

Ecological Relationships of the Thick-billed Parrot with the Pine Forests of Southeastern Arizona

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Abstract.—The thick-billed parrot (*Rhynchopsitta pachyrhyncha*) once ranged throughout the high mountains of southeastern Arizona. Disappearance of the species early in the present century may have been due primarily to widespread shooting. Experimental releases of thick-billed parrots back into the region were conducted between 1986 and 1993, and studies of released birds have revealed a strong dependence on certain conifer species for both food and nesting. The data obtained strongly suggest that the high diversity of conifer species found in southeastern Arizona was a critical factor in allowing the former residence of these parrots.

Conifer cone crops vary among species, among years, among seasons, and geographically. The most important foods of released parrots have been cones of Chihuahua pine (*Pinus leiophylla*), ponderosa pine (*Pinus ponderosa*), and Arizona pine (*Pinus arizonica*), although the parrots have also been observed taking cones of other pine species and Douglas fir (*Pseudotsuga menziesii*). Of all these species, Chihuahua pine appears to be the most important, because it bears cones with high regularity and its seeds are held within cones on a year-round basis. Most other species produce cones only irregularly and many offer seeds only during the summer and fall. It seems probable that the northern extent of the historical distribution of the parrot was tied most importantly to the distribution of Chihuahua pine.

INTRODUCTION

The thick-billed parrot (*Rhynchopsitta pachyrhyncha*) is presently limited in range to the Sierra Madre Occidental of Mexico, but formerly also occurred in the Madrean mountains of southeastern Arizona and southwestern New Mexico (Wetmore 1935, Phillips et al. 1964, Forshaw 1989). Whether the species was ever a fully established breeding resident north of the international border, or was only an irregular visitor to the U.S., has been a matter of debate. The historical record is too fragmentary to answer this question conclu-

sively, but the frequency of historical reports in at least the Chiricahua Mountains, coupled with the readiness of the species to breed in Arizona in recent release experiments, suggests that the thick-billed parrot may once have bred with some regularity in at least a portion of its U.S. range (Snyder et al. 1994).

The thick-billed parrot's disappearance from the U.S. early in the present century may have been due largely to shooting (Snyder and Wallace 1987, Snyder et al. 1994). As a large, noisy, social, and relatively tame species, it was highly vulnerable to such pressures, and shooting was noted in essentially all early U.S. accounts of the species (Lusk 1906, Smith 1907, Vorhies 1934, Wetmore 1935). Shooting is not known to have been a major problem for the species in Mexico, and the major conservation concerns south of the border have been the cutting of the pine forests on which the species is tightly dependent (Lanning and Shiflett

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1981, 1983), and a relatively recent upsurge in trapping of individuals for the illegal bird trade (Snyder and Wallace 1987).

GENERAL HABITS

The thick-billed parrot feeds heavily on the seeds of conifers, although it is known occasionally to take other foods such as acorns, buds of various trees, and flowers of agaves (Wetmore 1935, Blake and Hanson 1942, Stager 1954, Lanning and Shiflett 1983, Snyder and Wallace 1987, pers. obs.). Overall, however, the dependency on pine forests is very strong, as it is in crossbills (Benkman 1993). The bill of the thick-billed parrot is quite large, resembling that of a small macaw, and almost surely serves as an adaptation for husking the tough scales of conifer cones.

In apparent accord with a diet limited largely to pine seeds, the thick-billed parrot breeds very late in the year, most usually laying eggs in late June through July and fledging young in late September through October (Lanning and Shiflett 1981, 1983; pers. obs.). Most pines produce cones

that first become sufficiently mature for parrot feeding by the early summer. In some species, such as pinon (*Pinus edulis* and *discolor*) and Douglas fir (*Pseudotsuga menziesii*), seeds are shed from cones by mid fall. In other species, seeds are retained in closed or partially closed cones through the winter and spring months. Thus the maximum availability of food is in summer and early fall, while the minimum availability is in late spring. The parrot breeding season coincides with the period of maximum food availability.

Nest sites of the parrots are typically old woodpecker holes or natural cavities in dead pine snags or aspens. Contrary to early reports and conclusions (Bergtold 1906, Thayer 1906, Phillips et al. 1964), the species is not limited to old nest holes of imperial woodpeckers (*Campephilus imperialis*), but perhaps most commonly enlarges old nest holes of flickers (*Colaptes auratus*) or modifies natural cavities to serve its reproductive needs (Lanning and Shiflett 1983, pers. obs., fig. 1). Thus, the retention of snags is presumably an important forestry management consideration for nesting areas of this species. The thick-billed parrot commonly, but not always, nests in semi-social assemblages, and the exact distribution of nests is presumably controlled largely by the distribution of available cavities (Lanning and Shiflett 1983, pers. obs.).

Nesting records for the species have been limited to relatively high-elevation forests — ranging from about 2,300 to 3,070 m — although the species commonly feeds at lower elevations and readily flies distances on the order of 15-20 km between nests and foraging areas (Lanning and Shiflett 1983, pers. obs.). Roosting areas in the non breeding season also tend to be at relatively high elevations (commonly 2,200 to 2,500 m), and are often positioned in well-developed timber on north-facing slopes. The species centers its activities at high elevations throughout the year, and is well adapted to snow cover and low temperatures in winter.

FOOD RELATIONSHIPS

Like other birds feeding on pine seeds, the thick-billed parrot is a highly mobile species capable of dealing with spatial and temporal irregularities in abundance and distribution of its primary foods. Evidence suggests that at least some populations are migratory (Snyder et al. 1994). Under stress conditions, such as are pro-

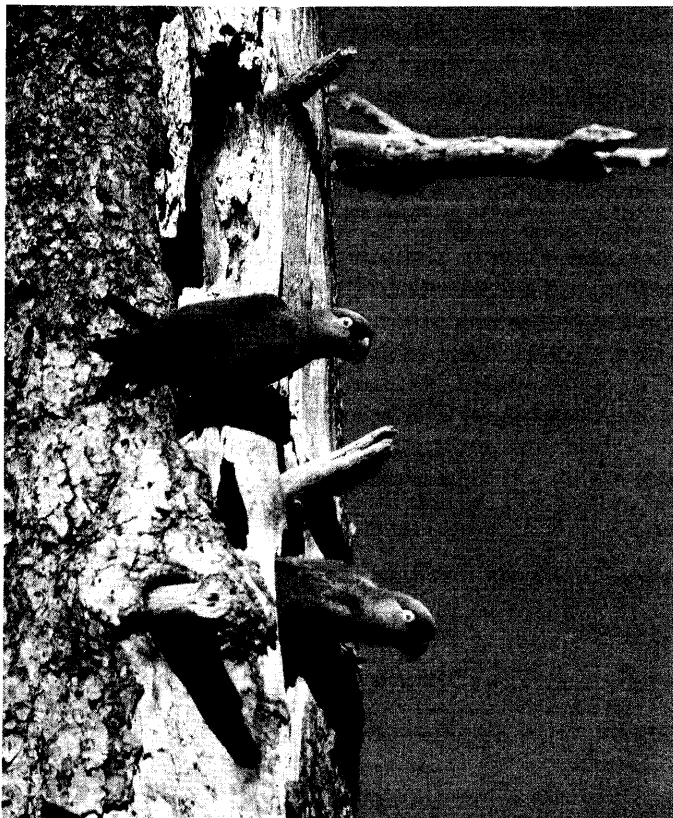


Figure 1.—Pair of released thick-billed parrots at their 1989 nest hole in a Ponderosa pine snag along the Mogollon Rim of central Arizona. Two other pairs nested within a kilometer.

duced by major droughts, large-scale movements of the birds occur from one part of the range to another (see Wetmore 1935, Marshall 1957), presumably correlated mainly with food availability. It is reasonable to hypothesize that the most favorable parts of the range of the species are regions characterized by the conifer species that fruit most regularly and that retain seeds in cones through all months of the year. Areas lacking such conifers presumably do not constitute viable year-round thick-bill habitat.

Different pine species show strong differences in the regularity of fruiting and in their seasonal availability of seeds for parrots. In table 1, we present summary data on fruiting of conifer species that have been important for thick-billed parrots released in southern Arizona since 1986. These data are based on permanent plots in the Chiricahua Mountains and along the Mogollon Rim of central Arizona, as well as upon more casual observations of cone production in other regions of southern and central Arizona. We have directly observed parrots feeding on all but one of the species listed in the table. The exception, southwestern white pine (*Pinus strobiformis*), is included because thick-billed parrots have been commonly observed feeding on this species (equals *Pinus ayacahuite*) in Mexico (Lanning and Shiflett 1983).

Although table 1 does not represent a complete listing of conifers found in Arizona, it is apparent that the diversity of foods available and presumably acceptable to parrots is considerably higher in southern Arizona than in central Arizona. In fact, several species of importance to the parrots — Chihuahua pine (*Pinus leiophylla*), Apache pine (*Pinus engelmannii*), and Arizona pine (*Pinus arizonica*) — are limited to southeast-

ern Arizona and southwestern New Mexico in their U.S. distributions. The vast pine forests of the Mogollon Rim in central Arizona are comprised largely of ponderosa pine (*Pinus ponderosa*), with lesser amounts of Douglas fir, white fir (*Abies concolor*), and southwestern white pine; and with pinon-juniper on relatively dry slopes. The diversity of pines in southern Arizona closely resembles that in many regions of the Sierra Madre Occidental in Mexico (see Marshall 1957, Kearny and Peebles 1960, Bailey and Hawksworth 1983, Perry 1991, Barton 1992). In this paper, we follow the taxonomy of Bailey and Hawksworth (1983).

With the exception of Apache pine and possible exception of southwestern white pine, all species listed appear to be consistently acceptable as food to the parrots — when cones are available and when seed content of cones is reasonably good. However, we saw apparent rejection of an excellent cone crop of Apache pine with good seed content in the winter and spring of 1992-1993. During this period a flock of released thick-bills on the west side of the Chiricahua Mountains fed exclusively on Chihuahua pine cones in a region of mixed Chihuahua and Apache pine. No feeding on the Apache pine cones was observed even after parrots had effectively exhausted the Chihuahua pine crop, in spite of the fact that the flock had been conditioned to feed on Apache pine cones prior to release in the area. In other years and areas, thick-bills were observed feeding commonly on Apache pine cones, so their failure to do so in 1992-1993 was notable. To some extent, a reluctance to feed on Apache pine cones may trace to the large size of cones and the tough cone scales characteristic of the species, but we cannot presently offer a conclusive expla-

Table 1.—Summary of distributional and cone production data of major thick-billed parrot food species in Arizona from 1986-1993.

Species	Arizona distribution	Regularity of cone production	Seasonal availability of seeds
Chihuahua pine (<i>Pinus leiophylla</i>)	SE	Most years	All seasons
Apache pine (<i>Pinus engelmannii</i>)	SE	<< Half of years	Summer to Spring
Arizona pine (<i>Pinus arizonica</i>)	SE	< Half of years	Summer to Spring
Ponderosa pine (<i>Pinus ponderosa</i>)	N, Cen., SE	Half of years	Summer to Winter
Pinon pine (<i>Pinus edulis</i> and <i>discolor</i>)	N, Cen., SE	Half of years	Summer and Fall
Southwestern white pine (<i>Pinus strobiformis</i>)	N, Cen., SE	Most years	Summer and Fall
Douglas fir (<i>Pseudotsuga menziesii</i>)	N, Cen., SE	All years	Summer and Fall

nation for the failure of the parrots to feed on Apache pine cones in the winter-spring of 1992-1993.

The absence of observations of thick-bills feeding on southwestern white pine cones may in part be an artifact of incomplete observations and a relative scarcity of this conifer in many of the areas that have been occupied by released thick-bills. It may, however, also relate to the large size and sap-covered nature of *Pinus strobiformis* cones. In Mexico, where thick-bills have been seen feeding on cones of this species, they have refrained from clipping cones from branches and have awkwardly worked on them still attached. In the process, the birds have exhibited difficulties in keeping their plumage free from sap (Lanning and Shiflett 1983; Lanning, pers. comm.). With all other conifers, cones are normally clipped free from branches and held in one foot before being attacked by the parrots. The seeds of *Pinus strobiformis* are very large and offer an apparently substantial nutritional reward (see Benkman et al. 1984), but the difficulties in dealing with cones of this species, especially the feather-fouling problems, may make it a species that is sometimes or generally avoided.

None of the released thick-bills observed from 1986 through 1993 was ever observed with sap-soiled plumage, suggesting that use of *Pinus strobiformis* cones was rare at best during this period. However, we have received a verbal report of sap-stained plumage of thick-billed parrots observed in the Chiricahua Mountains by Ralph Morrow (pers. comm.) early in the present century (probably 1917-1919). We suspect that the birds he encountered may have been feeding earlier on *Pinus strobiformis*, although he did not observe this directly. Wetmore (1935) similarly assembled sightings of thick-bills with plumage "smeared with pitch" from the Chiricahuas in 1917-1918.

Many of the conifer seeds fed upon are only available during the summer and fall. This has been especially true for pinon, Douglas fir, and southwestern white pine, but also to a large extent with ponderosa pine, which has usually shed nearly all seeds by mid winter. The most favorable species for the thick-bills, with respect to broad seasonality of seed availability have been Chihuahua pine, Apache pine, and Arizona pine, which exhibit year-round or nearly year-round availability. However, both Apache pine and Arizona pine have exhibited low frequency of cone production, making them completely unavailable in many years. The most regular cone producers have been

Chihuahua pine, Douglas fir, and southwestern white pine. Douglas fir, the most regular species of all, has produced at least some cones in all years of study.

At this point, however, we wish to emphasize that conclusions as to frequency of cone production are limited to relatively few years (1986-1993), and several of these years were high stress years because of drought, especially 1989-1990. Consequently, conclusions should be considered preliminary.

DISTRIBUTIONAL RELATIONSHIPS

Overall, it appears that Chihuahua pine is an extremely important species for the parrots, both by being a very regular cone producer and by offering seeds in all months of the year. Cones of this species normally remain tightly closed until the spring following full maturity and then open only to a variable extent by summer when a new cone crop becomes available. As discussed above, other species offering seeds nearly year-round have been irregular cone producers, while still other species that are regular cone producers have offered seeds only during summer and fall. Thus within Arizona, it may be possible for the parrots to maintain consistent year-round populations only within the range of Chihuahua pine. With the possible exception of an early Spanish record of the species in central Arizona (see Wetmore 1931), all historical records of the thick-billed parrot in the United States fall within the present range of Chihuahua pine.

Nevertheless, a release of thick-billed parrots in the Chiricahuas in 1986 resulted in a flock that migrated regularly to central Arizona, outside the range of Chihuahua pine, during the summer and early fall (see Snyder et al. 1994). This flock always returned to the Chiricahuas (and the range of Chihuahua pine) in winter and spring. However, the released flock of 1986 did not persist for more than a few years. It did quite well, carrying on a number of breeding attempts up until the drought of 1989-1990, but then suffered high mortality and dispersed from the region.

DISCUSSION

The thick-billed parrot is a species historically tied to the pine forests of the Sierra Madre Occidental and Madreaan Sky Islands of the southwestern United States. Although not a

strong specialist on particular conifers and not a species obviously limited by climatic factors, the thick-bill has apparently been unable to sustain viable populations in more northerly conifer forests, unlike other conifer-dependent species, such as crossbills, pinon jays (*Gymnorhinus cyanocephala*), Clark's nutcrackers (*Nucifraga columbiana*), and various squirrel species (see Balda and Bateman 1972, Ligon 1978, Smith and Balda 1979, Benkman 1987, and Vander Wall 1988). Some of the latter species have evolved food-storage behavior to counter the seasonal availability problems with conifer seeds that are characteristic of many of these forests. Such behavior is unknown in thick-billed parrots, although it is well to note that Dirk Lanning (pers. comm.) has observed thick-bills occasionally raiding the food storage granaries of acorn woodpeckers (*Melanerpes formicivorus*) in Mexico. The historical northern limit of the thick-bill's distribution in Arizona may have been determined largely by a steep south to north gradient of declining reliability of year-round food supplies, resulting mainly from a conspicuous drop in diversity of conifer species, especially those species bearing seeds on a consistent year-to-year basis and on a consistent throughout-the-year basis.

Failures in cone crops are a normal course of events among most conifers, and species dependent on these cone crops must generally be able to respond to failures either by moving long distances or by switching to alternative food species that may not be synchronized in patterns of failure. In our observations of cone production of conifers in southern and central Arizona, it has been apparent that cone failures have not been closely synchronized among various species in most cases. Nevertheless, severe droughts, such as in 1989 and 1990, can result in regional cone failures across many species, providing major problems for cone-feeding animals. Potentially, the historical northern limit of the range of the thick-billed parrot may have been determined as much by the frequency of such catastrophic events as by simple presence or absence of conifer species that tend to fruit regularly and provide seeds on a year-round basis.

At the present time the forests of central Arizona are subject to high rates of timber harvest, with unlogged areas limited largely to steep slopes. Benkman (1993) has discussed the severe impacts of intensive timbering activities, especially short-rotation timbering, on cone production of conifers and on food supplies for

species dependent on conifer seeds. If the forests of central Arizona were not known as thick-billed parrot habitat prior to the onset of timbering activities, they seem even less likely to be able to support this species on a sustained basis now, either as resident or migratory populations.

In any event, it seems likely that the historical presence of the thick-billed parrot in the Madrean mountains of the United States is in itself a reflection of the relatively high diversity of conifers found in these mountains, and is yet one more illustration of the unique biological values of the region. Efforts to reestablish the thick-billed parrot in southern Arizona have not yet yielded a self-sustaining population although preliminary experiments suggest that this may be possible if enough high-quality birds can be assembled for release. With the decline of subsistence hunting in this century, the potentially primary limiting factor causing the extirpation of the species in the region — shooting — is no longer a major threat. Equally importantly, the pine forests of the southern portion of the state are still largely intact and free from timbering pressures, although they have suffered some locally significant timbering activities in the past.

ACKNOWLEDGMENTS

The thick-billed parrot program has been a cooperative venture of a number of public and private parties. Principal agency contributors have been the Arizona Game and Fish Department, the U.S. Fish and Wildlife Service, the U.S. Forest Service, Wildlife Preservation Trust International, World Bird Sanctuary, and Avicultural Breeding and Research Center. We wish also to make special mention of the contributions of Josiah and Valer Austin, James Koschmann, and the Southwestern Research Station of the American Museum of Natural History.

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