A METHOD FOR AUTOMATIC MONITORING OF BEHAVIOR AND GROWTH OF FISH FRY

N. Blackburn[1], P. Haecky[1], K. Engell-Sørensen[2], L. Nørremark[2], P. Petersen[3], and N. Lorenzen[4]

[1] Bioras, Hejreskovvej 18B, DK-3490 Kvistgaard, Denmark
[2] Fishlab, Terp Skovvej 107B, DK-8270 Hojbjerg, Denmark
[3] OxyGuard International A/S, Farum Gydevej 64, DK-3520, Farum, Denmark
[4] Aarhus University, Department of Animal Science, Blichers Alle 20, 8830 Tjele, Denmark

Introduction

Abnormal behavioral patterns may indicate stress and/or disease, which can be difficult to detect. Therefore, a project (FishGuard, funded by the Danish Agrifish Agency, Ministry of Environment and Food of Denmark) was initiated to give an early warning of stress/disease in individual fish tanks. FishGuard was developed for monitoring growth, size, and swimming velocity in aquaculture systems using underwater cameras and image analysis. This has proved to be particularly well suited for monitoring of fish fry.

Growth and behavior in individual tanks can be followed closely around the clock. At the same time size distributions and growth rates can be followed on a day-to-day basis. Accurate measurements are made possible with 3D imaging.

The FishGuard system was tested in commercial fish farms on different fish species, including trout fry (*Oncorhynchus mykiss*) and common whitefish fry (*Coregonus lavaretus*), with good results, and introduces a new way of assessing health and growth of fish fry in commercial aquaculture systems.

Materials and methods

The FishGuard system consists of one or more cameras that are networked together and connected to a computer. FishGuard is based on the tracking software LabTrack for 3D motion detection (Thar et al., 2000). Usually, the FishGuard cameras are monochrome with a resolution of 500×700 pixels. This represents a bandwidth requirement of 30Mbit.s^{-1} per camera. The cameras use high-speed Ethernet for power supply and data communication which allows cable lengths of over 100m. Cameras were configured as stereo pairs for 3D behavior monitoring and added accuracy for size estimation. Cameras were mounted in waterproof housings and were submerged during operation. The FishGuard system is scalable from 1 camera upwards, for the current study one set of stereo cameras was used for each fish tank. The computer received video streams from the cameras and processed them to extract information on size and movement. The data was automatically entered into a database from which reports and statistical analysis were performed. A surveillance scheme can be set up to allow a central computer to multiplex monitoring of many tanks.

Common whitefish fry and trout fry behavior and growth were studied in indoor and outdoor hatchery facilities at Venøsund Fish and Shellfish Aps, Denmark. Common whitefish fry and trout fry behavior and sizes were monitored over a period of 3 and 6 weeks respectively, using the FishGuard system. The behavior was observed around the clock, for night-time observations infrared light was used. The infrared light is invisible to trout and whitefish, and did not affect the fry behavior. The fish fry sizes (lengths in cm) were measured automatically and manually during the trial period.

The effect of changing O_2 levels on trout swimming behavior was also tested. 78 trout were placed in a 0.5-m^3 square plastic tub located outdoors under cover. O_2 supply was through aerators and O_2 level was monitored using an Oxyguard Handy Polaris hand-held meter. A set of FishGuard stereo cameras was used for monitoring the fish behavior. Trout were monitored while the O_2 level was lowered to $4 mg.l^{-1}$ and increased up to $8 mg.l^{-1}$, respectively.

Results and discussion

Average daily swimming speed, measured over 3 weeks, showed that common whitefish fry had the same activity level day and night (Fig. 1A). Average daily swimming speed for trout measured over 6 weeks showed that trout were most active during the daytime (Fig. 1B).

The average swimming speed of common whitefish stayed at the same level throughout the trial period (Fig. 1C). On the other hand, the top speed (90% fractal) decreased during the trial period. Trout swimming speed increased steadily during the trial period (Fig. 1D). The top speed (90% fractal) increased significantly.

There was good agreement between automatic and manual size measurements for both common whitefish and trout fry (Fig. 2E,F). Common whitefish size increased by 40% over 20 days, while trout size increased by 88% over 6 weeks.

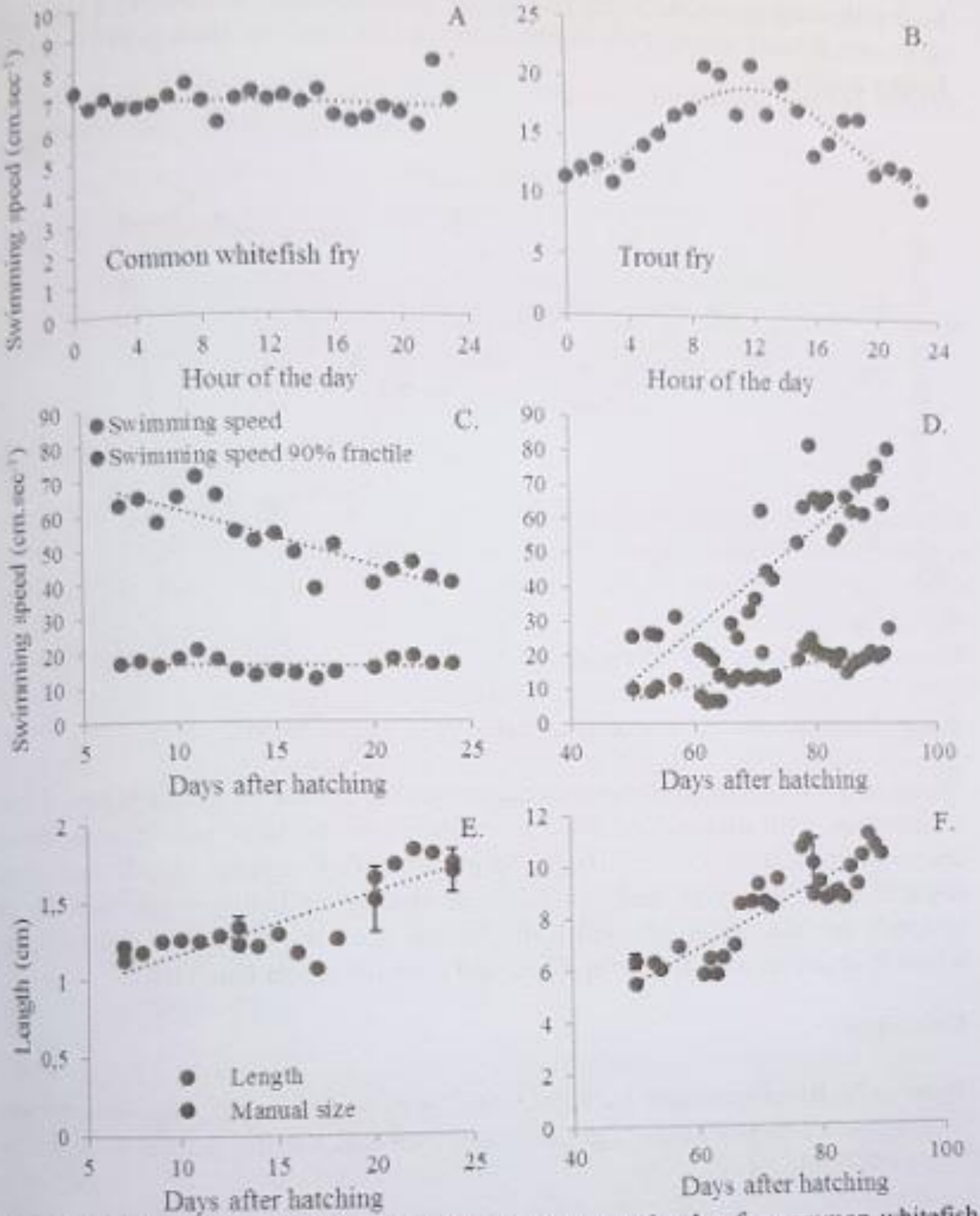

Fig. 1. (A) The average hourly swimming speed during the day for common whitefish fry, measured over 20 days, and (B) for trout measured over 6 weeks. (C) Average and top speed (90% fractile) of common whitefish, and (D) for trout. (E) Automatic and manual size measurements for common whitefish fry and (F) trout.

The swimming speed of trout was affected by decreasing oxygen concentrations (Fig. 2). The swimming speed decreased with decreasing oxygen levels from 8.5mg.l^{-1} to 4mg.l^{-1}. The swimming speed dropped even more during the first 1 hour following reestablishment of high oxygen concentration, before it increased to a normal level again. This might reflect a fast recovery strategy, but requires further analysis.

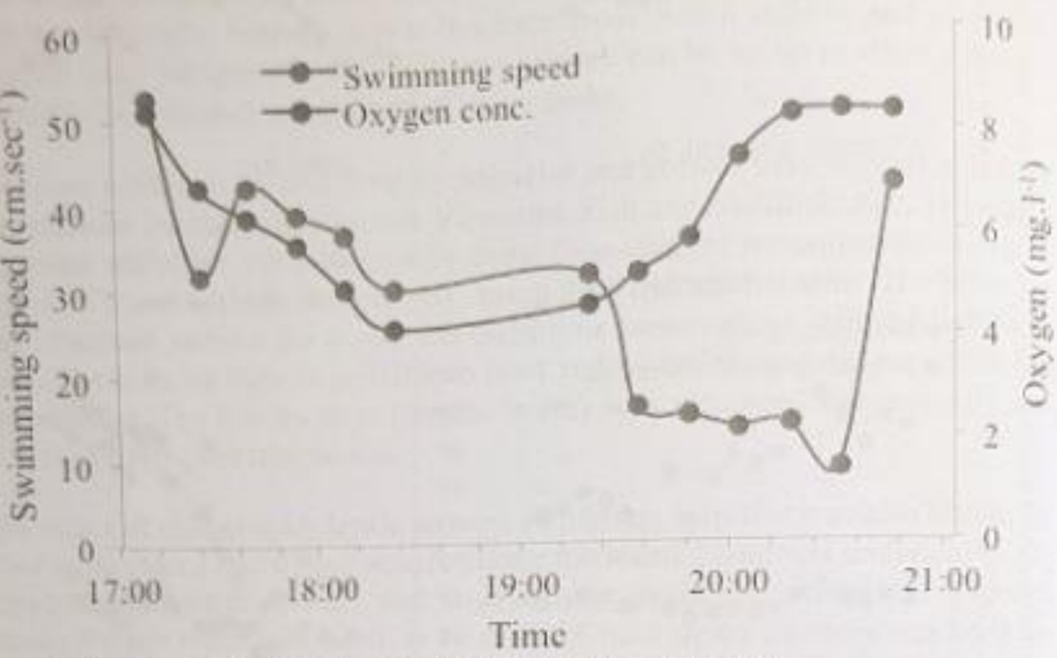

Fig. 2. Trout juvenile swimming speed and oxygen concentrations.

We expect the observed behavioral parameters to reflect abnormal behavioral in conjunction with disease and other complications. Accurate size measurements are possible on a day-to-day basis. The placement of cameras in fish tanks does not affect fish behavior, and can be fitted in existing fish farming facilities or research environments. Infrared light can be used for nighttime observations, which is invisible to most fish species, and does not affect behavior.

Reference

Thar R., N. Blackburn, and M. Kühl. 2000. A new system for three-dimensional tracking of motile microorganisms. Applied and Environmental Microbiology 66:2238-2242.