Would land sharing or land sparing allow more wild species to survive?

Rhys Green

Cambridge Conference on Global Food Security 2016

The team

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David Williams	Cambridge
Anthony Lamb	Cambridge
Erasmus zu Ermgassen	Cambridge
Johannes Kamp	RSPB, Münster
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Jörn Scharlemann	Cambridge, WCMC, Sussex

Demand-side interventions

e.g. reducing food waste, using food waste to feed livestock, reducing human consumption of animal protein

Would it be better for biodiversity if …..

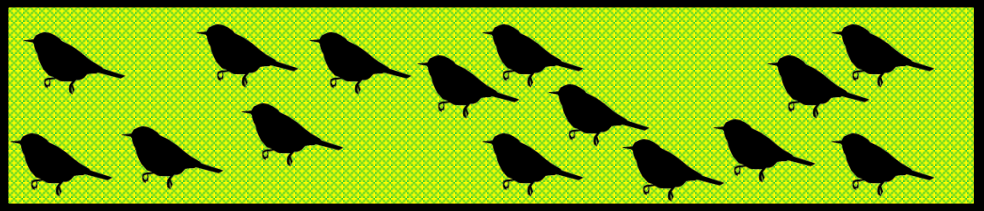
… production in farmed landscapes was low, allowing them to be benign for wildlife?

Would it be better for biodiversity if …..

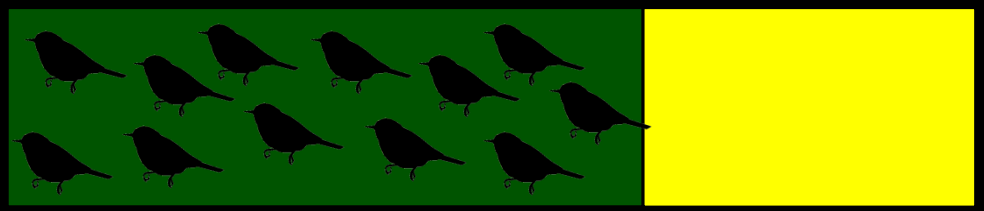
…production in farmed landscapes was high and natural habitats were thereby spared?

Trade-offs

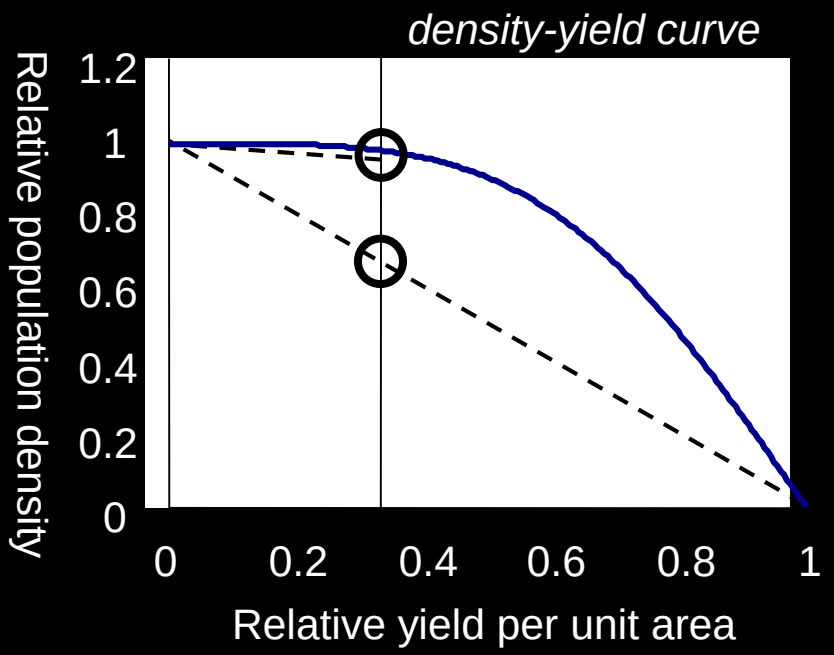
Which is better for wild species?



Land sharing



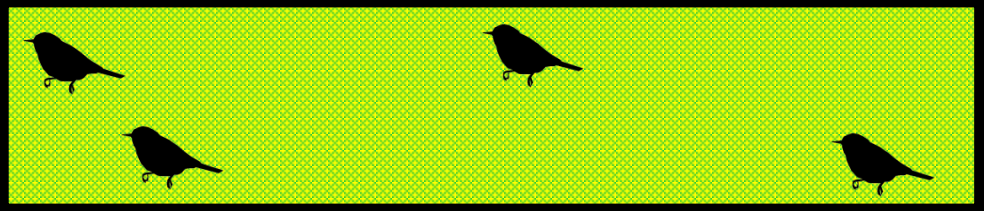
Land sparing



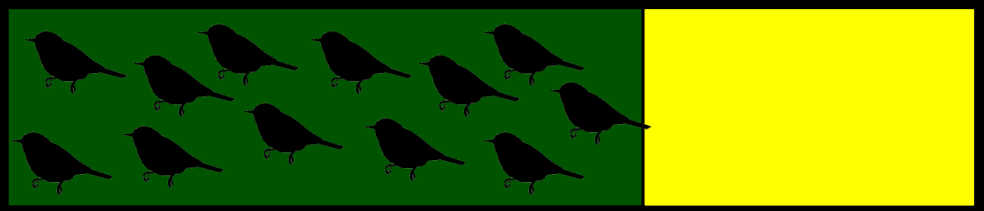
Green et al. (2005) *Science* 307: 550-555

Trade-offs

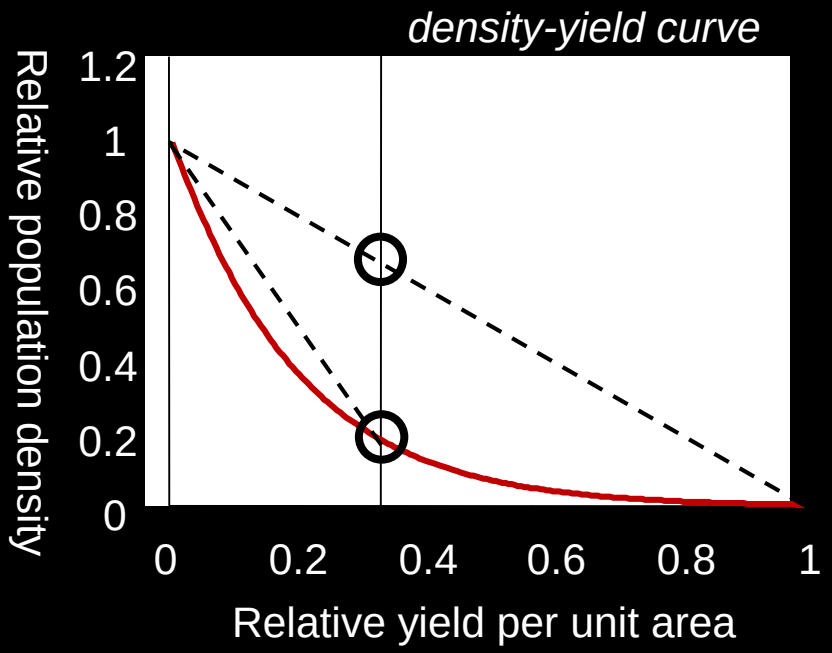
Which is better for wild species?



Land sharing

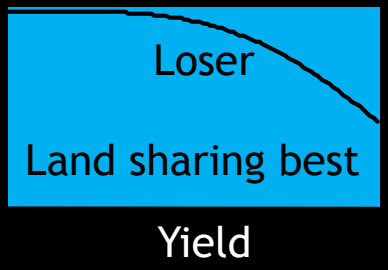


Land sparing

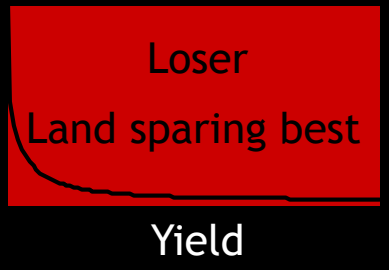


Green et al. (2005) *Science* 307: 550-555

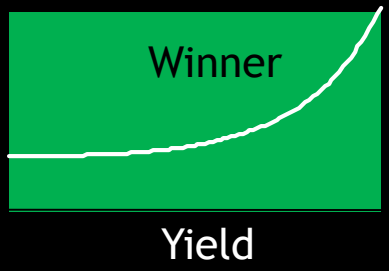
Categorisation of species: colour coding



Loser SH: total population smaller with than without agriculture: favoured by low yield and land sharing



Loser SP: total population smaller with than without agriculture: favoured by high yield and land sparing



Winner: total population larger with than without agriculture

What do the data say?

Field data from Ghana and India


Field data from Ghana and India

Field data from Ghana and India

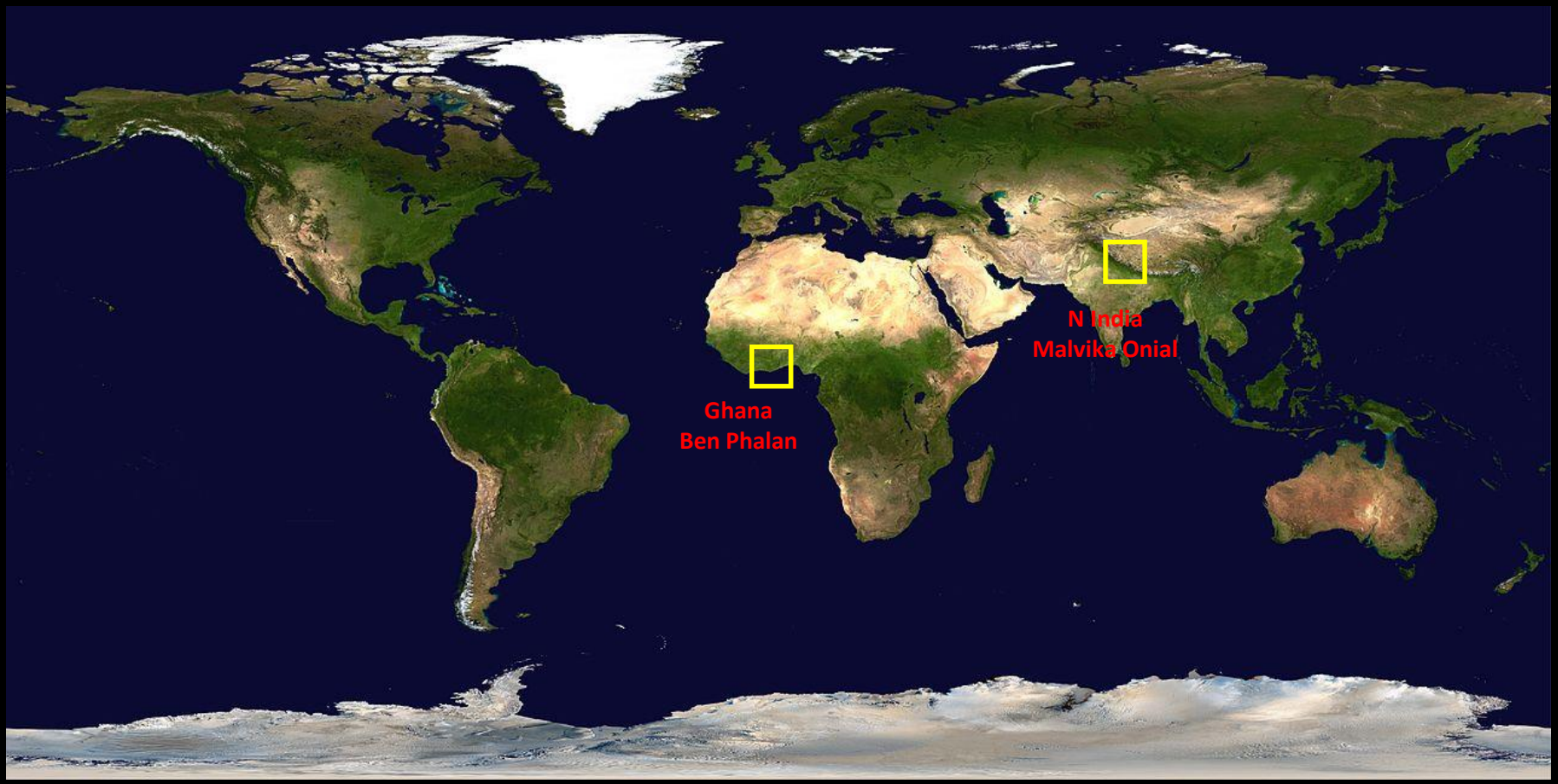
Field data from Ghana and India

Reconciling Food Production and Biodiversity Conservation: Land Sharing and Land Sparing Compared

Ben Phalan,[1] Malvika Onial,[1] Andrew Balmford,[1] Rhys E. Green[1,2]

The question of how to meet rising food demand at the least cost to biodiversity requires the evaluation of two contrasting alternatives: land sharing, which integrates both objectives on the same land; and land sparing, in which high-yield farming is combined with protecting natural habitats from conversion to agriculture. To test these alternatives, we compared crop yields and densities of bird and tree species across gradients of agricultural intensity in southwest Ghana and northern India. More species were negatively affected by agriculture than benefited from it, particularly among species with small global ranges. For both taxa in both countries, land sparing is a more promising strategy for minimizing negative impacts of food production, at both current and anticipated future levels of production.

Phalan et al. (2011) *Science* 333: 1289-1291

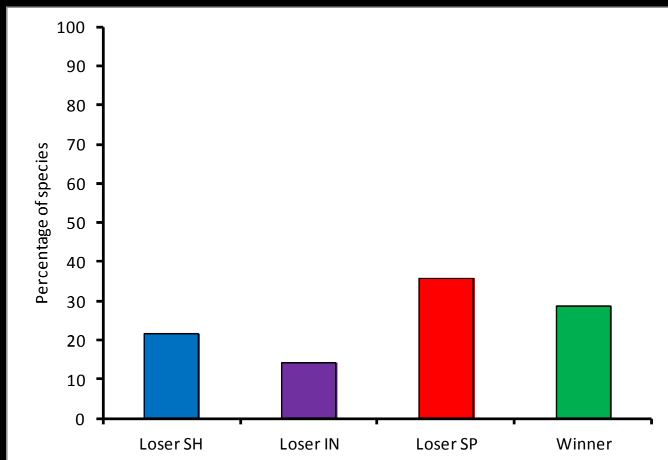

N India
Malvika Onial
Ghana
Ben Phalan

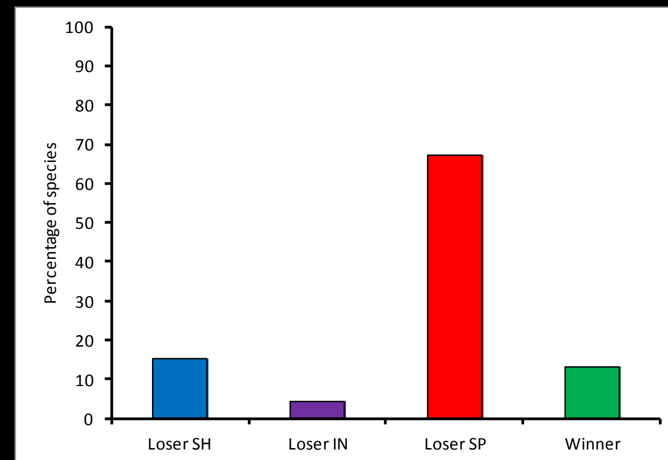
How many bird species win and lose from agriculture and how many of the losers benefit most from sparing or sharing? Field data from Ghana and India

Large global range

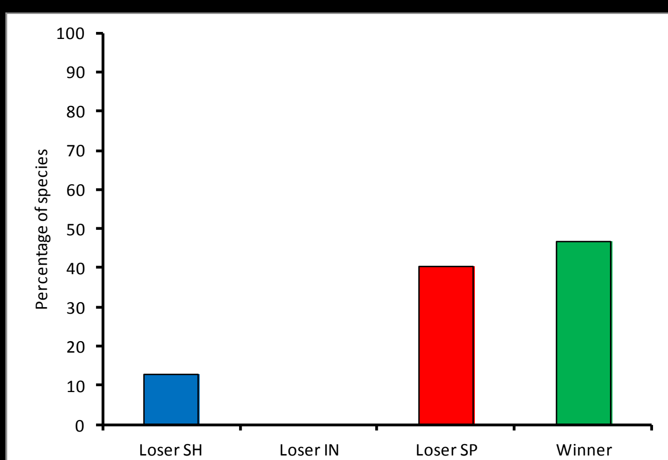
Small global range

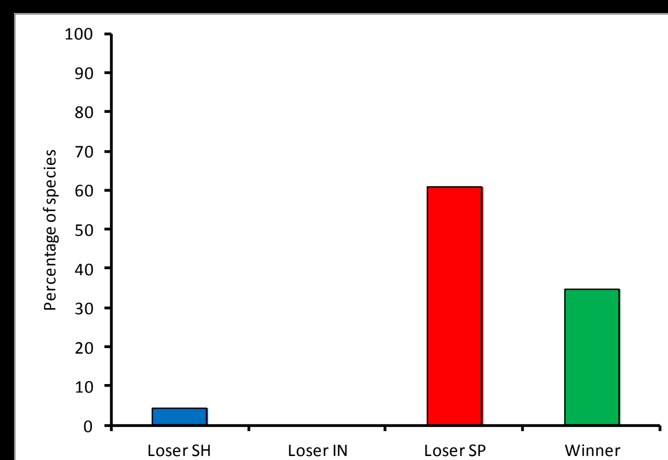
Ghana





India





KEY

Loser SH

Loser INT

Loser SP

Winner

Phalan et al. (2011) *Science* 333: 1289-1291

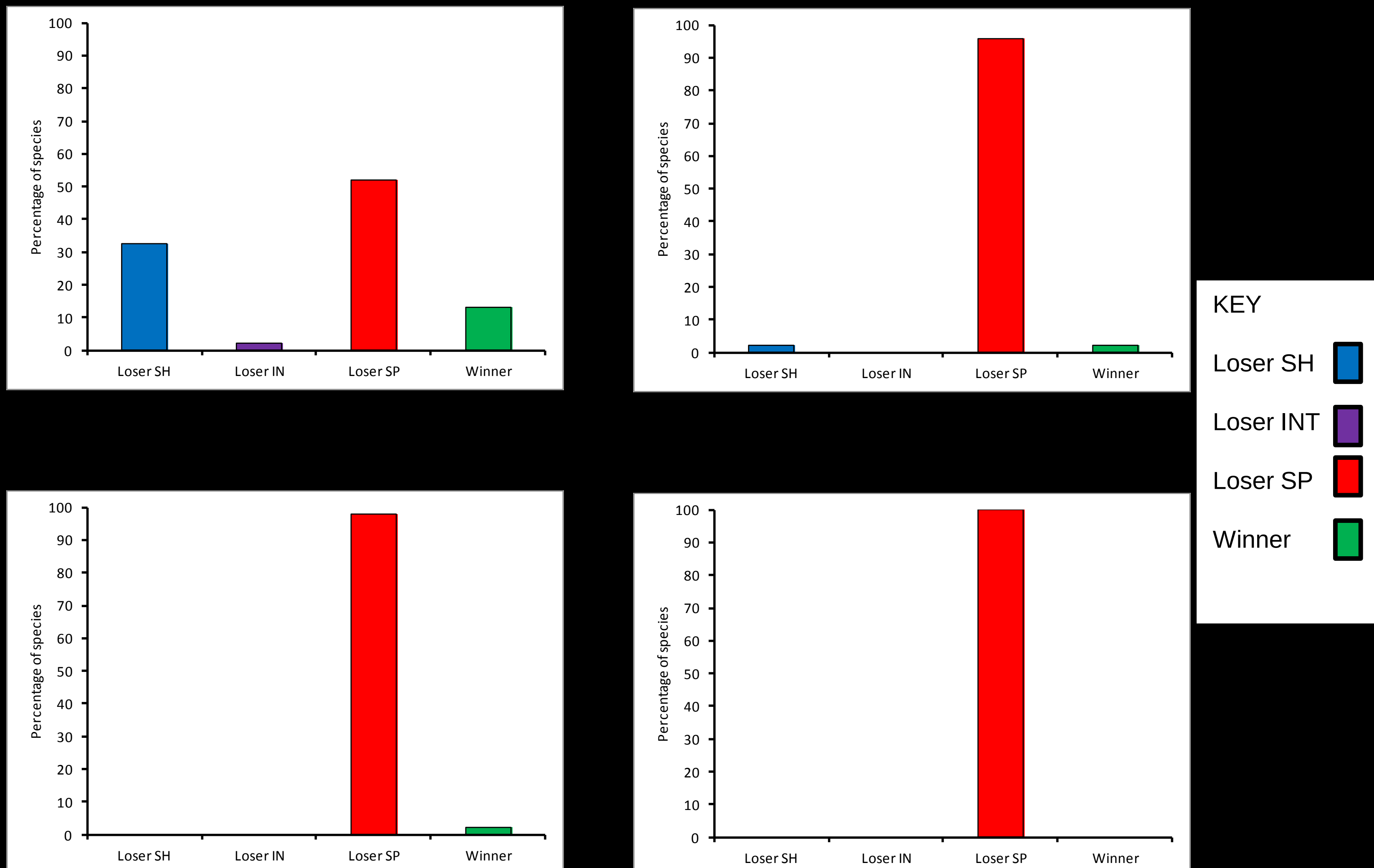
How many tree species win and lose from agriculture and how many of the losers benefit most from sparing or sharing? Field data from Ghana and India

Large global range

Small global range

Ghana

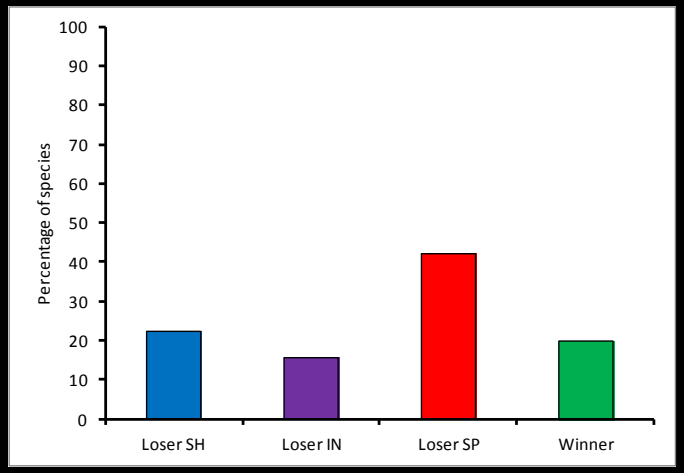
India



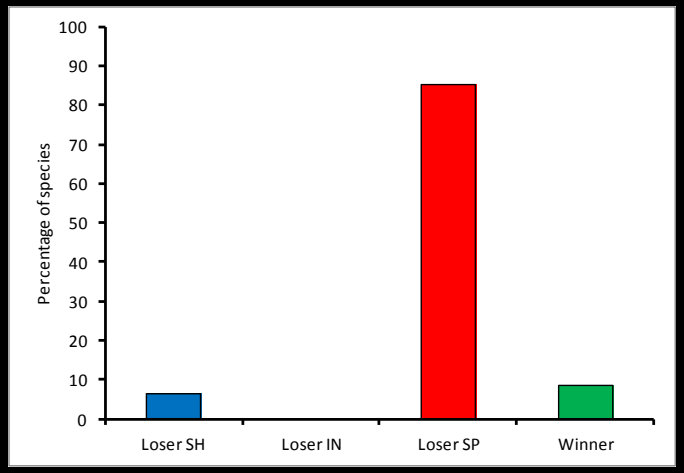
Phalan et al. (2011) *Science* 333: 1289-1291

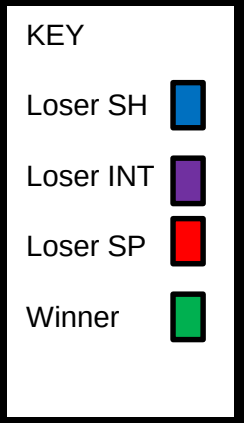
How many butterfly species win and lose from agriculture and how many of the losers benefit most from sparing or sharing? Field data from India

Large global range

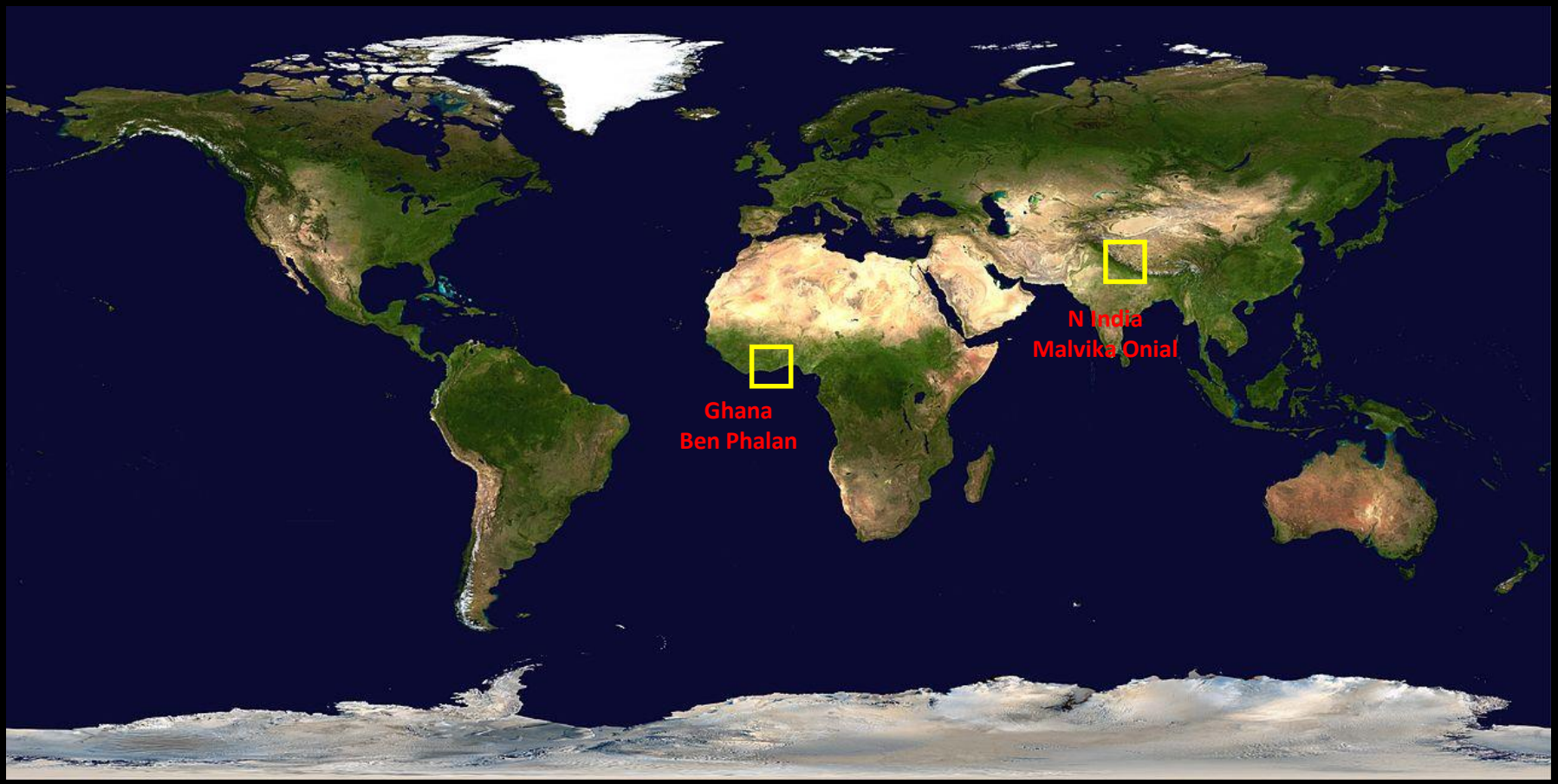


Small global range





Onial et al. (in prep)


N India
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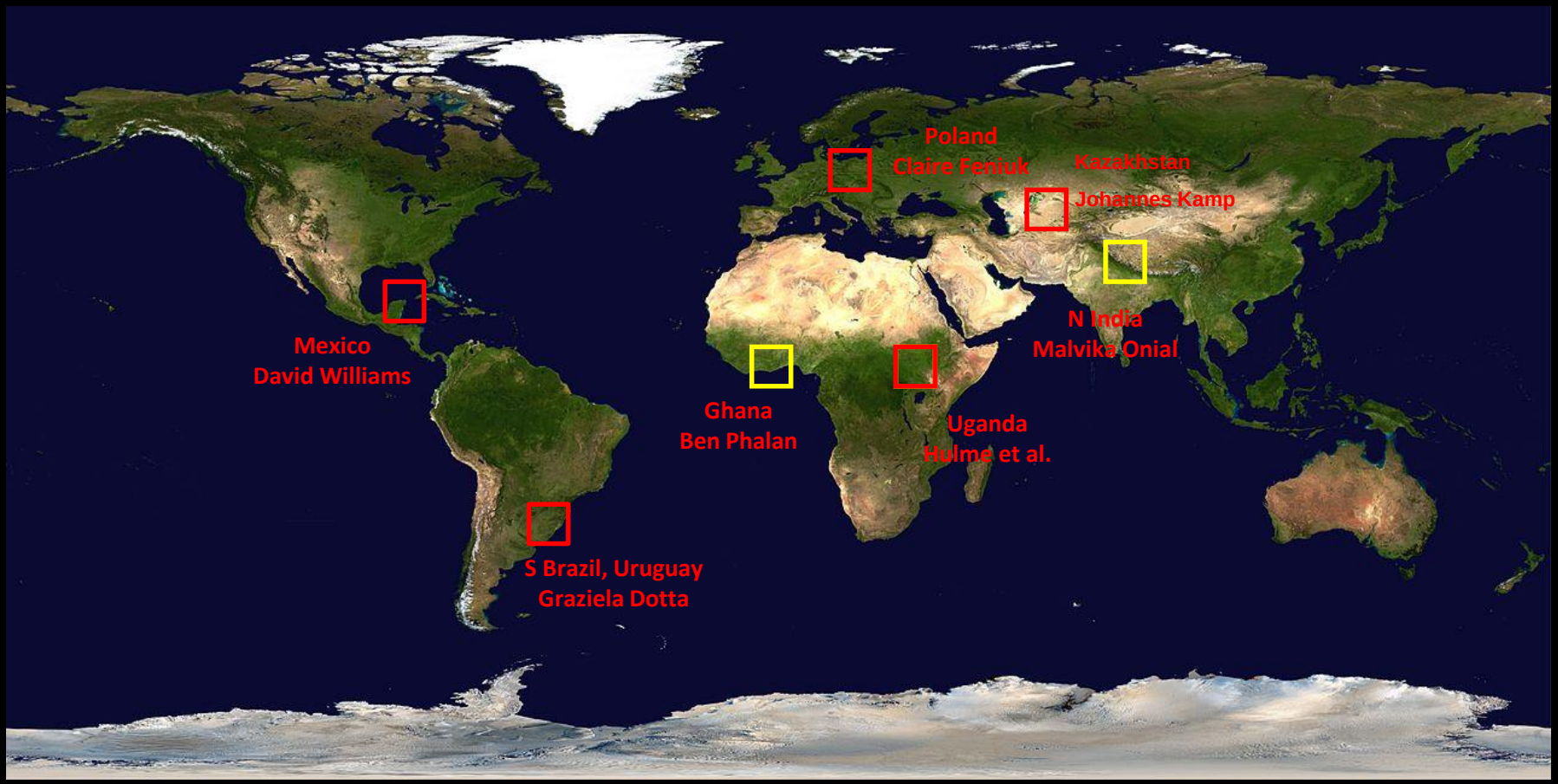

Poland
Claire Feniuk
Kazakhstan
Johannes Kamp
N India
Malvika Onial
Mexico
David Williams
Ghana
Ben Phalan
Uganda
Hulme et al.
S Brazil, Uruguay
Graziela Dotta

Contrasts between some of the new study areas and Ghana and India

Different biomes; grassland rather than forest (e.g. Kazakhstan, Pampas)

Duration and intensity of past agriculture (e.g Yucatan, Poland)

Magnitude of past changes caused by late Pleistocene megafaunal extinctions (e.g. Yucatan, Pampas, Kazakhstan, Poland)

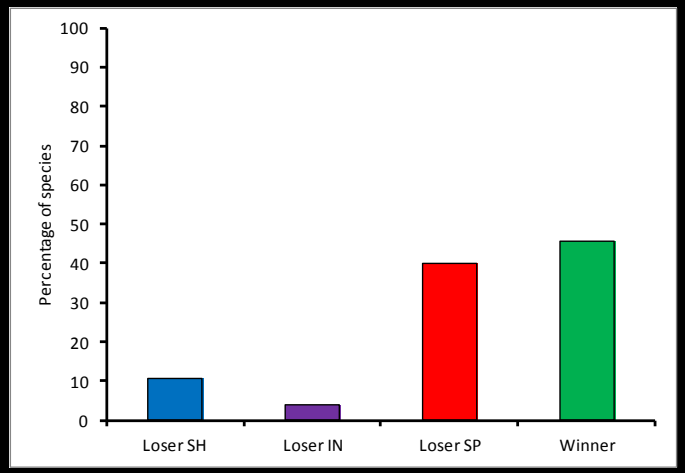
Magnitude of past changes caused by climatic fluctuations such as glaciation (e.g. Kazakhstan, Poland)

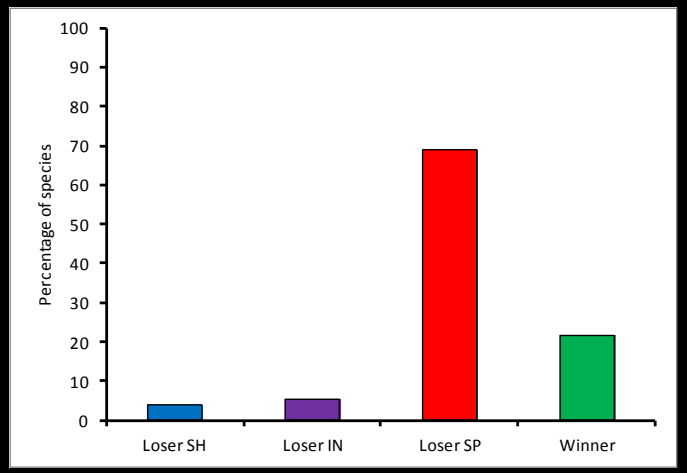
How many bird species win and lose from agriculture and how many of the losers benefit most from sparing or sharing? Field data from Uganda and the Pampas

Large global range

Small global range

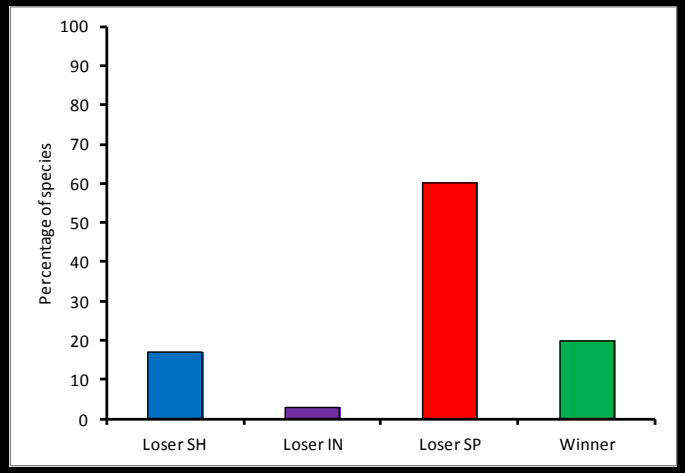
Uganda

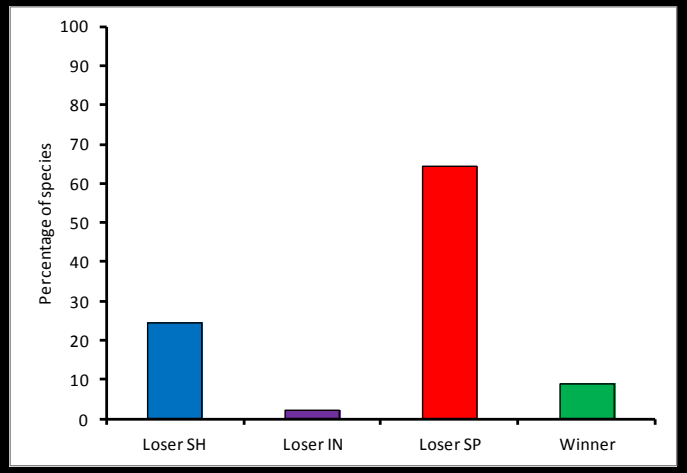




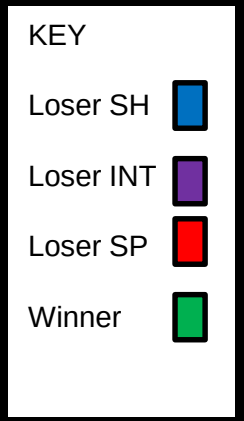
Hulme *et al.* (2013) *PLoS ONE* **8,** e54597.

Pampas



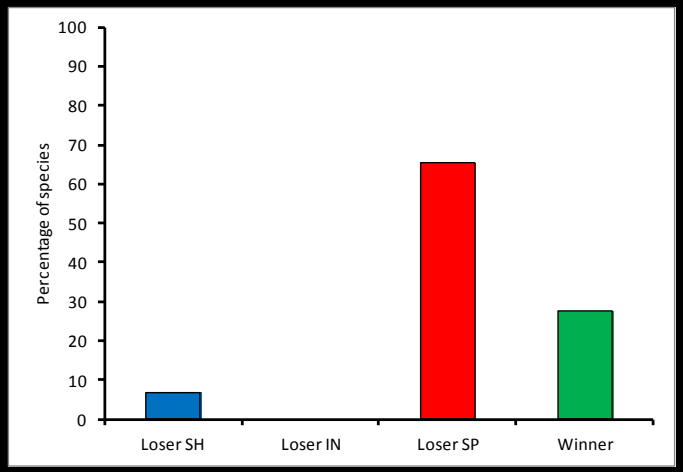


Dotta *et al.* (2016) *Conservation Biology*, **30,** 618-627.



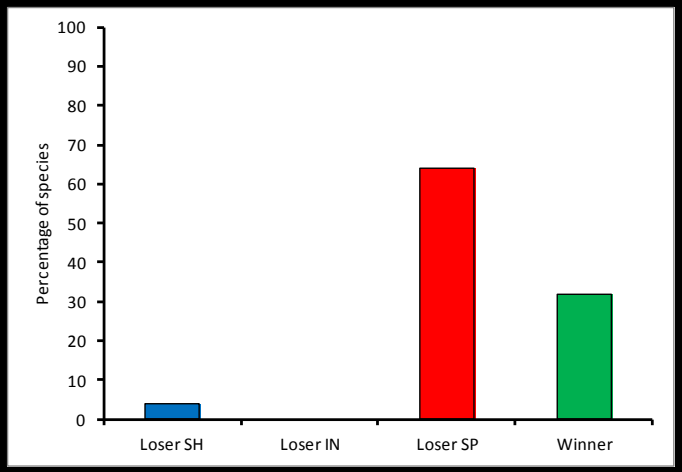
How many bird species win and lose from agriculture and how many the losers benefit most from sparing or sharing? Field data from Mexico and Kazakhstan

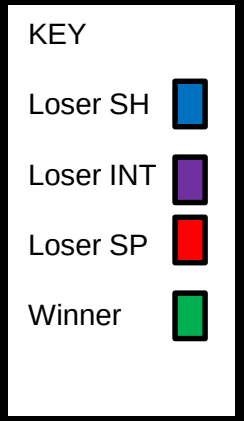
Mexico



Williams et al. (in prep)

Kazakhstan

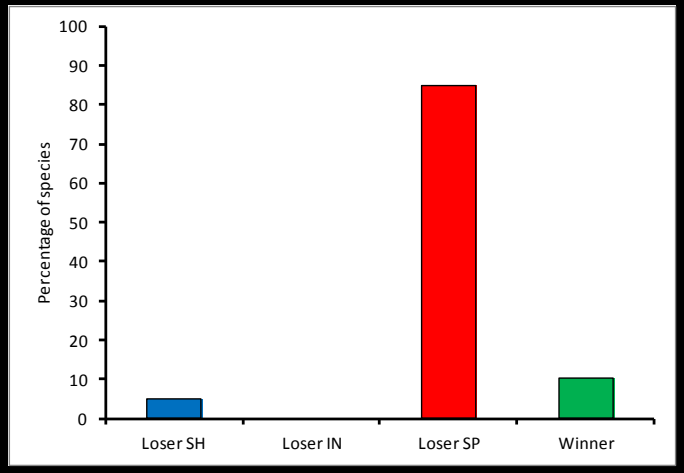




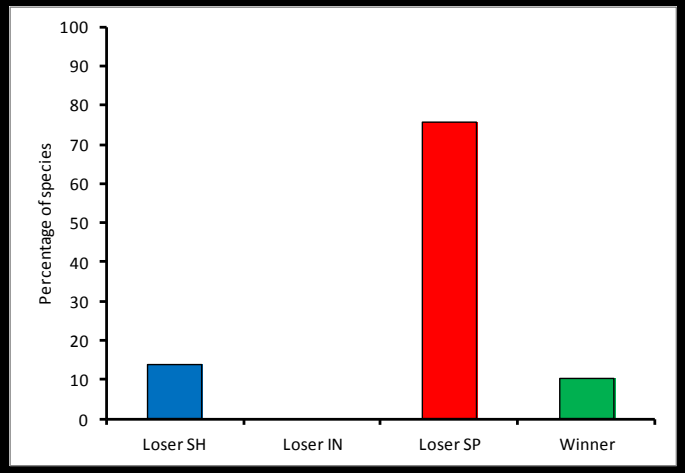
Kamp et al. (2015) *Journal of Applied Ecology* **52,** 1578 - 1587.

How many species of various taxa win and lose from agriculture and how many of the losers benefit most from sparing or sharing? Field data from Mexico and Poland

Mexico: trees



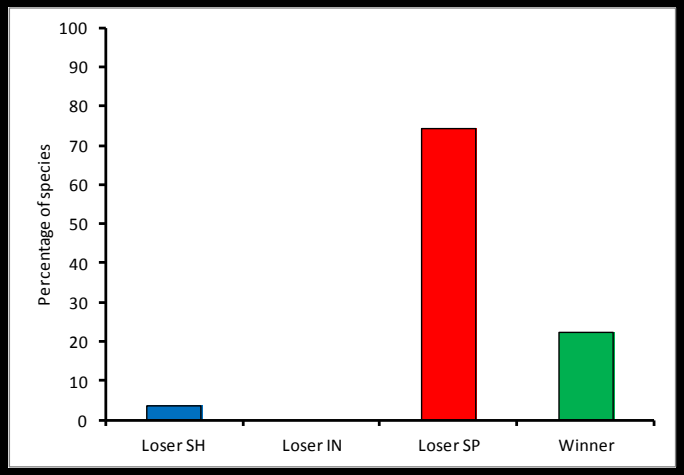
Poland: trees



KEY

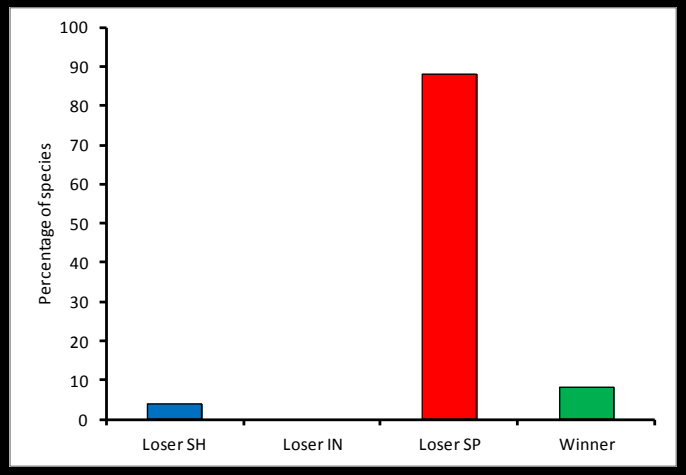
- Loser SH
- Loser INT
- Loser SP
- Winner

Mexico: dung beetles



Williams et al. (in prep)

Poland: sedges



Feniuk et al. (in prep)

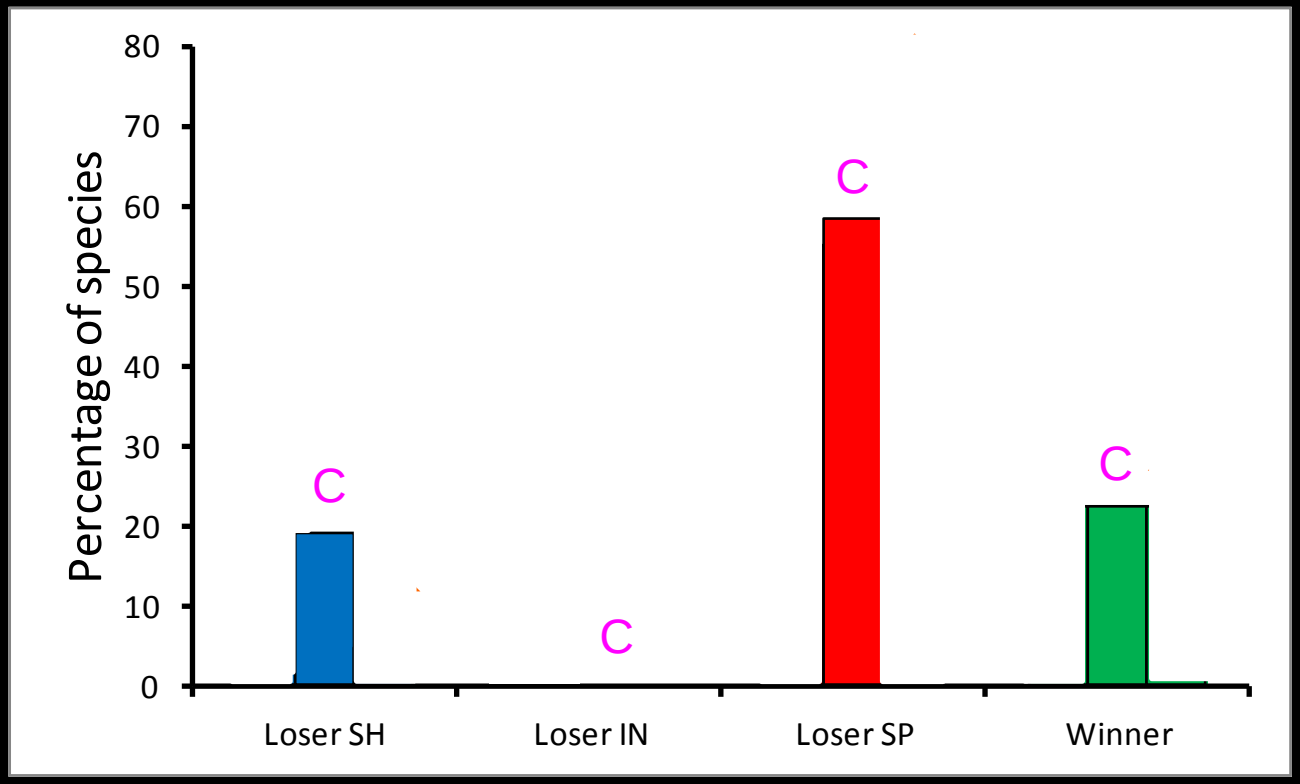
Plus similar findings for

Dung beetles, asters and grasses in the Pampas

Dotta *et al.* (in prep)

How does the production target affect how many bird species win and lose from agriculture and how many of the losers benefit most from sparing or sharing in Poland?

Current production C



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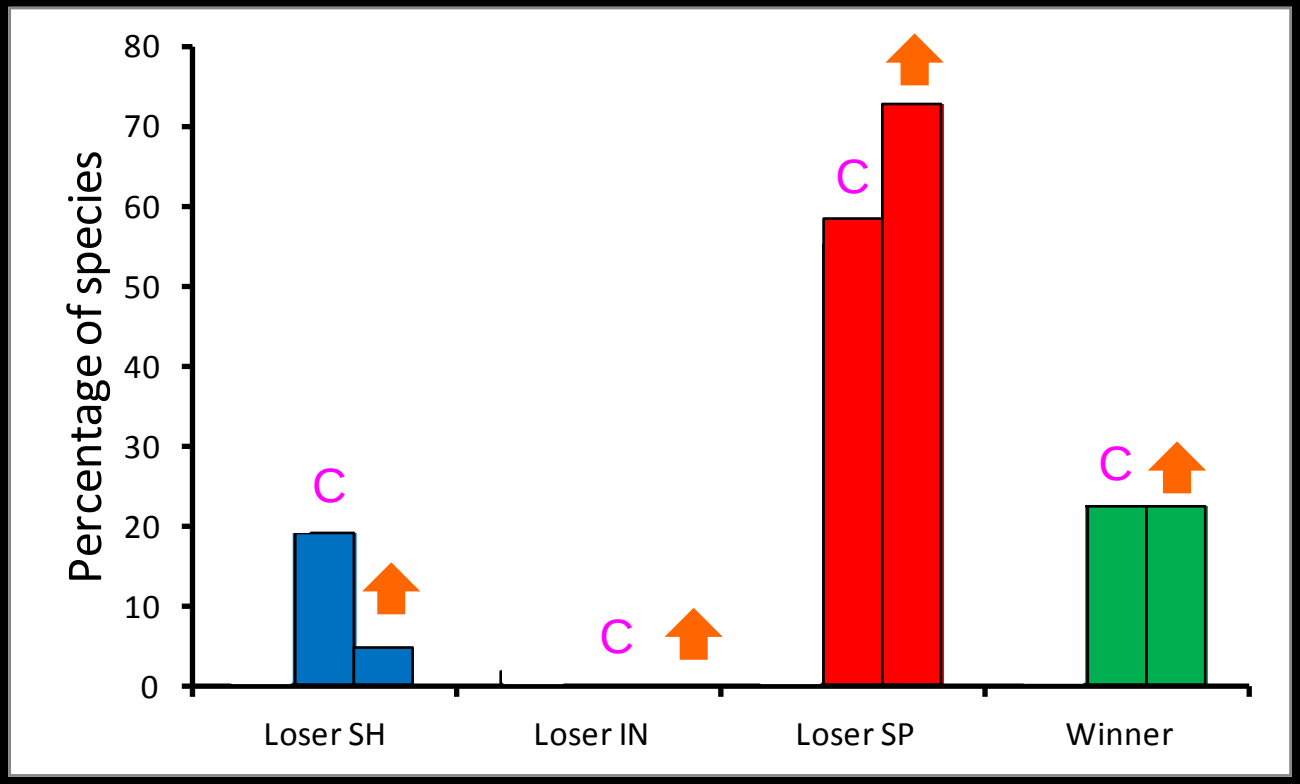
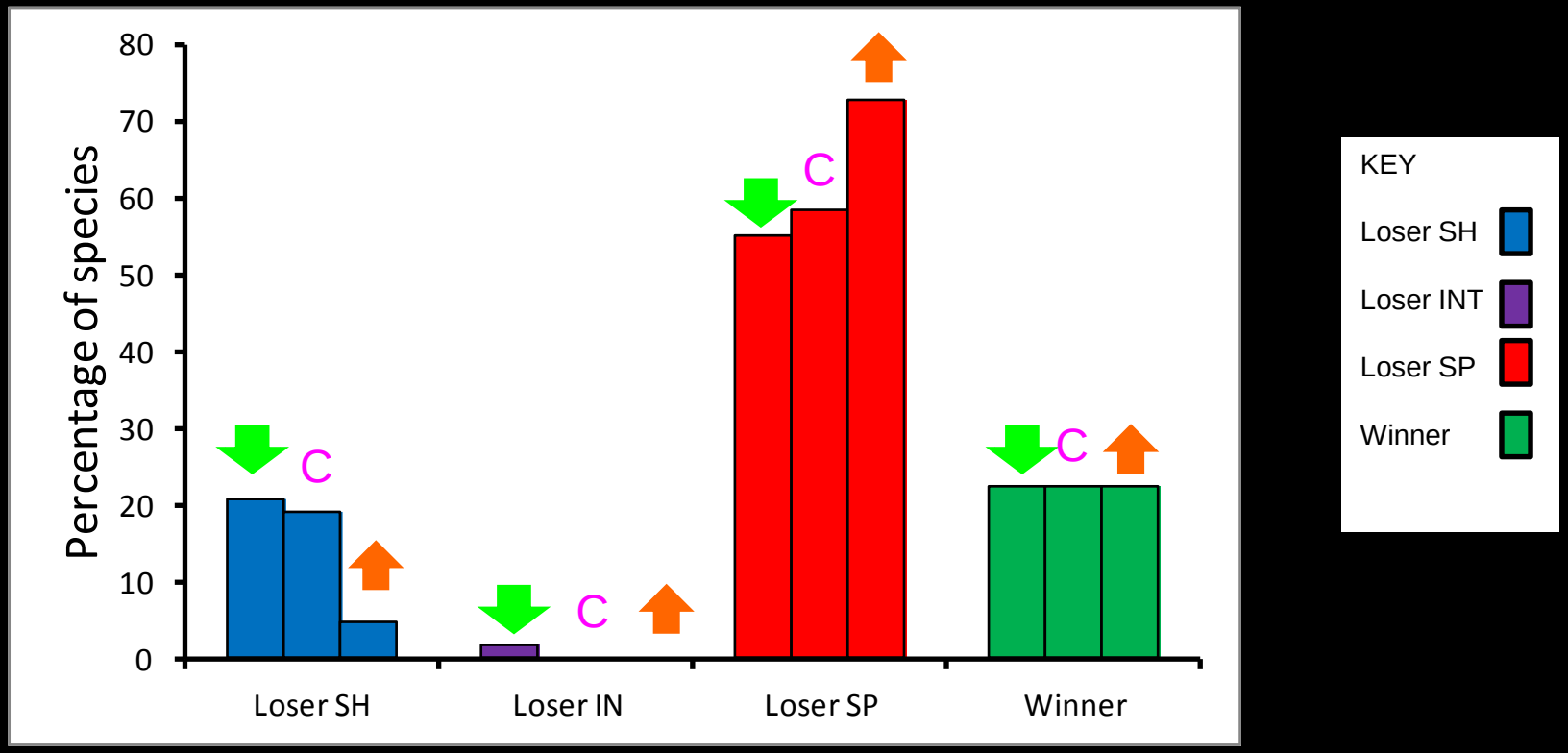
Current production C Increased production ↑



Feniuk et al. (in prep)

How does the production target affect how many bird species win and lose from agriculture and how many of the losers benefit most from sparing or sharing in Poland?

Current production C Increased production ↑ Reduced production ↓



Feniuk et al. (in prep)

Quantifying negative external environmental effects outside the farmed landscape

Quantify key external environmental effects such as atmospheric and water-borne nutrient and pesticide pollution, unsustainable water use greenhouse gas emissions and soil loss

Identify high-yield farming systems with low external environmental effects

Estimate the abatement costs per unit of product of external environmental effects for different systems for producing the same commodity

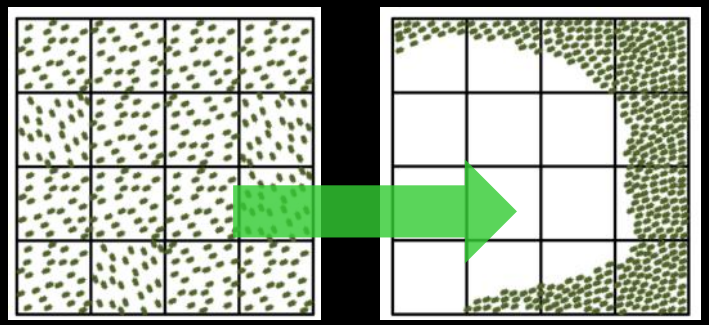
Include these abatement costs in the sharing-sparing analysis

Can land sparing be linked to yield increases by policies?

Reviewed in Phalan *et al.* (2016) *Science,* **351,** 450 - 451.

market effects alone limited

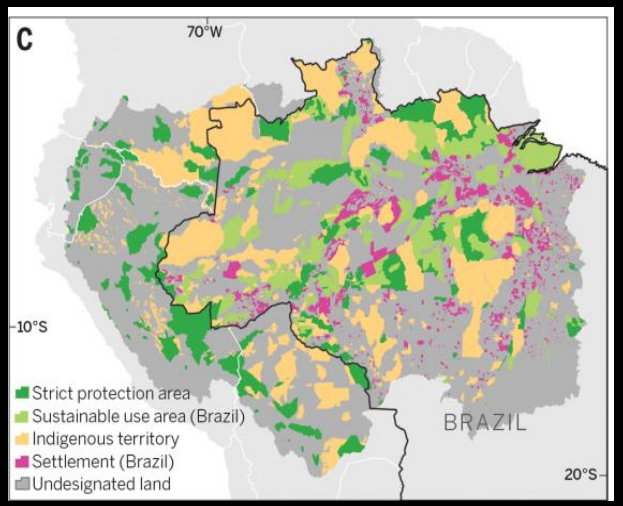
Stevenson *et al. 2013 PNAS 110: 8363*



market-based incentives

e.g. eco-certification, preferential access to credit

Balmford *et al. 2012 Proc R Soc Lond B 279: 2714*



command-and-control measures

e.g. land-use zoning, protected areas, legally-required offsets

Nepstad *et al. 2014 Science 344: 1118*

Can land sparing be linked to yield increases by policies?

Reviewed in Phalan *et al.* (2016) *Science,* **351,** 450 - 451.

publicly-funded financial incentives
e.g. agricultural subsidies and taxes, PES

strategic deployment of investments
e.g. new/improved roads, extension officers, irrigation

Laurance et al. 2014 Nature 513: 229
Sankaran & Madhusudan 2010 Hindu Surv. Env. 2010: 113

Conclusions

Field studies of farm yields and population densities of wild plant and animal species show that, at a given fixed level of total production, more species would be likely to persist long-term if high-yield farming was pursued and the land therefore not required for production was spared for natural habitats

Land sparing is potentially most beneficial for the restricted-range species most likely to be threatened in future

The potential benefits of land sparing relative to land sharing are not much affected by whether total production is greater or smaller than now

More work is needed to quantify and allow for abatement costs of key external environmental effects of farming, such as pollution

As yet, the benefits of land sparing are only theoretical: more work is needed to test the policy mechanisms capable of realising them