SIMSONAR

Accurate Underwater Vision

Report from Hednäs
9.6. – 28.9.2016

Simsonar Oy

Contents

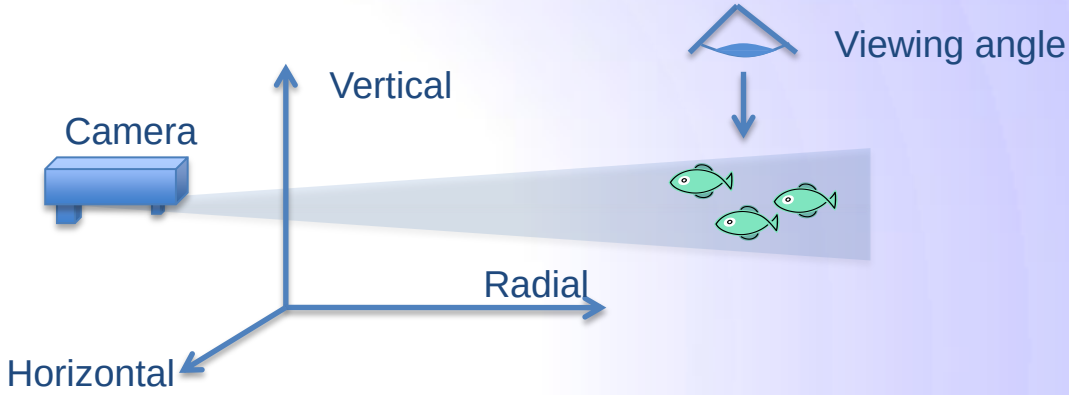
- Background
- System structure
- Location
- About measurement methods
- Statistical corrections
- Main results
- Observations
- Notes about measurement
- System uptime and support activities

Background

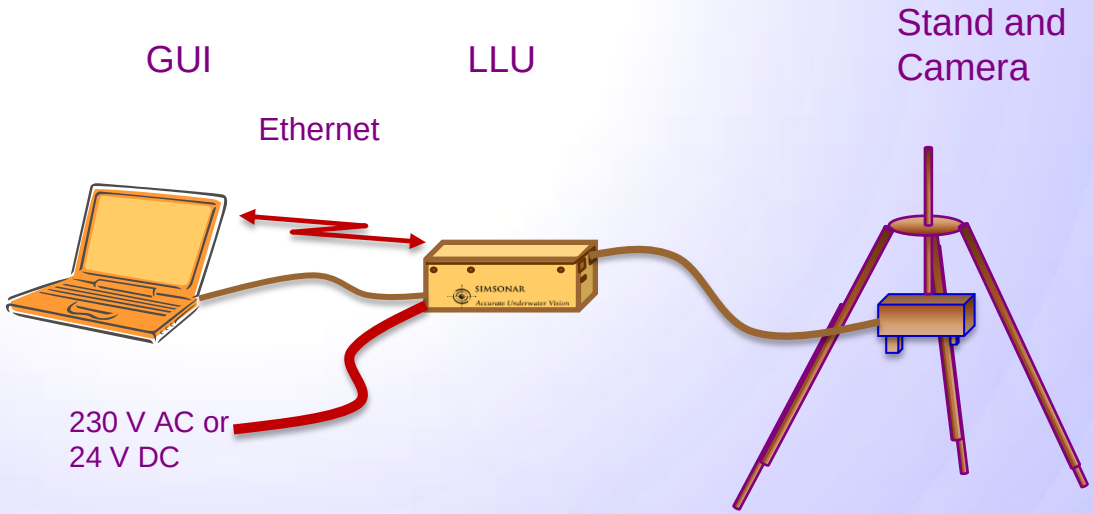
- Ultrasound camera uses sound (ping) to create real-time video image (similar to sonars).
- Speed of sound in water about 1500 m/s enabling real time video with reasonable frames/second speed up to 75 meters.
- Simsonar UVC recognizes movement and measures the length of the moving objects automatically.
- Visual inspection to eliminate boats, trash and recognize schools of fish.
- Monitoring project contains four main phases:
  - Selection of location for camera.
  - Installation and deployment.
  - Recording the data from camera.
  - Analysis of data and reporting.

System structure

- The direction of the view is from up.



- System consists of multiple components.



Location


Vidsel
Boden
Råneå
Töre
Kalix
Haparanda
Keminmaa
Kemi
Simo
Älvsbyn
Gammelstad
Luleå
Storsund
Piteå
Oulu
Kempele
Byske
Boliden
Skellefteå
Bureå
Raahe

About measurement methods

- Automatic measurement was the main method:
  - Parameters for movement detection and automatic measurement were tuned by analysing several days.
  - Tuning is based on visual checking of recordings and verifying the fish are found correctly and measured with adequate accuracy.
  - The parameters were checked during the analysis phase and updated when considered appropriate.
- Minimum length 40 cm.
- Material from every day was at least partially checked visually.
  - Clear movement up or downstream required.
- The results were cross-checked in multiple ways:
  - Analysts verified each other's results.
  - Exceptional results were double, triple and quadruple checked.
  - Statistical corrections were applied when considered relevant.

About cross-checking methods

- Randomly selected files were run with two set of movement parameters and by two persons.
- If differences were found they were analysed and material was rerun when necessary.
- Difference of down/up objects were analysed with special care:
  - Share of downstream objects varied with different parameters from 33% to 40% (same period, all sizes).
  - Software measured occasionally salmons staying in the same position multiple times. No strong correlation with direction was detected (55% of multiple measurements were downstream).
- Few days were run with 100% visual detection and measurement:
  - Rejection rate was 3% (objects that software measured but were considered not fish).
  - Visually measured were in average 13% longer than software measured but the average length in each length category was very similar (variance < 0.0003).
  - The main difference was in category > 100 cm: 43 vs. 9 fish. There are three reasons: software measures occasionally two queued fish as a long one (decreases the number) and splits a long fish to two smaller ones because of shadows caused by other fish and stones (decreases the number of long fish).
  - The error was corrected by measuring all long and short objects manually.

Statistical corrections

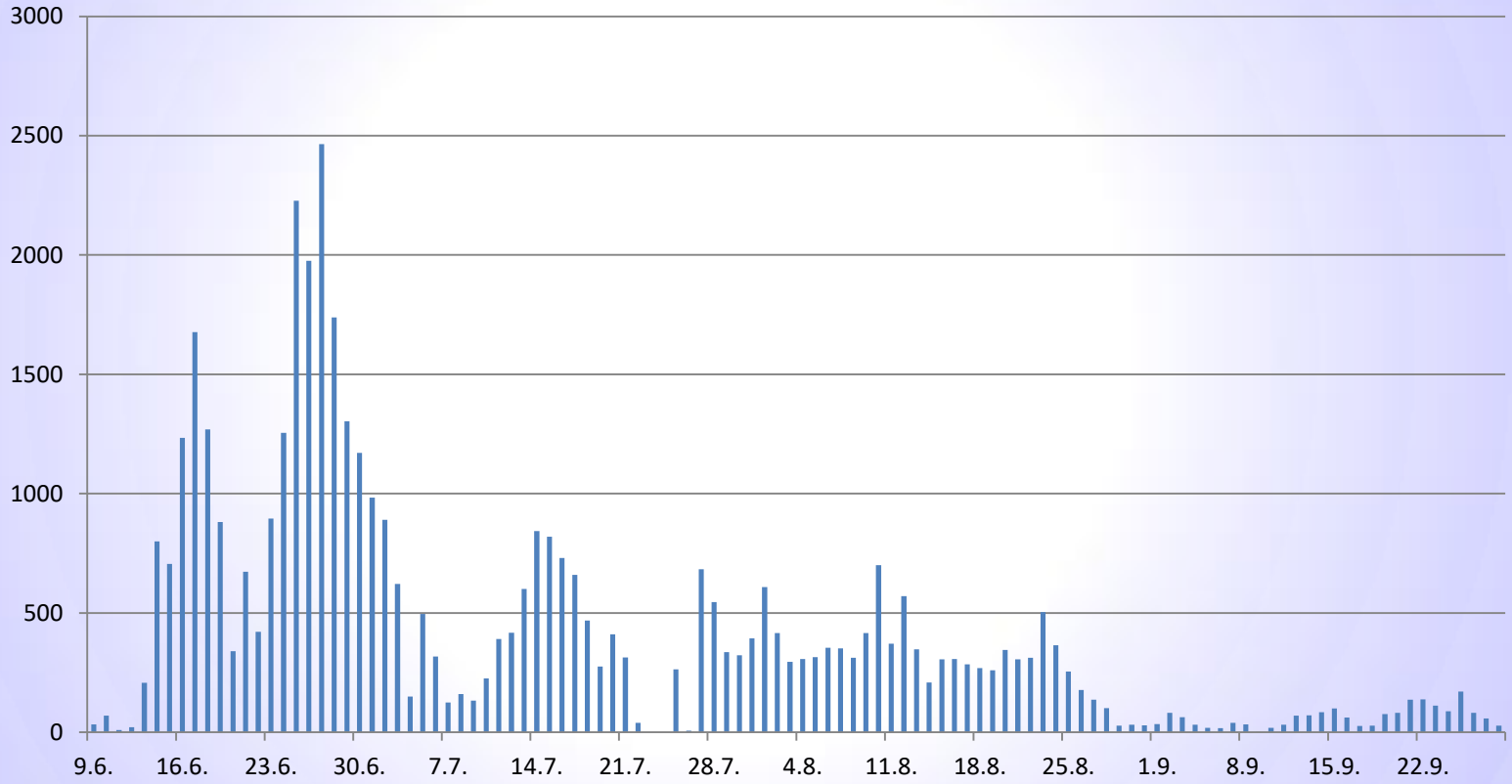
- Corrections were based on comparing visual and automatic measurement with multiple sets of parameters and on findings of the cross-checking phase.
  - Shorter track and tangential track lengths for downstream objects.
  - Higher aspect ratio (width/length).
  - Few high speed objects (downstream) were not detected by software.
- Measured lengths were decreased by the length of a half pixel: 0.5*tan(0.44)*distance.
- Number of detected fish was decreased by 7% (based on the overlapping multiple measurements; 7 % was used for both up and downstream).
- Downstream counts were multiplied with a factor 1,21 (=40/33).

Report 3.11.2016

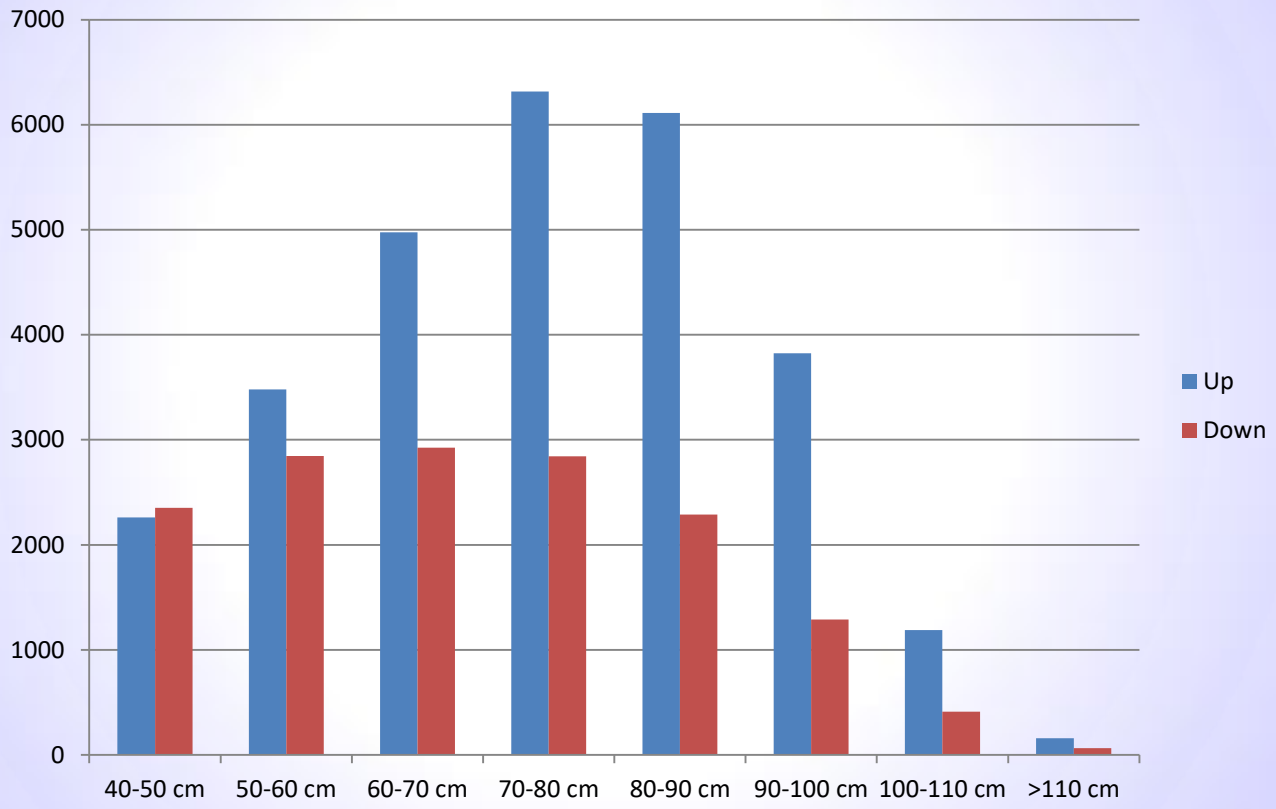
- Analysis of recordings 9.6 - 28.9.2016.
- 45 737 detected and measured objects.
- 43 332 objects longer than 39 cm.

	40-50cm	50-60cm	60-70cm	70-80cm	80-90cm	90-100cm	100-110cm	>110 cm
Up	2262	3480	4974	6315	6111	3824	1189	159
Down	2353	2845	2925	2844	2287	1290	410	64

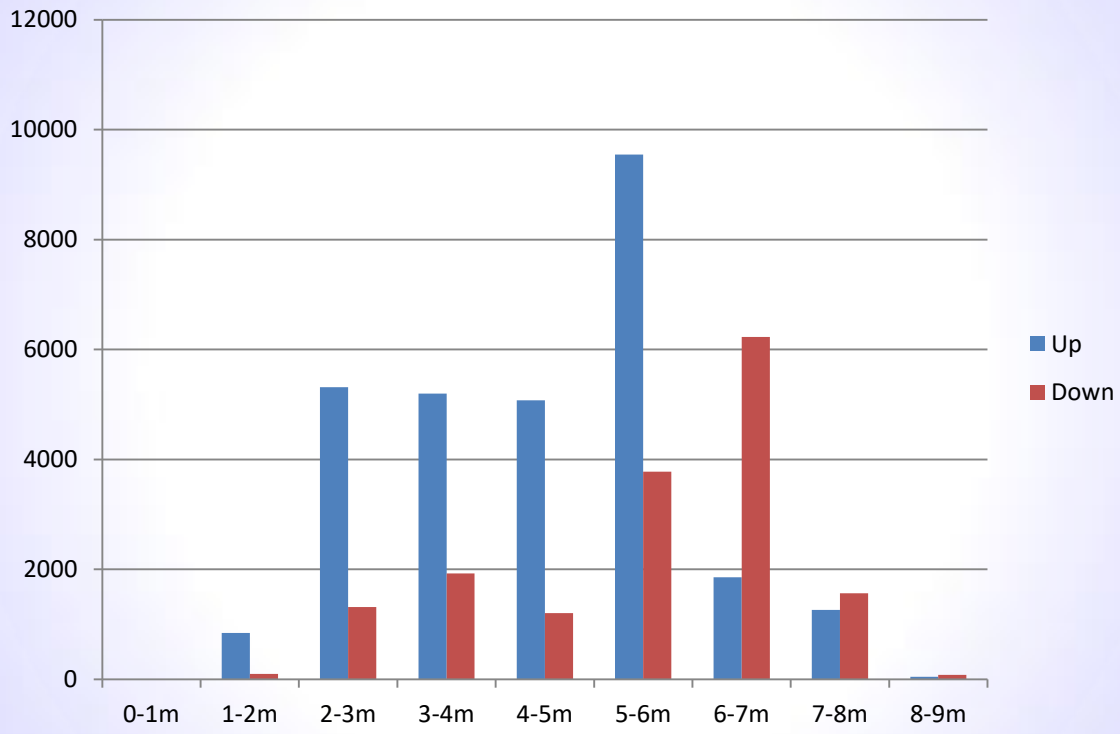
All observations



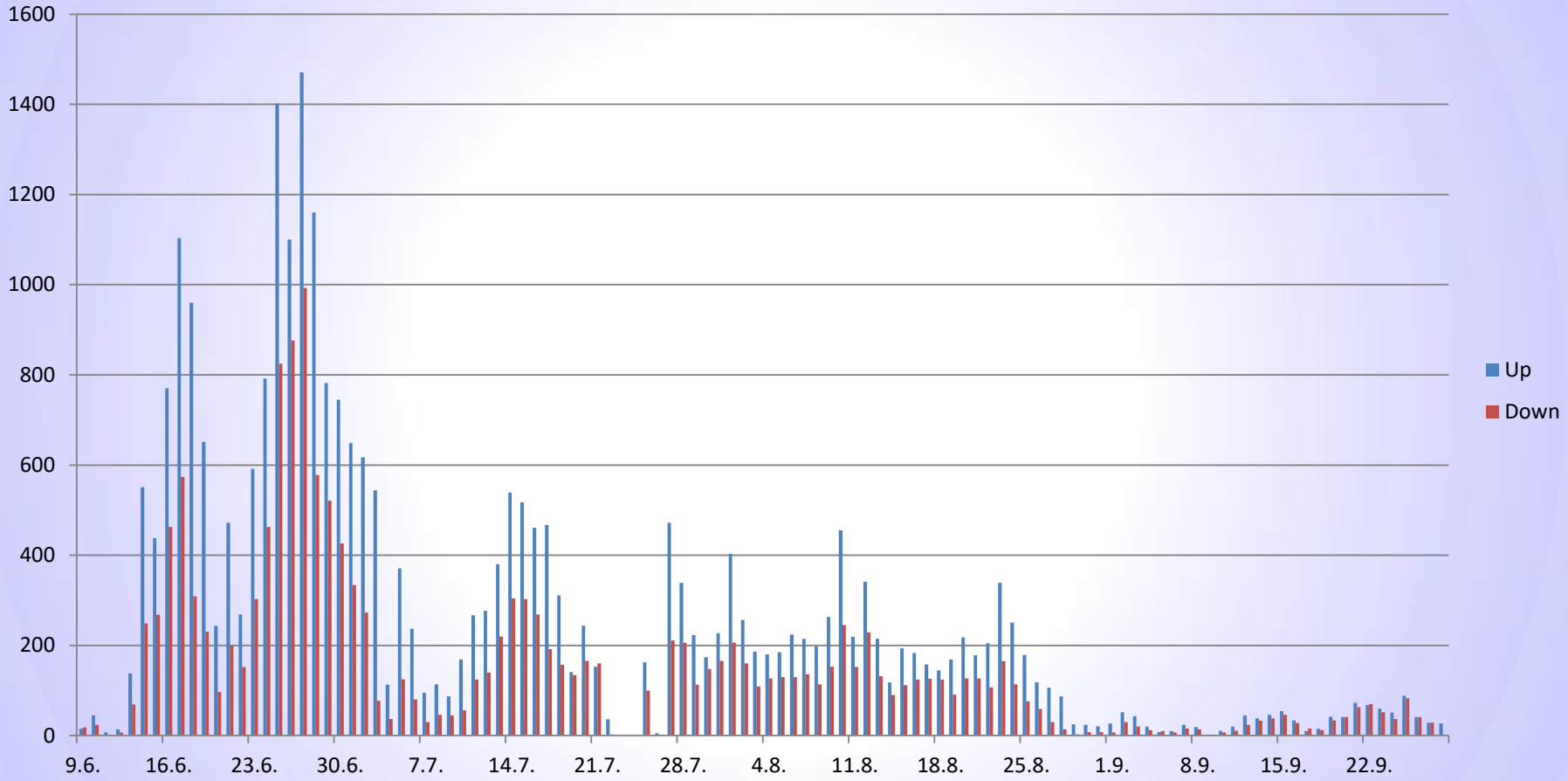
Per length


7000
6000
5000
4000
3000
2000
1000
0
40-50 cm
50-60 cm
60-70 cm
70-80 cm
80-90 cm
90-100 cm
100-110 cm
>110 cm
Up
Down

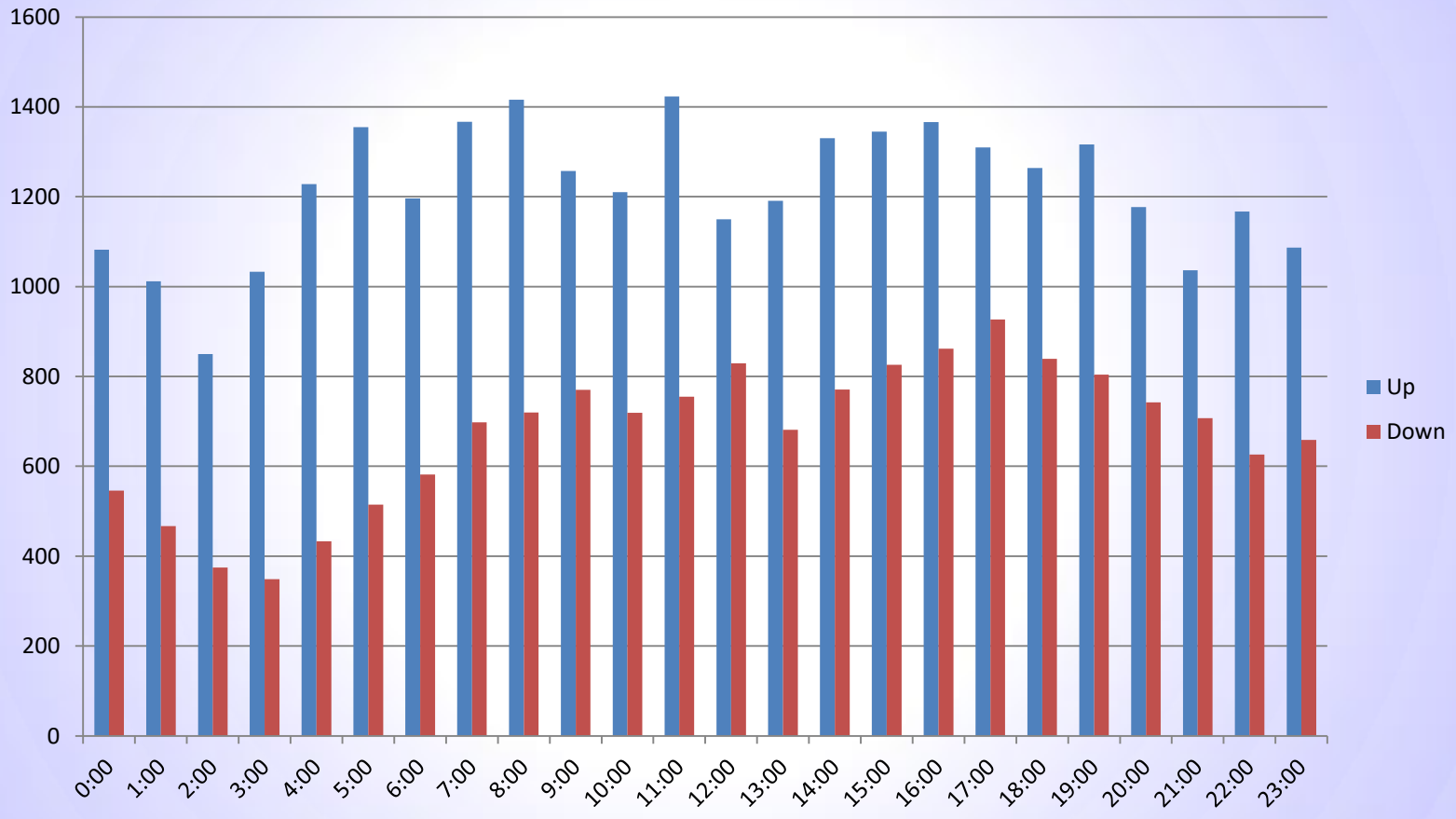
Distance from camera



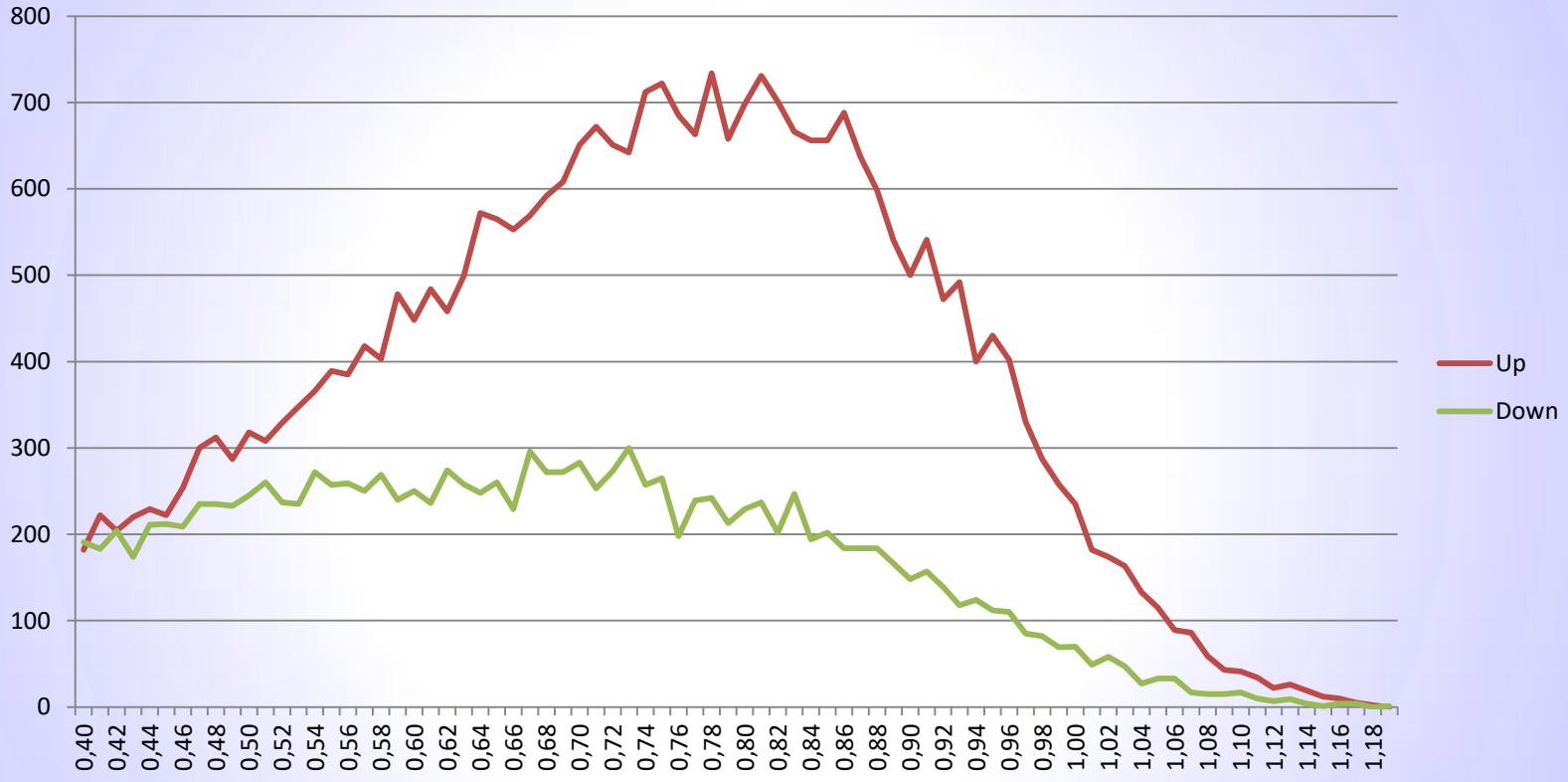
Observations per day



Observations per daily hour



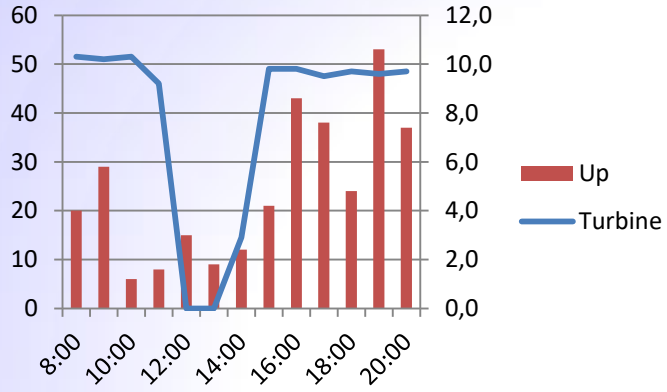
Length profile

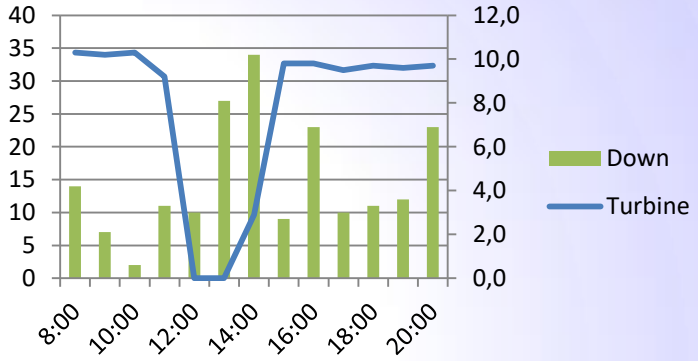


Number of length for each cm.

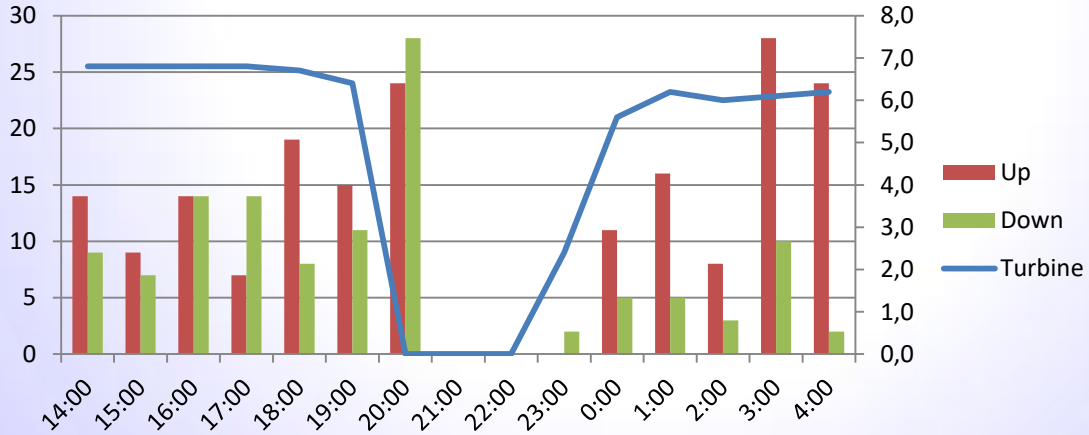
Effect of turbine intake

13.7.



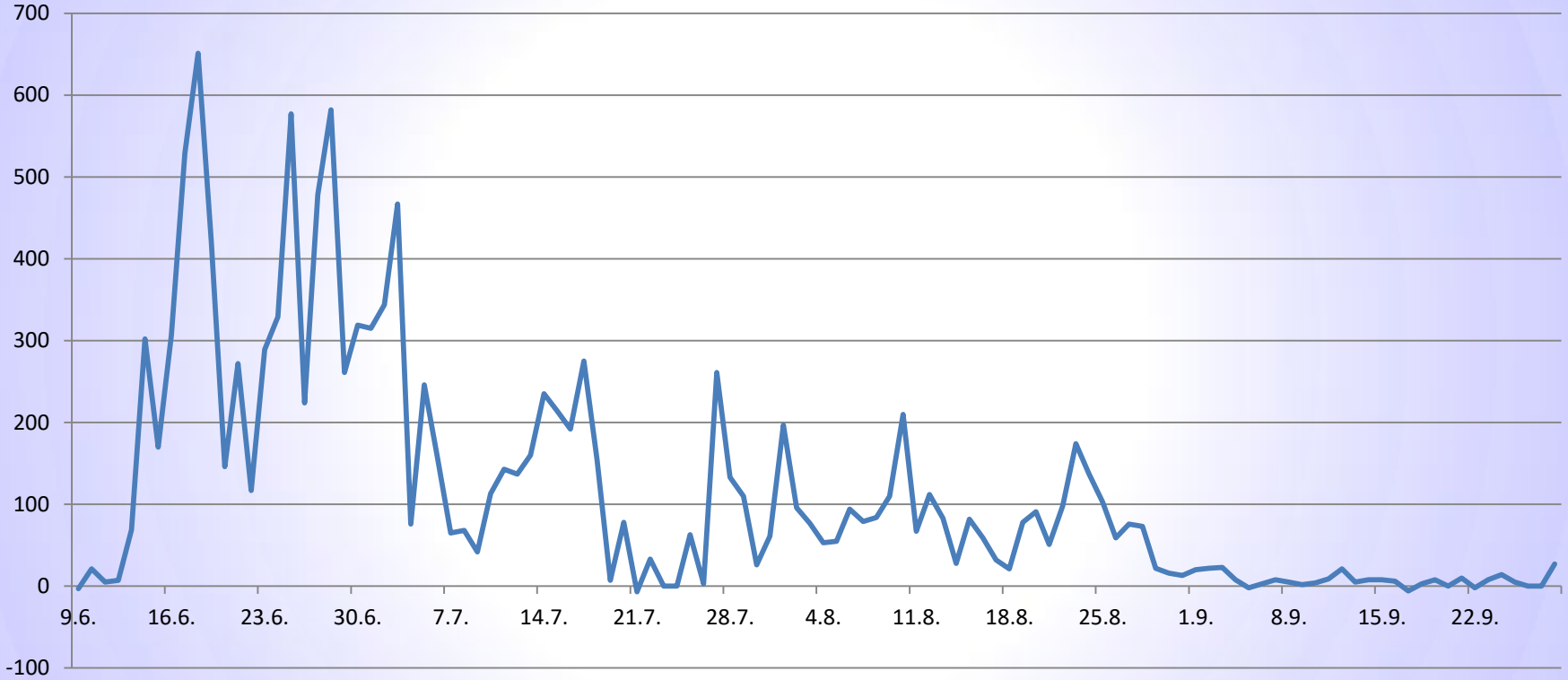


31.7.



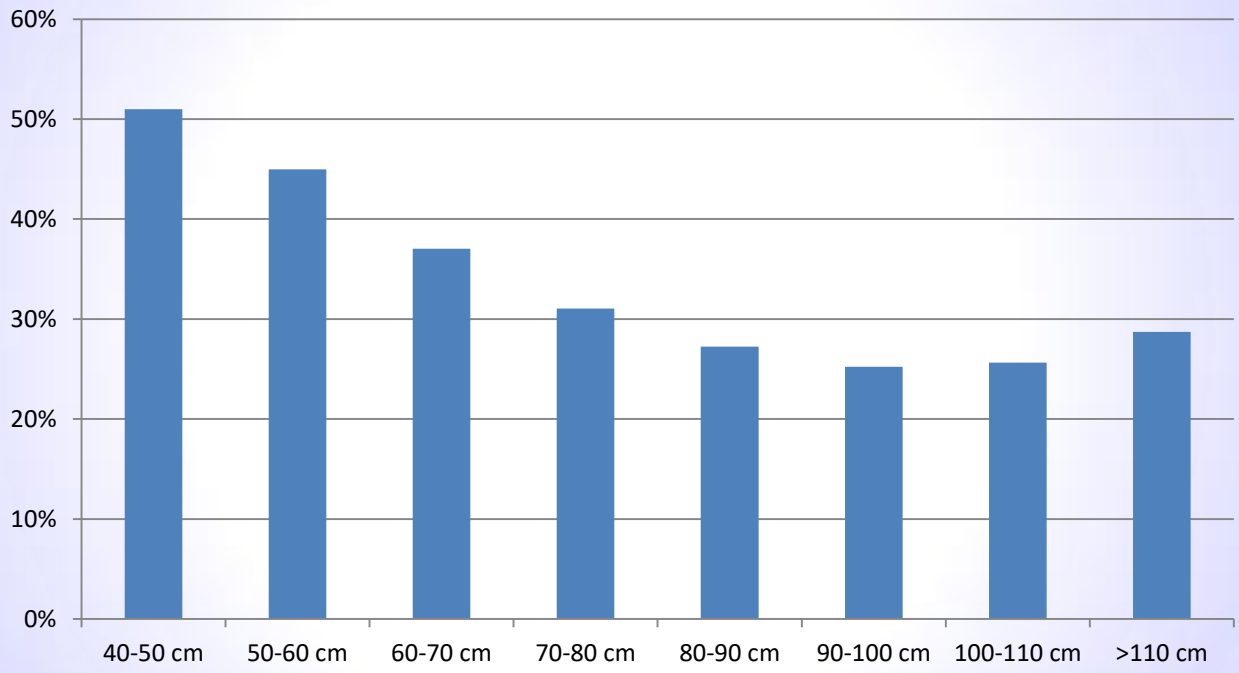
Note: two hour break in recording at 20:57

Net upstream



Upstream observations - downstream observations

Share of downstream objects



Observations

- Four types of behaviour:
  - Some big salmons remain static from few minutes to several hours.
  - Swimming upstream and floating downstream. Often head to upstream.
  - Some down moving objects seem to float freely.
  - Straight movement upstream.
- Overcrowded and silent periods vary. During three minutes there can be over 20 fish and right after there can be several minutes without a fish.
- The available data was researched extensively but we found no clear reason for unbalance between up and downstream observations.
- We see four possibilities for downwards routes not covered by camera:
  - Behind the camera especially when spill gates were open. The camera was installed 1.2 meters away from the river bank behind the camera.
  - Below the beam just in front of the camera (vertical beam angle about 12 degrees). There was about 70 cm water below the camera during installation.
  - In the deeper part of the stream blocked by the ridge of stones in the middle of the image.
  - Very close to the surface near the opposite river bank.

Notes about measurements

- Image quality was good.
- Short distance made measurements accurate.
- All recordings included starting from installation.
- Location was good giving view to the area just below the access to the fish way.
- Proposed solutions:
  - Fence preventing fish swim behind the camera.
  - Fence forcing fish to swim further away from the camera (at two meters the depth must be 40 cm or less).
  - Examine the bottom profile and remove stones blocking view.

System uptime

- Technical system uptime was 94.57%. Does not include poor image when camera was out of the water.
- Breaks in recordings:
  - 9.6. 14:28 – 15:34
  - 9.6. 22:37 – 10.6. 04:12
  - 10.6. 05:20 – 08:13
  - 11.6. 08:59 – 12.6. 14:47
  - 15.6. 17:46 – 21:02
  - 20.6. 10:37 – 17:43
  - 3.7. 22:04 – 4.7. 12:11
  - 4.7. 12:21 – 18:36
  - 22.7. 01:50 – 03:14
  - 23.7. 23:42 – 25.7. 14:09
  - 31.7. 20:57 – 22:55
  - 9.9. 2:49 – 10.9. 17:38
- The longest continuous running: over 31 million frames = 939 hours (over 39 days).

Support actions

- Visits on site:
  - 9.6. Installation.
  - 12.6. No connection to system. Modem reset.
  - 20.6. System restart.
  - 27.6. System restart
  - 4.7. New antenna installed.
  - 28.7. Water level had changed. Camera repositioned.
  - 28.9. Uninstallation.
- 221 remote sessions to system. Length of sessions was totally 23 hours 29 minutes.
- The 3G coverage was initially weak preventing often the detection of problems and delayed corrective actions. After installation of the directional antenna the situation improved.

Thank you
For good cooperation
and
For very interesting site!