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Survival of radio-collared nestling Puerto Rican Parrots.—A remnant population of the critically endangered Puerto Rican Parrot (*Amazona vittata*) survives in the Luquillo Mountains of northeastern Puerto Rico (Snyder et al. 1987). During the last three decades, intensive research and management have reversed a precipitous population decline to one of continual population growth (Wiley 1980, Snyder et al. 1987, Lindsey et al. 1989, Lindsey 1992). Prior to Hurricane Hugo in 1989, the wild population had grown from 14 birds during the mid-1970s to 47 (Meyers 1995). The hurricane reduced the population to about 22–24 birds; however, by early 1994, the population was estimated at 38–39 individuals (Meyers 1995). Population surveys for late 1994 (post-breeding) and early 1995 were 42 and 33, respectively (F. J. Vilella and F. Núñez, pers. comm.). These data invite optimism for the full recovery of the population because the species has shown the ability to recuperate about 83% of its pre-disturbance numbers within five years following a major disturbance.

Recovery of the species, however, will probably require relocation of wild parrots or releases of captive-reared parrots in the Luquillo Mountains and other suitable areas of Puerto Rico.

Low survival of free-flying, juvenile Puerto Rican Parrots hinders recovery efforts (Lindsey et al. 1994), and telemetry is the only reliable means for determining causes of mortality during this stage of the life cycle. Radio telemetry was first proposed in the mid-1980s as a field technique to monitor wild Puerto Rican Parrots. Using Hispaniolan Parrots (*A. ventralis*) as surrogates, S. A. Temple and E. Santana C. (pers. comm.) designed one of the first collar-mounted transmitters intended for future use on Puerto Rican Parrots. Early field research conducted by J. W. Wiley (Wiley 1983, Wiley et al. 1992) showed that radio telemetry was not only possible, but imperative, to determine survival rates of wild parrots. Until recently, telemetry was the only satisfactory method of individually identifying Puerto Rican Parrots in the field.

Herein, we report the resightings of three radio-collared Puerto Rican Parrots that were marked during 1985–1987 and present the expected survival for all radio-collared parrots released during those years. Our objectives are not only to report this information but to demonstrate that radio telemetry is crucial to our understanding of the Puerto Rican Parrot's ecology and indispensable for successful management and conservation.

Study area and methods.—The extant Puerto Rican Parrot population is confined to the 11,200 ha Luquillo Experimental Forest within the Luquillo Mountains and nearby forests (max. elev. ca 1000 m) of northeastern Puerto Rico (18°19′N, 65°45′W). Parrots nest among valleys and ridges at elevations of 370–670 m. Rainfall varies from 2000 mm in the foothills to more than 5000 mm on the highest peaks (Snyder et al. 1987). Following Holdridge's (1947) life zone classification scheme, the Luquillo Mountains are classified as subtropical wet and subtropical rain forest (Ewel and Whitmore 1973). More than 1200 plant species have been described, of which 240 are trees. Two forest types, tabonuco, characterized by its predominant species, tabonuco (*Dacryodes excelsa*), and palo colorado forest with the predominant palo colorado (*Cyrilla racemiflora*), constitute the dominant vegetative cover in the parrot nesting areas (Little and Wadsworth 1964, Snyder et al. 1987).

After relatively little disturbance in parrot areas for 50 years, major habitat disturbance was caused by Hurricane Hugo on 18 September 1989 which damaged much of the forest (Walker 1991, Walker et al. 1992). Although the parrot population declined 49%, presumably caused by the storm, the nesting population recovered within one to two years and produced six nesting pairs in 1991 and 1992 (Meyers et al. 1993).

From 1985 to 1987, 15 nestling parrots were radio-collared and released (Lindsey et al. 1994). In September 1985, three captive-reared parrots were released with radio transmitters (Snyder et al. 1987). Only one parrot survived the first week after the release. After 17 days, however, the sole survivor lost its radio 1.3 km from its release site. This parrot was identified by its leg band location in the spring of 1986. The second radio-marked parrot (No. 553) was hatched from a West Fork nest in 1986 and moved to an East Fork nest as a hatchling, a distance of about 1.3 km to the SSE. Parrot 553 successfully fledged on 25 June 1986 with a 6.3-g radio-collar attached (2.3% of its body weight). It was radio-tracked until 19 December 1986. The third parrot was one of the remaining 13 radio-collared and released from nests (wild-reared and foster captive-reared) on the eastern and western range of the Luquillo Mountains (Lindsey et al. 1994). All parrots were also marked with numbered stainless steel leg bands before release.

Results.—The first radio-collared parrot, released in 1985, was observed nesting at East Fork during 1989 and successfully produced one fertile egg that year (M. H. Wilson, pers. comm.). It was presumed dead after Hurricane Hugo when it failed to return to the nesting area with its mate.

During the 1991 breeding season, five years post-fledging, parrot 553 was observed with

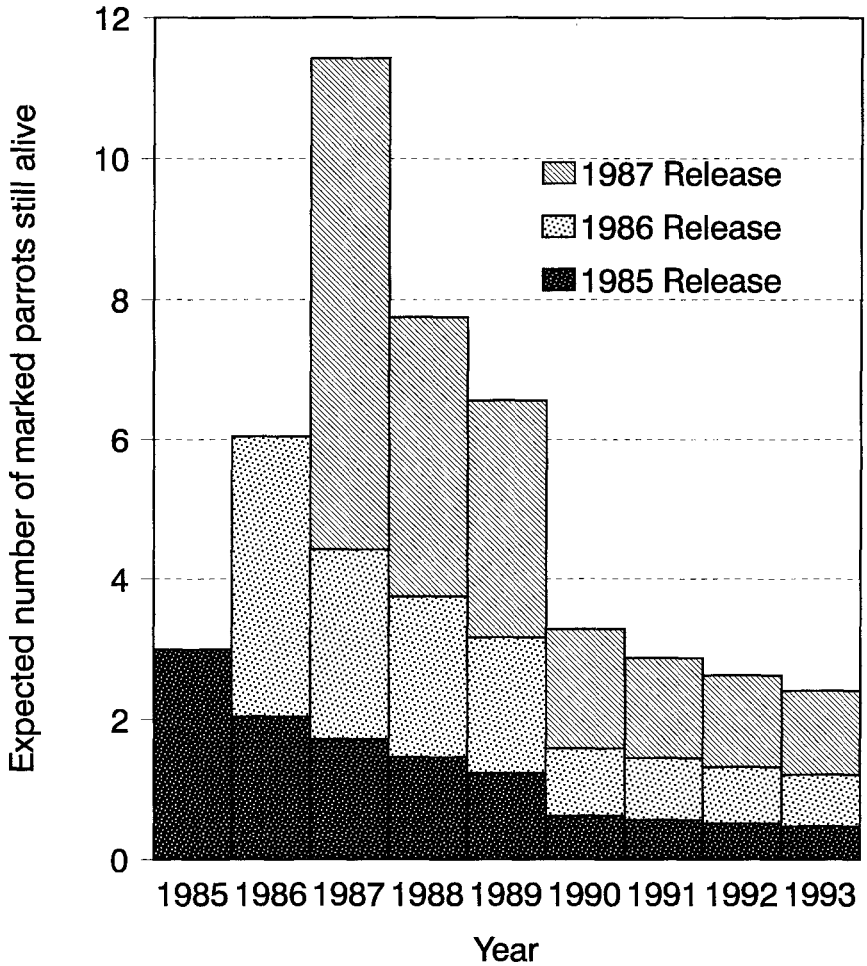

FIG. 1. Expected survival of marked Puerto Rican Parrots in the Luquillo Mountains, Puerto Rico, 1985–1987. Number of parrots radio-marked and released by year: 1985 = 3, 1986 = 4, 1987 = 7. Mortality estimated at 32.5% from fledging to one year of age, 15.2% for years 2–4, 8.7% per year after year 4 (Snyder et al. 1987, Lacy et al. 1989), and 50% (determined from surveys) for all parrots during the year of Hurricane Hugo. Survival for 1987 released parrots was calculated from raw data for minimum number alive at six months after fledging.

its transmitter still intact at an East Mountain nest, 1.1 km NE of its natal site (B. Roberts, pers. comm.). It was the male of a breeding pair that successfully nested in a natural cavity of a tabonuco tree (Meyers et al. 1993). The parrot's identity was confirmed when its radio was shed inside the cavity during the breeding season and later discovered during a nest check (H. Abréu, pers. comm.). During the 1992 breeding season, this pair nested again in

the same cavity and produced fledglings (Meyers et al. 1993). By early 1993, parrot 553 had disappeared and was presumed dead when the female was seen with a new mate (B. Roberts, pers. comm.).

The third radio-collared parrot was sighted in the South Fork nesting area on 18 February 1993 by B. Roberts (pers. comm.). Roberts noted a large bulge in the parrot's neck feathers, attributing it to an unseen transmitter. Her observations were later verified by other observers when the parrot (with its radio still attached), replaced the male of the South Fork 1A nest-pair in early June of the same year.

Discussion.—Based on survival estimates for Puerto Rican Parrots (Snyder et al. 1987, Lacy et al. 1989) and assuming from previous experience no effect on survival due to the transmitter, we believe that two to three of the 15 parrots marked in 1985–1987 would be alive in 1993 (Fig. 1). Verifying that at least two of the radio-collared parrots were alive in that year demonstrates that this type of radio attachment may have little influence on juvenile survival. Another study of 15 parrots of four *Amazona* species in Puerto Rico during 1991–1993 resulted in no mortalities as a consequence of similarly designed radio-collars that remained attached for up to 1.8 years (Meyers, unpubl. data, Meyers 1995). One the 15 radio-collared parrots (female) and its unmarked mate successfully fledged two nestlings. We believe that important information gained by radio telemetry more than compensates for minor effects that this technique may have on the parrots. Because most parrots spend considerable time in groups, telemetry provides invaluable life-history and survival information.

Most of the radio-collared parrots probably lost their transmitters within 1–2 years. Radio attachments should be sufficiently secure to retain the transmitter for the predicted battery life. For two Puerto Rican Parrots in this study, however, the attachment material (heavy gauge cotton thread) had not deteriorated sufficiently to allow the successful shedding of the transmitter for almost four years after the battery had expired. Research is underway using a new radio-collar design and attachment mechanism to test the practicality of low carbon steel connectors that rust and allow the parrot to shed the collar after the battery expires (Meyers 1995).

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