THE HERPETOFAUNA OF BALLONA

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INTRODUCTION

Reptiles and amphibians are vital components of many North American ecosystems. However, because many are cryptic or secretive and because they have little economic importance to man, these vertebrates are often overlooked in ecosystem studies. The importance of reptiles and amphibians was emphasized by Turner et al. (1976) who studied *Uta stansburiana* in a desert ecosystem and found this lizard to be as important as mammals and birds with respect to numbers, biomass and energetics. Other reptiles and amphibians are equally abundant in other ecosystems and undoubtedly have similar importance to those ecosystems as *Uta* does in the desert.

Our primary purpose in surveying the Ballona herpetofauna was to provide a framework through which sound management decisions for the region could be made. Early on, we became aware of how diffuse the basic literature on the species occurring at Ballona was. Therefore, a second purpose was to consolidate ecological data for these animals from the scientific literature to provide an easily accessible base for future studies. To this point, concise species accounts were written covering the following general topics: geographic distribution, general habitat preference, daily and seasonal activity patterns, growth, reproduction, population structure, food preferences, and predators. Our data summarize information on over 500 marked animals and over 1,500 observations of marked and unmarked animals of nine species (six reptiles and three amphibians). These data are compared to similar data from other populations. For species which have been studied from widely separated geographic regions, we have compared Ballona data with the closest populations or to studies of the same subspecies. Some species were captured or sighted so infrequently that little information is available for Ballona. In these cases, we have relied on studies of these species in similar habitats or localities in an effort to predict their ecology at Ballona. The topics we have chosen to cover should also indicate the following: sensitive habitats for reptiles and amphibians, species that are sensitive to perturbations, seasons during which each species might be sensitive to perturbations, and how each species fits into the Ballona ecosystem.

METHODS

Our primary sampling method was transects located in three designated units. We attempted to cover all major vegetative types and habitats. We sampled on three days each month from September 1980 through January 1981 and then four days from February 1980 through July 1981. Diurnal sampling was done with two people between 06:00 and 19:00 hours. We attempted to optimize the time of sampling based on our previous knowledge of the behavior of the species present. The duration of each sampling period varied from three to six and one-half hours, but we attempted to standardize distance so we sampled a roughly equivalent area each time. In addition, we did limited nocturnal sampling during the months of February, April, and June between 19:00 and 24:00 hours on six different days.

During a transect, we attempted to search beneath most movable surface objects and to capture any animal that did not require extensive time to pursue. We caught most species by hand, but the swifter lizards

(Sceloporus and Uta) required noosing. We marked most captured animals for future identification. We marked lizards except the legless lizard (Anniella) and tree frogs by toe clipping. We marked gopher snakes with a ventral scale clip. We did not mark Kingsnakes, instead we recorded their individually distinctive pattern of rings. We recorded the following measurements on most animals: 1) snout-vent length (the standard body length measurement); 2) weight (with Pesola spring scale); 3) tail length and its condition, broken or unbroken (when appropriate); and 4) cloacal temperature (with a Schultheis rapid-reading thermometer). We recorded the sex of each animal whenever possible. In addition, we recorded time of day, location, and behavior of captured individuals as well as the major vegetation type with which they were associated. Environmental temperatures adjacent to captured animals were recorded whenever possible. All animal-related temperature data are from September 1980 through March 1981. Finally, we recorded miscellaneous observations on reproductive condition, predators, food and other pertinent data that might contribute to a more complete knowledge of the sampled fauna whenever possible. Many individuals escaped capture. For these we recorded time of day, location and habitat used. Where possible, we noted the age class, sex, and reproductive status (females only).

On each sampling date, we took qualitative and quantitative climatic data. Qualitative data included an estimation of cloud cover, degree of air pollution and wind conditions. Quantitative data included relative humidity (taken with a sling psychrometer) and air temperature. Frequently, we took the last two measurements several times over a sampling period, but most often we took them twice, at the beginning and at the end of each sampling period.

For historical records, we collected a voucher of each of the nine recorded species. These vouchers will be deposited in the herpetological collection of the Los Angeles County Natural History Museum. For the first five months of the study, we placed a series of 17 small pitfall traps in different habitats. Returns on these trappings were so low that we removed these traps in late February 1981. From July to September 1980, insect pitfalls used by the entomology team caught many lizards (Gerrhonotus, Sceloporus and Uta). We added data from lizards caught in these traps after August 15, 1981 to growth plots for the respective species. We supplemented transect sampling with a regular checking of paved roads, for road kills before and after each sampling, and with limited sightings and collections made by Dick Friesen (mammals), Chris Nagano (insects), Ralph Schreiber (birds) and Robert Bezy (herpetology section Los Angeles County Natural History Museum).

Much of the data presentation that follows are scattered plots and frequency distributions which require no explanation. In the summary, faunal data compared over designated units and habitats based on the physiognomically dominant plant species were standardized for the time spent in each area and each vegetative habitat, respectively. This was calculated by simply taking the number of a given species observed in an area or habitat category and dividing it by the number of hours spent in the respective unit. This calculation gives values of relative density with units of individuals per observation hour. Our transect organization and the natural variation within designated Unit 1 required that we subdivide this area into two units to meaningfully discuss its herpetofauna. We divided Unit 1 into a dune portion (D) on its southwest boundary and a Unit 1A which comprises the remainder of this area.

SPECIES ACCOUNTS

Class Amphibia - Amphibians

Order Urodela - Salamanders

Family Plethodontidae - Lungless Salamanders

Pacific Slender Salamander - Batrachoseps pacificus

This is the only salamander known to occur at Ballona. Batrachoseps pacificus, like other species in this genus, is specialized for subterranean life. It has an attenuate, worm-like body with tiny limbs and a tail which, when unbroken, is less than twice the body length. Batrachoseps cannot actively burrow, and therefore, must rely on passages excavated by other organisms or produced by agents such as root decay and soil shrinkage (Yanev 1980). Adults exceed 40 mm in body length. This salamander is brown to yellow in life with a distincively light-colored venter and underside of tail. Ballona individuals have rust-orange blotching on the dorsal surface of the tail and lower back on a light brown ground color. The species ranges from the Santa Monica and San Gabriel mountains in Los Angeles county to northwestern Baja, California (Yanev 1980). Like other Batrachoseps, it is a secretive, sedentary species (Hendrickson 1954; Cunningham 1960; Maiorana 1978a). Batrachoseps are observed under surface debris during periods of sufficient moisture (Stebbins 1966). Only two individuals of this species were observed during this study, both on Unit 3 (Figure 1). Both were found under boards on well-drained high ground, one in association with thick Rhus laurina leaf litter and the other in thick matted grass next to a rodent burrow system.

We found one individual each on February 13 and March 9, 1981 on moist substrates with shade temperatures of 12.4°C and 14.5°C, respectively.

Cunningham (1960) commented on the close correspondence between B. pacificus body temperatures and substrate temperatures. He reports substrate temperatures on which salamanders were found ranging from $4^{o}C$ to $21^{o}C$, encompassing the two substrate temperatures on which the Ballona individuals were found. Brattstrom (1963) reports cloacal temperatures of $19.5^{o}C$ and $19.6^{o}C$ for two individuals emerging from a flooded hole in September.

Daily and seasonal activity is largely influenced by moisture (Cunningham 1960). Both individuals in this study were observed following winter and early spring rains. Insufficient data exist to show daily and seasonal activity patterns at Ballona. However, we expect Ballona populations to parallel what is known for other populations of this species. Fall rains initiate seasonal activity (Cunningham 1960). Surface activity continues as long as sufficient moisture is available. The diel pattern is typically a nocturnal one, with salamanders emerging at dusk and showing increased activity on moist or foggy nights. When the sky is overcast, Batrachoseps become active before darkness. Their general nocturnal habits and use of subterranean or surface objects as diurnal retreats allows this species to avoid extreme thermal conditions and dessication. The cessation of rainfall coincides with a general decrease in activity which culminates in aestivation when surface moisture is depleted. Limited rainfall over the winter as well as limited nocturnal sampling are the probable cause of only two individuals of this species being encountered at Ballona.

Reproductive information on B. pacificus is sparse, and no information is available for Ballona; however, we expect published data on reproductive patterns at other localities to be similar. Like other salamanders in this genus, B. pacificus lays terrestrial eggs. Jelly-encapsulated eggs (ca. 6 mm capsular diameter) are deposited in moist sites underneath surface cover (Davis 1952), and perhaps underground. The timing of egg deposition is unclear, but it may be before the wet season. Davis (1952) reported on the hatching of 18 eggs, first discovered on December 20, 1950 at Pasadena, which hatched between January 18 and 30, 1951. Presumably, these were all from the same female. Stebbins (1951) describes two female _B. pacificus_, obtained December 17, 1947 at Altadena, which contained 15 and 21 fully-developed eggs, apparently ready to be laid.

Like most lungless salamanders, _B. pacificus_ has direct development. It lacks an aquatic larval stage and the young hatch with essentially adult morphology. Davis (1952) reported the size of newly hatched individuals as between 17 and 20 mm total length. Cunningham (1960) did not see individuals hatch but suggested that individuals between 21 and 23 mm total length found on January 20 and February 1, 1956 were recently hatched. By March 1, Cunningham found young _B. pacificus_ of 29 to 34 mm total length (13 to 18 mm body length) presumably from the same cohort. This suggests that early growth is rapid. Campbell (in Stebbins 1951) observed three size classes of _B. pacificus_ near Monrovia on March 16, 1929 which had total lengths of 30 mm, 45 to 60 mm, and 90 to 120 mm, respectively. Using Stebbins' tail proportion for adult _B. pacificus_ and accounting for an increase in tail length as the individual grows, a feature known to occur in other _Batrachoseps_ species (Stebbins 1951), Campbell's size groups correspond to body lengths of approximately 22 mm, 28 to 35 mm, and 45 to 55 mm, respectively. Growth rates have been estimated by Hendrickson (1954) for _B. attenuatus_ at 5-10 mm/year for juveniles (less than 35 mm body length) and at 0-2 mm/year for adults (greater than 35 mm body length). If one couples these rates with Campbell's size classes for _B. pacificus_, allowing for the larger size in the latter a correspondingly more rapid growth to above 40 mm of body length, then Campbell's size groups represent young hatched that year, juveniles after one year of growth, and individuals two years or older (adults), respectively. If these estimates are correct, the 40 and 58 mm body length B. pacificus observed by us at Ballona represent an individual just entering the adult size group and roughly two years old, and an adult probably well in excess of two years of age. Hendrickson (1954) estimated that the largest individuals in the B. attenuatus populations he studied could not be less than 10 years of age. It would not surprise us if the large 58 mm female observed at Ballona was close to this age. Size and age at first reproduction for B. pacificus is unknown. There is no apparent sexual dimorphism in size or coloration (Stebbins 1951).

Knowledge of population structure for Batrachoseps is rudimentary. Both Cunningham (1960) and Hendrickson (1954) commented on the small numbers of salamanders observed in juvenile size classes. Both inferred higher juvenile mortality but caution that juvenile size classes frequently use refuges other than surface objects sampled in both these studies. Maiorana (1977) provided evidence of field mortality due to heat stress and/or dessication in B. attenuatus. This may be an important source of mortality, especially for juveniles that may be particularly susceptible because of their small size. Nothing is known of population sex ratios.

B. pacificus ate annelid worms, earwigs and terrestrial isopods in an urban habitat (Cunningham 1960). Maiorana (1978b) found B. attenuatus ate primarily collembolans and mites in less disturbed habitat. Based on the invertebrate fauna we observed, a diet of small terrestrial insects and crustaceans is suspected.

To our knowledge, the nocturnal and generally secretive habits of Batrachoseps preclude them being eaten by most predators. The two snake species occurring at Ballona do not eat Batrachoseps as part of their normal diet. One of these, the Kingsnake (*Lampropeltis getulus*), died after being fed *Batrachoseps* (Cunningham 1960). Other species reported as predators on *Batrachoseps* by Stebbins (1954) are not known to occur at Ballona. Potential predators at Ballona are the western toad, *Bufo boreas*, and some birds, like the Brown Towhee, *Pipilo fuscus*, that spend considerable time foraging in leaf litter where *Batrachoseps* is likely to occur.

SPECIES ACCOUNTS

Class Amphibia - Amphibians

Order Anura - Frogs and Toads

Family Bufonidae - Toads

Western Toad - *Bufo boreas*

The Western Toad (*Bufo boreas*) is the largest amphibian found at Ballona. Adults exceed 80 mm snout-vent length. The color of the Western Toad is greenish to light brown with dark spots over the dorsal area and lateral surfaces. The skin contains numerous warty protuberances which are often tan in color. A thin mid-dorsal stripe is found from between the eyes to the vent. Short hind legs restrict their locomotion to a waddle or short hops. *B. boreas* is distributed from southern Alaska south to Baja, California along the coast and to central Nevada, Utah, and Colorado at inland localities and from the Pacific coast east through British Columbia, western Montana, western Wyoming, and central Colorado. A variety of habitats are occupied by *B. boreas* from sea level to 3000 m (Stebbins 1966).

We found only two individuals at Ballona, one an adult female found under a rug at a trash pile on the Agricultural Lands, and the other an adult found dead at the intersection of Culver and Jefferson Boulevards adjacent to Unit 1 (Figure 1). In addition, C. Nagano (Pers. Comm.) reported toads from the east end of Unit 3 early in 1980.

The rarity of toads at Ballona is surprising since this animal is one of the most abundant amphibians in coastal California. This species typically requires lakes, ponds, or pools of freshwater that remain for the duration of the breeding months in spring and early summer. The only such habitats at Ballona are the Bulrush Marsh, eastern Centinela creek and the Jefferson Drain just east of the intersection of Culver and Jefferson Boulevards along Jefferson on the Agricultural Lands, and the dune pond on Unit 1 (D). Since toads are able to return to breeding sites after migrating long distances (Tracy and Dole 1968; Gorman and Ferguson 1970), these animals could range widely at Ballona and need not be localized around these breeding sites.

Surprisingly little ecological data are available for B. boreas. We predict that the following summary for toads in southern California is representative of B. boreas at Ballona. Breeding occurs between January and July (Hill 1948) with most occurring during the spring months of March and April (Mullally 1952; Stebbins 1954; Tracy and Dole 1969). Adults are normally nocturnal during this time and migrate to the breeding site from as far as 300 m (Tracy and Dole 1968). Males are the first to arrive at the breeding site. Females have up to 16,500 eggs that are laid in long strings (Storer 1925). Adults disappear from the breeding site three to four weeks after breeding (Tracy and Dole 1968) and do not reappear until the next breeding season. These adults probably enter rodent burrows or burrow in loose soil (Mullally 1952) and remain dormant during this time.

Tadpoles metamorphose in late July at about 20 mm snout-vent length (Lillywhite, Licht, and Chelgren 1973). These juveniles are largely diurnal and bask to maintain their body temperatures at 26° to 27°C (Brattstrom 1963; Lillywhite, Licht, and Chelgren 1973). This range of temperatures insures rapid growth and these toads reach a mean size of 32 mm by the following

April (Lillywhite, Licht, and Chelgren 1973). An additional two years are probably required before sexual maturity is reached, but the size at reproductive maturity is unknown (Stebbins 1951; Dunlap 1959). Sexual dimorphism is marked, some females attaining 127 mm snout-vent length, while the largest males barely exceed 100 mm. Tadpoles and juveniles B. boreas probably incur heavy mortality. Some breeding sites probably dry before metamorphosis can take place. Tadpoles may be eaten by wading birds (herons and egrets) and southern alligator lizards (Gerrhonotus multicarinatus) are also known to feed on tadpoles (Cunningham 1956). Subadults and adults possess parotoid glands which secrete a neurotoxin, which protects them from predation and probably assist in increasing their survival relative to younger animals.

Tadpoles scrape algae and detritus from the bottom film of pools (Stebbins 1951). After metamorphosis, the major prey items are beetles (principally carabids), ants, and spiders (principally lycosids) (Schonberger 1945; Campbell 1970). During the breeding season adult females eat more than adult males (Schonberger 1945).

SPECIES ACCOUNTS

Class Amphibia - Amphibians

Order Anura - Frogs and Toads

Family Hylidae - Treefrogs

Pacific Treefrog - Hyla regilla

The most abundant amphibian at Ballona is the Pacific Treefrog (Hyla regilla), a small hylid frog with an adult size of over 32 mm snout-vent length. This frog occurs in several different color phases and patterns. Color varies from light green or reddish-bronze to tan with dark brown blotches. All color phases have a black eye mask that runs from the nostrils to the shoulder. H. regilla are found from southern British Columbia south through Baja California and from the Pacific coast east through western Montana and Idaho and all but eastern Nevada. Within this range, H. regilla occurs from sea level to 3300 m (Stebbins 1966).

At Ballona, we found Pacific Treefrogs wherever slow moving or standing freshwater occurs (Figure 1). Most of our sightings are from the base of the bluff forming the southeast boundary of the Agricultural Lands, particularly the Scirpus freshwater marsh. These frogs are also common along eastern Centinela creek. We heard few calling males at the Eucalyptus grove in Unit 2 where a pool formed by street runoff is found. During the winter, we heard calling in clumps of pampas grass on Unit 3 and at other times in the cat-tails near the Jefferson Drain culvert just east of the intersection of Culver and Jefferson Boulevards. A final locality for Pacific Treefrogs is the dune pond at the southwest end of Unit 1. Here, we observed tadpoles and successful metamorphosis.

Size data indicate two age classes for Hyla regilla at Ballona, juveniles and adults (Figure 2). Juvenile growth is rapid. The mean size of newly transformed frogs at the dune pond increased at approximately 0.14 mm/day. The smallest size at transformation was 11 mm.

The size at sexual maturity is unknown. However, the adult size class at Ballona are typically greater than 30 mm snout-vent length. Jameson (1956; 1957) noted a similar size at metamorphosis and a similar growth pattern for frogs in Oregon. However, transformed frogs in Oregon grew about twice as fast as those at Ballona (Jameson 1956).

The cloacal temperatures from the only four adult frogs encountered averaged 18.0^{o}C (15.0 to 19.2). All temperatures were of frogs found hiding under surface objects. These are well within the ranges of temperatures reported for other H. regilla populations (Cunningham and Mullally 1956; Brattstrom 1963). Eggs are able to withstand temperatures of 30 to 35°C (Schechtman and Olson 1941) and tadpoles survive temperatures up to 34°C (Cunningham and Mullally 1956).

During winter months adult males were heard calling during daylight hours, indicating that at least a portion of the population remained active during the day. During one night in February 1981, 50-60 calling males were located from the freshwater marsh and flooded areas in the Agricultural Lands. We did not sample all nighttime hours so we do not know the extent of nightly activity of adult frogs. It is likely peaks of activity occur during the early evening and early morning hours of winter and spring months as they do in other southern California populations (Brattstrom and Warren 19-5). Newly-transformed frogs were found during all daylight hours from mid-April to mid-July. This group is diurnal until they approach adult size, as was reported by Cunningham and Mullally (1956).

We do not know the extent of nocturnal activity for these juveniles. Calling males were not heard during the day after May 4, 1981. During three nights in June 1981 we heard no choruses. Cessation of chorusing probably occured in late May, similar to the data reported for Idaho H. regilla (Schaub and Larsen 1978), but much earlier than the July date reported for southern California populations (Brattstrom and Warren 1955).

We captured or heard adult H. regilla during all months except October (Figure 3). During most of the year we found few adults (September through November and April through June). Nearly all activity was during winter months (December through March), when breeding occured (Figure 3). This is typical of southern California populations (Schechtman and Olson 1941, Brattstrom and Warren 1955). We were unable to determine if males arrive earlier than females as they do in other populations since we did not sample breeding sites at night (Jameson 1957, Schaub and Larsen 1978; Brattstrom and Warren 1955).

The Ballona population is composed primarily of adults much of the summer, fall and winter months. Large numbers of newly metamorphosed juveniles appear in early May through June with lesser numbers appearing through September. Egg and tadpole mortality are probably high with some areas incurring total mortality due to dessication of the breeding site. Juveniles and adults probably also incur heavy losses, with few individuals surviving more than one year similar to the frogs found in Oregon (Jameson 1957).

We observed no matings or egg masses. We found three gravid females between February 9 and 27, 1981 indicating clutches were laid in February or early March. We first observed tadpoles March 20 in the dune pond. We found other tadpoles in a temporary pool between two fields on the Agricultural Lands on March 27, and in the bulrush marsh below the bluffs on April 16, 1981. We observed metamorphosis in the dune pond on May 4, and in the freshwater on May 11. The temporary pool on the Agricultural Lands dried before any tadpoles reached metamorphosis. We caught recently metamorphosed frogs along the bluff that forms the southeast boundary of the Agricultural Lands from April 16 through June 1981, indicating that another breeding site exists in this general area. Another recently metamorphosed frog was observed along Centinela creek near the northeast boundary on September 20, 1980. This indicates very late breeding in Centinela creek, probably when flow rate recedes following winter rains. We have no evidence of reproduction on Unit 3 even though we heard calling males there. We suspect most breeding takes place early in the year when pools of water collect winter rain. However, breeding may occur as late as June in Centinela Creek. This is similar to the length of breeding observed in Oregon (Jameson 1957), but is much earlier and longer than the breeding season in Idaho (Schaub and Larsen 1978).

Since we found no eggs and found only large tadpoles, we cannot estimate development time or clutch size and frequency for *H. regilla* at Ballona. In other parts of its range, female Pacific Treefrogs contain 500 to 750 eggs during any breeding season and lay them in several clutches of five to 60 eggs (Smith 1940).

Little is known of the feeding habits of *H. regilla* and we made no attempt to determine food of this species at Ballona. Tadpoles feed on attached and suspended algae and detritus (Stebbins 1951). Post-metamorphic Pacific Treefrogs from several populations in southern California ate beetles, flies, leafhoppers and true bugs (Brattstrom and Warren 1955). This is probably typical of Ballona. We did not observe predation at Ballona. Suspected predators are cats, rats, opossum, egrets, herons, and white-tailed kites.

California Legless Lizard - *Anniella pulchra*

The California Legless Lizard (*Anniella pulchra*) is unique among Ballona lizards in lacking limbs. Its long, slender, snake-like body is adapted for a fossorial existence in sand and loose soil. It is longer than the Southern Alligator Lizard in snout-vent length, but is much less robust. The lizards are silver-grey in color with a yellowish venter. There are often a pair of lateral and a single mid-dorsal, dark stripes from the head to the tip of the tail. Legless lizards are found from the San Francisco Bay region south to Baja California and from the Pacific coast to the Coast ranges in southwestern California. They are found in coastal dunes, alluvial fans, and loose humus of oak-pine woodlands from sea level to 1920 m (Stebbins 1966).

We captured only two legless lizards at Ballona: One January 30, 1981 on the dune along the southwest edge of Unit 1, and another May 19, 1981 under a small board on the sandy alluvial fan on Unit 2 (Figure 4). We suspect that these lizards also occur at the larger alluvial fan along base of the bluff, on the Agricultural Lands. These appear to be the only suitable habitats for legless lizards at Ballona.

In addition to the two adults mentioned above we observed tracks on the dune on Unit 1. The occurence of their distinctive sinusoidal tracks indicate that legless lizards at Ballona maintain low levels of activity from September through April, followed by increasing activity in May and June (Figure 5). This activity peak is later than the May peak reported by Stebbins (1966). This pattern also appears to contradict the findings of Brattstrom (1965), who reports that legless lizards burrow as deep as 1.5 m into soil to avoid high summer temperatures.

We have no information on reproduction at Ballona. Ovulation occurs from May through July in this live-bearing lizard, with young born September through November (Miller 1944). One to four (typically two) young are produced per female each year (Miller op. cit.).

The two A. pulchra we observed in January and May were 113 mm and 130 mm snout-vent length, respectively. This corresponds to individuals over two and just three years old according to the size groups of Miller (op. cit.). Juveniles are approximately 50 mm snout-vent length at birth and by the end of the next year reach 80 to 90 mm. During the following year, subadults will grow to 120 mm, when they reach adult size. Thus legless lizards require three years to reach maturity (Miller op. cit.). Sexual dimorphism favors males, the largest attaining 185 mm snout-vent length. In contrast, the largest females attain 155 mm (Miller op. cit.).

Legless lizards bask during morning hours by moving just under the soil surface from under vegetation to soil exposed to the sun. During the midday hours the animals retreat to areas under vegetation and then return to open areas to bask during evening hours (Miller 1944; Cunningham 1959b). A. pulchra maintain their body temperature between 20 and 28°C, when possible, but have been found with temperatures as low as 7.8 and as high as 30°C (Brattstrom 1965; Bury and Balgooyen 1976; Gorman 1957). The soil must also remain moist for this species to survive (Bury and Balgooyen 1976; Miller op. cit.). The species is sedentary and does not wander (Miller op. cit.). Food consists primarily of beetles (carabids), insect larvae, and spiders. Since this animal is so secretive, it probably has few predators. Fisher (1901) reported shrike predation on Anniella. Other suspected predators at Ballona are cats, opossum, and American Kestrels.

Southern Alligator Lizard - Gerrhonotus multicarinatus

The Southern Alligator Lizard is the largest of the four lizard species known to occur at Ballona. It is the most widespread lizard next to Sceloporus occidentalis, and can be found over all areas above the tidal flux (Figure 6). Adults average about 120 mm in body length. When unbroken, the somewhat prehensile tail is over twice the body length. Its limbs are small, and the head is relatively large. Diverse in color patterns, this lizard varies from brown to yellow with various degrees of blotching or barring. The species ranges from central Washington state to north-central Baja California (Lais 1976). Like other alligator lizards, this is a secretive species which is generally found in dense vegetation (Stebbins 1966).

Fifty-three body temperatures had a mean of 21.9°C (range 10.4 to 30.2°C). This is lower than that of Brattstrom (1965), but is similar, except for a narrower range, to the data of Cunningham (1966) for 150 body temperatures. Our data agree with Cunningham (1966) in that Gerrhonotus is probably seldom exposed to extremely high temperatures.

Despite general agreement, thermal data on G. multicarinatus are unclear. We believe this confusion results primarily from an inadequate knowledge of its ecology. The primary difficulty in understanding these data is the recognition of when lizards are active. Since our data agree with Brattstrom (1965) in that this species does not actively bask (contra Cunningham 1966), its source of body heat is undoubtedly warmer substrates. Further, since all data suggest that Gerrhonotus frequently uses surface objects to modify its body temperature, the key to understanding activity patterns is recognizing what Gerrhonotus does while under surface cover. Except for short time periods when lizards are observed by either moving surface debris or on open ground, we are largely ignorant of this species' activity. The impression we gain from our data is that Gerrhonotus appears to have a broad thermal range (roughly 20-30°C) whose mean value is considerably lower than for basking species. It appears to raise its body temperature by contact (thigmothermy) at low environmental temperatures, and simply moves to avoid warmer microenvironments at higher temperatures. What Gerrhonotus does when avoiding warmer microenvironments should be investigated.

Daily and seasonal activity patterns for G. multicarinatus are also poorly understood because of its unobservability. Our data show G. multicarinatus is capable of year-round activity at Ballona. Because over 95% of our observations on Gerrhonotus were made by overturning surface objects (see Methods section), this biases the sampling toward this activity segment. Figure 7 does not show seasonal activity, but instead seasonal variation in the utilization of surface objects. It shows peak use of surface objects during February. As noted previously, Gerrhonotus probably opportunistically uses these rapid-heating surface objects to elevate its body temperature when environmental temperatures are coolest. As ambient temperatures increase when summer is approached, use of such objects both decreases and shifts to a bimodal use pattern (early morning and late afternoon). We suspect that activity under thick vegetation occurs frequently and that the months following February into early summer would show equivalent activity levels, if this activity segment could be adequately sampled.

Matings of Gerrhonotus are reported from March 24 at Whittier to May 5 at Newport (Goldberg 1972). G. multicarinatus lays clutches of five to 41 (mean = 13) leathery, immaculate white eggs (burrage 1965). Egg size varies from 13 x 8 mm to 18 x 10 mm (Fitch 1935). Shaw (1943) reports a pocket gopher burrow as a nest site. Deposition dates vary from late May in San Diego county to late June in Los Angeles county (Shaw 1943; Atsatt 1952). Our data suggest an incubation period of 10 weeks with female egg deposition taking place in June, similar to Goldberg's figure of 11 weeks (Goldberg 1972). Burrage (1965) gives in vitro evidence of multiple clutches. We feel Burrage's gestation and incubation periods were shortened by in vitro conditions and that third clutches in a field population are probably not possible, with second clutches being a rare event. Clustering of our growth data suggest that a single, synchronous clutch was laid by females during 1980 (Figure 8). At Ballona, a 30 mm individual caught by a pitfall trap on August 24, 1980 was recently hatched, as reported body sizes of newly hatched lizards vary from 26 to 36 mm (mean = 33 mm) (Fitch 1935; Shaw, op. cit.; Burrage 1965). This agrees with hatchling emergence reported in August, September and October by Goldberg (op. cot.).

Three size classes of alligator lizards can be distinguished over a year (Figure 8). Young of the year and juvenile animals in their first full year of growth (ca. 30-80 mm snout-vent length), subadults in their second full year of growth (ca. 80-100 mm snout-vent length) and adults (over 100 mm). During the fall, subadults merge with adults and become indistinguishable from the latter. At Ballona, marked juveniles grew rapidly after January 1, 1981. Growth rates varied from .06-.26 mm/day (mean .15 mm/day; n = 10). We have but a single estimate for late fall-early winter growth in juveniles, which was considerably slower (.03 mm/day). Subadults grew less rapidly than juveniles after January 1 (mean = .09 mm/day, range .04-.13 mm/day for n = 5). Adults grew even more slowly over the same period (mean = .04 mm/day, range .00-.07 mm/day for n = 6). We have no estimates of late fall-early winter growth for subadults and adults, but suspect the values would be equal to or lower than those obtained for juveniles over the same period. We observed the first recognizably gravid female on May 4, 1981, but most gravid females were observed from late May through early June. We observed females which had laid eggs in mid-late June, which agrees with previously noted late June egg deposition dates (Atatt 1952). A 95 mm body length female was our smallest reproductive individual. This is similar to the 92 minimum reproductive size noted for females at Whittier (Goldberg 1972). Our data suggest that lizards attaining an average adult size of 115 mm must be at least three years old. Growth rates observed in this adult size range suggest individuals approaching the largest size observed at Ballona may be five years old. Lais (1976) reported a maximum size of 175 mm snout-vent length for G. multicarinatus. If our growth rates are typical, they suggest some individuals can live to a considerable age. We distinguished no sexual dimorphism in size. We could distinguish males larger than 65 mm of body length from females where hemipenal eversion could be induced. The larger head breadth in males, noted by Stebbins (1954), is suitable for distinguishing the sexes above 80 mm body length.

The proportions in various size classes captured during any monthly interval are relatively constant (Figure 7) until July where the disappearance of the juvenile size category is the result of the entrance of these individuals into the subadult size class. Observed adults above 110 mm body length always had broken tails and are the only size group in which multiple tail breaks appear. Tail breakage decreases in a regular fashion to 50% in the juvenile size class which suggests that breakage occurs in proportion to the length of time an individual spends in the population. Although we believe that predation is an important source of mortality, we cannot unequivocally link tail break frequencies to predatory mortality, as interaction between conspecifics may be responsible for breakage (Atsatt 1952). Females outnumber males in a ratio of 1.4:1 above the 65 mm body length where individuals could be sexed.

Diet information from the feces of two captured lizards from Ballona shows the locustid grasshopper and wasps are eaten. Cunningham (1956) summarizes the diet from the contents of 262 digestive tracts, 76 of which were empty. Arthropod food dominated the diet. In order of importance, carabid beetles, tettigoniid and locustid grasshoppers, lepidopteran larvae, spiders and ants were the groups most often encountered. However, vertebrate food was observed in 21 digestive tracts. Seventeen of these were lizards including five instances of cannibalism. Two of the lizard species reported, _Sceloporus occidentalis_ and _Uta stansburiana_, occur with _Gerrhonotus_ at Ballona. The remainder of vertebrate food items found by Cunningham were juvenile mammals and birds. Fitch (1935) reported predation on bird's eggs. The relatively low temperature tolerance of _G. multicarinatus_ and its large size were the main factors cited by Cunningham (1956) as allowing these relatively slow-moving lizards to capture and eat swifter lizards. This agrees well with the data of Harwood (1979) who found *G. multicarinatus* maintained a high digestive efficiency at lower temperatures when compared to basking species.

The only record of predation on *Gerrhonotus* at Ballona was the finding of a 75 mm tail fragment in the stomach of a road-killed female kingsnake. Since it appeared recently swallowed, and since no other lizard remains were found in the snake, it was assumed this represented an unsuccessful attempt at predation by the snake, where it was left swallowing the tail fragment it had seized. Other suspected predators at Ballona are cats, rats, opossum, gopher snakes, which occasionally take lizard prey as juveniles (Fitch 1949), burrowing owls, sparrow hawks, and shrikes.

Western Fence Lizard - *Sceloporus occidentalis*

The most common lizard at Ballona and throughout much of coastal California is the Western Fence Lizard (*Sceloporus occidentalis*). Adults exceed 60 mm, making this species intermediate in size between two other Ballona lizards, the Southern Alligator Lizard (*Gerrhonotus multicarinatus*) and the Side-blotched Lizard (*Uta stansburiana*). *Sceloporus* is most often seen basking, particularly during morning hours when they are almost completely black in color. As lizards become warmed they lighten to a grey brown color, often with a series of paired dark bars down their backs. Adult males have a pair of dark, metallic-blue patches on their venter and a similarly-colored throat patch which are displayed during territorial disputes. These blue patches are the cause of the colloquial name "blue belly". Western Fence Lizards are found from central Washington state south through northwestern Baja California and from the Pacific coast east through southern Idaho and western Utah. They occur from sea level to 2700 m (Stebbins 1966).

We found S. occidentalis in all areas and all major vegetation of types at Ballona (Figure 9; Tables 1 and 2). They are abundant along the elevated dirt roads of Unit 1 with a particularly dense population among the debris at the northern edge northeast corner of the Agricultural Lands but are rare in lush growths of pickleweed (Salicornia sp.) and are probably absent from all areas flooded by saltwater. S. occidentalis are found throughout Units 2 and 3, but are particularly abundant when associated with native shrubs such as Laurel-Sumac (Rhus laurina) and California Sage (Artemisia californicum) (Table 2). No restriction of habitat selection appears for Western Fence Lizards at Ballona as reported for other populations of fence lizards occupying the same habitat with other iguanid lizards (Marcellini and Mackey 1970; Rose 1976; and Davis and Verbeek 1972).

Two age groups are distinguishable based on snout-vent length data for each sex (Figures 10 and 11). Young of the year appear in early July and grow slowly through January (mean = 0.06 mm/day for n = 7). These juveniles almost triple their growth rate during January through June (mean = .17 mm/day; n = 21). This group continues rapid growth until adult size is reached by early June for females and early to mid-July for males. Once adult size is reached little or no growth occurs (mean = 0.03 mm/day; n = 25). These data indicate that both sexes require two years to reach sexual maturity. Adult males (mean = 70.2 mm; range 60-82 mm; n = 113) are larger than adult females (mean = 67.6 mm; range 60-79 mm; n = 87). The growth pattern found at Ballona is typical of S. occidentalis in other parts of its range (Fitch 1940; Davis 1967; Rose 1976). However, lizards are larger at higher elevations (Jameson and Allison 1976) and females are larger in northern populations (Fitch 1978).

Cloacal temperature of 42 active S. occidentalis averaged 32.5^{o}C (24.6-36.5^{o}C), while 81 inactive lizards averaged 23.6^{o}C (13.0 to 34.1^{o}C). The ranges of active and inactive lizards at Ballona are similar to those reported by Brattstrom (1965) for other California S. occidentalis.

Western Fence Lizards were seen during all daylight hours at Ballona. These animals were found under surface objects during early morning hours or on cool, overcast days. Typically, lizards basked during the morning hours, remained in the shade of vegetation during the hot mid-day hours, returning to basking during evening hours. This behavior insures a rapid rise in body temperatures to a constant level that is maintained throughout as much of the day as possible.

Sceloporus occidentalis are found throughout the year at Ballona. Lowest numbers were observed from September through December. During January through March increasing numbers of lizards emerge, mostly individuals found inactive under surface objects. A sharp increase of lizards occurs in April followed by declining numbers through June (Figure 12). This contrasts with the pattern of S. occidentalis at higher elevations in California and Nevada which are inactive during winter months and show constant adult activity during spring, summer and fall (Tanner and Hopkin 1972; Jameson and Allison 1976).

Differences exist in seasonal activity between adults and juveniles, and between males and females. We found both adults and juveniles during fall and winter months but most observations were of juveniles. Juveniles were abundant from February through April after which their numbers gradually decreased (Figure 12). This decrease is due to juveniles entering adult size. Adults emerge in increasing numbers during April. Since juveniles do not reach adult size until later in the year, the April increase in adults must be due to adults that were largely inactive during the winter. Adult males appear earlier than adult females (Figure 12). These individuals are probably setting up territories in preparation for the reproductive season. These patterns are similar to other populations of S. occidentalis. Juveniles are more active than adults during winter in Monterey and Santa Barbara counties, California (Davis 1967; Davis and Verbeek 1972). Adult males emerge earlier than adult females in high elevation populations in California and Nevada (Jameson and Allison 1976; Tanner and Hopkin 1972).

During this study, several adult lizards were found dead and several others were found severely thin and emaciated. Most of the latter were found under surface objects during winter months. One emaciated female was discovered after having dropped a clutch of eggs. These data suggest that adults may sustain heavy mortality.

We observed the first visibly gravid female on May 5, 1981. By May 16, most adult females were gravid. The smallest of these was 60 mm snout-vent length. We observed the first female to have deposited eggs on May 16, 1981. We observed gravid females throughout July. However, the percentage of gravid females declined in July. The appearance of oviductal eggs during early May in lizards at Ballona is similar to the earliest date reported for lizards in other lowland areas of Los Angeles county during a wet year (Goldberg 1975). In dryer years oviductal eggs appeared by early April (Goldberg op. cit.). The three month period (May to August) over which females may be gravid is similar to that reported by Goldberg (1973) as is the size at first reproduction. We found no laying sites and did not attempt to determine clutch size. We also do not have sufficient recaptures to determine number and time between clutches. Stebbins (1954) described nests as being dug by females in loose damp, well-aerated soil. Since populations from nearby areas of Los Angeles county lay multiple clutches (1-3 clutches /year) of from three to 11 eggs (Goldberg 1973; 1974), it is likely that S. occidentalis at Ballona have a similar pattern. The variability of snout-vent length of juveniles captured from September through December indicates multiple clutches at Ballona.

We observed young of the year on July 3, 1981. The smallest of these measured 25 mm snout-vent length. Since the earliest known deposition of eggs was in mid-May, a maximum incubation time at Ballona is approximately six weeks. This is much shorter than the 13 weeks reported by Goldberg (1975) due to earlier time of deposition (early April) and later first emergence of hatchlings (mid-July). This may be an effect of drought conditions during most of Goldberg's study. An incubation time similar to that at Ballona was found by Goldberg (1974) for S. occidentalis at higher elevations. Hatchling size at Ballona is similar to other populations from a variety of habitats and elevations (Davis 1967; Goldberg 1973; Tanner and Hopkin 1972).

Scats of Western Fence Lizards at Ballona indicates that beetles (carabids and coccinelids) and orthopterans (acridids and gryllids) are common food items. These groups, along with ants, have been reported as major diet items in other populations (Davis 1967; Tanner and Hopkin 1972). We observed two cases of predation on S. occidentalis: A juvenile female was eaten by a juvenile kingsnake (see Lampropeltis account) and the remains of an adult female was impaled on a thorny bush, presumably by a Loggerhead Shrike. Southern Alligator lizards, and juvenile gopher snakes, both of which occur at Ballona, are known to feed on S. occidentalis (Cunningham 1956; Fitch 1949). Other suspected predators include dogs, cats, rats, opossum, American kestrels, white-tailed kites, burrowing owls, egrets and herons.

Side-blotched Lizard - Uta stansburiana

The Side-blotched Lizard (Uta stansburiana) is the smallest lizard found at Ballona, with adults exceeding 48 mm snout-vent length. As in S. occidentalis, the body of both sexes is greyish-brown with paired dark brown blotched down the middle of the back. Males possess a dark ink-colored blotch on each side near the axillae which is displayed during territorial disputes. Females may or may not possess faint axillary blotches. The scales of the Side-blotched lizard are smaller and less heavily keeled than those of S. occidentalis, giving a smoother appearance. U. stansburiana occurs from south-central Washington; eastern Oregon and southwestern Idaho south through Baja California and northern Mexico, to western Colorado and through New Mexico to western Texas, from sea level to 2700 m (Stebbins 1966).

Side-blotched lizards are found exclusively on sandy areas at Ballona (Figure 4), common on the dune in Unit 1; and occasionally at the sandy, alluvial fan in Unit 2, the large alluvial fan along the bluff, and the sandy area at the extreme east corner end of the Agricultural Lands. In southern populations, Side-blotched lizards are typically sand-dwellers (Tinkle 1967), but northern populations are primarily rock-dwellers (Nussbaum and Diller 1976).

One age group occurs at Ballona (Figure 13). It appears that the species is annual, individuals are born, grow, reproduce and die in the span of a year. Young first appear in early July and continue hatching through mid-September. They grow at a mean rate of 0.09 mm/day (0.08-0.10 mm/day; n = 5) and reach maturity by early March. As adults, growth slows or stops (0.00-0.02 mm/day for two adult females). A few adults may live to reproduce a second season. This agrees with the pattern of growth and longevity reported for U. stansburiana for Texas (Tinkle 1967) and Nevada (Turner et al. 1970). Northern and higher elevation populations live longer (Nussbaum and Diller 1976; Tinkle 1967; Tanner 1972). Males average 50.5 mm snout-vent (41.0-57.5; n = 15) and females average 46.7 mm (43.0-52.5; n = 15) at Ballona. This size dimorphism is typical for Side-blotched lizards, which is more pronounced in southern populations than northern ones (Parker and Pianka 1975).

Cloacal temperatures from six active lizards averaged 32.2°C (29.8-34.6), while eight inactive lizards averaged 21.2°C (16.0-27.8). The few basking lizards seen indicates that this species may not emerge from retreats until preferred temperatures are reached. The range of temperatures when inactive is similar to that reported by Brattstrom (1965). Our mean active temperatures is lower than that reported by Brattstrom (1965) and Tinkle (1967).

We found Side-blotched Lizards throughout all daylight hours when sunny. Activity was often restricted to areas of thick vegetation so patterns of daily activity were difficult to discern since capture was difficult. We encountered many individuals under surface objects both on cloudy or cold days and during hot, cloudless days. These retreats appeared to be used to escape both exceptionally cold and warm environmental temperatures. In Texas and Nevada, Side-blotched Lizards typically show a bimodal activity pattern with most activity occurring in morning and evening hours (Irwin 1965; Tanner 1972). It is likely that during warm summer months Side-blotched lizards at Ballona have a similar pattern.

Side-blotched lizards were found during all months of the year at Ballona, but numbers were lowest September through January with increasing numbers from February through June (Figure 14). Similar seasonal activity was reported for lizards from Texas and New Mexico (Tinkle 1967; Alexander and Whitford (1968). In Oregon, lizard activity ceases during winter (Rickard 1967; Nussbaum and Diller 1976).

During fall and winter months the population, we observed juvenile and small adult lizards (Figure 14), with approximately equal numbers of males and females encountered. During February, the population consisted of approximately equal numbers of adults and large juveniles approaching adult size. During the rest of the peak population months (March through June) the population consisted primarily of adults (Figure 14). Males predominated from February through April, whereas we found females more common from May through June. Males emerge early and set up territories before the females appear, similar to the pattern reported by Spoeker (1967) for lizards in the Mojave desert.

We first observed gravid females on April 20, 1981. By early May, nearly all adult females captured were gravid. They had bright orange to yellow patches on their throats and occasionally in the axillary region. We observed first female that appeared to have deposited eggs on June 1, 1981. Gravid females were captured throughout the month of June, but none were captured during July. The smallest female known to be gravid had 47 mm snout-vent length. Tinkle (1967) reported an earlier appearance of oviductal eggs in Texas Side-blotched lizards (early April). Since Tinkle's data are from sacrificed animals and ours from live animals in the field, it is likely that we did not recognize oviductal eggs until a much later stage of development. Egg deposition occured in mid-to-late April in Nevada (Turner et al. 1970), a month and a half earlier than at Ballona. Clutch sizes were not determined at Ballona. Mean clutch sizes from a variety of localities range from three to six eggs (Parker and Pianka 1975). U. stansburiana from southern California typically have three eggs per clutch (Goldberg 1977). In all populations clutch size increases with increase of female body size and decreases with time of year. Side-blotched lizards can lay up to five clutches per year (Turner et al. 1970), but typically lay three per year in Southern California (Goldberg 1977). Since hatchling sized lizards appeared over a long period of time (Figure 13), multiple clutches are probably laid at Ballona. The minimum adult female size found in this study is larger than any other study. Since our capture rate for Side-blotched lizards was low, this appears to be due to sampling error. Typically, female Side-blotched lizards become reproductive at about 40 mm snout-vent length in southern populations (Parker and Pianka 1975; Spoeker 1967; Tinkle 1967; Turner et al. 1970).

We first captured recently hatched juveniles on July 3, 1981. The smallest of these was 23 mm. Lizards captured in insect pitfall traps indicate hatchlings appear as late as mid-September. Since the earliest deposition date was early June, the minimum incubation at Ballona is approximately four weeks, less than half as long as the incubation time of other populations of <u>U. stansburiana</u> (Tinkle 1967; Goldberg 1977). The first observation of young of the year is similar to that reported for Mojave (Spoeker 1967), and mountain populations in southern California (Goldberg 1977). Later appearance of hatchlings occurred in Arizona (Parker 1974), Texas (Tinkle 1967), Nevada (Tanner 1972), Colorado (Tinkle 1967) and Oregon (Nussbaum and Diller 1976). In general, hatchlings appear later in northern populations and at higher elevations. Size at hatching in this study was similar to that of other populations (Goldberg 1977; Nussbaum and Diller 1976; Spoeker 1967; Tanner 1972; Tinkle 1967).

We have no data on feeding of Side-blotched lizards at Ballona. In other studies, they were observed to feed on beetles, termites, ants, and grasshoppers (Parker and Pianka 1975). It is likely that Ballona lizards feed on similar groups. No cases of predation on <u>U. stansburiana</u> were observed. Juvenile gopher snakes and common kingsnakes are known to feed on these lizards (Fitch 1949). Other suspected predators at Ballona are dogs, cats, rats, opossum, American kestrels, white-tailed kites, burrowing owls, and loggerhead shrikes.

Common Kingsnake - Lampropeltis getulus

The kingsnake is one of two snake species known to occur at Ballona. This snake is a terrestrial, non-venomous constrictor with a color pattern of alternating light and dark rings. Adults are under one meter in body length. This species is found across the continental United States north to southwestern Oregon and south to the states of Zacatecas and San Luis Potosi, Mexico (Blaney 1977). It frequents a great variety of lowland communities (Stebbins 1966). Several authors (Fitch 1949; Hayes and Cliff 1981) have commented on its tendency to aggregate around areas of persistent moisture. At Ballona, kingsnakes occur over most areas above the tidal flux (Figure 15).

Four active kingsnakes we measured had a mean body temperature of 28.6°C (range 28-29.5°). This value is nearly identical to that reported by Brattstrom (1965) for 17 kingsnakes. We observed a single inactive juvenile at 09:50 hours on February 6, 1981 under a wooden palate, presumably prior to warming to its preferred temperature, with a body temperature of 17°C, nearly identical to adjacent air and substrate temperatures of 17 and 17.6, respectively. Brattstrom also reports the temperature of a single individual emerging from a hole as 15.1°C, with air and soil temperatures of 14.8 and 15.2, respectively.

The 18 records of kingsnakes at Ballona suggest juveniles emerge first following winter hibernation, followed by adults (Figures16 and 17). There appear to be roughly four months of inactivity (October to January) at

Ballona in contrast to five months reported by Fitch (1949) in Madera county, California. Snakes observed in February through April were found under surface objects with rapid-heating capabilities (pieces of tin, boards, etc.). Peak surface activity was recorded in May (Figure 16), when snakes were frequently observed on open terrain. Summer months bring a decline in daytime activity, presumably because higher temperatures force the snakes to shift to crepuscular and nocturnal activity when temperatures are more equitable. A similar shift to nocturnal activity was also suggested by Fitch (1949) in central California.

Lampropeltis getulus is an egg-laying snake (Stebbins 1966). Reproductive information on this species is sparse. Clutch size varies from 3 to 10 (mean = 6) (Wright and Wright 1957). Egg deposition sites have not been described, but probably require loose, well-drained soil like that found in rodent burrow systems. Klauber (1931) recorded egg deposition dates in captivity for two females caught in the wild as July 19 and 30 in San Diego county. Klauber (1939) reported an incubation time period for snakes kept in captivity of 71 to 86 days, average of just under 11 weeks. The July egg deposition dates of Klauber and the June to August dates of Wright and Wright (1957), when coupled with Klauber's incubation times would produce young hatching in September, October and November. At Ballona recently-hatched individuals appeared in September.

The skeleton of a young juvenile Lampropeltis measured at 260 mm in body length was found at Ballona on September 15, 1980. Klauber's minimum juvenile sizes were 205 and 210 mm total length. It is likely that hatchling individuals are slightly over 200 mm in total length (over 170 mm snout-vent length). The only additional reproductive data from Ballona is a 703 mm road-killed female found June 15, 1981 that contained ovarian eggs, the largest of which was 9 x 5 mm. These eggs were clearly undeveloped, but it appeared yolk deposition was taking place. This size is close to the minimum we suspect required for reproduction.

Little is known of growth in Lampropeltis. Three age groups can be distinguished at Ballona (Figure 17): young of the year and first-year juveniles (250-500 mm snout-vent length), a middle size class of second-year juveniles (501-800 mm) and adults (801 mm and larger). Our impression is that juvenile Lampropeltis attain body lengths of above 500 mm at the end of their first year, and around 800 mm by the end of their second. Fitch (1949) reported slow growth (estimated at 0.0-0.1 mm/day from Fitch's table) in five adult kingsnakes. His data applied to adults well over 800 mm. Fitch has four recaptures of individuals already at this size when initially marked with six-year recapture intervals. This would give a minimum age of nine years for these snakes. The largest individual recorded at Ballona was a 1020 mm male, smaller than the largest individual recorded by Fitch (1949), also a male at 1160 mm. Size at first reproduction is unknown. Sexual dimorphism favors males (Klauber 1943).

Of 18 kingsnakes observed at Ballona, five (27%) were juveniles less than 500 mm long. This is higher than the 14% (six of 43) reported by Fitch (1949) in Madera county, California. Our impression is that young kingsnakes have a higher survivorship than young gopher snakes. Observed mortality was one of five (20%) in kingsnakes versus two of three (67%) in gopher snakes. Fitch gained the same impression from his data, but could not substantiate it conclusively. The size distribution of kingsnakes suggests that essentially all size groups are equally observable (Figure 18). It suggests equal representation if our sample has equal proportions of size groups to that found in the total population. Fitch's recapture data, noted in the discussion of growth, also suggest that adults have a high survivorship and considerable longevity. Sources of mortality are road casualties (n = 3) and unknown causes (n = 2). The two snakes listed under unknown causes included a 610 mm female whose dehydrated carcass was observed near a tidal pool fringed by pickleweed and the small juvenile mentioned under the discussion of hatchling sizes. Both snakes were fall casualities when fresh water is scarce. The sex ratio of observed snakes was essentially 1:1, of 15 individuals that could be sexed, 8 were males. A comparison of our data with Fitch's suggests that the density of kingsnakes at Ballona is higher than in Madera county, but no good density estimates for L. getulus exist.

Three records of food items for Lampropeltis exist for Ballona. A 42 mm long female Sceloporus occidentalis was palped from a 311 mm long juvenile Lampropeltis on February 19, 1981. On the night of June 15, two road-killed kingsnakes were found. One, a female, contained a Gerrhonotus tail fragment (see Gerrhonotus account) and the other, a 1020 mm male, contained the remains of an unidentified rodent. Diet items agree with the combined data of Klauber (1931), Fitch (1949), and Cunningham (1959a) who reported 31 food items eaten in a minimum of 16 predatory episodes. Reptiles were the food items in 63% (10 of 16) of the episodes, birds or their eggs in 25% (4), and mammals in the remaining 12% (2). Multiple food items in a single predatory episode are the result of juveniles or eggs being taken from nests. Fitch (1949) notes that a significant proportion of the diet may be obtained by nest robbing. When compared to other snake species (Fitch and Shirer 1970), Lampropeltis getulus is a relatively mobile predator. Fitch (1949) reported moves of ten kingsnakes varying from 45 to 553 m (mean = 260 m) over intervals from four days to over six years. Mobility may be a necessity in a foraging predatory mode where nest robbing occurs frequently. However, Fitch emphasizes that his data suggest permanent residence areas a few hundred meters at most in longest diameter.

Two records of snake predation exist for Ballona. On December 22, 1980 at 11:20, a burrowing owl was flushed from vegetation on Unit 3 carrying what appeared to be a snake. On February 6, 1980, a white-tailed kite (Elanus leucurus) or marsh hawk (Circus cyaneus) was observed carrying a snake at the west end of Unit 3. Neither snake was positively identified, but either of the two Ballona snake species were the possible food item for these predators. All three species mentioned are capable of capturing kingsnakes, particularly younger individuals. Fitch (1949) reports red-tailed hawks, great horned owls, and coyotes as kingsnake predators. Of these, only the first occurs at Ballona (C. Dock, pers. comm.). Fitch emphasized the low frequency of kingsnakes (14 occurrences) in the very large number of diet remains (7002 pellets and scats) examined over five years for the above three predators. He suggested predation on kingsnakes was infrequent. These data agree well with the previous suggestions on longevity. Other suspected potential predators at Ballona include cats, dogs, opossum, sparrow hawks and man.

Gopher Snake - Pituophis melanoleucus

The gopher snake is the larger of the two snake species known to occur at Ballona. Adults average somewhat over one meter in body length. Similar to the kingsnake, they are slightly stouter in build, terrestrial, non-venomous and powerful constrictors. Gopher snakes have regularly-spaced brown blotches on a tan to ochre ground color. This species ranges across the continental United States north to southern Alberta and Saskatchewan, Canada and south to central Mexico (Klauber 1947). They frequent a variety of habitats but are especially abundant in grassland and open brushland (Stebbins 1966). Frequently the most abundant terrestrial snake in many lowland communities (Klauber 1939; Sullivan 1981), they are the more numerous snake species at Ballona. Gopher snakes can be found over all areas above the tidal flux (Figure 15).

Our data for ten active gopher snakes show a mean body temperature of 28.5°C (range 22.6°C-32.2°C), similar to Brattstrom's (1965) mean for 17 active gopher snakes of 26.7 (range 16.4-34.6). Our range of body temperatures of active snakes also agrees well with Brattstrom's thermal gradient data where snakes, given a range of temperatures from 15 to 45°C, were most often found in the 22 to 31°C range.

Daily and seasonal activity patterns for adults agree well with the thermal data. The pattern is similar to that observed for kingsnakes with peak surface activity in May (Figure 16). This agrees well with Klauber's (1931) seasonal data for San Diego county. However,gopher snakes appear to use rapidly-heating surface objects less than kingsnakes, and they are diurnally active through July, while kingsnakes have undergone a shift to more nocturnal activity in June. Although still diurnal in June and July, snakes shift to activity times earlier in the day, when temperatures are more equitable.

Pituophis melanoleucus is an egg-laying species that produces clutches of three to 18 eggs (mean = 8) (Klauber 1947). We observed gravid females in June at Ballona. This agrees with Klauber's (1947) June and July egg deposition dates. Egg-laying sites have not been described but are expected to be similar to those postulated for kingsnakes (see Lampropeltis account). Klauber reports an incubation period in captivity varying from 64 to 71 days (mean = 66.5 days) and a hatchling size of 380 mm snout-vent length. At Ballona, we observed a 370 mm road-killed juvenile on September 29, 1980. Given a July egg deposition date, this agrees well with Klauber's estimates of incubation time and hatchling size.

We can distinguish two size categories in gopher snakes at Ballona (Figure 19). First-year juveniles (350-750 mm) and adults (1000 mm and up). We recorded no individuals in the 750 to 1000 mm size interval, which probably represents second-year juveniles (Figure 20). Fitch (1949) recorded only 7% (19 of 257) individuals in the 600 to 900 mm size interval, which he termed second year snakes. From the differential numbers observed in other size categories, Fitch suggested a high mortality (over 80%) of juveniles before their first hibernation as the reason a low frequency of the second year class is observed. We estimated growth rates from Fitch's size data for all size categories. Growth for juveniles and young of the year ranges from .31 mm/day to 1.99 mm/day (mean = .96 mm/day; n = 4). Growth during hibernation was estimated from a single individual at less than .005 mm/day. There are no estimates of growth during hibernation for the other size classes, but they are probably equally low. For the second year class, growth ranges from .51 mm/day to .97 mm/day; n = 2). Estimates for adult growth are only for the adult males that made the largest growth increases. Estimates range from .04 mm/day to .13 mm/day (mean = .11 mm/day). If growth is similar at Ballona, and the shorter winter period should allow more time for growth, it suggests snakes at Ballona attain the adult size range of 1000 mm midway through their second year of growth. The largest snake recorded at Ballona was a 1585 mm male, considerably smaller than the snake in excess of 1800 mm recorded by Fitch (1949). Fitch recorded two snakes recaptured after six year intervals which were already adult size, which suggests these two snakes were at minimum eight years old when recaptured. Klauber (1943) records sexual dimorphism in size in favor of males.

As previously noted, we gain the impression, concurring with Fitch (1949), that juvenile mortality is high (see Lampropeltis account). At Ballona, most (86% - 18 of 21) gopher snakes were adults. Fitch (1949) believed that adult mortality was less than the mortality of juvenile conspecifics. Sex ratios of observed snakes were not different from 1:1; of 21 snakes 11 were males.

Two records of predation by Pituophis exist for Ballona. The 370 mm juvenile mentioned under the discussion of hatchling size, a female, contained an unidentified mouse in its stomach. A 560 mm juvenile female was found basking on June 12, 1981 with a recently swallowed harvest mouse (Reithrodontomys sp.) in its stomach. A summary of the food records from Klauber (1931; 1947), Fitch (1949), and Cunningham (1959a) show that gopher snakes ate 112 food items in 57 predatory episodes. Fitch (1949) found 39% (13 of 33) of snakes with food were nest robbers. Similar to the kingsnake, it is a highly mobile predator, with moves up to 778 m recorded (mean = 138 m for n = 28) (Fitch 1949). In a telemetric study involving seven snake species, Pituophis made the longest mean movements (142 m = mean; n = 3, Fitch and Shirer 1971). Of 57 episodes summarized above, 45 (79%) were mammals, while 6 (10.5%) were birds or their eggs and the remaining six were reptiles. Reptiles in the diet were all lizards taken exclusively by juveniles except for a single report of cannibalism. Because of its size, larger mammals up to the size of a cottontail rabbit are occasionally taken. Juvenile rabbits, juvenile squirrels and adult and juvenile pocket gophers are frequent diet items. A notable feature of the gopher snake's diet is the presence of burrowing mammals that plug their burrows with dirt. The ability of gopher snakes to dig through the dirt, pushing defenses of pocket gophers, is an important reason for these snakes being major predators on these rodents (Hickman 1977). Species which occur at Ballona and have been reported as gopher snake prey include: pocket gophers (Thomomys sp.), meadow voles (Microtus sp.), house mice (Mus sp.), western fence lizards (Sceloporus sp.), side-blotched lizards (Uta sp.), and quail (Lophortyx sp.).

Two instances of potential predators on snakes are reported under the kingsnake account. Fitch (1949) reported predation on gopher snakes by red-tailed hawks, great horned owls, coyote, gray fox, barn owls, and kingsnakes. Gopher snakes represented 1-5% of the total prey items for the hawks, owls, and canids. One instance of a gopher snake eaten by a kingsnake occurred in six kingsnake food items reported. Of the reported predators, the hawk, barn owl, and kingsnake all occur at Ballona.

SUMMARY

Scope of the herpetofauna

The reptiles and amphibians known to occur on the sampled area consist of nine species: four lizards, two snakes, a frog, a toad, and a salamander. Our knowledge of habitat requirements suggest this sample represents all existing reptiles and amphibians, with the possible exceptions of the terrestrial salamander, *Ensatina eschscholtzi*, and the Western Spadefoot Toad, *Scaphiopus hammondi*, which may have been missed due to limited rainfall. Only one other study, that of Pluym et al. (1979) by Envicom Corporation, has attempted a more than cursory survey of the Ballona reptile and amphibian fauna. Unfortunately, that survey did not specify the number of hours of field observation, species' occurrences were often statements merely paraphrasing the field guide literature, and references were vague so that field observations could not be distinguished from literature records. The Envicom study reported 13 species of reptiles and amphibians, only four of which were observed in the field. These were *Bufo boreas*, *Hyla regilla*, *Sceloporus occidentalis* and *Uta stansburiana*. Four others reported were never observed by us. Three of these are probably absent from Ballona today (see historical data and changes). We caution that although the Envicom report is valuable as an initial estimate, it does not provide essential habitat and reproductive period data for species actually present. These data are needed for management decisions. We caution further that, even with rigorous sampling, certain species may be missed because of annual variability in climate.

Historical data and changes

Los Angeles County Natural History Museum (LACNHM) records suggest all species recorded were historically present. However, the greater area which includes the Ballona Marsh ecosystem has been considerably modified since the turn of the century, and changes in the herpetofauna are not reflected by confirmation that existing species were formerly present. Instead, we distinguished two types of changes: 1) elimination of species, recognized by comparing our data with historical records, and 2) gross movements and changes in population size for existing species, which we inferred from a knowledge of species' habitat requirements and differential habitat composition between historical and present-day marsh sites. Although other types of changes are certainly possible, historical data are insufficient to allow a more detailed comparison. Records indicate that the Ballona region once supported a freshwater marsh system behind today's halophytic tidal marsh. Historical records (LACNHM collections) of two reptiles, the Pacific Pond Turtle (*Clemmys marmorata*) and the Common Garter Snake (*Thamnophis sirtalis*), suggest that habitat and food resources required by these two species existed. Neither species invades halophytic marshes, but both are associated with cattail-tule vegetation in warmer, slow-moving waters of drainages to the north and south of the Ballona ecosystem (Storer 1930; Klauber 1931). Since both are common and easily collected by comparison to most reptiles and amphibians, it is not surprising they should appear in these records. However, at least two other species, the California Red-legged Frog (*Rana* for mammals that are fed upon by snakes and alligator lizards. The presence of mammals is a vital link to reptile survival for yet another reason. No Ballona reptile can burrow in dry, compacted soil. In the absence of physically-created holes, which are few and mostly unsuited to reptile use, reptiles must take refuge and lay eggs in burrows made by mammals. Access roads may also provide movement corridors for amphibians restricted by saline habitats.

New habitats have been created by extensive debris found throughout the study site, but primarily in Units 1 and 3. Utilization of different sorts of debris varied among reptiles. Light trash (paper, etc.) has a short longevity and poor heating capabilities; such objects were infrequently used. In contrast, wood, metal, and cement debris are long-lasting. Many such objects have rapid-heating capabilities and reptiles often used them to raise their body temperatures. Both lizards and snakes used such debris for thermoregulation and refuges. However, only larger debris was used consistently for the latter purpose. It is difficult to separate the positive impacts reptile populations have experienced from the combined effect of access road construction and the addition of larger debris. We believe, however, that the former is more important, though the latter is probably responsible for the high densities of Sceloporus occidentalis observed in many areas. This may secondarily influence the densities of the primarily saurophagous kingsnake (Lampropeltis getulus).

Certain changes linked to habitat alteration have probably decreased populations sizes. Freshwater habitat in the Ballona region has decreased. Changes which probably eliminated turtles (Clemmys marmorata) and garter snakes (Thamnophis sirtalis) may have simultaneously reduced populations of the two extant, aquatic-breeding amphibians (H. regilla and B. boreas).

Of the six freshwater sites found in the study site, the small drainage in the eucalyptus grove on Unit 2 and the drainage south of Jefferson Boulevard on the Agricultural Lands, appear polluted and had no successful amphibian reproduction; and the channelized drainage in the north corner of Unit 3 is probably marginal habitat because of the proximity of salt water. Successful amphibian reproduction was not observed there.

Farming activities on the Agricultural Lands also may have a negative impact on reptile and amphibian populations. Agricultural Lands were plowed at least twice a year. This activity probably restricts most reptiles to the unplowed fringes of the fields and reduces available habitat.

Exotic vegetation appears to have a negative impact. Distribution of the herpetofauna categorized by vegetative associates suggests the native vegetation is preferred (Table 1). Laurel Sumac (Rhus laurina), Bush Lupine Lupinus chamissonis), Saltgrass (Distichlis sp.), California Sage (Artemisia californicum), and Bulrush (Scirpus olneyi), all natives, have the highest relative densities of reptiles and amphibians. Eucalyptus, an exotic, has the lowest value. We believe that the observed difference between native and introduced vegetation is due to the fact that exotics harbor a poor food base (primarily insects) and are therefore less attractive to reptile and amphibian consumers.

Certain exotics appear to have greatly reduced available habitat. Present distribution patterns of the two sand-dwelling species suggest that both once had continuous distributions from the dunes fringing the beach to the bluffs bordering the south boundary (Figure 4). Although some habitat has been eliminated by development (the gas company facility), a substantial portion is now covered by the exotic iceplant, Carpobrotus sp. Present-day populations of U. stansburiana and A. pulchra occur on portions of Units 1, 2, and the Agricultural Lands not covered by this exotic.

The Ballona region is used by several introduced and domestic animals which have potentially serious effects. Feral cats and rats decrease existing reptile populations directly by predation (Iverson 1978; Honegger 1981), or indirectly by removing food items normally taken by reptiles (George 1974). The access roads on Unit 1 are used daily by horseback riders from the corrals on the south corner of this unit. Despite signs warning them to avoid marsh areas, the riders frequently ignore the signs and cause visible damage to the vegetation and disturb marsh soils. Vegetation damage reduces available habitat for reptiles. Unit 3 is frequently used by local residents to run their dogs, which often harry and kill the rabbits occurring on this unit. Since juvenile rabbits are prey for gopher snakes, a negative impact similar to that suggested for feral cats may be incurred.

Finally, certain human activities have or are suspected of having negative impacts. Off-road vehicle (ORV) use has clear negative effects (Berry 1973; Busack and Bury 1974; Bury, Luckenbach and Busack 1977). ORV's cause vegetation destruction and produce soil compaction. Burrowing mammals are deterred by compacted soils, and, in turn, the available habitat for reptiles and amphibians is limited. ORV use can also eliminate individuals directly. Field observations of several crushed reptiles and amphibians suggest they were killed in this manner. Further, reptiles, especially snakes, are susceptible to collection by amateurs wishing to keep them as pets. Since snakes are frequently collected as adults, there are potential negative consequences for the reproductive population. Two encounters with snake collectors at Ballona suggest this activity may be an important influence on local populations. Lastly, groups of young boys were observed hunting rabbits on Unit 3 on two different occasions. We suspect the effect of such hunting is similar to that suggested for dogs, and the combined effect may have a negative impact on gopher snake populations.

In summary, only a portion of Ballona's original herpetofauna remains today. Extant amphibian populations are probably smaller than in the past, due to physical alteration and pollution of freshwater habitats required for reproduction. Reptile populations have been variously affected. Some have probably benefited from the increase in area above the tidal flux and the addition of debris. The sand-dwelling lizards have probably experienced declines due to habitat encroachment by exotic vegetation. Farming activities, introduced predatory mammal species and various human impacts (ORV use, horseback riding and hunting) have or are suspected of having negative impacts on reptile and amphibian populations.

Ecological characteristics of the existing herpetofauna

That reptiles and amphibians are an integral part of the Ballona ecosystem is shown by trophic and other relationships. All reptiles and amphibians are higher-order consumers. Amphibians and lizards are primarily insectivorous, whereas the two snake species prey on mammals, reptiles, and birds. In turn, larval and adult amphibians are food for wading birds; lizards are eaten by snakes, shrikes, and raptors; snakes provide food for hawks, owls, and other snakes. As previously noted, amphibians and reptiles are dependent on burrowing mammals for their subterranean refuges.

A summary of the yearly cycles of the nine sampled species based on our data and literature records is shown in Figure 21. The three amphibians deposit eggs, when water is abundant in late winter and early spring. Most juvenile frogs and toads metamorphose well before late summer and fall, when freshwater is scarce. In contrast, most reptiles begin to breed after the end of the wet season into mid-summer, when productivity of this ecosystem is highest. Critical breeding periods for amphibians are January to March and April through June for reptiles. March to July is the critical period for aquatic larvae of amphibians.

The patterns of reproductive cycling are also important determinants of a species' ecological sensitivity. Of the nine species, two are annual (Hyla and Uta), one is biennial (Sceloporus) and the rest are perennial. Perennial species take two or more years to mature and are long-lived. Such species are sensitive to impacts that eliminate the breeding population since these are slow to be replaced. It is noteworthy that populations of species extinct in the Ballona ecosystem were all long-lived perennials. In contrast, annual species mature, reproduce, and die all in the span of one year. Thus, they are particularly sensitive to disturbances that eliminate a year's reproduction, since there are no additional possibilities for reproduction the following year. At Ballona, this may be particularly crucial since annual populations exist as isolates and cannot depent on recruitment from adjacent populations in the event of a reproductive setback.

Table 1 shows the relative density of species by Unit. Uta stansburiana is most abundant on Units 1(D) and 2, which contain prime sandy habitat. Hyla regilla is most abundant on the Agricultural Lands, where the largest concentrations of freshwater exist. Sceloporus occidentalis and Gerrhonotus multicarinatus are found in all areas, but the former has the highest densities on Units L(1A) and 3, while the latter appears most abundant on Unit 1 (1A and D). The two snakes species occur on Units 1, 3, and the Agricultural Lands, with Lampropeltis getulus most abundant on Unit 1 and the Agricultural Lands, and the gopher snakes (Pituophis melanoleucus) most abundant on Units 1 and 3. These data are unequivocal: Unit 1 is the most diverse with the highest relative densities of three of the nine species recorded.

Uniqueness of the Ballona ecosystem

The Ballona region is the only significant piece of saltmarsh remaining in Los Angeles county, and it contains a valuable salt marsh ecosystem. California salt marsh ecosystems have sustained reductions in area varying from 60% to over 90% since 1880 (MacDonald 1977). Estimates in 1975 indicate that just slightly over 36,000 hectares of this ecosystem remain in California (MacDonald 1977), making it the rarest of any major vegetational association.

Unit 1 contains a viable dune habitat. Only 23% of California's 1326 km long coast is occupied by beach and dune (Cooper 1967). Multi-recreational use of a number of California's largest dune systems have made the remaining less disturbed dunes one of the rarest habitats in California (Powell 1978). Dune and alluvial fan sand habitats harbor the unique limbless lizard, *Anniella pulchra*, a protected species under the California Fish and Game Code. Elimination and modification of many dune systems and sandy wash environments have reduced the range of this species, whose ecology is still poorly known. Since two reptile species at Ballona are restricted due to habitats and since the dune habitats are separated by other habitats, the dunes appear to be the most sensitive habitat for the herpetofauna. Disturbance to any dune habitat may result in elimination of a reptile species which will be unable to reestablish via migration.

Although we have no absolute density figures, the field experience of one of us (Hayes) suggests that in Ballona the snake and alligator lizard densities are unusually high. We believe this system presents a unique opportunity to study these three species under unusual conditions. Densities are sufficiently high that ecological data, obtainable only with difficulty at more typical densities would be easily available at Ballona.

The fact that this is a disturbed system would enhance the value of such a study, as our knowledge of the ecology of reptiles in disturbed systems is exceedingly limited.

Management recommendations

The Ballona region is a unique, viable, albeit highly-modified ecosystem. To regard this system as non-viable ignores the reality that populations continue to maintain themselves within this system despite a history of varied impacts. Because of the small size of the area and the urban position of the ecosystem, several impacts are liable to eliminate populations of remaining species if their effects are not reduced or removed. For Ballona to maintain its present reptile and amphibian species composition over a long period of time (over the next 50 to 100 years), we feel the following suggestions should be implemented:

1) Preserve the largest possible area

Both existing snake species require large contiguous areas in which to maintain viable populations. Historical records suggest that snake species no longer occurring at Ballona required large areas of undisturbed habitat. The remaining two species can survive in a disturbed habitat, but the area size remains crucial. We predict that any parcelling of the area into smaller units would eliminate the snake species before other species. Instead of preserving small areas of different habitats, we suggest maintenance of the largest possible contiguous area as the only alternative that will maximize the number of species retained at Ballona. We further suggest that elevation of through-traffic roads (i.e. Culver Blvd.) or the addition of wide culverts that would allow water and animal movement, is a necessary part of the above suggestion. It would aid area contiguity by allowing free movement of animals between Units 1 and 2, and would reduce vehicle-caused mortality. This is especially important for snakes to which this source of mortality may be significant.

2) Increase pickleweed

Our data suggest that pickleweed is a primary foraging habitat for alligator lizards, and is of secondary importance for others. Enhancement of the quality or increasing the extent of pickleweed and its associated insect fauna would benefit these species. Maintenance of adequate tidal flow through open channels is vital to restore pickleweed to a healthy state. The level of flooding should be limited so as not to reduce other drier, higher habitats required by reptiles as egg-laying and refuge sites. Thus, we suggest that the access road system to the gas wells in the central marsh be retained as habitat for these species.

3) Limit access

Vehicles, domestic animals, and human activity all share responsibility for significant mortality in reptiles and amphibians. ORV traffic probably has the greatest impact, as it results in habitat alteration over longer periods of time than the other factors. The utilization of the area by domestic animals would conflict with efforts to maintain the marsh system in a natural state. Vehicle access should be eliminated and use by domestic animals should be excluded. Human activities (hunting and collecting) in conflict with maintenance of the marsh system should be disallowed. Because of the urban position of this marsh system, adequate fencing is a prerequisite to limiting the impacts noted above. Human foot traffic should be the only access allowed and this should be limited to sites that will least impact the system.

4) Dune preservation

Coastal dunes, as previously discussed, are becoming increasingly rare, Unit 1 has a significant dune remanent inhabited by the unique limbless lizard, Anniella pulchra. Maintenance and protection of all areas where this species occurs at Ballona is recommended. The introduced iceplant encroaching on dune habitat should be limited. Removal would be preferable if it could be done in such a way as to avoid disturbance of existing populations. Growth of native dune vegetation, such as Bush Lupine (Lupinus chamissonis), should be encouraged.

5) Preserve freshwater habitats

Amphibian eggs must be laid in freshwater, and two of the Ballona amphibians lay aquatic eggs. Freshwater habitats are limited to six small sites, three of which are not suitable for successful amphibian breeding. The continued existence of both species requires preservation of their breeding sites. The eucalyptus trees on Unit 2 should be removed. They are poor habitat (Table 1) and probably contribute to the pollution of the freshwater site associated with them.

6) Exclude dumping

Some of the Ballona region has been used for trash disposal. Although this has provided some habitat for reptiles and amphibians, it detracts from the overall aesthetic value of the area. We suggest that littering of any kind not be permitted and that existing refuse be removed. Increasing the number of native shrubs will compensate for any habitat losses resulting from trash removal (see next management suggestion).

7) Increase native shrubs

Shrubs and trees are limited at Ballona, and their scarcity limits foraging habitat, refuges and prey items available for reptiles and amphibians. Reptiles and amphibians are more abundant in association with native shrubs (Table 1). Habitat enhancement by adding more of the native shrubs, particularly Laurel-Sumac (Rhus laurina), California Sage (Artemisia californicum), and the Bush Lupine (Lupinus chamissonis) in sandy sites would benefit existing reptiles and amphibians.

8) Preservation of the central marsh

Our data show that Unit 1 is the most biologically valuable area (Table 2). We believe the best solution to retaining a manageable marsh system in view of the previous recommendations is to preserve a contiguous piece that includes: 1) all of Units 1 and 2; 2) the bluffs; and 3) sufficient buffer around those areas. We believe restoration of Unit 3 to viable marshland would require great expense without certainty of success. The Agricultural Land north of Centinela Creek drainage and west of Lincoln Boulevard has limited biological value. We emphasize, however, that access to the protected area must be limited.

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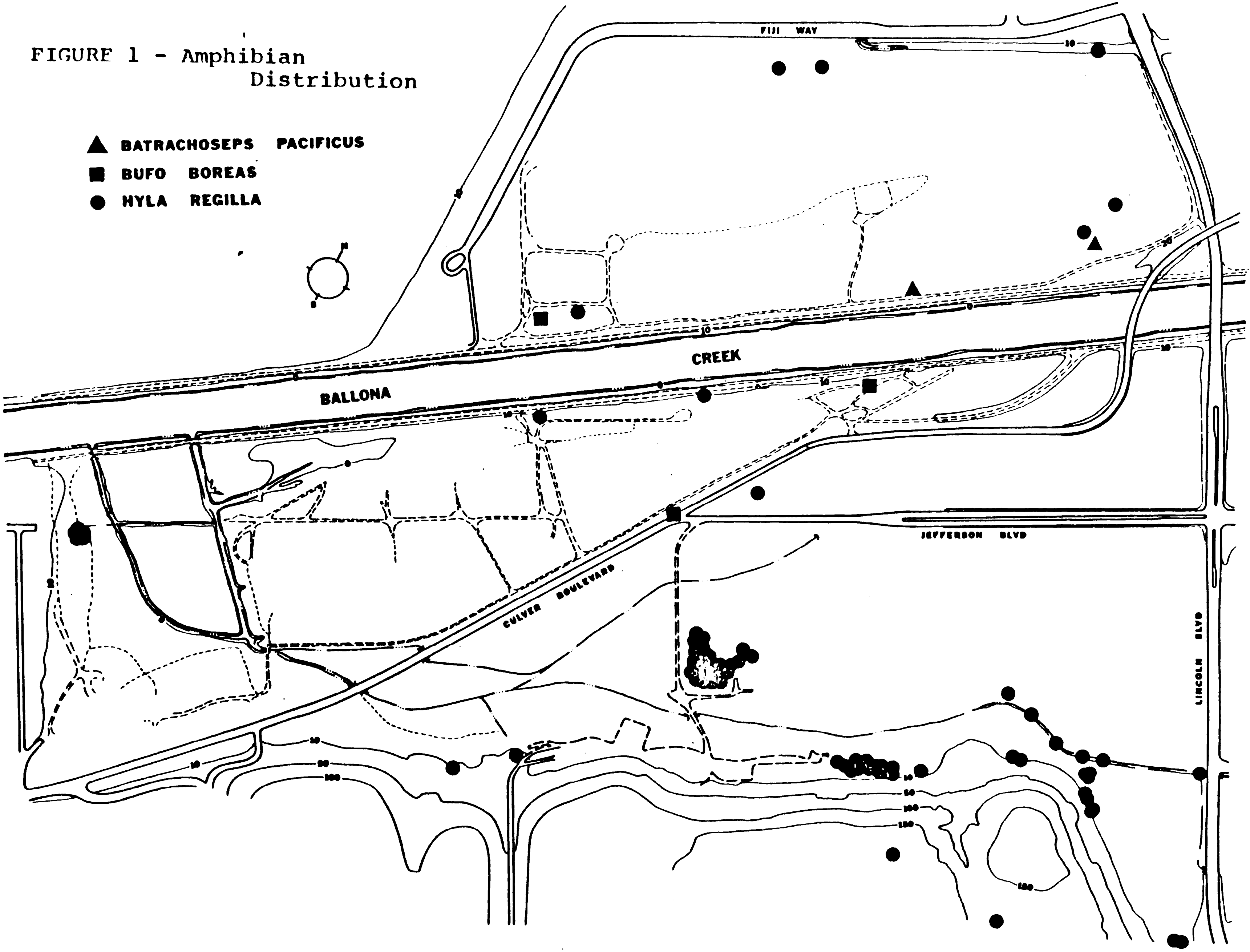
FIGURE 1 - Amphibian Distribution



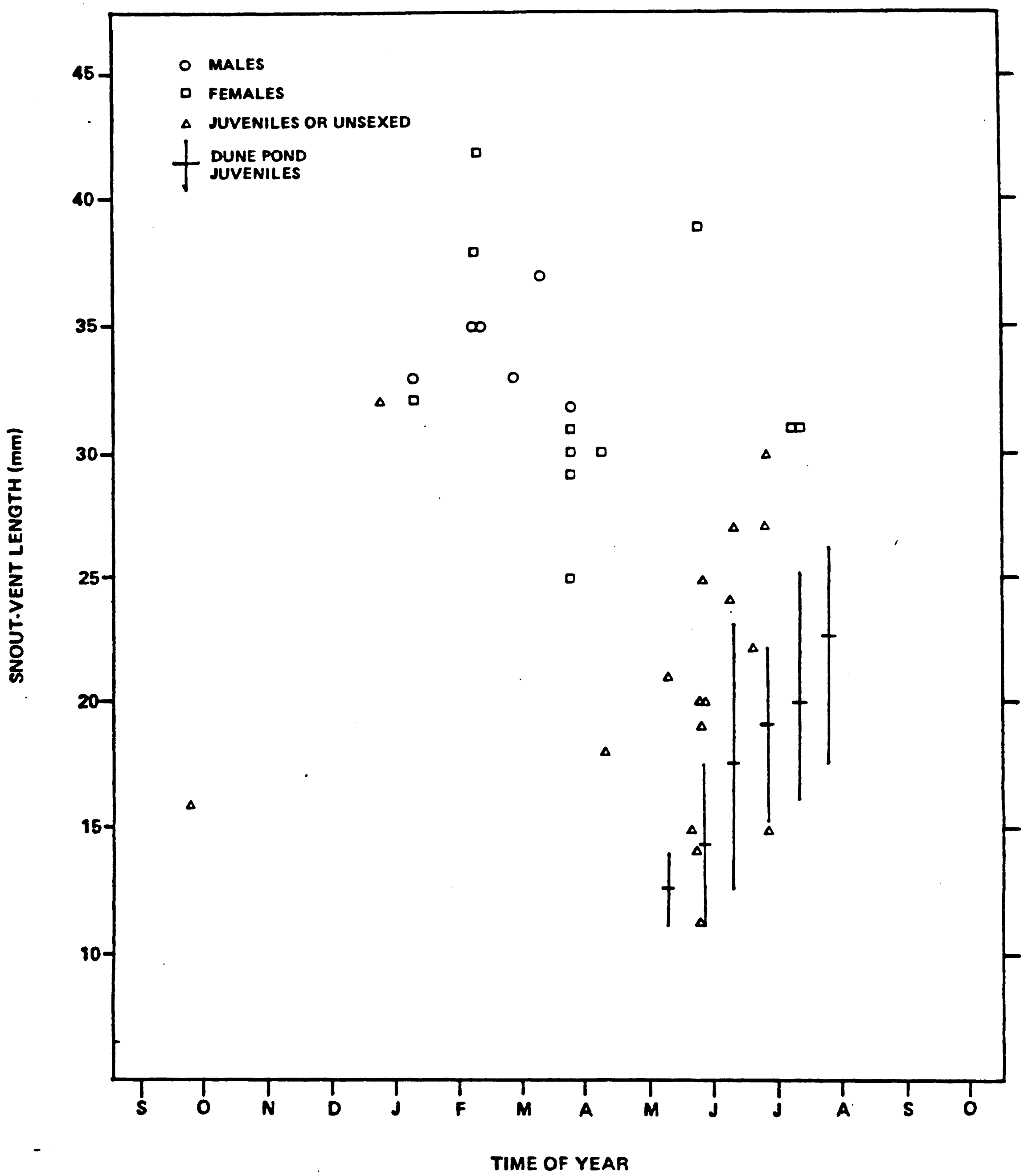


FIGURE 2 - Body lengths of <u>Hyla regilla</u> vs. time

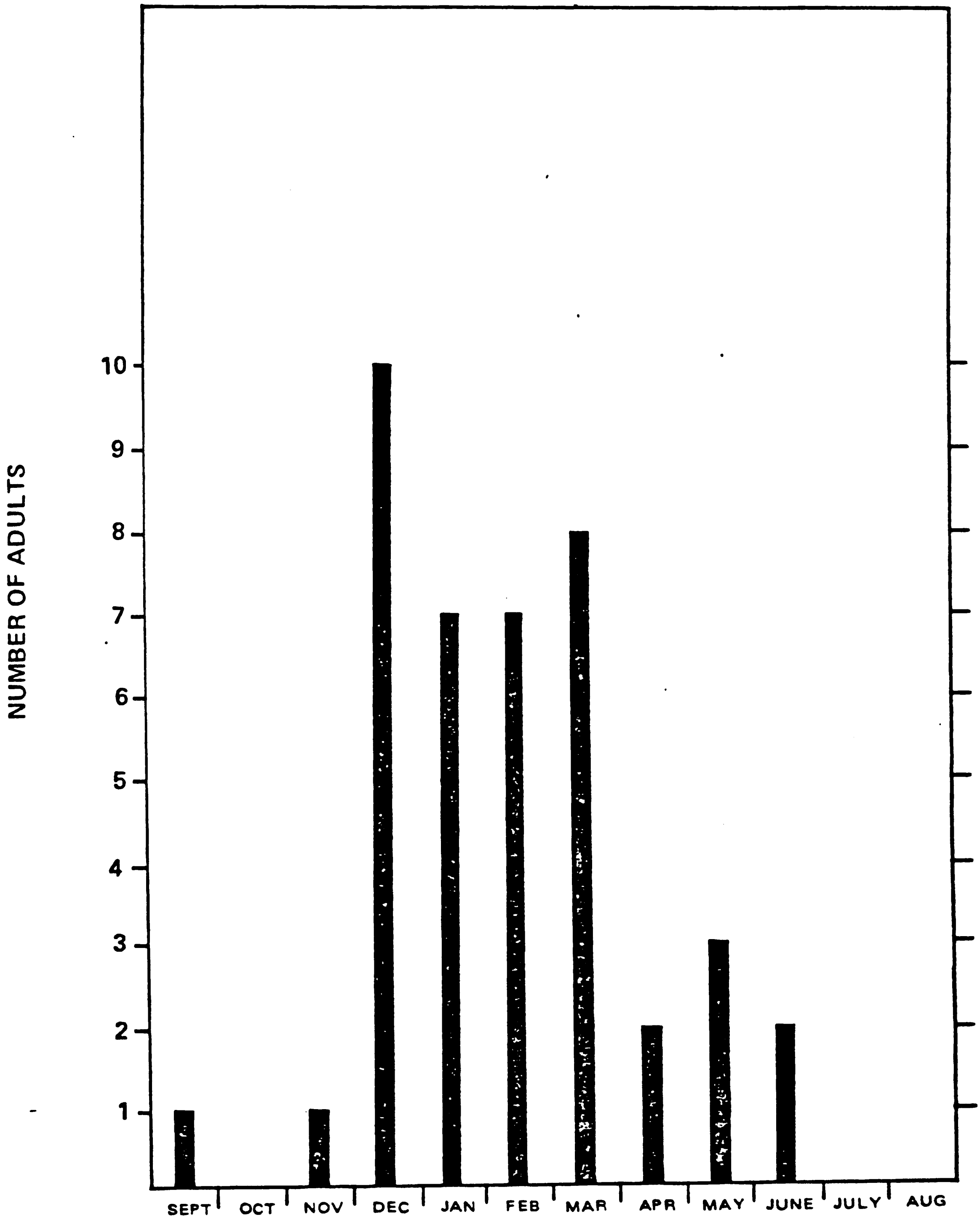
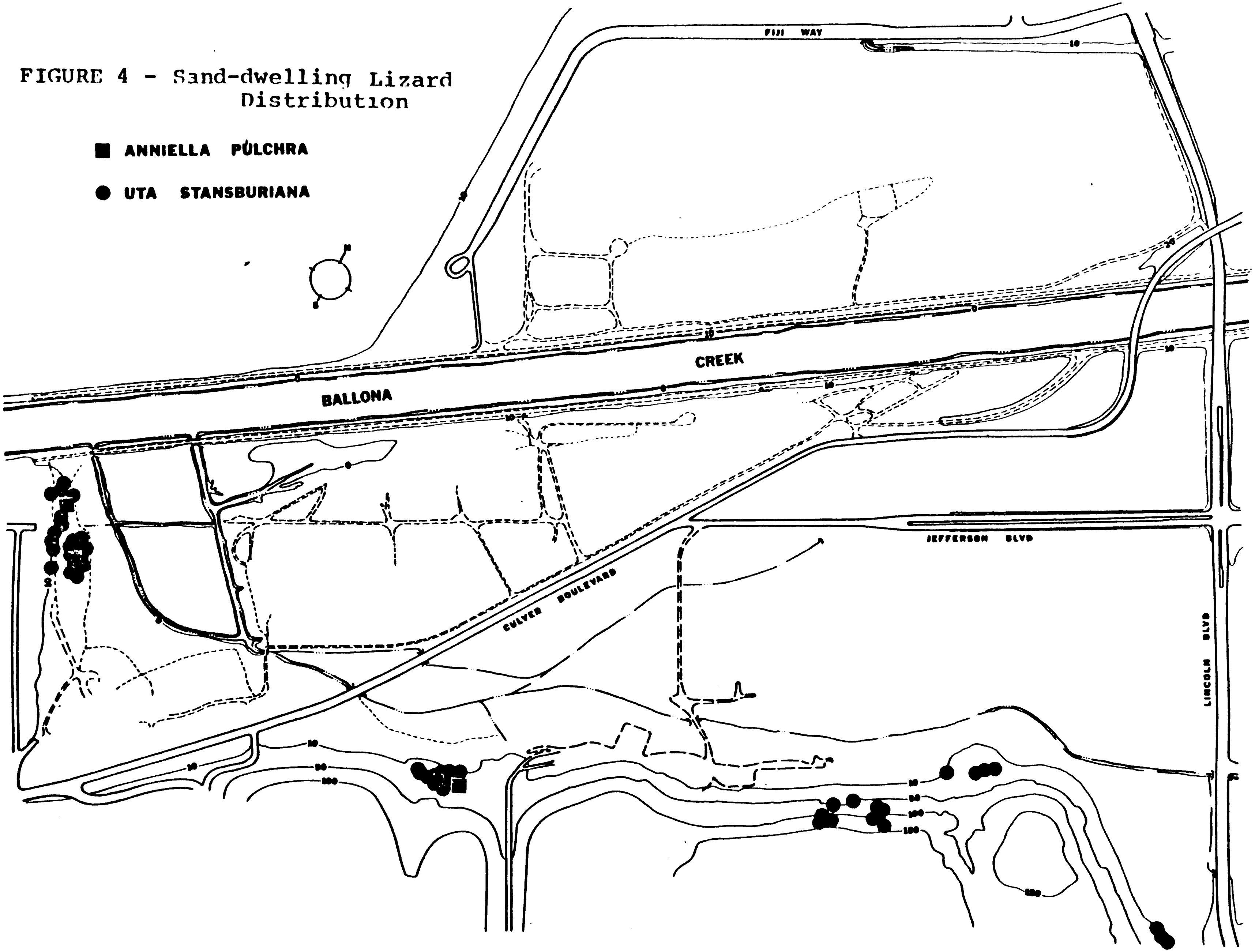


FIGURE 3 - Frequency distribution of adult treefrogs observed at Ballona by month

FIGURE 4 - Sand-dwelling Lizard Distribution



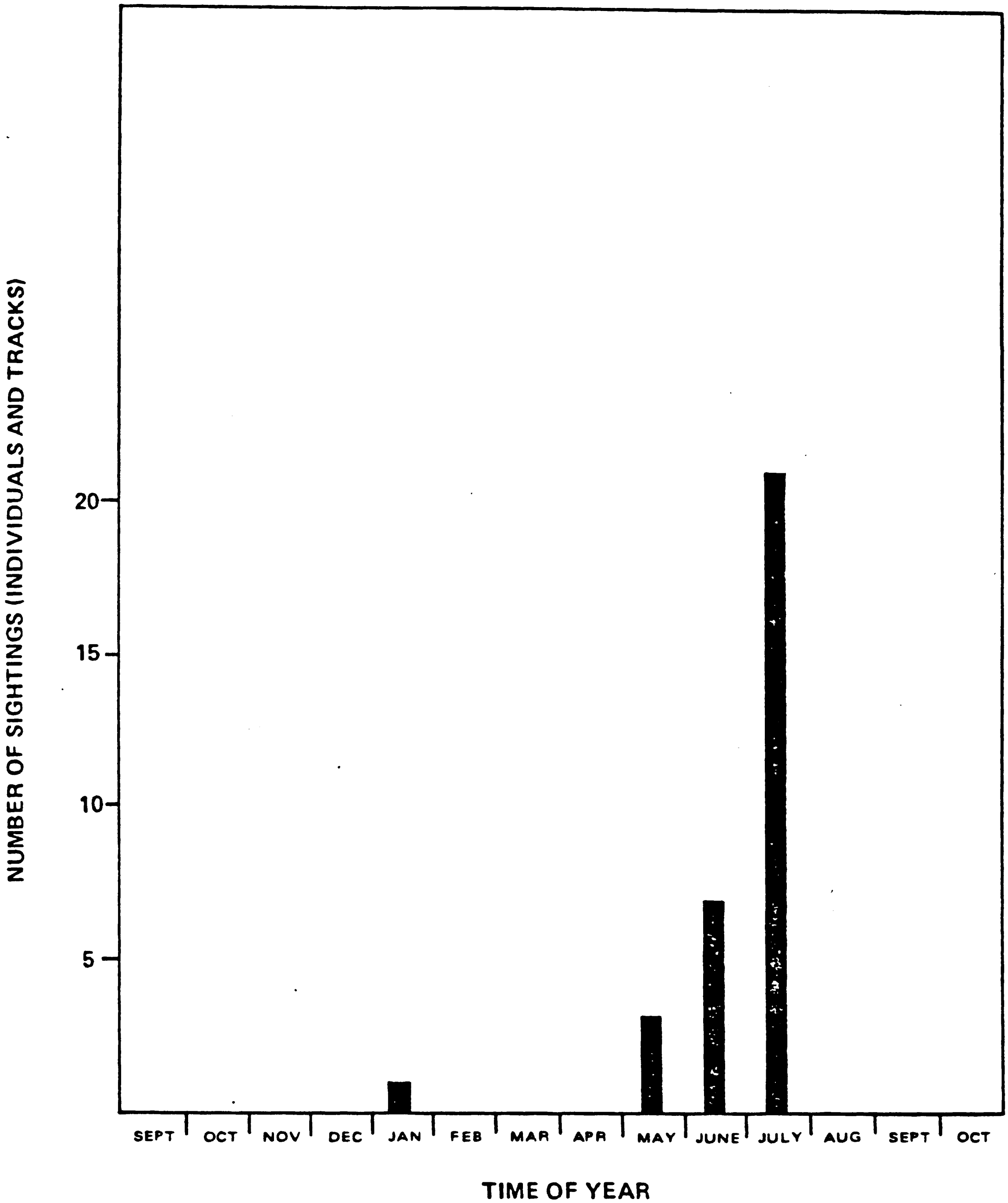
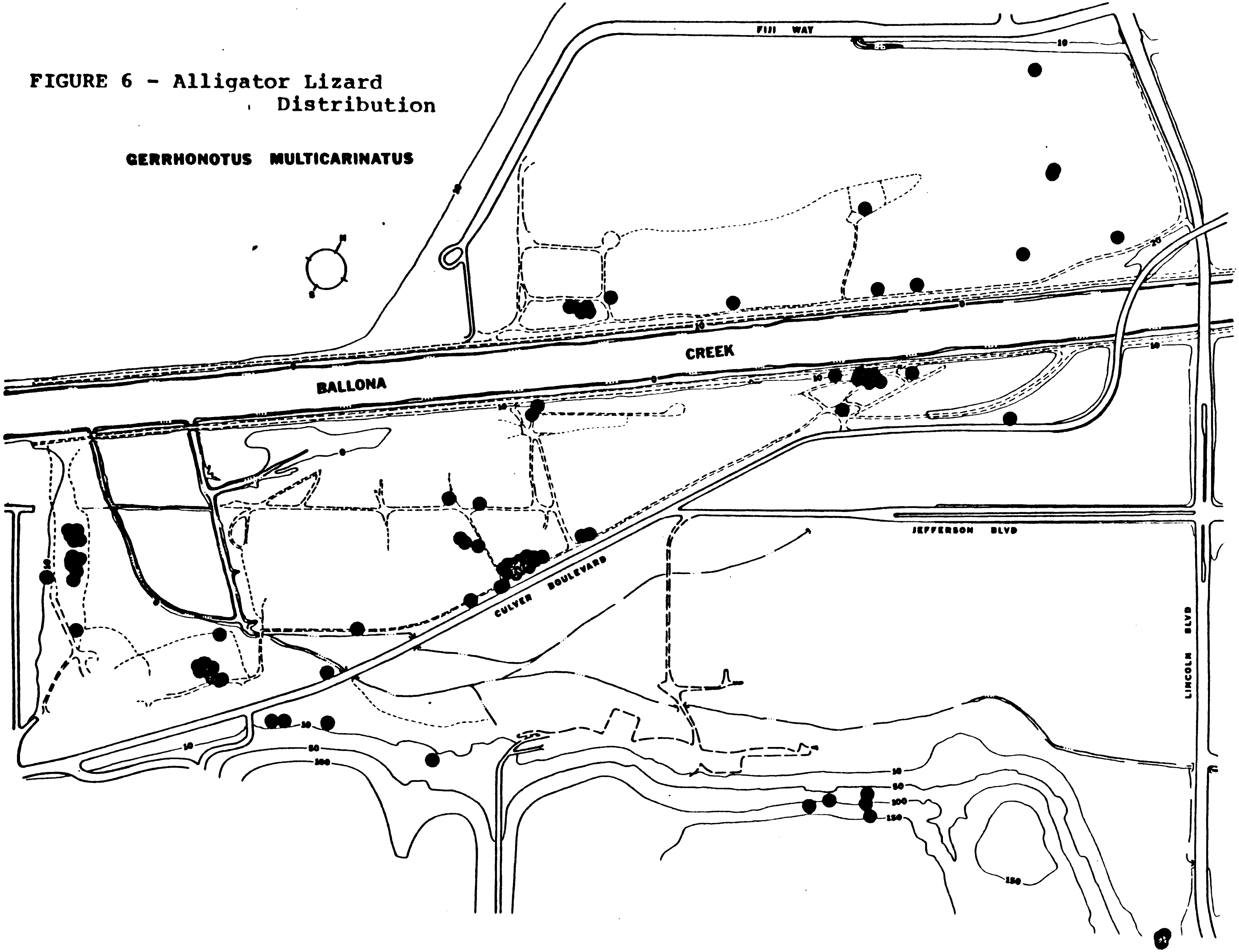


FIGURE 5 - Observed activity in <u>Anniella pulchra</u>

FIGURE 6 - Alligator Lizard Distribution



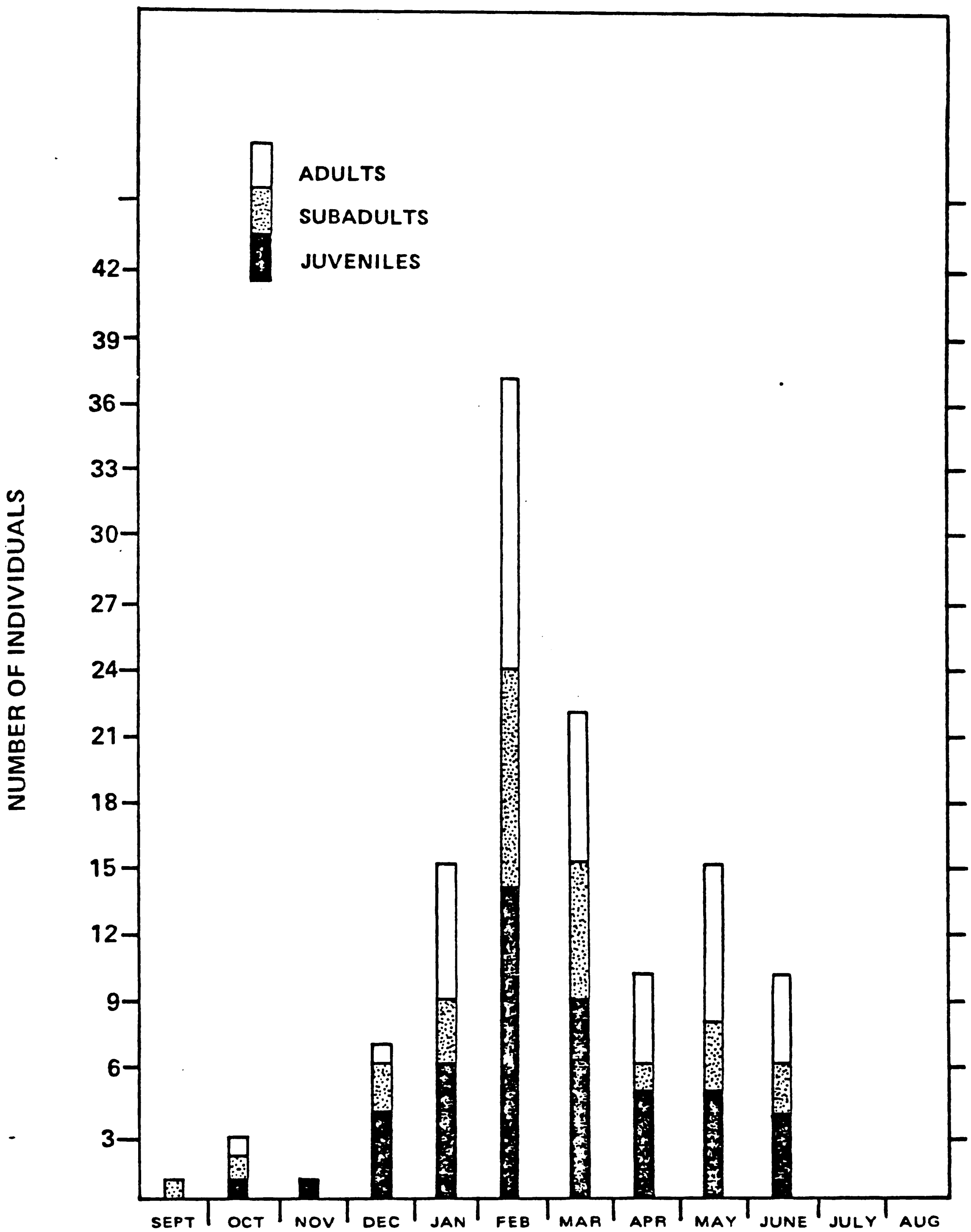


FIGURE 7 - Observed Activity in Gerrhonotus multicarinatus

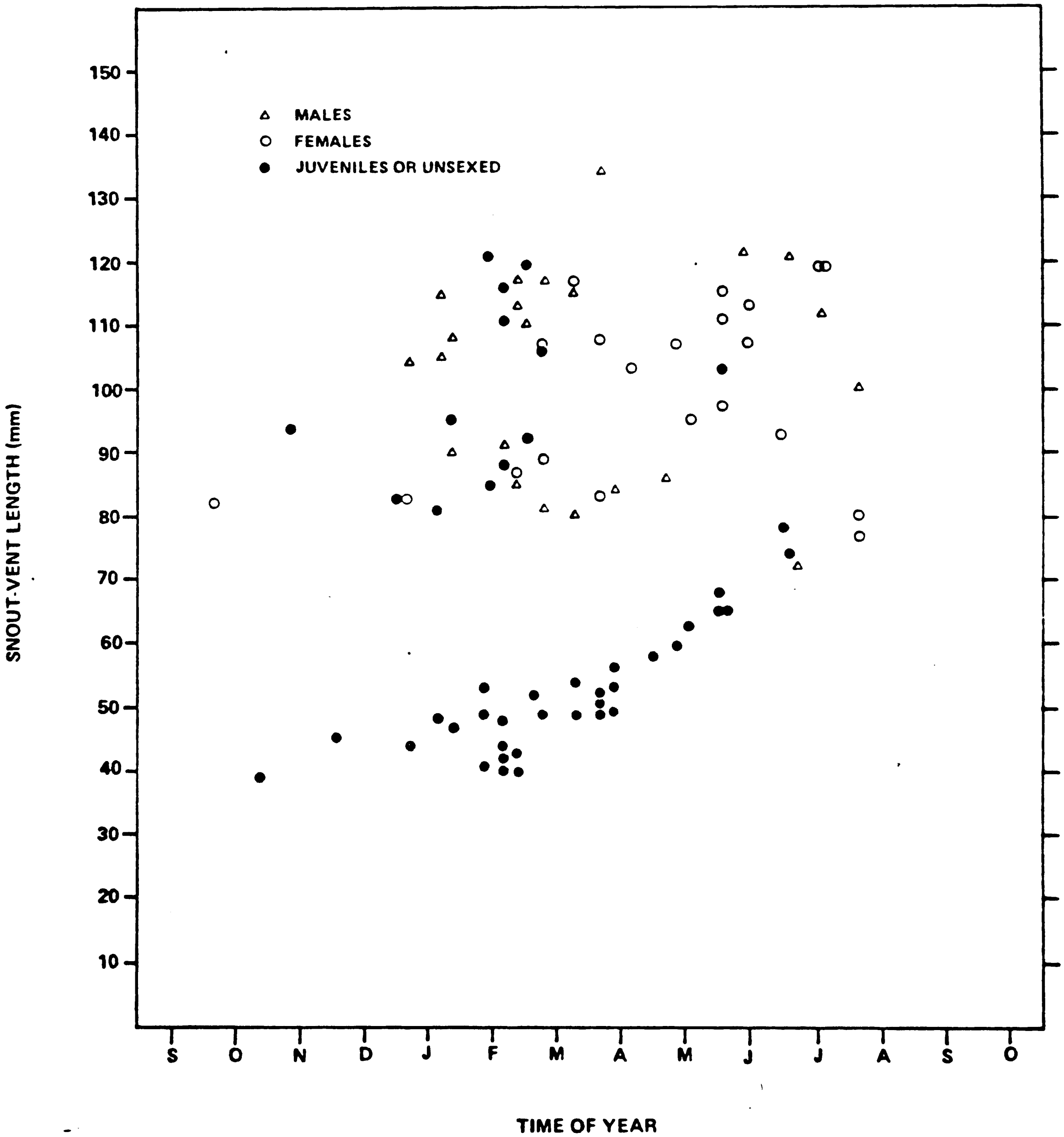
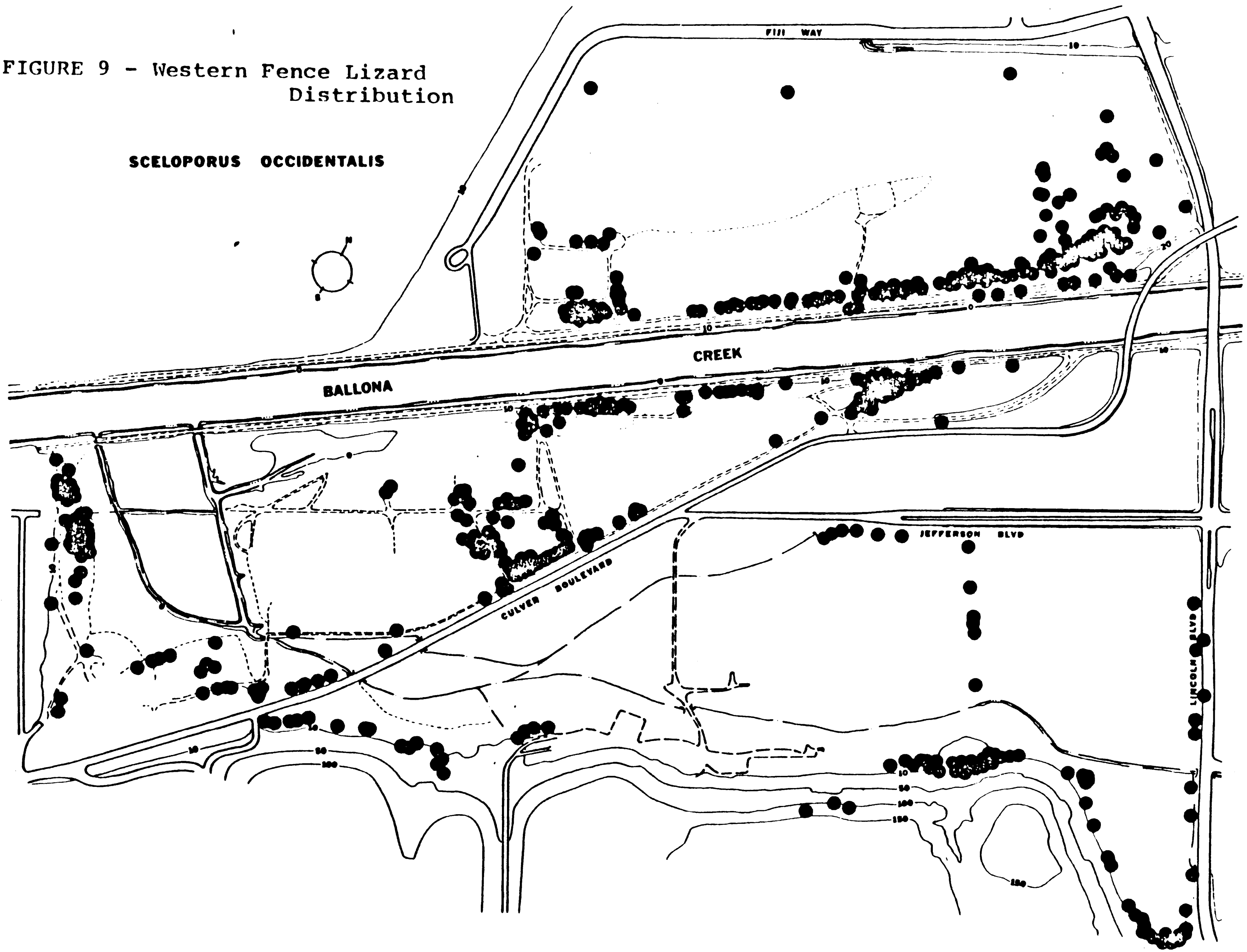


FIGURE 8 - Body lengths of <u>Gerrhonotus</u> <u>multicarinatus</u> vs. time showing growth

FIGURE 9 - Western Fence Lizard Distribution

SCELOPORUS OCCIDENTALIS



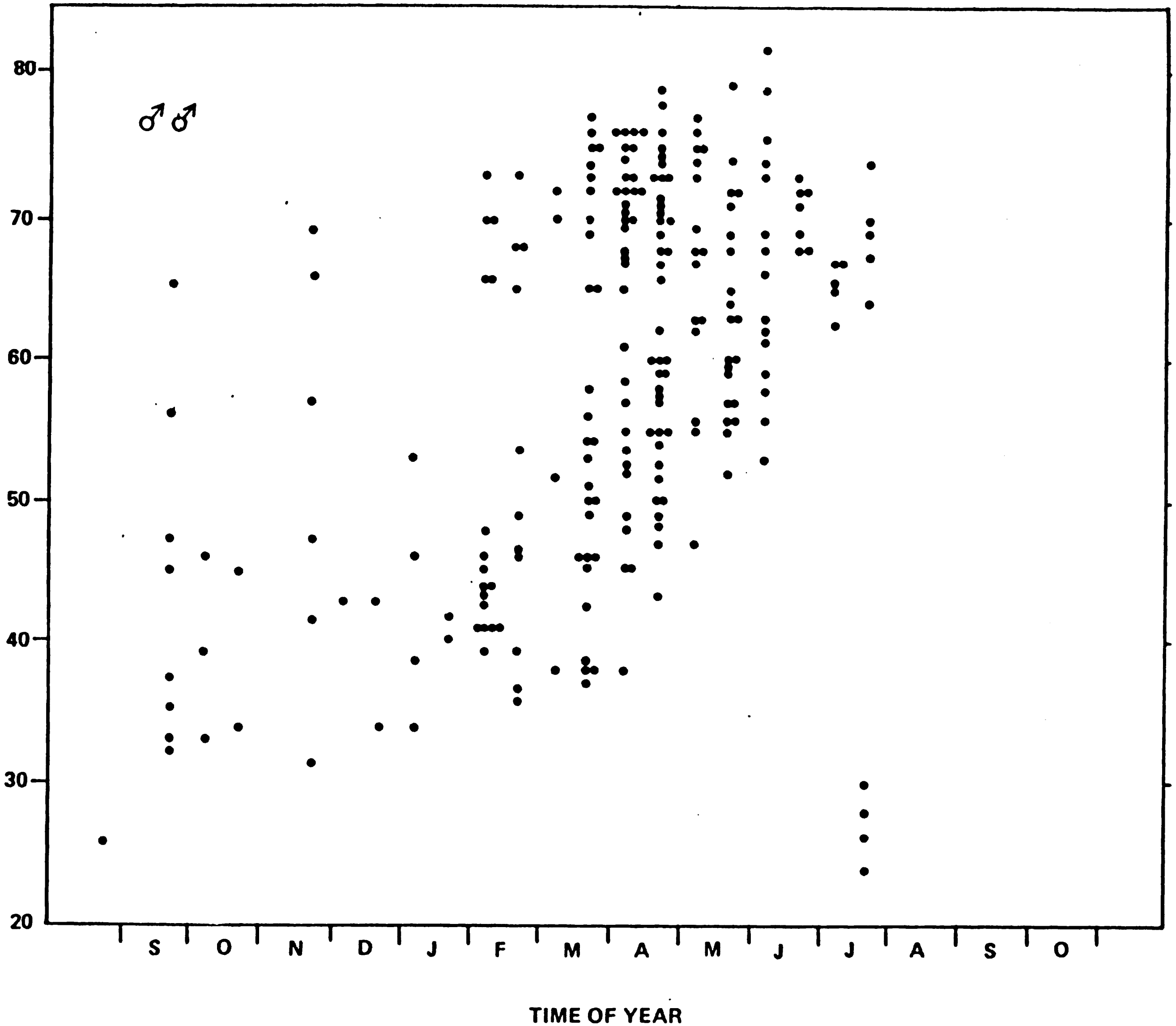


Figure 10 - Snout-vent lengths (mm) of male Sceloporus occidentalis vs. time showing seasonal growth

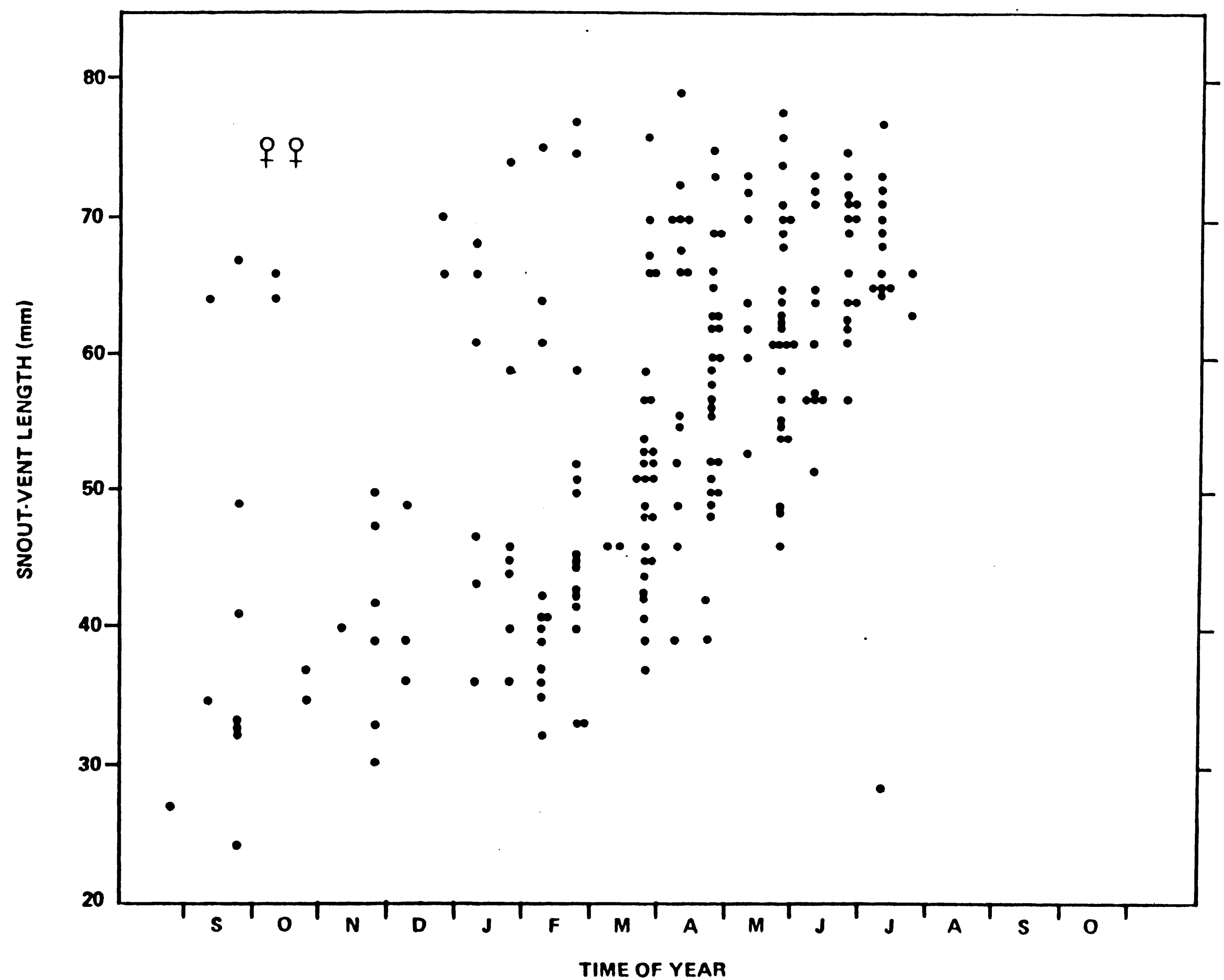


FIGURE 11 - Body lengths of female Sceloporus occidentalis vs. time showing seasonal growth

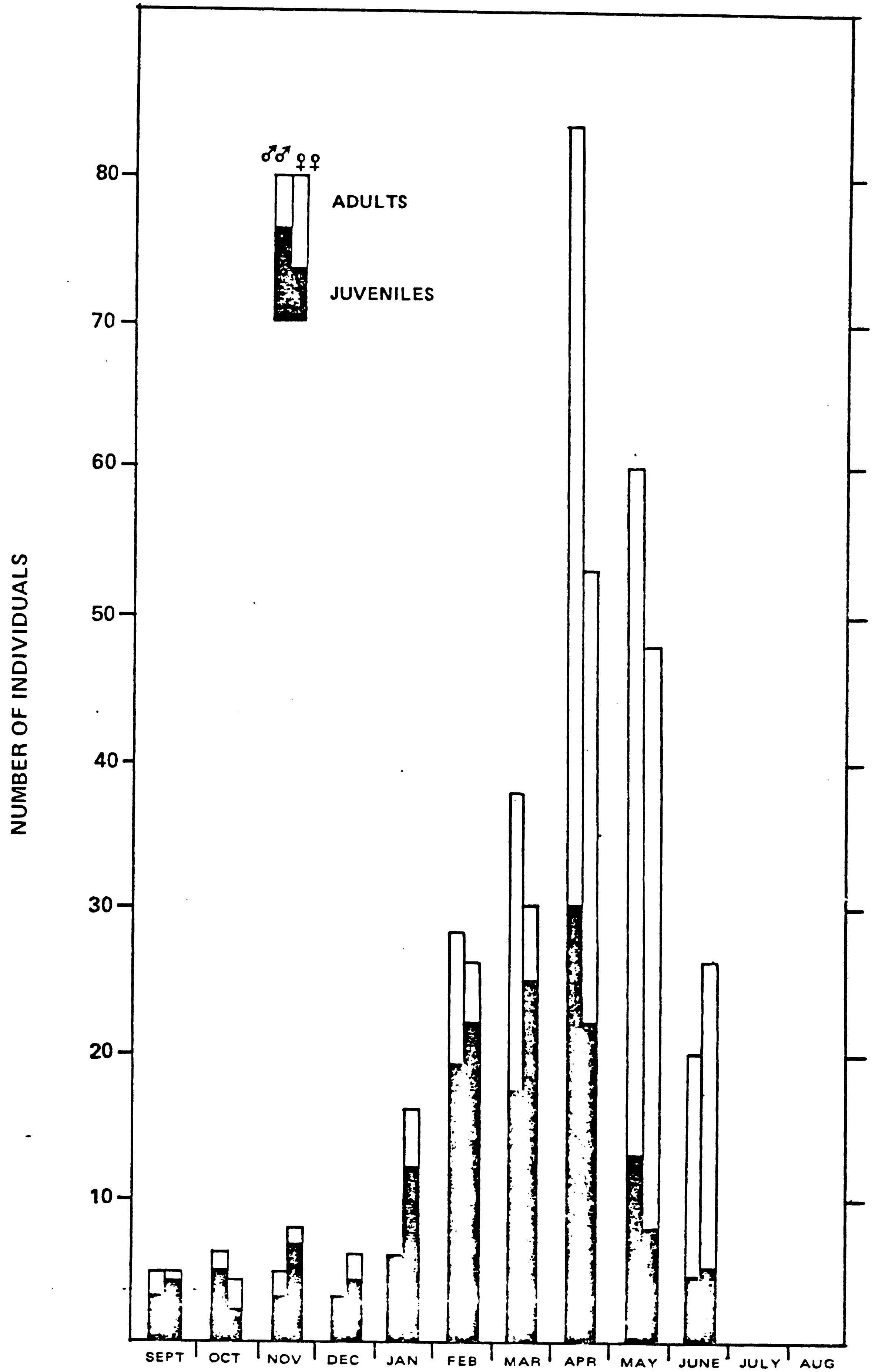


FIGURE 12 - Seasonal Activity in _Sceloporus occidentalis_

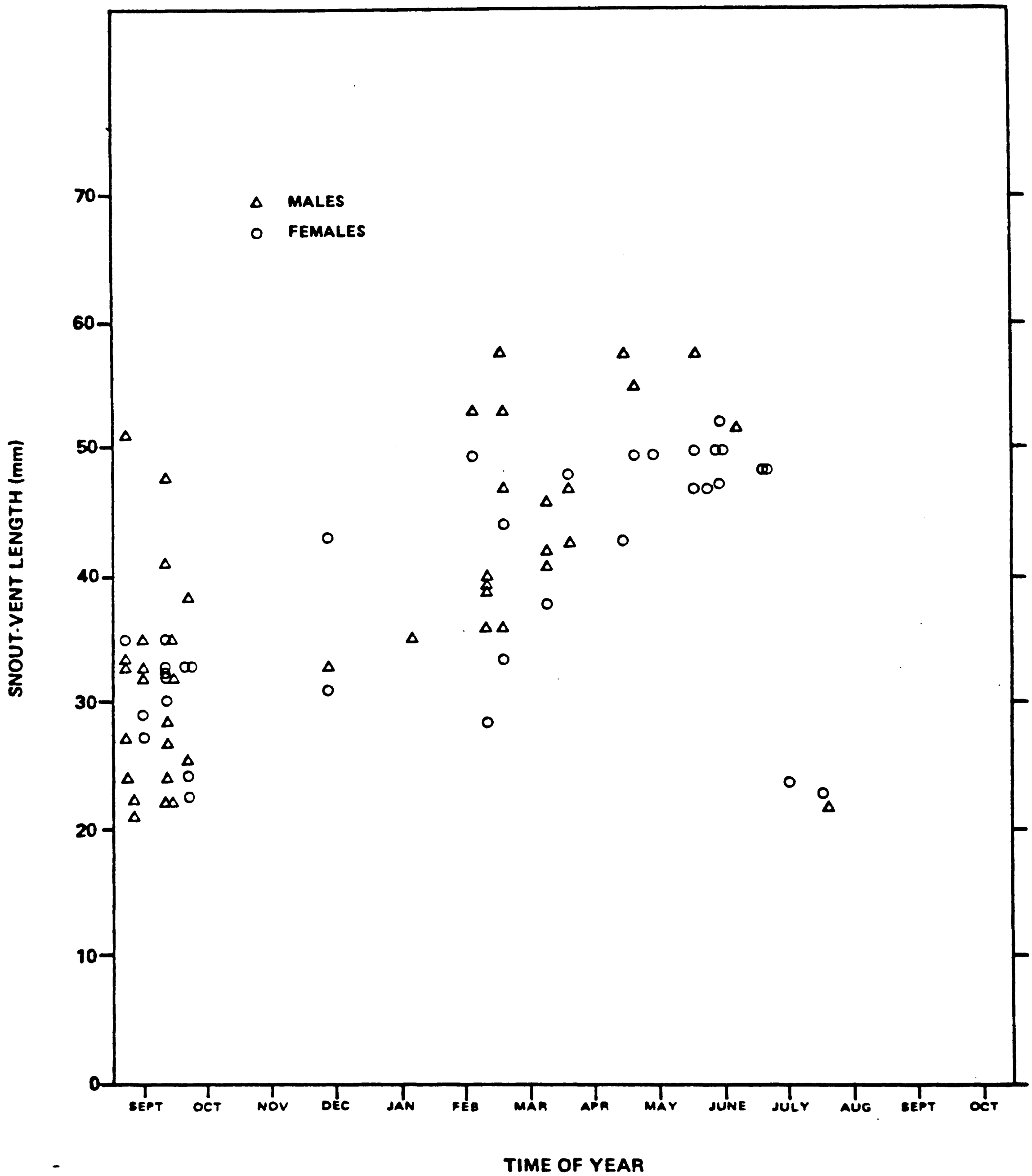


FIGURE 13 - Body lengths of Uta stansburiana vs. time showing growth

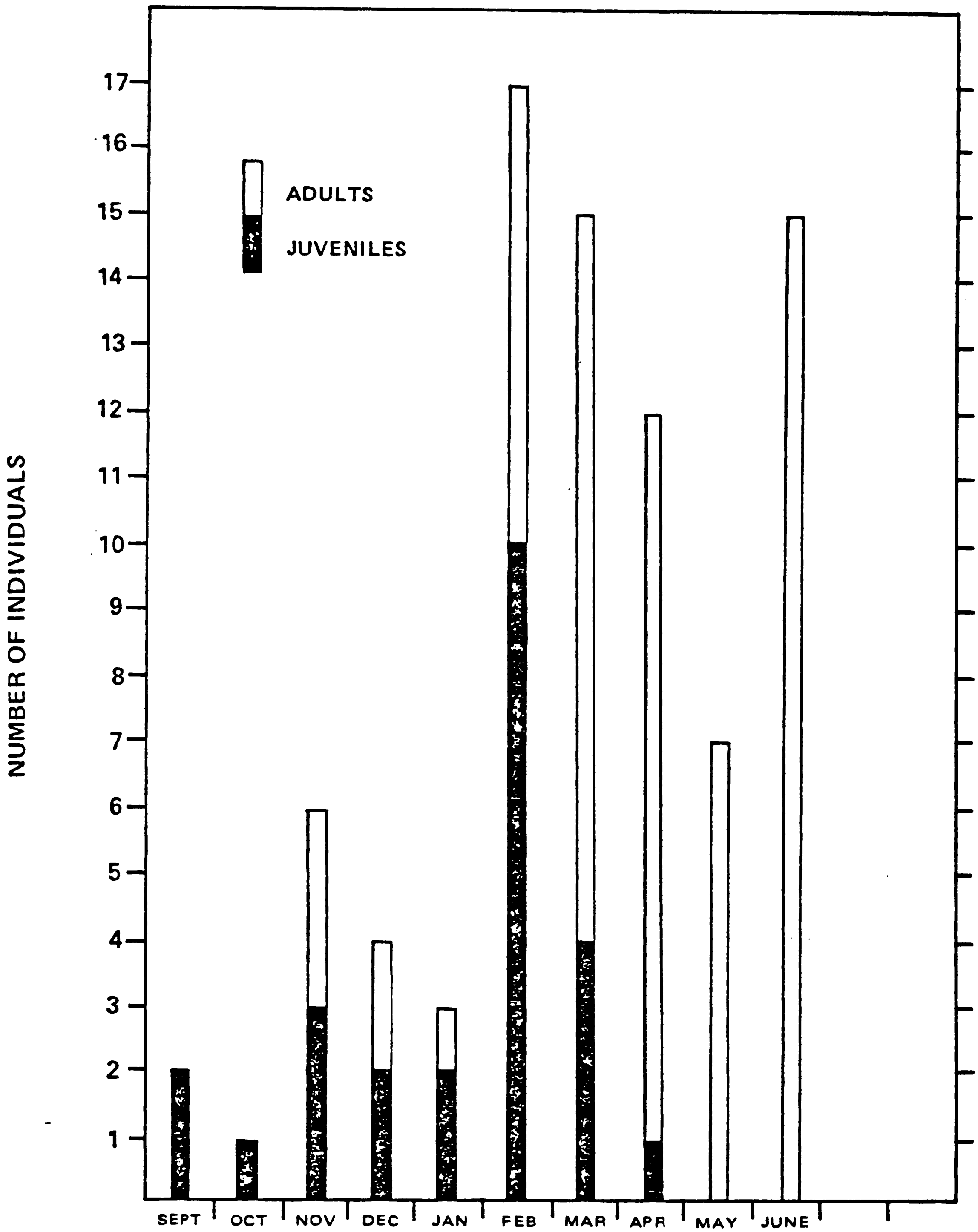
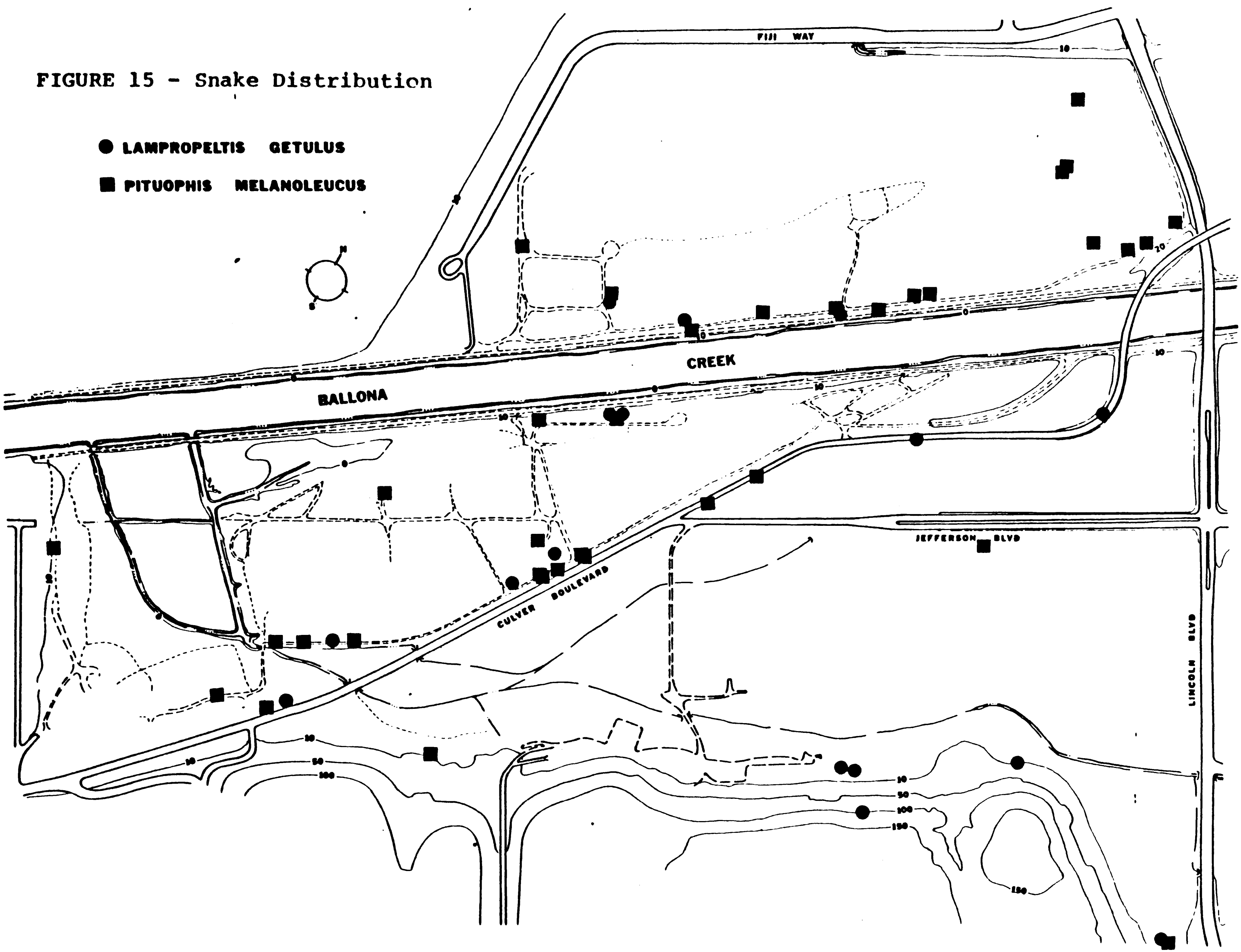


FIGURE 14 - Seasonal Activity in <u>Uta stansburiana</u>

FIGURE 15 - Snake Distribution



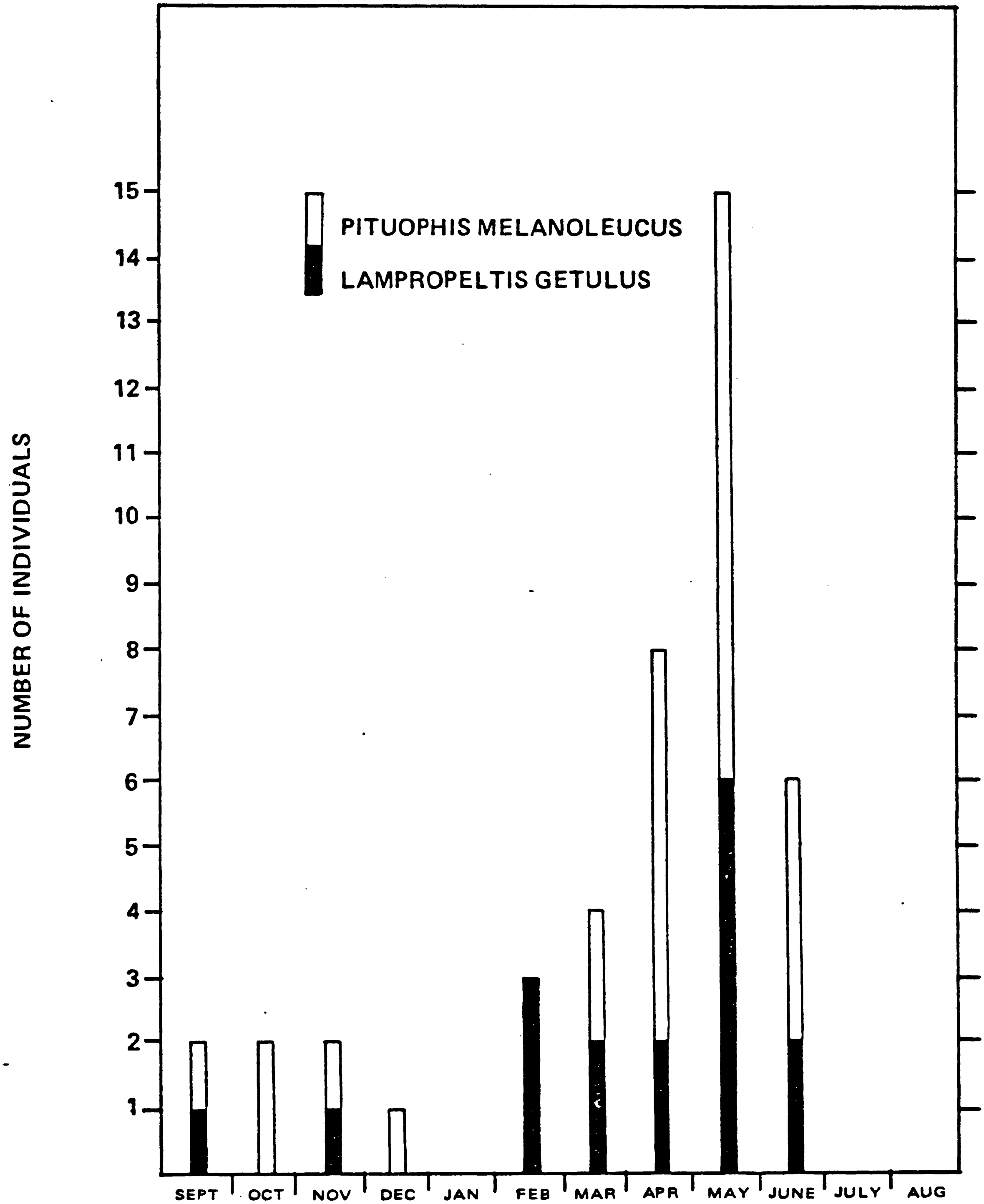


FIGURE 16 - Frequency distribution of the two snakes observed at Ballona by month

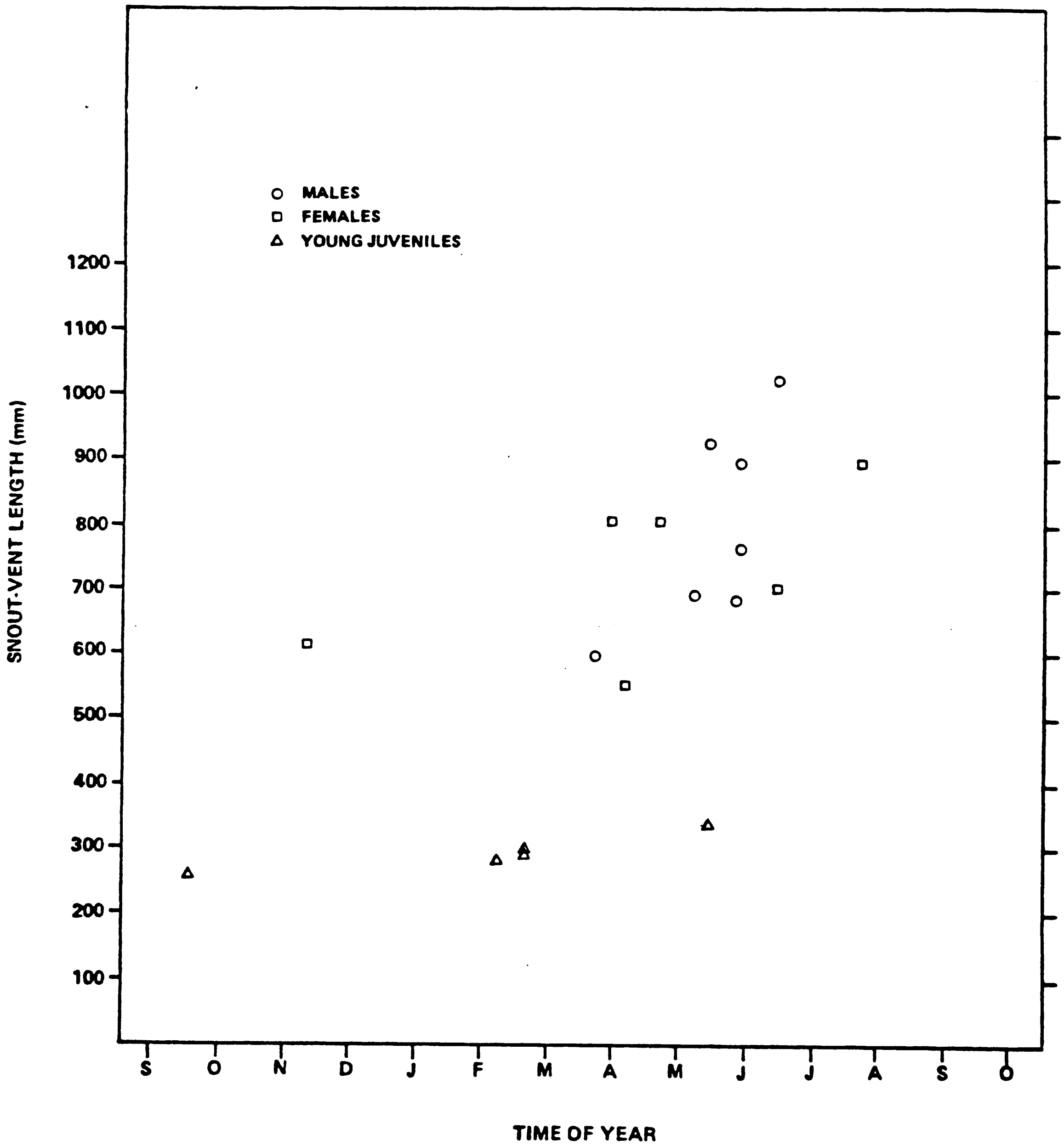


FIGURE 17 - Body lengths of Lampropeltis getulus vs. time

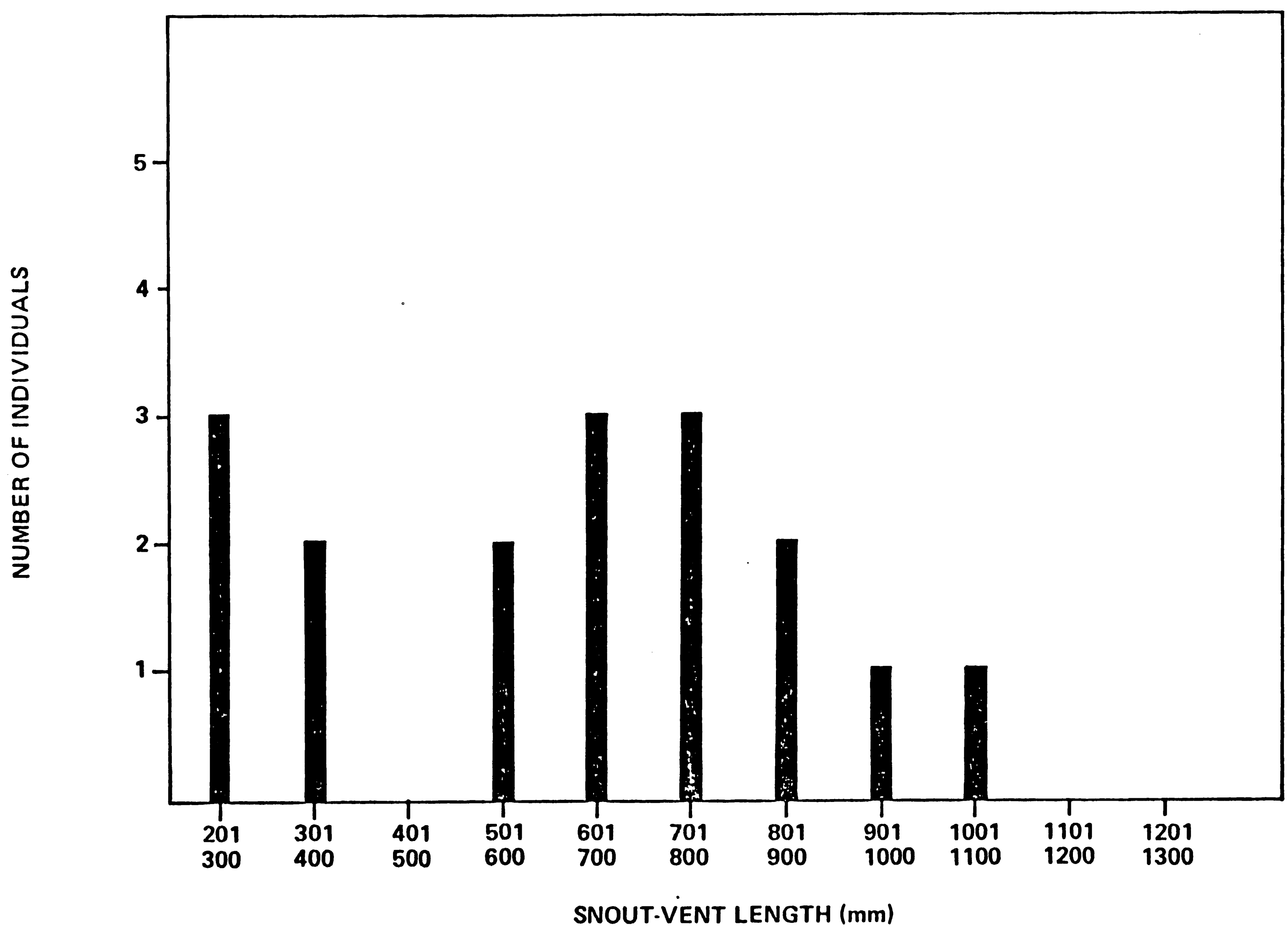


FIGURE 18 - Frequency distribution by 100 mm size intervals for *Lampropeltis getulus*

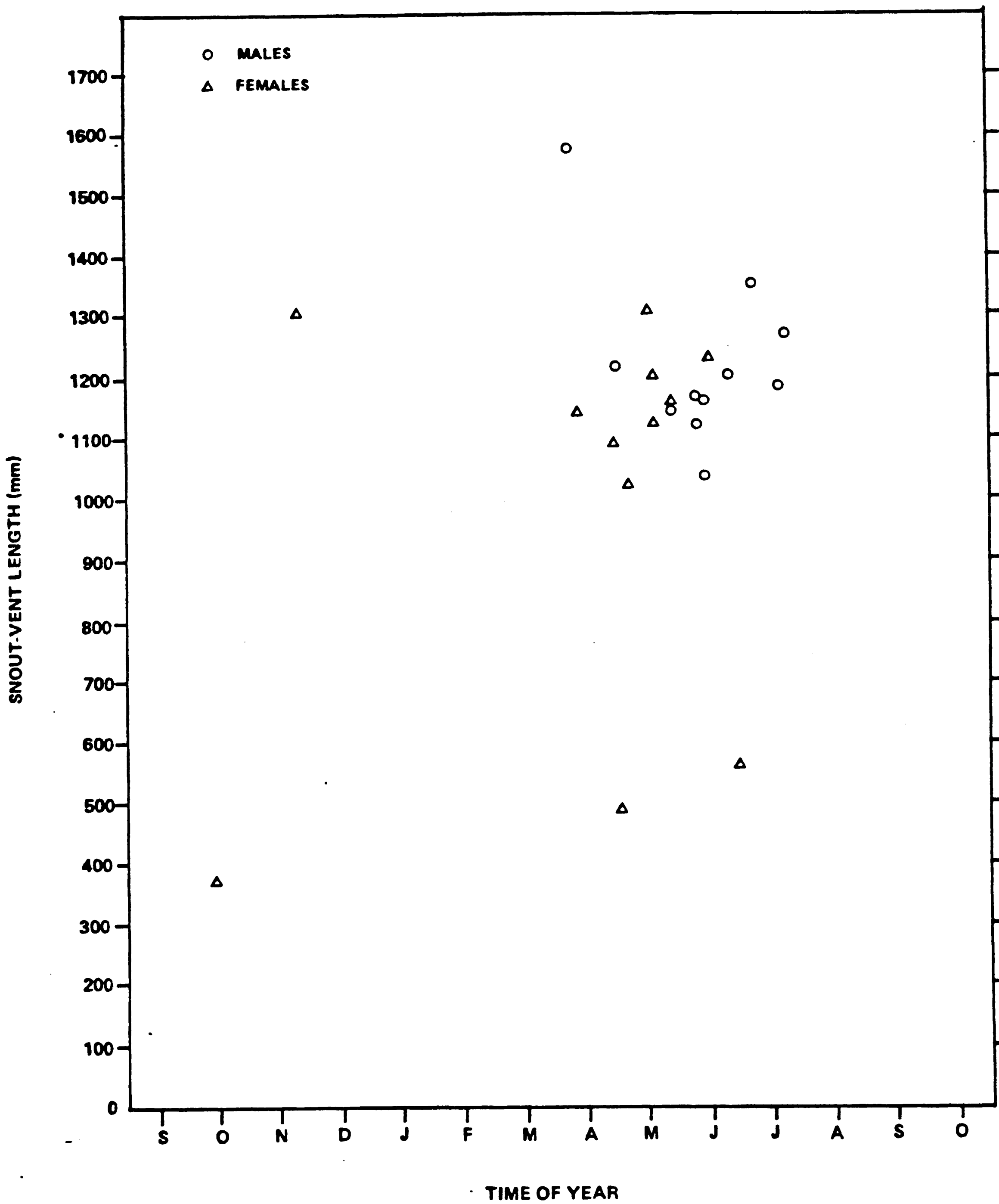


FIGURE 19 - Body lengths of Pituophis melanoleucus vs. time

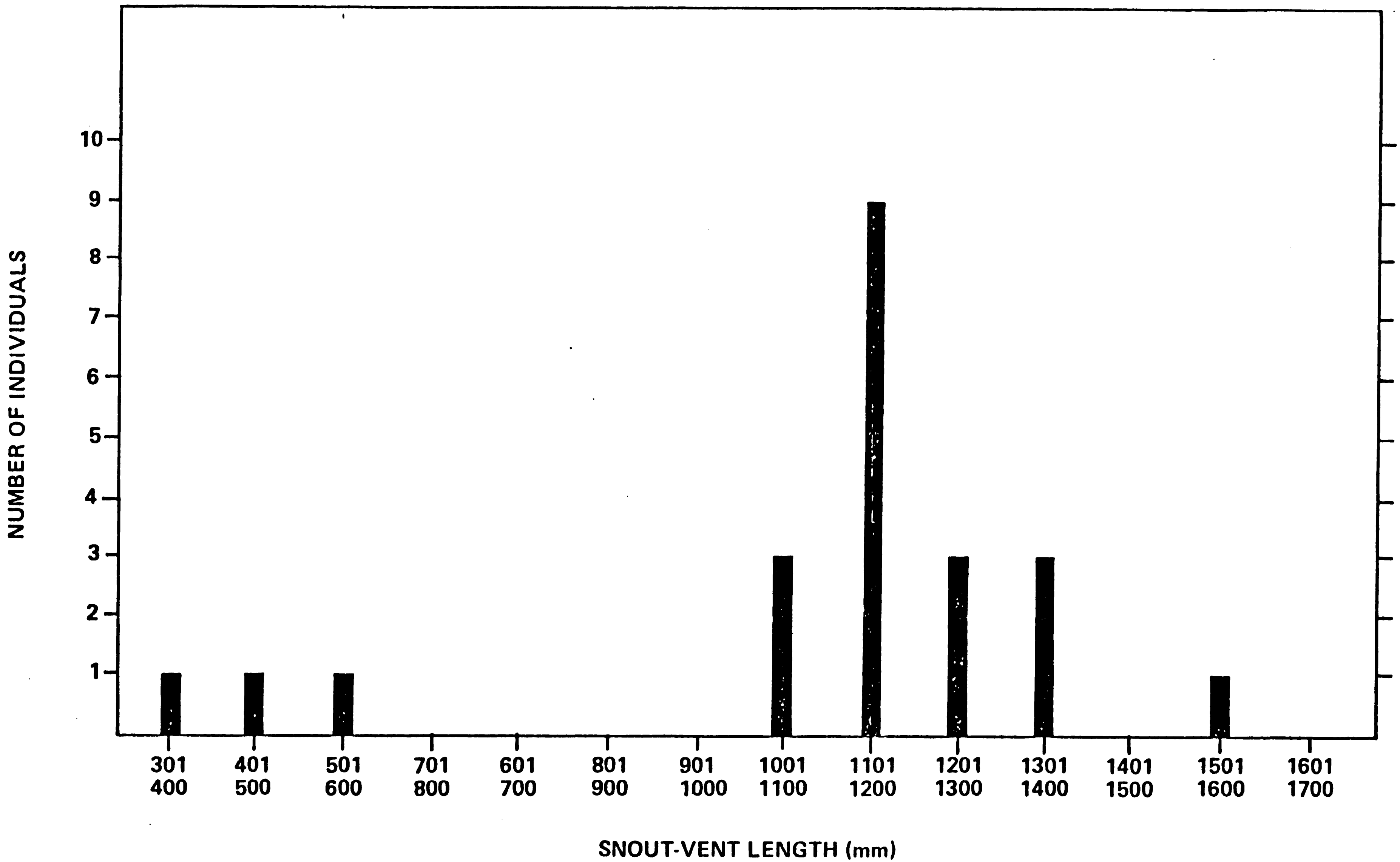
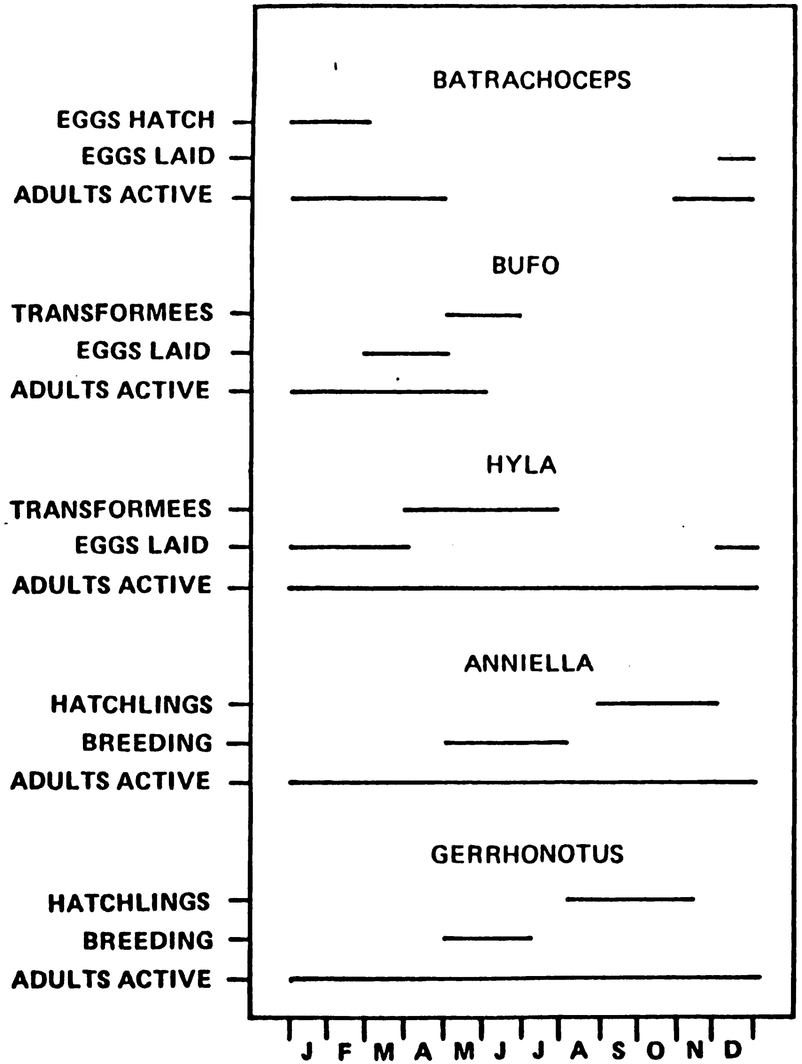


FIGURE 20 - Frequency distribution by 100 mm size intervals for *Pituophis melanoleucus*

FIGURE 21 - Seasonal activity patterns of the Ballona herpetofauna



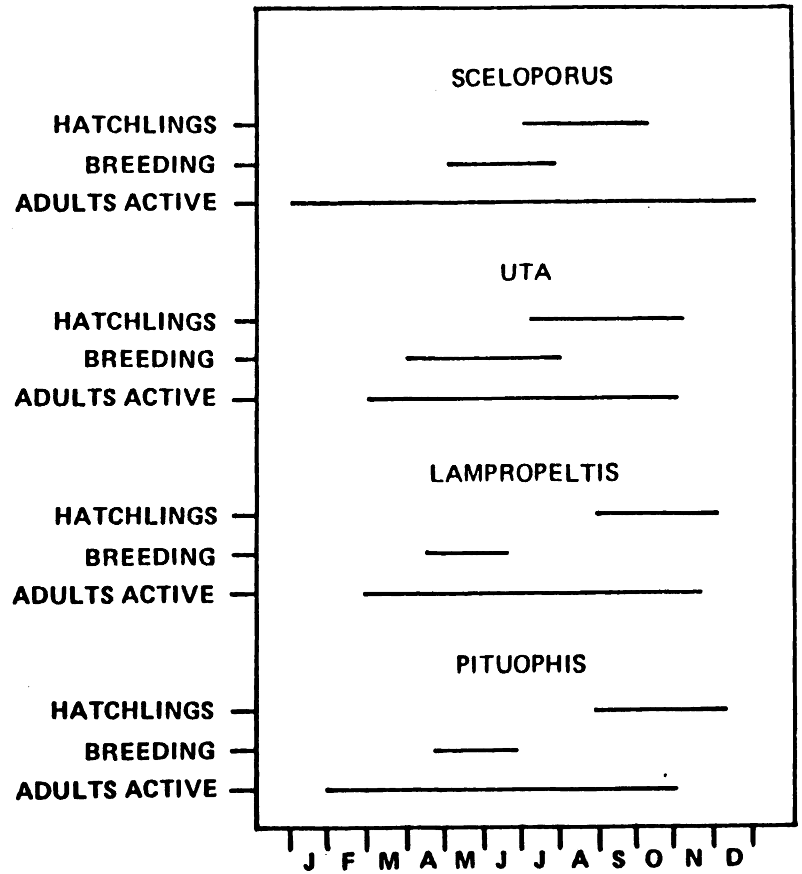


Table 1

Ballona herpetofauna relative abundance by unit and sample area

Unit	1		2	Ag Land	3	T*	N**
Sample Area	D	1A	2	Ag Land	3		
Batrachoseps	-	-	-	-	.05***	.01	2
Bufo	-	.01	-	-	.02	.01	2
Hyla	****	.03	.15	.70	.05	.19	49
Anniella	.03	-	.05	-	-	.01	2
Gerrhonotus	.49	.98	.39	.16	.32	.47	123
Sceloporus	2.20	6.81	1.80	2.69	6.14	4.93	1293
Uta	1.33	-	.93	.20	-	.32	84
Lampropeltis	-	.08	-	.12	.03	.05	14
Pituophis	-	.15	-	.12	.14	.11	29
Totals (Sample) N =	4.06 140	8.07 577	3.32 68	4.46 183	6.52 620	6.09	1598
Totals (Unit) N =	6.76 717						

*Total by species
**Number of sightings by species
***Estimates in number of individuals per sample hour
****No estimate

	Pickleweed	Castor bean	Iceplant	Lupine	Willow	Eucalyptus	Laurel-Sumac	Calif. Sage	Coyote Brush-Pampas Grass	Fennel	Cattail	Bulrush	Saltgrass	Weeds
Batrachoseps	-	-	-	-	-	-	.238	-	-	-	-	-	-	.013
Bufo	-	-	-	-	-	-	-	-	-	-	-	-	-	.030
Hyla	.003	.021	-	-	.180	-	.240	-	.140	-	.110	3.160	-	.070
Anniella	-	-	-	-	.090	-	-	-	-	-	-	-	-	.010
Gerrhonotus	.915	.104	1.060	-	-	-	-	-	.138	.028	-	-	1.170	.645
Sceloporus	1.450	4.610	2.880	2.920	2.840	.120	9.760	7.500	2.220	2.310	-	3.160	8.330	4.620
Uta	-	.104	1.590	.141	.367	-	-	-	-	.028	-	-	-	.161
Lampropeltis	-	.052	-	-	.092	-	-	-	-	.028	-	1.050	-	.134
Pituophis	-	.050	.060	-	-	-	-	-	.140	.080	-	-	.170	.080
Totals	2.390	5.130	5.290	10.00	3.580	.119	10.20	7.500	4.520	2.480	.108	7.370	10.00	5.770

All estimates are in numbers of individuals per sample hour

Table 2 - Ballona herpetofauna relative density estimates by habitat based on vegetative dominants