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Wildlife Research

Supplementary Material

Demographic estimates to assess the translocation of a threatened New Zealand amphibian

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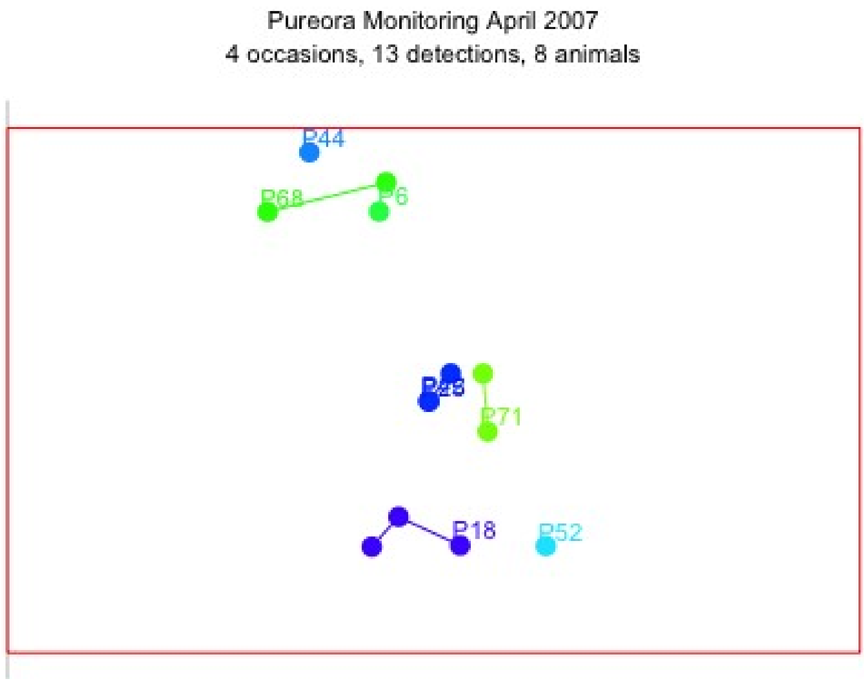
Supporting information

Appendix S1: Plot of detection (capture) histories for *Leiopelma archeyi* frog during monitoring on Pureora Forest, New Zealand, between April 2007 and November 2020, and histogram of frog individual movements within each monitoring session.

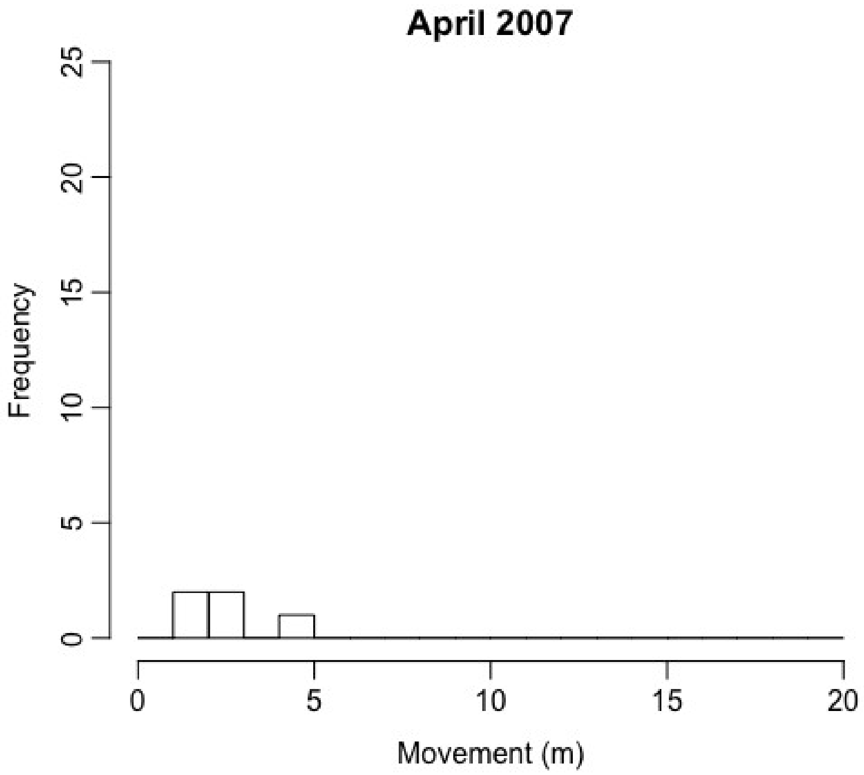
Session 1: April 2007

Monitoring dates (mean relative humidity during sampling):
April 16th (100%), 17th (96%), 18th (88%) and 30th (96.2%)
Search area: c. 400 m^2

- Plot of frog captures:



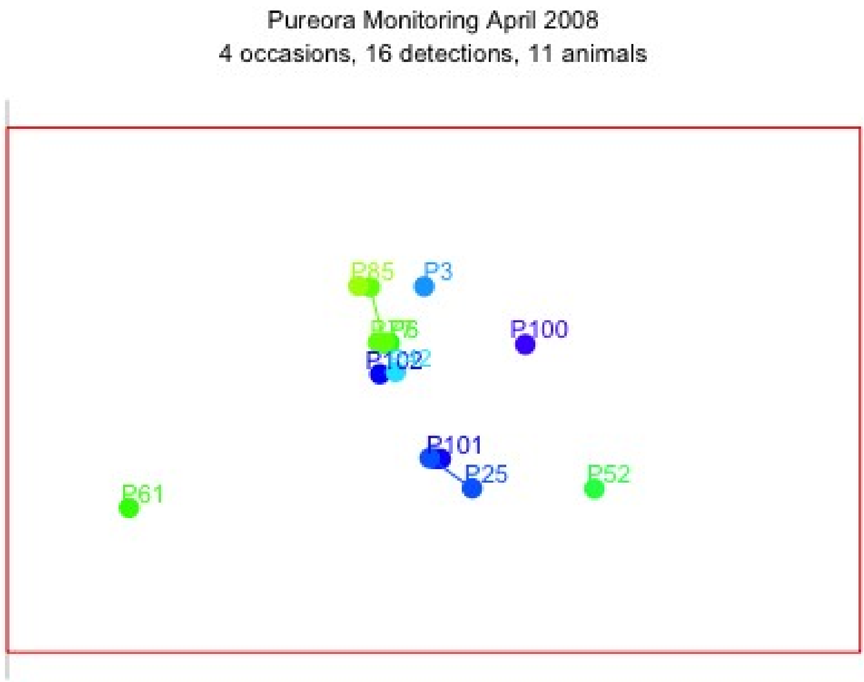
- Histogram of frog individual movements within the monitoring session



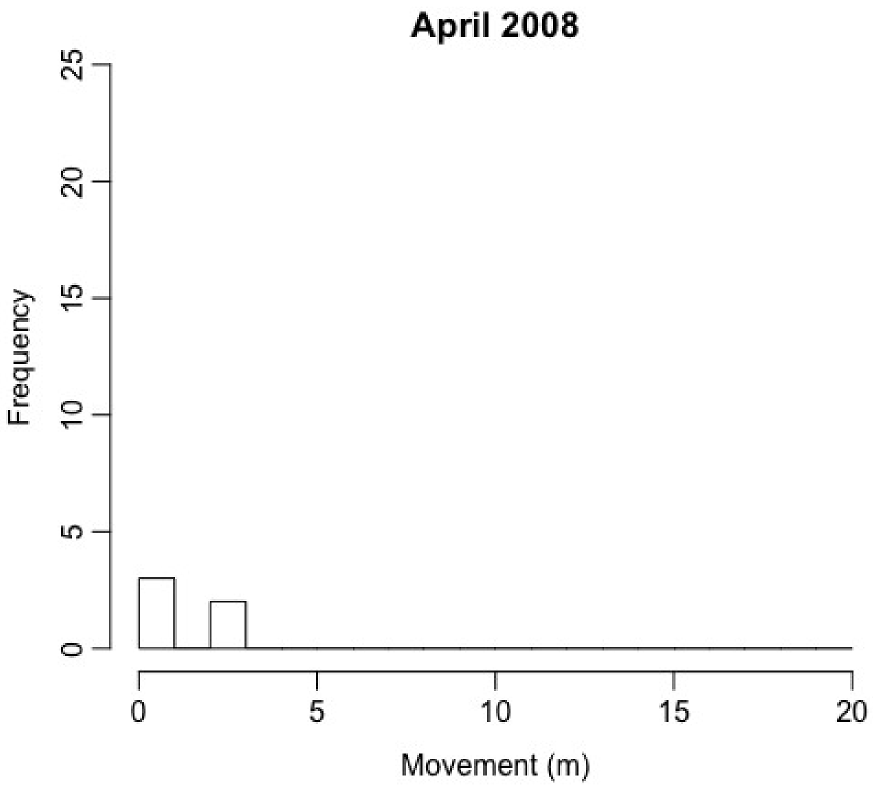
Session 2: April 2008

Monitoring dates (mean relative humidity during sampling):
March 31st (100%), April 1st (100%), 2nd (96.6%) and 3rd (100%)
Search area: c. 400 m^2

- Plot of frog captures:



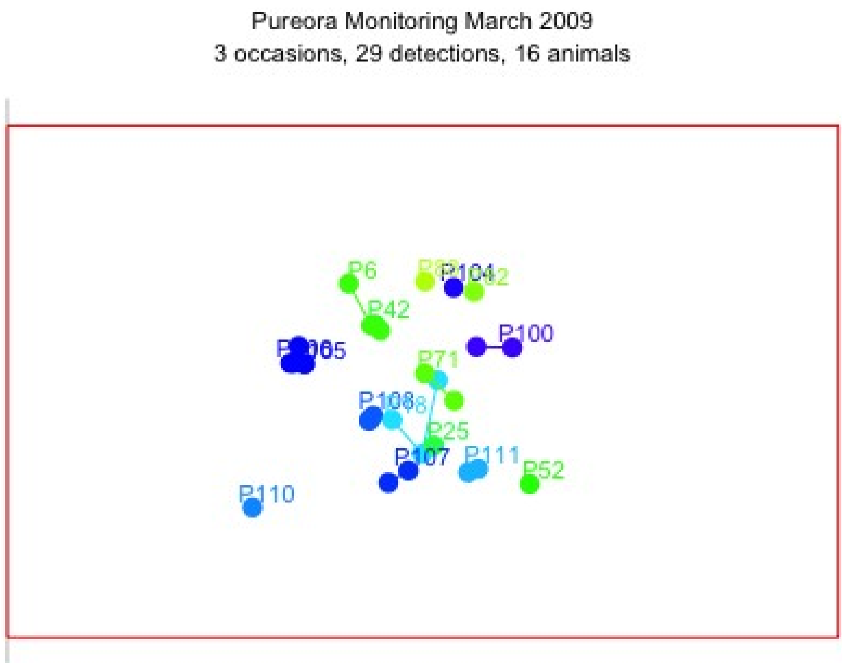
- Histogram of frog individual movements within the monitoring session



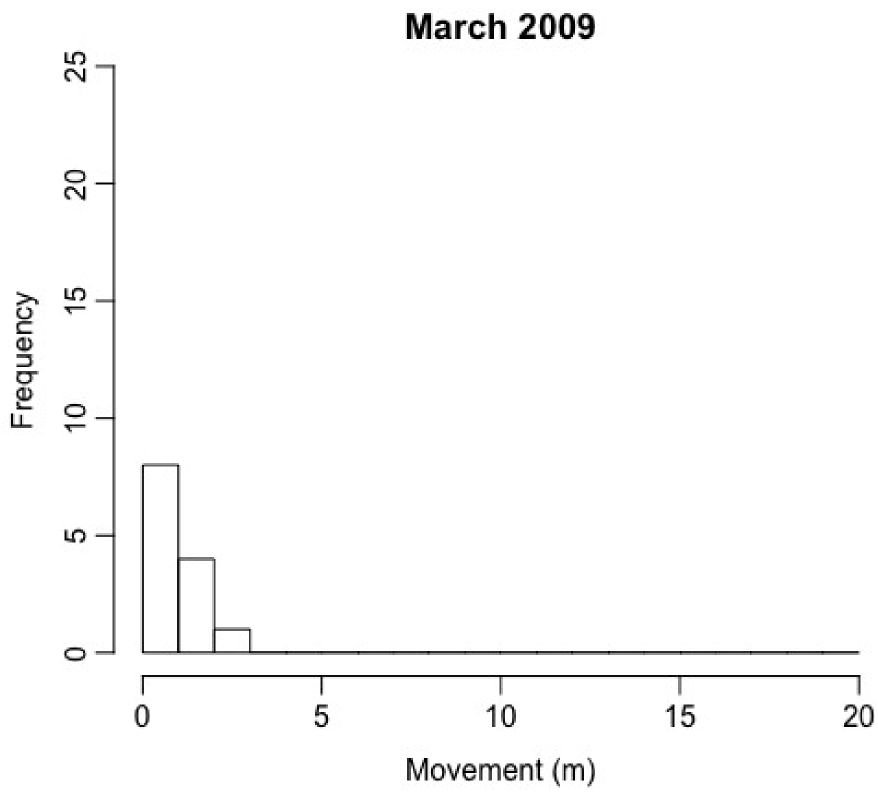
Session 3: March 2009

Monitoring dates (mean relative humidity during sampling):
March 17th (100%), 18th (98.3%) and 19th (95.7%)
Search area: c. 400 m^2

- Plot of frog captures:



- Histogram of frog individual movements within the monitoring session

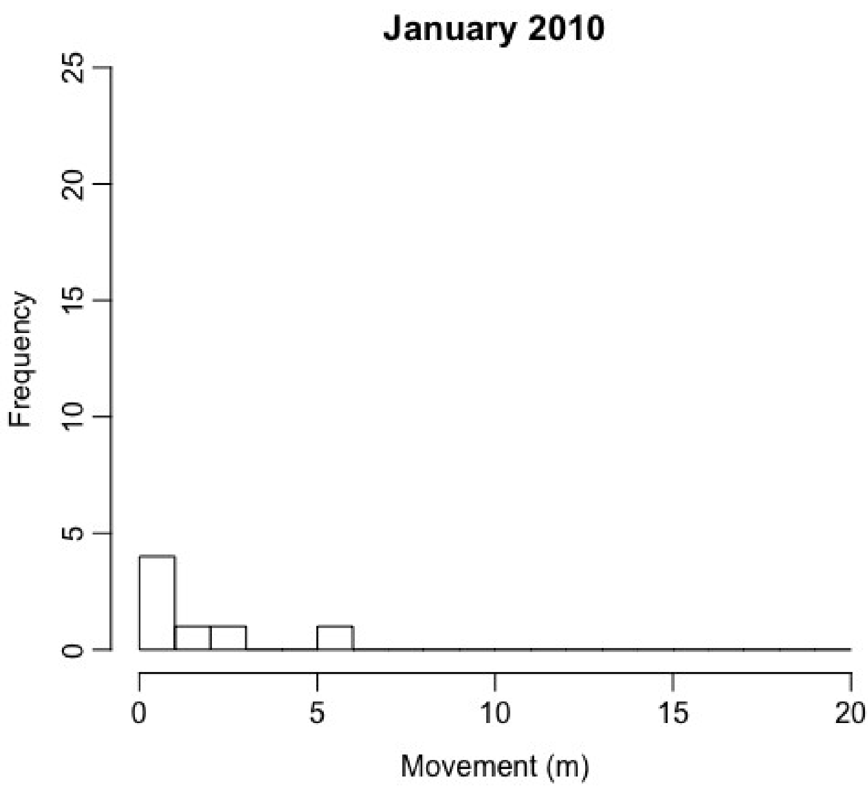


Session 4: January 2010

Monitoring dates (mean relative humidity during sampling):
January 25th (99.8%), 26th (100%), 27th (99.5%) and 28th (100%)
Search area: c. 400 m^2

- Plot of frog captures:

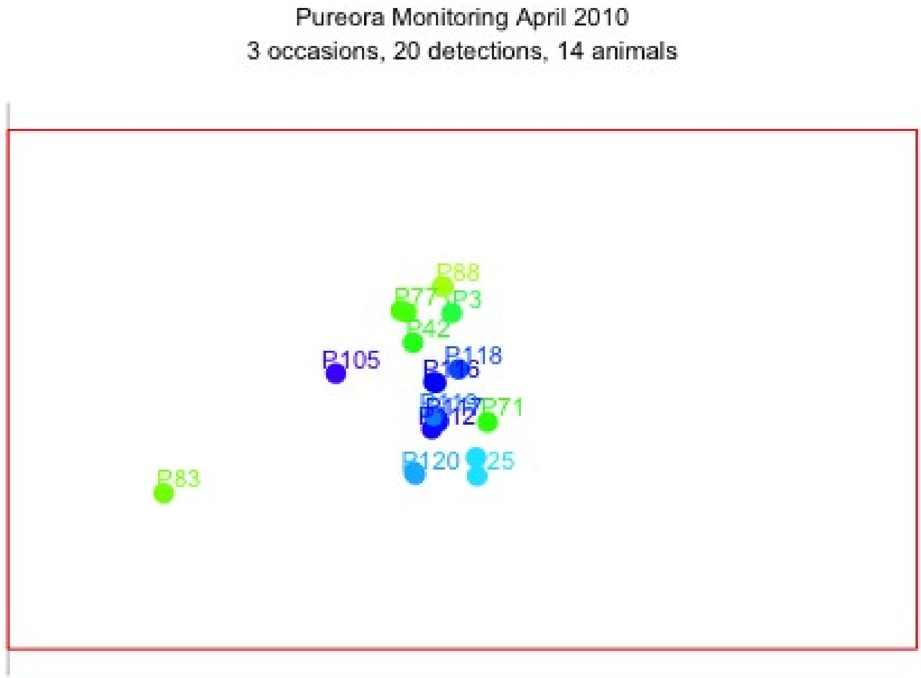
- Histogram of frog individual movements within the monitoring session



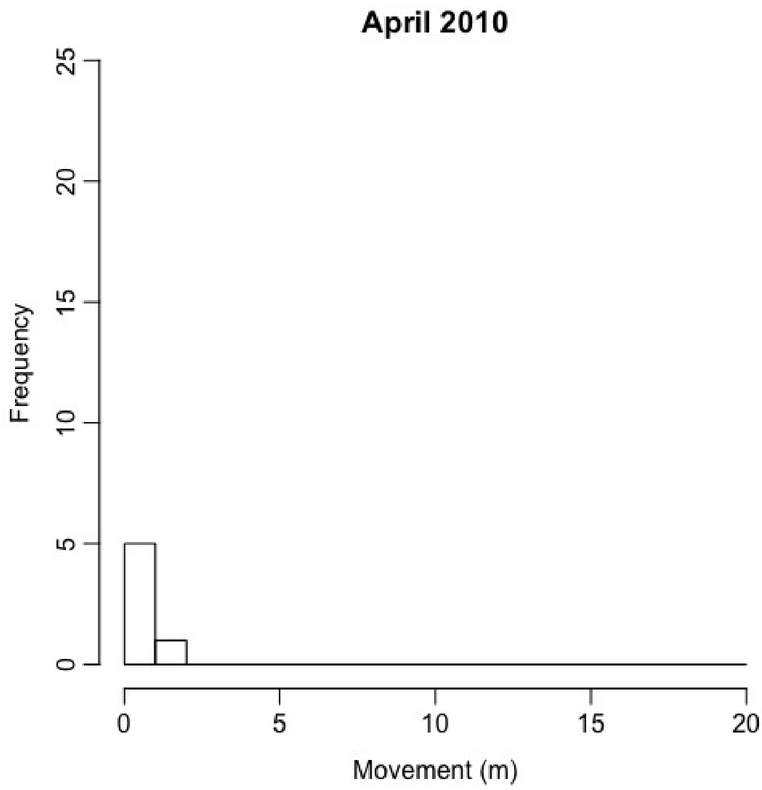
Session 5: April 2010

Monitoring dates (mean relative humidity during sampling):
April 6th (100%), 7th (92.5%) and 8th (90.6%)
Search area: c. 400 m^2

- Plot of frog captures:



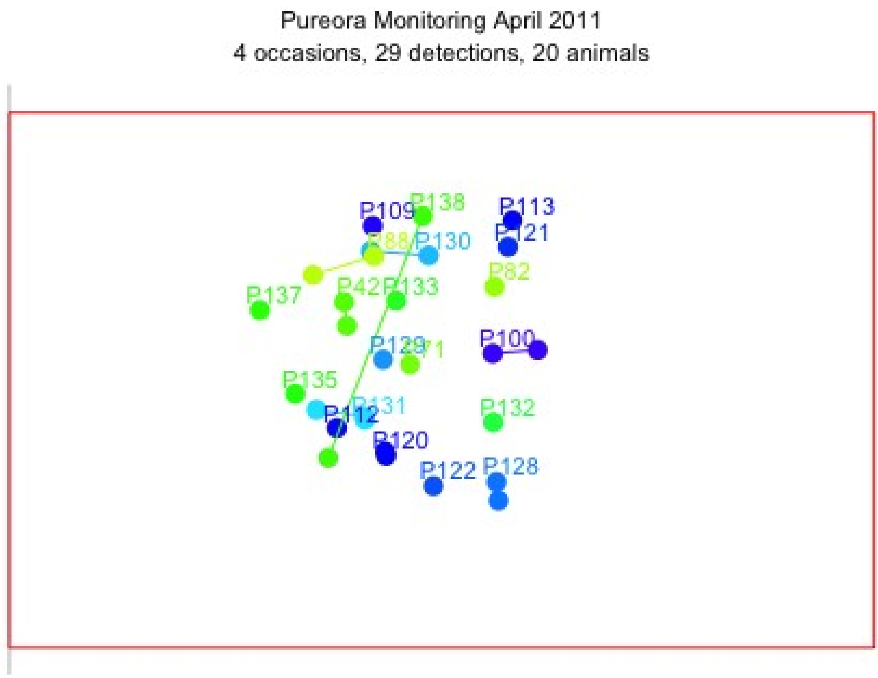
- Histogram of frog individual movements within the monitoring session



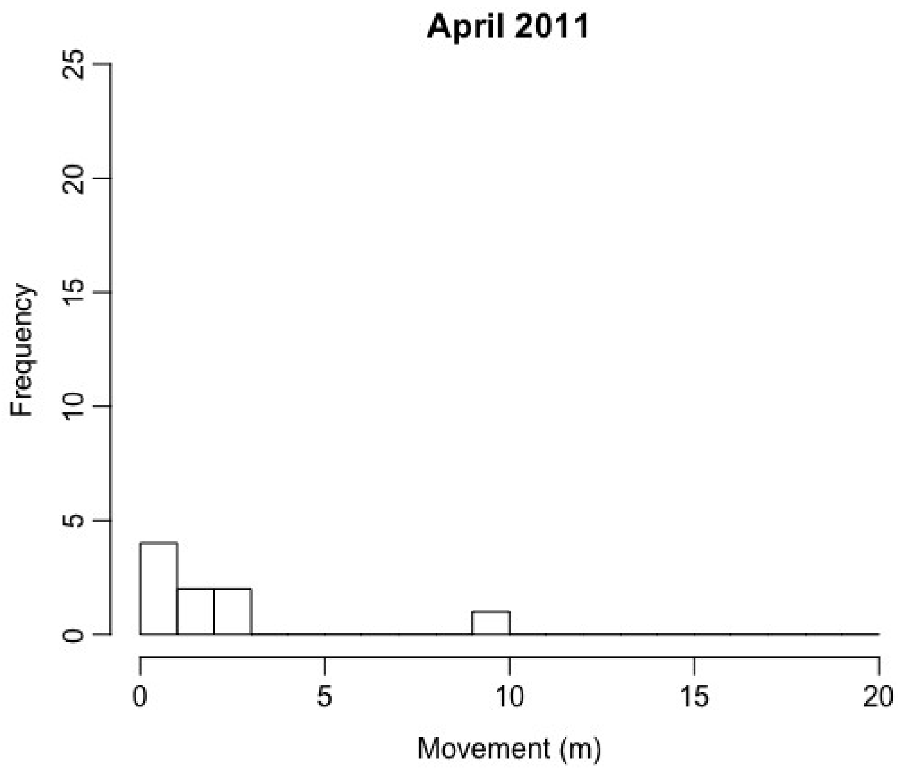
Session 6: April 2011

Monitoring dates (mean relative humidity during sampling):
April 11th (91.4%), 12th (90.8%), 13th (90.5%) and 14th (95.7%)
Search area: c. 400 m^2

- Plot of frog captures:



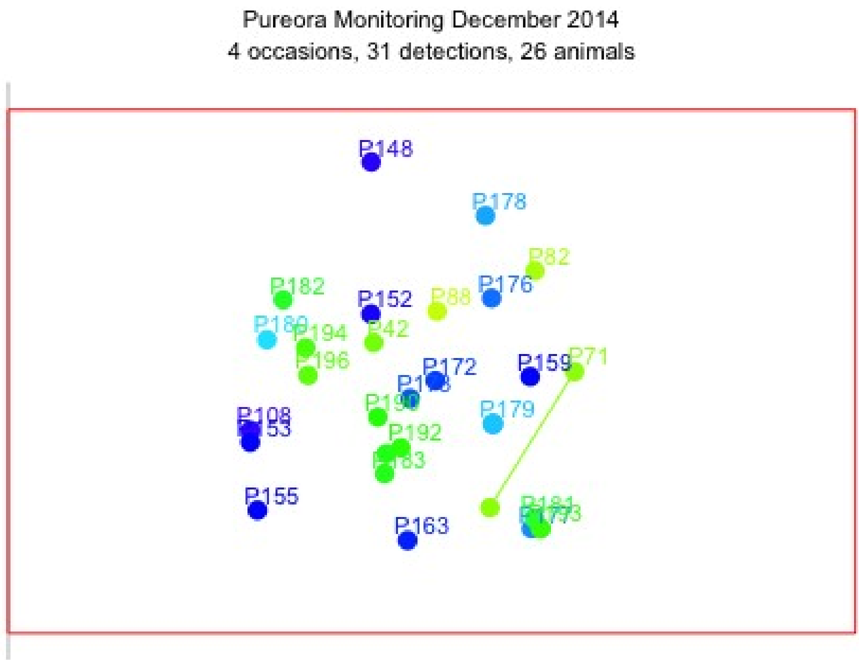
- Histogram of frog individual movements within the monitoring session



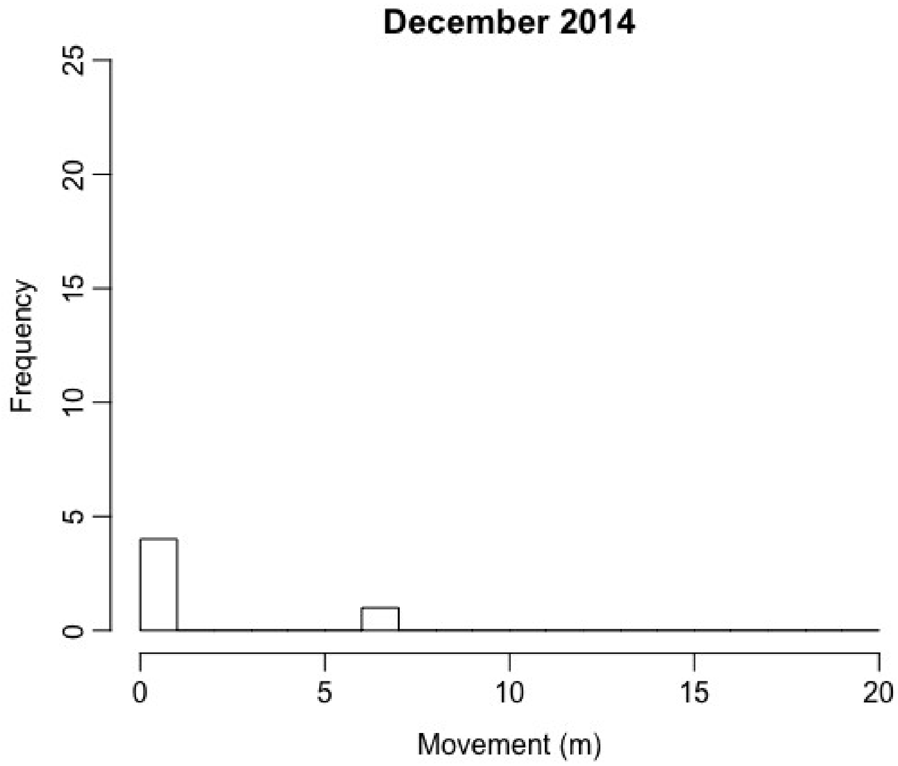
Session 7: December 2014

Monitoring dates (mean relative humidity during sampling):
December 15th (83.1%), 16th (89%), 17th (94.3%) and 18th (96.8%)
Search area: c. 400 m^2

- Plot of frog captures:



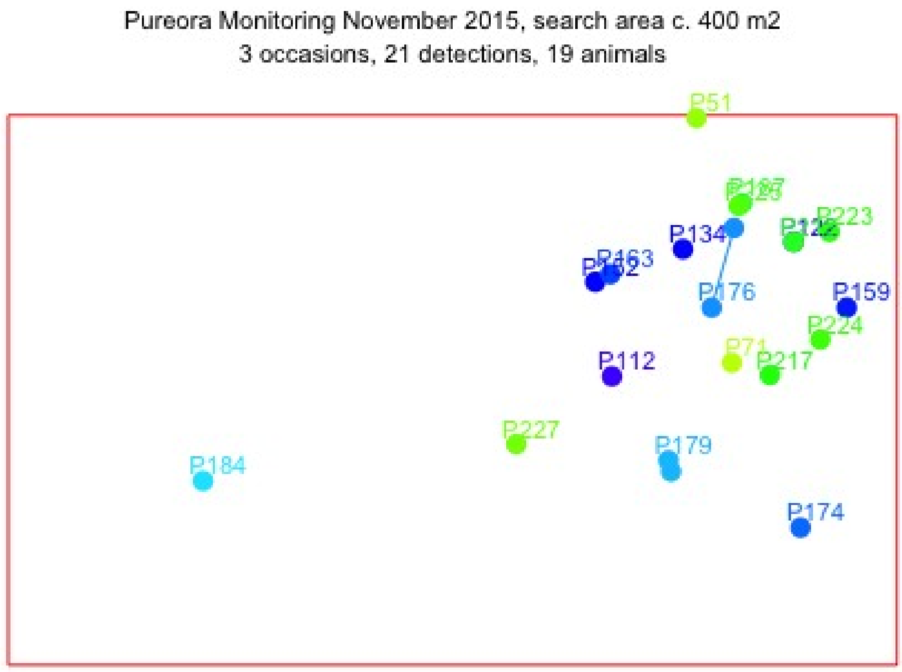
- Histogram of frog individual movements within the monitoring session



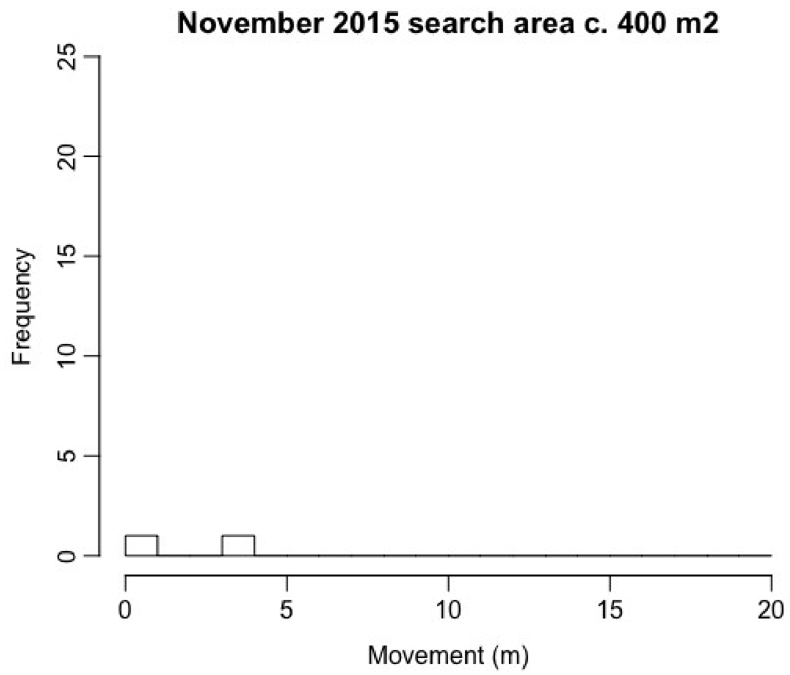
Session 8: November 2015

Monitoring dates (mean relative humidity during sampling):
November 24th (86%), 25th (79.3%) and 26th (86.15%)
Search area: c.400 m^2

- Plot of frog captures:



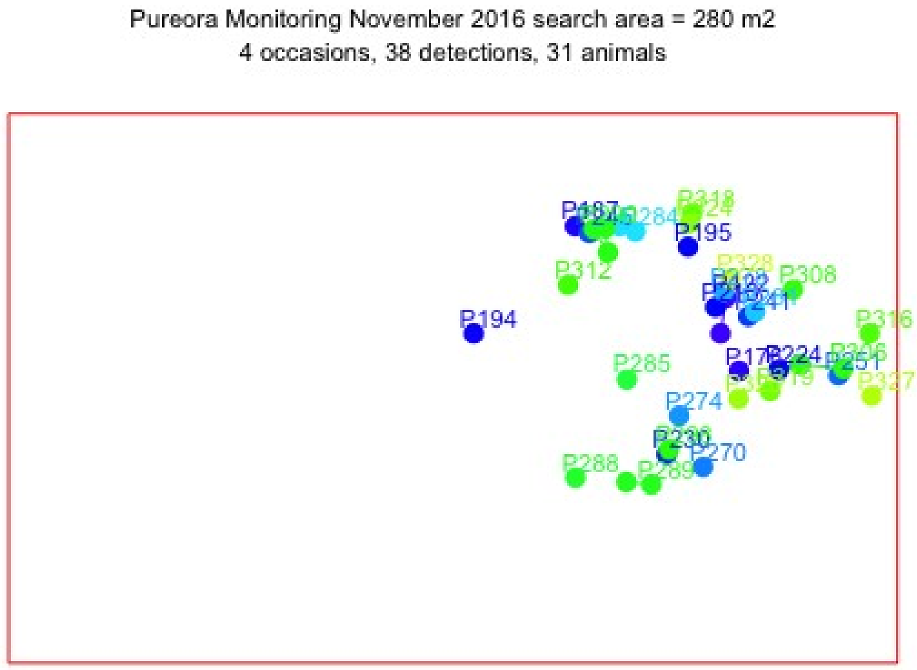
- Histogram of frog individual movements within the monitoring session



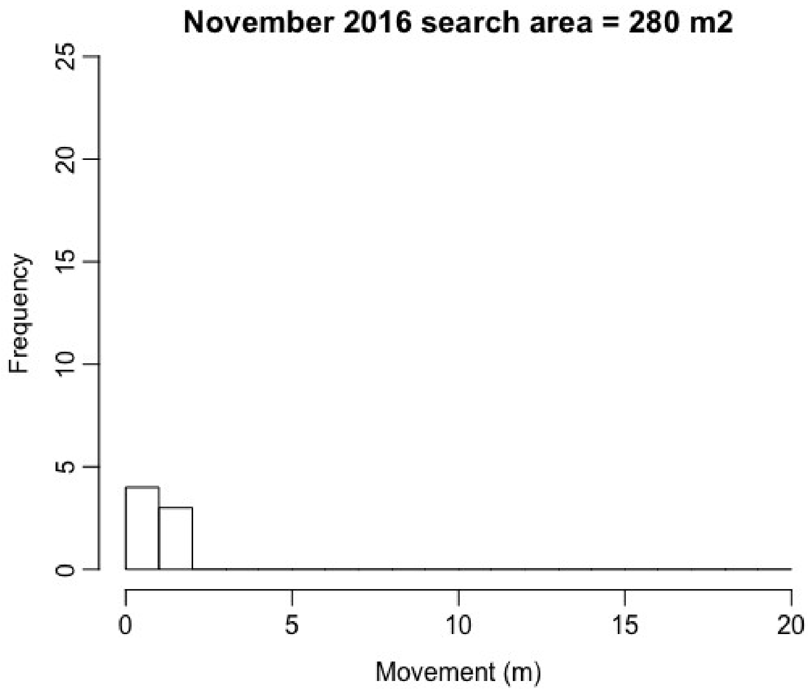
Session 9: November 2016

Monitoring dates (mean relative humidity during sampling):
November 28th (90.7%), 29th (94.4%), 30th (93.4%) and December 1st (91.1%)
Search area: 280 m^2

- Plot of frog captures:



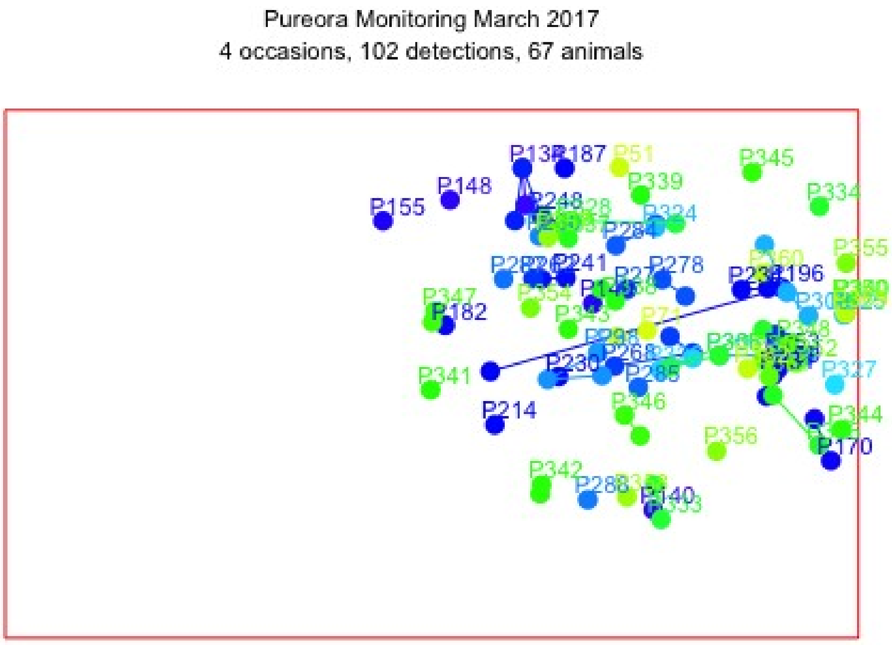
- Histogram of frog individual movements within the monitoring session



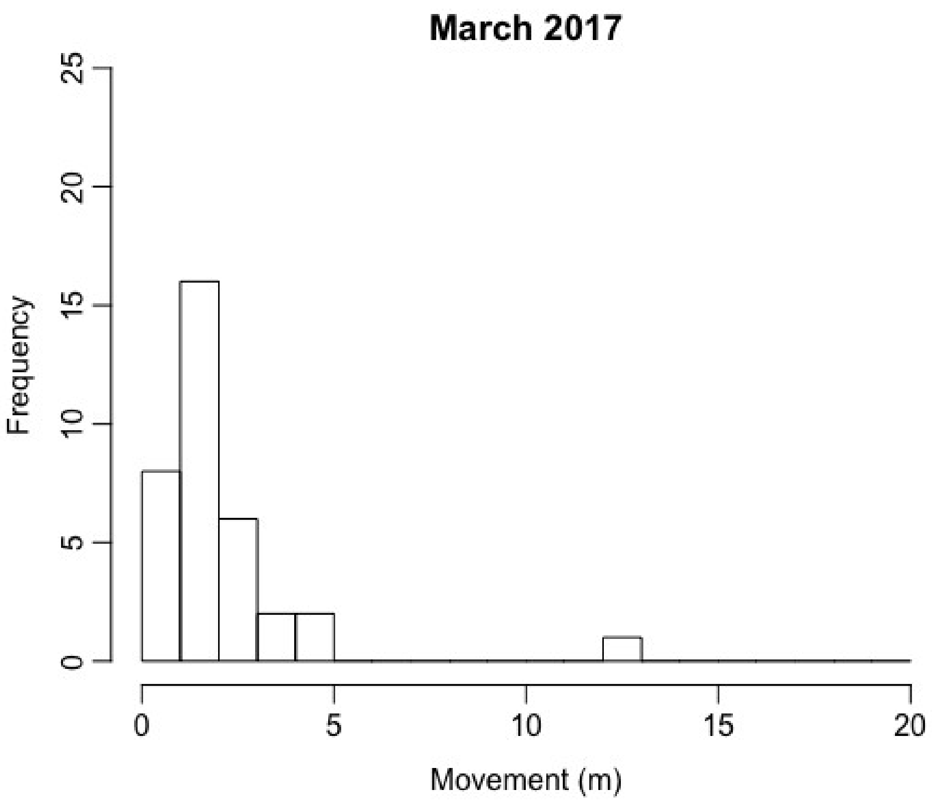
Session 10: March 2017

Monitoring dates (mean relative humidity during sampling):
March 27th (88.6%), 28th (92.6%), 29th (95.8%) and 30th (87%)
Search area: 280 m^2

- Plot of frog captures:



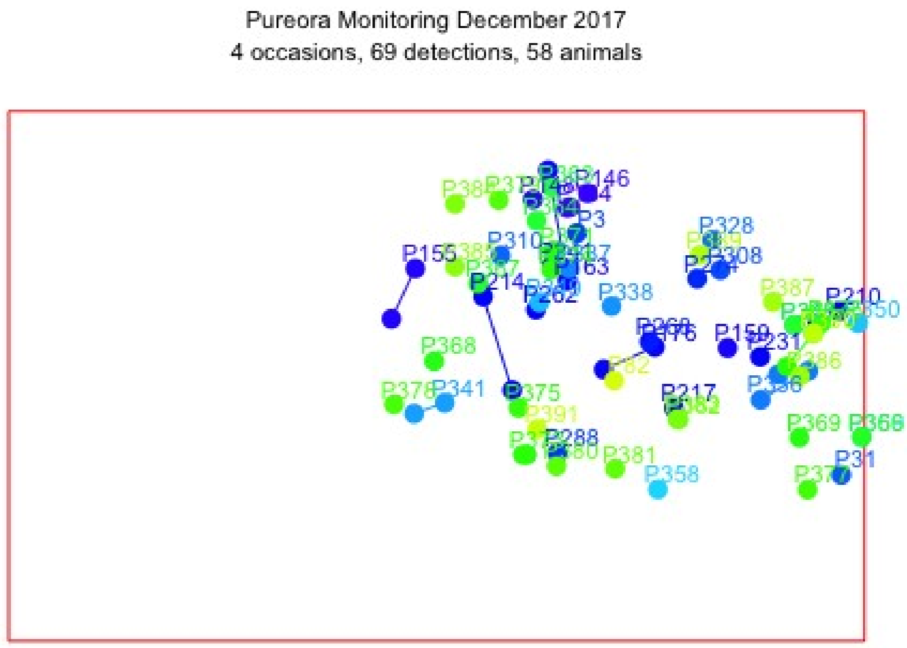
- Histogram of frog individual movements within the monitoring session



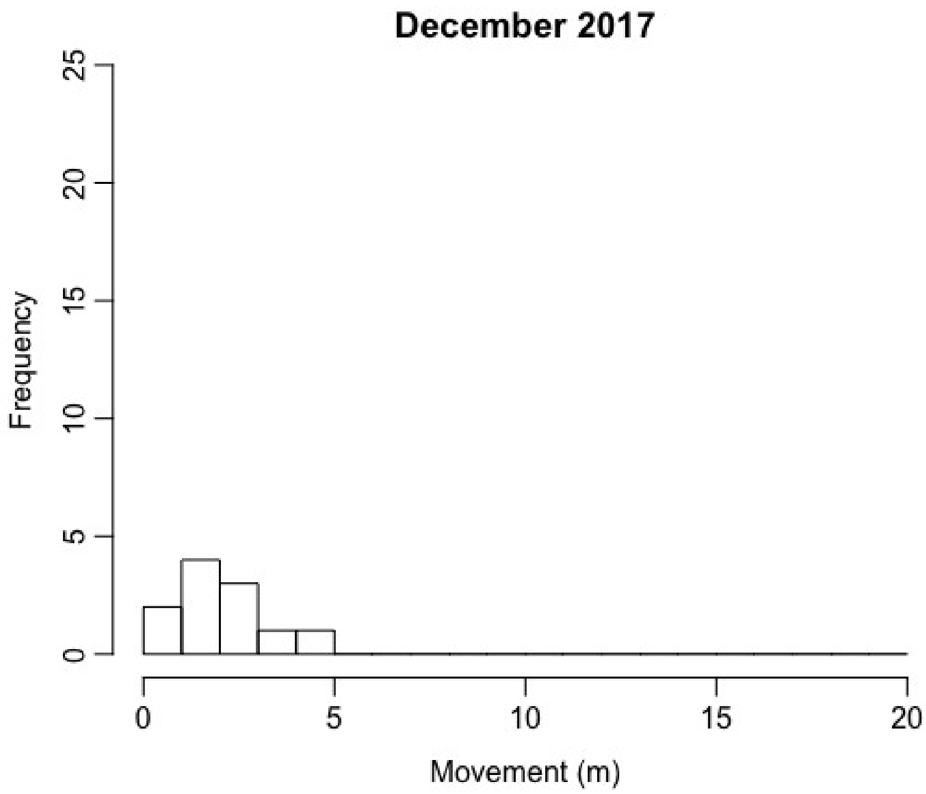
Session 11: December 2017

Monitoring dates (mean relative humidity during sampling):
December 4th (91.8%), 5th (80.5%), 6th (87.5%) and 7th (79.8%)
Search area: 280 m^2

- Plot of frog captures:



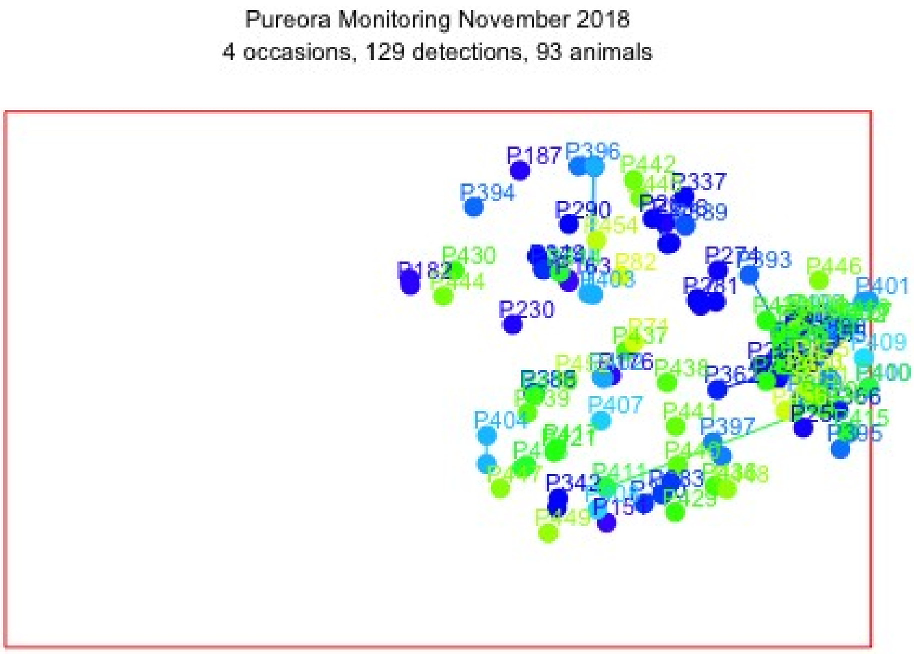
- Histogram of frog individual movements within the monitoring session



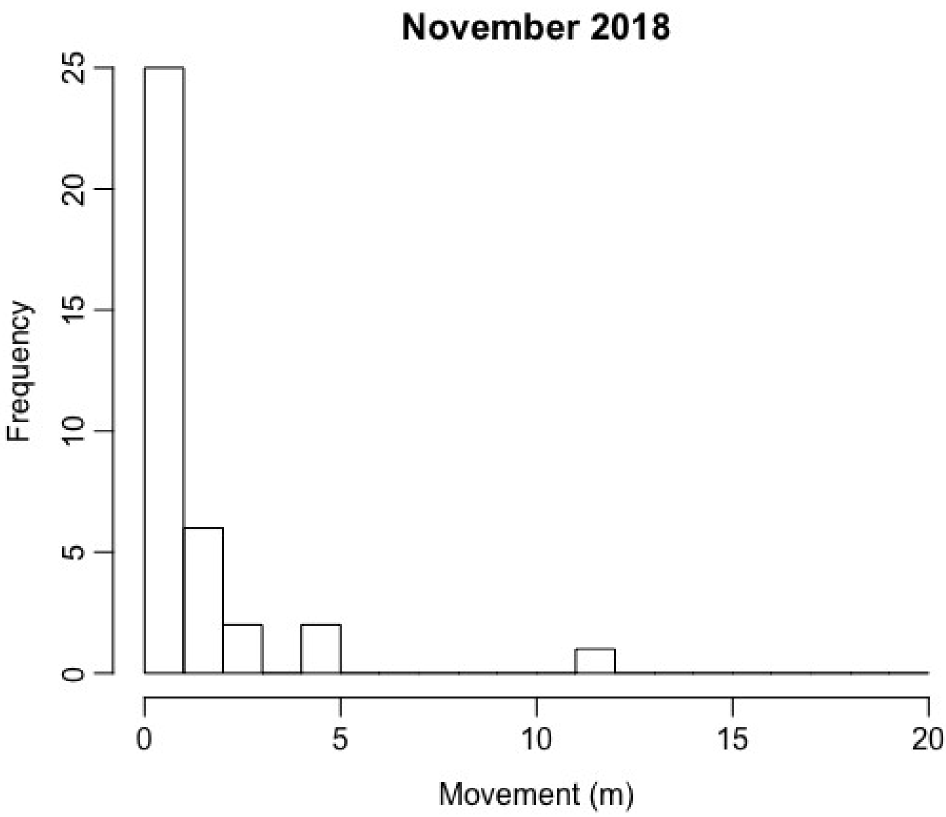
Session 12: November 2018

Monitoring dates (mean relative humidity during sampling):
November 12th (94.7%), 13th (99%), 14th (92.1%) and 15th (77.5%)
Search area: 280 m^2

- Plot of frog captures:



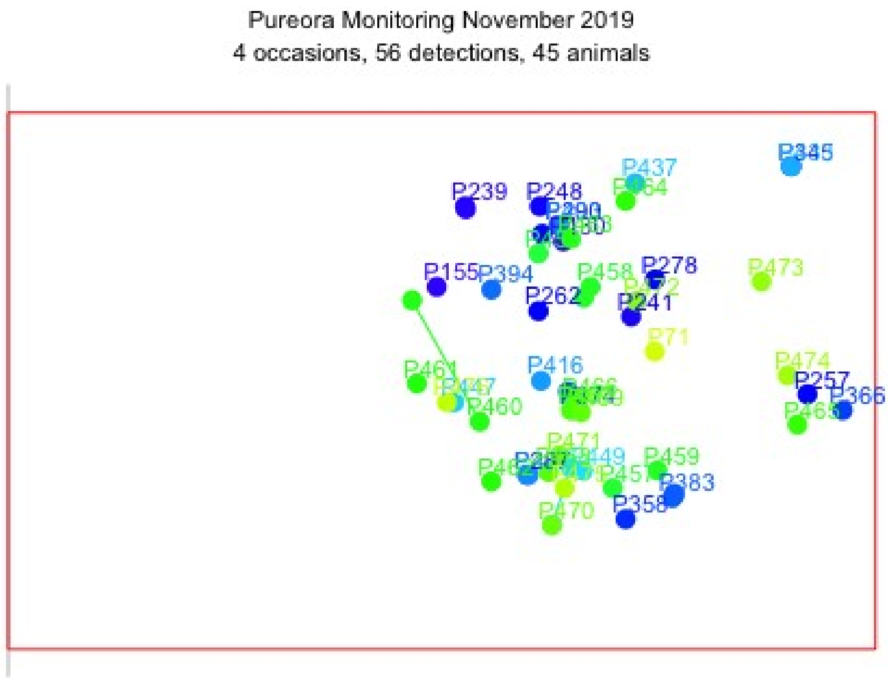
- Histogram of frog individual movements within the monitoring session



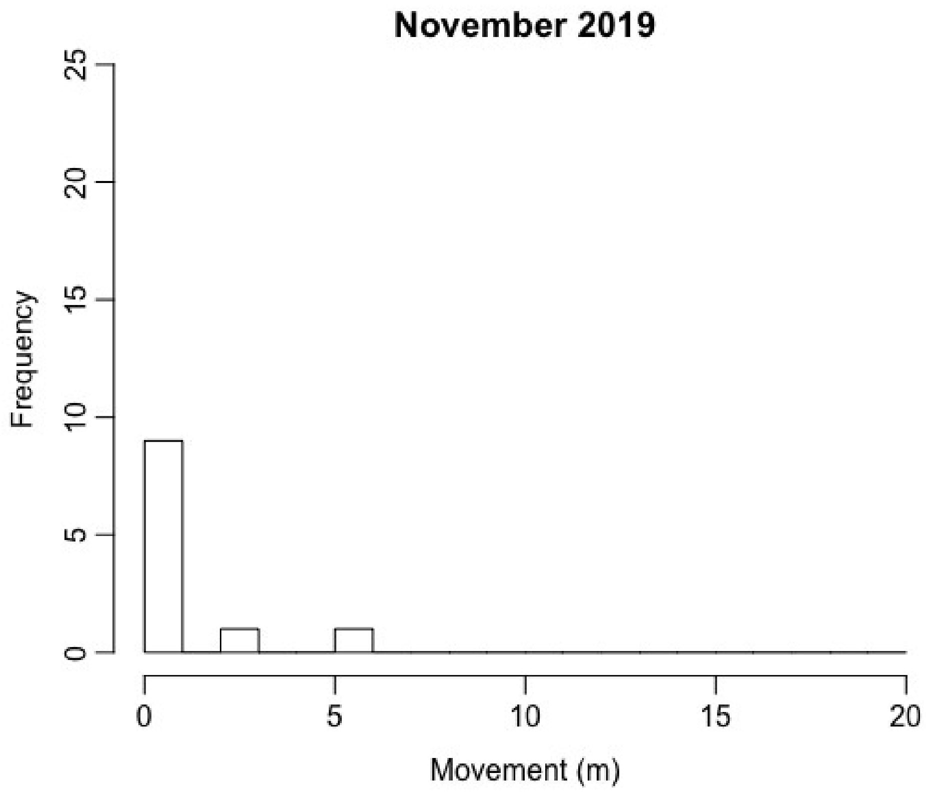
Session 13: November 2019

Monitoring dates (mean relative humidity during sampling):
November 11th (81.5%), 12th (89%), 13th (91.5%) and 14th (97%)
Search area: 280 m^2

- Plot of frog captures:



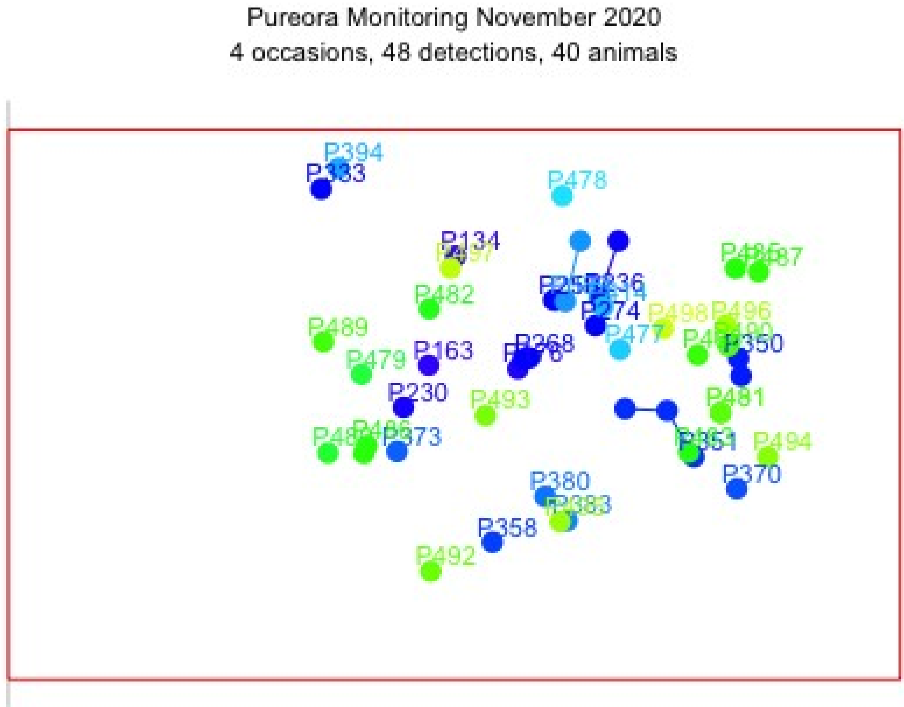
- Histogram of frog individual movements within the monitoring session



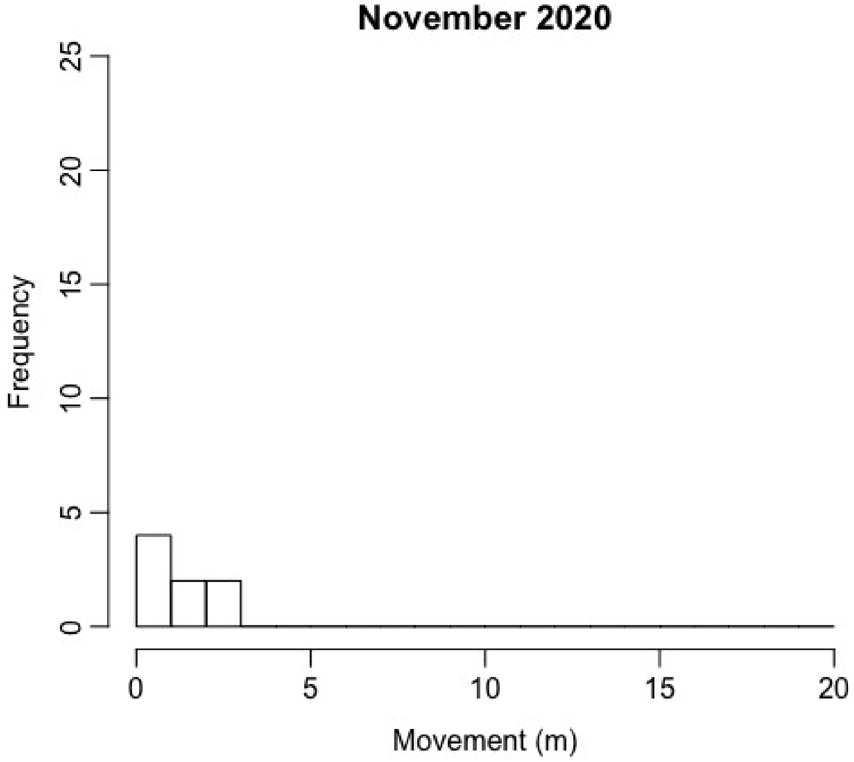
Session 14: November 2020

Monitoring dates (mean relative humidity during sampling):
November 9th (90.1%), 10th (93%), 11th (90.8%) and 12th (95.4%)
Search area: 280 m^2

- Plot of frog captures:



- Histogram of frog individual movements within the monitoring session



Demographic estimates to assess the translocation of a threatened amphibian from New Zealand

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[1*]– Aumen o el eco de los montes, NGO, Coyhaique, Chile
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Supporting information

Appendix S2: R code used for secr analysis.

- ***Exploratory analysis***

```
library(secr)
options(digits=4)

frogs <- read.capthist(("your_capture_history_data.csv", "your_detector_layout.csv", fmt =
'XY', detector = "polygon")

summary(frogs)

# Plot capture observations
plot(frogs, tracks = TRUE,varycol = TRUE,lab1cap = TRUE,laboffset = 0.6,
    border = 1 , title = " " )

# Home-range statistics
m <- unlist(moves(frogs))

max(m)
min(m)
mean(m)
sd(m)

# Histogram of movements for individuals recaptured
par(mar = c(3.2,4,1,1), mgp = c(2.1,0.6,0))
hist(m, breaks = seq(0,20), ylim=c(0,20), xlab = "Movement (m)", main = "  ")
```

- ***Density estimation***

```
#fit a multi strata/session model with session and occasion covariates
#e.g. below covariates correspond to the values used to model density for data collected after
the second release of frogs.
```

```
Model <-secr.fit(multisession_capthist_object, model=D~session,timecov =
c(90.7,94.35,93.35,91.1,88.6,92.6,95.8,86.95,91.8,80.45,87.45,79.75,94.7,98.95,92.05,77.45,
81.45,88.95,91.5,97,90.55,92.95,90.75,95.4), sessioncov = c('parental care', 'not parental
care', 'parental care', 'parental care', 'parental care', 'parental care'), buffer = 20, detectfn =
'HEX', trace = FALSE, details = list(contrasts = list(session = MASS::contr.sdif)))

predict(Model)
```

- ***Rate of change in density***

```
Model_2 <-secr.fit(only_sessions_equally_spaced_capthist_object,
model=D~session,timecov =
c(90.7,94.35,93.35,91.1,91.8,80.45,87.45,79.75,94.7,98.95,92.05,77.45,81.45,88.95,91.5,97,9
0.55,92.95,90.75,95.4), buffer = 20, detectfn = 'HEX', trace = FALSE, details = list(contrasts
= list(session = MASS::contr.sdif)))

coef(Model_2)

#back transform coefficients
beta <- coef(Model_2)[2:5, 'beta']
sebeta <- coef(Model_2)[2:5, 'SE.beta']

exp(beta)
exp(beta) * sqrt(exp(sebeta^2)-1)

lwr_beta <- coef(Model_2)[2:5, 'lcl']
upr_beta <- coef(Model_2)[2:5, 'ucl']

exp(lwr_beta)
exp(upr_beta)
```

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[†] – Passed away on January 23rd 2021

Supporting information

Appendix S3: Ranking of secr models fitted to single-session *Leiopelma archeyi* monitoring data on Pureora Forest, New Zealand.

- Ranking of secr models according to their values of AIC to select basal parameters for detection function (hazard half-normal or hazard exponential) and buffer width size (8* 'root pooled spatial variance' [value estimated with function RPSV] or 20 m). detectfn = detection function. npar = number of parameters estimated in the model. logLik = log likelihood. AICc = AIC corrected for small sample size. dAIC = difference between the AIC value of a model and the model with the lowest AIC value. AICcwt = AICc weight.

April 2007

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-90.94	187.9	193.9	0.000	0.2763
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-90.94	187.9	193.9	0.000	0.2763
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-91.13	188.3	194.3	0.386	0.2278
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-91.17	188.3	194.3	0.460	0.2195

April 2008

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-109.2	224.5	227.9	0.000	0.3224
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-109.3	224.7	228.1	0.195	0.2925
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-109.7	225.5	228.9	0.994	0.1961
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-109.8	225.6	229.0	1.068	0.1890

March 2009

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-171.7	349.4	351.4	0.000	0.5646
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-172.7	351.5	353.5	2.138	0.1939
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-173.2	352.3	354.3	2.990	0.1266
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-173.3	352.5	354.5	3.184	0.1149

January 2010

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-146.9	299.9	302.3	0.000	0.4758
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-147.1	300.2	302.6	0.380	0.3934
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-148.9	303.8	306.2	3.967	0.0655
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-148.9	303.8	306.2	3.970	0.0654

April 2010

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-119.6	245.3	247.7	0.000	0.6374
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-120.3	246.5	248.9	1.232	0.3443
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-123.2	252.4	254.8	7.100	0.0183
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-125.3	256.6	259.0	11.284	0.0000

April 2011

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-211.5	429.0	430.5	0.000	0.5062
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-211.6	429.1	430.6	0.153	0.4689
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-215.2	436.4	437.9	7.405	0.0125
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-215.2	436.4	437.9	7.405	0.0125

December 2014

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-228.2	462.3	463.4	0.000	0.4981
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-228.3	462.6	463.7	0.261	0.4372
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-230.9	467.8	468.9	5.469	0.0323
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-230.9	467.8	468.9	5.469	0.0323

November 2015

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-186.6	379.2	380.8	0.000	0.3028
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-186.7	379.5	381.1	0.255	0.2665
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-186.7	379.5	381.1	0.273	0.2641
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-187.2	380.4	382.0	1.195	0.1666

November 2016

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-258.7	523.4	524.3	0.000	0.4282
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-259.0	524.0	524.9	0.649	0.3096
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-259.8	525.5	526.4	2.175	0.1443
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-260.0	525.9	526.8	2.580	0.1179

March 2017

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-685.8	1378	1378	0.00	0.6682
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-686.5	1379	1379	1.40	0.3318
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-698.4	1403	1403	25.27	0.0000
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-698.4	1403	1403	25.27	0.0000

December 2017

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-486.9	979.8	980.3	0.000	0.3556
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-487.2	980.3	980.8	0.511	0.2755
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-487.6	981.1	981.6	1.313	0.1845
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-487.6	981.1	981.6	1.313	0.1845

November 2018

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-860.9	1728	1728	0.000	0.952
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-863.9	1734	1734	5.974	0.048
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-893.6	1793	1793	65.333	0.000
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-893.6	1793	1793	65.333	0.000

November 2019

	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-397.8	801.6	802.2	0.000	0.5984
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-398.2	802.4	803.0	0.798	0.4016
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-403.8	813.7	814.3	12.116	0.0000
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-403.8	813.7	814.3	12.128	0.0000

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	model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
Exponentialis	D~1 lambda0~1 sigma~1	hazard exponential	3	-342.1	690.2	690.9	0.000	0.3821
Exponential20	D~1 lambda0~1 sigma~1	hazard exponential	3	-342.4	690.8	691.5	0.605	0.2824
Halfnormalis	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-342.9	691.8	692.5	1.627	0.1694
Halfnormal20	D~1 lambda0~1 sigma~1	hazard halfnormal	3	-342.9	691.9	692.6	1.666	0.1661