Test on fish survivability of the "Venturi Enhanced Turbine Technology"

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VerdErg Renewable Energy Ltd.

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Content

Appendices

Summary

*The Venturi Enhanced Turbine Technology (*VETT*) is a hydropower technology currently under development by VerdErg Renewable Energy Ltd. A testing program was set up to investigate the fish survivability of* VETT *using a full scale instrumented model.. Special focus was given to assessing the effect of fish passage through the venturi section where hydrostatic pressure drops in an instant and might be harmful to fish. The test was carried out according to the protocol developed by VisAdvies known as "the forced exposure test". This test programme was performed on May 17th 2013 in the test facility of VisAdvies in Nieuwegein, The Netherlands and underwent Third Party Verification by Dr. Billy Sinclair, Reader in Conservation Genetics at the University of Cumbria who was present during testing.*

Four freshwater representative fish species were passed through the device:

- *Anguillidae*: (Silver-) Eel (*Anguilla anguilla*);
- *Salmonidae*:
    - Atlantic salmon (*Salmo Salar)*
    - Rainbow trout (*Oncorhynchus mykiss*);
- *Gobidae*: Round goby (*Neogobius melanostomus*).

In total 827 fish were passed through the test model at three different test scenarios consisting of head drops at 1.0m, 1.5m and 2.0m. After each test run, fish were examined for physical damage and deviant swimming behaviour followed by a storage time of 72 hours to monitor their post-passage survival. A number of test fish were sacrificed after this period to examine the swim bladder for damage and other barotrauma.

None of the test fish that passed through the VETT *model showed any characteristics of direct damages or injuries. Five Atlantic salmon smolts died within 72 hours due to a fungal infection acquired during post-passage fish husbandry; these casualties were considered not to be caused by passage through the* VETT *model. None of the anatomically examined fish showed any internal damage. The final survivability score is based on the amount of fish that pass the venturi and that survive without lethal injuries. This score is a weighted average of the three test scenarios and was rated with a maximum score of 1 ("Outstanding").*

In addition, the hydrodynamic conditions inside the device were measured by means of a device called the "Sensor Fish". This device measured pressure, acceleration and rotation during passage through the VETT *model on the same flow pathway that was experienced by the test fish. The pressure profiles created was in good agreement with what was expected. The acceleration profiles were more variable between the tests. The rotation profiles showed the most variability which can be explained by the fact that rotation increases with the presence of small transverse currents. No extreme hydrodynamic values were measured and this is in agreement with the good condition of the fish that passed the* VETT.

1 Introduction

1.1 General

VerdErg Renewable Energy Ltd. has developed a device that allows the use of hydropower at low head water flows in tidal and river environments. VETT (Venturi-Enhanced Turbine Technology) is designed to amplify a low head source by five times, so a small, high speed turbine can be utilized economically (figure 1.1).

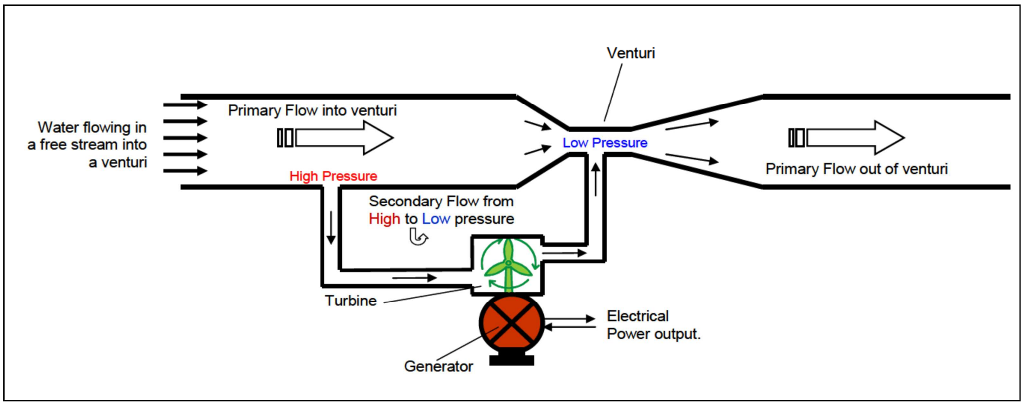


figure 1.1 *Diagrammatic representation of the* VETT

The low pressure that occurs in the constriction of the waterway (venturi) is not only the driving force behind the concept, but may also be a threat to migrating fish that pass through the device. Research shows that fish are vulnerable to extreme pressure transients that occur in hydropower plants (Cada *et al.*, 2007; Cada *et al.,* 2006; Deng *et al.,* 2005). The extent of the injury is dependent on the magnitude of the pressure gradient in the system and the duration of acclimatization and exposure (Cada, 2001). This causes barotrauma in fish with the type and severity of injury varying with fish species and life stage. One threat is the occurrence of air bubbles in the tissues of fish (figure 1.2). The most prominent threat is the air contained inside the swim bladder. Fish use the swim bladder to adjust their buoyancy so they can stay pelagic without any effort. A drop in pressure may lead to blood vessel rupture, bruising, severe organ damage or swim bladder rupture or expansion.

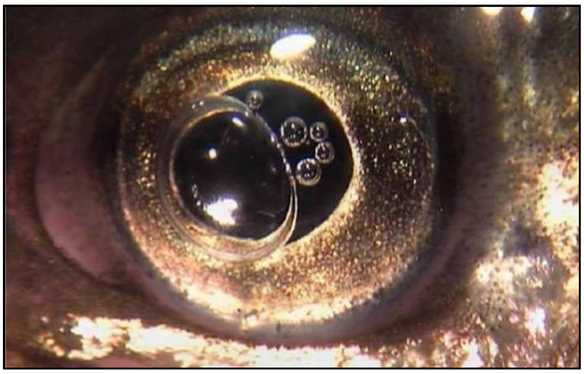


figure 1.2 *Air bubbles in fish eye due to a sudden drop in pressure.*

It was not expected that the pressure transient occurring in the venturi in the VETT *model was* severe enough to cause damage to fish. However, to exclude any doubt and acquire auditable evidence, tests on fish survivability was performed which assessed the effect of rapid pressure changes on young Atlantic salmons (smolts), Rainbow trout smolts, European silver eels and Round Goby.

1.2 Aim of the study

As the secondary flow pathway with the turbine is always screened, the primary aim of the testing program was to demonstrate that fish can pass through the primary flow pathway and venturi in the VETT *model* without any external or internal injury. The survivability of fish is based on the followed factors:

1. The survival rate of fish that passed through the device.
2. The type of injuries.
3. Extent of delayed mortality

2 Materials & Methods

2.1 Test on fish survivability

The test on fish survivability was carried out according to the "forced exposure method" which was developed by VisAdvies as detailed in Vis *et al*., 2011. This method includes:

- the procedures to test fish survivability;
- the evaluation of the results

The protocol is strictly standardized to assure that differences between devices can be evaluated properly.

2.2 Experimental animals

Tests were performed using live fish with at least 50 individuals released per test scenario. 50 test specimens were selected as this would generate statistically significant results, is in line with the "Reduction, Refinement, Replacement" animal testing criteria set in place by Experiments on Animals Act (Wet op de dierproeven (Wod)) and was approved as sufficient by the associated Animal Experimental Committee (Appendix I). The focus was on downstream migrating species with special attention given to sensitive and protected species in the UK. The selected groups were:

- *Anguillidae*: European (Silver-) Eel (*Anguilla anguilla*);
- *Salmonidae*:
    - Atlantic salmon (*Salmo Salar)* smolts
    - Rainbow trout (*Oncorhynchus mykiss*) smolts;
- *Gobidae*: Round goby (*Neogobius melanostomus*).
  N.B. Round goby was used as a surrogate for European bullhead (*Cottus gobio*) as the latter species is a common freshwater fish in the UK.

For the eels, two representative length classes were used for each of the tests:

- *size group 1: ≤ 45 cm*
- *size group 2: > 45 cm*

Length information of the other species is presented in table 3.4 and Appendix II. Images of the different species used in the experiments can be seen in Appendix III.

The Round gobies were wild caught specimens, provided by a commercial fisherman in the North Sea. The eel were obtained from a commercial eel farm in the Netherlands (Nijvis BV, Nijmegen) The Rainbow trout were purchased from a commercial fish farm in Mohnen (Germany) and the Atlantic salmon from a commercial fish farm in Chanteuges (France).

2.2.1 Fish husbandry

figure 2.3 *Fish storage tanks.*

All species were stored separately in fish tanks on arrival (1000 litre capacity, figure 2.3). The tanks were provided with a continuous flow of freshwater from the nearby canal (Merwede kanaal) at a rate of 9 m^3/hour. The eel were kept in a separate fish tank with the appropriate water circulation system. As the temperature of the water in which the fish were transported, was different from the water in the fish holding tanks, the fish were acclimatized for at least one day prior to testing. During the period of storage, fish welfare and water temperature was monitored 3 times a day (8:00 CEST, 14:00 CEST, and 20:00 CEST). Temperature was measured with a thermometer (Checktemp 1, Hanna Instruments BV.) The fish were stored for two days before the experiments were carried out. After the experiments, the test fish were stored separate fish tanks per species and per test scenario.
For each species, 50 untreated “control” fish were stored. This way the animals could be monitored for hidden diseases that otherwise could be mistaken as a consequence of passage through the VETT model.

The use of experimental animals was authorized by the Animal Experimental committee (Dier Experimenten Commissie, DEC) of the Central Veterinary Institute of Wageningen University and Research Centre (see Appendix I). All personnel involved in the experiments were authorized by the Animal Experimental committee (cf. Article 9 authorized officer WOD (J.H. Kemper) and cf. Article 12 authorized officer WOD (H. Vis and R. Blokhuijzen)) under the guidance of Drs P.S. Kroon of the Central Veterinary Institute (cf. authorized officer with Article 14 WOD).

2.3 Test setup

2.3.1 Test device

The experiments were carried out on the 17th of May 2013 in the test facility of VisAdvies in Nieuwegein, the Netherlands (figure 2.4).

figure 2.4 *Pumping engine(left) and the device (right).*

The VETT *model* was made up of four sections as listed below; the design is presented figure 2.5 .

1. A header tank (3m x 2m x 3m) which sourced the flow into the venturi device emulating upstream flow conditions
2. A rectangular Perspex culvert where the power generation and pressure decompression occurred
3. A sink tank (3.30m x 2.4m x 1.22m) were the fish was collected;
4. A sump tank (6 x 2.5 x 3 m) which stored water to be pumped back to the header tank. The container was connected to the sink tank with three hoses (2 x 10 inch, 1 x 12 inch).

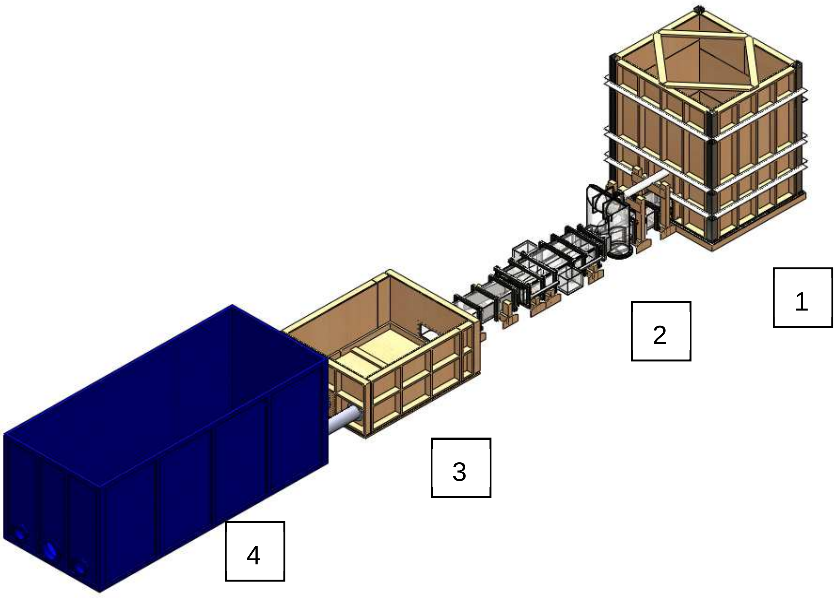


figure 2.5 *The experimental set-up to test the* VETT.

The total volume of the system was approximately 40,000 litres. Water from the nearby canal (Merwede kanaal) was used to fill the VETT model and was considered of good quality for the experiments and storage of the fish. The head drops for the three test scenarios were generated using a pump. Details can be found in appendix IV.

The VETT model was fitted with seven pressure transducers. One was positioned in the secondary flow. Six transducers were positioned in the primary flow, to measure the hydrodynamic conditions throughout the entire system where fish were subjected to during passage. In addition, slow motion video equipment was used to capture the swimming behaviour of the fish passing through the culvert.

2.3.2 Forced exposure of test animals

The VETT device was tested for three head levels:

- 1.0m
- 1.5m
- 2.0m

Once the VETT model had reached a steady state at the intended head level, approximately 50 fish from each species were introduced in turn into the device through the fish entry portal which consisted of a freshwater water filled funnel connected to a vertical pipe (diameter: 8 cm). The pipe was gently curved into the header tank horizontally (figure 2.7, right) and attached to a connecting pipe of the same diameter that was positioned partly into the entrance of the culvert (figure 2.7, left). This way the fish entered the device in a natural way, parallel to the main flow of the water.

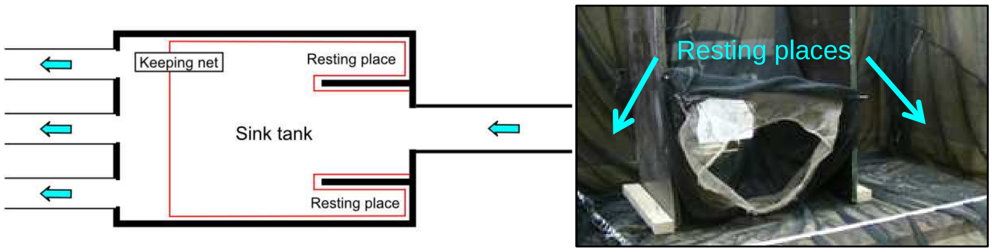


figure 2.6 *Plan view of sink tank, net and resting places for fish to take shelter from the current (left figure) and a picture of the front view on the inlet in the sink tank with the resting places on both sides of the inlet (right figure)*

Fish were caught in a knotless net (mesh size 3 mm) in the sink tank. In the sink tank resting places were created for fish to take shelter from the current at either side of the culvert outtake. Every experiment lasted approximately 7 minutes.

figure 2.7 *Fish injection pipe into the device.*

2.3.3 Fish Acclimatisation Chamber

The original plan was to acclimatise the test fish to a pressure in accordance to the head level for a few hours before entering the device. In the event, it was decided that the most appropriate way to perform the test was to expose the fish to the device, starting from atmospheric pressure. After all, most fish tend to approach a hydropower plant from the surface (smolts) or move up and down quickly in the water column (eel).

2.3.4 Qualification of fish injuries

Immediately after each test scenario was finished, fish were taken out of the life net and checked for injuries and mortalities. In this check, five classes were distinguished:

- No injury or mortality
- Deviant swimming behaviour (disordered, disorientation);

- External injuries (scale loss, haemorrhage, cuts etc.);
- Delayed Mortality (haemorrhage, cuts, bruising)
- Internal injuries causing instant mortality (blood vessel rupture, bruising, severe organ damage or swim bladder rupture or expansion);

Fish that survive passing the venturi without any noticeable damage can still have invisible damage and may die at a later stage as a result of internal damage. As a result, all fish were stored for 72 hours to monitor post-passage survival. After this period, 25% of the salmon and rainbow trout and 10% of the eels were sacrificed. This was done by administering an overdose of anaesthetic (benzocaïne (ethyl 4-aminobenzoate) 100 ppm.) over 30 minutes. After the fish deceased, they were internally examined to determine the state of the swim bladder (figure 2.8). Since the Round Goby lacks a swim bladder, they were not examined internally. The salmonids that survived the test were released in Lake Veere, the eel were returned to the hatchery and the Goby to the place where they were caught. This is all according to the agreement with the Animal Experimental Committee .

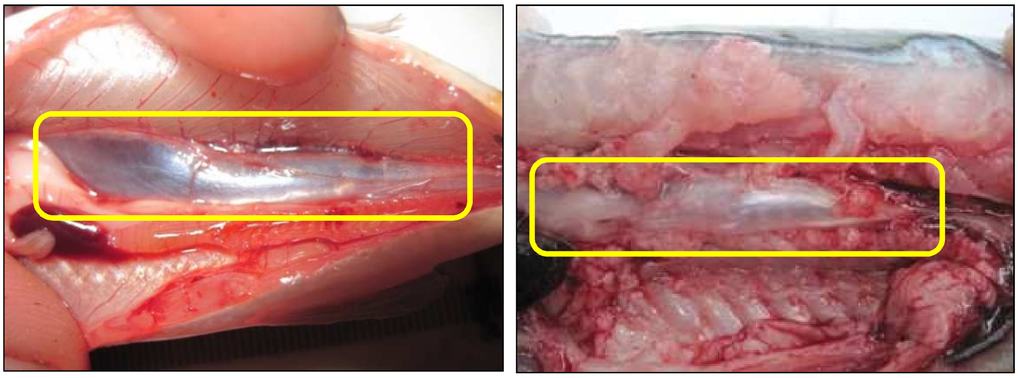


figure 2.8 *Intact swim bladders of the Atlantic salmon (left) and eel (right). Fish utilize the swim bladder to regulate the buoyancy of their body.*

2.3.5 Statistical evaluation

The estimated chance of survival is equal to the number of fish that survived the treatment divided by the total number of fish that passed the VETT as seen in Formula 1.

Formula 1. Survivability (%) = number of survived fish / total number of fish passed.

In addition, the 95% confidence intervals (C.I.) are calculated to express the reliability of the results. The confidence interval around the estimated survivability was calculated according using the Formula (2):

Formula 2.

$$CI = 1{,}96 * \sqrt{\frac{p*(100-p)}{(n-1)}} + survivability\,(\%) - 1{,}96 * \sqrt{\frac{p*(100-p)}{(n-1)}}$$

CI = Confidence interval
p = the estimated probability of survivability (%)
n = Sample size

2.3.6 Fish survivability score

Fish survivability is determined on the basis of all groups, so five groups are taken into account. The survival percentage refers to all fish that survived both the direct treatment and the post-passage monitoring period of 72 hours.

Every test on fish survivability of a group results in a score between 0% and 100% survival. The resulting survival percentages (0% - 100%) are divided into five classes of survivability as presented in the columns in table 2.1. The classification of these five classes is based on the results of the survival percentages of other devices (meanly pumps), whose test results were available (Kemper *et al,.* 2011).

table 2.1 *Classification of fish survivability percentage.*

	Group	Length class	Survivability classes (%)				
			Outstanding	**Excellent**	**Good**	**Insufficient**	**Bad**
1	**European Eel**	0-45 cm	100%	99%	95% -98.9%	90% -94.9%	0% -89.9%
2		>45 cm	100%	99%	95% -98.9%	90% -94.9%	0% -89.9%
3	**Atlantic salmon**	15-20 cm	100%	97.5%-99.9%	90% -97.4%	80% -89.9%	0% -79.9%
4	**Rainbow trout**	15-20 cm	100%	97.5%-99.9%	90% -97.4%	80%-89.9%	0% -79.9%
5	**Round goby**	10-20 cm	100%	97.5%-99.9%	90%-97.4%	80%-89.9%	0% -79.9%

The total survivability score ranges from 0 (no survival) to 1 (100% survival) and is calculated from the individual scores (survival percentage) of the five groups. However, the contribution is not equally distributed (0.2 each), but some groups have their own separate weighting factor. The idea behind this is that migration is not equally important for all species or length classes. For instance, carp or bream can hatch, grow up and reproduce in a relative small area, while for the silver eel it is required to pass barriers like hydro power plants, to reach its spawning grounds.

Therefore the total weighting factor is:

- European Eel (0-45 cm): 0.2
- >45 cm: 0.25
- Atlantic salmon: 0.2
- Rainbow trout: 0.2
- Round goby: 0.15

The result of the final score is calcified as presented in table 2.2

table 2.2 *Total Test Group Survivability Classification Key.*

Outstanding	Excellent	Good	Insufficiënt	Bad
1	0.75-0.99	0.50-0.75	0.25-0.50	0.00-0.25

2.3.7 Sensor Fish

Sensor Fish (figure 2.9) is a sensor package that characterizes the physical conditions and physical stresses to which fish are exposed when they pass through complex hydraulic environments. The Sensor Fish contains*:*

- tri-axial acceleration meters (g-force).
- pressure gauge. The pressure is measured in Pound-force per square inch (PSI), but is converted to the SI standard kPascal
- rate gyro. The rotations are measured in degrees per second during transit through the device. The rotation values are divided by 360 degrees and presented as rotations per second.

The Sensor Fish measures acceleration and rotation in three dimensions (X-, Y- and Z-axis), relatieve tot the Sensor Fish. The absolute rotation and acceleration are calculated from the square root of the summed squares of the tree measurements: $\sqrt{(X^2+Y^2+Z^2)}$.

Data is collected at a rate of 2,000 Hz over a recording time of up to four minutes. The data is stored on an internal memory card and transferred to computers via an infrared link. The device is 24.5 mm in diameter and 90 mm in length, weighs 42 g, and is neutrally buoyant in fresh water.

Six Sensor Fish units were introduced into the device, in the same way as the experimental fish species. At every test scenario, two Sensor Fish units were used to measure the hydrodynamic conditions and verify the change in pressure in the venturi of the device.

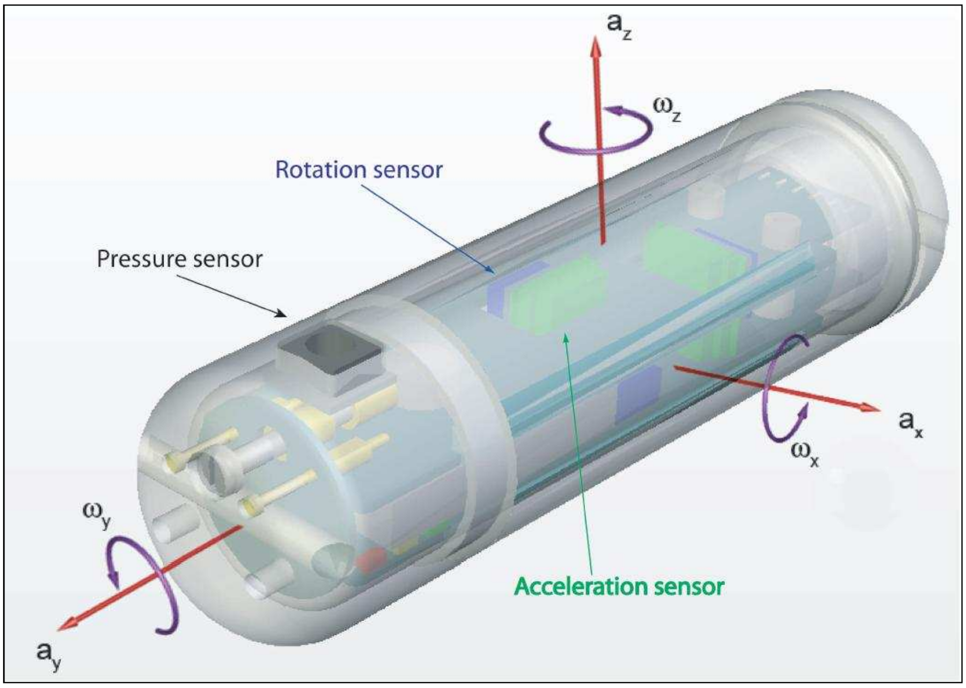


figure 2.9 *Sensor Fish (Deng et al., 2007).*

3 Results

3.1 Experimental animals

All fish were in good condition at the start of the experiment. For the first test (1m head) 271 fish passed the device: 112 eel; 106 salmonids and 53 gobies (table 3.3). In the second test (1,5 m head) 280 fish passed the device: 104 eel; 116 salmonids and 50 gobies. In third test (2 m head) 276 fish passed the device: 115 eels, 109 salmonids and 52 gobies. In the control group were stored 112 eels, 111 salmonids and 56 gobies.

The mean length ± standard deviation of all fish groups and test scenarios are presented in table 3.4. In addition, all length frequency diagrams are shown for all fish groups and test scenario's, in Appendix III

table 3.3 *# Fish used for each test and fish group.*

Group		Length class (cm)	Head level			Control group
			1 m	**1,5 m**	**2 m**	**-**
1	**Eel**	0-45	54	55	58	53
2		>45	58	59	57	59
3	**Atlantic salmon**	0-20	54	63	58	56
4	**Rainbow trout**	0-20	52	53	51	55
5	**Round goby**	0-20	53	50	52	56
Total			**271**	**280**	**276**	**279**

table 3.4 *Mean length ± standard deviation of all used fish.*

Group		Length class (cm)	Head level			Control group
			1 m	**1,5 m**	**2 m**	
1	**Eel**	0-45	37 ± 2.5	37 ± 2.5	36 ± 3.0	37 ± 2.5
2		>45	57 ± 3.5	59 ± 4.0	57 ± 5.0	56 ± 4.5
3	**Atlantic salmon**	0-15	18 ± 1.0	18 ± 1.0	18 ± 1.0	18 ± 1.0
4	**Rainbow trout**	0-15	18 ± 1.5	17 ± 1.0	17 ± 1.5	17 ± 1.5
5	**Round goby**	0-20	15 ± 1.5	16 ± 1.5	15 ± 1.5	15 ± 1.5

3.2 Percentage of Survival

Less than five fish per run experienced some minor scale loss. This was considered negligible and recoverable. It is assumed that it was caused by contact with the net. No further injuries or damages in any test fish were observed during visual inspection. In addition, no deviant swimming behaviour was noticed that could indicate internal damage. Since the results are similar for all groups and test scenarios, only the results of scenario 1 are presented graphically (figure 3.10). This graph can be considered representative for all groups.

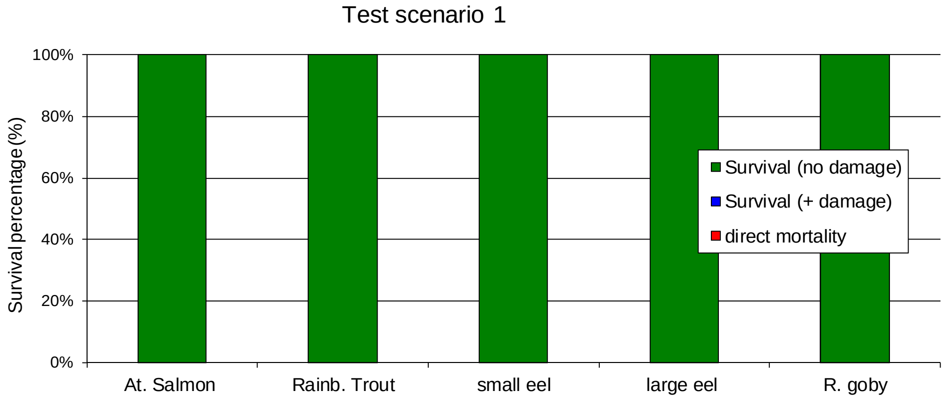
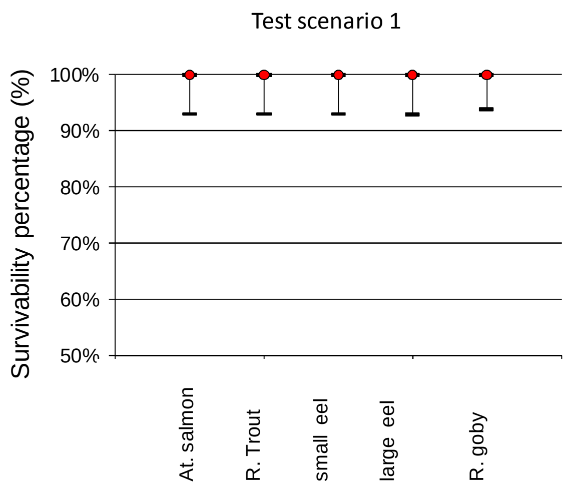


figure 3.10 *Survival percentages of the five fish groups for test scenario 1.The results of scenario 2 and 3 were identical, so this graph can be considered representative for all scenario's.*

Five Atlantic salmon smolts died in the 72 hour post-passage monitoring period, details of which are presented in table 3.5. Two fish from test run 2, one from test run 3 and two from the control group. All these fish showed signs of a fungal infection (not specified), which was prominent in their fins. At the first signs of the infection (after about 20 hours) 25 kg salt was added to 6000 liter of water (appr. 4‰) and recirculated for 4 hours. After this period the salinity gradually decreased again to 0 ‰ salinity. After the treatment, no additional infections were observed.
As two fish in the control group also died from the fungal infection, the deaths were considered the result of the infection itself and not due to the tests. This is emphasizes the fact that Atlantic salmon smolts are vulnerable to infection under stress and storage.

table 3.5 *Delayed mortality after the fish survivability test. Water temperature was measured in the storage tanks.*

Date	Time	Time after test (h)	Test group (m)	species	Water temp (C°).	Cause of dead
17-05-2013	18:00	2	-	-	14.6	
17-05-2013	20:00	4	-	-	14.6	
17-05-2013	22:00	6	-	-	14.6	
18-05-2013	8:00	16	1.5	At. Salmon	14.4	Fungal infection
18-05-2013	13:00	21	Control	At. Salmon	14.5	Fungal infection
18-05-2013	13:00	21	2.0	At. Salmon	14.5	Fungal infection
18-05-2013	18:00	26	-	-	14.7	-
19-05-2013	8:00	40	1.5	At. Salmon	14.4	Fungal infection
19-05-2013	12:00	44	-	-	14.4	-
19-05-2013	18:00	48	-	-	14.5	-
20-05-2013	8:00	62	Control	At. Salmon	14.8	Fungal infection
20-05-2013	12:00	66	-	-	15.3	-
20-05-2013	20:00	72	-	-	15.5	-



Since no mortality occurred any test runs, confidence intervals are very small (6-7%). There is a small variation in C.I .between the species due to the differing number of animals that were used in the experiments. In figure 3.11 only the results of test run 1 are presented and are representative for the other runs.

figure 3.11 *Overview of the survivability percentages (red point) per fish species for test run 1, including the confidence intervals.*

3.3 Final fish survivability scores

Just as with the percentage of survival, the final survivability scores presented in table 3.6 shows little to no variation between the different test runs. Since no mortality was observed, the VETT concept can be rated as "**Outstanding**" for all test runs.

table 3.6 *Final score on fish survivability for all scenario's. All fish survived until 72 hours after the test. So the device scores "**Outstanding**" for all head levels.*

No.	Group	Length class	Weigthing factor	Group surviv-ability	Group surviva-bility score
1	European Eel	0-45 cm	0.2	100%	0.2
2		>45 cm	0.25	100%	0.25
3	Atlantic salmon	15-20 cm	0.2	100%	0.2
4	Rainbow trout	15-20 cm	0.2	100%	0.2
5	Round goby	10-20 cm	0.15	100%	0.15
Total test group survivabilityScore survival					**1**

3.4 Sensor Fish

3.4.1 General

A pressure profile created by a Sensor Fish during its passage through the device is presented in figure 3.12. The measurement starts with a retention time of 2 - 4 seconds which reflects the time that the Sensor Fish was activated but not yet introduced to the injection pipe . In this period, the Sensor Fish measures the atmospheric pressure of 100 kPa. After the Sensor Fish enters the fish entry portal- header tank, the pressure increases until it reaches the lowest point of the fish entry portal. At the venturi the pressure dropped within 0.1 second to a minimum for less than 0,25 second. This is the time span that fish is exposed to the low pressure. of. The lowest pressure value recorded was 74 kPa. After passing the venturi the pressure increases again in the sink tank to near atmospheric pressure. An overview is presented of the pressure (kPa) at different places in the device in table 3.7. One of the measurements at head level 1,5 m failed.

table 3.7 *Pressure measurements (kPa) of the Sensor Fish at different locations in the device during operation at different heads*

Head level (m)	Entrance (Atmospheric p.)	Outtake of the fish injection pipe	Venturi (minimum)	Difference
1	100	116	88	**28**
1,5	100	119	86	**33**
2	100	132	74	**57**

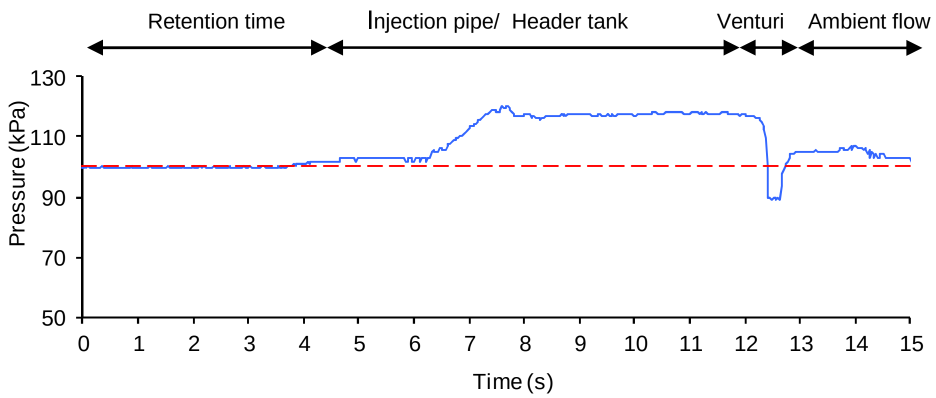


figure 3.12 *Example of the pressure measurements at 1.0 meter head of water during the passage through the device. The red dotted line represents the atmospheric pressure.*

3.4.2 Measurements

In the following graphical presentations the focus is on the moment the Sensor Fish passes the venturi. In these graphs (figure 3.14 to figure 3.16) the pressure, acceleration and the rotation profiles are presented.
The pressure profiles observed under different head levels is quite in agreement with what was expected. Also the duplicate Sensor Fish gave comparable results.
The peak in acceleration at the entrance to the venturi coincides with the drop in pressure. However there is some variation in the peaks between the two duplicate Sensor Fish especially with the 2 meter head level measurements. Most variable are the results from the rotation measurements. This can be explained by the turbulent environment in the venturi. The rotation of the Sensor Fish can be influenced in an unpredictable way by local currents. This could also be observed with the fish

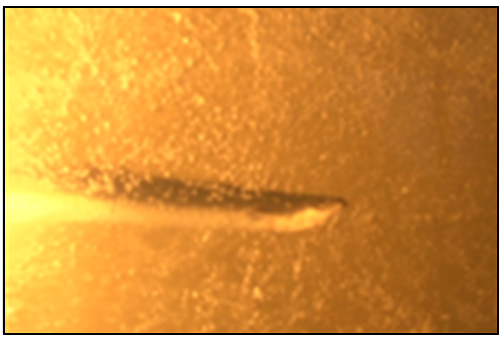


figure 3.13 *Eel tried to swim against the current.*

coming out of the venturi. From the observations it was also clear that fish did not experience any harm from passage through the VETT model. Many fish (Atlantic salmon, Rainbow trout and eel) even tried to swim upstream again into the venturi (figure 3.13).

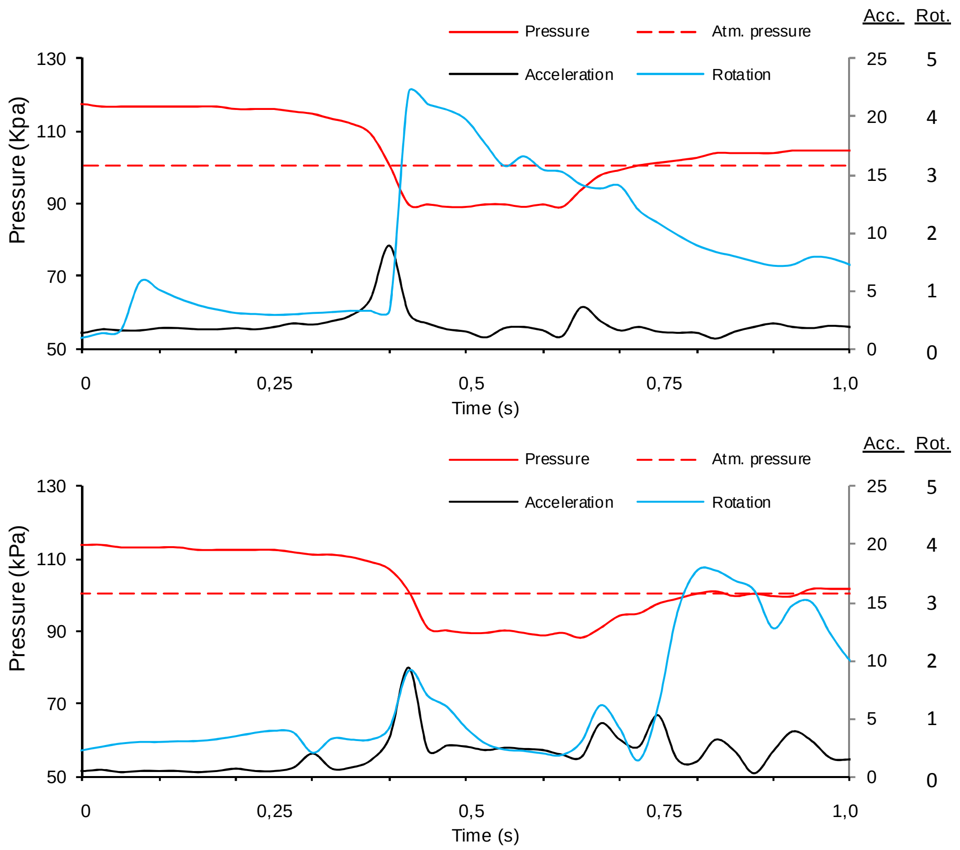


figure 3.14 *Sensor Fish measurements at head level 1 meter. Acceleration is measured in G- forces and the rotation in rotations (360 degrees)/sec*

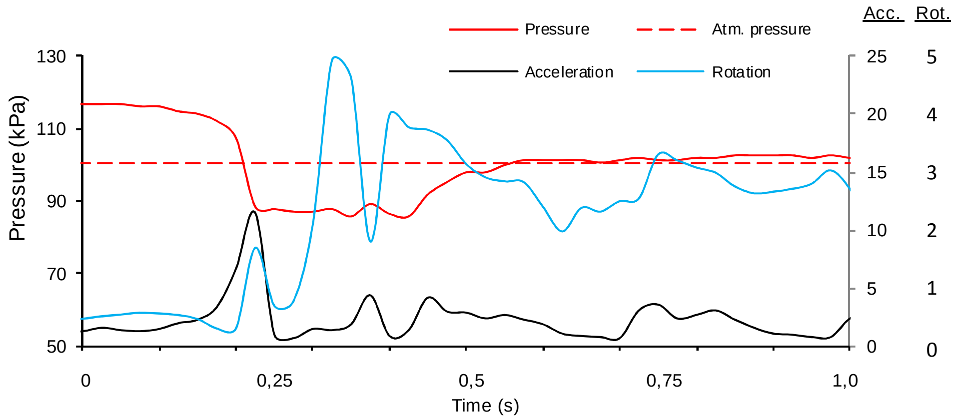


figure 3.15 *Sensor Fish measurements at 1.5 meter head of water.*

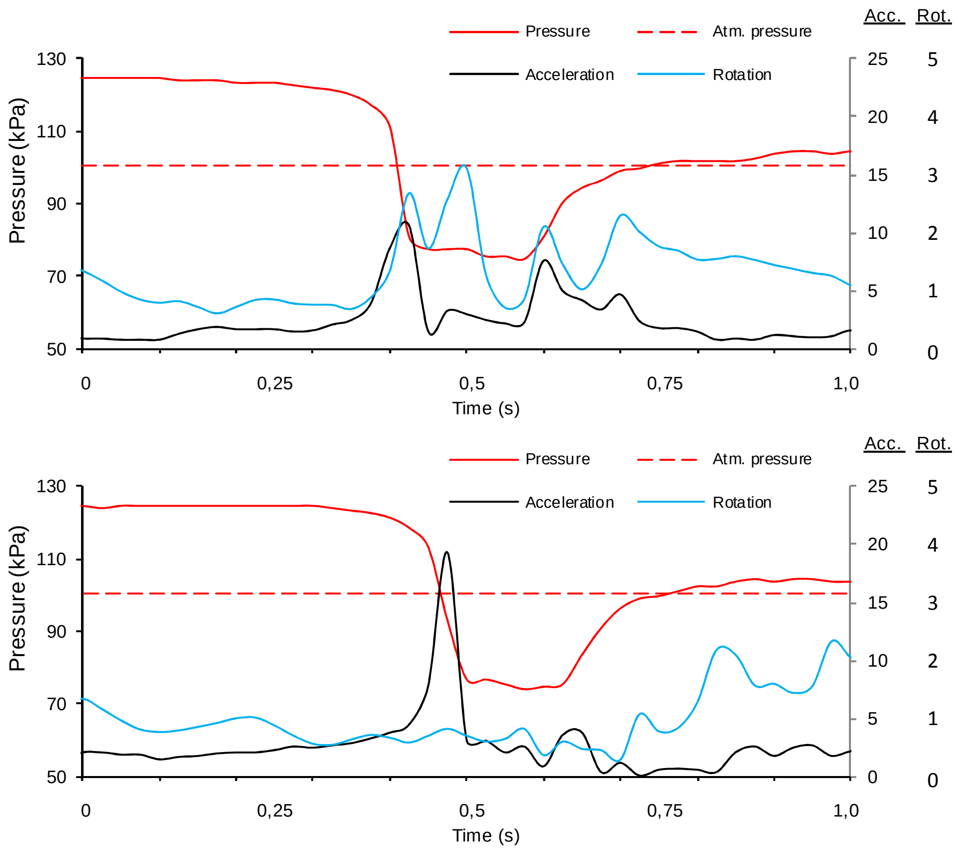


figure 3.16 *Sensor Fish measurements at 2.0 meter head of water.*

4 Conclusion

No external damage to any test fish species was observed immediately after the test runs. 72 hour post-passage monitoring assessments concluded that the test fish were in good health, except for a few salmon smolts that suffered from a fungal infection which is not attributed to passage through the VETT model. However, this was not considered to be related to the experiment. Therefore it is concluded that the experimental set up of the VETT concept can be rated “Outstanding” terms of fish survivability for head drops of 1.0m, 1.5m and 2.0m with a corresponding flow rate of **XX** What was the flow rate at these head drops - Paul Bird to confirm.. As the VETT is scalable, these findings can be extrapolated to tidal and river sites with the same hydrodynamic profiles.

5 References

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Appendix I Approval Animal Experimental Committee

WAGENINGEN UR
For quality of life

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t.a.v Drs. J.H. Kemper
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O&O

DATUM
8 mei 2013

ONDERWERP
beoordeling VA 2012_33

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Betreft Onderzoeksplan 2013_33
Titel Onderzoek visvriendelijkheid SMEC VerErg

Aantal dieren 1000
Diersoort: Atlantische zalm; Aal; regenboogforel; zwartbekgrondel
Risico van ongerief gering (250). Gering/matig (750)
Status: voortgezet onderzoek
Artikel 9 functionaris: Drs. J.H. Kemper
Periode advies: 1 mei 2013 tot 1 augustus 2013

- Het proefvoorstel is getoetst aan de hand van de eisen die gesteld worden ten aanzien van de 3 V's. en Art 2a van het Dierproevenbesluit
- Het doel van de proef. wordt onderschreven. Het belang van de proef weegt op tegen het ongerief van de betrokken dieren en er zijn geen alternatieven beschikbaar..
- -- De uitvoering is verder niet in strijd met andere ethische overwegingen m.b.t. het gebruik van proefdieren.

Voorwaarden

- De indiener dient iedere wijziging van het proefplan ten opzichte van dit advies alsmede onverwachte gebeurtenissen, onverwijld te melden aan de proefdierdeskundige
- Indien het ongerief tijdens de proef afwijkt van het opgegeven (verwachte) ongerief dient dit een welzijnsevaluatie na afloop van de proef te worden gemeld

Opmerkingen:

- Het proefplan is behandeld in de DEC vergadering van 23 april. Vanuit de vergadering zijn enkele vragen gesteld. Deze zijn naar het oordeel van de proefdierdeskundige bevredigend beantwoord (brief dd. 3 mei). Het proefplan is conform aangepast.

Advies : Positief

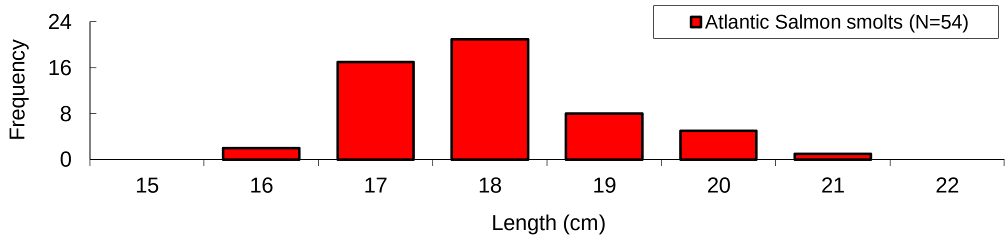
Met vriendelijke groet,

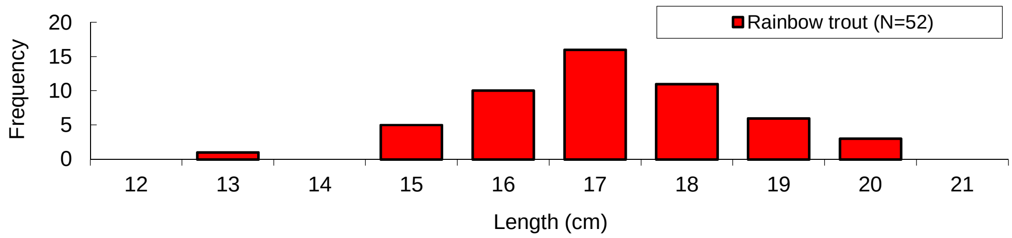
P.S. Kroon
Proefdierdeskundige / Veterinair

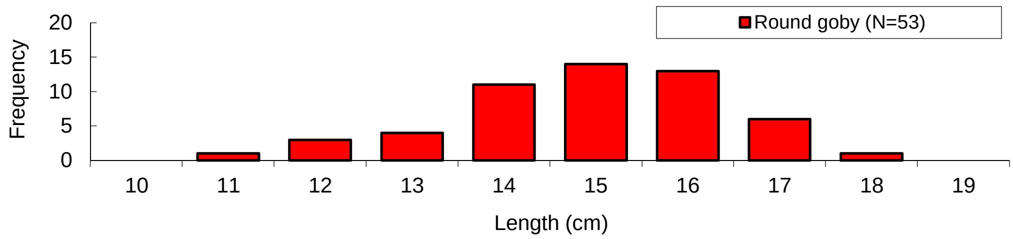
Wageningen UR (Wageningen University, Van Hall Larenstein University of Applied Sciences and various research institutes) is specialised in the domain of healthy food and living environment.

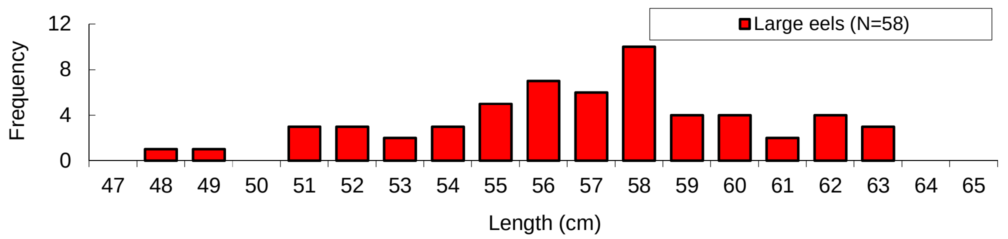
Appendix II Length frequency distribution diagrams

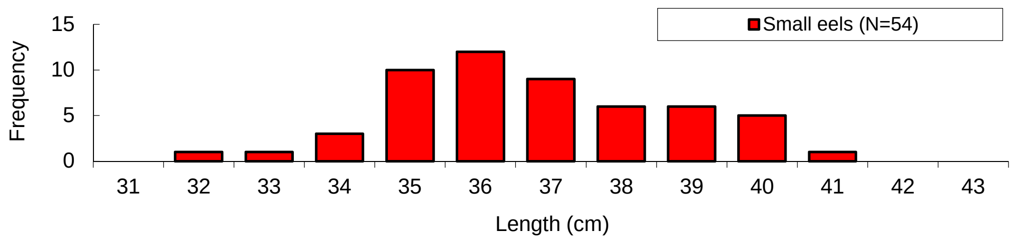
Scenario 1 (1.0 m head of water)



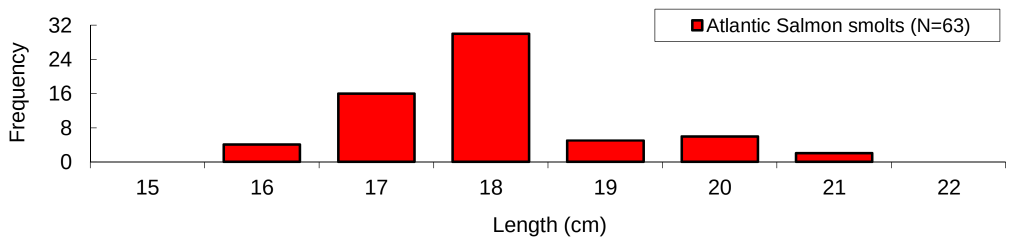


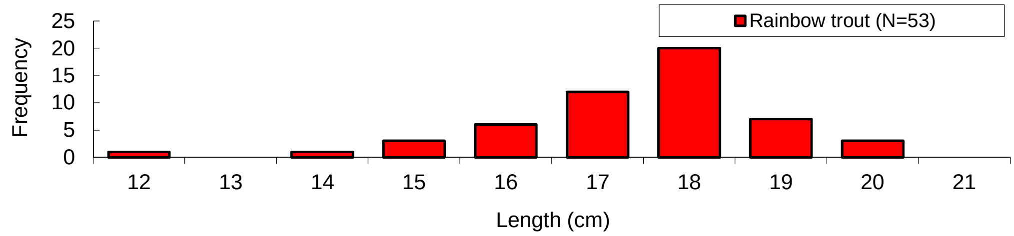


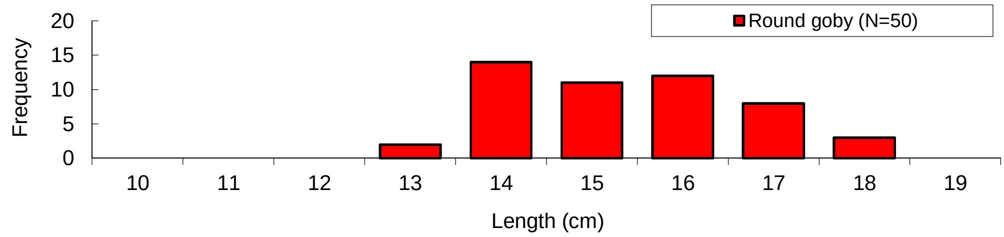


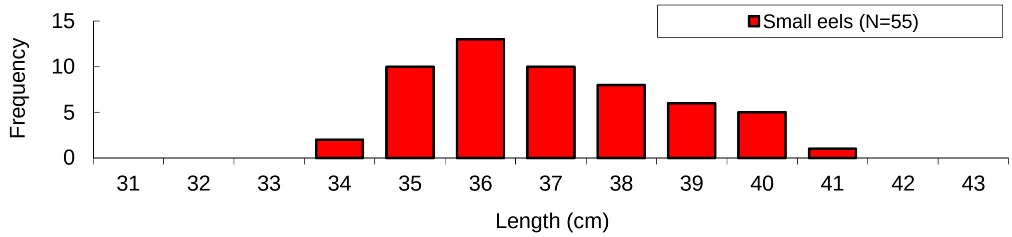


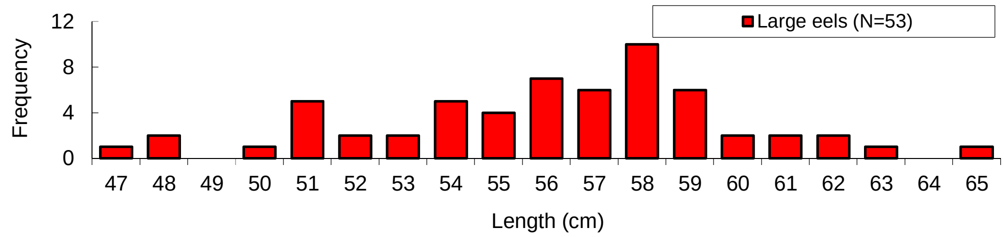
Scenario 2 (1.5 m head of water)



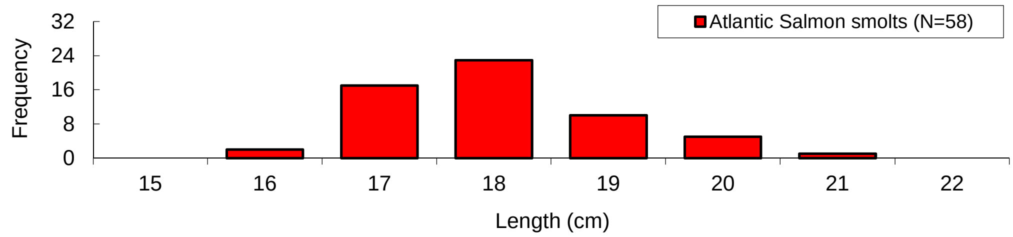


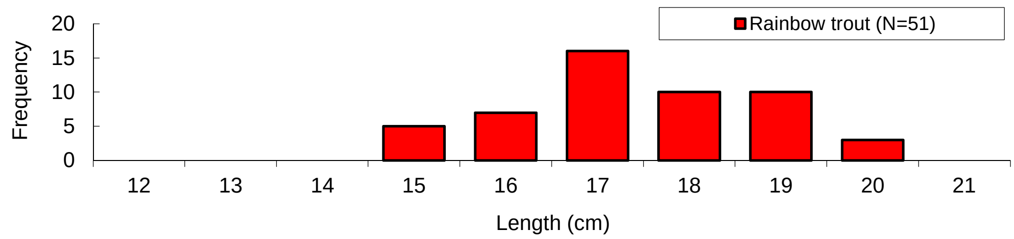


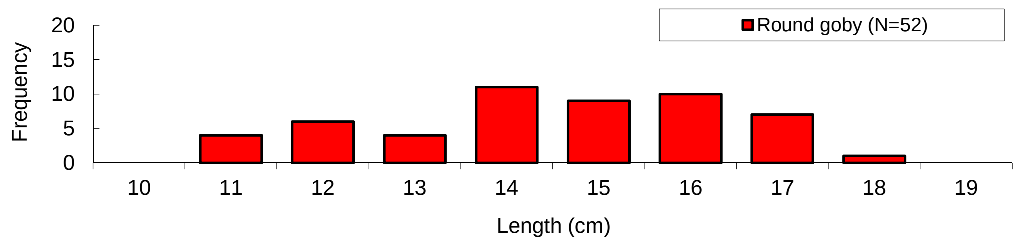


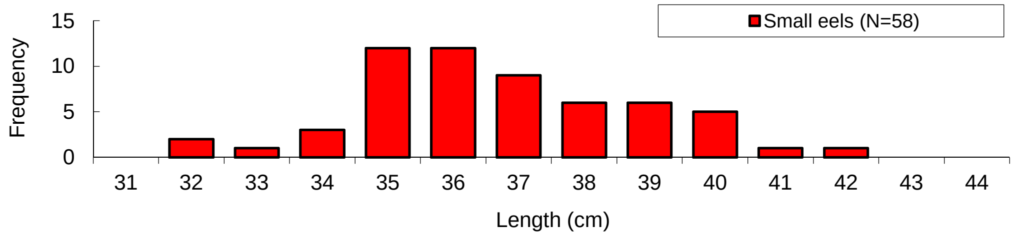


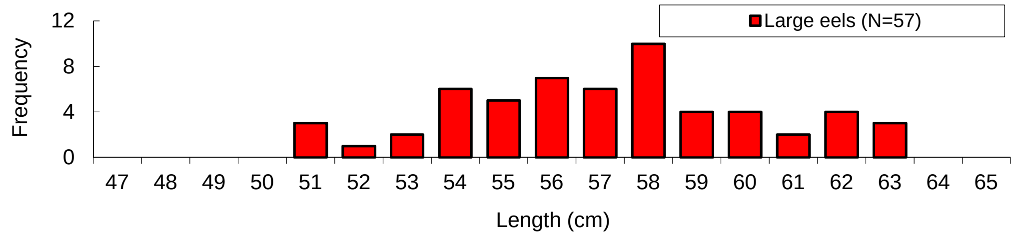
Scenario 3 (2.0 m head of water)



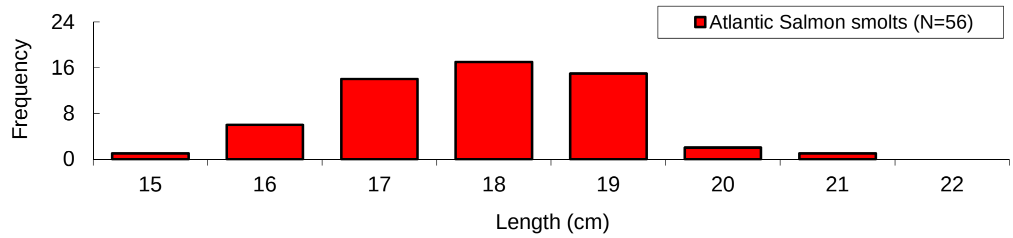


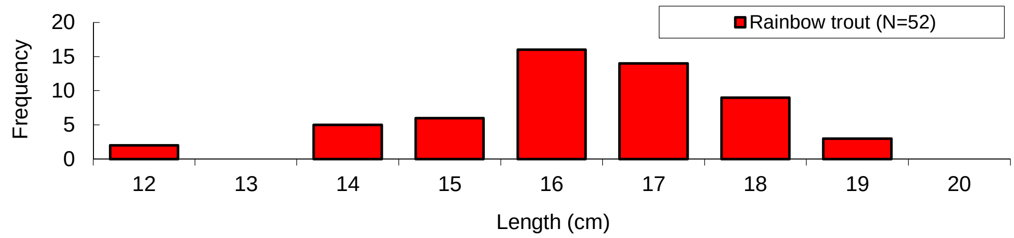


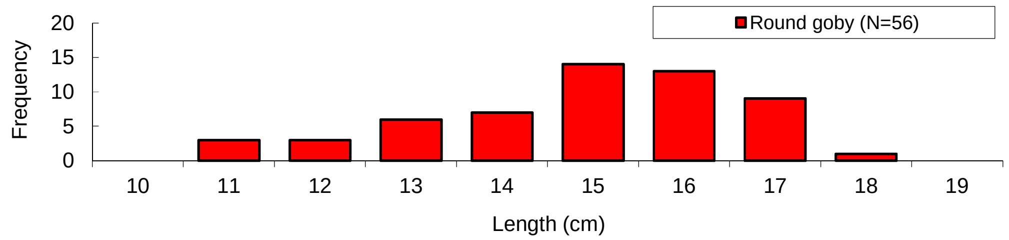


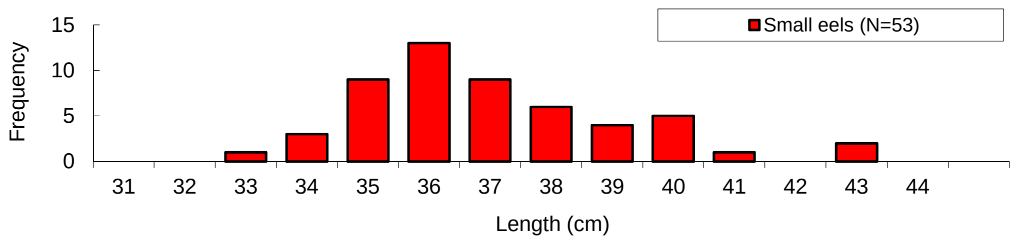


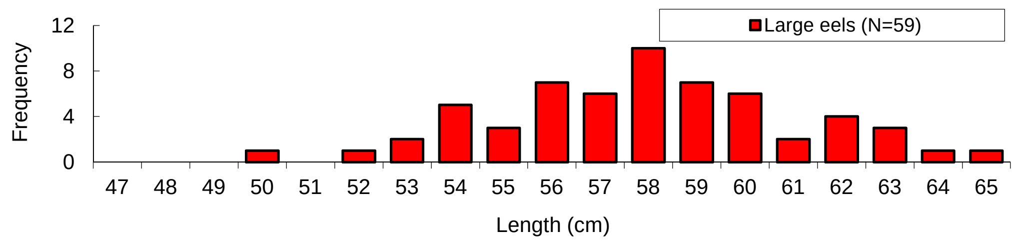
Control groups











Appendix III Fish species

Round Goby (*Neogobius melanostomus*)

Eel (*Anguilla anguilla*)

Rainbow trout (*Oncorhynchus mykiss*)

Atlantic salmon (*Salmo salar)*

Appendix IV *Pump specifications*

Motor :	Deutz 6M1013C
Pump :	Hidrostal H12K SD
Solid handling :	150 mm
Power :	135 kW at 1500 rpm
Weight :	4750 kg
Dimensions :	L=4,1 W=1,3 H=2,75 [mtr.]
Connections :	suction=16" discharge=12"
Tank capacity :	585 litre
Fuel consumption :	33 ltr./hour at full load
Facility :	- Central hoisting eye, - Fork lifting points - Automatic vacuum pump, - Spark arrestor
Details : -	- Optional with level switch or remote control - Can be equipped with 2x10" suction hoses for fast installation. - Capacity then maximum 1500 m3/hr

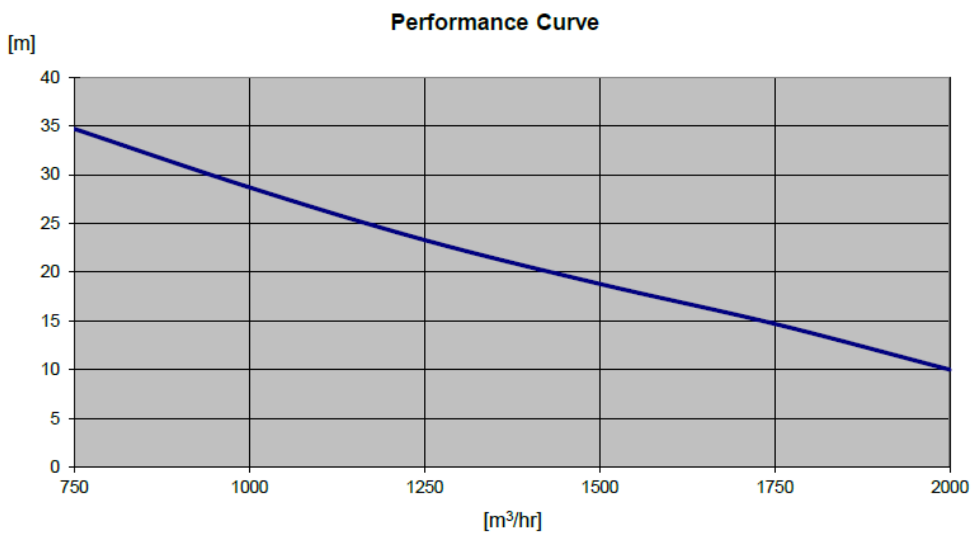


figure 5.17 *Pump used for the experiment*

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