Small Nocturnal Mammals Monitoring Protocol for the Ecological Monitoring Program in Organ Pipe Cactus National Monument, Arizona

Yar Petryszyn

Department of Ecology and Evolutionary Biology
Biological Sciences East, Room 123
The University of Arizona
Tucson, Arizona 85721

Contents

Figures

Introduction

Monitoring of small mammals by utilizing capture, mark, release, and recapture techniques provides data for long-term assessment of environmental effects such as rainfall, grazing, habitat changes, and people-usage impact. The status of rodent populations has a broad application in that it is indicative of the general health of the environment. Being primary consumers as well as the prey base for many predators (snakes, raptors, and a number of larger mammals), rodent populations rapidly react to changes in available food resources and, in turn, influence population numbers and the health of those animals dependant on them as a food source. Because rodents are found in most habitats, are easily captured and identified, and have a relatively small home range, monitoring is easily implemented, relatively low in cost, and does not require a great number of person hours to accomplish objectives.

Preliminary research for Organ Pipe Cactus National Monument (ORPI) rodent monitoring protocol was conducted by Yar Petryszyn, and summarized in his final report on Special Status Mammals. Nocturnal monitoring was implemented at Core I Ecological Monitoring Program (EMP) sites in 1991. Core II sites, as well as some non-core sites, were later added to this annual monitoring effort. With data collected in this project, total biomass and rodent densities per site are calculated annually.

Efficiency and effectiveness are of primary concern. Time constraints, along with limited personnel seem to be constant companions in any field effort. With this in mind, the following monitoring configurations are proposed.

Sampling Methods

Overview

Sampling in ORPI should be conducted annually, in July. This timing enables capture slightly before the period of highest population density for most rodents (Fig. 5-1) but avoids the unpredictable nature of August monsoon weather. For comparability, monitoring should always take place in July. This sampling effort is adequate for documenting general trends in population sizes on an annual basis.

If adequate funding is available, yearly monitoring of the chosen sites is preferred. In any case, no less than biannual sampling of each site is necessary. Many of the rodent populations may react rapidly to environmental changes, reaching peaks and crashing within a 2- or 3-yr period (Fig. 5-2). At a minimum, a 2-yr cycle of monitoring assures that population highs and lows are noted.

If more refined information is desired (such as over-winter loss and reproductive effort), a semiannual monitoring effort may be used. Live trapping should be conducted in late summer or early fall, and again in early spring. Early spring trapping should be conducted sometime in April or, at the latest, the first week in May. This sampling period assures that the smaller rodents have emerged from winter inactivity, and trapping can occur before the above-ground appearance of a large number of the young born that spring.

Two monitoring sessions (spring and late summer) for each site for each year is ideal, providing the best resolution of population activity. This effort exposes minor fluctuations as well as any major changes in small mammal populations. It also assures that any variation in population highs (and lows) between species is documented. The kangaroo rat (*Dipodomys* spp.), for example, generally has higher populations in the spring than in late summer.

Materials Required

The following equipment is needed to conduct a monitoring session of small nocturnal mammals:

Sherman traps (98)	3.0 x 3.5 x 9.0 in. These traps are capable of capturing the largest and smallest rodents found in the area. Folding traps are preferred to rigid ones to reduce the bulkiness of traps during transportation to the grids.
Compass	For determining grid corners and for trueing grid lines.
100-m tapes (2)	For laying grid lines.

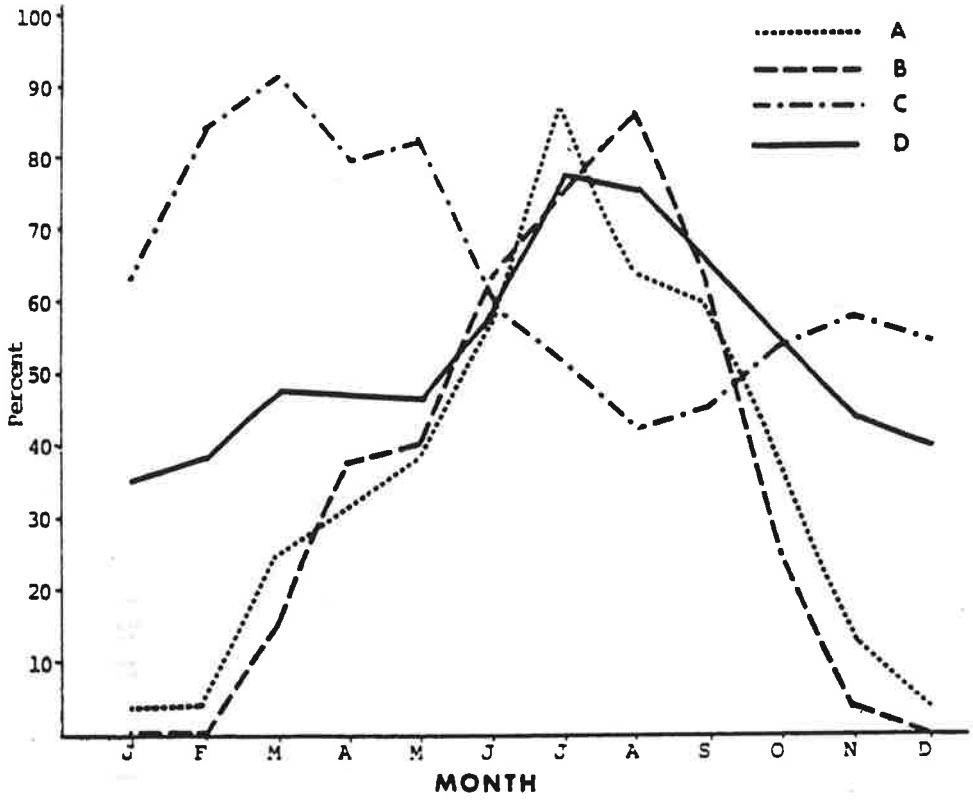

Figure 5-1. Seasonal activity of heteromyid rodents: as an accumulated mean percent over 9 years. Key: A = desert pocket mouse *(Chaetodipus penicillatus)*, B = Arizona pocket mouse (*Perognathus amplus*), C = Merriam's kangaroo rat (*Dipodomys merriami*), D = Bailey's pocket mouse *(Chaetodipus baileyi)*.

Petryszyn, Y. 1982. Population dynamics of nocturnal desert rodents: a nine-year study. Ph. D. Dissertation. The University of Arizona, Tucson. 108 p.

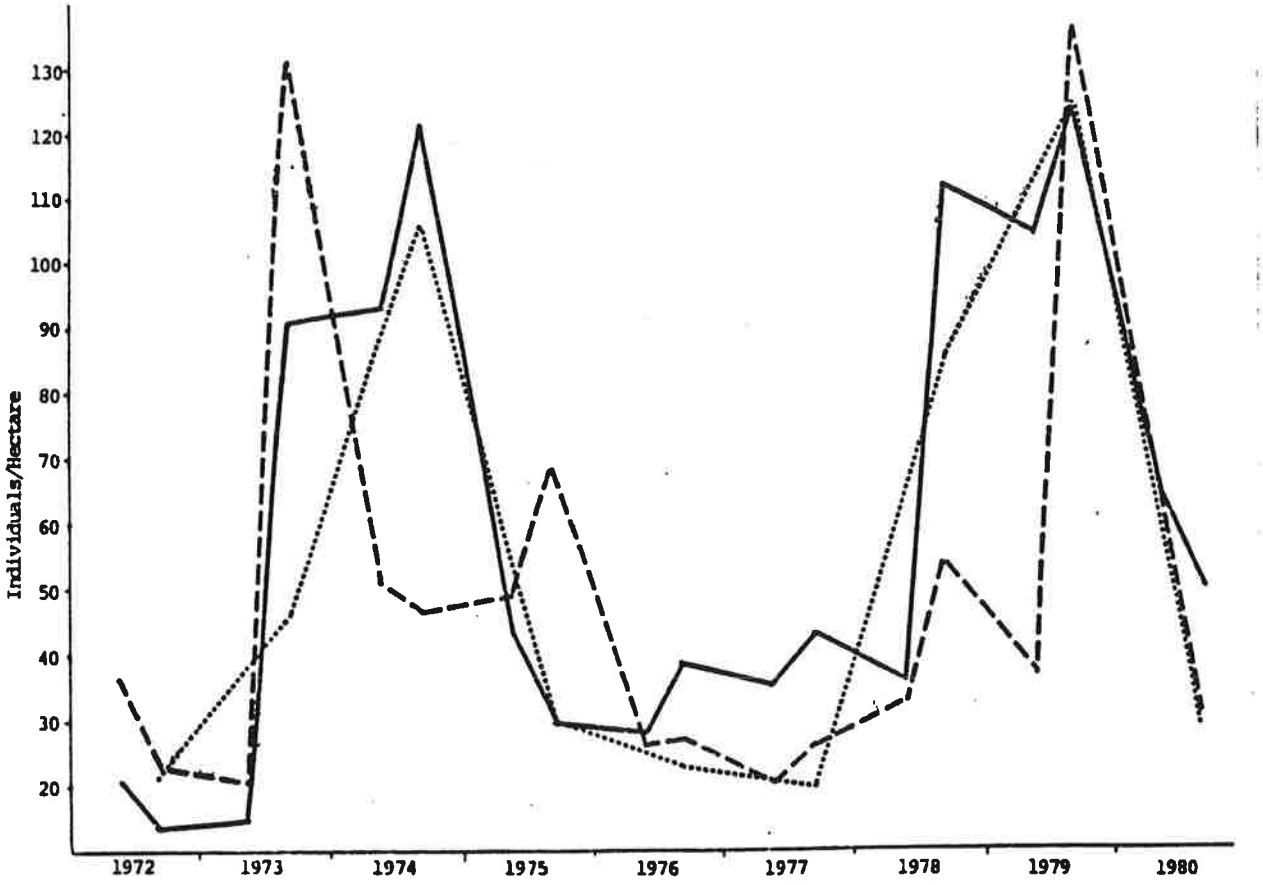

Figure 5-2. Heteromyid numbers on 3 sites sampled from 1972 to 1980, Pima Co., Arizona.

Petryszyn, Y. 1982. Population dynamics of nocturnal desert rodents: a nine-year study. Ph. D. Dissertation. The University of Arizona, Tucson. 108 p.

Bait	Either dry Quaker rolled oats (not the quick type) or mixed bird seed consisting of millet, sunflower seeds, wheat, cracked corn, and milo. (The latter is preferred during rainy weather in order to avoid the gluey effect of wet rolled oats).
Bait pouch	One that can be carried on a belt, if possible.
Cloth bag	Into which rodents, once removed from traps, can be placed during processing.
Lingerie mesh bags (2)	With zippers, for safe handling and processing of packrats (*Neotoma* spp.).
Spring-loaded scales (2)	Pesola scales are ideal; one capable of 100-gm weight, the other of 300-gm weight, and both accurate to 1 gm.
Reference	Indicator keys for distinguishing between species (Appendices 5-1 and 5-2).
Data forms	For collecting data (Appendix 5-3).
Clipboard	For carrying data forms.
Pencils or pens (2)	For completing data forms.
Pencil sharpener	If using pencils.
Surgical scissors –or– Indelible marking pen	For identification marking of rodents. If using a marking pen, refillable Pilot Super Color Marker works best, although any brand with very wet ink may be used.
Flagging tape	For marking grid-line ends in difficult terrain. Should be of 2 contrasting colors.

Setting Up the Trapping Grids

Each site is to be sampled by 1 or 2 grids of 7 rows x 7 stations, with trap stations at 15-m (49-ft) intervals. This configuration conveniently samples 1.4 ha (3.5 a.). Two people can easily set the traps out in 2 grids (total of 98 traps) and check and process the catch without an excessive expenditure of time and effort. Only experienced personnel should attempt to sample a site alone, so that rodent lives are not risked through lack of speed in processing.

The end rows of the 1.4-ha (3.5-a.) monitoring area also sample an area that extends 15 m (49.2 ft), which is the average radius of the home range of most nocturnal rodents. The area confined within the grid proper plus the extended peripheral sample area totals 1.4 ha (3.5 a.) (Fig. 5-3).

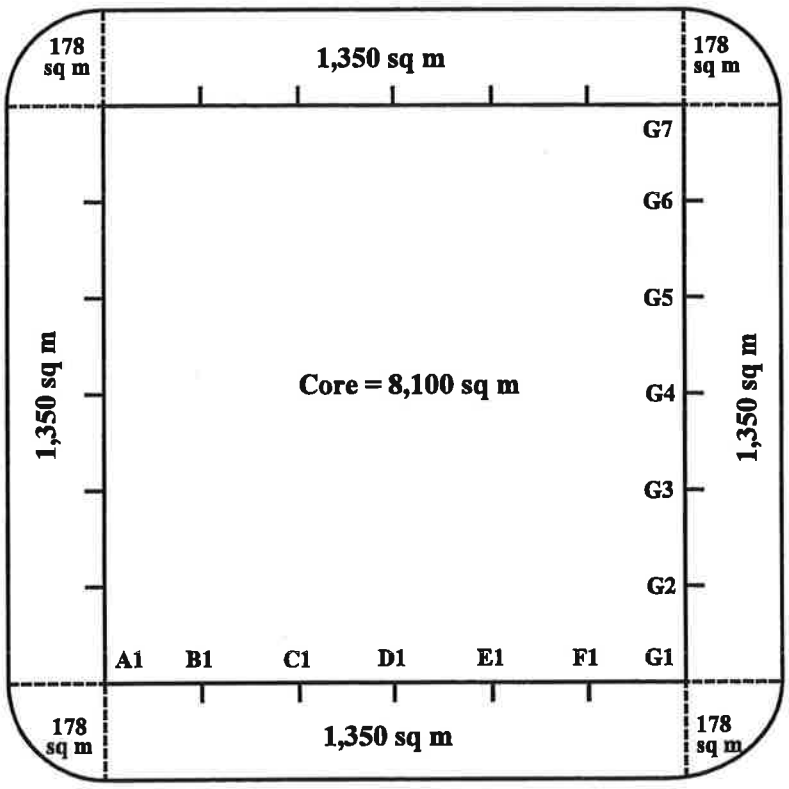

Figure 5-3. Sampling area of trapping grid for small nocturnal mammals in the Ecological Monitoring Program in Organ Pipe Cactus National Monument, Arizona. The total area of the grid (including the periphery) is 1.4 ha (3.5 a.).

The trapping grids are marked with rebar at each corner and identifying tags with site name and compass orientation (example: Petryszyn, Y. Pozo SW). Find and flag each corner of the grid. Forty-nine traps are placed in a 90 x 90-m (295 x 295-ft) grid, spaced 15 m (49 ft) apart and identified by locations A1 to G7. (Fig. 5-3) Trap placement and identification are made consistent each year in order to track long-term trends in microhabitat selection.

Several methods can be used to accurately set up the trapping grids, depending on terrain and personal preference. The techniques described here can be applied in a variety of ways. If near sunset, the traps may be baited at the same time they are placed in the grid. Otherwise, return to the grid later to bait the traps. If traps are baited too early, there is a chance for diurnal mammals such as roundtail ground squirrels (*Spermophilus tereticaudus*) or Harris' antelope squirrels (*Ammospermophilus harrisi*) to enter the traps.

Sampling grids are activated for a period of 2 consecutive nights. The sequence of sampling activity is (1) the first evening, set up the trapping grids and bait the traps; (2) the following morning, process the mammals and leave the traps closed on the grids; (3) the following evening, rebait the traps; and (4) on the last morning, process the mammals trapped, then pick up all traps and disassemble the grids.

The fundamental procedures for setting up the trapping grids and laying and baiting the traps are:

1. Lay out a tape on one (or two) of the lines, preferably the baseline (southwest corner to southeast). The tape provides assistance in keeping on the grid lines.

2. Using the compass bearing for that grid, pace 15 m to each trap location. At each location, find the closest spot that will provide shade from the morning sun and prepare by scraping a flat, bare spot to set the trap. Check the tension on the trap and place on the ground. Leave trap door shut until ready to bait.

3. When using the compass, pick a spot on the distant horizon that fits your bearing, if possible. In thick foliage, consult the compass after placing each trap.

4. When large trees or other obstacles are on the line, use the offset method of pacing to stay on line: (a) at the obstacle, turn 90° from the line; (b) move away from the obstacle, counting the number of paces required to clear it; (c) turn 90° again, and now parallel with the line, continue 15-m interval pacing to the next trap-setting location; (d) turning 90° to face the line, return to it by counting the number of offset paces required in step "b" to bypass the obstacle; finally (e) set the next trap and continue 15-m interval pacing on the line.

5. For very difficult terrain, such as is encountered when setting up the Alamo Canyon trapping grids, follow the method described in step 4, with the following addition. Place flagging of 2 alternating, contrasting colors at the ends of each of the lines. These can be labeled with "A1," "A7," "B1," "B7," and so forth. This will help to determine at a distance if traps are being accurately set on line.

6. Along easier terrain, the "perimeter method" of setting grids and traps may be adopted. For this method, a tape may or may not be placed along one line. Initially, the field worker carries 24 traps to place around the perimeter and, by pacing, determines trap locations. This creates a boundary by which the remaining interiors of the lines can be accurately filled in with traps. The remaining 5 traps per line are placed using compass and pacing.

7. In all of the above methods, workers may prefer to delay checking trap tension, as well as placing traps in shade until after the grid has been established. To speed up the grid placement, unfold the traps but merely place them on their "exact" grid location without checking their tension or finding shade. This can also aid in grid alignment accuracy by allowing the worker to see traps on an adjacent line and more precisely judge proper

spacing. Later, when the traps are baited, they are also checked for tension and placed in a shady location.

8. Avoid placing traps in proximity to ant colonies. If active ant colonies are present in the area, it is virtually impossible to prevent the loss of bait from the traps.

9. Place traps clear of nearby twigs or branches that, if blown by wind, may possibly cause the trap to spring during the night. Also, place traps on a level surface if at all possible, as wind may rock and consequently spring them.

10. Baiting and setting of the traps should be conducted just before sundown.

11. Adjust the tension on the trap treadle so that a light tap on the top of the trap causes it to spring shut. When set with too much tension, the trap will not spring at the correct time; with not enough, it can be triggered too easily.

12. Toss a two-fingered pinch of oats to the far back, inside of the trap. A few flakes may also be placed in front of the trap opening to attract rodents; however, the animal needs to cross to the back of the treadle in order to spring the trap.

13. Always keep track of your location on the grid. Count to yourself as you lay out or bait traps: "B6," "B7," and so forth. This will help avoid any confusion of nonbaited traps. It is especially critical to keep track of your location when processing the rodents in the morning. Missing a trap could mean a horrible death for a rodent.

14. The problems inherent in live trapping through the daylight hours make gathering information on diurnal rodents (such as ground squirrels) exceedingly difficult. If monitoring of diurnal animals is necessary, the traps must be checked every hour. A raised shade-board, placed above the trap, provides shade yet allows air circulation. This is normally required to prevent death due to overheating.

Processing Rodents

Checking traps and rodent processing should begin at first light. Not enough emphasis can be placed upon the need to process the animals very early in the morning. The metal box traps heat up rapidly in sunlight and become little ovens, much to the detriment of the animals inside.

The basic protocols for processing rodents are:

1. Carry a cloth bag, lingerie bag (for packrats), 100- and 300-gm scales, a marking pen (on the first morning only), data forms, and species keys. Make sure the pen is very wet with ink.

2. Wrap the mouth of the cloth bag around the end of the trap, gathering the extra cloth with one hand so that no opening is presented to the rodent. With the other hand, use two fingers to open the trap door (through the cloth of the bag). While doing this, make sure that the rodent is not behind the trap door.

3. Turn the trap upside down and firmly shake the rodent into the bag. When it is at the bottom of the cloth bag, make a ring with your fingers to close around the top of the bag (leaving no openings) and place the trap back in its location.

4. Remove the rodent from the bag with a firm grip on the skin behind its ears. Face away from the sun while handling, so as to minimize the animal's stress from heat and light.

5. Determine species, sex, and weight; record this information on the data form. For more detailed instructions on these procedures, see the following section, Completing Data Forms.

6. Make a wide, thick ink mark on the rodent's belly and release.

7. Close each trap for the day as you progress along the grid.

8. On the second morning of processing, note on the data form if a rodent is recaptured (®), along with its species, but do not weigh or sex.

Completing Data Forms

Record sampling data on forms such as the one provided (Appendix 5-3). Information recorded includes species, individual identification number, trap number, sex, weight, and notes.

Species

Identify each rodent to species using diagnostics such as nose hair, rump spines, baculum, hind foot length, etc. The most difficult determination of species will be for the Arizona pocket mouse (*Perognathus amplus*), desert pocket mouse (*Chaetodipus penicillatus*), rock pocket mouse (*Chaetodipus intermedius*), and Bailey's pocket mouse (*Chaetodipus baileyi*). Appendix 5-1 summarizes differentiating characteristics to consider.

The mesquite mouse (*Peromyscus merriami*) has only been caught in the monument twice, however, look for this species in heavily wooded mesquite bosques. The mesquite mouse is difficult to distinguish from the cactus mouse (*Peromyscus eremicus*). Appendix 5-2 summarizes differentiating characteristics to consider.

Individual Identification Number

If a permanent mark is being used, record the 4-digit, unique identification number for each captured sample. To determine this identifier, refer to the following section, Identification Numbering.

Trap Number

The grids are set out in 7 rows with 7 stations per row. Each row is designated as a letter of the alphabet, A through G. Each station in each row is numbered, 1 through 7; thus, the stations are matrixed: A1 to A7 through G1 to G7. The specific location in which individual animals are captured is important to the determination of foraging area, habitat selection, and distribution of each species.

Sex

Record whether the animal is male or female. Generally, sex is determined by comparing the relative distance between the anus and the base of the urethral papilla. In packrat males, for example, this distance is at least twice that found in females. When sexing Arizona pocket mice (*Perognathus amplus*), check carefully, as the male organs are very small.

Weight

The weight of the animal should be taken. This information is used to calculate the biomass of each species present. A hand-held, metric Pesola scale is the easiest and most convenient to use. If the animal is small (up to kangaroo rat size), the clip of the scale can be attached to the base of the animal's tail and the weight read directly as the animal dangles. Determine weight to the nearest 1.0 gm. Be cautious of rodents chewing on or wrapping their tails around the scale, as such behavior may impair accurate weight reading. A cloth bag is needed to weigh larger animals, such as packrats. The animal's weight is computed by subtracting the weight of the bag with the animal included, less the weight of the empty bag.

A 100-gm capacity scale and a 300-gm capacity scale are the most appropriate. The 100-gm scale, with increments of 1 gm, will suffice for most rodents. The 300-gm scale, with 2 gm increments, is needed for larger rodents, such as packrats and ground squirrels (*Spermophilus* spp. and *Ammospermophilus* spp.).

Notes

Include in this section information such as age (adult or juvenile) and reproductive condition (females pregnant or lactating, males testes descendant [TD] or inguinal). Also note any obvious ectoparasites, such as fleas or ticks, that the animal carries.

Additional information included on each data form is (1) date, (2) time traps were checked, (3) information on the weather (wind direction and estimated speed, cloudiness, rain, etc.), and (4) phase of the moon, along with time of moon rise. (The best trapping success usually coincides with no or little moon.)

Identification Numbering

To establish the number of individuals present on the site, a method for marking individuals is needed. The number of animals captured per night does not answer the question of density or biomass per hectare. For example: if, on a grid, 8 kangaroo rats are captured during the first night, and 9 on the second night, it is not known without marking them whether there are actually

9 or possibly 17 kangaroo rats on the grid. The difference in interpretation is almost two-fold. Obviously, a means of marking previously captured individuals is needed.

The use of a permanent-ink pen (such as a wide-tipped magic marker) suffices as just such a marking method. Make a mark on the animal's underside (such as an X or streak). This mark should be placed high on the chest so the animal cannot easily reach it with its mouth. It is suggested that a second mark be made on top of the head, as insurance in the event that the animal removes the initial marking. All animals captured on the first night would be thus marked and readily noticed if recaptured on the second night. Second night recaptures are noted on the data form (Appendix 5-3) with the symbol ®.

The use of permanent ink is of utmost importance when utilizing this system. Any other type of ink will be rapidly removed when the rodent grooms itself and might not be noticeable on the second night of trapping. The permanent ink mark will disappear in a couple of weeks, thereby not interfering in future sampling efforts.

Marking with ink is not adequate if information such as territory, home range, movement, or longevity is desired. A more permanent and individualistic marking system, such as toe clipping, is needed. In this system, each animal has its own unique ID number, created by amputating certain toes. A set of sharp-pointed surgical scissors are used for the amputations. Only 1 toe is removed per foot, and at least 2 toes are removed per animal (though removing as many as four may be necessary). This method of marking the animals has been utilized in field work by numerous researchers over a great number of years and seems to have very little detrimental effect on the animals.

The numbering system, itself, consists of a 4-digit number, each digit referring to a particular foot. The first digit references the right, front foot; the second digit, the left, front foot; the third digit denotes the right, hind foot; and the final digit indicates the left, hind foot. With the proper viewing orientation—the ventral surface of the animal facing the examiner—first the front feet are read (from left to right) and then the rear (also from left to right). The toes on each foot are counted from the midline of the body outward, medial to lateral (Fig. 5-4). If no toes are clipped on a foot, that foot is designated as zero (0). As an example: an individual numbered as 0102 will have no toe missing on the right, front foot; the first toe medially missing on the left front foot; no toe missing on the right hind foot; and the second toe out from the body midline missing on the left hind foot. A copy of the logical numbers available for use with this method is found in Appendix 5-4.

Compiling Data

For the monitoring of small mammals at ORPI, both the actual number of individuals captured as well as an estimate of population size should be collected. This information will be entered into a database, using dBase III. Necessary data should be compiled into 3 major groups: raw data, population estimate, and biomass estimate.

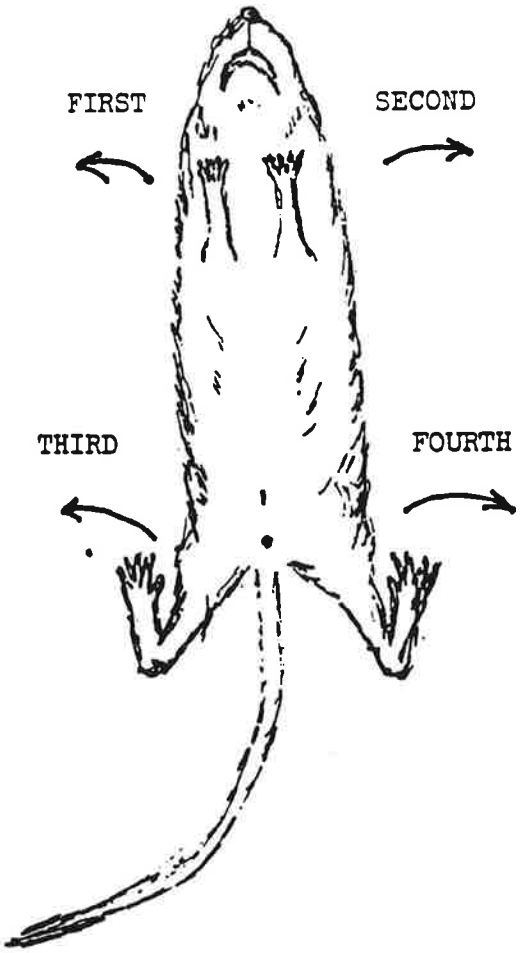

Figure 5-4. Diagrammatic for permanent rodent identification numbering in the Ecological Monitoring Program in Organ Pipe Cactus National Monument, Arizona. As an example: to mark individual 2234, clip toe #2 (second from midline of the body) on right, front foot; clip toe #2 on left, front foot; clip toe #3 on the right, hind foot (do not count the thumb, if present); and clip toe #4 on the left, hind foot. Toes are always counted from the midline outward and feet are read like lines on a page.

Raw Data

This is the actual number of individuals captured per grid over a 2-night trapping period. Although it is an underestimate of the actual numbers present in the environment, it is adequate for comparing fluctuations within the system. This data is the actual number of "individuals captured per hectare" per sample period. It is essential that these "raw data" be archived.

Population Estimate

Consistency is the most important factor in estimating rodent population sizes. As long as an estimation system, regardless of type, is used consistently for the duration of the study, a valid comparison between different sites during different periods of time, as well as between other studies, can be made.

The 2 consecutive nights of capture, mark, and release provide a means of estimating the total rodent population at a site during the sampling period. Past long-term research (Petryszyn 1982) has shown that the number of new individuals captured (animals not previously trapped during the monitoring session) declines steadily from night to night. Two nights of trapping typically result in the capture of a certain percentage of the total number of individuals present (Fig. 5-5). Although this value may vary slightly for different species, for the sake of simplicity a standard unit is recommended for all species for use in this project. Two nights of trapping produce a volume of approximately 80% of the animals captured during a 3-night trapping period (Fig. 5-5). Furthermore, captures over a 3-night sampling period total approximately 90% of the animals that are present (Petryszyn 1982). In utilizing these figures as a base, it is assumed that captures over a 2-night trapping period total approximately 72% of the actual number of rodents present:

$$2\text{-}night\ (N2) = 0.8 * 0.9\ (est.\ N) = 0.72\ (est.\ N)$$

Therefore, to compute an estimated density, increase the number of actual captures by 40% (actual number of individuals captured in 2 nights x 1.4 = estimated number of individuals per ha).

Biomass Estimate

To determine a species' estimated biomass/ha value, following each trapping period multiply the species' population estimate value by the species' mean body weight. Total all species' biomass/ha values to derive the total biomass of nocturnal rodents/ha.

It must be emphasized that the number of *individuals* captured is utilized in these estimates, not the number of captures. Although some animals are caught on both nights, they should be counted only once in calculating population estimates.

The use of these methods in a monitoring system at ORPI should produce consistent, reliable, and comparable estimates of nocturnal rodent populations in varied habitats over both short and long periods of time. Rapid changes in diversity and/or number of small mammals would be noticed by the recommended monitoring schedule. The simplified methods of determining population number and biomass provide a ready means of comparing sites within and between years.

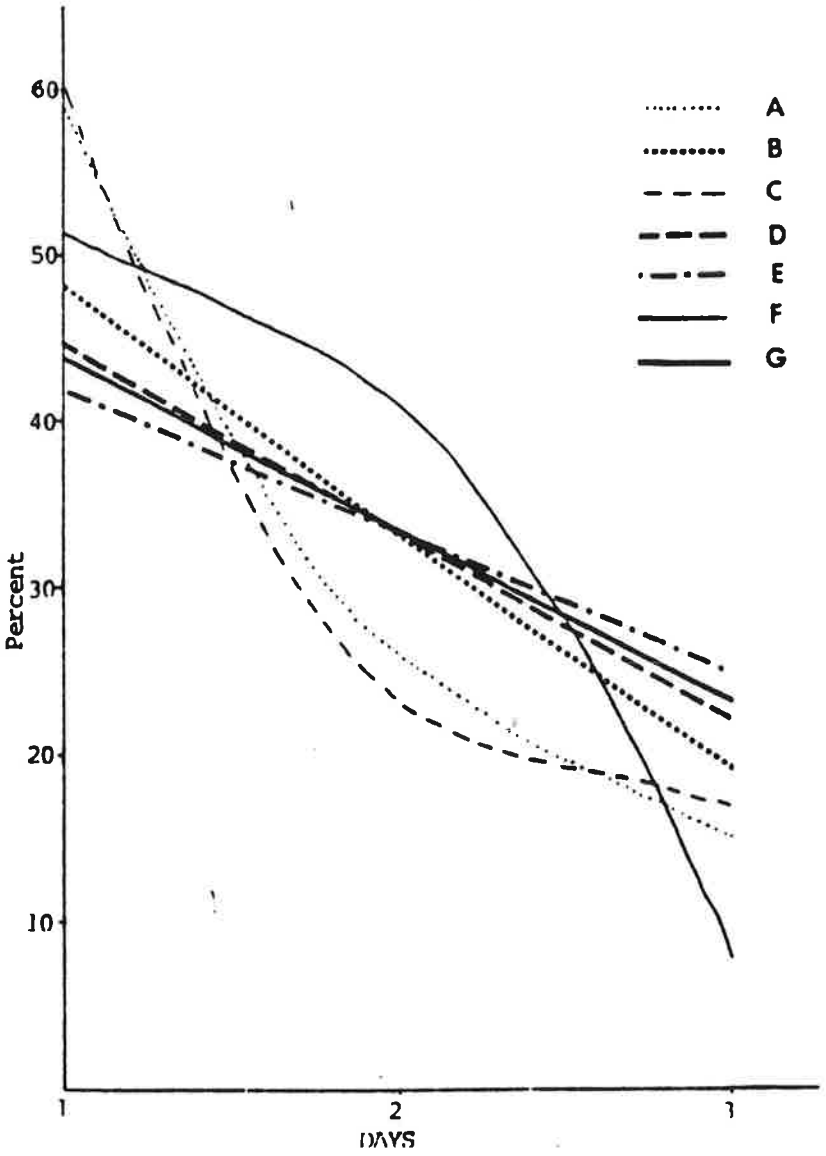

Figure 5-5. Rate of capture of new individuals for 7 species at the Silverbell Site, Pima Co., Arizona. Key: A = rock pocket mouse (*Chaetodipus intermedius*), B = Average for all species, C = Merriam's kangaroo rat (*Dipodomys merriami*), D = desert pocket mouse (*Chaetodipus penicillatus*), E = Arizona pocket mouse (*Perognathus amplus*), F = white-throated woodrat (*Neotoma albigula*), G = Bailey's pocket mouse (*Chaetodipus baileyi*).

Petryszyn, Y. 1982. Population dynamics of nocturnal desert rodents: a nine-year study. Ph. D. Dissertation. The University of Arizona, Tucson. 108 p.

Monitoring Site Locations

Grid locations are indicated on copies of the original sketch site-maps provided for the Ecological Monitoring Program by Peter Bennett and R. Roy Johnson of the Cooperative Parks Studies Unit, The University of Arizona. Each grid is demarcated in the field by a 0.5-in (1.3-cm) rebar stake anchored at each corner.

Any significant notes pertaining to location of the grids accompany the following descriptions of the monitoring sites. Also, please note Appendix 5-5, which gives a map location for the grid(s) at all sites.

Aguajita Wash (2 grids)

Both grids are on the east side of the wash. The first is located just to the north and west of the small hill found on the east side of the wash, north of the border road coming into Quitobaquito. The second grid is directly east of the first.

Alamo Canyon (2 grids)

Both grids are located on the south fork of the drainage, just south of the first, small drainage coming in from the east (middle fork?). One grid is on the east slope, the other on a bench on the west side of the main drainage.

Arch Canyon (1 grid)

This is found directly in the bottom of the drainage, starting just below the huge boulder located there.

Armenta Ranch (2 grids)

These grids lie on either side of the deep drainage cut that the road crosses. The first covers the bare, flat area across the road west from the building, while the second grid is directly on the other side of the 5-ft-deep drainage cut (directly north of the first grid).

Bull Pasture (1 grid)

This grid is set directly straddling the south/north drainage at the confluence with a small east/west drainage. The main drainage is on the east side of the ridge that contains the weather station, and is the one that runs into 2 small catchments.

Burn Site (2 grids)

One grid is set bordering the west side of a small north-south drainage found approximately 100 m (328 ft) from the road. The second is directly to the east of the first, approximately 120 m (394 ft).

Dos Lomitas (2 grids)
The southwest corner of the first grid begins at the northeast corner of the fenced enclosure. The other grid runs north and west, and begins at the northwest corner of the fenced enclosure.

Dripping Springs (1 grid)
The grid is set on the slope just north of the drainage from the springs.

East Armenta (2 grids)
As I never knew where this site was exactly, I set the grids near a pull off that seemed well used. From the small pullout of the main road, the grids are located approximately 30 m (100 ft) away at 45° (one to the south, the other to the west).

Growler Canyon (2 grids)
The first grid is located approximately 40 m (131 ft) northeast of the northeast corner of the corral. The second grid is directly towards Growler Wash, flanking its northern side.

Lost Cabin Mine (2 grids)
The first grid is on the north side of the road, with the northeast corner of the grid approximately 15 m (49 ft) from the weather station. The second is across the road, its northwest corner beginning approximately 5 m (16 ft) from the road. This site is located slightly more east than the first grid.

Lower Colorado Larrea (1 grid)
This site was added in 1995. Information will be provided when this area is mapped.

Middle Bajada (2 grids)
This site was added in 1995. Information will be provided when this area is mapped.

Pozo Nuevo (2 grids)
These 2 grids are part of Petryszyn's 5 macrohabitat-study grids. The 2 EMP grids are the southern-most of the macrohabitat-study grids and sample typical creosote/bursage habitat. Both grids parallel the road, with the first line of each approximately 10 m (33 ft) from it. Both are found on the west side of the road, approximately 0.8 km (0.5 mi) south of the windmill at Pozo Nuevo.

Salsola Site (2 grids)
The first grid is right in the thickest part of the site, beginning about 10 m (33 ft) from the road. The second is approximately 30 m (98 ft) northwest of the northwest corner of the first grid, and samples the open creosote area. The northwest corner of this grid is near the large saguaro.

Senita Basin (2 grids)
These grids are opposite each other on both sides of the road, approximately 0.5 km (0.3 mi) southwest of a picnic area. The grids begin approximately 20 m from the road.

Valley Floor (2 grids)

This site was added in 1995. Information will be provided when this area is mapped.

Vulture Site (2 grids)

Both grids are on the north side of the road, approximately 30 m (98 ft) from it. The first grid begins near the middle of the site, with a west boundary parallelling the wash. The second grid is directly north of the first, approximately 40 m (131 ft) away.

Literature Cited

Petryszyn, Y. 1982. Population dynamics of nocturnal desert rodents: a nine-year study. Ph.D. Dissertation. The University of Arizona, Tucson. 108 p.

Appendix 5-1

Small Nocturnal Mammals Monitoring Protocol for the Ecological Monitoring Program in Organ Pipe Cactus National Monument, Arizona: Simplified Key to Select *Chaetodipus* Species of Arizona

1. Hind foot measures > 26 mm (1 in.) in length, baculum is straight, tail is thick and not very bicolored . . . . . *Chaetodipus baileyi*

   Hind foot measures < 26 mm (1 in.) in length, baculum has bend, tail is relatively slender and bicolored 2

2. Rump spines, hair on very tip of nose is dark, dark tubercles on sole of hind foot . . . . . *Chaetodipus intermedius*

   No rump spines, hair on very tip of nose is light-colored, light-colored tubercles . . . . . *Chaetodipus penicillatus*

Appendix 5-2

Small Nocturnal Mammals Monitoring Protocol for the Ecological Monitoring Program in Organ Pipe Cactus National Monument, Arizona: Simplified Key to Select *Peromyscus* Species of Arizona

1. Tail is longer than body-head length 2

   Tail is the same length or shorter than body-head length 3

2. Hind foot measures > 21 mm (0.83 in.) in length, ear measures > 18 mm (0.71 in.) in length, stout body form ..... *Peromyscus eremicus*

   Hind foot measures < 21 mm (0.83 in.) in length, ear measures < 18 mm (0.71 in.) in length, slender body form ..... *Peromyscus merriami*

3. Tail shows white on either side of dark strip when viewed from above ..... *Peromyscus maniculatus*

   Tail dorsal strip extends to edges with very little white showing when viewed from above ..... *Peromyscus leucopus*

Appendix 5-3

Small Nocturnal Mammals Monitoring Protocol for the Ecological Monitoring Program in Organ Pipe Cactus National Monument, Arizona: Field Data Form

The blank field data entry form on the next page is to be photocopied and used in the actual monitoring fieldwork.

ORPI Ecological Monitoring Program—Small Nocturnal Mammals Field Data Form

Plot _____ Date (*dd/mm/yy*)_____ Time (*2400*)_____

Weather (*cloud cover, wind speed, humidity*) _____ Temp. _____

	Species	ID #	Trap #	Sex	Weight	Notes
	Spp	*####*	*##*	♂/♀	*gm*	
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