Animal welfare: Monitoring of broiler welfare

Conclusions on behaviour

- Works of Bokkers and Bergman provide initial reference values for expected time allocation across different behaviors

- Expression of all behaviors listed in Ethogram used by Bokkers should be present

Table 3
Percentage of the general behavioral parameters observed in the alternative, enriched rearing concept, Cobb Sasso and Ross 308 in comparison, by age in days

Behavioral parameter	Day 2	Day 9	Day 16	Day 23	Day 30	Day 37
Cobb Sasso—alternative rearing concept						
Lying/resting[a]	23.30 (5888)	32.86 (8113)	34.15 (4928)	42.51 (6868)	48.75 (5862)	55.47 (1288)
Locomotion	2.80 (707)	2.43 (601)	3.91 (564)	2.73 (439)	1.80 (217)	0.52 (12)
Grooming/dust bathing	0 (1)	0.40 (98)	0.58 (84)	0.71 (114)	0.71 (85)	0.60 (14)
Foraging by standing/scratching/pecking	13.13 (3318)	8.61 (2127)	9.99 (1441)	9.60 (1547)	8.57 (1031)	5.94 (138)
Eating	5.48 (1384)	10.46 (2583)	11.59 (1673)	12.68 (2042)	11.93 (1435)	12.06 (280)
Drinking	3.84 (971)	3.38 (834)	3.80 (549)	3.85 (620)	3.53 (424)	2.63 (61)
Ross 308—alternative rearing concept						
Lying/resting[a]	18.88 (1588)	37.74 (1855)	40.71 (2459)	40.84 (2161)	44.61 (2500)	—
Locomotion	3.19 (283)	1.38 (68)	1.52 (92)	0.89 (47)	0.37 (21)	—
Grooming/dust bathing	0.03 (3)	0.18 (9)	0.35 (21)	0.77 (41)	0.46 (26)	—
Foraging by standing/scratching/pecking	11.34 (1007)	9.20 (452)	6.87 (415)	5.18 (274)	5.17 (290)	—
Eating	5.06 (449)	8.14 (400)	10.10 (610)	11.96 (634)	11.99 (672)	—
Drinking	3.99 (354)	3.95 (194)	3.51 (212)	4.16 (220)	3.57 (200)	—

—, Investigation was not performed because animals were already slaughtered at that age.
Total number of observed birds is provided in parentheses. All performed rearing periods (n = 6 for Cobb Sasso and n = 2 for Ross 308) are summarized.
[a] Data in the table exclude lying/resting around straw bales and pecking stones.

Conclusions on behaviour

- Decrease of locomotion, use of perches (or platforms) and increased sitting during the growth period are indicators of decreased welfare (inability to express behavioral needs)

- Grooming and dust bathing are part of broilers normal behavior and both behaviors should be seen in flocks. Their proportion of the daily time budget is quite low.

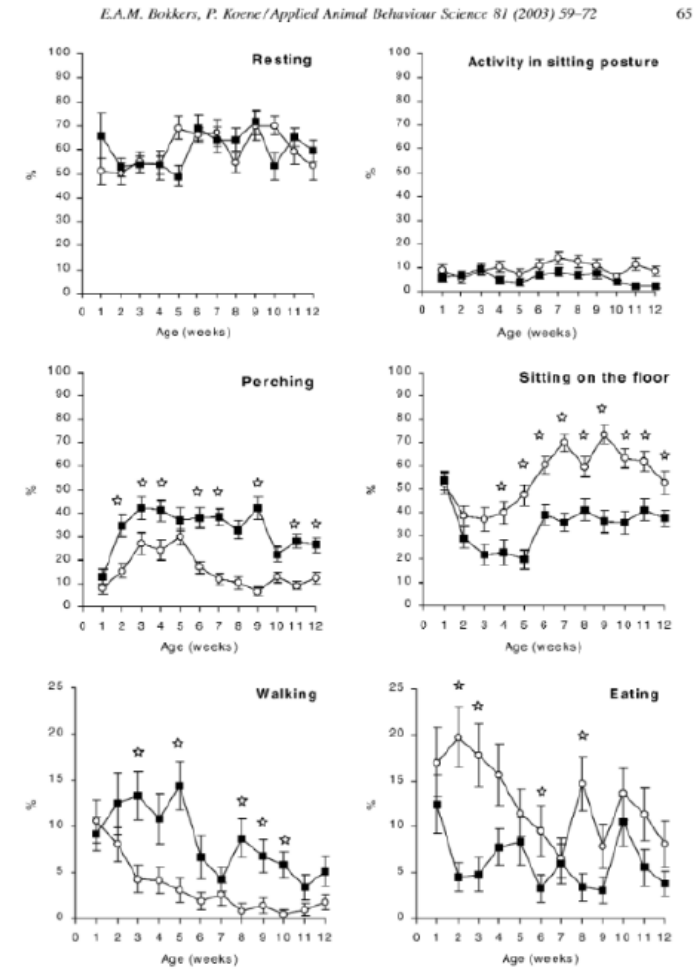


Fig. 1. From top left to bottom right: resting, activity in sitting posture, perching, sitting on the floor, walking and preening as percentage of observed behaviour in fast growing (○) and slow growing (■) broilers. The symbol (☆) means a significant difference of at least $P < 0.05$ at a certain age.

Behaviour (Bokkers & Koene 2003)	Positioning tags	Accelerometers	Computer vision: Object detection	Computer vision: Action classification
Eating	++	++	++	+++
Drinking	++	++	++	+++
Preening	-	+	+	+++
Scratching	-	++	+	+++
Ground pecking	-	++	+	+++
Stretching	-	+	+	+++
Aggression	-	+	-	+++
Standing idle	+	++	+++	+++
Sitting idle	+	++	+++	+++
Walking	++	++	+++ (combined with tracking)	+++
Wing flapping	-	+	++	+++
Dust bathing	-	+	++	+++
Lying	+	++	+++	+++
Perching (perch or platform)	++	-	+++	+++

Table: Evaluation of different technologies for measuring the occurrence of main behavioral needs. (-) can't be done, (+) can give some estimate but not differentiate all behaviors, (++) can give moderately good estimate, (+++) can give very good estimate.

Conclusion on technology

- Computer vision with a deep learning based model is the best technology option:
  - It can be used for birds of all ages
  - Sensors don't need to be attached to animals
  - It has the potential to classify all behaviors listed in the ethogram

- Main limitations
  - Group level monitoring instead of individual level
  - Cost, depending on the system set up
  - Probably requires additional training data from first pilot before good performance is reached in different broiler houses

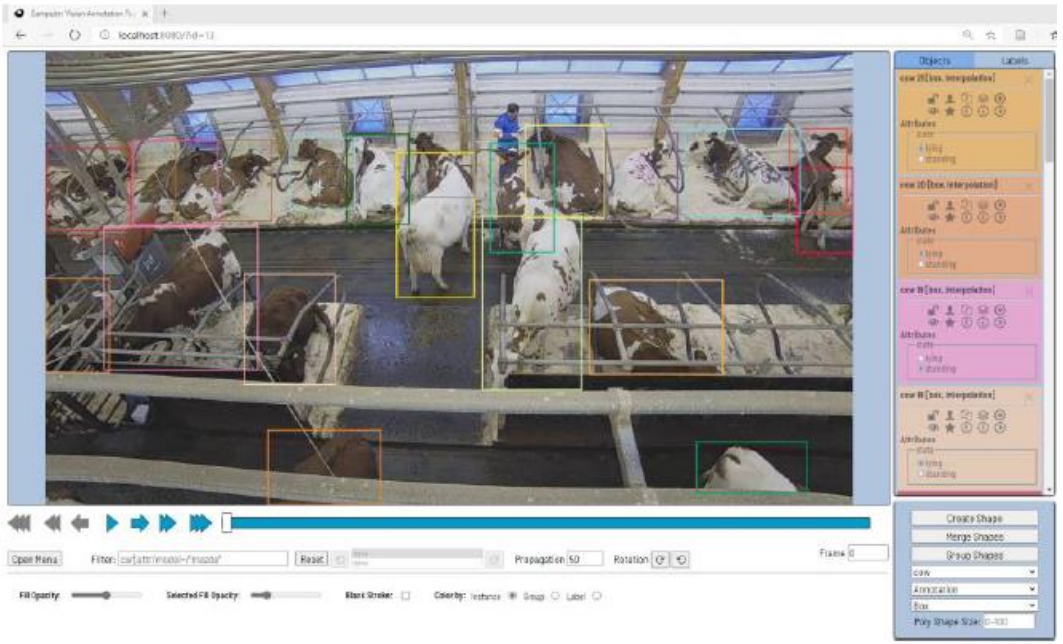
Practicalities of running a deep learning model

- Hardware cost of embedded camera + computing unit solution under 2000 €

- Cloud computing cost from continuous model operation at least 3500 – 15 000€ depending on the complexity of the model and number of cameras + high speed internet cost

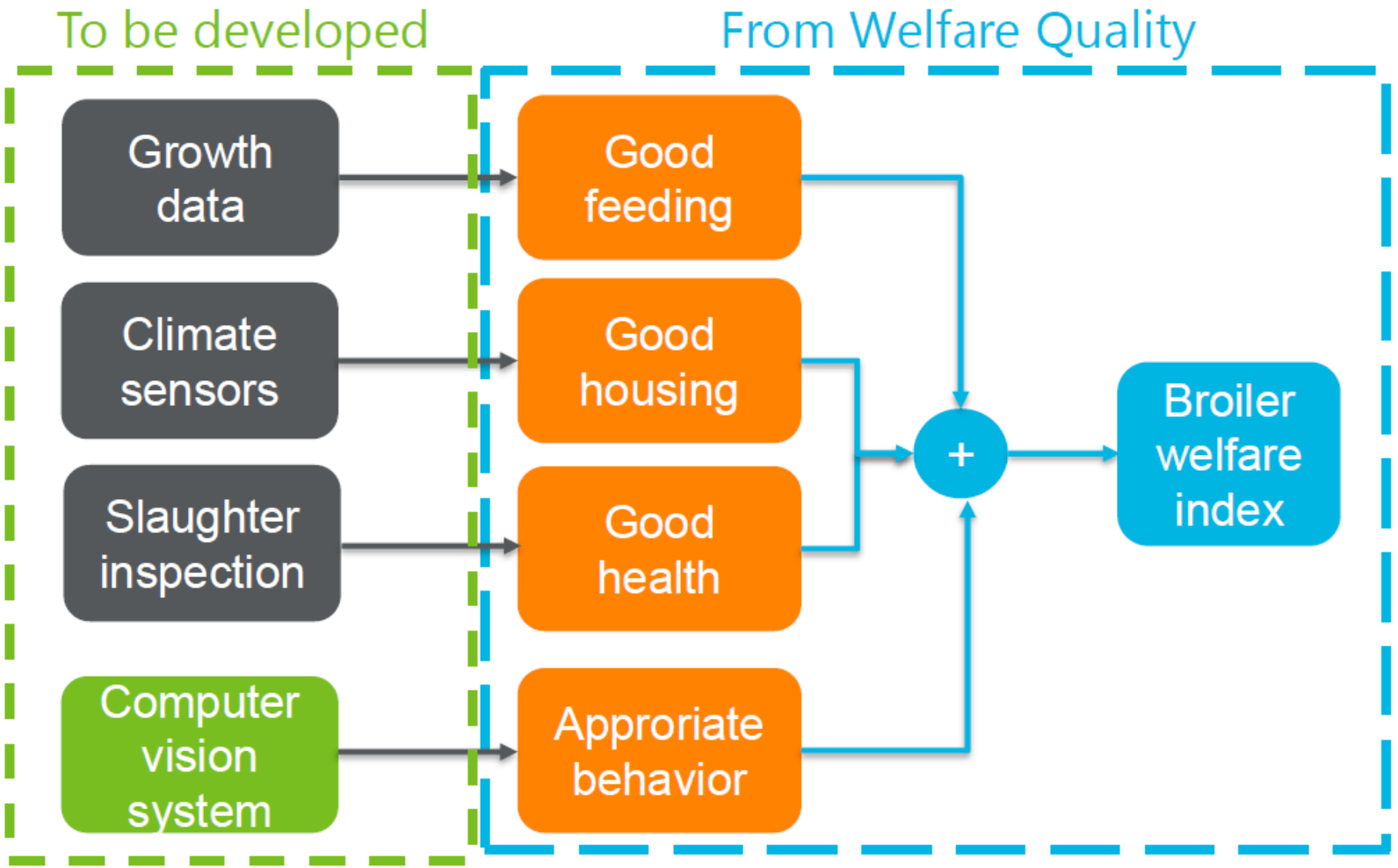
How to develop new object detection model?

- Annotate new images ~500 – 1000/class
- Use transfer learning:
  - Start with a pretrained model
  - Train the model with new annotated dataset
- Test -> annotate more images if needed



- **Practical constraints:**
  - Deep learning models are computationally quite heavy

Towards a welfare index



WQ basic principles

Properties of a set of criteria

The set of criteria, which makes an overall assessment possible, should fulfil the following requirements (Bouyssou 1990):

- It must be *exhaustive*, ie containing every important viewpoint.
- It must be *minimal*, ie containing only necessary criteria (banning redundant or irrelevant criteria).
- Criteria must be *independent* of each other. The interpretation from one criterion shall not depend on that from another criterion. Moreover, to avoid double counting there should be, as far as possible, no functional links between criteria.
- The set of criteria should be *agreed* by all stakeholders and considered as a sound basis for operating a practical assessment. The criteria and their application should be transparent and easy to understand, avoiding 'black boxes' in the aggregation procedure.
- To be '*legible*' the set of criteria should be composed of a limited number of criteria. In fact, to implement an aggregation procedure, it is necessary to show the values obtained for the different criteria correspond to one another. To handle this task, it is generally considered that twelve criteria is a maximum.

Table 1 Set of criteria and subcriteria used in WelfareQuality® to develop an overall welfare assessment.

Criteria	Subcriteria	Specifications
Good feeding	1. Absence of prolonged hunger.	
	2. Absence of prolonged thirst.	
Good housing	3. Comfort around resting.	Assessed through behaviour (including rising up and lying down movements) but not injuries (included in 5).
	4. Thermal comfort.	
	5. Ease of movement.	Not considering health problems (included in 6, 7, 8) and movements around resting (included in 3).
Good health	6. Absence of injuries.	Except those produced by a disease or voluntary interventions (eg mutilations)[1].
	7. Absence of disease.	Absence of clinical problems other than injuries[2].
	8. Absence of pain induced by management procedures.	Eg mutilations and stunning.
Appropriate behaviour[3]	9. Expression of social behaviours.	Balance between negative (eg aggression) and positive (eg social licking) aspects.
	10. Expression of other behaviours.	Balance between negative (eg stereotypies) and positive (eg exploration) aspects.
	11. Good human-animal relationship.	No fear of humans.
	12. Absence of general fear.	Except fear of humans.

WQ basic principles

- Four criteria representing different dimensions of welfare, independent of each other (Good feeding, good housing, good health, appropriate behavior)
    - Are the animals properly fed and supplied with water?
    - Are the animals properly housed?
    - Are the animals healthy?
    - Does the behaviour of the animals reflect optimised emotional states?

- Criteria score is formed from subcriteria:
    - Scale 0 – 100, 50 corresponds to a neutral situation
    - Weighing of different subcriteria formed based on expert opinion
    - Compensations between welfare criteria should be limited
    - Non-linear scale: both extremes are "difficult" to achieve

WQ on-farm measurements in broilers

Birds per drinker
Litter quality
Dust sheet test
Stocking density kg/m2
Plumage cleanliness
Panting (%)
Huddling (%)
On farm mortality
Culls on farm
Lameness (gait score)
Hock burn
Foot pad dermatitis
Avoidance distance test

Qualiative behaviour assessment:

Active	**Scared**	**Nervous**
Calm	**Comfortable**	**Confident**
Friendly	**Inquisitive**	**Frustrated**
Relaxed	**Drowsy**	**Distressed**
Content	**Fearful**	**Depressed**
Positively occupied	**Unsure**	**Bored**
Helpleess	**Playful**	
Tense	**Agitated**	
	Energeti	

Simplified approaches

De Jong et al (2015) found reasonable correlations when testing a simplified protocol for indicators of FPD, hock burn, cleanliness and gait score. => they estimated equations to predict one measure from the values of other measures.

=> Validation is important!

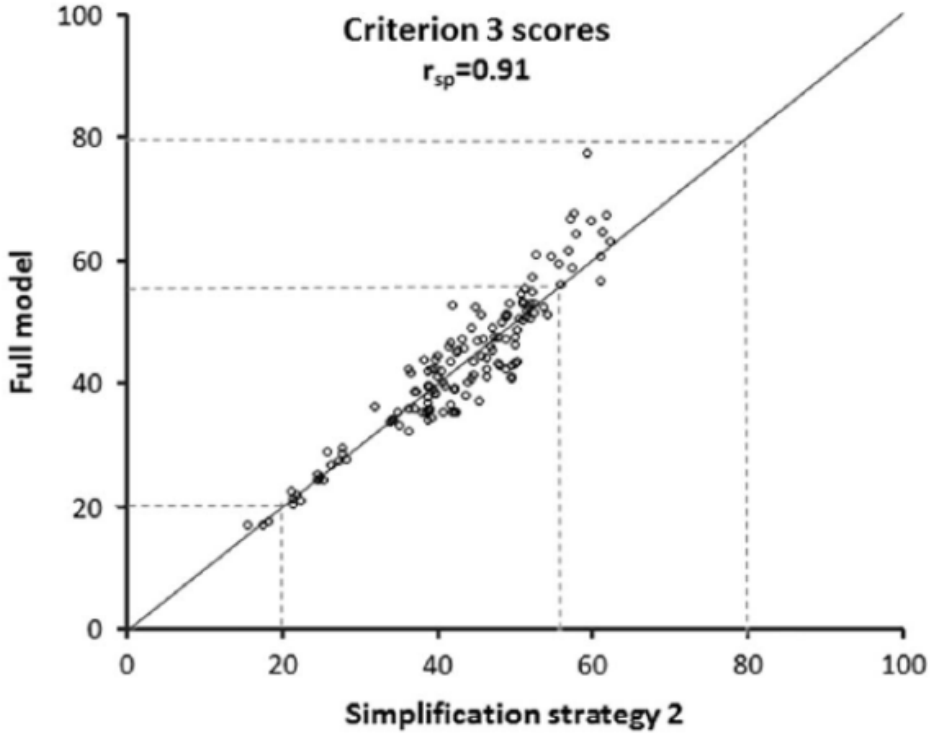
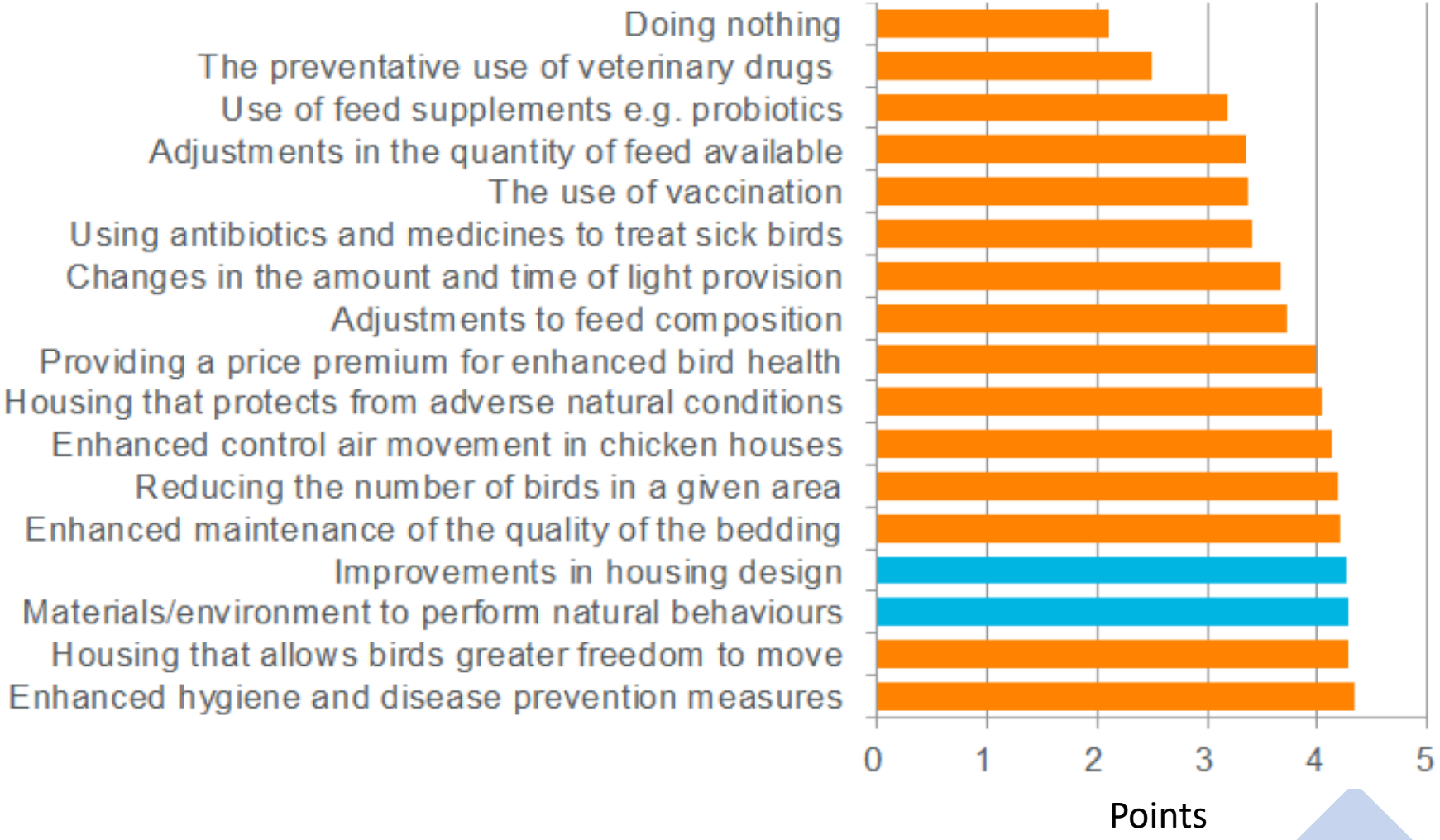


Figure 3 Criterion 3 (comfort around resting) assessment scores based on the full model (y axis) plotted against assessment scores according to simplification strategy 2. The graph shows distribution of flocks over classification groups ⩽20, 20 to 55, ⩾55 and the correlation (Spearman rank correlation; r_{sp}) between the full model and the simplified model.

Assessment aspects

- Genetic and management factors (e.g. housing, feeding, light, rewards) are likely to cause differences in the time budgets of birds between farms (e.g. Alvino et al. 20019, Bokkers & Koene 2013, McGarth et al. 2016, Bergman et al. 2017, Wallenbeck et al. 2017)
- Positive behaviours and growth rate (or factors associated with growth) tend to be negatively associated
- The system should acknowledge these differences and aim towards a consistent assessment
- Possible indicators to be followed:
    - How animal welfare indicators are improved thanks to the system?
    - What is the level of animal welfare indicators at the farm?

Consumer acceptance



Miele (2014):
"Naturalness"
"Humane treatment"

Clark ym. (2019)