

Population Monitoring of Deer Mice (*Peromyscus maniculatus*) on the California Channel Islands, 1989 – 2009

Summary Data and Metadata

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Summary

This report presents all of the known records of deer mouse (*Peromyscus maniculatus*) monitoring from the California Channel Islands (excluding islands in Mexico), from 1989 – 2009. The data are from multiple sources, including the National Park Service, The Nature Conservancy, USGS, and independent researchers (Table 1). The data are the results of live trapping and release sampling, and include information on the number of animals captured during each session and estimates of population size and density. Also included are brief descriptions of how the data were collected, the methods of analysis, the vegetation type for most sampling sites, and explanations of missing data or data gaps.

Data Record

Deer mice are found on all of the eight California Channel Islands, and are the only native small mammal species on five of the islands. Long-term monitoring of deer mice by the National Park Service began in 1993 on three of the islands - San Miguel (SMI), Anacapa (AI) and Santa Barbara (SBI) - after several years of design studies and directed research (Arnold et al. 1988, Drost and Fellers 1991). Consequently the records for these three islands are the most extensive. Data were also collected by R. Klinger on Santa Cruz Island (SCI), and on San Nicolas Island (SNI) by C. Drost and C. Schwemm in cooperation with the US Navy. Deer mouse population monitoring has never been conducted on Santa Rosa Island, or as far as is known on San Clemente or Santa Catalina islands.

For all the islands except SCI the sampling methods have been identical, as described in Fellers et al. (1988), except that the size of the grid has occasionally varied. The sampling methods on SCI were likely similar, though additional communication with R. Klinger will be necessary to confirm grid size and design and the vegetation types in which each grid was located. A few details explaining the data collection history from each island are provided below.

San Miguel – SMI is the only one of the three islands with an extensive deer mouse dataset that supports terrestrial predators. Island foxes (*Urocyon littoralis*) are naturally abundant on SMI (and do not occur on the smaller islands), and prey heavily on mice. Consequently the population dynamics of deer mice changed dramatically when foxes were absent from the system between 1999 and 2005 (Schwemm 2008, Drost et al. in prep.). Deer mouse monitoring has been recently suspended on SMI due to the substantial increase in disturbance to traps by either foxes and/or ravens (*Corvus corax*). The last sampling event was in the spring of 2009, and efforts are ongoing to develop trapping methods that will prevent trap disturbance.

Santa Barbara – SBI has the longest record of deer mouse sampling. C. Drost began sampling on SBI in the late 1980s in support of the monitoring protocol development and as part of his own research (Drost and Fellers 1991). With some volunteer and USGS help, NPS has continued monitoring since that time except for two interruptions. In 1994 sampling was suspended due to Hanta virus concerns, and from about 1999-2001 staff shortages prevented annual sampling.

Anacapa – Anacapa has three islets, East (EAI), Middle (MAI) and West (WAI). Deer mice are native to all three islets, but were temporarily absent from all of them in the recent past. There were no mice on EAI when NPS began deer mouse monitoring in 1993. The cause of their extirpation from EAI is unknown, but it is suspected that it was due, at least in part, to the presence of black rats (*Rattus rattus*). NPS began monitoring mice on MAI and WAI in 1993, and continued until about 1997. Mice re-colonized EAI around 1998, again for unknown reasons, (rats were still present), and sampling began there in 1999.

In 2000 a rat eradication program was begun on AI that resulted in the temporary (about one year) elimination of mice from all three islets. Monitoring was conducted within the scope of the rat eradication program, but in different areas and using somewhat different methods than the previous NPS monitoring. The summary data from eradication monitoring are presented here, but NPS does not have access to the original data.

Santa Cruz – The data from Santa Cruz were obtained from NPS. R. Klinger provided a copy of the summary files to NPS but retains the original data (Tables 3 and 4). The estimation models cannot be applied without the data on individual capture histories, but the summary data provide important information on relative numbers of captures and individuals present on the SCI grids. If the original data become available population and density estimates can be calculated. In lieu of those estimates, comparisons can perhaps be made with the total numbers of captures and individuals as indices of abundance.

San Nicolas – SNI has the shortest record of monitoring because trapping started much more recently than on the other islands. Continuing monitoring on SNI will be especially informative because it both supports foxes and the fox population did not decline as on SMI and SCI.

Deer mouse monitoring methods

Population and density estimates for deer mice are obtained from mark-recapture methods, wherein animals are caught live, marked in some way, and released. Subsequent trapping results in the recapture of some portion of the marked population and new captures of unmarked animals. The relationship between the numbers of marked and unmarked animals in the population during the sampling period can be used to estimate the size of the total population.

A very coarse index of density can be derived by calculating the ratio of the total number of individuals captured to the sampling area, and in this report that value is termed the naïve density index. This value is almost certainly an underestimate of density in all cases, but has no variance and can be easily compared across events.

Mark-recapture data can be further analyzed using mathematical models to provide more robust estimates of population size. By incorporating the impacts of such factors as animal behavior and

environmental conditions on trapping success, models can better estimate the true number of unmarked animals remaining in the population and the actual area from which animals are being trapped. The application of models is used extensively in animal population studies (Menkens and Anderson 1988, Boulanger and Krebs 1994, Parmenter et al. 2003, Efford 2004, Hopkins and Kennedy 2004, Conn et al. 2006) and models have been applied to most of the datasets presented here.

Determining which of the available models to apply to a given dataset is sometimes problematic. Software programs have been developed to both assess the applicability of various models to specific datasets and then to apply the models to the data to estimate population size and density. The program most commonly used for the Channel Islands data has been CAPTURE (Nichols and Pollock 1983), and a general description of the application of CAPTURE to our data is provided in Arnold et al. (1988) and Drost and Fellers (1991).

A caveat of using models, however, is that they cannot be applied to small sample sizes. (i.e. if few animals are captured the data are insufficient to determine the importance of additional factors on the likelihood that animals will be caught (Hammond and Anthony 2006, Menkens and Anderson 1988). Because the deer mouse populations on the Channel Islands exist over time at both extremely high and very low population sizes, models cannot always be applied, a condition which potentially reduces the ability to temporally compare estimates to determine trends. To address this problem, a recent analysis concluded that using models whenever possible, and an index only when necessary, (as opposed to using indices in all cases), will most accurately describe the long-term changes in island deer mouse populations that may be of ecological relevance (Schwemm et al. 2008).

Summary of existing data

Reported here are the dates and locations of each trapping session (n=223) with corresponding values for total captures, and in most cases when trapping numbers were sufficient, calculated capture probabilities, and estimates of population and density using the most appropriate model selected by CAPTURE (Table 2). If the trapping data were insufficient for model application (generally less than 10 individuals), only a naïve density estimate is provided. In some cases original data and/or information needed to apply estimation models (for example the trapping grid size) were not available. There are also a few cases where the number of individuals captured was relatively high, but all models failed (for example in one instance where there were 31 individuals caught but only one was recaptured). Field definitions are as follows:

Island	Self-explanatory
Year	Self-explanatory
Site	Site names are taken from NPS protocols (SMI, AI and SBI), or as assigned by investigators (SCI and SNI). Site vegetation types (except for SCI) are presented in Table 5.
Season	Seasons are defined as follows: Dec-Feb (winter); Mar-May (spring); June-Aug (summer); Sept-Nov (fall)
Month	Self-explanatory

Individuals	Number of individual mice caught
Total Captures	The total number of first-time captures and recaptures
Capture Probability	CAPTURE-derived estimate of the likelihood of capture for an individual; higher probabilities result in higher confidence for population and density estimates
Model	The model that either was determined within CAPTURE to best fit the data, or in some cases that was selected by the investigator for various reasons (i.e. the selected model had a very high standard error). See White et al. 1978.
Population Estimate	Calculated by CAPTURE using the selected model
Population Estimate standard error	Calculated by CAPTURE
Density Estimate	Calculated by CAPTURE using the selected model
Density Estimate standard error	Calculated by CAPTURE
Density Index	The total number of individuals divided by the grid area

Future work on this project should include additional analysis of the data using program DENSITY (Efford 2004), an examination and comparison of the data and trends across islands and in relation to climate factors, and further data mining to be sure that deer mouse population sampling has not been conducted on Santa Catalina or San Clemente islands.

References

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Table 1. Summary of deer mouse sampling records from the Channel Islands, 1989-2009

Island	Sampling Grid (Site)	Inclusive Dates	Total Records	Spring (March-June)	Fall (Sept-Nov)	Winter (Dec-Feb)	Source	Comments
SMI	Willow Canyon (WC)	1993-2009	27	14	13	0	NPS	
SMI	Nidever Canyon (NC)	1993-2008	26	14	12	0	NPS	
SMI	Airstrip (AS)	1993-2009	26	15	11	0	NPS	
EAI	Grassland (EAI)	1997-2000	5	2	3	0	NPS/ IC	
MAI	Grassland (EAI)	1993-2000	10	5	4	1	NPS/ IC	
WAI	Grassland (EAI)	1993-2000	5	2	3	0	NPS/ IC	
SBI	Terrace Grassland (TG)	1991-2008	27	12	14	1	NPS/ C. Drost	
SBI	Terrace Coreopsis (TC)	1989-2009	33	15	16	2	NPS/ C. Drost	
SNI	Grassland	2004, 2006-2009	6	5	1	0	C. Drost/ C. Schwemm	
SNI	Coreopsis scrub	2004, 2006-2009	6	5	1	0	C. Drost/ C. Schwemm	
SCI	Matanzas	1991-1995	6	0	4	2	TNC/ R. Klinger	Source file for data attached; no original data
SCI	Willows	1991-1995	20	4	11	5	TNC/ R. Klinger	Source file for data attached; no original data
SCI	Canada del Medio	1991-1995	5	0	3	2	TNC/ R. Klinger	Source file for data attached; no original data
SCI	Valle del Medio	1991-1995	6	0	4	2	TNC/ R. Klinger	Source file for data attached; no original data
SCI	Lake Pasture	1991-1995	5	0	3	2	TNC/ R. Klinger	Source file for data attached; no original data
SCI	Central Valley	1991-1995	5	0	3	2	TNC/ R. Klinger	Source file for data attached; no original data
SCI	Portesuela	1991-1995	5	5	3	2	TNC/ R. Klinger	Source file for data attached; no original data
		TOTAL	223					

Table 2. Records of deer mouse population sampling, Channel Islands, 1989-2009

Island	Year	Site	Season	Month	Inds.	Total captures	Recaps	Capture prob.	Model	Pop. est.	Pop. est. s.e.	Dens. est. (#/ha)	Dens. est. s.e.	Dens. index (#/ha)
SMI	1993	WC	Spring	April	19	36	17	0.61	M (h)	22	2.9	38	17.5	48
SMI	1995	WC	Fall	Oct	139	179	40	0.25	M (h)	240	14.4	327	67.7	348
SMI	1996	WC	Fall	Oct	100	124	24	0.24	M (h)	173	12.3	262	61.0	250
SMI	1997	WC	Spring	March	15	23	8	0.43	M (h)	17	13.0	29	58.3	38
SMI	1997	WC	Fall	Oct	132	186	54	0.30	M (t)	189	2.0	230	21.4	330
SMI	1998	WC	Spring	March	16	23	7	0.51	M (h)	22	3.6	46	24.8	40
SMI	1998	WC	Fall	Oct	211	240	29	0.21	M (h)	388	19.0	692	101.7	528
SMI	1999	WC	Spring	May	135	196	61	0.47	M (b)	158	11.0	329	58.6	338
SMI	1999	WC	Fall	Nov	186	288	102	0.35	M (h)	278	14.1	673	91.8	465
SMI	2000	WC	Spring	April	14	26	12	0.51	M (h)	17	2.8	41	18.5	35
SMI	2000	WC	Fall	Oct	184	302	118	0.39	M (h)	260	13.1	517	79.7	460
SMI	2001	WC	Spring	April	44	74	30	0.45	M (h)	32	4.6	171	43.3	110
SMI	2001	WC	Fall	Oct	232	317	85	0.28	M (h)	378	17.5	895	114.0	580
SMI	2002	WC	Spring	April	69	97	28	0.30	M (h)	109	9.3	238	58.7	173
SMI	2002	WC	Fall	Oct	156	268	112	0.57	M (t)	176	6.2	312	37.5	390
SMI	2003	WC	Spring	April	68	117	49	0.40	M (h)	97	8.1	184	48.7	170
SMI	2003	WC	Fall	Nov	145	184	39	0.25	M (h)	245	14.4	525	87.4	363
SMI	2004	WC	Spring	April	116	207	91	0.47	M (h)	147	8.7	362	52.1	290
SMI	2004	WC	Fall	Oct	249	351	102	0.46	M (tb)	277	13.9	631	97.1	623
SMI	2005	WC	Spring	May	71	116	45	0.37	M (h)	104	8.6	186	48.4	178
SMI	2005	WC	Fall	Nov	85	96	11	0.20	M (h)	157	12.1	381	79.5	213
SMI	2006	WC	Spring	May	113	231	118	0.58	M (h)	133	6.5	144	32.3	283
SMI	2007	WC	Spring	May	19	41	22	0.68	M (h)	20	2.4	30	13.4	48
SMI	2007	WC	Fall	Nov	45	78	33	0.43	M (h)	60	5.9	82	28.7	113
SMI	2008	WC	Spring	May	46	76	30	0.53	M (t)	52	3.5	40.7	21.0	115
SMI	2008	WC	Fall	Nov	74	110	36	0.26	M (tb)	345	498.4	174.8	75.9	185
SMI	2009	WC	Spring	May	52	69	17	0.27	M (h)	86	8.5	96.1	35.1	130
SMI	1993	NC	Spring	April	46	112	66	0.78	M (h)	48	2.6	91	16.4	115
SMI	1994	NC	Fall	Oct	168	223	55	0.27	M (b)	206	16.1	339	87.1	420
SMI	1995	NC	Spring	April	49	94	45	0.37	M (b)	65	13.0	131	62.4	123
SMI	1995	NC	Fall	Oct	167	254	87	0.34	M (h)	252	13.6	395	69.0	418
SMI	1997	NC	Spring	March	84	175	91	0.60	M (h)	97	5.0	155	35.5	210
SMI	1998	NC	Spring	March	62	126	64	0.58	M (h)	73	4.7	150	40.1	155

Island	Year	Site	Season	Month	Inds.	Total captures	Recaps	Capture prob.	Model	Pop. est.	Pop. est. s.e.	Dens. est. (#/ha)	Dens. est. s.e.	Dens. index (#/ha)
SMI	1998	NC	Fall	Oct	255	327	72	0.25	M (h)	436	19.3	976	120.3	638
SMI	1999	NC	Summer	June	156	278	122	0.44	M (h)	213	11.4	415	67.0	390
SMI	2000	NC	Spring	April	52	94	42	0.45	M (h)	70	6.7	92	31.0	130
SMI	2000	NC	Fall	Oct	165	285	120	0.44	M (b)	176	5.7	211	59.2	413
SMI	2001	NC	Spring	May	78	173	95	0.62	M (h)	93	6.0	264	62.3	195
SMI	2001	NC	Fall	Nov	181	330	149	0.46	M (h)	240	11.8	465	68.1	453
SMI	2002	NC	Spring	May	80	133	53	0.46	M (h)	96	5.6	219	38.2	200
SMI	2002	NC	Fall	Nov	133	272	139	0.55	M (b)	146	6.5	270	54.5	333
SMI	2003	NC	Spring	May	103	206	103	0.52	M (h)	133	8.5	279	52.3	258
SMI	2003	NC	Fall	Oct	177	312	135	0.46	M (h)	224	10.9	264	48.7	443
SMI	2004	NC	Spring	March	108	245	137	0.68	M (h)	121	5.1	257	41.3	270
SMI	2004	NC	Fall	Oct	193	323	130	0.4	M (h)	269	13.1	577	78.7	483
SMI	2005	NC	Summer	June	123	241	118	0.63	M (h)	149	8.0	237	45.0	308
SMI	2005	NC	Fall	Nov	209	317	108	0.39	M (h)	310	14.9	561	82.1	523
SMI	2006	NC	Spring	May	67	156	89	0.70	M (h)	74	3.9	157	29.1	168
SMI	2006	NC	Fall	Nov	168	263	95	0.36	M (h)	243	12.9	419	72.8	420
SMI	2007	NC	Spring	May	8	13	5	0.48	M (h)	9	2.2	22	16.1	20
SMI	2007	NC	Fall	Nov	59	128	69	0.60	M (t)	60	0.8	152	8.6	148
SMI	2008	NC	Spring	May	38	50	12	0.26	M (h)	64	7.4	160	49.7	95
SMI	2008	NC	Fall	Nov	152	289	137	0.60	M (h)	189	9.8	419.2	57.2	380
SMI	1993	AS	Spring	April	26	48	22	0.47	M (h)	34	4.2	78	29.6	65
SMI	1995	AS	Winter	Feb	35	65	30	0.50	M (h)	43	4.1	67	26.4	88
SMI	1995	AS	Fall	Oct	143	218	75	0.35	M (h)	210	12.2	451	77.7	358
SMI	1996	AS	Fall	Oct	127	199	72	0.35	M (h)	188	11.6	462	77.4	318
SMI	1997	AS	Spring	March	38	54	16	0.34	M (h)	59	6.8	141	46.0	95
SMI	1997	AS	Fall	Oct	111	210	99	0.51	M (tb)	111	0.9	278	31.1	278
SMI	1998	AS	Spring	March	44	93	49	0.62	M (h)	50	3.8	110	20.8	110
SMI	1998	AS	Fall	Oct	242	317	75	0.26	M (h)	404	18.4	723	100.6	605
SMI	1999	AS	Spring	May	155	262	107	0.40	M (h)	218	11.5	541	74.4	388
SMI	1999	AS	Fall	Oct	171	275	104	0.36	M (h)	255	13.2	531	80.1	428
SMI	2000	AS	Spring	April	19	41	22	0.68	M (h)	20	2.1	17	9.4	48
SMI	2000	AS	Fall	Oct	151	286	135	0.49	M (h)	195	10.4	330	57.5	378
SMI	2001	AS	Spring	April	59	107	48	0.60	M (t)	63	2.5	84	21.4	148
SMI	2001	AS	Fall	Nov	138	239	101	0.43	M (h)	186	10.7	452	74.0	345
SMI	2002	AS	Spring	April	65	122	57	0.52	M (h)	79	44.2	183	44.2	163

Island	Year	Site	Season	Month	Inds.	Total captures	Recaps	Capture prob.	Model	Pop. est.	Pop. est. s.e.	Dens. est. (#/ha)	Dens. est. s.e.	Dens. index (#/ha)
SMI	2002	AS	Fall	Nov	85	168	83	0.52	M (h)	108	48.0	251	48.0	213
SMI	2003	AS	Spring	April	34	73	39	0.64	M (h)	38	21.7	95	21.7	85
SMI	2003	AS	Fall	Nov	93	159	66	0.41	M (h)	128	58.5	319	58.5	233
SMI	2004	AS	Spring	March	94	179	85	0.50	M (h)	119	47.8	224	47.8	235
SMI	2004	AS	Fall	Oct	99	182	83	0.47	M (h)	129	50.9	217	50.9	248
SMI	2005	AS	Spring	April	42	88	46	0.59	M (b)	50	39.4	102	39.4	105
SMI	2006	AS	Spring	March	117	242	125	0.59	M (h)	137	29.3	128	29.3	293
SMI	2007	AS	Spring	May	27	57	30	0.61	M (h)	31	22.1	67	22.1	68
SMI	2007	AS	Fall	Nov	23	50	27	0.72	M (tb)	23	0.4	58	10.0	58
SMI	2008	AS	Spring	April	24	44	20	0.46	M (h)	32	4.4	36	21.1	60
SMI	2009	AS	Spring	April	23	50	27	0.72	M (h)	23	0.8	54	14.4	58
SBI	1989	TC	Winter	Jan	126	256	130	0.66	M (h)	149	6.3	193	33.6	315
SBI	1991	TC	Winter	Jan	60	143	83	0.54	M (b)	66	3.4	106	28.0	150
SBI	1991	TC	Spring	Apr	37	79	42	0.73	M (h)	40	2.5	55	15.2	93
SBI	1991	TC	Fall	Oct	331	429	98	0.17	M (h)	657	30.0	1363	178.6	828
SBI	1992	TC	Fall	Sept	231	353	122	0.40	M (th)	339	15.1	590	81.2	578
SBI	1993	TC	Spring	Mar	22	49	27	0.74	M (h)	23	2.1	33	13.7	55
SBI	1993	TC	Fall	Oct	208	331	123	0.44	M (h)	308	14.7	668	90.5	520
SBI	1994	TC	Fall	Sept	48	96	48	0.64	M (h)	57	4.4	140	42.8	120
SBI	1995	TC	Spring	Mar	3	3	0	0.97						13
SBI	1995	TC	Fall	Nov	31	32	1	0.18	M (h)	61	7.7			78
SBI	1996	TC	Spring	Mar	131	205	74	0.42	M (h)	190	11.5	468	76.6	328
SBI	1996	TC	Fall	Oct	127	162	35	0.22	M (h)	212	13.4	262	57.8	318
SBI	1997	TC	Spring	Mar	19	30	11	0.45	M (t)	28	4.5	63	34.7	48
SBI	1997	TC	Fall	Oct	27	35	8	0.26	M (h)	47	6.4	86	37.0	68
SBI	1998	TC	Spring	Apr	50	66	16	0.27	M (h)	85	8.5	209	54.5	125
SBI	1998	TC	Fall	Nov	162	191	29	0.16	M (h)	294	16.4	577	89.4	405
SBI	2000	TC	Spring	Apr	43	92	49	0.70	M (b)	48	3.4	52	19.6	108
SBI	2000	TC	Fall	Oct	83	114	31	0.31	M (h)	134	10.2	753	110.2	346
SBI	2001	TC	Spring	Mar	141	215	74	0.40	M (h)	216	12.7	360	66.7	353
SBI	2001	TC	Fall	Sept	167	219	52	0.26	M (h)	283	15.5	1024	135.7	928
SBI	2002	TC	Spring	Apr	44	82	38	0.58	M (th)	56	5.2	140	34.1	110
SBI	2002	TC	Fall	Sept	2	2	0							5
SBI	2003	TC	Spring	Apr	60	89	29	0.38	M (h)	87	8.0	169	47.1	150
SBI	2003	TC	Fall	Oct	144	176	32	0.20	M (h)	254	15.0	1034	93.3	800

Island	Year	Site	Season	Month	Inds.	Total captures	Recaps	Capture prob.	Model	Pop. est.	Pop. est. s.e.	Dens. est. (#/ha)	Dens. est. s.e.	Dens. index (#/ha)
SBI	2004	TC	Spring	Apr	169	238	69	0.33	M (h)	277	15.0	453	76.5	423
SBI	2004	TC	Fall	Nov	27	39	12	0.23	M (h)	41	5.8	160	53.7	68
SBI	2005	TC	Spring	Mar	40	68	28	0.50	M (h)	53	5.5	68	26.1	100
SBI	2005	TC	Fall	Oct	266	385	119	0.31	M (h)	365	18.8	694	94.3	665
SBI	2006	TC	Fall	Sept	196	275	79	0.32	M (h)	283	18.9	573	86.0	490
SBI	2007	TC	Spring	May	6	8	2	0.33	M (h)	8	2.3	14	13.9	15
SBI	2007	TC	Winter	Dec	40	101	61	0.64	M (b)	40	0.4	16	70.2	100
SBI	2008	TC	Spring	Mar	34	67	33	0.52	M (h)	43	4.7	94	33.7	85
SBI	2009	TC	Spring	Mar	59	59	93	0.43	M (t)	63	2.9	132	20.1	147
SBI	1991	TG	Winter	Jan	7	16	9	0.76	M (h)	8	1.1	3	3.3	17
SBI	1991	TG	Spring	Apr	12	19	7	0.55	M (h)	15	2.8	3	3.7	30
SBI	1991	TG	Fall	Oct	203	255	52	0.24	M (h)	335	17.6	621	95.8	508
SBI	1992	TG	Fall	Sept	224	456	232	0.41	M (th)	279	9.8	383	55.1	560
SBI	1993	TG	Spring	Mar	6	9	3	0.48	M (h)	6	1.9			15
SBI	1994	TG	Fall	Nov	19	25	6	0.28	M (h)	32	5.3	73	32.6	48
SBI	1995	TG	Fall	Nov	12	14	2	0.17	M (h)	21	4.4	38		30
SBI	1996	TG	Spring	Mar	100	146	46	0.36	M (h)	156	11.0	240	54.7	250
SBI	1996	TG	Fall	Oct	84	101	17	0.18	M (t)	148	11.5	363	74.7	210
SBI	1997	TG	Spring	Mar	14	23	9	0.49	M (h)	20	3.8	28	16.1	35
SBI	1997	TG	Fall	Oct	12	16	4	0.30	M (th)	18	3.7	26	18.2	30
SBI	1998	TG	Spring	Apr	48	72	24	0.39	M (t)	73	7.5	130	39.2	120
SBI	1998	TG	Fall	Nov	46	53	7	0.14	M (h)	83	8.8	151	48.0	115
SBI	2001	TG	Spring	Apr	91	135	44	0.38	M (h)	137	10.1	273	60.0	228
SBI	2001	TG	Fall	Sept	93	118	25	0.23	M (h)	160	11.8	647	111.0	233
SBI	2002	TG	Spring	Apr	40	44	4	0.10	M (h)	75	8.5	119	42.0	100
SBI	2002	TG	Fall	Sept	0	0	0							
SBI	2003	TG	Spring	Apr	52	106	54	0.48	M (h)	86	9.9	91	38.0	130
SBI	2003	TG	Fall	Oct	123	157	34	0.24	M (h)	254		660	109.2	683
SBI	2004	TG	Spring	Apr	101	140	39	0.11	M (b)	174	23.8	251	55.3	253
SBI	2004	TG	Fall	Nov	5	5	0							13
SBI	2005	TG	Spring	Apr	36	46	10	0.24	M (h)	61	7.3	91	36.3	90
SBI	2005	TG	Fall	Oct	125	186	61	0.33	M (h)	164	11.1	365	68.8	313
SBI	2007	TG	Spring	Mar	3	3	0							8
SBI	2007	TG	Winter	Dec	9	19	10	0.70	M (th)	10	3.0			23
SBI	2008	TG	Spring	Mar	17	29	12	0.45	M (h)	22	3.4	44	21.0	43

Island	Year	Site	Season	Month	Inds.	Total captures	Recaps	Capture prob.	Model	Pop. est.	Pop. est. s.e.	Dens. est. (#/ha)	Dens. est. s.e.	Dens. index (#/ha)
SBI	2008	TG	Fall	Nov	68	122	54	0.29	M (b)	104	27.0	231	141.4	170
SBI	2009	TG	Spring	Mar	34	71	37	0.68	M (th)	76	28.3	179	311.5	85
AI	1997	EAI	Fall	Nov	24	44	20	0.58	M (o)	25	1.8	54	10.2	60
AI	1998	EAI	Spring	March	10	21	11	0.70	M (o)	10	0.6	12	11.4	25
AI	1999	EAI	Fall	Nov	65	141	76	0.65	M (h)	72	3.8	111	24.9	108
AI	2000	EAI	Spring	March	16	31	15	0.64	M (o)	16	1.1	8	4.3	27
AI	2000	EAI	Fall	Nov	130	239	109	0.56	M (o)	141	4.4	235	24.0	325
AI	1993	MAI	Spring	March	17	26	9	0.73	M (o)	18	4.0	45	10.9	43
AI	1994	MAI	Fall	Oct	59	81	22	0.28	M (t)	77	8.1	192	57.2	148
AI	1995	MAI	Spring	April	17	26	9	0.38	M (o)	23	3.6	55	24.7	43
AI	1995	MAI	Fall	Nov	75	93	18	0.30	M (h)	131	10.8	315	67.5	188
AI	1996	MAI	Fall	Oct	53	100	47	0.51	M (h)	65	5.2	260	45.4	221
AI	1997	MAI	Spring	March	11	15	4	0.28	M (h)	18	3.9	45	26.0	28
AI	1998	MAI	Spring	April	16	22	6	0.32	M (o)	23	11.0	22	17.7	40
AI	1999	MAI	Winter	Dec	70	124	54	0.27	M (b)	114	66.0	142	132.4	175
AI	2000	MAI	Spring	March	12	24	12	0.67	M (o)	12	0.8	20	6.2	30
AI	2000	MAI	Fall	Nov	109	151	42	0.31	M (h)	161	15.0	264	127.0	273
AI	1993	WAI	Spring	March	6	7	1	0.23	M (bh)	6	0.7	10	8.6	15
AI	1995	WAI	Spring	March	4	7	3							10
AI	1995	WAI	Fall	Nov	91	135	44	0.38	M (o)	120	19.0	190	54.2	228
AI	1996	WAI	Fall	Oct	24	45	21	0.54	M (h)	28	3.0	132	42.6	100
AI	2000	WAI	Fall	Nov	124	154	30	0.21	M (o)	243	32.1	265	175.9	310
SNI	2004	SN grass	Spring	April	14	21	7	0.33	M (h)	17	4.1	116	38.3	35
SNI	2004	SN grass	Winter	Dec	6	8	2							32
SNI	2006	SN grass	Spring	April					M (o)			79.4	13.5	
SNI	2007	SN grass	Spring	May					M (o)			12.6	14.9	
SNI	2008	SN grass	Spring	April					M (h)			20.4	14.5	

Island	Year	Site	Season	Month	Inds.	Total captures	Recaps	Capture prob.	Model	Pop. est.	Pop. est. s.e.	Dens. est. (#/ha)	Dens. est. s.e.	Dens. index (#/ha)
SNI	2009	SN grass	Spring	May					M (h)			37.7	21.8	
SNI	2004	SN cogi	Spring	April	38	65	27	0.43	M (h)	50	5.3	302	75.1	215
SNI	2004	SN cogi	Winter	Dec	23	44	21	0.46	M (h)	32	4.6	230	77.4	147
SNI	2006	SN cogi	Spring	April					M (o)			102.6	11.1	
SNI	2007	SN cogi	Spring	May					M (o)			114.2	26	
SNI	2008	SN cogi	Spring	April					M (h)			101.2	34.1	
SNI	2009	SN cogi	Spring	May					M (o)			110.2	13.5	

Table 3. Summary of original data available from Santa Cruz Island.

Island	Year	Site	Season	Month	Session Code	Individuals	Total Captures	Recaptures
SCI	1991	Canada del Medio	Fall	Nov	F91	5	8	3
SCI	1992	Canada del Medio	Fall	Nov	F92	15	26	11
SCI	1993	Canada del Medio	Winter	Dec	W93	18	30	12
SCI	1994	Canada del Medio	Winter	Dec	W94	2	4	2
SCI	1995	Canada del Medio	Fall	Nov	F95	4	7	3
SCI	1991	Central Valley	Fall	Nov	F91	9	16	7
SCI	1992	Central Valley	Fall	Nov	F92	24	38	14
SCI	1993	Central Valley	Fall	Nov	F93	14	23	9
SCI	1994	Central Valley	Winter	Dec	W94	0	0	0
SCI	1995	Central Valley	Winter	Dec	W95	0	0	0
SCI	1991	Lake Pasture	Fall	Nov	F91	21	37	16
SCI	1992	Lake Pasture	Fall	Nov	F92	94	112	18
SCI	1993	Lake Pasture	Winter	Dec	W93	56	74	18
SCI	1994	Lake Pasture	Fall	Nov	F94	12	17	5
SCI	1995	Lake Pasture	Winter	Dec	W95	10	16	6
SCI	1991	Matanzas	Winter	Jan	W91	0	0	0
SCI	1991	Matanzas	Fall	Nov	F91	5	9	4
SCI	1992	Matanzas	Fall	Nov	F92	21	34	13
SCI	1993	Matanzas	Fall	Nov	F93	16	23	7
SCI	1994	Matanzas	Fall	Nov	F94	3	8	5
SCI	1995	Matanzas	Winter	Dec	W95	2	4	2
SCI	1991	Portesuela	Fall	Nov	F91	8	11	3
SCI	1992	Portesuela	Fall	Nov	F92	21	29	8
SCI	1993	Portesuela	Fall	Nov	F93	17	27	10
SCI	1994	Portesuela	Winter	Dec	W94	5	10	5
SCI	1995	Portesuela	Winter	Dec	W95	2	4	2
SCI	1991	Valle del Medio	Winter	Jan	W91	0	0	0
SCI	1991	Valle del Medio	Fall	Nov	F91	0	0	0
SCI	1992	Valle del Medio	Fall	Nov	F92	15	19	4
SCI	1993	Valle del Medio	Fall	Nov	F93	0	0	0
SCI	1994	Valle del Medio	Winter	Dec	W94	0	0	0
SCI	1995	Valle del Medio	Fall	Nov	F95	0	0	0
SCI	1991	Willows_95	Winter	Jan	W91	1	1	0
SCI	1991	Willows_36	Fall	Nov	F91	8	12	4

SCI	1991	Willows_38	Fall	Nov	F91	3	6	3
SCI	1991	Willows_41	Fall	Nov	F91	9	13	4
SCI	1991	Willows_95	Fall	Nov	F91	13	19	6
SCI	1992	Willows_36	Fall	Nov	F92	20	31	11
SCI	1992	Willows_38	Fall	Nov	F92	12	20	8
SCI	1992	Willows_41	Fall	Nov	F92	29	47	18
SCI	1992	Willows_95	Winter	Dec	W92	31	45	14
SCI	1993	Willows_36	Fall	Nov	F93	3	6	3
SCI	1993	Willows_38	Fall	Nov	F93	0	0	0
SCI	1993	Willows_41	Fall	Nov	F93	11	16	5
SCI	1993	Willows_95	Fall	Nov	F93	5	7	2
SCI	1995	Willows_41	Spring	Mar	S95	4	6	2
SCI	1995	Willows_95	Spring	Mar	S95	5	8	3
SCI	1995	Willows_38	Spring	Mar	S95	0	0	0
SCI	1995	Willows_36	Spring	Mar	S95	2	5	3
SCI	1995	Willows_95	Winter	Dec	W95	0	0	0
SCI	1995	Willows_36	Winter	Dec	W95	4	10	6
SCI	1995	Willows_41	Winter	Dec	W95	0	0	0

Table 4. Data by capture days for Santa Cruz Island. (Density and population estimates cannot be done without knowing which individuals were recaptured.)

Site	Year	Date	Month	Season	Plot	Day	New Captures	Recaps	Total Captures	Total Individuals
Canada del Medio	1991	11/19/1991	Nov	Fall	74	1	3	0		
Canada del Medio	1991	11/20/1991	Nov	Fall	74	2	0	1		
Canada del Medio	1991	11/21/1991	Nov	Fall	74	3	2	2	8	5
Canada del Medio	1992	11/29/1992	Nov	Fall	74	1	9	0		
Canada del Medio	1992	11/30/1992	Nov	Fall	74	2	6	5		
Canada del Medio	1992	12/1/1992	Nov	Fall	74	3	0	6	26	15
Canada del Medio	1993	12/28/1993	Dec	Winter	74	1	8	0		
Canada del Medio	1993	12/29/1993	Dec	Winter	74	2	10	4		
Canada del Medio	1993	12/30/1993	Dec	Winter	74	3	0	8	30	18
Canada del Medio	1994	12/2/1994	Dec	Winter	74	1	1	0		
Canada del Medio	1994	12/3/1994	Dec	Winter	74	2	0	1		
Canada del Medio	1994	12/4/1994	Dec	Winter	74	3	1	1	4	2
Canada del Medio	1995	11/16/1995	Nov	Fall	74	1	3	0		
Canada del Medio	1995	11/17/1995	Nov	Fall	74	2	0	2		
Canada del Medio	1995	11/18/1995	Nov	Fall	74	3	1	1	7	4
Central Valley	1991	11/19/1991	Nov	Fall	23	1	5	0		
Central Valley	1991	11/20/1991	Nov	Fall	23	2	1	3		
Central Valley	1991	11/21/1991	Nov	Fall	23	3	3	4	16	9
Central Valley	1992	11/10/1992	Nov	Fall	23	1	12	0		
Central Valley	1992	11/11/1992	Nov	Fall	23	2	8	5		
Central Valley	1992	11/12/1992	Nov	Fall	23	3	4	9	38	24
Central Valley	1993	11/19/1993	Nov	Fall	23	1	9	0		
Central Valley	1993	11/20/1993	Nov	Fall	23	2	4	4		
Central Valley	1993	11/21/1993	Nov	Fall	23	3	1	5	23	14
Central Valley	1994	12/2/1994	Dec	Winter	23	1	0	0		
Central Valley	1994	12/3/1994	Dec	Winter	23	2	0	0		
Central Valley	1994	12/4/1994	Dec	Winter	23	3	0	0	0	0
Central Valley	1995	12/27/1995	Dec	Winter	23	1	0	0		
Central Valley	1995	12/28/1995	Dec	Winter	23	2	0	0		
Central Valley	1995	12/29/1995	Dec	Winter	23	3	0	0	0	0
Lake Pasture	1991	11/19/1991	Nov	Fall	78	1	16	0		
Lake Pasture	1991	11/20/1991	Nov	Fall	78	2	2	6		
Lake Pasture	1991	11/21/1991	Nov	Fall	78	3	3	10	37	21

Site	Year	Date	Month	Season	Plot	Day	New Captures	Recaps	Total Captures	Total Individuals
Lake Pasture	1992	11/7/1992	Nov	Fall	78	1	41	0		
Lake Pasture	1992	11/8/1992	Nov	Fall	78	2	32	7		
Lake Pasture	1992	11/9/1992	Nov	Fall	78	3	21	11	112	94
Lake Pasture	1993	12/29/1993	Dec	Winter	78	1	27	0		
Lake Pasture	1993	12/30/1993	Dec	Winter	78	2	21	6		
Lake Pasture	1993	12/31/1993	Dec	Winter	78	3	8	12	74	56
Lake Pasture	1994	11/29/1994	Nov	Fall	78	1	5	0		
Lake Pasture	1994	11/30/1994	Nov	Fall	78	2	5	1		
Lake Pasture	1994	12/1/1994	Nov	Fall	78	3	2	4	17	12
Lake Pasture	1995	12/8/1995	Dec	Winter	78	1	6	0		
Lake Pasture	1995	12/9/1995	Dec	Winter	78	2	3	1		
Lake Pasture	1995	12/9/1995	Dec	Winter	78	3	1	5	16	10
Matanzas	1991	1/8/1991	Jan	Winter	20	1	0	0		
Matanzas	1991	1/9/1991	Jan	Winter	20	2	0	0		
Matanzas	1991	1/10/1991	Jan	Winter	20	3	0	0	0	0
Matanzas	1991	11/19/1991	Nov	Fall	20	1	2	0		
Matanzas	1991	11/20/1991	Nov	Fall	20	2	2	1		
Matanzas	1991	11/21/1991	Nov	Fall	20	3	1	3	9	5
Matanzas	1992	11/10/1992	Nov	Fall	20	1	12	0		
Matanzas	1992	11/11/1992	Nov	Fall	20	2	6	7		
Matanzas	1992	11/12/1992	Nov	Fall	20	3	3	6	34	21
Matanzas	1993	11/19/1993	Nov	Fall	20	1	3	0		
Matanzas	1993	11/20/1993	Nov	Fall	20	2	10	0		
Matanzas	1993	11/21/1993	Nov	Fall	20	3	3	7	23	16
Matanzas	1994	11/29/1994	Nov	Fall	20	1	2	0		
Matanzas	1994	11/30/1994	Nov	Fall	20	2	1	2		
Matanzas	1994	12/1/1994	Nov	Fall	20	3	0	3	8	3
Matanzas	1995	12/8/1995	Dec	Winter	20	1	1	0		
Matanzas	1995	12/9/1995	Dec	Winter	20	2	0	1		
Matanzas	1995	12/10/1995	Dec	Winter	20	3	1	1	4	2
Portesuela	1991	11/22/1991	Nov	Fall	84	1	3	0		
Portesuela	1991	11/23/1991	Nov	Fall	84	2	1	1		
Portesuela	1991	11/24/1991	Nov	Fall	84	3	4	2	11	8
Portesuela	1992	11/29/1992	Nov	Fall	84	1	10	0		
Portesuela	1992	11/30/1992	Nov	Fall	84	2	7	3		
Portesuela	1992	12/1/1992	Nov	Fall	84	3	4	5	29	21

Site	Year	Date	Month	Season	Plot	Day	New Captures	Recaps	Total Captures	Total Individuals
Portesuela	1993	11/22/1993	Nov	Fall	84	1	11	0		
Portesuela	1993	11/23/1993	Nov	Fall	84	2	3	4		
Portesuela	1993	11/24/1993	Nov	Fall	84	3	3	6	27	17
Portesuela	1994	12/11/1994	Dec	Winter	84	1	4	0		
Portesuela	1994	12/12/1994	Dec	Winter	84	2	0	2		
Portesuela	1994	12/13/1994	Dec	Winter	84	3	1	3	10	5
Portesuela	1995	12/27/1995	Dec	Winter	84	1	2	0		
Portesuela	1995	12/28/1995	Dec	Winter	84	2	0	1		
Portesuela	1995	12/29/1995	Dec	Winter	84	3	0	1	4	2
Valle del Medio	1991	1/8/1991	Jan	Winter	81	1	0	0		
Valle del Medio	1991	1/9/1991	Jan	Winter	81	2	0	0		
Valle del Medio	1991	1/10/1991	Jan	Winter	81	3	0	0	0	0
Valle del Medio	1991	11/22/1991	Nov	Fall	81	1	0	0		
Valle del Medio	1991	11/23/1991	Nov	Fall	81	2	0	0		
Valle del Medio	1991	11/24/1991	Nov	Fall	81	3	0	0	0	0
Valle del Medio	1992	11/7/1992	Nov	Fall	81	1	2	0		
Valle del Medio	1992	11/8/1992	Nov	Fall	81	2	7	1		
Valle del Medio	1992	11/9/1992	Nov	Fall	81	3	6	3	19	15
Valle del Medio	1993	11/22/1993	Nov	Fall	81	1	0	0		
Valle del Medio	1993	11/23/1993	Nov	Fall	81	2	0	0		
Valle del Medio	1993	11/24/1993	Nov	Fall	81	3	0	0	0	0
Valle del Medio	1994	12/11/1994	Dec	Winter	81	1	0	0		
Valle del Medio	1994	12/12/1994	Dec	Winter	81	2	0	0		
Valle del Medio	1994	12/13/1994	Dec	Winter	81	3	0	0	0	0
Valle del Medio	1995	11/17/1995	Nov	Fall	81	1	0	0		
Valle del Medio	1995	11/17/1995	Nov	Fall	81	2	0	0		
Valle del Medio	1995	11/17/1995	Nov	Fall	81	3	0	0	0	0
Willows_95	1991	1/30/1991	Jan	Winter	95	1	0	0		
Willows_95	1991	1/31/1991	Jan	Winter	95	2	1	0		
Willows_95	1991	2/1/1991	Jan	Winter	95	3	0	0	1	1
Willows_36	1991	11/1/1991	Nov	Fall	36	1	2	0		
Willows_36	1991	11/2/1991	Nov	Fall	36	2	4	1		
Willows_36	1991	11/3/1991	Nov	Fall	36	3	2	3	12	8
Willows_38	1991	11/5/1991	Nov	Fall	38	1	1	0		
Willows_38	1991	11/6/1991	Nov	Fall	38	2	1	1		
Willows_38	1991	11/7/1991	Nov	Fall	38	3	1	2	6	3

Site	Year	Date	Month	Season	Plot	Day	New Captures	Recaps	Total Captures	Total Individuals
Willows_41	1991	11/5/1991	Nov	Fall	41	1	3	0		
Willows_41	1991	11/6/1991	Nov	Fall	41	2	4	1		
Willows_41	1991	11/7/1991	Nov	Fall	41	3	2	3	13	9
Willows_95	1991	11/1/1991	Nov	Fall	95	1	4	0		
Willows_95	1991	11/2/1991	Nov	Fall	95	2	4	1		
Willows_95	1991	11/3/1991	Nov	Fall	95	3	5	5	19	13
Willows_36	1992	11/17/1992	Nov	Fall	36	1	9	0		
Willows_36	1992	11/18/1992	Nov	Fall	36	2	9	4		
Willows_36	1992	11/19/1992	Nov	Fall	36	3	2	7	31	20
Willows_38	1992	11/17/1992	Nov	Fall	38	1	7	0		
Willows_38	1992	11/18/1992	Nov	Fall	38	2	5	2		
Willows_38	1992	11/19/1992	Nov	Fall	38	3	0	6	20	12
Willows_41	1992	11/21/1992	Nov	Fall	41	1	15	0		
Willows_41	1992	11/22/1992	Nov	Fall	41	2	7	8		
Willows_41	1992	11/23/1992	Nov	Fall	41	3	7	10	47	29
Willows_95	1992	12/9/1992	Dec	Winter	95	1	14	0		
Willows_95	1992	12/10/1992	Dec	Winter	95	2	8	5		
Willows_95	1992	12/11/1992	Dec	Winter	95	3	9	9	45	31
Willows_36	1993	11/1/1993	Nov	Fall	36	1	1	0		
Willows_36	1993	11/2/1993	Nov	Fall	36	2	2	1		
Willows_36	1993	11/2/1993	Nov	Fall	36	3	0	2	6	3
Willows_38	1993	11/5/1993	Nov	Fall	38	1	0	0		
Willows_38	1993	11/6/1993	Nov	Fall	38	2	0	0		
Willows_38	1993	11/7/1993	Nov	Fall	38	3	0	0	0	0
Willows_41	1993	11/5/1993	Nov	Fall	41	1	5	0		
Willows_41	1993	11/6/1993	Nov	Fall	41	2	2	4		
Willows_41	1993	11/7/1993	Nov	Fall	41	3	4	1	16	11
Willows_95	1993	11/1/1993	Nov	Fall	95	1	3	0		
Willows_95	1993	11/2/1993	Nov	Fall	95	2	1	0		
Willows_95	1993	11/2/1993	Nov	Fall	95	3	1	2	7	5
Willows_41	1995	2/28/1995	Mar	Spring	41	1	1	0		
Willows_41	1995	3/1/1995	Mar	Spring	41	2	1	0		
Willows_41	1995	3/2/1995	Mar	Spring	41	3	2	2	6	4
Willows_95	1995	2/28/1995	Mar	Spring	95	1	1	0		
Willows_95	1995	3/1/1995	Mar	Spring	95	2	2	0		
Willows_95	1995	3/2/1995	Mar	Spring	95	3	2	3	8	5

Site	Year	Date	Month	Season	Plot	Day	New Captures	Recaps	Total Captures	Total Individuals
Willows_38	1995	2/28/1995	Mar	Spring	38	1	0	0		
Willows_38	1995	3/1/1995	Mar	Spring	38	2	0	0		
Willows_38	1995	3/2/1995	Mar	Spring	38	3	0	0	0	0
Willows_36	1995	2/28/1995	Mar	Spring	36	1	2	0		
Willows_36	1995	3/1/1995	Mar	Spring	36	2	0	1		
Willows_36	1995	3/2/1995	Mar	Spring	36	3	0	2	5	2
Willows_95	1995	12/12/1995	Dec	Winter	95	1	0	0		
Willows_95	1995	12/13/1995	Dec	Winter	95	2	0	0		
Willows_95	1995	12/14/1995	Dec	Winter	95	3	0	0	0	0
Willows_36	1995	12/12/1995	Dec	Winter	36	1	4	0		
Willows_36	1995	12/13/1995	Dec	Winter	36	2	0	3		
Willows_36	1995	12/14/1995	Dec	Winter	36	3	0	3	10	4
Willows_41	1995	12/19/1995	Dec	Winter	41	1	0	0		
Willows_41	1995	12/20/1995	Dec	Winter	41	2	0	0		
Willows_41	1995	12/21/1995	Dec	Winter	41	3	0	0	0	0

Table 5. General vegetation types for deer mouse sampling grids

Island	Sampling Grid (Site)	Vegetation Type
SMI	Willow Canyon (WC)	Non-native annual grasses
SMI	Nidever Canyon (WC)	Lupine scrub
SMI	Airstrip (AS)	Haplopappus scrub
EAI	Grassland (EAI)	Non-native annual grasses/iceplant
MAI	Grassland (MAI)	Non-native annual grasses
WAI	Grassland (WAI)	Non-native annual grasses
SBI	Terrace Grassland (TG)	Non-native annual grasses
SBI	Terrace Coreopsis (TC)	Coreopsis/grass mix
SNI	Grassland (SN-G)	Non-native annual grasses
SNI	Coreopsis scrub (SN-C)	Coreopsis/lupine scrub
SCI	Matanzas	Unknown
SCI	Willows	Unknown
SCI	Canada del Medio	Unknown
SCI	Valle del Medio	Unknown
SCI	Lake Pasture	Unknown
SCI	Central Valley	Unknown
SCI	Portesuela	Unknown