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The H2020 project GAIN: towards trout precision farming.

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GAIN – Key ideas

- **Closeness to market**: all GAIN innovations will be tested during the project lifetime in collaboration with project partners and committed end users in real world situations.
- Enhancing the implementation of the **principles of circular economy**, in order to valorize huge quantities of biomass and side streams which, at present, are wasted, being a burden to producers and the environment. (Estimated annual biomass waste only for salmon: about 500.000 tonnes).
- **Improving animal welfare and product quality**, through novel nutritious and sustainable feeds, non-invasive monitoring protocols, real time monitoring of environmental conditions.
- **Supporting optimal fish farmer decisions**, thus moving towards precision aquaculture, based on predictive models and Big Data analysis, assisted by IoT (Internet of Things).
- **Improving marketing strategies**, promoting the idea of **"good fish"** and providing to customers transparent information about production systems and supply chains.

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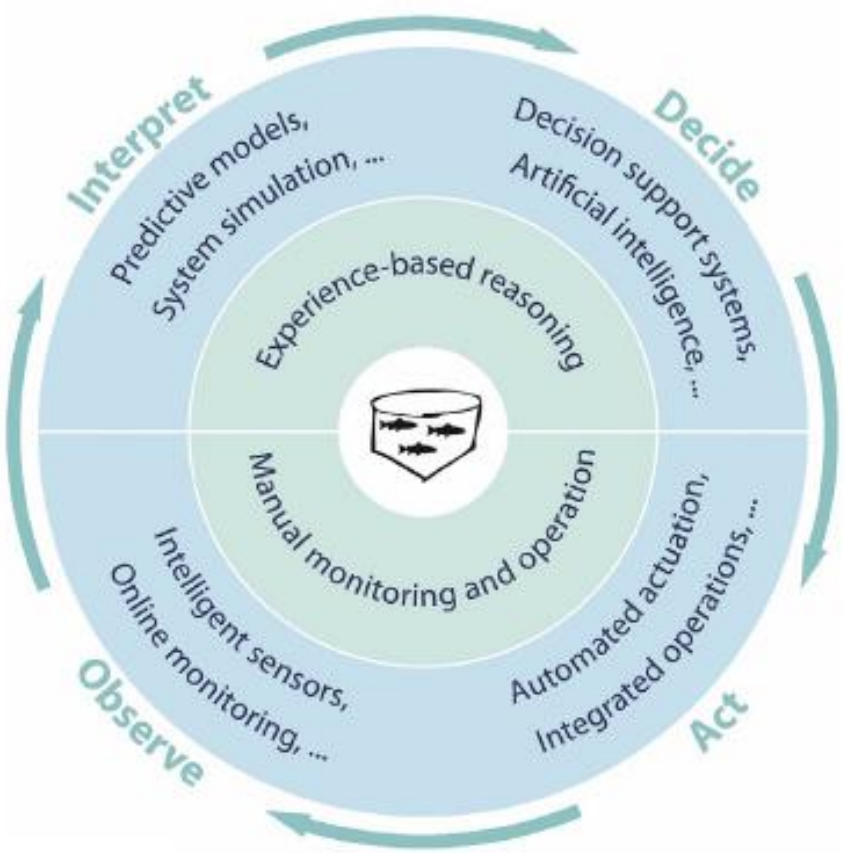
GAIN – Implementing Precision Fish Farming (PFF)



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ELSEVIER

Special Issue: Engineering Advances in Precision Livestock Farming

Review

Precision fish farming: A new framework to improve production in aquaculture

GAIN:

-Real time monitoring of environmental variables and **fish size distribution/biomass;**

-System simulation using:

a) **Data driven models** (machine learning, deep learning)

b) Mechanistic model with **data assimilation algorithms**

- Decision support system: **Affiliated Farm Platform**

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GAIN – pilot sites

➢ **Cage culture**

Atlantic Salmon

Rossøya Nord – Norway

Carness Bay, Orkney-Scotland (UK)

McNutt'S Island, Shelburne - Nova Scotia, Canada

Seabass/bream

Gorguel – Spain

➢ **Land based - raceway**

Rainbow trout

Preore, Trentino Alto Adige – Italy

➢ **Pond – semi-intensive**

Common carp

NOWE CZARNOWO - POLAND

➢ **Pond – semi-intensive**

Shrimp

Guangzhou - China

➢ **Shellfish**

Pacific oyster/Blue mussels

Dundrum bay – Northern Ireland

Mediterranean mussels

Sagres – SW of Portugal

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GAIN – application of PFF to rainbow trout

The rainbow trout pilot site is located in Preore, Trentino Alto-Adige (Northern Italy). The farm is owned by Troticoltura F.lli Leonardi, GAIN end-user. The site observation capacity was complemented by **UNIVE** and **FEM**.

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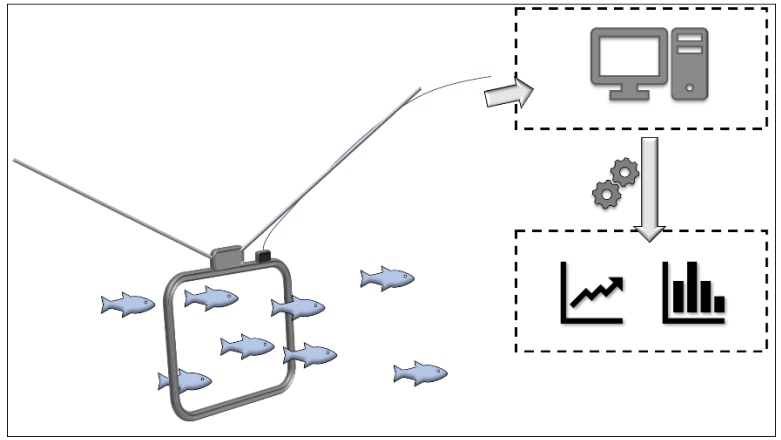
GAIN – Rainbow trout

Environmental data	Frequency	Biomass	Frequency
Dissolved oxygen	hourly	fish length/weight distribution	continuous recording
Water temperature	hourly		
pH	hourly		
N-NH4	hourly		
conductivity	hourly		
Total Suspended Solids	hourly		

Biomass daily system



Other data provided by the end-user:

- Total biomass, fish weight, monthly manual sampling;
- Feeding time and ration, feed composition and estimated FCR;
- Observations concerning fish behaviour and health.

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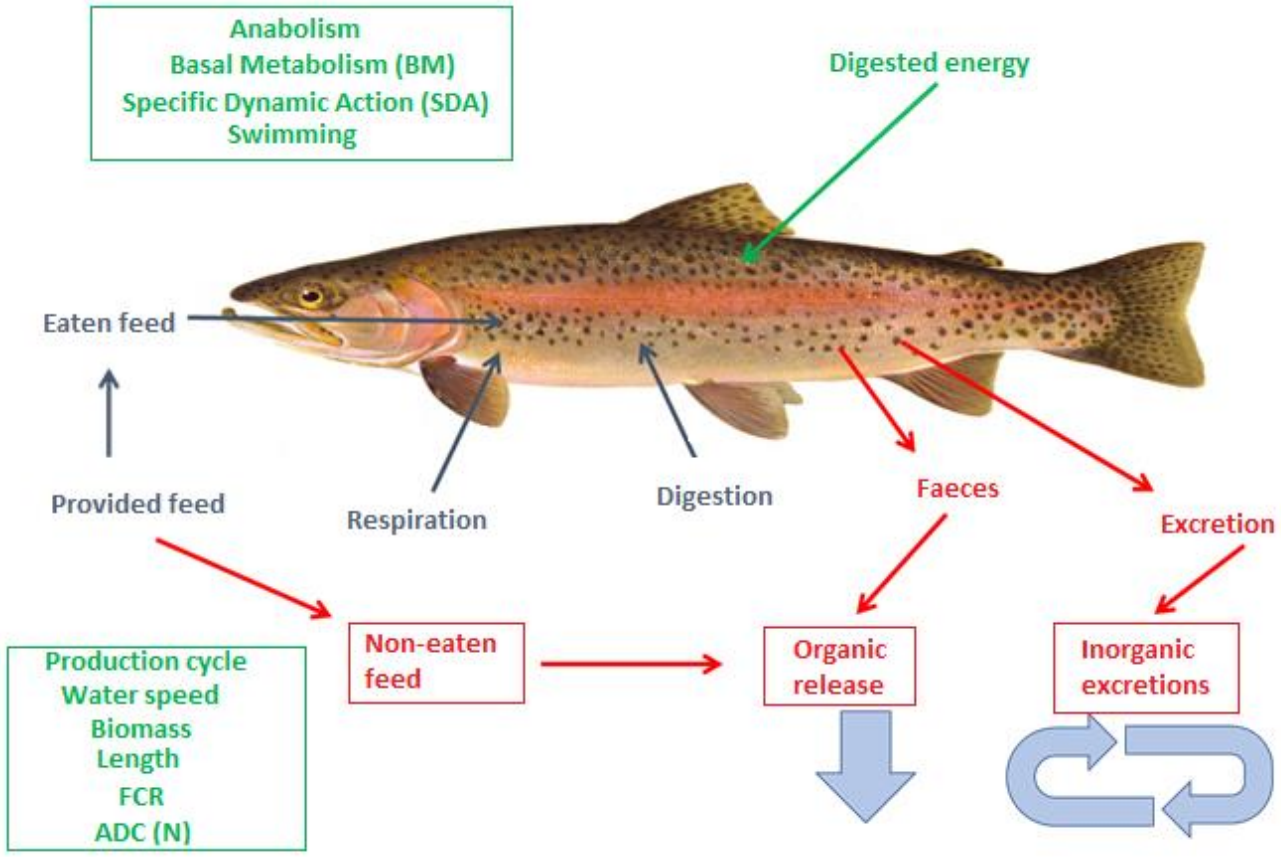
GAIN – Rainbow trout – modelling activity



The core of the modelling system is a **dynamic energy budget** model of rainbow trout, based on its physiology and metabolic responses to:

- Water temperature;
- Dissolved oxygen;
- Suspended particles.

The model will be applied to the farmed population using Monte Carlo methods, i.e. following the evolution of a "virtual" population.

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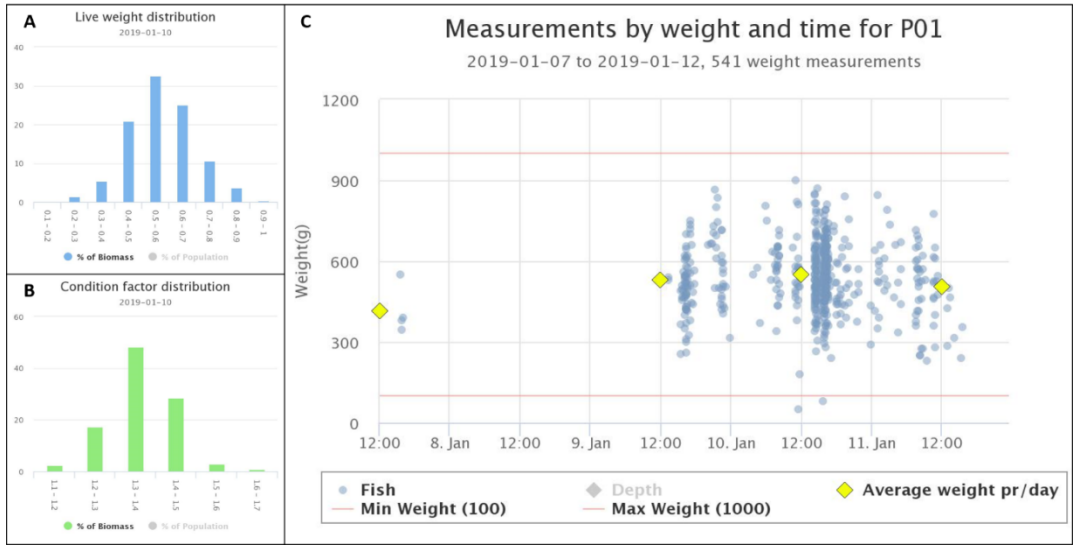
GAIN – Rainbow trout – modelling activity



The model output is post processed in order to support farmer decision concerning:

- **oxygen supply**;
- **feed management (quantity and timing)**

Key model "parameters" are estimated dynamically, in relation to the data which will be collected: e.g. **feed digestibility** will be estimated on the basis of the feed ration and the growth observed using the **Biomass Daily System**.

The model allows the estimation of:

- Dissolved Oxygen demand;
- Fish feed demand, taking into account feed composition;
- Ammonia excretion;

in relation to fluctuations of the environmental variables.

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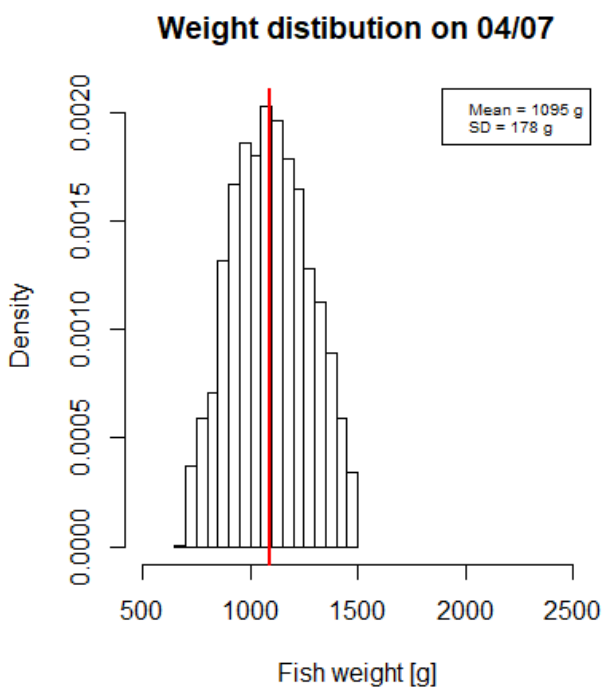
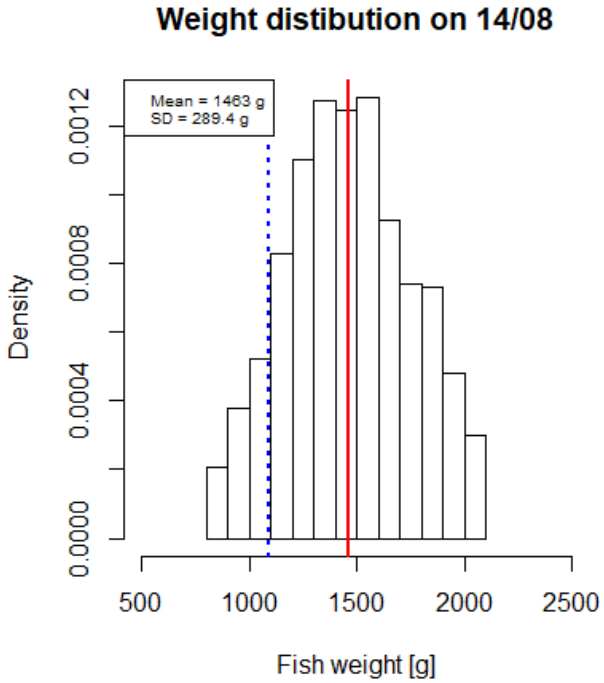
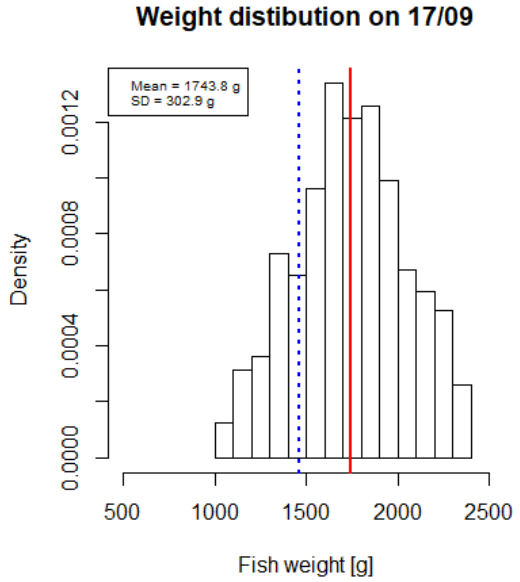
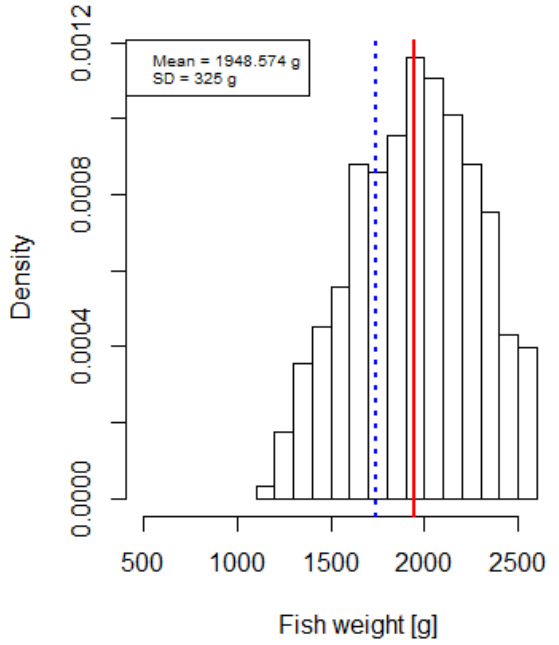
Biomass Daily: mean/median
and dispersion indeces (std)









Biomass Daily was tested on > 500 g specimen in summer-autumn 2019

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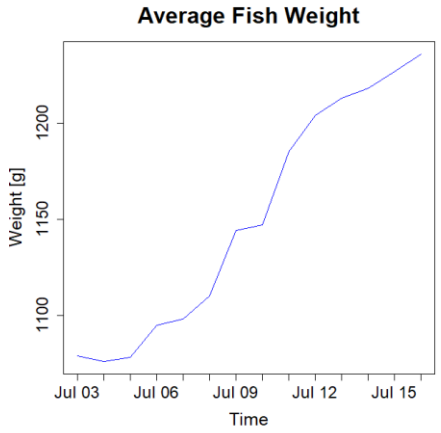
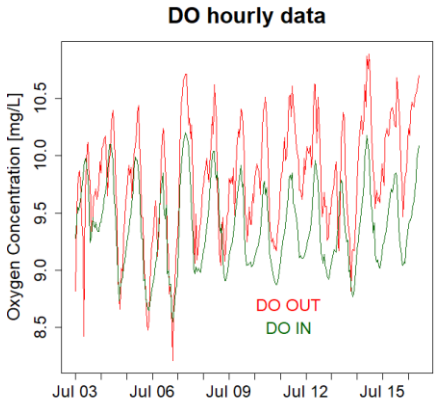
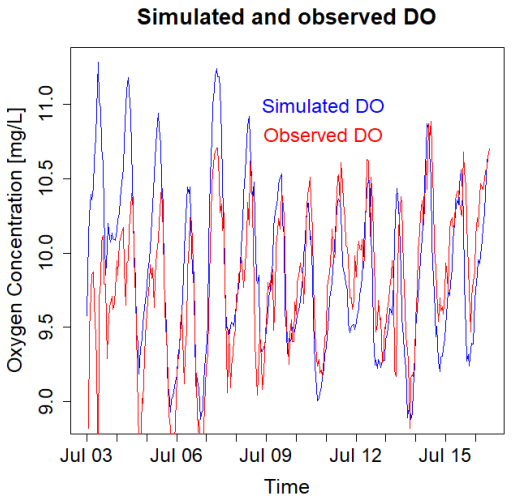
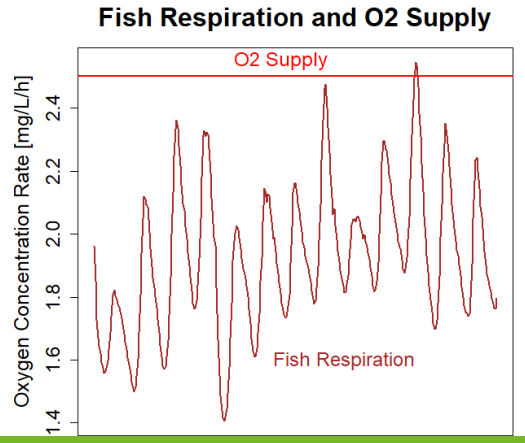
Step wise model calibration: respiration and Oxygen supply optimization

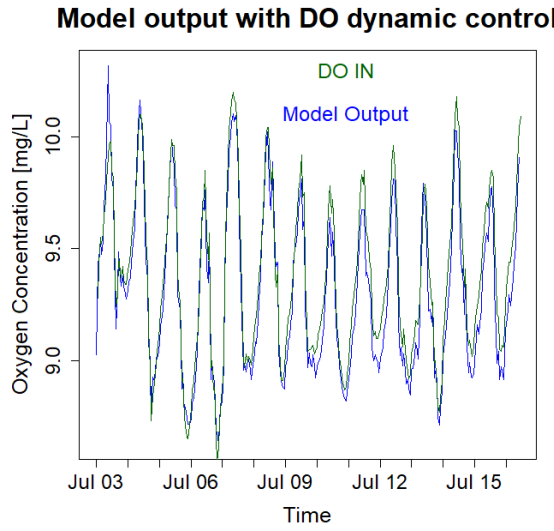




Dissolved Oxygen dynamic model







Oxygen actually supplied in **two weeks** : 773 m^3
Simulated dynamic oxygen supply : 587 m^3
Saving = 93 m^3/week **= 15 € / week**
Assuming 26 weeks/year of O_2 supply, the farmer could achieve a **potential saving of about 2700 Euros**/year.

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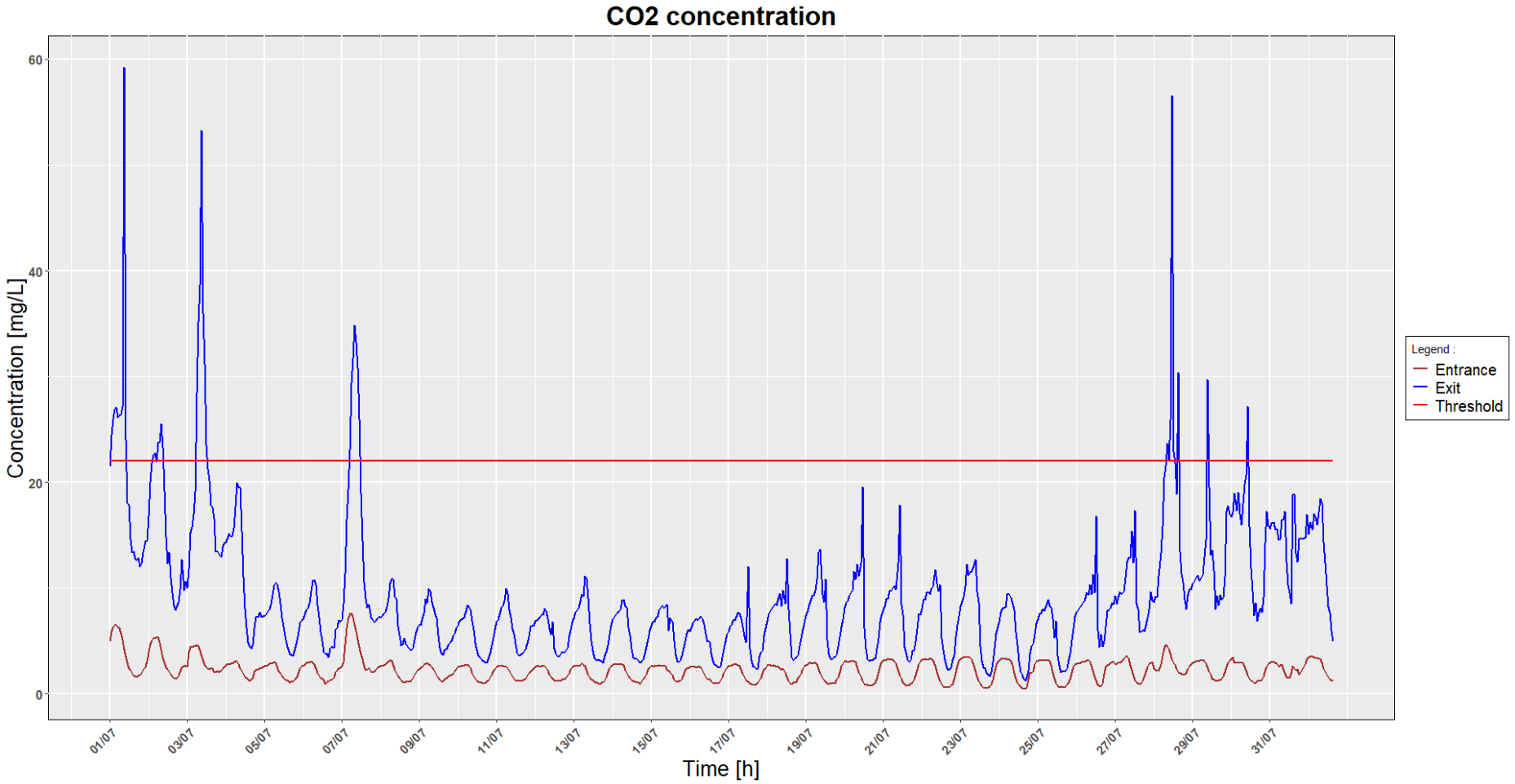
DIC speciation module: allows the estimation of CO_2 concentration



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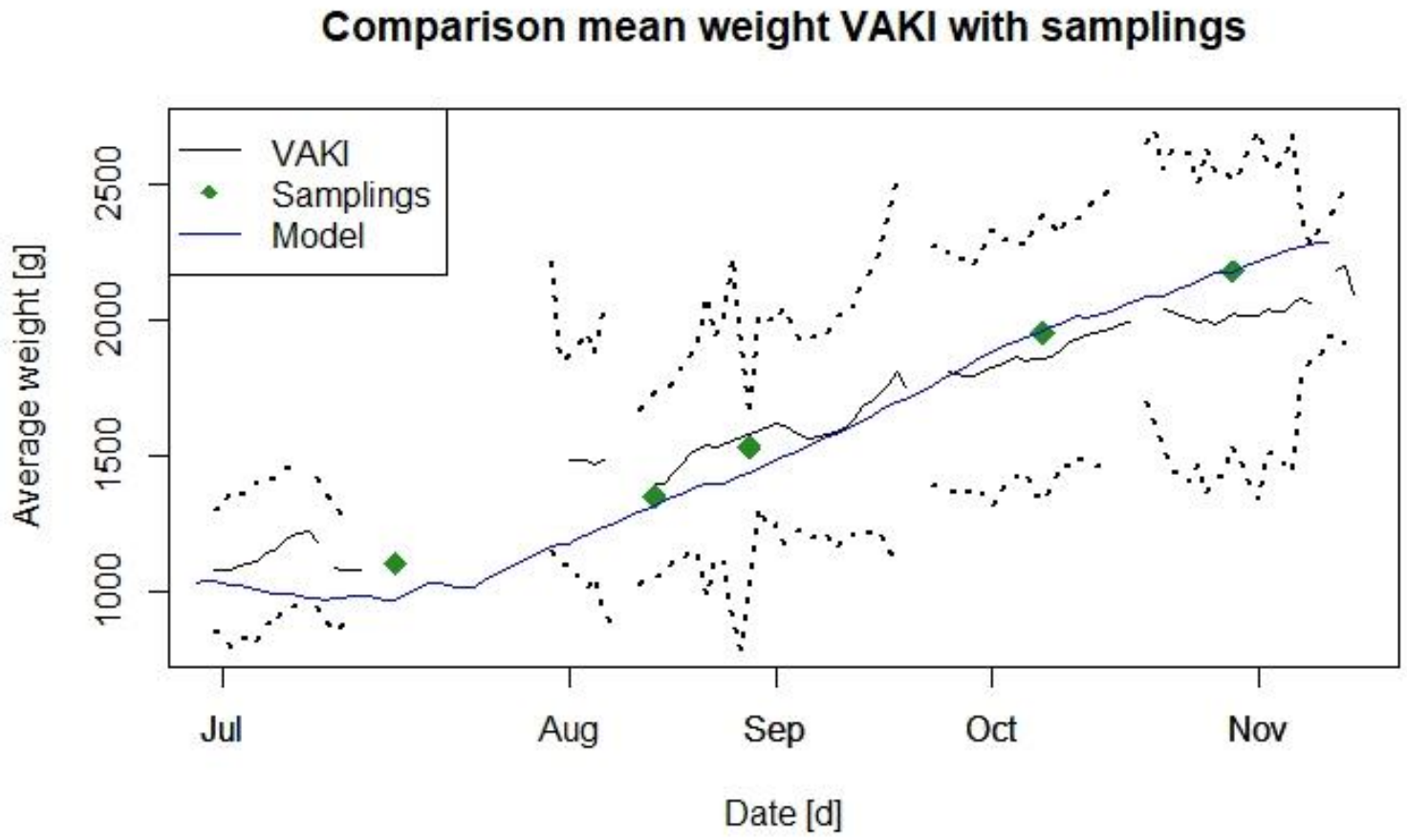
Stepwise model calibration: feed assimilation in relation to fish size and water temperature



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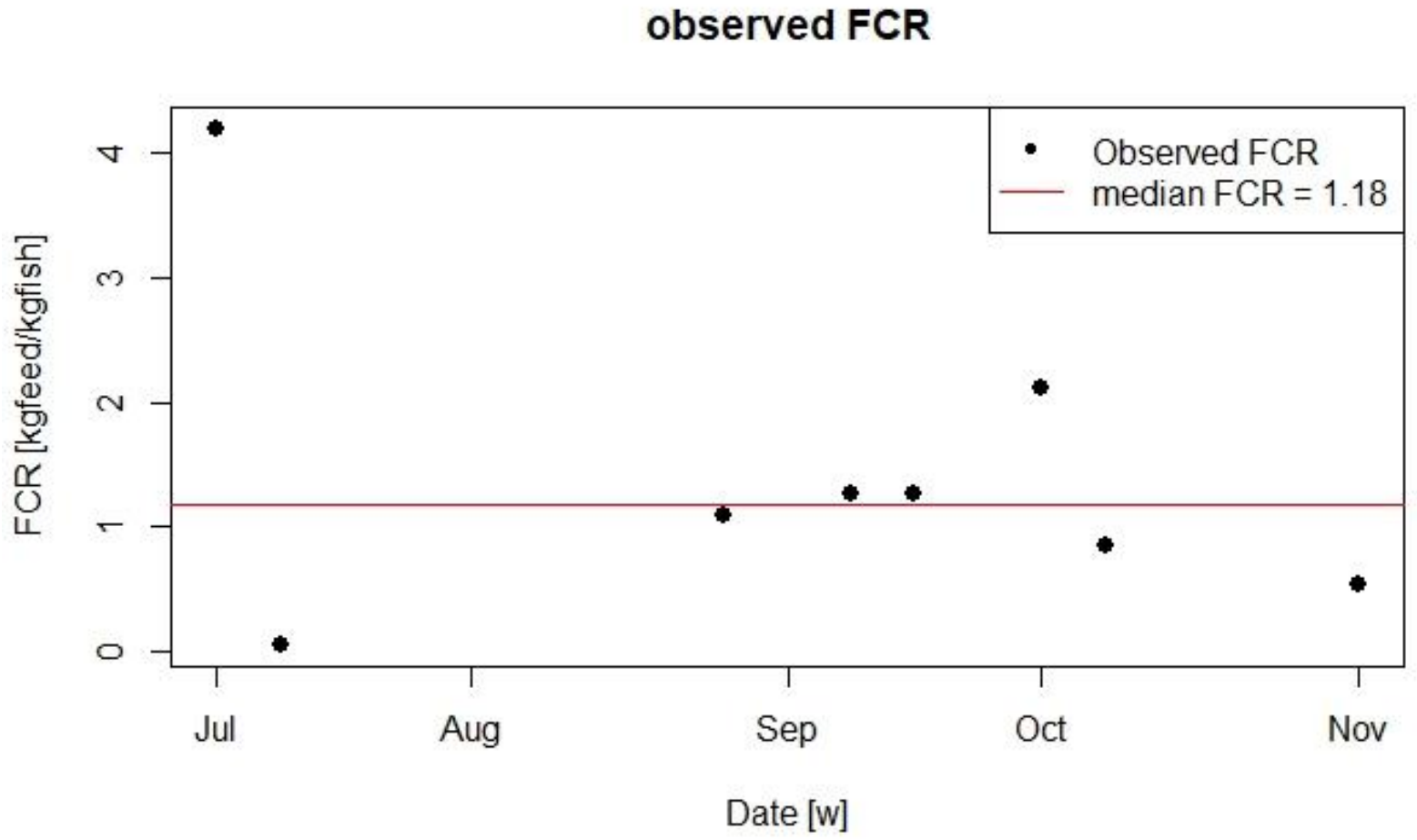
Dynamic FCR: will be used for adjusting the feed ration



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Work in progress/concluding remarks

Dynamic Nitrogen budget: assessment of trout farm N load

Data assimilation: real time estimation of FCR and feed ration.

Sustainability assessment: comprehensive index, based on LCA.

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