Minutes from the COST KeelBoneDamage meeting, 21-22 March 2017, Ljubljana, Slovenia

Present: Appendix A

March 21, 2017

1. University introduction (Manja Zupan)
   a. Manja welcomed the group, and talked about the country Slovenia – half the country is forest, caves, wine, bears, beaches, mountains! And the programme for the coming days together with the short description of the first AW project in Slovenia.
   b. Prof Peter Dovč head of department welcomed the group
   c. Assist. Prof Dusan Tercic, head of poultry unit
      - brief history of poultry production in Slovenia (2015 – 60% broilers, 25% layers, 12% other chickens, 2% turkeys).
      - Layers 35% enriched cages, 42% barn, 13% free range, 9% organic, largely Lohmann Brown.
      - 3 poultry barns, egg quality lab, egg sorting room, poultry slaughterhouse

2. Introduction (Mike Toscano)

a. Purpose of action and this meeting, including what should be accomplished
   - Background on keel bone damage in commercial flocks
   - Goal is to understand the basic mechanisms of damage, leading to data-driven and objective solutions
   - The Action is composed of 19 nations, 75 participants
   - Aim is to link researchers together; inform producers and stakeholders; train next generation of scientists
   - This meeting: to learn what research is happening now, and to identify gaps; propose definitive steps to coordinate the gap filling; planning for potential experiments, review papers etc
   - Grant periods:
     - GP1: 1 Nov 2016 – 30 April 2017 – two STSMs, preparation of this meeting, meeting itself, database of participants, development of logo and business card and leaflet, development of website (http://www.keelbonedamage.eu)
     - GP2: 1 May 2017 – 30 April 2018 – STSMs (up to 10), call for applications will be Summer 2017 and January 2018; training school; joint management committee (MC)/workshop (host still to be decided)
   - How to use the Action – does not fund research, but does give extra legitimacy to your applications (you are a member of this exclusive group); supports STSMs, training, workshops…; website showcasing our activities; dissemination to other scientists, producers, etc. (So any research grant you apply for will be showcased on the COST Action website, to its researchers etc, at no cost to that grant.)

b. Website
   - http://www.keelbonedamage.eu

c. The next round of STSMs
   - June/July 2017 and January 2018

--00-- Icebreaker and get to know each other --00--

3. Update from SG4 on scientific committee recommendations

SG4 – research and training coordination, Eva Sossidou, and Ivan Dimitrov (presenting)

a. Suggestions to identify gaps in expertise were made including WGs to work on cross-WG deliverables, communicating to industry, collaborating for future projects (e.g. Horizon 2020 funding)

b. Co-ordinating and producing materials for Research in Focus

4. WG 1 presentations/discussions (leaders: Ian Dunn and Ariane Stratmann)

a. Ian Dunn, The Roslin Institute, UK: Brief Introduction

- Aim of WG1: to address the ways of measuring/assessing keel bone damage, in the live hen but also post mortem. We aim to work towards spreading and standardising the most used methods.
- Keel bone damage is multifactorial; but for genetic and nutritional interventions, using non-keel bone measurements (i.e. other bones in the skeleton) may be effective because of the high genetic correlation between measurements of quality on different bones and with fractures; keel bone damage could be viewed as one indicator of overall bone quality.

b. Heather McCormack, The Roslin Institute, UK: Assessment of bone quality and keel bone damage

- Bio mechanical testing – to measure breaking strength, deformation, stiffness etc
- Histology of bones to look at mineral apposition, to quantify bone types, to examine e.g. Keel composition/fracture callus
- X-Ray densitometry, using mammography X-ray film for high resolution. Use free software ImageJ to artificially colour different densities of bone for analysis.
- Does improving bone strength in one bone improve it in others including the keel? Yes it does.
- Method difficulties: different bone types affect the radiographic density (I.E. Fractures increase radiographic density, but this is not a stronger bone than one without a fracture which might have lower radiographic density). Likewise deviations are not necessarily visible on xray but can be more radiographic opaque, thus skewing the 'bone strength' score. Bones and X-rays are scored differently by different people (experienced/inexperienced)
- Keel bone shear strength as a novel phenotype– measured at various places along keel
- Ultrasound to measure toe mineral density as a proxy for skeletal mineral density; and measure of humerus (neither can be used on the keel) – work in progress, not currently well correlated with bone strength or radiographic density. Believe that tailor made solutions may get over some of these problems.
- Further non-destructive methods of measuring are required.

c. Ariane Stratmann, University of Bern, Switzerland: Improving and validating keel bone palpation

- Manual handling to feel for any abnormalities from smooth, straight bone
- Two popular scoring systems:
    - Scholz et al 2008: score 4 (perfect) to 1 (severed deformity). Includes both fractures AND deviations
    - Wilkins at al 2004: fracture only, score 0 (no fracture) to severe fracture (2). For dissected keels, severity scale of fracture 0-4
- Palpating is a quick, cheap, validated scoring system, and independent of the setting. BUT does not give detailed information, can have poor sensitivity and specificity, or under/over emphasise the severity of the fracture or deformity, and relatively low repeatability
    - Users should have appropriate training
    - Regular recalibration of a person's technique
    - Handlers should regularly handle birds with a variety of KBD to protect their accuracy of scoring
- Suggestions for improvement: detailed in Casey-Trott et al. 2015
    - SKAP: simplified keel assessment protocol – yes/no fracture and yes/no deviations
- Use X-rays of live birds' keels to validate palpation, and revisit birds to understand what is felt.
- Using 3D models of keels to improve palpation reliability. The models can be taken on farm to calibrate staff
- Propose a **training school in Bern in Autumn 2017** to standardise palpation techniques.

d. Sarah Baur, University of Bern, Switzerland: Radiographic evaluation of keel bone damage in living laying hens

- Divided the X-ray images into 5 areas: A-E
- Identified distinct fracture types, when callus forms, and in which keel areas in hens X-rays over 40 weeks

e. Beryl Eusemann, Friedrich-Loeffler-Institute, Germany: Radiographic examination of deformities and fractures of keel bones in laying hens

- Comparative X-ray study of different hen lines and of different production levels (artificially induced low production with a hormone implant) and housing types
    - Measured keel bone area. Where deviations, straight line from edge to edge drawn in to estimate the proportion of deviation
    - Assessed fractures, with and without callus formation. Fracture measured on a binary score
- Radiographic density of keel bones
    - Using an aluminium stepwedge (Fleming et al 2000)
- Further work
    - X-rays of keels after dissection – is density the same with and without soft tissue?

f. Björn Andersson, Lohmann Tierzucht, Germany: Keel bone damage, clues from genetic assessment

- Measurements taken using palpation, by ultrasound of humerus, breaking strength of humerus and tibiatarsus (in LSL lines)
    - Palpation done on two lines of hens (n=6,000) housed in single cages at 46 and 70 weeks
    - Use a method similar to Sholz et al (but mentions Gebhardt-Henreich 2011)
    - Large differences between the lines related possibly to onset of laying, but in both lines the % of birds with damage (yes/no) does not change much with age. Heritabilities in line A especially were useable.
    - If select for later onset of laying, some loss of eggs but these are relatively less saleable eggs anyway.
    - Ultrasound – as per Roslin, measured the humerus, heritability estimates vary with the two lines; for line A it was respectable but for line D variation was low and heritability could not be estimated.
    - Breaking strength – measured onthe top and bottom birds of bone quality as classified by ultrasound or palpation, Humerus and Tibiotarsus breaking strength differed between top and bottom birds for both bones when categorised by palpation but not when categorised by ultrasound.

g. Alejandro Navarro, University of Granada, Spain: Physico-chemical assessment of avian bone. The methodology allows a sophisticated assessment of the chemical components and their state from bone. May lead to novel biomarkers and lead to greater understanding of the biology behind avian bone quality.

- Optical microscopy
- Electron microscopy
- 2D X-ray diffraction techniques
- Infrared spectroscopy – to inform chemical composition of the bone (which changes with age and skeletal location of sample)
    - The group has developed software to analyse large numbers of samples measured with IRS
- Assess bone quality using a wide-range of measures from different housing
    - As a proof of principle cage versus aviary housed hens previously known to differ in bone quality differ in their physico chemical bone parameters

5. WG 2 presentations/discussions

a. Anja Brinch Riber, Aarhus University, Denmark: Brief introduction

- What are the criteria for objectively evaluating the severity of KBD and at what threshold should there be concern? At what level is welfare and production affected?

b. Rachel Lynn Dennis, University of Maryland, USA: Understanding the quality and quantity of keel innervation

- To help us understand pain associated with KBD
- Not just about quantity of receptors, but quality

- There are no published reports of pain receptors in the keel
- How to measure innervation/potential for pain – nociceptor pathways, such as neurotransmitter profile (normally requires a tissue sample); the quality of stimulators vs inhibitory receptors; the quantity of overall receptor density; measure substance P (involved in bone remodelling); measure TRK; measure nerve injury (BDNF, morphological changes visible through tissue staining); measure pain-associated proteins; investigate spinal remodelling; take direct electrical readings from the peripheral nerves; imaging (MRI, fMRI)
- Memory and pain
- Pain and swearing!
- Possibly greater innervation of keel than mammalian long bones
- Expect to be able to produce an 'map' of keel bone innervation, subject to a further study.
- Presence/absence of nociceptors does not tell us if there is chronic pain – use histology to help determine this, but tricky to do histo with bone. Would need to map surrounding soft tissue as well
- Immunology link with chronic pain

c. Anja Brinch Riber, Aarhus University, Denmark: Effects of keel bone damages on welfare and production in laying hens - a review

- 'Animal welfare' – combination of biological functioning, affective states, and naturalness
- Distinguish between keel bone fracture and keel bone deviation
- Using behavioural measures to assess the effect of fractures on welfare: Nasr's et al 2012 – mobility of hens with KBF was decreased, and hens with fractures spent more time sleeping on the floor. Casey Trott and Widowski 2016 found opposite – birds with keel bone fracture spent more time sleeping on the perch, but perches are only 10 cm off floor (no flying or jumping required to reach). Richards et al 2012 free range hens, birds with more severe fractures used pop holes less and a greater % remained indoors, particularly with decreasing ambient temperature. Gebhardt-Henrich and Fröhlich 2015, found that both brown and white hens use the nest box for longer after a fracture occurs compared to before.
- Using physiological measures: thermal images of keel bone area was lower in birds with fracture – possible muscle atrophy?
- Does severe keel bone damage affect respiration?
- Clinical measures – FAWC 2010 pointed out the keel fracture is a clinical measure which is an indicator of reduced welfare. Nasr et al 2013 found that KBF hens increased food and water intake, which will have production cost effects
- KBF indicators of affective states: Nasr et al 2012, using butorphanol or saline on fractured and non-fractured hens, the NSAID reduced the latency to descend from a perch only in birds with KBF. Nasr et al 2013 showed in conditioned place preference tests that birds with *healed* fracture chose the coloured area of a T maze where they had experienced the NSAID
- Production parameters – Nasr et al 2012 showed that shell weight and egg production % was lower in hens with fractures than those without; Gebhardt-

Henrich and Fröhlich 2015 found no association between egg production and KBF, but that early lay was associated with a greater incidence of KBF

- Keel bone deviations – Harlander-Matauschek et al 2015 recommend the investigation of the relationship between KBD and KBF – no scientific data to show that there is a link.
- Conclusions: KBF prevent motivated behaviours, are painful, and have negative effects on egg production. Welfare effects of KBD are unclear.
- Thoughts – do green stick fractures (i.e. at caudal tip) have same welfare impact as complete fractures elsewhere on the keel? And KBD are largely overlooked, needs more attention.

d. Christina Rufener, University of Bern, Switzerland: Effect of keel bone damage on productivity and mobility - ongoing studies

- In 10 small aviaries of brown and white hens, use dye to identify eggs (up to 15 distinct colour combinations) from 15 individuals per aviary, over 22-61 wks of age (at 11 time points), then X rayed hens after each data collection point to look for fractures.
    - Compared X-ray data (fractures, location, type, callus, whether new or old, etc) with production factors (used first 3 eggs out of 5 laid at each data collection point)
    - NO effect of new fractures on production measures. Fractures took variable times to heal so need to have a descriptive state of healing (new, stable, healing, healed?) to rank them for statistical modelling
    - New fractures do not involve a lot of calcium immediately, but healing fractures require calcium so it is expected that this time will decrease production. Mobility is more likely to be affected by new and stable fractures.
- Mobility hypothesis – fractures may cause pain, which will affect bird mobility (perhaps hens will stay on aviary levels that have primary resources if they have fractures)
    - Using an infrared tracking system on 120 focal hens over 6 commercial system pens. There are 6 levels that hens can access. Work here is ongoing
    - IR tracking validation pilot (in a 4-level aviary, e.g. Litter and 3 tiers, plus a veranda) showed that individual hens had distinct behaviour patterns – great variation in the number of level changes per hen;
    - Some birds move little, some move a lot – are they affected by fractures?
    - Some birds roost in the lower tier, some on the top, some on the litter – do they have different fracture statuses?
    - Some birds visit nest boxes for a long time per bout, some for short periods per bout, but overall time in nest boxes is similar. Are birds spending longer bouts in NBs differing in fracture status? Some never visit nest boxes – are they laying elsewhere or not at all?

MT – this kind of information is essential to producers, to give them objective information about potential (or actual) financial losses due to keel bone damage.

6. WG3 presentations/discussions

a. Bas Rodenburg, Wageningen University, NL: Brief Introduction

- Objectives are to determine causes of KBD in different systems; what interventions can be adopted to reduce KBD (housing and management, genetics, nutrition methods)
- Innovations to reduce KBD should be based on science AND attractive to producers
    - Need close collaboration industry/research
    - Close attention to uptake of innovations; how the information is relayed to industry (workshops, leaflets, etc)
- Recommendations 4-8 of the Harlander-Matauschek et al. 2015 paper will be addressed in this WG.
- Need an inventory of current research
- Investigate possibilities for new collaborations – by connecting existing national projects, and by expanding collaborations

b. Alexandra Harlander, UoGuelph, Canada: Effects of early-life environment

- Hen locomotion and development of locomotor skills – how are skills developed by housing system in the layer pullet?
    - Chicks initially use the ground mostly, and with age increasingly use raised areas, for locomotory activities
- How does physical activity levels (low, moderate, and high-intensity) differ with age and strain – brown birds show less low, and more moderate, activity than white birds
- Development of locomotion over inclined surfaces – wing-assisted running started at 40 degrees ramps (just walked at 0-30 degrees); birds use greater force to push off to climb steeper inclines
- Physical health problems (e.g. Bumble foot, wing feather damage, keel damage) and environmental challenges (low lighting, crowded or moving perch) influence balancing behaviour – both require more intense and variable movement corrections to maintain balance
- Effects of pain on locomotion – do birds with foot damage avoid weight bearing on the injured side when landing onto tiers? Do hens with keel bone damage avoid using wing deceleration during landing, and thus increase force through the legs?
- Do chicks raised with/without mother differ in their use of complex environments?

c. John Tarlton, UoBristol, UK: Effects of nutrition – diet and Omega 3

- In one year, a modern laying hen will lose over 800 g of calcium in egg formation, most of which comes from medullary bone
- Conventional caged hens show osteoporosis, whereas free range hens show greater bone strength with age, suggesting that egg laying per say does not lead to bone weakness, but rather a lack of exercise does
- Perch height is positively correlated with greater fracture prevalence (Wilkins et al)
- Believes that keel bone deformities have a degree of fracture in them

- Interest in Omega-3 fatty acids: human studies, have excess of n6 (possible contribute to health problems including osteoporosis); however hens have a diet closer to equal parts n3 and n6 naturally. However, artificial diets have an excess ratio of n6:n3, due to the grains they are fed (corn is very high, for example)
- n3s promote bone formation, n6s promote bone resorption
- Role of prostoglandins in bone biology
- Increased n3 in hens' diets increased bone density, volume and trabecular thickness AND bone remodelling (i.e. Improving hens' abilities to repair bones), and reduced (keel bone or all?) bone fractures by 40-60%

d. Teun van der Braak, Hendrix Genetics, NL: Possibilities to reduce KBD through breeding

- Major genetic progress in hens – more eggs for less feed
- Doubts that keel bone damage results in less eggs, more likely greater consumption of feed
- Breeding goals have changed over the years to include health and welfare (social behaviour, feather cover, ability to use commercial systems, keel bone damage etc)
- Multiplication factor: 1 pure line female results in 85 grandparents, which results in 7,225 parent birds, which leads to 750,000 commercial hens!
- Want hens that lay almost an egg a day from 20-100 weeks
- Birds bred for cages and for alternative systems have somewhat different breeding goals, for example for alternative systems:
    - Body weight development (need good reserves for challenging environment) and against earlier sexual maturity
    - Feed intake in relation to BW development
    - Feather cover
    - Social behaviour
- But Hendrix Genetics does not breed so far for specific use of a system
- There ARE existing differences between breeds with system use (but not sure why)
- Breeding has multiple traits involved, lots of inter-linkages which means selecting for one trait can alter/influence others
- Selection for high and low bone mineral density worked, (Fleming et al) but resulted in reduced egg production etc. These lines have been used for KBD studies
- Laying hen breeding (where margins are low between input and output) should be cheap, accurate.

e. Alexandra Jeremiasson, SvenskaAgg, Sweden: Experience with KBD in various housing systems in practice

- 95% white hybrids in Sweden, 15% in enriched cages, 57% in multi-tier barn, 9% single-tier barn, 3% free range, 16% organic (latter two mostly in multi-tier systems)

- Pullets mostly reared in aviaries (synonymous with multi tier) to match to the adult system, with ramps to aid access to tiers; some single level rearing with perches, some cage rearing with perches (required since Jan 2017)
- Hens in enriched cages – less risk of KBF, more risk of deformation, more risk of fracture at slaughter?, lower bone strength (cf. loose-housed)
- Hens in multitier systems are initially given additional perches to reduce the distance to jump to the first tier – removed after a few weeks.
- Some single tier housing use aerial perches, others count the slats as perch
- Various perch materials and shapes in use – wood discouraged due to red mite harbourage; some parts of the housing design are not intended as, but are used as, perches
- KBD more common in flocks experiencing stressful/fearful event(s)
- Possibly less prevalent in flocks with access to coarse limestone
- Possible aviary housing design differences on KBD

7. Wrap up, plan for Day 2

a. How are we going to tackle the recommendations given in the Harlander-Matauschek et al. WPSJ paper 2015

b. What can the Action pay for – STMS, training schools, workshops. Big, small, advanced or in early stages. Please do MAKE SUGGESTIONS to make this Action work for you. So far, STSMs that could come from what we discussed today:

- How much Ca is needed for bone healing?
- Basic morphology and keel innervation
- Development of dissemination materials for specific audiences (in support of SG5) e.g. Fact sheets for producers

c. Suggestions:

- Working on tracking technology to combine expertise would be good (JT)
- Encourage sharing materials with other institutes (perhaps in exchange for labour intensive study day participation) and also shares the workload of interpreting the material (different analyses) (DJ, Sweden)
    - Could be a really good 3Rs paper here, massive sharing of huge quantities of data from one set of birds – in this example about 3,000 birds whose data was shared among SLU, Roslin, University of Granada
- Central database of KBD statistics, including methods of collection (S G-H). Could use the binary scales that Casey-Trott et al paper suggested, for ease of comparison (MT). Would need a lot of meta-data to make it useful.
- Risk analysis at farm level that influence KBD (ES) – could be analysed from the central database mentioned above (but needs detailed methodology to make studies comparable). The detailed meta-data may be lacking in order for the data to be useful (ID)
- Produce a reference data set for radiographs to ensure that institutes that use these methods have common protocols on how to perform X-rays (DJ Sweden)

d. Tomorrow morning (08:30-10:30), share what novel equipment we have that may be of interest to others; from 11:00-13:00 meet in specific WGs; from 14:00-15:00 wrap up with all

March 22, 2017

WG Leaders and replacement leaders held rooms specific WG-meetings followed by a meeting where the groups came back together and provided a summary (only the final summary is provided). Before breaking up, Action Chair Mike Toscano provided a summary of what the groups should be focusing on and then Bas Rodenburg and Mike Toscano presented some resources at their facilities which could benefit the network as a whole.

1. To think about:
    - Future STSMs
    - Training schools
    - Workshops
    - Dissemination materials

In other words, DO NOT HESITATE to make suggestions of how we can sensibly spend this grant money

2. Novel equipment/resources which could be shared

a. Bas Rodenburg, Wageningen, the Netherlands, PhenoLab

- Automatic recording (using sensor tags) of individual phenotype in group-housed hens. This tracks location, activity and proximity of hens to one another
- Uses video camera mounted on the ceiling to visually track. Uses the Observer software for manual behaviour recording, or Ethovision for automatic video tracking, or Ubisense/TrackLab for ultra wide band (UWB) tracking of active tags, and the THREE systems can link together.
- Beacon(s) in the room detects time of arrival, angle of arrival (triangulation)
- The sensor goes in a backpack (sourced from USA)
- Can sample 2x per second
- Size of area that can be monitored depends on the number of beacons, used in dairy cow sheds so can be large…
- Coordinates include X, Y and Z-axis
- TrackLab software combines the data together
- For 20 tags and 4 beacons plus all cameras, software etc cost 40,000 Euro
- Probably won't work well in a multi tier system, because of high level of obstructions between the tags and the beacons

b. Mike Toscano, UoBern, Switzerland, tracking methods

- Aviforum facility, pens with winter garden, covered yard, and range access, 4 of which are equipped with RFIDs (to assess use of indoors, winter garden, covered yard, and range)
- Inside, have infrared beams placed at each level, and hens fitted with receivers

- RFIDs do not work well indoors where there is lots of metal, and they are expensive
- Infrared system works indoors only where there is little light, and in small indoor systems (needs lots of cabling) – could not be used easily in a commercial system
- Comparing Noldus Ubisense UWB and another company's UWB in a trial this summer
    - Battery life is an issue, but 2nd company thinks this battery will last 2 yrs

Ine Kempen offered the use of the Belgian facilities, which are commercial conditions (enriched cages and multi tier (900-1300 bird colonies)), for further testing of the equipement.

c. Mike Toscano, UoBern, Switzerland, Impact testing

- Behaviour is a confound in unpicking the cause of keel bone damage from, e.g., genetic line, nutrition etc
- Can cause the same type of collision (force), same angle, etc, repeatedly on birds of different lines and so on.
- Work on 5 different genetic lines showed large differences in fracture severity when exposed to the same impact force.
- Predicted fracture with age suggests that probability of fracture goes up to about 45 weeks of age, but then declines (greater bone mineral density/maturity of the bones?) This is upheld in farm tests.

3. WG-specific breakout meetings

a. Summary of WG1 by Ian Dunn and Ariane Stratmann

- Palpation: important to train people at the training school, but PRIOR to this we propose a workshop to agree on WHICH system to use.
- Xrays: this also needs discussion on interpretation and to adopt, as far as practical, a common protocol for categorisation
- STSM proposals:
    - Develop keel bone models with artificial overlying muscle and develop a tactile analog scale
    - Histology techniques for the measurement of bone properties including bone mineral density
- KBD measurement data could be collected for epidemiology analysis and potential long-term monitoring (funding source would need to be identified – EFSA? Or egg accreditation scheme such as (UK) Red Lion Code?)
- Possible self-monitoring of KBD on farm, if there is a harmonious method, to identify risk factors for KBD associated with housing/management methods
- Novel methods of measurement: ultrasound, morphology, image analysis of deviations and some lateral thinking would be required to define traits for genetic selection
- Funding: this is the right time to influence the call topics for the 2018-2020 funding period for H2020 by contacting national contact points. Animal welfare features for example, but with no text at the moment.

b. Summary of WG2 Anja Brinch-Riber (MT acted as replacement as Anja needed to leave and FT was not present at this meeting)
   - Further analysis of C Rufener's data including physiological measures of bone
   - STSM proposals:
     - Comparing floor eggs with KB status in C Rufener's birds, possibly use Lohmann tracking system (which identifies which hen lays in a nest box), and do hens with KBD have increased feed demands (August 2017)
     - Assess the innervation of the keel (R Dennis)
     - Using EEG and/or fMRI to assess evidence of pain (R Dennis with others)
     - Emotional assessment of KBD (M Zupan, I Dimitrov)
     - Assessing KBD in other nations (with training of staff in the host nation in palpation techniques
   - Training school
     - Emphasis on validation and palpation
     - Essential to include non-scientists (people in NGOs such as RSPCA, veterinary inspectors, etc)
     - 1.5 day training school plus some lectures on e.g. Assessment of pain
   - Chat forum on our website on methods for studies
   - Possible funding for colleagues to meet to prepare grant materials
   - Explore funding options – USPEA, EIC, FFAR, EU (need to check eligibility)

c. Summary of WG3 Bas Rodenburg
   - Presentation by Jens Peter Christensen (Denmark) on the pathology of keel bone damage, to focus not only on high-energy collisions, and defining different types of fractures/causes
   - Intervention strategies:
     - Housing and management: some specific interventions already proposed (light, perches, platforms, bird management)
     - Genetics: need for good phenotype/genomic selection – more information needed on the impact of KBD on the bird
     - Nutrition: focus on early feeding, possible benefits of selenium, Omega 3/6 ratios, melatonin , link nutrition manipulations to bone muscle and physiology
   - Focus areas
     - We must involve industry – by producing leaflets for producers on bird management, transition from rear to lay, perch design (mine/Lars Schrader from 2014) – revamp and redistribute
     - ITC participation – in these countries, majority of hens are in cages, little or no research in KBD. Assess the prevalence in various systems and present the results to industry (there is limited knowledge on KBD in cage systems – low impact damage).
   - STSMs:
     - Pullets reared with and without perches are currently housed in furnished cages for a study in France, needs a trained assessor to come assess the hens before depopulation in Nov 17

    - Ramps and hybrids and how they effect KBD – Belgium (Nikkie Mackie, UoBristol)
    - Assessment of fractures in other species – e.g. Quail in cages or aviaries, or other species, in Slovakia
- Training schools
    - On management and housing at Vencomatic (NL)
    - Bone and muscle physiology workshop, linked to nutrition and genetics, at EPC meeting in Croatia, Sept 2018.
- Possibility for a small group meeting of KBD Cost members, if you are attending the International Symposium on Animal Science, 5-10 June 2017, Montenegro

4. Core Group meeting

Present: Mike T, Manja Z and Maryse (SG6), Ivan D (SG4) Ari and Ian (WG1), Bas (WG3), Vicky S

Signing up Austria – Ari to contact poultry scientists there to see if they wish to join.

Action: AS

SG5 Dissemination

Dissemination to industry (SG5 Lubor and Ine) – Lubor has produced leaflet, 2 sides of a sheet of paper, can be translated into different languages

Ine is working on a poster to take to conferences – MT to check with Ine on progress. VS to take to WPSA-UK meeting (April 25th ish) if available

Action: MT

Ine working on a database of egg industry contacts – what would they like to get from us for e.g. Their newsletters?

Action IK

Update the perch technical leaflet (VS to do, by soliciting updated information, but notify Ine)

Action VS

STSMs (SG6)

Produce a table of suggestions so far, with brief description, and see where there is interest. Additional STSMs can be proposed as well. Only develop those where there is interest. More than one person may show interest in being on the same STSM – in that case, the host can filter which applicant they want to move forward with. Offer up to 10 STSMs for GP2, if not all funded will consider a second call around Nov depending on available funds. For STSMs that were offered but not funded in the last round, they can be proposed again for this round.

Manja and Maryse to contact hosts for short description to produce the table of suggestions, and to produce a timetable of when applications are due etc.

Action: MZ and MG

Maryse and Manja to use a prioritisation scoring system (sent from Bas from another Cost) to assess the applicants.

Identifying funding options

Produce a short paragraph about the Cost to be used on grants, to support the grant application (that this is a topic identified by a COST Action, which is composed of the EU's core scientists work on keel bone damage etc)

Action: MT

EU funding – suggestion is to stay ahead of the game, with your subject formulated and your core team prepared, well ahead of the call. Ivan and Eva (SG4) to keep an updated list of available funding schemes (ALL COST members to send funding announcements to them). SG4 will email members regularly, reminding them to provide information. Will also put announcement on the website to send information to SG4

Action: All
Action: IvD, ES
Action: BB and DZ

Finalising the budget for GP2

Management committee meeting, and grant writing workshop, planned to be in Slovenia in Feb 2018

Training school in Bern, on palpation methods, SOME attendees get reimbursed IN PART

STSMs – fund 10

Dissemination – to be used for e.g. Updating the perch leaflet (production of paper copy or design company? What does it pay for ?)

Bank charges

Appendix A – Attending

Name	Work in
Bjorn Andersson	Germany
Marianna Andreopoulou	Greece
Michael Appleby	United Kingdom
Zoitsa Basdagianni	Greece
Sarah Baur	Switzerland
Boris Bilcik	Slovakia
Ivana Božičković	Serbia
Jana Brankovic	Slovenia
Maksimiljan Brus	Slovenia
Jens Peter Christensen	Denmark
Rachel Dennis	United States
Ivan Dimitrov	Bulgaria
Mirjana Djukic Stojcic	Serbia
Ian Dunn	United Kingdom
Beryl Eusemann	Germany
Paolo Ferrari	Italy
Sabine G. Gebhardt-Hendrich	Switzerland
Tania Gonzalez Ovin	Spain
Maryse Guinebretiere	France
Christin Habig	Germany
Tone Beate Hansen	Norway
Magne Kjerulf Hansen	Norway
Alexandra Harlander	Canada
Daniel Hoop	Switzerland
Vlatko Ilieski	fYR Macedonia
Andrew Janczak	Norway
Zlatko Janjecic	Croatia
Magnus Jeremiasson	Sweden
Alexandra Jeremiasson	Sweden
Dusanka Jordan	Slovenia
Ine Kempen	Belgium

Dirk-Jan Koning	Sweden
Lubor Kostal	Slovakia
Zlata Kralik	Croatia
¨jorgen Nyberg Larsen	Denmark
Chaozong Liu	United Kingdom
Astrid Loven Persson	Sweden
Nikki Mackie	United Kingdom
Heather McCormack	United Kingdom
Georgios Michailidis	Greece
Virginie Michel	France
Florian Muijres	Netherlands
Mohammed Nasr	Egypt
Lidija Peric	Serbia
Mojca Pestotnik	Slovenia
Stefanie Petow	Germany
Katarina Pichova	Slovakia
Estella Prukner Radovcic	Croatia
Mafalda Quintas	Belgium
Renata Relic	Serbia
Vida Rezar	Slovenia
Anja Brinch Riber	Denmark
Bas Rodenburg	Netherlands
Alejandro B. Rodriguez Navarro	Spain
Christina Rufener	Switzerland
Charles Saliba	Malta
Charles Saliba	Malta
Victoria Sandilands	United Kingdom
Lars Schrader	Germany
Janja Sirovnik Koscica	Switzerland
Evangelia Sossidou	Greece
Uros Sraj	Slovenia
Ariane Stratmann	Switzerland
John Tarlton	United Kingdom
Dusan Tercic	Slovenia

Michael Toscano	Switzerland
Frank Tuyttens	Belgium
Teun Van De Braak	Netherlands
Frans Van Sambeek	Netherlands
Helena Wall	Sweden
Steffen Weigend	Germany
Mark Williams	United Kingdom
Dragan Zikic	Serbia
Manja Zupan	Slovenia