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Importance of land cover in determining vector-borne disease risk (Ecology NOT modelling)

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The ecology of disease vectors

- Ticks & Borrelia (Lyme disease)
- Urban disease ecology
- Mapping and predicting rare tick species
- Imported ticks and host habitat suitability
- British mosquitoes and wetlands
- *Culex modestus* and West Nile virus
- Invasive mosquitoes and “human habitats”

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Ixodes ricinus ticks

- **Can we create a suitability map for *Ixodes ricinus* ticks (and hence Lyme risk)?**
- Life in the “leaf litter”, OR life in the “ecotone”
- Spend most of time (90%) in the soil/litter
- Lose moisture easily
- Need to keep moisture up – needs to be humid
- Less active when very hot or very cold temps – like mild winters
- Spends most of the year alternating between leaf litter and tips of vegetation (returning to actively rehydrate)
- Opportunities for “questing”
- Two key requirements for *I. ricinus* survival
    - Moist microclimate / high humidity for survival off the host
    - Available hosts for blood-feeding

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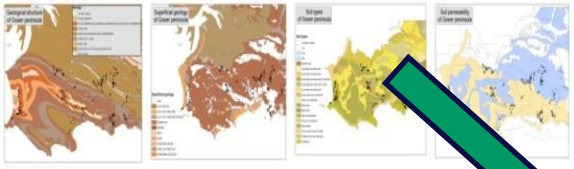
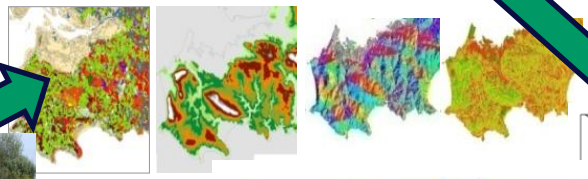
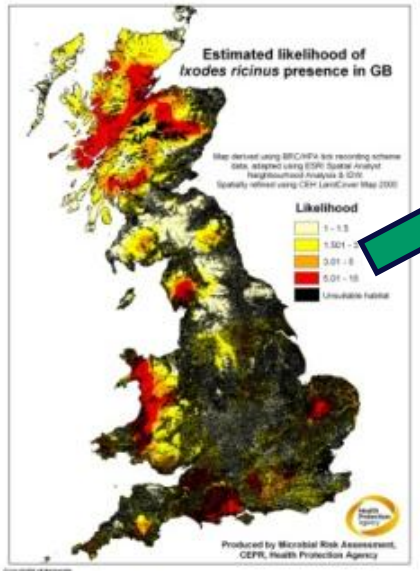
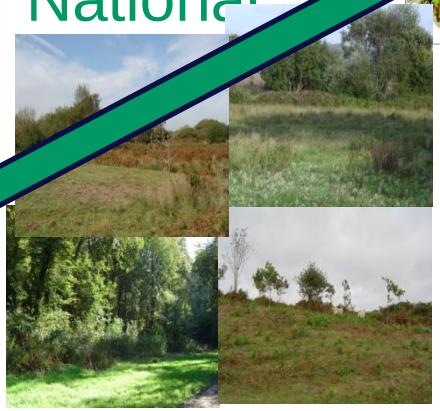


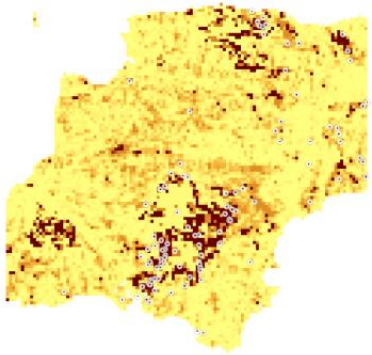


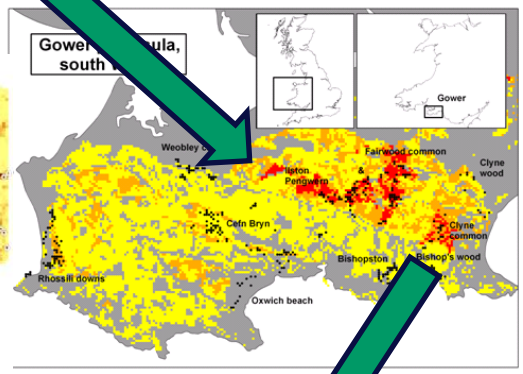
Regional

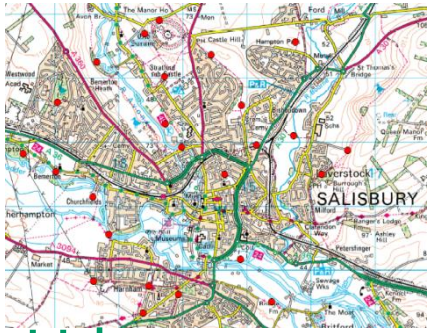
National

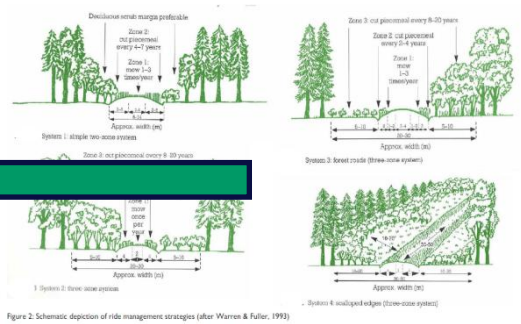












Urban greenspace & LA management

Habitat management

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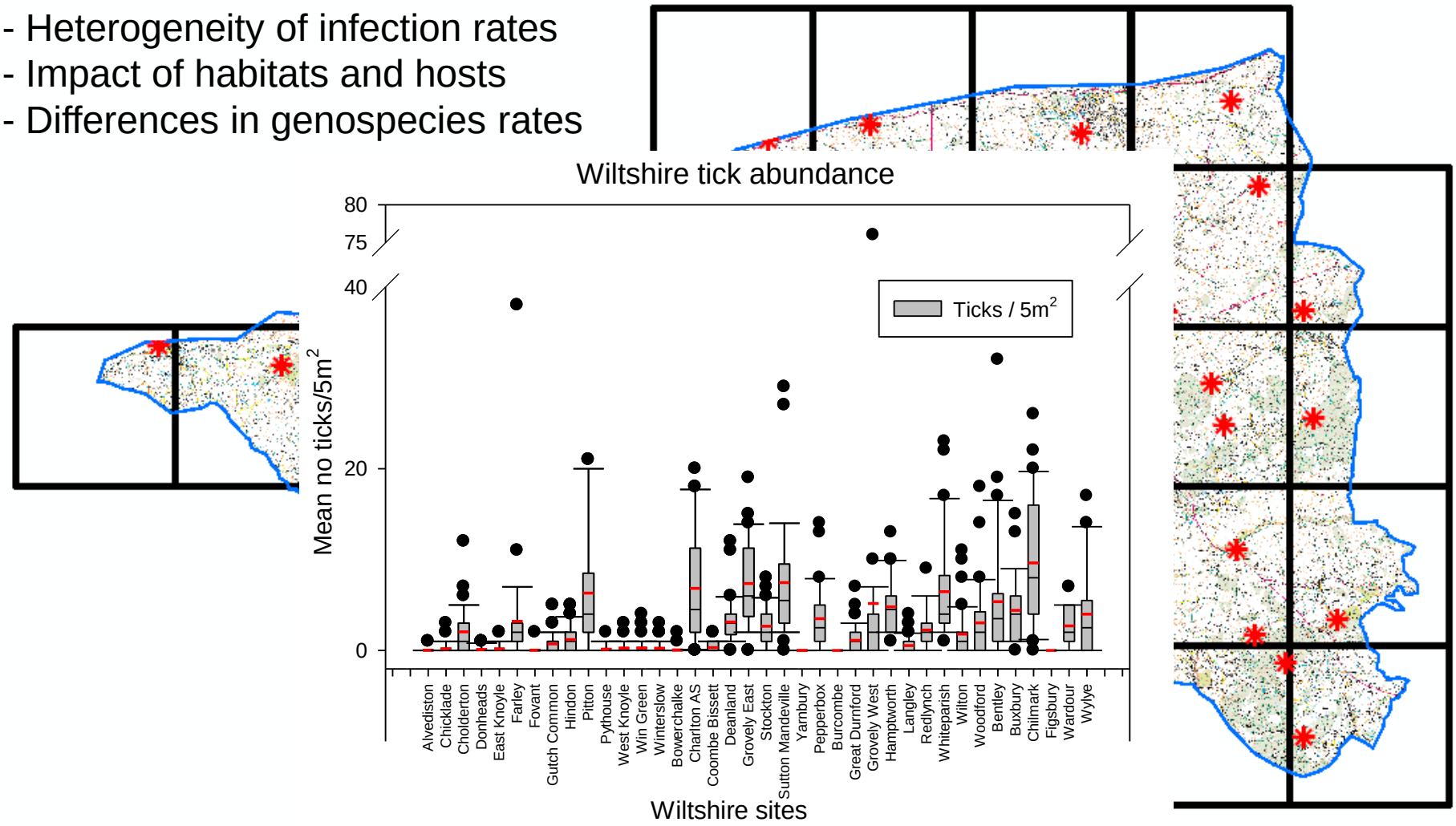
Mapping *Borrelia* infection rates in ticks across a landscape – South Wiltshire

- Heterogeneity of infection rates
- Impact of habitats and hosts
- Differences in genospecies rates



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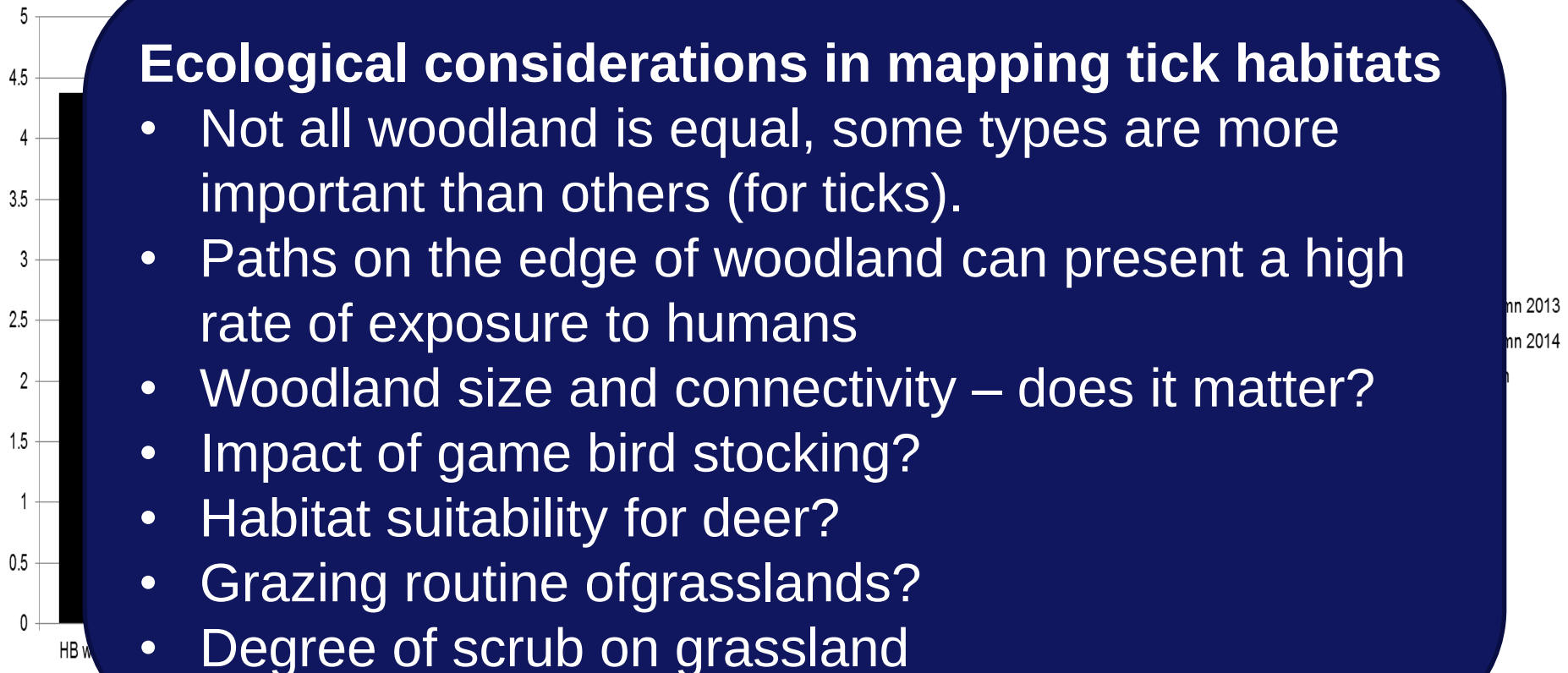
Classifying woodland type, structure and connectivity in relation to tick suitability



Ecological considerations in mapping tick habitats

- Not all woodland is equal, some types are more important than others (for ticks).
- Paths on the edge of woodland can present a high rate of exposure to humans
- Woodland size and connectivity – does it matter?
- Impact of game bird stocking?
- Habitat suitability for deer?
- Grazing routine ofgrasslands?
- Degree of scrub on grassland

Lyme borreliosis Transmission cycle

Large mammals:
- Deer species
- Sheep


Not generally involved in transmission cycles; localised transmission through co-feeding in sheep reported; both important tick hosts

Blood host

ADULT FEMALE

Feed

Feed & infect

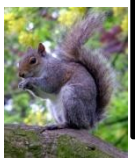
Trans-stadial transmission

moult

Source of infection,
More conspicuous
Low no. lower risk

Woodland birds:
- *T. merula*
- *E. rubecula*
- *P. colchicus*


Medium-sized mammals:
- *Sc. carolinensis*
- *Le. europaeus*



Acquire infection

NYMPHS

Source of infection
Less conspicuous
High no., High risk

HUMAN

Feed & infect

Trans-stadial transmission

moult

Low probability of infection


Small mammals:
- *Ap. sylvestris*
- *Ap. flavicollis*
- *My. glareolus*
- *S. araneus*
- *M. agrestis*

Acquire infection

Feed

LARVAE

- Seasonal activity of Questing tick stages
- Tick prevalence rates
- Seasonal behaviour of humans, hence exposure

- Host seasonal dynamics
- Seasonal changes in tick infestation rates
- Seasonal changes in tick infection rates
- Differences in Borrelia genospecies cycles

Trans-ovarial transmission very low: <2%

Example of peri-urban tick & *Borrelia* area

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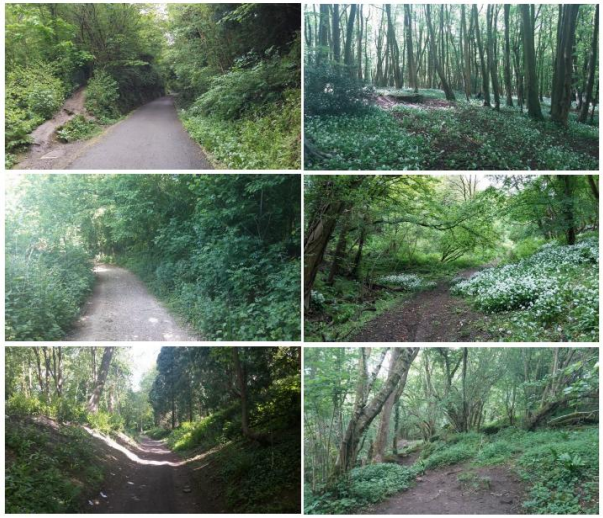


Site ID	Habitat	Transect (5m)	Total nymphs collected	Total nymphs per 10m²	Nymphs tested/positive (% positive for Borrelia)	Females tested/positive (% positive for Borrelia)	Total ticks tested/positive (% positive for Borrelia)
1	Grassland	61	**11**	0.36	0/11 (0)	1/5 (20)	1/16 (6.3)
2	Woodland	60	**6**	0.20	0/6 (0)	0/0 (0)	0/6 (0)
3	Woodland	60	0	0.00	0/0 (0)	0/0 (0)	0/0 (0)
4	Grassland	60	**14**	0.47	0/14 (0)	3/8 (37.5)	**3/22 (13.6)**
5	Woodland edge	33	**54**	3.27	2/54 (3.7)	0/2 (0)	**2/56 (3.6)**
6	Woodland	45	**14**	0.62	1/13 (7.7)	0/2 (0)	**1/15 (6.7)**
7	Park	60	5	0.17	0/5 (0)	0/0 (0)	0/5 (0)
8	Woodland	60	**6**	0.20	0/6 (0)	0/2 (0)	0/8 (0)
9	Grassland	60	3	0.10	0/3 (0)	0/0 (0)	0/3 (0)
10	Woodland	63	0	0.00	0/0 (0)	0/0 (0)	0/0 (0)
11	Park	66	0	0.00	0/0 (0)	0/0 (0)	0/0 (0)
12	Park	60	2	0.07	0/2 (0)	0/0 (0)	0/2 (0)
13	Woodland	60	**31**	1.03	0/29 (0)	0/0 (0)	0/29 (0)
14	Grassland	61	0	0.00	0/0 (0)	0/0 (0)	0/0 (0)
15	Park	61	0	0.00	0/0 (0)	0/0 (0)	0/0 (0)
16	Park	61	0	0.00	0/0 (0)	0/0 (0)	0/0 (0)
17	Woodland edge	30	**116**	7.73	2/117 (1.7)	0/4 (0)	**2/121 (1.7)**
18	Woodland edge	61	**49**	1.61	1/53 (1.9)	0/0 (0)	**1/53 (1.9)**
19	Grassland	60	3	0.10	0/3 (0)	0/0 (0)	0/3 (0)
20	Park	60	0	0.00	0/0 (0)	0/0 (0)	0/0 (0)
21	Woodland edge	60	2	0.07	0/1 (0)	0/0 (0)	0/1 (0)
22	Grassland	62	0	0.00	0/0 (0)	0/0 (0)	0/0 (0)
23	Grassland	60	1	0.03	0/1 (0)	0/0 (0)	0/1 (0)
24	Grassland	62	**19**	0.61	0/10 (0)	0/0 (0)	0/10 (0)
25	Grassland	60	2	0.07	0/2 (0)	0/0 (0)	0/2 (0)
26	Grassland	59	**30**	1.02	3/30 (10)	0/1 (0)	**3/31 (9.7)**
27	Woodland	64	**57**	1.78	6/53 (11.3)	2/7 (28.6)	**8/60 (13.3)**

Can we map rare tick species with limited data? – canine babesiosis

How good are livestock maps?
Is there a “dog walking” layer in GIS?

Combining climate suitability maps for imported ticks from migratory birds AND
Breeding bird data – where do the wheatears spend the summer?

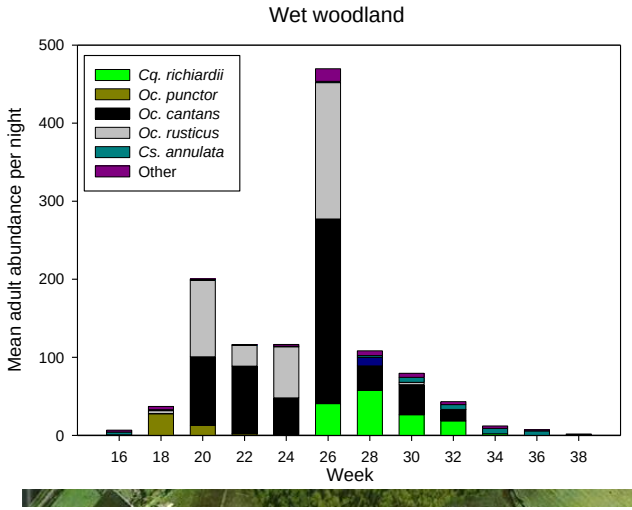
Monitoring for ticks on migratory birds

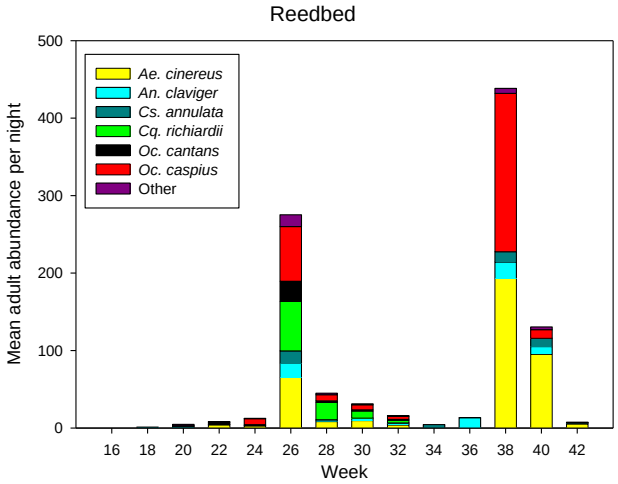
970 birds sampled, 7% infested, 21% *Hyalomma marginatum*

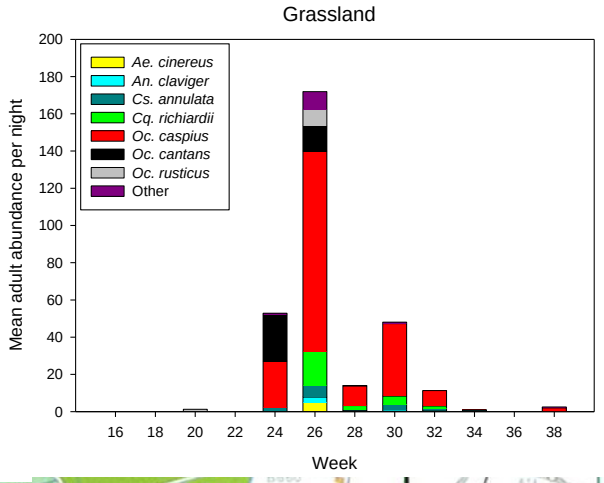
Wheatear, whitethroat, Sedge warbler, Redstart

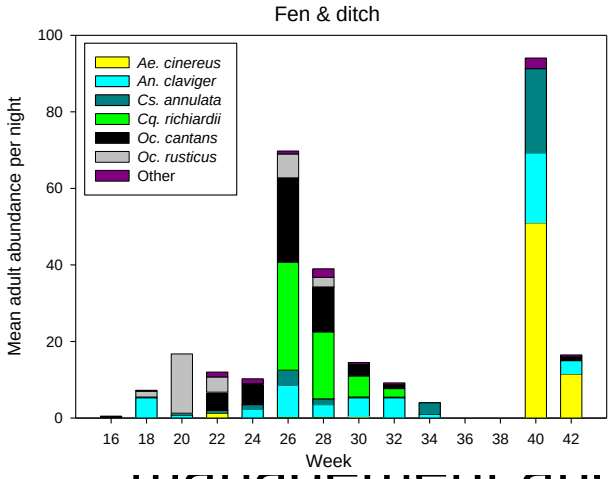
The Great Fen – a waterland for the future

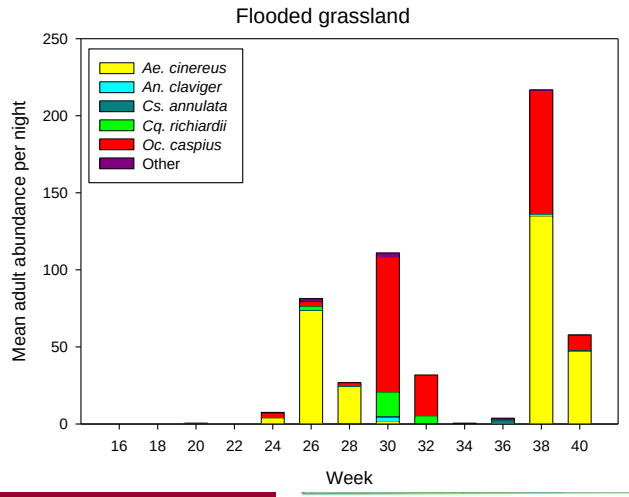
Wetland creation, expansion and management – impact on mosquitoes

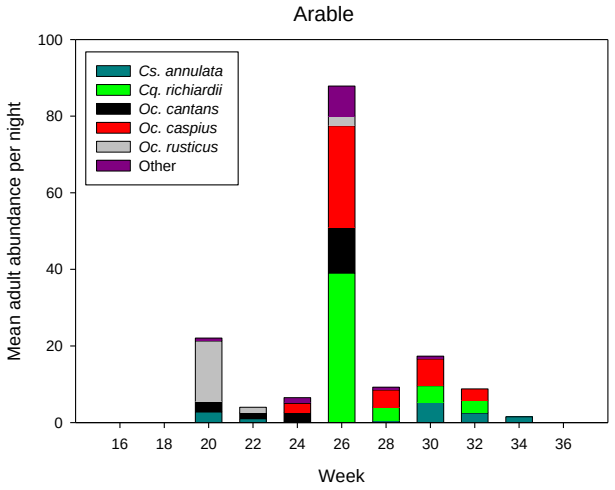












management and

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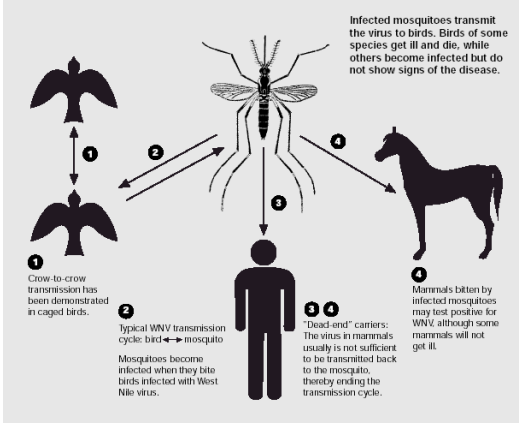
West Nile virus & *Culex* mosquitoes



How long has *Culex modestus* been in England?

Where else should we be looking?

Golding *et al. Parasites & Vectors* 2012, **5**:32
http://www.parasitesandvectors.com/content/5/1/32

Parasites & Vectors

SHORT REPORT — Open Access

West Nile virus vector *Culex modestus* established in southern England

Nick Golding[1,2*], Miles A Nunn[2], Jolyon M Medlock[3], Bethan V Purse[4], Alexander GC Vaux[3] and Stefanie M Schäfer[2]

Letters

VIROLOGY

Distribution of West Nile virus vector, *Culex modestus*, in England

Culex modestus is considered the main bridge vector of West Nile virus in continental Europe, responsible for transmitting virus

C modestus in marshes on the Isle of Sheppey and close to Cliffe, both in Kent (Golding and others 2012).

Further immature mosquito surveys by the HPA during 2012 at additional marshes from Cliffe to Thanet (Kent) and near Basildon (Essex) did not find evidence of greater expansion beyond the north Kent foci. Further surveys will continue in 2013.

However, during the 2011 HPA mosquito surveillance work, one female

are evidence-based. The presence of *C modestus* in the UK suggests that WNV risk to humans and horses may be higher in these locations; however, further research on biting rates, host preference and dispersal, in addition to nationwide and targeted surveillance, are also required.

Jolyon M. Medlock, Alexander G. C. Vaux, Medical Entomology and Zoonoses Ecology group, MRA/BS, Emergency

Letters

VIROLOGY

Potential vector for West Nile virus prevalent in Kent

THE mosquito *Culex modestus* is considered the main bridge vector of West Nile virus in continental Europe, responsible for transmitting the virus from birds to humans (Balenghien and others 2008). *Cx modestus* was reported in three nature

Land cover and *Aedes albopictus/aegypti*

Can we use satellite data to generate a map of urban habitats for invasive mosquitoes?

Or used tyre dumps?

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The ecology of disease vectors

- Ticks and mosquitoes are impacted by land cover – so we should be able to map their suitability….
- We may also need to map….

…..their hosts, the connectivity of their habitats, consider soil type, geology, aspect, elevation, hydrology (groundwater), habitat and water level management, microclimate…..

- Can we used to predict risk, inform RA, advice the public and direct surveillance