
TECHNIQUES

Field Evaluation Of Using Passive Integrated Transponder (PIT) Tags To Permanently Mark Lizards

Identifying individuals permanently is an important step in any long-term study of vertebrate populations. Techniques vary, however, and some methods may be better than others. Permanently marking lizards presents difficulties that may compromise study objectives. Ideally, the marking techniques should not affect survivorship or behavior of the animal, should be permanent, should allow for individual identification, should be usable on lizards of different sizes, should be easily read, and should not create undue stress or pain to the individual (Ferner 1979; Lewke and Stroud 1974; Ricker 1956). Avoiding undue stress or pain is often important when working with endangered species.

Lizards have been marked by painting numbers or letters on the dorsum, attaching colored tape to tails, attaching aluminum bands to thighs, and by clipping toes (Ferner 1979). All these techniques present problems for satisfying criteria necessary for long-term marking (Le Boulenge-Nguyen and Le Boulenge 1986; Stoddart 1970; Woodbury 1956). In addition, no estimates of tag loss have been made for these techniques.

The use of passive integrated transponder (PIT) tags alleviates many of the problems inherent with other methods (Camper and Dixon 1988). PIT tags are glass-encased electromagnetic coils and microchips implanted under the skin or in the body cavity. Each PIT tag is encoded with a unique alphanumeric code that is read by generating a low-frequency electromagnetic signal with an external reader; the signal energizes the transponder at close range (1–5 cm), which causes it to transmit its code back to the reader (Camper and Dixon 1988; Fagerstone and Johns 1987). PIT tags are passive units and expected longevity of the tags are 15–20 yrs.

Equipment consists of PIT tags, a modified 3-cc plastic syringe, 12-gauge stainless-steel needles, and a PIT-tag reader. The syringes we received from the supplier were large and impractical for field use. We modified a plastic 3-cc syringe by replacing the plastic plunger with a length of brass wire that serves as a mechanical plunger to push PIT tags out of the needle. Groups of needles were loaded with PIT tags and carried into the field. PIT tags were held in place inside the needles by coating tags with antiseptic ointment. The ointment also served as an antibacterial agent that was injected into the lizard along with the tag.

Since 1988, we have been studying a population of blunt-nosed leopard lizards (*Gambelia sila*) on the Elkhorn Plain, San Luis Obispo Co., California (Germano et al., ms. in review). The blunt-nosed leopard lizard is a state and federally listed endangered species. Although toe-clipping has been used by other researchers to permanently mark blunt-nosed leopard lizards (Montanucci 1965; Tollestrup 1982; Uptain et al., *in press*), it was believed that another method should be tried that would cause less misidentification of individuals due to natural marking, would not mutilate individuals, and that would allow assigned numbers to be more easily and accurately read. Here we report on the efficacy of marking lizards with PIT tags during a long-term field study.

In August 1989 we began PIT-tagging lizards, and over the course of four years we marked 581 blunt-nosed leopard lizards (Table 1). When a lizard was first encountered, it was weighed and

measured, sex was determined, and reproductive status and age class (young or adult) were recorded. Individuals also were marked with a numeral on their dorsum using a felt-tipped pen, and injected with a PIT tag.

The area in which tags were injected varied over the course of the study because of tag loss or destruction. In 1989 we injected lizards (N = 52) subcutaneously in the dorsum just anterior to the tail with the needle facing towards the head. We later found that the skin was too tight in this area and that the tags tended to break through the skin. In 1990 and 1991 for all lizards (N = 172), and in July 1992 for hatchling lizards (N = 81), we injected tags subcutaneously in a lateral fold of skin on the torso by inserting the needle at a point just posterior to the shoulder and sliding the needle into the fold (Fig. 1). We believed that tag loss would be reduced in this area. However, tag destruction under the skin in several adults in 1991 led us to inject adults intra-abdominally starting in April 1992. We also found that well-fed hatchling lizards in July 1992 had tight skin over all their body, and we began injecting hatchling lizards intra-abdominally in August 1992.

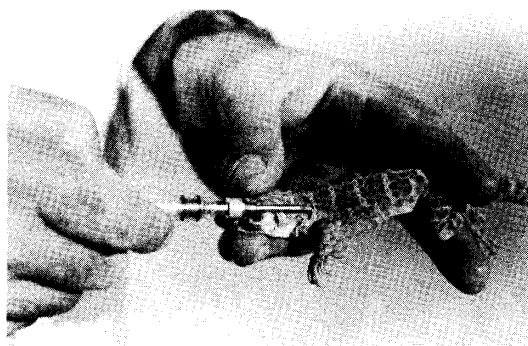


FIG. 1. Blunt-nosed leopard lizard that is being injected subcutaneously with a PIT tag using a modified 3-cc syringe and a 12-gauge needle.

The rate of loss or malfunction of PIT tags in blunt-nosed leopard lizards was 8.4% for first recaptures and 4.1% for all recaptures (Table 1). Twenty tags were lost in lizards and three tags malfunctioned during 3.5 years of tagging. Of the 20 tags that were lost, 17 lizards lost tags that were injected subcutaneously and three lizards lost tags injected abdominally. These individuals were known to have had tags because either they still had marker-pen numerals on their backs or a scar was evident at the point where the tag had been inserted. Based on scarring, tags lost subcutaneously either worked their way back out of the point of entry (N = 6) or the tag broke through the skin where the tag resided (N = 11). Ten of the 11 tags that broke through the skin occurred in hatchling lizards marked in July 1992. These lizards were injected subcutaneously along the lateral fold, but because of a high abundance of food in this month, the lizards were well fed and their skin was tight over all their body. This prompted us to begin injecting all lizards intra-abdominally.

Three PIT tags malfunctioned during the study; two tags were in adult males and one was in a hatchling male. All had been injected subcutaneously. In the adults, one tag cracked and the other tag was completely broken, and only small pieces of glass were found under the skin. Male blunt-nosed leopard lizards are territorial (Montanucci 1965; Tollestrup 1983) and are very aggressive towards each other, often biting each other's flanks (Montanucci 1965). Both broken tags in adults may have been damaged during male combat. We found that one of the males with a broken

tag had scars on its head that were not evident before the tag was damaged. The inoperable tag in the hatchling was intact, but each end of the glass housing was cracked.

TABLE 1. Number of *Gambelia sila* PIT-tagged, number recaptured, and number of tags lost from August 1989 – November 1992.

Total Tagged	No. Lizards Recaptured At Least Once	Total Recaptures	% Tags Lost / Lizard	% Tags Lost / Recapture
581	273	558	8.4%	4.1%

We have not found estimates of tag loss in lizards for other types of tags, but the loss of PIT tags is higher than what is desirable. Twenty of the 23 losses were due to tags that were injected subcutaneously. Loss may be decreased by injecting the tag into the body cavity, although we still found some loss of tags. Injecting tags intra-abdominally could damage internal organs; however, this method of PIT-tag attachment has been used with several species of captive lizards (Camper and Dixon 1988) and with free-ranging Sacramento mountain salamanders (*Aneides hardii*) as small as 40 mm SVL (N. Scott, Jr., pers. comm.) without apparent ill effects. We also have injected PIT tags intra-abdominally into 10 adult blunt-nosed leopard lizards that are in captivity, and all appear normal. Beginning in August 1992, we started injecting PIT tags into the body cavity of hatchling blunt-nosed leopard lizards as small as 50 mm SVL.

Unlike other techniques for tagging lizards, the PIT tag method is expensive. PIT tag readers cost about \$950.00 for the least expensive model. In addition, each tag costs from \$4.75 to \$6.00 depending on the quantity ordered. The price of readers and tags may decrease in the future as this system is used more widely.

Loss of information in population studies is due to lost tags or illegible marks. Errors in data for marked animals derive from errors in applying, reading, or recording codes. The PIT tag method overcomes some of these problems for marking lizards, but our field evaluation of tag loss in blunt-nosed leopard lizards suggests that tags must be placed inside the body to decrease the rate of tag loss.

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DAVID J. GERMANO

and

DANIEL F. WILLIAMS

Department of Biological Sciences

California State University, Stanislaus

Turlock, California 95380, USA.