

# REALTIME NON-INVASIVE FISH SWIMMING SPEED MEASUREMENT BY DEPTH USING ECHO SOUNDER IN HIGH DENSITY *Seriola quinqueradiata* AQUACULTURE CAGE

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## Background & Objective



Swimming speed of farmed fish is one of the important indicators of fish behavior<sup>[1]</sup>.

- In recent years, fish welfare is emphasized in aquaculture.
- Behaviors represent some specific reaction to the environment as fish perceive it and are therefore key elements of fish welfare.

[1] Martins C.I. et al. (2012) Behavioural indicators of welfare in farmed fish. Fish Physiol. Biochem. 2012;38:17-41.

Conventional tools are not suitable for commercial real-time remote fish speed monitoring.

- Echo sounder is a new tool with wide depth range. However, it has not been verified yet.

	Invasiveness	Sensor lifetime	Sample size	Depth range	Verification	Real-time	Special Pros/Cons
Data logger	Invasive	Limited	Limited	No limitation	Verified	Memory based*	- Single fish continuous logging <sup>[2]</sup> . - Fish speed may change due to drag force <sup>[3]</sup> . *Some special Data logger has the real-time capability.
Acoustic telemetry	Invasive	Limited	Limited	No limitation	Verified	Real-time	- Single fish position monitoring <sup>[2]</sup> . - Fish speed may change due to drag force <sup>[3]</sup> .
Stereo camera	Non-invasive	No limitation	No limitation	Limited	Verified	Real-time	- Fish size and weight monitoring <sup>[4]</sup> . - Image based health monitoring. - Huge machine power required.
Echo sounder	Non-invasive	No limitation	No limitation	No limitation	Not Verified	Real-time	- Fish depth distribution monitoring.

The purpose of this study :

Verification of fish speed measuring method using an echo sounder

[2] Thorstad EB. Et al. (2013) The use of electronic tags in fish research—an overview of fish telemetry methods. Turkish J Fish Aquat. Sci. 2013;13:881-96.  
 [3] Jepsen, N. et al. (2015) The use of external electronic tags on fish: an evaluation of tag retention and tagging effects. Anim Biotelemetry 3, 49.  
 [4] Komeyama, K., Ikegami, A. et al. Body size estimation method for seasonally growing farmed yellowtail *Seriola quinqueradiata* in an aquaculture net cage using a stereo camera. Fish Sci 90, 227-237 (2024).

## Results Echo sounder result shows high accuracy, and high precision.

Table. 1 The average, confidence interval, and difference in measured fish speed of the methods of the echo sounder and the stereo camera.

Depth	Echo sounder			Stereo camera			Difference of the two methods		
	Average [m/s]	Confidence interval[m/s]		Average [m/s]	Confidence interval[m/s]		RMSE [m/s]	Difference [m/s]	
		Mean	SD		Mean	SD		mean	SD
3.4m	0.77	0.12	0.13	0.84	0.04	0.04	0.14	-0.11	0.08
4.8m	0.84	0.28	0.50	0.84	0.04	0.04	0.10	-0.01	0.10
6.3m	0.95	0.25	0.59	0.86	0.11	0.31	0.17	0.04	0.16
Total	0.85	0.26	0.51	0.86	0.08	0.22	0.14	-0.03	0.13

## Materials and Methods

- Date & Time : 2023/3/6 16:00~18:00
- Place : Kagoshima, Japan
- Facility : Aquaculture commercial cage
- Target : Yellowtail (*Seriola quinqueradiata*)

### Fish speed measuring methods

#### ① : Echo sounder

- Company : **FURUNO**
- Model : FAS-2100
- Sampling rate : 20 Hz
- Setting depth : 1.0 m
- Analyze operation : Automated
  - Individual fish detection, tracking

#### ② : Stereo camera

- Company : **FURUNO**
- Model : **UC-300**
- Sampling rate : 30 Hz
- Setting depth : 3.4 m, 4.8 m, 6.3 m
- Analyze operation : Automated
  - with image recognition, 3D measurement, and state-space model tracking

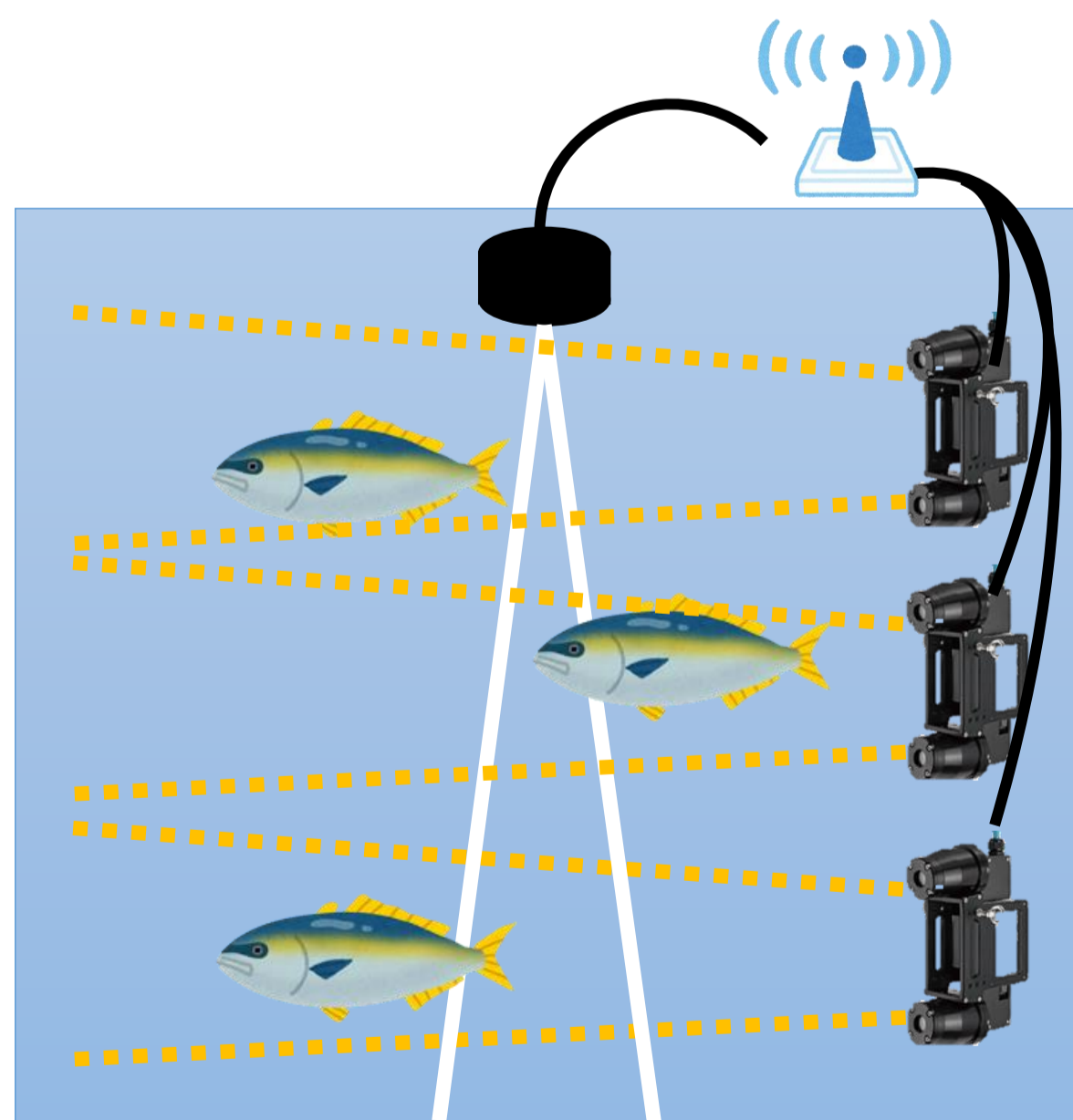


Figure. 1 Schematic experimental set up.

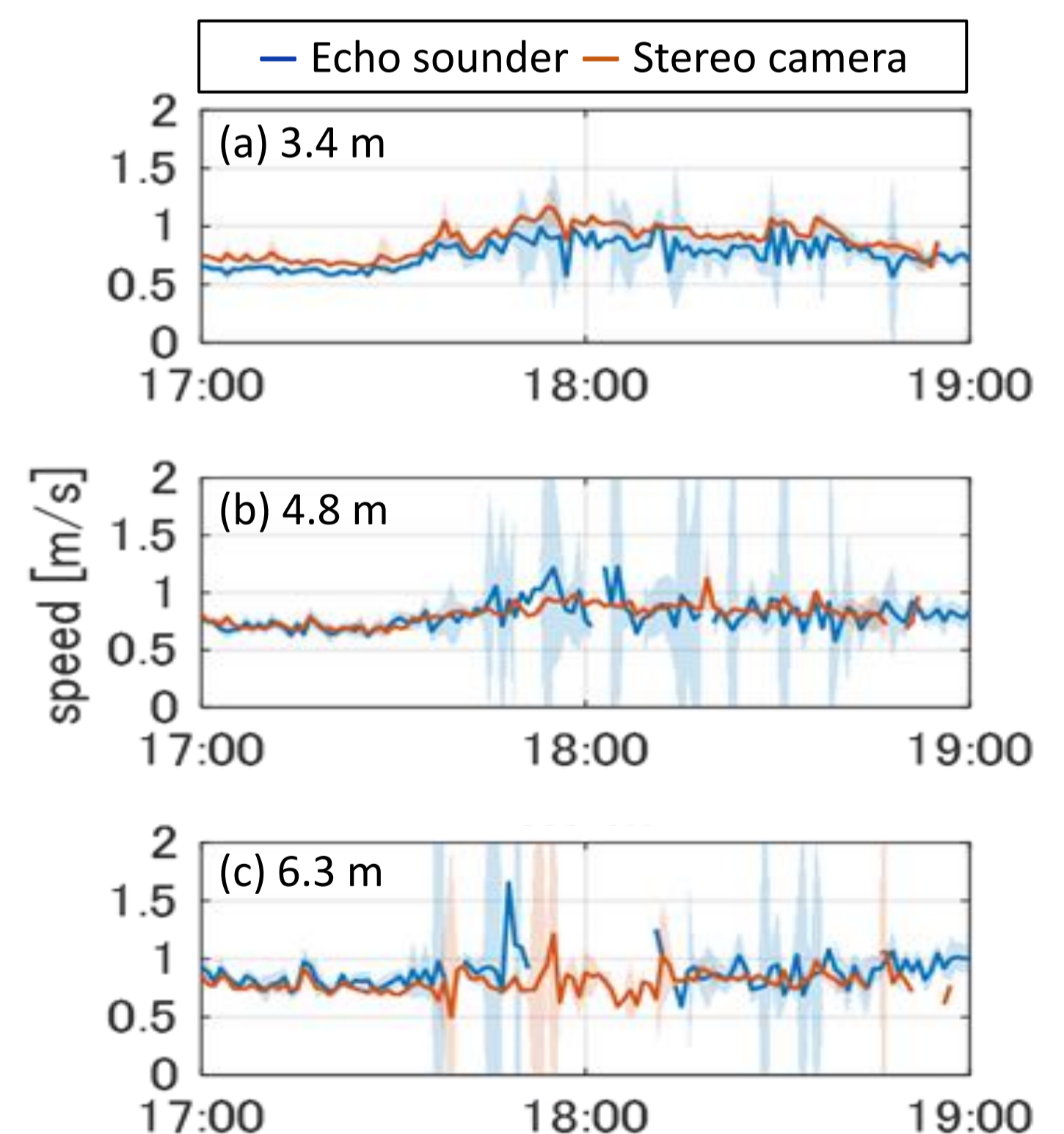


Figure. 2 Comparison of measured fish speed. Bold lines represent the means, highlights represent the confidence intervals.

## Conclusion Echo sounder is a powerful tool to measure the fish speed.

Fish speed measurement using echo sounder has high accuracy, and high precision.

Fish speed measurement using echo sounder is researcher-friendly as well as fish-friendly.

- Researchers do not need to make much efforts for analyzing.
- Fish are not forced to surgery, invasion, dead weight, and undesirable drag force.