Table 1 Studies of bat responses to different levels of agricultural management intensity

Agricultural system	**Comparison / design[a]**	**Continent / country**	**Methods / responses surveyed (bats)**	**Outcome[b]**	**Other taxa**	**Reference**
Arable	*Organic vs non-organic*; Paired farms (n=65 pairs)	Europe (U.K.)	Acoustic detectors: Species richness, species evenness, activity (all bats)	Sample mean ratio comparing Organic / Non-organic: • Act: O > NO (1.35, 1.06 – 1.75) • SR: O > NO (1.33, 1.08 – 1.65) • Div: NO > O (0.84, 0.73-0.97)	Vascular plants; Arthropods (spiders, carabid beetles); Birds	Fuller et al. 2005
Arable/pasture farming	*Organic vs non-organic*; 4 habitat comparisons: water (n=8), woodland (n=10), pasture (n=21), arable (n=8); Paired farms (n=24)	Europe (U.K.)	Acoustic detectors: Species richness, activity,	• Act: O > NO (80% higher activity on organic farms; $p < 0.05$) • SR: n.s., although 3 species were only found on organic farms	Nocturnal insects (primarily Diptera and Lepidoptera)	Wickramsinghe et al. 2003, 2004
Arable	*Organic vs non-organic*; assessed effects of agrochemical inputs; silage/hay; boundary loss); Paired farms (n=21 pairs)	Europe (U.K.)	Acoustic detectors: Activity of 4 species / species groups	• Agrochemical inputs: 0/4 species/groups responded • Hay to silage: 0/4 species/groups responded • Boundary loss*: P. pipistrellus*, *P. pygmaeus*, *Myotis* spp. reduced activity away from field margins in both cereal crops (p = 0.094 - < 0.001) and grass fields (p = 0.003 - < 0.001); no change for *Nyctalus/Eptesicus* spp.	Shrews; Invertebrates (Coleoptera, Diptera, Lepidoptera - moths)	Pocock & Jennings 2008
Arable/pasture farming	*Organic vs non-organic (some within AES schemes);* Sample sizes vary according to species survey; n = 5-55.	Europe (U.K.)	Acoustic detectors: Activity of 6 species (*full dataset not currently available*)	• *P. pipistrellus*: n.s. • *P. pygmaeus*: O > NO for farms within AES; NO > O for farms not within AES (but n=5 for organic farms not within AES); • *N. noctula:* n.s. • *M. daubentonii*: O > NO (p=0.017) • *R. ferrumequinum*/*R. hipposideros*: n.s.	Arable plants, bryophytes, grassland fungi, selected birds, butterflies, brown hare, water vole	Macdonald et al. 2012a[c]
Olive groves	*Organic vs non-organic*; N=6 for each x 3 repeat surveys	Europe (Greece)	Acoustic detectors: Bat activity, species richness	• Act: O > NO (p = 0.065)	Nocturnal invertebrates	Davy et al. 2007
Arable/pasture farming	*Agri-environment scheme vs conventional*; 4 habitat comparisons: margins (n=15), hedgerows (n=13), water margins (n=17), species rich grassland (n=16); Paired farms (n=18 pairs)	Europe (U.K.)	Acoustic detectors : Activity of 2 species	• Act: C > AES (Activity at AES farms 50% & 38% lower of *P. pipistrellus* & *P. pygmaeus* respectively; $p < 0.05$)	Nocturnal invertebrates (primarily Diptera and Lepidoptera)	Fuentes-Montemayor et al. 2011a,b
Arable/pasture farming	*Agri-environment scheme vs conventional farms;* Paired farms n=40-60 pairs	Europe (U.K.)	Acoustic detectors: Activity of 6 species	Comparisons of activity per species: • *P. pipistrellus*: C>AES (n.s.) • *P. pygmaeus*: AES>C (n.s.)	Arable plants, bryophytes, grassland fungi,	Macdonald et al. 2012a[c]

	depending on survey type.			• *N. noctula*: C> AES (n.s.) • *M. daubentonii*: C=AES (n.s.) • *R. ferrumequinum*: C>AES (n.s.) • *R. hipposideros*: C>AES (n.s.)	selected birds, butterflies, brown hare, water vole	
Arable/pasture farming	*Agri-environment scheme;* permanent pasture without inputs; Paired fields (n=18).	Europe (U.K.)	Acoustic detectors: activity	• Act: AES > C (Total bat activity at AES fields 2.6x higher; n.s.)	Vascular plants, bumblebees, butterflies, foliar invertebrates	Macdonald et al. 2012b
Agroforestry, (coffee)	Various wooded habitats vs 2 levels of management intensity (low & high); n = 3-52 per treatment (total n=73)	Central America (Mexico)[d]	Trapping: abundance, species richness	Comparison of total captures (no statistical analysis): • Ab & SR: riparian forest > low coffee > high coffee > forest	-	Estrada & Coates-Estrada 2001
Agroforestry, (coffee, cacao) & citrus, alllspice	*Forest vs 2 levels of management intensity* (low & high) in two landscapes with contrasting matrices (low & high coffee management); n=3 per treatment in each landscape (total n=18)	South America (Colombia)	Trapping: species richness	High intensity matrix: • SR: forest > low coffee > high coffee Low intensity matrix: • SR: forest = low coffee = high coffee	-	Numa et al. 2005
Agroforestry, (coffee)	*Forest vs 5 levels of management intensity* (low to high); n=1 per treatment x ~ 16 repeat surveys[f]	Central America (Mexico)	Trapping: abundance & species richness, diversity	• Ab: all coffee treatments except low > forest > low coffee • SR: forest > coffee (all treatments similar) • Div: forest > coffee (all treatments similar)	-	Estrada et al. 2006
Agroforestry (cacao & banana) & plantain	*Forest vs 2 types of agroforestry vs plantain monoculture*; n=7-14 across 4 habitats (total n=35)	Central America (Costa Rica)	Trapping: abundance & species richness, diversity	• Ab: agroforestry = plantain > forest (n.s.) • SR: agroforestry > forest > plantain ($p < 0.05$)[e] • Div: agroforestry > forest > plantain ($p < 0.05$)[e]	Birds, trees	Harvey & González Villalobos 2007
Agroforestry, (coffee)	*Forest vs 3 levels of management intensity* (low, moderate and high-intensity management); n=11 per treatment (total n=44)	Central America (Mexico)	Trapping: abundance & species richness, evenness (family Phyllostomidae)	• Ab: low coffee > forest > medium coffee > high coffee ($p < 0.05$)[e] • SR: forest > low coffee > medium coffee > high coffee (n.s.) • Div: forest > low coffee > medium coffee > high coffee (diversity and evenness similar between all treatments but lower in high coffee)	-	Williams-Guillén & Perfecto 2010
Agroforestry, (coffee)	*Forest vs 3 levels of management intensity* (low, moderate and high-intensity management); n=11 per treatment (total n=44)	Central America (Mexico)	Acoustic detectors & trapping: activity, abundance & species richness, evenness (insectivorous bats)	• Act-forest bats: similar activity in forest, low & medium coffee; reduced in high coffee ($p < 0.05$) • Act-open space bats: very low activity in forest, low & medium coffee; slightly higher in high coffee ($p < 0.05$) • Ab-forest bats: forest + low coffee > medium + high coffee ($p = 0.079$) • SR: no difference between treatments. • Species composition: no difference between treatments.	-	Williams-Guillén & Perfecto 2011

Agroecosystem cultivation	*2 levels of coffee management intensity (low, medium) vs pasture;* n=3 per treatment x 8 repeat surveys.	North America (Mexico)	Trapping: abundance & species richness	• Ab: low coffee > medium coffee = pasture ($p < 0.05$) • SR: low coffee > medium coffee = pasture ($p < 0.05$)	-	Castro-Luna & Galindo-González 2012

[a] A variety of terms are used to describe the different levels of management intensity that coffee is produced under. For ease of interpretation here three levels have been used: low intensity (corresponding to the terms traditional polyculture, diversified coffee, polyspecific shade), medium (commercial polyculture, simple coffee, biodynamic) and high (monospecific shade with high chemical inputs, unshaded monoculture).

[b] Key to codes used: Act = bat activity (number of passes); SR = species richness; Div = diversity (Shannon's H index/evenness); O = organic; NO = non-organic; AES = agri-environment scheme; C = conventional farming; n.s. = non-significant.

[c] Whilst this extensive study did assess a variety of other taxa, these comparisons have not been included in Table 2 as there was relatively little overlap of sites where bat monitoring was conducted.

[d] Whilst geopolitically Mexico is wholly within North America geophysically, south of the Isthmus of Tehuantepec it is considered part of Central America; studies have been classed accordingly.

[e] No pairwise test statistics available.

[f] In this study there was some variation in sampling effort between treatments; forest and low management intensity had the highest number of mist net hours with the other treatments at 90-95% of this. Abundance data does not appear to be corrected for sampling effort.

[g] As measured by Sorenson's index of similarity.

Table 2 Comparison of bat responses with responses of other taxa to different levels of agricultural management intensity (the results of Pocock & Jennings 2008 are summarised in the text)

Comparator taxa	**Comparison**	**Response[a]**	**Bat response[a]**	**Association[b]**	**Response detail**	**Reference**
Vertebrates						
Birds	Organic vs non-organic arable	Ab SR Div	Ab SR Div	+++ ++ ++	• Response of birds was given separately for two winter surveys but are similar so amalgamated here; • Species richness and diversity of birds was similar between organic and conventional farms but abundance was significantly higher at organic farms.	Fuller et al. 2005
Birds	Agroforestry vs plantain monoculture	Ab SR Div	Ab SR Div	++ +++ +++	• Abundance, species richness and diversity (Shannon index) all higher at cacao and banana agroforestry systems than plantain monoculture. • Data also provided at the level of feeding guild but only totals used for comparisons here.	Harvey & Villalobos 2007
Terrestrial mammals	Agroforestry vs plantain monoculture	Ab SR	Ab SR	+++ +++	• Abundance and species richness higher at cacao and banana agroforestry systems than plantain monoculture.	Harvey et al. 2006; Harvey & Villalobos 2007
Invertebrates						
Lepidoptera (moths)	Organic vs non-organic arable	Ab	Act	+++	• Moth abundance higher on organic farms	Wickramsinghe et al. 2003, 2004
	AES vs conventional farms: - macromoths - micromoths	 Ab Ab	 Act Act	 --- ---	• Abundance of macro- and micro-moths was higher on AES farms than conventional.	Fuentes-Montemayor et al. 2011a,b
Lepidoptera (butterflies)	AES vs conventional pasture	Ab	Act	++	• Butterfly abundance 5x higher on AES pastures	Macdonald et al. 2012b
Hymenoptera	AES vs conventional pasture	Ab	Act	-	• Bumblebee abundance similar on AES & conventional pastures	Macdonald et al. 2012b
Hymenoptera	AES vs conventional pasture	Ab	Act	-	• Hymenoptera abundance very similar on AES & conventional pastures	Macdonald et al. 2012b
Coleoptera	AES vs conventional pasture	Ab	Act	-	• Carabid beetle activity-density very similar on AES & conventional pastures	Macdonald et al. 2012b
	Organic vs non-organic arable: - boundary, pre-harvest - boundary, post-harvest - crop, pre-harvest - crop, post-harvest	 Ab SR Div Ab SR Div Ab SR Div Ab	 Act SR Div Act SR Div Act SR Div Act	 ++ -- -- -- --- ++ +++ ++ -- ++	• Carabid species richness, dominance and abundance compared between organic and conventional farms within the crop and at the crop boundary, both pre- and post-harvest (12 comparisons in total); • Responses were mixed: 6/12 responses showed a trend towards higher species richness, abundance and lower dominance at organic farms compared to conventional, but were predominately non-significant.	Fuller et al. 2005

		SR Div	SR Div	++ --		
Coleoptera	Agroforestry vs plantain monoculture	Ab SR Div	Ab SR Div	--- +++ +++	• Species richness and diversity (Shannon index) of dung beetles higher at cacao and banana agroforestry systems than plantain monoculture; abundance higher in plantain systems.	Harvey et al. 2006; Harvey & Villalobos 2007
Diptera	AES vs conventional pasture	Ab	Act	+	• Diptera similar on AES & conventional pastures	Macdonald et al. 2012b
Heteroptera	AES vs conventional pasture	Ab	Act	+	• Heteroptera very similar on AES & conventional pastures	Macdonald et al. 2012b
Spiders	AES vs conventional pasture	Ab	Act	-	• Spiders very similar on AES & conventional pastures	Macdonald et al. 2012b
	Organic vs non-organic arable: - boundary, pre-harvest - boundary, post-harvest - crop, pre-harvest - crop, post-harvest	 Ab SR Div Ab SR Div Ab SR Div Ab SR Div	 Act SR Div Act SR Div Act SR Div Act SR Div	 ++ ++ ++ +++ ++ -- +++ +++ ++ ++ ++ ++	• Spider species richness, dominance and abundance compared between organic and conventional farms within the crop and at the crop boundary, both pre- and post-harvest; • With the exception of one comparison, trends were for higher species richness, abundance and lower dominance at organic farms compared to conventional;	Fuller et al. 2005
Combined invertebrate groupings	Organic vs non-organic arable	Ab SR	Act SR	+++ ++	• Insect abundance higher on organic farms (specifically pastural + water); family richness higher on organic farms.	Wickramsinghe et al. 2003, 2004
	AES vs conventional farms	Ab	Act	+++	• Insect abundance (excluding Lepidoptera) higher on conventional farms than AES.	Fuentes-Montemayor et al. 2011a,b
	Organic vs non-organic olive groves	Ab	Act	+	• Insect abundance did not differ between habitat types (figures not available)	Davy et al. 2007
Vascular plants	AES vs conventional pasture	%C	Act	+	• Plant % forb cover similar on AES & conventional pastures	Macdonald et al. 2012b
	Organic vs non-organic arable: - crop margin - field boundary - crop	 SR Ab SR Div Ab SR Div	 SR Act SR Div Act SR Div	 +++ ++ +++ ++ +++ +++ +++	• Plant species richness, dominance and abundance compared between organic and conventional farms at the crop margin, field boundary and within the crop. Abundance and dominance comparisons not available for crop margins.	Fuller et al. 2005

a. Codes for response metrics: Ab = abundance, Act = activity (bats only), Div = diversity metrics (e.g. dominance, Shannon's H index), SR = species richness, %C = percentage cover.

b. Codes for associations: these are based on the similarity of bat responses to those of other taxa: + both taxa respond in the same direction but are not statistically significant; ++ both taxa respond in the same direction and for one taxa the difference is significant; +++ both taxa respond in the same direction and both are significant; - taxa respond in different directions but neither difference is significant; - - taxa respond in different directions and for one taxa the difference is significant; --- taxa respond in different directions and both are significant.