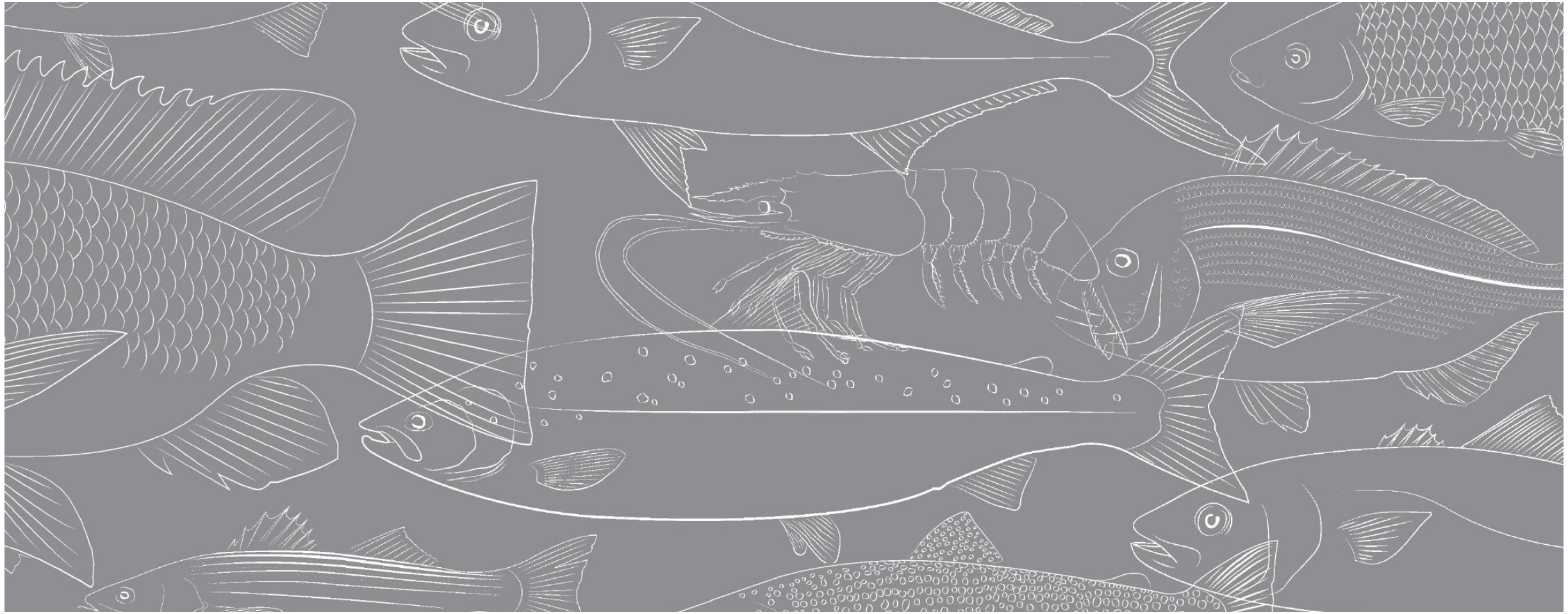

Optimizing Atlantic salmon and steelhead/trout feeds for closed containment systems

Roar Sandvik

30th of November 2017, Vancouver

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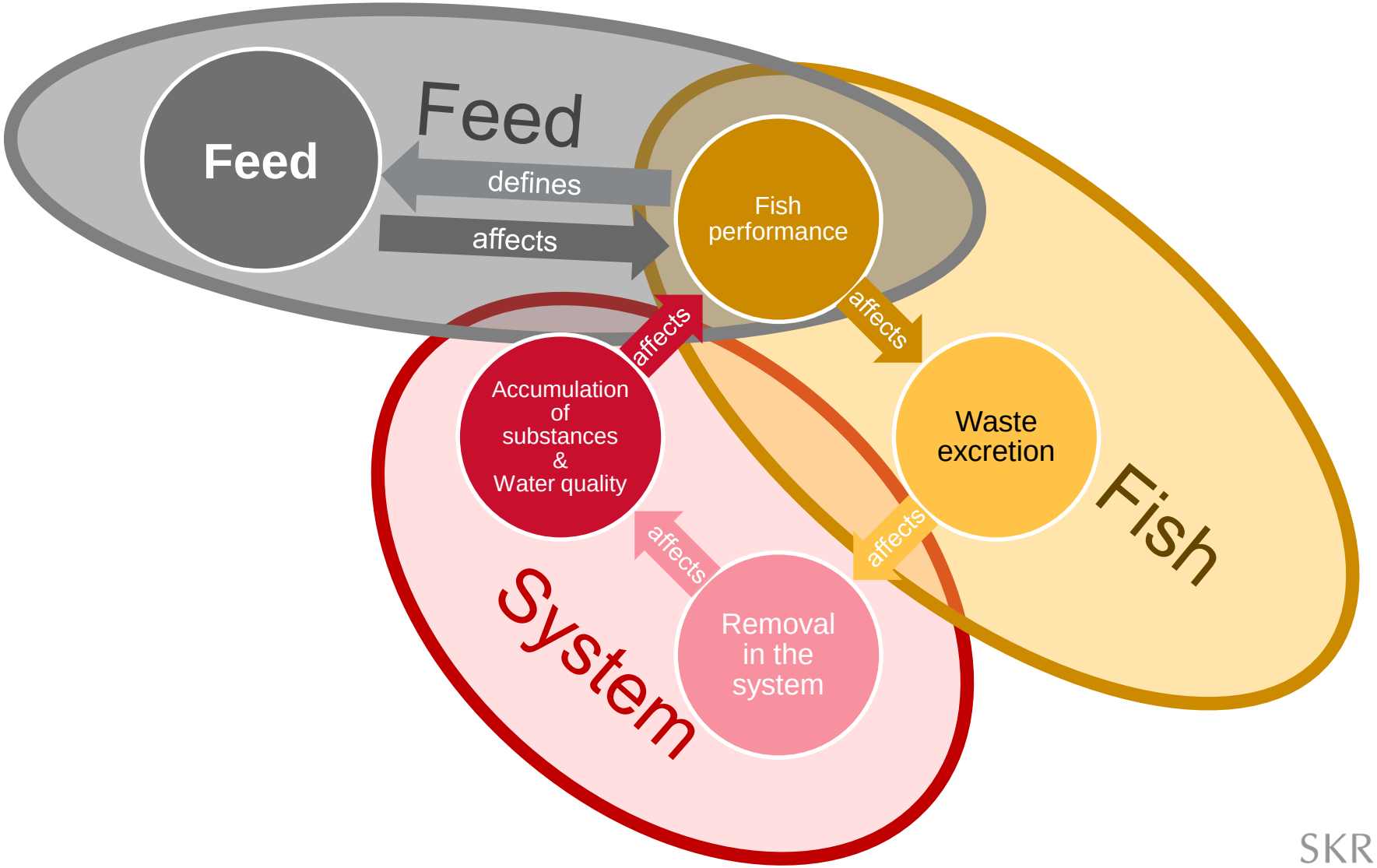
Feed-Fish-System interactions: the RAS approach



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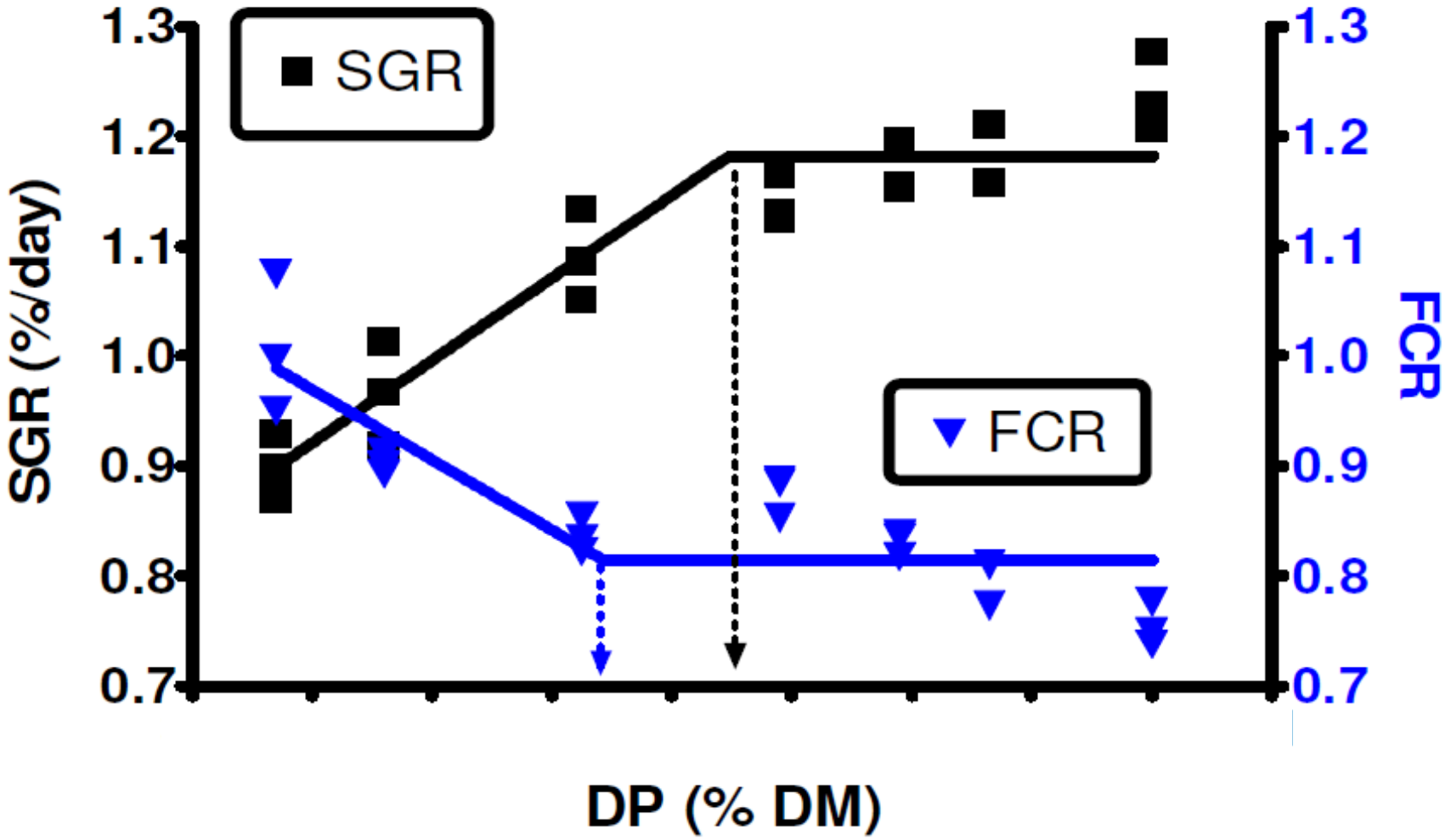
DP requirement studies



Depending of:

- Size
- Species
- Temperature

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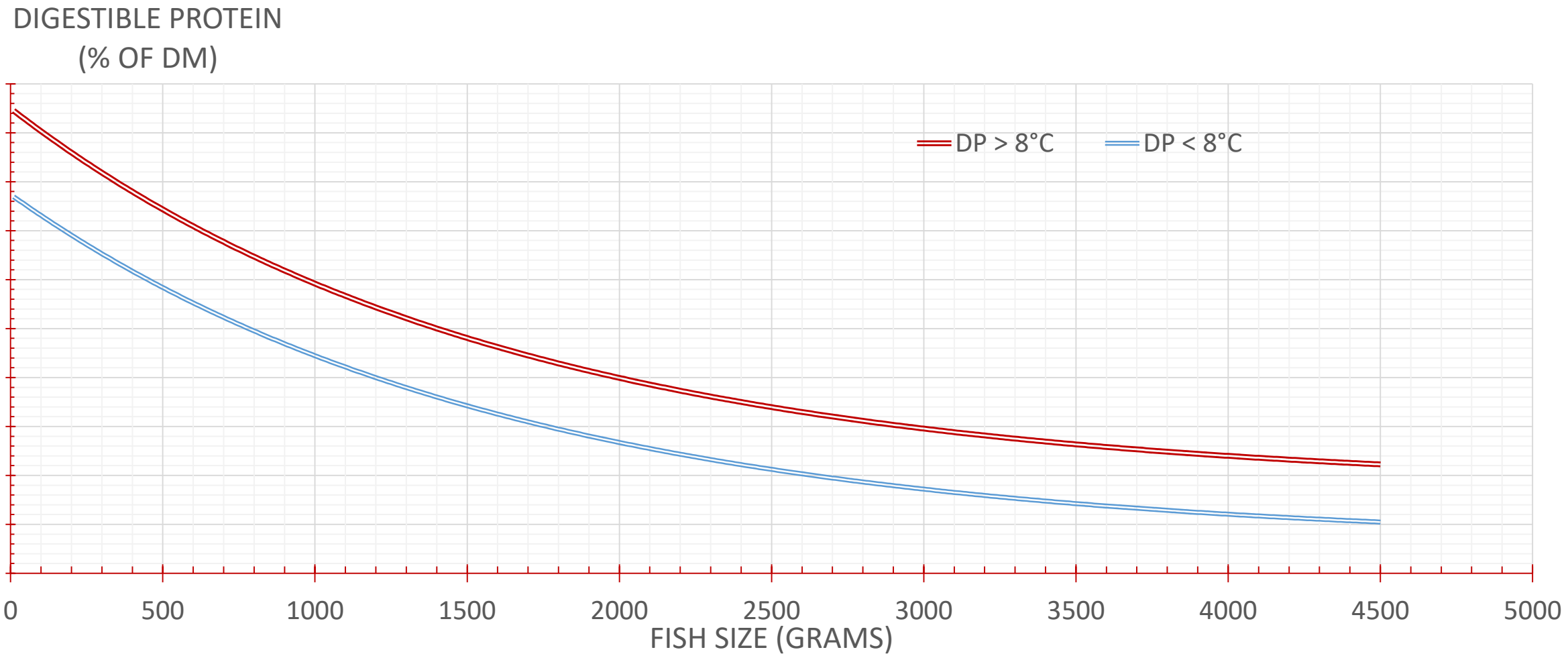
DP as a function of size and temperature



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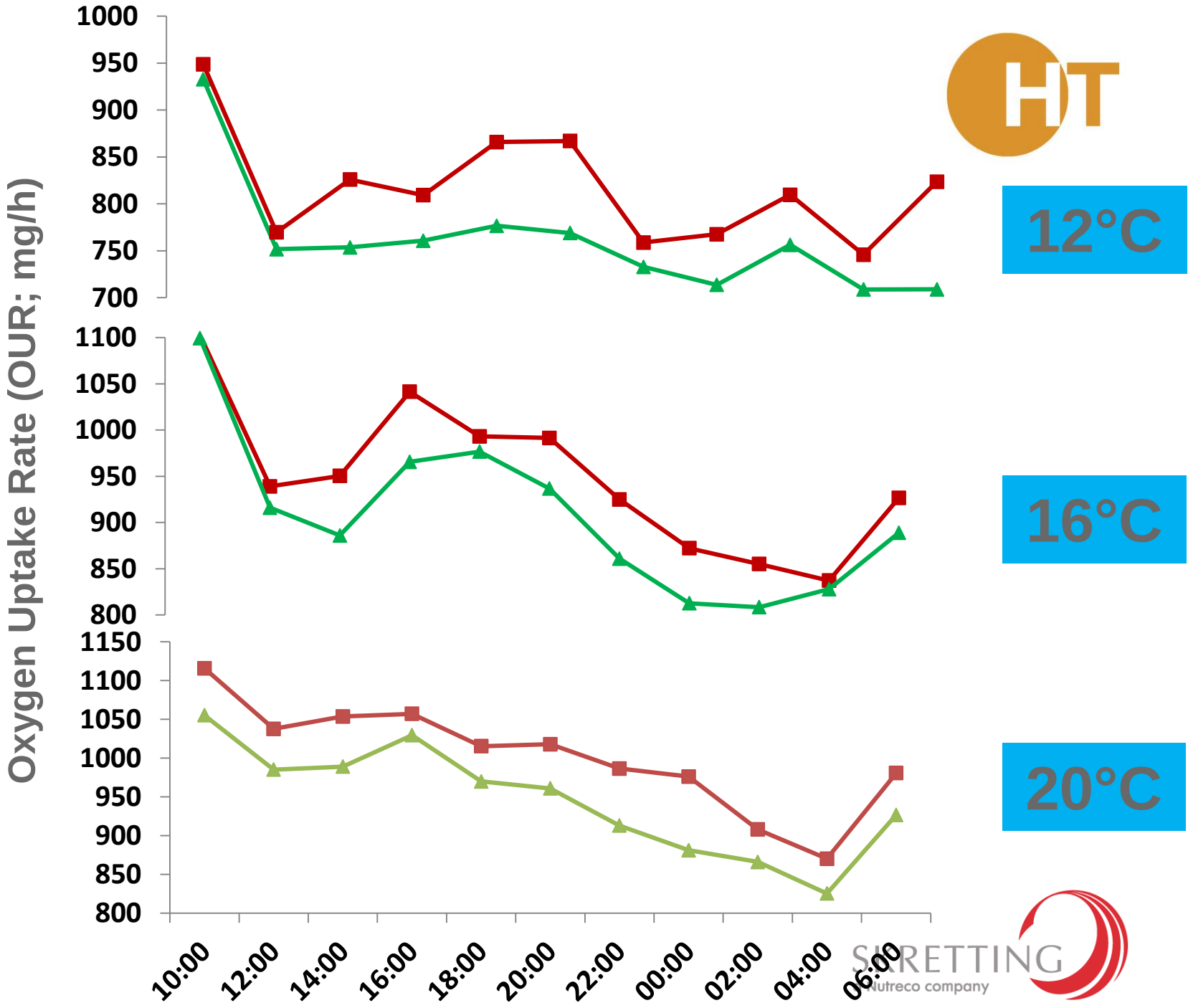
Oxygen consumption at different temperatures with high or low protein diets

High Protein (49%)

Low Protein (42%)

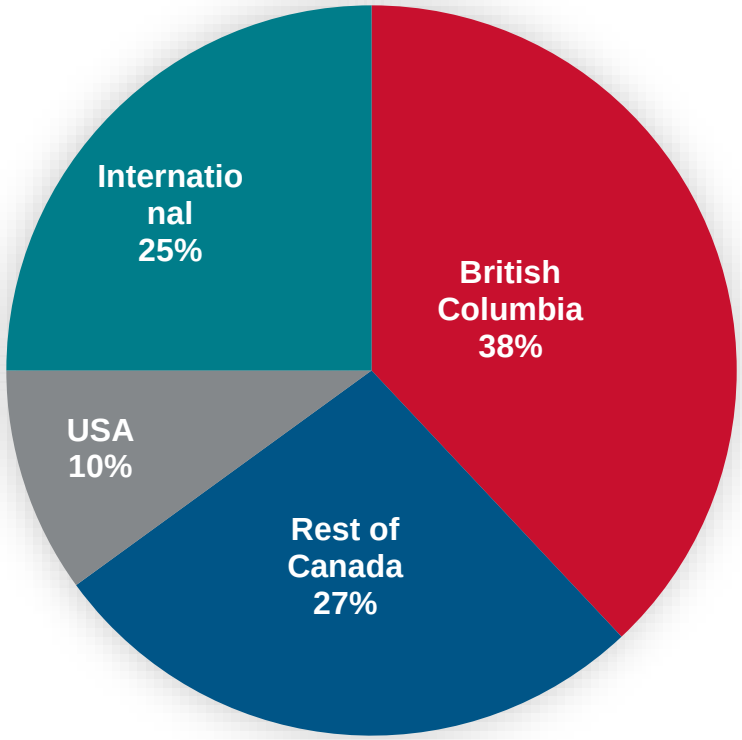
(DE equal between diets)



Feed Ingredient choice

North American	Norway
Fish Meal	Fish Meal
Corn Gluten	Wheat Gluten
Corn Protein Concentrate	Wheat
Wheat Gluten	Fish Oil
Wheat	Rapeseed Oil
Poultry Oil	Soy Bean Meal / Soy Protein Concentrate
Poultry Meal	Corn Protein Concentrate
Feather Meal	
Soy Bean Meal / Soy Protein Concentrate	
Fish Oil	
Canola Oil	
Blood Meal	

Ingredient source by location



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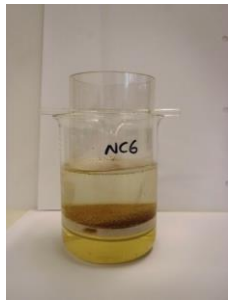
Water stability methods-Description

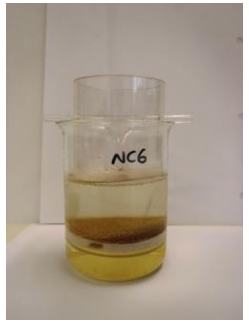
- Dry matter loss

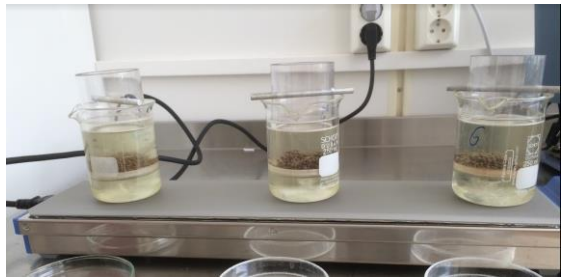


35°C, 100 RPM, 240 min.

16h, 101°C

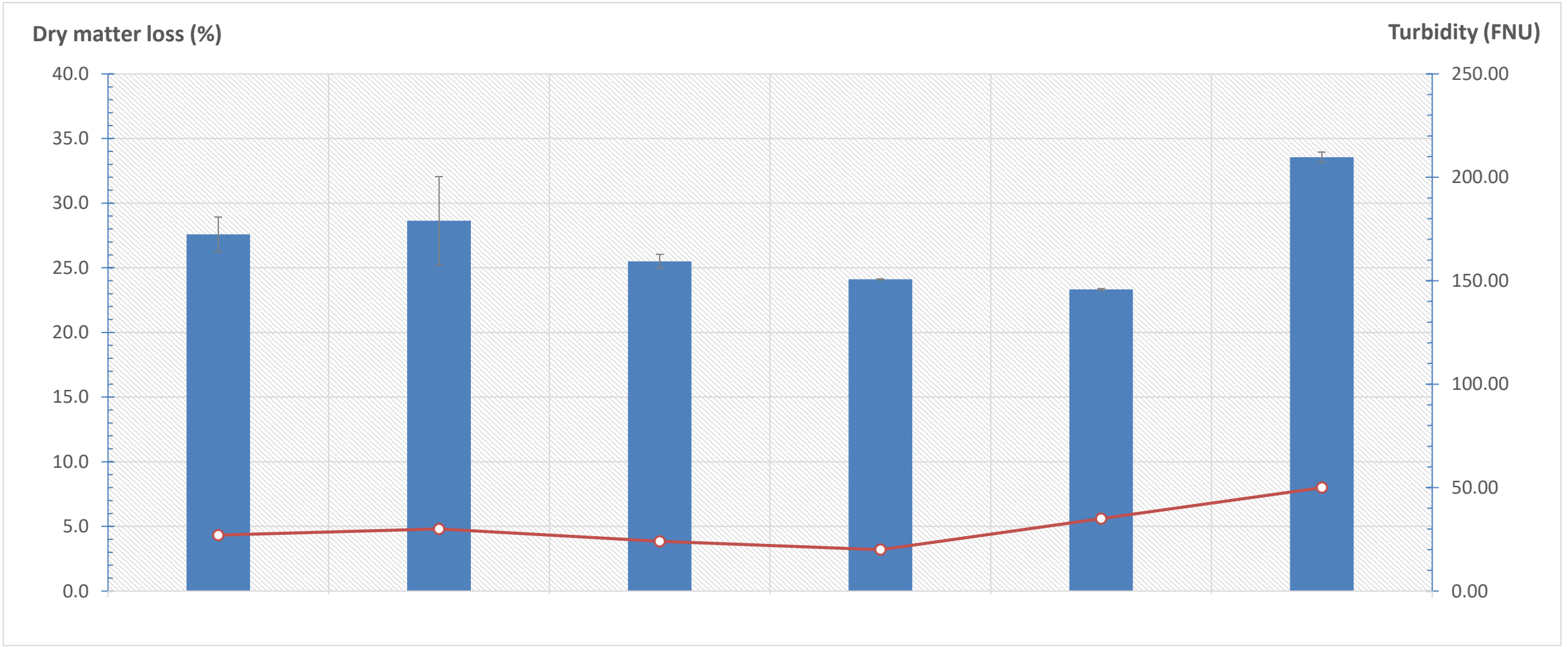
- Turbidity





15 minutes, 450 rpm, 20±5°C

Results – tubidity & dry matter loss



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Faeces

Trial design

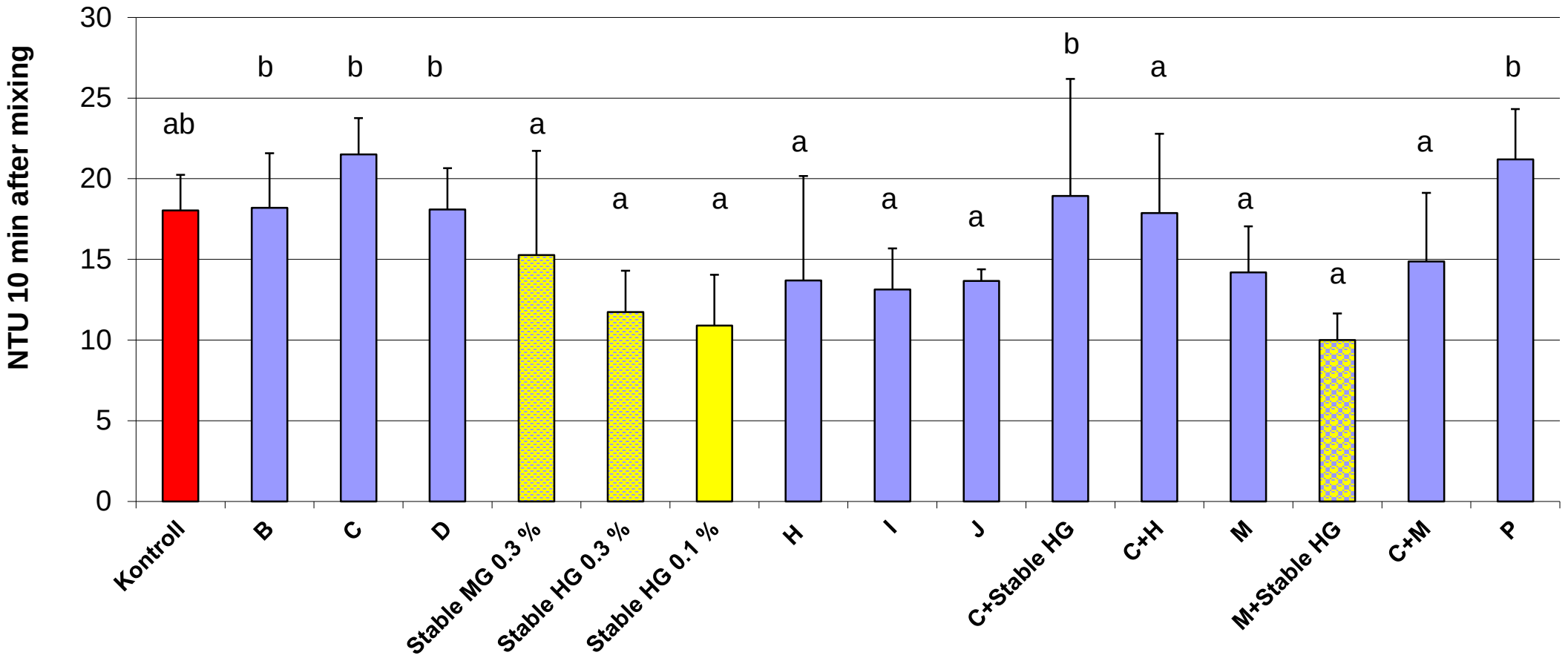
- Rainbow trout; start weight of 225 g
- 25 fish per tank
- Fed 17 diets in 2 weeks
- Sampling
  - Turbidity measured after mixing
  - Sedimentation columns

Turbidity

- Faeces collected from 1day of feeding
- Water + faeces volume adjusted to 500 ml
- Placed in 1L non transparent dark brown bottles
- Mixing 1 turn and sedimentation for 10 min
- Turbidity reading 2 cm below surface
- Repeated for 3 days

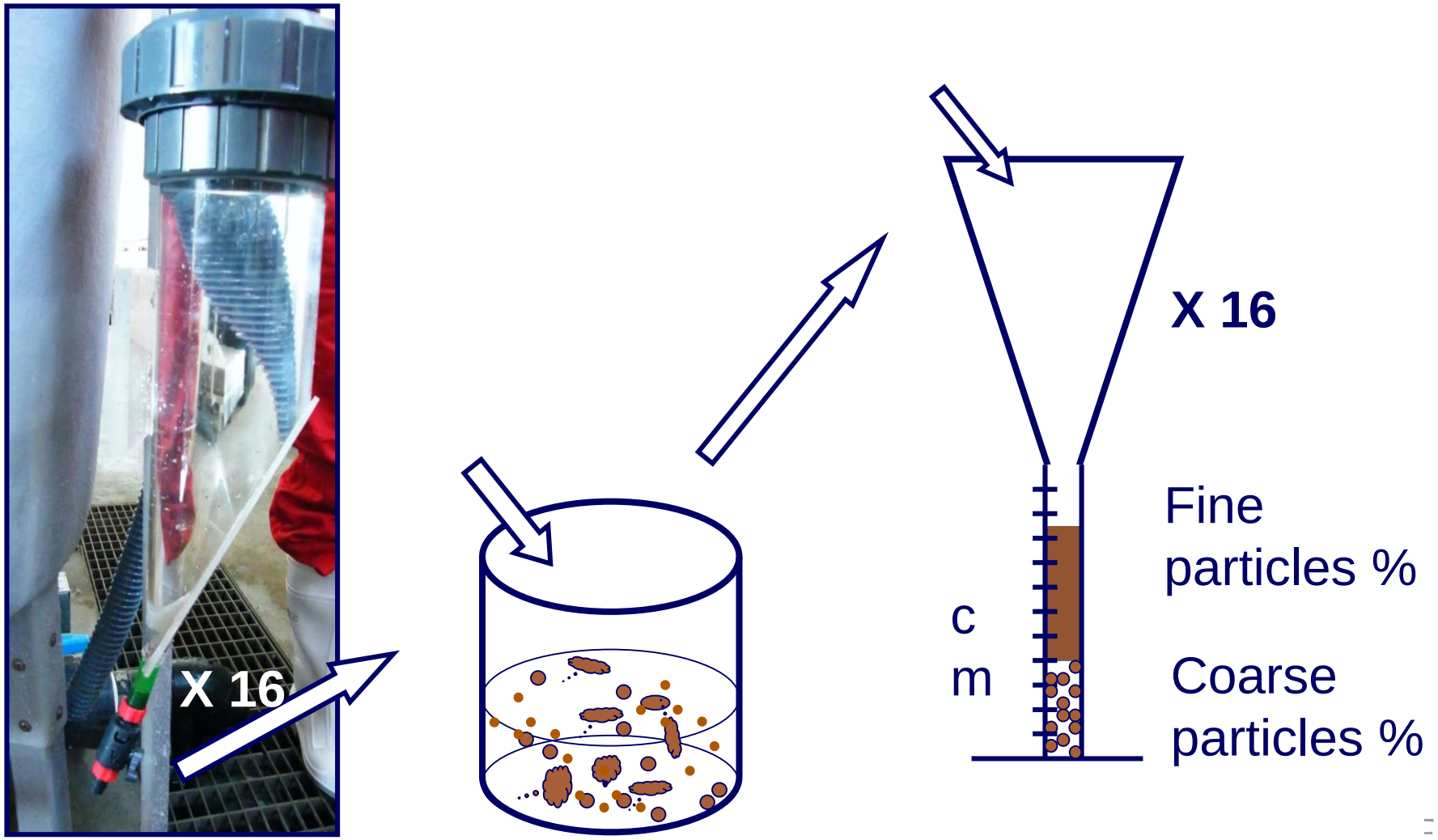
Turbidity (NTU – nephelometric turbidity unit)

Mean and SD after 3 days sampling



Evaluation of faeces quality

Sedimentation columns

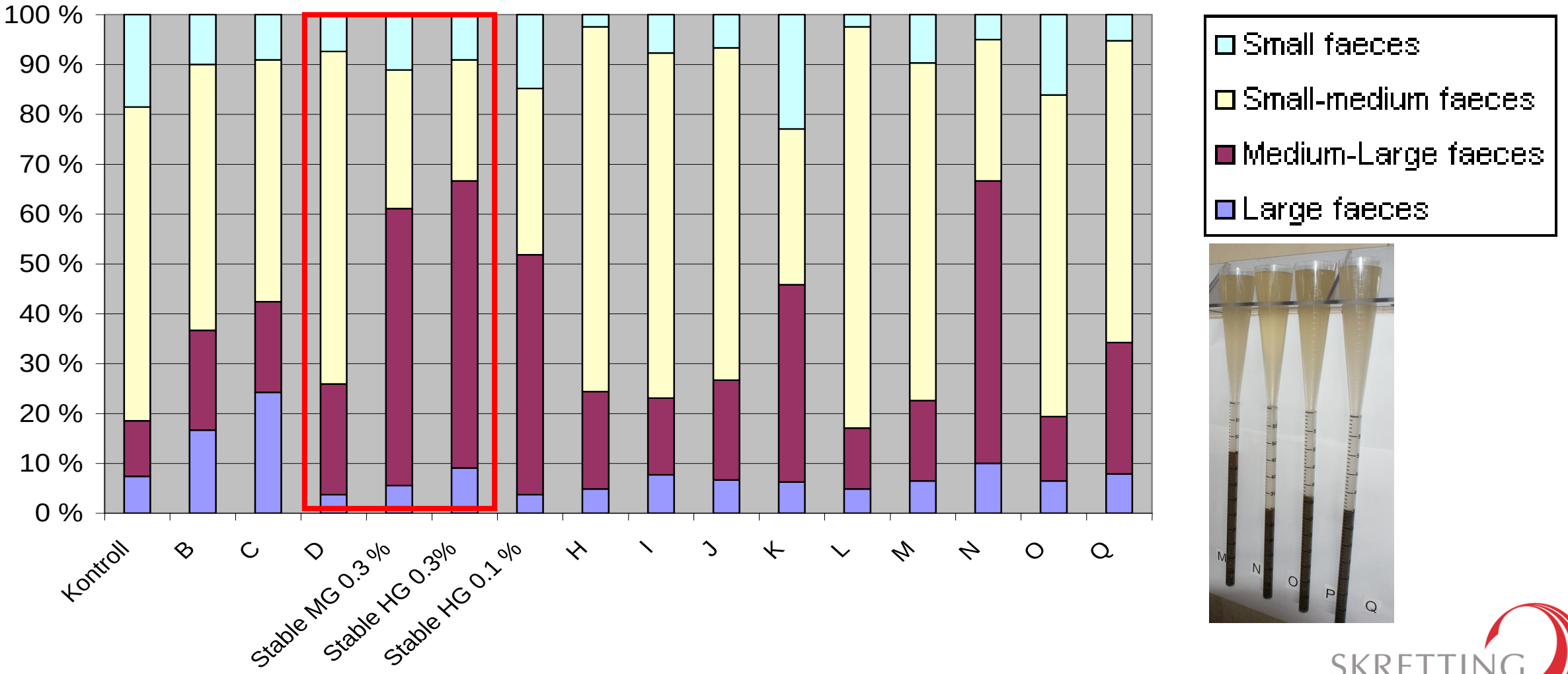


Faeces column data

Data collected over 4 days

RECIRC READY

Share



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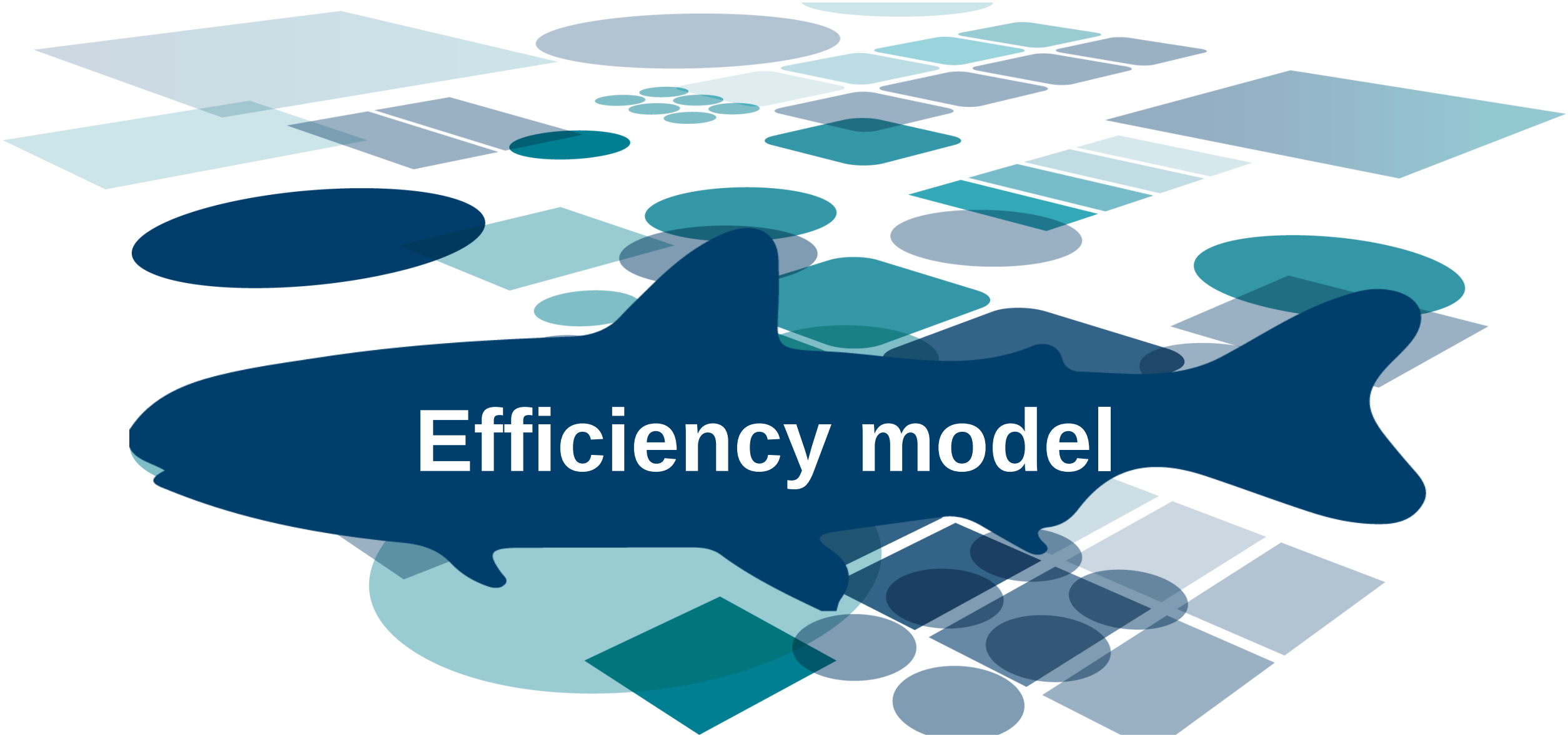
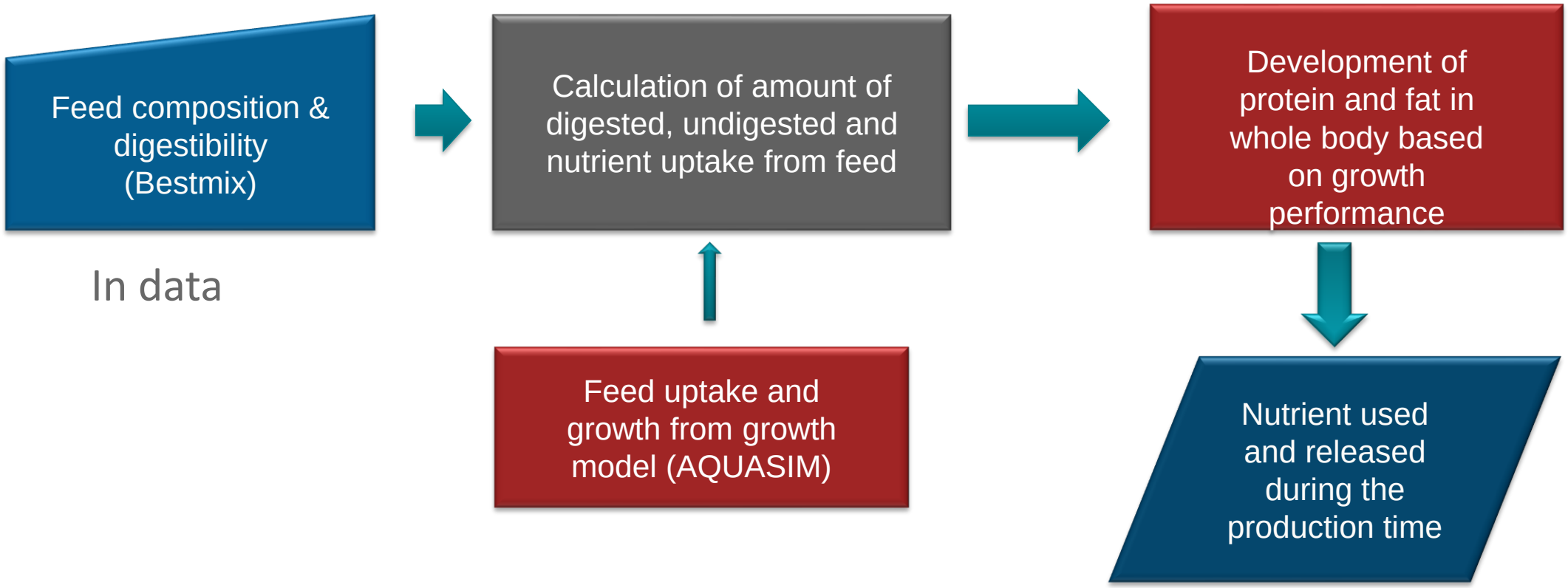


Efficiency model

Model steps


Feed composition & digestibility (Bestmix)
In data
Calculation of amount of digested, undigested and nutrient uptake from feed
Feed uptake and growth from growth model (AQUASIM)
Development of protein and fat in whole body based on growth performance
Nutrient used and released during the production time
Out data

An example

- 1 million fish from 0.18 gram to 80 gram
- Temperature 12°C
- Feed conversion of 0.7 vs. 1.0

Different feeding regimes

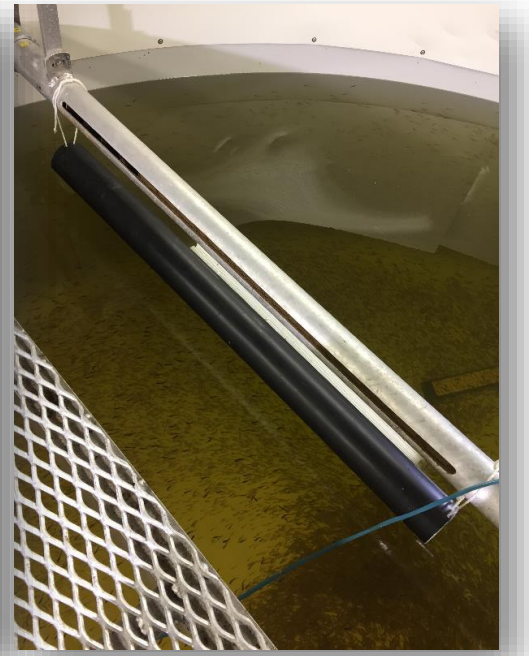
FCR 0.7	Nitrogen	Carbon	Phosphorus
	(kg)	(kg)	(kg)
Faeces	715	5980	492
Filterable faeces	500	4186	343
Dissolved	2239	9428	112
Total	2954	15408	604
Return after filtration	2454	11222	261

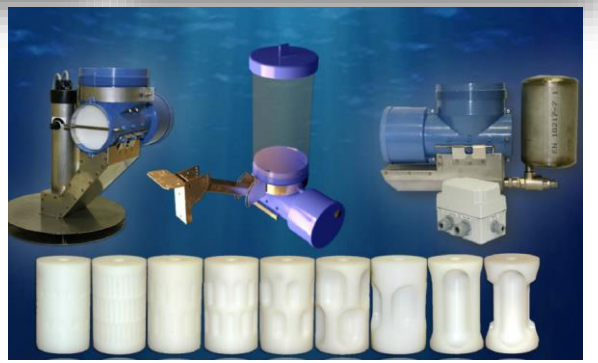
FCR 1.0	Nitrogen	Carbon	Phosphorus
	(kg)	(kg)	(kg)
Faeces	910	7591	625
Filterable faeces	636	5313	436
Dissolved	3366	15284	219
Total	4276	22875	844
Return after filtration	3640	17562	408

Δ nitrogen	=	+1186 kg
Δ carbon	=	+ 6340 kg
Δ phosphorus	=	+147 kg

Feed availability/coverage is about:

- Sinking speed of feed
- Feeding intensity
- Spread from feeder\feeding system
- Speed of current in tank
- Tank depth





Different feed regimes

Standard	Nitrogen	Carbon	Phosphorus
	(kg)	(kg)	(kg)
Faeces	715	5980	492
Filterable feces	500	4186	343
Dissolved	2239	9428	112
Total	2954	15408	604
Return after filtration	2454	11222	261

RC	Nitrogen	Carbon	Phosphorus
	(kg)	(kg)	(kg)
Faeces	714	5988	492
Filterable faeces	624	5237	429
Dissolved	2241	9430	112
Total	2955	15418	604
Return after filtration	2331	10181	175

Δ nitrogen = - 123 kg
Δ carbon = - 1041 kg
Δ phosphorus = - 86 kg

New R&D facilities

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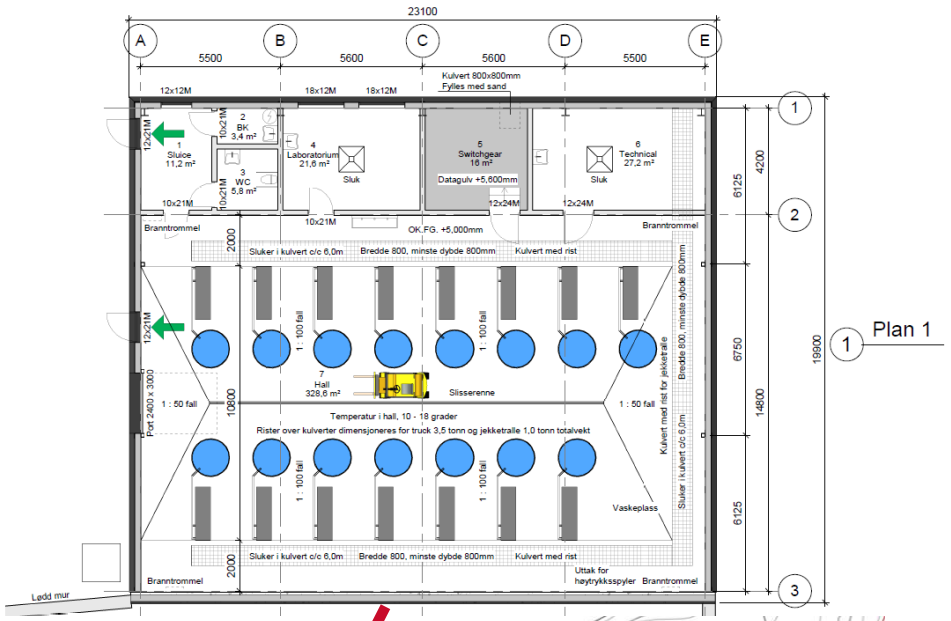
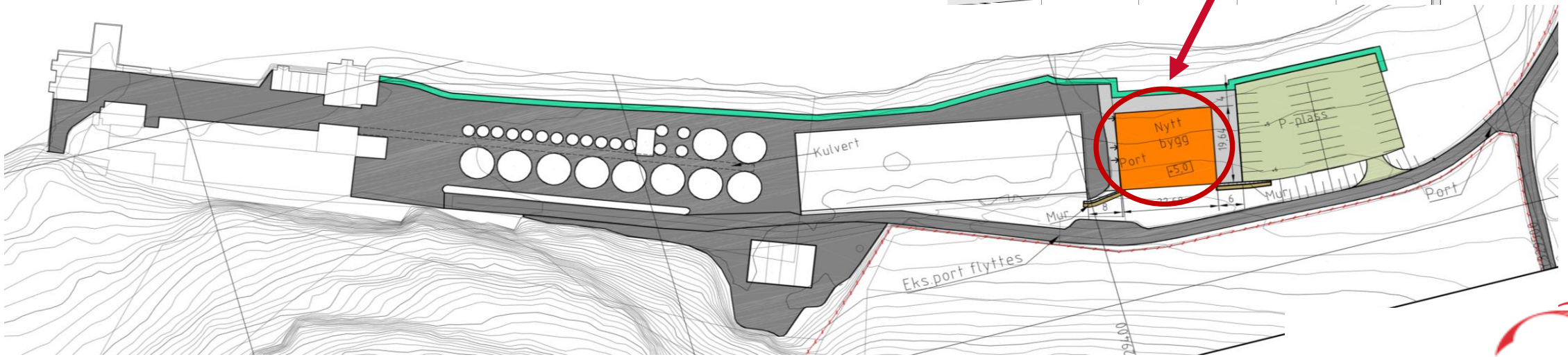
Expansion at Lerang

- 12 independent, «modular», 1.5 m^3 RAS
- Laboratory for water analysis
- Operational from Q3 2017
- Freshwater and full salinity range, 20-1000 g fish
- Alarm and control system for O_2, CO_2, pH, temp., salinity, tank+system level





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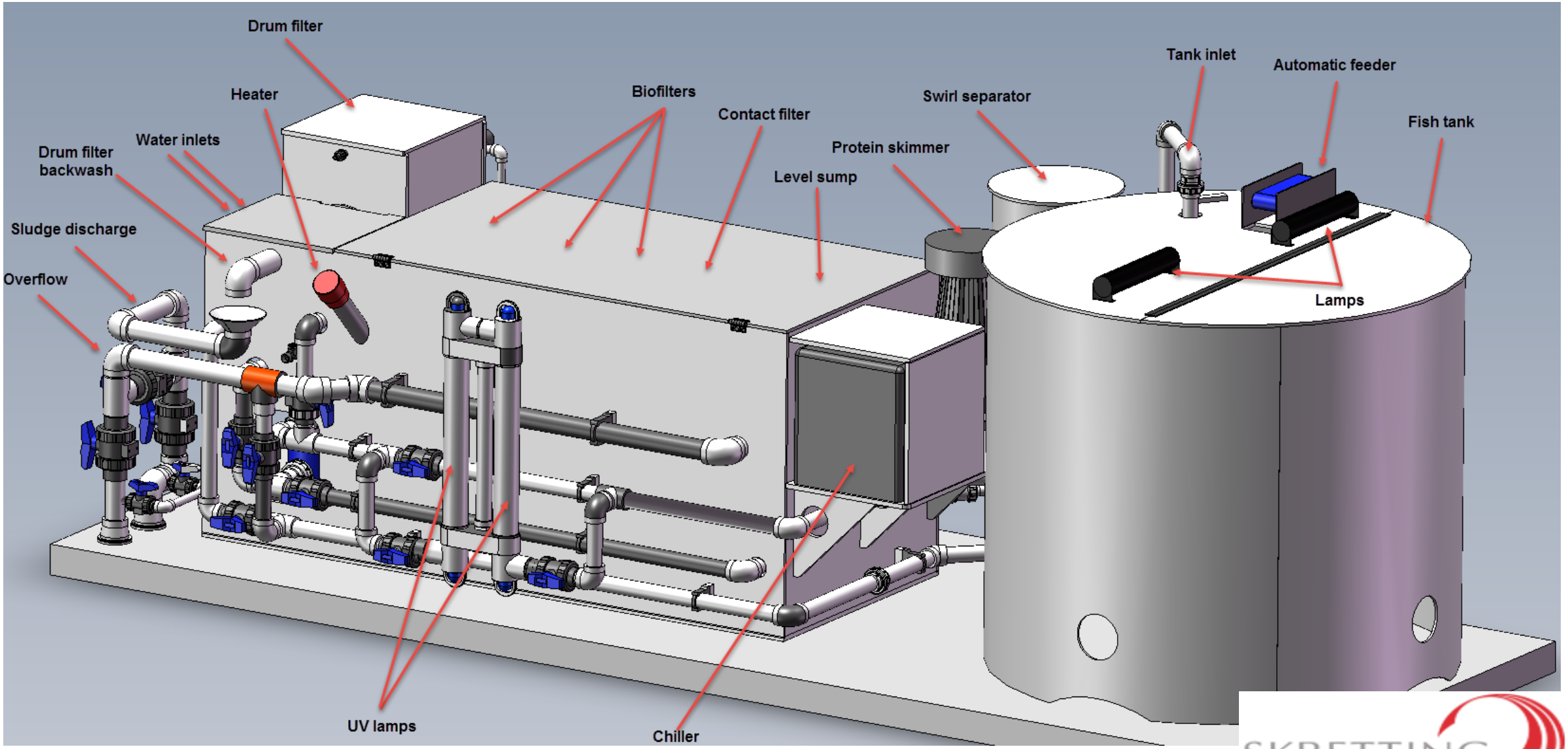
Mikroflex possibilities



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Sludge handling

- Pilot project between Marine Harvest, Scanship, Ivar, Høst and Skretting

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