Oikos

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Appendix 1

Additional tables and figures

Table A1. Types of harassment recorded.

Type of harassment	Description
Chase	Aggressor approaches victim aggressively, victim leaves, aggressor chases aerially
Supplant	Aggressor approaches victim aggressively and takes victim's place
Harassment	Aggressor approaches victim and behaves aggressively physically or vocally
Posturing	Aggressor approaches victim with caution, usually at a distance and "monitors" the presence of the victim, making its presence felt, rather than actively trying to evict the victim. This form of aggression was mostly recorded for *Manorina melanocephala* behaviour towards larger birds such as Australian ravens

Table A2. Landscape- and patch-scale predictors used in models.

Predictor	Expected impact on rates of foraging and harassment
Patch-scale features	
Total stems (Average no. of tree stems in a 20 × 20 m quadrat at each of three marker posts along the 200 m site transect in each patch)	Higher stem densities are likely to have greater resource abundance. *Manorina melanocephala* prefers sites with lower stem density (Howes et al. 2010). We expected patches with higher stem density to have higher rates of foraging and lower rates of harassment.
Patch area	Smaller patches have relatively more edge, are likely to experience greater biotic edge effects (Fischer and Lindenmayer 2007) and are likely to have less habitat diversity than larger patches (Saunders et al. 1991). Among biotic edge effects, patches with more edge support higher populations of aggresssive generalist species and *Manorina melanocephala* (Maron et al. 2013). We therefore expected more foraging and less harassment in larger patches. All our patches were within a narrow range (4–49 ha) so we did not expect a big effect.
Corrected perimeter to area ratio (CPA) $\text{CPA} = \frac{\text{Perimeter}}{\sqrt{\text{Area x } 4\pi}}$ Hence a circle has a CPA of 1 and all other shapes have a CPA >1	As with patch area above, patches with a higher CPA have relatively more edge so are likely to have a greater abundance of *Manorina melanocephala* and other aggressive generalist species. Hence, we expected more foraging and less harassment in patches with lower CPA.
Landscape-scale features	
Per cent woodland cover at 1000ha	Greater woodland cover is likely to provide better connectivity for small woodland birds (Fischer and Lindenmayer 2007) and *Manorina melanocephala* density is lower in landscapes with higher tree cover (Montague-Drake et al. 2011). We therefore expected more foraging and less harassment in patches with higher per cent woodland cover at 1000 ha.
Topographic wetness index (TWI)	TWI has been used as a measure of productivity (Montague-Drake et al. 2011). Higher productivity may support higher populations of small woodland birds but is also associated with higher *Manorina melanocephala* density (Montague-Drake et al. 2011). We therefore made no prediction about the influence of TWI on harassment and foraging.

Table A3. No. of harassment events suffered by each victim species (ascending order). An asterisk indicates small woodland birds.

Victim species	No. harassment events	% of total
CBr	1	0.4
CP	1	0.4
FTC	1	0.4
HS	1	0.4
M*	1	0.4
NNH	1	0.4
RW*	1	0.4
W*	1	0.4
WNH*	1	0.4
WTE	1	0.4
Mammal (Y F Antech	1	0.4
GST*	2	0.8
RWB*	2	0.8
WBW	2	0.8
AH	3	1.2
BFH	3	1.2
Mammal (fox)	3	1.2
NF	3	1.2
PC	3	1.2
SCC	3	1.2
SK	3	1.2
WW*	3	1.2
BTC*	4	1.6
R	4	1.6
RRP	5	2
G	6	2.4
GBB	6	2.4
PBB	6	2.4
St	6	2.4
CSp	7	2.8
LK	7	2.8
SuP	7	2.8
WPH*	10	4
WWC	10	4
NK	11	4.3
BF	12	4.7
AR	13	5.1
ER	13	5.1
AM	15	5.9
NM	16	6.3
BFCS	18	7.1

ML	18	7.1
StP*	18	7.1
Sum	253	100

Table A4. No. of harassment events conducted by each aggressor species (ascending order). An asterisk indicates small woodland birds.

Aggressor species	No. harassment events	% of total
BFH	1	0.4
CK	1	0.4
HS (exotic)	1	0.4
NK	1	0.4
PC	1	0.4
RF*	1	0.4
RW*	1	0.4
SK	1	0.4
St (exotic)	1	0.4
GBB	2	0.8
LK	2	0.8
WWC	2	0.8
AR	3	1.2
BFCS	3	1.2
SCC	3	1.2
AH	4	1.6
DB	4	1.6
G	5	2
ML	8	3.2
WW*	9	3.6
PBB	10	4
AM	18	7.1
WPH*	19	7.5
NM	152	60.1
Sum	253	100

Table A5. Glossary of species names (alphabetical by abbreviated name). An asterisk indicates small woodland birds.

Abbreviation	Common name	Scientific name
AH	Australian hobby	*Falco longipennis*
AM	Australian magpie	*Cracticus tibicen*
AR	Australian raven	*Corvus coronoides*
BF	Brown falcon	*Falco berigora*
BFCS	Black-faced cuckoo shrike	*Coracina novaehollandiae*
BFH	Blue-faced honeyeater	*Entomyzon cyanotis*
BTC*	Brown treecreeper	*Climacteris picumnus*
CBr	Common bronzewing	*Phaps chalcoptera*
CP	Crested pigeon	*Ocyphaps lophotes*
CK	Common koel	*Eudynamys scolopaceus*
CSp	Collared sparrowhawk	*Accipter cirrhocephalus*
D	Dollarbird	*Eurystomus orientalis*
ER	Eastern rosella	*Platycercus eximius*
FTC	Fan-tailed cuckoo	*Cacomantis flabelliformis*
G	Galah	*Cacatua roseicapilla*
GBB	Grey butcherbird	*Cracticus torquatus*
GST*	Grey shrike-thrush	*Colluricincla harmonica*
HS	House sparrow (exotic)	*Passer domesticus*
LK	Laughing kookaburra	*Dacelo novaeguineae*
M*	Mistletoebird	*Dichaeum hirundinaceum*
ML	Magpie lark	*Grallina cyanoleuca*
NF	Noisy friarbird	*Philemon corniculatus*
NK	Nankeen kestrel	*Falco cenchroides*
NM	Noisy miner	*Manorina melanocephala*
NNH	Nankeen night heron	*Nycticorax caledonicus*
PBB	Pied butcherbird	*Cracticus nigrogularis*
PC	Pied currawong	*Strepera graculina*
R	unidentified raptor	*NA*
RBE	Rainbow bee-eater	*Merops ornatus*
RCR*	Red-capped robin	*Petroica goodenovii*
RF*	Restless flycatcher	*Myiagra inquieta*
RRP	Red-rumped parrot	*Psephotus haematonotus*
RW*	Rufous whistler	*Pachycephala rufiventris*
RWB	Red wattlebird	*Anthochaera carunculata*
SCC	Sulphur-crested cockatoo	*Cacatua galerita*
SFW*	Superb fairy wren	*Malurus cyaneus*
SK	Sacred kingfisher	*Todiramphus sanctus*
St	Starling (exotic)	*Sturnus vulgaris*
StP*	Striated pardalote	*Pardalotus striatus*
StrTh*	Striated thornbill	*Acanthiza lineata*
SuP	Superb parrot	*Polytelis swainsonii*
W*	Weebill	*Smicrornis brevirostris*
WG*	Western gerygone	*Gerygone fusca*
WBW*	White-browed woodswallow	*Artamus superciliosus*
WNH*	White-naped honeyeater	*Melithreptus lunatus*

WPH*	White-plumed honeyeater	*Lichenostomus penicillatus*
WTE	Wedge-tailed eagle	*Aquila audax*
WTG*	White-throated gerygone	*Gerygone olivacea*
WW*	Willie wagtail	*Rhipidura leucophrys*
WWC	White-winged chough	*Corcorax melanorhamphos*
WWT*	White-winged triller	*Lalage tricolor*
YRTh*	Yellow-rumped thornbill	*Acanthiza chrysorrhoa*
YTh*	Yellow thornbill	*Acanthiza nana*
Mammals		
Y F Antech	Yellow-footed antechinus	*Antechinus flavipes*
Fox	European fox (exotic)	*Vulpes vulpes*

Harassment models

Table A6. Effect size and 95% confidence intervals for modelled effect of cull on harassment rates. Coefficient estimates represent the log of the relative change in expected harassment rate for a change from the reference level of the corresponding BACI variable (n = 256 surveys in 16 sites).

	Best harassment model, victims = small woodland bird species			Best harassment model, victims = all bird species		
Fixed effects	Coefficient estimate	Lower confidence interval	Upper confidence interval	Coefficient estimate	Lower confidence interval	Upper confidence interval
Intercept	-1.52	-2.42	-0.62	-0.01	-0.48	0.45
Treatment	-1.62	-3.11	-0.13	-0.65	-1.34	0.05
Phase	-0.98	-1.75	-0.21	0.10	-0.21	0.41
Treatment: Phase	0.98	-0.60	2.56	0.25	-0.27	0.77
Random effects (log scale)	**Variance**					
Farm	NA			4.84×10^{-8}		
Site	0.94			3.23×10^{-1}		

Table A7. Summary of candidate models to explain variation in harassment rates of small woodland birds, constrained by inclusion of BACI base model (treatment, phase, treatment:phase)

Model	No. of variables	AIC	ΔAIC
Base + area + total stems + TWI	6	213.52	0.69
Base + CPA	4	213.63	0.79
Base + area + TWI	5	214.19	1.36
Base + TWI	4	214.31	1.48
Base + CPA + FE-1000ha	6	214.66	1.83
Base + CPA +TWI	5	214.76	1.93
Base + area + CPA	5	214.76	1.93
Base + FE-1000ha	4	214.77	1.94
Base + TWI + total stems	5	214.77	1.94
Base	3	214.78	1.95
Base + FE-1000ha + total stems	5	214.81	1.97

Table A8. Summary of candidate models to explain variation in harassment rates for all victim species, constrained by inclusion of BACI base model (treatment, phase, treatment:phase).

Model	No. of variables	AIC	ΔAIC
Base + CPA + TWI	5	731.9	0.0
Base + TWI	4	732.0	0.1
Base + CPA + TWI + area	6	732.8	0.9
Base	3	733.4	1.5
Base + CPA + TWI + area + total stems	7	733.5	1.6
Base + CPA + TWI + total stems	6	733.7	1.8

Table A9. Effect size and 95% confidence intervals for modelled effect of cull on amount of harassment conducted by *Manorina melanocephala* on all victim species. Coefficient estimates represent the log of the relative change in expected amount of harassment by *Manorina melanocephala* for a change from the reference level of the corresponding explanatory variable.

Fixed effects	Coefficient estimate	Lower confidence interval	Upper confidence interval
Intercept	-0.44	-1.05	0.18
Treatment	-0.12	-0.98	0.74
Phase	-0.04	-0.59	0.52
Treatment: Phase	-0.22	-1.09	0.65
Random effects, variance			
Farm	0.09		
Site	0.34		

Foraging models

Table A10. Summary of candidate models to explain variation in foraging rates of small woodland birds, constrained by inclusion of BACI base model (treatment, phase, treatment:phase).

Model	No. of variables	AIC	ΔAIC
Base model + area + FE-1000ha + total stems	6	1096.84	0.00
Base model + area + total stems + TWI	6	1098.30	1.46
Base model + area + CPA + FE-1000ha + total stems	7	1098.54	1.70
Base model + area + FE-1000ha + total stems + TWI	7	1098.83	1.99

Table A11. Effect size and 95% confidence intervals for modelled effect of cull on foraging rate of small woodland birds. Coefficient estimates represent the log of the relative change in expected foraging rate for a change from the reference level of the corresponding BACI variable. For landscape and vegetation variables, the estimates represent the change in expected foraging rate for a unit change in the variable. (n = 256 surveys in 16 sites).

	Best forage model 1, (base model + area + forest extent at 1000 ha + total stems)			Best forage model 2 (base model + area + total stems + TWI)		
Fixed effects	Coefficient estimate	Lower confidence interval	Upper confidence interval	Coefficient estimate	Lower confidence interval	Upper confidence interval
Intercept	0.87	-0.06	1.81	1.59	0.46	0.69
Treatment	0.64	-0.32	1.61	0.50	0.50	-0.49
Phase	0.33	0.10	0.56	0.33	0.12	0.10
Area	-0.96	-1.57	-0.33	-1.12	0.36	-1.82
FE 1000ha	0.07	0.01	0.14	NA	NA	NA
Total stems	-0.19	-0.31	-0.07	-0.19	0.06	-0.32
TWI	NA	NA	NA	-0.34	0.20	-0.74
Treatment: Phase	0.66	0.34	0.98	0.66	0.16	0.34
Random effects	**Variance**					
Farm	2.66×10^{-8}			1.26×10^{-8}		
Site	6.80×10^{-1}			7.845×10^{-1}		

Table A12. Summary of candidate models to explain variation in foraging rates of small woodland birds (excluding striated pardalote), constrained by inclusion of BACI base model (treatment, phase, treatment:phase).

Model	No. of variables	AIC	ΔAIC
Base model + area + FE-1000ha + total stems	6	618.12	0.00
Base model + area + CPA + total stems + TWI	7	618.81	0.69
Base model + area + total stems + TWI	6	619.19	1.08
Base model + area + CPA + FE-1000ha + total stems	7	619.35	1.23
Base model + area + CPA + FE-1000ha + total stems + TWI	8	619.35	1.23
Base model + area + FE-1000ha + total stems + TWI	7	619.53	1.41

Table A13. Effect size and 95% confidence intervals for modelled effect of cull on foraging rate of small woodland birds, excluding commonest species (striated pardalote). Coefficient estimates represent the log of the relative change in expected foraging rate for a change from the reference level of the corresponding BACI variable. For landscape and vegetation variables, the estimates represent the change in expected foraging rate for a unit change in the variable. (n = 256 surveys in 16 sites).

	Best forage model 1 (base model + area + FE-1000ha + total stems)			Best forage model 2 (base model + area + total stems + TWI)		
Fixed effects	Coefficient estimate	Lower confidence interval	Upper confidence interval	Coefficient estimate	Lower confidence interval	Upper confidence interval
Intercept	-1.23	-3.29	0.82	0.84	-1.42	3.11
Treatment	-0.57	-2.29	1.15	-1.03	-2.98	0.91
Phase	-1.08	-3.12	0.96	0.14	-0.37	0.66
Area	-1.58	-3.13	-0.02	-2.58	-4.71	-0.46
FE 1000ha	0.19	0.05	0.34	NA	NA	NA
Total stems	-0.33	-0.66	0.00	-0.38	-0.77	0.01
TWI	NA	NA	NA	-1.08	-2.07	-0.09
Treatment: Phase	2.34	1.47	3.22	2.35	1.48	3.22
Random effects	**Variance**					
Farm	1.36			1.101		
Site	1.20			2.098		

Models of intensity of harassment

Table A14. Effect size and 95% confidence intervals for modelled effect of cull on duration of harassment conducted by *Manorina melanocephala* on all victim species. Coefficient estimates represent the log of the relative change in expected duration of harassment *M. melanocephala* for a change from the reference level of the corresponding explanatory variable.

Fixed effects	Coefficient estimate	Lower confidence interval	Upper confidence interval
Intercept	1.72	1.3476	2.0924
Treatment	0.04	-0.352	0.432
Phase	-0.27	-0.6228	0.0828
Treatment: phase	0.51	-0.0584	1.0784
Random effects, variance			
Farm	0.15		
Site	7.91×10^{-9}		

Table A15. Effect size and 95% confidence intervals for modelled effect of cull on group size of harassment conducted by *Manorina melanocephala* on all victim species. Coefficient estimates represent the log of the relative change in expected group size of harassment by *M. melanocephala* for a change from the reference level of the corresponding explanatory variable. Model output shown used a negative binomial distribution. Using a Poisson distribution did not change model AIC.

Fixed effects	Coefficient estimate	Lower confidence interval	Upper confidence interval
Intercept	-0.19	-0.48	0.10
Treatment	-0.30	-0.75	0.15
Phase	0.31	0.04	0.58
Treatment: phase	-0.10	-0.57	0.37
Random effects, variance			
Farm	2.91×10^{-9}		
Site	8.06×10^{-2}		

Table A16. Effect size and 95% confidence intervals for modelled effect of cull on intensity of harassment conducted by *Manorina melanocephala* on all victim species. Coefficient estimates represent the log of the relative change in expected intensity of harassment by *M. melanocephala* for a change from the reference level of the corresponding explanatory variable.

Fixed effects	Coefficient estimate	Lower confidence interval	Upper confidence interval
Intercept	2.08	1.53	2.63
Treatment	0.32	-0.28	0.94
Phase	-0.54	-0.52	0.42
Treatment: phase	-0.08	-0.88	0.72
Random effects, variance			
Farm	0.32		
Site	0.04		

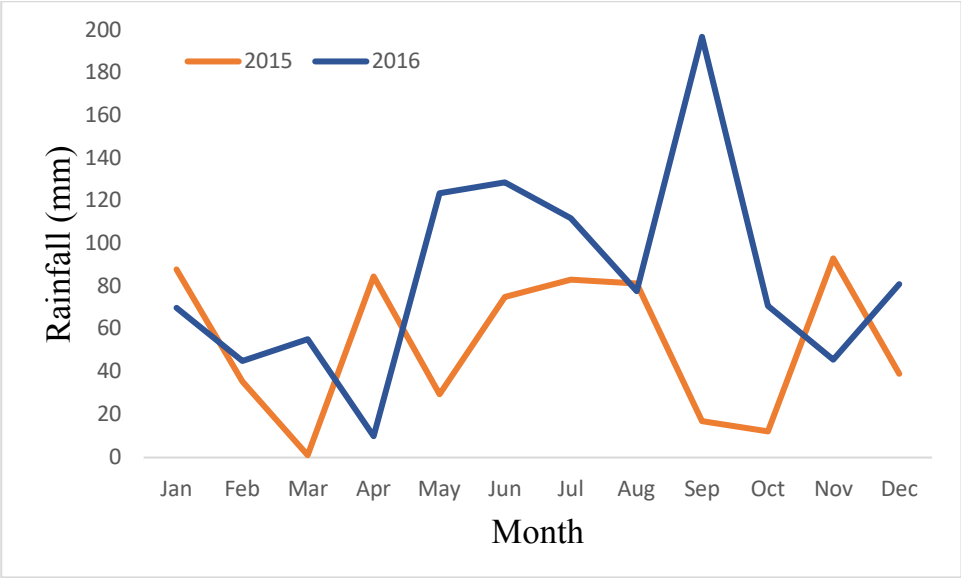

Figure A1. Regional rainfall during the period of the study (average monthly rainfall at Bureau of Metereology weather stations Mt Horeb and Old Junee, situated at the eastern and western ends of the study region respectively). The pre-cull monitoring period was October–December 2015; post-cull monitoring was done October–December 2016. The cull of *Manorina melanocephala* was completed May–June 2016.

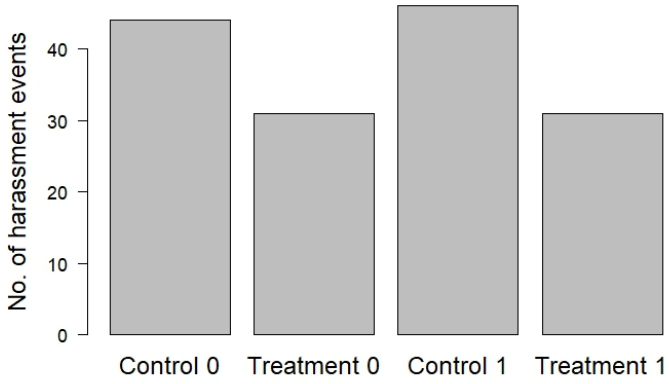

Figure A2. No. of harassment events conducted by *Manorina melanocephala* by treatment and phase (all victim species)

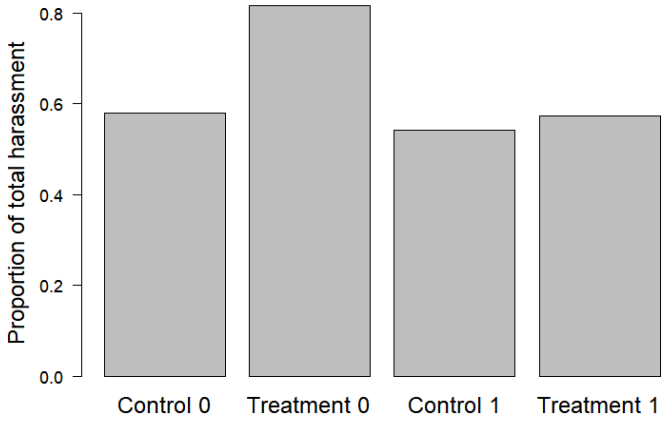

Figure A3. Proportion of total harassment events conducted by *Manorina melanocephala* by treatment and phase (all victim species)

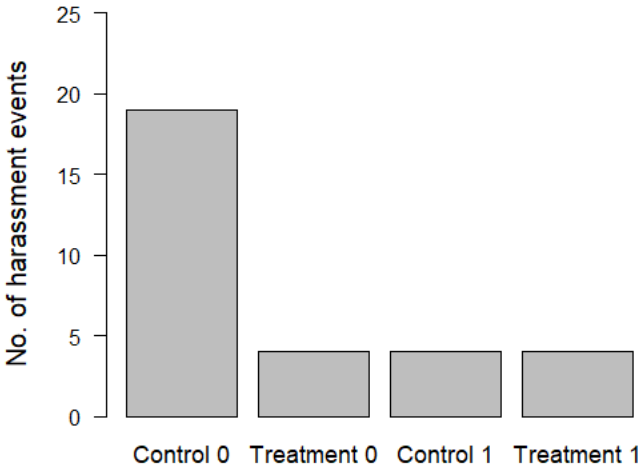

Figure A4. No. of harassment events conducted by *Manorina melanocephala* on small woodland birds by treatment and phase

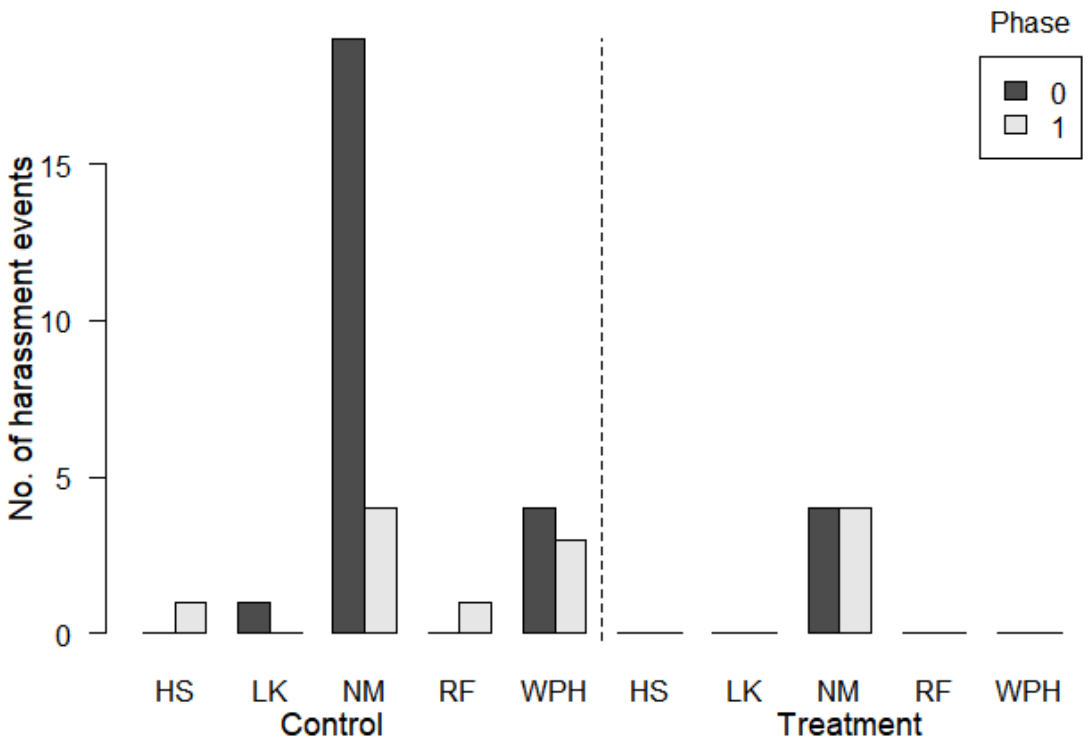

Figure A5. Harassment events of small woodland birds by aggressor species

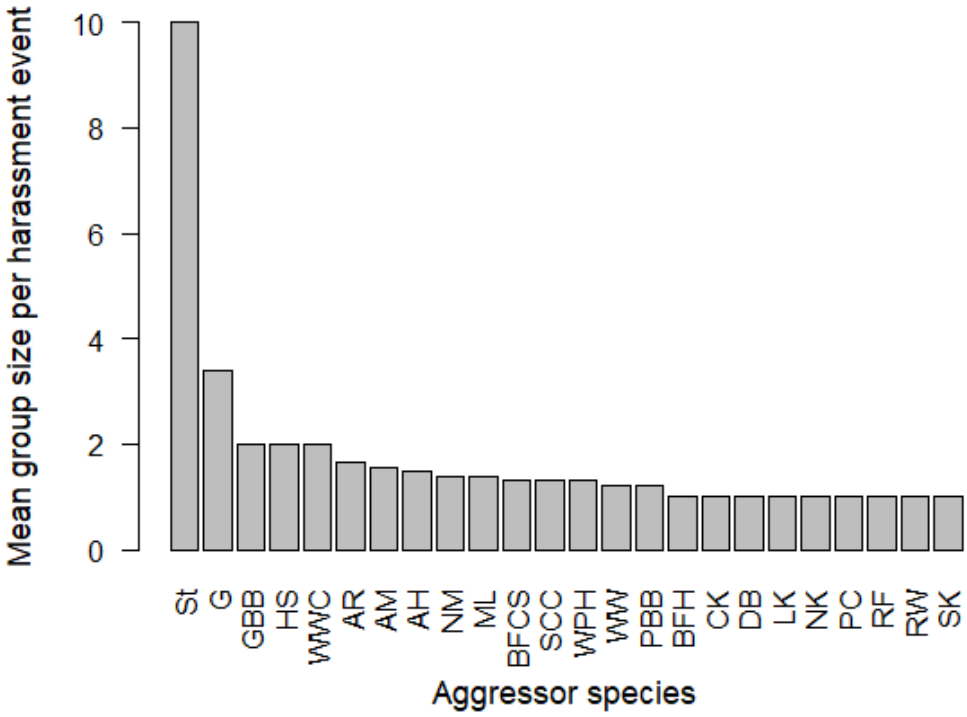

Figure A6. Mean group size of aggressors by species

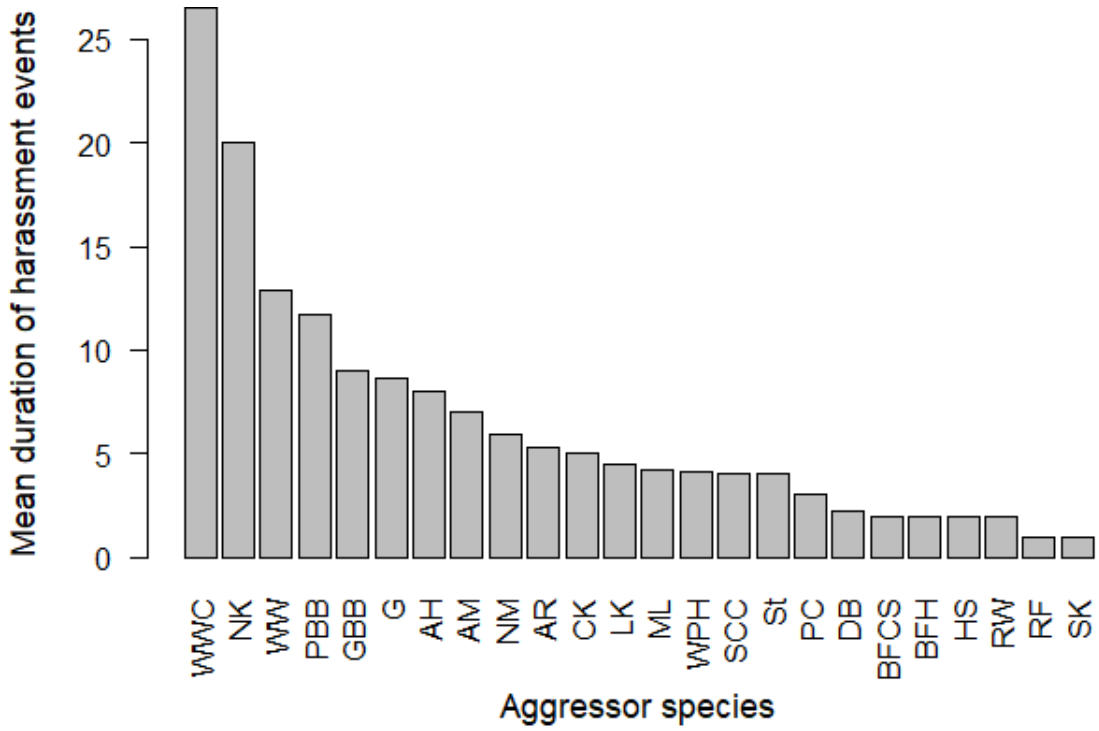

Figure A7. Mean duration of harassment events by aggressor species

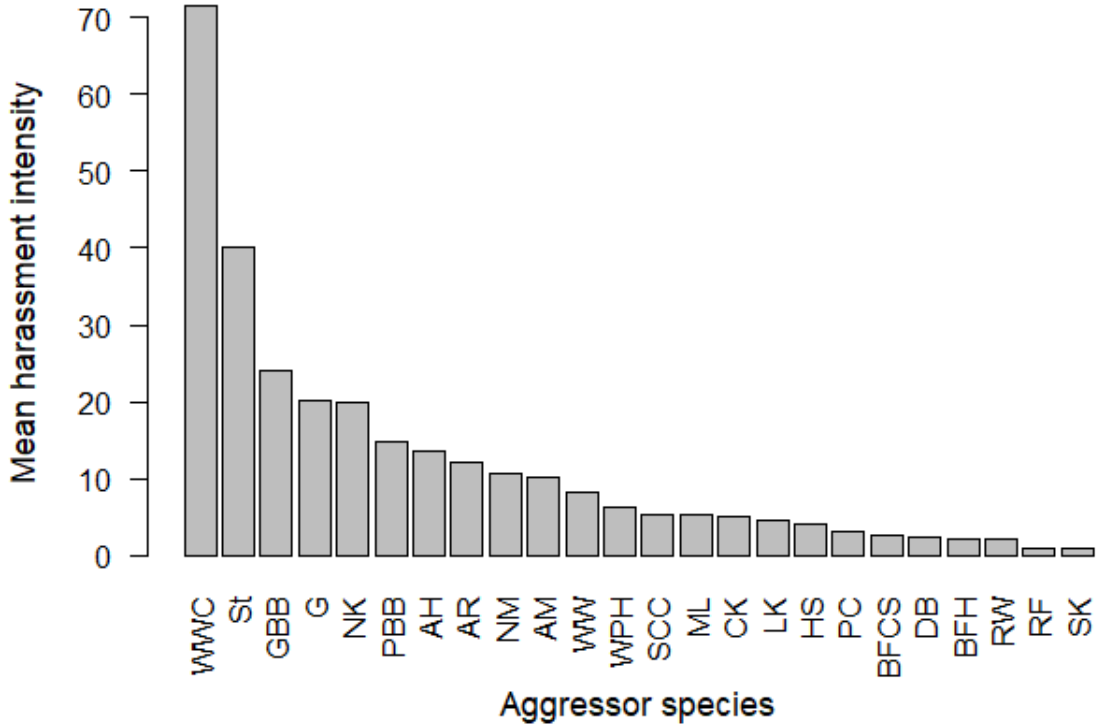

Figure A8. Mean harassment intensity by aggressor species