

# Operational Welfare Indicators for Lumpfish

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# Background

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Lumpfish widely used as 'cleaner fish' for sea lice control in salmon farming

Welfare challenged → compromise delousing efficiency

Welfare standards for lumpfish are still missing

Development/Validation of an Operational Welfare Score Index

# OWI for lumpfish

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- Environment-based OWIs
  - Water chemistry parameters ( $t^{\circ}$ ,  $O_2$ ,  $CO_2$ , ammonia, ...)
- Laboratory-based OWIs
  - Blood parameters (plasma cortisol, glucose, lactate, ...)
- Group-based OWIs
  - Behaviour, appetite, mortality rate, growth rate...
- Individual-based OWIs
  - Physical damage (fin damage, opercular damage, ...)
  - Body condition
  - Liver colour (+ carotenoids/lipid content) (Eliassen *et al.*, 2020)

# Material and Methods

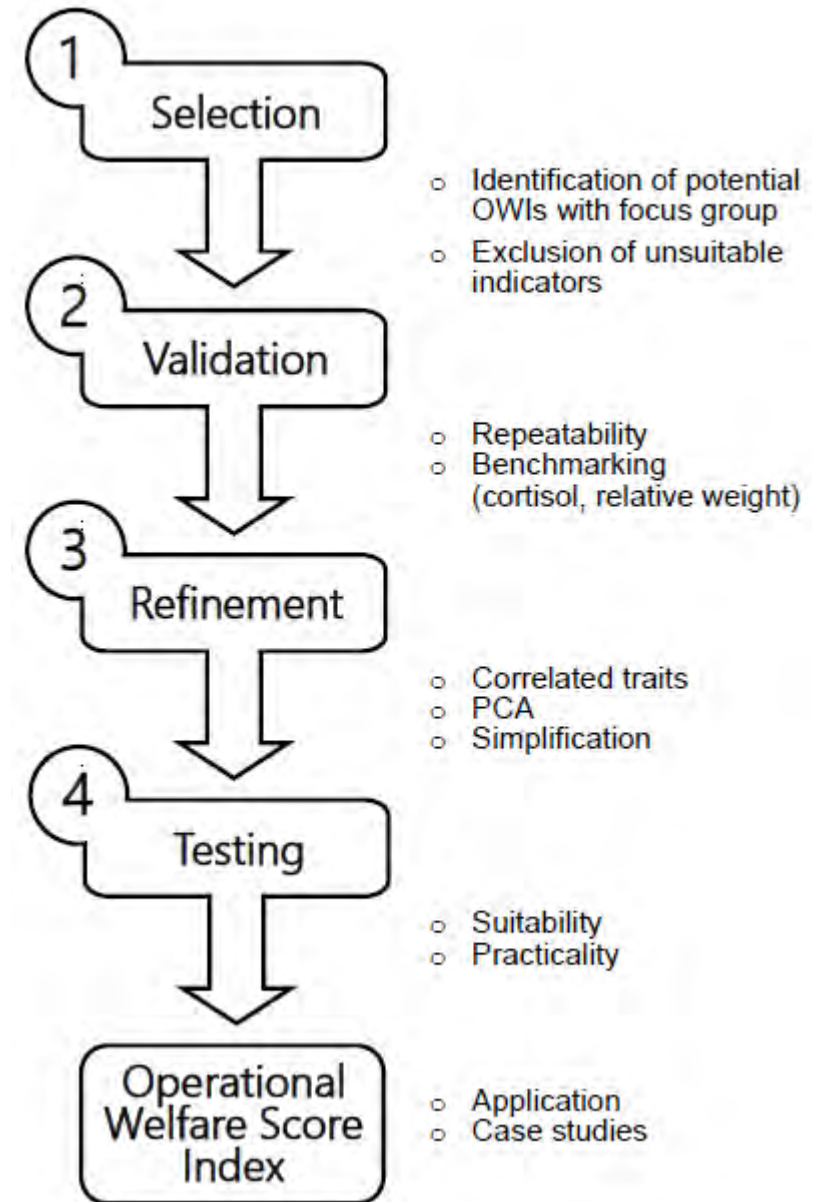
1. External body damage
2. Fin damage
3. Eye condition
4. Eye darkening
5. Suction disc deformities



n=95



n=245




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Development, validation and testing of an Operational Welfare Score Index for farmed lumpfish *Cyclopterus lumpus* L.

C. Gutierrez Rabadan, C. Spreadbury, S. Consuegra, C. Garcia de Leaniz

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# External body damage

Score 0: no lesions present  
Score 1: lesions present

**Score 0**

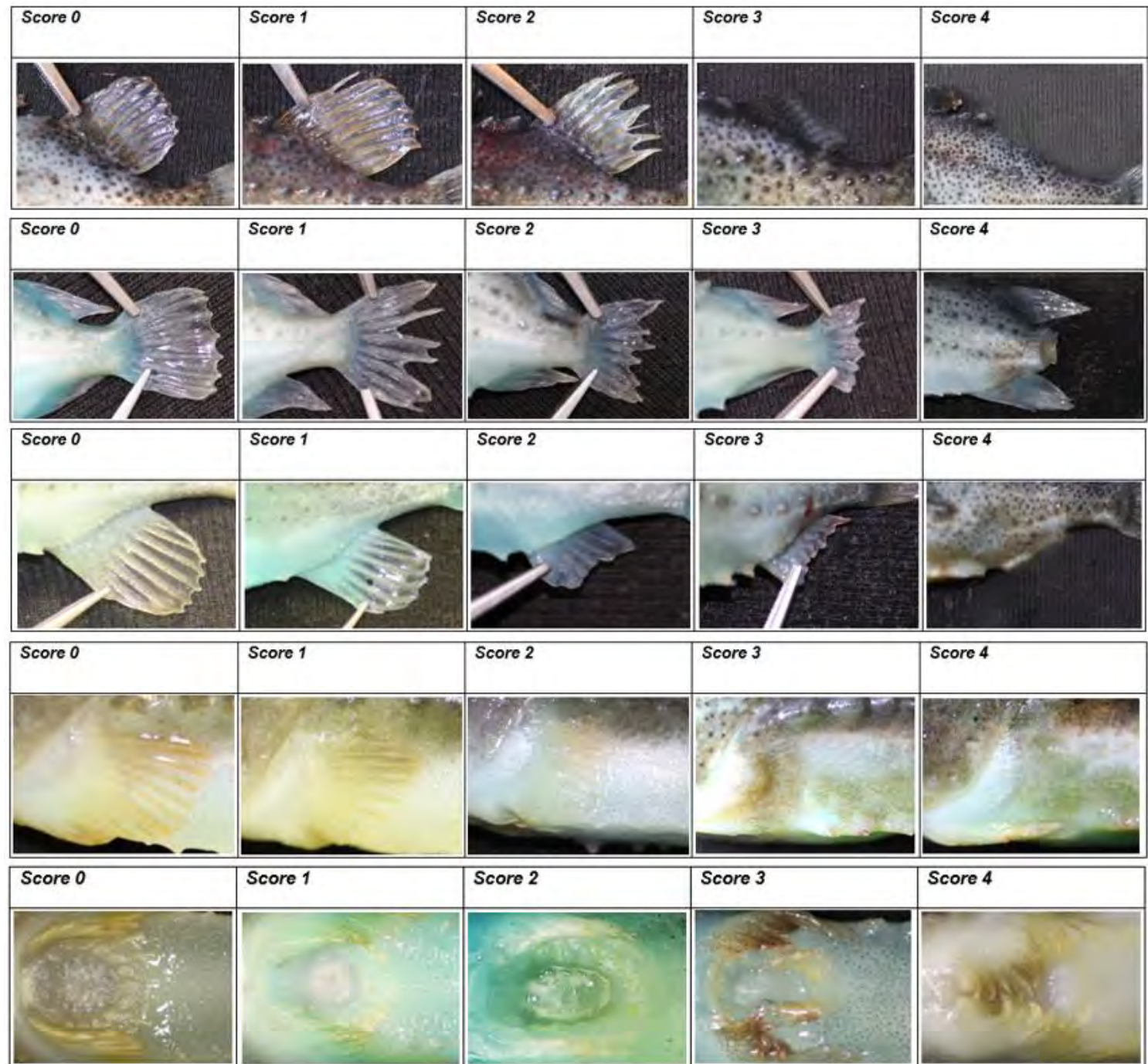


**Score 1**



# Fin damage

Score 0: no fin damage  
Score 1: <25% fin damage  
Score 2: < 50% fin damage  
Score 3: < 75% fin damage  
Score 4: 75-100% fin damage

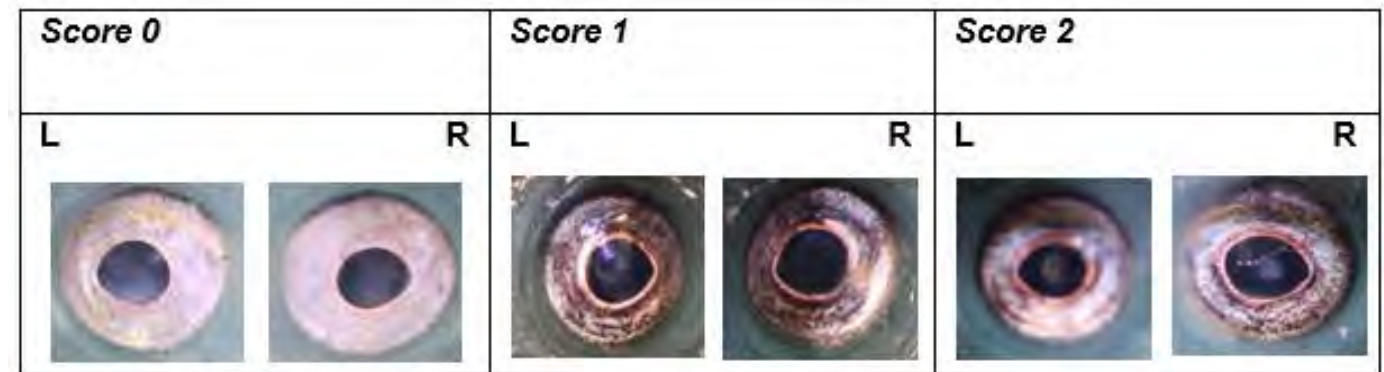
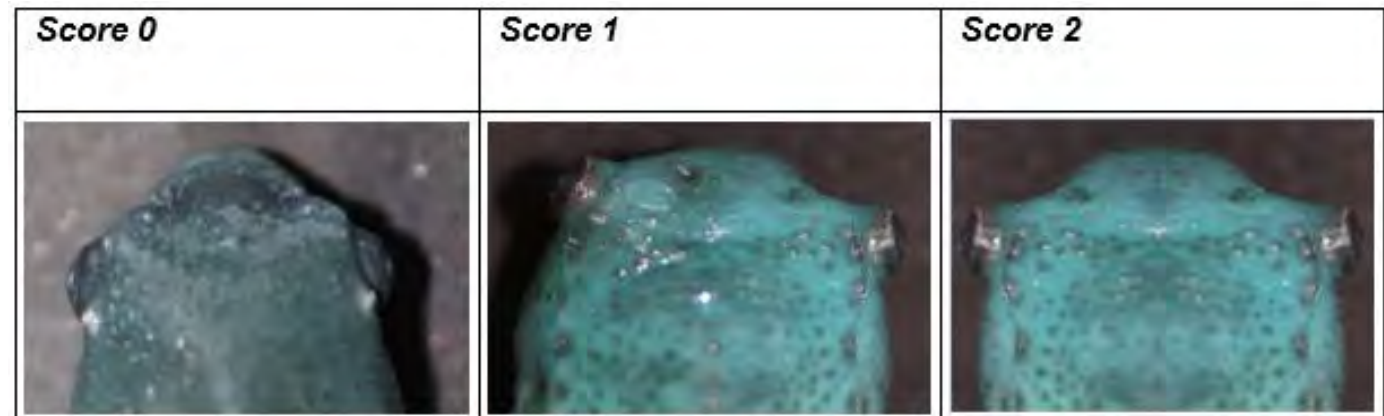
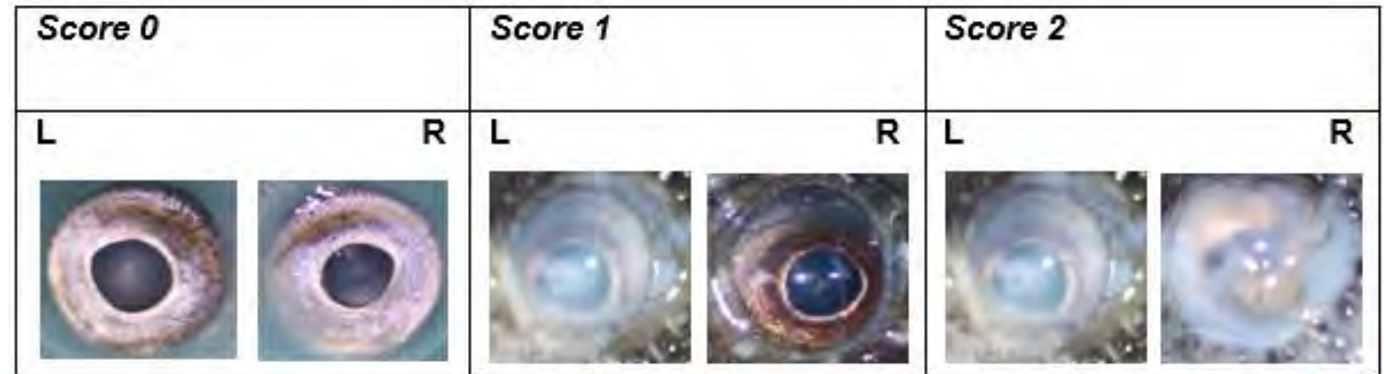





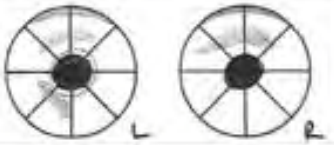




# Eye condition

Eye damage  
Exophthalmia  
Cataracts










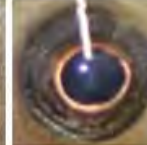
Score 0: no present  
Score 1: unilateral  
Score 2: bilateral



# Eye darkening

ID	Observation	Drawing	Total	ED (%)
17.220618			16.25% 10%	<b>13.13%</b>
9.220618			43.75% 47.5%	<b>45.63%</b>
10.220618			70% 91.25%	<b>80.63%</b>

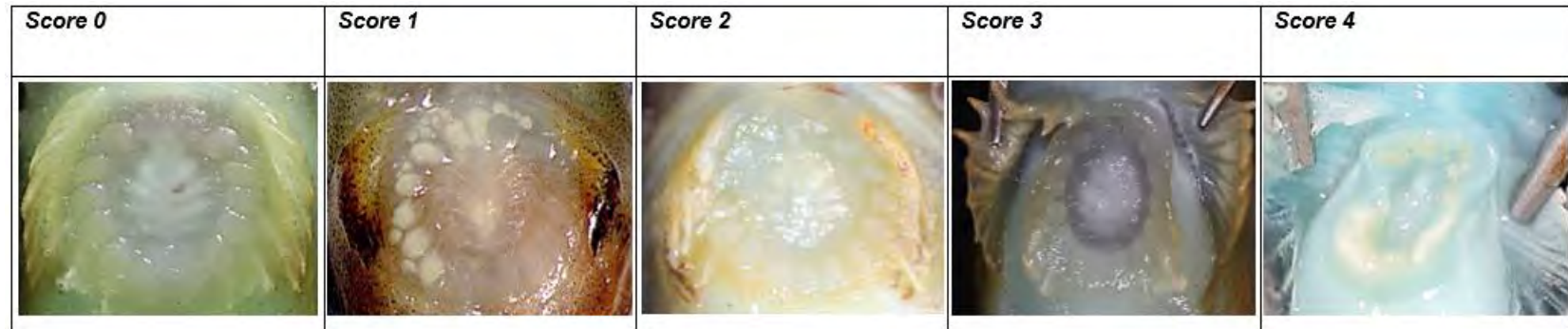
- Score 0: ED 0%
- Score 1: ED < 25%
- Score 2: ED < 50%
- Score 3: ED < 75%
- Score 4: ED 100%

Score 0		Score 1		Score 2		Score 3		Score 4	
L	R	L	R	L	R	L	R	L	R
									



# Suction disc deformities

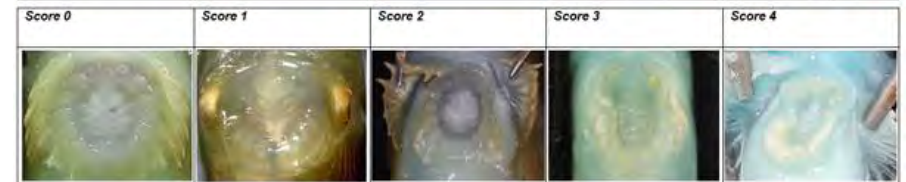
Score 0: No deformity  
 Score 1: Mild deformity  
 Score 2: Moderate deformity  
 Score 3: Substantial deformity  
 Score 4: Severe deformity



Symmetry



Indentation



Depression



Papillae development



Pectoral fin (ventral section) deformity



# Validation

## Reliability

Two raters (A, B)  
Randomly  
Rater A scored twice  
ICC (intra and inter-rater)

## Construct validity

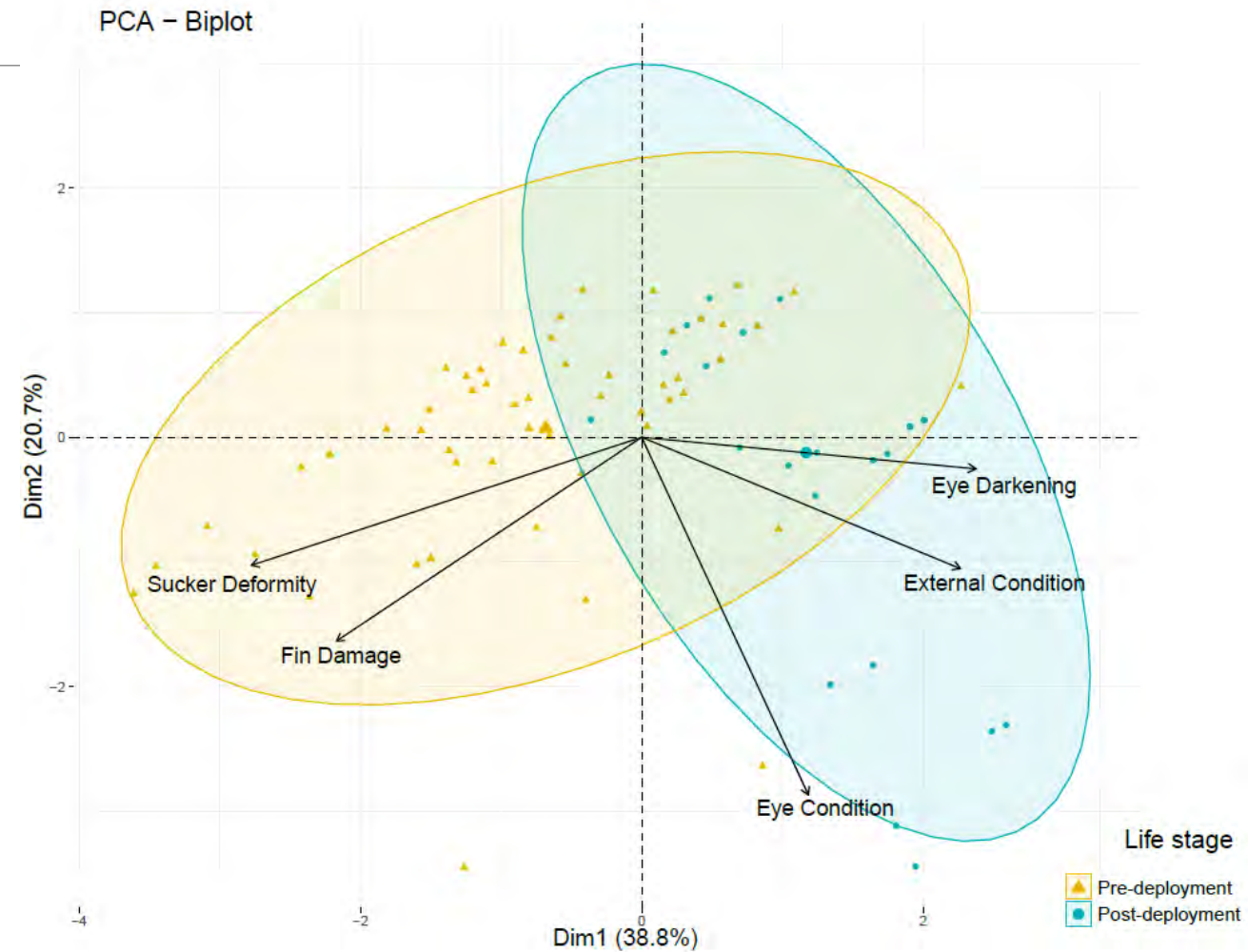
- Body condition ( $W_r$ )

$$\log_{10} W_s = a + (b * \log_{10} TL)$$
$$W_r = (W/W_s) * 100$$

- Plasma cortisol







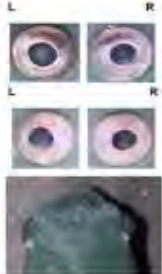










PCA



# Refinement



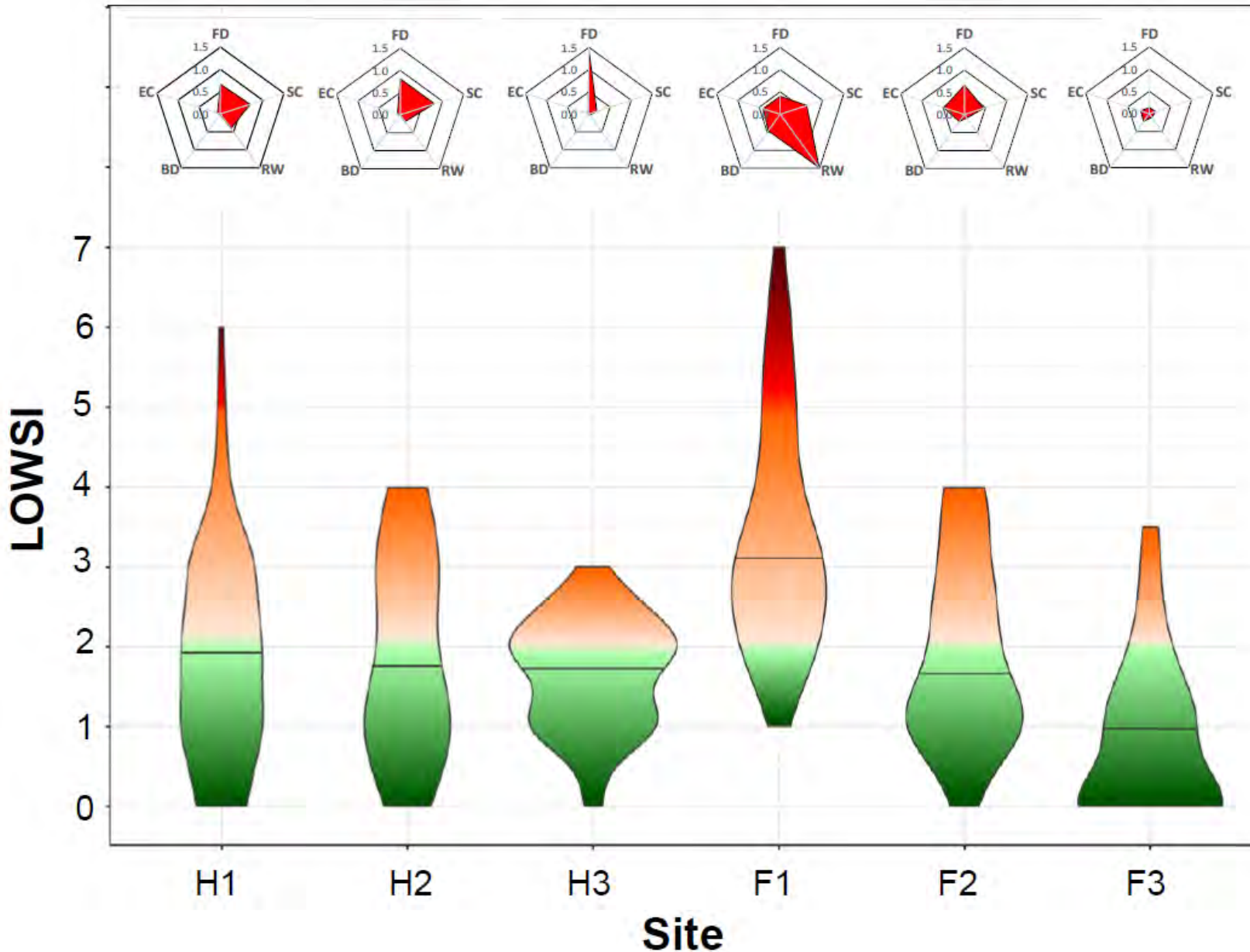
OWI	0 points	1 point	2 points
<b>Skin damage</b> <ul style="list-style-type: none"> <li>• reddening</li> <li>• abrasion</li> <li>• wounds</li> <li>• ulcers</li> </ul>	 <p>No damage</p>	 <p>Moderate damage</p>	 <p>Severe damage</p>
<b>Caudal fin damage</b> <ul style="list-style-type: none"> <li>• ray splitting</li> <li>• fin erosion</li> </ul>	 <p>No damage</p>	 <p>Moderate damage</p>	 <p>Severe damage</p>
<b>Eye condition</b> <ul style="list-style-type: none"> <li>• cataracts</li> <li>• exophthalmia</li> <li>• injuries</li> </ul>	 <p>No damage</p>	 <p>One eye damaged</p>	 <p>Both eyes damaged</p>
<b>Suction disc</b> <ul style="list-style-type: none"> <li>• asymmetry</li> <li>• indentation</li> <li>• depression</li> <li>• papillae</li> <li>• curling</li> </ul>	 <p>No deformities, fully functional</p>	 <p>Moderate deformity, some impairment</p>	 <p>Severe deformity, non-functional</p>
<b>Relative weight</b>	 <p>Normal Normal weight for its size (Wr &gt; 90%)</p>	 <p>Underweight 10-25% below expected weight (Wr = 75-90%)</p>	 <p>Emaciated 25% or more below expected weight (Wr = &lt; 75%)</p>
<b>Average LOWSI</b>	<b>Class A: &lt;3 points</b> <b>Good welfare</b>	<b>Class B: 3-5 points</b> <b>Moderately compromised welfare</b>	<b>Class C: &gt;5 points</b> <b>Severely compromised welfare</b>
<b>ACTION PLAN</b>	<ul style="list-style-type: none"> <li>• No action needed</li> <li>• Continue monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Increase frequency of monitoring</li> <li>• Check mortality</li> <li>• Check diet and food delivery</li> <li>• Check use of shelters</li> <li>• Check diseases &amp; parasites</li> <li>• Check sources of stress</li> <li>• Check environmental parameters</li> </ul>	<ul style="list-style-type: none"> <li>• Consider immediate corrective actions</li> <li>• Consult with Veterinary Services</li> <li>• Consider culling (under veterinary advice)</li> <li>• Continue monitoring &amp; reassess</li> </ul>





n = 245

FD: Fin Damage  
SC: Suction cup deformity  
RW: Relative weight  
BD: Body damage  
EC: Eye Condition



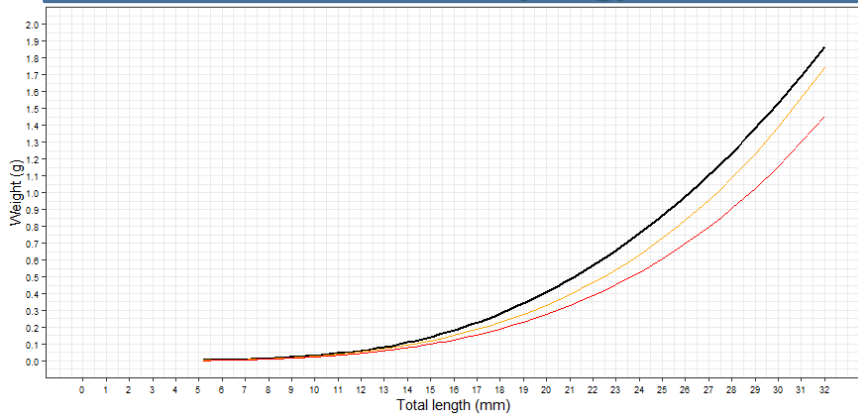
$$ICC_{\text{LOWSI}} = 0.83 \pm 0.05$$

71% Class A  
27% Class B  
2% Class C

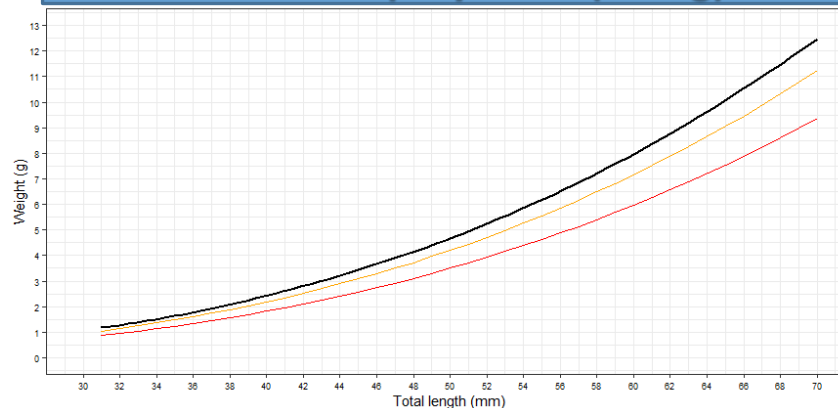
# Application

LOWSI

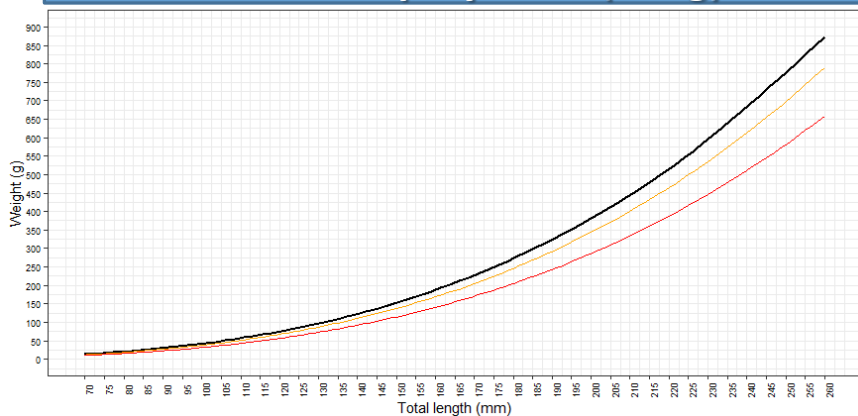
### S1 – Larvae (0-1g)



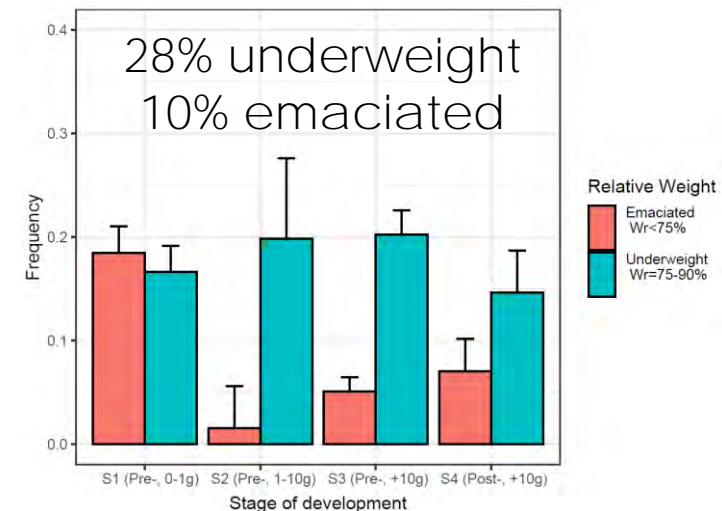
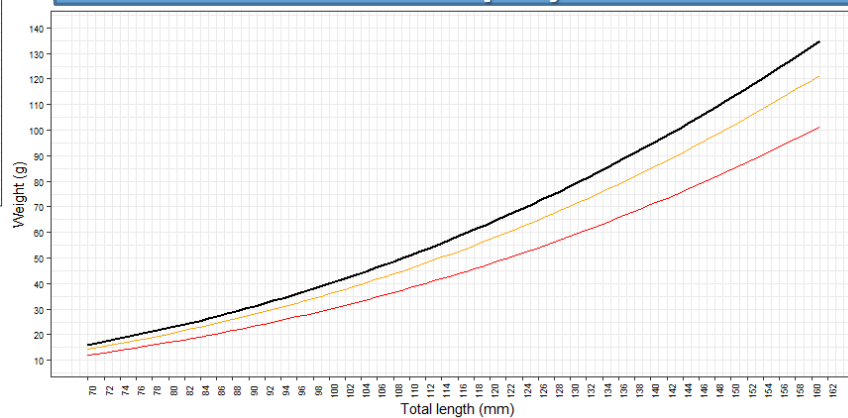
### S2 - Pre-deployment (1-10g)



### S3 - Pre-deployment (>10g)



### S4 - Post-deployment



# Application

## LW Percentile charts



n = 2658

# Microbial communities

16S amplicon sequencing

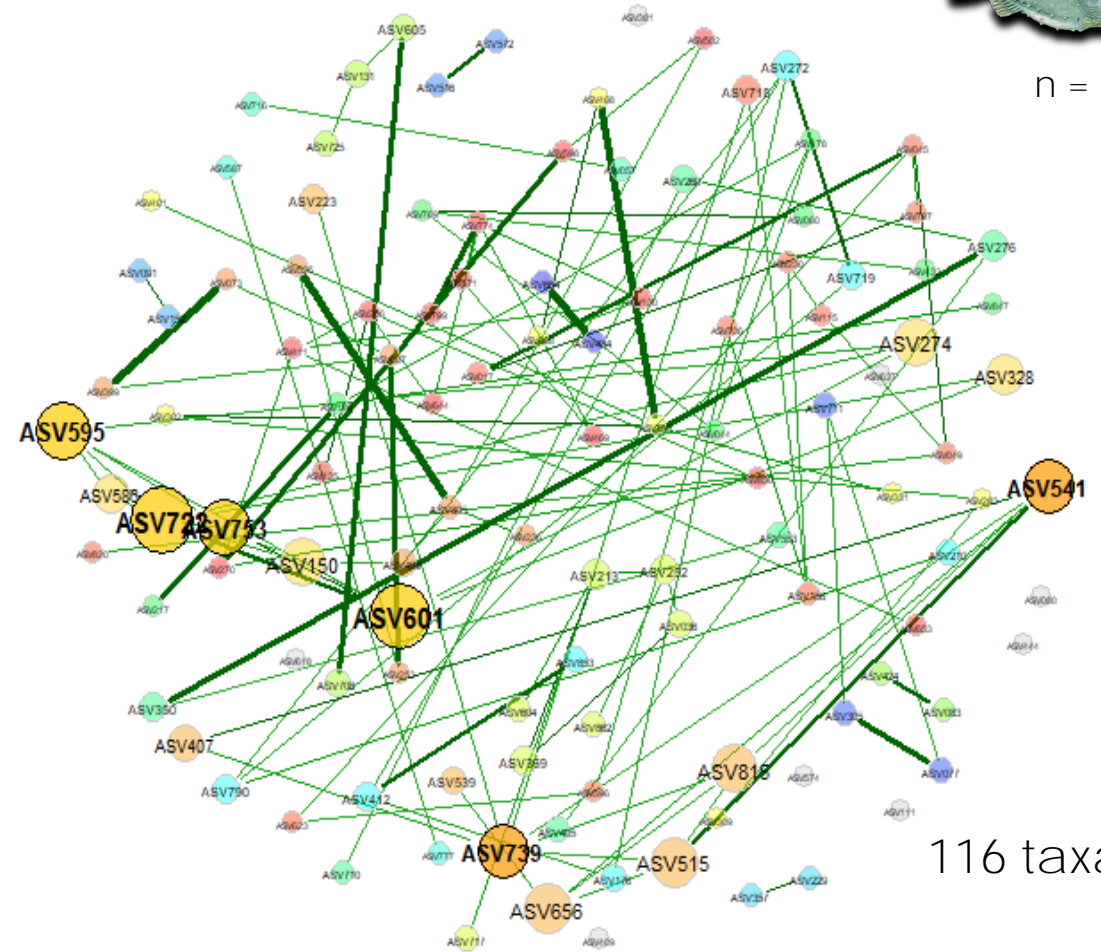
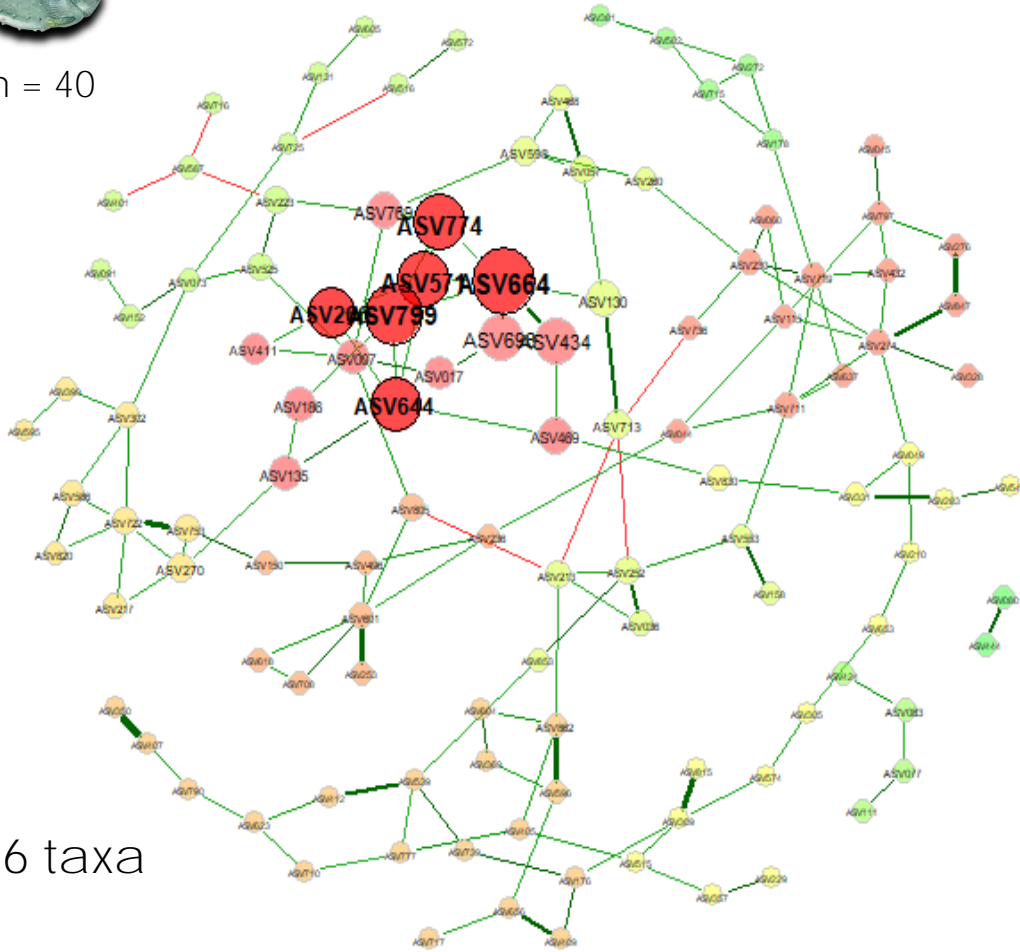
Compromised welfare

Good welfare



n = 40

n = 51



116 taxa

116 taxa



# Conclusions

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- ❖ We developed, validated and tested a Lumpfish Operational Welfare Score Index (LOWSI) to be used as a practical tool by the industry
- ❖ Life stage was a determinant factor:
  - ❖ Fin damage and suction disc deformities in hatcheries
  - ❖ Body/Eye damage and poor growth in sea cages
- ❖ Testing at 6 commercial sites → 29% lumpfish with compromised welfare and 2% undoubtedly poor



# Many thanks