoring of the common and less common and easy to sample species. The lesser probability to encounter either a rare or a difficult to sample species has been taken into consideration for the species composition metric by basing the metric on the encounter probability per species at standardised sampling.

8. REFERENCES

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