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THICK-BILLED PARROT RELEASES IN ARIZONA[1]

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Abstract. Thick-billed Parrots (*Rhynchopsitta pachyrhyncha*) once ranged as far north as central Arizona, but have rarely been seen outside Mexico since the 1920s. Extirpation from the United States may have resulted mainly from widespread shooting.

Experimental releases of the species in Arizona since 1986 have yielded mixed results. Birds obtained as wild-caught adults have exhibited good survival and some reproduction in the wild. Captive-reared birds have had poor survival rates due mainly to deficits in foraging and socialization, and to heavy losses to predators. Although parent-reared, captive-bred birds have performed better than hand-reared birds, and young captive-bred birds have done better than older captive-bred birds, the only birds showing good potentials for reestablishment have been translocated wild-caught adults.

Present habitat quality in southern Arizona appears adequate to support a population of these parrots, but it is questionable that the species might sustain consistent populations north of the range of Chihuahua pine (*Pinus leiophylla*). Thick-billed Parrots appear to be highly dependent on flocking for security from predation, so their successful reestablishment may depend directly on the numbers of birds released. Principal natural enemies of the species in Arizona have been Goshawks (*Accipiter gentilis*), Red-tailed Hawks (*Buteo jamaicensis*), and ring-tailed cats (*Bassariscus astutus*)—species that also occur through much of the Thick-billed Parrot's range in Mexico.

Key words: *Thick-billed Parrot;* Rhynchopsitta pachyrhyncha; *Arizona; extirpation causes; endangered species; reestablishment.*

INTRODUCTION

HISTORICAL STATUS OF THE THICK-BILLED PARROT IN THE UNITED STATES

With the sole exception of the extinct Carolina Parakeet (*Conuropsis carolinensis*), the Thick-billed Parrot (*Rhynchopsitta pachyrhyncha*) is the only parrot species whose natural distribution once included parts of the continental United States. In recent historical times, this species ranged as far north as the pine forests of central Arizona and southern New Mexico (Wetmore 1931, 1935; Phillips et al. 1964). It still occurs widely in the Sierra Madre Occidental of Mexico (Forshaw 1989, Lanning and Shiflett 1983, Marshall 1957), but has been considered endangered by the International Council for Bird Protection and the U.S. government since the late 1970s (U.S. Fish and Wildlife Service 1977, King 1977).

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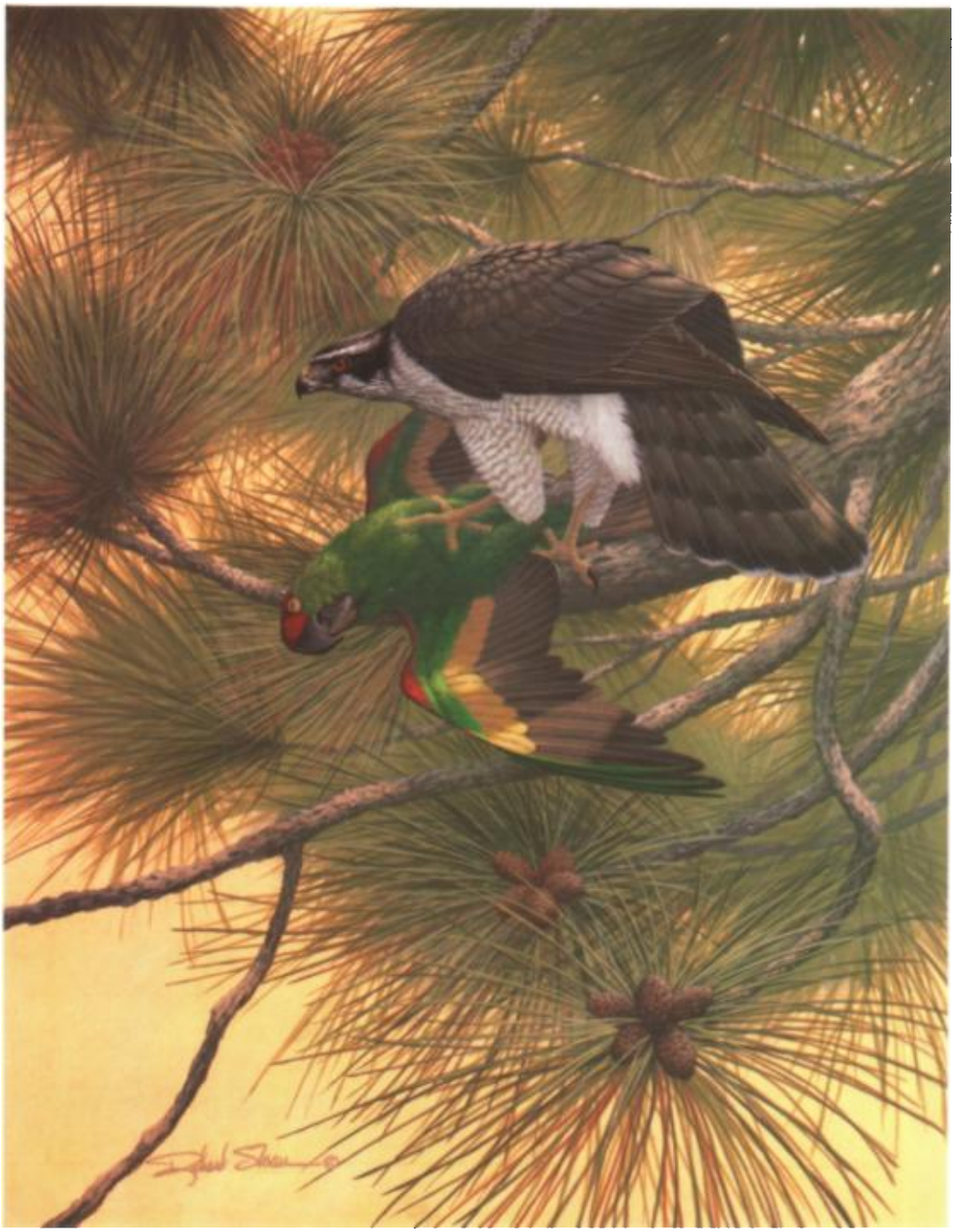

A Northern Goshawk with Thick-billed Parrot prey. Painting by Richard Sloan from the forthcoming *Raptors of Arizona,* University of Arizona Press, R. Glinski [ed.]. Publication of the color plate was supported by the Arizona Wildlife Foundation and Josiah and Valer Austin.

The last credible historical sightings of the species north of the border were a flock reported by F. Fish from the Chiricahua National Monument in southeast Arizona in 1938 (Monson and Phillips 1981) and a flock seen by Charles Hanson in the Animas Mountains of southwest New Mexico in 1964 (J. Aldrich, pers. comm.). The species still bred within 120 km of the U.S. in northern Chihuahua in the late 1970s (Lanning and Shiflett 1983).

Like other birds feeding primarily on pine seeds, the Thick-billed Parrot exhibits considerable temporal irregularities in its distribution, apparently correlated with spatial and temporal variations in the fruiting of its usual food supplies (Lanning and Shiflett 1983, Marshall 1957). In the U.S., the species has been known to feed mainly on cones of Chihuahua pine (*Pinus leiophylla*), Mexican pinyon (*P. discolor*), ponderosa pine (*P. ponderosa*), Arizona pine (*P. arizonica*), Apache pine (*P. engelmannii*), and Douglas fir (*Pseudotsuga menziesii*); although acorns (especially *Quercus emoryi*), juniper berries (*Juniperus deppeana*), terminal buds from various conifers, and nectar from *Agave* flowers have also been taken (Wetmore 1935, Snyder and Wallace 1987, pers. observ.). In Mexico, diet is likewise centered on seeds of various pine species—*Pinus arizonica, P. ayacahuite, P. discolor, P. teocote*—with occasional items such as cherry fruits (*Prunus capuli*), terminal buds of various pines, and seeds of an undetermined leguminous plant (Lanning and Shiflett 1983, Blake and Hanson 1942, Stager 1954).

The general consensus in the ornithological literature is that the Thick-billed Parrot was probably not an established U.S. resident in historical times, but a sporadic visitor from Mexico (e.g., Wetmore 1935, Phillips et al. 1964). This consensus has apparently stemmed mainly from the absence of U.S. breeding records and from a tendency for large flocks to be seen north of the border only irregularly.

Nevertheless, careful examination of records of the species and of the history of ornithology in Arizona and New Mexico allows a reasonable inference that breeding of the species in the U.S. could easily have been overlooked. None of the early first-hand accounts of the species in the U.S. were from trained biologists likely to have been interested in looking for nests. In fact, none of the capable ornithologists visiting the region while Thick-billed Parrots were still being seen frequently (e.g., Bendire, Mearns, Coues) ever encountered the species. Even the renowned account of Wetmore (1935), upon which much of our knowledge of the species in the U.S. is based, was a second-hand assembly of sightings of ranchers and other residents. Thick-billed Parrots tend to nest in high-elevation pine forests (Lanning and Shiflett 1983; Snyder, pers. observ.), and other than loggers and prospectors, few residents of southern Arizona and New Mexico frequented this zone historically. Furthermore, Thick-billed Parrots nest extremely late in the year (mid-summer to mid-fall), a season when most naturalists do not search for bird nests. It is also notable that extremely few historical nest records exist for the species in Mexico (see Bergtold 1906, Thayer 1906). The absence of nesting records from the U.S. must be judged from a perspective that acknowledges the very low probability of Thick-billed Parrot nests being reported from any location.

Certainly, there is good reason to believe that some historical sightings of Thick-billed Parrots in the U.S. represented incursions from Mexico. The flocks of thousands seen in 1917–1918 and documented thoroughly by Wetmore (1935) were unquestionably a phenomenon that was not seen every year. These flocks appeared at a time of severe regional drought and probably were a result of failure of the species' food supply in northern Mexico. However, the existence of incursions does not preclude the simultaneous existence of a resident population in the U.S. Sightings of the species in the U.S. were sufficiently frequent and well-distributed through the months of the year that one may question whether all these sightings might have represented misplaced Mexican individuals. One longtime resident of the Chiricahua Mountains—William Reed of Cave Creek Canyon—maintained that the species was an every-year resident around the turn of the century (pers. comm. via Jerram Brown). Similarly, a report of V.W. Owen dated 24 September 1915 (John Law Collection, Virginia Polytechnic Institute) indicated that "in eight summers spent in the Chiricahuas he always noted a few [Thick-billed Parrots]," although he found no evidence that the species nested there. Published records of the species in the Chiricahuas exist for 1898, 1900, 1902, 1904, 1906, 1917, 1918, 1920, 1922, 1935, and 1938 (Phillips et al. 1964, Monson and Phillips 1981). Many of these reports were of relatively small flocks.

FIGURE 1. Soldiers with Thick-billed Parrots shot in the Chiricahua Mountains in about 1904. Photo: courtesy U.S. National Park Service.

Phillips et al. (1964) doubted that the Thick-billed Parrot would ever again be seen in the U.S. because of rapid destruction of pine forests in Sonora and Chihuahua, Mexico. Nevertheless, a plausible indigenous cause for disappearance of the species from the U.S. existed at the time of its disappearance—shooting—and it is possible that loss of the species from the U.S. had little to do with the cutting of Mexican forests. Almost all of the early published accounts of Thick-billed Parrots in the U.S. mention shooting of the birds observed. Wetmore (1935), for example, reported that about 100 of 300 parrots seen in Pinery Canyon of the Chiricahuas in 1917–1918 were shot. Similarly, Lusk (1900) and Smith (1907) reported shooting, while Vorhies (1934) made special mention of the risks the species faced from gunfire. Photographs exist of parrots shot by soldiers in the Chiricahuas around the turn of the century (Fig. 1).

Perhaps the most convincing evidence we have obtained of the extent of shooting was the direct testimony of Ralph Morrow, who resided in the Chiricahuas from 1903 until his death in the mid-1970s (pers. comm. via Kim Murphy). Morrow, an Arizona Game and Fish Department agent for most of his life, reported widespread shooting of the species early in this century and believed it was plausible that the bird had been extirpated by this cause. He admitted that he had personally shot many dozens of individuals during his youth. The Thick-billed Parrot is highly gregarious and noisy, and relatively large and tame, characteristics making it especially vulnerable to hunting. Moreover, a substantial fraction of the residents of southeastern

Arizona around the turn of the century were destitute prospectors whose survival depended on subsistence-hunting. Other vertebrate species, for example, elk (*Cervus canadensis*), pronghorn (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*), and Wild Turkey (*Meleagris gallopavo*), disappeared from this region during the same period, in large part because of overhunting (Davis 1982, Phillips et al. 1964).

In sum, the available historical information does not rule out the possibility that the Thick-billed Parrot may once have been a breeding resident of southern Arizona, despite a consensus to the contrary in the ornithological literature. It is against this background that efforts to reestablish this species in the U.S. should be viewed.

ORIGINS OF A REESTABLISHMENT PROGRAM

In the early summer of 1986 a joint meeting of representatives of the Arizona Game and Fish Department, the U.S. Fish and Wildlife Service, the U.S. Forest Service, and relevant outside parties was convened to consider a proposal for releases of Thick-billed Parrots in Arizona. A modest number of wild-caught parrots were available for such releases from confiscations of smuggled birds. Sam Jojola, a USFWS enforcement agent, had proposed that it might be worthwhile to attempt introducing these birds to the wild rather than distributing or selling them to zoos or aviculturists, as is normally done with confiscated birds.

A consensus developed during the meeting that since historical data allowed the possibility that the species had once been a resident in Arizona, such releases would be worth attempting. This conclusion seemed especially defensible if shooting had been the major problem in the past, because subsistence hunting and widespread, indiscriminate shooting were no longer typical in the region. Further, in view of progressive loss of pine forests in Mexico, it was plausible that reestablishment of the species in Arizona could be a significant component of conservation of the species as a whole. The pine forests of southern Arizona (e.g., in the Chiricahuas Mountains) have been largely free of lumbering in recent decades, mainly because of the logistic and environmental problems in felling trees on steep slopes and because of competing values of the forests.

A program was quickly organized to pursue parrot releases on an experimental basis, with the Arizona Game and Fish Department as the lead agency and with cooperation from the U.S. Forest Service and the U.S. Fish and Wildlife Service. Subsequently, this program has received additional support from many private donors and organizations.

In this paper, we summarize the results of experimental releases of Thick-billed Parrots in Arizona from 1986 through 1993. We also discuss the relevance of these results to future reestablishment efforts.

METHODS

Between September 1986 and September 1993, 88 Thick-billed Parrots were released to the wild in the Chiricahua Mountains of southeastern Arizona. Sixty-five of these birds, obtained mainly as confiscations by the U.S. Fish and Wildlife Service, were believed to be individuals originally trapped from the wild in Mexico. Of these, four were apparently juveniles when received, based on gonad size or partial white coloration of their bills. The other 23 birds released were all captive-bred: 16 had been parent-reared and seven hand-reared. Primary releases were all "soft" releases, which involves preconditioning birds to the local environment and food supply. These were performed as follows:

(1) Release of 13 wild-caught adults on 20 September 1986.
(2) Release of 16 wild-caught adults on 19 October 1986.
(3) Release of six hand-reared adults on 16 October 1987.
(4) Combined release of eight wild-caught adults and 10 parent-reared captive-bred birds of various ages on 27 November 1991.
(5) Release on 14 December 1992 of 16 wild-caught adults, including four birds obtained as wild-caught juveniles and four other birds recaptured from the preceding release.

In addition, 16 wild-caught adults, one hand-reared captive-bred bird, and six parent-reared captive-bred birds of various ages were introduced directly into wild flocks in "hard" releases of one to three birds conducted from 1987 through 1993. (A hard release involves no preconditioning.)

Birds for releases 1 and 2 were held in cages measuring 2.3 × 2.3 × 2.3 m for at least one month prior to release. This was a relatively small cage size, but allowed some flight exercise, which was encouraged by positioning feeding trays cen-

trally and below the height of peripheral perches. Birds for release 3 were housed in the same-sized cages but were held approximately six months prior to release to allow training on pine cones. Birds for releases 4 and 5 and for most of the miscellaneous hard releases were held for longer periods (up to several years) prior to release. They were trained in cages measuring 2.3 × 2.3 × 10 m, which allowed considerable flight exercise.

Prior to release, all birds were conditioned to eat locally available cones (primarily of Chihuahua, pinyon, ponderosa, and Apache pines). However, birds were maintained primarily on a commercial seed mixture with daily supplements of exotic Mondell pine cones (*Pinus brutia eldarica*), which were obtained mainly from ornamental plantings in the city of Douglas, Arizona and the Santa Teresa Country Club near El Paso, Texas.

No deliberate efforts were made to condition birds with predators. Nevertheless, all birds were held in outdoor cages in the company of experienced wild-caught birds and had repeated opportunities to observe conspecifics reacting in alarm as raptors flew low overhead and even sometimes hit the cages in attempts to capture birds within.

All birds for which sex was unknown were surgically sexed under anesthesia, weighed, and closely inspected for feather condition. Many of the birds received for releases 1 and 2 had right wings whose primaries and secondaries had been clipped off (presumably by trappers anxious to avoid accidental escapes). Where possible, these wings were rebuilt by "imping" (Woodford 1966) with whole, molted Thick-billed Parrot feathers obtained from various sources. For subsequent releases, imping was rarely used and no bird needed more than one or two imped feathers. A considerable number of the birds received for the first releases had wings beyond repair and were distributed to captive breeding programs, rather than released.

Approximately half of the birds in the first two releases (almost all males) were provided with neck-collar radios developed by James Wiley for use in releases of Puerto Rican and Hispaniolan Parrots (*Amazona vittata* and *A. ventralis*) and provided by Wildlife Materials. These units weighed about 8 g, had trailing antennas that measured about 22 cm, and had lifetimes of about six months. In releases 3, 4, and 5, and in all miscellaneous releases, all birds were provided with neck-collar radios. Radios for releases 3 and 4 were similar to those used in releases 1 and 2, but had lifetimes of about a year and weighed about 11 g. Radios for release 5 had lifetimes of about a year and a half, weighed about 12 g, and lacked the trailing antenna; the collar itself was the antenna. As most Thick-billed Parrots weigh 300–350 g, transmitter mass was generally under 4% of body mass. Birds were radiotracked from the ground and sometimes by small airplane when ground contact was lost.

All birds were quarantined for at least a month prior to release or association with other birds. For the most recent releases, we used quarantine periods ranging from several months to years because of occurrences of diseases in some birds available to the program. Most confiscated wild-caught birds had also undergone a 30-day quarantine period supervised by the U.S. Department of Agriculture before we received them.

RELEASE PROCEDURES

All "soft" releases from holding cages were conducted in early to mid-morning under sunny weather conditions. For release 1, the door at one end of the cage was opened and birds were allowed to exit on their own volition. Because birds generally were reluctant to leave the cage in this release, subsequent soft releases entailed placement of cone-covered pine branches just outside the opened ends of the cages to encourage departures. In all soft releases, some birds were retained in the cages to attract released birds back to subsidies of food (seed mixture) and water (in bowls) left atop the cages. However, food subsidies were generally ignored except in release 4.

Because the wild-caught birds in releases 1 and 2 proved to be migratory (adopting a winter range in the Chiricahua Mountains and summer range in central Arizona), subsequent major releases were conducted in the late fall months. This timing was expected to maximize chances that the birds would winter in the Chiricahuas and that their potential migratory tendencies would take them farther north into Arizona during summer.

Cages for releases 1–4 were located in a riparian area at an elevation of about 1,700 m on the east side of the Chiricahuas, a region dominated by Chihuahua and Apache pines. Release 5 was from cages in a riparian area on the west side of the Chiricahuas at an elevation of 1,770 m and also in a region dominated by Chihuahua and Apache pines. All major releases were limited to

years when cone crops, at least of Chihuahua pines, were judged favorable.

"Hard" releases were conducted by transporting the birds in kennels to the locations of wild flocks. The kennels were simply opened, allowing the birds to join the wild flocks.

RESULTS

RELEASES 1 AND 2

Once outside the cages, the wild-caught birds of releases 1 and 2 immediately formed flocks and began feeding on cones of nearby pine trees. Flocks soon began more extensive movements, and the pattern of range expansion was saltatory, rather than gradual, with frequent returns to the release cage vicinity (Fig. 2). For the first few days, birds in the first release roosted close to the cages in dense Douglas firs and Chihuahua pines. Roost locations then began to change progressively, moving uphill. Roosting finally stabilized about 4 km from the release cages at about 2,440 m elevation on a north-facing slope characterized by heavy growth of Douglas fir, white fir (*Abies concolor*), and Arizona pine. Birds continued to visit the cages daily for about the first month, usually drinking from bowls on the cage top in early morning or mid-afternoon and often feeding in Chihuahua and Apache pines nearby.

The birds remaining inside the cages continued to interact with released birds throughout this period. Caged birds responded vocally to the calling of wild birds whenever the latter came near, and in turn often apparently caused the latter to change direction and land in trees over the cages. This influence waned through the first few weeks, and once the released birds discovered natural drinking sources, about a month after release, their visits to the cages became infrequent and brief (see Snyder and Wallace 1987). The last time birds from releases 1 and 2 were observed drinking water provided at the cages was 21 October 1986.

The birds in release 2 joined the birds of release 1 on their first day in the wild (19 October). They immediately adopted the current roosting and drinking behavior of the first release group, and never developed a daily pattern of returning to the cages for water.

During the first year after release, all known movements of the birds in the Chiricahuas were confined to a roughly oval region with a major axis of about 13 km and a minor axis of about 6 km centered approximately on the release cages (Fig. 2). However, habitat and food supplies in areas outside the known range also appeared to be of good quality. While the birds did not use the full extent of this range in the first few days after release, essentially all major regions were visited within three weeks of the first release. Thereafter, the range within the Chiricahuas did not expand significantly through June 1987.

However, the birds of releases 1 and 2 did not remain confined to the Chiricahuas through this entire period. Ten days after the second release (29 October), the combined flock of 22–23 birds split into two groups. One group of 14 or 15 birds left the Chiricahuas for an unknown destination. The remaining group of eight birds stayed within the usual range in the Chiricahuas for another week, but then also left the mountains. Departure of the group of eight was tracked closely until the birds moved beyond radio contact, toward the Mexican border, and along the east slopes of the Chiricahuas. These birds were never again confirmed in the Chiricahuas, although they may have been synonymous with a group of birds later detected summering in central-western New Mexico.

Five days after departure of the group of eight toward the Mexican border, the group of 14 (15) that had left the Chiricahuas on 29 October returned as a group of 14 to the usual range in the Chiricahuas. This group remained sedentary until 4 December, when they again left the Chiricahuas. This time, aerial tracking revealed their destination to be the Graham (Pinaleno) Mountains, approximately 110 km to the northwest of the Chiricahuas. The flock remained in the Graham Mountains for nearly a month before returning again to their usual range in the Chiricahuas where they remained until mid-June of 1987.

Overall, the birds of releases 1 and 2 showed some considerable local exploratory movements during their first fall and winter, including several movements to locations external to the Chiricahua Mountains. However, most surviving birds eventually adopted a fairly restricted and stable range within the Chiricahuas. Their fall-spring movements were much more conservative in subsequent years, being confined almost completely to the usual range in the Chiricahuas until a severe drought in 1989 disrupted this pattern.

Once the immediate post-release period was over, the birds consistently chose high-elevation

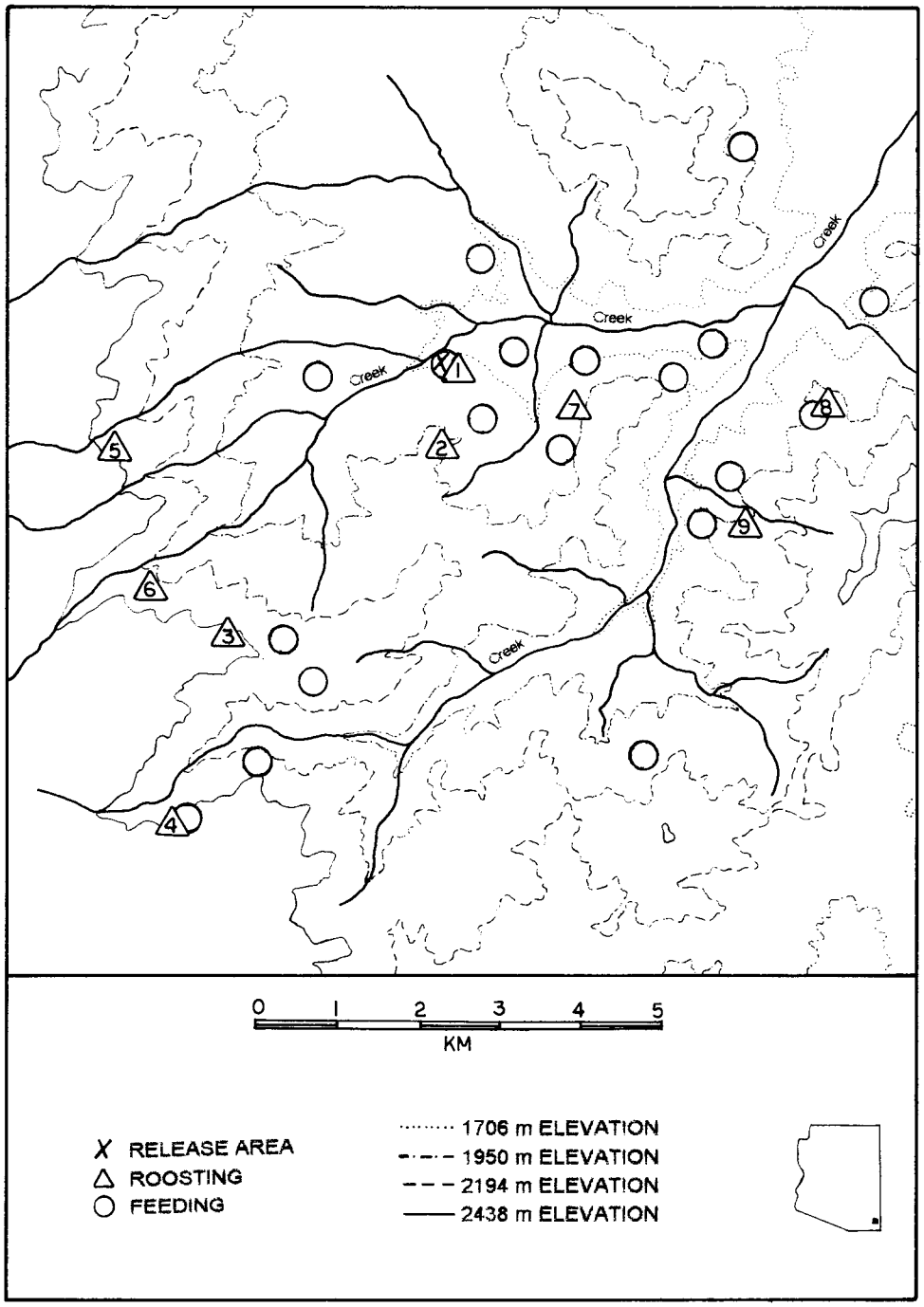

FIGURE 2. Range of released Thick-billed Parrots in the Chiricahuas following releases 1 and 2. Roosting areas are numbered triangles, feeding areas are open circles, and releases cages are denoted by an X. All documented use areas during the first year are depicted. Documented sequence of use of roosting areas through first two and one-half months was: 1,1,1,1,1,1,1,1,1,2,3,4,3,5,3,1,1,1,1,1,1,1,1,1,6,5,1,1,7,8,8,8,8,3,3,3,3,3,3,3,9,3, 3,3,3,6,6,5,5,5,3,3,5,6,6,3,6,3,3,3,3,6,6,6,5,5. Almost all roosting thereafter was in roost 3.

roosting and nesting locations (between 2,200 and 2,500 m). Such roosting and nesting elevations are also usual in Mexico (see Lanning and Shiflett 1983). They are high enough that during winter the birds usually experience sub-freezing temperatures on a nightly basis and commonly eat snow to obtain water. The Thick-billed Parrot is clearly not a tropical species in its habitat tolerances.

Exploratory movements also characterized the behavior of the birds after their first annual migration north to central Arizona in the late spring of 1987. On 14 June, the main flock in the Chiricahuas (now bolstered to 17 individuals by several hard releases) was observed leaving the mountains toward the northwest. Immediate aerial searches of nearby mountain ranges in southeastern Arizona failed to reveal the birds. By mid-summer, however, Thick-billed Parrot sightings were being reported by residents across a broad swath of central Arizona from Flagstaff southeast to the White Mountains. Unfortunately, we failed to locate any of these birds in ground searches through the entire summer. A group of about a dozen birds spent a major portion of the summer in the upper Tonto basin near Payson. By the time we received reports of this group, they had left the region and we failed to find them in nearby areas. From the air, we found one dead bird on the rim of Oak Creek Canyon, but we failed to pick up signals of any others. We later learned that a small flock of up to six parrots was also seen in central-western New Mexico during the same and following summers. This flock may have represented a northern migration of the group that disappeared from the Chiricahuas heading toward Mexico in early November 1986. Alternatively, it could have been a splinter group from the flock of 17 that headed north from the Chiricahuas in June of 1987. The single record of a Thick-billed Parrot in the White Mountains of central-eastern Arizona was an "imped" feather found by a hiker. Most of these records placed the birds in the ponderosa pine zone at elevations of about 1,500 to 2,300 m.

On 19 September 1987, a flock of five birds returned to the release area in the Chiricahuas. None of these birds possessed a functioning radio transmitter, but we quickly released a wild-caught bird with a transmitter into the flock. This yielded a trackable flock of six, which was joined by four additional birds returning to the Chiricahuas on 2 October. The combined flock remained in the usual range in the Chiricahuas through the winter and spring of 1987–1988, then again migrated north to the Payson area in the summer of 1988.

During the summer of 1988, one pair of parrots raised two young which migrated south with their parents to the Chiricahuas in mid-fall. One of the two fledglings survived until late spring of the following year, but by the time the flock returned north to its summering area near Payson in 1989, it consisted of only seven adults.

Three pairs adopted nest holes in the summer of 1989 (Fig. 3), but none was successful in fledging young. One never laid eggs. Another got to the point of hatching two young, but one adult and the young were lost when a ring-tailed cat (*Bassariscus astutus*) entered the nest hole. The third hatched two young but both apparently starved when food supplies failed in late summer due to severe drought conditions. After failure of both active nests, the flock migrated back to the Chiricahuas but found extremely poor food conditions in this location as well (Douglas fir was the only food available). After a few days they migrated back to the Payson area (approximately a 400 km trip), stayed a few more days, then returned once again to the Chiricahuas. Thus the flock made two separate fall migrations to the Chiricahuas from central Arizona in 1989.

Douglas fir cones in southeast Arizona lose their seeds by mid-fall, and the flock went into a nomadic phase at this point in 1989, leaving the usual range in the Chiricahuas for parts unknown. Unfortunately, we were unable to introduce a bird with a functioning radio transmitter into the flock before it departed. Subsequent records of the birds have been limited to occasional sightings in a variety of Arizona locations, including, but not limited to, the Chiricahuas and the Payson area. How many survivors might still exist from the first two releases is unknown. It is unlikely, in any event, to be more than a very few birds, as all recent sightings of these birds have been only of singletons or pairs.

RELEASE 3

On 16 October 1987, six hand-reared captive-bred birds were liberated in a soft release after six months of training on pine cones and socialization with wild-caught Thick-billed Parrots. On release, none of these birds showed any tendency to flock, to feed on cones in the wild, or to return to the release cages. Furthermore,

FIGURE 3. Pair of Thick-billed Parrots at their 1989 nest hole in a ponderosa pine snag along the Mogollon Rim of central Arizona. Two other pairs nested within a kilometer. Most nests were in abandoned flicker holes enlarged by the parrots.

none of the birds displayed normal vigilance against predators. After two days in the wild, it was evident their chances of survival were negligible, and all were dispersing in separate directions. We then recaptured all birds by carrying food trays to their respective locations and apprehending them as they landed on the trays. Despite their rescue, all six birds were classified as probable starvation mortalities.

Although the wild flock from releases 1 and 2 was not present nearby at the time of release 3, we also released a hand-reared bird directly into the wild flock two days later. This bird showed no inclination to join the wild flock and was also recaptured.

RELEASE 4

On 27 November 1991 we released eight wild-caught birds with 10 parent-reared captive-bred birds. There was a substantial local crop of Chihuahua and Apache pine cones, but even though many birds began feeding on these cones, they soon abandoned these efforts and returned to feed on the subsidy at the release cages. Very likely this abandonment was due to the relatively low seed content of the wild cones in this year.

Prior to the release we had observed Apache fox squirrels (*Sciurus apache*) readily feeding on cones and had erroneously assumed that cone quality was favorable for a release.

While most wild-caught birds flocked together on release, as in previous releases of wild-caught birds, flocking in the parent-reared captive-bred birds was deficient. Most of the latter dispersed as ephemeral pairs, small groups, or singletons, and all were lost in the first few days except for one starving individual retrapped into captivity (and ranked as a mortality) and three individuals that did orient on the cages and began feeding on the subsidy provided.

Socialization of the three surviving captive-bred birds with the wild-caught birds (also feeding on the subsidy) was weak at first, but improved with time. Most of these birds roosted near the cages for the first few nights, but not in a tightly integrated group. By five days after release, five wild-caught birds were roosting in a Douglas fir over the cages, while the three surviving captive-bred birds roosted together in a nearby Chihuahua pine. By the next day all eight birds roosted together in the Douglas fir. They continued to roost together thereafter, but the roost location moved progressively away from the cages to a location 5 km distant by three weeks after the release.

Unfortunately, several weeks after the release, an adult female Northern Goshawk (*Accipiter gentilis*) discovered the concentration of free-flying parrots around the cages and began daily and sometimes more frequent attacks on the birds. The three captive-bred birds were quickly killed, along with one of the wild-caught birds. Six weeks after the release we terminated the carnage by trapping the four surviving wild-caught birds back into captivity. The goshawk continued to visit the cage area for at least a month after all birds were recaptured.

Overall, the parent-reared captive-bred birds in release 4 exhibited much better socialization than did the hand-reared birds of release 3, and at least some did some feeding on wild cones. Nevertheless, flocking was generally weak in these birds, and most were lost to raptors, ring-tailed cats, or starvation within three days. The goshawk quickly, and apparently selectively, removed the few captive-bred birds that did manage to join the wild-caught flock, indicating a relatively high susceptibility to predation among even the very best of the captive-bred birds. Survival of these birds was significantly lower than that of their flockmate wild-caught birds by simulation of their joint binomial distribution, $P < 0.025$. Although an unanticipated result, the rapid elimination of the birds on subsidy by the goshawk strongly suggested that gradual "hacking" of this species from captivity to the wild is not a promising technique in areas with normal avian predator populations.

RELEASE 5

Sixteen additional adult, wild-caught birds were released on 14 December 1992, including four individuals obtained as juveniles in late 1988. As in the first release, most birds quickly formed an integrated wild flock feeding on wild cones, and most roosted near the release cages for a few days but then progressively changed their roosting location to higher elevations, eventually settling on a high elevation north-facing slope. Also, as in the first release, the birds remained initially dependent on water provided at the release cages, but switched to natural water sources after about one month.

However, release 5 yielded results different in a number of respects from those of releases 1 and 2 during the first few months. These differences included: (1) much more restricted exploratory movements, (2) a much smaller foraging range, amounting to a narrow canyon bottom only about 6 km in length, (3) a much more restricted diet (exclusively Chihuahua pine), despite an abundance of Apache pine cones with good seed content in the release area, and (4) an absence of a northern migration in the first summer following release.

The four birds in this release that had been obtained originally as juveniles fared poorly. Although all showed reasonably good flocking tendencies, their tendencies to remain tightly integrated with the wild flock were inconsistent and two of the four showed some inefficiencies in feeding behavior. Perhaps because of these problems, three were lost to predators and the fourth was recaptured in starving condition within the first three weeks. All of these birds had been in excellent physical condition at the time of release.

One pair from release 5 attempted breeding in the Chiricahuas in the summer of 1993, but failed when the female perished in the nest hole at the point of egg laying.

MISCELLANEOUS HARD RELEASES OF WILD-CAUGHT BIRDS

In 1987, 1988, 1989, and 1993 a total of 16 wild-caught adults were released into existing wild flocks mostly as singletons or pairs, although there was one release of a trio in 1988. These releases were generally successful, with birds fully integrating into the wild flocks within a few days and sometimes within a single day. Time needed for full integration appeared to be dependent on flight condition of the birds, and on the extent of daily movements of the wild flocks at the time of release. Released birds apparently lacked sufficient stamina to keep up with the wild flocks if the flocks were commuting distances of several kilometers between roosts and foraging areas, but they usually developed such strength in three or four days.

The quickest full integration was achieved with a wild-caught male obtained from the San Diego Zoo, which joined a largely sedentary wild flock in early 1989. Interestingly, this bird had been in captivity since 1956 (see Lint 1966), was a member of the first known pair of Thick-billed Parrots to breed in captivity (in 1965), and was a minimum of 34 years old at the time of release. Nevertheless, he immediately joined the wild flock and remained with them through a summer migration to the Payson area and a return migration south to the Chiricahuas in September 1989. At this time, however, he began to fall behind the flock and was taken by a raptor shortly after his lagging became apparent. His rapid integration with the wild flock in early 1989 demonstrated that he had lost little, if any, of his capacities for wild survival despite his long stay in captivity.

MISCELLANEOUS HARD RELEASES OF PARENT-REARED, CAPTIVE-REARED BIRDS

We saw generally poor socialization in hard releases of six parent-reared, captive-bred birds, despite their continuous caging with conspecifics since hatching and their apparently normal socialization with wild-caught birds before release. None of these birds showed strong initial tendencies to join the wild flocks, although the wild flocks were clearly motivated to join the released birds. Nevertheless, in all cases the association between wild flocks and released birds broke apart during the first day. In one case, a released bird did reassociate with the wild flock on the second day, but no released birds were associated with wild flocks by the third day, and all released birds still surviving at this point had dispersed from the release areas.

Although all released birds had reached a high level of competence in feeding on cones attached to branches prior to release, their initial feeding behavior in the wild was generally poor. Only two of the six birds were observed feeding during their first day in the wild. Three of the six fed on the second day, but only two fed well at this point, and one bird that did feed to some extent on all days after release had to be recaptured in starving condition on day 5. In general, the birds appeared to have difficulties in identifying the proper habitat in which to find food.

The poor socialization and feeding behavior observed in these birds was similar to that of the parent-reared, captive-bred birds in release 4. The youngest parent-reared, captive-bred birds (ages 13–20 months) performed the best overall, although their performance was still deficient (Table 1). All birds more than 20 months old on release fared poorly, suggesting that there may be some critical age window for development of essential survival skills.

The single "hard-released" captive-bred bird to survive more than a week in the wild apparently owed his survival to unusual circumstances. This bird, a male, was released with his mate from captivity, but the pair stayed together only partway into the second day, and neither bird showed any inclination to associate with the wild flock. By the end of the second day, the bird destined for survival had moved from the release canyon to a different canyon system that had a good food and water supply, and perhaps most importantly, lacked Red-tailed Hawks (*Buteo jamaicensis*), Northern Goshawks, and Peregrine Falcons (*Falco peregrinus*). Here he remained for three months. Although wild-caught birds visited this site occasionally during this period, he failed to join them in an enduring manner. Only at 4 months post-release did he begin associating with a wild-caught singleton, and left his safe location to travel much more widely in the mountains.

The adoption of a relatively safe and limited location during the first few months was not seen in any other parent-reared, captive-bred birds, and may have been completely accidental. All other parent-reared, captive-bred birds, with the exception of the three young birds that formed

TABLE 1. Release performance of parent-reared captive-bred Thick-billed Parrots.

Bird	Age (months) at release	First-week[a] socialization with wild birds	Observed[b] feeding on wild cones	Survival > 1 week	Survival >2 months
WAP12221	13	+	+	0	0
SDZ1257	15	0	0	0	0
ABR90168	15.5	+	+	+	0
ABR90184	15.5	+	+	+	0
74D0112	16.5	+	+	+	0
74D0072	16.5	0	+	0	0
WAP12128	20	0	+	+	+
SDZ12477	20	0	+	0	0
E163	20	0	0	0	0
E157	25.5	0	0	0	0
D0001	27	0	no data	0	0
SDZGA246	38.5	0	0	0	0
SDZGA260	38.5	0	0	0	0
SDZ491	39.5	0	no data	0	0
SDZGA244	39.5	0	0	0	0
D025	51.5	0	no data	0	0

[a] A + indicates some positive integration with wild flock; 0 indicates no signs of socialization with wild flock within first week.
[b] A + indicates some feeding on wild cones observed; 0 indicates no feeding on wild cones observed.

an association with a food subsidy at the release cages in release 4, exhibited apparently aimless dispersal, and most became raptor victims within a few days of release.

MORTALITY

For both wild-caught and captive-bred birds, mortality was greatest in the days immediately following release (Table 2). Approximately 72% of all released wild-caught adults survived through the first month, and there was little variation in this rate among the various releases, including the miscellaneous hard releases. Two-month survival of wild-caught adults averaged about 67%, indicating considerable improvement in survival with time (possibly because the least-fit individuals had already been eliminated). Parent-reared, captive-bred birds also showed signs of improved survival with time, although overall survival in this group was very poor, with two-month survival less than a tenth that of wild-caught birds.

Subsequent survival rates of released birds have been difficult to compute comprehensively because of several factors, including dispersal of birds from areas under observation and expiration of radio transmitters. Nevertheless, useful calculations of survival rates have been possible for certain groups of birds during periods when flocks apparently remained together. These calculations provide some indication of levels of adult survival beyond the initial post-release period of heavy mortality. For the main flock of wild-caught adults under observation after releases 1 and 2, one bird of 14 was lost in the seven-month period from mid-November 1986 to mid-June 1987, yielding an annual mortality rate of 12.9%. For the 10-month period from September 1987 to July 1988, one adult of nine was lost for an annual mortality rate of 14.6%. Finally, for a one-year period from October 1988 to October 1989, two adults were lost from a group of seven adults, yielding an annual mortality rate of 33.8%. For these calculations, we have computed mortality on the basis of numbers of birds lost in the total number of bird-exposure months.

In general, these figures suggest declining mortality rates with increasing flock size, although this conclusion needs to be viewed with caution. While the lowest survival rate was indeed associated with the smallest flock size, it was also associated with the extreme drought of 1989, which greatly distorted movement patterns and very likely increased vulnerability to predation substantially.

In Table 3, specific causes of mortality are given for all birds for which such information was available. Birds retrapped into captivity in starving condition were classified as mortalities from this cause. Cases of starvation were limited almost completely to captive-bred birds. One of the only two wild-caught birds lost to starvation proved on close examination to have an injured

TABLE 2. Post-release survival of Thick-billed Parrots.

Type release	Hard/soft	Date	No. released	No. survive			% Survive	
				1 week	1 month	2 months	1 month	2 months
Wild-caughts obtained as adults								
Release #1	soft	9/20/86	13	12	10	9[e]	76.9	64.7[e]
Release #2	soft	10/19/86	16	15	13[e]	—	70.4[e]	—
Release #4[a]	soft	11/27/91	8	5	5	—	62.5	—
Release #5	soft	12/14/92	12	11	9	9	75.0	75.0
Miscellaneous[b]	hard	1987–1993	16	15	12	10	75.0	62.5
Totals, means			65	58	49	—	72.0	67.4
Wild-caught obtained as juveniles								
Release #5[c]	soft	12/14/92	4	2	0	0	0.0	0.0
Captive-bred hand-reared								
Release #3	soft	11/16/87	6	0	0	0	0.0	0.0
Miscellaneous[b]	hard	11/18/87	1	0	0	0	0.0	0.0
Totals, means			7	0	0	0	0.0	0.0
Captive-bred parent-reared								
Release #4[d]	soft	11/27/91	10	3	1	0	10.0	0.0
Miscellaneous[b]	hard	1987–1993	6	1	1	1	16.7	16.7
Totals, means			16	4	2	1	12.5	6.3

[a] Release terminated by retrapping all surviving birds on 1/10/92. Survivors again release in Release 5.
[b] Birds released directly into wild flock.
[c] Birds released together with 12 wild-caught birds obtained as adults.
[d] Birds released together with 8 wild-caught birds obtained as adults.
[e] Birds from release 2 join birds of release 1 on 10/19/86. Total of at least 22 birds survive 19 days later, although exact apportionment of mortalities among releases not possible after 10/19/86 as not all birds are marked. The numbers surviving in columns 6 and 7 represent the most likely apportionment at 19 days after release 2, while the percent survival figures in columns 8 and 9 represent 19-day survival data extrapolated to a full month.

wing which may have been the primary cause of starvation.

The major source of mortality was raptor predation. In most cases, this was due to Northern Goshawks or Red-tailed Hawks, although Peregrine Falcons may also have accounted for a few birds. Other raptors resident in the area included Great Horned Owls (*Bubo virginianus*) and Cooper's Hawks (*Accipiter cooperii*), but we obtained no evidence for their involvement in any losses. Cooper's Hawks made occasional feints at the parrots, but we witnessed no serious attacks and believe that Thick-billed Parrots are too large to be potential prey for Cooper's Hawks under normal circumstances.

One of the birds taken by a Red-tailed Hawk was straggling from the flock when it was killed, and we were able to retrieve the bird before the

TABLE 3. Mortality causes in released birds.[a]

Cause	Numbers lost		
	Captive-bred	Wild-caught	Total
Starvation or probable starvation	10	2[b]	12
Raptor Predation			
Unidentified raptor	3	5	8
Northern Goshawk or probable Northern Goshawk	3	2	5
Red-tailed Hawk or probable Red-tailed Hawk	3	5[c]	8
Total raptors	9	12	21
Probable ring-tailed cat predation	1	4	5
At least scavenged by ring-tailed cat	1	4	5
Possibly eggbound		1	1

[a] Only birds for which some information on causes of mortality was available are considered.
[b] One starving bird has wing injury.
[c] One Red-tailed Hawk victim has *Pasteurella* complications.

hawk had fed significantly on it. On necropsy, we found a substantial deposit of mucus in the bird's choanal slit that in bacterial culture revealed a heavy growth of *Pasteurella* (avian cholera). This bacterium might be more appropriately blamed for the loss of the bird than the hawk. Other birds lost to hawks over the years were similarly stragglers before being taken, although we were not able to recover enough of their carcasses for meaningful necropsies. Whether the *Pasteurella* detected above came originally from captivity or from the wild after release is unknown.

Another significant, and somewhat unexpected, cause of mortality was predation by ring-tailed cats. Two birds were evidently taken by ring-tailed cats while inside nest holes, and three were apparently captured at night roosts in dense conifers. Others were at least scavenged by ring-tailed cats, although it was unclear whether these predators were the primary cause of death in these cases. In many instances involving *Bassariscus,* Thick-billed Parrot remains and neck-collar radio transmitters were recovered from deep inside rock crevices and lairs. In one case, the radio was more than a meter underground in a burrow.

The various predators involved in the aforementioned losses also occur throughout much of the Mexican range of the Thick-billed Parrot. Presumably the species is normally able to cope with these sources of mortality. Nevertheless, it is clear that the Thick-billed Parrot lives in a relatively high-predation environment, a fact that may help explain the species' extremely social nature.

About half the birds in releases 1 and 2 were fitted with radio transmitters, and this proportion remained stable through the next few years of life of these birds. This suggests that the radios themselves were not a major contributor to mortality.

REPRODUCTION

We do not know if any parrots bred during the first summer after releases 1 and 2, as we were unable to locate the birds in central Arizona at the time. During the second summer, at least one successful breeding attempt occurred, yielding two fledglings (Fig. 4), and the post-breeding season discovery of a dead parrot in a nest hole (an apparent ring-tailed cat victim) suggested another attempt. When we began observations of the flock early in the third breeding season, there were three pairs associated with nest holes. Although none of these pairs was successful, two of the three pairs got to the point of hatching broods of two young each. Despite a relatively poor food supply, reproductive effort was substantial in this year; the wild flock numbered only seven birds at the time.

One final documented case of attempted breeding took place in 1993 in a pair from release 5. This attempt took place in mid-July in the Chiricahua Mountains, rather than central Arizona, and failed at the point of egg laying when the female died in the nest hole. As the nest snag was not safely climbable, we did not establish the cause of death. However, circumstantial evidence suggested a possible case of egg-binding. It is notable that this nesting attempt also took place in spite of a poor local food supply. With a total failure of the ponderosa and Arizona pine cone crops in the region, the birds were apparently subsisting entirely on Douglas fir cones.

The apparent readiness of the birds to breed as far north as central Arizona, and under poor food conditions as were observed in 1989 and 1993, is of considerable interest in the light of the general consensus in the ornithological literature that the birds present historically in Arizona were probably nonbreeders. Although the overall rate of success in documented nesting attempts was not high, two of the failures can be attributed to a very poor food supply during the unusually severe 1989 drought. It is premature to generalize about nesting success in Arizona on the basis of the small sample of nests documented.

DISCUSSION

The development of a regular migration pattern in the birds of releases 1 and 2, and the absence of clear migratory tendencies in the birds of release 5 could reflect different areas of origin of the birds in Mexico, although areas of origin were unknown for all wild-caught birds. There is evidence for migrations in at least some Mexican populations (Schnell et al. 1974), but overall migration patterns have not been carefully studied. The migration pattern that developed from releases 1 and 2 had a northwest orientation in spring and southeast orientation in fall. This route parallels the general orientation of the Sierra Madre Occidental in Mexico and suggests that the birds were repeating compass aspects of migra-

FIGURE 4. Fledgling Thick-billed Parrot awaiting a feeding by its nearby parent in the Chiricahuas on 30 November 1988. Easily recognizable by their white bills, fledglings remain dependent on their parents for food for about 4–5 months after leaving the nests.

tions they had performed prior to original capture.

The seasonal timing of witnessed raptor attacks and predation on parrots showed an apparent pattern that may be important in reducing immediate post-release losses in future releases. Raptor predation pressures, especially as documented in releases 1, 2, 4, and 5 were consistently high through the fall and winter months, but declined in mid–late spring, a season when most raptor species are incubating eggs and may have reduced food needs. This decline was especially noticeable in release 5, and suggests that April–May may be a relatively favorable period for releases. However, because cones of many species have largely shed seeds by this season and a new cone crop does not become available until June, the mid–late-spring period is also normally the season of lowest food availability for the species. Nevertheless, we suspect that the success of releases may be maximized by an April–May timing, if releases are limited to years of favorable food supplies.

Overall foraging and movement data suggested that the conifer species of greatest importance to the released parrots were Chihuahua, ponderosa, and Arizona pines. Chihuahua pine tends to bear cones in a high percentage of years, and its seeds are retained in cones in all months of the year. Ponderosa and Arizona pine cones also retain seeds relatively well through the seasons, but have not been produced as consistently (less than half the years in most areas) and have tended to shed most seeds by spring. Douglas fir has been the most consistent cone producer of all the local conifers (at least some cones in all years),

but its seeds are available to the birds only in summer and early fall. Apache pines have produced cones very irregularly. While their cones hold seeds through most of the year, the birds have shown reluctance to feed on this species in some years (especially 1993), perhaps in part because of the toughness of its cone scales. Mexican pinyon is a favored food, when available. However, pinyon cones have been produced in less than half the years of study, and seeds are available in cones only in the summer and early fall. We suspect the Thick-billed Parrots may experience difficulties in maintaining consistent year-round populations north of the range of Chihuahua pine, and this conifer does not occur commonly north of the mountain ranges of the southeastern portion of Arizona.

While efforts to date have not resulted in a self-sustaining wild population of Thick-billed Parrots, the numbers of birds released in our experiments fell far below the numbers that would be optimal for reestablishment efforts (see Griffith et al. 1989). Furthermore, we had to contend with a 1989–1990 drought that was severe enough to result in death of many Chihuahua pine trees. Despite these impediments, results with wild-caught birds have been sufficiently encouraging overall to suggest that reestablishment might succeed if enough high-quality birds could be obtained to support a quantitatively satisfactory release effort. The Thick-billed Parrot, with its extremely social habits and exposure to heavy predation pressures from raptors, is a species that one might expect to be especially dependent on "critical mass" effects in keeping mortality rates at acceptable levels.

Release experiments have demonstrated a number of requisites for success. First, at least some wild-caught parrots have settled within Arizona; homing of released birds to Mexico has not been a major problem. Second, at least some wild-caught parrots have initiated reproductive efforts in Arizona with some success. Finally, survival rates of wild-caught birds, at least under nondrought conditions, have been high enough to suggest that a demographically viable population might be possible in Arizona.

None of the mortality documented during the release experiments traced to the principal historical stress factor of shooting that may have led to the species extirpation. Further, we have seen no signs that the birds might be facing significant limitations either in availability of nest sites or the extent of forested habitat. Although it is valid to question whether viable populations may be possible in the absence of extensive old-growth pine forests (see Benkman 1993), substantial old-growth pine forests persist in southeastern Arizona. Timber cutting is much more prevalent in central Arizona where slopes are more gentle. The potentials for Thick-billed Parrots to become fully established in the latter region may be quite limited, due to the generally younger ages of forest stands, the lesser diversity of conifer species, and especially the absence of Chihuahua pine.

Results of releases of captive-reared birds have not been encouraging. Almost all individuals have been lost within a few days of release as a result of substantial deficiencies in basic survival skills. While the numbers of birds available for release have been small, results achieved to date suggest that establishment of a viable wild population from captive-bred birds would necessitate the rearing, training, and release of large numbers of individuals—perhaps thousands. The logistical and financial investments that would be required in such an effort would be formidable, and the training requirements could in themselves result in deforestation of substantial regions. Thick-billed Parrot fledglings, including fledglings in the wild, often take on the order of 4–5 months to achieve competence in removing cones from branches and removing seeds from cones. Training in captivity must include providing each individual with substantial volumes of tree branches with cones still attached.

While the single captive-bred bird that did survive release in 1993 demonstrated that such a transition is possible, the expense and labor needed to establish a viable population from captive-bred stock, based on current success rates, would be hard to justify, especially when the potential for translocations of wild-caught birds exists. Aside from the enormous investments that would be needed to train captive-bred birds properly, production levels of captive-bred parrots to date have fallen far short of providing the numbers of birds presumably needed.

We believe it is reasonable to expect that refinements in techniques might significantly increase the chances for survival of captive-bred birds in the wild. For example, our results suggest better success might be achieved by releasing rel-

atively young birds, and by focusing on training of young birds in the presence of their parents in extremely large cage environments. Nevertheless, we question whether we could ever achieve better survival of captive-bred juveniles than what we have observed in birds obtained as wild-caught juveniles or with wild-produced juveniles never taken from the wild. Survival of these latter birds has been poor in the small samples observed to date, and we question whether captive-produced juveniles would make reasonable release candidates under even the best of pre-release training regimes.

Because the numbers of parrots available have been so limited, the sample sizes in our experimental treatments have been small. Results have nevertheless been highly consistent both within and between different groups. Captive-bred birds, even when trained intensively, have had serious behavioral problems in adapting to the wild. Unfortunately, it appears that in this species, birds with any behavioral flaws whatsoever have small potentials for long-term survival. If the Thick-billed Parrot inhabited an environment with fewer predators, the potential for successful release of captive-bred individuals would probably be substantially higher.

Additionally, we have been troubled by dangerous and untreatable diseases in birds coming both from confiscations and from captive-breeding institutions. Some of these diseases, for example, parrot wasting disease (psittacine proventricular dilation syndrome) and Pacheco's disease, are impossible to detect reliably in carrier individuals, even with extended quarantine periods (see Derrickson and Snyder 1992). Releasing birds that have been potentially exposed to such pathogens poses the inherent risks of spreading serious diseases from captivity to those birds already established in the wild and possibly to other native sympatric species. The endangerment of the desert tortoise (*Xerobates agassizii*) in the wild, apparently due to releases of diseased animals from captivity (Anonymous 1989, Jacobson and Gaskin 1990), is a clear example of the magnitude of risks involved. While there is no perfect defense against such difficulties, the risks are clearly substantial for species as highly social as the Thick-billed Parrot, particularly when released birds have been held in proximity to exotic avian species prior to release. In the Thick-billed Parrot program, cases of diseased birds have been sufficiently frequent to cause us to reconsider the wisdom of supporting a release program from the sources we have been using.

Thus, while we see some grounds for optimism about the chances of reestablishing the Thick-billed Parrot in Arizona, we no longer believe that it may be cost-effective or even defensible to attempt reestablishment with captive-bred birds, particularly those originating from open multi-species institutions. Confiscated wild-caught birds also represent a questionable source because of disease risks, and have not proved to be numerous enough to sustain a satisfactory reestablishment effort in any event. Clearly, available evidence suggests that the most promising, economical, and risk-conservative option would be direct translocations of wild-origin birds, a conclusion consistent with the comparative data presented by Griffith et al. (1989) and Beck et al. (in press) on a wide variety of species. Before any such translocations might be contemplated, however, there is a crucial need to evaluate the conservation status and health of potential source populations to ensure the conservation of these populations and to determine if any populations could safely afford to become donors. Conservation of the Thick-billed Parrot should not be viewed only from the limited perspective of reestablishing the species in the U.S., but must incorporate actions that will achieve the wider and much more important goal of ensuring long-term survival of the species and its habitats throughout its international range.

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COLOR PLATE: The painting of the Northern Goshawk is one of a series of 42 paintings by Richard Sloan, commissioned by the Arizona Wildlife Foundation. Limited first edition prints are available from the Foundation at 644 North Country Club Drive, Suite E, Mesa, AZ 85201-4948.