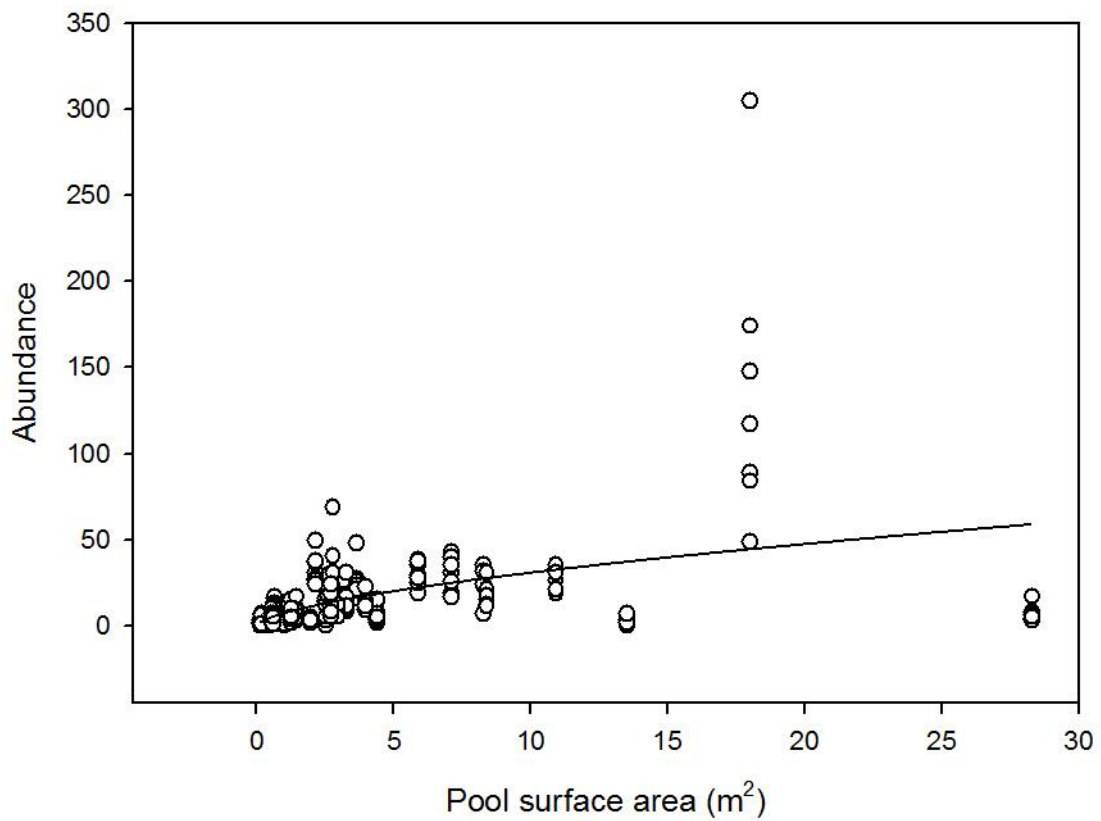
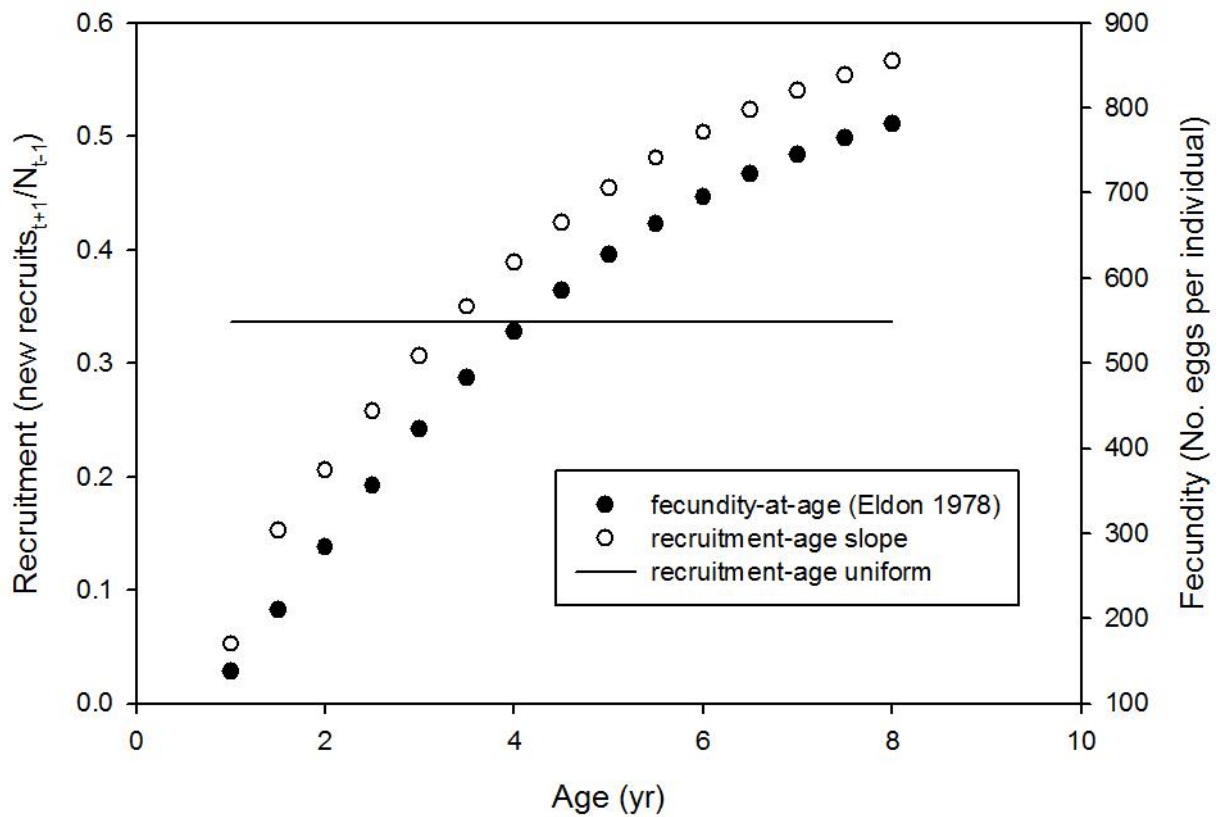


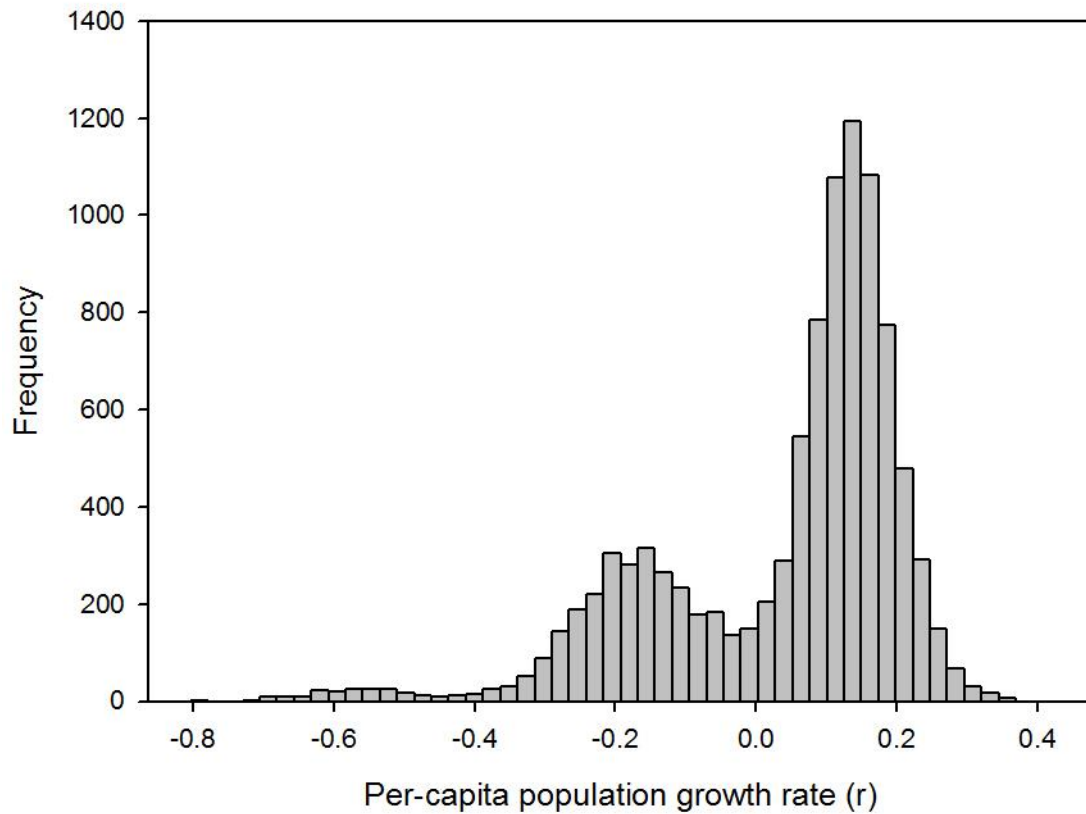
Supplementary Figure 1: Time series analysis of (a) rainfall deficit recorded near the study region at rainfall gauge 4054 between 1965 and 2013, and (b) the partial autocorrelation coefficients which describe the strength of autocorrelation between rainfall deficits at time t and $t+n$ (lag between time periods in years). Correlation coefficients above or below the dashed lines are significantly different from 0 at $\alpha = 0.05$.



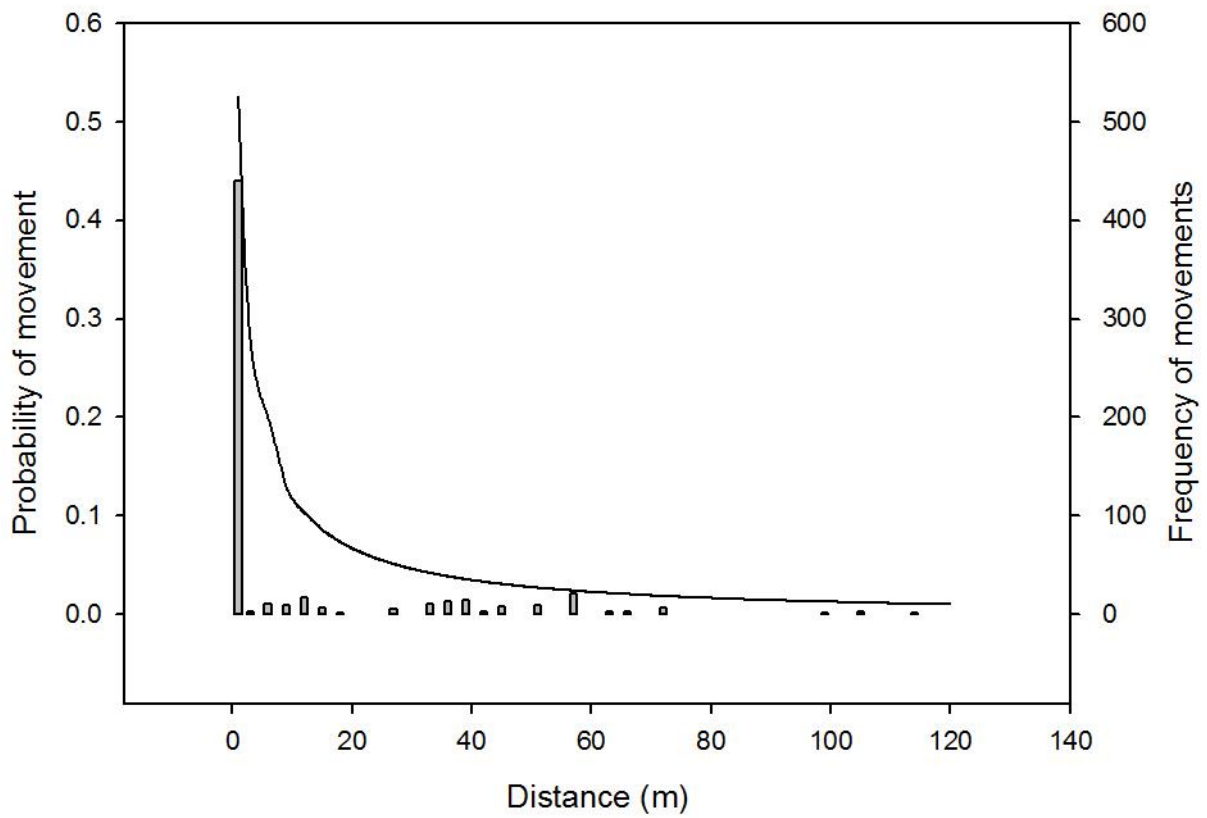
Supplementary Figure 2: Population abundance of *N. apoda* in South Westland forest pools, as a function of pool surface area. The line is fitted from a quasipoisson generalised linear model of the relationship when pool surface area is \log_e transformed according to the equation $N=1.99+0.62\times\log_e(\text{pool surface area})$, which explained 43 percent of the deviance in abundance.



Supplementary Figure 3: *N. apoda* recruitment and fecundity as a function of age. Filled circles show fecundity (right y-axis) according to the equation $0.011 \cdot \text{length}^{2.2}$ presented by Eldon (1978). Length was converted to age for display purposes using the length-age relationship in Eldon (1978). The fecundity equation was used to constrain recruitment for different ages (open circles), while holding mean recruitment across ages at 0.37, which was equivalent to that used in the final metapopulation model that used uniform recruitment across ages (solid line). This enabled us to compare results from a metapopulation model with uniform recruitment, to that with a positive recruitment-age relationship, while holding mean recruitment constant.



Supplementary Figure 4: An example of per-capita growth rates resulting from a sample of 10000 independent projection matrices taken for a particular sub-population. The tri-model distribution reflects the frequency of low, moderate and extreme drought matrices (right, centre and left modes, respectively), each of which have vital rates with a different mean \pm SD, depending on pool depth during a particular drought as shown in Fig 2c in-text.



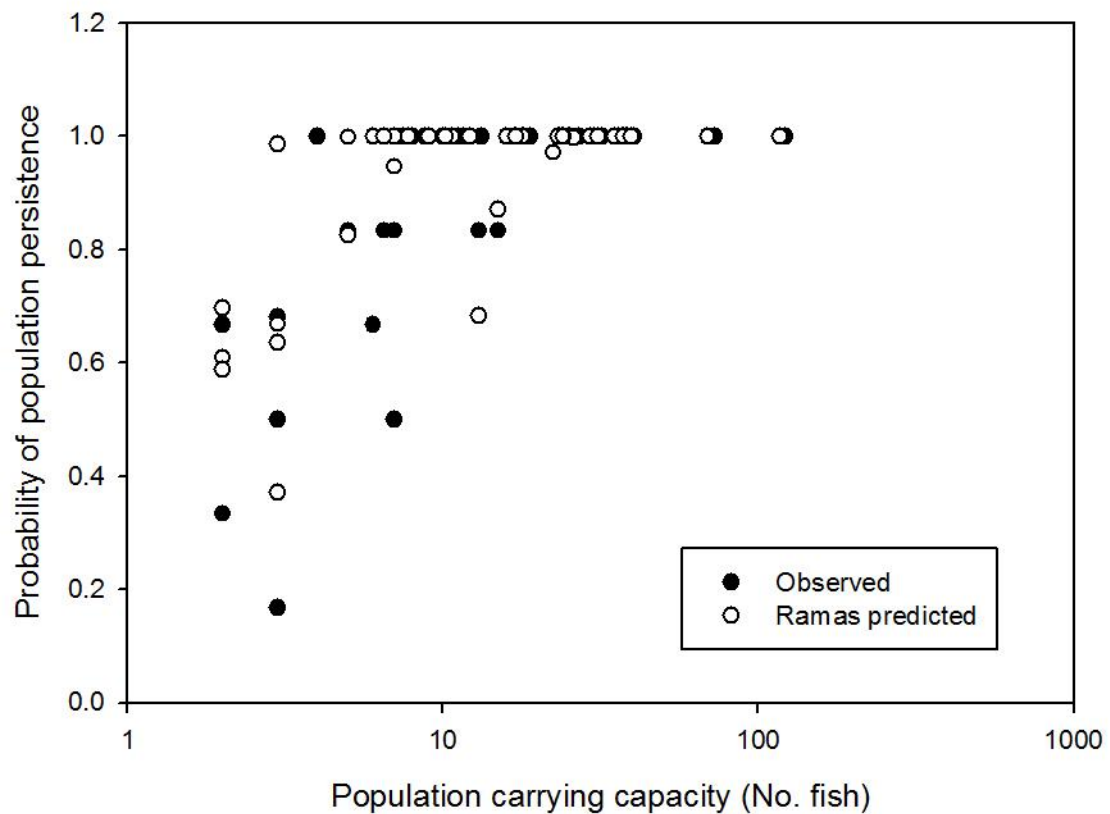
Supplementary Figure 5: Frequency of observed mudfish movements between pools of certain inter-pool distances during the mark-recapture study (bars), and the fitted Kitchings Dispersal Kernel (line) indicating the relationship between distance and probability of movement.

Supplementary Table 1: Differences in parameters used in the final metapopulation model relative to that used for model training and validation. The final metapopulation model used parameters estimated using the full duration mark-recapture dataset, whereas model training for validation was limited to the first 1.5 years of mark-recapture to ensure an independent validation. Survival parameters were estimated using the Cormack-Jolly-Seber model reported by White *et al* (2016), which was fitted using data restricted to the first 1.5 years, and thus did not require temporal splitting to ensure independent validation.

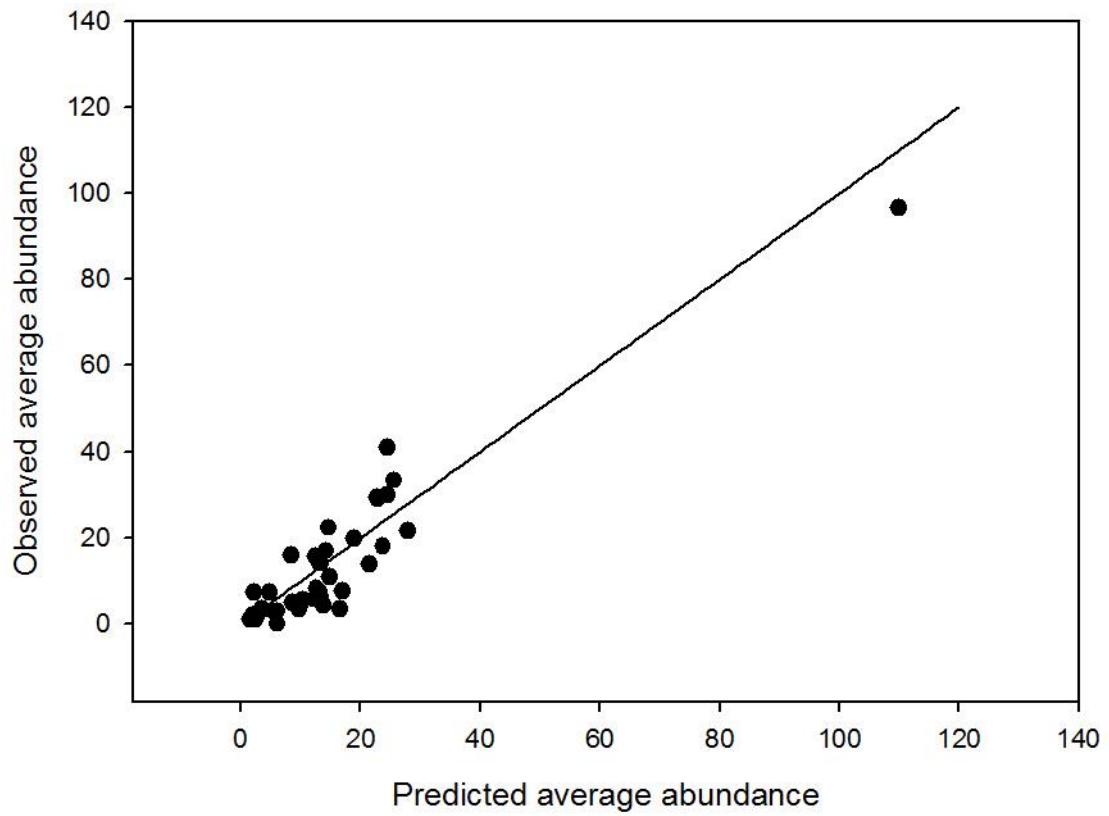
Parameter	Full duration		First 1.5 years	
	Mean	SD/range	Mean	SD/range
Low drought recruitment	0.37	0.06	0.41	0.06
Moderate drought recruitment	0.13	0.02	0.11	0.02
Extreme drought recruitment	0.13	0.01	0.13	0.02
Total metapopulation size	596	97	635	32
Sub-population carrying capacity	25	1-305	23	1-305
Dispersal events	97	3-112m	22	3-72m
Dispersal kernel equation	$y=9.68 \times e^{-D^{0.18}/0.10}$		$y=10.00 \times e^{-D^{0.18}/0.10}$	

Supplementary Table 2: Sensitivity of slope parameters of the relationship between population size and persistence to adjustments in vital rates and model structural parameters. Percent slope change refers to the change in the slope after parameter adjustment relative to that in the final model (which was 7.49) parameterised by mean values and structured as described and shown in Supplementary Figs 8-9. *P*-values of the interaction between environmental stochasticity and carrying capacity (ES-K interaction) after parameter modifications are also shown along with *c* values for the population with the highest environmental stochasticity, where *c* is the average rate of population growth relative to its variance resulting from environmental stochasticity.

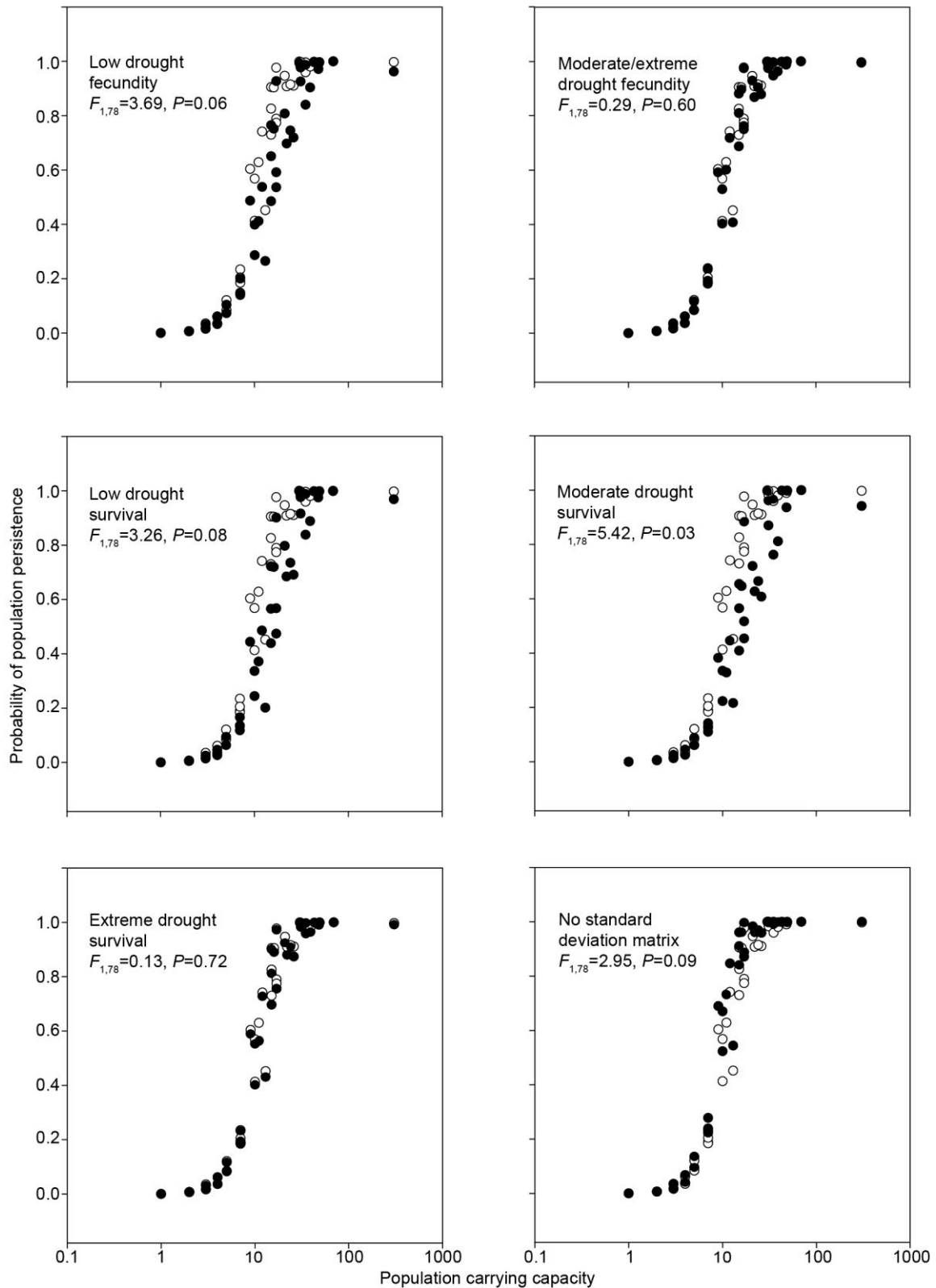
Parameter	Final model	Parameter adjustment	% slope change	P-Value ES-K interaction	Minimum <i>C</i>
<i>Vital rates</i>	<i>Mean</i>	<i>Lower 95% CI</i>			
Low drought recruitment	0.37	0.29	-23	<0.001	1.37
Mod/extreme drought recruitment	0.13	0.11	-5	<0.001	2.11
Low drought survival	0.99	0.95	-21	<0.001	1.45
Moderate drought survival	0.90	0.82	-28	<0.001	1.18
Extreme drought survival	0.82	0.79	-4	<0.001	2.38
<i>Structural settings</i>	<i>Description</i>				
Standard deviation matrix	on	off	+16	<0.001	3.53
Population carrying capacity	max N	95 th quantile	+4	<0.001	2.53
Time varying carrying capacity	max N	Max N±SD	+8	<0.001	NA
Fecundity-at-age slope	uniform	positive	+19	<0.001	1.53
Moderate drought probability	0.27	0.34	-17	<0.001	1.51
Extreme drought probability	0.02	0.03	-8	<0.001	2.22



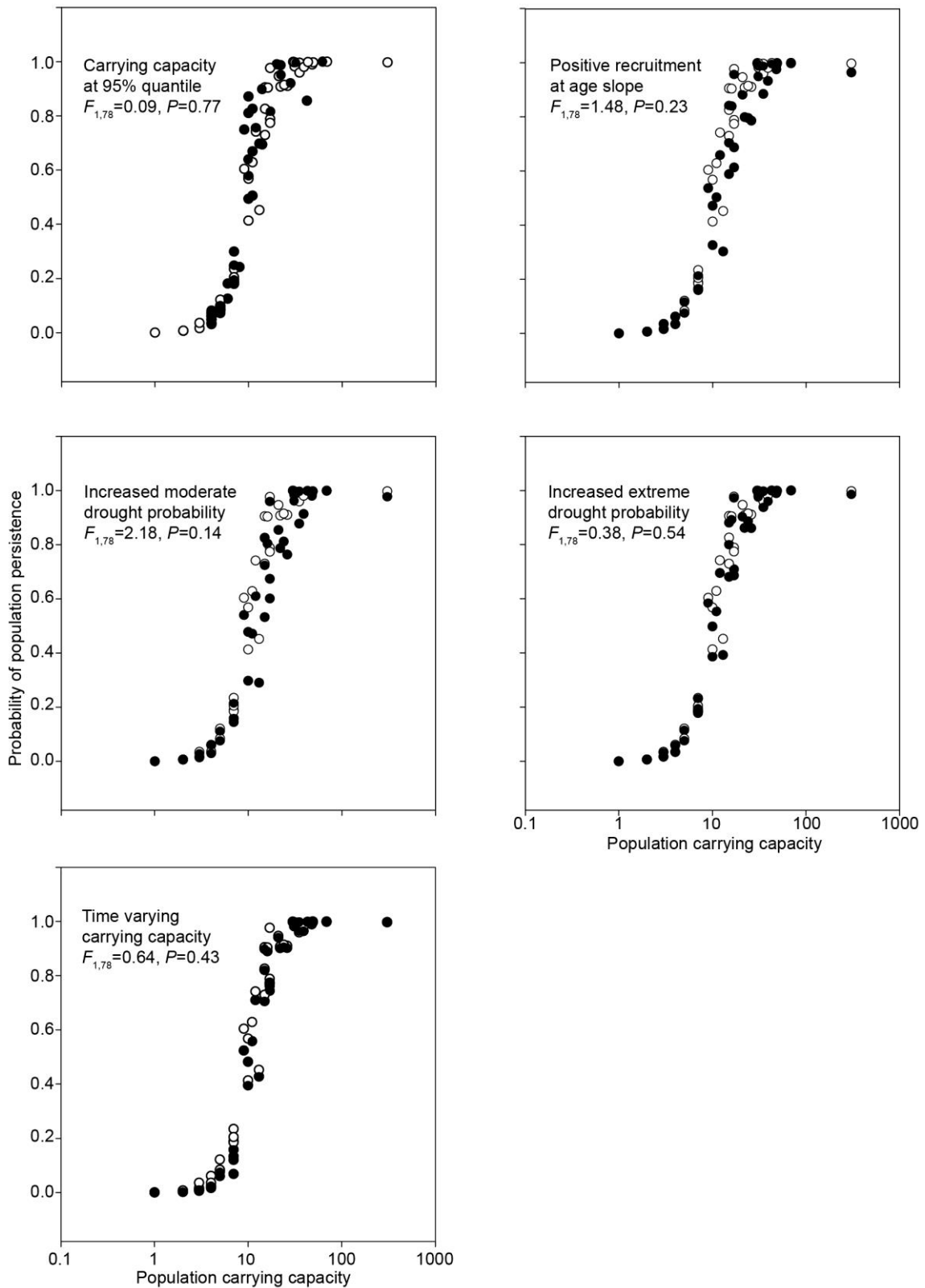
Supplementary Figure 6: Relationship between the probability of population persistence and population carrying capacity for populations of *N. apoda* in forest pools. Filled circles show observed values, where persistence is calculated as the proportion of sampling occasion's fish were present in pools during the final 1.5 years of the mark-recapture study. Open circles show values predicted by the metapopulation matrix model, whereby persistence is the average proportion of time steps fish are present in a pool.



Supplementary Figure 7: The relationship between observed average abundance during the final 1.5 years of mark-recapture, and that predicted by the metapopulation matrix model for populations of *N. apoda* in forest pools. The solid line shows the 1:1 relationship.



Supplementary Figure 8: Relationship between population persistence and carrying capacity predicted by the final metapopulation (open circles) and after modification to specific vital rates (closed circles). Each respective vital rate has been reduced to the lower confidence interval reported in Table A1. “No standard deviation matrix” refers to model predictions after the standard deviation matrix is removed (closed circles). Differences in slopes between datasets in each panel can be seen in Table A1 for which F-ratios and P-values are shown in-figure.



Supplementary Figure 9: Relationship between population persistence and carrying capacity predicted by the final metapopulation (open circles) and after modification to model structural parameters (closed circles). Each parameter has been adjusted according to the description in Table A1 where statistics on differences between datasets in each panel can also be seen. Differences in slopes between datasets in each panel can be seen in Table A1 for which F-ratios and P-values are shown in-figure.

