

2 Materials and method

2.1 General monitoring method

The STOWA directives for sampling prescribe that a monitoring project should be performed continuous if possible. Continuous monitoring of a land drainage pumping station is given the dimensions and flow rates commonly found, deemed not feasible from a water safety point of view and in connection with animal welfare. A fyke net left in place for long periods fills rapidly with debris making it harder for the pumping station to lose its water and fish mortality occurs.

We have therefore emptied the monitoring fyke nets at least five times in all locations during the evening / night (from 19: 00h to 0: 00h). The fyke net was lifted every hour to check for floating debris or fish stock of fish. This is a generally accepted monitoring method which is widely used. Five monitoring nights is generally sufficient to make an informed judgment on the use of the pumping station by fish and the extent of fish-friendliness.

In addition, the fish stock is also measured. For this we placed fyke nets (eel fyke nets with 3 netting bags) on both sides of the water course. Eel fyke nets were used because the focus in the fall is on big eels, they also catch scaled fish. These fish stock fyke nets were emptied two to three times per week during the monitoring weeks. Fyke nets with more sections do not increase the capture rate but can be left longer as there is more space. Since we are emptying the nets 2 to 3 times a week we do not require more sections. The fyke nets are placed with the opening to the pumping station. The fyke nets are cleaned after emptying with a high pressure cleaner. The fyke nets are placed as close as possible to the pumping station. We normally monitor the fish stock for about 4 weeks. In this study, at most locations shorter periods were monitored for various reasons:

- ♣ At Pumping Station Hollands Ankeveen the monitoring period was shorter because of mowing activities with fish mortality in the fish stock fyke nets as a result;
- ♣ At Pumping Station Dooijersluis the monitoring period was shorter due to work activities in the watercourse in front of the pumping station and the pumping station itself.
- ♣ At Pumping Station Kortenhoef and Water Mill de Onrust the fish stock was only monitored during the migration monitoring period. This research was stopped halfway because of the low catch numbers. By removing the fish stock fyke nets the opportunity was created to catch more fish in the pumping station fyke as with larger passage catch numbers a more informed decision can be made on the operation of the pumping station.

When emptying the catch the following is documented:

- ♣ The number of fish, species, length;
- ♣ Potential damage / injury of fish observed:
 - Damage observed was for example divided into no damage, drowsiness, light damage (survivable damage) or fatal injury (terminally damaged and dead fish);
 - Type of damage / injury to fish passed. For example incision, fractures, eye damage, damage to gill plates, scraped scales and abnormal swimming movements.

- ♣ Potential other catches (crustaceans, exotics etc.) and / or details;
- ♣ Description of the research location;
- ♣ Datum, start and end time of monitoring periods;
- ♣ Weather details from the nearest KNMI station;
- ♣ Any other remarkable aspects or impacts that can affect the monitoring results.

2.2 SITE SPECIFIC METHOD

2.2.3 PUMPING STATION KORTENHOEF

Introduction

Besides pumping station Dooijersluis pumping station Kortenhoef has also recently been renovated and has been equipped with fish-friendly archimedian screws (FishFlow Innovations). Waternet wanted to evaluate the effect of the fish-friendly archimedian screws in the autumn of 2014.

Fyke net monitoring

For the monitoring of the pumping station a tailored frame and fyke net was used. These were placed in the lattice on the water side, at the outflow of the pumping station. In the monitoring period the fish stock was also monitored, on the same nights as the monitoring of the pumping station fyke net (7-10-2014 and 16-10-2015). Because of the absence of good numbers of fish stock measured, it was decided to discontinue the fish stock monitoring. For a general description of the work see section 2.1. The monitoring was conducted by fishing company Hoetmer.

2.3 MATERIALS USED

The work was carried out jointly with fishing company Kalkman and fishing company Hoetmer. Per location the following materials were manufactured and supplied:

- ♣ Customised frame + fyne net at the outflow of the pumping station / mill to encompass the entire outflow from the pumpingstation/mill (see Figure 3) the mesh size is 13-11-9 half mesh;
- ♣ Fish stock fyke nets (2 wing fyke nets with a 125 mesh design with a mesh size of 13-11-9 mm for each half mesh with a synthetic cover so that no damage can be caused by crabs whereby catch could be lost);
- ♣ Materials required during monitoring such as measuring boards, live nets, bowls etc .;
- ♣ Boat to be used for the emptying of the pumping station and fish stock fyke nets, if required.



Figure 3: Example of a tailored fyne net and frame, location: waler mill De Onrust

The table below shows the number of monitoring evenings, total number of hours, the capacity and the total volume pumped by each location

Location	Number of monitoring nights	Total pumping hours	Capacity of pump/screw	Total volume pumped
Pumping station Dooijersluis	5	15.0	70 m ³ /min	63.067 m ³
Pumping station Hollands Ankeveen	5	12.9	24.8 m ³ /min	19.195.m ³
Pumping station Kortehoef	5	24.0	60 m ³ /min	86.400 m ³
Water mill De Onrust	5	N/A	Wind dependent	111.673 m ³

2.5 EXEMPTIONS, PERMITS AND CONSENTS

Fishing company Kalkman, fishing company Hoetmer and the project staff of ARCADIS have all the necessary permits and licenses to carry out the work. In the months of September, October and November a separate exemption from the Government is necessary because of the closed season for eel. Waternet applied to the department of Economic Affairs and received exemptions for all locations as well as an exemption for releasing the eels caught downstream of the pumping station to the upstream side of the pumping station.

3 Results fyke net monitoring

3.5 FISH STOCK MONITORING PUMPING STATION KORTENHOEF

3.5.1 CATCH SIZE

The total number of fish caught in the fish stock fyke nets at pumping station

Kortenhoef is 272 (excl. Crawfish). Table 10 summarizes the species caught, numbers (total and per monitoring night) and the length range of the species caught. The table also shows the numbers of fish caught per monitoring period. The catch size ranges from 2 to 270 fish per time. On 14 November, considerably more fish were found in the fyke net compared with 7 November.

Emptying of fish stock fyke net	Perch	Roach	Eel	Pos	Crayfish	Total
7-10-2014			2			2
14-10-2014	217	37	10	6	5	275
Total	217	37	12	6	5	277
Average per monitoring night (N=2)	108.5	18.5	6	3	2.5	138.5
Length range (cm)	0-30	0-20	>50cm	0-20	N/A	N/A

Table 10. Fish stock Catches pumping station Kortenhoef broken down into species, number per monitoring night and length range.

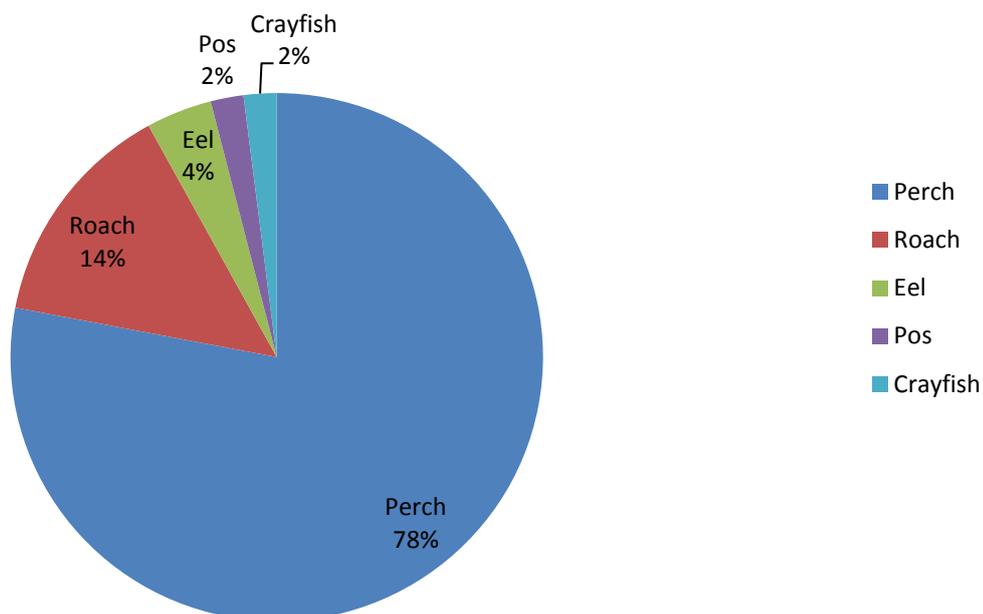


Figure 13. Species composition of the fish stock

3.5.2 SPECIES COMPOSITION

In total 4 fish species and crayfish have been caught during the monitoring of the fish stock. The fish species caught were perch, roach, eel and pos. The fish stock catches were dominated in numbers by perch, with 78% of the total (Figure 13).

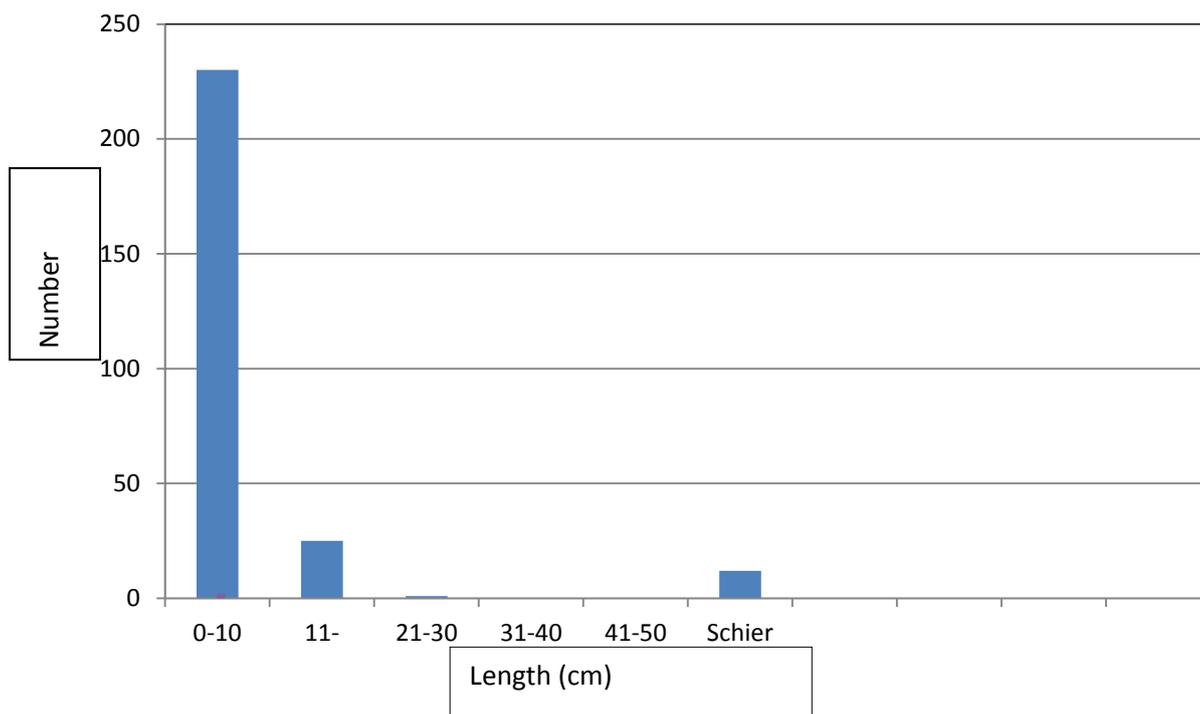


Figure 14. Length distribution of the fish stock catch

3.6 Monitoring of passage through pumping station Kortenhoef

3.6.1 CATCH SIZE

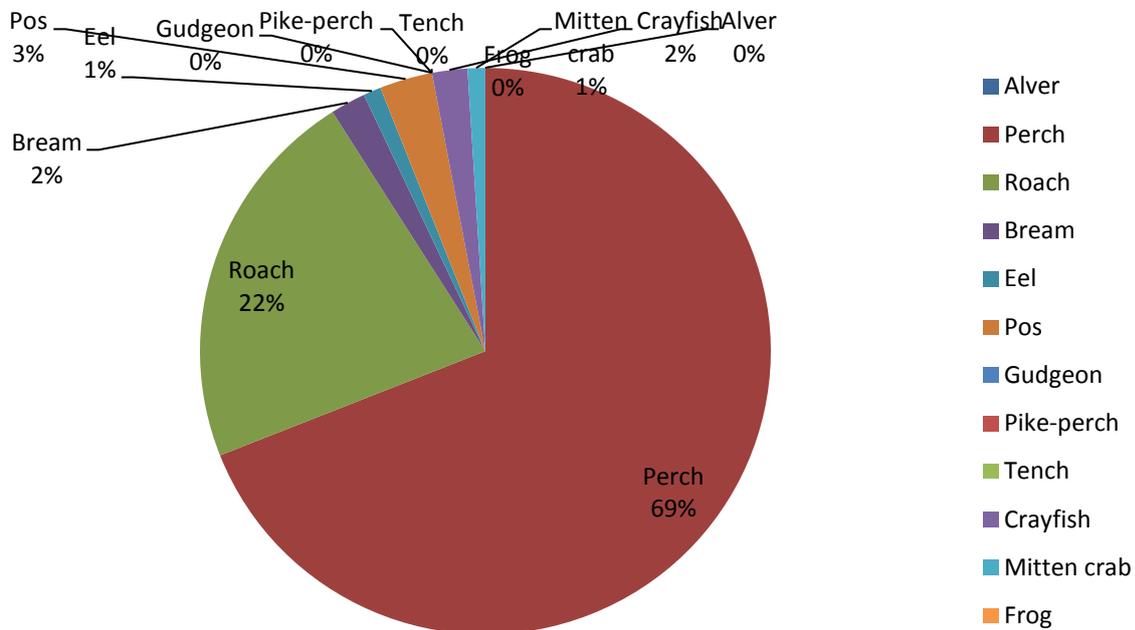
The total number of fish caught during the monitoring of the passage through pumping station Kortenhoef is 914. Table 11 shows the absolute numbers caught, numbers adjusted for the volume pumped and the length range of the species caught. The table also states the numbers caught per monitoring date. The catch size ranges from 42 to 267 fish per monitoring period. On October 22, most of the fish were caught.

Datum	Alver	Perch	Roach	Bream	Eel	Pos	Gudgeon	Pike perch	Tench	Cray fish	Mitten crab	frog	Total
7-10-2014		29		2	6	4	1			6			48
14-10-2014		172	7	3	2	9					2	1	195
16-10-2014		77	7							4	7		95
20-10-2014		125	56	6		6			1	1	1		196
22-10-2014	1	214	45	5		2		1					267
11-11-2014		30	90	5		7				1			133
TOTAL	1	647	205	21	8	28	1	1	1	12	10	1	934
Number /100.000 m3	1	757	236	24	9	32	1	1	1	14	12	1	1071
	10-20	0-30	0-20	0-40	25-90	0-20	0-10	30-40	0-40	-	-	-	0-90

Table 11. Catch size in absolute numbers, catch size in relation to pumped volume (per 100.000m3) and length range of the catch per species. Calculated from 86400m3 pumped volume in the period the fyke net was placed behind the pumping station.

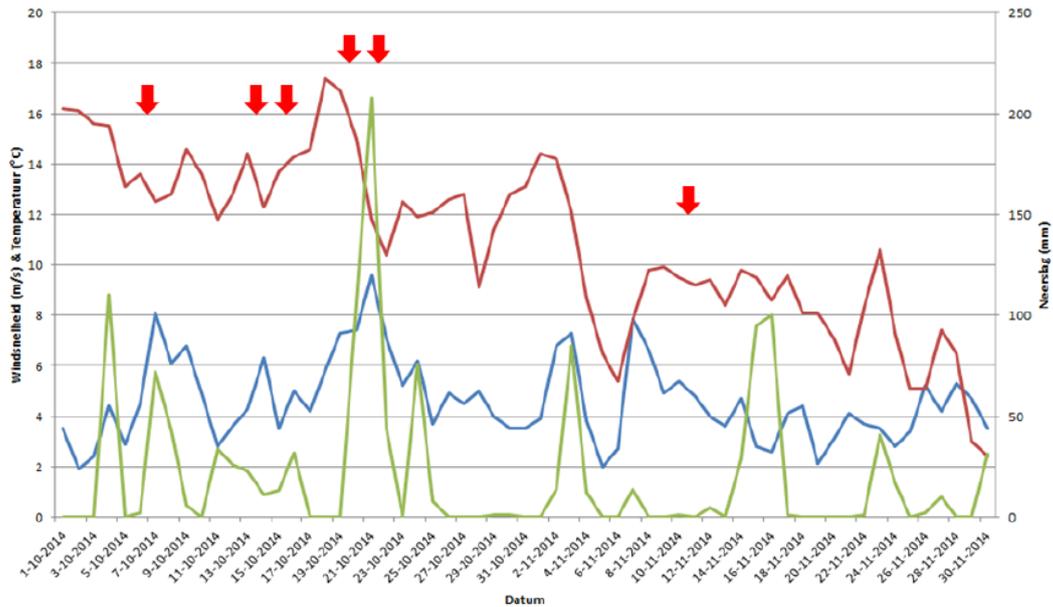
3.6.2 Species Composition

In total 9 fish species, cray fish, mitten crab and frog have been caught during during the monitoring of the passage through pumping station. The fish species consisted of alver, perch, raoch, bream, eel, pos, gudgeon, pike-perch and tench. The perch dominated in numbers with 69% of the total catch (figure 11)



3.6.3 Meteorology

The graph below shows the mean daily wind speed, temperature and rainfall displayed by the closest KNMI station; Schiphol. The red arrows indicate the monitoring periods. The catch data do not demonstrate clearly discernible peaks. However, it is noticeable that the highest catch number of catch was on the fifth monitoring day which coincides with a significant spike in rainfall. Also notable is that the last day of monitoring took place in a period when the temperature has dropped below 10 degrees Celsius, but unlike Dooijersluis and Ankeveen this has not led to increased catches.

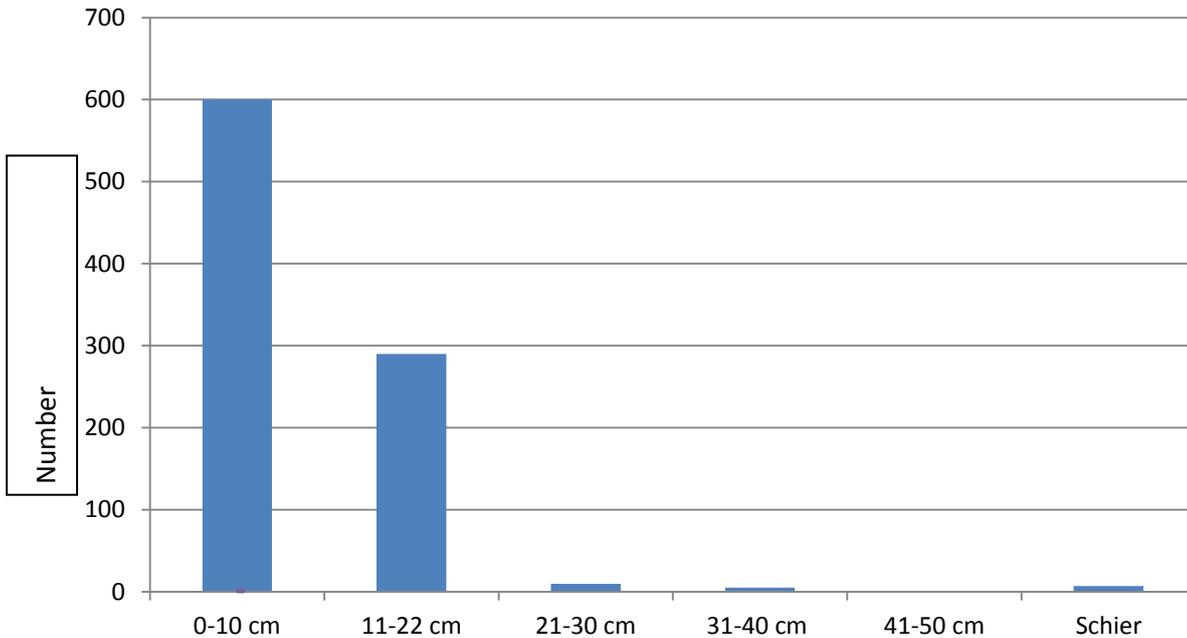


- average temperature (celsius)
- windspeed (m/s)
- rainfall (mm)

3.6.4 LENGTH DISTRIBUTION

The length distribution of the fish species which passed the pumpin station during the monitoring period is shown in figure 17. Especially the smaller size classes (<20cm) are strongly represented and make approximately 97.4% of the catches. There are 14 fish caught in the length class of 20-40 cm and 8 eels.

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3.6.5 DAMAGE AND MORTALITY

In table 12 the number damaged and dead fish is shown. The number of damaged fish is very small (0.1%). In total 1 eel was damaged. This was of the “snap damage” type and it is suggested that it has therefore been caused by the pumping station. (figure 18).



Figure 18 Eel with snap damage pumping station Kortenhoef

Datum	Alver	Perch	Roach	Bream	Eel	Pos	Gudgeon	Pike perch	Tench	Cray fish	Mitten crab	frog	Total
7-10-2014		29		2	6	4	1			6			48
14-10-2014		172	7	3	2	9					2	1	195
16-10-2014		77	7							4	7		95
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22-10-2014	1	214	45	5		2		1					267
11-11-2014		30	90	5		7				1			133
TOTAL	1	647	205	21	8	28	1	1	1	12	10	1	934
Number damaged					1								1
Percentage damaged					12.5								0.1
Number dead													0
Percentage dead													0

Figure 12. Catch results and damage percentages per species.

Species	Fish stock pumping station Kortenhoef	Passage through pumping station Kortenhoef
Total number fish	272	901
Alver		X
Perch	X	X
Bitterling		
Roach	X	X
Bream		X
Hybrid		
White Bream		
Eel	X	X
Pos	X	X
Gudgeon		X
Rudd		
Pike		
Pike perch		X
10 spine stickleback		
Tench		X
Goby		
Other species		
Mitten crab		X
Frog		X
Cray fish	X	X

4.2 CONCLUSIONS

4.2.3 PUMPING STATION KORTENHOEF

Catch Size

At pumping station Kortenhoef significantly less fish were caught compared with pumping station Hollands Ankeveen and pumping station Dooijersluis. Both the fish stock catches and catches of the passage monitoring are small. This may be due to a lack of fish stock caused by low fish stock or a temporary effect by, for example a low volume pumped by the drainage pumping station. For this reason, the fish stock fyke nets were discontinued after being emptied twice to be able to catch as many fish as possible during the monitoring of the passage through the pumping station.

Species composition

The kind of compositions in the fish stock catch and the passage monitoring is largely comparable; approximately 75% of perch and approximately 20% roach and approximately 5% other species dominated by eel and pos. This is in contrast with the pumping stations Dooijersluis and Hollands Ankeveen. This may indicate that the fish at pumping station Kortenhoef are only to a limited extent deterred as a result of the use of a silent archimedian screw. Therefore the strong swimmers may not be inclined to turn back whereas they do turn back at other pumping stations.

Length Distribution

As with the previous pumping stations the length distribution is similar in the fish stock and passage measurements. Most fish are smaller than 20cm, in both cases, approximately 96% of the total.

Damage and Mortality

The damage and mortality table of pumping station Kortenhoef shows that hardly any damage of fish has been noted. The number of damaged fish is negligible (0.1%). In total 1 eel with snap damage has been observed. The percentage of damage is well below the generally accepted damage percentage of maximal 5%. No dead fish have been observed.