Determining research priorities for developing on-farm salmon welfare assessments:

Thank you for your interest in this survey. As an individual working within the salmon farming industry, your responses will provide us with a greater understanding behind where research can best improve on-farm salmon welfare measures. This will allow for future salmon welfare assessments to be more practical and effective.

WHAT WILL HAPPEN IF YOU TAKE PART:
You will be asked a number of questions regarding your views on developing on-farm salmon welfare measures. Some questions are open-ended, while others will have you rate or rank certain welfare measures/research priorities. The survey will take approx. 20-30 minutes to complete.

DATA PROTECTION AND CONFIDENTIALITY:
All data collected from this study will be ANONYMISED prior to analysis. Any details of work experience, current job title, or qualifications will be processed in such a way that will not allow you or your responses to be identifiable.

* Required

Determining research priorities for developing on-farm salmon welfare assessment:

When improving salmon welfare, we must first be able to measure and assess salmon welfare.

The GOAL of this survey: 'Determine where research can best improve on-farm welfare measures to be as feasible and effective as possible'.

When assessing welfare, we must cover all welfare concerns. Although health is essential for welfare, there are other ways that welfare can be reduced. This includes:

- Being prevented from performing certain behaviours.
- Being deprived of certain environments from which the animal evolved in.
- Being in a constant state of fear/anxiety (even when the animal is objectively healthy and safe).

When answering these questions, try your best to consider such welfare concerns in addition to the central aspect of maintaining physical health.

Thank you again for your participation!

1. Unique Identification Number *

Enter your answer

2. Current job title: *

Enter your answer

3. Experience in salmon farming (years): *

Enter your answer

4. Please select the following salmon production stages for which you have had any experience of working in: *

- [ ] Hatchery stage
- [ ] Smolt production stage
- [ ] Seawater rearing stage
- [ ] Other

5. Please list any qualifications and/or training that you may have which are relevant to animal welfare:

Enter your answer

Identifying important farming stages & practices, and determining major welfare concerns:

The various stages of salmon farming are all relevant to the fish's welfare, with each stage having unique factors that influence a salmon's quality of life.

6. Please rank the different production stages of a farmed salmon's life-cycle by how much effort should be concentrated towards monitoring and assessing salmon welfare (1 = the most important. A maximum of two different stages may be given the same ranking):

	1	2	3	4	5
Broodstock Stage	○	○	○	○	○
Early Freshwater stage (alevin/fry/parr)	○	○	○	○	○
Smoltification process (change from FW->SW)	○	○	○	○	○
Seawater rearing stage (post-smolts/adults)	○	○	○	○	○
Other (please specify below)	○	○	○	○	○

7. Other production stage (if ranked above):

Enter your answer

8. Comments box (optional): Please feel free to any additional opinions, suggestions or critique with regards to the previous question:

Enter your answer

9. In order of importance, please list a minimum of 3 (up to 5, if possible) of the most significant welfare concerns that you believe currently face farmed salmon; 1st = most important:

Enter your answer

10. Comments box (optional): Please feel free to any additional opinions, suggestions or critique with regards to the previous question:

Enter your answer

11. In order of importance, please list 3 salmon husbandry practices during which are events that require the most attention in monitoring salmon welfare (e.g. crowding / grading / transport / slaughter / treatments / feeding); 1st = most important:

Enter your answer

12. Comments box (optional): Please feel free to any additional opinions, suggestions or critique with regards to the previous question:

Enter your answer

Evaluating welfare indicators by practicality and effectiveness:

IMPORTANT INFORMATION: Some welfare indicators can be developed to provide more information on the welfare status of a fish (e.g. its physical or mental state), while some indicators can be developed to be more practical for on-farm use.

In this next question, you will be asked to rate welfare indicators by these two points:

First point: The PRACTICALITY of the welfare indicators ('how easy are they to use on a farm?').

Second point: The EFFECTIVENESS of the welfare indicators ('what quality of information do they provide on fish welfare, as if they have NO practical limitations at all?').

PRACTICALITY:

Please rate the following welfare indicators, on a scale of 1 to 10, by their practicality for on-farm use (1 = COMPLETELY IMPRACTICAL, 5-6 = SOMEWHAT PRACTICAL, 10 = VERY PRACTICAL).

Under these scores, please list any practical limitations these indicators may currently have. If you are unsure about how to rate a certain indicator, you may skip on to the next one.

13. Practicality score for welfare indicator(s): Grading individuals on their external abnormalities:

Examples include (but are not limited to): Fin/Skin/Eye/Scale condition, wounds or lesions on fish, opercular/vertebral/jaw deformities.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

14. Possible limitation(s):

Enter your answer

15. Practicality score for welfare indicator(s): Sampling individuals for physiological measures of stress:

Examples include (but are not limited to): measuring levels of lysozyme, haematocrit, glucose, proteins etc. found within blood/muscle.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

16. Possible limitation(s):

Enter your answer

17. Practicality score for welfare indicator(s): Determining disease/health status of fish by prevalence of certain conditions during routine observations or sampling of individuals:

Examples include (but are not limited to): simple scoring of cataracts, gill bleaching / gill status, scoring for levels of sea lice infestation

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

18. Possible limitation(s):

Enter your answer

19. Practicality score for welfare indicator(s): Presence of acute injuries during husbandry practices:

Examples include (but are not limited to): fin splitting / crush injuries / haemorrhages during hard handling / crowding / pumping.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

20. Possible limitation(s):

Enter your answer

21. Practicality score for welfare indicator(s): Assessing aspects of positive welfare by the presence/absence of enrichment within the production systems:

Examples include (but are not limited to): determining higher positive welfare within hatcheries enriched with artificial kelp, compared to hatcheries devoid of any enrichment.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

22. Possible limitation(s):

Enter your answer

23. Practicality score for welfare indicator(s): Deviations from normal behaviour during routine monitoring:

Examples include (but are not limited to): surface activity, abnormal swimming patterns, increased aggression, decreased feed responses.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

24. Possible limitation(s):

Enter your answer

25. Practicality score for welfare indicator(s): Changes in behaviour during husbandry practices:

Examples of such behaviours include (but are not limited to): signs of panic / exhaustion / disorientation / aggression during crowding / pumping / handling etc.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

26. Possible limitation(s):

Enter your answer

27. Practicality score for welfare indicator(s): Changes in appetite after potentially disturbing husbandry practices:

Gentle reminder: 'Practicality' = How easy this indicator is to measure on a farm-site.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

28. Possible limitation(s):

Enter your answer

29. Practicality score for welfare indicator(s): Production-related parameters:

Examples include (but are not limited to): growth rates, mortality rates, sexual maturation, stage of smoltification etc.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

30. Possible limitation(s):

Enter your answer

31. Practicality score for welfare indicator(s): Duration of time out of water for salmon during certain husbandry practices:

Examples for practices include (but are not limited to): pumping, handling pre-vaccination, and crowding.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

32. Possible limitation(s):

Enter your answer

33. Practicality score for welfare indicator(s): Water quality parameters:

Examples include (but are not limited to): Temperature, Ammonia for FW systems, Harmful Algal Blooms for SW systems, Turbidity etc.

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

34. Possible limitation(s):

Enter your answer

35. Practicality score for welfare indicator(s): Stocking density of rearing system:

	1	2	3	4	5	6	7	8	9	10	
Completely impractical	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very practical

36. Possible limitation(s):

Enter your answer

37. Comments box (optional): Please feel free to any additional opinions, suggestions or critique with regards to the previous question:

Enter your answer

EFFECTIVENESS

Now, assuming that there are no practical limitations involved when using these indicators, please rate each indicator by how effectively they reflect their relevant aspects of salmon welfare (1 = COMPLETELY INEFFECTIVE, 5-6 = SOMEWHAT EFFECTIVE, 10 = VERY EFFECTIVE):

For example: "How effectively, from 1 - 10, does fin condition reflect the physical condition of a salmon?". If you are unsure about how to rate a certain indicator, you may skip on to the next one.

38. Effectiveness score for welfare indicator(s): Grading individuals on their external abnormalities:

Examples include (but are not limited to): Fin/Skin/Eye/Scale condition, wounds or lesions on fish, opercular/vertebral/jaw deformities etc.

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

39. Effectiveness score for welfare indicator(s): Sampling individuals for physiological measures of stress:

Examples include (but are not limited to): measuring levels of lysozyme, haematocrit, glucose, proteins etc. found within blood/muscle.

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

40. Effectiveness score for welfare indicator(s): Determining disease/health status of fish by prevalence of certain conditions during routine observations or sampling of individuals:

Examples include (but are not limited to): simple scoring of cataracts, gill bleaching / gill status, scoring for levels of sea lice infestation.

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

41. Effectiveness score for welfare indicator(s): Presence of acute injuries during husbandry practices:

Examples include (but are not limited to): fin splitting / crush injuries / haemorrhages during hard handling / crowding / pumping.

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

42. Effectiveness score for welfare indicator(s): Assessing aspects of positive welfare by the presence/absence of enrichment within the production systems:

Examples include (but are not limited to): determining higher positive welfare within hatcheries enrich with artificial kelp compared to hatcheries devoid of any enrichment

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

43. Effectiveness score for welfare indicator(s): Deviations from normal behaviour during routine monitoring:

Examples include (but are not limited to): surface activity, abnormal swimming patterns, increased aggression, decreased feed responses).

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

44. Effectiveness score for welfare indicator(s): Changes in behaviour during husbandry practices:

Examples of such behaviours include (but are not limited to): signs of panic / exhaustion / disorientation / aggression during crowding / pumping / handling etc.

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

45. Effectiveness score for welfare indicator(s): Changes in appetite after potentially disturbing husbandry practices:

Gentle reminder: These scores are simply for how well these measures reflect fish welfare, assuming NO practical limitations are involved

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

46. Effectiveness score for welfare indicator(s): Production-related parameters:

Examples include (but are not limited to): growth rates, mortality rates, sexual maturation, stage of smoltification etc.

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

47. Effectiveness score for welfare indicator(s): Duration of time out of water for salmon during certain husbandry practices:

Examples of husbandry practices include (but are not limited to): pumping, handling pre-vaccination, crowding.

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

48. Effectiveness score for welfare indicator(s): Water quality parameters:

Examples include (but are not limited to): Temperature, Ammonia for FW systems, Harmful Algal Blooms for SW systems, Turbidity etc.

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

49. Effectiveness score for welfare indicator(s): Stocking density of rearing system:

	1	2	3	4	5	6	7	8	9	10	
Completely ineffective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very effective

50. Comments box (optional): Please feel free to any additional opinions, suggestions or critique with regards to the previous question:

Enter your answer

Research priorities for developing welfare indicators:

This next section will ask you to rate the RELEVANCE and URGENCY behind improving certain welfare indicators in different ways.

To clarify by 'RELEVANCE': How relevant is the need for developing this welfare indicator, through research, in order to allow for better monitoring & safeguarding of salmon welfare?

Please rate the relevance, to fish welfare, in developing these welfare measures:

1 = COMPLETELY IRRELEVANT, 5-6 = SOMEWHAT RELEVANT, 10 = EXTREMELY RELEVANT.

If you are unsure about how to rate one of the following research outcomes, you may skip on to the next one.

51. Developing understanding behind environmental conditions (e.g. optimal light conditions, turbidity, & total suspended solids for each specific life stage in salmon (parr, smolts & post-smolts)

This could help ensure that the quality of early life stages are not jeopardised, and that later quality of life is not affected through improper development.

	1	2	3	4	5	6	7	8	9	10	
Completely irrelevant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely relevant

52. Developing more fish/user-friendly methods for welfare indicators which currently require catching & handling of the fish (e.g. having to sample cages for scoring physical injury, body condition, malformations):

These processes still have potential in disturbing salmon during the capture process.

	1	2	3	4	5	6	7	8	9	10	
Completely irrelevant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely relevant

53. Developing the ability to quantify fish behaviours with monitoring systems (e.g. passive, vision-based / acoustic devices):

Developing such systems more towards quantifying certain fish behaviours could allow for a more detailed analysis of welfare through behavioural indicators.

	1	2	3	4	5	6	7	8	9	10	
Completely irrelevant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely relevant

54. Developing welfare indicators that are currently only able to be carried out in the lab, to the point where they can become operational on farm sites:

Such indicators could provide a closer insight to the welfare of the animals that otherwise could only have been done within a laboratory setting.

	1	2	3	4	5	6	7	8	9	10	
Completely irrelevant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely relevant

55. Developing welfare indicators that allow for the remote monitoring of the salmon:

These indicators could help with the safeguarding of salmon welfare when access for staff to the farm sites becomes limited (e.g. during storms for sea cages, or during pandemics which limit staff presence).

	1	2	3	4	5	6	7	8	9	10	
Completely irrelevant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely relevant

56. Comments box (optional): Please feel free to any additional opinions, suggestions or critique with regards to the previous question:

Enter your answer

Now, on a similar scale, please rate the urgency of developing these welfare measures:

1 = NOT URGENT AT ALL, 5-6 = SOMEWHAT URGENT, 10 = EXTREMELY URGENT.

If you are unsure about how to rate one of the following research outcomes, you may skip on to the next one.

57. Developing understanding behind environmental conditions (e.g. optimal light conditions, turbidity, & total suspended solids for each specific life stage in salmon (parr, smolts & post-smolts)

This could help ensure that the quality of early life stages are not jeopardised, and that later quality of life is not affected through improper development.

	1	2	3	4	5	6	7	8	9	10	
Not urgent at all	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely urgent

58. Developing more fish/user-friendly methods for welfare indicators which currently require catching & handling of the fish (e.g. having to sample cages for scoring physical injury, body condition, malformations):

These processes still have potential in disturbing salmon during the capture process

	1	2	3	4	5	6	7	8	9	10	
Not urgent at all	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely urgent

59. Developing the ability to quantify fish behaviours with monitoring systems (e.g. passive, vision-based / acoustic devices):

Developing such systems more towards quantifying certain fish behaviours could allow for a more detailed analysis of welfare through behavioural indicators.

	1	2	3	4	5	6	7	8	9	10	
Not urgent at all	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely urgent

60. Developing welfare indicators that are currently only able to be carried out in the lab, to the point where they can become operational on farm sites:

Such indicators could provide a closer insight to the welfare of the animals that otherwise could only have been done within a laboratory setting.

	1	2	3	4	5	6	7	8	9	10	
Not urgent at all	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely urgent

61. Developing welfare indicators that allow for the remote monitoring of the salmon:

These indicators could help with the safeguarding of salmon welfare when access for staff to the farm sites becomes limited (e.g. during storms for sea cages, or during pandemics which limit staff presence).

	1	2	3	4	5	6	7	8	9	10	
Not urgent at all	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely urgent

62. Comments box (optional): Please feel free to any additional opinions, suggestions or critique with regards to the previous question:

Enter your answer

Determining when welfare monitoring/assessment best fits within the farmer's routine

For any welfare assessment to be effective, the welfare indicators must be used in such a way that best falls within the farm staff's routines, thus minimising any conflicts with their other responsibilities.

63. Which parts of a farmer's routine (daily, or during specific tasks) do you believe provide the most suitable opportunities for monitoring certain welfare indicators with the salmon (please select a maximum of THREE options):

- [ ] During feeding times
- [ ] During health checks
- [ ] During routine cage/tank inspections
- [ ] During grading and/or transfer
- [ ] During video monitoring
- [ ] Other

64. Comments box (optional): Please feel free to any additional opinions, suggestions or critique with regards to the previous question:

Enter your answer

END OF SURVEY

Thank you very much for your participation!

If you have any further queries, or would like to see your responses within your own document, please do not hesitate to contact t.r.wiese@stir.ac.uk with your Unique ID Code.

Best wishes,

Timothy Robert Wiese.