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Wildlife Research

Supplementary Material

Fighting the flames: site-specific effects determine species richness of Australian frogs after fire

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Supplementary Material

Table S1: Changes in species richness counts within sites (Grid ID) across Australia for DEA/NIAFI Hotspot data (19 sites). Species richness increased in some sites and decreased in others post-fire. Some sites did not change in species richness. Latitude and longitude of each site was based on a centroid within each grid. SR = species richness. N = number of samples used both before and after for each site.

Grid ID	Longitude	Latitude	SR before	SR after	SR change	N
34684	150.1935	-33.462	7	5	-2	24
318292	131.1111	-12.5304	10	8	-2	9
30874	150.0184	-33.834	5	4	-1	9
35681	150.1841	-33.373	4	3	-1	6
38240	150.3193	-33.1385	4	3	-1	7
171839	152.5155	-25.139	10	9	-1	14
14062	150.127	-35.8012	5	5	0	6
22581	150.2177	-34.6719	4	4	0	11
29991	115.666	-31.5574	3	3	0	7
33705	150.2562	-33.547	7	7	0	12
17667	150.4459	-35.2377	7	8	1	6
42037	150.1809	-32.8348	3	4	1	6
93294	152.3166	-29.484	3	4	1	6
14884	148.9638	-35.7497	2	4	2	13
15478	150.2104	-35.5703	6	8	2	5
37203	150.2229	-33.2355	5	7	2	11
90932	152.6352	-29.5901	12	14	2	11
15481	150.3738	-35.5576	5	10	5	6
98085	153.1931	-29.1379	6	13	7	11

Table S2: Changes in species richness counts within sites (Grid ID) across Australia for FESM data (26 sites) for which four corresponding levels of fire severity from FESM were attributed (low, moderate, high, extreme). Species richness increased in some sites and decreased in others post-fire. Some sites did not change in species richness. Latitude and longitude of each site was based on a centroid within each grid. SR = species richness. N = number of samples used both before and after for each site.

Severity	Grid ID	Longitude	Latitude	SR before	SR after	SR change	N
Moderate	598432	153.033	-29.0746	8	5	-3	6
High	296989	150.173	-33.4731	5	3	-2	10
High	444936	152.464	-31.2891	6	5	-1	5
Moderate	599067	153.043	-29.073	5	4	-1	8
Moderate	125026	148.6241	-35.946	4	4	0	5
Low	131507	150.172	-35.8279	11	11	0	138
Moderate	162591	150.358	-35.3846	5	5	0	7
Moderate	272881	150.0223	-33.8195	2	2	0	5
High	280517	150.3144	-33.7049	2	2	0	5
Moderate	291289	150.242	-33.5508	6	6	0	6
High	297624	150.188	-33.4679	4	4	0	13
High	135313	150.1974	-35.7731	4	5	1	5
Moderate	136581	150.1992	-35.7544	6	7	1	46
High	137212	150.161	-35.7522	4	5	1	15
Extreme	137736	148.9512	-35.7687	2	3	1	6
Low	212032	150.212	-34.6817	4	5	1	11
High	291923	150.242	-33.5505	6	7	1	6
High	590216	153.3086	-29.1836	4	5	1	5
High	135947	150.197	-35.7691	5	7	2	6
Low	156249	150.3363	-35.4765	6	8	2	8
Moderate	562253	152.642	-29.6074	12	14	2	11
Moderate	569297	153.3632	-29.4793	3	5	2	5
Moderate	313476	150.2062	-33.242	3	6	3	9
Extreme	411358	152.746	-31.7544	5	8	3	6
Moderate	178459	150.5478	-35.1498	5	10	5	5
Moderate	594007	153.175	-29.1379	6	13	7	11

Table S3: Percentage of presence records of frog species across sampling grids in areas burnt by **low severity** fires. Percentages were calculated per species by summing presence records across grids per each of the 10 random samples and dividing the mean of these sums by the number of grids (n=3 grids). The 36 species included are derived only from the sampling grids used to compare frog presence and richness before and after fire.

Species	**Before (%)**	**After (%)**
Adelotus brevis	0	0
Crinia parinsignifera	0	0
Crinia signifera	33.3	100
Crinia tinnula	0	0
Limnodynastes dumerilii	33.3	33.3
Limnodynastes peronii	66.7	76.7
Limnodynastes tasmaniensis	33.3	33.3
Limnodynastes terraereginae	0	0
Litoria caerulea	0	0
Litoria chloris	0	0
Litoria citropa	0	0
Litoria dentata	0	0
Litoria ewingii	33.3	0
Litoria fallax	66.7	60
Litoria gracilenta	0	0
Litoria jervisiensis	33.3	48.1
Litoria latopalmata	0	0
Litoria nudidigitus	0	0
Litoria peronii	66.7	60
Litoria phyllochroa	0	0
Litoria quiritatus	100	66.7
Litoria revelata	0	0
Litoria tyleri	66.7	56.7
Litoria verreauxii	33.3	100
Litoria wilcoxii	0	0
Mixophyes fasciolatus	0	0
Paracrinia haswelli	33.3	33.3
Platyplectrum ornatum	0	0
Pseudophryne bibronii	66.7	33.3
Pseudophryne coriacea	0	0
Pseudophryne dendyi	0	33.3
Rhinella marina	0	0
Uperoleia fusca	0	0
Uperoleia laevigata	0	0
Uperoleia rugosa	0	0
Uperoleia tyleri	33.3	33.3

Table S4: Percentage of presence records of frog species across sampling grids in areas burnt by **moderate severity** fires. Percentages were calculated per species by summing presence records across grids per each of the 10 random samples and dividing the mean of these sums by the number of grids (n=11 grids). The 36 species included are derived only from the sampling grids used to compare frog presence and richness before and after fire.

Species	**Before (%)**	**After (%)**
Adelotus brevis	16.4	0
Crinia parinsignifera	36.4	27.3
Crinia signifera	81.8	76.4
Crinia tinnula	0	0
Limnodynastes dumerilii	9.1	35.5
Limnodynastes peronii	49.1	61.8
Limnodynastes tasmaniensis	33.6	57.3
Limnodynastes terraereginae	0	9.1
Litoria caerulea	9.1	13.6
Litoria chloris	0	0
Litoria citropa	0	0
Litoria dentata	9.1	16.4
Litoria ewingii	0	0
Litoria fallax	31.8	36.4
Litoria gracilenta	9.1	10.1
Litoria jervisiensis	0	0
Litoria latopalmata	20.9	27.3
Litoria nudidigitus	9.1	9.1
Litoria peronii	63.6	57.3
Litoria phyllochroa	0	18.2
Litoria quiritatus	18.2	38.2
Litoria revelata	0	0
Litoria tyleri	27.3	32.7
Litoria verreauxii	45.5	44.5
Litoria wilcoxii	0	0
Mixophyes fasciolatus	9.1	15.5
Paracrinia haswelli	9.1	9.1
Platyplectrum ornatum	0	9.1
Pseudophryne bibronii	9.1	9.1
Pseudophryne coriacea	11.8	0
Pseudophryne dendyi	0	0
Rhinella marina	0	9.1
Uperoleia fusca	15.5	17.3
Uperoleia laevigata	18.2	20
Uperoleia rugosa	0	9.1
Uperoleia tyleri	0	9.1

Table S5: Percentage of presence records of frog species across sampling grids in areas burnt by **high severity** fires. Percentages were calculated per species by summing presence records across grids per each of the 10 random samples and dividing the mean of these sums by the number of grids (n=9 grids). The 36 species included are derived only from the sampling grids used to compare frog presence and richness before and after fire.

Species	Before (%)	After (%)
Adelotus brevis	11.1	11.1
Crinia parinsignifera	0	0
Crinia signifera	100	83.3
Crinia tinnula	11.1	11.1
Limnodynastes dumerilii	21.1	18.9
Limnodynastes peronii	66.7	75.6
Limnodynastes tasmaniensis	12.2	11.1
Limnodynastes terraereginae	11.1	11.1
Litoria caerulea	0	11.1
Litoria chloris	11.1	11.1
Litoria citropa	11.1	0
Litoria dentata	0	11.1
Litoria ewingii	11.1	0
Litoria fallax	33.3	40
Litoria gracilenta	0	11.1
Litoria jervisiensis	0	0
Litoria latopalmata	0	0
Litoria nudidigitus	0	0
Litoria peronii	30	41.1
Litoria phyllochroa	0	0
Litoria quiritatus	11.1	21.1
Litoria revelata	0	0
Litoria tyleri	11.1	14.8
Litoria verreauxii	44.4	25.6
Litoria wilcoxii	11.1	0
Mixophyes fasciolatus	0	0
Paracrinia haswelli	0	0
Platyplectrum ornatum	11.1	0
Pseudophryne bibronii	11.1	0
Pseudophryne coriacea	0	0
Pseudophryne dendyi	0	0
Rhinella marina	0	0
Uperoleia fusca	0	0
Uperoleia laevigata	11.1	11.1
Uperoleia rugosa	0	0
Uperoleia tyleri	0	11.1

Table S6: Percentage of presence records of frog species across sampling grids in areas burnt by **extreme severity** fires. Percentages were calculated per species by summing presence records across grids per each of the 10 random samples and dividing the mean of these sums by the number of grids (n=2 grids). The 36 species included are derived only from the sampling grids used to compare frog presence and richness before and after fire.

Species	Before (%)	After (%)
Adelotus brevis	0	0
Crinia parinsignifera	0	0
Crinia signifera	50	100
Crinia tinnula	0	0
Limnodynastes dumerilii	50	50
Limnodynastes peronii	50	50
Limnodynastes tasmaniensis	0	50
Limnodynastes terraereginae	0	0
Litoria caerulea	0	50
Litoria chloris	0	0
Litoria citropa	0	0
Litoria dentata	50	50
Litoria ewingii	0	0
Litoria fallax	50	50
Litoria gracilenta	0	50
Litoria jervisiensis	0	0
Litoria latopalmata	0	0
Litoria nudidigitus	0	0
Litoria peronii	0	0
Litoria phyllochroa	0	0
Litoria quiritatus	0	0
Litoria revelata	50	50
Litoria tyleri	50	50
Litoria verreauxii	0	50
Litoria wilcoxii	0	0
Mixophyes fasciolatus	0	0
Paracrinia haswelli	0	0
Platyplectrum ornatum	0	0
Pseudophryne bibronii	0	0
Pseudophryne coriacea	0	50
Pseudophryne dendyi	0	0
Rhinella marina	0	0
Uperoleia fusca	0	0
Uperoleia laevigata	0	0
Uperoleia rugosa	0	0
Uperoleia tyleri	0	0

Table S7: Percentage of presence records of frog ecological grouping (from Mahony et al. 2023) across sampling grids in areas burnt by severity of fires. Ecological grouping indicates breeding habitat (E=ephemeral pond, M=bog/soak, P=permanent water, S=stream associated, T=terrestrial breeder, and C= Cane Toad *Rhinella marina*, for which ecological groupings were not assigned in Mahony et al. 2023), Percentages were calculated per ecological grouping by summing presence records of each grouping across grids per each of the 10 random samples and dividing the mean of these sums by the number of grids in each severity level.

Ecological grouping	Severity	Before (%)	After (%)
E	Low	100	66.7
	Moderate	35.5	56.4
	High	22.2	32.2
	Extreme	50	50
E/P	Low	66.7	100
	Moderate	100	90.9
	High	100	83.3
	Extreme	50	100
M	Low	0	0
	Moderate	0	0
	High	0	0
	Extreme	0	0
P	Low	100	96.7
	Moderate	90.9	95.5
	High	100	93.3
	Extreme	100	85
S	Low	0	0
	Moderate	17.3	41.8
	High	22.2	0
	Extreme	0	0
S/P	Low	33.3	100
	Moderate	45.5	53.6
	High	55.6	36.7
	Extreme	0	50
T	Low	66.7	33.3
	Moderate	20.9	9.1
	High	11.1	0
	Extreme	0	50
T/E	Low	0	0
	Moderate	0	0
	High	0	0
	Extreme	0	0

C	Low	0	0
	Moderate	0	9.1
	High	0	0
	Extreme	0	0

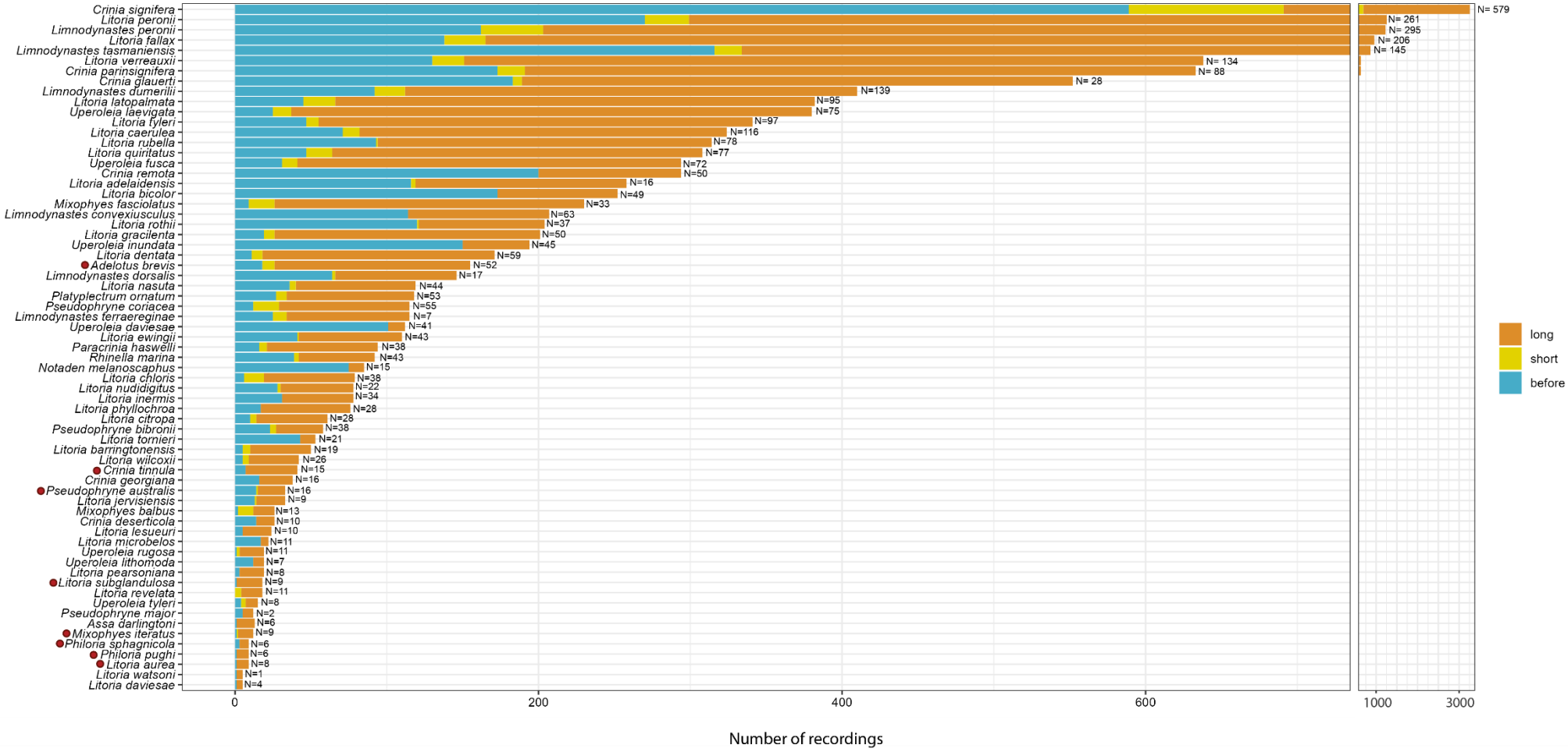

Figure S1: Well sampled frog species (n ≥ 5) calling before fire (blue), short-term after fire (yellow) and longer-term after fire (orange) for DEA Hotspot data. All species previously recorded with FrogID in burnt areas were found to be calling in the long-term. Note that some species (Notaden spp. Litoria adelaidensis, L. bicolor, Crinia glauerti) have low overlap with fire. Axis truncated due to large number of records for some species. N= unique number of sites.

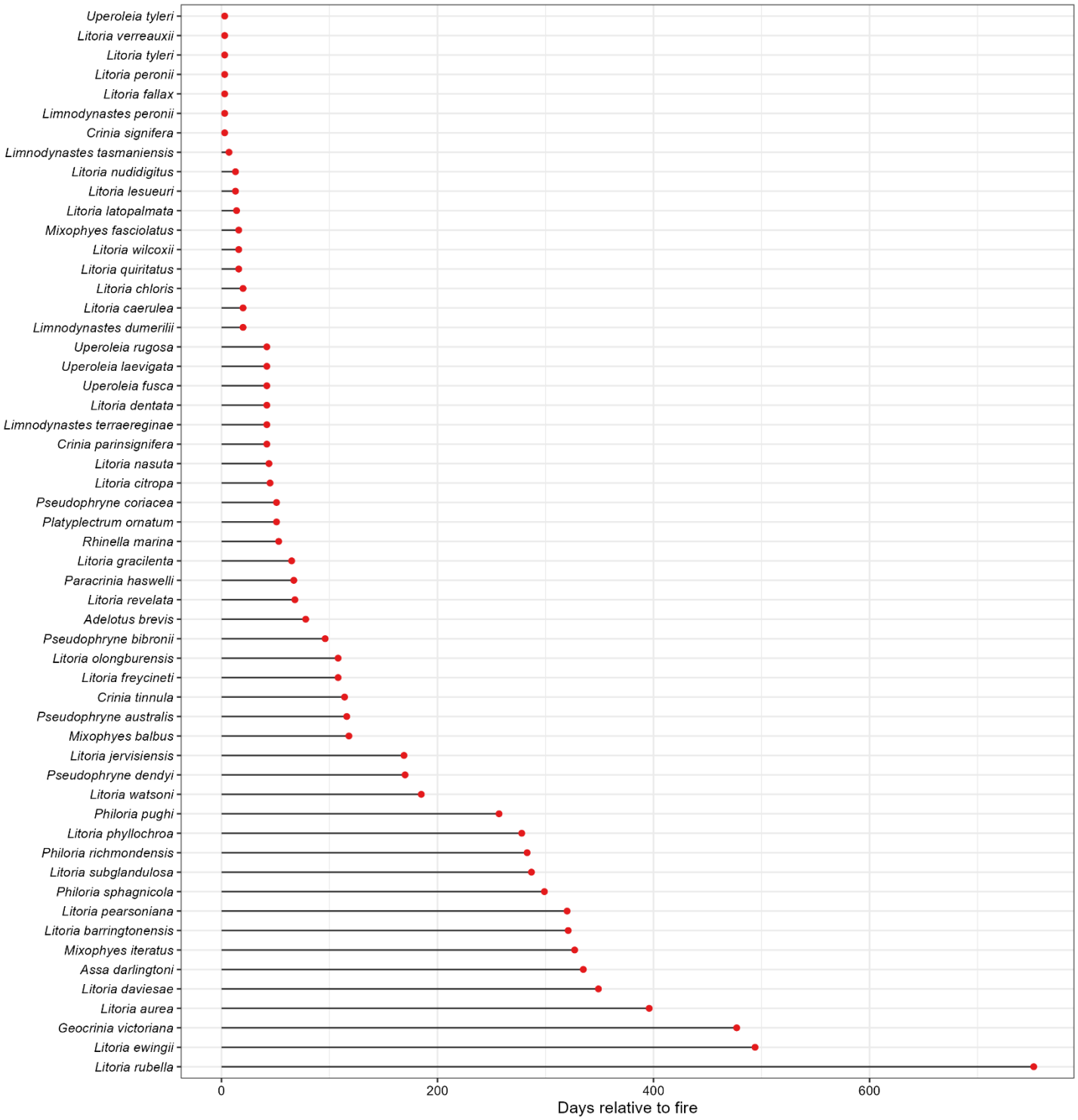

Figure S2: Minimum number of days for each species to start calling after fire. Only species recorded with FrogID and found in burnt areas are included. Approximately 58% of the frog species detected before fire were calling after three months, 72% after six months, 92% after 12 months, and 98% after 18 months, until all previously recorded with FrogID were calling by around two years post-fire. Data encompasses all species records from within burnt areas determined by New South Wales Fire Extent and Severity Mapping Data in the 2019/2020 megafires.

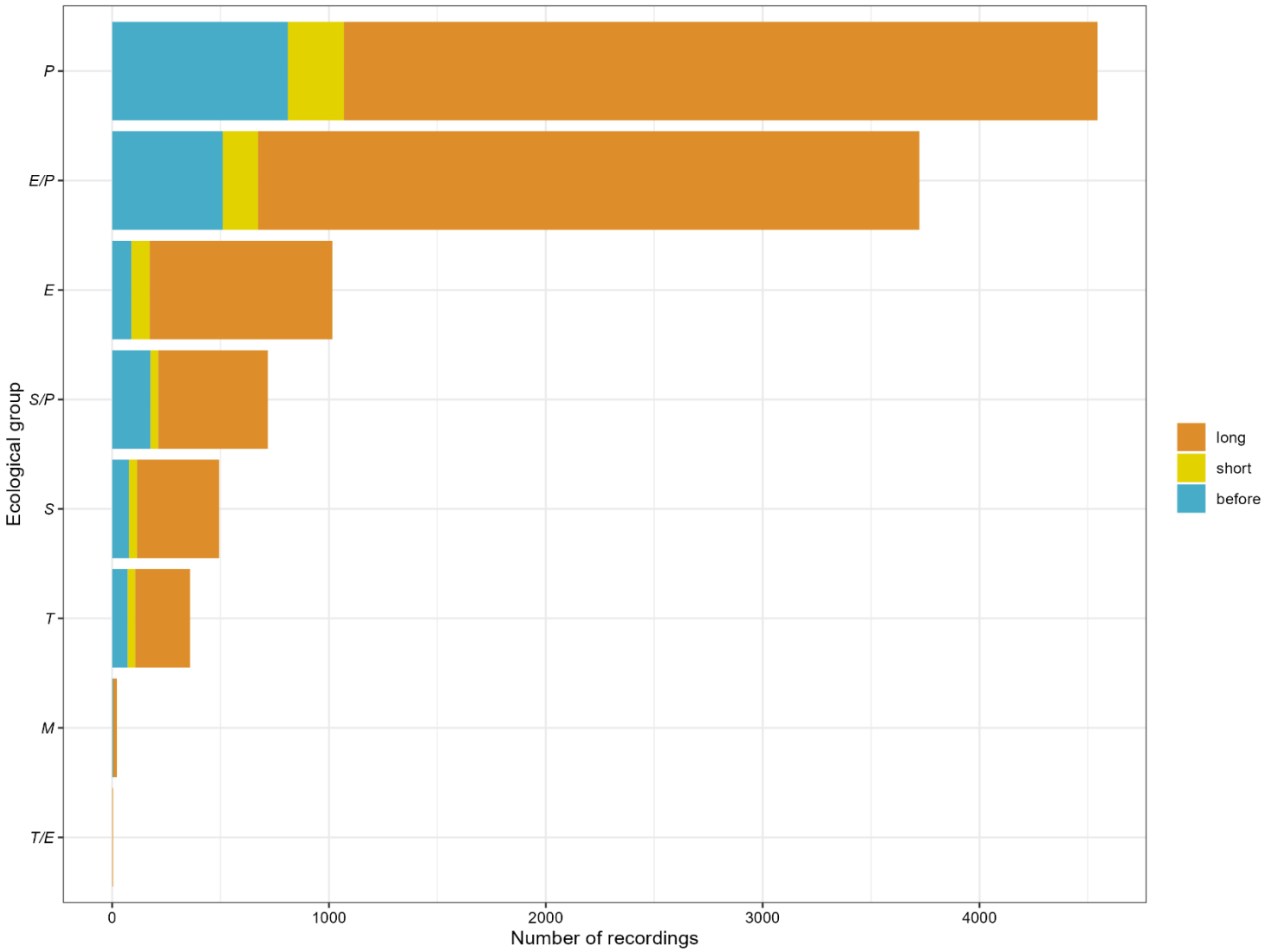

Figure S3: Well sampled frog species (n ≥ 5) calling before fire (blue), short-term after fire (yellow) and longer-term after fire (orange) by ecological group. T terrestrial breeders, E ephemeral pond, P permanent water mostly lentic (pond), S permanent stream associated (lotic), and M bog or soak, derived from Mahony et al. (2023).

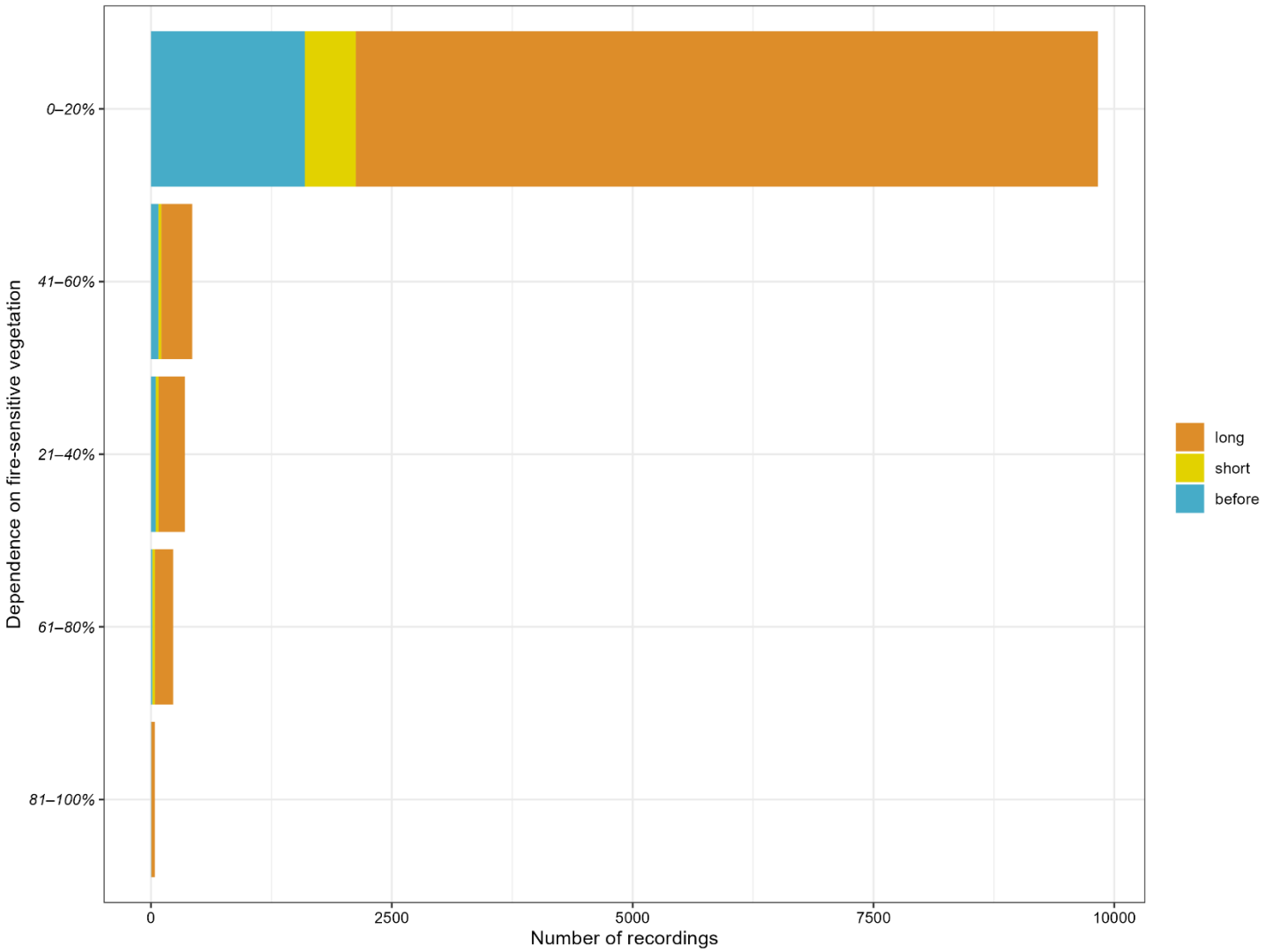

Figure S4: Well sampled frog species (n ≥ 5) calling before fire (blue), short-term after fire (yellow) and longer-term after fire (orange) split by their dependence on fire-sensitive vegetation (%), derived from Mahony et al. (2023).

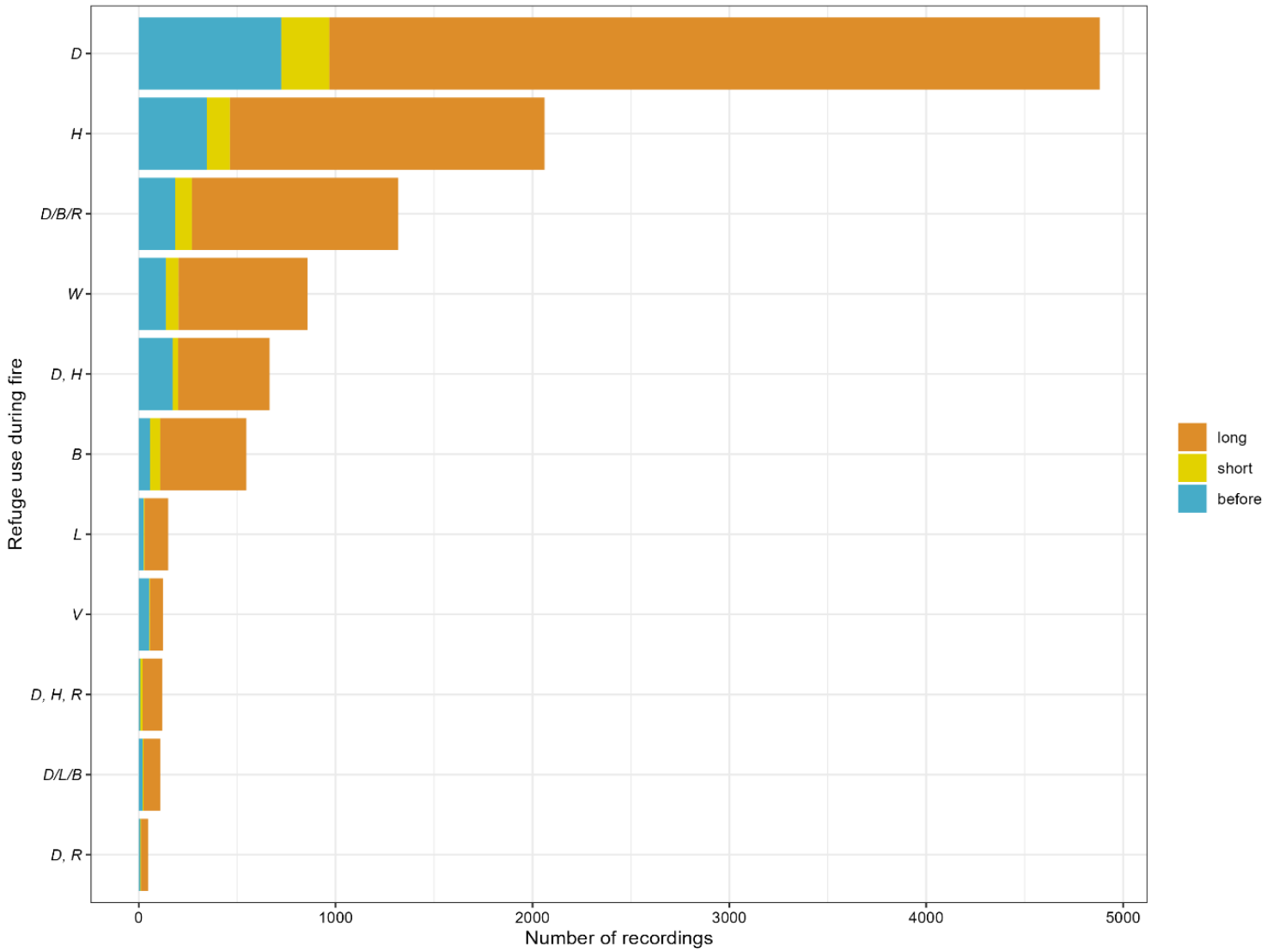

Figure S5: Well sampled frog species (n ≥ 5) calling before fire (blue), short-term after fire (yellow) and longer-term after fire (orange) by refugia used during fire. B burrow, H hollow, D under debris, R under rocks, L under leaf litter or topsoil, V dense riparian vegetation, and W wetland, derived from Mahony et al. (2023).