Small Mammal Survey of the Point Loma Ecological Reserve

Draft Report

Prepared for:

National Park Service
Cabrillo National Monument

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

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2003

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INTRODUCTION

Point Loma Ecological Reserve is approximately 668 acres of natural habitat located on the Point Loma peninsula in San Diego County, California. It is co-managed by 5 agencies; National Park Service, Department of the Navy, Office of Veterans Affairs, U.S. Coast Guard, and the City of San Diego. The reserve is essentially a habitat island. The peninsula's western coastline abuts the Pacific Ocean, its eastern shore protects the entrance to the San Diego Bay, and the north borders the community of Point Loma (Fig. 1). The area is characterized by a Mediterranean-type climate, with 80% of 20-100 cm of annual rainfall (50 cm average) falling between November and April (Keeley 2000). The habitat is predominantly coastal sage scrub, with areas of succulent scrub and maritime chaparral. Most of the habitat has been maintained within the Reserve boundaries, although some areas may have been periodically disturbed for military, construction, and restoration purposes.

Because the reserve is small and isolated, it must be actively managed in order to retain its current species composition. Small populations of species are at great risk of extirpation due to demographic and environmental stochasticity and low genetic variability. These populations cannot be naturally re-established once they are gone. It is important that all species within the reserve are inventoried, monitored, and managed to best ensure their persistence.

In 2002, we sampled small mammals throughout the reserve using live-traps. Historically, 11 small mammal species have been recorded on the peninsula. We captured 5 species, 2 of which are listed by California Department of Fish and Game as Mammal Species of Special Concern. Although we did not assess plant species composition or vegetation structure in this survey, trends in the data collected suggest associations between small mammal species and vegetative cover characteristics. We used the data collected in this survey, as well as those generated in previous surveys, to identify immediate research needs and make recommendations for future small mammal monitoring and management activities.

METHODS

Design and Protocol

We live trapped small mammals on thirteen 100 m transects located throughout the Pt. Loma Ecological Reserve (Fig. 2). The transects were located in coastal sage scrub habitat on the eastern (1-3, 11), southern (4 and 5), and western (6-13) slopes of the peninsula. Three of the transects (7, 9, and 12) were immediately adjacent to roads. Two of these 3 transects (7 and 9) were placed in what we considered disturbed habitat composed primarily of open non-native grasses. Each transect consisted of 10 trap stations placed 10 m apart. At

each trap station we placed 1 short Sherman live trap (3” x 3.5” x 9”) and 1 long (3” x 3.5” x 12”). We conducted a 3-day trapping session in January and 2-day sessions in May and November of 2002. We opened, set, and baited all traps with a mixture of oats and birdseed during the afternoon preceding a trap session and placed polyester batting in each trap as nesting material to protect the animals from cold night temperatures. We checked traps beginning at sunrise each morning thereafter. At the end of each trap session we collected and cleaned all traps.

For each capture we recorded the array, trap station, trap type (short or long), and date at which the capture occurred. During each capture we recorded, species identity, weight, gender, age, sexual characteristics, body measurements and either recorded or assigned (first capture) a unique toe-clip. We placed tissue in microtubes containing alcohol for preservation and future analysis and labeled them with species, array, trap station, and date of capture. We used Pesola spring scales to weigh each animal to the nearest gram. We used the presence or absence of juvenile gray pelage to distinguish juveniles from adults. Female sexual characteristics recorded included vagina condition (perforate or not perforate) and pregnancy (pregnant or not pregnant), and male sexual characteristics included testes condition (descended or not descended). We measured body length from the tip of the nose to the base of the tail, hind feet from the nail tip to the end of the heel, tail length from the base of the tail to the tip, and ear length from the base of the ear to the tip of the ear. After examination and marking, all individuals were released at the site of capture.

Statistics

Demographic variables were calculated for every species at each array when possible. Population abundances were estimated as the Minimum Number Alive (MNA; Krebs 1966). We estimated capture probabilities by averaging across individuals, the number of captures of an individual divided by the number of possible captures of that individual. We then used general linear modeling (GLM) in Systat version 10.0 (SPSS 2000) to test for significant differences in capture probabilities across array and session. Because capture probability estimates were biased only by session for *P. californicus* (GLM, $F = 10.687$, *d.f.* = 2, 141, $P = 0.0001$) and *P. eremicus* (GLM, $F = 4.207$, *d.f.* = 2, 285, $P = 0.016$), but not by array, MNA is used here to provide low-bias estimates for population abundance comparisons (Table 1).

We calculated other demographic variables either at, or across each array during each trapping session as follows. In cases of multiple captures of an individual within a trapping session, we used data collected at the first capture. Age structure was the proportion of juveniles captured relative to all captures. Sex ratio was the proportion of females captured. Reproductive activity was the proportion of individuals showing external signs of reproductive activity. For males, descended testes indicated reproductive activity and a perforate vagina and/or pregnancy were considered signs of reproductive activity for females.

To test for significant effects of explanatory variables (array and session) on continuous dependent variables (MNA and average adult weight), we used GLM in Systat version 10.0 (SPSS 2000). When we did not have enough degrees of freedom to run a GLM with an interaction term, or when no explanatory variables or interaction terms significantly influenced the dependent variable, we ran separate 1-way ANOVAs.

To test for significant effects of explanatory variables (array; 1-13 and session; 1-3) on proportional, or categorical, dependent variables (age structure; juvenile or adult, sex ratio; male or female, and reproductive activity; reproductive or non-reproductive), we ran chi-square tests in StatXact-5 (Cytel 2001).

Last, to test for significant effects of trap size (short or long) on sex of captures, for each species we compared the number of males and females caught in short and long traps using chi-square tests in StatXact-5 (Cytel 2001). To test for significant effects of trap size (short or long) on numbers of captures, we used chi-square tests in StatXact-5 (Cytel 2001) to compare the actual number of individuals captured in short and long traps to the number of individuals expected to be captured at random in short and long traps. For this test, males and females were examined separately when trap size had a significant effect on sex of captures, but grouped together otherwise.

RESULTS

Inventory and Diversity

A total of 352 captures of 212 individuals was recorded over 1,820 trap-nights (260 traps x 7 nights). Five small mammal species were captured (Tables 2A and 2B). The small mammal community was comprised of 3 relatively common and abundant species: the desert woodrat (*Neotoma lepida*), California mouse (*Peromyscus californicus*), and cactus mouse (*Peromyscus eremicus*). *Peromyscus eremicus* had the greatest number of captures and was found at all transect locations. Similarly, *P. californicus* and *N. lepida* were found at all but the 2 disturbed transects. In comparison, 2 species: the San Diego pocket mouse (*Chaetodipus fallax*) and the western harvest mouse (*Reithrodontomys megalotis*), were not commonly captured. *Chaetodipus fallax* was captured at only 4 transects on the west side of the peninsula. All 4 of these transects were located next to roads. The transect with the most *C. fallax* captures (9) was located in disturbed grassland. Similarly, a single capture of *R. megalotis* was at this same transect (9).

We conducted statistical analyses on the 3 most common species. Results indicated different patterns of abundance and/or reproductive activity for each species over time (Fig. 3, Table 2A) and space (Fig. 4, Table 2B). We present results for these individual species below.

Species Analyses

Neotoma lepida

Abundance of *N. lepida* varied significantly with array, with no captures on arrays 7 and 9 and greatest abundance on array 4 (GLM, $F = 6.137$, $d.f. = 10, 20$, $P < 0.0001$; Fig. 4). While the proportion of reproductive males was lowest during session 2 and highest during session 3, ($x^2 = 13.31$, $d.f. = 2$, $P < 0.0009$), the proportion of reproductive females was lowest during session 3 and highest during session 1 ($x^2 = 17.80$, $d.f. = 2$, $P < 0.0001$; Table 3).

Peromyscus californicus

Abundance of *P. californicus* decreased significantly from session 1 to session 3 (GLM, $F = 23.686$, $d.f. = 2, 19$, $P < 0.0001$; Fig. 3). Abundance also varied significantly with array, with no captures on arrays 7 and 9 and greatest abundance on array 8 (GLM, $F = 6.230$, $d.f. = 10, 19$, $P < 0.0001$; Fig. 4). The proportion of reproductive males varied significantly with array, with little reproductive activity on arrays 7-11 and high levels of reproductive activity on arrays 1-6 ($x^2 = 16.43$, $d.f. = 9$, $P < 0.0234$; Table 4).

Peromyscus eremicus

Abundance of *P. eremicus* decreased significantly from session 1 to session 3 (GLM, $F = 5.261$, $d.f. = 2, 24$, $P < 0.013$; Fig. 3). Abundance also varied significantly with array, with lowest abundance on array 7 and greatest abundance on array 4 (GLM, $F = 2.270$, $d.f. = 12, 24$, $P < 0.042$; Fig. 4). The proportion of reproductive males varied with array, with reproductive individuals captured only on arrays 1, 2, 4, 6, and 7 ($x^2 = 21.91$, $d.f. = 12$, $P < 0.0001$; Table 4). Average adult female weight varied with array with the lowest average weight on array 9 and the greatest on array 5 (GLM, $F = 3.176$, $d.f. = 11, 42$, $P < 0.003$; Fig. 5; Table 5).

Design Testing

Trap Length

While similar numbers of male *P. californicus* were captured in long and short traps, female *P. californicus* demonstrated a significant preference for long traps over short traps ($x^2 = 5.456$, $d.f. = 1$, $P < 0.0282$; Table 6). Though they did not demonstrate differences in trap length preference between sexes, both *N. lepida* ($x^2 = 9.453$, $d.f. = 1$, $P < 0.0026$) and *P. eremicus* ($x^2 = 9.037$, $d.f. = 1$, $P < 0.0038$) demonstrated significant preferences for long traps over short (Table 6).

DISCUSSION

Surveys conducted at the Point Loma Ecological Reserve in the spring and fall of 1996 (Rotenberry et al. 1999) documented the same 5 small mammal species and an additional 2 species that we did not encounter during this survey; the deer mouse (*Peromyscus maniculatus)* and large-eared woodrat (*Neotoma macrotis*, formerly *N. fuscipes*). A species list provided by Andrea Compton, Chief of Natural Resource Science for Cabrillo National Monument, also listed species found in past small mammal surveys that were not encountered in this current survey: the California vole (*Microtus californicus*), brush mouse (*Peromyscus boylii*), desert shrew (*Notiosorex crawfordi*), and house mouse (*Mus musculus*, a non-native species).

Of the species previously noted but not captured in this survey*, M. musculus* is associated with human-made structures, thus their presence in and around buildings is probable. *Microtus californicus* and *N. crawfordi* are preferentially captured using pitfall traps (Laakkonen J. et al. 2001, 2003, Jones et al. 1996, Szaro et al. 1988, R. Fisher and C. Brehme *unpublished data*) and are frequently recorded in the pitfall trap arrays located throughout the reserve (Brown and Fisher 2001). *Neotoma macrotis, P. maniculatus*, and *P. boylii*, however, are most effectively captured using Sherman traps. If these species are still present on the reserve, they likely would have been documented during this recent trapping effort.

Small mammal abundance and reproductive activity varied with time during this survey (Fig. 3 and Table 3). Reproductive activity of both *N. lepida* and *P. californicus* was greater in the wet season (January and November trapping sessions) than the dry season (May trapping session), though only significantly so with *N. lepida*. This pattern is consistent with previous descriptions of *N. lepida* and *P. californicus* reproductive activity (Ingles 1965). In contrast, *P. eremicus* reproductive activity did not decrease during the May trapping session, but instead dropped during the November trapping session. This agrees with previous descriptions of *P. eremicus* reproductive activity, which reported a drop in reproductive characteristics in October and November (Veal and Caire 1979).

Variations in small mammal abundance with space, likely driven by habitat selection, also became apparent during this survey. The absence of *N. lepid*a and *P. californicu*s on arrays 7 and 9, which consisted mostly of grasses and few shrubs, suggests these species prefer the more substantial vegetation structure found on the other arrays. This is consistent with previous descriptions of *N. lepida* and *P. californicus* habitat preferences (Ingles 1965). In contrast, *C. fallax*, a species typically found in open coastal sage scrub habitat, was found in moderate numbers on array 9, but was abundant nowhere else (Lackey 1996). Variations in small mammal reproductive activity and average weight with space provide further evidence for variation in habitat quality and selection (Figs. 4 and 5, Tables 4 and 5).

Lastly, we found significantly more small mammal captures in large traps than in standard traps within the coastal sage scrub habitat of the Point Loma

Ecological Reserve. Perhaps capture probabilities are increased with the use of large traps. Future trapping studies may someday shed further light on this interesting issue.

MANAGEMENT RECOMMENDATIONS

First, it is imperative to determine the confidence of previous researchers in their designation of the following species in the reserve; *N. macrotis (*formerly *fuscipes), P.* boylii and *P. maniculatus.* Some species can be difficult to distinguish from one another, even by somewhat experienced researchers*.* If there is confidence in the data's accuracy*,* it is vital to trap for these species in the areas where they were last documented and/or would most likely occur on the reserve. *Neotoma macrotis* and *P. boylii* are most often associated with dense oak woodland and chaparral habitats (Ingles 1965). There may be some areas of high density vegetation in the reserve that support these species. *Peromyscus maniculatus* is often associated with disturbed open areas and edges in Southern California. This species is also effectively captured in pitfall traps and, if present, should be documented with the current pitfall trapping regime. In the event that there is confidence in the previous data and there are no captures of these species after targeted efforts, we may assume we are documenting species relaxation in the reserve. A newly created fragment such as the Point Loma Ecological Reserve may initially contain more species than it is able to maintain (Bolger et al. 1997). The number of species in such a fragment may be expected to decline due to an excess of extinction rates over levels of immigration until equilibrium is reached (Saunders et al. 1991).

Long term monitoring of small mammals should occur on a yearly or bi-yearly basis in the reserve. This will provide the necessary data to document native species recoveries and/or declines, responses to habitat restoration activities, and any invasions of non-native species. Trapping should preferably occur in spring (to note reproductive activity) and fall (to record young of the year). In order to better understand and manage patterns of small mammal abundance at the Point Loma Ecological Reserve we recommend vegetation surveys of plant species composition and vegetation structure be coupled with any future small mammal surveys. It is important to understand the habitat preferences of each small mammal species in order to manage for them. Such management could be accomplished by setting up permanent Sherman trap transects. Sherman traps could also be placed in a pattern around the current herpetofauna arrays, where the vegetation is surveyed on an intermittent basis (Hathaway et al. 2003). The current overall low numbers of *C. fallax*, a California Species of Special Concern, suggest the need to provide more open habitat structure in the south and west portions of the reserve. Historically, disturbances such as fire probably created appropriate habitat patches for *C. fallax* needs. Currently, these habitat patches may be provided by anthropogenic disturbances. In order to maximize the number of species that the reserve can sustain, heterogeneity of habitat must be provided. For small mammals, this may include managing for both 'disturbed' and undisturbed habitats.

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Table 1. Capture probabilities (the number of captures of an individual divided by the number of possible captures of that individual) averaged for each species by array and session.

		Array												
	Session	1	2	3	4	5	6	7	8	9	10	11	12	13
N. lepida	1	0.13	0.14	0.20	0.17	0.11	0.33	*	0.33	*	0.25	0.33	0.17	0.24
	2	0.30	0.21	0.25	0.29	0.17	0.25	*	0.00	*	0.13	0.25	0.38	0.07
	3	0.40	0.21	0.25	0.25	0.17	0.00	*	0.00	*	0.06	0.00	0.25	0.29
P. californicus	1	0.43	0.67	0.44	0.27	0.56	0.48	*	0.26	*	0.33	0.33	0.00	0.67
	2	0.43	0.30	0.33	0.30	0.33	0.36	*	0.25	*	0.33	0.25	0.00	0.33
	3	0.07	0.00	0.17	0.00	0.00	0.07	*	0.14	*	0.17	0.13	0.50	0.00
P. eremicus	1	0.29	0.30	0.27	0.42	0.56	0.17	0.00	0.12	0.06	0.14	0.20	0.24	0.17
	2	0.21	0.11	0.40	0.17	0.33	0.33	0.50	0.18	0.25	0.29	0.15	0.25	0.21
	3	0.21	0.06	0.10	0.08	0.00	0.17	0.00	0.27	0.25	0.17	0.10	0.14	0.17

Table 2. Total captures and, in parentheses, numbers of unique individuals of each species by A) session and B) array.

A) Session	*N. lepida*		*P. californicus*		*P. eremicus*		*C. fallax*		*R. megalotis*		Total	
1	36	(28)	70	(41)	73	(59)	4	(3)	*	*	183	(131)
2	32	(11)	14	(3)	48	(20)	5	(3)	1	(1)	100	(38)
3	26	(15)	11	(9)	33	(18)	1	(1)	*	*	71	(43)
B) Array	***N. lepida***		***P. californicus***		***P. eremicus***		***C. fallax***		***R. megalotis***		**Total**	
1	12	(5)	13	(6)	12	(7)	*	*	*	*	37	(18)
2	8	(7)	11	(5)	12	(8)	*	*	*	*	31	(20)
3	17	(9)	10	(6)	9	(5)	*	*	*	*	36	(20)
4	22	(10)	6	(3)	20	(1)2	*	*	*	*	48	(25)
5	3	(3)	5	(3)	7	(3)	1	(1)	*	*	16	(10)
6	2	(2)	13	(6)	9	(5)	*	*	*	*	24	(13)
7	*	*	*	*	1	(1)	*	*	*	*	1	(1)
8	1	(1)	21	(14)	12	(10)	1	(1)	*	*	35	(25)
9	*	*	*	*	6	(6)	7	(5)	1	(1)	14	(12)
10	10	(7)	4	(2)	18	(9)	1	*	*	*	33	(18)
11	2	(2)	5	(4)	11	(8)	*	*	*	*	18	(14)
12	7	(3)	1	(1)	20	(13)	*	*	*	*	28	(17)
13	10	(6)	6	(3)	17	(10)	*	*	*	*	33	(19)

Table 3. Proportions of female, reproductive (male and female), and juvenile individuals during sessions 1-3. Proportions that vary significantly with session are in bolded letters. Number of captures used for proportion calculations are shown in parentheses.

Session		1		2		3	
N. lepida	Females	77%	(23/30)	67%	(14/21)	52%	(11/21)
	Reproductive Females	**91%**	**(21/23)**	**36%**	**(5/14)**	**27%**	**(3/11)**
	Reproductive Males	**86%**	**(6/7)**	**25%**	**(2/8)**	**100%**	**(10/10)**
	Juveniles	0%	(0/30)	3%	(1/40)	0%	(0/60)
P. californicus	Females	45%	(19/42)	69%	(9/13)	55%	(6/11)
	Reproductive Females	89%	(17/19)	67%	(6/9)	83%	(5/6)
	Reproductive Males	70%	(16/23)	25%	(1/4)	60%	(3/5)
	Juveniles	3%	(1/40)	0%	(0/13)	0%	(0/11)
P. eremicus	Females	40%	(24/60)	42%	(15/36)	63%	(19/30)
	Reproductive Females	83%	(20/24)	87%	(13/15)	63%	(12/19)
	Reproductive Males	14%	(5/36)	14%	(3/21)	0%	(0/11)
	Juveniles	0%	(0/60)	3%	(1/35)	7%	(2/28)

Table 4. Proportions of female, and reproductive individuals (male and female) at arrays 1-13. Proportions that vary significantly with array are in bolded letters. Number of captures used for proportion calculations are shown in parentheses. The number of juvenile individuals captured by array was too low for analyses.

Array		1		2		3		4		5		6		7	
N. lepida	Females	75%	(6/8)	71%	(5/7)	69%	(9/13)	50%	(8/16)	67%	(2/3)	50%	(1/2)	*	*
	Repro. females	50%	(3/6)	60%	(3/5)	44%	(4/9)	38%	(3/8)	50%	(1/2)	100%	(1/1)	*	*
	Repro. males	50%	(1/2)	100%	(2/2)	75%	(3/4)	75%	(6/8)	100%	(1/1)	100%	(1/1)	*	*
P. californicus	Females	43%	(3/7)	67%	(4/6)	43%	(3/7)	60%	(3/5)	33%	(1/3)	44%	(4/9)	*	*
	Repro. females	100%	(3/3)	75%	(3/4)	67%	(2/3)	67%	(2/3)	100%	(1/1)	75%	(3/4)	*	*
	Repro. males	**75%**	**(3/4)**	**100%**	**(2/2)**	**100%**	**(4/4)**	**100%**	**(2/2)**	**100%**	**(2/2)**	**80%**	**(4/5)**	*****	*****
P. eremicus	Females	64%	(7/11)	36%	(4/11)	29%	(2/7)	44%	(7/16)	25%	(1/4)	38%	(3/8)	0%	(0/1)
	Repro. females	57%	(4/7)	75%	(3/4)	50%	(1/2)	57%	(4/7)	100%	(1/1)	100%	(3/3)	*	*
	Repro. males	**50%**	**(2/4)**	**29%**	**(2/7)**	**0%**	**(0/5)**	**22%**	**(2/9)**	**0%**	**(0/3)**	**20%**	**(1/5)**	**100%**	**(1/1)**

Array		8		9		10		11		12		13	
N. lepida	Females	100%	(1/1)	*	*	78%	(7/9)	50%	(1/2)	40%	(2/5)	86%	(6/7)
	Repro. females	100%	(1/1)	*	*	86%	(6/7)	100%	(1/1)	50%	(1/2)	83%	(5/6)
	Repro. males	*	*	*	*	50%	(1/2)	100%	(1/1)	33%	(1/3)	100%	(1/1)
P. californicus	Females	44%	(8/18)	*	*	67%	(2/3)	100%	(4/4)	0%	(0/1)	67%	(2/3)
	Repro. females	88%	(7/8)	*	*	100%	(2/2)	75%	(3/4)	*	*	100%	(2/2)
	Repro. males	**30%**	**(3/10)**	*****	*****	**0%**	**(0/1)**	*****	*****	**0%**	**(0/1)**	**0%**	**(0/1)**
P. eremicus	Females	82%	(9/11)	50%	(3/6)	29%	(4/14)	44%	(4/9)	56%	(9/16)	42%	(5/12)
	Repro. females	100%	(9/9)	100%	(3/3)	75%	(3/4)	100%	(4/4)	78%	(7/9)	60%	(3/5)
	Repro. males	**0%**	**(0/2)**	**0%**	**(0/3)**	**0%**	**(0/10)**	**0%**	**(0/5)**	**0%**	**(0/7)**	**0%**	**(0/7)**

Table 5. Average adult male and female weights (in grams) of three species by A) session and B) array and C) total captures.

	N. lepida		*P. californicus*		*P. eremicus*	
A) Session	Male	Female	Male	Female	Male	Female
1	170.71	149.90	37.24	33.29	17.83	18.42
2	154.38	146.58	28.00	32.00	18.89	17.43
3	174.36	142.73	31.00	31.67	18.95	17.35
	N. lepida		*P. californicus*		*P. eremicus*	
B) Array	Male	Female	Male	Female	Male	Female
1	162.50	135.00	32.75	32.00	19.13	17.71
2	179.00	148.00	33.00	34.00	17.14	19.25
3	154.25	152.67	31.00	30.67	16.75	22.50
4	161.25	134.67	31.50	34.67	19.22	16.57
5	189.00	127.00	33.50	28.00	16.67	23.00
6	178.00	144.00	32.60	33.67	18.00	16.67
7	*	*	*	*	18.00	*
8	*	150.00	40.15	32.38	18.00	17.63
9	*	*	*	*	17.67	15.00
10	170.00	151.29	37.00	30.50	18.70	17.00
11	190.00	140.00	*	33.33	19.80	18.50
12	178.00	161.00	34.00	*	18.29	18.63
13	157.00	164.80	37.00	33.50	18.67	17.50
	N. lepida		*P. californicus*		*P. eremicus*	
C) Total	Male	Female	Male	Female	Male	Female
N	26.00	44.00	32.00	32.00	65.00	56.00
Mean	167.23	147.21	35.12	32.63	18.33	17.85
Std. Error	4.02	2.85	3.25	0.62	0.29	0.30

Table 6. Proportions of each species (males, females, and total) captured in long and short Sherman live traps (raw counts in parentheses).

		Long		Short	
N. lepida	Female	77%	(36/47)	23%	(11/47)
	Male	60%	(15/25)	40%	(10/25)
	Total	71%	(51/72)	29%	(21/72)
P. californicus	Female	79%	(27/34)	21%	(7/34)
	Male	50%	(16/32)	50%	(16/32)
	Total	65%	(43/66)	35%	(23/66)
P. eremicus	Female	66%	(38/58)	34%	(20/58)
	Male	69%	(47/68)	31%	(21/68)
	Total	67%	(85/126)	33%	(41/126)

Figure 1. Study site- Point Loma Ecological Reserve, San Diego, California.

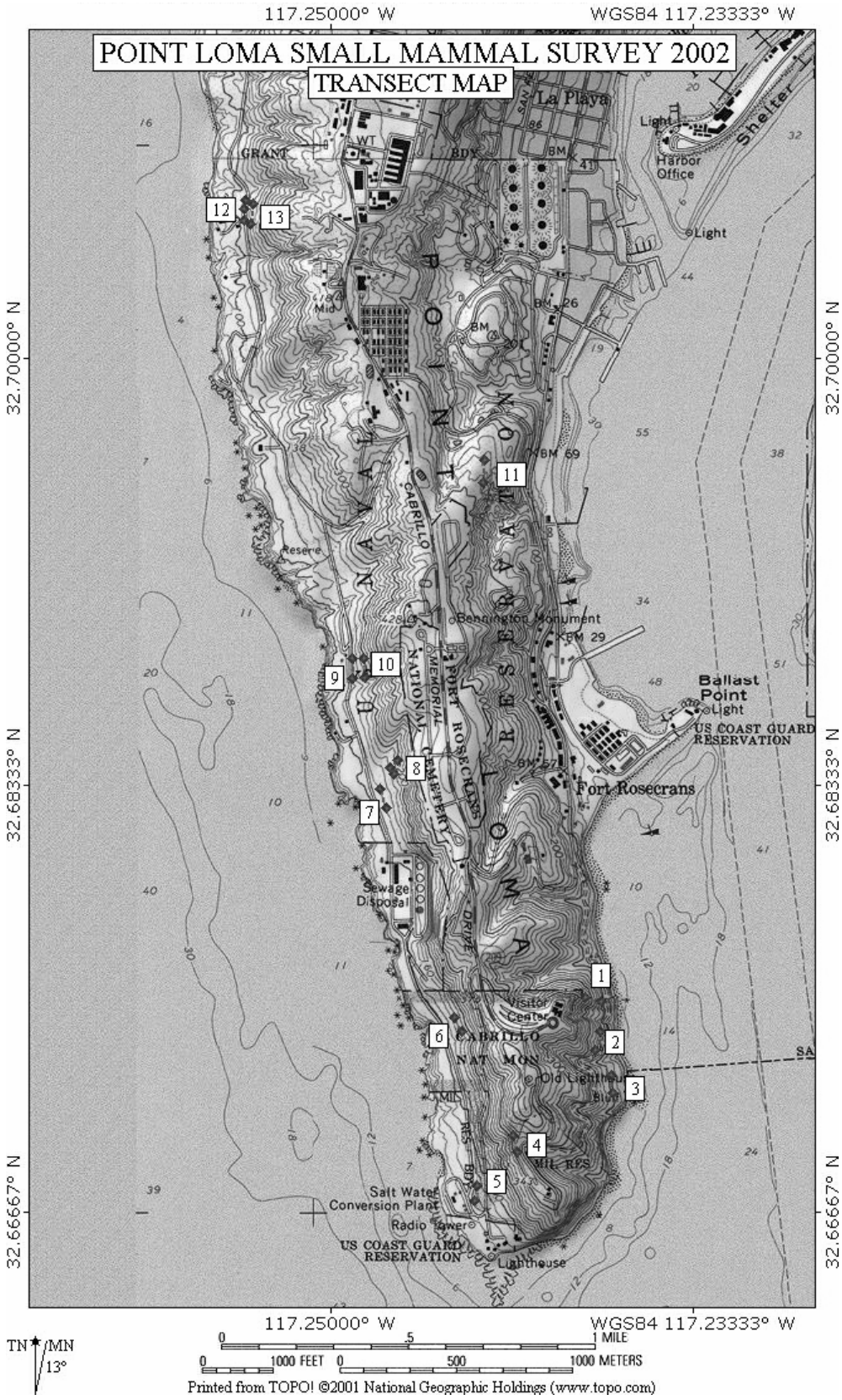

Fig. 2.-Locations or arrays 1-13 at Point Loma/ Cabrillo Monument.

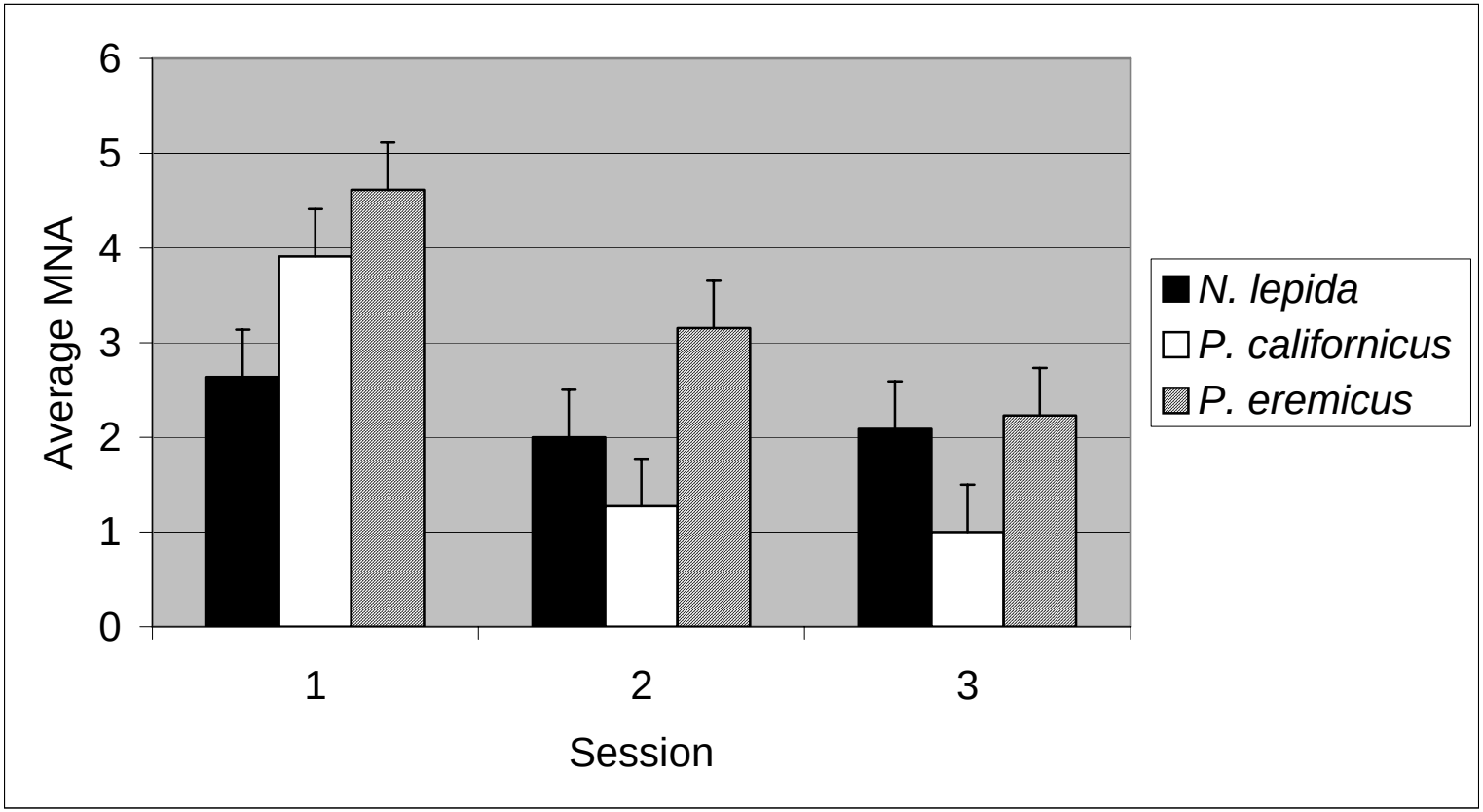

Figure 3. Average abundance of *N. lepida*, *P. californicus*, and *P. eremicus* at trap sessions 1-3 as estimated by MNA.

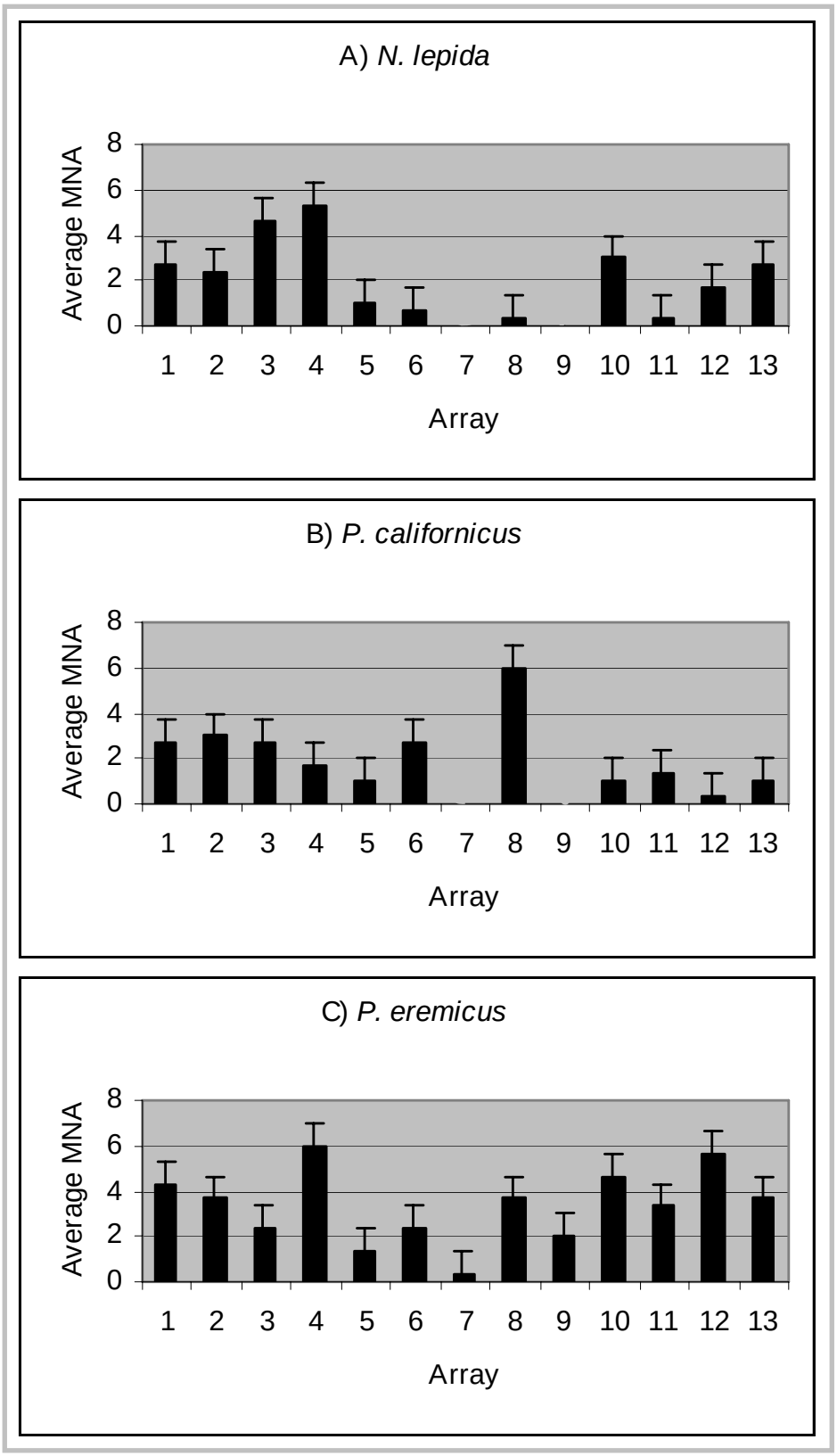

Figure 4. Average abundance of A) *N. lepida*, B) *P. californicus*, and C) *P. eremicus* at arrays 1-13 as estimated by MNA.

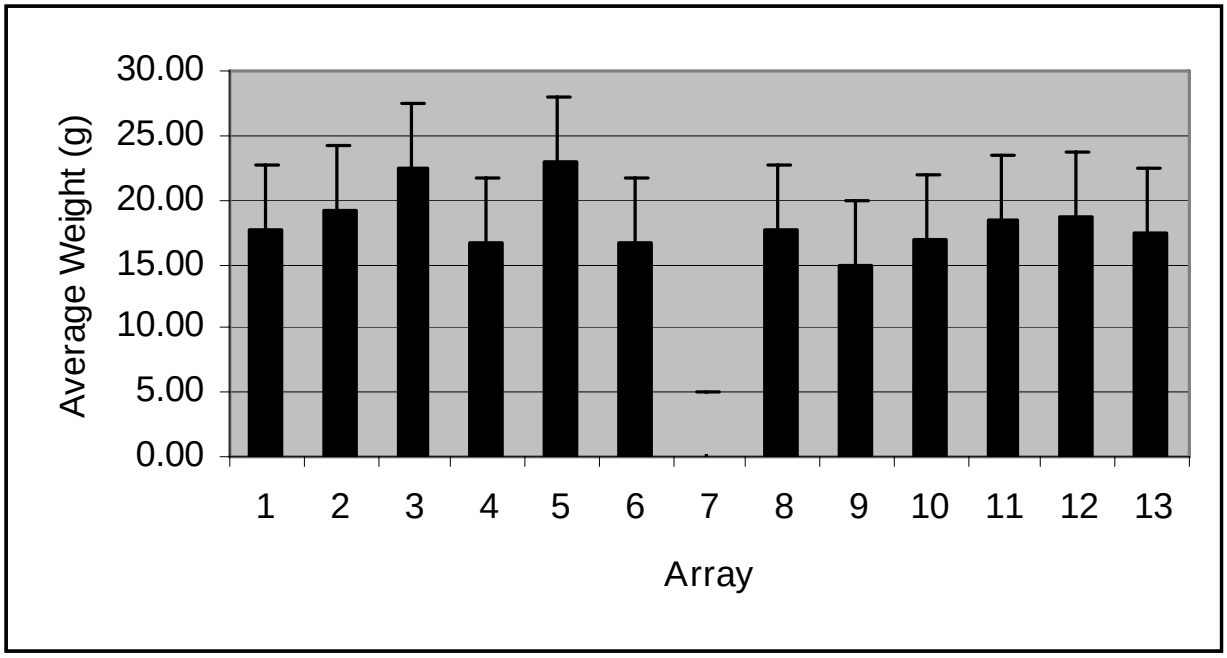

Figure 5. Average adult weight of female *P. eremicus* at arrays 1-13