

UNIVERSITY OF CALIFORNIA, SANTA CRUZ

Population Analysis of *Peromyscus boylii* and *Peromyscus californicus* in mixed evergreen coastal forest

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of the requirements for the degree of

BACHELOR OF ARTS

in

ENVIRONMENTAL STUDIES

by

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ABSTRACT: California mixed evergreen forests are under increasing pressure from growing human populations in coastal zones and are particularly vulnerable to changes in precipitation patterns associated with global climate change. We can learn about the impacts of such external factors on these environments through the study of the species that inhabit them. Our study 1) uses mark-recapture techniques to analyze the small mammal population trends, specifically of *Peromyscus boylii* and *Peromyscus californicus*, in the mixed evergreen forest in the Santa Cruz mountains, and 2) proposes possible external factors that drive these trends. The *P. californicus* population was consistently smaller than the *P. boylii* population. Both populations were most abundant in the winter, except the winter of 2012. Survival increased steadily for both populations until a decrease in 2013. The change in survival probability was much more drastic for *P. boylii* than *P. californicus*.

KEYWORDS: *peromyscus boylii*, *peromyscus californicus*, mark-recapture, program MARK, small mammals, abundance, survival, population dynamics

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INTRODUCTION

Understanding population dynamics of native small mammals is essential for the conservation of these populations and the ecosystems they inhabit. Small mammals are good biodiversity indicators because of their high reproductive capacity and invasive ability (Slábová *et al.* 2008), and studies have shown that *Peromyscus* mice specifically may be useful biological indicators of ecosystem change because of their predictable response to both long-term and short-term disturbance (Leis *et al.* 2006). An indicator species is a species thought to be sensitive to and therefore to serve as an early warning indicator of environmental changes (Lindenmayer, *et al.* 2010). If changes such as decreased survival are happening to small mammals, comparable changes are likely happening in other populations as well. Factors such as rainfall and drought significantly influence the population dynamics of small mammals (Recher *et al.* 2009). Because small mammals respond dramatically to such factors and the subsequent modifications to the growth or structure of habitat vegetation (Dickman *et al.* 1987), we can potentially learn about impacts of urbanization and climate change by studying small mammal populations.

The Small Mammal Undergraduate Research in the Forest (SMURF) program is a long-term monitoring project of the small mammal populations on the UC Natural Reserve in the Santa Cruz mountains. Since 2009, graduate and undergraduate researchers have been measuring the population dynamics and habitat use patterns of native small mammals; the two primary species which occur on the plot are *Peromyscus boylii* (brush mouse) and *Peromyscus californicus* (California mouse). *P. californicus* inhabits chaparral and mixed woodland areas along the California coast and as far inland as the eastern Sierras, from the San Francisco Bay area southward to Baja California. The largest of the *Peromyscus* mice, *P. californicus* is able to

use its strong front teeth to crack open seeds that other *Peromyscus* mice cannot. Such seeds, like those from *Umbellularia californica* (California bay laurel), make up the majority of its diet, along with fruits and flowers. *P. californicus* is semi-arboreal, but tends to nest on the ground, in areas with debris such as the nests of *Neotoma fuscipes* (dusky-footed woodrat) or fallen logs (Merritt 1974). *P. boylii* is much smaller than *P. californicus*, and can be found from northern California, to eastern Colorado and western Texas, and south to Baja California and southern Mexico (Luensmann *et al.* 2005). *P. boylii* is known for its semi-arboreal behavior, and prefers habitat with medium to high (<50%) cover density. *P. boylii* will feed primarily on acorns when available, but will also consume various arthropods, worms, fruits and seeds (Luensmann *et al.* 2005). Both species are most active at night.

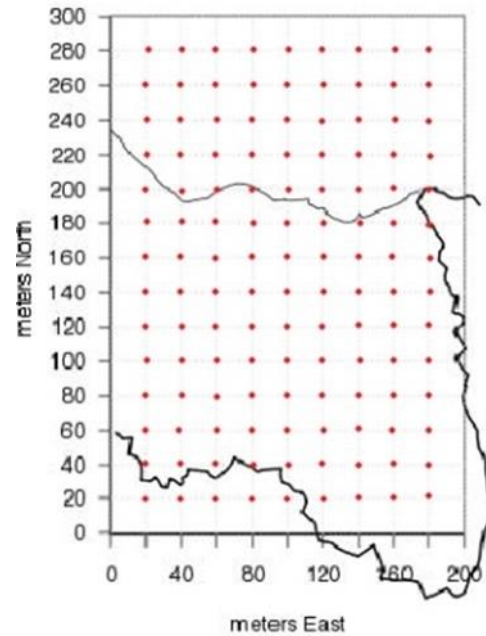
The objective of our study was to use data collected through mark-recapture techniques to compute survival probabilities and abundance estimates of the two *Peromyscus* species that inhabit the Natural Reserve. We expected to find variation among *P. boylii* and *P. californicus*, possibly reflecting the differences in size, diet, and habitat preference. We expected both abundance and survival to vary with season. We also hoped to further understand the effects of climate change on biological systems; we expected to find that survival probabilities fluctuate with changes in precipitation levels and temperature.

METHODS

Study Area:

Live trapping data came from the Forest Ecology Research Plot (FERP), a mapped study area in Mediterranean-climate, mixed-evergreen coastal forest in the Santa Cruz mountains. The FERP is protected as part of the Campus Natural Reserve at the University of California, Santa

Cruz, and measures 6 hectares, extending 300 m north and 200 m east from its southwest corner at 37°0.745'N, 122°4.490'W. Vegetation on the FERP is composed of 31 woody species and dominated (nearly 70% of all stems) by Douglas-fir (*Pseudotsuga menziesii*) and three species of Fagaceae (*Quercus agrifolia*, *Q. parvula* var. *shrevei*, and *Lithocarpus densiflorus*) (Gilbert *et al.* 2010). The plot is divided into a grid consisting of 20 by 20 meter quadrants, which are marked in each corner with a pvc pipe and a flag delineating the grid coordinates.



Field Methods:

The small mammal team conducts a trapping session consisting of three consecutive trapping nights once per season. We generally conduct winter trapping in late January/early February, spring in late April/early May, summer in late July/early August, and fall in late October/early November. We set 126 Sherman live traps, one every 20 meters, throughout the 200 by 300 meter FERP grid. We placed the traps on the ground within a few meters of each flag marking the quadrant corner, excluding the edges of the plot. To reduce potential overheating of the animals, we set the traps each evening as close to sunset as was practical, and checked them the next morning soon after sunrise. We placed a small amount of bait, a mixture of peanut butter and plain oats, in each trap, along with some polyester bedding to provide insulation and minimize death from exposure or trap shock.

Figure 1: map of the FERP with walking trails (Gilbert, et. al). Each red coordinate represents a trapping station.

This is a mark-recapture study, so all *Peromyscus* individuals captured were marked with a unique small metal ear tag before we released them unharmed. We also recorded the location (grid coordinates), species, sex, weight, and body measurements, as well as any significant/interesting details about the individual (e.g., exposed nipples in females). If the animal was a recapture, we noted so and recorded the tag number along with the other data. Additional species we captured occasionally were *Neotoma fuscipes* and *Sorex ornatus*.

Population Analyses:

Equation 2: Schnabel method of population abundance estimation

$$\hat{N} = \frac{\sum_t (C_t M_t)}{\sum_t R_t}$$

N = Size of population
 C_t = total number of individuals caught in sample t
 R_t = number of individuals already marked when caught in sample t
 M_t = number of marked individuals in the population just before the tth sample is taken

We used trap data from the spring of 2009 to

the winter of 2013 in my analyses. Though this study took place over multiple years, we wanted a specific abundance estimate for each trapping session, which only

Equation 1: Lincoln-Petersen method of population abundance estimation

$$\hat{N} = \frac{C M}{R}$$

N = Size of population at time of marking
 M = Number of individuals marked in the first sample
 C = Total number of individuals captured in the second sample
 R = Number of individuals in second sample that are marked.

span for 3 days. Thus, we classified the *Peromyscus* on the FERP as a closed population: one which does not change in size during the study period, and in which the effects of births, deaths, and movements are negligible (Krebs 1999). Since we had more than two encounter occasions per session, resulting in multiple markings and recaptures, the commonly-used Lincoln-Petersen method of abundance estimation would not suffice. We instead used the Schnabel method, a variation of the Lincoln-Petersen method which treats the multiple samples as a series of Petersen samples, and obtains a population estimate as a weighted average of Petersen estimates (Krebs 1999). For N to be an

accurate estimate of the population size, the following assumptions must hold: 1) the population is closed, so that N is constant, 2) all animals have the same chance of getting caught in the first sample, 3) marking individuals does not affect their catchability, 4) animals do not lose marks between the two sampling periods, and 5) all marks are reported upon discovery in the second sample. To utilize the Schnabel method, we calculated the total number of individuals caught in each sample, or sample t (C_t), the number of individuals already marked (recaptures) when caught in sample t (R_t), and the number of marked individuals in the population just before the t^{th} sample was taken (M_t). The total number of recaptures ($\sum R_t$) for each session was less than 50, so we used confidence limits from the Poisson distribution [Appendix I] to produce 95% confidence intervals for the Schnabel estimates (as directed by Krebs). We calculated N separately for *p. boylii* and *p. californicus*, to get estimates of the population size of each species.

To produce survival probabilities of the *Peromyscus* populations on the FERP, we utilized Program MARK, a statistical software designed for the analysis of marked individuals. Our small mammal data was stored in a “vertical file,” where each line in the file is a record of when a particular individual was seen; in our case, each row in the database corresponds to an individual animal being seen on a specific day. Program MARK, in contrast, requires the data to be in an *encounter history* (or capture history). For a mark-recapture analysis, the encounter history consists of a contiguous series of “1”s and “0”s, where “1” indicates that an animal was recaptured during that encounter occasion and “0” indicates that the animal was not recaptured (White 2013). We wanted to find the survival probabilities for each quarterly trapping session, thus for the purpose of this analysis, we counted each three-day trapping session as one encounter occasion, disregarding recaptures within the session. The reformatted data is a series of unique encounter histories for each individual animal encountered throughout the study.

There are a total of 15 encounter occasions, one every quarter from the spring of 2009 to the winter of 2013 (excluding the summer of 2011, when the team did not execute any trapping—time intervals were adjusted appropriately).

The encounter histories generated can now be used to estimate survival in Program MARK. I selected the “live recaptures (Cormack-Jolly-Seber)” data type and ran several models with two parameters: survival probability (ϕ or φ) and recapture probability (p). The various models tested the dependency of each parameter on time passed, season, year, and the possibility that the values remained constant throughout the study. I manipulated the parameter index matrices (PIMs) in order to create and run new models. MARK sorts the models by Akaike’s Information Criterion (AIC), a criterion for selecting the most parsimonious model, or the model which best explains the variation in the data while using the fewest parameter. This can loosely be called the “best-fit” model (White 2013). I based my model selection on the AIC, and ranked alternate models using the difference in AIC score (Δ AIC) relative to the model with the lowest AIC.

RESULTS

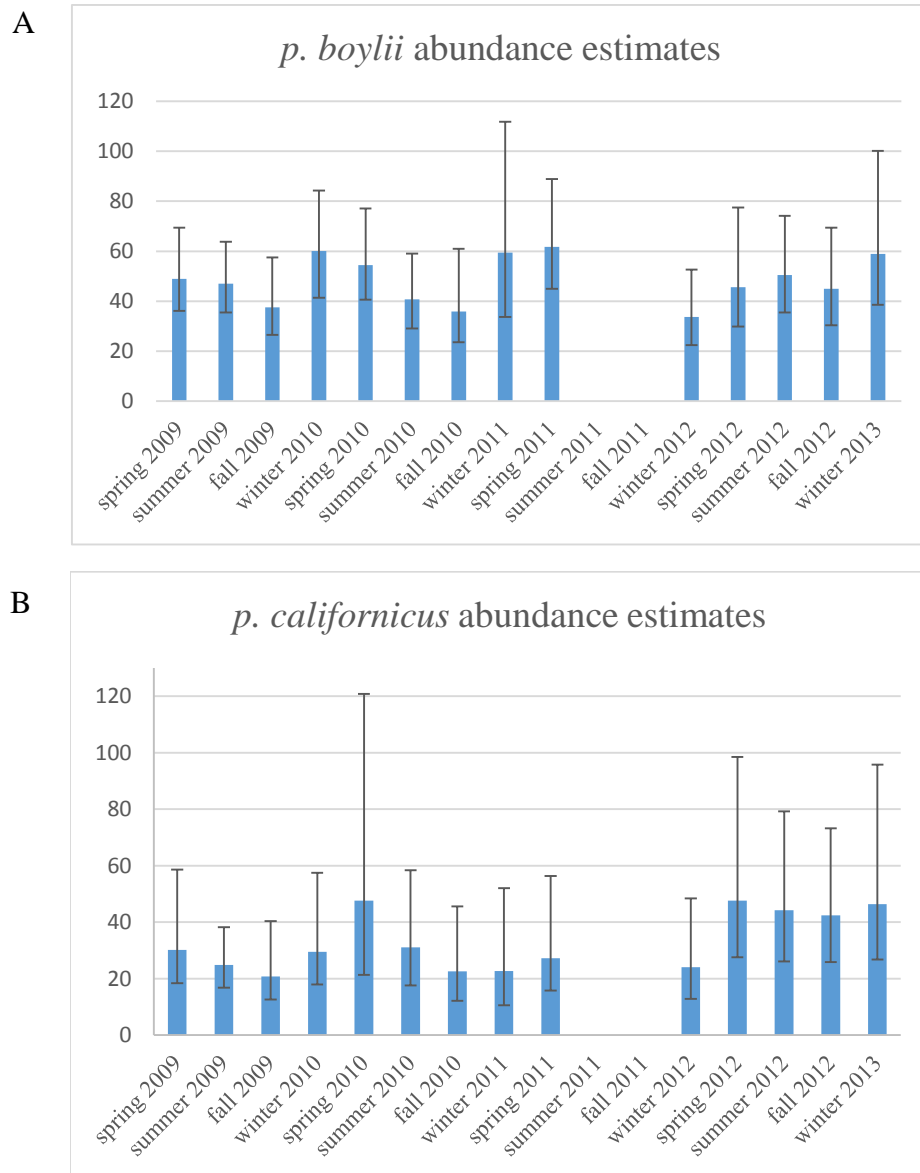
Abundance:

We caught a total number of 943 individual *Peromyscus* mice throughout the study, including 597 *P. boylii* and 346 *P. californicus*. There were significantly fewer *P. boylii* than *P. californicus* captured, until the winter of 2012 and subsequent seasons, when the totals grew nearer to each other. The abundance estimates I produced are consistent with the trends of the capture totals (see Appendix II). The mean estimated population size for *P. boylii* was 48.5 individuals, and the mean estimated population size for *P. californicus* was 32.9 each session. *P.*

boylei abundance generally peaked in the winter (excluding 2012), with an average of 53, while *P. californicus* abundance was generally highest in the spring, with an average of 38.2.

There was no trapping session in the summer of 2011, and the fall of 2011 session did not yield enough recaptures for the Schnabel method to produce accurate population estimates.

Figure 2. Schnabel abundance estimates with 95% confidence intervals for (A) *P. boylei* and (B) *P. californicus*



Survival probabilities:

Survival for *P. californicus* was best modeled assuming no difference in probability over the study period (model $\{\varphi(.)p(.)\}$). The next best model was only one AIC point away from the best-fit, and assumed that the survival probability varied with season, while recapture probability remained constant (model $\{\varphi(\text{season})p(.)\}$).

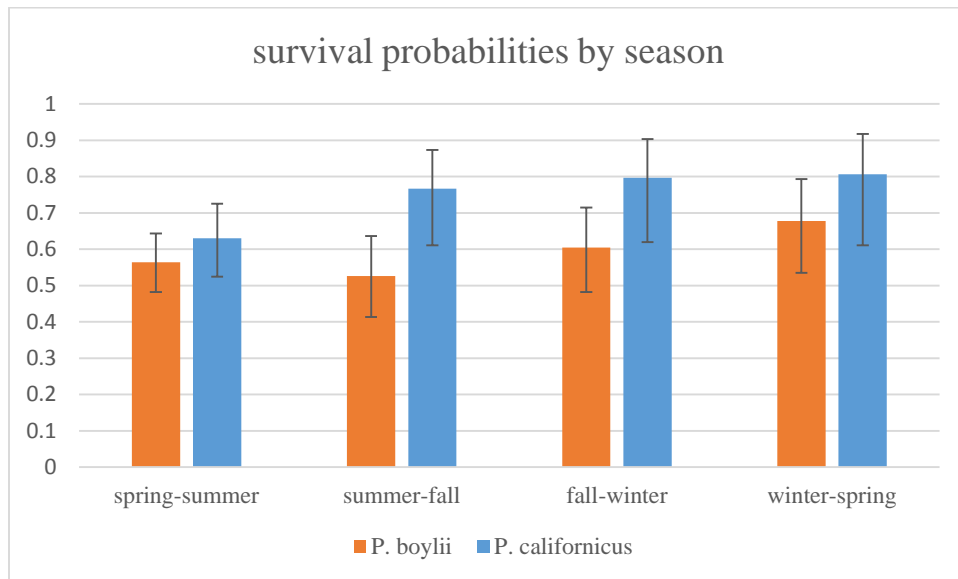


Figure 3. Survival probabilities based on the model $\{\varphi(\text{season})p(.)\}$ with 95% confidence intervals. Suggests that survival varies with each season. This model was the best-fit for *P. californicus*, but 15 AIC points from the best-fit model for *P. boylii*.

Survival probabilities for *P. boylii* were best modeled assuming that both survival and recapture were dependent on the year, or trended over time (model $\{\varphi(\text{year})p(\text{year})\}$). Survival for both species decreased significantly after 2012. However, 2013 is only representative of the winter of 2013, as that was the last trapping session included in this study. Consequently, there is no standard error for that year, as there is only one probability (no variation).

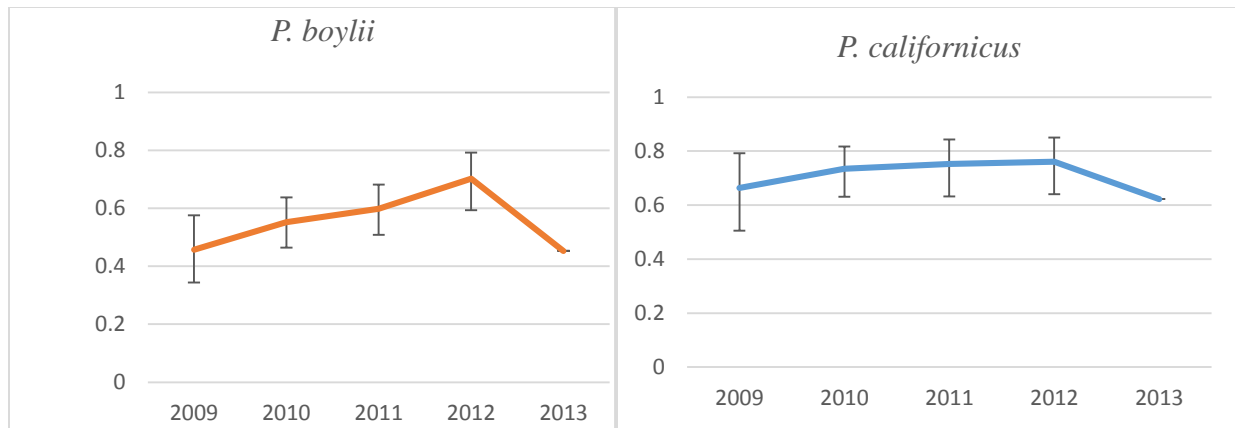


Figure 4. Survival probabilities for (A) *P. boylii* and (B) *P. californicus* based on the model $\{\varphi(\text{year})p(\text{year})\}$ with 95% confidence intervals. Suggests that survival changed over time, a different probability each year. This was the best-fit model for *P. boylii*, but 8 AIC points from the best-fit model for *P. californicus*.

DISCUSSION

The survival and abundance trends differ between *P. boylii* and *P. californicus*. Though morphologically similar with comparable life history strategies, we can infer that the small differences of the two species are in fact significant.

P. boylii abundance was consistently high in the winter and spring, except for those of 2012. The data for the trapping sessions immediately preceding these incongruities is unavailable, but I hypothesize that the low precipitation in the rainy season of 2012 is a factor of the dramatic decrease in population size. A long-term monitoring study in Australia found that all periods of drought during the study were associated with declines in abundance of several different small mammals (Recher *et al.* 2009), and a study on Montana deer mice found that higher temperatures and more precipitation were correlated to increased survival and recruitment (Luis *et al.* 2010).

P. boylii are known to prefer areas with medium to high cover density (Luensmann 2005), which may be scarce if drought has resulted in loss of cover. *P. boylii* survival slowly increases with time but also drops dramatically in 2013, a possible result of a lagging effect of an

abnormally dry winter. I plan to use precipitation, temperature, and vegetation data for the study area to further explore the effects of climate change on the *Peromyscus* population.

P. californicus abundance estimates follow a steady pattern of higher in the spring and lower in the fall, however after the winter of 2012, the population remains at a higher level than usual for the species. If the low precipitation was indeed an influence on the *p. boylii* population, perhaps this trend suggests that *P. californicus* are more resilient to climate change/dry winters. *P. californicus* does not need dense vegetation to survive, and usually nests on the ground, under debris such as fallen logs or the nests of *N. fuscipes* (Merritt 1974). Also, increased precipitation leads to increased primary productivity, and greater abundance of preferred food items (Luis *et al.* 2010). It is possible that *P. californicus*, with its ability to crack and consume seeds that *P. boylii* cannot (Merritt 1974), was able to thrive in a period of food scarcity. The best model of survival probability of *P. californicus* assumed that survival of the species did not change over time, but rather by season, indicating little long-term effect of a changing climate. Low survival from spring to summer may be due to lost energy exerted on efforts of females to raise new pups.

Though there are consistently fewer *P. californicus* present than there are *P. boylii*, *P. californicus* survival is higher. This suggests that *Peromyscus* populations do better at lower densities, possibly due to lack of intraspecific competition for resources, territory, or mates. It is also possible that since *P. californicus* are larger, they naturally occur at lower densities.

It is plausible that the consistently (relatively) low abundance estimates of both species in the fall is a reflection of the high availability of acorns throughout the habitat, and thus decreased desire/need to eat our bait. I plan to test this hypothesis in the future by comparing *Peromyscus* abundance estimates with the number of acorns.

The accuracy of abundance estimates for both species depended on the number of recaptures present each session (Krebs 1999). With a study area of only 200 by 300 meters, this is potentially problematic; some sessions had estimates with very wide confidence intervals. The Schnabel method does not regard differential capture probability, but instead assumes that marking individuals does not affect their catchability (recapture probability is constant). This excludes the possibility of “trap-happy” mice, which may be a factor during periods of low food availability, and “trap-shy” mice, who quickly learn to avoid the traps. I would like to strengthen the accuracy of my abundance estimates by incorporating differential recapture probability, for which I will utilize program MARK.

Appendix I

Confidence limits for the expectation of a Poisson Variable

c	80		90		95		99		99.9	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
0	0	1.819	0	2.436	0	3.285	0	4.771	0	7.065
1	0.223	3.546	0.105	4.532	0.051	5.323	0.010	6.914	0.001	9.561
2	0.824	4.758	0.532	5.976	0.355	6.686	0.149	8.727	0.045	11.532
3	1.535	5.882	1.102	7.512	0.818	8.102	0.436	10.473	0.190	13.596
4	1.819	7.564	1.745	8.597	1.366	9.598	0.823	12.347	0.429	15.144
5	2.645	8.529	2.433	9.716	1.970	11.177	1.279	13.793	0.739	17.114
6	3.546	9.922	2.436	11.342	2.613	12.817	1.785	15.277	1.107	18.490
7	3.914	10.969	3.589	12.531	3.285	13.765	2.330	16.801	1.520	19.987
8	4.758	12.481	4.532	13.553	3.285	14.921	2.906	18.362	1.971	21.603
9	5.696	13.243	4.532	15.298	4.460	16.768	3.507	19.462	2.452	23.170
10	5.882	15.205	5.976	15.985	5.323	17.633	4.130	20.676	2.961	24.677
11	7.564	15.438	5.976	17.810	5.323	19.050	4.771	22.042	3.491	26.126
12	7.564	16.914	7.512	18.403	6.686	20.335	4.771	23.765	4.042	27.530
13	8.529	18.537	7.512	20.054	6.686	21.364	5.829	24.925	4.611	28.907
14	9.922	18.938	8.597	21.035	8.102	22.945	6.668	25.992	5.195	30.372
15	9.922	20.414	9.484	22.258	8.102	23.762	6.914	27.718	5.794	31.993
16	10.969	22.037	9.716	23.824	9.598	25.400	7.756	28.852	6.405	33.622
17	12.481	22.326	11.342	24.452	9.598	26.306	8.727	29.900	7.028	34.745
18	12.481	23.744	11.342	26.158	11.177	27.735	8.727	31.839	7.065	35.916
19	13.243	25.707	12.531	26.935	11.177	28.966	10.009	32.547	8.023	37.384
20	15.205	25.707	13.553	28.092	12.817	30.017	10.473	34.183	8.840	39.108
21	15.205	26.972	13.553	29.988	12.817	31.675	11.242	35.204	9.561	40.124
22	15.438	28.469	15.298	30.179	13.765	32.277	12.347	36.544	9.561	41.245
23	16.914	29.983	15.795	31.639	14.921	34.048	12.347	37.819	10.710	43.041
24	18.537	30.152	15.985	33.444	14.921	34.665	13.793	38.939	11.532	44.162
25	18.537	31.507	17.810	33.643	16.768	36.030	13.793	40.373	11.532	45.213
26	18.94	33.03	18.28	35.08	16.77	37.67	15.28	41.39	12.73	47.08
27	20.41	34.42	18.40	37.00	17.63	38.16 ^s	15.28	42.85	13.60	48.01
28	22.04	34.58 ^s	20.05	37.04	19.05	39.76	16.80	43.91	13.60	49.32
29	22.04	35.92	21.03 ^s	38.44	19.05	40.94	16.80	45.26	14.89	50.97
30	22.33	37.39	21.03 ^s	40.10 ^s	20.33 ^s	41.75	18.36	46.50	15.14	51.76
31	23.74	39.07	22.26	40.99	21.36	43.45	18.36	47.62	16.11	53.54
32	25.71	39.07	23.82	41.74	21.36	44.26	19.46	49.13	17.11	54.45 ^s
33	25.71	40.23 ^s	23.82	43.22	22.94 ^s	45.28	20.28 ^s	49.96	17.11	55.88
34	25.71	41.62	24.45	44.87	23.76	47.02 ^s	20.68	51.78	18.49	57.15
35	26.97	43.25	26.16	45.00	23.76	47.69	22.04	52.28	18.49	58.20
36	28.47	44.20	26.93 ^s	46.38	25.40	48.74	22.04	54.03	19.87	59.87 ^s
37	29.98	44.48	26.93 ^s	47.97	26.31	50.42	23.76 ^s	54.74	19.99	60.63
38	29.98	45.79	28.09	49.12	26.31	51.29	23.76 ^s	56.14	21.27	62.67
39	30.15	47.20	29.99	49.56	27.73 ^s	52.15	24.92 ^s	57.61 ^s	21.60	63.18
40	31.51	48.99	29.99	50.96	28.97	53.72	25.83	58.35	22.68	65.13
41	33.03	49.46	30.18	52.64	28.97	54.99	25.99	60.39	23.17	65.70
42	34.42	49.94 ^s	31.64	53.46	30.02	55.51	27.72	60.59	24.13	67.62
43	34.42	51.25	33.44	54.05	31.67 ^s	56.99	27.72	62.13	24.68	68.19
44	34.58 ^s	52.64	33.44	55.44 ^s	31.67 ^s	58.72	28.85	63.63 ^s	25.63	70.12 ^s
45	35.92	54.29	33.64	57.10	32.28	58.84	29.90	64.26	26.13	70.66
46	37.39	55.16	35.08	57.99	34.05	60.24	29.90	65.96	27.18	72.66
47	39.07	55.33	37.00	58.48	34.66 ^s	61.90	31.84	66.81 ^s	27.53	73.10
48	39.07	56.61	37.00	59.85	34.66 ^s	62.81	31.84	67.92	28.76	74.96
49	39.07	57.95	37.04	61.41	36.03	63.49	32.55	69.83	28.91	75.52
50	40.23 ^s	59.44	38.44	62.69	37.67	64.95	34.18	70.05	30.37	77.22

(Crow & Gardner, 1959)

Appendix II

Abundance estimates for *P. boylii* and *P. californicus*

I used 95% confidence intervals—limits obtained from the Poisson Distribution. I included the total number of individuals caught per session in the table to provide a comparison with the estimate.

<i>P. boylii</i>				
trapping session	abundance estimate	lower confidence limit	upper confidence limit	total individuals caught (ΣU_i)
spring 2009	48.9722	36.1715	69.4094	48
summer 2009	47	35.46236	63.81434	45
fall 2009	37.59259	26.59853	57.57232	35
winter 2010	60.0333	41.4494	84.31648	49
spring 2010	54.4878	40.62557	77.11426	51
summer 2010	40.70968	29.04488	59.0824	38
fall 2010	35.89474	23.54485	61.01816	34
winter 2011	59.5	33.74355	111.7791	34
spring 2011	61.78788	45.03092	88.88405	57
summer 2011				
fall 2011				19
winter 2012	33.75	22.48726	52.66443	28
spring 2012	45.57895	29.89712	77.48054	36
summer 2012	50.42857	35.51308	74.12073	44
fall 2012	45.04348	30.42763	69.43234	37
winter 2013	58.89474	38.6315	100.1163	42

<i>P. californicus</i>				
trapping session	abundance estimate	lower confidence limit	upper confidence limit	total individuals caught (ΣU_i)
spring 2009	30.15384615	18.34862385	58.62997308	24
summer 2009	24.78261	16.74107	38.20119	24
fall 2009	20.76923	12.63808	40.38289	18
winter 2010	29.53846	17.97416	57.43344	24
spring 2010	47.6	21.29373	120.8122	24
summer 2010	31.1	17.63738	58.4257	22
fall 2010	22.5556	12.10639	45.5157	18
winter 2011	22.66667	10.61091	52.04746	16
spring 2011	27.27273	15.74803	56.3592	22
summer 2011				
fall 2011				10
winter 2012	24	12.88168	48.43049	19
spring 2012	47.63636	27.50656	98.44073	31
summer 2012	44.16667	26.06344	79.27012	31
fall 2012	42.35714	25.84441	73.1918	31
winter 2013	46.36364	26.77165	95.81063	32

Appendix III

Values of real function parameters with 95% confidence intervals.

Phi = survival probability, p = recapture probability.

Model: phi(season)p(.)

<i>P. californicus</i>					
Parameter	Survival period	Estimate	Standard Error	Lower confidence limit	Upper confidence limit
1:Phi	spring-summer	0.6303284	0.0519282	0.5241891	0.7252031
2:Phi	summer-fall	0.7668391	0.0676049	0.6105089	0.8734313
3:Phi	fall-winter	0.7962258	0.0723939	0.6197165	0.9035578
4:Phi	winter-spring	0.806038	0.0778564	0.6102598	0.916868
5:p	Year round	0.5734801	0.0364698	0.5009574	0.6429747

<i>P. boyllii</i>					
Parameter	Survival period	Estimate	Standard Error	Lower confidence limit	Upper confidence limit
1:Phi	spring-summer	0.5643134	0.0416423	0.4816878	0.6435154
2:Phi	summer-fall	0.5261591	0.0579925	0.4130969	0.6366009
3:Phi	fall-winter	0.604247	0.0603798	0.4820832	0.7146514
4:Phi	winter-spring	0.677273	0.0671708	0.5346776	0.7930817
5:p	year round	0.5089108	0.034987	0.4405972	0.5768931

Model: phi(year)p(year)

<i>P. boyllii</i>					
Parameter	Year	Estimate	Standard Error	Lower confidence limit	Upper confidence limit
1:Phi	2009	0.4576887	0.060267	0.3439926	0.5759697
2:Phi	2010	0.5524912	0.0448961	0.4637719	0.6379897
3:Phi	2011	0.5980782	0.0446217	0.5084068	0.6816353
4:Phi	2012	0.702191	0.051233	0.5932853	0.7921515
5:Phi	2013	0.4532792	0	0.4532792	0.4532792
6:p	2009	0.7747939	0.0931777	0.5470926	0.9073948
7:p	2010	0.5680133	0.0653728	0.4382088	0.6891041
8:p	2011	0.3475166	0.0583032	0.2434343	0.4685406
9:p	2012	0.5177614	0.0610867	0.399284	0.6342749
10:p	2013	0.4532792	0	0.4532792	0.4532792

<i>P. californicus</i>					
Parameter	year	Estimate	Standard Error	Lower confidence limit	Upper confidence limit
1:Phi	2009	0.6641365	0.0749943	0.5057034	0.7926134
2:Phi	2010	0.7348468	0.0478069	0.6314532	0.8176121
3:Phi	2011	0.752872	0.054267	0.6323507	0.843653

4:Phi	2012	0.760627	0.0539229	0.6400651	0.8502539
5:Phi	2013	0.6222664	0	0.6222664	0.6222664
6:p	2009	0.6811346	0.094236	0.477159	0.8333294
7:p	2010	0.6698458	0.0633682	0.5364046	0.7805886
8:p	2011	0.4917671	0.0761182	0.3475416	0.6373762
9:p	2012	0.5096074	0.0645653	0.3851028	0.6329314
10:p	2013	0.6222568	0	0.6222568	0.6222568

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