



**FOOTPRINT
ECOLOGY**

www.footprint-ecology.co.uk

Environmental evidence and monitoring

Durwyn Liley



Footprint Ecology

- Established 2005
- 10 staff – range of ecological, planning and policy expertise. All passionate about the environment and nature conservation
- Work only with NGOs, local authorities, statutory agencies.
- Our work involves applied research, visitor surveys, analysis, planning advice, management plans, HRA.
- Over 50,000 interviews with visitors to countryside sites and bird disturbance fieldwork on around 20 SPA sites
- Work UK wide – from Caithness to Cornwall

Welcome!

This session:

- Impact pathways & monitoring implications
- Examples for discussion





Impact pathways

Impacts of Recreation

Damage

- Vegetation wear
- Soil compaction, erosion
- Wear & tear on infrastructure
- Direct damage (e.g. vandalism)

Contamination

- Dog fouling
- Water quality
- Non-natives
- Litter
- Biosecurity

Increased fire risk

- Direct mortality
- Long-term habitat change

Disturbance

- Avoidance of suitable habitat
- Energetic costs
- Physiological costs
- Direct mortality

Other/management

- Difficulty in managing sites – grazing, public opposition etc.
- Costs of managing access
- Demand for facilities
- Harvesting

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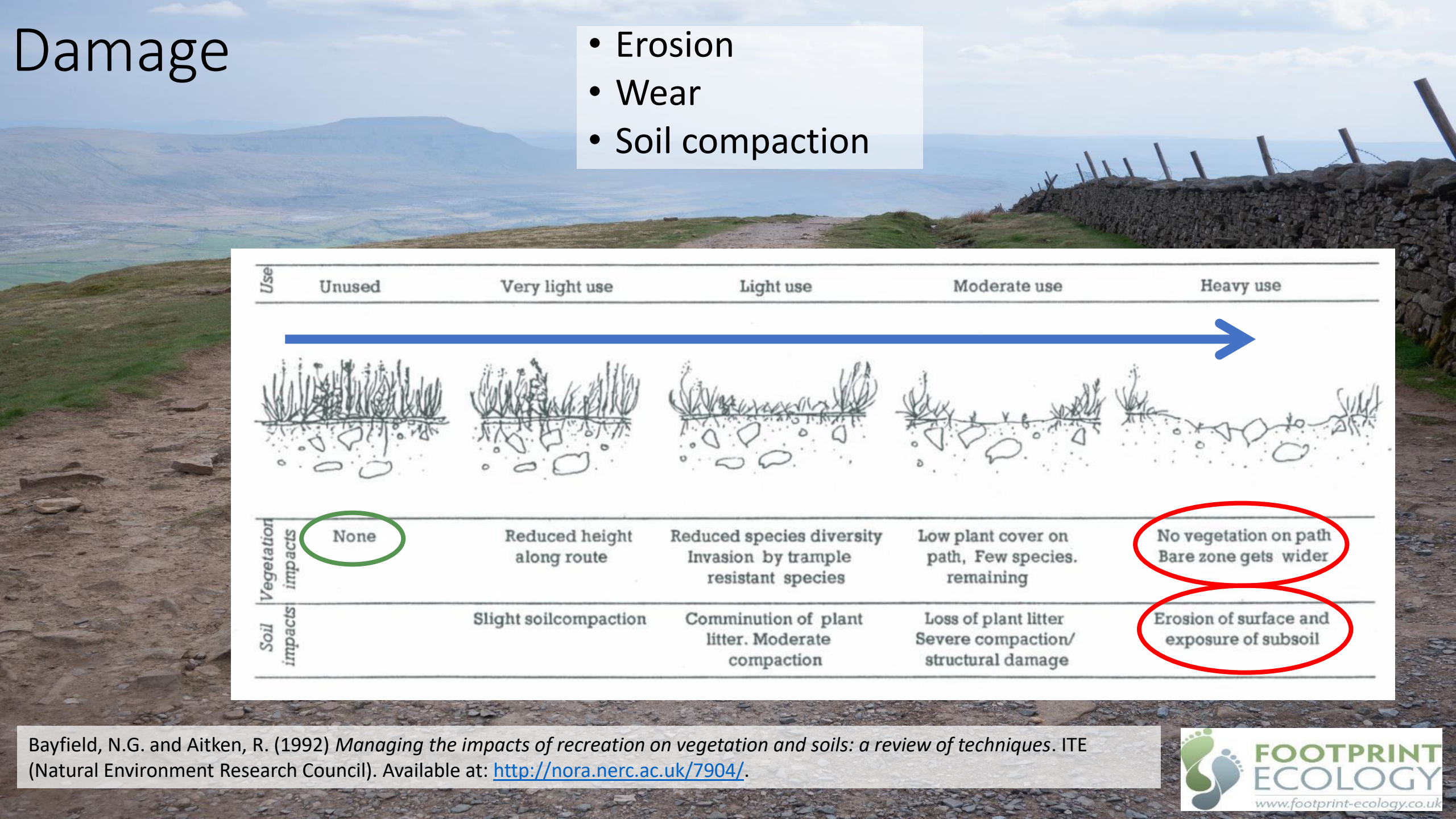
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Damage

- Erosion
- Wear
- Soil compaction



Use	Unused	Very light use	Light use	Moderate use	Heavy use
					
Vegetation impacts	None	Reduced height along route	Reduced species diversity Invasion by trample resistant species	Low plant cover on path, Few species remaining	No vegetation on path Bare zone gets wider
Soil impacts		Slight soil compaction	Comminution of plant litter. Moderate compaction	Loss of plant litter Severe compaction/ structural damage	Erosion of surface and exposure of subsoil

Bayfield, N.G. and Aitken, R. (1992) *Managing the impacts of recreation on vegetation and soils: a review of techniques*. ITE (Natural Environment Research Council). Available at: <http://nora.nerc.ac.uk/7904/>.







187 people per day



153 people per day

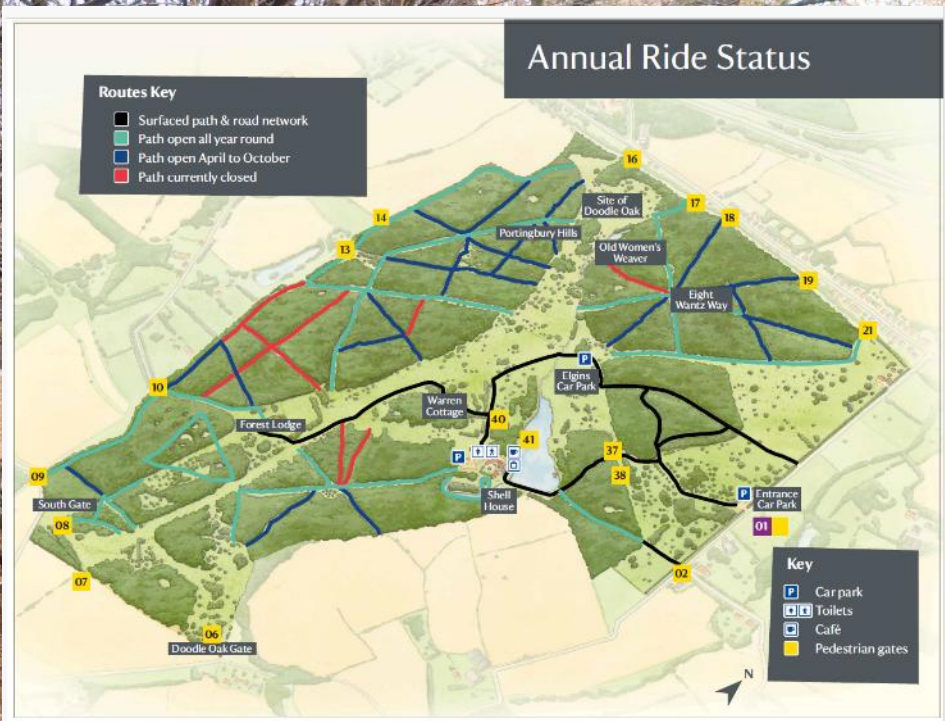


20 people per day

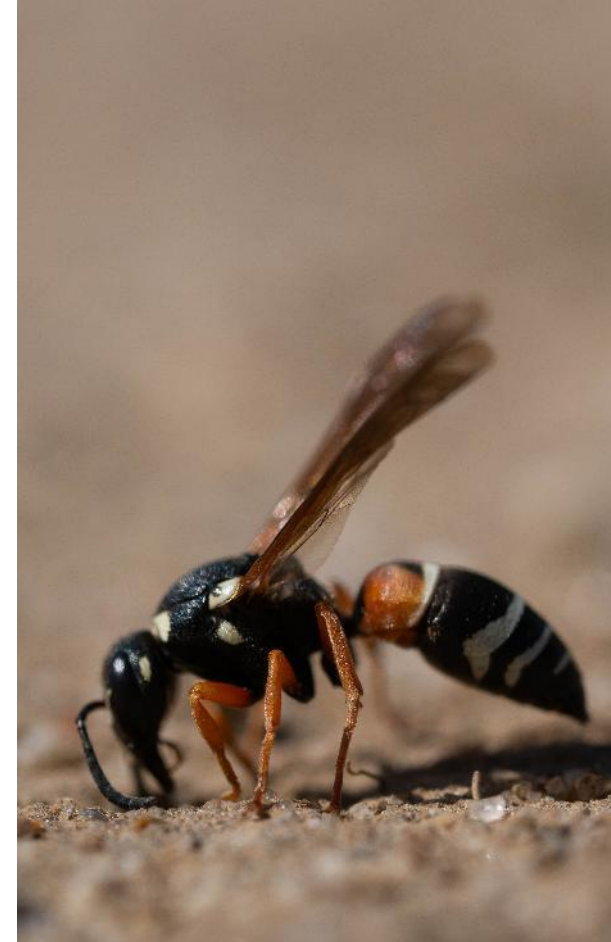
Images from Burnham Beeches Jan 2022

- 41km of paths at Burnham Beeches
- Total area of paths 16ha (7% of total site 220ha)

Liley, D. *et al.* (2022) *A review of sustainable visitor numbers at Burnham Beeches*. 660. Footprint Ecology / City of London.



Damage to habitat structure



- Particular risks for certain species

Vulnerable sites and features

- Sand dunes
- Heathland
- Grassland
- Fen
- Veteran trees
- Lichen heath
- Maritime grassland/heath
- Woodland (ground flora)
- Species rich ledges (climbing)
- Mires, flushes and springs
- Blanket bog
- Invertebrates, shearwater burrows

Impacts likely to be greater as a result of new places being damaged than from deterioration of places that are already damaged: creating new access is likely to have a greater impact than more footfall in existing areas

Monitoring implications:

- **Soils difficult to monitor**
- **Impacts related to weather and type of access**
- **Path widths and condition often useful metric**
- **Target species??**

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Dog fouling

- Dog waste rich in N and P due to protein rich diet
- Substantial nutrient enrichment (N from urine and faeces, P from faeces)
- Enrichment from dogs may be greater than atmospheric pollution
- Patchy and very high localised impacts

De Frenne, P. *et al.* (2022) *Ecological Solutions and Evidence*, 3(1), p. e12128. Available at: <https://doi.org/10.1002/2688-8319.12128>.



Dogs and water quality

- Growing evidence of high levels of pesticides such as fipronil in ponds where dogs swim
- Turbidity also a problem in some ponds

- Perkins, R. *et al.* (2021) 'Potential role of veterinary flea products in widespread pesticide contamination of English rivers', *Science of The Total Environment*, 755, p. 143560. Available at: <https://doi.org/10.1016/j.scitotenv.2020.143560>.
- Denning, L. *et al.* (2024) *The Sand Dune Managers Handbook. Version 2*. Dynamic Dunes (DuneLIFE) project.
- Perkins, R., Glauser, G. and Goulson, D. (2025) 'Swimming emissions from dogs treated with spot-on fipronil or imidacloprid: Assessing the environmental risk', *Veterinary Record*, 196(11), p. e5560. Available at: <https://doi.org/10.1002/vetr.5560>.

Non native species

- Walking humans can disperse seeds to very long distances, up to at least 10km.
- The abundance and richness of non-natives higher in areas with tourism/recreation compared to control sites.
- Some suggestion horse riding a particularly strong vector.
- Evidence for fungal pathogens too.



Wichmann, M. C., Alexander, M. J., Soons, M. B., Galsworthy, S., Dunne, L., Gould, R., Fairfax, C., Niggemann, M., Hails, R. S., & Bullock, J. M. (2009). *Human-mediated dispersal of seeds over long distances*. 276(1656), 523–532.

Anderson, L. G., Roccliffe, S., Haddaway, N. R., & Dunn, A. M. (2015). The Role of Tourism and Recreation in the Spread of Non-Native Species: A Systematic Review and Meta-Analysis. *PLOS ONE*, 10(10), e0140833.



Vulnerable sites

- Riparian habitats
- Freshwater
- Heathland
- Sand dunes
- Any low nutrient habitat...

Monitoring implications:

- **Soils & water quality difficult to monitor**
- **Indicator species for water quality**
- **Dog faecal counts**
- **Fixed point photography**

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Fire impacts

- Direct mortality – e.g. breeding birds, herptiles
- Reduced habitat suitability
- Shifts in vegetation communities

Monitoring implications:

- **Occurrence, area affected**
- **Vegetation recovery/change**

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Disturbance



Avoidance of
suitable habitat

Behavioural
response



Direct mortality



Physiological
response



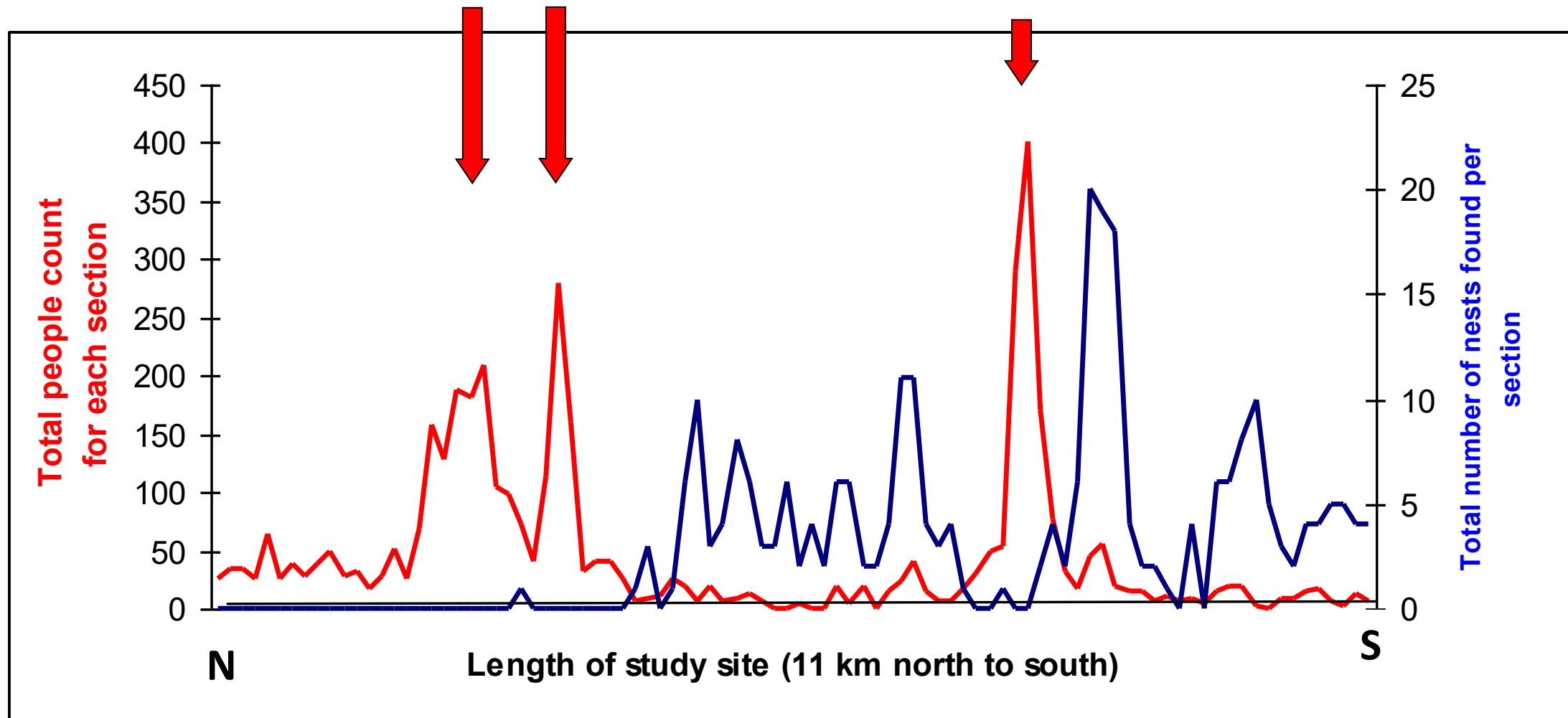
Not just birds: adder, tiger beetles, mammals





- Usually four eggs
- 1-5 nesting attempts per season
- Nests anywhere above HW mark
- c.25 days to hatch

Settlement pattern & access



Other examples

- Pink-footed geese not using fields close to roads (Gill 1996)
- Controlled experiment with dog walking – 41% reduction in abundance (Banks et al 2007)
- Controlled experiments showed reduced densities of black-tailed godwits with experimental disturbance (Holm & Laursen 2009)
- ‘Phantom road’ 4 days on and 4 days off using 0.5km array of speakers – 25% decline in bird abundance (migrants) and almost complete avoidance by some species (McClure et al 2013)



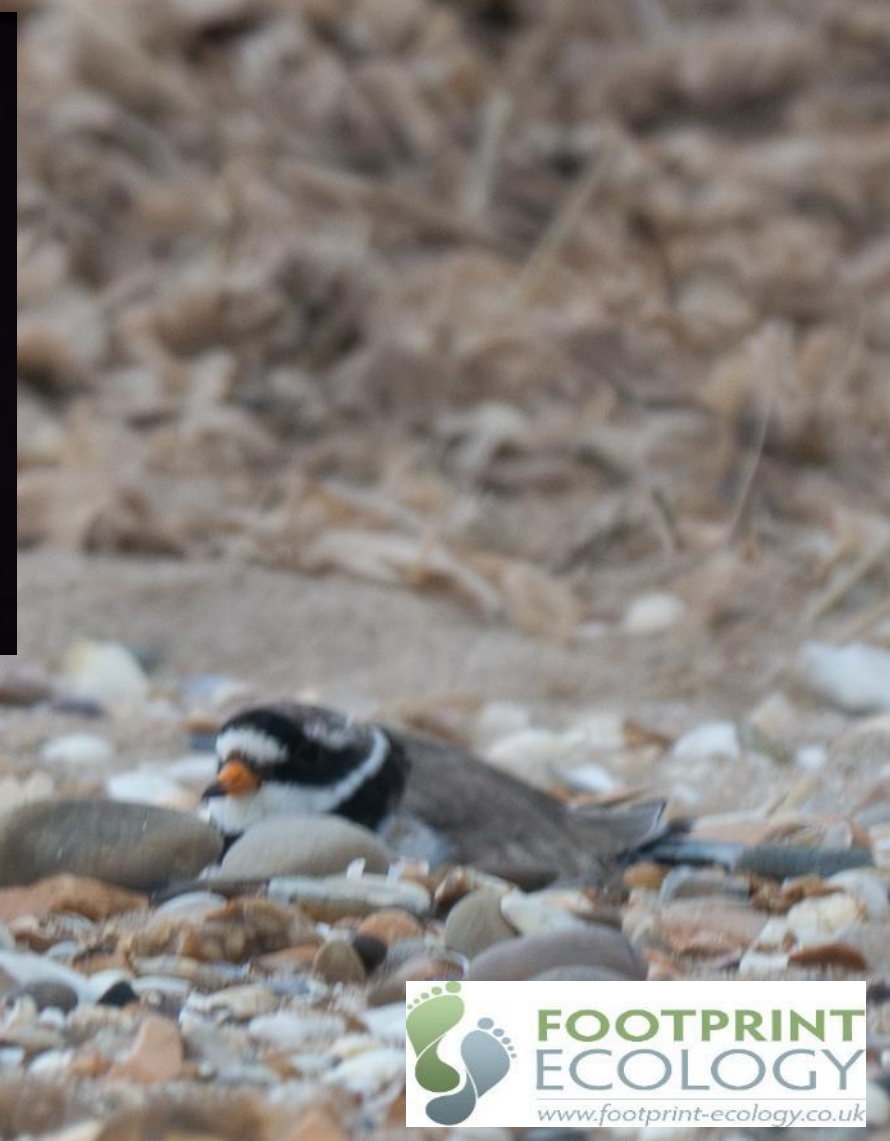
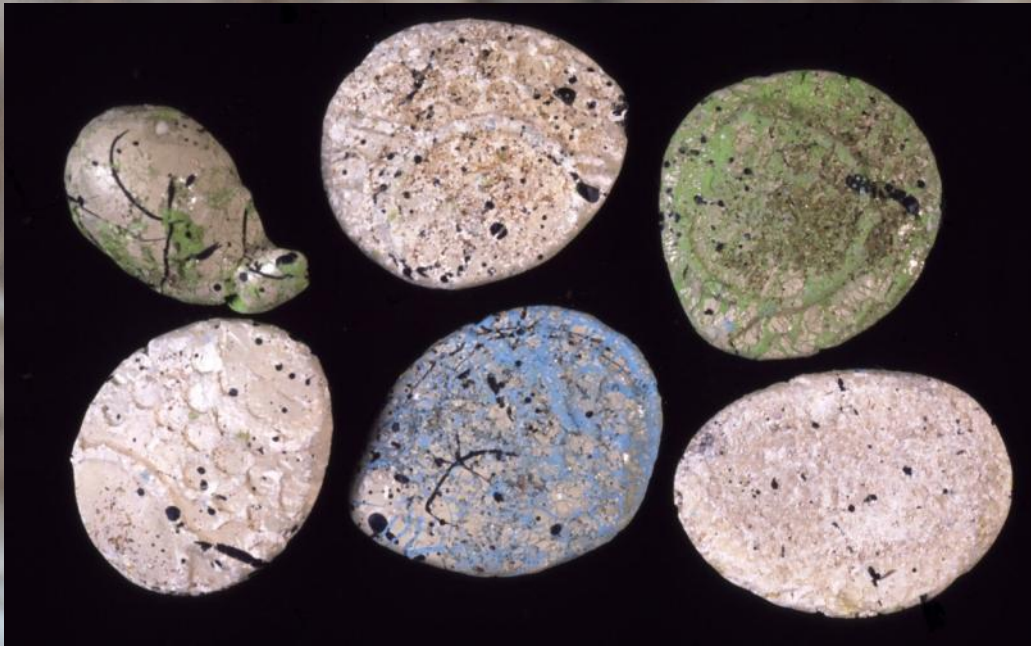


Direct mortality

- Increased predation
- Chicks dying as a result of hypothermia/heat
- Accidental trampling of nests etc.
- (Deliberate killing?)

Trampling and avoidance included in modelling

- No people at all: population increase of 85%
- Numbers of people doubled: decrease of 23%



Liley, D. *et al.* (2021) 'Beach-nesting Ringed Plovers and their conservation in England', *British Wildlife*, 33(3), pp. 157–165.
Liley, D. and Sutherland, W.J. (2007) 'Predicting the population consequences of human disturbance for Ringed Plovers *Charadrius hiaticula*: a game theory approach', *Ibis*, 149(s1), pp. 82–94. Available at: <https://doi.org/doi:10.1111/j.1474-919X.2007.00664.x>.



Behavioural Response

Differentiating between effect and impact

- Lost feeding time
- Increased energy expenditure
- Increased interference
- Displacement to poorer quality sites
- Nest left unattended



Stress & Physiological responses



- Heart Rate increases
- Body temperature increase
- Increased energy expenditure
- Stress hormones (faecal samples)
- Evidence for difference between individuals

Ellenberg, U. *et al.* (2006) *Biological Conservation*, 133, pp. 95–106. <https://doi.org/10.1016/j.biocon.2006.05.019>.
Tarjuelo, R. *et al.* (2015) *Behavioral Ecology*, 26(3), pp. 828–838. <https://doi.org/10.1093/beheco/arv016>.
Thiel, D. *et al.* (2008) *Journal of Applied Ecology*, 45(3), pp. 845–853. <https://doi.org/10.1111/j.1365-2664.2008.01465.x>.
Ellenberg, U., Mattern, T. and Seddon, P.J. (2013), *Conservation Physiology*, 1(1), p. cot013. <https://doi.org/10.1093/conphys/cot013>.
Weimerskirch, H. *et al.* (2002), *J Exp Biol*, 205(Pt 4), pp. 475–83.
Image © Pierre Dalous ([Creative Commons](https://creativecommons.org/licenses/by/4.0/))

Groups of species particularly vulnerable?

Birds:

- Ground nesting (terns, waders, passerines etc)
- Colonial nesters
- Seabirds
- Wintering waterfowl (waders and geese)
- Rare breeding birds (including some raptors)
- Grouse (e.g. Capercaillie)

Also herps, burrowing inverts, mammals, fish

Monitoring implications:

- **Can't just monitor birds taking flight**
- **Breeding success, energetics, health all difficult to monitor**



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Grazing

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Warning over dog attacks after 18 lambs killed in Cornwall

🕒 2 February

The Northern Echo

NEWS
11th January

Almost 20 sheep killed and more injured in suspected dog attack

By Alexa Fox | [@echoalexa](#)
Reporter (Thirsk & Ripon)



MOST READ | **COMMENTED**

1  Train company is looking for drivers





Examples for discussion

What to monitor to track recreation impact and inform interventions?

4 Examples











What to monitor to track recreation impact and inform interventions?

