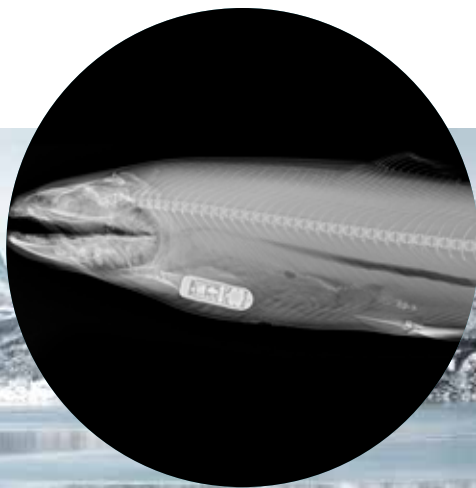


# Improve welfare and reduce mortality

Ultra small implantable physio-loggers  
for aquatic animals



**STAR : ODDI**  
Logging Life Science

# High performance, small size

Available parameters in each size

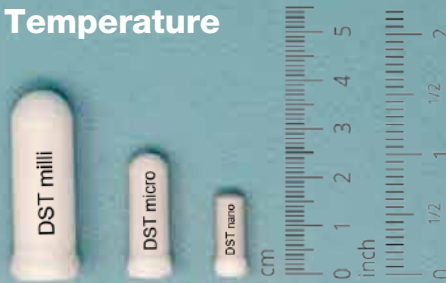
## Physio loggers



### Choose parameters:

Heart rate	Heart rate	Heart rate
Activity	Activity	Activity
Temperature	Temperature	Temperature

## Depth & Temperature loggers



### Choose parameters:

Depth	Depth	
Temperature	Temperature	Temperature

## **Advantages at a glance**

**Monitor environmental impact or  
behavioural patterns**

**Long term or detailed short term studies**

**Stress-free accurate measurements**

**Simple to set up and implant**

# Cage distribution

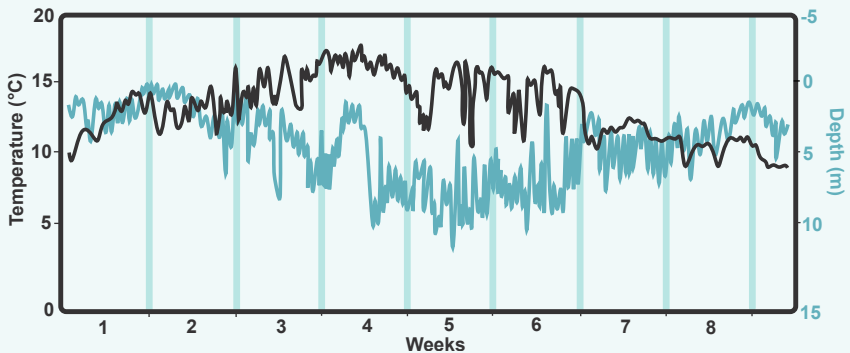
## Using Temperature and depth

### Detailed behavioural profile

Identify cage distribution with no disturbance to the study animal. A fixed measurement interval or multiple measurement interval can be set, as short as every second to several minutes or even hours.

### Long term and short term studies

The long battery life of the loggers facilitates long term as well as short term studies, up to 2-4 years with the largest logger type.



Mean depth and temperature measured on Atlantic Salmon in a commercial sea cage every 5 minutes with a DST milli-TD tag. Image inspired from [2].

	DST nano-T	DST micro-T	DST micro-TD	DST milli-TD
Size	6 mm x 17 mm	8.3 mm x 25.4 mm	8.3mm x 25.4mm	13 mm x 39.4 mm (15mm at the closure end)
Weight (in Air/in Water)	1.3g	3.3g/1.9g	3.3 g/1.9g	12g/7g
Battery life	14 months*	28 months*	28 months***	3.5 years****
Memory capacity per sensor	43,477 measurements	65,535 measurements	87,906 measurements****	1,398,102 measurements in total ****
Minimum measurement interval	1 second	1 second	1 second	0.1 second fastest
Temp range	-1 to +40°C (30.2-104°F)**	-1 to +40°C (30.2-104°F)**	-1 to +40°C (30.2-104°F)**	-1 to +40°C (30.2-104°F)**
Temp resolution	0.032°C (0.058°F)	0.003°C (0.0054°F)	0.032°C (0.058°F)	0.032°C (0.058°F)
Temp accuracy	+/-0.2°C (+/-0.36°F)	+/- 0.06°C (+/- 0.11°F)	+/- 0.2°C (+/- 0.36°F)	Standard range: +/-0.1°C (0.18°F) Extended range: +/-0.2°C (0.36°F)

\*For sampling interval of 10 min.

\*\*Outside ranges available upon request.

\*\*\*For sampling interval of 10 minutes, temperature and pressure recorded simultaneously.

\*\*\*\*Divided between the two sensors.

\*\*\*\*\* For sampling interval of 5 minutes, temp & depth recorded simultaneously. 2 minutes interval = 2.5 years lifetime.

# Crowding Events

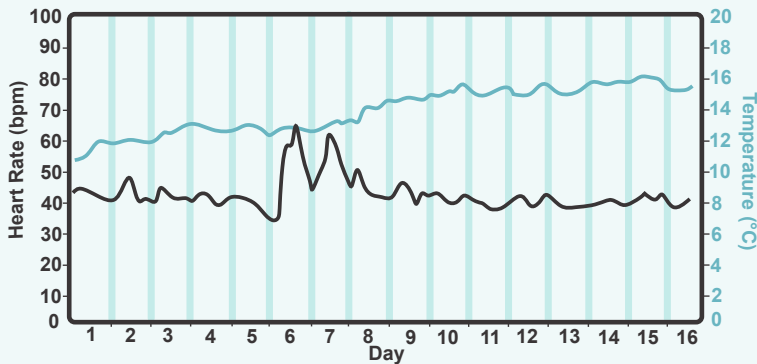
## Using Heart Rate and Temperature

### Long or short term heart rate response

These loggers are ideal for long or short term studies looking at heart rate dynamics; studying behaviour, energetics, stress response or environmental challenges.

### Suitable for measuring most fish species

It is possible to record extended ECG records for periods where slow heart rates (<20bpm) are expected.



Average heart rate response to level 3 crowding event in a sea cage measured with DST centi-HRT in Atlantic Salmon. Image inspired from [1].

	DST micro-HRT	DST milli-HRT	DST centi-HRT
Size	8.3 mm x 25.4 mm	13 mm x 39.5 mm	15 mm x 46 mm
Weight (in Air/ In Water)	3.3g/1.9g	12g/7g	19 g/12g
Battery life	3 months*	8.5 months*	19 months*
Memory capacity per sensor	87,381 measurements per sensor, 349 ECG buffer measurements	699,051 measurements per sensor or 2785 ECG buffer measurements	699,051 measurements per sensor or 2785 ECG buffer measurements
Minimum measurement interval	30 seconds	30 seconds	30 seconds
Temp range	5-45°C (41-113°F)**	5-45°C (41-113°F)	5-45°C (41-113°F)
Temp resolution	0.032°C (0.058°F)	0.032°C (0.058°F)	0.032°C (0.058°F)
Temp accuracy	+/- 0.2°C (0.36°F)	+/- 0.2°C (0.36°F)	+/- 0.2°C (0.36°F)
Heart rate (HR): ECG sampling frequency	80-800Hz	80-800Hz	80-800Hz
Duration of HR measurement	600 or 1500 ECG sample	600 or 1500 ECG sample	600 or 1500 ECG sample

\*For a measurement interval of 10 min at fs=600 Hz. Battery life of heart rate loggers is subject to change based on sampling frequency. Battery is non-replaceable and non-rechargeable.

\*\*Outside ranges available upon request.

# Swimming Performance

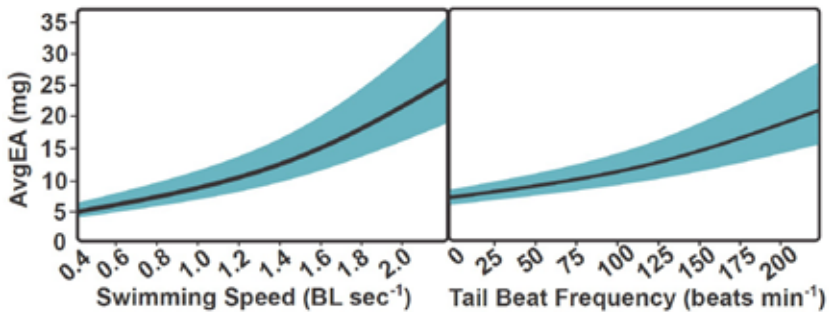
## Using Activity and Temperature

### Overview of changes in activity over time

Measure acceleration derived activity in three dimensions, in addition to temperature. Statistical parameters provide estimation of swimming speed and non-steady swimming in addition to raw data.

### Quantify swimming behaviour

Ideal for a variety of studies in swim tunnels, tanks or sea cages, looking at behaviour, swimming, stress response or other swimming physiology.



AvgEA measured in Atlantic Salmon during a critical swim speed test (Ucrit) in swim tunnel with DST centi-HRT ACT loggers. Image inspired from [3].

	DST micro-ACT	DST milli-ACT	DST centi-ACT
Size	8.3 mm x 25.4 mm	13 mm x 39.5 mm	15 mm x 46 mm
Weight (in air/in water)	3.3g/1.9	12g/7g	19g/12g
Battery life	19-154 days*	2-17 months*	3-26.5 months*
Memory capacity bytes	1,048,575 bytes / temperature 2 bytes, acceleration statistics 18 bytes	2,097,152 bytes / temperature 2 bytes, acceleration statistics 18 bytes	2,097,152 bytes / temperature 2 bytes, acceleration statistics 18 bytes
Minimum measurement interval	2 minutes***	2 minutes***	2 minutes ***
Temp range	5-45°C (41-113°F)**	5-45°C (41-113°F)**	5-45°C (41-113°F)**
Temp resolution	0.032°C (0.058°F)	0.032°C (0.058°F)	0.032°C (0.058°F)
Temp accuracy	+/-0.2°C (0.36°F)	+/-0.2°C (0.36°F)	+/-0.2°C (0.36°F)
Acceleration sampling frequency	0.03Hz-10Hz	0.03Hz-10Hz	0.03Hz-10Hz
Acceleration resolution	2 mg	2 mg	2 mg
Duration of ACT measurement	1 minute	1 minute	1 minute

\* For 1Hz sampling frequency over 1 minute. Sampling interval 2-20min. Activity and temperature recorded simultaneously.

\*\*Outside ranges available upon request.

[3] Z. Zrini et al. Validating Star-Oddi heart rate and acceleration data storage tags for use in Atlantic salmon (*Salmo salar*). *Animal Biotelemetry*, (2021) vol.9

# Welfare Indication Tool

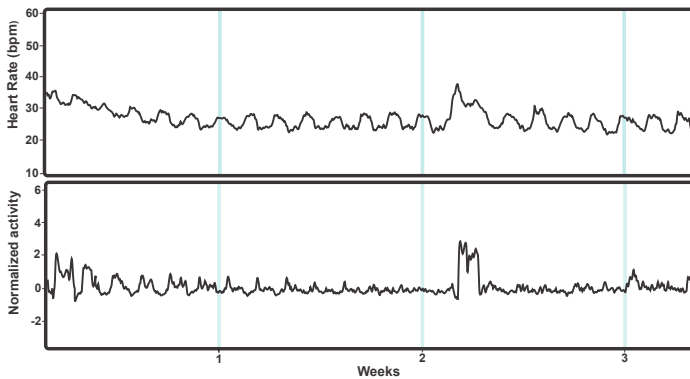
## Heart Rate, Activity and Temperature

### Identify correlation between heart rate, activity, and temperature

Determine these parameters as proxies for stress in fish and help identify farming practices that can improve welfare.

### Overview of physiological response over time

Measure physiological response to environmental variations, including high and low temperature and hypoxia.



Heart rate and activity derived from raw acceleration data in Atlantic Salmon tank experiment at stable temperature using DST centi-HRT ACT loggers. Recovery after surgical implantation showed in the first week and a stress experiment in week 3. Image inspired from [4].

	DST milli-HRT ACT	DST centi-HRT ACT
Size	13 mm x 39.5 mm	15 mm x 46 mm
Weight (In Air/In Water)	12g/7g	19g/12g
Battery life	1-7.5 months*	2-17 months*
Memory capacity bytes	2,097,152 bytes / HR+T 3 bytes, acceleration statistics 18 bytes	2,097,152 bytes / HR+T 3 bytes, acceleration statistics 18 bytes
Minimum measurement interval	2 minutes (T+HR+ACT,T+HR,T+ACT)***	2 minutes (T+HR+ACT,T+HR,T+ACT)***
Temp range	5-45°C (41-113°F)**	5-45°C (41-113°F)**
Temp resolution	0.032°C (0.058°F)	0.032°C (0.058°F)
Temp accuracy	+/-0.2°C (0.36°F)	+/-0.2°C (0.36°F)
HR sampling frequency	80-800Hz	80-800Hz
Acceleration sampling frequency	0.03Hz-10Hz	0.03Hz-10Hz
Duration of ACT measurement	1 minute	1 minute
Duration of HR measurement	600 or 1500 ECG samples	600 or 1500 ECG samples

\*For sampling interval of 2-20 minutes; ECG sampled at 600Hz, Activity 1Hz over 1 minute.

\*\*Outside ranges available upon request.

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Front cover X-ray photo provided by Hvas M, Folkedal O, Oppedal F. Heart rate bio-loggers as welfare indicators in Atlantic salmon (*Salmo salar*) aquaculture. *Aquaculture* 2020.