

Can we boost lumpfish welfare and survival through nutrition?

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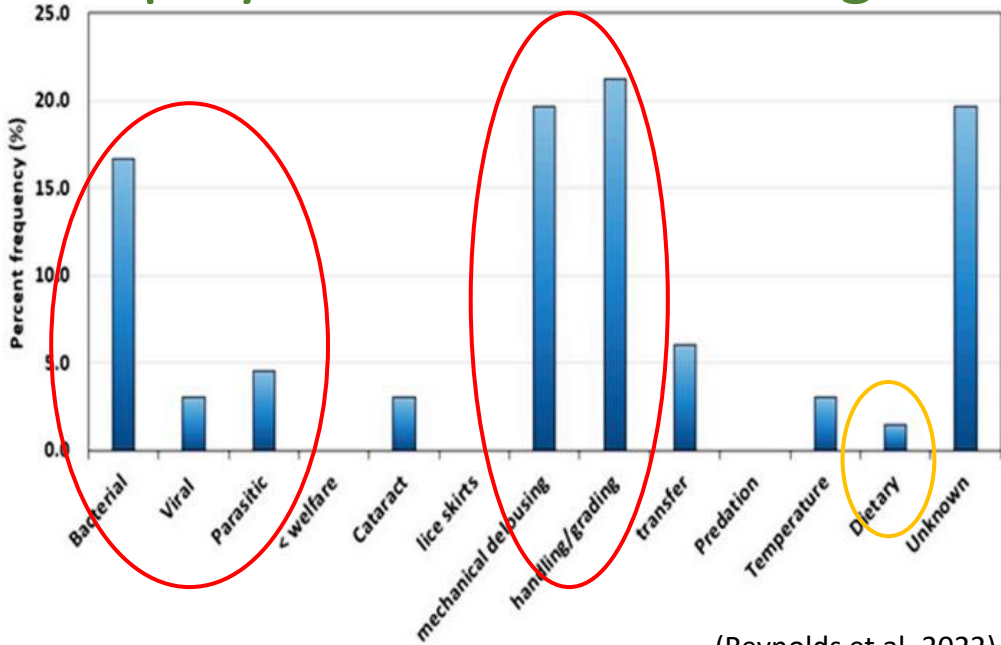
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Fish welfare

$$Welfare = Health \& Disease \times Nutrition \times Genetics \times Environment \times Management$$



Lumpfish deployed in salmon sea cages:



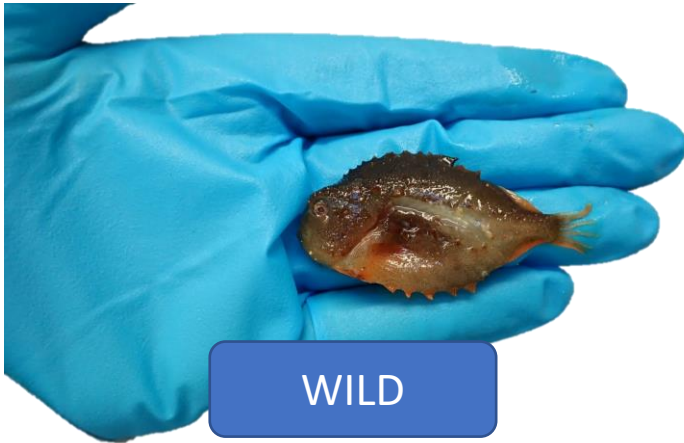
(Reynolds et al.,2022)

High mortalities (40% - 100%)

↓

- Poor health conditions
- Nutritional deficits

Aim of the study



- Investigate key differences between **wild** and **farmed lumpfish** regarding welfare and nutritional status.
- Elucidate nutritional requirements.
- Formulate a **new feed** that can improve lumpfish survival at the deployment stage.

Materials & Methods

WILD

- 170 Coastal and pelagic lumpfish

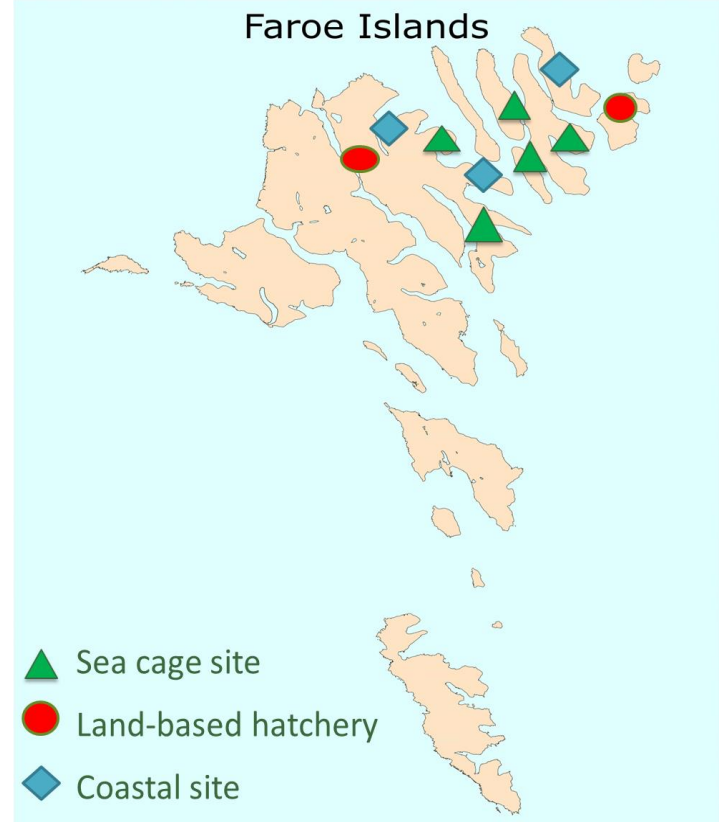


SIZE CLASS

<50 g
50-150 g
150-300 g
>300 g -1kg
1 - 3 kg
3 - 5 kg

FARMED

- 390 Deployed lumpfish
- 60 pre-deployment lumpfish



LUMPFISH SURVEY



FEED TRIAL

HEALTH & WELFARE

- ❖ Morphometric data
- ❖ Operational Welfare Indicators (OWIs):

Fin damage

Skin

Eyes

Sucker disc

Liver color (Eliassen et al., 2020)

- ❖ **Stomach content**

- ❖ Histology on liver, intestine,
Spleen

WILD - FARMED



NUTRITION

- ❖ Liver:

Total lipid (Folch *et al.*, 1957)

Fatty acid profile (Christie, 2003)

Lipid classes (Henderson and Tocher, 1992)

Pigments (Barua *et al.*, 1993)

- ❖ Whole fish and feeds:

Proximate analysis (AOAC, 2000)

Fatty acid profile (Christie, 2003)

Amino acid profile

Results – Welfare

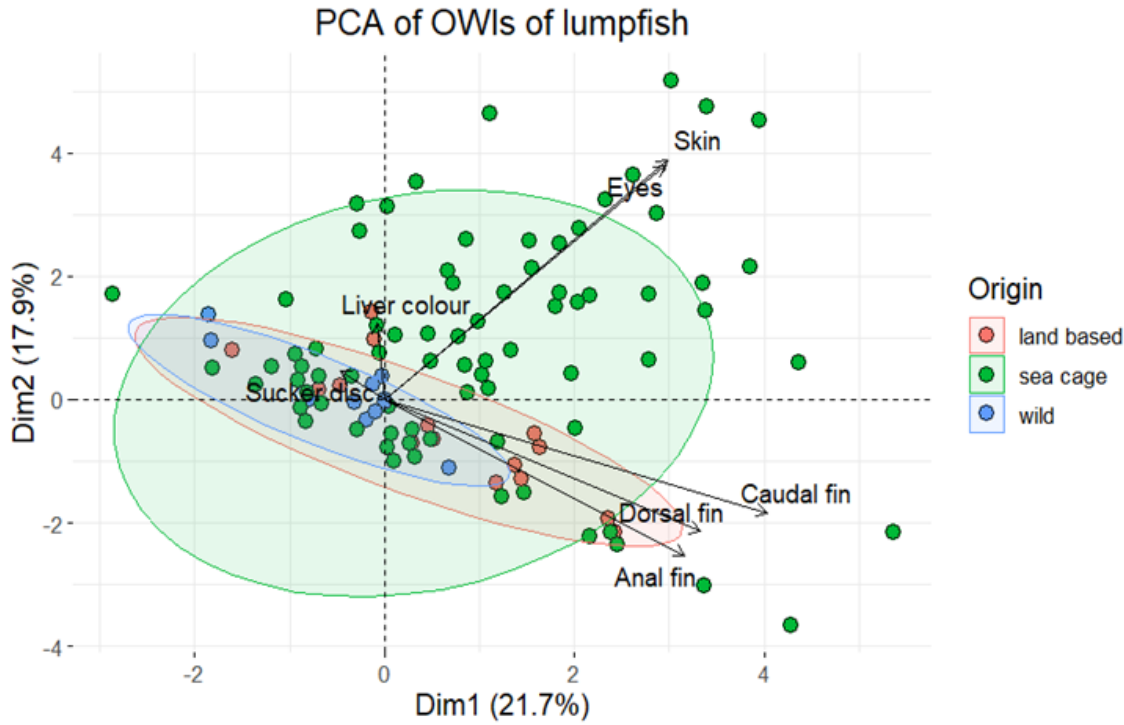
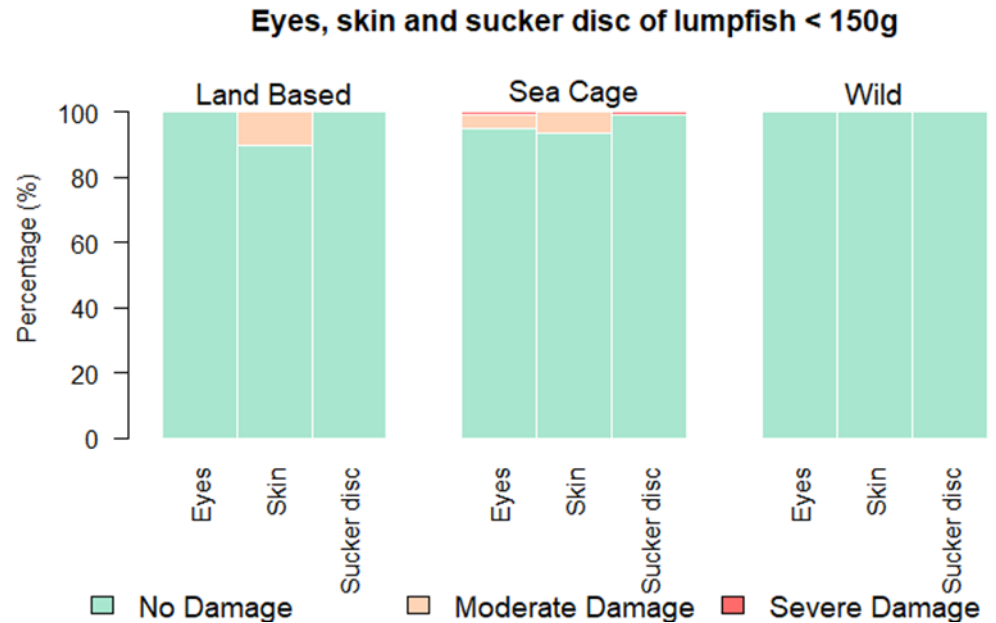
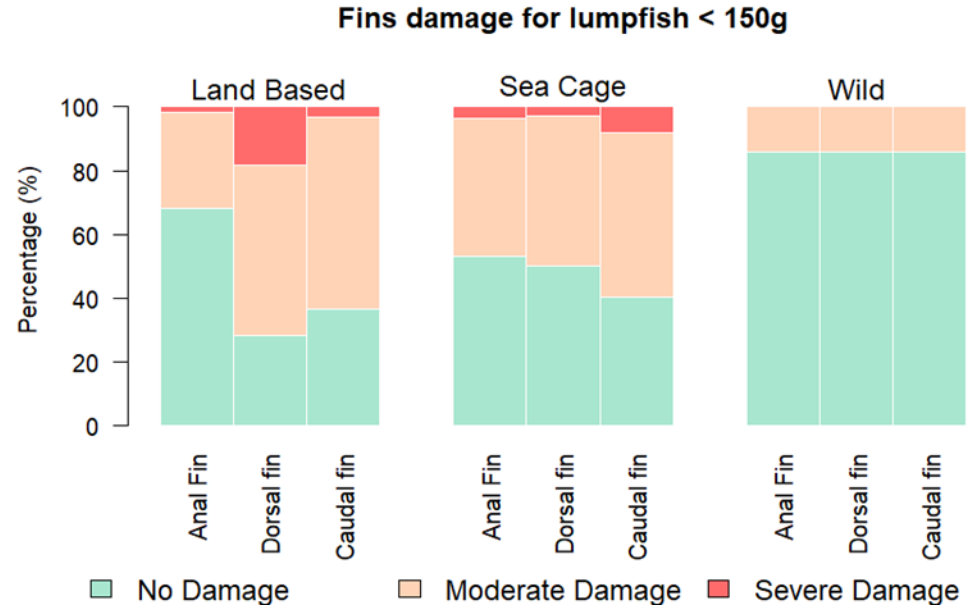
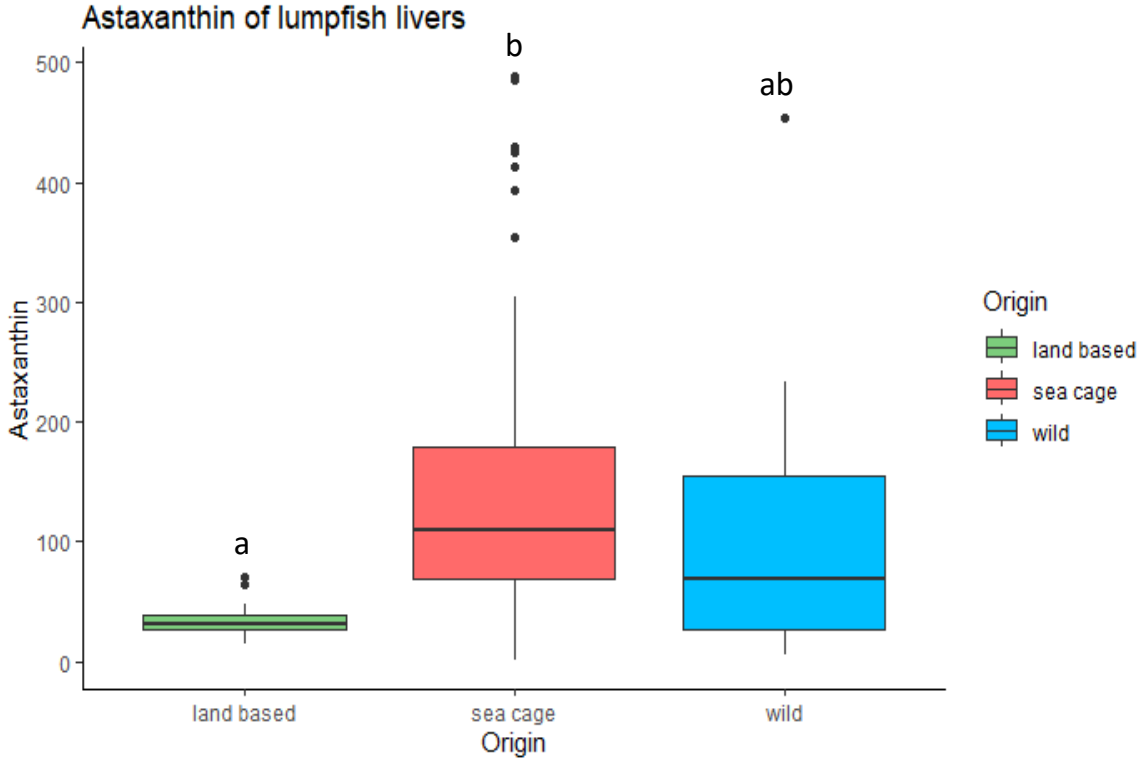
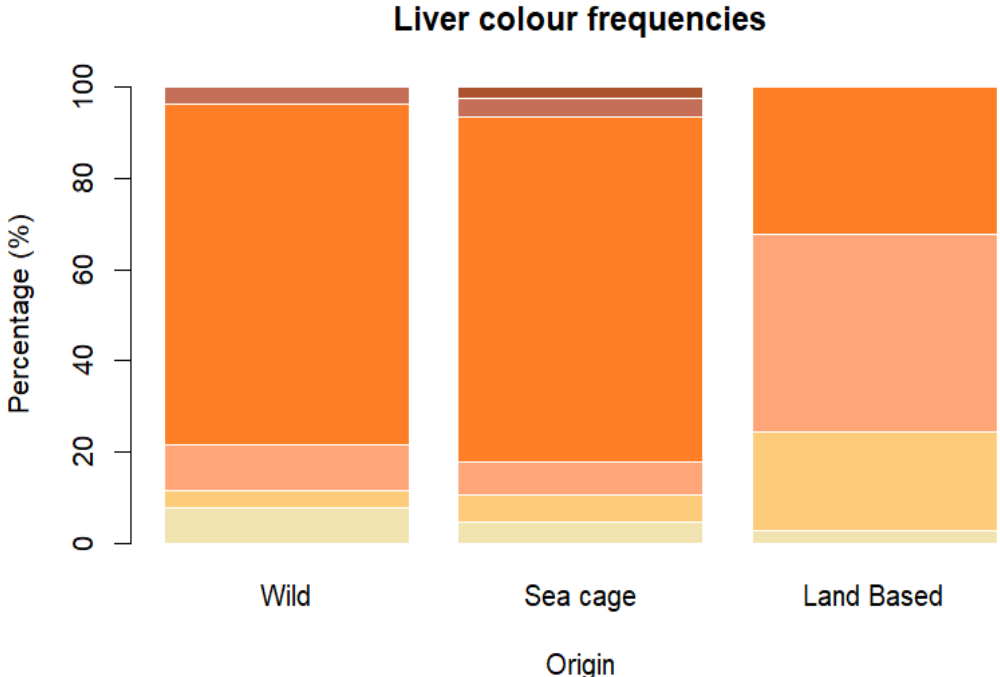


Fig 1. Principal Components Analysis biplot of OWIs of lumpfish from different origins.

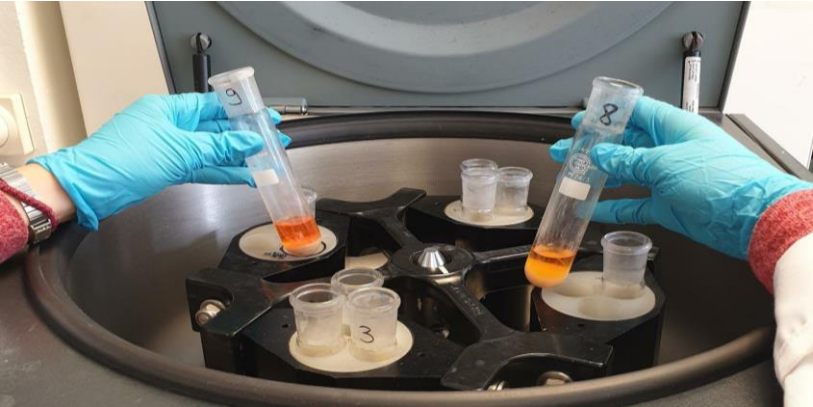


Results – Welfare & Nutrition

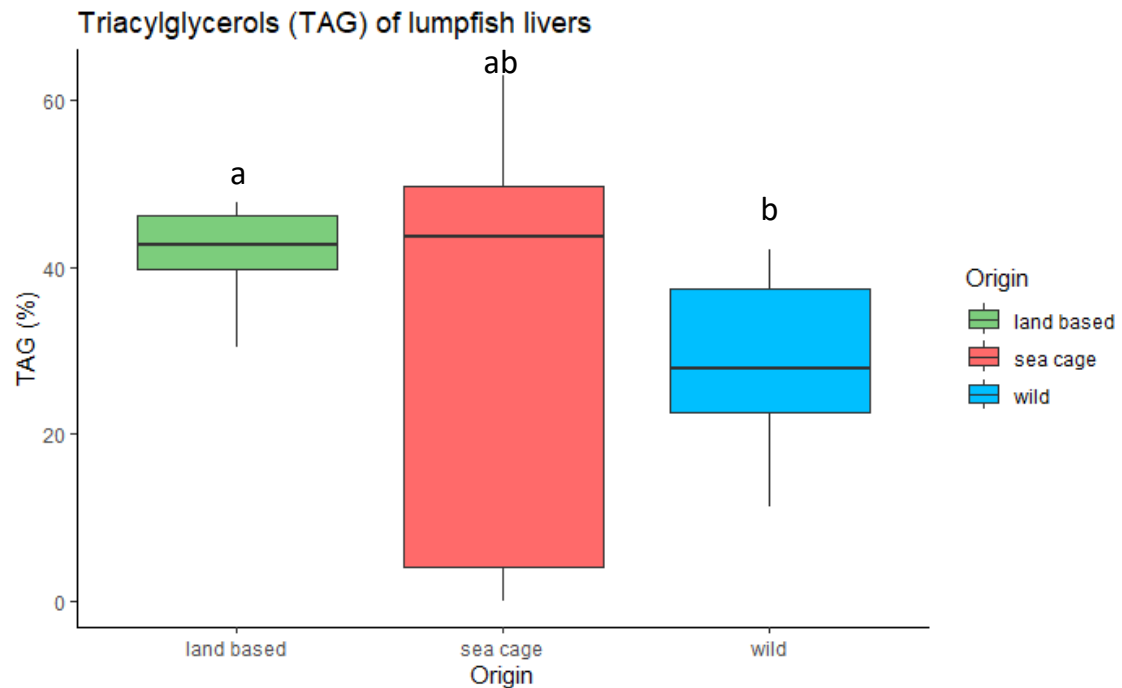
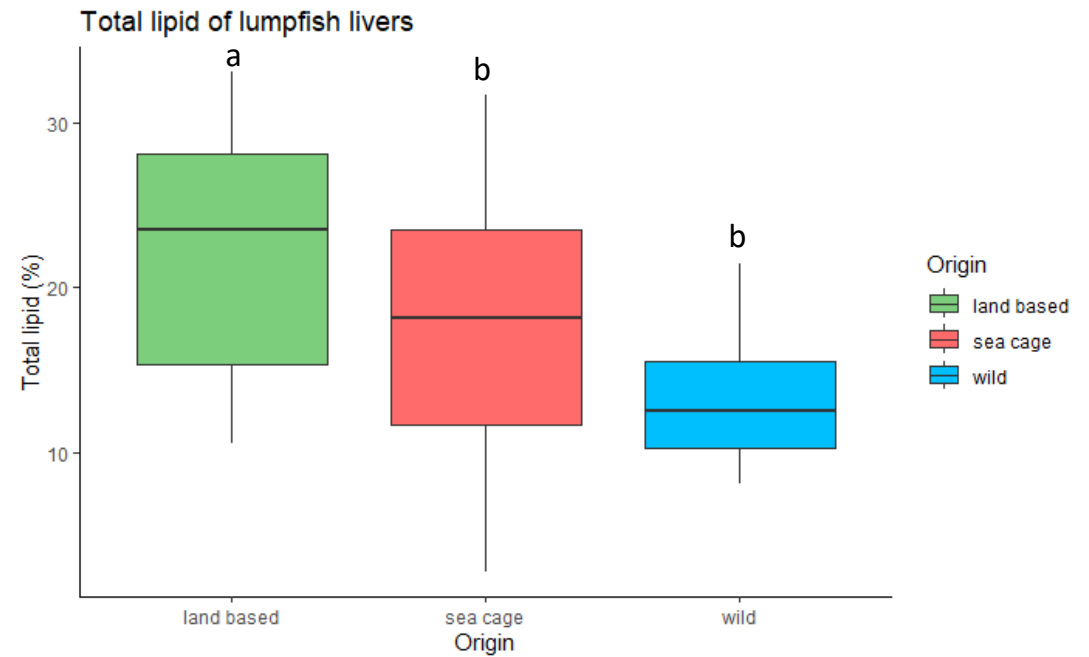
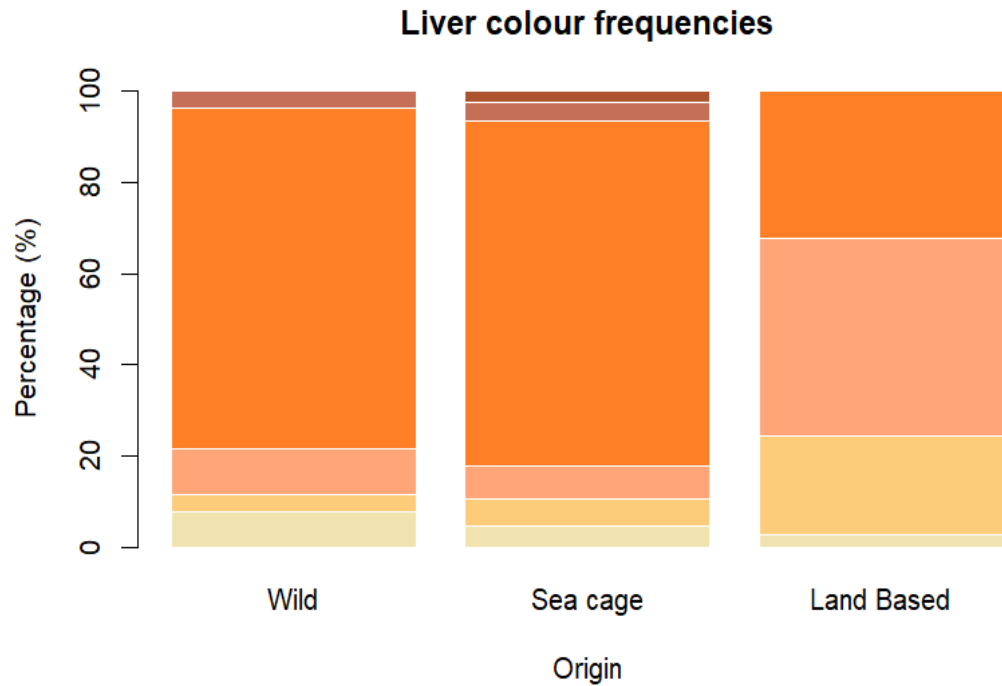


(Eliassen et al., 2020)

Astaxanthin levels are **higher** in livers from lumpfish in the **sea cages** compared to the land based hatcheries.



Results – Welfare & Nutrition



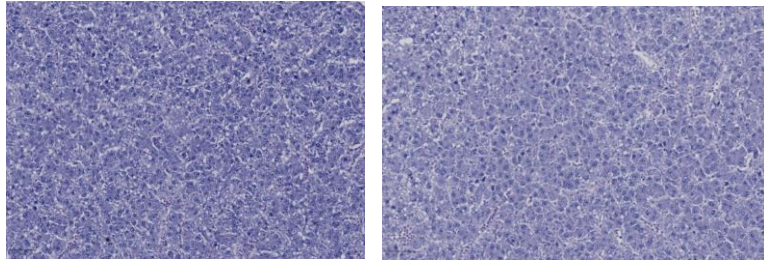
(Eliassen et al., 2020)

Fat content and TAG are **higher** in livers from lumpfish in the **land based hatcheries** compared to the sea cages and the wild.

Results – Health

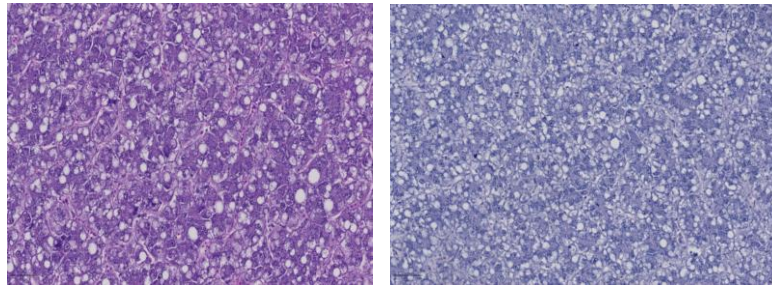
Liver histology

1-2%



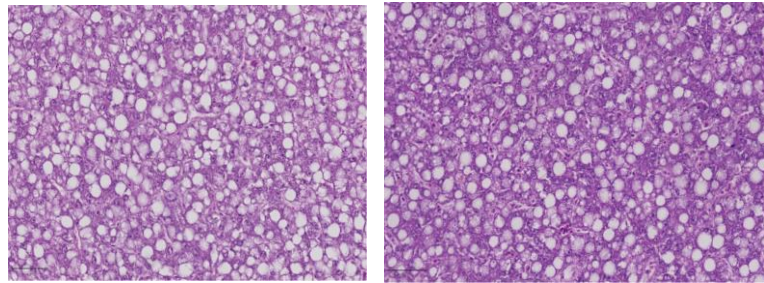
Sea cage

6-9%



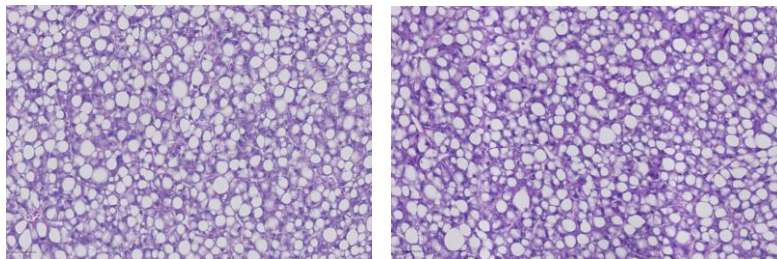
Wild

13-15%

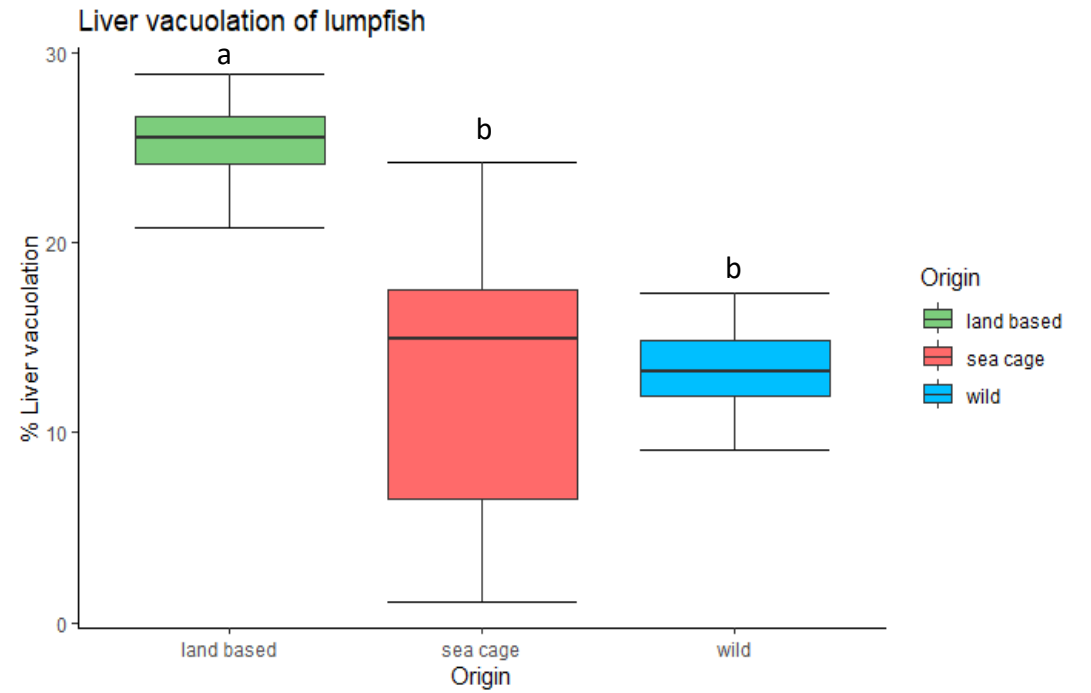


Sea cage

27-29%



Land based hatchery

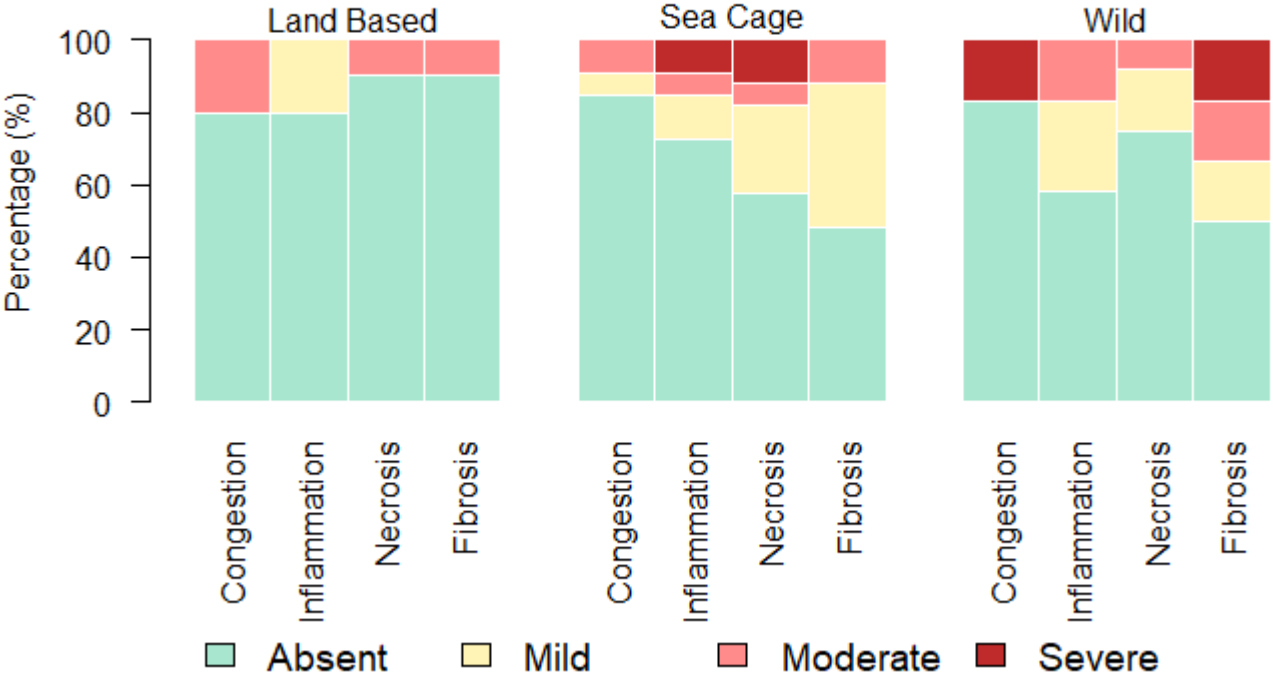


Liver vacuolation is **higher** in livers from lumpfish in the **land based hatcheries** compared to the sea cages and the wild.

Results – Health

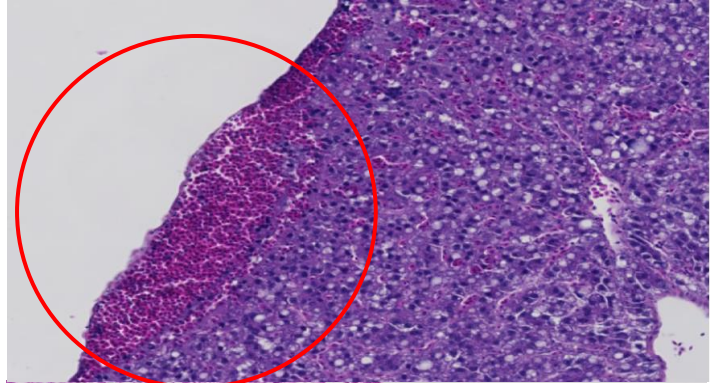
Liver histology

Histological observations of lumpfish livers

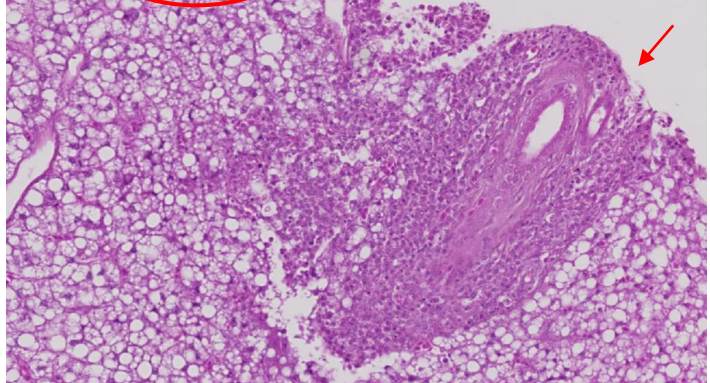


Severe inflammation and **necrosis** are found in the fish from the **sea cages**.

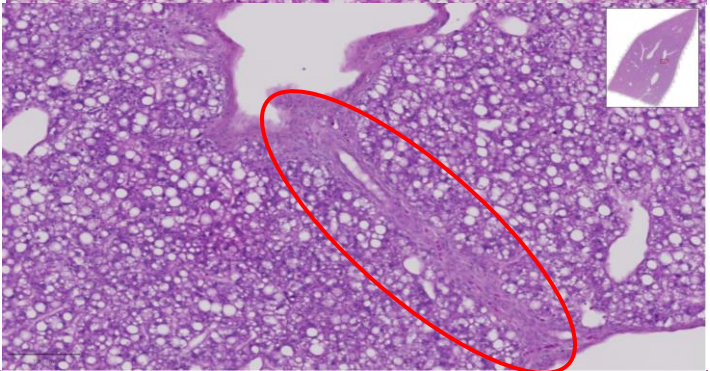
Wild fish had some severe signs of **congestion** and **fibrosis**.



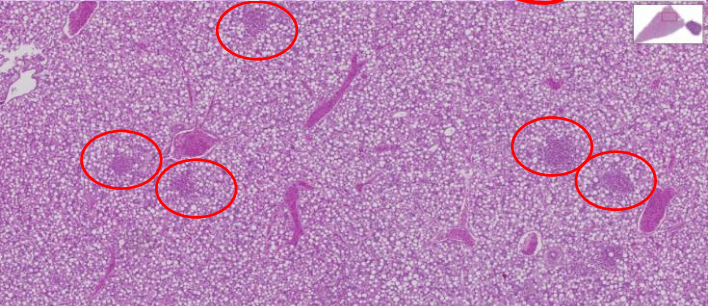
Congestion



Inflammation



Fibrosis



Necrosis

Results - Nutrition

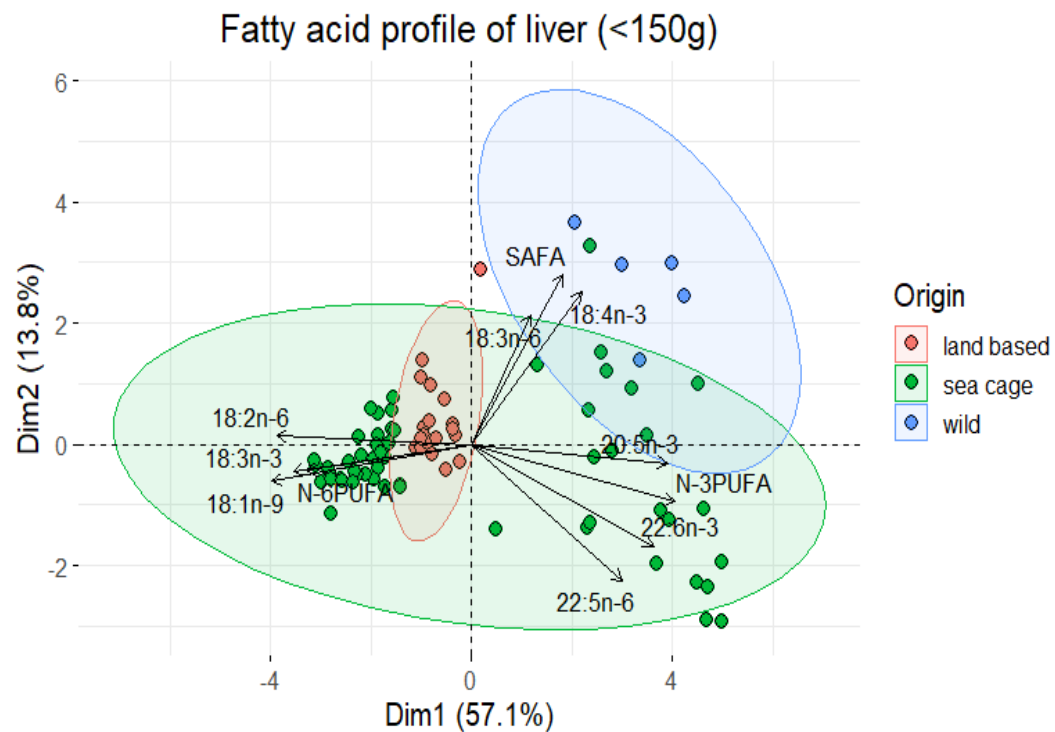
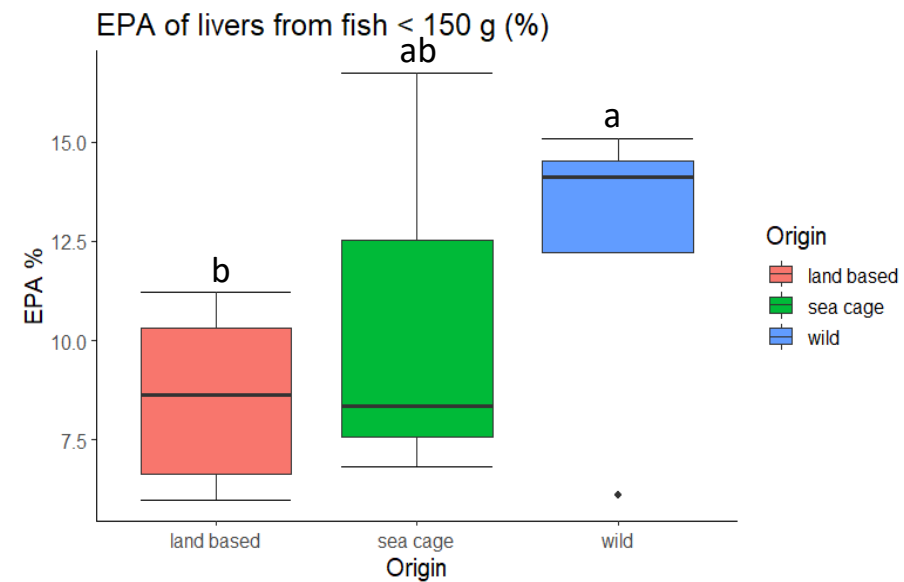
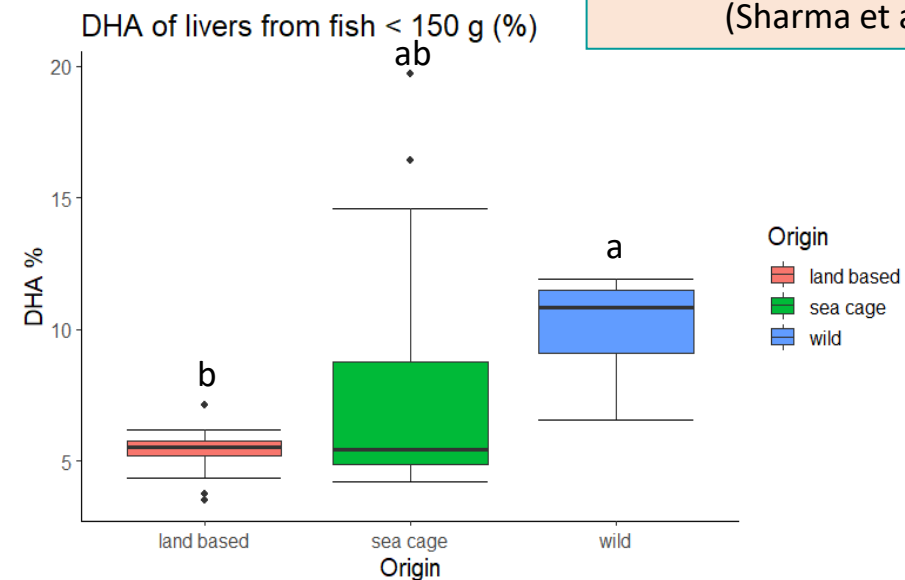


Fig 7. Principal Components Analysis biplot of fatty acid profile of livers.

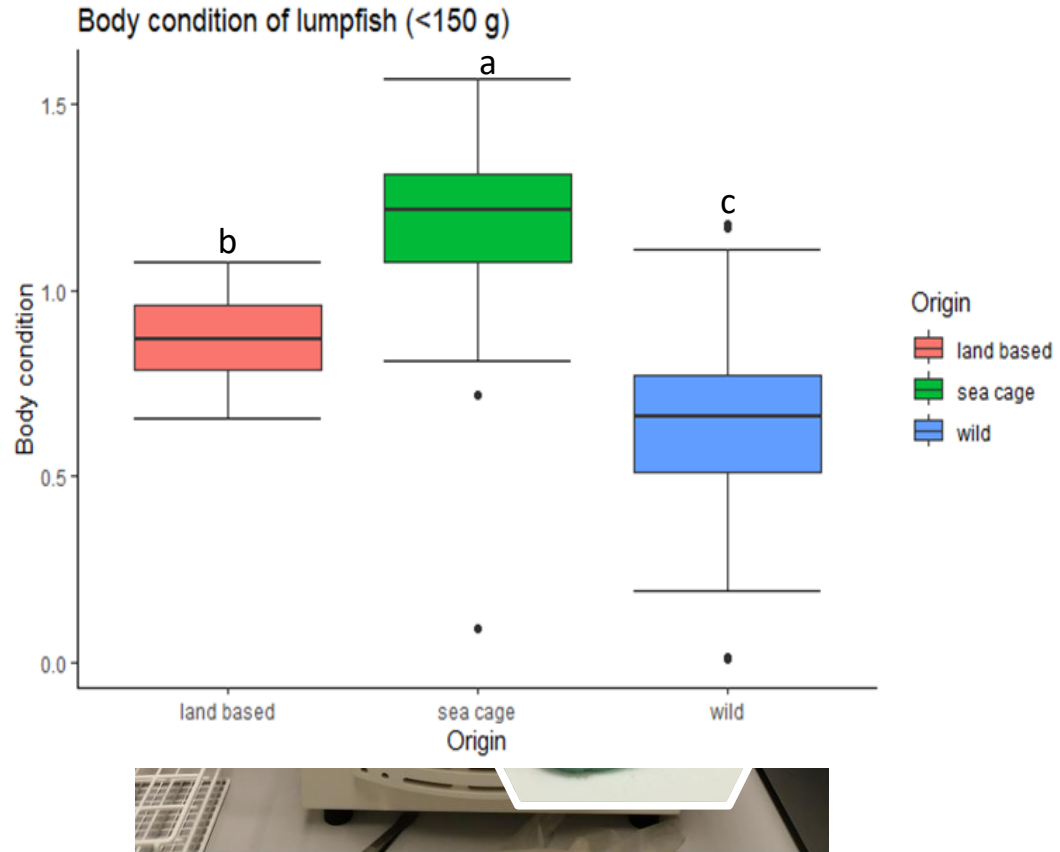
The PCA for fatty acid profile shows that the highest variation is found in **Omega-3**.



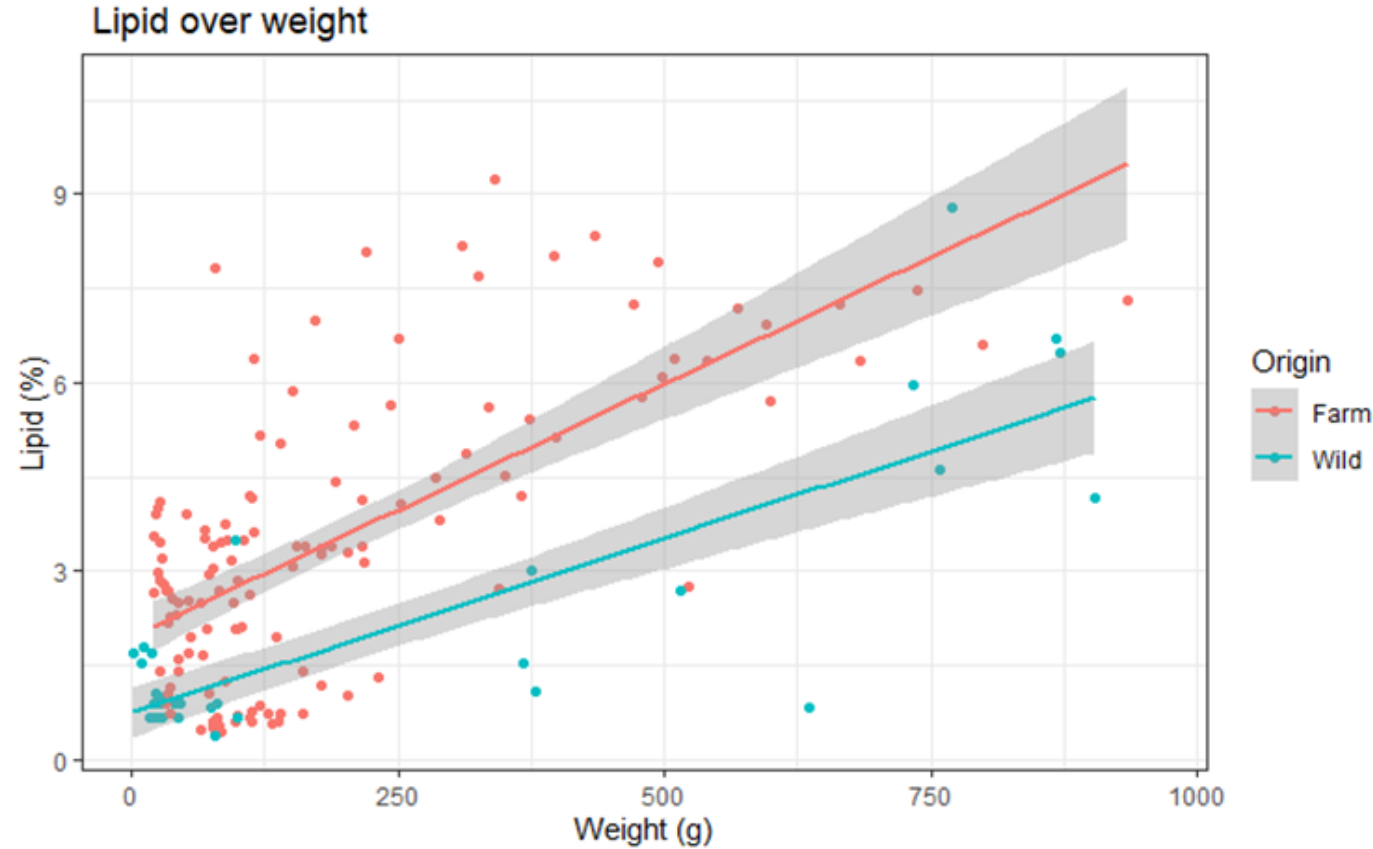
Omega-3 (EPA and DHA) are higher in wild fish than farmed ones (Sharma et al., 2010).



Results - Nutrition



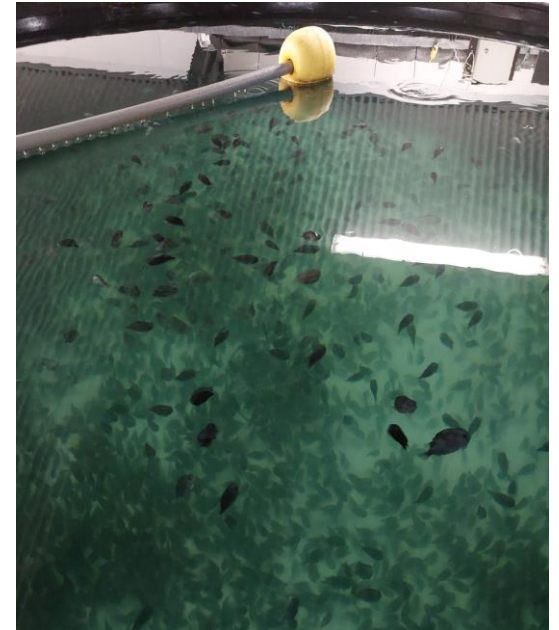
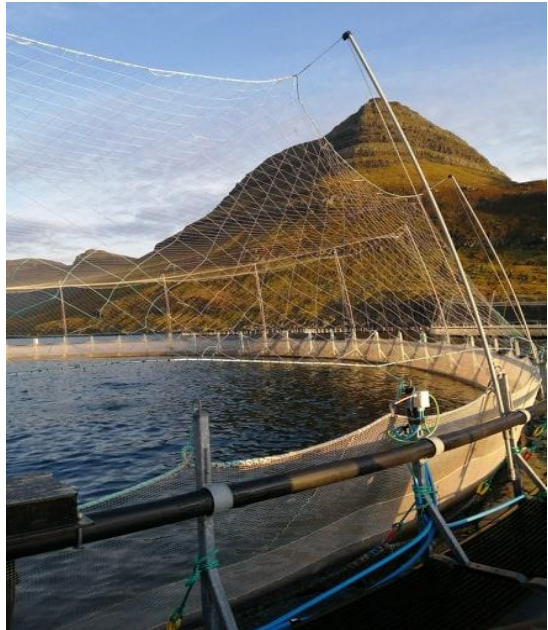
Lumpfish from the sea cages have an higher body condition.



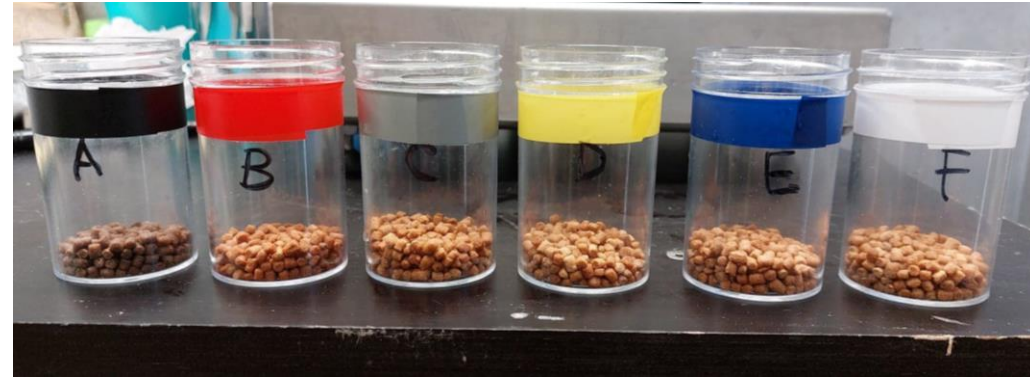
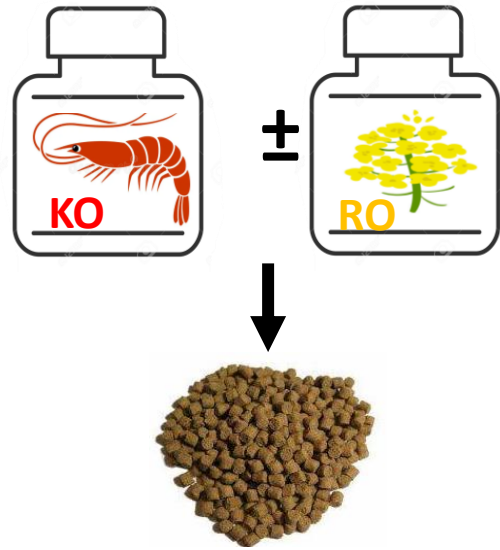
Wild fish have significantly **lower fat** in their body compared to the farmed ones.

Conclusions of the survey:

- **Lumpfish deployed in the sea cages:** higher variability on body composition and welfare parameters such as fin damage and liver score. They have access to both salmon and lumpfish feeds, seasonal preys and they are exposed to different environmental conditions.
- **Pre-deployment lumpfish:** higher amount of lipid and higher dorsal fin damage. This reflects the diets they get in the hatcheries and the controlled environmental conditions.
- **Wild lumpfish:** different body composition and lower amount of lipid due to their natural diet.



Feed trial and stress challenge

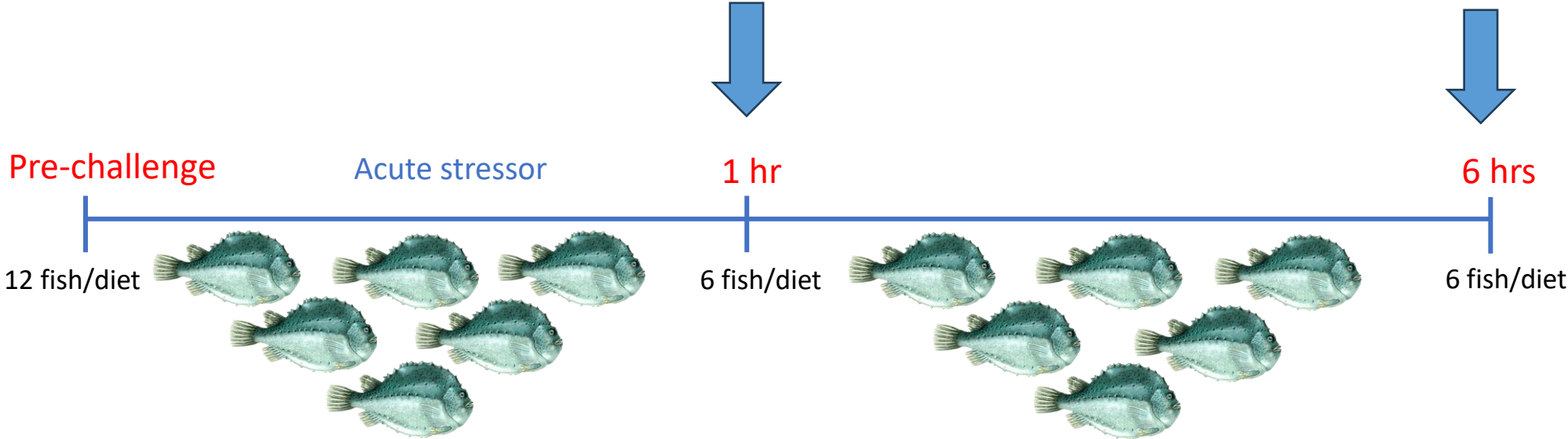


COM 100 KO 75KO 50KO 25KO OKO



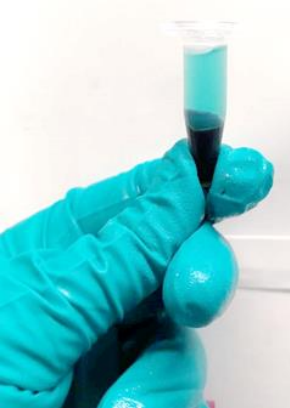
Stress challenge:

Fish were actively chased using a net for a duration of **8 minutes** and they were netted and confined in the water for **1 minute** (adapted from Hvas et al., 2018).



Each fish was sampled for:

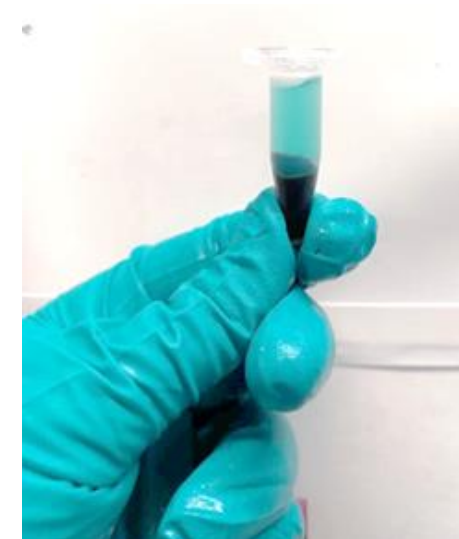
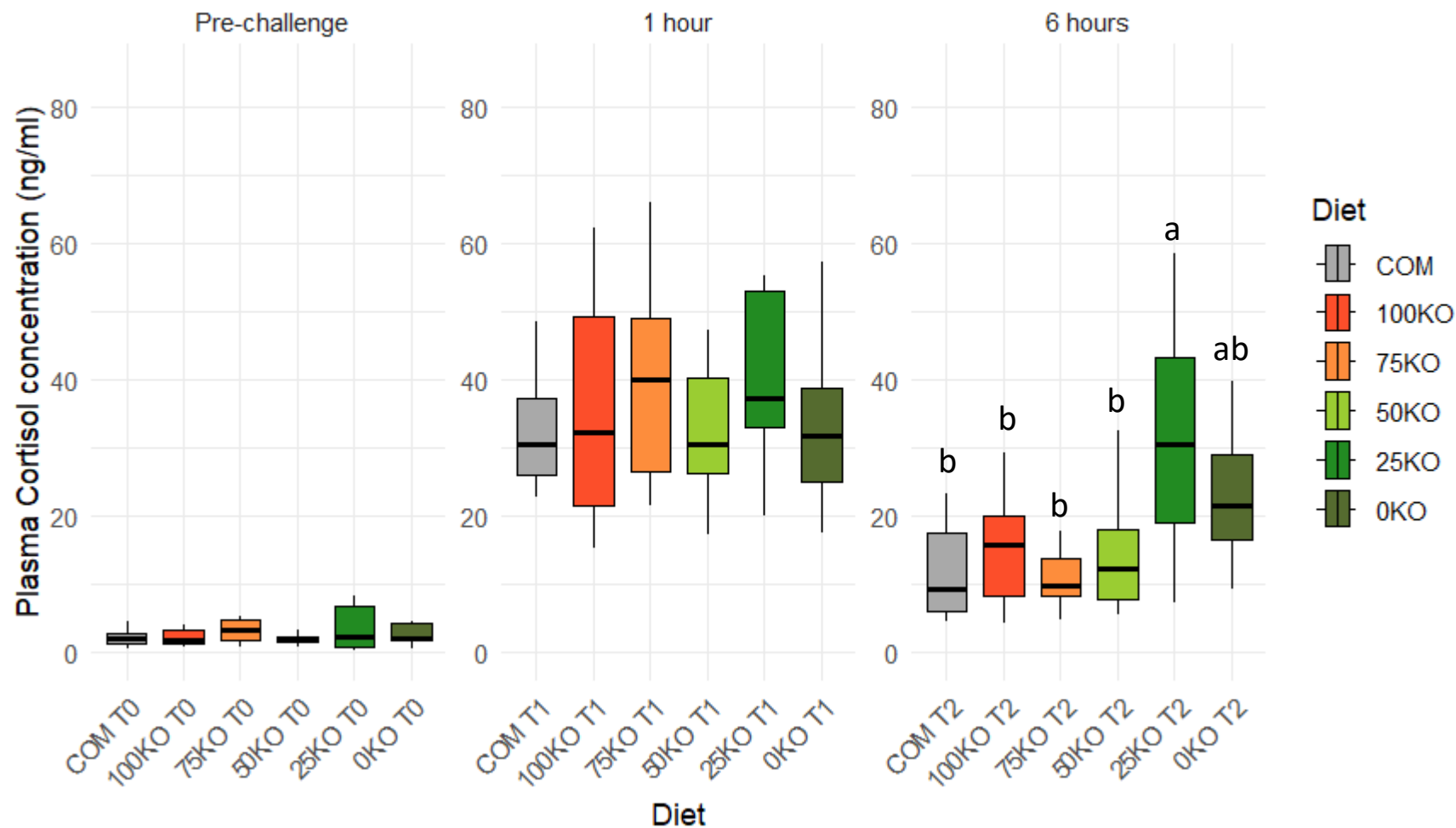
- Blood for plasma cortisol.



Results – Plasma cortisol



Variations in plasma cortisol concentrations over different sampling points



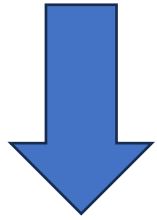
Fish fed with a higher inclusion of rapeseed oil had a longer recovery time after exposure to an acute stressor.



(Jutfelt et al., 2007; Pérez-Sánchez et al., 2013)

Final conclusions

LUMPFISH
SURVEY



FEED TRIAL

- Omega-3 (EPA and DHA) are higher in wild than farmed fish.
- Wild fish are leaner than farmed fish.

High energetic feeds are not recommended.

- The minimum requirements of EPA + DHA were covered by all the experimental diets.

However, to boost the health and stress responses of lumpfish, inclusions of 18-20% EPA+DHA should be used when formulating.



Takk fyri!



Viðurkenning



H A V S B R Ú N



AKER BIOMARINE