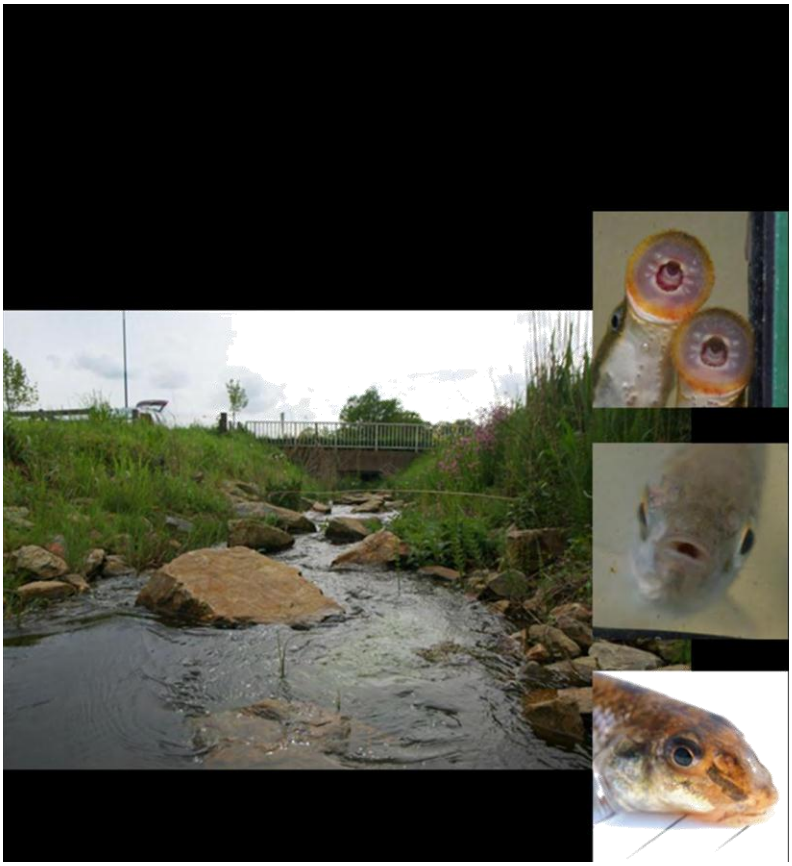
MONITORING OF 22 FISH MIGRATION FACILITIES SPRING 2012

WATER BOARD DE DOMMEL, WATER BOARD AA AND MAAS, WATER BOARD BRABANTSE DELTA, WATER BOARD DE STICHTSE RIJNLANDEN, WATER BOARD VAN RIJNLAND, WATER BOARD VELUWE & WATERNET



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ARCADIS

1 Introduction

1.1 BACKGROUND

Last years fish migration facilities are constructed throughout the whole country (the Netherlands) to restore the free migration of fish through the water system. This restoration is part of the water- and nature policy. In fact, fish is one of the four biological quality indicators used in the European Water Framework Directive (WFD).
The WFD requires that all waters are in an ecologically healthy condition for 2015. However, this will not be achieved. It is expected this will be achieved no earlier than in 2027. Hence fish and fish migration are a central role in the policy of water boards. By constructing fish migration facilities, areas previously inaccessible for fish should become accessible.

For many fish species migration is important to complete the lifecycle. There are three different functional distinct habitats required for the grown fish: for reproduction (spawn habitat), for foraging and as shelter (Figure 1). If one of these habitats can't be reached, this can have consequences for the size and robustness of the fish population. Migration to or from spawning grounds is seasonal, while migration between resting and foraging areas can be daily (Figure 1).

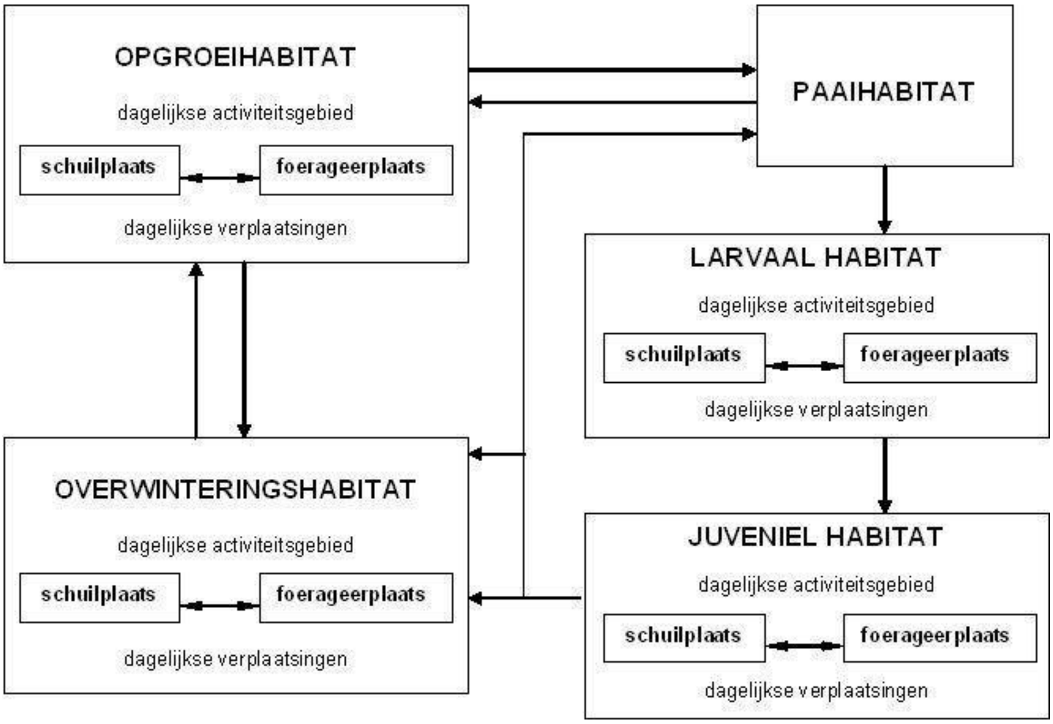


Figure 1 Schema migration pattern of fish (Coeck, 2002 in Kroes & Monden, 2005)

To regulate the water levels the water boards have divided the management areas in level areas. For this they use structures such as weirs and pumping stations. For many fish these structures are an impassable obstacle. To make the structures fish passable and contribute to the realisation of the WFD goals, more and more fish passes are constructed. These migration facilities are placed, dependent on the type of passage, around the weir or instead of the weir. Also structures (like a pumping station) are addressed so fish can pass.

After realisation of the fish pass it is important to control whether it is functioning properly. This is done by monitoring. By monitoring it can be examined which fish(species) use the migration facility. On behalf of 6 water boards, in the spring of 2011 research was conducted on 14 fish passes. This has been carried out by ARCADIS. This research has led to the report 'Monitoring and evaluation of fish migration facilities'. Two of these passes were, together with a recently constructed migration facility, also monitored in the autumn of 2011. Following the results and insights these researches have yielded a new monitoring period which started in the spring of 2012. In total 21 fish passes in 17 waters bodies covered by 7 water boards were monitored. Figure 2 displays the research locations.

Figure 2 Map with the research locations in the Netherlands (BingMaps, 2012)

1.2 GOAL RESEARCH

In the spring and autumn of 2011 on behalf of several water boards multiple fish passages were examined by ARCADIS. Like 2011, the spring research of 2012 focuses on the function of the fish passage. The goal of this research is:

- To map out the function of the 21 fish migration facilities for the benefit of upstream migration;
- To form recommendations based on the results in order to improve the investigated fish migration facilities (if any);
- Comparing the monitored fish passage types;
- Comparing investigated fish passages in 2011 and 2012.

These goals are divided in a main question and sub questions, these questions are addressed in this report.

Main question:

- **What is the function of the monitored fish migration facilities?**
  - How many fish use the facility?
  - Which fish species use the facility?
  - Which species groups use the facility? (slow swimmers, moderate swimmers, fast swimmers and benthic zone fish)
  - Which length classes use the facility?

Additional questions per location:

- How do the catches relate to the fish stock?
- How do the catches relate to the possible offer?
- Which external factors possibly influence the function?
- Which recommendations can be formed regarding the improvement? (if any)

General questions to compare results per location:

- How does the function of various fish passage compare?
- Are there differences in the function of a certain type fish passage in different water systems or are there differences noticeable for the function per specie group?
- Which similarities and differences are there in the monitoring of 2012 compared to 2011?

Scope and delimitation

In this project only the function of fish passes with respect to upstream migration have been examined. To be able to answer additional questions also offer and fish stock have to be examined. This requires great effort with associated costs. Because of this it has not been taken into account in this research.

However, we try to answer additional questions based on present data such as previous migration research or fish stock samplings. In most cases this information is not sufficient to formulate well-founded answers but this can be seen as an indicative consideration. This is important to be able to give directions for a follow-up study and to formulate recommendations for additional measures.

1.3 READING GUIDE

Chapter 2 gives a short description of different fish migration facilities monitored in this research. Chapters 3 describes materials commonly used, methods and interpretations of the results. The monitoring period in 2012 is also discussed and communication with water boards and third parties.

In chapter 4 to 24 the investigated fish passages are discussed. In these chapters the current situation is described. Among others a description of the water flow, the fish stock, the fish passage and target species which the water board has drafted and are appointed. Subsequently the location specific materials, methods and the progress of the research for this passage are described. Furthermore the results are shown and the main questions and sub questions per location are answered. Finally recommendations are formulated per location

In chapter 25 the results of different fish migration facilities are compared. Also the migration peaks of different fish species are perceived. The results of this research are compared with the results of 2011. Chapter 26 discusses the various issues of possible influence on the results. Finally, chapter 27 gives the overall conclusion of this research.

5 Waterboard Aa and Maas – Fish siphon pass Kaweise Loop

5.1 KAWEISE LOOP

The Kaweise Loop is a normalised brook (Figure 18) which makes the boundary between de municipalities Deurne and Bakel. The WFD has marked the Kaweise Loop as a 'permanent flowing upstream on sand' (type R4). The brook rises at airbase De Peel and continues along the remnants of the Deurnse Peel. The Biesheuvelse Loop (upstream of the fish pass) and the Vlier (downstream of the fish pass) join with the Kaweise Loop. The Kaweise Loop then flows in the Oude Aa, which becomes the Bakelse Aa. This water eventually flows into the Aa (Arends *et al*., 2007). In 2008, a rebuilding plan has been written for a part of the Kaweise Loop with the objective to create a more natural situation. In this plan fish passage has been discussed (Cleveringa *et al*., 2008). The topographical location of the fish siphon pass in the Kaweise Loop near Bakel is shown in Figure 17.

Figure 17. The red circle represents the fish siphon pass in the Kaweise Loop.

Fish population

In 2006 a fish population sampling of the Kaweise Loop has been carried out. The following types have been detected: bleak (*Albumus albumus*), perch (*Perca fluviatilis*), stone loach (*Barbatula barbatula*), roach (*Rutilus rutilus*), gibel carp (*Carassius gibelio*), carp (*Cyprinus carpio*), spined loach (*Cobitis taenia*), silver bream (*Blicca bjoerkna*), gudgeon (*Gobio gobio*), rudd (*Scardinius erythrophtalmus*), pike (*Esox lucius*), three spined stickleback (*Pungitius pungitius*), belica (*Leucaspius delineates*) and tench (*Tinca tinca*) (Arends *et al., 2007)*.

The above fish data apply for the entire Kaweise Loop. The supply for the fish siphon pass near Bakel is smaller. This is because there is another impassable weir in the Bakelse Aa. In the future, this weir will be made into a passable weir, so fish from the Aa and the rest of the Bakelse Aa can use the fish siphon pass in the Kaweise Loop (mon. med. B. Arends, 2012).

Figure 18. The Kaweise Loop, on the right side the fish pass (23-03)

Target species

The target species of the Kaweise Loop are stone loach (*Barbatula barbatula*), bullhead (*Cottus perifretum*), gudgeon (*Gobio gobio*) and common dace (*Leuciscus leuciscus*). Accompanying species are three-spined stickleback (*Gasterosteus aculeatus*) and European brook lamprey (*Lampetra planeri*) (Arends *et al*., 2007).

5.2 THE FISH SIHPON PASS

The fish pass in the Kaweise Loop near Bakel exists of a combination of a shallow "V" notch weir pass and a siphon fish pass. In this monitoring only the siphon fish pass was sampled, but it can be assumed that the fish found in the fish trap also passed the shallow "V" notch weir pass.

The Kaweise Loop flows via ecological connection zone (ECZ) out of the Bakelse Aa in to the Aa, so when all migration constraints are solved, fish from the Aa can use the area behind the fish pass near Bakel. The fish pass is shown in Figure 19.

Figure 19. The shallow V notch pass Kaweise Loop (left, 12-03) and the upstream inlet of the fish siphon pass with fish trap and coupling piece (right, 12-03)

5.3 MATERIALS, METHODS AND PROCESS OF THE RESEARCH

Material and method

For monitoring this pass, Waterboard Aa and Maas have supplied a fyke net with frame and coupling piece. The upstream inlet opening of the fish siphon pass has slots. The coupling piece has been slid in the slots. Due to this the opening is turned 180°, so there will be enough space for the fyke net. The fyke net was tightly stretched around a pole in the water (see also Figure 19 right side). During the emptying the fyke net was checked for fish from front to rear, so fish was gathered in the last compartment. Every time the net was emptied the fyke was checked for floating debris and defects. During the research the fyke was emptied 2 to 3 times per week. On request of the water board the monitoring was continued until the 8th of June. In total the fyke was emptied 32 times.

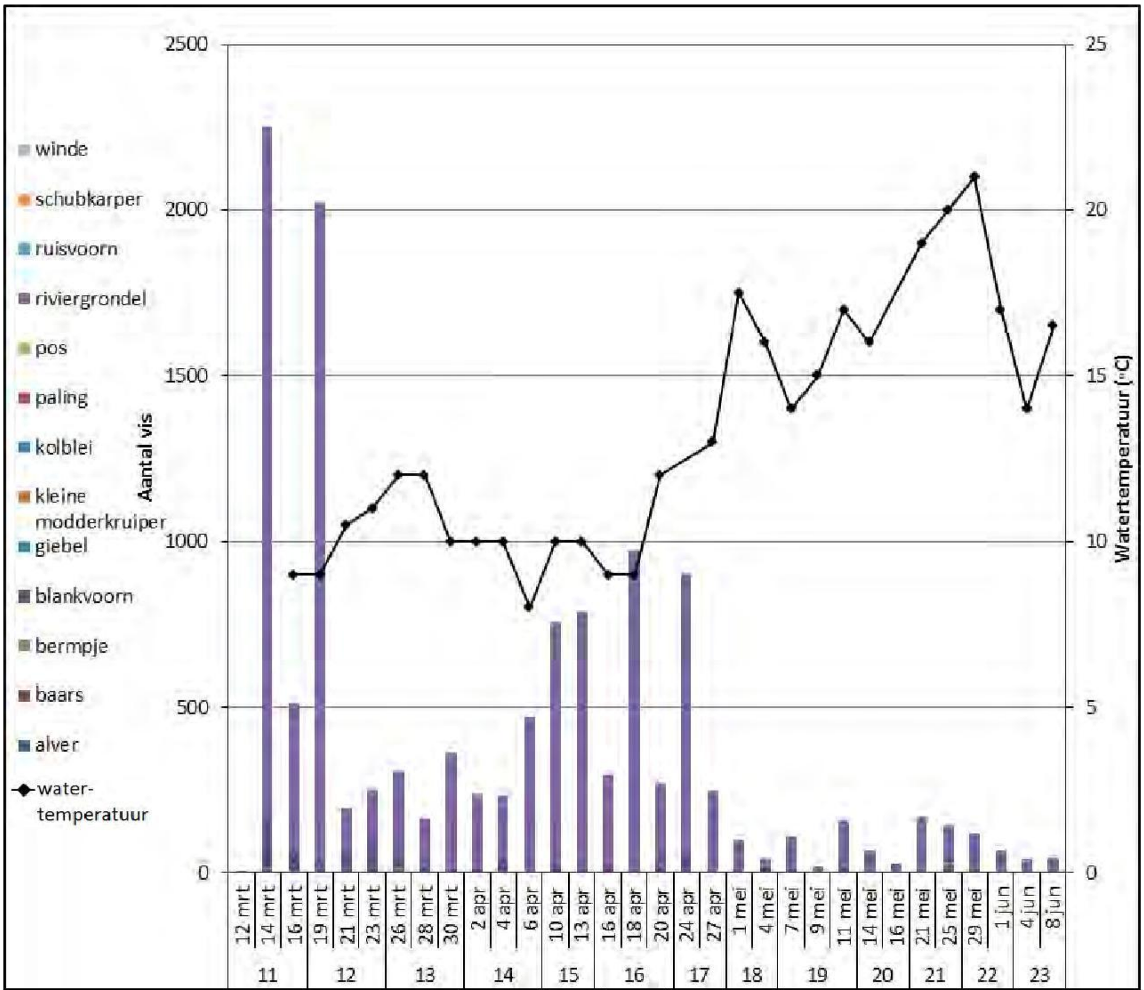
Process of the research

With the aid of employees from the water board, the fyke was placed in the water on 12 March. On 9 May it turned out the fish siphon pass was turned off for a couple of days and so did not function properly. Fish could not pass the pass. This was restored the same day. By placing the fyke, a stagnant zone arose between the shore and the fyke so flab (floating algal beds) piled up. These were removed during every emptying. As during the first period of the research only small fish (<20 cm) were caught, from 1 until 16 May a supply fyke (a fyke to check stocks) was placed right in front of the fish siphon pass and randomly sampled so it could be determined if there were and large fish present in the water course.

5.4 RESEARCH RESULTS

During the research 12.375 fish and 13 species used the fish siphon pass. The types are: bleak (*Albumus albumus*), perch (*Perca fluviatilis*), stone loach (*Barbatula barbatula*), roach (*Rutilus rutilus*), gibel carp (*Carassius gibelio*), spined loach (*Cobitis taenia*), eel (*Anguilla anguilla*), ruffe (*Gymnocephalus cernua),* silver bream (*Blicca bjoerkna*), gudgeon (*Gobio gobio*), rudd (*Scardinius erythrophtalmus*), carp (*Cyprinus carpio*) and ide (*Leuciscus idus*). The lengths vary between 6 and 77 cm. Almost all fish were smaller than 21 cm, only two carp and one eel were larger than 31 cm. Figure 20 and Figure 21 show the monitoring results. Figure 22 show some of the caught fish.

Outstanding are the high numbers of fish in the beginning of the monitoring. With temperatures below 10 °C, during the first sampling of the nets high numbers of gudgeon were caught. Also roach show (although lower number) a same peak as gudgeon: during the first weeks of the monitoring more roach were caught than during the rest of the monitoring period. Another peak in the number of gudgeon is visible in week 15 (18 and 24 April). The Kaweise Loop seems to disagree with the literature and other locations, usually peaks appear in April. Gudgeon have an optimal spawn temperature of 12 °C (Beers, 2005) and roach of 12-14 °C (Laak, 2010). Because migration starts earlier (the fish have to move to the spawning areas) this perhaps explains the early peak at 10 °C. Nevertheless it is very early compared to other locations where peaks of migration of the gudgeon were observed later. Hoogerwerf *et al.* (2005) gives a spawn period between May and June for gudgeon and roach.



Week	11	12	13	14	15	16	17	18	19	20	21	22	23	
Type														Total
bleak	17	25	8	1		1	1		6		21	9		89
pearch	1	2	4	2	3	2	4	1	2	1	3	3	1	29
stone loach	3	1	5		2	1		4	1	1	10		4	32
roach	196	169	62	48	30	39	53	16	21	2	15	1		652
gibel carp	4	2	1	2					2		1			12
spined loach													3	3
silverbream	11	8	10	5	1	4	11	6	3		2	4		65
eel												1		1
ruffe	2		1			1								4
gudgeon	2529	2254	741	880	1509	1495	1080	117	254	90	258	173	78	11458
rudd		2	1	1				1	1		3			9
carp	1	2									2			5
ide	3	6	5				1	1						16
Total	2767	2471	838	939	1545	1543	1150	146	290	94	315	191	86	12375

Figure 20. The fish types and numbers being caught in the Kaweise Loop

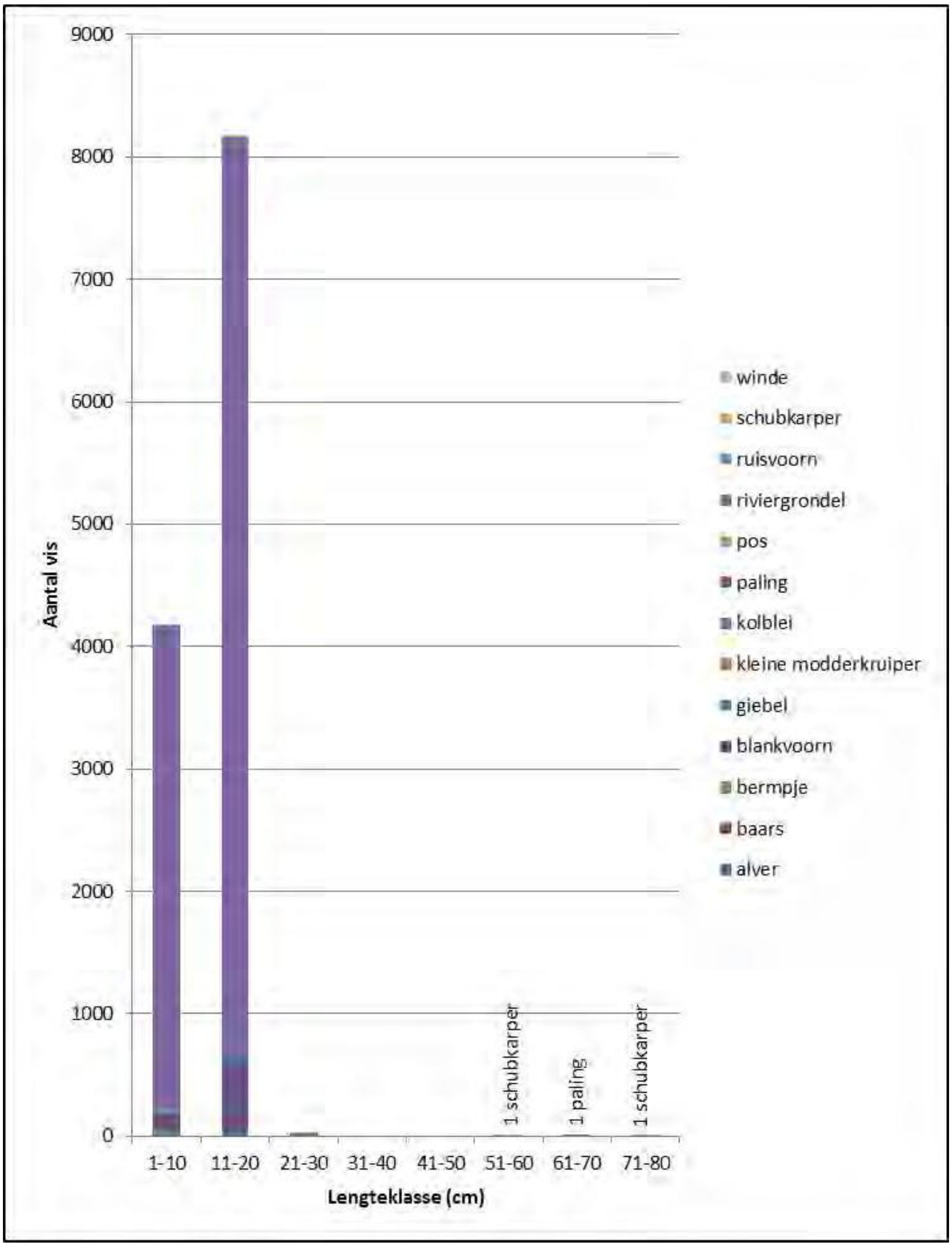


Figure 21. The length distribution of the caught fish in the Kaweise Loop

Figure 22. From upper left clockwise: ide (14-03), gudgeon (23-03), two carps (25-05) and two spined loaches (04-06)

5.5 EVALUATION OPERATION AND RECOMMENDATIONS

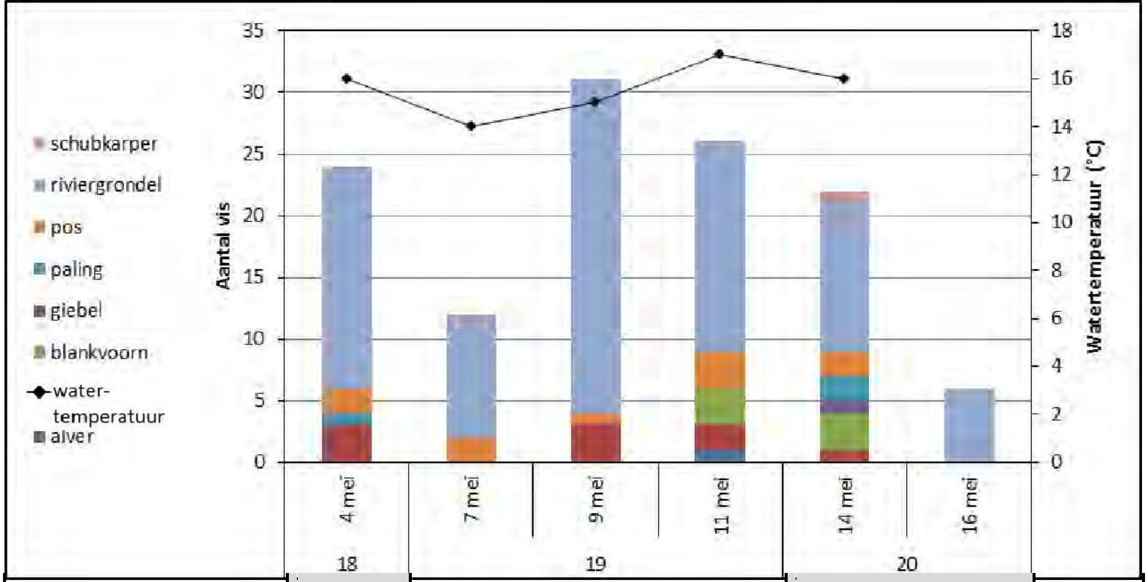
Evaluation operation

During the monitoring period 12,375 fish made up of 13 different species have been able to pass the provision. Of the species only a few spined loach and eel have been detected. Within the different detected species of which more than a few specimens were caught are slower and faster swimmers. Also from the benthic zone fish species multiple fish were caught. There are both small fish (<20cm) and large fish detected in the fyke net, however there were only 2 fish detected larger than 40 cm, the rest of the larger fish are eel. The table below has been completed according to the assessment method in paragraph 3.5, X= meets criteria, V= doesn't meet criteria.

Criteria	Rating
Number of passed fish >100	X
Number of types>5	X
Group 'Slow', 'Fast' and benthic species represented	X
Both small fish as large fish caught	V

Tabel 4 Rating results fish siphon pass Kaweise Loop

Overall evaluation based on the table is that the pass functions 'Sufficient to good'. Only the last criteria is not met because only a few large fish passed the provision. From an earlier monitoring of the type fish siphon pass it is thought that it may be restrictive to large fish. These may be deterred because the conduit is dark and not aerated. It is also possible that there just was no supply of large fish, the sample with the supply fish trap yielded during two weeks no fish larger than 20 cm, except from a few eels, shown in figure and table below.



Week	18	19	20	
Type				**Total**
bleak	0	1	0	**1**
perch	3	5	1	**9**
roach	0	3	3	**6**
gible carpl	0	0	1	**1**
eel	1	0	2	**3**
ruffe	2	6	2	**10**
gudgeon	18	54	18	**90**
carp	0	0	1	**1**
Total	**24**	**69**	**28**	**121**

Figure 23 Results sample supply fish trap

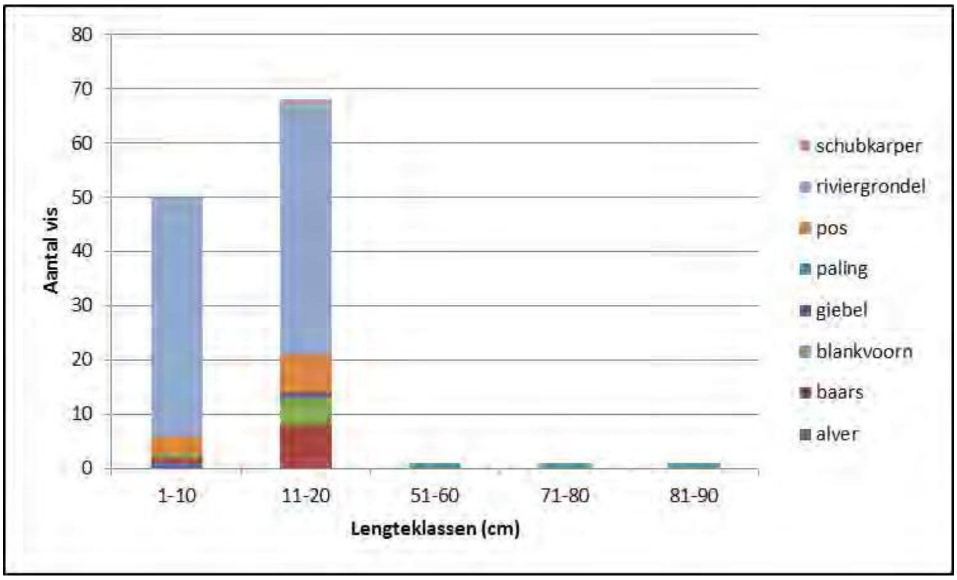


Figure 24 Length distribution of the caught fish in supply fish trap

The number of passed target species is dependent of the supply. A few target species have been caught, namely stone loach and gudgeon. Probably the rest of the target species are not (yet) present, during the fish stock sampling of 2006 these types were not detected in the Kaweise Loop.

Final conclusion

The fish siphon pass in the Kaweise Loop has been reviewed as 'Sufficient to good'. The pass has been used by only a few large fish. However, it is not clear if there is supply of large fish. Final conclusion is that the pass functions well for a large range of types, for slow and fast swimmers and for benthic zone species. Possibly the pass is restrictive for large fish.

Recommendations

- A point of attention is that during the monitoring of the passage it was noted that it was not functioning for a period of time. This can be prevented simply by checking regularly. Because this pass has a technical construction with moving parts, regular maintenance is necessary for an optimum operation. Technically this pass functions well.

25 Comparing results monitored fish migration facilities

25.1 GENERAL

During the monitoring of the fish migration facilities, in total (during the complete monitoring and at all locations) 21,890 fish have been caught in the fish traps. In total 29 different fish species have been caught. These species and the numbers per specie are shown in Figure 134. During the monitoring gudgeon was the most caught fish species. This is mainly due to big numbers in the fyke net at the Kaweise Loop (see also Chapter 5). The second most caught fish is roach, followed by perch and silver bream. Of the species smelt, zander and grass carp only had one individual fish per specie detected during the complete monitoring.

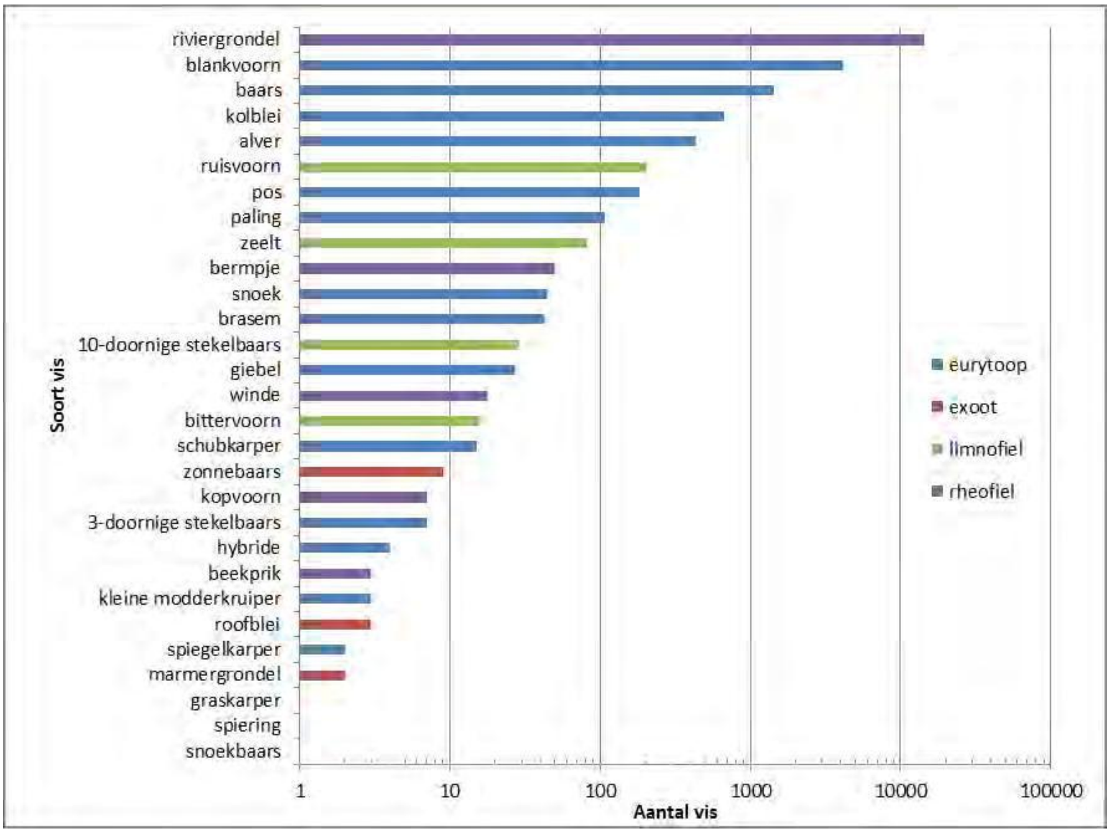


Figure 134 Caught fish types and the total number of specimens per type (for all fish passages)

25.2 NUMBER AND SPECIES PER FISH PASS TYPE AND PER WFD WATER TYPE

Number and Species per location

During the monitoring at the different fish passages, per location different types and varying numbers of fish were found. In Figure 135 and Figure 136 the number of fish caught and species per location are shown. In appendix 2 a table is included which shows the number of fish and fish specie per fish migration facility. The numbers in both figures and appendix 2 are the absolute caught numbers. The different lengths of the period of monitoring per location has not been taken into account.

To make the figure readable different axes have been used. As can be seen, at the fish siphon pass of the Kaweise Loop about more than ten times as much fish are caught than at the other fish migration facilities. The third axis is for locations where less than 100 fish are caught.

As the figure below shows, there are large differences in the number of caught fish per location. Apart from the peak of the fish siphon pass Kaweise Loop, large numbers are mainly caught at facilities constructed in relatively large water bodies such as Leijgraaf, Essche Stroom, Limmerwetering and Dommel. Logically, smaller number s of fish are caught in the smaller watercourses like the brooks in management area of Brabantse Delta. At other locations lower numbers are caught, this can be explained by external factors or deficiencies of the fish migration facility. See chapters per location.

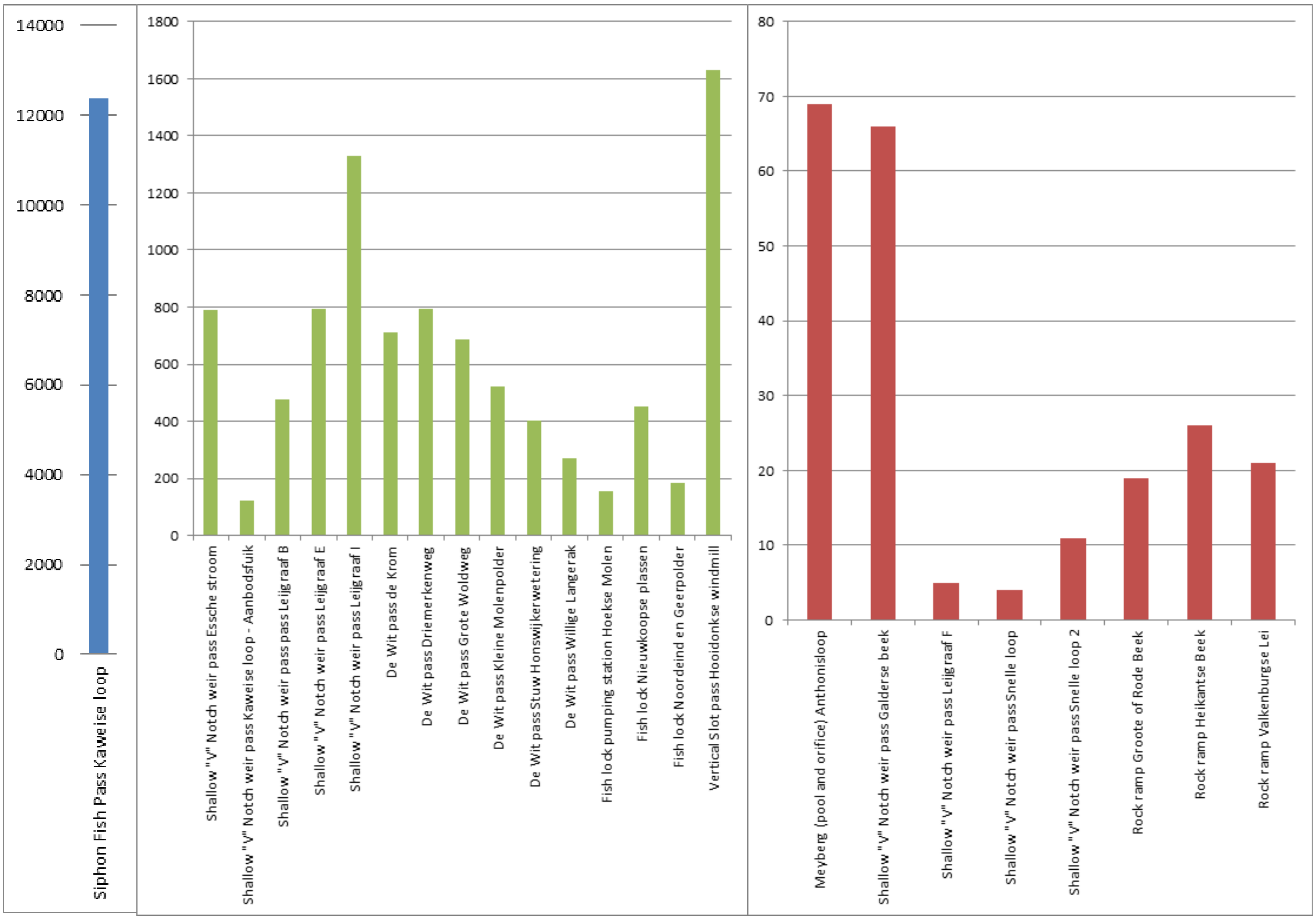


Figure 135 Number of caught fish per fish migration facility

Figure 133 shows that the differences in the number of fish species caught per location are smaller than the differences in numbers of fish caught per location. At more than two thirds of all locations more than 7 species are caught. Only at locations with a very low catch number or a low supply of species less species are caught. At almost all locations species are caught in different species groups rheofiel, limnofiel and eurotoop. At a bit less than half of the locations exoten are caught.

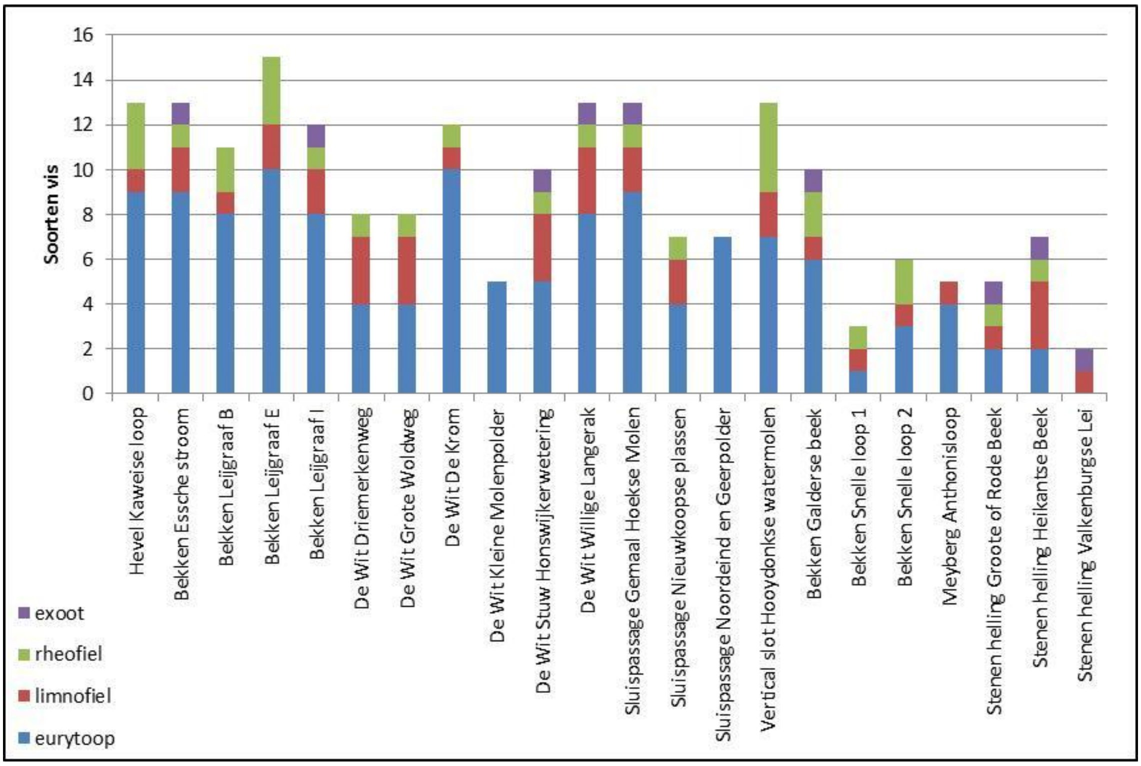


Figure 136 Number of caught fish types per fish migration facility

Number and types per fish pass type

In Figure 137 the number of caught fish per fish pass type are shown in box plots per specie group (eurytoop, rheofiel, limnofiel and exoot). Above some of the box plots the '*outliers*' are represented as a circle with the number of fish. With the data of these box plots statistical tests have been executed to find out if there are significant differences between the number of fish of each fish species caught per fish pass type. The results of these statistical tests are provided in appendix 3. For the box plots and statistical tests, the fish pass types where only one location has been monitored have been removed (fish siphon pass, *vertical slot* pass and Meybergpass). Also the shallow V notch passages Snelle Loop 1 and 2 are removed because nearly no fish were caught due to external factors.

The box plots and statistical tests show:

- Significantly more eurytope fish are caught at 'De Wit' fish passage than at rock ramps.
- Significantly more rheofiele fish are caught at basin pass than at 'De Wit fish passages.

All remaining differences visible in the box plots for eurytope and rheofiele fish are not significant. As regards caught limnofiele fish and exoten, there are no significant differences between the different fish pass types.

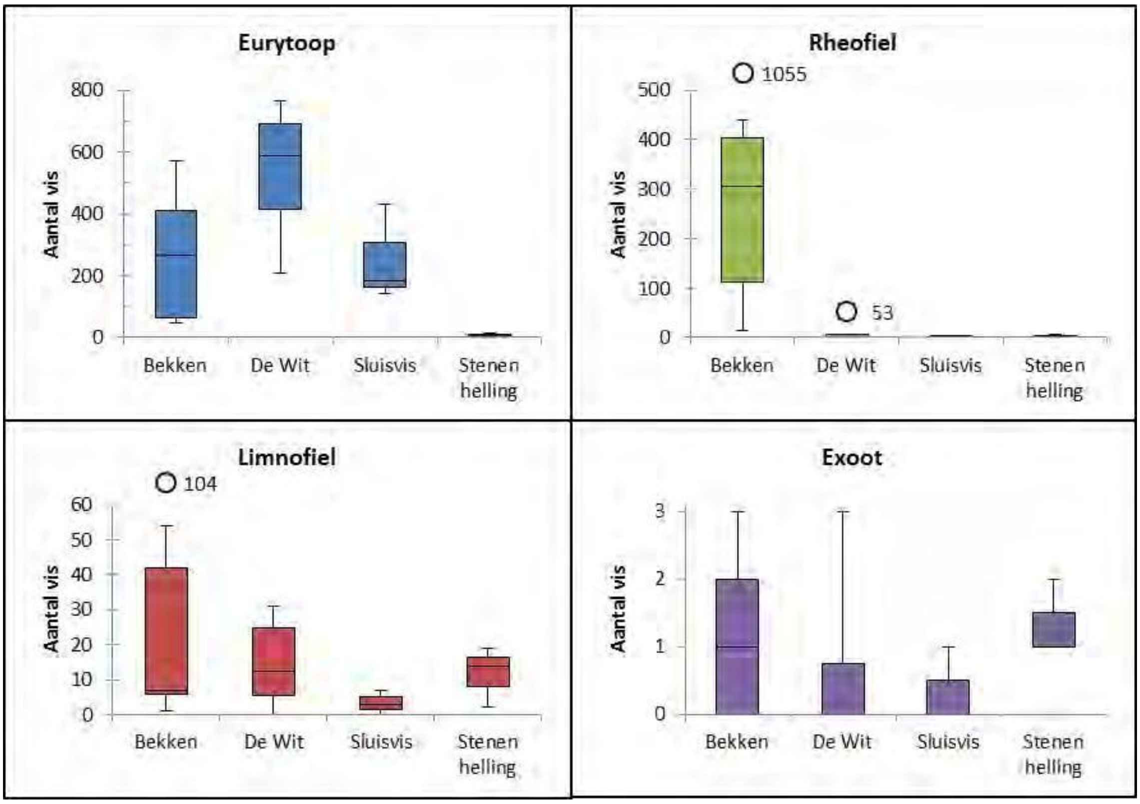


Figure 137 Box plots of number of fish, per group, for the different fish pass types

The number of fish caught and the species per fish pass type and the statistical differences are strongly dependent of the supply. Basin passages and rock ramps are commonly constructed in R-type waters and the De Wit passes in M-type waters. Automatically, there is a difference in the number of fish species caught which use the passage. In R-type waters more rheofiele fish are expected, where in M-type waters more eurytope fish are expected.

Numbers and types per WFD water type

In Figure 138 the number of caught fish per WFD water type is shown in box plots per specie group (eurytoop, rheofiel, limnofiel and exoot). Statistical tests are executed on the data of these box plots to see if there are significant differences between the number of fish caught of each specie group per WFD water type. The results of these statistical tests are provided in appendix 3. The basin passages Snelle Loop 1 and 2 are not taking into account for the box plots and statistical test because due to extern factors almost no fish were caught.

The box plots and statistical test reveal that only for the rheofiel group a significant difference was found between R- and M-water types. There are significantly more rheofiele fish caught in R-types than in M –types. In regards to eurytope fish, limnofiele fish and exoten, no significant differences were found between the different water types. There is a difference visible in the box plot between the number of caught eurytope fish in M-type and R-type waters, however this difference is not significant.

The results show that the differences in the number of fish caught per specie group between the fish pass types are indeed mainly explained by the fact shallow V notch passes and rock rampe are mainly constructed in R-type waters en De Wit passes mainly in M-type waters. Based on this research no decision can be made about the suitability of certain fish pass types for certain specie groups.

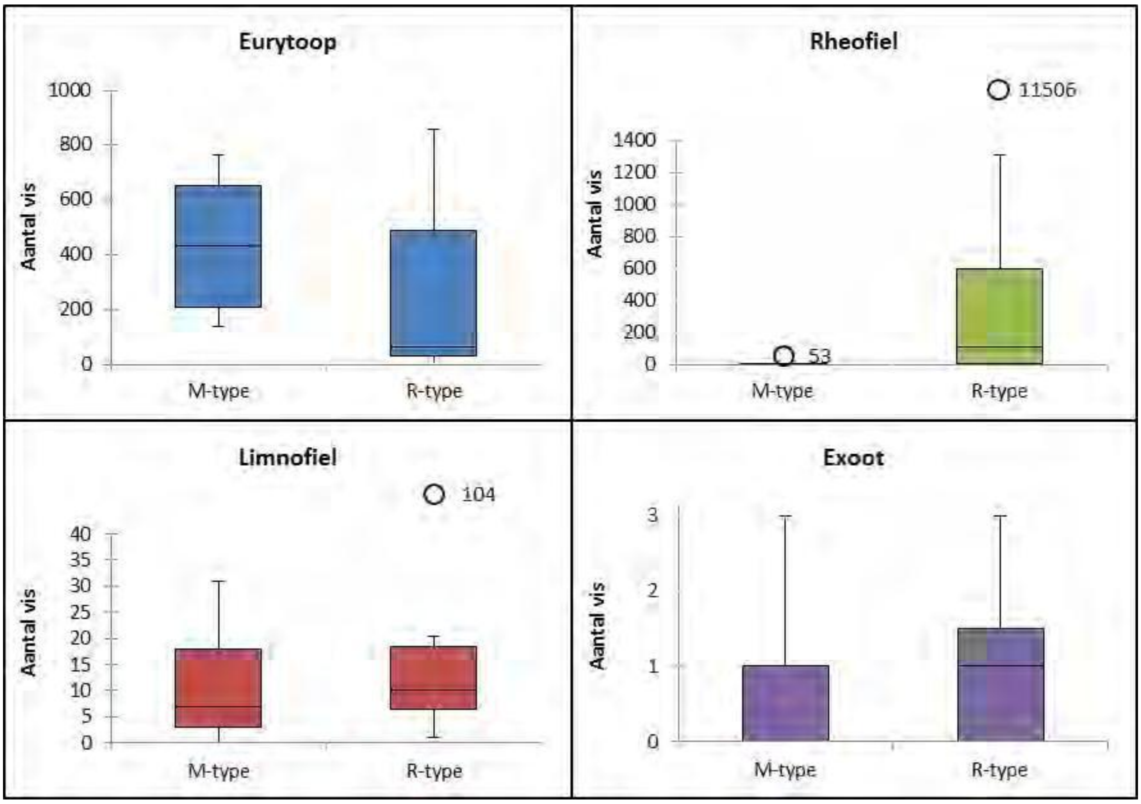


Figure 138 Box plots of the number of fish, per guild, for M-type and R-type waters

25.3 LENGTH CLASSES PER FISH MIGRATION FACILITY

Besides the number of fish and number of fish types which a fish migration facility is suited for, it is also important to know for which length classes the facility is suitable. Figure 139 shows the percentages of the length classes of the fish who used de different facilities. Eel have not been taken into account. Appendix 4 provides a table with the number per length classes per location.

From the fish catches it appears that length class 1-20 cm dominates. This can be explained by:

- The natural supply exists mainly of fish in these length classes;
- A number of fish migration facilities are located in water bodies where low numbers or no large fish are expected (for instance all rock ramps);
- The migration peak of pike, a specie where commonly mainly larger specimens are caught, takes place in the period February to March with temperatures between 6 and 14 °C (Hoogerwerf *et al.*, 2005 & Laak & Emmerik, 2006). This research started half way March at most locations. The temperature of the water varied between 8 en 10 °C.

It is noticeable that on many locations the number of fish in the second length class of 21-40cm are very low. On two thirds of the locations the length class 1-20 cm contained more than 90% of the total. In a more natural fish population it is expected that the transition is more smooth.

The transition on many locations is abrupt. Outliers in the length class 21-40 are the Groote or Rode Beek and Noordeind and Geerpolder. In the Groote of Rode brook, the relatively large number (small) spikes contributed to the high part of fish in the length class 21-40cm. In the nutrient rich Noordeind and Geerpolder, silver bream and bream have a large share in the length class 21-40cm (in the Snelle Loop only 4 fish were caught). Fish in the largest length class are caught more often in the St. Anthoniusloop and in the Galderse brook. Respectively large tench and large carp made frequent use of the pass.

A side note to make is that large fish probably notice the fish trap earlier than small fish and they probably show more reversing behavior (o.a. Spier *et al*., 2007). Therefore the number of fish in the larger length classes can be lower than expected. It is also possible that when fish grow larger, they seek out these larger waterways. Pollux *et al.* (*2004*) suggest that roach, born in the Everlose brook (Noordelijk Peelgebied) leave the brook at a length of 15-19 cm and swim to the Maas. Because the majority of the waters included in this research are relatively small, it is possible that the larger length classes from species can be lacking because the fish moved to larger waters.

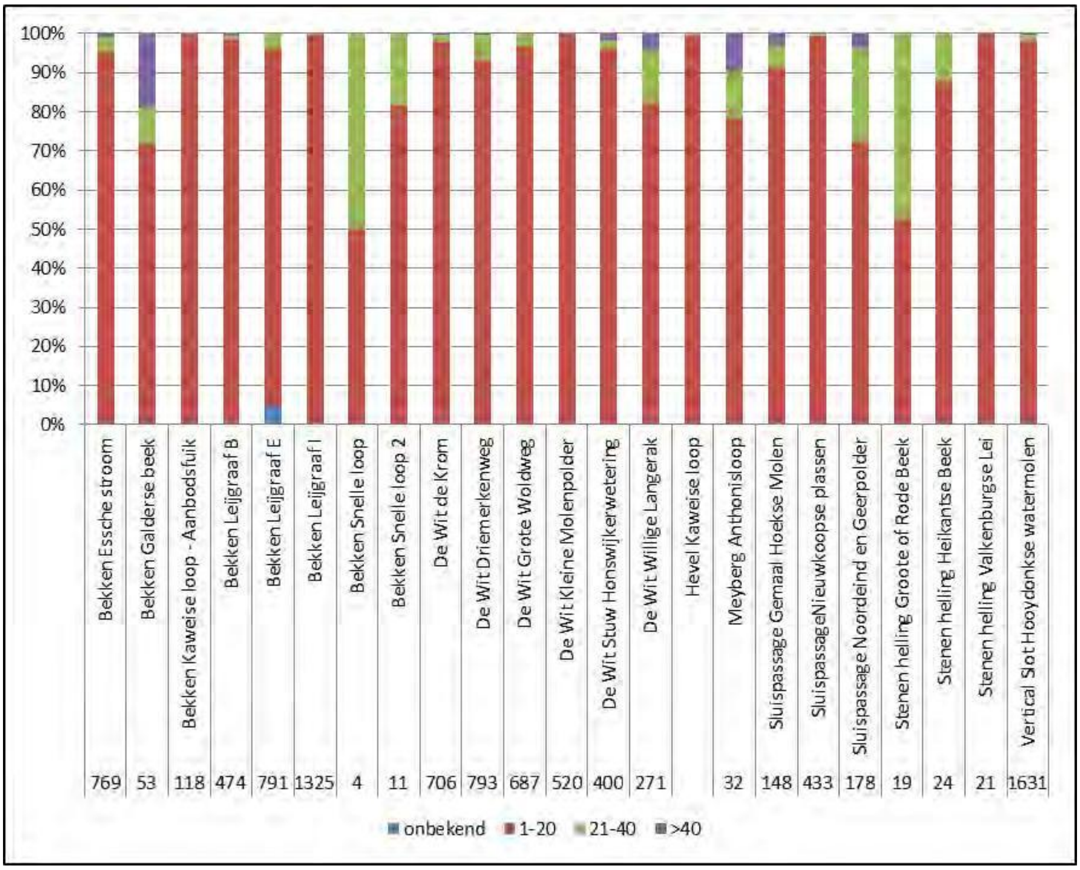


Figure 139 Length classes (except eel, in percentages) per fish migration facility

25.4 RELATION TEMPERATURE AND MIGRATION ACTIVITY

Threshold

The increase of the water temperature is one of the most important factors of the start of the fish migration in the spring. During the monitoring of 2012, especially with high increase of the water temperature in a short period of time peaks in the fish catch were observed.

This can be seen in the figures with the results per location in previous chapters. Plotting the number of fish against the temperature shows that only a few locations have a positive correlation ($R^2>0.3$) between temperature and fish catch.

The absence of a positive statistical correlation can be explained due to the fact that most species show a migration peak at a certain water temperature. If the water temperature reaches a certain minimum value, a so called threshold, the fish can migrate suddenly. Also other factors as flow rate and increasing day length are important. Although the water temperature increases further after the migration peaks, there is no further increase in migration activity because the majority of the fish have already migrated when the threshold was reached. The threshold whereby a migration peak can be detected is specie dependent; this can be seen in Figure 140 where for 3 species the catch per week is plotted. It is visible that roach shows a clear peak in week 18, where perch shows a peak in week 20, for silver bream this relation is less obvious even though the largest numbers are caught in week 19-21.

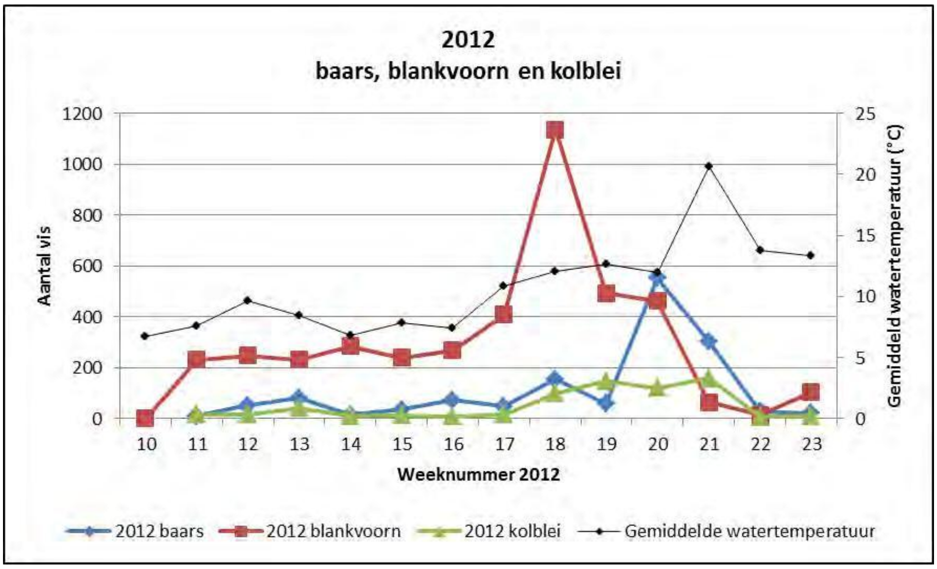


Figure 140 Migration peaks perch, roach and silver bream 2012

2011 vs. 2012

In 2011 a similar research was executed by ARCADIS on 14 locations (see Janssen, 2011). Also in 2011 the catch data were plotted for several species per week. Figure 141 shows the catches of perch, roach and silver bream in 2011.

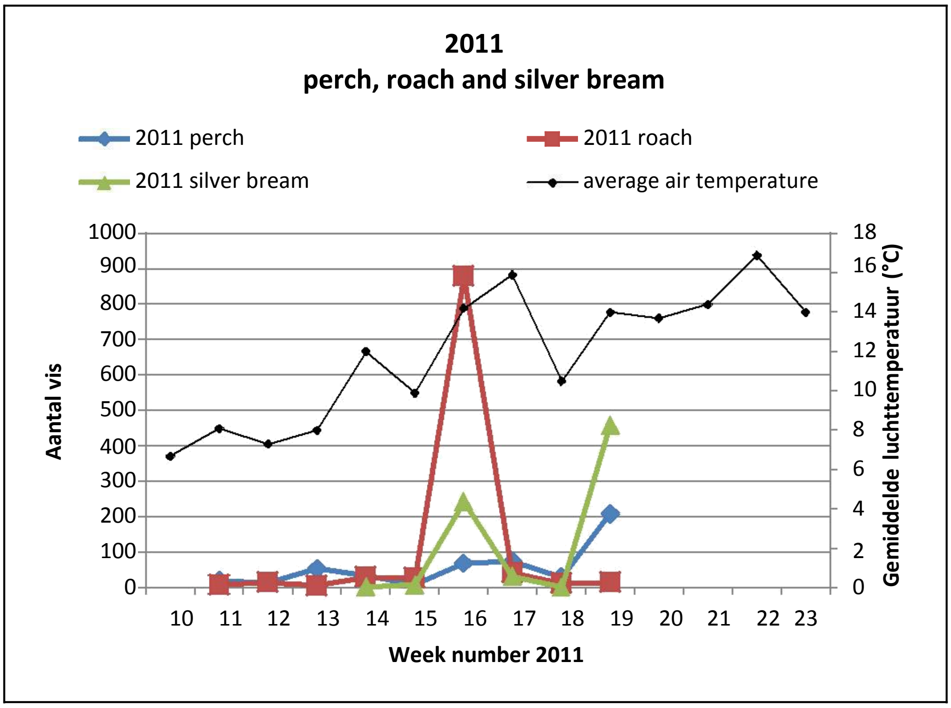


Figure 141 Migration peaks perch, roach and silver bream 2011

There is also one clear peak in the number of roach caught, this occurred in week 16. Prior to the peak in 2011 was a large increase in air temperature. This probably functioned as a trigger for the roach to migrate. Also silver bream show a peak in the same week. In 2012 there was no large increase in water temperature prior to the migration peak of roach. The water temperature reached the limiting value of +/- 12 °C in the week of the migration peak. In the literature this temperature is given as lower limit for the start of spawning period (de Laak, 2010). Migration peaks in the number of perch in 2011 and 2012 were respectively two and three weeks after de migration peak of roach.

When looking at both figures of 2011 and 2012, it can be seen that the migration peaks in 2012 take place approximately 2 weeks later than in 2011. The spring of 2011 was relatively warm, in the spring of 2012 the temperature remained low for a long time. This is shown by the data of KNMI (Royal Dutch Meteorological Institute) (Figure 142). The average week temperature in 2011, from week 13 to 20, was seven degrees higher than in 2012.

In 2011 the water temperature wasn't measured, for this the air temperature data of the KNMI were used. Generally the water temperature follows the increase and decrease of the air temperature, only with smaller peaks and drops, as shown in Figure 143 over 2012. In 2012 the water temperature was measured with each fish trap emptying, the black dots in the figure represent the average water temperature on the respective day on all locations.

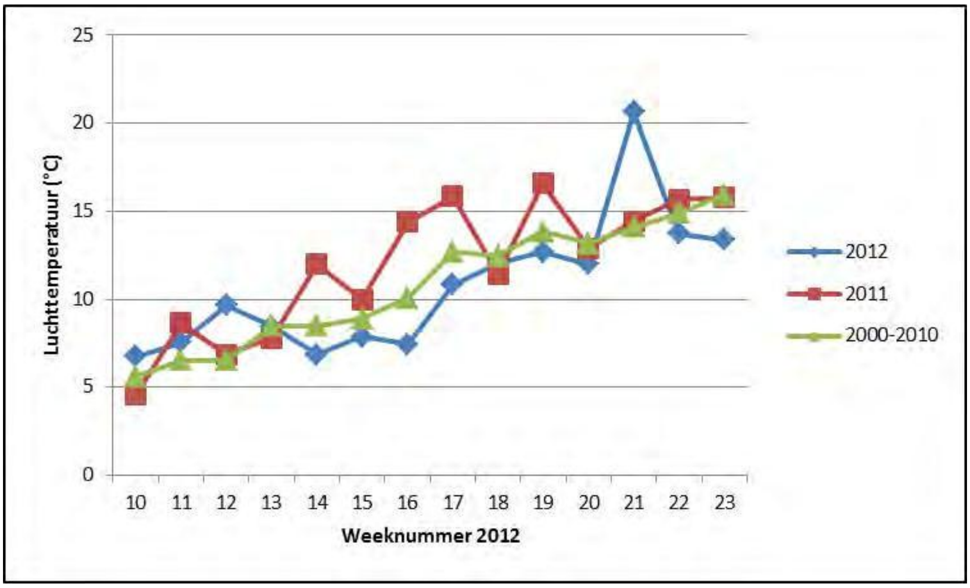


Figure 142 Average week temperature of 2011, 2012 and the 10-year average of 2000-2010

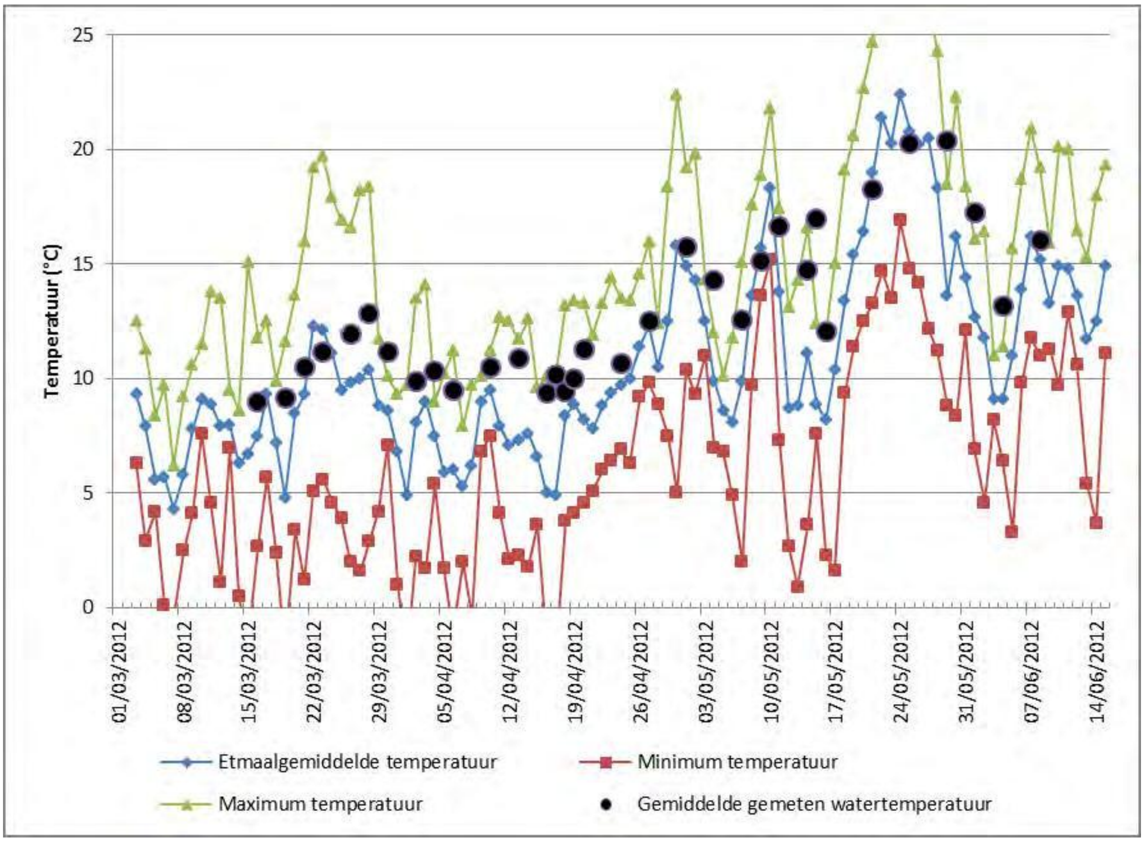


Figure 143 Average water temperature at the monitored fish passages and the minimum, average and maximum air temperature measured at De Bilt.

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Foto's en afbeeldingen

Foto's op voorblad: eigen materiaal

Foto's en afbeeldingen in rapport: eigen materiaal tenzij anders vermeld

Kaartmateriaal: Atlas Wolters-Noordhof

Bijlage 1 Nieuwsbrieven

Bijlage 2 Tabel aantallen en soorten per vismigratievoorziening

Vismigratievoorziening	Bekken Essche stroom	Bekken Galderse beek	Bekken Kaweise loop - Aanbodsfuik	Bekken Leijgraaf B	Bekken Leijgraaf E	Bekken Leijgraaf I	Bekken Snelle loop	Bekken Snelle loop 2	Stenen helling Groote of Rode Beek	Stenen helling Heikantse Beek	Stenen helling Valkenburgse Lei	Vertical slot Hooydonkse watermolen
KRW-type	R6	R4	R4	R5	R5	R5	R4	R4	R4	R4	R4	R6
Soort												
eurytoop												
3-doornige Stekelbaars				1				2				3
alver			1	21	85	183	1					40
baars	229	11	9	14	112	22		2	5			52
blankvoorn	301		6	12	169	46		2				629
brasem	1				1							3
giebel	1	12	1									
hybride					2							
kleine modderkruiper												
kolblei	16			6	27	8						98
paling	19	13	3	1	3	6				2		
pos	2		10	6	8							
schubkarper	2	4	1		1	1						
snoek	1	7		3	1	1			9	3		4
snoekbaars												
spiegelkarper		1				1						
spiering												
limnofiel												
10-doornige stekelbaars										3	19	4
bittervoorn												
ruisvoorn	92				16	4			2	1		14
zeelt	12	1		7	26	2	2	2		10		
rheofiel												
beekprik												3
bermpje		2		3	1		1	2	2	6		
kopvoorn												7
riviergrondel	111	12	90	401	304	1055		1				773
winde					1							1
exoot												
graskarper	1											
marmergrondel												
roofblei												
zonnebaars		3				2			1	1	2	
onbekend												
blankvoorn/ruisvoorn					25							

Vismigratievoorziening	Bekken Essche stroom	Bekken Galderse beek	Bekken Kaweise loop - Aanbodsfuik	Bekken Leijgraaf B	Bekken Leijgraaf E	Bekken Leijgraaf I	Bekken Snelle loop	Bekken Snelle loop 2	Stenen helling Groote of Rode Beek	Stenen helling Heikantse Beek	Stenen helling Valkenburgse Lei	Vertical slot Hooydonkse watermolen
onbekend					12							
Totaal	**788**	**66**	**121**	**475**	**794**	**1331**	**4**	**11**	**19**	**26**	**21**	**1631**
Aantal soorten	13	10	8	11	15	12	3	6	5	7	2	13

Vismigratie-voorziening	Hevel Kaweise loop	Meyberg Anthonisloop	De Wit Driemerkenweg	De Wit Grote Woldweg	De Wit De Krom	De Wit Kleine Molenpolder	De Wit Stuw Honswijkerwetering	De Wit Wilgenlangerak	Sluispassage Gemaal Hoekse Molen	Sluispassage Nieuwkoopse plassen	Sluispassage Noordeind en Geerpolder	Totaal
KRW-type	R4	R4	M3	M3	M27	M27	M1	M1	M3	M27	M27	
Soort												
eurytoop												
3-doornige Stekelbaars									1			**7**
alver	89				2				9			**431**
baars	29	19	69	163	307	346	16	10	5	13	1	**1434**
blankvoorn	652		651	443	149	121	35 3	189	45	414	1	**4183**
brasem					4		2	2	4		25	**42**
giebel	12	1										**27**
hybride					2							**4**
kleine modderkruiper	3											**3**
kolblei	65		42	41	172	52		2	68	2	68	**667**
paling	1	37			5	1	3	1	6	2	5	**108**
pos	4			8	58	1		1	2		82	**182**
schubkarper	5							1				**15**
snoek		2	3		3		4	3	1			**45**
snoekbaars					1							**1**
spiegelkarper												**2**
spiering											1	**1**
limnofiel												
10-doornige stekelb.									1	2		**29**
bittervoorn			10	4			1	1				**16**
ruisvoorn	9		15	25	5		13	3	6	1		**206**
zeelt		10	2	2			4	3				**83**
rheofiel												
beekprik												**3**
bermpje	32			1								**50**
kopvoorn												**7**
riviergrondel	11458		1		3		6	53	5	1		**14274**
winde	16											**18**
exoot												
graskarper												**1**
marmergrondel							1		1			**2**
roofblei								3				**3**
zonnebaars												**9**
onbekend												**0**
blankvoorn/ruisvoorn												**25**
onbekend												**12**
Totaal	**12375**	**69**	**793**	**687**	**711**	**521**	**40 3**	**272**	**154**	**435**	**183**	**21890**
Aantal soorten	13	5	8	8	12	5	10	13	13	7	7	29

Bijlage 3 Statistische tests voor de verschillende gilden en typen vispassages

gilde	passage 1	passage 2	test	uitkomst	p-waarde	verschil	opmerkingen
eurytoop	bekken	De Wit	ANOVA	1.571	0.239	nee	
eurytoop	bekken	sluisvis	ANOVA	0.019	0.895	nee	
eurytoop	**bekken**	stenen helling	ANOVA	3.930	0.095	nee	verschil in boxplot
eurytoop	De Wit	sluisvis	ANOVA	1.439	0.265	nee	
eurytoop	**De Wit**	stenen helling	ANOVA	7.440	0.026	ja	
eurytoop	**sluisvis**	stenen helling	ANOVA	7.337	0.054	nee	verschil in boxplot
exoot	bekken	De Wit	Mann-Whitney U	11.000	0.537	nee	
exoot	bekken	sluisvis	Mann-Whitney U	4.500	0.393	nee	
exoot	bekken	stenen helling	Mann-Whitney U	8.500	0.786	nee	
exoot	De Wit	sluisvis	Mann-Whitney U	8.500	0.905	nee	
exoot	De Wit	stenen helling	Mann-Whitney U	14.000	0.262	nee	
exoot	sluisvis	stenen helling	Mann-Whitney U	8.000	0.200	nee	
limnofiel	bekken	De Wit	ANOVA	0.884	0.372	nee	
limnofiel	bekken	sluisvis	ANOVA	1.221	0.311	nee	
limnofiel	bekken	stenen helling	ANOVA	0.604	0.467	nee	
limnofiel	De Wit	sluisvis	ANOVA	2.188	0.183	nee	
limnofiel	De Wit	stenen helling	ANOVA	0.133	0.726	nee	
limnofiel	sluisvis	stenen helling	ANOVA	2.350	0.200	nee	
rheofiel	**bekken**	De Wit	Mann-Whitney U	1.000	0.016	ja	
rheofiel	**bekken**	sluisvis	ANOVA	2.381	0.174	nee	verschil in boxplot
rheofiel	**bekken**	stenen helling	ANOVA	2.373	0.174	nee	verschil in boxplot
rheofiel	De Wit	sluisvis	Mann-Whitney U	6.500	0.786	nee	
rheofiel	De Wit	stenen helling	Mann-Whitney U	7.500	1.000	nee	
rheofiel	sluisvis	stenen helling	ANOVA	0.082	0.789	nee	

1 gilde	KRW- watertype 1	KRW-watertype 2	test	uitkomst	p-waarde	verschil
eurytoop	M	R	Mann-Whitney U	31.000	0.175	nee
exoot	M	R	Mann-Whitney U	60.500	0.412	nee
limnofiel	M	R	Mann-Whitney U	62.500	0.331	nee
rheofiel	M	**R**	Mann-Whitney U	76.500	0.038	ja

Bijlage 4 Aantallen per lengteklasse per locatie

	Bekken Essche stroom	Bekken Galderse beek	Bekken Kaweise loop - Aanbodsfuik	Bekken Leijgraaf B	Bekken Leijgraaf E	Bekken Leijgraaf F	Bekken Leijgraaf I	Bekken Snelle loop	Bekken Snelle loop 2	De Wit de Krom	De Wit Driemerkenweg	De Wit Grote Woldweg	De Wit Kleine Molenpolder	De Wit Stuw Honswijkerwetering	De Wit Willige Langerak	Hevel Kaweise loop	Meyberg Anthonisloop	Sluispassage Gemaal Hoekse Molen
Lengteklasse																		
onbekend					37													
1-10	367	16	50	217	260	1	922		7	331	49	118	318	53	19	4174	5	31
11-20	367	22	68	249	463	4	397	2	2	359	690	548	202	331	204	8177	20	104
21-30	27 (1)	2		4	28		4	1	1	13	51	21		6	33	21	1	8
31-40	10 (8)	3		1	2			1	1					3	4		5 (1)	5 (4)
41-50	3 (1)	4 (1)			1									4	3		13 (10)	3 (1)
51-60	6 (3)	6 (3)	1 (1)		1 (1)		2 (2)			3 (1)	1				3	1	16 (16)	2
61-70	4 (4)	7 (4)		1 (1)			1			2 (2)			1 (1)	2 (1)	2	1 (1)	6 (6)	
71-80	1	5 (4)	1 (1)	1	2 (2)		4 (3)			1	1			3 (1)	4 (1)	1	3 (3)	1 (1)
81-90	3 (2)	1 (1)	1 (1)	2						1 (1)	1			1 (1)				
91-100							1 (1)			1 (1)								
Totaal	**788**	**66**	**121**	**475**	**794**	**5**	**1331**	**4**	**11**	**711**	**793**	**687**	**521**	**403**	**272**	**12375**	**69**	**154**

Colofon

MONITORING VAN 22 VISMIGRATIEVOORZIENINGEN VOORJAAR 2012

OPDRACHTGEVER:

Waterschap de Dommel, Waterschap Aa en Maas, Waterschap Brabantse Delta, Hoogheemraadschap de Stichtse Rijnlanden, Hoogheemraadschap van Rijnland,
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