Terrestrial Vertebrate Monitoring Channel Islands National Park 1994 Annual Report

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ABSTRACT

Amphibians and reptiles, deer mice (*Peromyscus maniculatus*), and island fox (*Urocyon littoralis*) populations were sampled to estimate abundance, population size and density on three islands from December 1993 to November 1994. Population index values were calculated for one salamander and two lizard species, whereas insufficient data was obtained to calculate such values for two addtional lizard species. Weight/length regressions were performed for populations of the same three species. The discovery of Hanta virus in several of the island deer mouse populations halted further sampling until the summer season, at which time it resumed only on Santa Barbara Island. Consequently, deer mouse populations were insufficiently sampled to provide estimates of density and population numbers on San Miguel and Anacapa islands in 1994. Island fox populations were sampled for population size and density on three grids on San Miguel Island, an increase of one grid from 1993. With only two years of sampling completed on these populations, no significant trends or changes are notable; however, this year's sampling provided important additions to the long-term database.

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INTRODUCTION

The terrestrial vertebrate monitoring program at Channel Islands National Park began in 1993, and includes sampling of native reptiles, amphibians, and mammals on three of the California Channel Islands. The descriptions and methodologies of the program are explained in the Terrestrial Vertebrates Monitoring Handbook (Fellers et al. 1988), hereafter referred to as the Handbook. The purpose of the program is to track population trends by annual estimates of population density or indices of abundance for each species. Long-term observations of these numbers will provide park management and outside researchers with population trends, with the expectation that any threats to the health of these populations will be reflected in the data.

Of the seven species included in the vertebrate monitoring program, two, the island fox, *Urocyon littoralis*, and the island night lizard, *Xantusia riversiana*, are endemic to the Channel Islands. In addition, separate subspecies have been identified for the island fox and the island deer mouse, *Peromyscus maniculatus*, for each of the islands on which they occur. All of the species monitored also exist on other islands in California not included in the program. There are four additional native vertebrate species which occur within Channel Islands National Park; however, they are not currently included in the monitoring program. Landbirds are monitored separately (Van Riper et.al 1988, Coonan 1995, Coonan 1996).

This is the second report which presents the data obtained during the annual sampling schedule.

AMPHIBIANS AND REPTILES

We continued to sample amphibian and reptile populations using cover board transects (Fellers et al. 1988; Schwemm 1995). Seven transect samples were taken on San Miguel Island, ten on Anacapa Island, and four on Santa Barbara Island during the sampling season between December 1993 and November 1994 (Table 1). Three additional transects not included in 1993 were sampled in 1994 on Anacapa Island.

Some transects were sampled more than once during the year (Table 1). Sampling schedules were modified from the described protocol in the Handbook (Schwemm 1995) during the first sampling year in 1993, but were not altered significantly from that schedule in 1994. In some instances the scheduling has been permanently changed due to additional knowledge of a species' natural history, while in other cases transportation conflicts or bad weather prevented access to the island at the appropriate time. Table 1 also gives the scheduled sampling dates and actual sampling dates for amphibian and reptile sampling.

METHODS

Details of methods used to sample amphibians and reptiles are described in the Handbook (Fellers et al. 1988). Sampling transects consist of two parallel rows of 30, 2-inch thick pine boards, which are turned over in sequence early in the morning during the scheduled sampling period. Any animals found are identified, weighed, measured, and replaced. The locations of the reptile/amphibian sampling transects are displayed in Figures 1-3.

Indices of population abundance for amphibian/reptiles are calculated by dividing the total number of animals found on a transect in a sampling year by the total number of boards checked (Fellers et al. 1988). The calculation of a population index is problematic due to the difficulty in obtaining three samples on each transect at the appropriate time each year (Schwemm 1995). Although we have data from three sampling occasions on some transects, the population index values presented in this report are based only on the sampling occasions which occurred between December and April, inclusive of those months, as directed in the Handbook. It will be left to future analysis of available samples to determine whether these indexes are adequate for comparison with other sampling results.

Several of the sampling periods were not those described in the written protocol. To determine when salamanders are active on the surface of their habitat, sampling was conducted this year whenever there was time available to do so.

RESULTS AND DISCUSSION

Pacific slender salamander (*Batrachoseps pacificus*)

Salamanders were found in 1994 during 11 of the 17 sampling periods, and on six of the eight transects on Anacapa and San Miguel Islands (Table 2). Salamanders do not occur on Santa Barbara Island. They were not found on the San Miguel Willow Canyon (WC) or the Middle Anacapa Fish Camp (FC) transects at any time. There were large differences in the number of salamanders found between samples on the same transect during 1994 and 1993.

The highest population index for salamanders was obtained from the Lighthouse (LH) transect on East Anacapa, and the lowest from the WC transect on San Miguel (Table 3). The LH transect is located in mostly grassland habitat, but the east end of the line runs into an area that is used for nesting by western gulls (*Larus occidentalis*) and is denuded of vegetation for several months of the year. The boards located at this end of the grid had no salamanders under them, so conceivably the index for this transect would be higher if the gulls did not nest here. This might suggest that this type of grassland habitat is preferred by the salamanders. The WC transect on San Miguel, however, is also grassland habitat, and no salamanders were found on this line during either of two sampling sessions. The only immediately apparent difference between these transects is that the boards on the LH transect on Anacapa were placed just six to eight months before the spring sampling season, while the WC boards on San Miguel had been in place for five years or more. Whether this difference in ages of the boards can be detected by the salamanders, resulting in their preference of one type over the other, is unknown. Off-season sampling this year resulted in observations of fewer animals in dry periods. For example, the East Anacapa Terrace Grassland (TG) transect revealed 13 salamanders during April sampling in 1994, but none a month later in May. Salamanders were also absent under the boards on Anacapa during the dry, pre-rainy season sampling in October and November, 1994.

The Terrace Grassland transect on Middle Anacapa supported the next fewest number of salamanders. Most likely this is also attributable to the high numbers of gulls that nest near this area and remove most of the vegetation, as on the LH grid. Much of this area never really revegetates during the year, and consequently is usually a very dry area. It is not surprising that few salamanders are found here.

Once the rain begins to soak the ground, the salamanders migrate to the surface, where they remain until the ground begins to dry again, usually in late spring (Hendrickson 1954). Because soil moisture is influenced by many variables, different transects in the different habitat types will support salamanders for varying periods of time. Annual variation in rainfall will likewise affect salamander numbers.

However, the amount of rain that falls in a given season does not alone influence salamander behavior, but also the period of rainfall. For example, Table 2 shows that the Air Strip (AS) grid on San Miguel, which is a combination grassland/shrub habitat, supported 19 salamanders on the transect in April of 1993, but only 1 during the same period in 1994. Interestingly, rainfall totals for December-April in 1993 on San Miguel were 5.93 inches and 8.61 inches for 1994 (Table 4a). So, while there was greater rainfall during all winter months in 1994, there were fewer salamanders.

When the amount of rainfall is divided into monthly totals, however, March of 1993 had 2 more inches of rain than did March of 1994 (Table 4a). On the Nidever Canyon transect (NC) the numbers of salamanders for April sampling for each year were the same. This transect is dominated by iceplant, which may absorb much of the precipitation which falls in the area.

Consequently, salamanders may be more influenced by short-term rainfall amounts, associated with local vegetation types, than solely by seasonal rainfall totals. Several more years of sampling will hopefully show what effects temporal variability of rainfall and local vegetation have on salamander movements.

Alligator lizards (*Elgaria multicarinata*)

Alligator lizards were sampled concurrently with salamanders and other lizards and were found on 14 of the 17 transect samples (Table 1). Alligator lizards were present on all transects except the San Miguel Island WC and the Middle Anacapa FC transects (Table 5). Along with the slender salamander, alligator lizards are commonly found under the cover boards. The alligator lizards are much less dependent on surface water than salamanders, and hence are found under the boards much longer into the dry season.

The highest population index values for alligator lizards were found on the San Miguel AS transect and the Anacapa LH transect, and the fewest on the San Miguel WC transect (Table 6). These results are similar to observations for salamanders, though there is no relationship between high numbers of salamanders and alligator lizards. For example, it could be suggested that high moisture conditions under the boards would favor salamanders and lizards concurrently, but this does not seem to be the case. When there were 19 salamanders on the AS transect in April 1993 and ten on the NC transect in January 1994, there were zero and two alligator lizards, respectively. Conversely, when there were 16 alligator lizards in January 1994 on the AS transect, there were only three salamanders.

There may be an interspecific competitive relationship, or different habitat requirements for each species. Hence, while both slender salamanders and alligator lizards utilize cover boards for habitat, they do so for different reasons and at different times.

The lowest population indices were calculated for the WC and NC transects, both on San Miguel. Although only two sampling sessions were included in the index calculations, each was sampled one additional time in 1993, and the results were similarly very low. As we continue to modify the monitoring protocols, we may eliminate such sites from sampling, if they continue to have null values.

Side-blotched and fence lizards (*Uta stansburiana* and *Sceloporous occidentalis*)

Side-blotched lizards occur only on Anacapa Island, and none were seen under cover boards. These lizards are commonly seen sunning themselves along the trails, but are not currently sampled systematically. Western fence lizards occur only on San Miguel Island, and are occasionally seen under the boards. This year three were seen during sampling on the AS transect (Table 7). Like the side-blotched lizards, fence lizards are commonly seen on the island but are not currently sampled.

Island night lizards (*Xantusia riversiana*)

Island night lizards occur only on Santa Barbara Island, and were sampled four times on three transects in 1994 (Table 1). Night lizards are usually common on the transects, and are often abundant (Table 8). Sampling has been inconsistent, and was not conducted during the spring. Cessation of the deer mouse monitoring program because of Hanta virus concerns (discussed in this report) combined with other Park projects occurring on the island, resulted in our postponing any vertebrate sampling until the summer. Based on previous night lizard research conducted on Santa Barbara during the 1980's, (Fellers and Drost 1991), the night lizard population is thought to be increasing due to recovery of the island after severe disturbance by feral animals (Fellers and Drost 1991). Consequently, the monitoring program for night lizards has been scaled back, and sampling is conducted only once each year (Schwemm, 1995).

The results from the three transects sampled in 1993 and 1994 indicate that night lizards exhibit definite habitat preferences (Table 8). Night lizard numbers were consistantly higher on the Cave-Middle (CM) transect. *Opuntia* and boxthorn were identified by Fellers and Drost (1991) as being the preferred habitat of night lizards. The CM habitat is a mixture of grassland and shrubland, with *Coreopsis* and boxthorn being the dominant shrubs, with patches of *Opuntia*. The other two transects, the TG and the MG, are grassland, and grassland/iceplant habitat respectively, and are less favored by night lizards on Santa Barbara Island.

The CM transect is the only one that was sampled in the same season both in 1993 and 1994 (Table 8). There were 50% fewer lizards on this transect in November of 1994 than in October of 1993. Continued sampling will determine whether lizards are more abundant under the boards earlier in the fall, whether these lower numbers in 1994 stem from sampling error, or whether the result of fewer observations was caused by real changes in population numbers.

All observed lizards, whether captured or not, were placed in one of three size classes (Table 9). This procedure is not described in the protocol, but is included here for two reasons. Fellers and Drost (1991) found that relative ages could be determined closely from animal size. Therefore, size class information would aid in the determination of the relative ages of the lizards. Fellers and Drost suggested that more young animals would be observed during the fall, and therefore by placing observed animals in size class, we could test this hypothesis. Secondly, occasionally two or three lizards are found under one board, and one observer cannot catch all the animals. By recording the estimated length of the animals, even when they are not measured, some information is gained regarding size and age.

WEIGHT-LENGTH REGRESSIONS

The monitoring handbook directs that regressions of weight vs. length^3 be done for each species, each year; it does not, however, specify whether this should be done island-wide for each species, or for each island population. We determined that any change in the regression slope over time would be of interest on an individual island basis. In cases where data is sufficient for analysis, regression coefficients (slopes) are presented for each species on each island for 1994 (Table 10). These numbers are of little interest in themselves, but will be used in future years as comparative values. Higher coefficients indicate healthier, i.e. 'fatter', animals, since higher slope values indicate greater weights per snout-vent length.

ISLAND DEER MOUSE

Island deer mouse (*Peromyscus maniculatus* subsp.) sampling was sharply reduced in 1994 as a result of the discovery of Hanta virus in deer mice on several of the Channel Islands. This virus is potentially fatal to humans, and is transmitted to humans from deer mice in many parts of the country. In December, 1993, we began a testing program of mice on the islands in conjunction with the Centers for Disease Control in Atlanta and the University of California School of Veterinary Medicine at Davis, California. By the summer of 1994, results from these tests showed that mice on San Miguel commonly carried the virus (23%) while mice on Santa Barbara did not (Table 11). Because deer mice have been extirpated from East Anacapa and because traveling to Middle and West Anacapa is difficult, those islands were not tested until October of 1994.

Blood tests for exposure to the virus were also conducted on several members of the park staff who worked closely with mice either during the monitoring program or in the course of other activities, and on ranch employees on Santa Rosa Island who had lived and worked around mice for many years. Though many of these people were thought to be at high risk of infection due to working in buildings with mice and mouse droppings, testing showed that none had been exposed to Hanta virus.

Based on this information, we resumed mouse sampling on Santa Barbara in June, and on San Miguel in November, 1994 (Table 12). In October we trapped on Anacapa for Hanta virus testing, and also trapped the Terrace Grassland (TG) grid for density (Table 12). The monitoring handbook does not call for San Miguel sampling in the fall, but because of delays in sampling we initiated the fall surveys to get preliminary mouse densities on San Miguel for 1994. Because of the off-season sampling of Anacapa and San Miguel, only density estimates from Santa Barbara can be used for comparison to previous years.

To avoid introduction of the virus on Santa Barbara Island, we used one set of traps solely on Santa Barbara, and one on San Miguel/Anacapa. Biologists took precautions when handling mice on San Miguel Island, since those mice did test positive, and on Anacapa, since the status of virus on that island was unknown.

METHODS

Deer mouse sampling methods are described in the Handbook (Fellers et al. 1988). They recommend placing 100 Sherman live traps in 10 x 10 grids, baited with rolled oats. The grids are maintained for three nights, and traps are checked early each morning. Each animal trapped is weighed, sexed, and marked with a small ear tag. Data obtained is entered into the program CAPTURE, (White et al. 1982), which selects an appropriate estimation model, and estimates population size and density. The locations of the deer mouse sampling grids are displayed in Figure 1-3.

RESULTS AND DISCUSSION

The spring season for mouse trapping was eliminated on all the islands in 1994 and we did not trap on San Miguel and Anacapa because of Hanta virus concerns (Table 12).

A single between-island comparison can be made in 1994 for San Miguel and Middle Anacapa islands. Two grids, one grid from each island, were trapped within a week of the other, and the results show that in October of last year, the density of mice was almost three times higher on the Nidever Canyon (NC) grid on San Miguel than on the Terrace Grassland (TG) grid on Middle Anacapa (Table 13). This difference may be due in part to the differences in habitat type. The grassland habitat on Middle Anacapa is populated by nesting gulls for much of the summer, resulting in large areas of bare ground within the mouse trapping grid. Therefore, mice likely avoid these areas, both because of lack of cover, increased susceptibility to predation, and sparseness of food. The NC grid on the other hand is mostly lupine shrubs and iceplant, a type of habitat which seems to be favored by mice.

The terrace grassland (TG) grid on Santa Barbara Island was the only grid trapped twice in

1994. In June, the density estimate on that grid was 81/ha, and in November, 53/ha. These estimates appear low when compared to those obtained in previous years (Drost and Fellers 1991; Schwemm 1995). The 1994 autumn season was followed by a winter of unusually high rainfall in Southern California. Most individual mice do not survive the winter season, and population sizes are typically lowest in the spring. Those mice surviving the winter begin reproduction in the spring, when females produce the first of one or more litters. It will be interesting to note what effect this year's severe winter conditions have on the reduced pre-winter population, and whether or not next summer's density estimates reflect this possibly detrimental combination of factors.

ISLAND FOX

Density and population estimates for island fox (*Urocyon littoralis*) were obtained from the Willow Canyon (WC) and the San Miguel Hill (SMH) grids on San Miguel Island, both of which were sampled last year. A third area, the Dry Lakebed (DLB) grid, was added.

METHODS

Trapping protocols were identical to those described last year (Schwemm 1995), except for a few changes in tagging methods and the number of grids. The success rate of the PIT tags applied in 1993 was high (see below) and for that reason, animals on the SMH and DLB grid were permanently marked with PIT tags, and ear tags were applied only to foxes caught on the WC grid.

Foxes were marked temporarily on the head and/or ears with water-soluble markers, because it was important to know whether or not any particular animal had been caught during the current trapping session. These temporary marks were important for several reasons. The first time an animal is caught in any given year, it is thoroughly examined and weighed (Fellers et al. 1988; Schwemm 1995). The head mark indicated that an animal had been recently examined, that a PIT tag was currently in place, and that the animal did not need to be handled again. By eliminating this handling time, we reduced the level of stress on the animals and consequently increased the possibility of recapture.

Occasionally PIT tags were lost. We were, therefore, interested in whether or not a PIT tag was in place on any particular animal. It is often possible to read the PIT tag while the animal is in the cage, which is the optimal situation. If no tag could be read by this means, the animal was removed from the trap, and re-scanned. If a tag was present, the number was recorded and the animal released. If there was no PIT tag present, but there was a head mark, we could assume that it was a newly-tagged animal this year and the tag had been lost. If an animal had a head mark and no PIT tag, a new PIT tag was applied. Occasionally we could determine which PIT tag had been lost, but not in all cases. A step-down diagram showing the process used is shown in Figure 3.

PIT TAG SUCCESS

To assess the long-term reliability of PIT tags, we double-tagged all animals in 1993 with PIT and ear tags. Table 13 shows the number of each type of tag applied in 1993, and any documented losses. Our work and other's (Schooley et al. 1993; Fagerstone & Johns 1987) indicates that PIT tag loss occurs usually during the first few days after application, before the tag becomes constrained by connective tissue, and before the insertion hole is closed. Consequently, if a tag remained in place for the course of a trapping session, (2-5 days depending on how early in the week the animal was caught and how many days later it was recaptured), we felt confident that it would stay in place for the life of the animal. Conversely, ear tags can come out at any time, and do not become more secure with age.

During the first trapping session of 1994, we continued with double-marking, and then examined the success rate of PIT tags applied the previous year. Based on the success of the PIT tags and the dislike of some people for the ear tags and the damage they can cause, we eliminated all ear tagging with the start of the second grid in 1994.

GRID LOCATIONS

A third trapping grid was added to the protocol in 1994 (Figure 4). Last year we had time to trap only two grids (Schwemm 1995), although the protocol calls for three or four to be trapped each year (Fellers et al. 1988). The protocol describes two grids for the west end of the island. For several reasons we decided to include only one for future use. First, there was concern by park staff that we would effectively be trapping all of the island if we included all the grids as described in the protocol. Also, given the schedule, (Schwemm 1995), we would only have time to trap three grids each season. Consequently, we combined some of the area of each of the two west-end grids into a new grid which we call the Dry Lakebed grid.

We chose this new grid because of the high numbers of foxes observed here and the interesting nature of the habitat. We eliminated the westernmost grid because it is located in predominantly dune habitat, and not many foxes are seen in that area, except around a research station on the far west side of the grid. Also, people do sometimes feed fox from that station, and we wanted to avoid any animals that had become especially conditioned to obtaining food directly from humans.

The dry lakebed is an area of the island that is quite low, and occasionally floods during the winter and spring. When it is not flooded, it is predominantly a grassland, and is used as a landing strip for park fixed-wing operations. People landing here often report many fox in the area feeding around the perimeter of the meadow. This is somewhat of an artificial habitat, since the strip area is mowed each spring for landing, and many people during their trips on and off the island both store food in a closed box at the landing strip and occasionally eat lunch here.

The new grid includes the lakebed, most of the original grid to the east, and a small bit of the dune grid. Because of the narrow shape of the island at this point, seven trap spacings did not fit from north to south, so we had to shorten the north-south distance of the grid to six trap distances. To maintain the same number of traps as on the other grids, we increased the east-west length of the grid from seven to eight traps. Hence, the grid is a 6x8 trap configuration, resulting in 48 traps instead of the 49 on the other grids. Change in grid configuration is acceptable because CAPTURE takes into account the layout of the grid in its calculations.

RESULTS AND DISCUSSION

Table 14 presents the population and density estimates for all three grids, along with the standard errors of the estimates, as calculated for several models for each grid, and compares these estimates to those obtained last year. (The various models are based on different probabilities of capture for individuals from one trapping night to the next. See White et al. 1982 for a thorough explanation of CAPTURE).

CAPTURE results from 1994 data do not provide unambiguous estimates for either population or density on the three grids. For the WC and the DLB grid, CAPTURE's model selection process selected as most appropriate a model that resulted in estimates that were considerably higher than other models, with high standard errors. In this case it is hard to know whether to use estimates resulting from the selected model, or from a less preferred model but with a lower standard error. With many years of data behind us, it might be easier to judge which models are resulting in the best estimates. However, we only have one previous year of data on which to base any assumptions.

The comparison of weights of animals from one season to the next is one common tool utilized in wildlife studies for assessing population health (Caughley & Sinclair 1994). An observable decline in average weight from one year to the next can indicate effects of disease, lack of available food sources, parasite outbreaks, overpopulation, and/or other factors which may negatively affect the overall health of the population.

Average weights for adult males, adult females, and pups are presented by grid for 1994 in Table 15. Without prior weight data for foxes from San Miguel, we are unable to determine whether these weights are typical for the population. These data will be useful in comparison to future years and to other Channel Islands fox populations.

CONCLUSION

Several advancements were made in 1994 in the terrestrial vertebrate monitoring program, while some populations of mice and lizards were not sampled adequately due to Hanta virus concerns.

In the island fox monitoring program, a third sampling grid was added on San Miguel Island. Ear tags were eliminated from fox monitoring methodology based on the success of PIT tag marking.

The amphibian/reptile monitoring program was expanded to include three transects on Anacapa Island that were not sampled in 1993. Many amphibian and reptile sampling transects were sampled during periods outside of those specified in the protocol. This data provided additional information on the natural history of the sampled species.

Deer mice were not well sampled this year due to concerns regarding the threat of Hanta virus in island populations. An unexpected benefit of the discovery of Hanta virus was the participation of State, County, and University of California personnel in sampling activities on the islands.

Future monitoring activities will continue as much as possible the schedule established in 1993 and 1994. An attempt will be made in future years to relate changes in terrestrial vertebrate populations, as monitored in this program, with changes in other terrestrial processes, including vegetational changes and weather conditions.

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Table 1. Dates of sampling of amphibian/reptile transects on three islands, 1994.

Island	Transect	Actual sample date (s)	Scheduled sample dates
Santa Barbara	CAVE-MIDDLE (**CM**)	February/November	March/May/June
	TERRACE GRASSLAND (**TG**)	November	March/May/June
	MIDDLE-GRAVEYARD (**MG**)	February	March/May/June
San Miguel	AIR STRIP (**AS**)	December 93/January/April	December/January/April
	NIDEVER CANYON (**NC**)	January/April	December/January/April
	WILLOW CANYON (**WC**)	January/April	December/January/April
West Anacapa	TERRACE GRASSLAND (**TG**)	March/May	December/January/April
Middle Anacapa	TERRACE GRASSLAND (**TG**)	April/October	December/January/April
	FISH CAMP (**FC**)	October	December/January/April
East Anacapa	ICEPLANT (**IP**)	April/May	December/January/April
	LIGHTHOUSE (**LH**)	April/May/November	December/January/April

Table 2. Number of Pacific Slender Salamanders found on each transect sampled in 1993 and 1994.

Island	Transect	Date (s)	# of salamanders
San Miguel	Air strip (AS)	4/93	19
		12/93	3
		1/94	3
		4/94	1
	Nidever Canyon (NC)	4/93	3
		1/94	10
		4/94	3
	Willow Canyon (WC)	4/93	0
		1/94	0
		4/94	0
West Anacapa	Terrace grassland (TG)	3/93	6
		3/94	5
		5/94	0
Middle Anacapa	Terrace grassland (TG)	3/93	2
		4/94	1
		10/94	0
	Fish camp (FC)	10/94	0
East Anacapa	Iceplant (IP)	4/94	8
		5/94	3
	Lighthouse (LH)	4/94	13
		5/94	0
		11/94	1

Table 3. Population index values for Pacific Slender Salamanders on San Miguel and Anacapa Islands, 1994.

Transect	Sample size	# animals/board
San Miguel - **AS**	3	.039
San Miguel - **NC**	2	.128
San Miguel - **WC**	2	0
West Anacapa - **TG**	1	.083
Middle Anacapa - **TG**	1	.017
East Anacapa - **IP**	1	.133
East Anacapa - **LH**	1	.217

Table 4a. Monthly rainfall totals in inches for Santa Barbara, Anacapa, and San Miguel islands, winter seasonal months, 1992-1993 and 1993-1994.

	1992		1993						1994			
ISLAND	NOV	DEC	JAN	FEB	MAR	APR	NOV	DEC	JAN	FEB	MAR	APR
Santa Barbara	0	2.28*	5.81*	3.17	.03	0	0	.35	.73	1.56	2.02	.21
Anacapa	**	3.22	8.2	4.25	2.01	0	.62	1.49	.65	5.51	3.05	.29
San Miguel	.67	2.42	6.3	3.31	3.26	.03	1.05	2.0	.02	5.09	1.41	.57

*missing reports, this is an estimated total
** not available

Table 4b. Winter seasonal rainfall totals in inches for Santa Barbara, Anacapa, and San Miguel islands, 1992-1993, and 1993-1994.

ISLAND	1992-1993	1993-1994
Santa Barbara	11.29	4.87
Anacapa	17.68*	11.61
San Miguel	15.99	10.14

*does not include November, 1992

Table 5. Number of California Alligator Lizards found on each transect sampled in 1993 and 1994.

Island	Transect	Date (s)	# of lizards/board
San Miguel	Air Strip (AS)	4/93	0
		12/93	10
		1/94	16
		4/94	4
	Nidever Canyon (NC)	4/93	0
		1/94	2
		4/94	1
	Willow Canyon (WC)	4/93	0
		1/94	0
		4/94	0
West Anacapa	Terrace Grassland (TG)	3/93	3
		3/94	2
		5/94	2
Middle Anacapa	Terrace Grassland (TG)	3/93	1
		4/94	4
		10/94	5
	Fish Camp (FC)	10/94	0
East Anacapa	Iceplant (IP)	4/94	2
		5/94	2
	Lighthouse (LH)	4/94	6
		5/94	5
		11/94	12

Table 6. Population index values for California Alligator Lizards on San Miguel and Anacapa Islands, December 1993 - April 1994.

Transect	Sample size	# animals/board
San Miguel - **AS**	3	.167
San Miguel - **NC**	2	.025
San Miguel - **WC**	2	0
West Anacapa - **TG**	1	.033
Middle Anacapa - **TG**	1	.067
East Anacapa - **IP**	1	.033
East Anacapa - **LH**	1	.1

Table 7. Locations and Dates of Western Fence Lizards found in 1993 and 1994.

Island	Transect	Date (s)	# of lizards/board
San Miguel	Air Strip (AS)	4/93	1
		1/94	2
		4/94	1
	San Miguel Hill (SMH)	4/93	1

Table 8. Locations and dates of Island Night Lizards found on Santa Barbara Island in 1993 and 1994.

Transect	Date (s)	# of lizards	Population index value
Terrace-Grassland (TG)	7/93	2	
	11/94	7	.08
Middle-Graveyard (MG)	7/93	9	
	11/94	7	.13
Cave-Middle (CM)	10/93	38	
	11/94	15	.44

Table 9. Number of island night lizards observed in each size class on transects of 60 cover boards on Santa Barbara Island, 1993 and 1994.

	Size Class		
Date/Transect	Small (50-80 mm)	Medium (81-140 mm)	Large (>140 mm)
7/17/93 - **TG**	1 (14%)	3 (43%)	3 (43%)
7/20/93 - **MG**	1 (12%)	4 (44%)	4 (44%)
10/14/93 - **CM**	12 (31.5%)	14 (37%)	12 (31.5%)
2/14/94 - **CM**	19 (48%)	9 (23 %)	12 (30%)
11/8/94 - **TG**	2 (29%)	3 (43%)	2 (29%)
11/9/94 - **CM**	3 (23%)	8 (62%)	2 (15%)
11/11/94 - **MG**	3 (43%)	2 (29%)	2 (29%)

Table 10. Regression coefficients for weight vs length^3 for amphibian/reptile species on selected islands. Only presented for groups where data was sufficient for analysis.

	Island	**Sample size**	**Regression coefficient**
Alligator lizards	Anacapa	18	.552
Alligator lizards	San Miguel	17	1.83
Western fence lizards	San Miguel	3	4.46^{-5}
Island night lizards	Santa Barbara	27	.288
Pacific slender salamanders	San Miguel	4	1.46

Table 11. Percentages of mice found positive for Hanta Virus (all strains) on all five islands within Channel Islands National Park, and dates of testing.

Island	Date (s)	# and % of positive mice/total mice tested
Santa Barbara	2/94	0/58 **(0%)**
Anacapa *	10/94	3/40 **(7.5%)**
Santa Cruz	4/94	25/35 **(71%)**
Santa Rosa	1/94	25/50 **(50%)**
	4/94	19/31 **(61%)**
San Miguel	1/94	9/39 **(23%)**

* this is a different strain of the virus, currently believed to be non-lethal to humans

Table 12. Dates, locations, and results of deer mouse sampling, 1994.

	SBI- Terrace Grassalnd	SBI - Terraace *Coreopsis*	SMI- Nidever Canyon	MAI- Terrace Grassland	SBI- Terrace Grassland
Date	6/28-30/94	9/28-30/94	10/12-14/94	10/18-20/94	11/8-10/94
# Animals captured	41	48	168	59	19
Total captures	48	96	223	81	25
Selected model	M(t)	M (o)	M (b)	M (t)	M(t)
Population estimate w/95% C.I.	83 (40-126)	50 (46-54)	206 (174-238)	77 (61-93)	25 (16-34)
Density estimate/ha	81.2	131.0	339.4	192.3	53.0
S.E. of density estimate	43.3	23.0	87.0	57.2	23.9

SBI - Santa Barbara Island
SMI - San Miguel Island
MAI - Middle Anacapa Island

Table 13. Total number of ear and PIT tags applied in 1993, and documented losses.

	Ear tags	PIT tags
TAGS APPLIED	64	73
TAGS LOST	5	1
LOSS RATE	7.8 %	1.4 %

Table 14. Results of island fox trapping on San Miguel Island, 1993 & 1994

GRID	DATES	# PUPS/TOTAL INDIVIDUALS	% OF PUPS IN SAMPLE	TOTAL CAPTURES	SELECTED MODEL	MODEL SELECTION CRITERIA VALUE (highest is 1.0)	POPULATION ESTIMATE	S.E. of POPULATION ESTIMATE	DENSITY ESTIMATE/ha	S.E. of DENSITY ESTIMATE
WC/93	8/1-5/93	11/40	28	58	M(tbh)	1.00*	43	2.9	.13	.02
SMH/93	8/20-25/93	12/42	29	70	M(bh)	.91	46	3.9	.18	.05
WC/94	7/19-24/94	16/53	30	118	M(h)	1.00	115	16.2	.46	.10
					M(o)	.89	57	2.6	.15	.02
					M(t)	0	57	2.3	.15	.01
SMH/94	8/10-16/94	9/43	21	109	M(h)	1.00	53	4.0	.13	.03
					M(bh)	.97	43	.67	.11	.01
DLB/94	8/24-29/94	11/62	18	129	M(h)	1.00	102	10.5	.26	.07
					M(bh)	.82	64	2.1	.17	.01

* No estimator available for this model: used M(bh)

Note: In 1993, all estimators under the selected model returned with the lowest standard error.

Table 15. Average weights of island fox in kg. (x) plus standard errors (SE) and sample sizes (n), San Miguel Island, 1994.

Grid	Pups		Adults			
			Males		Females	
	x ± SE	n	x ± SE	n	x ± SE	n
Willow Canyon (WC)	1.35 ± 0.09	16	2.27 ± 0.06	16	2.08 ± 0.07	18
San Miguel Hill (SMH)	1.19 ± 0.08	9	2.25 ± 0.06	15	1.99 ± 0.07	14
Dry Lakebed (DLB)	1.45 ± 0.09	10	2.18 ± 0.07	29	2.03 ± 0.05	23

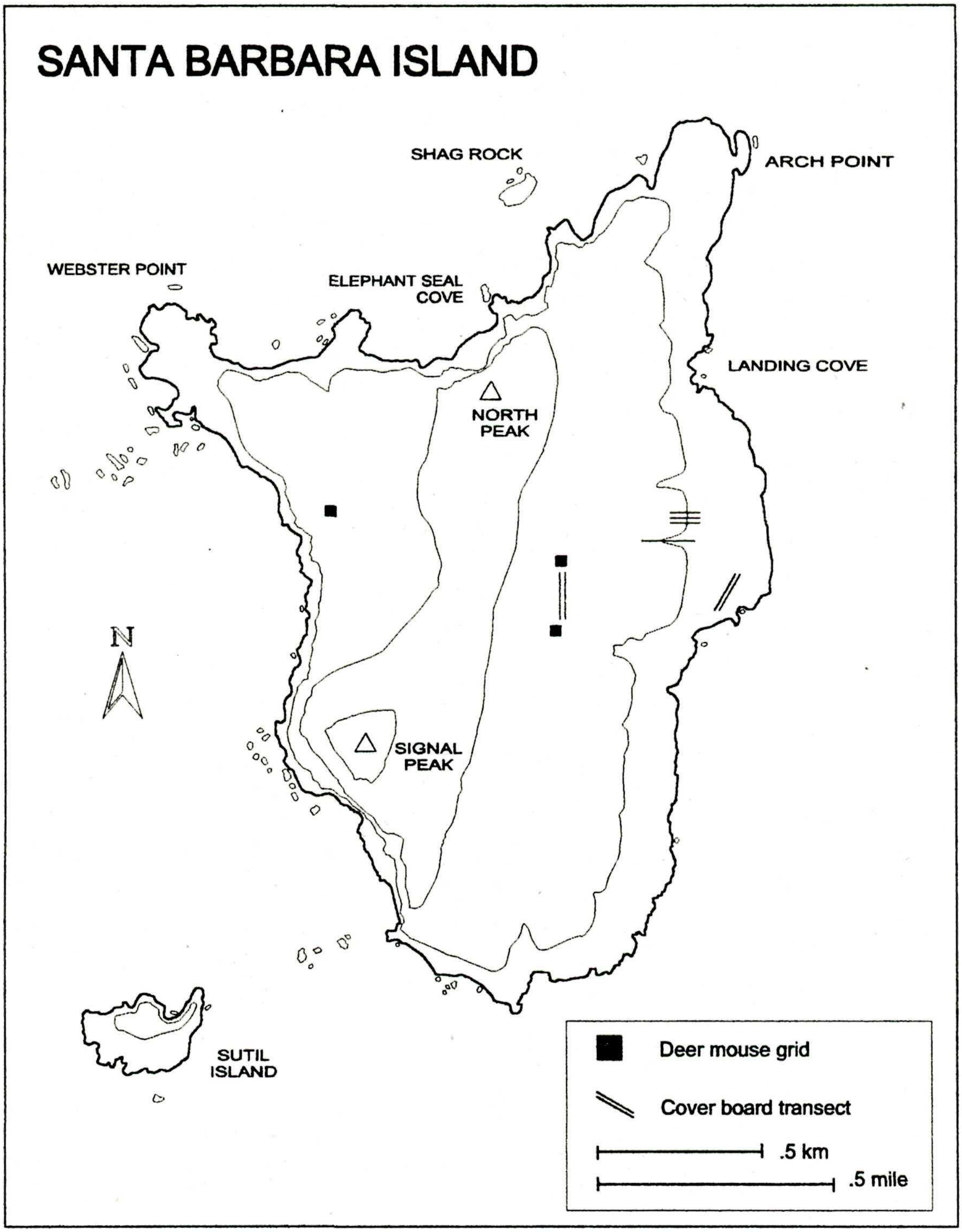

Figure 1. Deer mouse sampling grids and amphibian/reptile sampling transects on Santa B arbara Island, California.

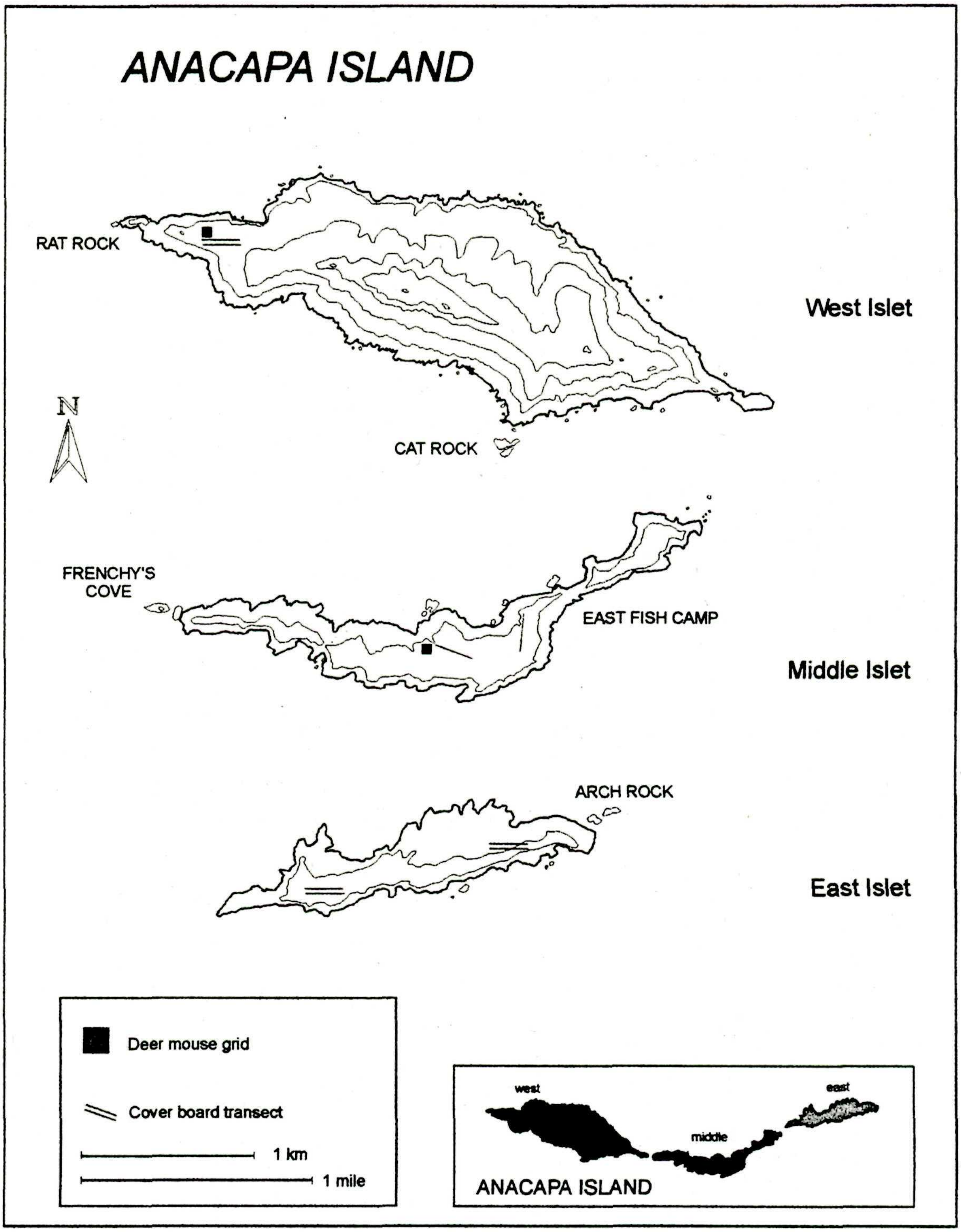

Figure 2. Deer mouse sampling grids and amphibian/reptile sampling transects on Anacapa Island, California.

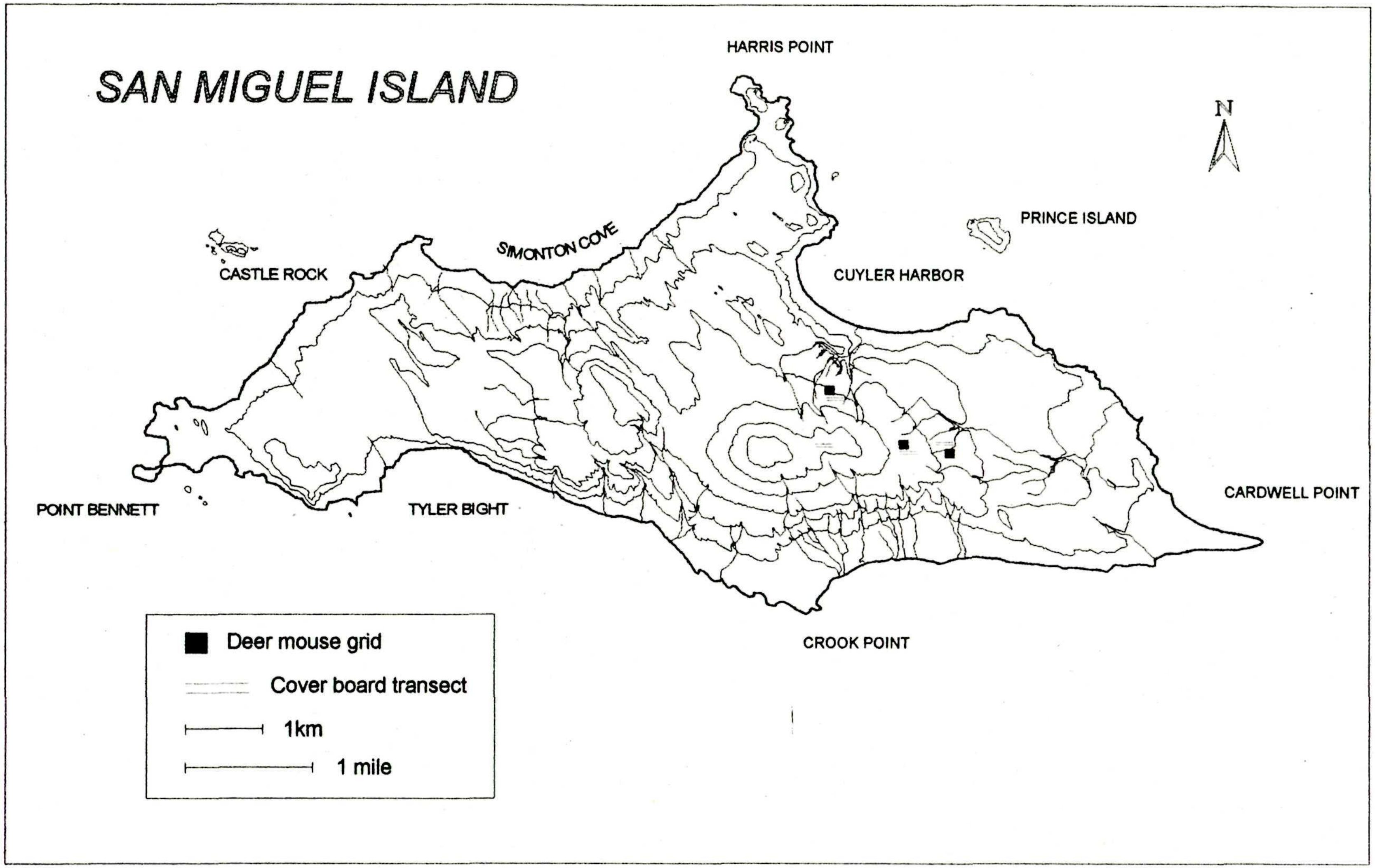

Figure 3. Deer mouse sampling grids and amphibian/reptile sampling transects on San Miguel Island, California.

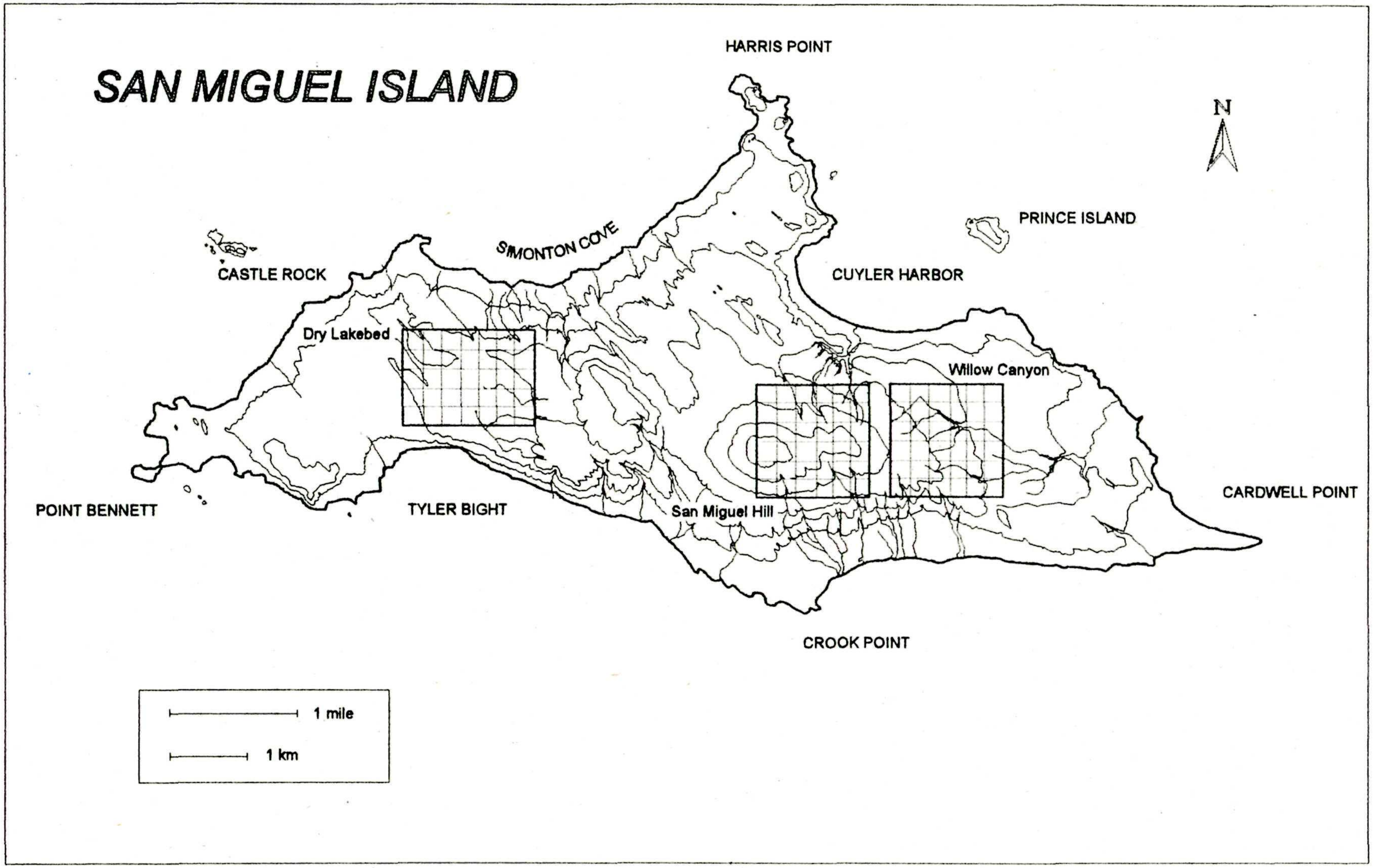

Figure 4. Location of three island fox trapping grids on San Miguel Island, 1994.

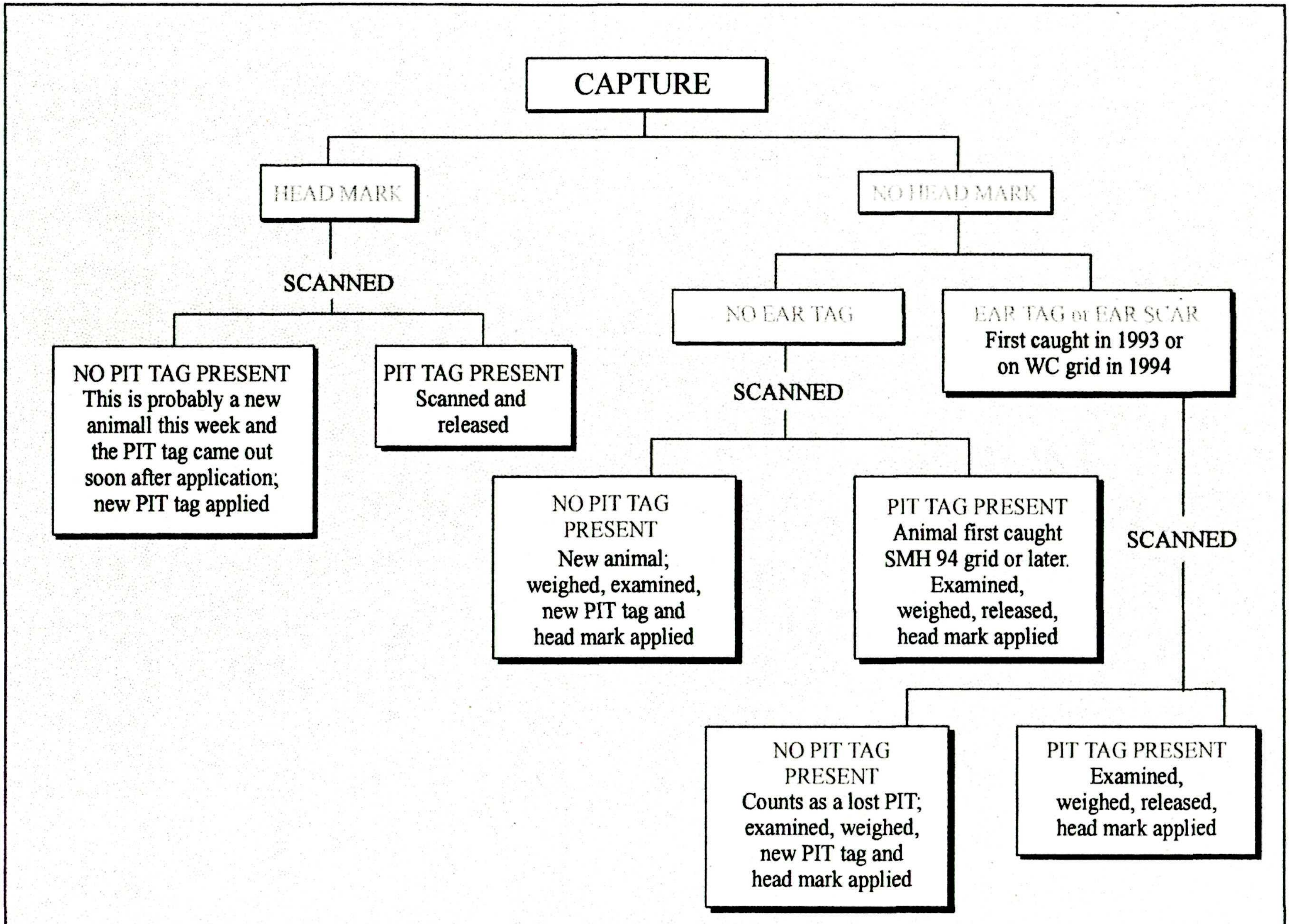

Figure 5. Step-down diagram showing island fox marking and identification procedures