Landscape scale exposure and breeding success in bird populations

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CEA

CAMBRIDGE ENVIRONMENTAL ASSESSMENTS

Landscape *and* populations?

CEA

- Exposure and effects at the landscape scale
  - Makes sense to look at populations rather than individuals
- Will cover
  - Breeding success estimates in populations of birds
  - A method to estimate potential exposure at landscape scale
  - Comparing different bird species, crops

Breeding success: context

- Plant Protection Products, EU 1107/2009
- Dietary risk assessment for birds
  - Treated crop seed as a food source
- Spring crops may be drilled during breeding period
  - Potential reproductive risk to birds from spring drilled treated seed?

Current risk assessment

- High failure rate at Tier 1, and after refinement
- Assumes exposure to spring seed during breeding
- Risk assessment conducted at individual level
- Protection goal: *"No long-term repercussions for abundance and diversity"*
- Can we improve risk assessments?
  - More realistic exposure estimates?
  - Population level effect measures?

Matrix population model

- Two types of model developed by Joe Crocker
- ‘Broods at risk’ model
  - Information on drilling and breeding calendar
  - How many broods experience TERs <safety trigger?
  - Counts individual TERs
- ‘Seasonal success’ model
  - How many offspring successfully raised per season?
  - → Estimate *Population Growth Rate* (PGR)
  - Compare to control scenario
- Models focus on temporal exposure

Birds

Skylark, omnivorous, Red List, multiple broods

Linnet, granivorous, declining, multiple broods

Yellowhammer, omnivorous, Red List, multiple broods

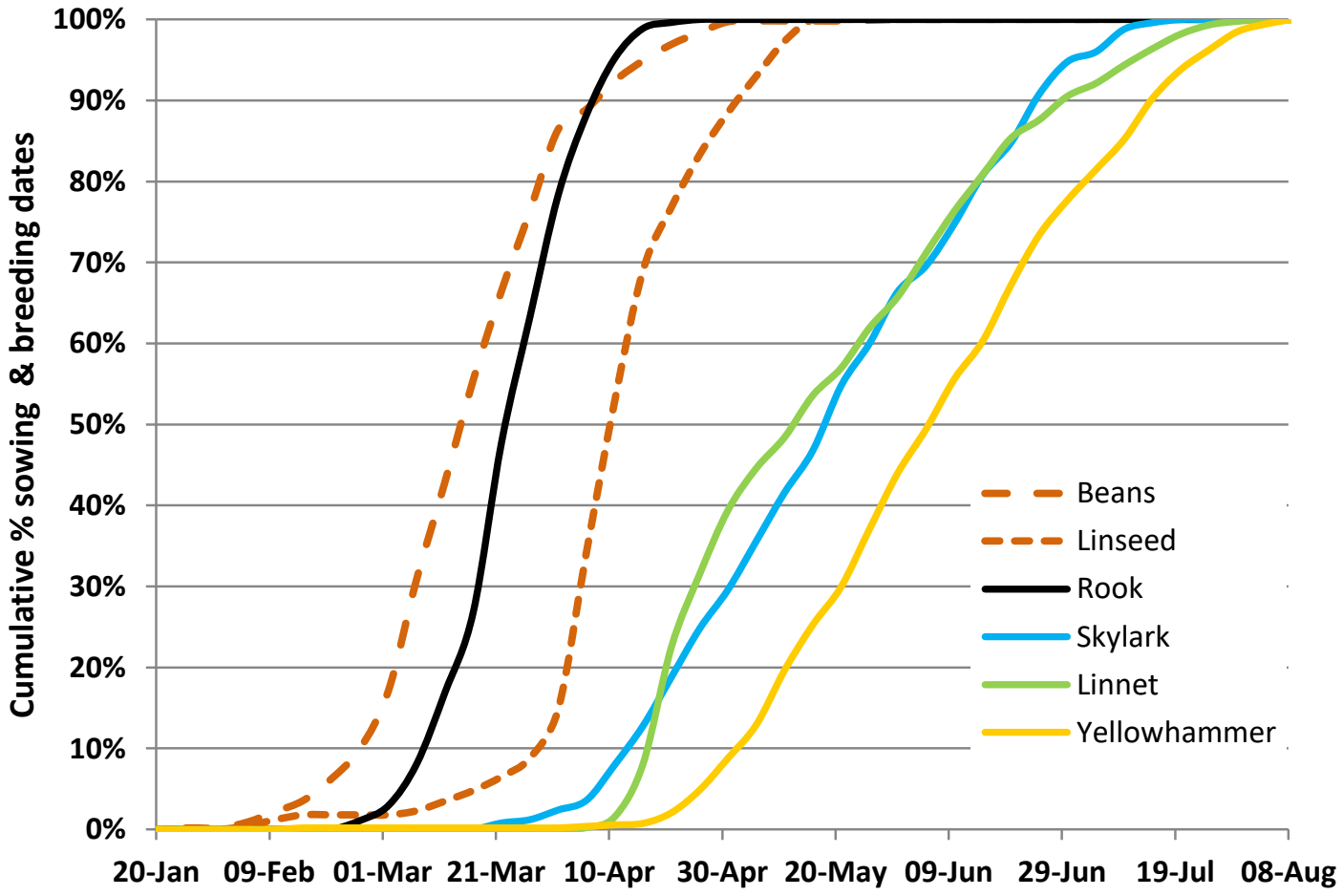
Rook, omnivorous, single broods

…Different life histories

Data

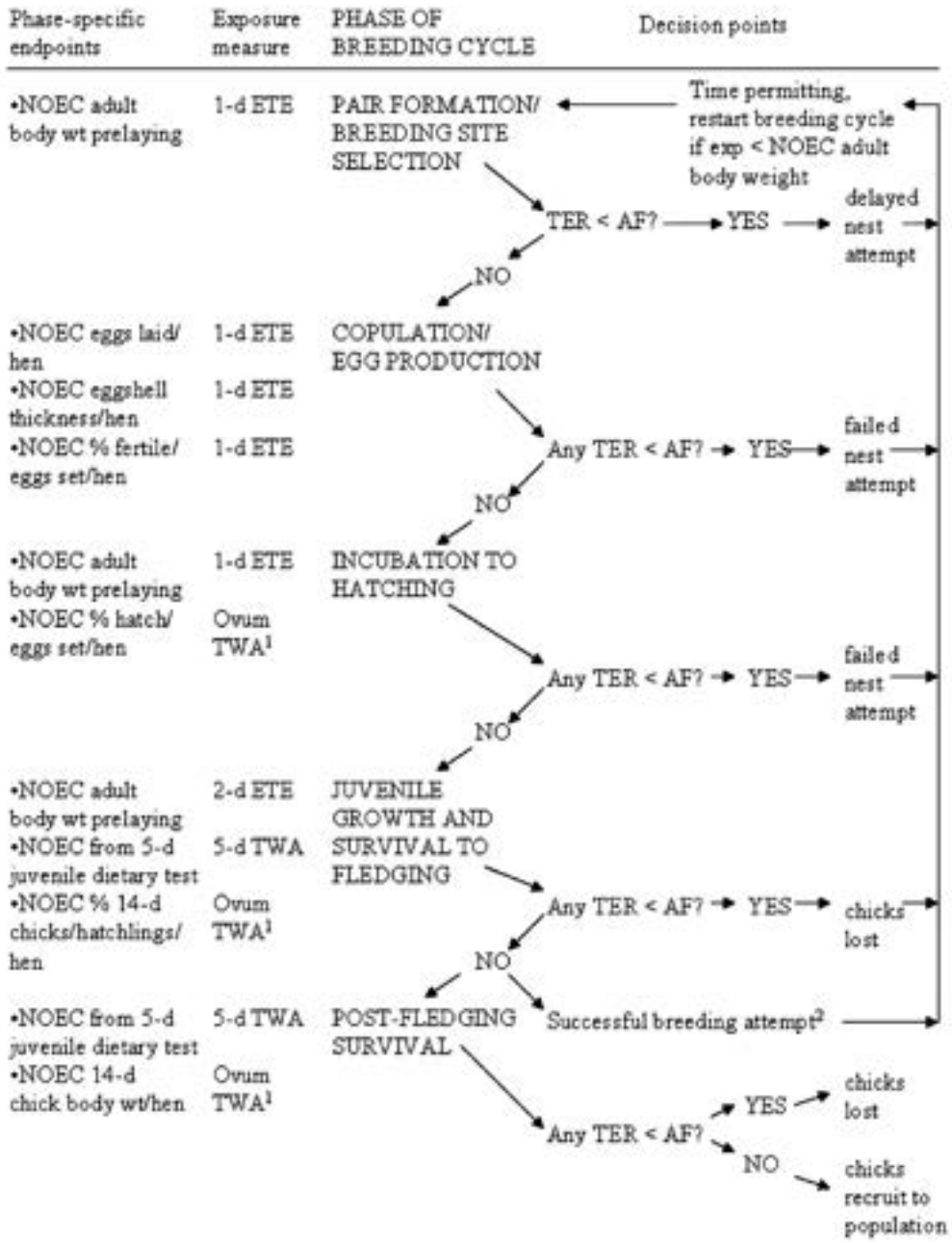
- British Trust for Ornithology (BTO)
  - Nest Records Scheme data, arable land, 2002-2011
  - First egg dates: Skylark, Yellowhammer, Linnet, Rook
  - Which first egg dates belong to first clutches? Developed population of birds → give rise to observed clutches
  - Duration of breeding phases, natural nest failure rates
- FERA Pesticide Usage Survey, ADAS data
  - Dates of spring crop drilling, 2000-2010
  - Wheat, barley, oats, OSR, beans, beets, peas, linseed

Calendars


Cumulative % sowing & breeding dates
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
20-Jan
09-Feb
01-Mar
21-Mar
10-Apr
30-Apr
20-May
09-Jun
29-Jun
19-Jul
08-Aug
Beans
Linseed
Rook
Skylark
Linnet
Yellowhammer

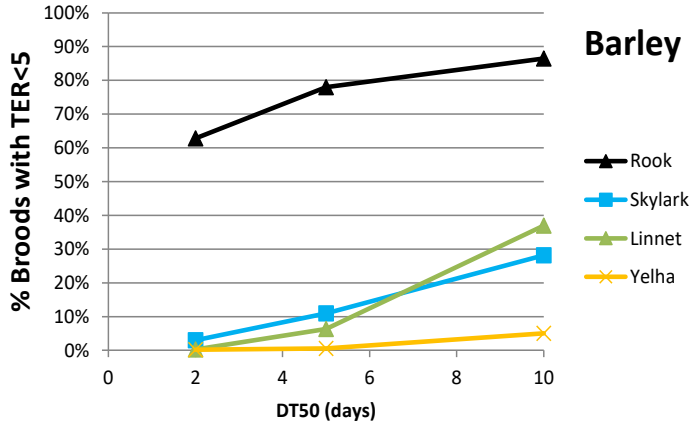
Seasonal success model

- Population of birds, transition matrix
  - Probability of progressing through each day of breeding, or failing due to natural causes
  - Daily TER calculated: drilling calendar, residue decay
  - Drilling data resampled; results median
  - DT_{50} 2d, 5d, 10d; 3-5d averaging period
  - NOAEL 5 mg/kg bw/d; 20 mg as/kg seed
  - If fail breeding, enter recuperation phase.. if time
  - Effects on different breeding phases captured
  - No competition, no resource limitation, no density dependence, no feeding preferences
  - Not an Individual Based Model!



Models implement phase-specific approach
Bennett *et al*, 2005; EFSA, 2009

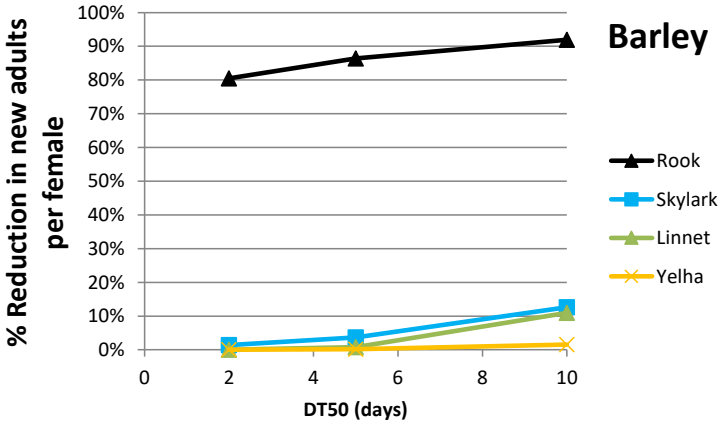
Surrogate endpoint	Breeding phase
Adult bw pre-laying	PF, CO, LA, IN, NE, FL
n eggs laid	CO, LA
Eggshell thickness	CO, LA
% fertile eggs	CO, LA
% hatched	IN
Survival to 14d	NE
Juvenile dietary tox	NE



Broods at Risk model

For rook, nearly 90% of broods with TER <5. For skylark and linnet, 30-40%. Effect of earlier breeding in rook.

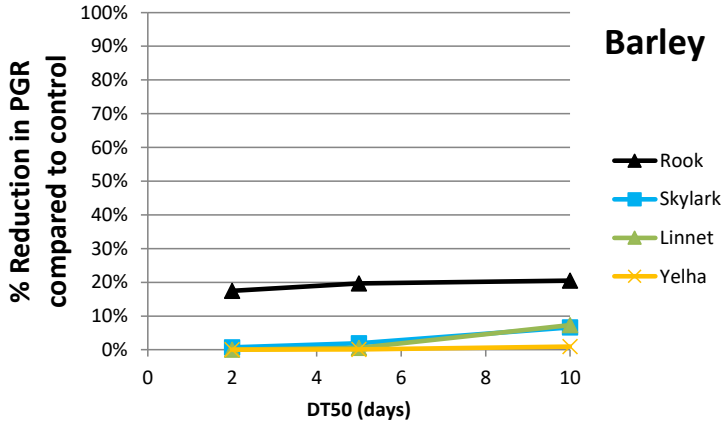
Results assume pesticide affects <u>all</u> phases of breeding *via* adult body weight: PF, IN, NE, FL, CO, LA



Seasonal Success model

Allowing for multiple broods, the impact on skylark and linnet is reduced, but not for rook which breeds only once.

Mitigation: effect of multiple broods



Population Growth Rate model

The higher annual survival rates of rook mitigates some of the impact on PGR. **Overall the effects on PGR are less severe than on the individual.**

+ Effect of annual survival rate

Compare to dietary TER_{LT}

- Model makes different assumptions to dietary risk assessment
  - Averaging windows, phases, multiple broods
- Linnet breeding calendar, spring barley, inputs as before:

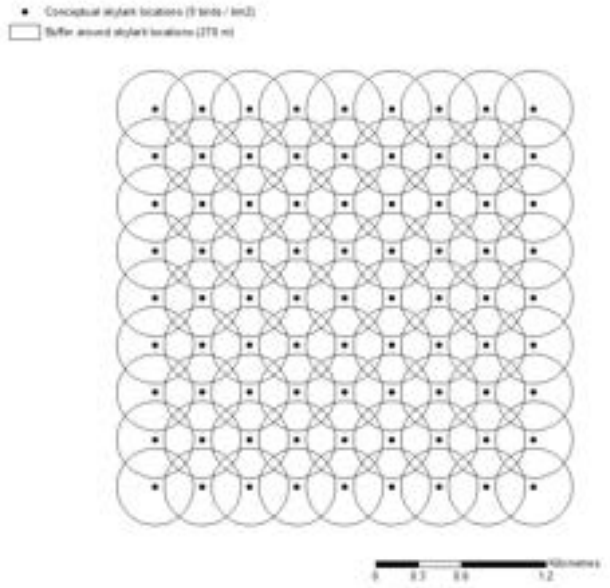
DT_{50}	FIR/BW	Dietary TER_{LT}	Trigger	PGR reduction vs. control (%)	
				PPP affects all phases	PPP affects nestling phase
N/A	0.3	**0.83**	5	N/A	N/A
10		**1.6**		7.32	0
5		**2.6**		0.54	0

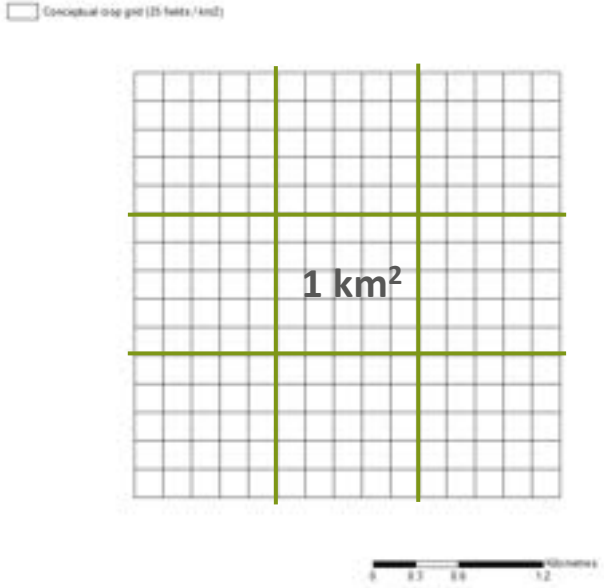
- Model considered protective

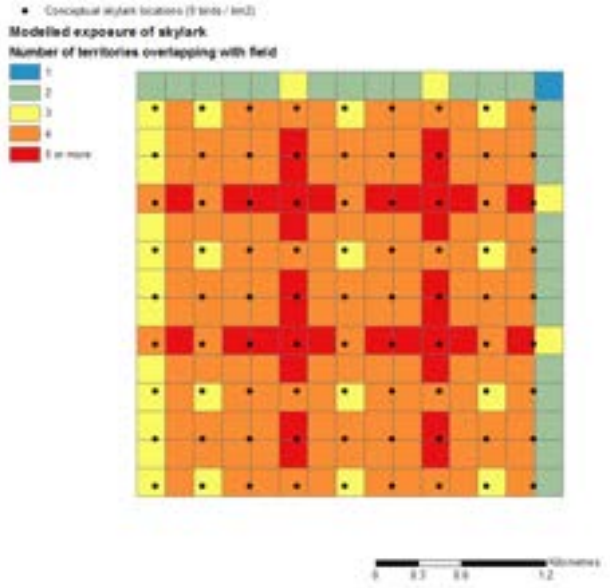
Landscape

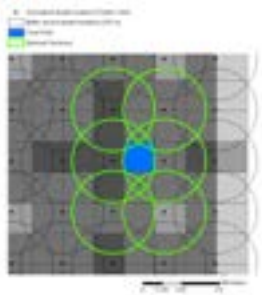
- We assume birds are exposed to pesticides on crops during breeding period
- What proportion of a population could encounter treated seed in the landscape?
  - How far do birds forage from the nest?
  - How likely is it they could encounter a given crop?
  - Does it vary between birds, crop and region?

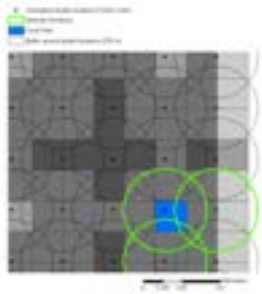
[Skylark nest locations at RSPB Hope Farm, UK, 2000]







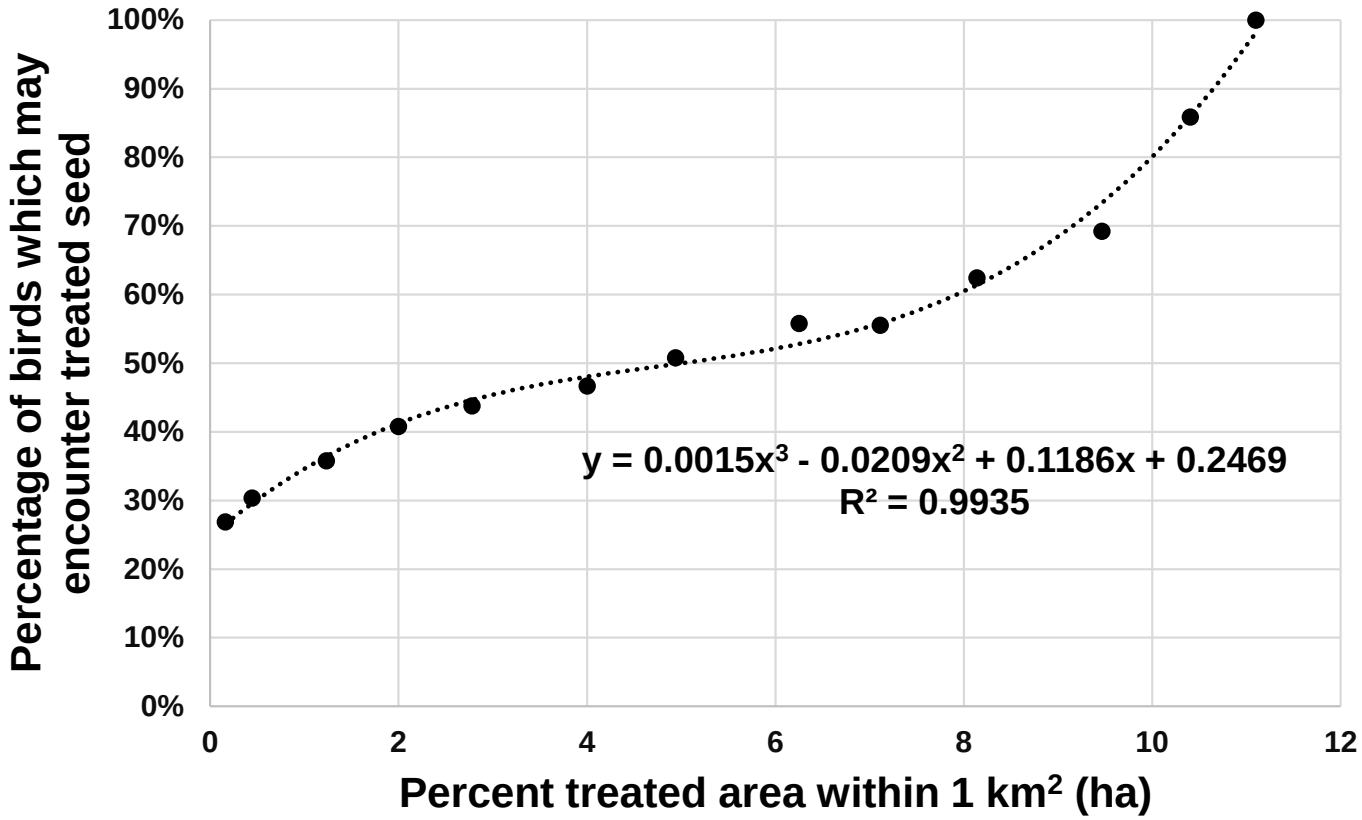




Conceptual approach:

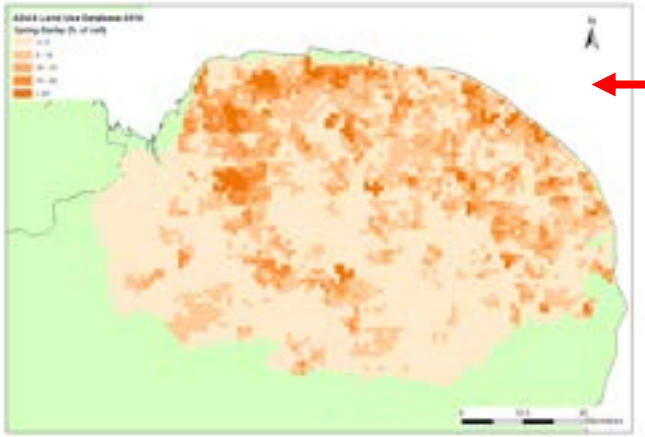
- Forage range of birds, skylark and rook
- BTO breeding bird survey data
- Crop area – full ag census 2010
- Overlap of foraging ranges with treated area
- Varied % treated area
- Informed by real crop density & field size data
- Analyses by Hester Lyons

Skylark

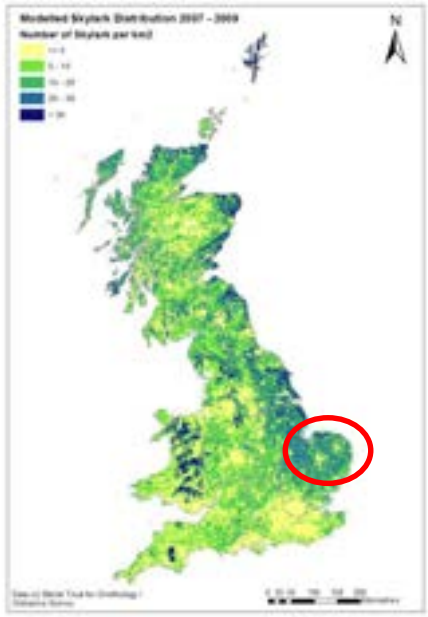


Applied to 1 km^2 grid cells data for crops and birds

Political boundary

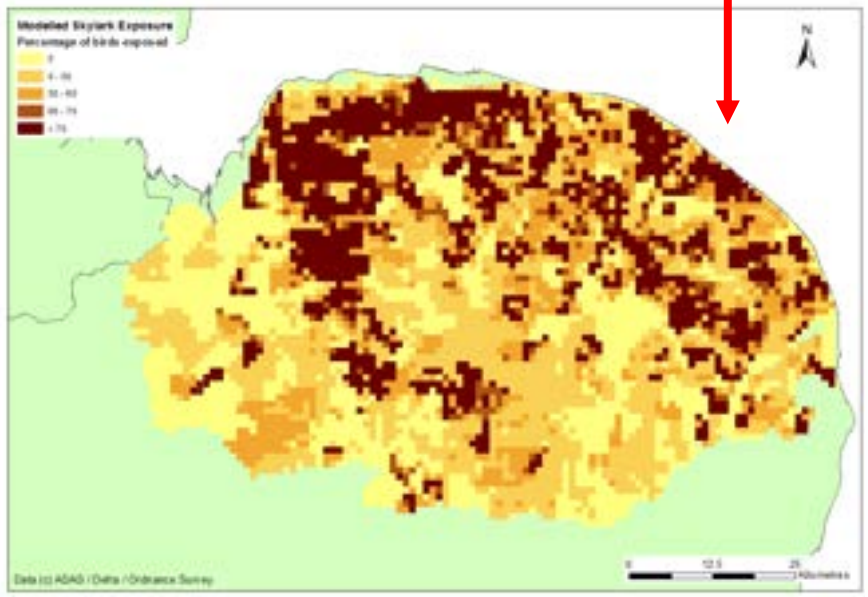


Spring barley in Norfolk 10%

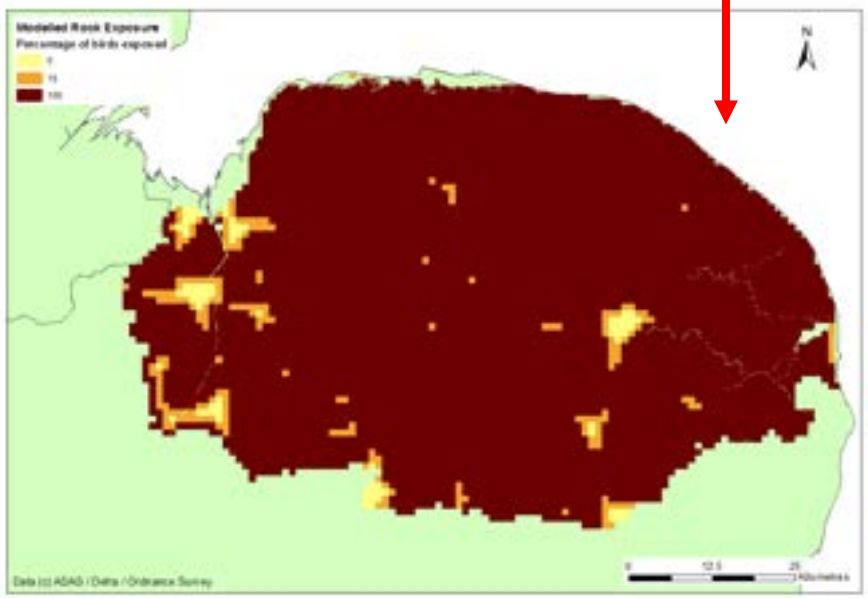


Skylark 1 km^2 distribution data – BTO breeding bird survey

51% of **skylark** may encounter crop



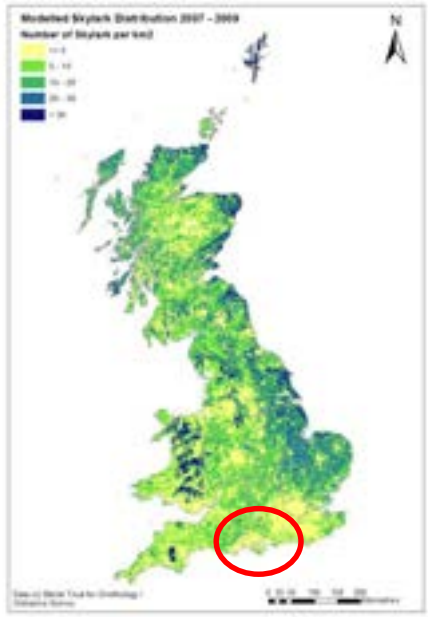
96% of **rook** may encounter crop



English regions:
North West = 15.8%
East Midlands = 20.4%
East of England = 30.7%

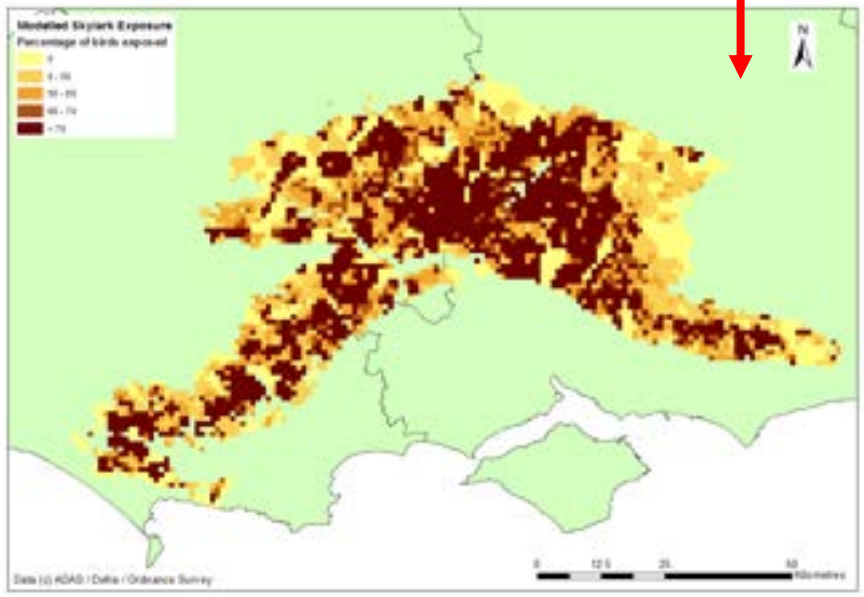
Geological boundary

Spring barley in focal area 18%

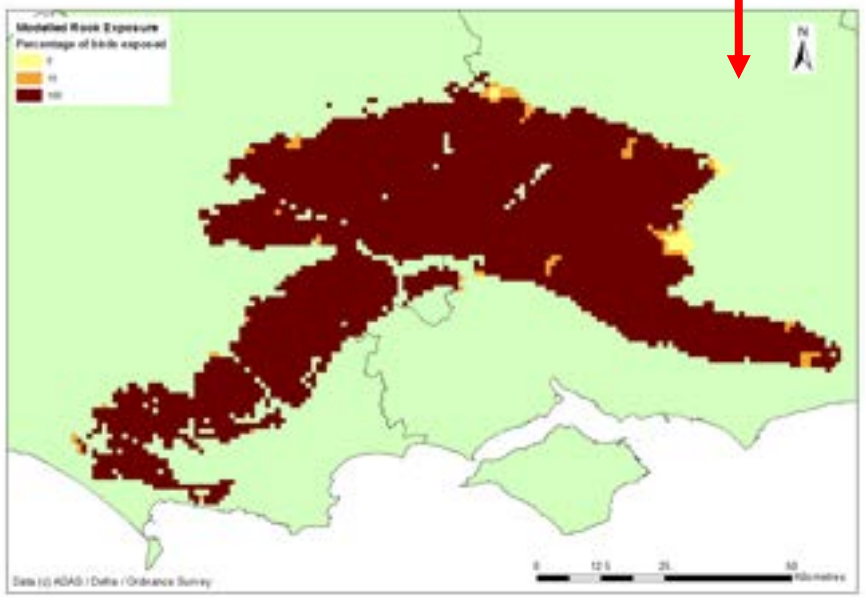


Skylark 1 km^2 distribution data – BTO breeding bird survey

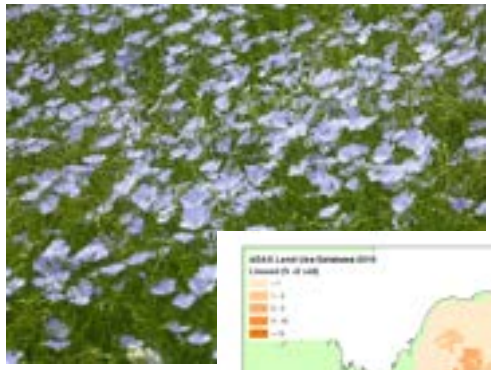
65% of **skylark** may encounter crop



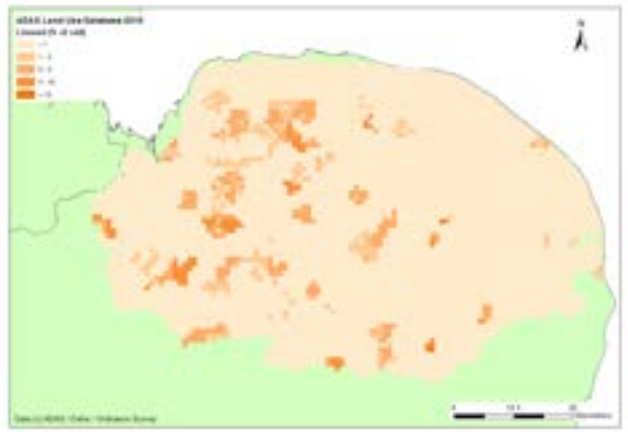
98% of **rook** may encounter crop

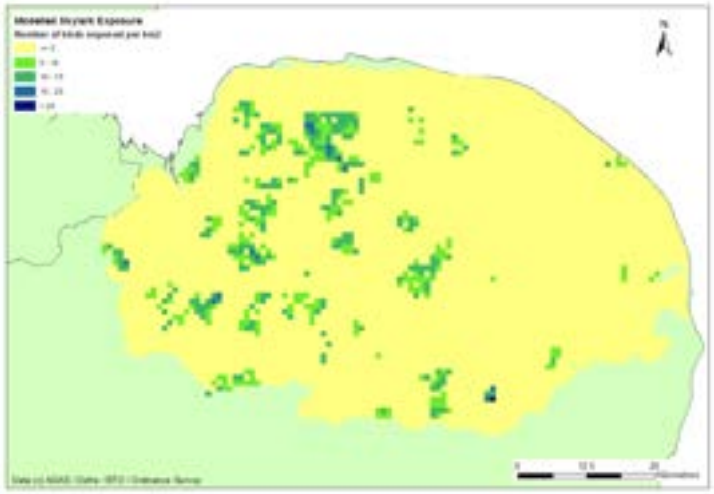


Minor crop

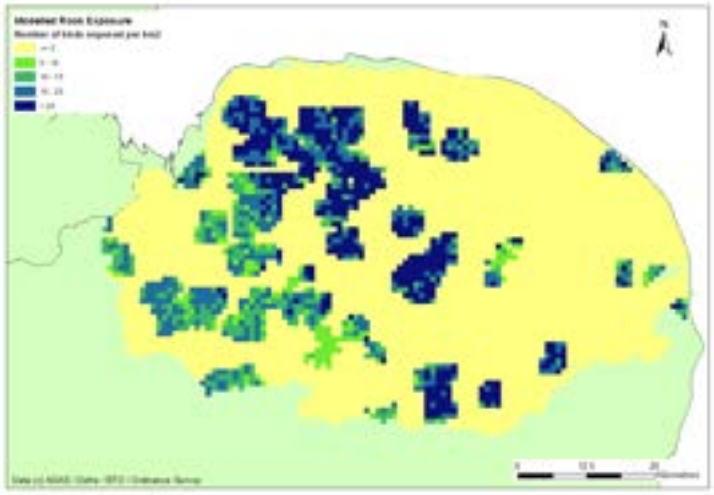


Spring linseed
0.6% land area





5.7% **skylark** could encounter crop



30% **rook** could encounter crop

Alternative approaches

- We assume no foraging preferences
  - Only what birds *could* encounter
  - Few assumptions
- Individual based models
  - ‘Exposure is an emergent property’
  - Various decision steps; more detailed
  - Require more data
- Parameterisation
  - Regulators say: more parameters, more uncertainty! (??)

Conclusions: landscape

- Populations of breeding birds are not always 100% exposed in the landscape. Scenario specific
  - Bird species, crop
  - Different vulnerabilities emerge
  - Selection of appropriate geographical area
- Regulation focuses on single active substances and products, conducted at field level
  - At landscape scale, exposure to multiple pro
    multiple fields??
  - Outside of existing procedures?
  - A major challenge for landscape RA

Conclusions: breeding success #1

- Individual effects do not always translate to the population level
  - Broods at risk > seasonal success > population growth rate
  - Mitigation offered by life histories, multiple broods, survival rates, calendars
  - Sometimes TER_{LT} <5 → PGR 0% effect
- Scope to put risk assessments into context at population level
  - At higher tiers
  - Weight of evidence

Conclusions: breeding success #2

- Ecological vulnerability
  - Not currently considered in guidance for birds and mammals
  - Model results suggest different vulnerabilities
  - Species with higher body weight may be more vulnerable than those with lower body weight
  - Driven by life history
  - Does this require us to consider different focal species?

Summary

- Population and landscape assessments go hand in hand
  - When and how many times birds breed, how far they may forage, when crops are sown (or sprayed) all impact scenario vulnerability
- Debate on population level effect measures
  - A better comparison to protection goals at higher tiers?
  - Individual effect ≠ population level effect
  - Are theoretical risks real?
- Landscape scale assessments are not easy!

- We thank UK HSE/DEFRA for funding; project number PS2373
- *No endorsement by HSE/CRD is implied!*
- Ecotoxicology & Environmental Safety, 147, 124-131.

Any questions?

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www.cea.adas.co.uk

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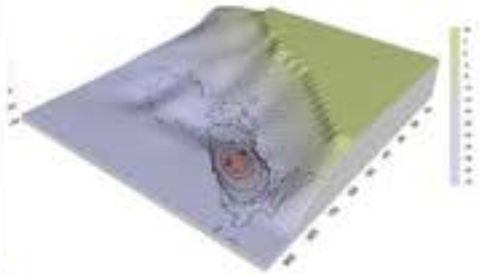

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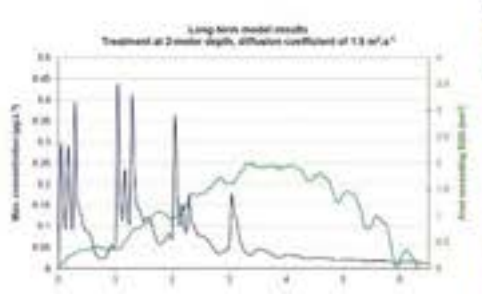
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