



Veterinærinstituttet  
Norwegian Veterinary Institute

# Fish welfare from farm to fork - Welfare indicators in use in Norway

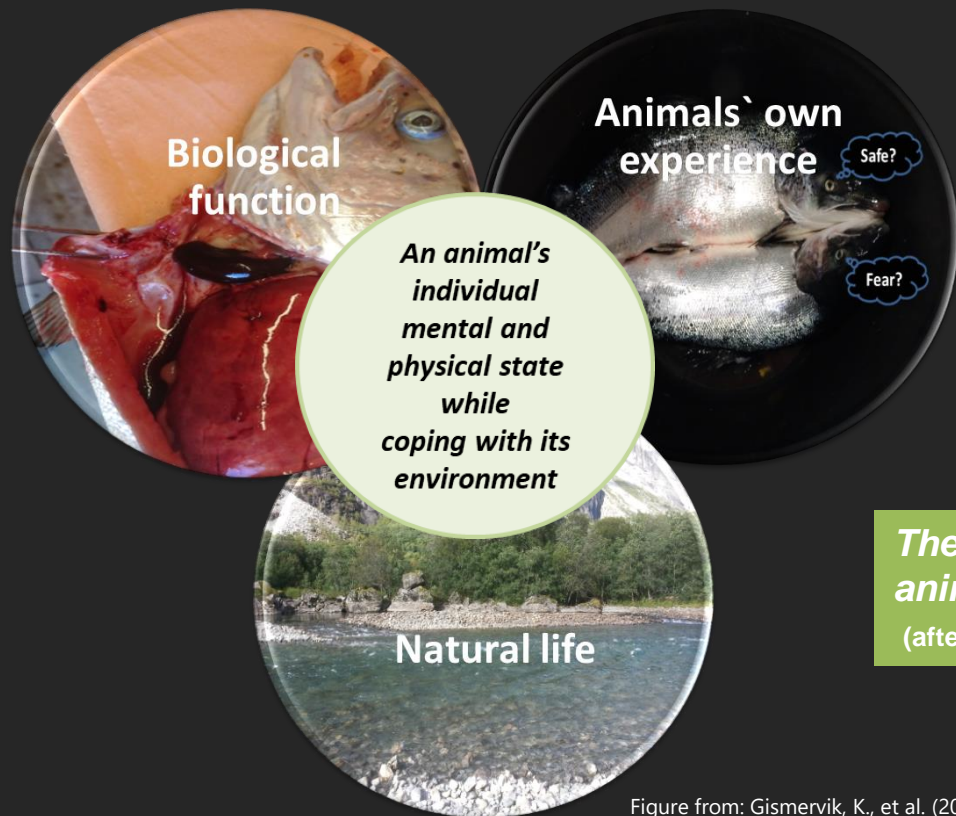
WOAH, ITALY- Chioggia, October 2023

Kristine Gismervik, scientific coordinator fish welfare NVI,  
PhD, veterinarian





# What is welfare?



*The quality of life as perceived by the animal itself*

(after Stien et al., 2013)

# Agenda

- WI use- Different needs and perspectives
- From FISHWELL to Laksvel
- From governmental data to GOWIS
- Future perspectives/developments
- Summary

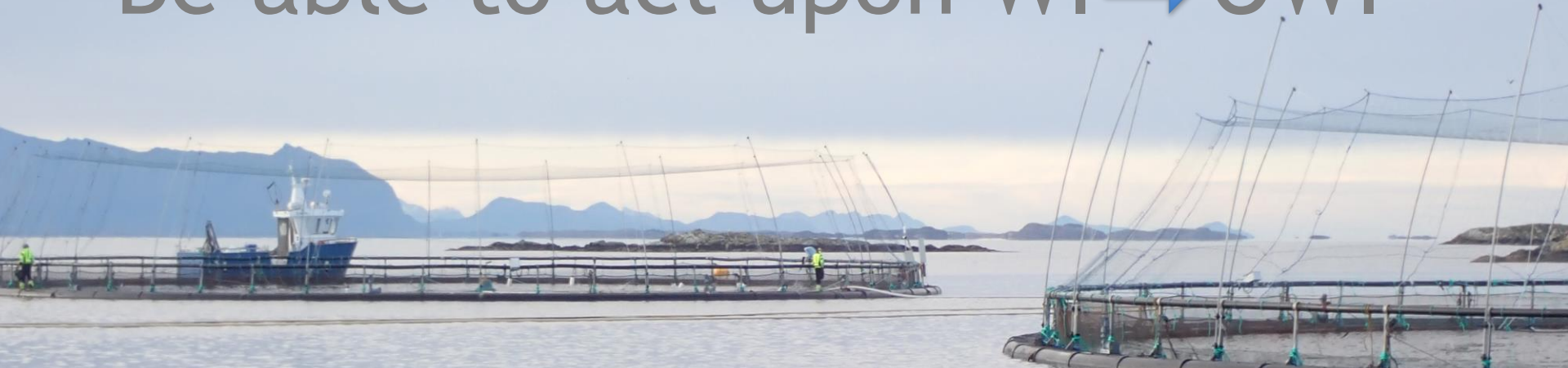
# Welfare indicators

## 3 perspectives





Keep the fish healthy and alive  
Be able to act upon WI → OWI



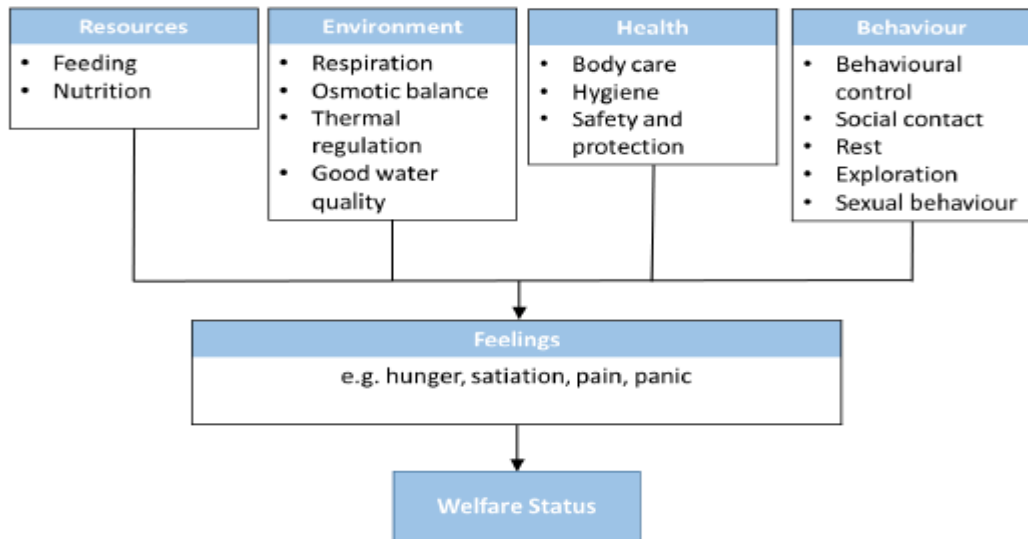


# Welfare indicators (WI)

- WI: Measurements/observations; information about the extent of welfare needs are met



# Welfare needs



*Fig. 2-1. The welfare needs of salmon can broadly be categorised into available resources, a suitable water environment, good health and freedom to express behaviours. The degree of fulfilment of these needs affects their mental state and thereby the welfare status of the animals. Adapted from "Mellor, D. J., Patterson-Kane, E. & Stafford, K. J. (2009) The Sciences of Animal Welfare. John Wiley & Sons Ltd, Oxford, UK, 212 pp. Copyright 2009" with permission from Wiley-Blackwell.*

# Welfare indicators (WI)

- WI: Measurements/observations; information about the extent of welfare needs are met
- Operational welfare indicators (OWIs): «used on farm»
  - Reflect welfare, reproducible, simpel to record, interpret
- Laboratory based welfare indicators (LABWIs)
- WI can be:
  - **Animal based** (direct)- observations on/from the animal
  - **Environmental based** (indirect/resourch-based)





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# Welfare indicators - through review and research

## FISHWELL



FHF#901157



# Welfare indicators in FISHWELL

Welfare Indicators for farmed  
Atlantic salmon:  
tools for assessing fish welfare



Even in a school, there are individuals. Photo: Lars H. Stien

Edited by Chris Noble, Kristine Gismervik, Martin H. Iversen, Jelena Kolarevic,  
Jonatan Nilsson, Lars H. Stien and James F. Turnbull

 An EU-financed project, led by Nofima in partnership with



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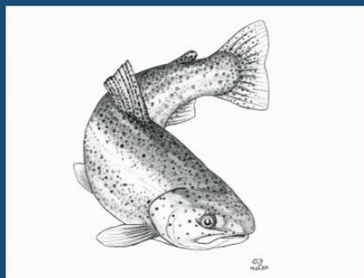


UNIVERSITY OF STIRLING



THE NORWEGIAN SEAFOOD RESEARCH FUND

Welfare Indicators for  
farmed rainbow trout:  
tools for assessing fish welfare



Edited by Chris Noble, Kristine Gismervik, Martin H. Iversen, Jelena Kolarevic,  
Jonatan Nilsson, Lars H. Stien and James F. Turnbull

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UNIVERSITY OF STIRLING



THE NORWEGIAN SEAFOOD RESEARCH FUND

Noble C, Gismervik K, Iversen MH, Kolarevic J, Nilsson J, Stien LH, Turnbull JF (eds) (2018) Welfare indicators for farmed Atlantic salmon: tools for assessing fish welfare. 351 p.

Noble, C., Gismervik, K., Iversen, M. H., Kolarevic, J., Nilsson, J., Stien, L. H. & Turnbull, J. F. (Eds.) (2020). Welfare Indicators for farmed rainbow trout: tools for assessing fish welfare. 310 pp.



# Welfare indicators in FISHWELL

## 5.5. Overview of OWIs and LABWIs covered in Part A & used in Part B and C

What follows is a summary figure outlining all the WIs, OWIs and LABWIs that we have covered in Part A. This figure will be refined into tables in Part B: rearing systems and Part C: routines and operations to provide the farmer with fit for purpose OWIs and LABWIs for different farming situations.

Welfare Indicators (WIs)							
Environment based WIs	Animal based WIs						
	Group based WIs	Individual based WIs					
<ul style="list-style-type: none"><li>• Temperature</li><li>• Salinity</li><li>• Oxygen<ul style="list-style-type: none"><li>• Total gas pressure</li></ul></li><li>• CO<sub>2</sub></li><li>• pH and alkalinity</li><li>• Total ammonia nitrogen</li><li>• Nitrite and Nitrate</li><li>• Turbidity and susp. solids</li><li>• Water current speed</li><li>• Lighting</li><li>• Stocking density</li></ul>	<ul style="list-style-type: none"><li>• Mortality rate</li><li>• Behaviour<ul style="list-style-type: none"><li>• Decreasing echo</li></ul></li><li>• Appetite</li><li>• Growth</li><li>• Disease / health</li><li>• Emaciated fish</li><li>• Water signs</li><li>• Bulk oxygen uptake</li><li>• Surface activity</li></ul>	<ul style="list-style-type: none"><li>• Gill beat rate</li><li>• Sea lice</li><li>• Gill bleaching and status</li><li>• Condition indices</li><li>• Condition factor</li><li>• Hepo-somatic index</li><li>• Cardio-somatic index</li><li>• Feed in intestine</li><li>• Emaciation state</li><li>• Sexual maturity state</li><li>• Smoltification state</li><li>• Vertebral deformation</li><li>• Fin damage and fin status</li><li>• Reflexes/eye roll</li><li>• Scale loss and skin condition</li><li>• Snout jaw wound</li></ul>	<ul style="list-style-type: none"><li>• Eye haemorrhage and status</li><li>• Opercula deformation</li><li>• Handling trauma</li><li>• Skin colour change</li><li>• Abdominal organs</li><li>• Vaccine related pathology</li></ul> <table border="1"><thead><tr><th>Blood</th></tr></thead><tbody><tr><td><ul style="list-style-type: none"><li>• Cortisol</li><li>• Ionic composition</li><li>• Glucose</li><li>• Lactate</li><li>• pH</li></ul></td></tr><thead><tr><th>Muscle</th></tr></thead><tbody><tr><td><ul style="list-style-type: none"><li>• pH</li><li>• Rigor mortis</li></ul></td></tr></tbody></tbody></table>	Blood	<ul style="list-style-type: none"><li>• Cortisol</li><li>• Ionic composition</li><li>• Glucose</li><li>• Lactate</li><li>• pH</li></ul>	Muscle	<ul style="list-style-type: none"><li>• pH</li><li>• Rigor mortis</li></ul>
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Muscle							
<ul style="list-style-type: none"><li>• pH</li><li>• Rigor mortis</li></ul>							

*Fig. 5.5-1. Summary of the WIs, OWIs and LABWIs covered in Part A of the handbook. Indicators are broken down into environment based and animal based WIs. Animal based WIs are further divided into group based and individual based WIs.*



# Scoring schemes

	1	2	3
Eye haemorrhage	Minor haemorrhages	Larger haemorrhages, or traumatic injury	Large haemorrhages / traumatic injury. Eye may be ruptured
Exophthalmia	Eye protruding a little	Moderate eye protrusion	Major eye protrusion
Opercular damage	Operculum only partly covering gills	Operculum absent on one of the gills (gill exposed)	Both opercula absent (both gills exposed)
Snout damage	Minor wound on snout (either jaw)	Moderate wound and broken skin on snout	Large deep and extensive wound. Can cover the whole head
Upper jaw deformity	Suspected malformation	Distinct malformation	Major malformation, jaw pointing backwards
Lower jaw deformity	Suspected malformation	Distinct malformation	Major malformation, jaw pointing backwards

	1	2	3
Emaciation	Potentially emaciated	Emaciated	Extremely emaciated
Vertebral deformity	Signs of deformed spine	"Short-tail"	Extreme deformity
Skin haemorrhages	Minor haemorrhaging, often on the belly of the fish	Large area of haemorrhaging, often coupled with scale loss	Significant bleeding, often with severe scale loss, wounds and skin edema
Lesions / wounds <sup>1</sup>	One small wound (< 10 pence piece) <sup>1</sup> ; subcutaneous tissue intact (no muscle visible)	Several small wounds	Large, severe wounds, muscle often exposed (≥ 10 pence piece)
Scale loss	Loss of individual scales	Small areas of scale loss (< 10% of the fish)	Large areas of scale loss (≥ 10% of the fish)
Sea lice infection	Light infection	0.05 - 0.08 pre-adult or adult lice cm <sup>2</sup> of fish skin	≥ 0.08 pre-adult or adult lice cm <sup>2</sup> of fish skin

<sup>1</sup> For pre-smolts "one small wound" should be < 1 cm. NB! Wounds that penetrate the abdominal cavity should be scored as a 3) irrespective of size





# Scoring schemes



1. Very slight adhesions, most frequently localized close to the injection site. Unlikely to be noticed by laymen during evisceration.

2. Minor adhesions, which may connect colon, spleen or caudal pyloric caeca to the abdominal wall. May be noticed by laymen during evisceration.

3. Moderate adhesions including more cranial parts of the abdominal cavity, partly involving pyloric caeca, the liver or ventricle, connecting them to the abdominal wall. May be noticed by laymen during evisceration.









4. Major adhesions with granuloma, extensively interconnecting internal organs, which thereby appear as one unit. Likely to be noticed by laymen during evisceration

5. Extensive lesions affecting nearly every internal organ in the abdominal cavity. In large areas, the peritoneum is thickened and opaque, and the fillet may carry focal, prominent and/or heavily pigmented lesions or granulomas

6. Even more pronounced than 5, often with considerable amounts of melanin. Viscera irremovable without damage to fillet integrity.

Fig. 3.4. The Spellberg Scale for intra-abdominal lesions after intraperitoneal vaccination of Atlantic salmon. Photos provided and reproduced with kind permission from Lars Spellberg. Text reproduced from "Midtlyng et al., 1996, Experimental studies on the efficacy and side-effects of intraperitoneal vaccination of Atlantic salmon (*Salmo salar* L.) against furunculosis. Fish & Shellfish Immunology 6, 335–350. Copyright 1996" [98] with permission from Elsevier.

	1	2	3
Healed fin damage	 Most of the fin remaining	 Half of the fin remaining	 Very little of the fin remaining
Active fin damage, splitting, haemorrhaging	 Most of the fin remaining	 Half of the fin remaining	 Very little of the fin remaining



0. No cataract



1. Cataract covers less than 10% of lens diameter



2. Cataract covers between 10 and 50% of lens diameter



3. Cataract covers 50 to 75% of lens diameter



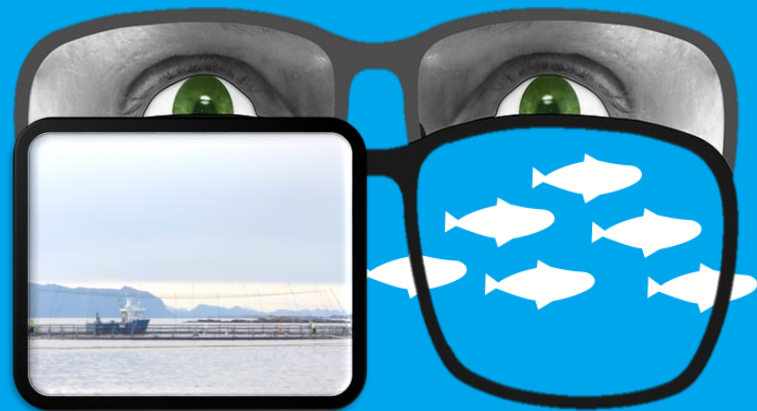
4. Cataract covers over 75% of lens diameter



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# Welfare indicators - through review and research

## LAKSVEL



FHF#901554



## LAKSVEL

Standardisert operasjonell velferdsovervåking for laks i matfiskanlegg

Jonatan Nilsson (HI), Kristine Gismervik, Kristoffer Vale Nielsen (Veterinærinstituttet), Martin Haugsmo Iversen (Nord universitet), Chris Noble, Jelena Kolarevic (Nofima), Hilde Frotjold, Kathrine Nilsen (STIM), Eirik Wilkinson (Labora), Barbo Klakegg, Hege Sorvåg Hauge, Per Anton Sæther (Åkerblå), Tore Kristiansen og Lars Helge Stien (HI)



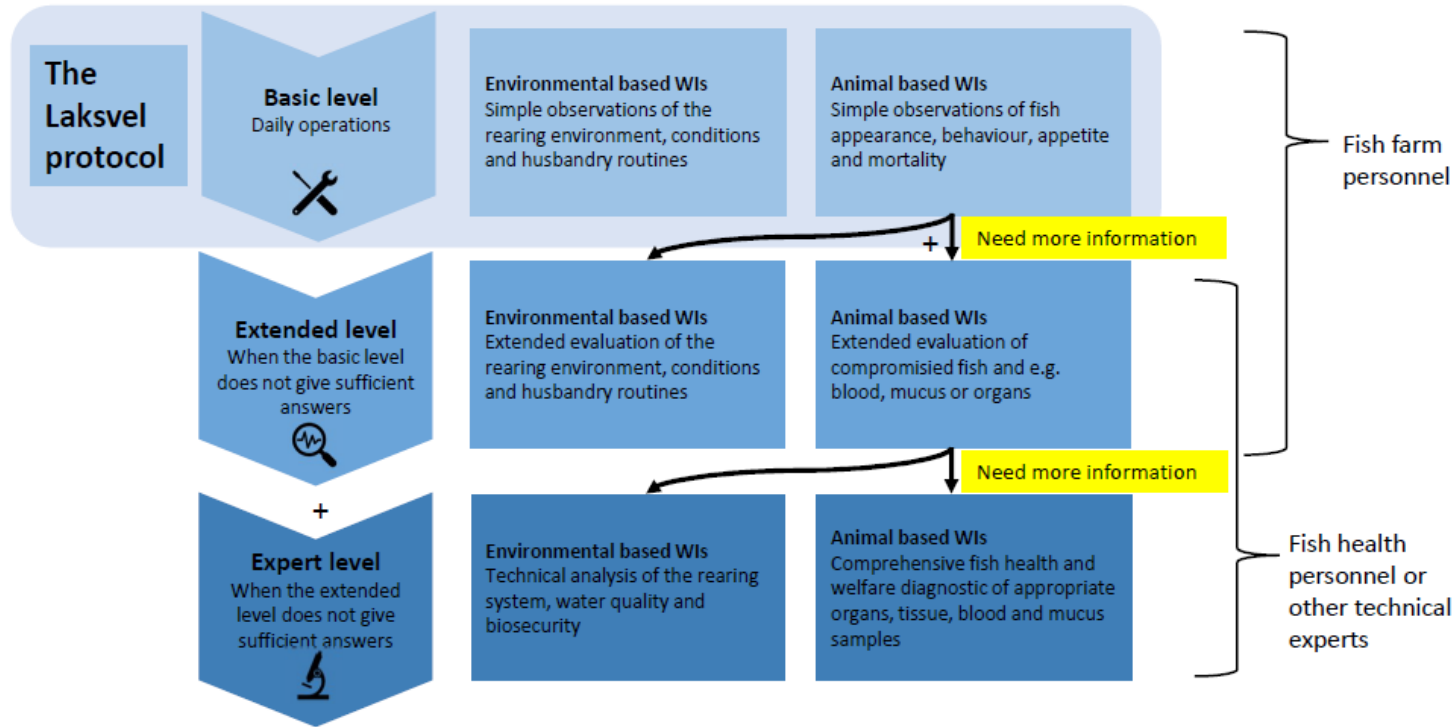
May 2022, Laksvel ([ww.hi.no](http://ww.hi.no))



# Standardised operational welfare monitoring for salmon in on-growth sea



# 3-step decision framework



*Three-step decision framework for how welfare indicators can be used as a welfare documentation and assessment platform on site. On the basic level operational welfare indicators (OWIs) will be used, while on the extended and expert levels an increasing degree of analysis that require a laboratory (LABWIs) will be taken into use, and/or larger samples will be collected.*



Table 4.1.1. Welfare indicators in the Laksvel project

Laksvel operative welfare indicators (OVIs)			
Environmental based	Animal based		
	Group based	Individual based	
Oxygen	Behaviour	First impressions	Maxillary lesions
Temperature	Appetite	Skeletal deformity	Jaw deformity
Salinity	Mortality	Emaciation	Cataract
		Sexual maturation	Eye injury
		Scale loss	Opercula
		Skin haemorrhage	Gill status
		ulceration	Fin status

# Laksvel- environmental OWI-salmon

Environmental based
Oxygen
Temperature
Salinity

Temperature (°C)



*Welfare impact of water temperature. The colour codes should be seen as approximates, as the welfare impact of temperature is dependent on a number of factors, for instance if the temperature is rising or falling, stress level and presence of pathogens in the water*

# Laksvel- group based OWI-salmon

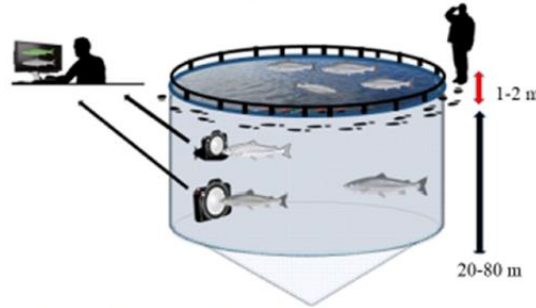
Group based

Behaviour

Appetite

Mortality

## Observations of behaviour



### General impression of the group

- Schooling
- Nervous fish
- Panic behaviour
- Jumping

### Individuals

- Lethargic swimming
- Reduced flight response
- Reduced balance
- Resting against the current

*Illustration of daily observations of behaviour of caged salmon, and examples of signs to look for.*

Score	Impression of behaviour
0	Normal group behaviour with no or very few individuals with deviant behaviour
1	Normal behaviour by most fish, but small groups of individuals not included in the school («loser fish»)
2	Clear deviant behaviour of large parts of the group or an increasing or significant part of the group with disease related or other abnormal behaviour
3	Very clear deviant behaviour, or large part of the group showing behaviour that indicates bad environmental conditions or disease, often connected with increased mortality

# Laksvel- individual OWI -First impression

**Score 1**

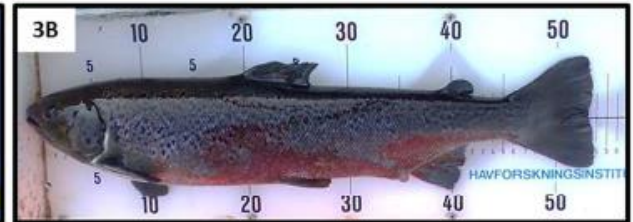
**Score 2**

**Score 3**

Minor deviations

Clear deviations

Severe deviations



# Body wound

## Score 1

Small or healed wound (not scare). Not penetrating to muscle (hypodermis intact)



## Score 2

Several small "score 1 wounds" or one moderate open wound

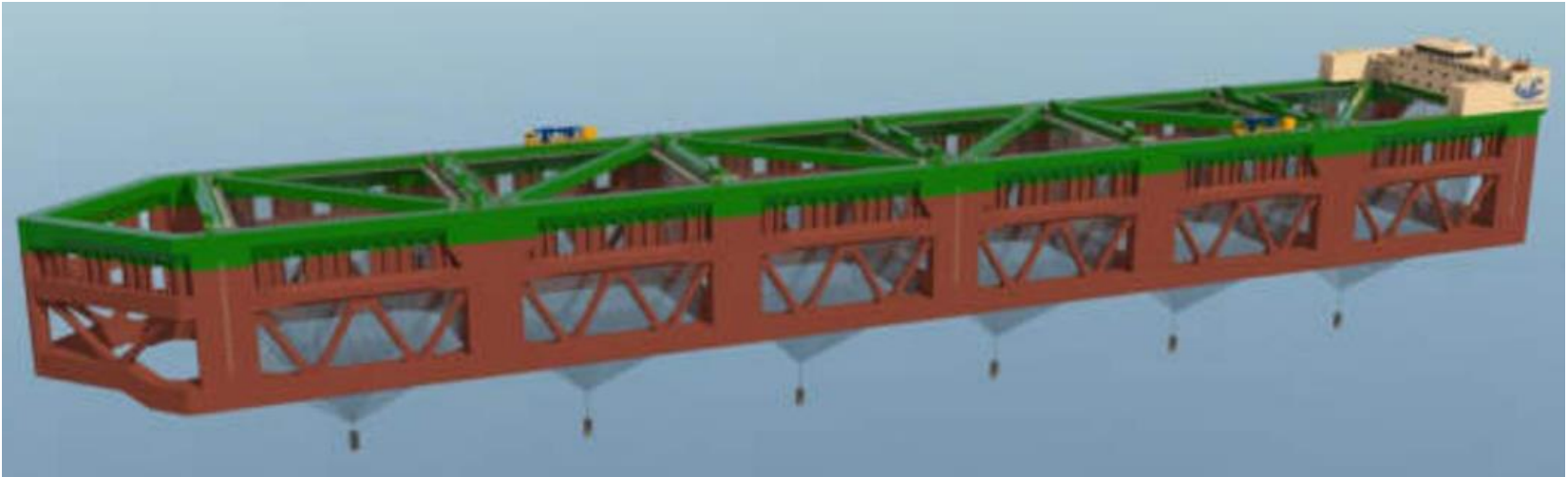


## Score 3

Severe larger wounds penetrating into muscle or abdominal cavity

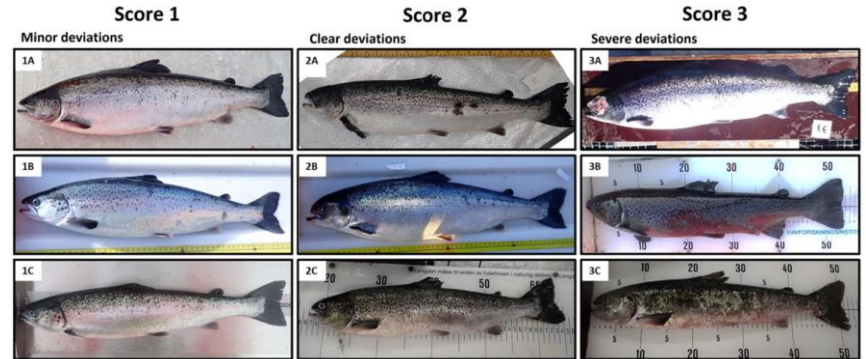
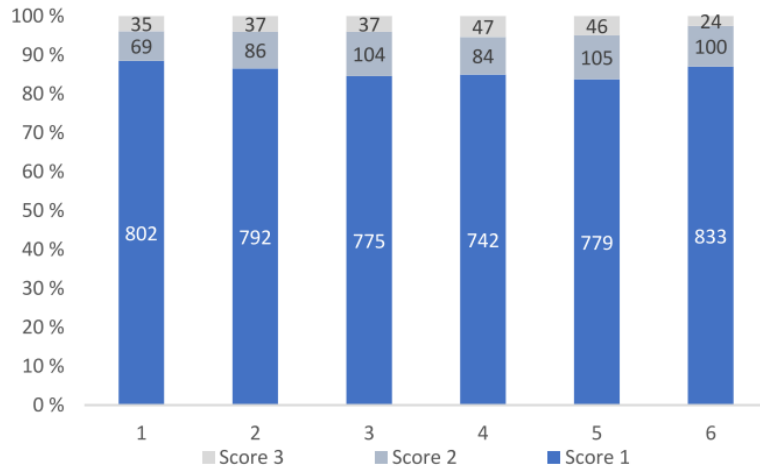


# Use of Laksvel- ie. New technology



# Example of use of Laksvel

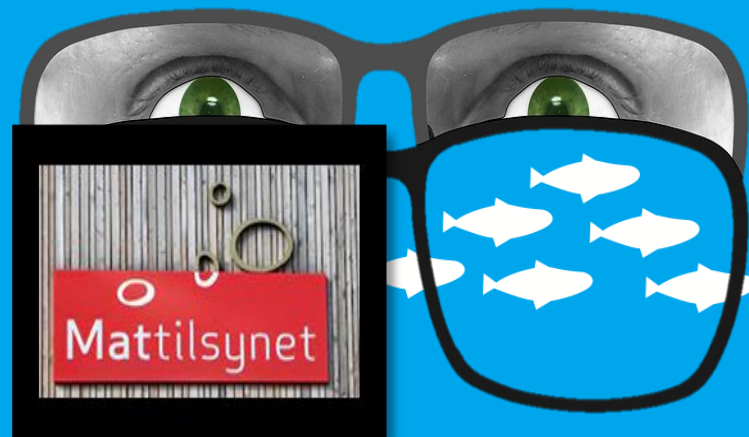
## Percentage of first impression per category (N=number evaluated fish)





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# Welfare indicators - through data monitoring, Authorities



FHF#901554





Know + warn,  
Fish health  
and welfare



# The Norwegian Fish Health Report



Published annually since 2003

Based on data from NVI

Access to data from private  
laboratories since 2020

Public data

Questback

Ref: Sommerset et. al. (2023) Norwegian Fish Health Report 2022, Norwegian Veterinary Institute Report, series #5a/2023

# Statistical Basis for the report



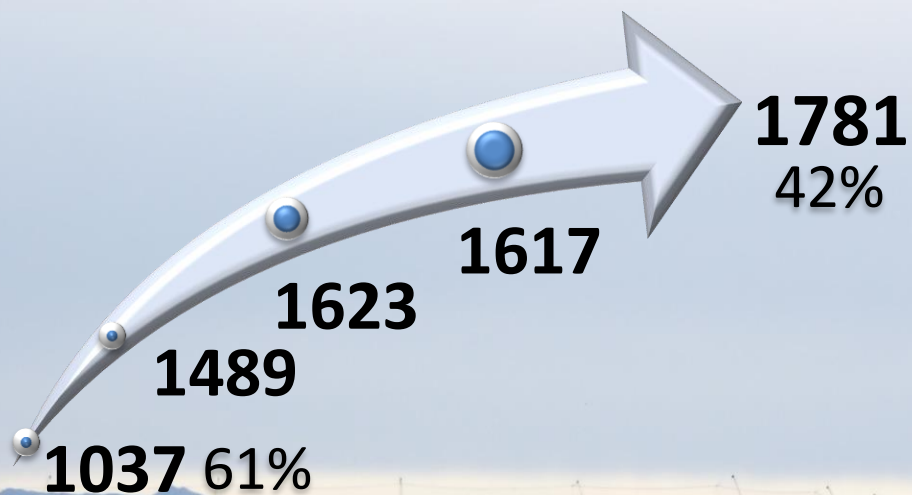
## Public data:

- Active sites
- Biomass, loss, mortality and harvest
- Lice numbers, treatment and prescriptions
- Listed diseases

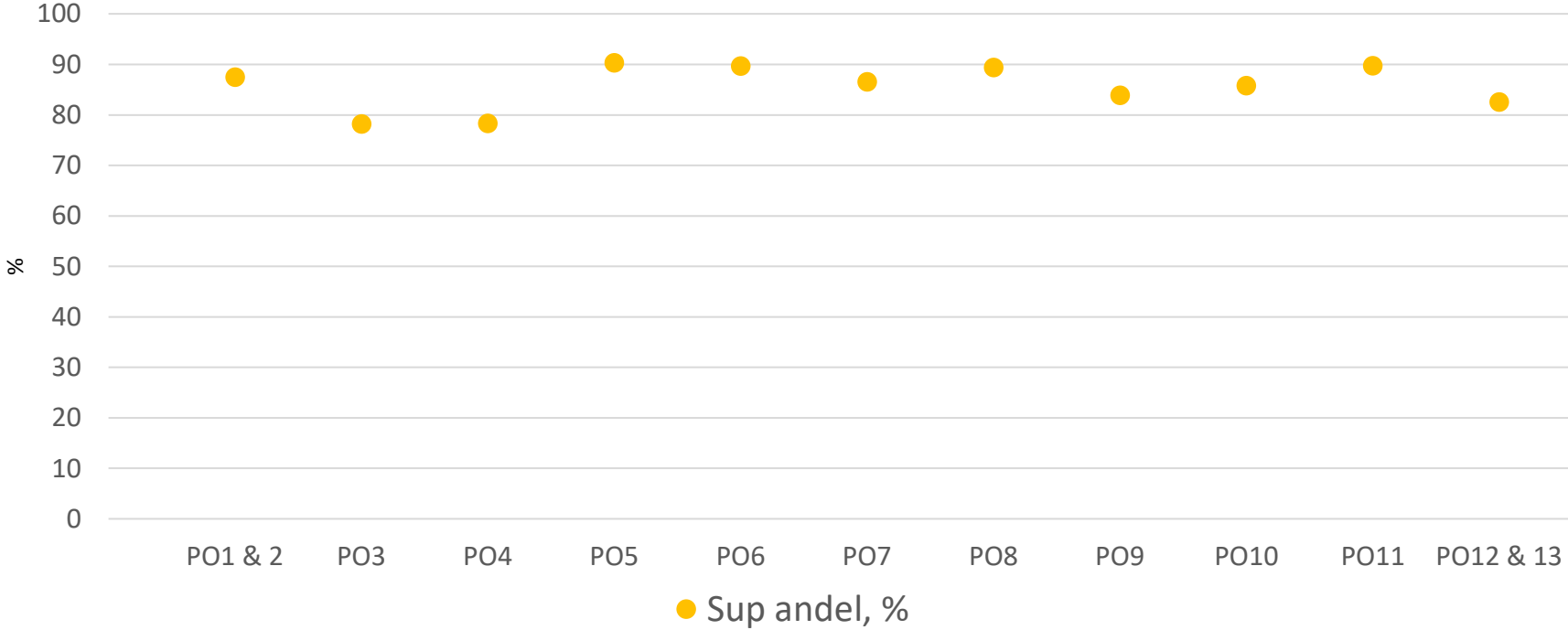
# Governmental operative welfare indicators (GOWI`s)

Mortality/ destruction	Disease	Delousing/ cleaner fish	Incidents welfare	Slaughter quality	Resarch animals	Legislation violations
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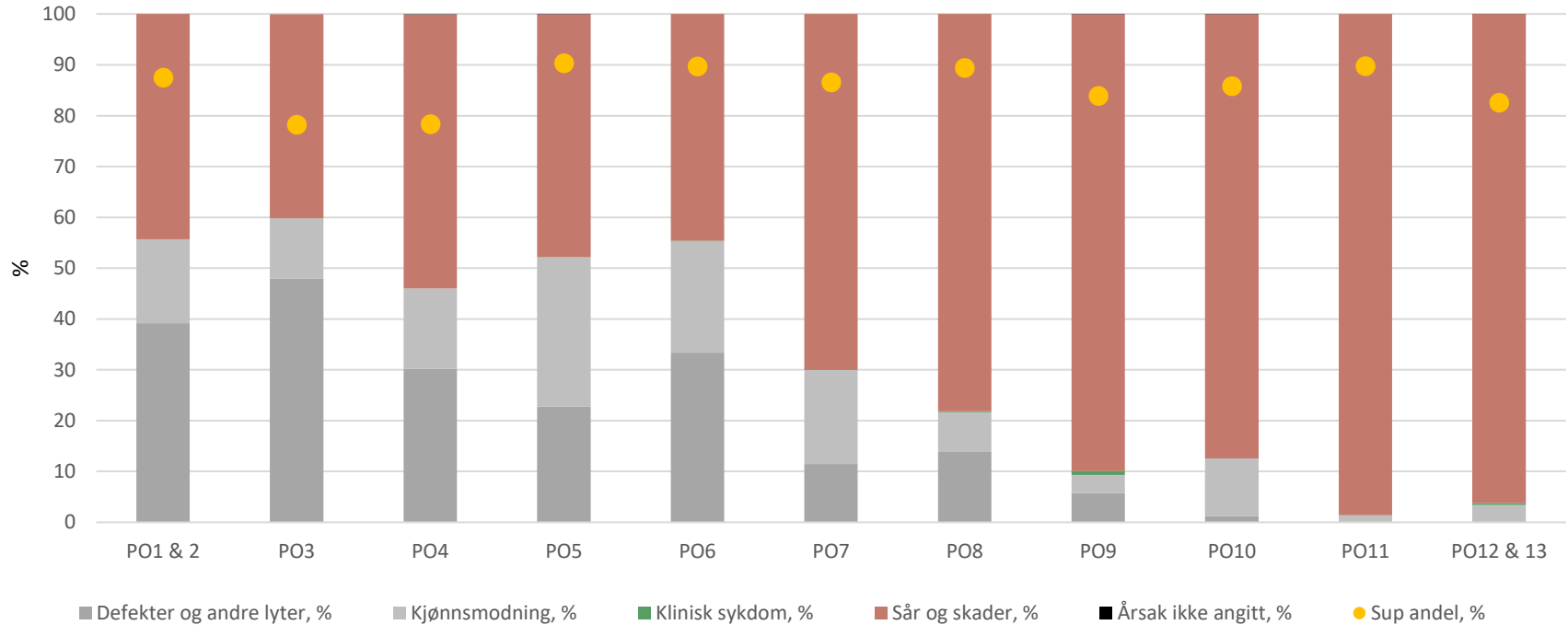
# Total welfare incidents reported 2018-22



# Superior quality salmon 2022 per sone



# Main downgrading causes salmon slaughter 2022



# Future perspectives





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# Welfare indicators

## - Through building a scenario scale: delicing

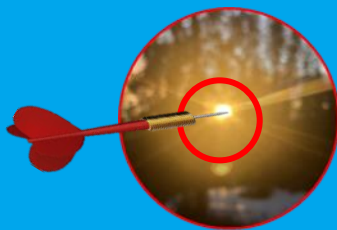


NFR#326980, Figure: L.H. Stien/Welfare Severity



# Welfare indicators

- Through building regulations
- Lessons learned from REGFISHWELH



# Papers REGFISHWELH

REVIEWS IN **Aquaculture**

*Reviews in Aquaculture* (2020) 12, 2396–2410 doi: 10.1111/raq.12440

**Comparison of Norwegian health and welfare regulatory frameworks in salmon and chicken production**

Kristine Gismervik<sup>1</sup>, Brit Tørud<sup>1</sup>, Tore S. Kristiansen<sup>2</sup>, Tonje Osmundsen<sup>3</sup>, Kristine Vedal Størkersen<sup>3</sup>, Christian Medaas<sup>4</sup>, Marianne Elisabeth Lien<sup>4</sup> and Lars Helge Stien<sup>4</sup>

*Journal of Agricultural and Environmental Ethics* (2021) 34:29  
<https://doi.org/10.1007/s10806-021-09869-w>

ARTICLES

**Minding the Gaps in Fish Welfare: The Untapped Potential of Fish Farm Workers**

Christian Medaas<sup>1</sup>, Marianne E. Lien<sup>1</sup>, Kristine Gismervik<sup>2</sup>, Tore S. Kristiansen<sup>3</sup>, Tonje Osmundsen<sup>4</sup>, Kristine Vedal Størkersen<sup>4</sup>, Brit Tørud<sup>2</sup>, Lars Helge Stien<sup>3</sup>

Marine Policy 117 (2020) 103969

Contents lists available at ScienceDirect

**Marine Policy**

journal homepage: <http://www.elsevier.com/locate/marpol>

**Governing the welfare of Norwegian farmed salmon: Three conflict cases**

Lars Helge Stien<sup>a,\*</sup>, Brit Tørud<sup>b</sup>, Kristine Gismervik<sup>b</sup>, Marianne Elisabeth Lien<sup>c</sup>, Christian Medaas<sup>c</sup>, Tonje Osmundsen<sup>d</sup>, Tore S. Kristiansen<sup>a</sup>, Kristine Vedal Størkersen<sup>d</sup>

Marine Policy 129 (2021) 104530

Contents lists available at ScienceDirect

**Marine Policy**

journal homepage: [www.elsevier.com/locate/marpol](http://www.elsevier.com/locate/marpol)

Full length article

**Fish protection during fish production. Organizational conditions for fish welfare**

Kristine Vedal Størkersen<sup>a,\*</sup>, Tonje C. Osmundsen<sup>a</sup>, Lars Helge Stien<sup>b</sup>, Christian Medaas<sup>c</sup>, Marianne Elisabeth Lien<sup>c</sup>, Brit Tørud<sup>d</sup>, Tore S. Kristiansen<sup>b</sup>, Kristine Gismervik<sup>c</sup>

Manus: Regulating for fish welfare (performance-based vs. prescriptive requirements)



# Summary

## GOWI's

Governmental operative welfare indicators (GOWI's)

Mortality/ destruction	Disease	Delousing/ cleaner fish	Incidents welfare	Slaughter quality	Resarch animals	Legislation violations	Silage
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## OVI's

Table 4.1.1. Welfare Indicators in the Lake

Laksvel operative welfare indicators (OVIs)			
Environmental based		Animal based	
	Group based	Individual based	
Oxygen	Behaviour	First impressions	Maxillary lesions
Temperature	Appetite	Skeletal deformity	Jaw deformity
Salinity	Mortality	Emaciation	Cataract
		Sexual maturation	Eye injury
		Scale loss	Opercula
		Skin haemorrhage	Gill status
		ulceration	Fin status

34

Mattilsynet



Even in a school, there are individuals. Photo: L...

*Faglig ambisiøs, fremtidsrettet og  
samspillende - for Én helse!*



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[www.vetinst.no](http://www.vetinst.no)

# Welfare challenges

