FishGuard

Automatic monitoring of behaviour and growth of fish fry

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Introduction

FishGuard was developed for monitoring growth and behaviour in aquaculture systems by measuring size and swimming velocity using underwater cameras and image analysis. This has proved to be particularly well suited for monitoring fish fry. Size distributions and growth rates can be followed on a day to day basis. Accurate measurements are made possible with 3D imaging.

Stress factors such as poor water quality, low oxygen concentrations, and disease affect swimming behaviour. Prolonged stress can reduce growth and increase the risk of disease. Monitoring of fish fry behaviour will show signs of stress early and enable the improvement of fish welfare and the treatment of disease.
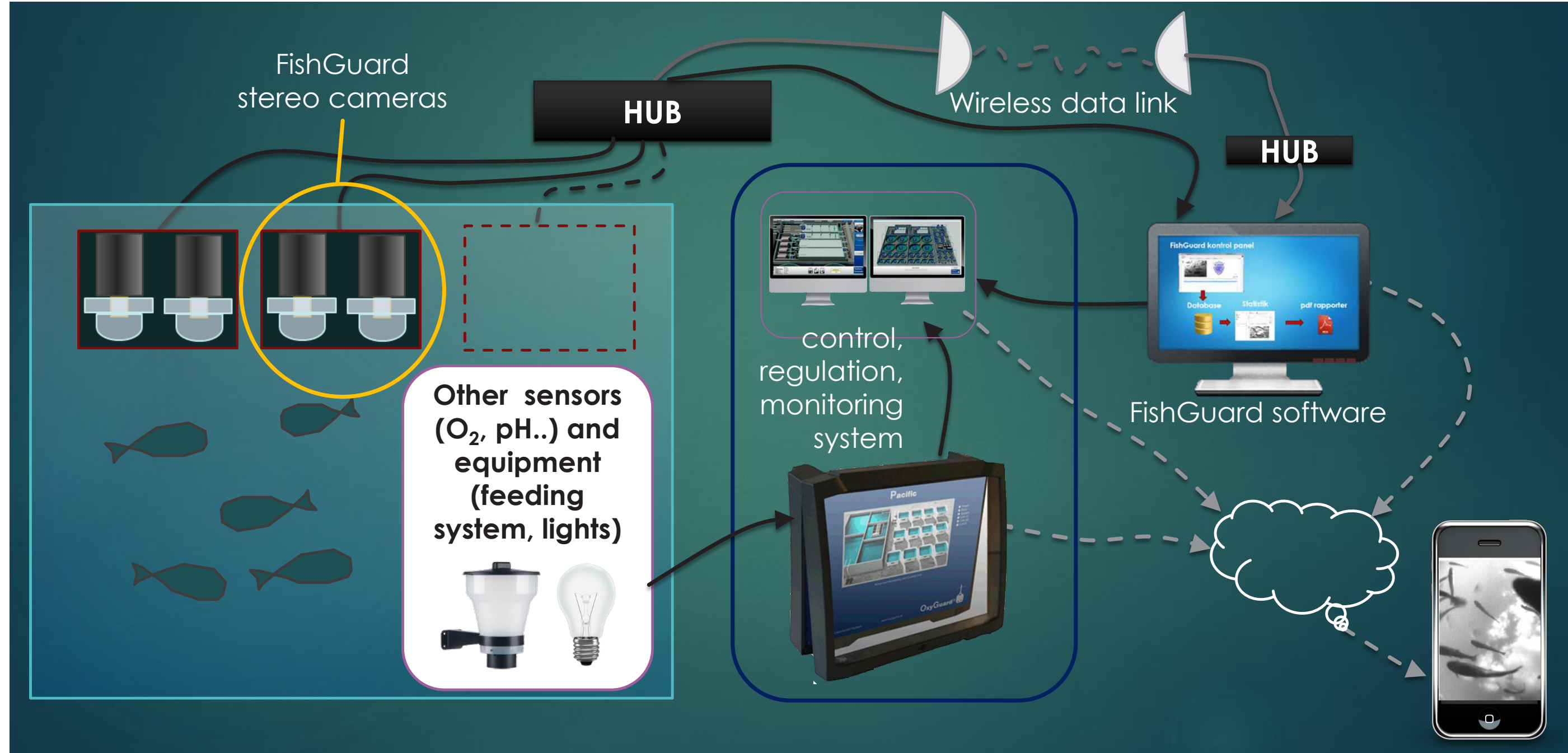

Figure 1. *Diagram showing the FishGuard system: Cameras and computer with the FishGuard software (software, database, etc.) associated with the farming management system. It is possible to access live video and captured data via internet at any time of day.*

Materials and Methods

The FishGuard system consists of one or more cameras that are networked together and connected to a computer (Fig. 1). The cameras use high speed Ethernet for power supply and data communication which allows cable lengths of over 100m. Cameras are configured as stereo pairs for 3D behaviour monitoring and added accuracy for size estimation. Cameras are mounted in waterproof housings and are submerged during operation (Fig. 2). The FishGuard system is scalable from 1 camera upwards. One set of stereo cameras was used for each fish tank in the current study. The computer receives video streams from the cameras and processes them to extract information on size and movement. Moving objects are tracked between successive video frames (Fig. 3). The data is automatically entered into a database from which reports and statistical analysis are performed.
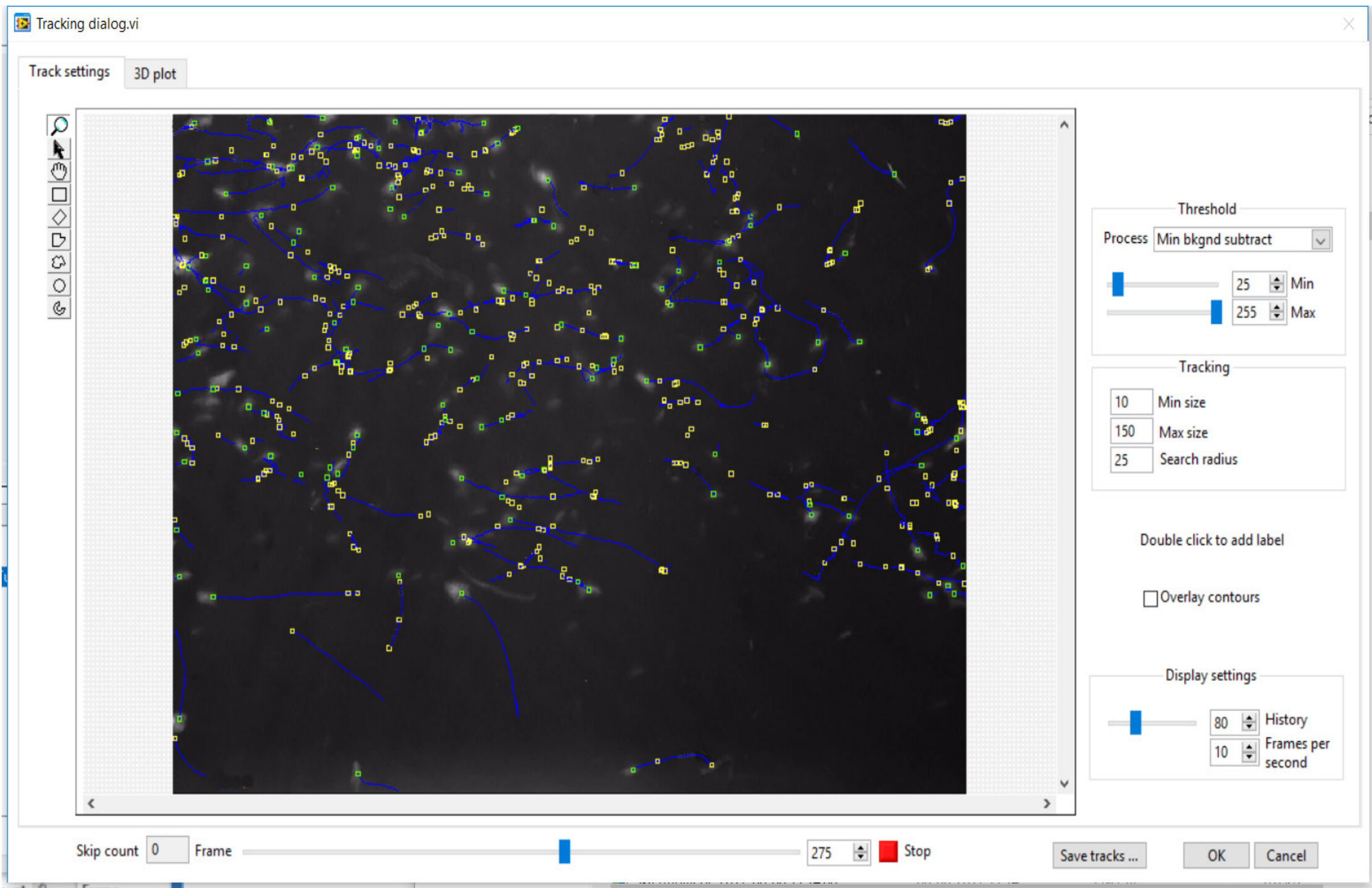
Figure 3. *Motion tracking dialogue, where threshold values for detection of organisms and size limits are adjusted (in this example turbot fry). The tracks are shown as blue lines, green squares are moving organisms, yellow squares are tracks paused for more than 2 frames. The video was recorded at 10 frames/sec.*
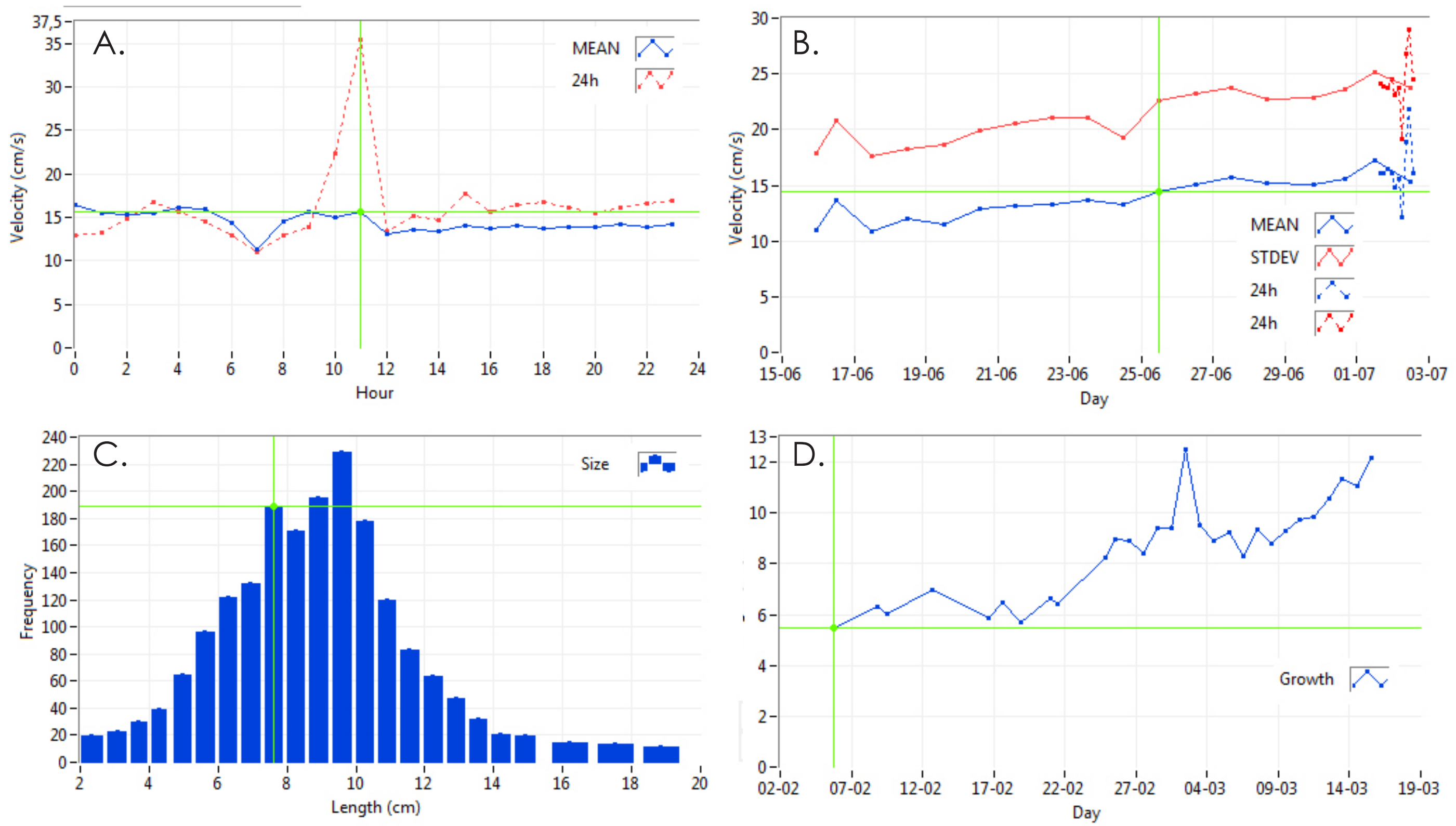

Figure 4. *FishGuard reports are continuously updated. The results above are from Venosund Fisk og Skaldyr. A: Diurnal average and current swimming velocity rate for flounder; B: Swimming velocity trend over time; C: Size distribution for trout; D: Growth curve for trout.*

What can FishGuard do?

- Surveillance of normal swimming behaviour over time, and warnings against deviations
- Measure the densities of fish fry
- Automatic 24-hour monitoring (infrared light at night)
- Measure fish sizes and growth continuously
- Access to live video and captured data via the internet at any time of day

Figure 2. *FishGuard stereo camera setup with 2 parallel cameras.*
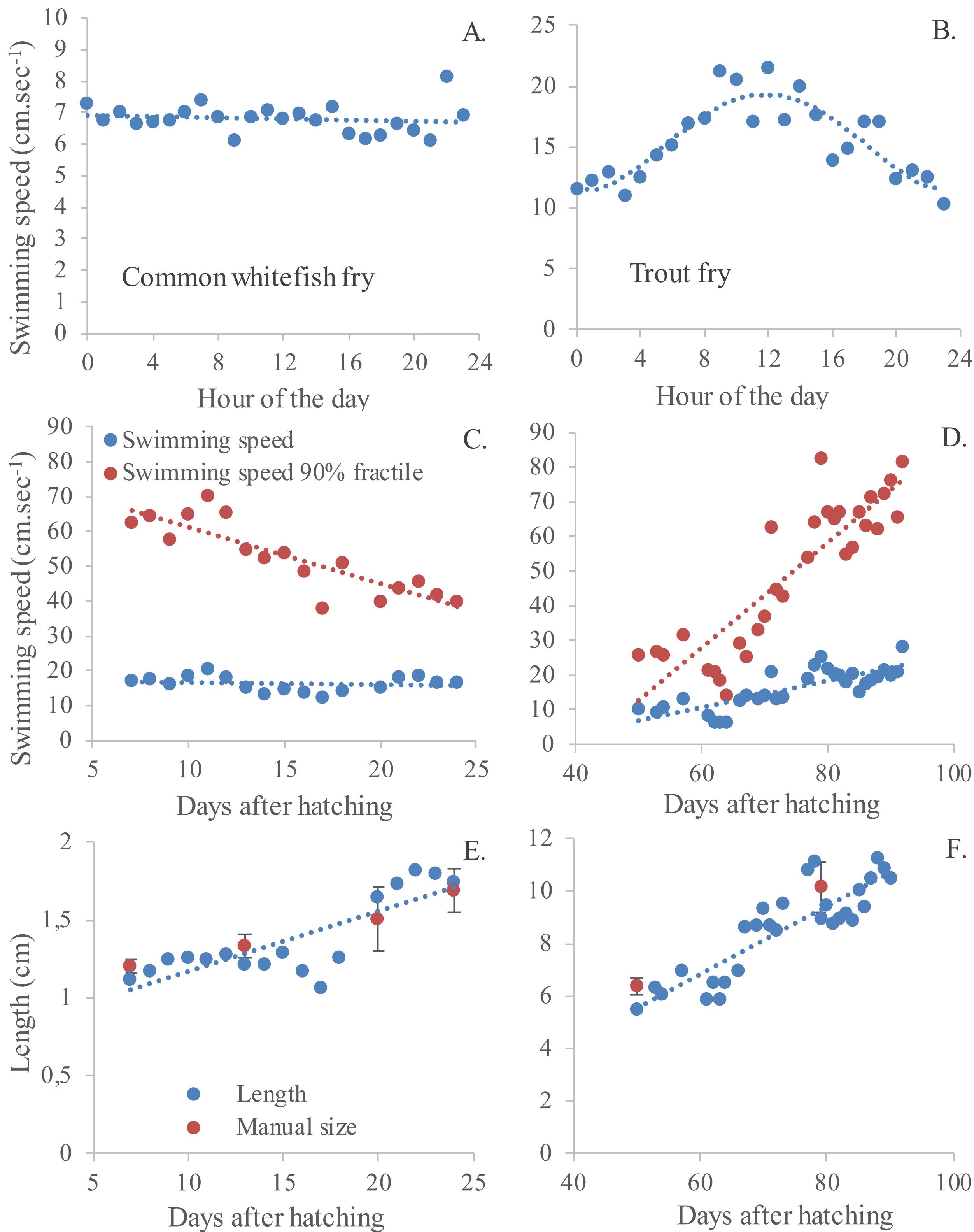
Figure 5. *A) The average hourly swimming speed during the day for common whitefish fry, measured over 20 days, and (B) for trout measured over 6 weeks. (C) Average and top speed (90% fractile) of common whitefish, and (D) for trout. (E) Automatic and manual size measurements for common whitefish fry and (F) trout.*

Results and discussion

Behaviour and size of fish fry are measured continuously, and entered into a database from which data like diurnal swimming velocity, swimming velocity over time, growth and size distribution can be extracted (Fig. 4).

Measurements of the daily swimming activity for common whitefish fry showed the same activity level day and night (Fig. 5A). On the other hand, trout were most active during the daytime (Fig. 5B).

The average swimming speed for common whitefish fry and trout fry was measured over 3 and 6 weeks respectively. The swimming speed of common whitefish stayed at the same level throughout the trial period, while the top speed (90% fractal) decreased during the trial period (Fig. 5C). Trout swimming speed increased steadily during the trial period, and the top speed (90% fractal) increased significantly (Fig. 5D). The difference between to species possibly reflect size related behavioural differences.

Accurate size measurements were possible on a day to day basis. There was good agreement between automatic and manual size measurements for both common whitefish and trout fry (Fig. 5E,F). Common whitefish size increased by 40% over 20 days, while trout size increased by 88% over 6 weeks.

Acknowledgement