Using SmartTag as operational welfare indicator of farmed fish

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Using SmartTag as operational welfare indicator of farmed fish

1) What is SmartTag?

What is SmartTag?



The SmartTag provides online measurements of breathing pattern in free-swimming fish

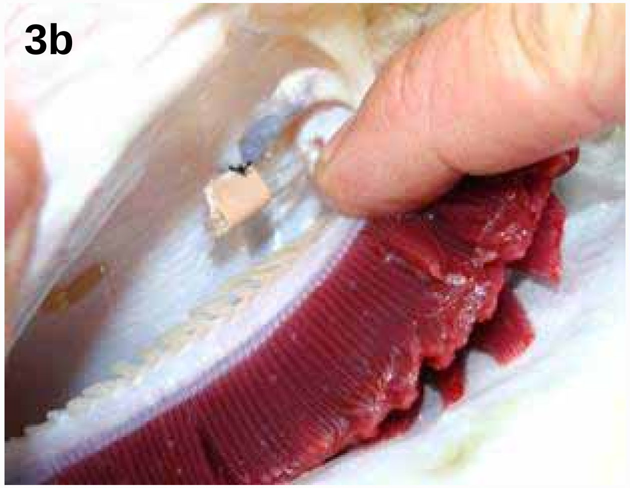
- Monitor and document fish welfare status in aquaculture
- Early warning system
- Optimize production regimes
- Assess feed intake rates

What is SmartTag? (II)

1) SmartTag prototype
- 46 x 16 mm, 6 g in water / 15 g in air
- 60 - 130 kHz acoustic transmission
- produced by THELMA, Norway

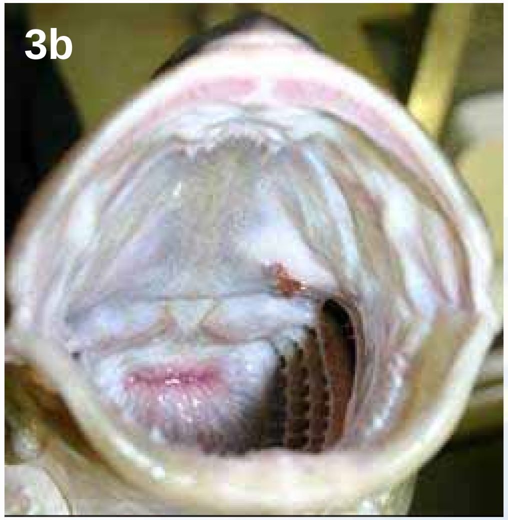
2ab) The tag is attached externally, on the back of the anaesthetized fish

What is SmartTag? (II)

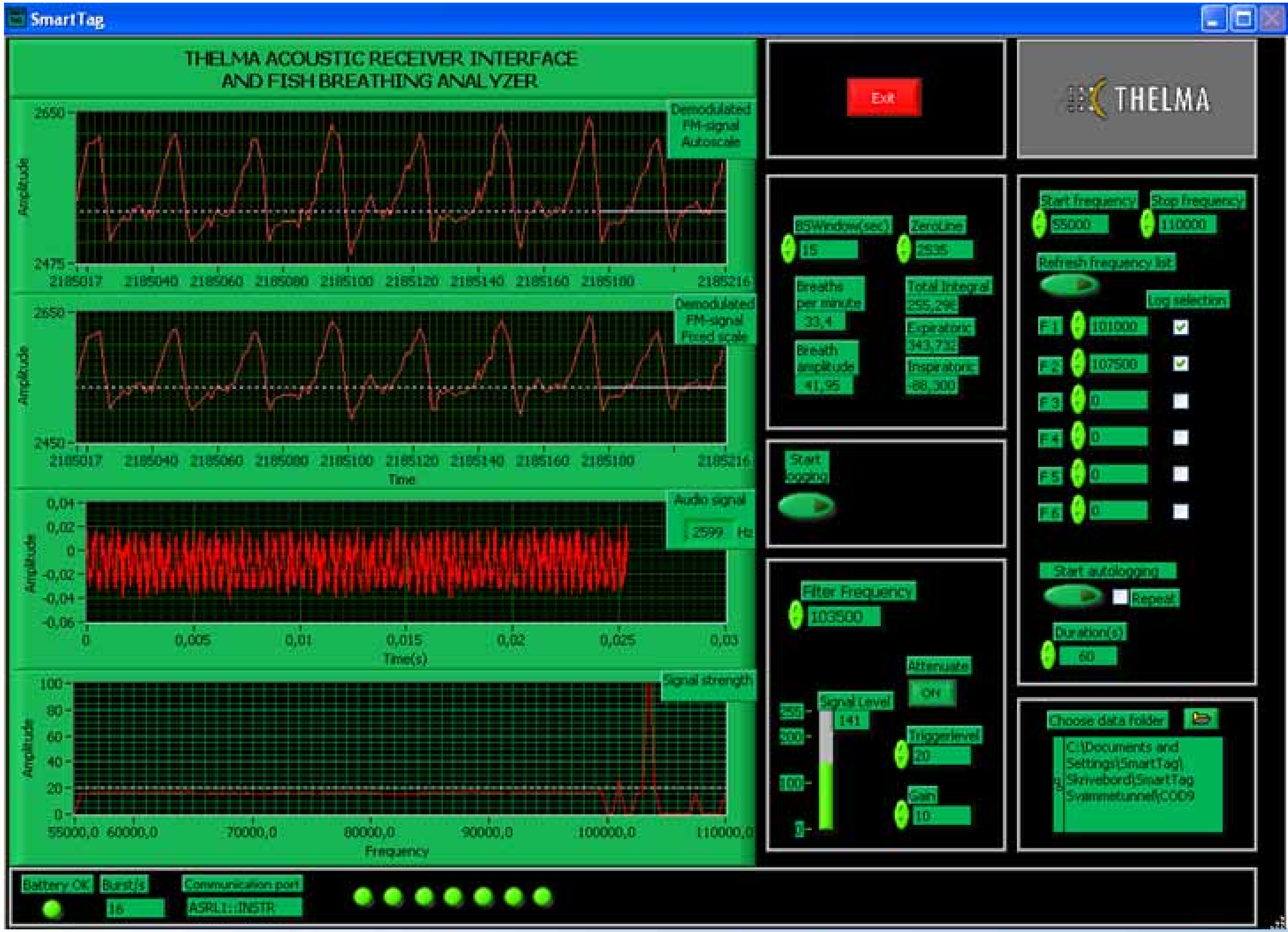


3abc)

A water-filled tube (TYGON 1.6 mm ID) is sutured inside the mouth and connected to the tag for online pressure measurements, thus producing detailed data on fish breathing activity.



What is SmartTag? (III)



The fish breathing is visualised and stored on a computer

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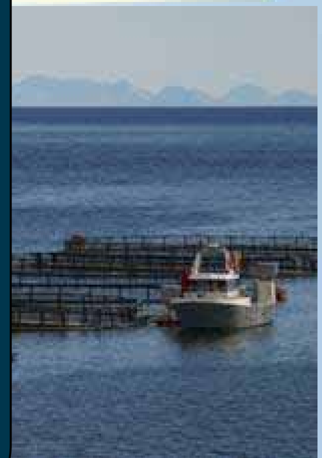
2) Background

SEAFOODplus:
A value-chain - “fork to fish farm” perspective

- RTD-pillar 1: Seafood and human nutrition
- RTD-pillar 2: Seafood and consumer behaviour and well-being
- RTD-pillar 3: Seafood safety
- RTD-pillar 4: Seafood from source to consumer product
- **RTD-pillar 5: Seafood from aquaculture**

RTD 6: Seafood traceability to ensure consumer confidence

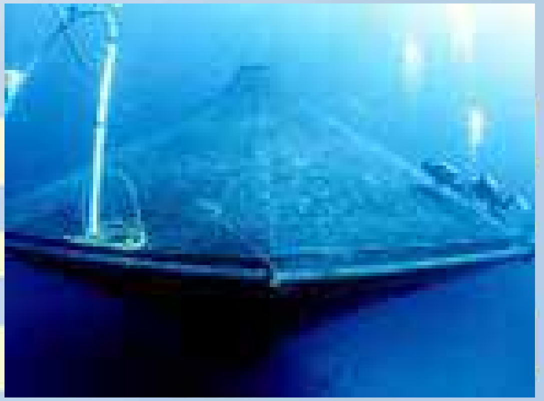


Trends in today's aquaculture (I)

- **Larger fish production units**
- **More intensive production:**
  - **more fish pr volume water**
  - **artificial oxygenation, accumulation of CO_2 and other metabolites**
- **More off-shore and submerged production facilities**
- **Rationalization of man-work**

(fewer people pr kg fish produced)

Large off-shore facility



Submerged facility

Trends in today's aquaculture (II)

- **Increased scepticism among consumers on food safety and animal welfare issues (Damsgård 2006)**

➢ ***Need for <u>monitoring</u> and <u>documenting</u> fish welfare and rearing conditions***

Fish farm

Product offered consumers / retailers

Monitoring and documenting fish welfare in aquaculture

Traditional approach (1):

- **Veterinarian inspections and analyzes of sick or dead fish**

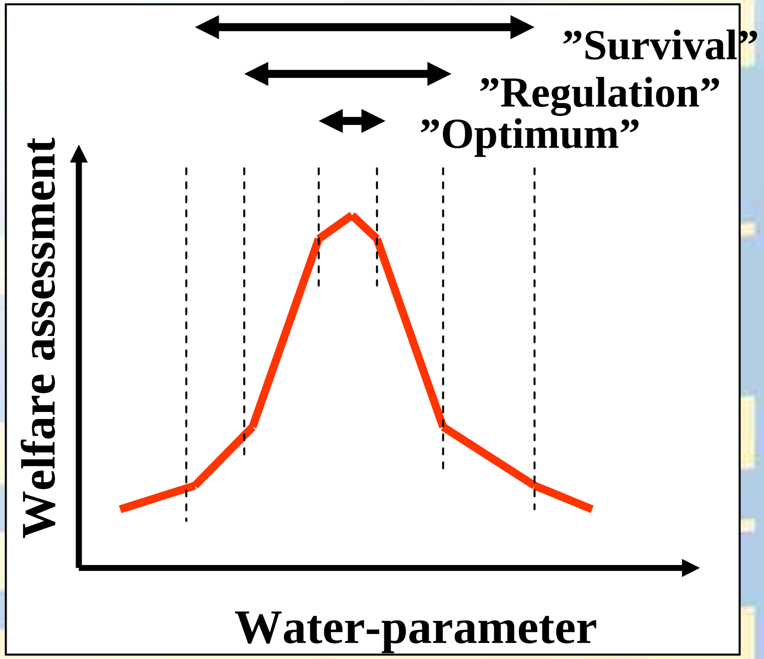
➢ ***Periodical, and/or based on prior suspicion of something being wrong, and may often be too late***

Monitoring and documenting fish welfare in aquaculture

Traditional approach (2):

- **Monitor environmental factors and ensure that these are within a pre-determined, acceptable range**

➢ ***Does not take in to account the "sum of factors", and that fish responses to such factors are variable***



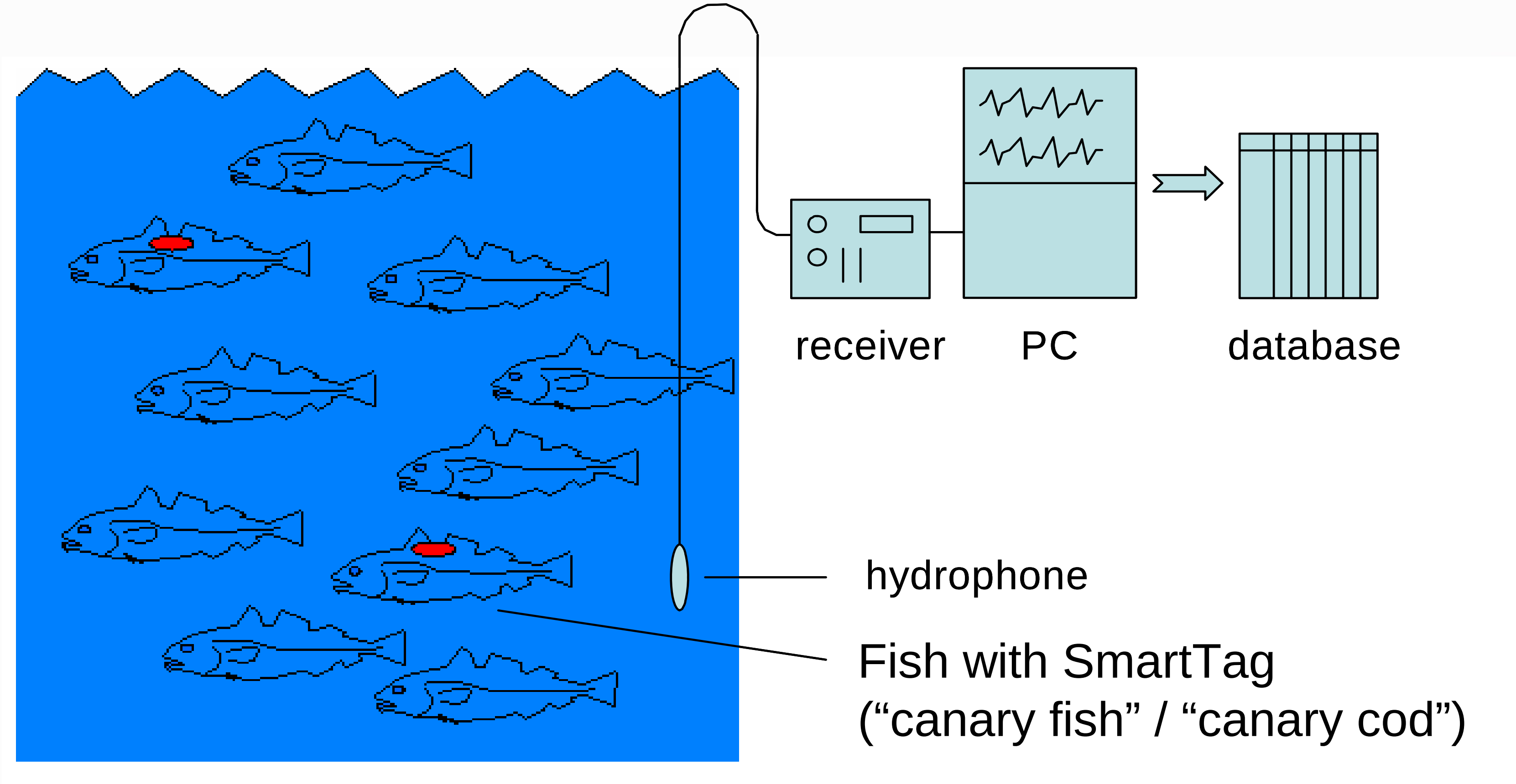
New approach:
SmartTag and the "canary cod" principle (I)

Canary birds were used as indicators of air quality in mines

Small cage with canary bird used in testing for carbon monoxide gas in Hollinger Mine, Timmons, Ontario, Canada (http://www.msha.gov)

SmartTag and the "canary cod" principle (II)

- Online monitoring of how individual fish respond to their aquaculture environment



A physiological parameter is continuously monitored by the tags, picked up by a reception system, and processed online on a computer with relevant parameters being stored automatically in a database.

3) Validation of the SmartTag system and of fish breathing as welfare indicator

Validation of the SmartTag system:
A. Existing scientific literature

We know from the scientific literature that fish breathing activity responds to factors such as:

- Hypoxia, hypercapnea and water pH (e.g. Smith & Jones 1982; Reid et al. 2000)
- Toxic or sub-toxic levels of metabolites and xenobiotics in feed and water (e.g. Pane et al. 2004)
- Parasite infection, disease, anaemia (e.g. Byrne et al. 1991)
- General stress response (e.g. Laitinen et al. 1996)
- Fear and pain (e.g. Sneddon et al. 2003)

Validation of the SmartTag system:
B. Controlled experiments

I) Responses to water quality manipulation

• SmartTagged Atlantic cod (*Gadus morhua*) swimming in a swim tunnel respirometer

• Breathing activity at normal (excellent) water quality is compared with breathing activity during short-term exposure to different water qualities relevant to the aquaculture industry

II) Responses to handling disturbance (pilot studies)

• Free-swimming, SmartTagged Atlantic cod are exposed to a handling disturbance

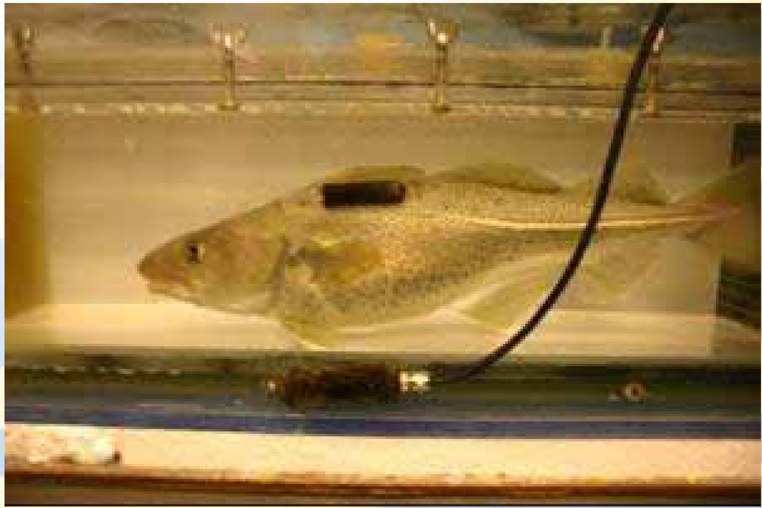
• Fish breathing activity compared before, during and after stress

1. Responses to water quality manipulation:
experimental design

Experimental day 1:

Fish SmartTagged and introduced to swim tunnel respirometer at normal (excellent) water quality

Experimental room with swim tunnel



SmartTagged 1.5 kg cod swimming at 0.5 BLs^{-1} at 10°C in the swim tunnel respirometer.

1. Responses to water quality manipulation:
experimental design (II)

Experimental day 2:

1) Control measurements (3 x 0.5 hours)
2) Treatment exposure (A, B, C, D, E or F) at low level (3 x 0.5 hours)
3) Treatment exposure (as above) at high level (3 x 0.5 hours)
4) Blood sampling

Treatments (water qualities):

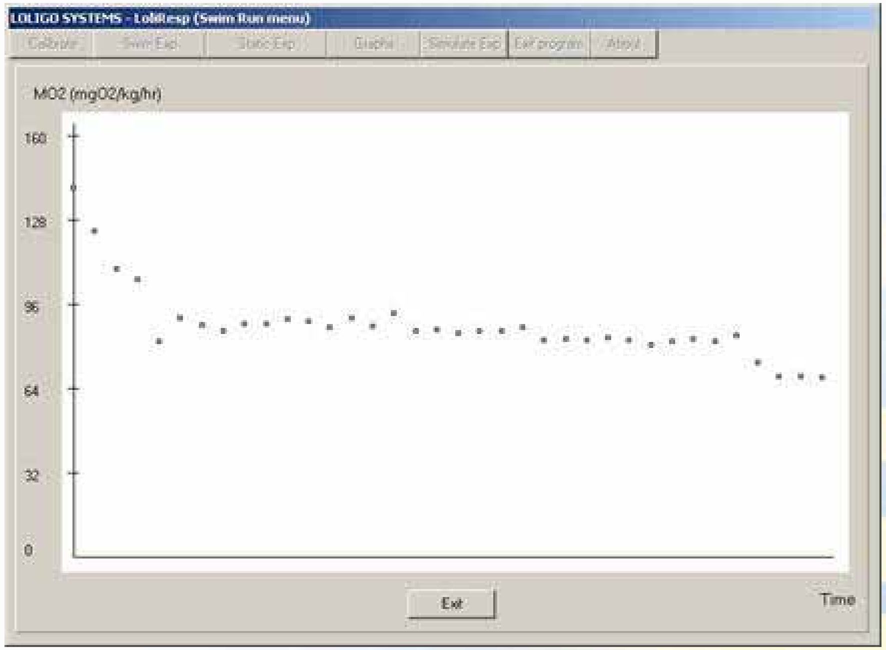
A. Control
B. Low O_2
C. High O_2
D. High CO_2
E. Low O_2 + high CO_2 (B + D)
F. High O_2 + high CO_2 (C + D)

Blood is sampled for cortisol (stress hormone) analysis at day 1, and for analyses of cortisol, glucose, lactate, ions and gas tensions at day 2.

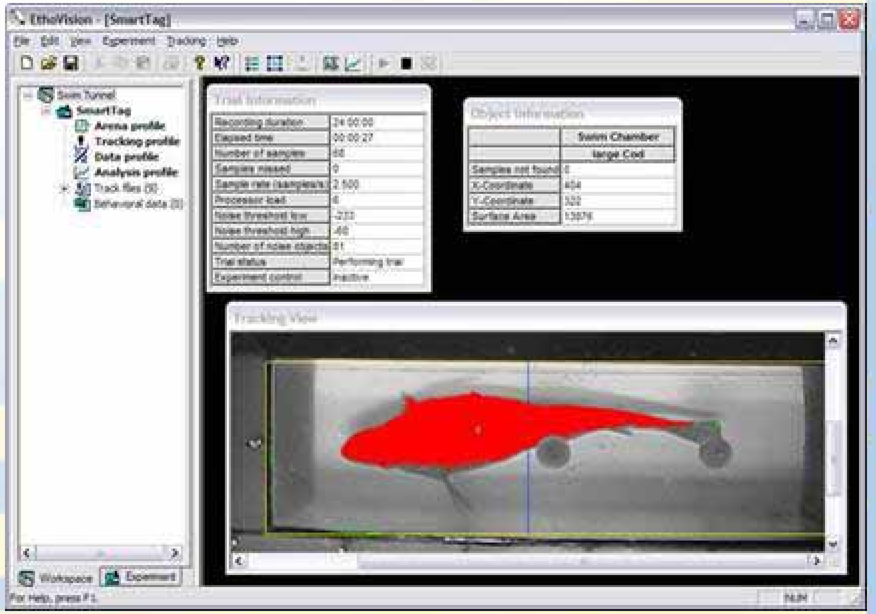
1. Responses to water quality manipulation:
experimental design (III)

Experimental day 1 *and* 2:

- Continuous registration of fish metabolism (30 min cycles)
- Continuous registration of fish behaviour (online video analysis)

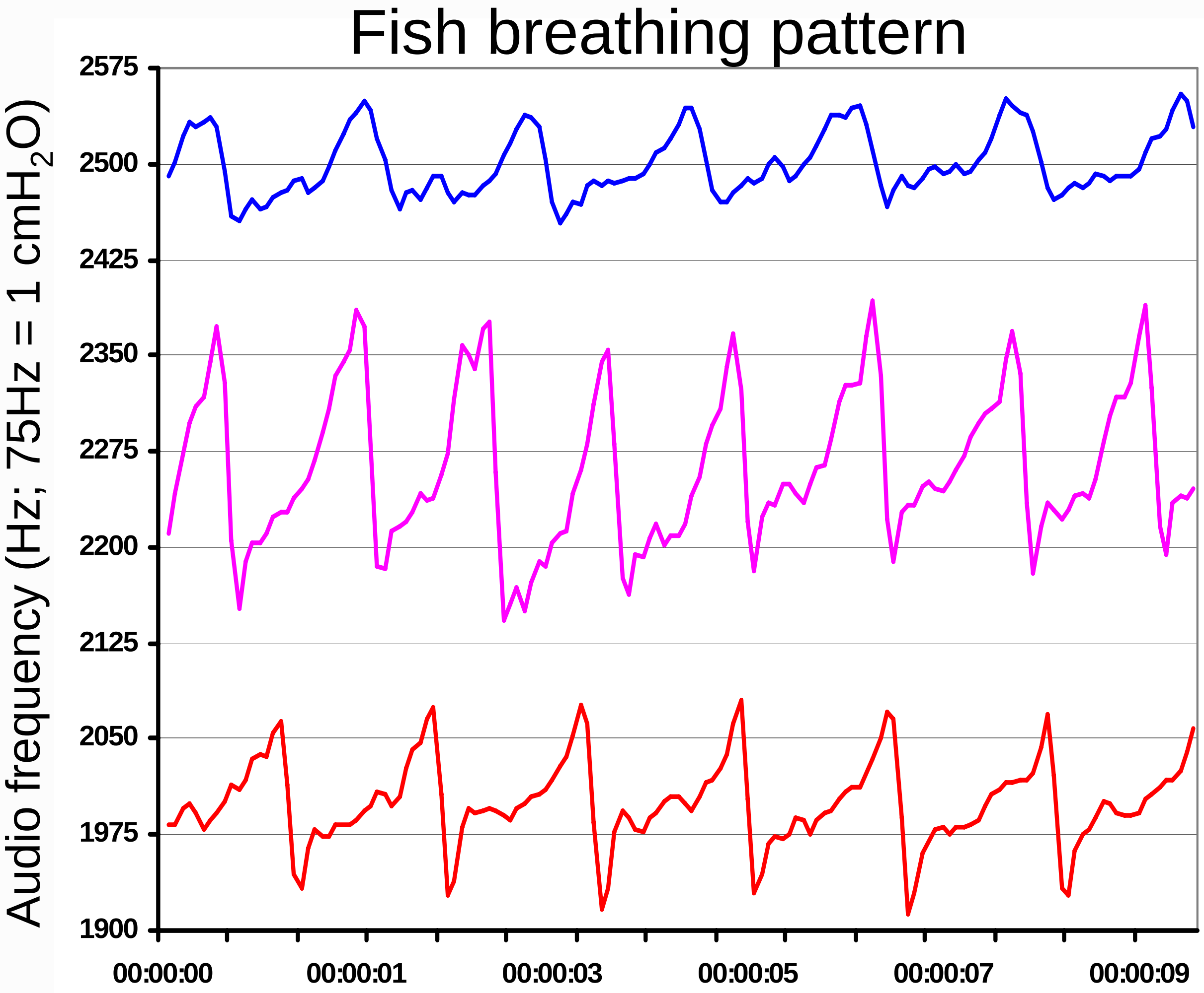


Changes in metabolism following introduction into the swim tunnel respirometer



Automatic video-tracking and analysis of fish behaviour in the swim tunnel respirometer

1. Responses to water quality manipulation:
Low O_2 levels (*e.g.* sea cage culture)



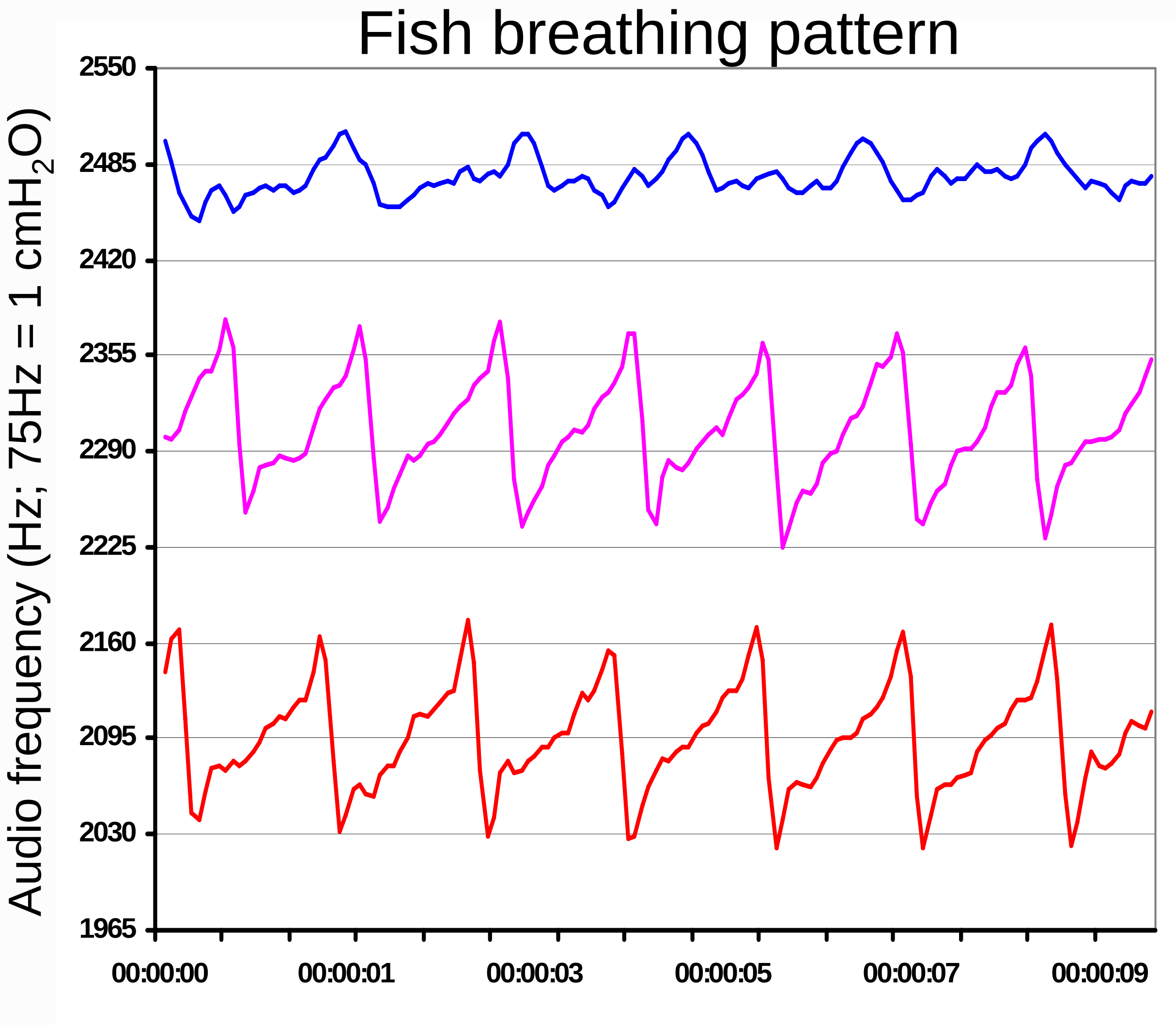
Normoxia; O_2= 100 %
- Frequency = 38 min^{-1}
- Amplitude = 1.2 cm H_2O

Hypoxia; O_2= 65%
- Frequency = 47 min^{-1}
- Amplitude = 3.0 cm H_2O

Hypoxia; O_2= 45%
- Frequency = 41
- Amplitude = 2.3 cmH_2O

1. Responses to water quality manipulation:

High CO_2 levels (*e.g.* recirculation systems)



Normal water

(CO_2 = 1 mg/L)

- Frequency= 35 min^{-1}
- Amplitude = 0.8 cm H_2O

CO_2= 17 mg/L

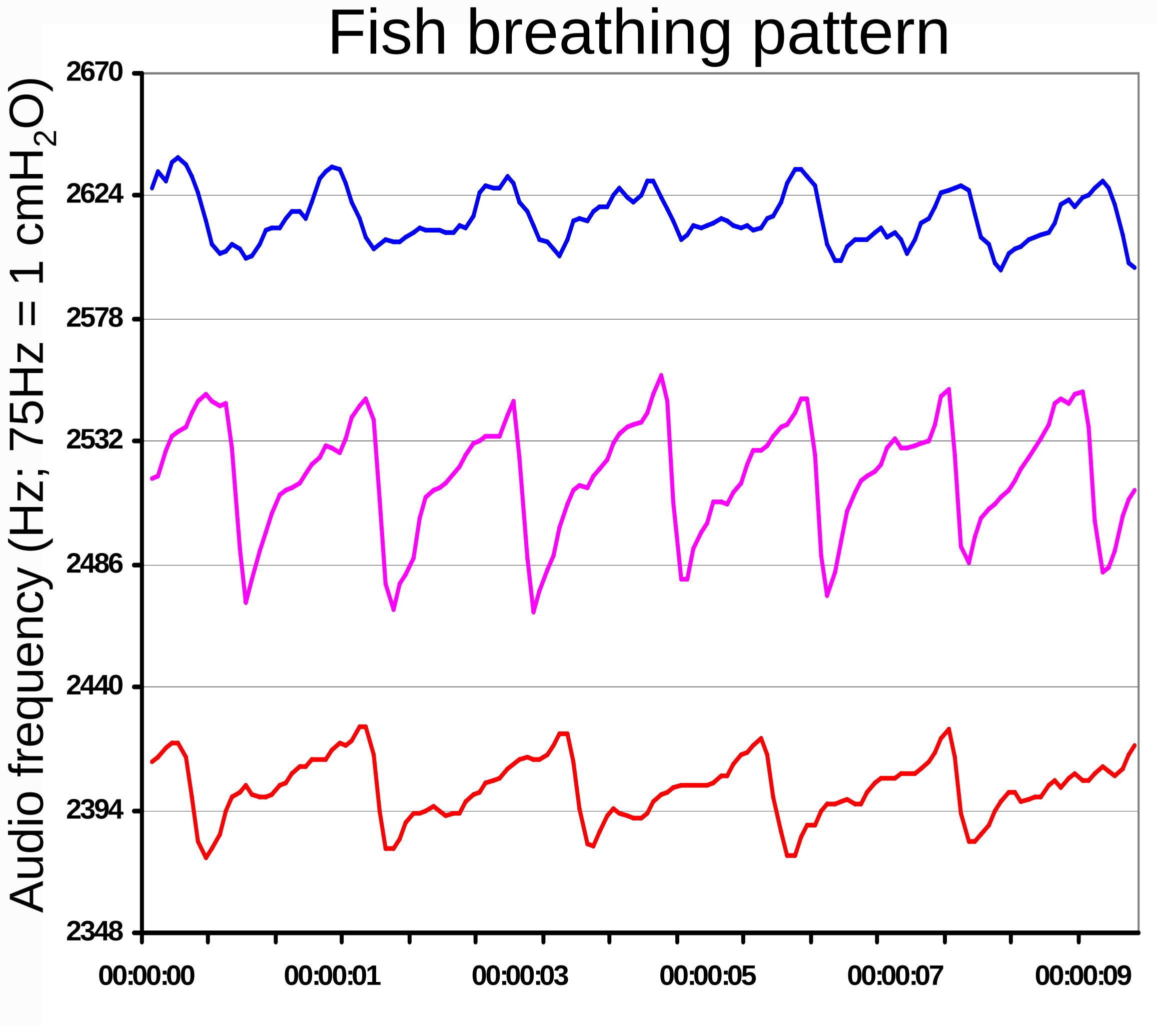
- Frequency= 45 min^{-1}
- Amplitude = 2.2 cm H_2O

CO_2= 30 mg/L

- Frequency= 41 min^{-1}
- Amplitude = 2.4 cmH_2O

1. Responses to water quality manipulation:

low O2 levels + high CO2 (*e.g.* pond culture)



Normal water

(O_2= 100%, CO_2= 1mg/L)

- Frequency= 38 min^{-1}
- Amplitude = 0.8 cm H_2O

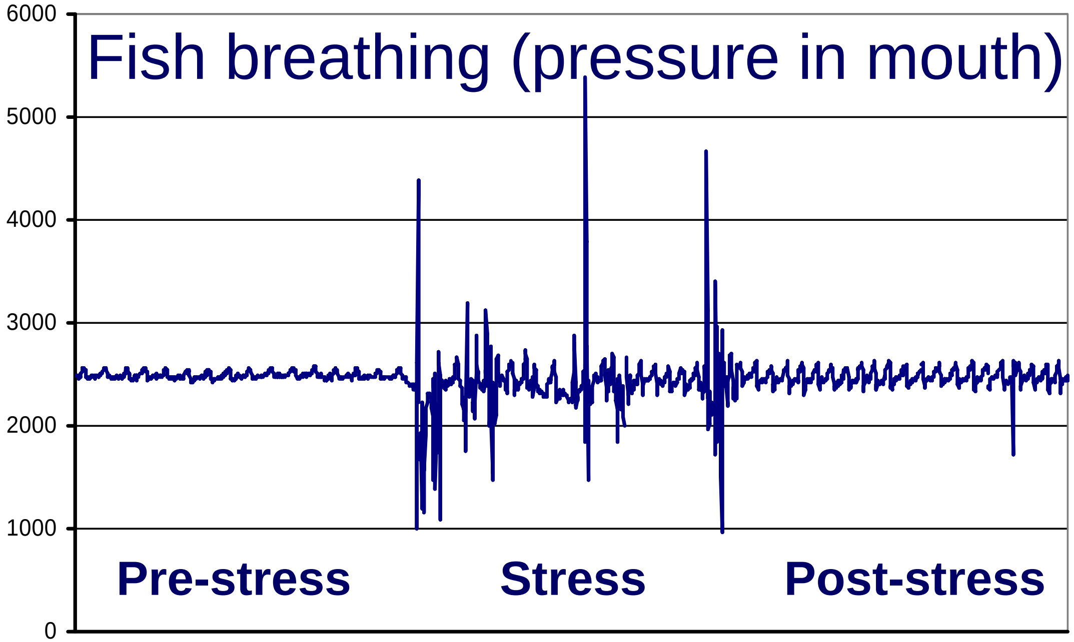
O_2= 65% + CO_2= 13mg/L

- Frequency= 42 min^{-1}
- Amplitude = 1.7 cm H_2O

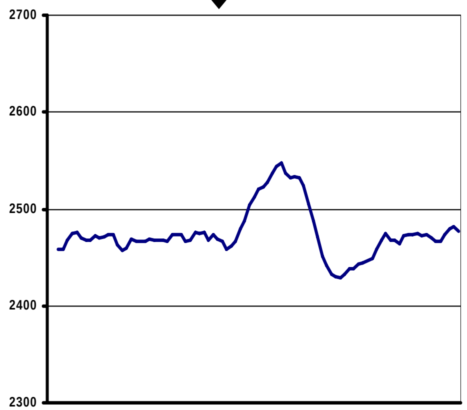
O_2= 45% + CO_2= 35 mg/L

- Frequency= 31 min^{-1}
- Amplitude = 1.1 cm H_2O

Validation of SmartTag:
2. Responses to handling disturbance



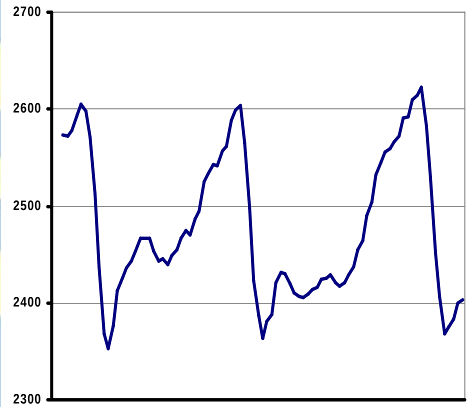
Method: 2 min dip-netting in small sea cage



Stress:
RF = ?, ΔP up to 50 cmH_2O

RF = 16
ΔP = 1 cmH_2O

RF = 22
ΔP = 3 cmH_2O



Using SmartTag as operational welfare indicator of farmed fish - CONCLUSIONS

- The SmartTag system is a promising candidate operational welfare indicator of farmed fish
- May also function as an early warning system and be used to optimize production regimes
- Further development and validation is needed before full-scale usage of the SmartTag system

Acknowledgements

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A better life with seafood…

Thank you!

www.seafoodplus.org