Respiratory cryptosporidiosis: impacts of infection on Red Grouse, a wild gamebird of economic importance

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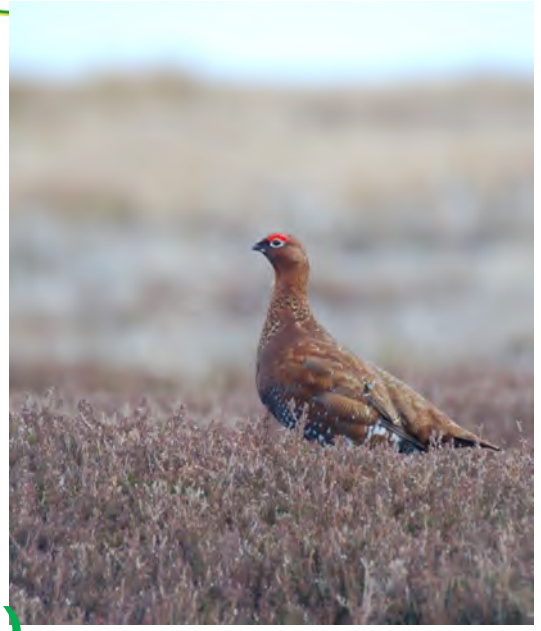
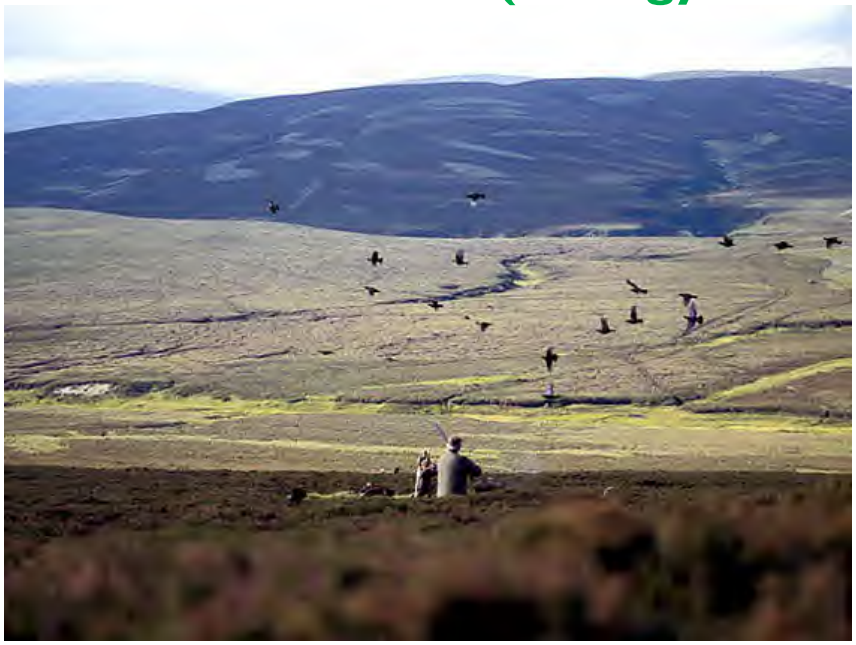
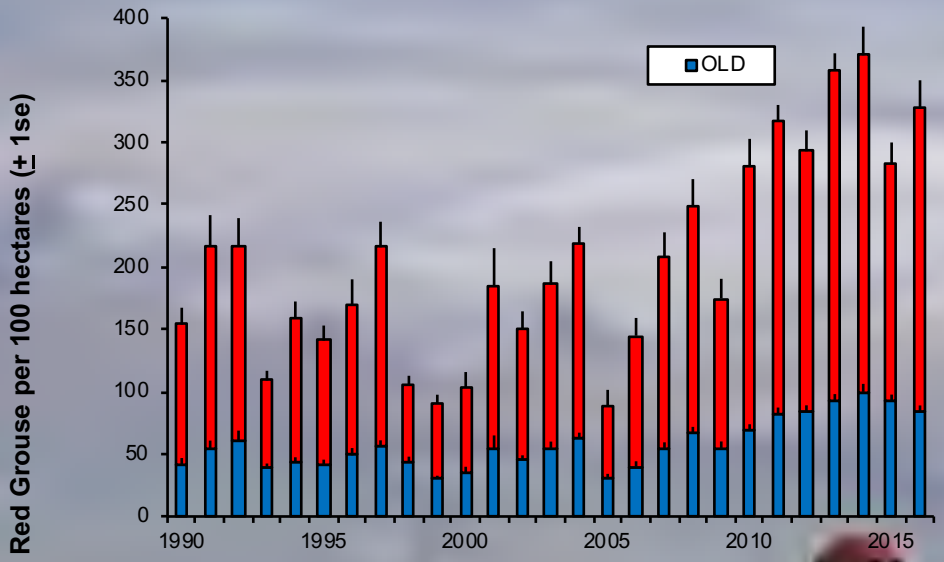
Successful management for Red Grouse *Lagopus lagopus scotica* requires;

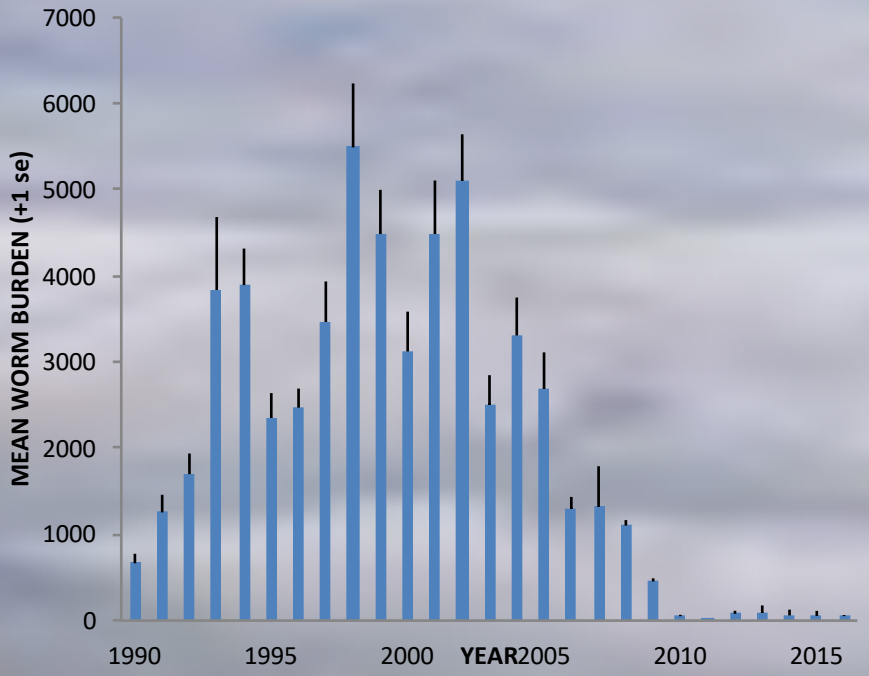


- Control of generalist predators
- Managing heather habitat by rotational burning and sheep grazing
- Parasite reduction (strongyle worms, sheep ticks)



Grouse up, *Trichostrongylus tenuis* parasites down





SO, NEXT PROBLEM?
Nutrition or Disease

Respiratory cryptosporidiosis: a first diagnosis

- **Autumn 2010 – young red grouse in northern England**
- **Eyes swollen / discharge**
- **Exudate from infra-orbital sinuses**
- **Mucus in trachea / larynx**
- ***Cryptosporidium baileyi***

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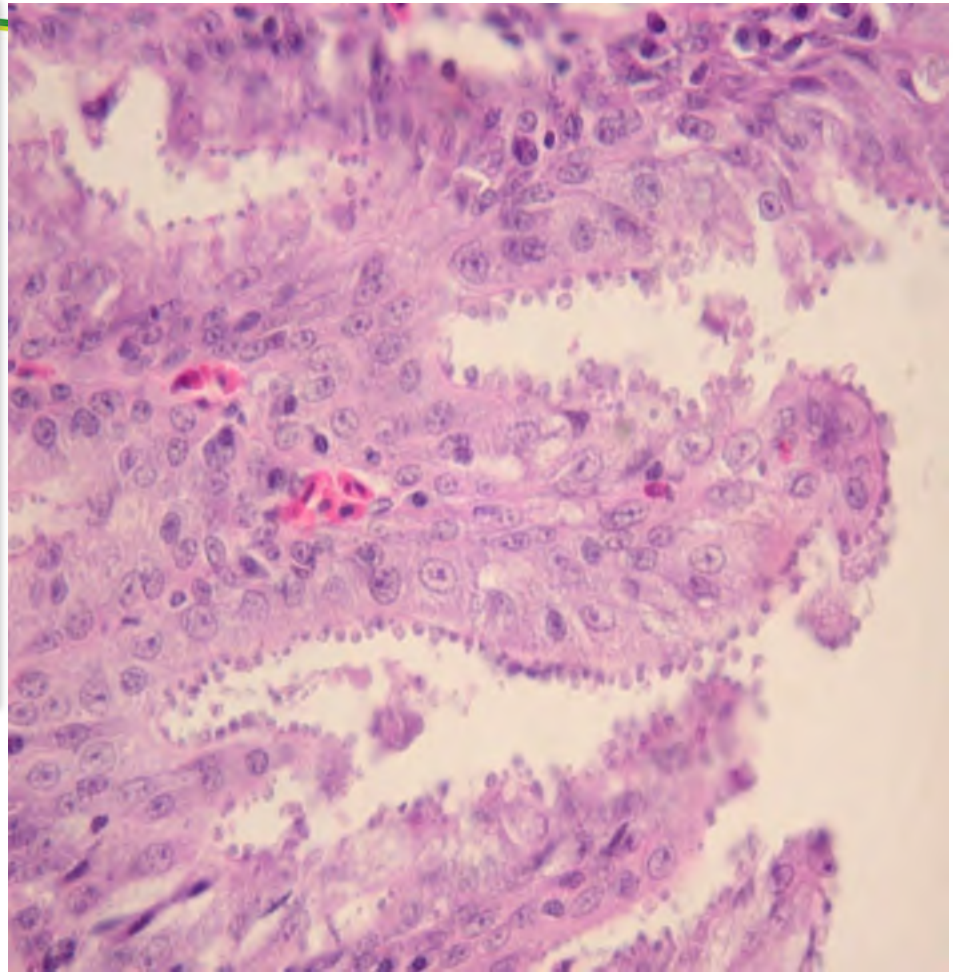
Cryptosporidia spp.

Protozoan parasite

- Single-celled organisms
- examples: Coccidia, Hexamita, Trichomonas

Cryptosporidia of different species found in all vertebrates (mammals, birds, reptiles, fish)

C. baileyi - commonest, capable of infecting many bird species: chickens, turkeys, pheasants, partridges, gulls, ostriches, owls, falcons etc.



Extensive infection of :-

- **nasal passages**
- **sinuses**
- **trachea & bronchi**

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Study Methods

1. **Desk studies – questionnaire**
surveys of symptom distribution (presence / absence)

2. **Radio-telemetry:**
Individual-based models of grouse survival, fecundity and productivity

3. **Field screening**: shot grouse for symptom prevalence

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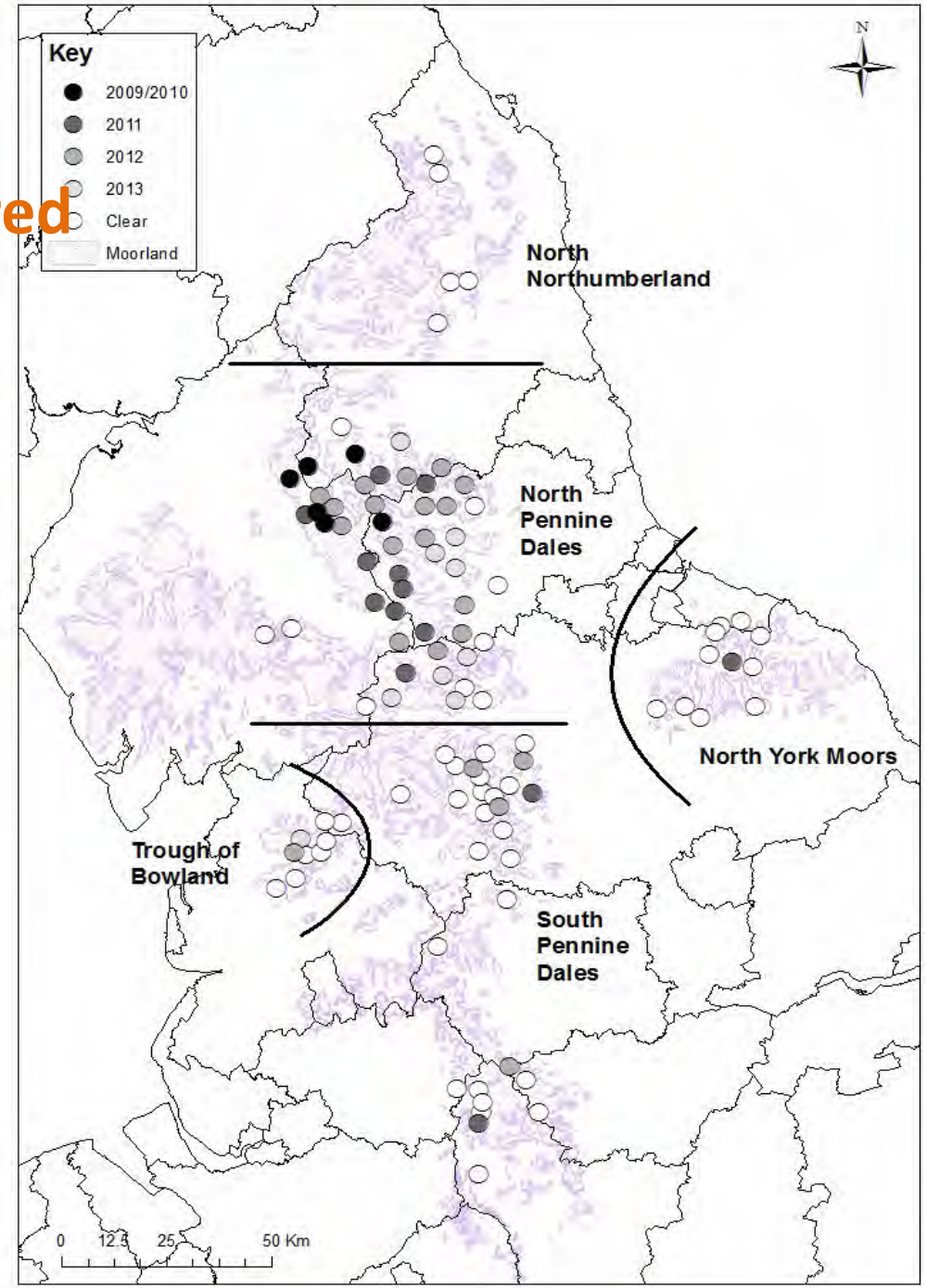
Questionnaire survey:

Symptoms soon found in red grouse on most moors in northern England

- First diagnosed in 2010, more in 2011
- By 2013 found on 50% of 150 grouse moors, 80% of those in North Pennine Dales

(Baines *et al.* 2014 Vet Record)



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Radio telemetry: Does infection reduce natural grouse survival rates? (six month survival rates: mean (95% CL))

- Males

	n	
Healthy	13	**0.60** (0.29-0.81)
Infected	37	**0.22** (0.10-0.34)

- Females

Healthy	48	**0.74** (0.59-0.85)
Infected	67	**0.44** (0.32-0.56)

(Baines *et al*. 2018 Ibis)

Radio-tagged individuals on two sites 2013-15

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Radio telemetry: causes of mortality

	Healthy (n=34)	Infected (n=82)
Shot	32%	9%
Predated	53%	40%
Disease	9%	45%
Other	6%	6%

Data pooled across sites and years

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Radio telemetry: Impacts of infection on laying dates and nesting success

(Baines *et al*. 2018 Ibis)

	Healthy (n)	Healthy mean + se	Infected (n)	Infected mean + se	P
First egg (Apr)	(31)	**20.3** ± 2.6	(22)	**28.4** ± 3.8	0.005
Clutch size	(39)	**8.7** ± 0.3	(29)	**8.1** ± 0.3	0.08
Egg volume	(39)	**22.8** ± 0.3	(27)	**22.6** ± 0.3	0.63
% clutch hatch	(39)	**85** ± 6	(30)	**77** ± 8	0.57

Radio-telemetry: Impacts of infection on chick survival and breeding success (Baines *et al*. 2018 Ibis)

	Healthy (n)	Healthy mean + se	Infected (n)	Infected mean + se	P
Chick survival	(32)	**0.62** ± 0.06	(23)	**0.37** ± 0.06	0.008
Pairs rearing broods	(39)	**0.70** ± 0.09	(36)	**0.51** ± 0.08	0.12
Chicks / pair	(39)	**3.7** ± 0.4	(36)	**2.1** ± 0.4	0.012

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Radio telemetry: Grit stations visited by infected grouse had a higher frequency of *C. baileyi* oocyst contamination (77%, when screened using PCR) than background trays (30%)

(Baines *et al*. 2017 Pathogens)

Field screening: Symptom prevalence (%) amongst shot grouse varies between MOORS (Baines *et al*. submitted)

Moor	Years sampled	Screened	% infected
Bowes	1	568	8.6%
Nidderdale A	6	5703	4.1%
Teesdale A	5	5942	3.5%
Swaledale	5	11650	2.9%
Teesdale B	4	4825	3.7%
Tynedale	1	738	4.3%
Upper Teesdale	6	6702	3.7%
Nidderdale B	2	238	8.4%
Allendale	2	525	1.0%
Lunedale	6	9023	3.9%

Field screening: Symptom prevalence (%) in shot grouse varies between years and grouse age

n= number birds screened at 10 moors

	Adults		Juveniles	
Year	(n)	mean + se	(n)	mean + se
2013	(685)	**3.9** ± 1.2	(1,725)	**3.6** ± 0.7
2014	(4,029)	**3.3** ± 0.4	(11,205)	**7.4** ± 0.6
2015	(2,547)	**1.0** ± 0.3	(5,628)	**2.5** ± 0.4
2016	(1,809)	**1.1** ± 0.3	(4,575)	**2.2** ± 0.4
2017	(2,791)	**3.0** ± 0.6	(4,706)	**4.5** ± 0.7
2018	(919)	**1.2** ± 0.5	(1,377)	**2.3** ± 0.6
MEAN		**2.4** ± 0.2		**4.5** ± 0.3

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Summary

- Grouse densities risen following improved medication to combat *T. tenuis* intestinal parasites
- Respiratory cryptosporidiosis first diagnosed in 2010, by 2013 half of 150 English moors had infected grouse
- *C. baileyi* infection reduced adult survival by 52% and breeding success by 43%, the latter through lower chick survival
- Infection prevalence varies across moors, years, was highest in young birds, but shows no trend over time
- Infection may impact upon future harvesting economics should prevalence increase beyond current 2-5% levels.

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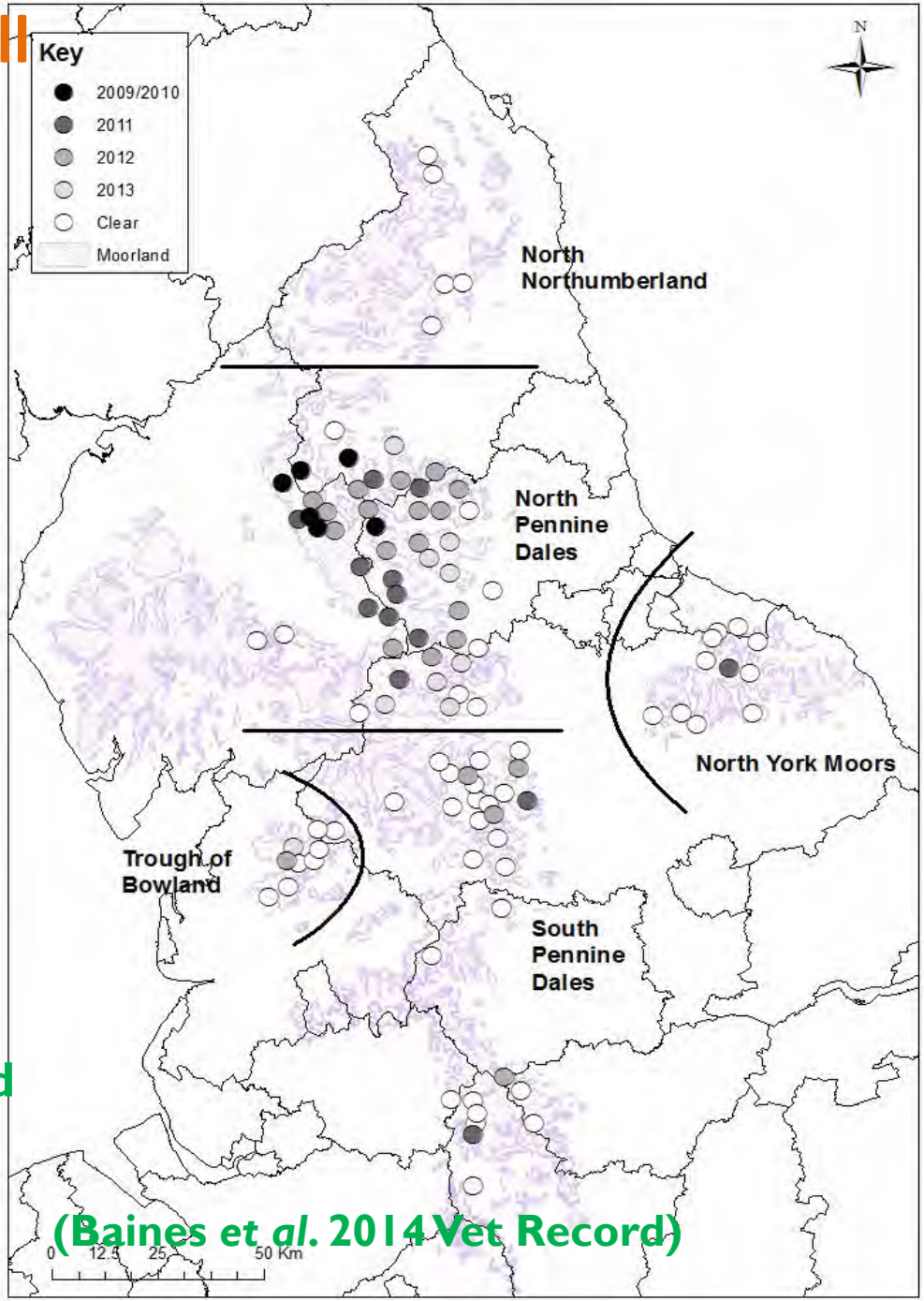
Why is *C. baileyi* infection still chiefly confined to the Pennine chain?

- In 2018 still absent from
  - North York Moors (?)
  - North Northumberland
  - Lammermuirs
  - Scotland as a whole?

Not looked for X
Use of grit trays X
Density-dependent X
Connectivity - dispersal ?

Is infection spread bird to bird?

Do all grouse contain *C. baileyi* and symptoms are stress induced?



(Baines *et al.* 2014 Vet Record)