



Sand Dune Lizards (*Liolaemus multimaculatus*) are endemic to Pampean coastal areas of Buenos Aires and Río Negro provinces in Argentina.

Biology and Conservation of the Sand Dune Lizard (*Liolaemus multimaculatus*)

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Photographs by the author.

Since 2005, with IRCF aid, the “Sand Dune Lizard Study and Conservation Project” has addressed its goal of protecting the endemic and vulnerable Sand Dune Lizard (*Liolaemus multimaculatus*) and its habitat in the pampas coastal dunes in Argentina. New information generated about the species’ ecology during 2008 and 2009 has been instrumental in the development of management tools. We also developed educational programs to inform children, local people, and tourists about the threats facing these lizards and their sand dune habitat.

Diverse coastal ecosystems support numerous native plant and animal species that are threatened to varying degrees. Several of these species are poorly known, and some are in danger of extinction, as is the case with the Sand Dune Lizard. The populations of endemic fauna and flora, that is, those species that evolved in and can only survive in coastal habitats, are the most affected by these activities, and they could be wiped off the face of the Earth within a few years. The Sand Dune Lizard is one of these species, and its populations already are severely compromised.



Coastal ecosystems support numerous native plant and animal species that are threatened to varying degrees. Populations of species that evolved in and can only survive in coastal habitats are particularly vulnerable to extinction.



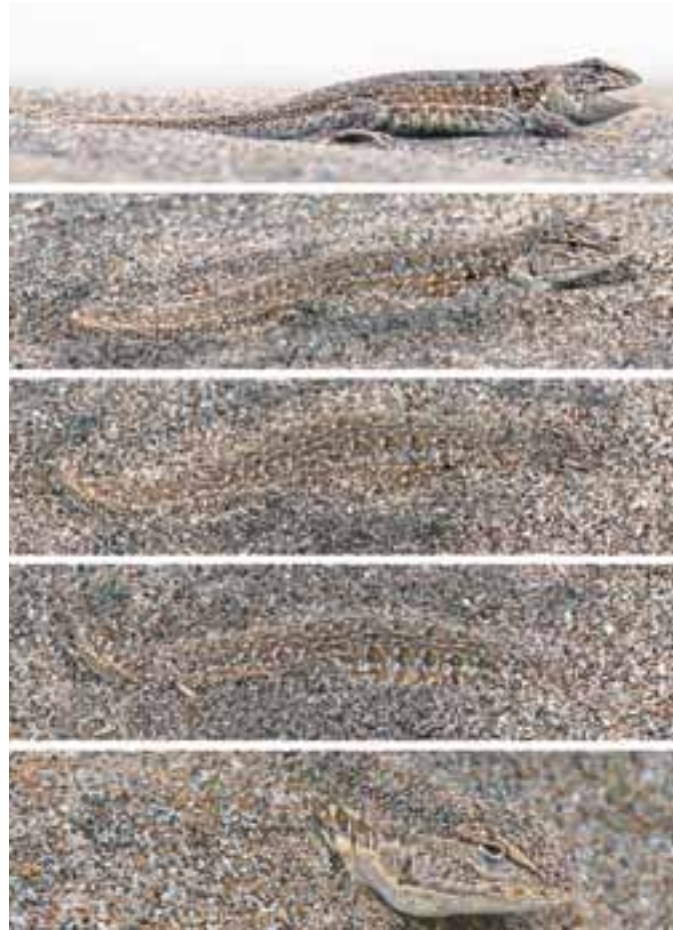
Sand Dune Lizards are small, less than 70 mm from snout to vent, with flattened bodies and stout heads.

Basic Biology

The Sand Dune Lizard (*Liolaemus multimaculatus*) is a small saurian, less than 70 mm long from snout to vent, with a flattened body and stout head. Its dorsal coloration shows a somewhat irregular pattern of dark spots in transverse series on a brownish background. The spots are outlined posteriorly by white scales, which give them a sand-like appearance. These lizards display obvious sexual dimorphism in size and ventral coloration (males are larger and have scattered ventral spots). They usually are seen on dunes with low or sparse plant cover as they scurry away. When not in motion, the lizards are virtually undetectable; their coloration and texture are a perfect match for the substrate. For sand-burying and sand-swimming (two of the main escape strategies of these lizards), they require loose sandy substrate, which does not occur in areas with abundant vegetation, such as those planted with exotic species like pines (*Pinus* sp.) and acacias (*Acacia* sp.). The Sand Dune Lizards are endemic to Pampean coastal areas of Buenos Aires and Río Negro provinces in Argentina (Cei 1993).

Threats

Due to its restricted distribution, low abundance, and human disturbances of their habitat, the species is considered vulnerable to extinction (Lavilla et al. 2000). These lizards are highly specialized for life in the sand. Their sand-burying and sand-swimming abilities, as well as their cryptic coloration and habitat preferences, attest



“Sand-burying” is one of the main escape strategies of these Sand Dune Lizards.

to the close evolutionary ties between these reptiles and the coastal dunes.

Further information about wild Sand Dune Lizard populations is critically needed in order to devise conservation strategies. Suitable habitats are still available. However, such habitats are highly fragmented and shrinking rapidly. Coastal reserves and dune areas are suffering in particular, mainly due to uncontrolled tourism and the expansion of coastal urban areas. Sand Dune Lizards also face



Sand Dune Lizards usually occur on dunes with low or sparse plant cover.



Dune sectors in Buenos Aires Province, Argentina. The two large brown sectors correspond to the Barrera Medanosas Oriental and the Barrera Medanosas Austral respectively. The figure also shows the reserves within each dune sector.

the risks associated with all small populations, such as the increased likelihood of extinction triggered by stochastic events (Miller and Lacy 2005). This lizard also must confront threats associated with all highly specialized species especially dependent on undisturbed habitat. Previous studies demonstrated that anthropogenic factors, such as habitat fragmentation and loss of native plant species in coastal dunes, could be reducing the abundance of these lizards, increasing the frequency of local extinctions (Vega et al. 2000).

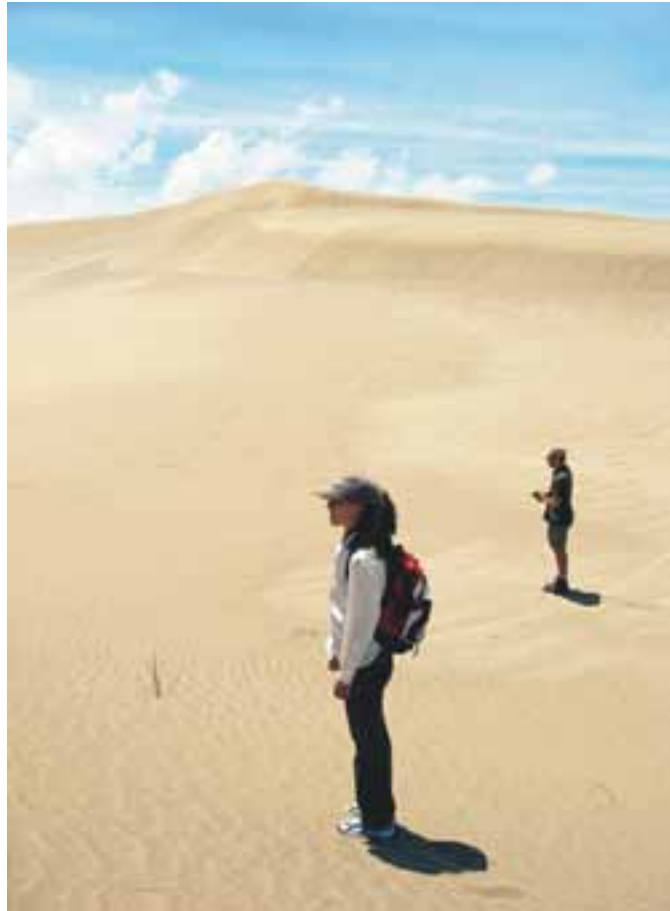
Habitat

Total suitable Sand Dune Lizard habitat covers approximately 20,000 ha, but much of it is threatened by human encroachment. Moreover, populations are isolated by natural and human barriers, some of which impede the lizards from interbreeding.

The marine coastal zone of Buenos Aires Province is particularly diverse in natural environments that include sandy beaches, cliffs, extensive sand dunes, and a large brackish lagoon (Mar Chiquita). The coastal dunes are divided into two large sectors by a natural barrier near the city of Mar del Plata. These sectors are the Barrera Medanosas Oriental (in the northeast of the province) and the Barrera Medanosas Austral (in the southwest of the province). Both sectors are further subdivided by smaller natural and human barriers such as rivers, towns, and cities. Several sites are designated as reserves, but only one, the Mar Chiquita Natural Reserve, effectively protects Sand Dune Lizard populations (Kacoliris et al. 2006).

Coastal environments represent about 8% of Earth's surface, and they are considered among the most threatened environments on the planet. Most human-generated threats to biodiversity are exacerbated in these areas, mainly because human populations have always flourished along shorelines. Over half of the world's population (about 3.2 billion people) lives within 200 km of oceans and seas (only 10% of Earth's land surface). With this population distribution, increasing human numbers and mounting developmental pressures are taking a grim toll on coastal and near-shore resources.

The Mar del Plata hills clearly divide populations into two isolated groups that are unable to interbreed, and other smaller barriers also could be impeding interbreeding between populations (Chevez and Kacoliris 2008). Four of these dunes areas are considered to be “Valuable Grassland Areas” in South America (Bilenca and Miñarro 2004) because they are important for the conservation of Pampean biodiversity. These areas encompass 80% of the current distribution of Sand Dune Lizards.



Observers employing distance sampling techniques along transects were used to develop estimates of Sand Dune Lizard population sizes.

Research

The explicit goal of the “Sand Dune Lizard Study and Conservation Project” is to study fundamental aspects of population dynamics and viability (spatial ecology, population density, survival, and mortality), autoecology (habitat use, home range), and any additional factors that allow us to assess more effectively the status of wild populations, such as the study of fluctuating asymmetry (a bioindicator of environmental stress that is expressed in populations subject to primarily anthropic impacts producing size differences between left and right body sides) and any decreases in genetic variability due to population isolation. Knowledge of the basic ecology of a species is essential for establishing management guidelines and initiating conservation action.

The most recent field season (August 2008 to May 2009) focused on three sites, all of them “Valuable Grassland Areas” in South America: (1) Mar Chiquita Provincial Reserve (Barrera Medanos Oriental); (2) Arroyo Zabála Reserve (Barrera Medanos Austral); and, (3) Balneario Marisol, located between the Arroyo Zabála and the Pehuen Có-Monte Hermoso reserves (Barrera Medanos Austral). Although Mar Chiquita and Arroyo Zabála are Natural Reserves, vehicular traffic in the dunes of the latter is unregulated, whereas such activity is regulated by park rangers in Mar Chiquita. Although also affected by vehicle transit, the Balneario Marisol is currently being considered as a possible site for a new reserve. Educational activities have been initiated in these as well as other areas.

Population Sizes

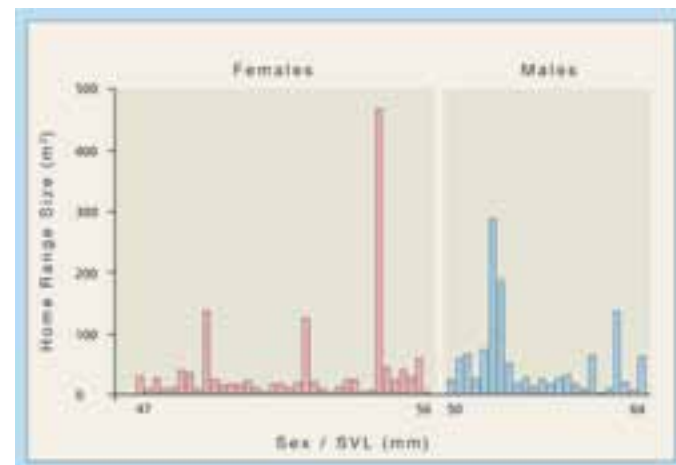
Knowing population density and how it changes over time is the key to understanding population dynamics and viability. We estimated Sand Dune Lizard population sizes in the three dune sectors using distance sampling techniques. Previous results have shown that this method is appropriate for this species in this habitat (allowing all model assumptions). We worked with a systematic line transect design. Transects were crossed by three observers until we obtained the critical number of detections necessary to generate robust models for density estimates. Population densities varied little between sectors: Mar Chiquita 5.4 lizards/ha (95% confidence interval: 3.6–8.1), Arroyo Zabála 5.6 lizards/ha (3.8–8.2), and Balneario Marisol 5.9 (3.2–10.9). However, all densities were low according to Zug et al. (2001), who considered densities with fewer than 10 individuals/ha to be “low.” Low densities suggest that the long-term viability of Sand Dune Lizards, especially of smaller populations, is of considerable concern.

Because the three sectors are subjected to different degrees and types of human impact, these results could indicate that the lizards are not severely affected by some types of disturbances, that the degree of disturbance has not reached a critical level, or that effects are not reflected in lizard population density. Further studies in dune sectors with higher levels of disturbance are necessary to corroborate the possible existence of any effect.

Microhabitat Use

Knowledge of spatial ecology is critical to planning and promoting the conservation of threatened species. We assessed the lizards’ preferences regarding certain microhabitat variables such as plant types, vegetation cover, and vegetation structure (sizes of shrubs used as shelters). We employed a use-availability comparison to evaluate whether microhabitats were used as often as their frequency would predict (Manly et al. 1993).

Our results indicate that Sand Dune Lizards do not use habitat in a random fashion. Instead, they select microhabitat with low to medium vegetation cover (1–50% coverage), composed primarily of herbaceous species. This could be related to the sand-burying and sand-swimming behaviors used by lizards to escape from predators. Microhabitats with higher vegetation cover impede this behavior due to sand compaction.

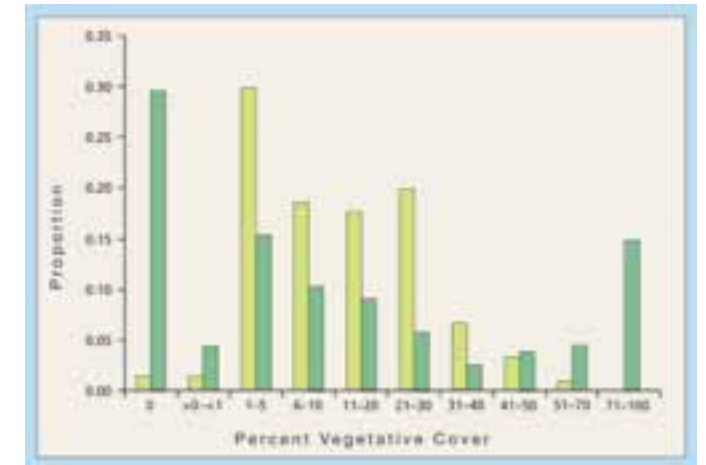


Sand Dune Lizard home ranges; individuals are arranged first by sex and secondarily by SVL.



Assessments of microhabitat variables such as plant types, vegetation cover, and vegetation structure were employed to evaluate whether microhabitats were used as often as their frequency would predict.

In terms of vegetative structure, lizards most frequently sought shelter under shrubs of intermediate size. This could be related to smaller plants providing only limited cover and large plants restricting visibility for detecting predators, prey, and mates. However, the availability of ideal refugia is too low to permit each lizard access to



Frequency of use and availability of vegetation cover categories. Yellow columns represent availability, whereas green columns represent use by Sand Dune Lizards.

one shrub. Only adults used shrubs, suggesting that juveniles are excluded from these shelters.

Previous studies demonstrated that human disturbances (such as vehicle transit) of sand dunes dramatically affect vegetation, promoting the loss of plants and reducing vegetative cover. These kind



When not in motion, lizards are virtually undetectable; their coloration and texture is a perfect match for the sandy substrate.



Educational campaigns are held in schools and community centers. Information about problems facing the coastal dunes and the Sand Dune Lizards are used to encourage local people to become engaged in conservation.

of disturbances could reduce the amount of habitat available for escape and thermoregulatory behaviors to the extent of triggering local extinctions (Iribarne et al. 2001).

Home Ranges

A home range is the space used by an individual, and determining home range sizes is crucial to understanding social systems. With the aim of assessing home range sizes and overlap in Sand Dune Lizards, we recorded the location, sex, and size of lizards. Home ranges and overlap were calculated using the minimum convex polygon method.

Because *L. multimaculatus* is insectivorous and relies on sit-and-wait predation, it does not need to cover large areas to find food. Mean home range sizes differed between sexes, with those of males ($33.5 \pm 24.6 \text{ m}^2$) significantly larger than those of females ($21.3 \pm 17.6 \text{ m}^2$). As in many lizard species (Perry and Garland 2002), dominant males probably require large home ranges to meet both energy and mating requirements. A small number of lizards of both sexes occupied home ranges that were much larger than those of the majority of individuals, which is suggestive of a hierarchical social system. Overlap in home ranges was high (22–58%) for both males and females.

Educational Programs

Another goal of this program is to provide clear and understandable information about the severe threats affecting Sand Dune Lizards and the coastal dunes. Results of the research program are conveyed to the local community in an effort to create a greater awareness of these issues. Using a conservationist approach, we emphasize information on the benefits of conserving the coastal natural resources.

We undertook a number of educational campaigns from July 2008 through May 2009 in several coastal cities: San Bernardo, Mar del Tuyú, Marisol, Pehuen-Có, and Villa Gesell. We held meetings in schools and community centers to reach conservation and governmental organizations as well as local people. Using presentations and handouts (pamphlets and posters), we provided information about the problems facing the coastal dunes and the Sand Dune Lizards, and encouraged local people to undertake conservation actions.

Conservation Status

According to IUCN Red List criteria, the Sand Dune Lizard is critically endangered based on a small area of occupancy, low and apparently declining population densities, and a high degree of specialization with respect to habitat and microhabitat use. Small disturbances affecting the dunes in which lizards live could promote local extinc-

tions through the loss and fragmentation of suitable habitats, the main cause of which is uncontrolled access of vehicles, which destroys the native vegetation that lizards use for shelter and nesting.

Current Needs

Sand Dune Lizards are best protected at the Mar Chiquita Reserve. Human disturbances are low because park rangers work hard to regulate them. However, considerable exotic forest cover exists in this area and is expanding. In these exotic forests, the microhabitats most frequently used by Sand Dune Lizards have been altered, excluding them from these areas. The primary need at this site is to develop strategies to halt and diminish the expansion of exotic forests.

Arroyo Zabála is one of the larger areas inhabited by Sand Dune Lizards within the coastal dunes. Although this area has been designated as a reserve, no park rangers have been hired and no management plans or conservation actions have been developed. Disturbances are increasing in frequency. A strong educational campaign is needed and local authorities must be encouraged to regulate indiscriminate access of vehicles in the dunes.

Marisol is a large area in which a large population of Sand Dune Lizards can be protected. Although disturbances exist in this area, they currently are relatively low. Marisol could be categorized as a natural reserve. We are working toward this objective in collaboration with other conservation groups, and the local people appear to be very enthusiastic about our proposal. Aside from the restriction of vehicles in the dunes, educational activities are necessary to demonstrate to local people the benefits of establishing a natural reserve in this dune sector.



Sand Dune Lizards excavate burrows in the sand into which they retreat from inclement conditions and hide from predators.

Future Work

We need to continue both research and educational activities. Future studies will assess the degree of genetic isolation of each Sand Dune Lizard population, measure the effects of disturbances and isolation (fluctuating asymmetry), and evaluate extinction probabilities using models that consider further habitat reductions and various management strategies. Educational activities will continue with the development of new handout material, scientific information, and meetings targeting schools and local people. We need to work intensely with governmental agencies to promote the regulation of some disturbances, most notably the transit of vehicles. We also need to evaluate the possibility of implementing a plan to restrict the expansion of exotic forests and restore native grasslands in dune sectors like the Mar Chiquita Natural Reserve. We need to explore other dune areas in order to evaluate the status of additional Sand Dune Lizard populations and the requirements for promoting their protection.

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