

Risk factors for laying hen keel bone damage

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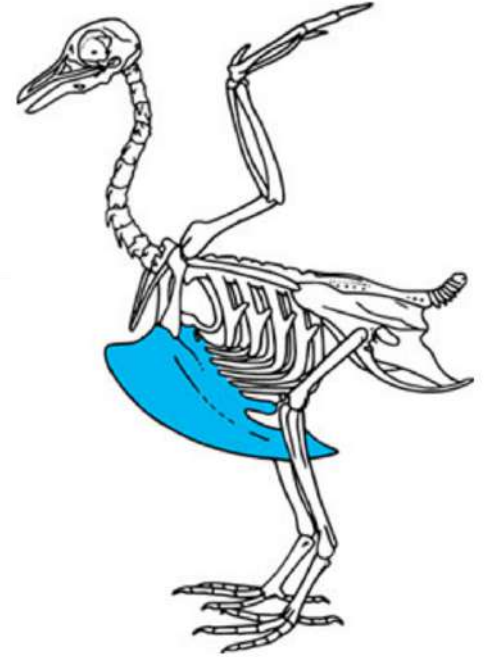
Background

Keel bone damage:

- Recognized as an important concern affecting hens in alternative housing systems^[1,2]
- Linked to increased mortality^[3], reduced egg production efficiency and egg quality^[4,5]
- Likely association with pain^[5,7,8]

Previous work:

- Focused on aviary and barn systems
- Evaluated causes of damage indirectly



Location of the keel bone. [Image: I, Toony. Wikipedia]

Research Objectives:

Objective 1: Determine which behaviors produce high energy outputs and long point pressure exposure outputs at the keel within enriched colony cage systems.

Objective 2: Evaluate the relative occurrence of keel damage types at different flock ages.

Objective 3: Determine the roles of collision and perching frequencies, the energy thresholds experienced at the keel, and evidence of previous damage on the development of keel curvature and fracture.

Housing

Laying Hen Research Facility, MSU

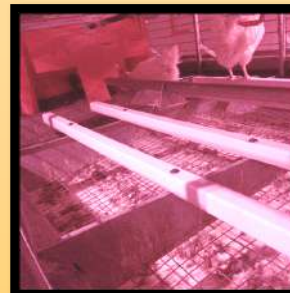
Rm.1: Cage Type R



Rm.2: Cage Type R



Rm.3: Cage Type S



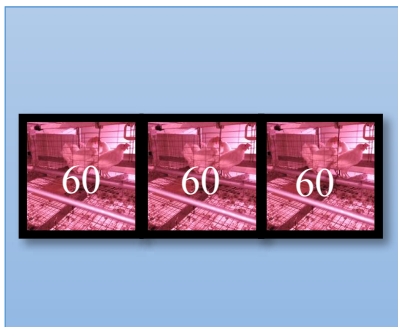
Rm.4: Cage Type S



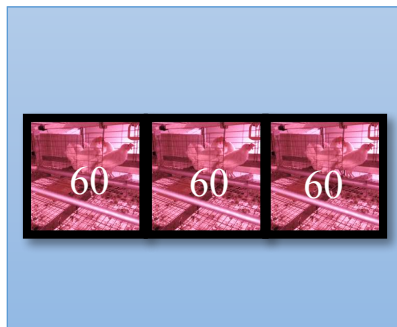
Housing

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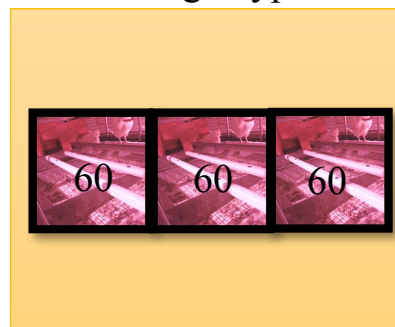
Rm.1: Cage Type R



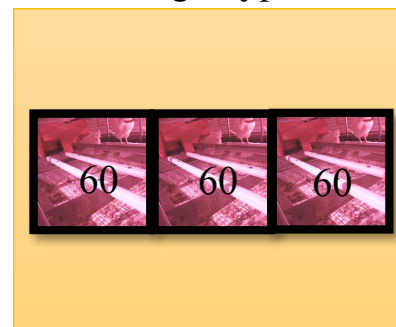
Rm.2: Cage Type R



Rm.3: Cage Type S

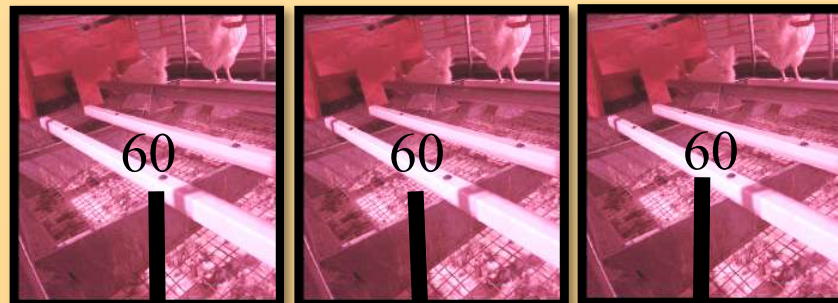


Rm.4: Cage Type S



Data Collection

Rm.4: Cage Type S



Focal hens:

10 hens

10 hens

10 hens

Time rep. 1 (3 week):

52-55 wk

55-58 wk

58-61 wk

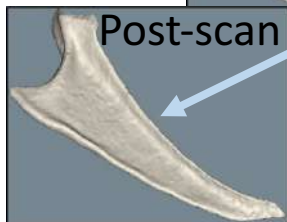
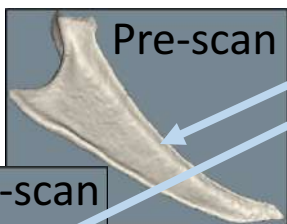
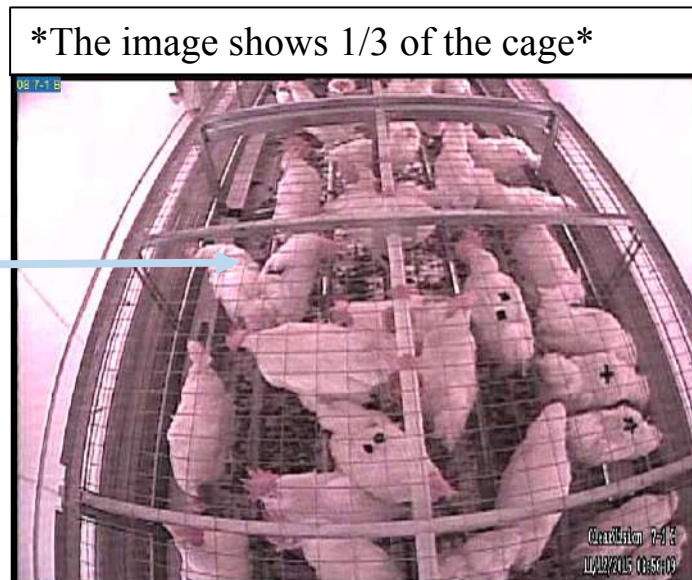
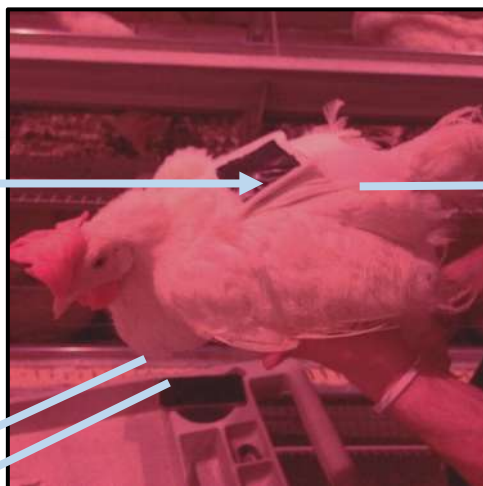
Time rep. 2 (3 week):

74-77 wk

77-80 wk

81-84 wk

Data Collection



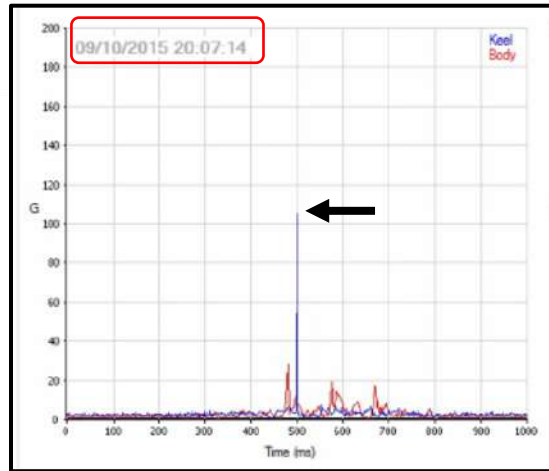
Research Objectives

Objective 1: Determine which behaviors produce high energy outputs and long point pressure exposure outputs at the keel within enriched colony cage systems.

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Impacts and Behaviors: Accelerometer Data

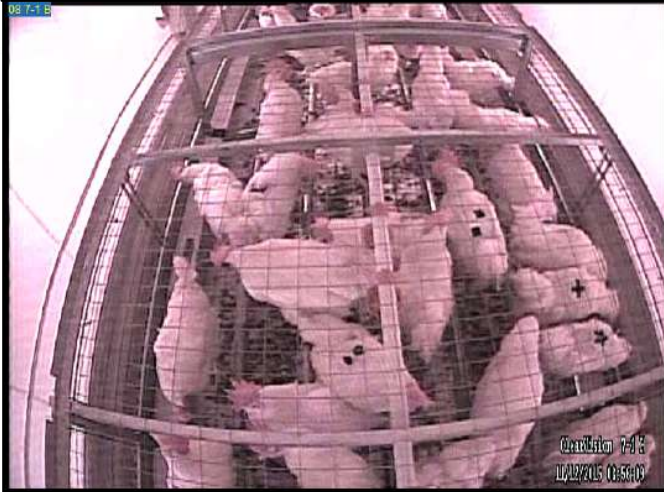


Peak summed acceleration forces:

- 12-20 G (<20 G)
- 20-39.99 G
- 40-50.99 G
- 60-79.99 G
- 80-99.99 G
- >100 G

Impacts and Behaviors: Behavioral Data

The image shows 1/3 of the cage



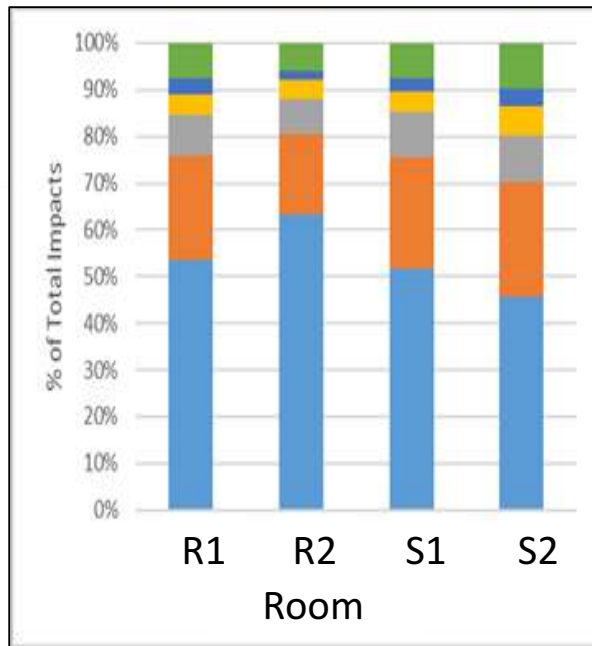
Behavioral categories:

- collision
 - grooming
 - aggressive interaction
 - wing flapping
 - mass scattering
 - cannot ID (removed from analysis)
- action leading to collision
- collision object

Impacts and Behaviors: Results

14,516 impacts categorized

→ 7,877 impacts matched to video



Legend:

≥100 G

80-99 G

60-79 G

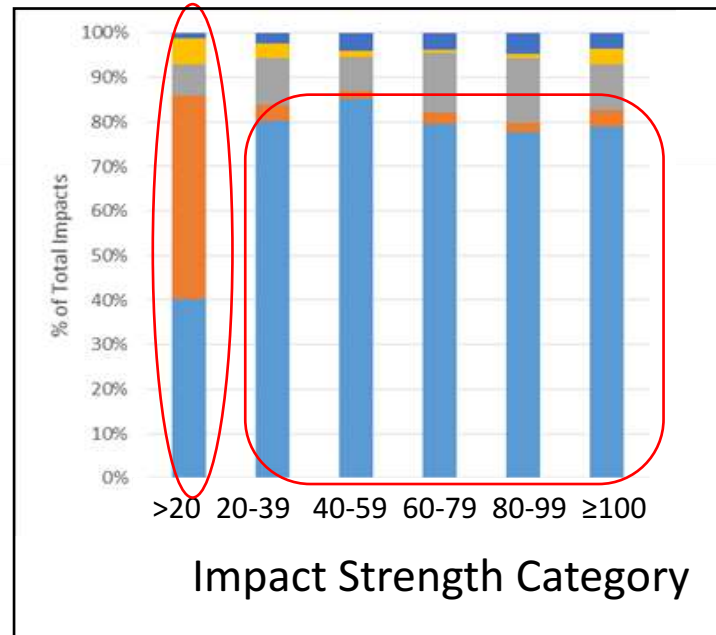
40-59 G

20-39 G

>20 G

Impacts and Behaviors: Results

7,877 impacts matched to video



Legend:
Scattering
Wing flapping
Aggressive interaction
Grooming
Collision

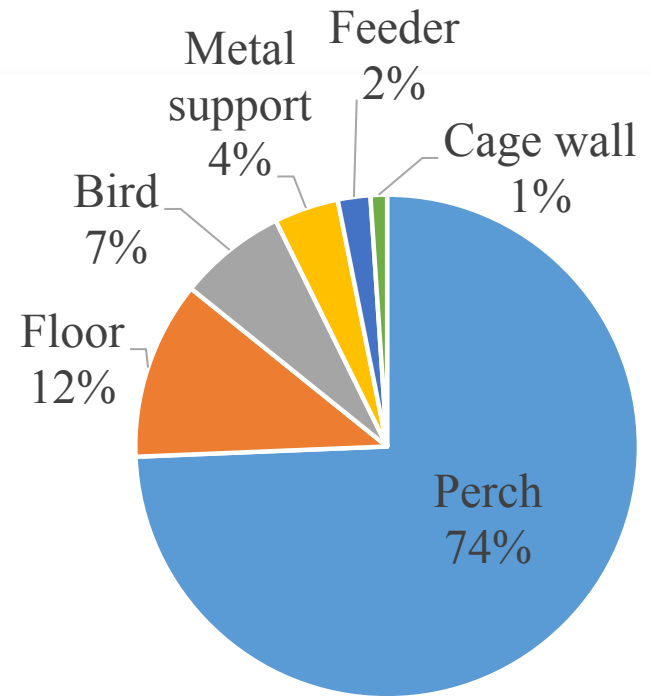
Impacts and Behaviors: Results

Collisions occurred when hens:

- ascended onto perches (30.1%)
- were pushed into an object (26.5%)
- fell into an object (17%)
- moved between perches (11.5%)

Objects of collision:

(based on 2,920 collisions observed):



Research Objectives

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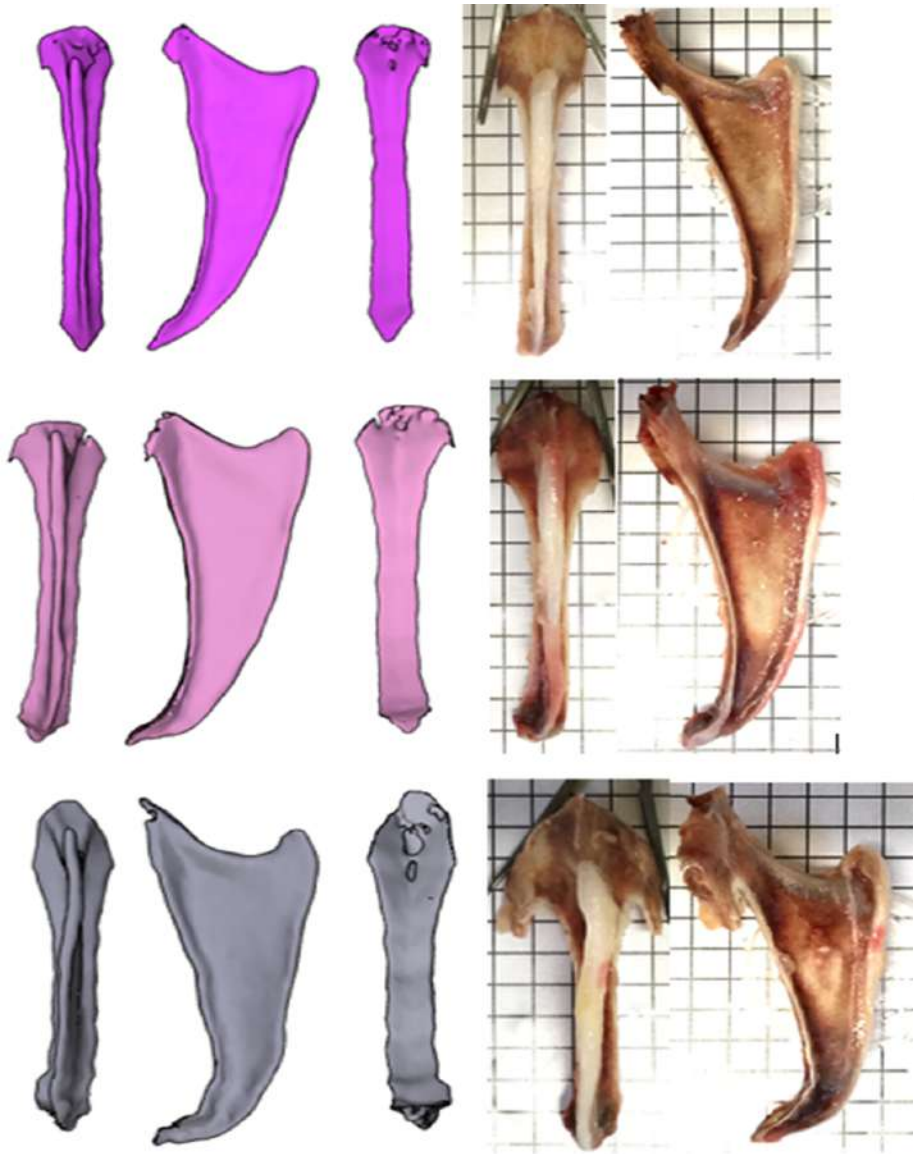
Objective 3: Determine the roles of collision and perching frequencies, the energy thresholds experienced at the keel, and evidence of previous damage on the development of keel curvature and fracture.

Keel Bone Integrity

Score	Fracture	Deviation	Tip Fracture	Tip Bend
0	none	none	No	No
1	one	slight	Yes	Yes
2	multiple	severe		



Keel Bone Integrity



Keel Bone Integrity

Time Replicate 1
Pre-scan

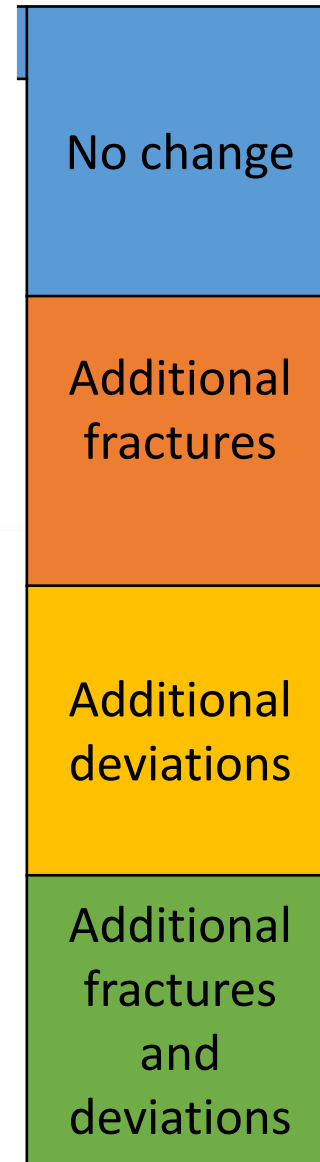
Damage Type	Nr. (%) bones
None	6
Fracture	32
Deviation	8
Fracture & Deviation	55

Keel Bone Integrity

Time Replicate 1
Pre-scan (101 bones)

Damage Type	Nr. bones
None	6
Fracture	32
Deviation	8
Fracture & Deviation	55

Post-scan (81 bones)



Keel Bone Integrity

Time Replicate 1
Pre-scan (101 bones)

Damage Type	Nr. bones
None	6
Fracture	32
Deviation	8
Fracture & Deviation	55

Post-scan (81 bones)

0	
	No change
	Additional fractures
	Additional deviations
	Additional fractures and deviations

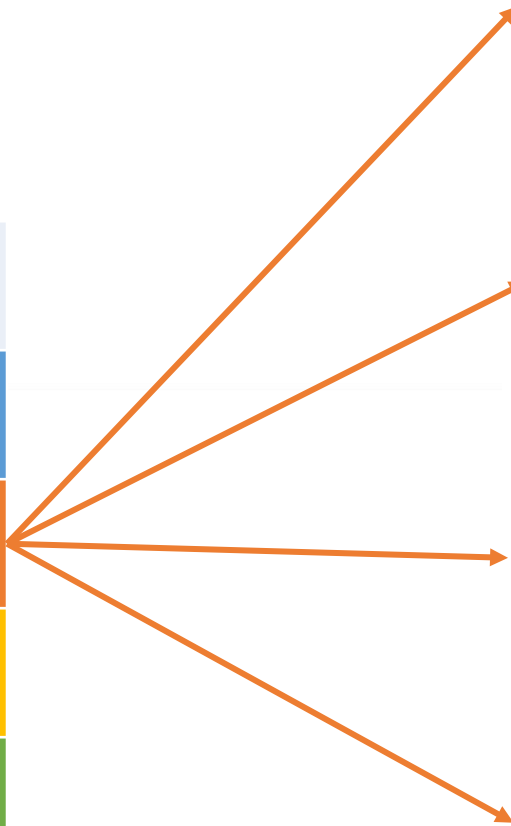
Keel Bone Integrity

Time Replicate 1
Pre-scan (101 bones)

Damage Type	Nr. bones
None	6
Fracture	32
Deviation	8
Fracture & Deviation	55

Post-scan (81 bones)

0	No change
3	Additional fractures
0	Additional deviations
2	Additional fractures and deviations



Keel Bone Integrity

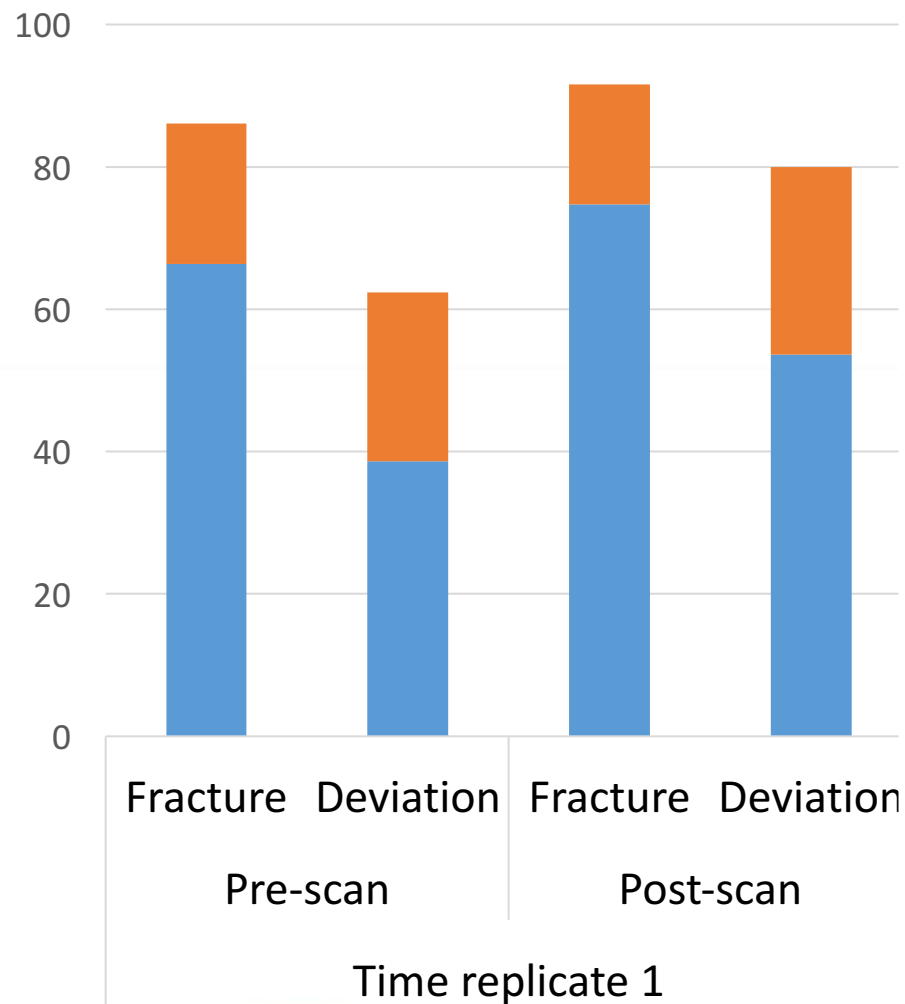
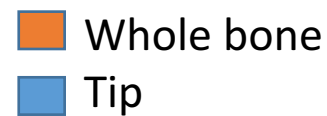
Time Replicate 1
Pre-scan (101 bones)

Damage Type	Nr. bones
None	6
Fracture	32
Deviation	8
Fracture & Deviation	55

Post-scan (81 bones)

0	No change
7	
3	
3	Additional fractures
5	
0	Additional deviations
2	
2	Additional fractures and deviations
10	

Keel Bone Integrity



Keel Bone Integrity

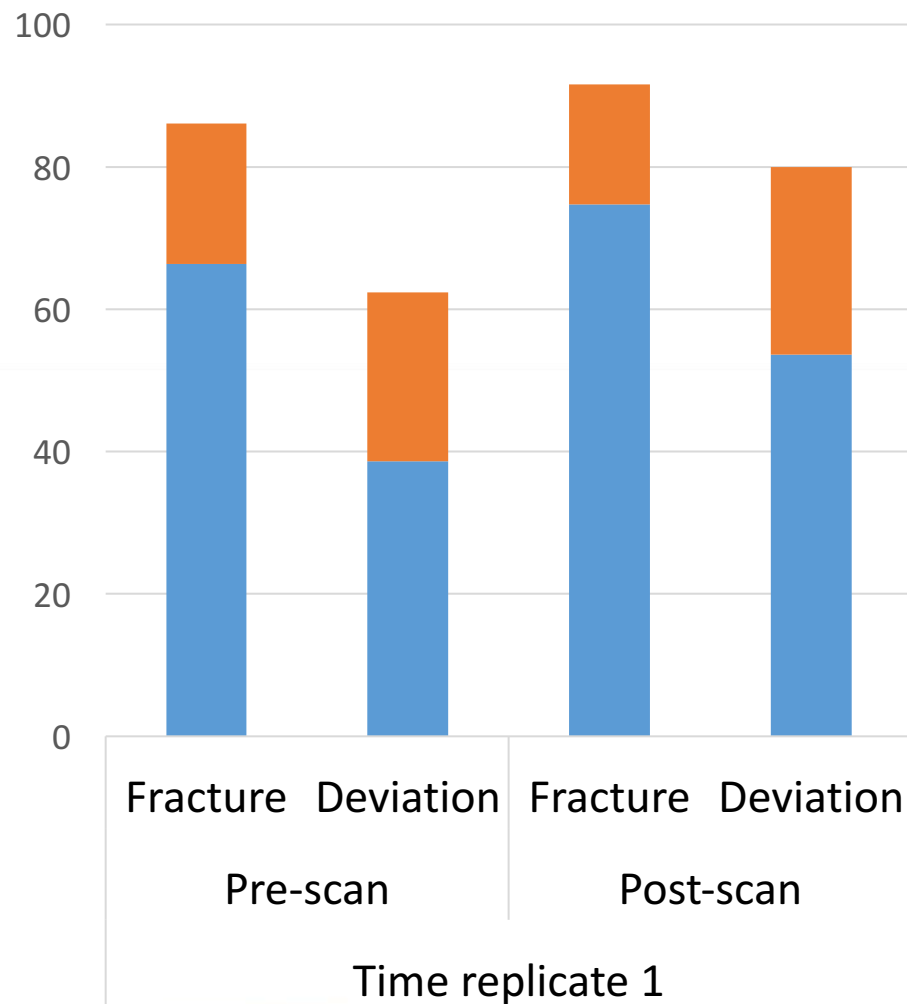
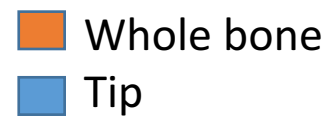
Time Replicate 2
Pre-scan (102 bones)

Damage Type	Nr. bones
None	1
Fracture	30
Deviation	7
Fracture & Deviation	62

Post-scan (100 bones)

0	No change
14	
2	
32	
0	Additional fractures
8	
4	
20	
1	Additional deviations
4	
0	
6	
0	Additional fractures and deviations
4	
1	
4	

Keel Bone Integrity



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Impacts, Behavior and Keel Bone Integrity

What cause new damage (fractures and deviations)?

- Number of impacts? ~~X~~
- Strength of impacts? ~~X~~
- Presence of previous fractures? ~~X~~
- Number of collisions? ✓
 - P=0.06 (Collisions – new fractures)
 - P=0.05 (Collisions – new damage)



Summary and Discussion

- Summed peak accelerations ranged up to $>100G$
- Collisions accounted for over 80% of impacts $>20 G$
- Hens collided most often with perches (74% collisions), mainly while ascending onto them (30.5% collisions)
- Descriptive data and statistical trends highlight the perch as a likely risk factor for the development of keel bone damage by hens in enriched colony cage systems.
- Further research needed to understand what aspects of perch provision are associated with risk of keel bone damage (ex. height, design, location...), and role of variable outside the scope of this study (ex. hen strain, housing type...)

Acknowledgements



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