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Status and conservation of old-growth forests and endemic birds in the pine-oak zone of the Sierra Madre Occidental, Mexico

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Status and conservation of old-growth forests and endemic birds in the pine-oak zone of the Sierra Madre Occidental, Mexico

Estatus y conservación de los bosques maduros y las aves endémicas en la zona de pino-encino de la Sierra Madre Occidental, México

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Summary

The pine-oak forests of the Sierra Madre Occidental, a mountain range in NW Mexico, have recently been recognized as an area of high endemism and biodiversity. Selective logging threatens three bird species endemic to this habitat, who depend on standing dead trees (snags). This report is based on an 11 month field survey that aimed to locate old-growth remnants and to assess the status of the endemic birds. Old-growth is defined here as *a forest that has never been logged mechanically.*

Old-growth forests were located by ground-truthing of areas predicted by various methods: analyses of topographical maps and satellite images, aerial surveys, interviews with forestry technicians and local inhabitants, and literature studies. None of the prediction methods gives unambiguous results on their own. Only by applying the whole set of techniques could a comprehensive inventory be obtained of old-growth sites.

Of the original 93, 560 km^2 of pine-oak habitat in the Sierra Madre Occidental, 571 km^2 remained as old-growth in 1995. This is a reduction of 99.4 %. The forests on high mesas, where the largest and most accessible timber stood, have been reduced to 22 km^2 uncut forest. In logged forests pines greater than 30 cm girth have been extracted and snags have been cut for the production of paper pulp. Small settlements are everywhere.

Information on the **Imperial Woodpecker** *Campephilus imperialis* was obtained through interviews with 62 elder inhabitants who had known the bird. The extinction peak of this species was between 1946 and 1965, when 60 % of the informants saw their last Imperial Woodpecker. Hunting by settlers and loggers, for fun and for medicinal purposes, quickly decimated populations. Recovery from the shooting became impossible through the ensuing logging of nearly all the pine-oak habitat. Mature pines and pine snags were removed, depriving the Imperial Woodpecker of foraging and nesting sites. Imperial Woodpeckers were often seen in groups. A typical group consisted of seven or eight birds. With an estimated average density of one Imperial Woodpecker per 13 km^2, the original pine-oak habitat in the whole range of the species may have carried only 8,000 individuals or 1060 groups. Interviews, and workings found in one old-growth area, indicate that very few Imperial Woodpeckers may have survived into the 1990s. Extinction of the species seems nevertheless inevitable since nowhere does any breeding habitat remain.

Cutting of snags is the main threat to the **Thick-billed Parrot** *Rhynchopsitta pachyrhyncha*. This species only breeds at altitudes above 2300 m, but snags are scarce on the exploited mesa forests in the highest parts of the sierra. The breeding range runs from within 85 km of the US border in northern Chihuahua south to central western Durango, with an apparent gap in southern Chihuahua. Pine seeds for foraging are widely available in young recovering forest. Compared with historical records, encountered groups of wintering Thick-billed Parrots were small, few groups were seen, and the numbers of bathing and drinking parrots at a waterfall in northern Chihuahua were low. This indicates numbers have sharply declined in the course of the 20th century.

The status of the **Eared Trogon** *Euptilotis neoxenus* is far less critical. Eared Trogons were observed at 55 locations, mainly in canyons. Nests were found in riparian corridors in canyons. Such corridors are hardly accessible to the logging industry. The ability, and probable preference, of the Eared Trogon to breed in canyons likely explains why it is still fairly common. The erroneous notion that the Eared Trogon is a local and rare species must stem from the paucity of field studies in the Sierra Madre Occidental, as well as the wariness of the bird. It is mostly to be detected by its vocalizations.

Efforts are being made to ensure the total protection of three **priority areas** (figures 26 to 28). These areas encompass the main old-growth fragments in the Sierra Madre Occidental. They are also of major importance to the endemic fauna. Protection of snags is required for three **breeding areas of the Thick-billed Parrot** (figures 29 to 31). Ideally, exploitation of snags should be banned throughout the Sierra Madre Occidental.

Resumen

A los bosques de pino-encino de la Sierra Madre Occidental, una cadena montañosa en el noroeste de México, recientemente se les ha reconocido como un área de amplia bíodiversidad y un alto grado de endémismo. La tala selectiva amenaza a tres especies de aves endémicas de este hábitat las cuales dependen de árboles muertos en pie (chomonques). Este reporte esta basado en una investigación de campo de 11 meses que tuvo como objetivo localizar los remanentes de bosque de viejo crecimiento y evaluar el estatus de las aves endémicas. Viejo-crecimiento aquí se define como *un bosque que no se ha cortado por medios mecánicos.*

Los bosques de viejo crecimiento fueron localizados a través de recorridos de verificación de áreas predeterminadas por varios métodos: análisis de mapas topográficos e imágenes de satélite, verificación áerea, entrevistas con técnicos forestales y con habitantes locales así como revisión bibliográfica. Ninguno de estos métodos por si solo proporciona resultados categóricos. Unicamente al aplicar el conjunto de técnicas se logro obtener un inventario confiable de sitios de viejo crecimiento.

De los 93,560 km^2 originales de hábitat de pino-encino de la Sierra Madre Occidental, 571 km^2 permanecieron como bosque de crecimiento viejo hasta 1995. Lo cual significa una reducción del 99.4%. Los bosques de las mesas altas en donde se encontraban las reservas de madera más grandes y accesibles, se han reducido a solo 22 km^2 de bosque de viejo crecimiento. En los bosques de corta los pinos de diámetro mayores a 30 cm fueron extraídos y los arboles muertos en pie se utilizaron para la producción de pulpa para papel. Poblados pequeños se encuentran en todas partes.

La información sobre el **Carpintero Imperial** *Campephilus imperialis* se obtuvo de 62 habitantes nativos quienes conocían a esta ave. El pico de extinción de esta especie ocurrió entre 1946 y 1965, cuando el 60% de los informantes dijeron haber visto su último Carpintero Imperial. La cacería de los colonos y madereros con propósitos de diversión y medicinales diezmó las poblaciones rápidamente. La recuperación por la cacería llegó a ser imposible ante una consecuente tala de prácticamente todo el hábitat de pino-encino. Tanto pinos maduros como arboles muertos en pie fueron removidos, privando al Carpintero Imperial de sus sitios de anidación y de alimentación. A los Carpinteros Imperiales se les observaba seguido en grupos. Un típico grupo consistía de siete u ocho aves. Con una estimación de densidad promedio de un Carpintero Imperial por 13km^2, el hábitat original de pino-encino en el rango completo de la especie podría soportar solamente 8,000 individuos o 1060 grupos. Las entrevistas, asi como ciertos rastros que se encontraban en un área de bosque de viejo crecimiento, indican que muy pocos Carpinteros Imperiales podrían haber sobrevivido en los 1990's. No obstante la extinción de la especie parece inevitable dado que no existe ningún hábitat remanente de anidacion.

La tala de arboles muertos en píe es la principal amenaza para la **Cotorra Serrana** *Rhynchopsitta pachyrhyncha.* Esta especie se reproduce sólamente a altitudes mayores de 2,300 m, sin embargo los chomonques son escasos en los bosques de mesa explotados en las partes mas altas de la sierra. Su rango de anidación va desde el norte de Chihuahua, a unos 85 kms de la frontera con Estados Unidos, hacia el sur hasta el centro-occidente de Durango, con un aparente espacio vacio en el sur de Chihuahua. Semillas de pino para forrageo se encuentran disponibles ampliamente en los bosques jovenes de recuperación. Acorde con los registros históricos, los grupos invernantes de Cotorra Serrana que se encontraban eran pequeños, eran pocos los grupos que se observaban y el número de Cotorras Serranas que se observaban bañandose y abrevando en una cascada del Norte de Chihuahua era bajo. Lo cual indica que los números han declinado agudamente en el curso del siglo 20.

El estatus de la **Coa Silbadora** *Euptilotis neoxenus* es mucho menos crítico. Las Coas Silvadoras fueron observadas en 55 localidades, principalmente cañones. Los nidos se encontraban en corredores de galería en cañadas. Estos corredores son completamente inaccesibles a las actividades de la industria maderera. La habilidad y probable preferencia de la Coa Silvadora para anidar en estas cañadas explica el porque es aún relativamente común. La idea equivocada de que la Coa Silvadora es una especie local y rara se debe a

la escacez de estudios en la Sierra Madre Occidental, así como a la cautelosidad del ave la cual es detectada principalmente por sus vocalizaciones.

Se han hecho esfuerzos para asegurar la protección total de tres **areas prioritarias** (figuras 26 a 28). Estas areas comprenden los principales fragmentos del bosque de crecimiento viejo en la Sierra Madre Occidental. Estas son tambien las de mayor importancia para la fauna endémica. Se requiere la protección de arboles muertos en píe para las tres **areas de reproducción de la Cotorra Serrana** (figuras 29 a 31). Idealmente la explotación de estos arboles debería vedarse para toda la Sierra Madre Occidental.

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Preface

This is a report on an ecosystem that we will know, in all probability, only without its most impressive representative. The remnants of old pine-oak forest in the Sierra Madre Occidental are too small to offer the Imperial Woodpecker a future.

Before the fieldwork of the Mexican Mountain Forest - Imperial Woodpecker Project, many believed there still was a large primary forest in some inaccessible part of the rugged sierra. This proved to be an idle hope, as far as the habitat of the Imperial Woodpecker is concerned. Its park like open pine-oak forest with many big dead pines was to be found only on the high mesas of the Sierra Madre Occidental. These mesas were not at all inaccessible, and consequently almost all of the habitat of the Imperial Woodpecker has been logged. This, together with the indifferent shooting by an unexpectedly widespread human population, caused the decline of the Imperial Woodpecker. Although interviews with local inhabitants indicate that very few birds may still exist, there is no reason for optimism. Forced by the deplorable state of their forests, the woodpeckers have to wander over enormous areas for foraging while the shooting continues and, most important, nowhere is any breeding habitat left. This situation cuts off any hope for a feasible management plan. The loss of the largest and most spectacular woodpecker in the world is inevitable.

This report gives guidelines for the management of other endemic birds of the Sierra Madre Occidental, as well as a plan for conserving representative tracts of the different forest types of the region. Most conservation goals can be met by the complete protection of three key areas, while the Thick-billed Parrot can only be saved by a forest management that offers sufficient amounts of dead pines in its breeding regions. These plans must be realized in Mexico, a country that is haunted by towering political and economical problems, and has a conservation movement only in its infancy.

The world watched passively while the Imperial Woodpecker was being exterminated. Time will tell if, by the end of the 20th century, the international and Mexican conservation forces have grown strong enough to offer the remaining birds in the Sierra Madre Occidental a better fate. The prospects are not discouraging, but there is a long way to go.

Introduction

The pine-oak forests of the Sierra Madre Occidental have only recently been recognized as an important biome. Biodiversity studies pointed out the forests make up an area of endemism for birds (Escalante-Pliego *et al.* 1993, ICBP 1992) as well as for other groups of animals and plants (Ramamoorthy *et al.* 1993). These endemics blend with biota from temperate North America that have a southern range extension into the Sierra Madre Occidental. The combination leads to a rich and unique set of flora and fauna in this region.

Only in primary forest can it be expected to find all the original biota with their web of relationships as it developed over time. Unfortunately, the pine-oak habitat in the Sierra Madre Occidental has been massively logged over the past 115 years. The Mexican Mountain Forest -Imperial Woodpecker Project aimed to fill in the urgent need to locate remnants of old-growth pine-oak forest in the Sierra Madre Occidental, as well as to study the actual status of threatened birds that occur in these forests.

Three birds, endemic to the pine-oak forests of the Sierra Madre Occidental and adjacent mountain ranges, were considered threatened or endangered by Collar *et al.* (1992). These are the Imperial Woodpecker *Campephilus imperialis*, the Thick-billed Parrot *Rhynchopsitta pachyrhyncha* and the Eared Trogon *Euptilotis neoxenus*. All require standing dead trees, mostly pines, for nesting. The Imperial Woodpecker depends on snags for its food as well. In old-growth forests standing dead trees are naturally abundant. Therefore, in this study a search for the last tracts of old-growth forest in the pine-oak zone of the Sierra Madre Occidental was combined with a survey of these snag-dependent birds. Some disturbed but snag-rich forests were also searched. During the fieldwork attention was paid also to the Tufted Jay *Cyanocorax dickeyi*, which has a micro endemic distribution in the SW corner of the Sierra Madre Occidental, and to two birds that are rare but not endemic to the region, the Spotted Owl *Strix occidentalis* and the Golden Eagle *Aquila chrysaetos*. Furthermore, from interviews and fieldwork information was gathered on the Mexican Wolf *Canis lupus baileyi* and the Black Bear *Ursus americanus* .

The project was organized by Patricia Escalante, Jan Wattel and Martjan Lammertink. Fieldwork was carried out by Jorge Rojas (November 1994 to June 1995), Federico Casillas (January 1995 to May 1995), Roger Otto (June 1995 to October 1995) and Martjan Lammertink (November 1994 to October 1995). This publication is the final report on the Mexican Mountain Forest - Imperial Woodpecker Project.

Area covered

The Sierra Madre Occidental is a mountain range that runs from the Río Grande de Santiago in Jalisco north to within 80 km of the US border in northern Sonora and Chihuahua. The pine-oak forests are found at altitudes from about 2000 m to the highest mountain tops around 3300 m. Field studies were carried out in the states of Jalisco, Nayarit, Durango, Sinaloa, Chihuahua and Sonora. Areas which one, or preferably more, of the methods for predicting old-growth (page 9 to 11) indicated as a potential site, were visited in the field. Figure 1 gives an overview of the area for which information was obtained on the actual status of the pine-oak forest. The southern part of the state of Chihuahua was explored from April to July 1995 by Ramiro Uranga and Diana Venegas with objectives and methods similar to this study (Uranga-Thomas and Venegas-Holguín 1995).

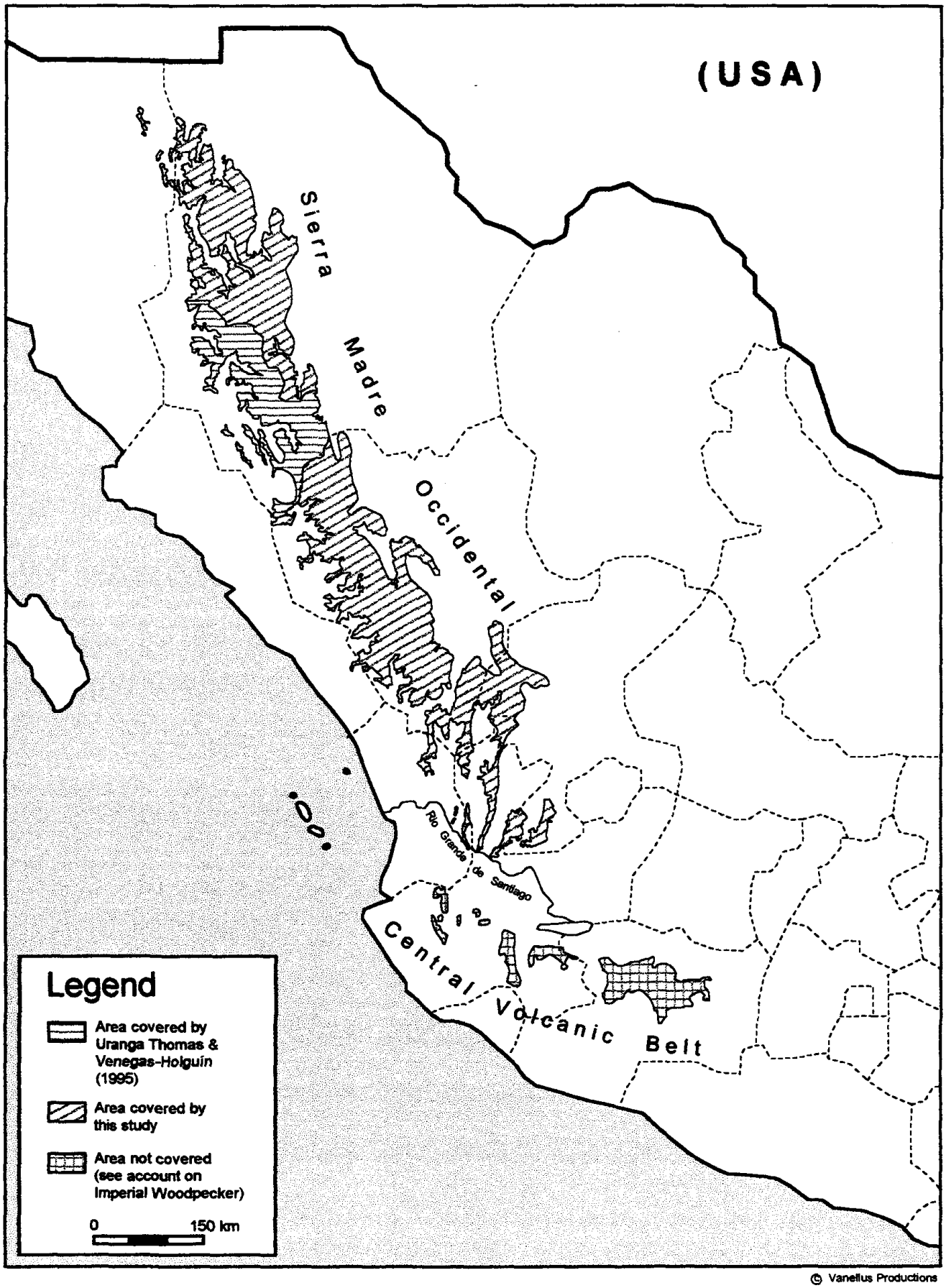


Figure 1. Original distribution of the Imperial Woodpecker and the area for which the present status of the pine-oak forest has been assessed
Figura 1. Distribución original del Carpintero Imperial y el área para la cual el estatus actual del bosque de pino-encino ha sido determinado

Safety of fieldwork in the Sierra Madre Occidental

In the popular press the image has been raised that the Sierra Madre Occidental is riddled with trigger-happy *narcos* (e.g. Shoumatoff 1995, Weisman 1994). In practice, most parts of the Sierra Madre are safe though there may be some small scale *Cannabis* cultivation. Notable exceptions are the region along the Sinaloa border in south-west Durango, and the Colorados de la Virgen / Pino Gordo region in southern Chihuahua. In these areas many men carry a pistol or machine-gun and stories of local shootings abound. However, even in these regions people are cordial to outsiders, ready to assert that it is the neighbouring village where the bad guys live. Risks can be minimized by working with a local guide who can take a route around active plantations, and can give an introduction to any people met in the field. When driving through the Sierra Madre Occidental it is not uncommon to run into road blocks of soldiers or federal police. They search cars for arms and drugs and occasionally carry out a body search. Usually they are polite and efficient. Altogether, there is no reason to avoid research and conservation action in the Sierra Madre Occidental.

Methods for locating old-growth forests

One of the main objectives of this study was to assess at which sites the most important tracts of old-growth pine-oak forest in the Sierra Madre Occidental remain. Old-growth is defined here as *a forest that has never been logged mechanically* (see page 12). From the start it was clear that only in few areas in the Sierra Madre Occidental uncut forest could be expected. To make a selection of potential sites, different methods were used, which are listed and discussed here. This discussion offers insight into the advantages and drawbacks experienced with each method, which could be useful for studies looking for old-growth in other regions.

Analysis of topographical maps

On topographical maps scale 1: 250 000 (INEGI 1977 - 1983) potential areas for the Imperial Woodpecker were drawn, which had to meet the following criteria (Lammertink and Rojas Tomé 1994) :

-forested
-at elevations higher than 2000 m
-5 km away from villages, roads and paths
-within or near the original range of the Imperial Woodpecker

Although these criteria were set up to select areas that would meet the specific habitat requirements of the Imperial Woodpecker, they were expected to predict old-growth areas as well, for their remoteness from any infrastructure. Figure 2 gives an overview of the 53 selected areas. Two of the areas (J2 and D6) are less then 5 km from roads and villages but were nevertheless selected since they are found at spots with a topography that looked too rugged to allow for any logging operations.

On 47 of the selected areas information on their present status was obtained through fieldwork or information from other sources (see below). The six areas on which no information was obtained, due to time constraints, are Z1, Z3, C11, C13, C14 and C18. These areas all lie just outside the known historic distribution of the Imperial Woodpecker (*cf.* figure 1). Of the 47 areas covered, only four (8.5 %) appeared to hold significant stands of old-growth (i.e. larger than 1 km^2) still: J1, Z3, D7 and S3. There apparently is a weak correlation between old-growth areas and areas that appear remote on topographical maps. This is caused by two factors: (1) many of the predicted areas are not as remote as the topographical maps suggest: the maps are outdated (the most recent sheets are from 1983) and a lot of new roads are therefore not depicted and (2) old-growth areas exist because of political circumstances rather than because of remoteness.

Supervised classification Landsat images

For southern Chihuahua , Landsat images were available on which predicted old-growth areas were depicted. These areas showed up in an analysis by Dana Slaymaker for the Sonoran Institute. In the computer-generated analysis, two indications were used to predict old-growth: (1) an irregular canopy and (2) a low absorbance of infrared light associated with slow growing mature forest. For the southern Chihuahua / NW Durango border area a preliminary prediction of old-growth was made by Dana Slaymaker by looking for dark red areas on the images.

Eight of the predicted old-growth sites were visited on the ground. They are discussed from case to case in appendix 5. Four of the sites held old-growth vegetation. Canyon forest was found in three of the cases and small pockets, as predicted, of mesa forest stand in the fourth area. (For definitions of forest types, see page 12). The disturbed vegetation in the other four areas is either selectively logged mesa forest or selectively logged dry open forest. Old, non-commercial conifers left in such areas may be responsible for the prediction. However, the analyses were far from consistent. Other selectively-logged forests with comparable amounts of non-commercial old conifers were not predicted. Of eight old-growth areas known to have existed in the study area at the time the images were taken, four were predicted (appendix 5). The largest tract of canyon

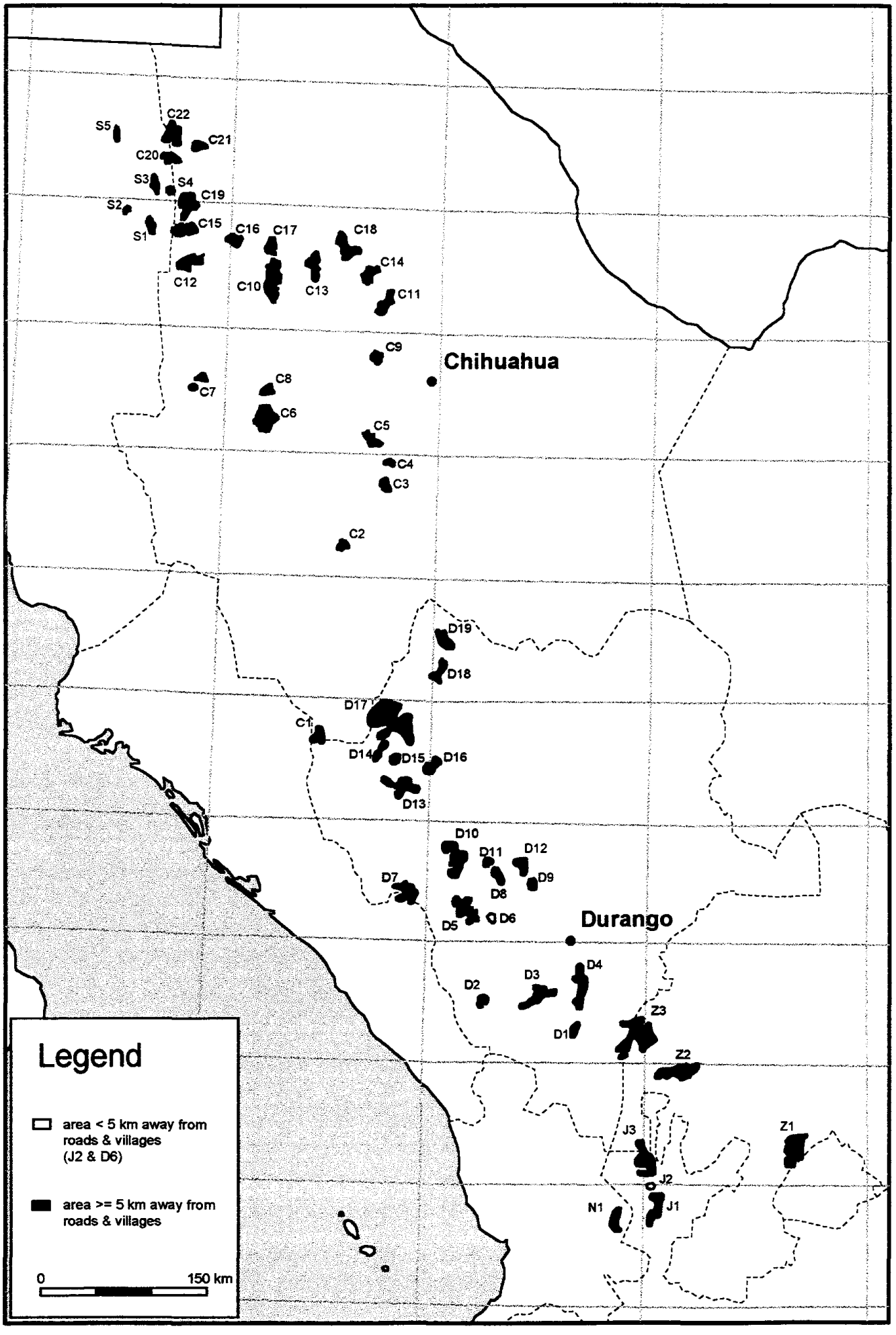


Figure 2. Potential areas for the Imperial Woodpecker that showed up in an analysis of 1 : 250 000 topographical maps

Figura 2. Áreas potenciales para el Carpintero Imperial obtenidas a través de un análisis de cartas topográficas escala 1: 250 000

forest in the area did show up in the analysis (though it has now been logged), but another major canyon forest area was missed (Quebrada de Peñol, figure 15). The analyses did not predict any of the old-growth dry open forests in the area and missed the largest tract of mesa forest (which has now been logged as well).

Aerial surveys

In the Sierra de los Huicholes in northern Jalisco an overflight of two hours was made. Furthermore, information was available from aerial surveys in central and southern Chihuahua by the Sonoran Institute (B. Burns *in litt*). The old-growth sites of Mesa Rechánachi (figure 17) and San Miguel Huaistita (figure 8) were found through these flights.

Aerial surveys are costly and yield limited results. The size of pines was overestimated from the air both for the drier part of the Sierra de los Huicholes and for the canyons surrounding Mesa Rechánachi. Logging roads were not seen from the air in the selectively logged mesa forests between Ocampo and Pinos Altos and west of Santa Eduwiges (see appendix 5), leading to a false old-growth prediction. Logging roads in dry open forest are more readily seen from the air.

Interviews with forestry units

The forests of the Sierra Madre Occidental in Durango and Chihuahua were formerly divided between state-controlled forestry units called UCODEFO's (Unidades de Conservación y Desarrollo Forestal), which often had their own sawmill. Since 1994 the UCODEFO's have been privatized and some have been split in smaller co-operations. The forestry units make exploitation studies for forest owners (ejidos, communities and private owners). Forestry engineers working for the units often have an excellent knowledge of the status of the forests in their area. Uncut areas with large pines are now so scarce and valuable that they could not remain unnoticed. In this study much use was made of information from forestry technicians, especially in the state of Durango.

Of the 19 old-growth areas located in the Sierra Madre Occidental, four were found entirely through the information of the forestry units. In addition, the existence of old-growth in two of the areas from the analysis of topographical maps was confirmed.

Obviously, one should not trust a forestry technician to share his knowledge with a conservationist. Throughout the study, information from the UCODEFO's was therefore double-checked by interviewing neighbouring forestry units and inhabitants of the sierra. UCODEFO 'Santiago Papasquiaro' deliberately concealed the presence of 12 km^2 of mesa forest in Piélagos, which was found through information from local inhabitants. However, in the majority of cases the UCODEFO'S were cordial and frank.

Interviews with local inhabitants

During the fieldwork, inhabitants of the sierra were asked if there was any uncut forest left in the surrounding area. In this way four of the old-growth sites were found. Drawbacks to this method are that information can be obtained only on the small area the villager is familiar with, while the size of an uncut tract is often exaggerated.

Leads from previous field studies

Information leading to five of the 19 old-growth sites came from previous field studies looking for old-growth areas in the Sierra Madre Occidental (Perless 1992, Ceballos-Lascurain 1987, R. Otto pers. obs.). Old-growth sites described only a few years back (Balvanera *et al.* 1992) appeared to have been cut already, like 100 km^2 of mesa forest near Cebollitas in northern Durango.

Conclusions

None of the used methods for predicting old-growth give unambiguous results. The information from forestry units and inhabitants of the Sierra Madre Occidental appeared most useful. Using a whole set of different methods, one source filling in the shortcomings of another, is the only way to reach a comprehensive inventory of old-growth sites. Ground-truthing remains essential.

Status of pine-oak forest in the Sierra Madre Occidental

The first sawmill in the Sierra Madre Occidental was opened in Madera, northern Chihuahua, in 1880. Since then nearly all of the pine-oak forest has been logged. The last extensive primary forests were exploited between 1950 and 1975. In this section, the current status of the pine-oak forest is discussed.

Old-growth forests

In this study, old-growth is defined as *a forest that has never been logged mechanically*. The forests are not labelled "primary" or "virgin" since in all of the old-growth of today there has been occasional hand cutting of pines and snags (to obtain resin-rich pine wood, *ocote*, for cooking). Free ranging cattle is encountered everywhere. Except for Pino Gordo, the old-growth forests are unroaded and uninhabited.

In theory, given time a logged forest would regain many of its original characteristics. In the Sierra Madre Occidental, however, rotation cycles of logging are usually under 20 years and no such recovered forests exist.

During the ground-truthing of predicted old-growth areas (page 9 to 11), 19 sites have been found where old-growth forests bigger than 100 ha (1 km^2) remain. The total area of these forests combined is 571 km^2; this is just 0.61 % of the original 93,560 km^2 of pine-oak forest in the Sierra Madre Occidental (figures 3 and 4).

Within the remaining uncut forests, some forest types are rarer than others (figure 5). By far the most threatened habitat is the mesa forest on the high plateaus or gently rolling slopes in the highest parts of the Sierra, in general between 2400 and 3000 m of altitude. In this forest, large (50 to 150 cm d.b.h.) pines (*Pinus*) and Douglas firs (*Pseudotsuga*) are common, and consequently big snags abound. Because of its valuable timber and relative easy accessibility, old-growth stands of this type of forest have all but completely disappeared. At present, only 22 km^2 remains, most of which - 20,6 km^2 - stands in the Sierra de Huicholes (El Carricito, figures 7 and 26 and plate 1). No old-growth mesa forest is found in the protected areas of the Sierra Madre Occidental, Basaseachic National Park and the Michilía Biosphere Reserve.

Between 1900 and 2400 m, especially on the eastern slope of the Sierra Madre Occidental, dry open pine-oak forest is found with small (< 50 cm d.b.h.) pines. In these areas many rocks show up at the surface and the dominant pine is *Pinus lumholtzii* (plate 2). This forest is less attractive to loggers and therefore some fair sized tracts remain, with a total area of 369 km^2. The Basaseachic and Michilía protected areas hold dry open pine-oak forest.

On still lower elevations oak-pine or oak forest becomes dominant. No large scale logging takes place in these forests and the Michilía Reserve holds extensive tracts of these forest types. In this study, little attention has been paid to the oak forest because no threatened birds are found there.

Canyons in the Sierra Madre Occidental fall within the pine-oak zone for the parts that are found at altitudes above approximately 2000 m. Valleys with gentle slopes have largely been opened up with logging roads, but some abrupt canyons have been spared. The vegetation in such canyons is characterized by stunted pine-oak forest on the exposed steep slopes with a thin soil (plate 4), while a narrow riparian corridor can usually be found along the streams down in canyons. Such riparian corridors -usually less than 100 m wide- are characterized by lush forest with cypresses and big pines or Douglas firs (plate 3). The canyon mix of poor forest on slopes and lush forest along streams is categorized and mapped in this study under the term "canyon forest". The total area of old-growth canyon forest within the pine-oak zone found is 176 km^2. It is quite possible that some other, small uncut canyons have been missed. The largest tracts remain in Quebrada de Peñol (figure 15) with 29.8 km^2 and in Las Bufas (figures 13 and 27) with 91.4 km^2. Of the canyon forest in Las Bufas, 43 km^2 is located at altitudes above 2000 m though pine forest is found in this area down to 1500 m. In Basaseachic National Park 3.2 km^2 of canyon forest is protected.

In the area covered by Uranga-Thomas and Venegas-Holguín (1995), the only old-growth forest found was the dry-open forest of Pino Gordo (figure 16). This site was also reported by Perless (1992). Pino Gordo was visited during this study for a comparison with other old-growth sites.

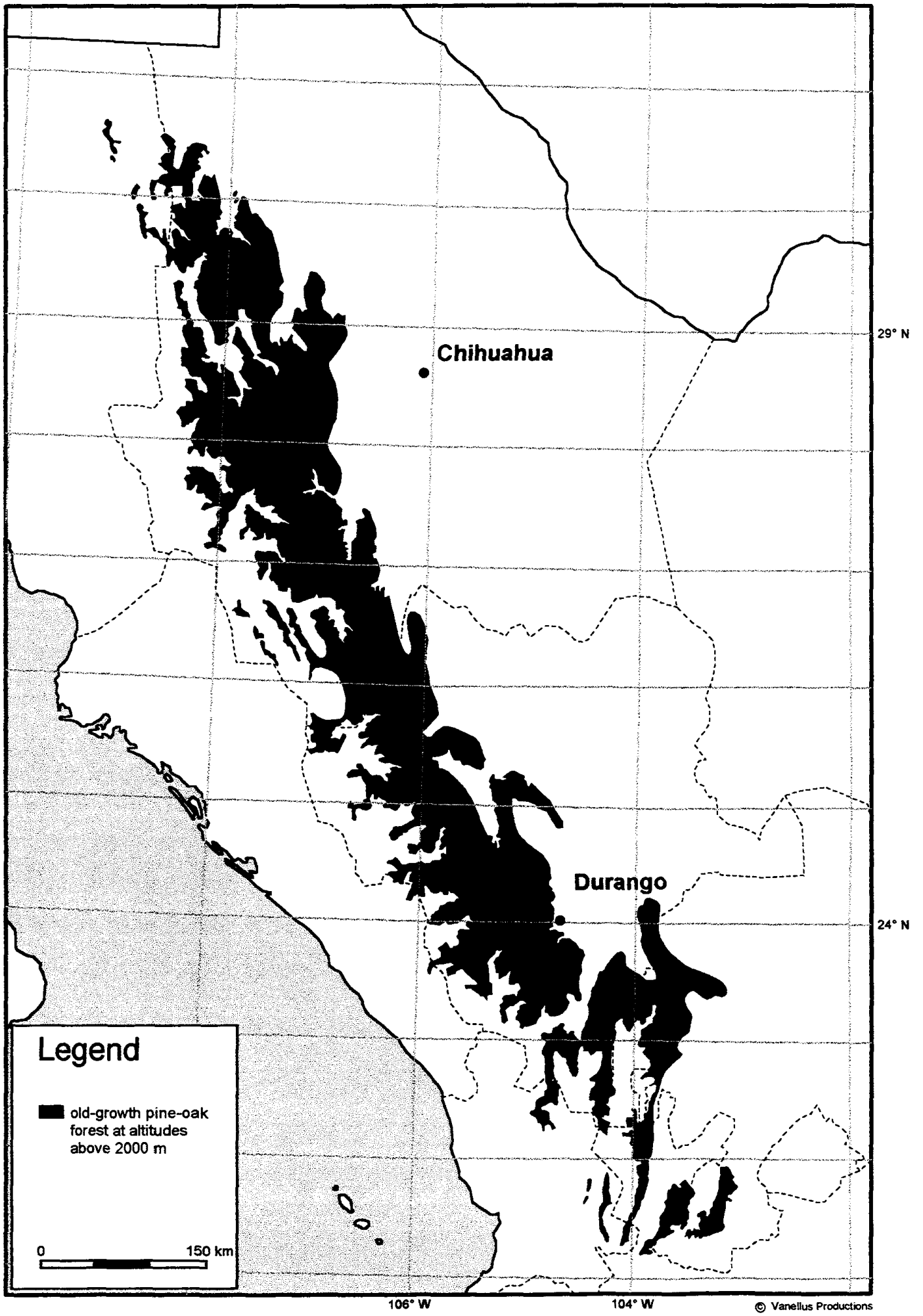


Figure 3. Original area of pine-oak forest in the Sierra Madre Occidental (ca. 1880): 93,560 km^2. After Rzedowski (1992)

Figura 3. Área original del bosque de pino-encino en la Sierra Madre Occidental (1880): 93,560 km^2. Tomado de Rzedowski (1992)

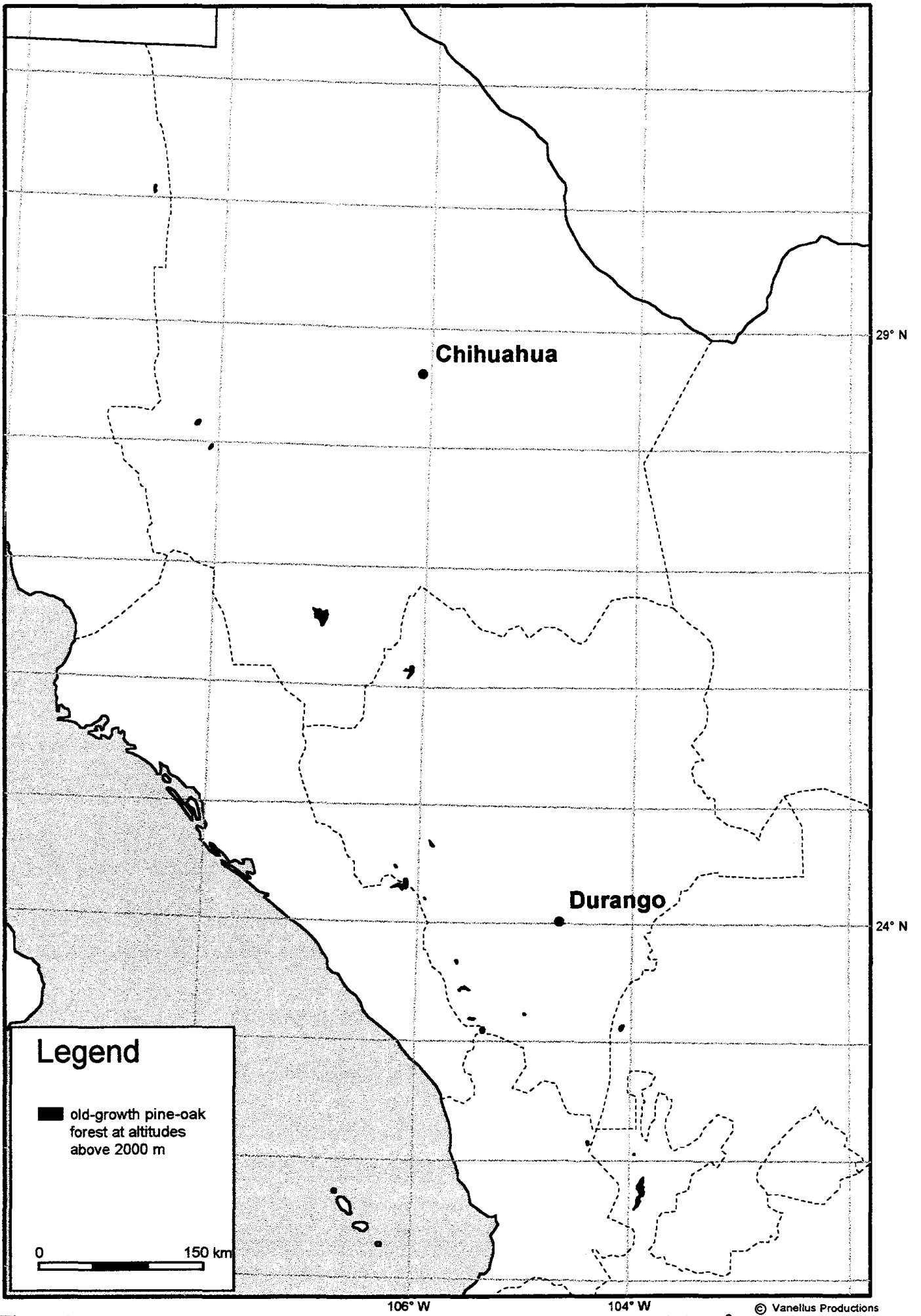


Figure 4. Remaining old-growth pine-oak forest in October 1995. Total area: 571 km^2. This is 0.61% of the original area

Figura 4. Bosque maduro de pino-encino que aún quedaba en octubre de 1995. Área total: 571 km^2. Eso es 0.61% del área original

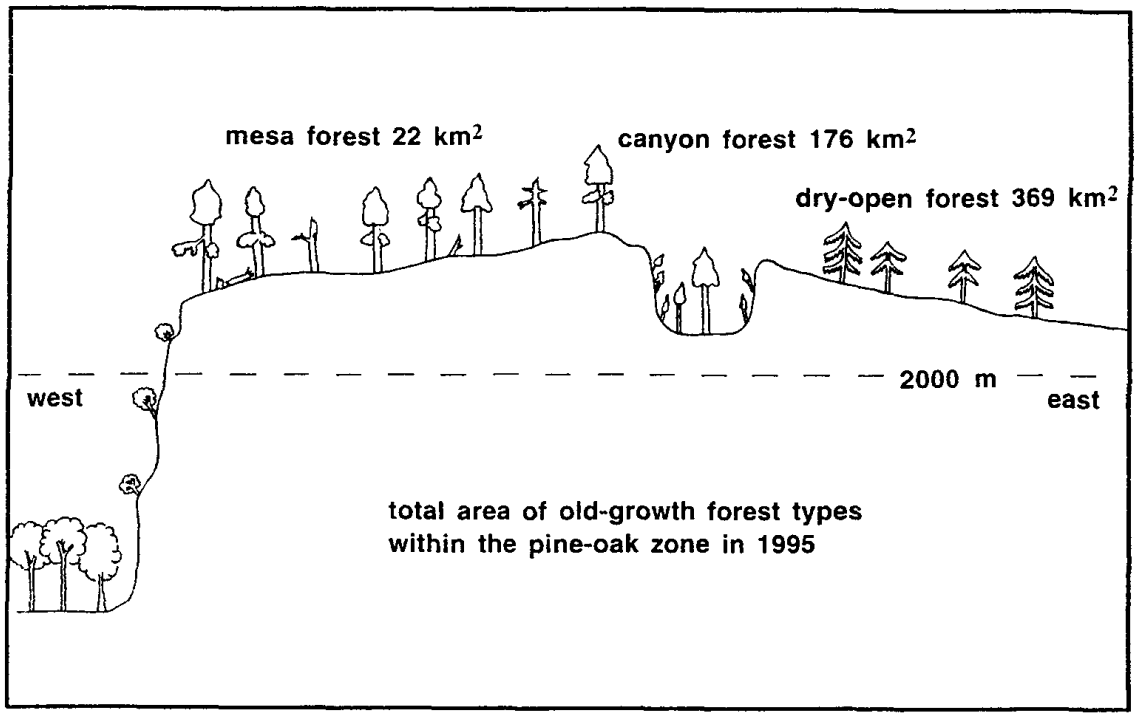


Figure 5. Schematic cross-section of the Sierra Madre Occidental from west to east, with the total area of three different old-growth forest types in October 1995. The vegetation is not to scale.
Figura 5. Esquema de la sección transveral de la Sierra Madre Occidental de oeste a este, con el área total de tres diferentes tipos de bosque maduro a octubre de 1995. La vegetación no parece a escala.

Selectively logged and second-growth forests

Logging operations in the Sierra Madre Occidental usually involve the selective cutting of pines over 30 cm d.b.h. and the removal of most standing dead wood. The snags are cut for the production of paper pulp. The lack of mature pines in logged forest implies that few new snags appear. Areas that were logged only once usually still hold fairly varied forest. Mature oaks *Quercus* and madroños *Arbutus*, and sometimes non-commercial conifers like *Abies* and *Pseudotsuga*, add some old elements to the forest. Most severely impoverished are the forests that have been cut various times. Such second-growth areas are converted into even-aged, monotonous young pine forest. In many regions, oaks are girdled in order to kill them and create a pure pine forest. The timber industry in northern Mexico is almost exclusively adapted to pines. In many areas logging takes place every 10 to 16 years. It can therefore be expected that most of the selectively cut forests will soon degrade to poor second-growth.

Riparian corridors in canyons are often left uncut. They are hardly accessible and logging of such spots is restricted in order to avoid erosion. These corridors are important as habitat for the Eared Trogon (plate 3).

Exploitation of standing dead wood is allowed up to 70 % of the stock. Usually all accessible snags on mesas are taken, however, under the assumption that the required 30 % will remain in inaccessible spots. The snags taken from mesas are far bigger than the remaining snags on inaccessible slopes, where no large pines grow. Among some forestry units in Chihuahua there now is a total restriction on the exploitation of snags, which seems to be well respected.

Deforestation is not practised much in the Sierra Madre Occidental. Small areas around villages are clearcut and converted into cornfields. For grazing the understory of the forest is used. As a rough estimate, of the pine-oak habitat 10 % has been cleared, 50 % is selectively logged and 40 % is secondary growth. There is no clear boundary between the latter two categories.

Plate 1. Mesa forest, El Carricito, northern Jalisco, November 1994
Lámina 1. Bosque de mesa. El Carricito, norte de Jalisco, noviembre de 1994

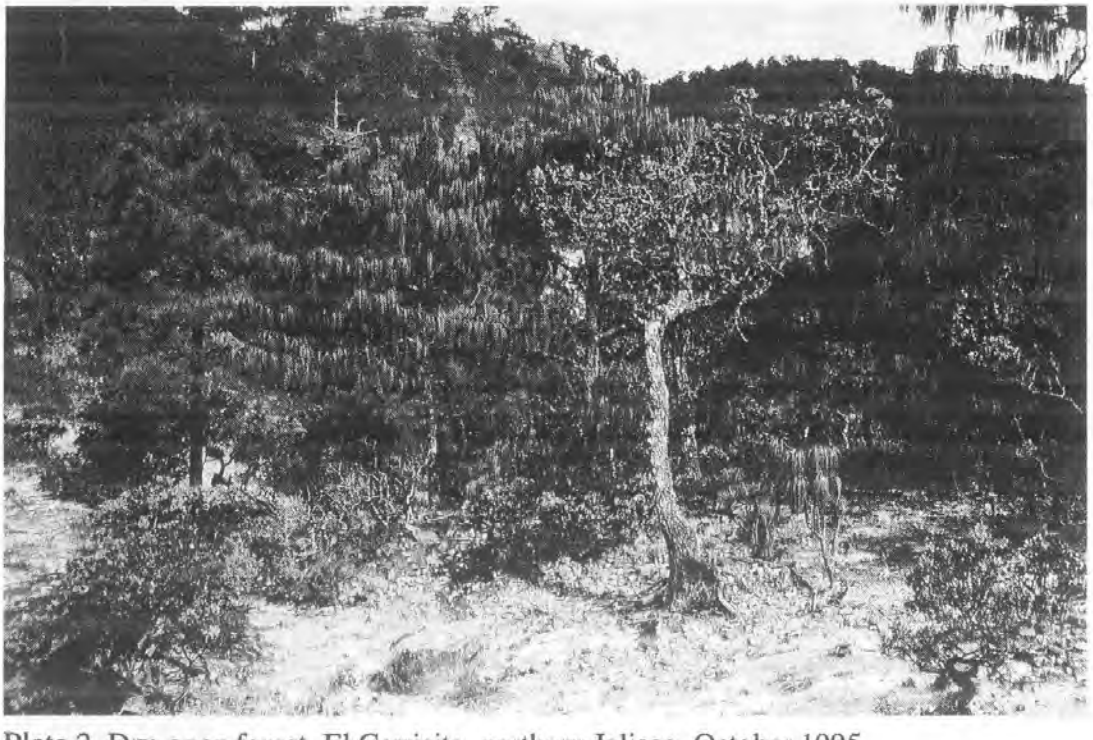


Plate 2. Dry-open forest, El Carricito, northern Jalisco, October 1995
Lámina 2. Bosque seco-abierto. El Carricito, norte de Jalisco, octubre de 1995

Plate 3. Riparian corridor with large Douglas firs *Pseudotsuga* sp. ; the pine snag in the middle was used as a nesting tree by Eared Trogons. Mesa las Guacamayas, northern Chihuahua, August 1995
Lámina 3. Bosque de galería con grandes oyameles Pseudotsuga *sp.; el pino seco que aparece en el centro estabe siendo empleado como árbol de anidación por las Coas Silbadoras. Mesa las Guacamayas, norte de Chihuahua, agosto de 1995*

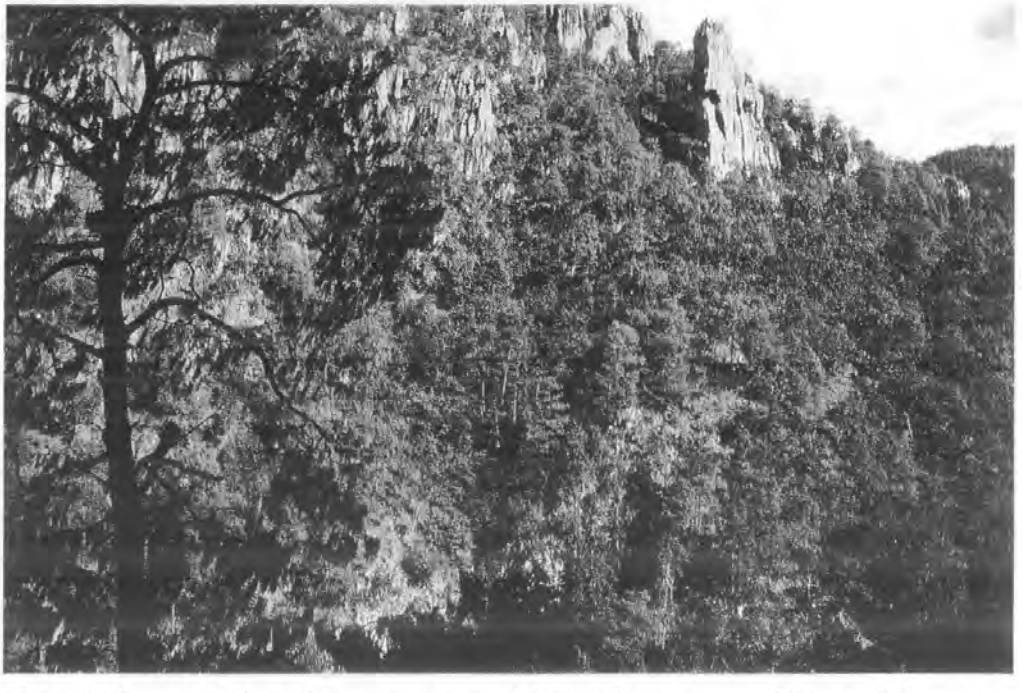


Plate 4. Stunted pine forest on steep slopes of a canyon, Monte Oscuro, southern Durango, January 1995
Lámina 4. Bosque de pino falto de desarrollo en la pendiente de un cañón. Monte Oscuro, sur de Durango, enero de 1995

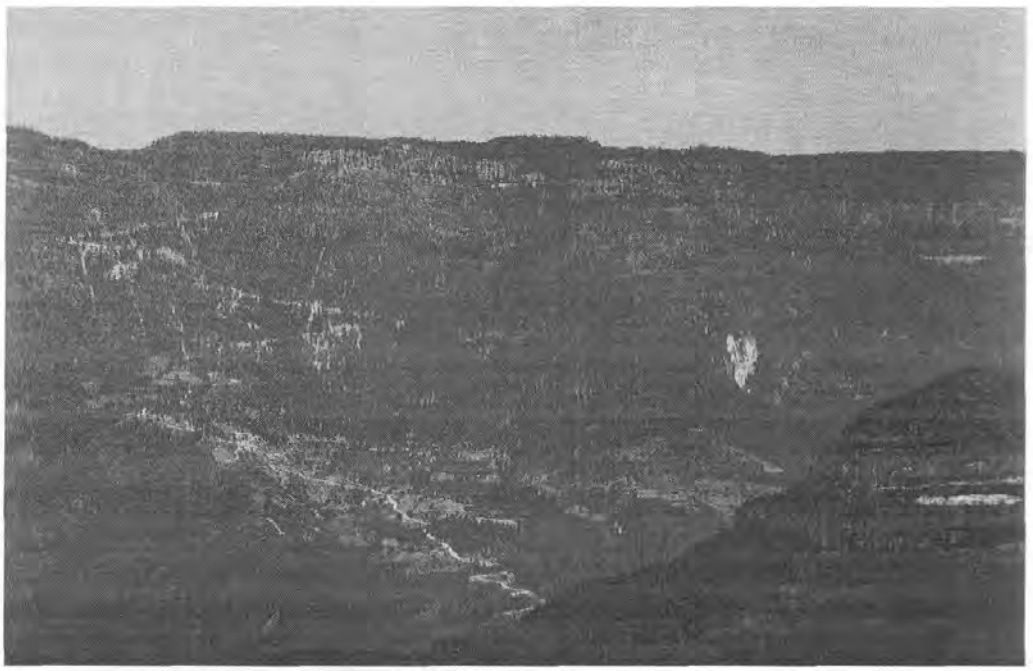


Plate 5. Logging road zig-zagging to plateau, San Blas, western Durango, March 1995
Lámina 5. Camino para la extracción de madera serpentandose por una meseta. San Blas, occidente de Durango, marzo de 1995

Plate 6. Snag piles ready for transport to paper mill, Piélagos, central Durango, October 1995
Lámina 6. Pilas de árboles secos listos para ser transportados a la fábrica de papel, Piélagos, centro de Durango, octubre de 1995

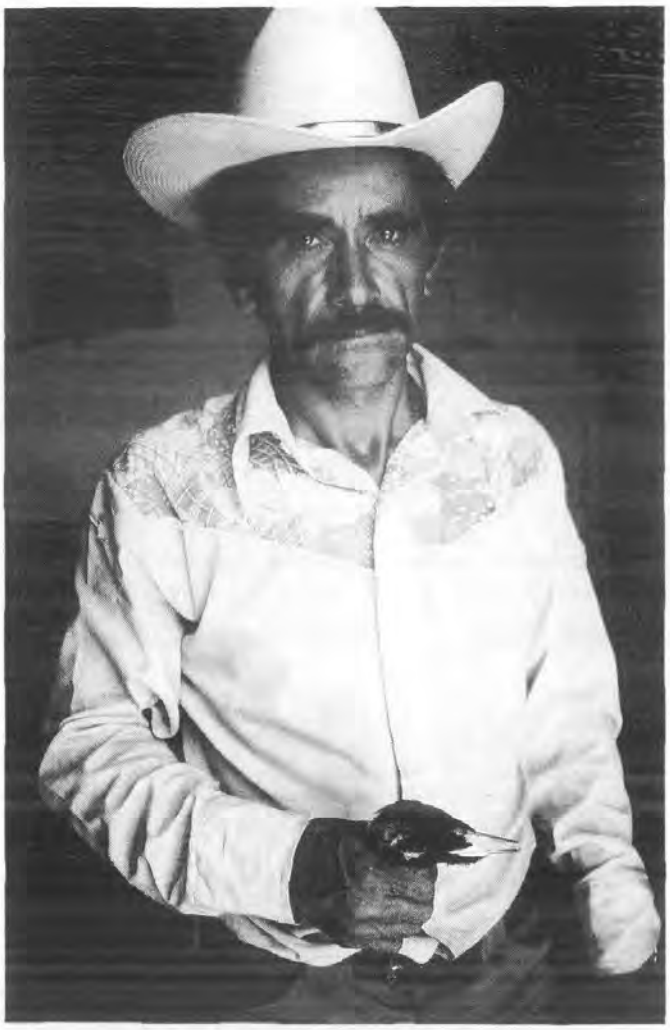


Plate 7. Guadalupe Riveras showing the head of a male Imperial Woodpecker *Campephilus imperialis* that was killed by his father in the 1940s. The red crest feathers have been removed to be used as a medicine against earache. El Zape, NW Durango, October 1995
Lámina 7. Guadalupe Riveras presenta la cabeza de un Carpintero Imperial Campephilus imperialis *el cual fue cazado por su padre en los 1940's. Las plumas rojas de la cresta fueron removidas para emplearlas como medicina para curar el dolor de oido. El Zape, noroeste de Durango, octubre de 1995*

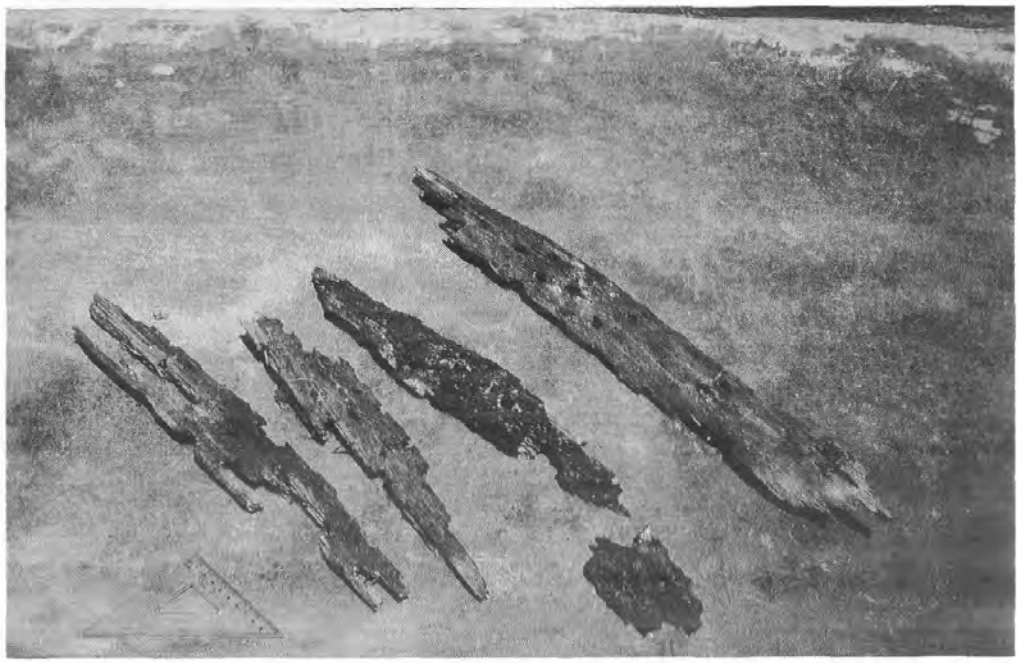


Plate 8. Chunks of outer wood layer, up to 40 cm in size, scaled from Acorn Woodpecker granary trees. The small holes in the fragments are the storage holes. Piélagos, central Durango, April 1995
Lámina 8. Fragmentos de madera, con un tamaño de más de 40 cm, desprendidos de árboles empleados como almacenes por el Carpintero Arlequín

Negative impacts of logging

In all logged forests there is an extensive network of logging roads, which quickly become washed out after a few rainy seasons. The erosion clouds the mountain streams, with negative consequences for the fresh-water ecosystem. Logging roads allow people access to the forest, with (local) extinction through excessive hunting of White-tailed Deer, Wild Turkey and Imperial Woodpecker as a consequence.

The exploitation of standing dead pines has an extremely negative impact on snag-dependent birds like the Imperial Woodpecker, Thick-billed Parrot, Eared Trogon, owls and other woodpeckers. The disappearance of old and dead trees will also have less obvious but far-reaching consequences for small mammals, insects and the herpetofauna.

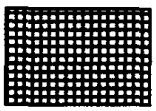
Conclusions

Nearly all of the pine-oak habitat in the Sierra Madre Occidental has been exploited. Old-growth forests remain in 0.61 % of the original area. By far the most threatened forest type is mesa forest, which holds the biggest pines and is only found on relatively flat plateaus in the highest parts of the sierra. The protected areas that currently exist in the Sierra Madre Occidental (Basaseachic and La Michilía) do not hold representative tracts of the most threatened forest types, i.e. mesa forest and canyon forest. Therefore, priority areas for conservation in the Sierra Madre Occidental (page 54 to 65) should fill in this shortcoming.

In logged areas, the lack of mature and standing dead pines is detrimental for much of the biodiversity in the forest. As a management guideline, at least 10 mature pines should be left on each square km. Exploitation of snags should be banned. Minimally, these guidelines should be applied in the breeding areas of the Thick-billed Parrot (figures 29 to 31) but, preferably, throughout the Sierra Madre Occidental as well.

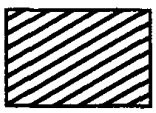
Remnants of old-growth pine-oak forest

The detailed maps of the old-growth sites (figures 7 to 18) were kept on scale 1: 250 000 so they can be laid over the corresponding series of topographical maps by INEGI (1979 - 1983). The sheet numbers of that series are given in figure 6. Threatened birds that are found at each site are summed up with the short descriptions, for more details on birds is refered to the species accounts (page 30 to 53) and appendices 1 to 4.

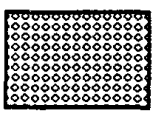


pine-oak forest on mesa, with pines > 50 cm d.b.h.

pine-oak forest on steep slopes, with most pines < 50 cm d.b.h. ("canyon forest")



dry open pine-oak forest, with pines < 50 cm d.b.h.



high altitude oak forest (oaks forming the canopy)

———— ***road***

———— ***provincial border***

---------- ***contour line***

• ***village***

Legend to figures 7 to 18.

El Carricito and Los Amoles (figure 7)

El Carricito		Los Amoles	
oak forest:	1.1 km^2	dry open p.o. forest	4.9 km^2
mesa p.o. forest:	20.6 km^2		
dry open p.o. forest:	117.9 km^2		

El Carricito is the largest unroaded and uninhabited highland forest left in the Sierra Madre Occidental. It also holds almost all of the exceedingly rare mesa forest remaining today (plate 1). Efforts are being made to obtain a protected status for this area (see page 55 to 60).
Threatened birds: Eared Trogon, Spotted Owl, Golden Eagle. Wintering Thick-billed Parrots reported by local inhabitants. The region of Bolaños is the probable type locality of the Imperial Woodpecker (see page 41).

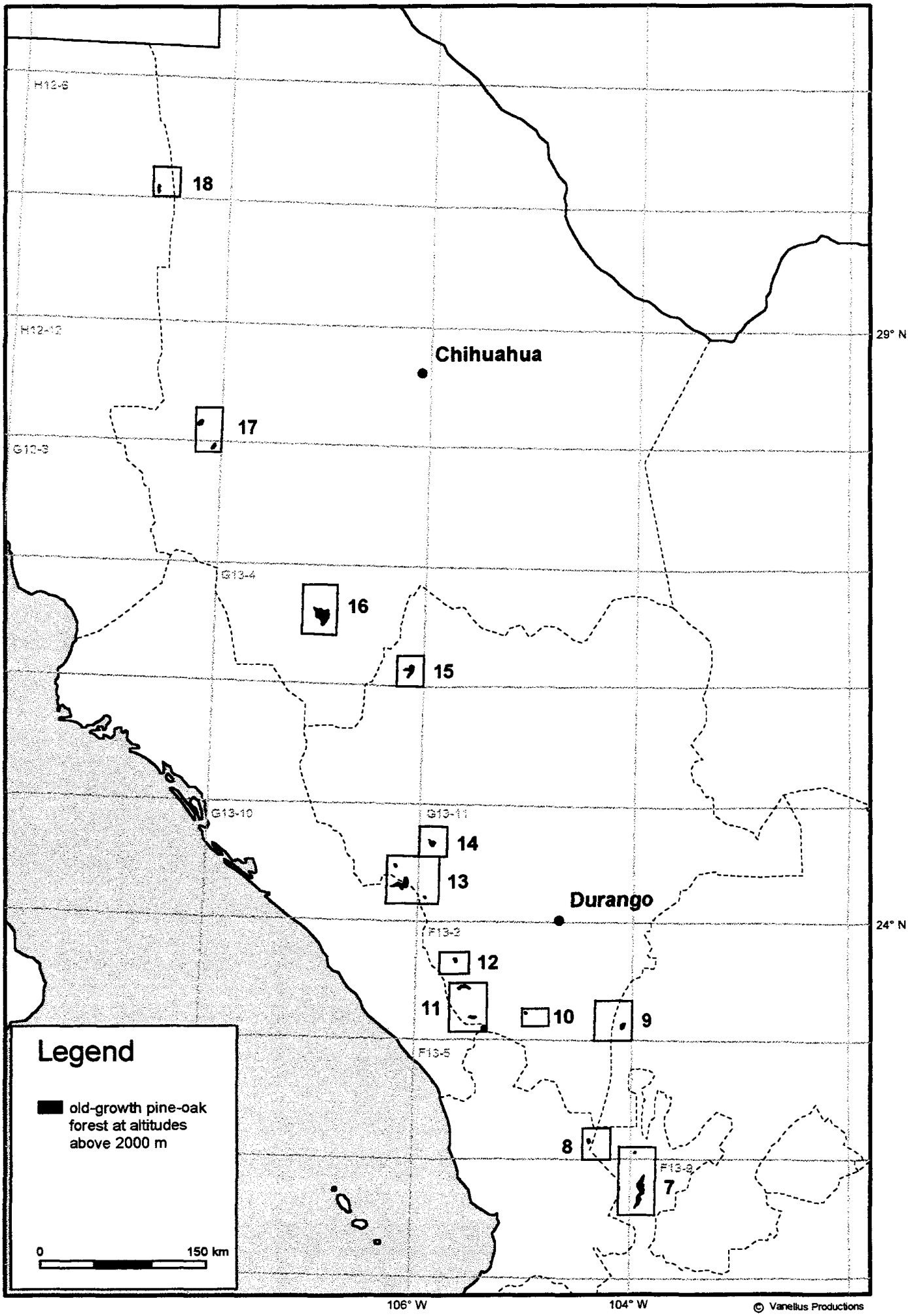


Figure 6. Key to figures 7 to 18. In grey the sheet numbers are given of the corresponding 1: 250 000 topographical maps by INEGI (1979 - 1983)

Figura 6. Clave para las figuras 7 a la 18. En gris se dan los números de las correspondientes cartas topográficas escala 1:250 000 del INEGI (1979-1983)

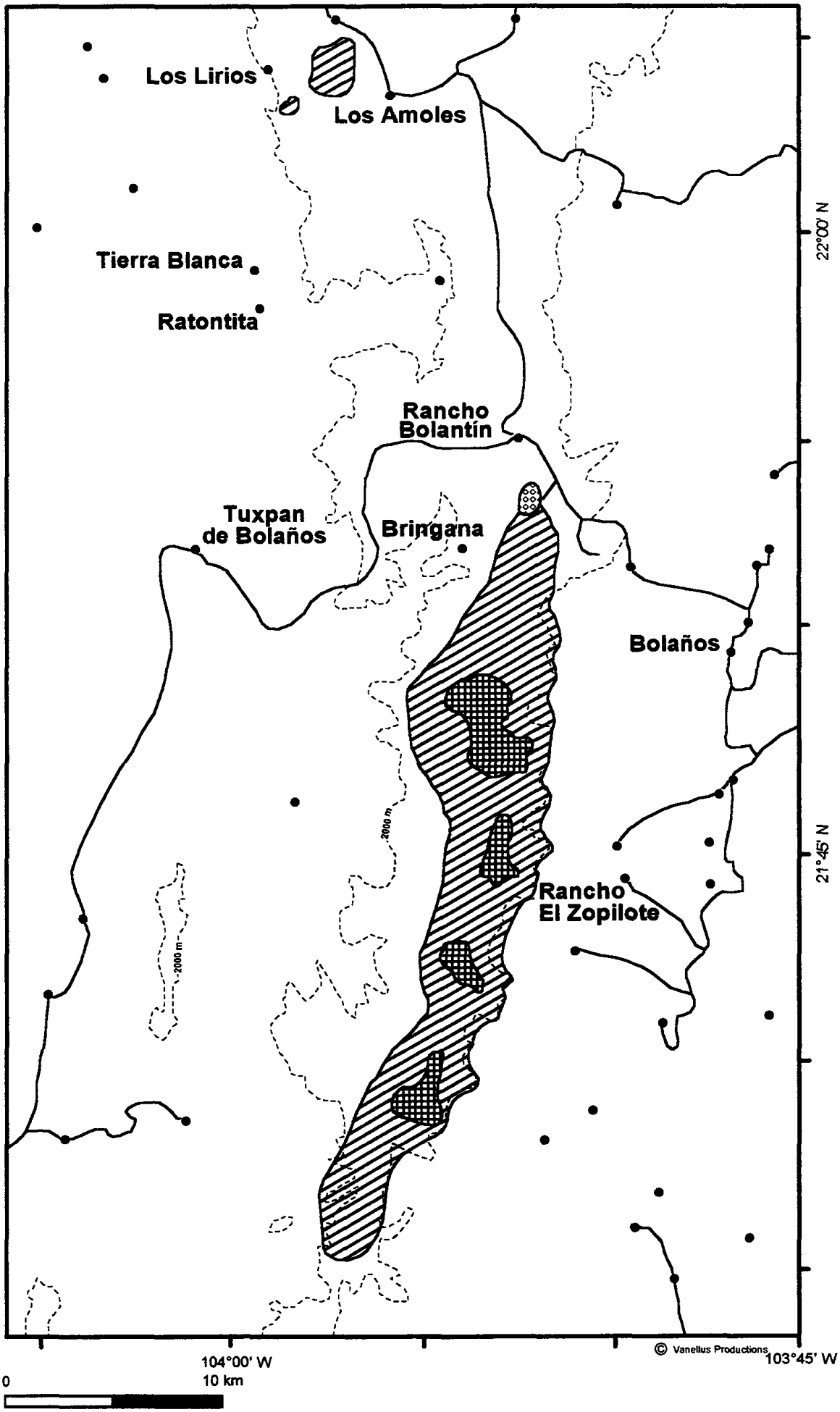


Figure 7. El Carricito and Los Amoles

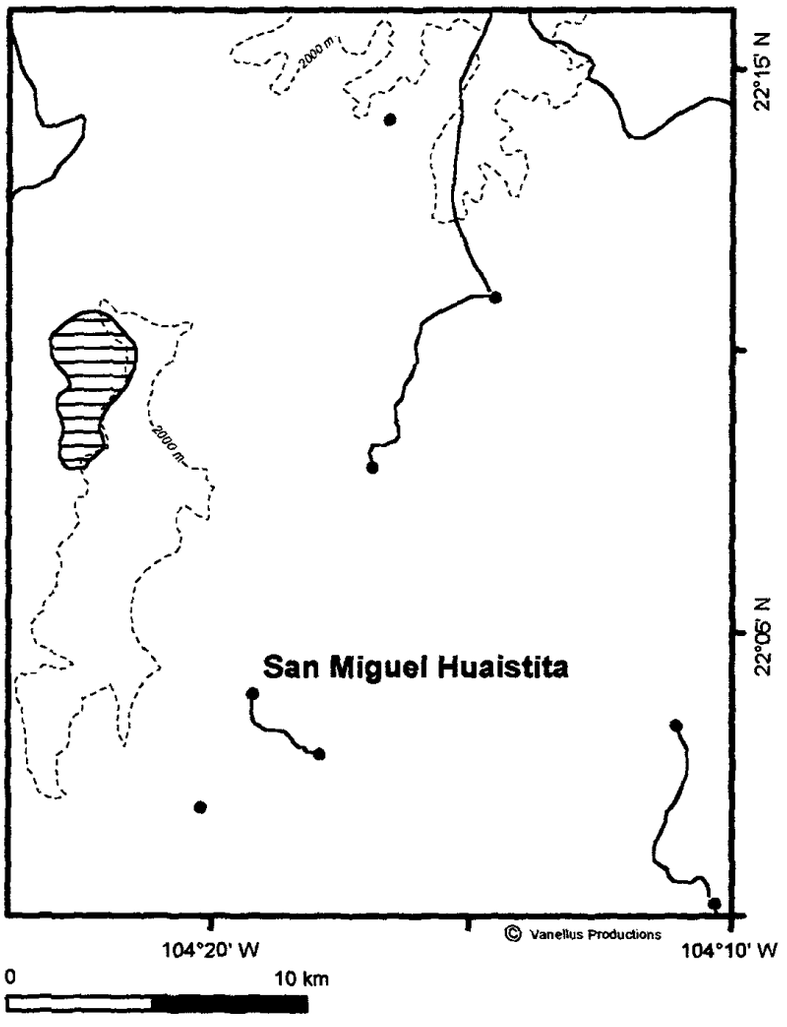


Figure 8. **San Miguel Huaistita**. Canyon forest: 9.8 km^2. This area is classified as canyon forest for its vegetation (forest on steep slopes), though actually it is situated on the slopes of a high mountain. This forest was surveyed from the air, but not visited on the ground.

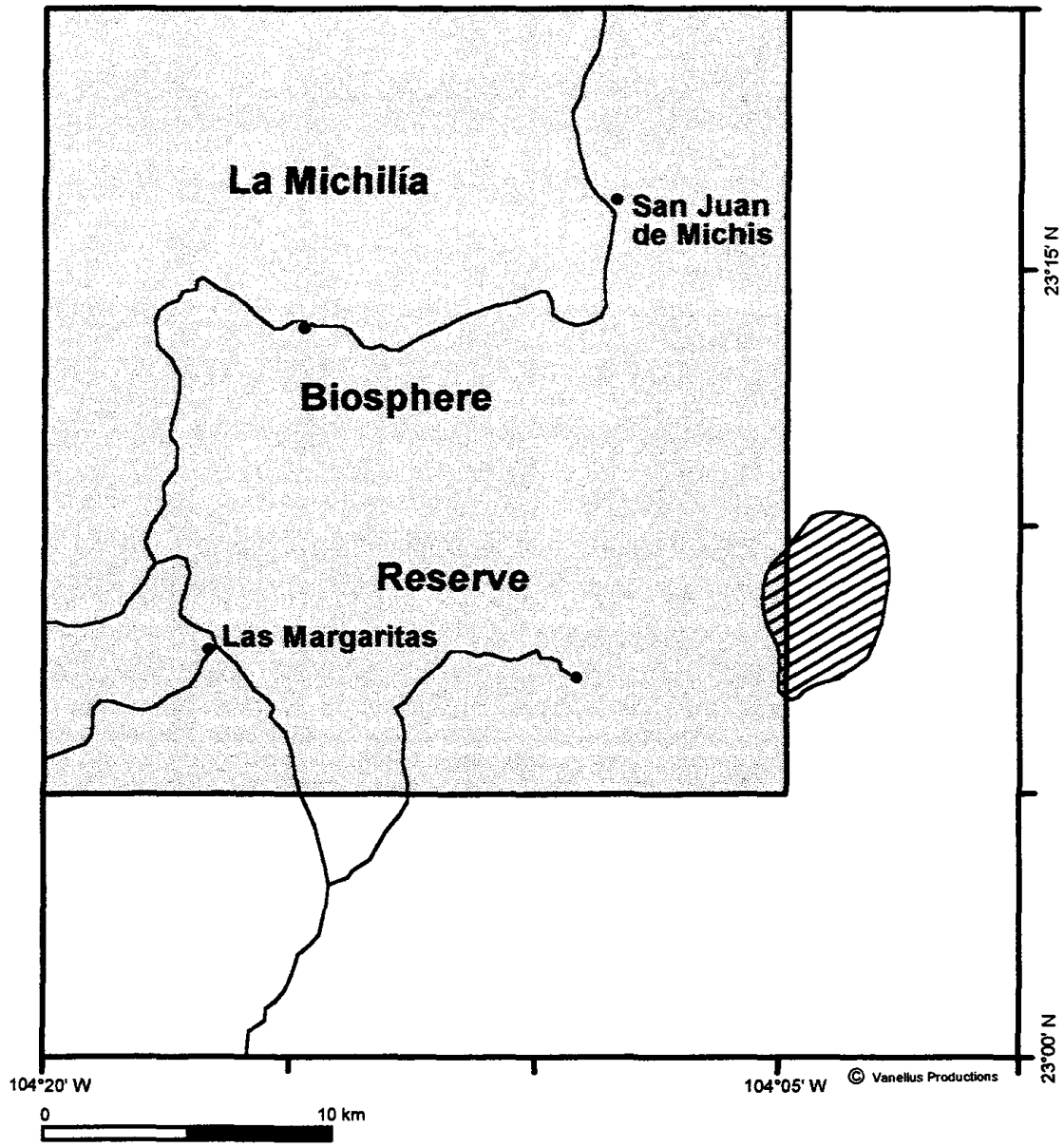


Figure 9. **Dry open p.o. forest south-east of La Michilía Biosphere Reserve**. This area of 21.2 km^2 was found by Roger Otto in 1989. In the Michilía reserve most forest has been cut in the past (A. Garza *pers. comm.*).

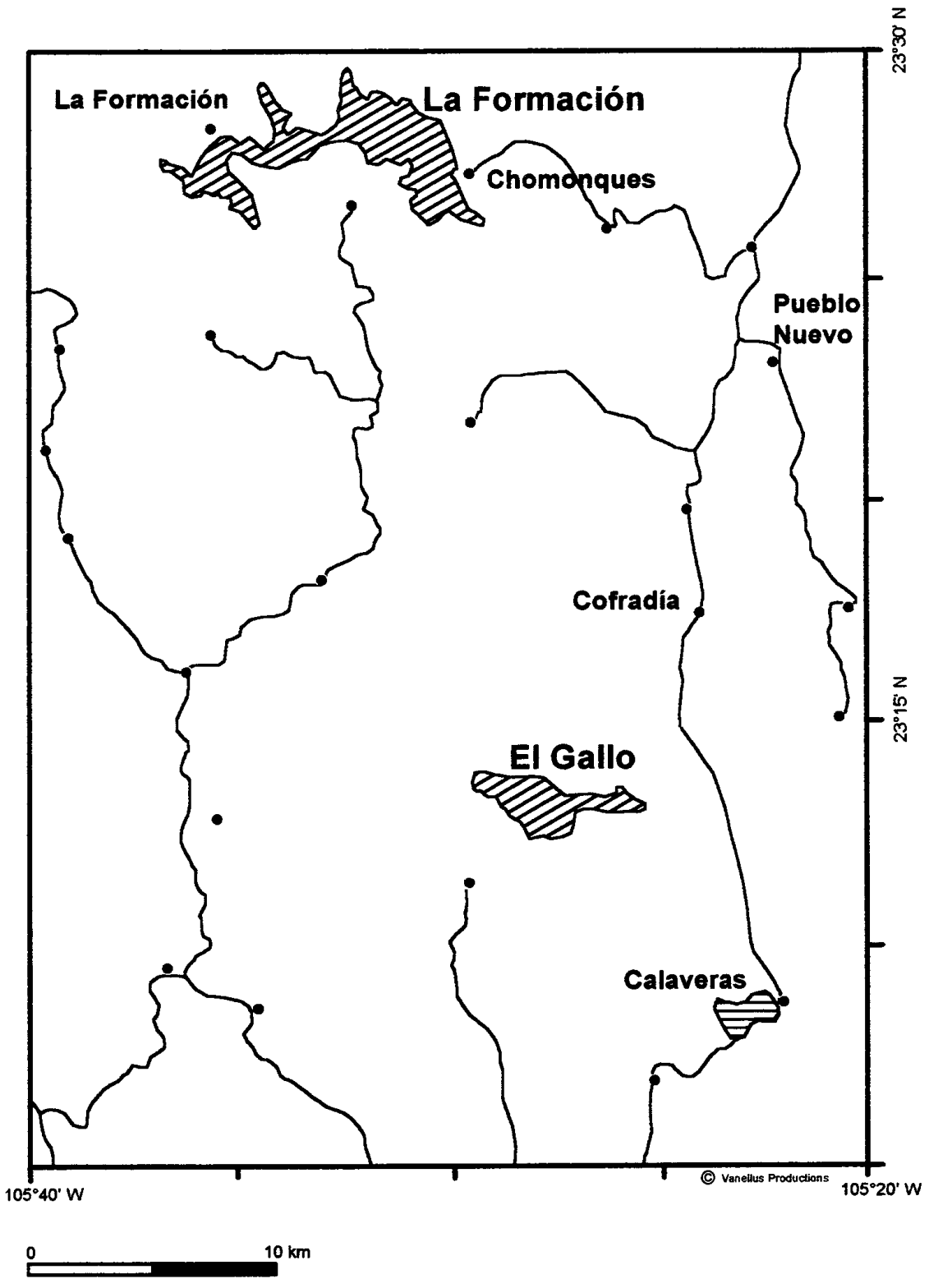


Figure 11. **La Formación, El Gallo and Calaveras**
The Calaveras site, 2.9 km^2 of canyon forest with numerous large firs *Abies* sp., was found to be an important area for the Tufted Jay in 1987 (Ceballos-Lascurain 1987) and approved as a reserve at the state level in Durango in 1995. The reserve is well respected by the forestry unit of Pueblo Nuevo, but an old road cutting right through the reserve has been reopened. Threatened birds: Tufted Jay.
The 25.1 km^2 dry open p.o. forest of La Formación is scheduled to be logged in 1996 or 1997. Threatened birds: Golden Eagle, Eared Trogon.
Exploitation studies were being made in February 1995 for the 8.0 km^2 dry open p.o. forest of El Gallo and the area probably was logged in the winter of 1995 - 96.

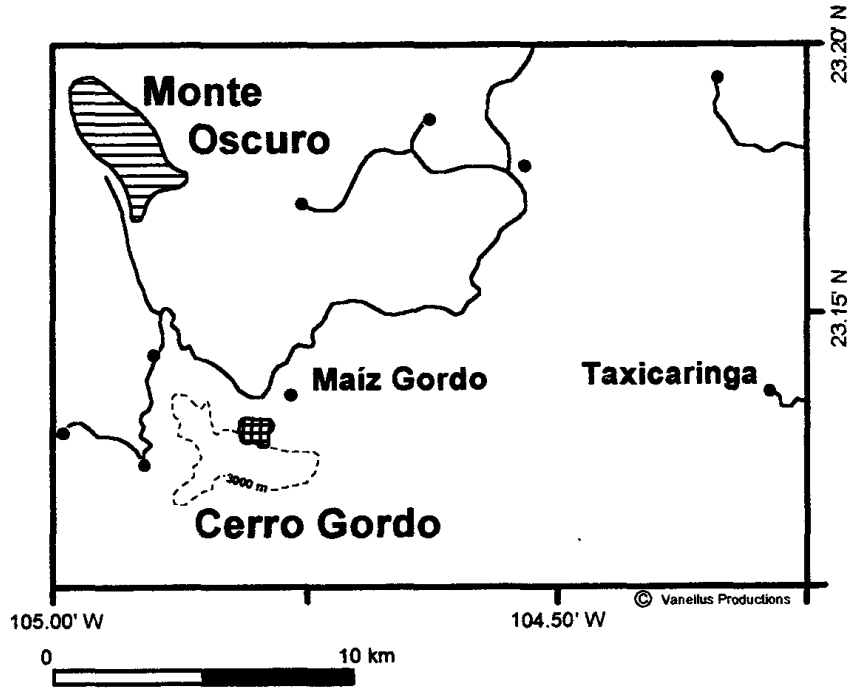


Figure 10. **Monte Oscuro**. Canyon forest: 8.2 km^2. Efforts are being made to turn this area into a reserve for the Eared Trogon at the state level in Durango. The small patch of mesa forest near the top of Cerro Gordo is protected as part of a pilgrimage site for Huichol indians.
Threatened birds: Eared Trogon, wintering group of 30 Thick-billed Parrots, Spotted Owl

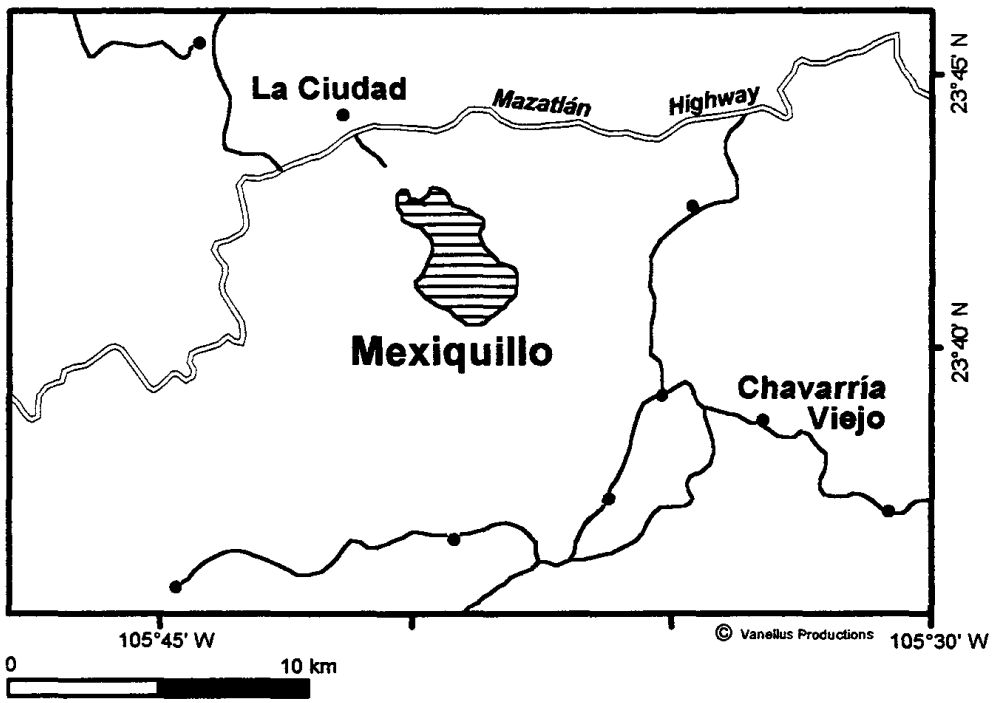


Figure 12. **Mexiquillo**. Canyon forest of 9.7 km^2. The canyon of Mexiquillo will not be logged because it is included in a large scale development plan for a tourist centre. Cabins and camping grounds will be build on the surrounding plateaus. Likely these development plans will not affect the vegetation or birds in the nearly inaccessible canyon. A sawmill upstream, which at the moment pollutes the stream in the canyon with sawdust, will be relocated. Mexiquillo may become a popular bird watching site. It lies close to the Durango-Mazatlán highway and holds Tufted Jays and large numbers of Eared Trogons. According to inhabitants of La Ciudad large groups of Thick-billed Parrots pass by during the winter months. Spotted Owls may well be present in this canyon, which has not been visited at night.

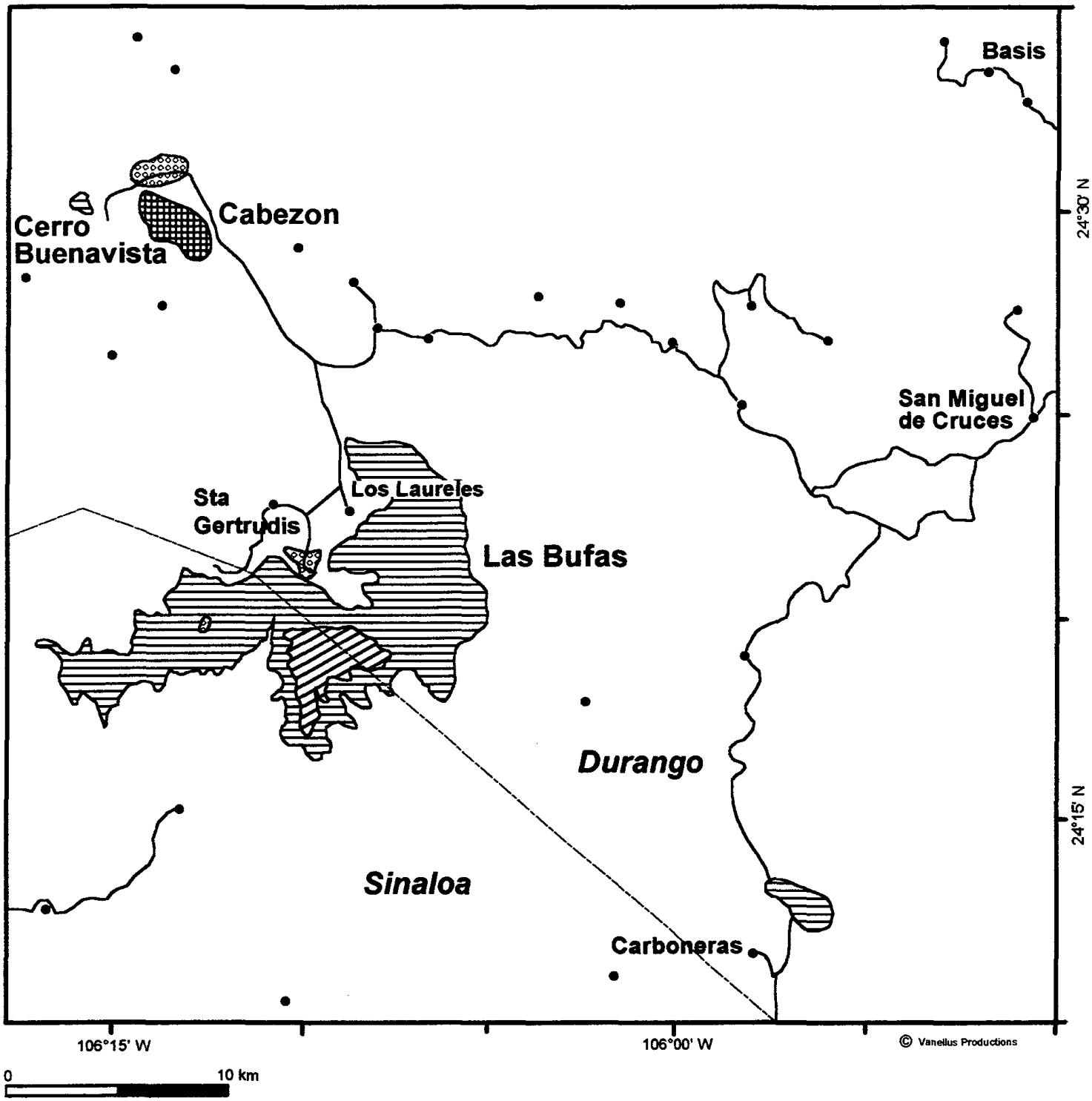


Figure 13. **Cerro Buana Vista, Cabezón, Las Bufas and Carboneras**

	Cerro B.Vista	Cabezon	Las Bufas	Carboneras
mesa p.o forest	0.6 km^2	(5.7 km^2)		
canyon p.o. forest			91.4 km^2	3.7 km^2
dry-open p.o. forest			10.2 km^2	
oak forest		2.6 km^2	1.2 km^2	

The old-growth forest of Las Bufas, together with adjacent selectively-logged mesa forest to the north-west and deciduous tropical forest on the Pacific slope to the south-west, has been proposed as a reserve (page 60 to 63).
Birds: In the canyon forest Tufted Jay, Eared Trogon and Spotted Owl occur. Thick-billed Parrots breed in the logged mesa forest. Military Macaw is reported in the tropical forest on the adjacent Pacific slope.
The mesa forest of Cabezón was being logged in March 1995.

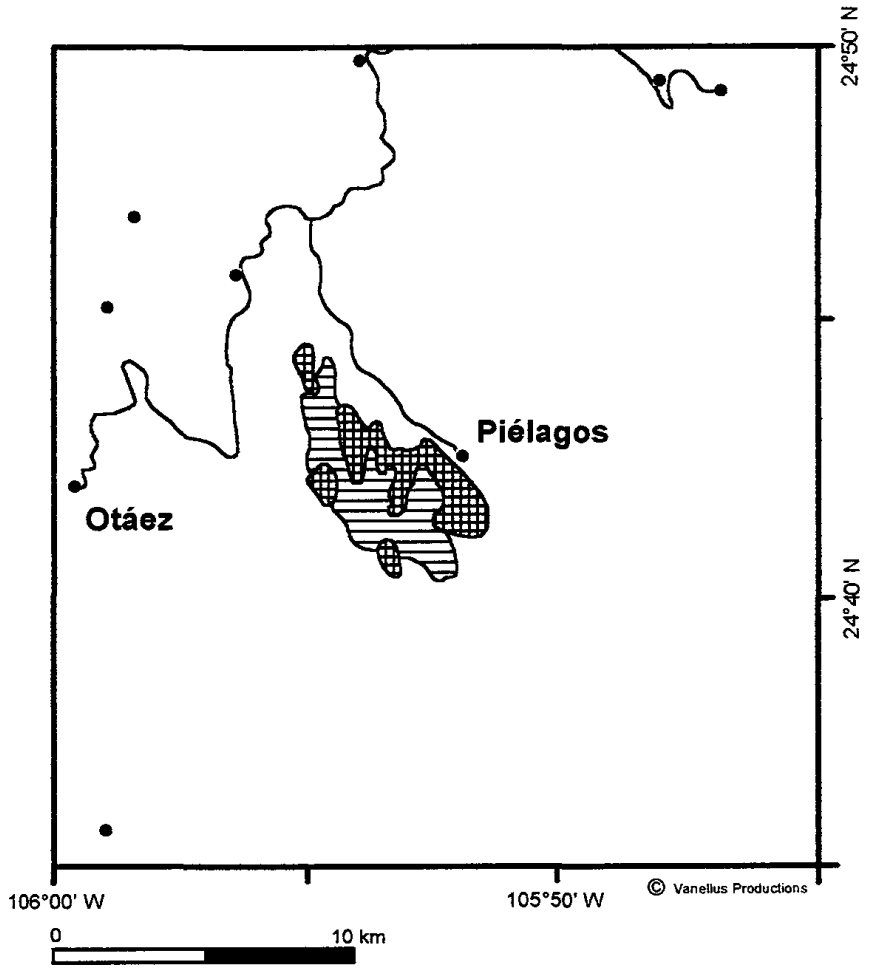


Figure 14. **Piélagos**. Canyon forest 12.7 km^2, mesa forest 10.5 km^2. The mesa forest was being logged in October 1995, when a political conflict that had spared the area from logging for more then 20 years was suddenly solved.
Threatened birds: Eared Trogon, Golden Eagle. There is a convincing description of a sighting of a pair of Imperial Woodpeckers 6 km north of this area from 1993. In April 1995 possible Imperial Woodpecker workings not more than a few months old were found in the mesa forest (see page 38 and 39 and plate 8)

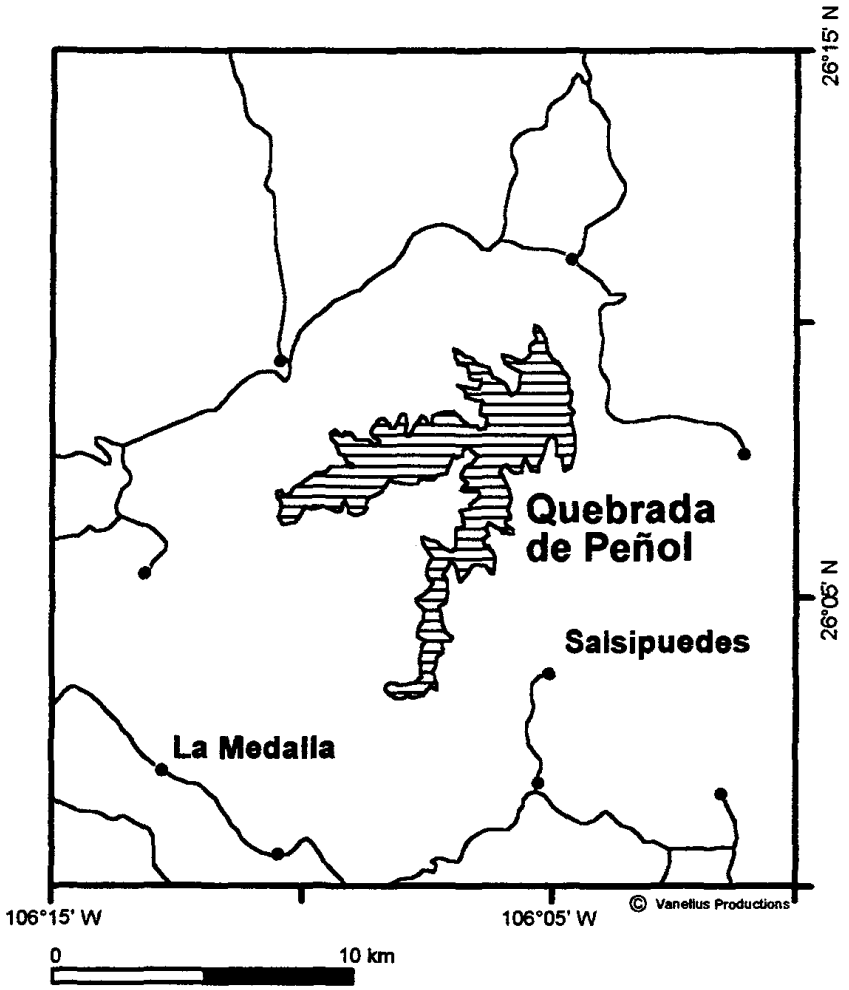


Figure 15. **Quebrada de Peñol**. Canyon forest 29.8 km^2.
Threatened birds: Eared Trogon, Thick-billed Parrot. The Thick-billed Parrots probably breed in or near the canyon: a group of 25 was seen flying through the canyon on 11 September 1995, which is still in the breeding season. No nests were found, however.

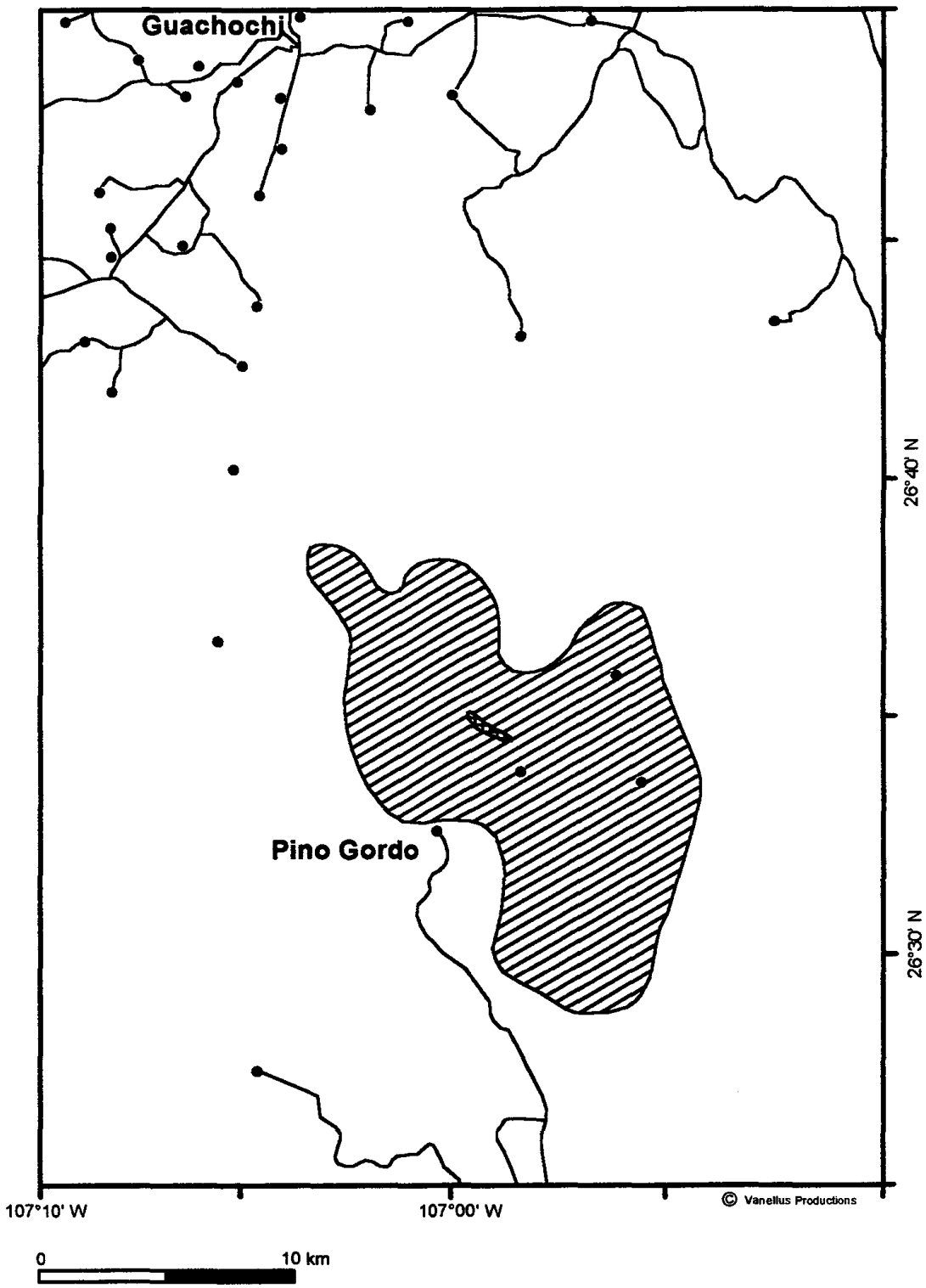


Figure 16. **Pino Gordo**. Dry open pine-oak forest 154.0 km^2, mesa forest 0.6 km^2. Together with El Carricito this is one of the largest uncut areas remaining. However, unlike the other old-growth areas described, the forest of Pino Gordo is inhabited. There are small ranchos of Tarahumara indians scattered throughout the forest. Most snags have been cut for fire wood. There also has been extensive manual cutting of larger pines for construction wood, or the pines were felled to get at squirrels for consumption. Game species as Wild Turkey and White-tailed Deer have become rare in the area through excessive hunting. A long term community-based conservation project by Forest Guardians / CASMAC is attempting to prevent commercial logging of this area.
Threatened birds: Eared Trogon.

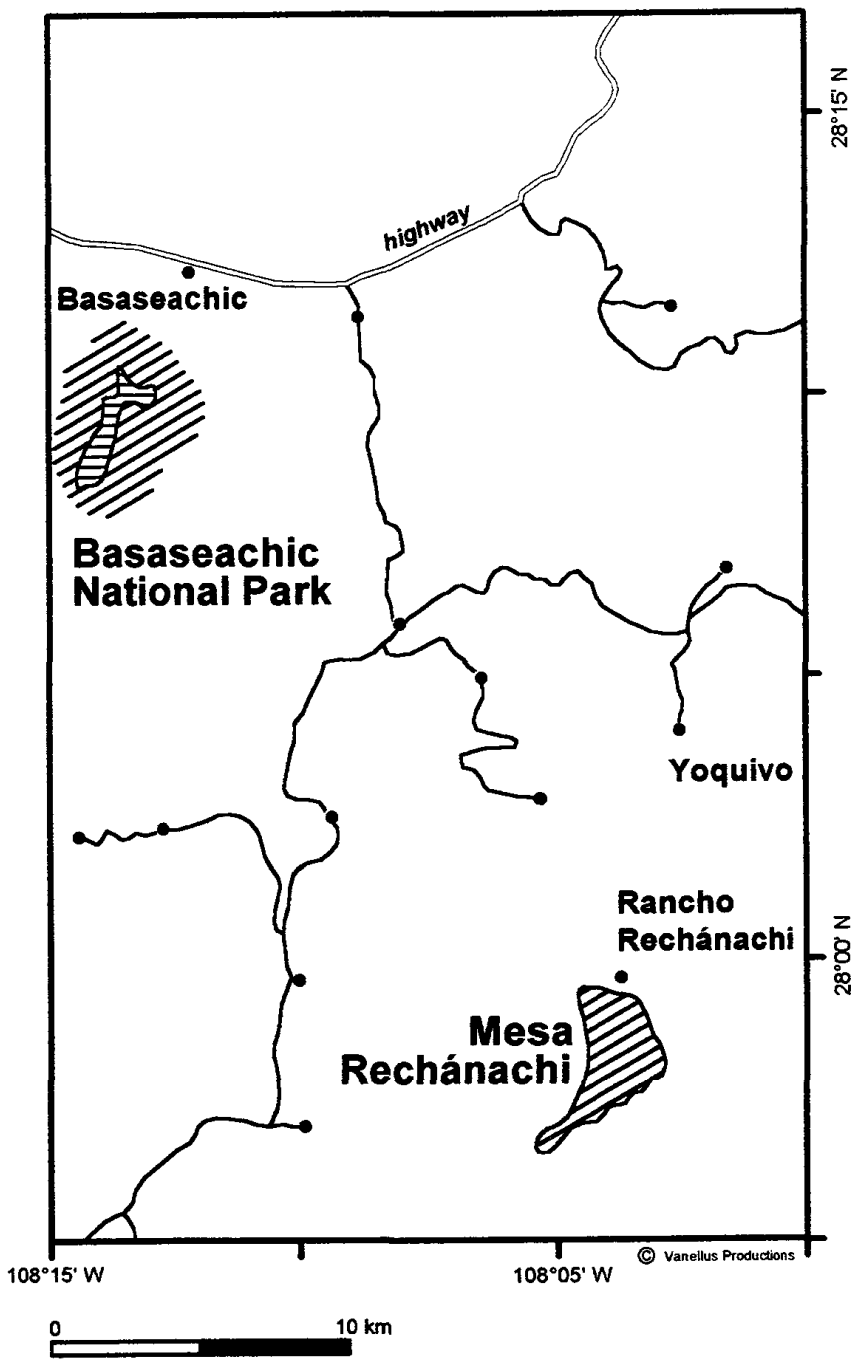


Figure 17. **Mesa Rechánachi and Basaseachic National Park**
Mesa Rechánachi: 9.8 km^2 dry open pine-oak forest. The area is surrounded by unlogged canyons which, however, could not be visited on the ground due to extensive drug growing. Threatened birds: Eared Trogon
Basaseachic National Park: the mapped boundaries of the uncut forest are approximate. Dry open pine-oak forest 17.8 km^2, canyon forest 3.2 km^2. Threatened birds: Eared Trogon.

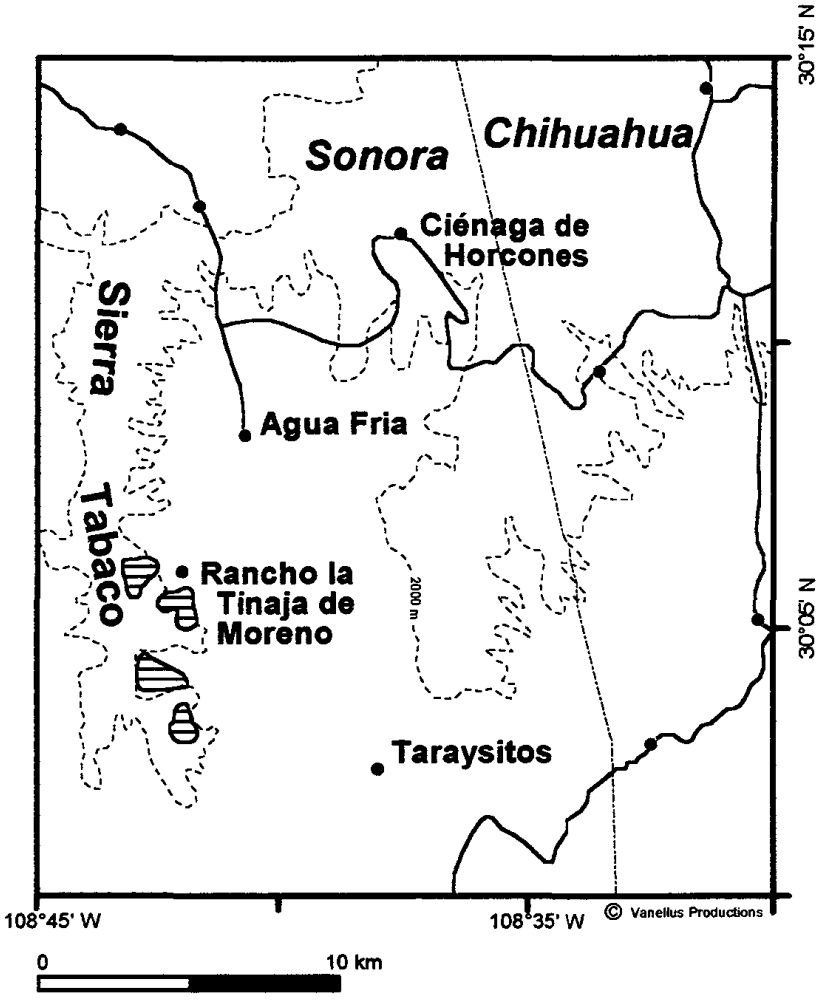


Figure 18. **Sierra Tabaco**
Canyon forest 4.3 km^2. This old-growth site is surrounded by the largest (515 km^2) unroaded and uninhabited area left in the Sierra Madre Occidental. Most of the vegetation is oaks and shrubs, however. There are many 600-800 year old cliff dwellings from Mogollon indians in this area. A convincing report of a female Imperial Woodpecker in 1990 and 1993 stems from Sierra Tabaco (page 38). The area has been proposed as a reserve (page 63 to 65).

The extinction process of the Imperial Woodpecker *Campephilus imperialis*

The Imperial Woodpecker *Campephilus imperialis* is the largest and, if not extinct, rarest woodpecker in the world. As the principal causes for its decline have been regarded excessive hunting by man (Tanner 1964) and destruction or modification of its habitat (Collar *et al.* 1992). Originally, the Imperial Woodpecker occurred in the pine-oak forests of north-west Mexico, i.e. in the Sierra Madre Occidental and the western part of the Central Volcanic Belt (figure 1). Although this distribution is just south of the USA, the country with the highest number of ornithologists and birdwatchers, the Imperial Woodpecker has been neglected in an appalling way. Since it was last observed by W.L Rhein in 1956 (Tanner 1964) only small scale searches were carried out (Ceballos-Lascurain 1987, Perless 1992, Plimpton 1977, Tanner 1964).

The urgent need for a systematic search for the Imperial Woodpecker was pointed out by Collar *et al.* (1992). It seemed reasonable to expect that small numbers of the woodpecker would still survive in primary forest in inaccessible parts of the rugged Sierra Madre Occidental. Since the only close relative of the Imperial Woodpecker, the Ivory-billed Woodpecker *Campephilus principalis*, is almost certainly extinct (Lammertink and Estrada 1995), the Imperial Woodpecker represented the last hope for saving this lineage of large and specialized woodpeckers. The Mexican Mountain Forest - Imperial Woodpecker Project was set up with a survey for remnant populations of the Imperial Woodpecker as one of its objectives. Between November 1994 and October 1995 potential areas for the Imperial Woodpecker were searched in the field. Furthermore, a total of 62 local inhabitants who had known the Imperial Woodpecker were interviewed to obtain information on the ecology and extinction process of the bird.

Methods

It was assumed that the Imperial Woodpecker should be sought for in old-growth forests or in selectively logged forests where snags had not been cut. Only in such areas can the required dead pines for foraging and nesting (see below) be expected in sufficient numbers. Moreover, the hunting pressure usually is lower in old-growth areas since they are mostly uninhabited. Judging from topographical maps, it seemed highly unlikely that unsettled or old-growth areas could be found in the western part of the Central Volcanic Belt. Therefore, the search for the Imperial Woodpecker was limited to the Sierra Madre Occidental. Potential old-growth areas were selected by an analysis of topographical maps, aerial surveys, information from satellite images, interviews with forestry people and local inhabitants, and literature studies (see page 9 to 11). Ground-truthing was done by truck, on foot and horse-back. The few remaining areas supporting potential habitat were searched extensively for direct observations and signs of the Imperial Woodpecker, i.e. holes and foraging signs (scaled pines and excavations with large wood chips). Occasionally the call of the Ivory-billed Woodpecker *Campephilus principalis*, which supposedly is very similar to that of the Imperial Woodpecker (Tanner 1964), was imitated on a trumpet mouthpiece.

Interviews followed a strict procedure to avoid false leads concerning other woodpeckers of the Sierra Madre Occidental. If someone claimed to know the Imperial Woodpecker (*pitoreal*) he was first asked to describe the bird. In two cases, the description did not even indicate a woodpecker but the Green Kingfisher *Chloroceryle americana* and the Magpie Jay *Calocitta formosa*, respectively. When the *pitoreal* was described as a large woodpecker, the observer was asked to choose the bird from an illustration of different woodpeckers of the Sierra Madre Occidental (figure 19), and to describe the size, manner of flight, voice and habitat of the bird. In this way a distinction could be made between true and false claims of Imperial Woodpecker sightings. People who had known the Imperial Woodpecker were asked a standard list of questions on the habits and disappearance of the bird.

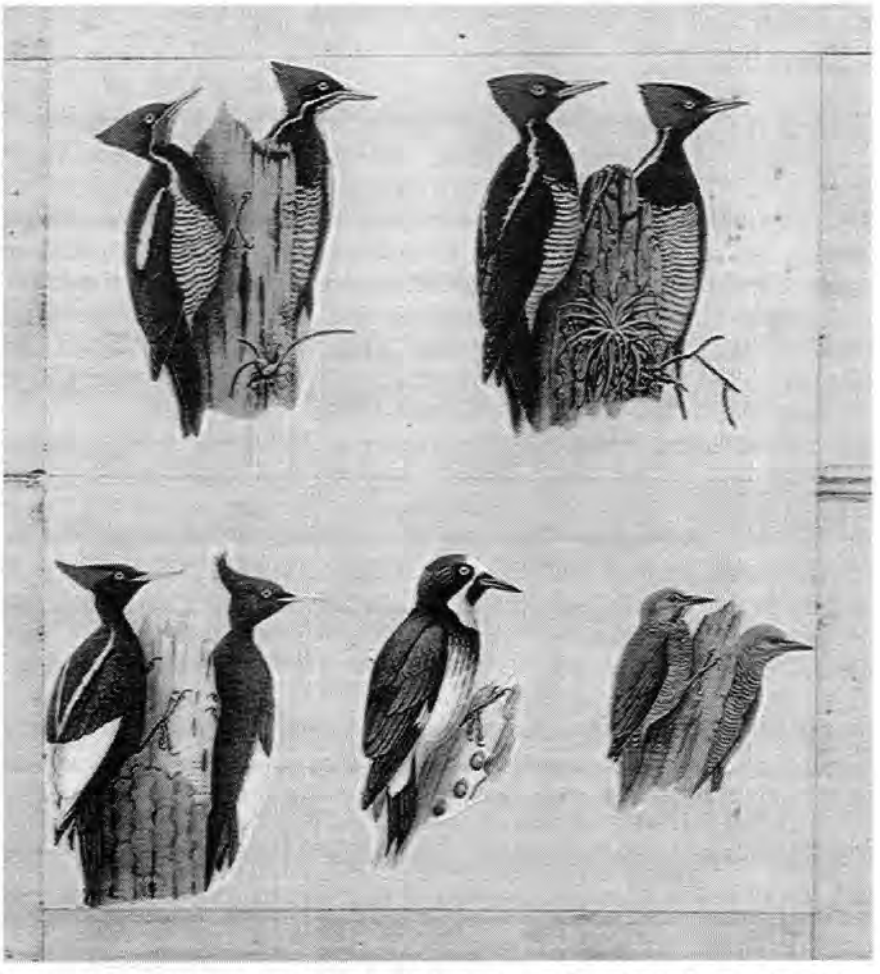


Figure 19. Illustration used for interviews. People who said to have seen the Imperial Woodpecker were asked to choose it from the depicted woodpeckers. Original in colour; this is a collage of illustrations from Edwards (1989)
Figura 19. Ilustración empleada durante las entrevistas. Las personas que dijeron haber visto al Carpintero Imperial fueron invitadas a señarlo entre los carpinteros representados. El original en color; se trata de un arreglo de ilustraciones tomadas de Edwards (1989)

Results and discussion
In the searched old-growth and snag-rich logged forests no Imperial Woodpeckers were observed. The current status of the Imperial Woodpecker had to be inferred from reports by local inhabitants, along with possible workings found in one area and the assessed status of the pine-oak habitat in the Sierra Madre Occidental. From the interviews and the exploitation history of the pine-oak forests, insight has been gained into the extinction process of the Imperial Woodpecker, which will be discussed first.

rate and period of extinction
Of the informants, 60 % saw their last Imperial Woodpecker within a period of just 20 years, between 1946 and 1965 (figure 20). There were only two localities where no one could recall the Imperial Woodpecker, against 48 localities where an extinction date could be obtained. This implies that the concentration of local extinction dates is not an artefact caused by the death of older witnesses by 1995. From figure 20 it becomes clear that the last documented sighting, by W.L. Rhein in 1956 (Tanner 1964), coincided with the peak in extinctions but Imperial Woodpeckers have still been reported after that date.

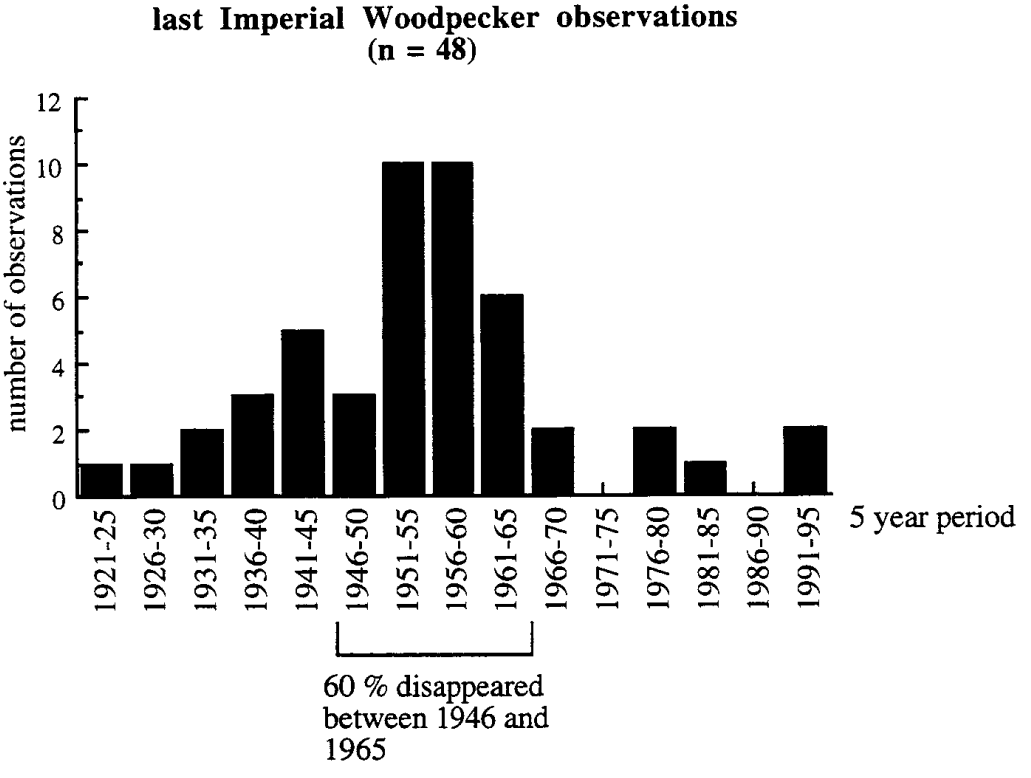


Figure 20. Last observations of Imperial Woodpeckers by inhabitants of the Sierra Madre Occidental. For a discussion of post-1965 sightings, see below
Figura 20. Últimas observaciones de Carpinteros Imperiales realizadas por habitantes de la Sierra Madre Occidental. Para una discusión de observaciones con posterioridad a 1965, ver más adelante

factors causing the decline of the Imperial Woodpecker

habitat destruction

First of all, it should be assessed as precisely as possible what the preferred habitat of the Imperial Woodpecker looked like. For the Nahuatzin District in Michoacán, in the western part of the Central Volcanic Belt, Nelson (1898) reported: "Their range in this region appears to be restricted to the rather narrow belt along the top of the main central ridge of the Sierra Madre which lies above an altitude of 7000 feet [2100 m]. This belt is more like a rolling and irregular table-land than the summit of a great mountain chain". Indirectly, there are many indications that the Imperial Woodpecker was a bird of the high plateaus in the Sierra Madre Occidental as well. Collar *et al.* (1992) give nine altitude registrations of Imperial Woodpecker specimens or sightings in the Sierra Madre Occidental. One bird collected at 1,675 m is considered a post-breeding wanderer, the other eight were all found above 1,920 m, and the average height is 2,550 m. At such altitudes, almost all of the terrain of the Sierra Madre Occidental is made up of relatively flat plateaus. Many of the people interviewed during this study also reported that the Imperial Woodpecker occurred on the flat or gently undulating plateaus in the highest parts of the sierra.

This occurrence on high plateaus is most likely linked with the species' habitat preference: forests of large pines with many dead trees (Tanner 1964). The larger pines grow in the higher parts of the sierra, which are the coolest and most humid zones. Moreover, the soil layer is better developed on the flat plateaus than on the steep slopes of canyons at lower altitudes. The supposed dependence of the Imperial Woodpecker on dead pines for both foraging and nesting (Tanner 1964) is confirmed by the interviews. Of the 24 people who described the foraging behaviour of the Imperial Woodpecker, 22 (92 %) mentioned that the birds could be seen excavating and bark-scaling dead pines. The woodpeckers were mostly observed working on standing dead pines but would also

excavate the stems and roots of fallen pines. The food item extracted from the dead wood was invariably reported (12 informants) to be big white grubs (*gusanos* or *misticuís*), presumably beetle larvae. Five informants described how Imperial Woodpeckers would plunder acorns from the granary trees of Acorn Woodpeckers *Melanerpes formicivorus*, three of them remembered this as the only foraging activity. The preferred nesting site was described by 100 % (n = 24) of the informants as a big dead pine, though snags of Douglas fir *Pseudotsuga* sp. (three informants) and oaks *Quercus* (one informant) were said to be used occasionally besides pines.

Sadly, the forests on plateaus preferred by the Imperial Woodpecker are readily accessible to the logging industry (plate 5). Today, in the whole Sierra Madre Occidental only 22 km^2 of old-growth mesa forest remains (figure 5), while the average density of the Imperial Woodpecker was estimated at one pair per 10 square miles or 26 km^2 by Tanner (1964). Besides the rare mesa forest, another 549 km^2 of presumably less attractive old-growth forest types is left. In the -fragmented- 369 km^2 of dry-open forest, pines are usually under 50 cm d.b.h. so the large snags that are associated with the Imperial Woodpecker are not available. Riparian corridors within the 176 km^2 of old-growth canyon forest hold some large pines and snags, but the surface of the corridors is usually limited to 1 or 2 km^2 per valley. Therefore, even in old-growth canyon forest, habitat with large snags is fragmented.

Of the original extent of pine-oak forest (all types together) in the Sierra Madre Occidental, 99.4 % has been selectively logged or cleared (figures 3 and 4). In most of the logged forests the snags have been cut for the production of paper pulp (plate 6). The absence of mature pines in logged forest means that few new snags appear.

Tanner (1964) reported no exploitation of snags and found the selective logging activities at that time to be no threat to the Imperial Woodpecker. However, it seems likely the impact and extent of logging was underestimated. Many mature and dead pines could still be found in the recently opened areas that were visited, but snags and mature pines must have been rare in areas where forest exploitation had been going on for decades (e.g. Madera region in northern Chihuahua since 1880, El Salto region in western Durango since 1918). Several inhabitants of the Sierra Madre Occidental described how the Imperial Woodpecker had suddenly disappeared after the snags were cut, as early as in 1940 in one case. Certainly the direct removal of the Imperial Woodpecker's main feeding sites could have caused a quick, local extinction. However, in other areas, there still were vast old-growth areas left at the time the Imperial Woodpecker had become extinct. The bird disappeared even before any logging had taken place in six out of 18 locations, for which such information was available. In such cases the local extinction must have been caused by other factors.

hunting

The motivation for hunting Imperial Woodpeckers was described in 23 of the interviews carried out (table 1). The most frequent (30 %) reason for killing Imperial Woodpeckers was vandalism. The woodpecker was a striking and easy target that people would shoot for fun or to get a closer look. As Mr. Fimbres of Mesa Tres Rios, northern Sonora, put it: "Those woodpeckers were big and pretty. We had guns". Then he shrugged ("need I say more ?"). Hunting for medicinal purposes was the secondmost common reason (22 %), while hunting for food is the motivation in 17 % of the cases. This is in contrast with Tanner (1964), who thought that hunting for food was the principal cause for the decline of the Imperial Woodpecker. Some of the motivations listed in table 1 have been recorded previously (overview in Collar *et al.* 1992), though new reports are the use of the bill as a hair pin and as a tool for removing kernels of corn from the ear, and the use of a head as an amulet for luck in love. The most frequent medicinal purpose, described by three informants, was to use the red crest feathers of the male Imperial Woodpecker as a cure against earache (plate 7). The feathers were stuck in the aching ear with a little oil. A woman from Otaez reported that the bill of the Imperial Woodpecker, ground to powder, was used as a medicine against nerve attacks.

motivation	n	
for fun / out of curiosity	7	30 %
medicinal use (curing earache 3, curing headache 1, curing nerve attacks 1)	5	22 %
food	4	17 %
bill as a tool for removing kernels of corn from ears	3	13 %
head as an amulet for luck in love	1	4 %
bill as a hair pin	1	4 %
bill thought to be of valuable ivory	1	4 %
catched alive for pet trade	1	4 %

Table 1. Motivations for hunting Imperial Woodpeckers learned from interviews with local inhabitants (n=23)
Tabla 1. Motivos para la cacería de Carpinteros Imperiales según las entrevistas realizadas con habitantes locales (n=23)

Medicinal use of Imperial Woodpecker feathers has a long tradition. Pennington (1963) cites "Relaciones" (writings by Franciscans) from the state of Chihuahua in 1777 and 1778. They mention that the feathers of the *pito real* had been thought to be useful by Tarahumara indians for fainting spells of men and in childbirth. In fact, this must be the oldest written reference to the Imperial Woodpecker, 65 years before the bird was described to science by Gould in 1832 (*Proc. Zool. Soc. London* 1832: 139-140).

The hunting pressure was augmented by the widespread human settlement in the Sierra Madre Occidental. Contrary to what one would expect for such a rugged mountain range, people are living almost everywhere. There are no "remote" areas. This stems in part from the time of the Mexican Revolution (1910-1917) when many people who did not want to participate in the fighting settled in the most secluded parts of the Sierra (Mr. Guerrero, La Formación pers. comm.). After the revolution, the government started giving land (ejidos) to an ever increasing population, causing further overpopulation of these mountains. Human settlement increased sharply in the 1950s. In this period many new ejidos were founded, while increasing logging activity brought more people into the Sierra Madre Occidental as well. In addition, .22 caliber rifles using cheap ammunition were introduced on a large scale in the 1950s. Before, the heavy .30 bullets were too expensive to waste on Imperial Woodpeckers (Ing. D. Trujano pers. comm.). Besides the areas that became colonized in the course of the 20th century, there are regions in the Sierra Madre Occidental historically inhabited by Tarahumara, Tepehuanes and Huichol indians. Lumholtz (1903, vol. 1 p. 212) reported hunting of Imperial Woodpeckers by Tarahumara indians: "it is on the point of being exterminated, because the Tarahumares consider his one or two young such a delicacy that they do not hesitate to cut down even large trees to get at the nests."

There can be little doubt that hunting decimated Imperial Woodpecker populations in many areas. Of the 45 local inhabitants who were asked their opinion on the cause of the disappearance of the woodpecker, 55 % thought it was hunting, while 29 % thought logging or the exploitation of snags and 16 % did not have a clue. Though hunting may be a more obvious and direct link than habitat destruction, these opinions at least show that many local inhabitants considered the hunting to be excessive. At the same time, no one had the slightest notion that they were exterminating a rare and endemic species. A particular tragic example is the extinction of the Imperial Woodpecker in the surroundings of Los Altares in central Durango. Mr. Juventino Herrera of that village said that by 1948 all males had been shot for their red crest feathers. A lonely female, constantly calling, roamed the forest for another four or five years.

occurrence of the Imperial Woodpecker in groups

A third factor contributing to the sudden extinction of the Imperial Woodpecker may be a property of the bird that has hardly been recognized before. Nearly half of the people interviewed on the subject (n=57), remembered the Imperial Woodpecker as occurring in groups (figure 21a). Groups larger than four individuals were reported by 82 % (n=17) of these informants (figure 21b). Two observers described groups of up to 20, one man

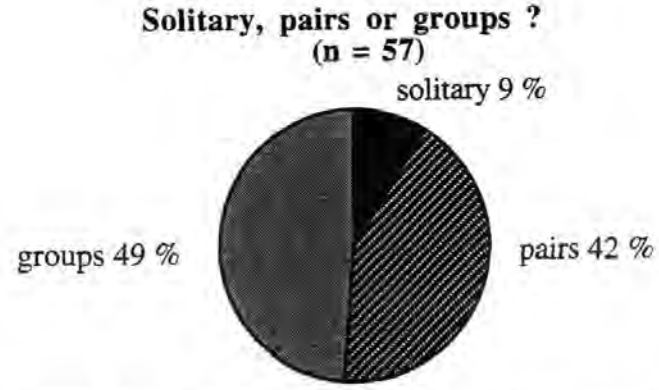


Figure 21a. Proportion of informants who remembered Imperial Woodpeckers occurring as solitary, in pairs or in groups. Descriptions as "in pairs and in groups" were scored as two independent reports. As such, 57 reports were used, while there were 42 informants on this subject

Figura 21 a. Proporción de informantes que recordaron a los Carpinteros Imperiales presentandose solitarios, en parejas o en grupos. Las descripciones como "en parejas y en grupos" se registraron como dos reportes independientes. Por ello, se emplearon 57 reportes, mientras que hubo solo 42 informantes al respecto

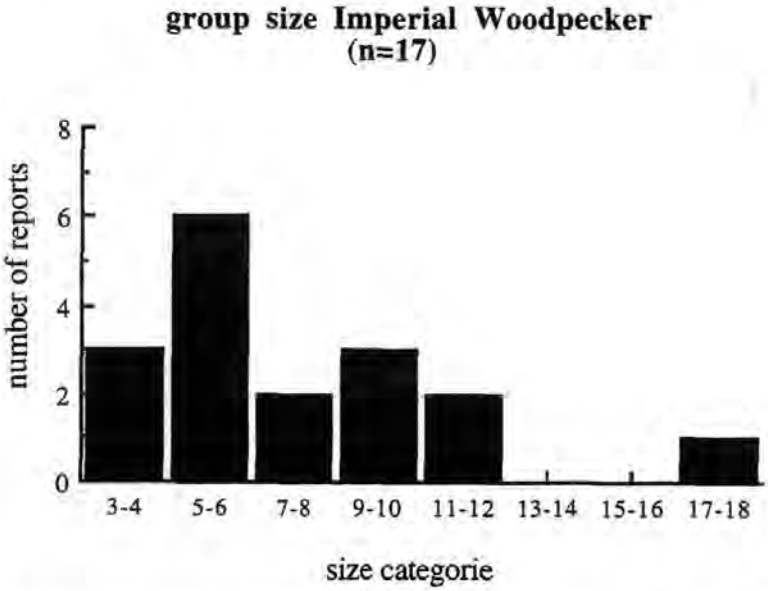


Figure 21b. Size of the reported Imperial Woodpecker groups. If a size range was given, the average was taken.

Figura 21b. Tamaño de los grupos de Carpinteros Imperiales reportados. Cuando se obtuvo un rango de tamaño se tomó el promedio

even up to 50 individuals, which seems hardly credible. Nelson (1898) observed in the autumn of 1892 one pair and three groups; of five, five or six and eight or ten birds respectively.

Only groups of Imperial Woodpeckers of about four individuals would likely relate to a pair with the offspring of the year. The nests described in the literature contained two eggs (one nest, Nelson 1898), or one or two young (Lumholtz 1903, vol. 1 p. 212). Nests with one to three young were reported by seven of the informants interviewed during this study. Only one man observed pairs with four to six juveniles "which could be recognized by their smaller size, clumsy way of flying and were fed by the parents". The closely related Ivory-billed Woodpecker laid one to four eggs (average 2.9) and the average brood out of the nest was 2.1 (Tanner 1942, p. 88). Tanner (1964) thought larger groups of

Imperial Woodpeckers were pairs with the young from more than one breeding season, but this seems an unlikely explanation for the frequently reported groups of eight or more individuals. It is hardly conceivable that all offspring from up to three previous years would survive and stay with the parents. The larger groups are reported too often to be considered chance encounters between family groups, as suggested in Collar *et al.* (1992).

The grouping behaviour of the Imperial Woodpecker may well be related to its foraging specialisation. The main food source of the Imperial Woodpecker, snags with beetle larvae, was probably distributed patchily (due to local forest fires, plagues etc.) while the larvae populations peaked in a short lapse of time. In that case, the feeding sites were probably best exploited by "nomadic" groups of Imperial Woodpeckers, which were not necessarily related. The Ivory-billed Woodpecker, with a much similar foraging ecology, has been reported in groups by early observers when the species was still relatively abundant. Scott (1898) and Ellis (1917) reported groups of 11 and 12 Ivory-billed Woodpeckers respectively (both cited in Tanner 1942, p. 61). A group of 6 Cuban Ivory-billed Woodpeckers was seen in the pine-forests in the hills of eastern Cuba in 1941 (Dennis 1948). The Ivory-billed Woodpecker showed no territorial behaviour even in the breeding season (Tanner 1942, p. 65).

Whatever the nature of the Imperial Woodpecker groups, this aspect of the ecology of the species may well have contributed to its rapid extinction. If the Imperial Woodpecker operated at least part of the year in groups of, on average, seven to eight individuals (figure 21b), the minimal area of old-growth forest required would be 98 km^2 for one group and not 26 km^2 for a pair. This means the fragmentation of the old-growth forest would have had far reaching consequences in an early stage of the forest exploitation. Furthermore, the impact of hunting might be more severe if the shooting of a few individuals undermined group structure and functionality.

original population may have consisted of only 1100 groups

At this point, it should be considered how large the original populations of the Imperial Woodpecker may have been. Within the original distribution of the Imperial Woodpecker (taken from Collar *et al.* 1992) and at altitudes above 2000 m, pine-oak forest is the potential vegetation in an area of 93,560 km^2 in the Sierra Madre Occidental and 9,860 km^2 in the western part of the Central Volcanic Belt (figure 1, based on Rzedowski 1992). The total habitat once available to the Imperial Woodpecker thus was 103,420 km^2.

Tanner (1964) estimated the average density of the Imperial Woodpecker at one pair per 26 km^2, based on the average distance between three groups described in Nelson (1898). This may seem a large range, but is in the same order of magnitude as the densities found for the closely related Ivory-billed Woodpecker. In bottomland forest of the southern U.S.A. the maximum density of the Ivory-billed Woodpecker was one pair per 16 km^2 (Tanner 1942) and in disturbed pine forests of eastern Cuba one pair per 25 square miles or 65 km^2 (Lamb 1957). The low density of the Imperial Woodpecker is not necessarily in contradiction with the commonly heard opinion of local inhabitants that the woodpeckers were abundant. An average group of seven to eight Imperial Woodpeckers would range over 98 km^2, or a square of approximately 10 by 10 km. If the woodpeckers were constantly calling and moving through the open pine-oak woodland (as is apparent from the interviews), they would be seen regularly by anyone living in the area. Moreover, if a group would settle for some time in a patch with dead pines, they would frequently be encountered at such a site.

With an average density of one Imperial Woodpecker per 13 km^2, the 103,420 km^2 of original habitat could have held a total population of some 8,000 individuals or 1060 groups. In the Sierra Madre Occidental, the extinction peak between 1946 and 1965 may have involved a maximum of 4,300 individuals or 576 groups (figure 20: 60 % of the birds or groups that lived in 93,560 km^2 of habitat in the region). It seems conceivable that the factors described above could have been responsible for exterminating such numbers.

indications for the recent existence of Imperial Woodpeckers

There are 14 claims of sightings of the Imperial Woodpecker by local inhabitants since 1965, which will be discussed from case to case. Not listed here are reports that obviously referred to the Pale-billed Woodpecker *Campephlius guatemalensis* , nor claims of sightings from people who could not come up with a convincing description. The accepted and most of the rejected reports discussed come from informants who most likely had known the Imperial Woodpecker. These persons selected the correct bird in our illustration and gave a further convincing description of the Imperial Woodpecker (noted as "identification & description correct"). The crucial point in each case is if the year of the report is credible or not. The date of the observation is scrutinized against other reports from the same region, the status of the habitat and the overall impression the informant made in terms of reliability. In case of report 7, the recent observation is supported by possible workings found in the same area, which are discussed along with the report.

The descriptions of the reports are built up as follows: name and year of birth of observer; locality of the interview with co-ordinates; the description of the observed bird; the observation (in italics); a short discussion of the report.

accepted reports 1966-1990

(1) Cruz Reyes Romero, born 1934. Calabazas, southern Durango (23°12'39"N 104°59'48"W). Identification & description correct. *Last Imperial Woodpeckers around Calabazas could be seen between 1965 and 1970, shortly after a lumber mill opened there in 1965.* Mr. Reyes made the impression of being a careful observer, and his report is just after the extinction peak of 1946-1965. Imperial Woodpeckers likely held on a little longer in this area because forest exploitation started relatively late.

(2) Reyes Lozano, born 1935. Yahuirachic, central Chihuahua (28°34'00"N 108°09'50"W, figure 30). Identification & description correct. *Last Imperial Woodpeckers could be seen in the neighbourhood of Yahuirachic around 1970.* As with report 1, logging started in this area only in 1965. The recent occurrence of Imperial Woodpeckers in this general area was also reported to Plimpton (1977), who was told of sightings around 1970 in the vicinity of Cebadilla, 14 km NW of Yahuirachic.

(3) Buenaventura Murillo, born 1944. Huajumar, central Chihuahua (28°11'25"N 108°17'02"W). Identification & description correct. *Mr. Murillo saw his last Imperial Woodpecker near Huajumar between 1975 and 1980. Forest exploitation had been going on in this region since 1955.* Mr. Murillo's information on other topics (Thick-billed Parrot etc.) was very precise. Occurrence of the Imperial Woodpecker in this region around 1980 is confirmed by report 4.

(4) Ignacio Montañés, born 1925. Forest between Pinos Altos and Ocampo, central Chihuahua (approx. 28°13'N 108°20'W). Mr. Montañés did not want to look at the illustration to choose the Imperial Woodpecker, he gave the impression of being far sighted. He described the Imperial Woodpecker as a black and white woodpecker the size of a raven that could only be found in the highest parts of the mountains. *The Imperial Woodpecker disappeared gradually and when he saw his last one in 1980 or 1981 the bird had become very rare. Mr. Montañés said the forest in the region had been cut gradually and selectively at first.* Recent occurrence of the Imperial Woodpecker in this region is confirmed by report 3.

(5) José Soto, born 1918. Parajito (a sawmill on the road to Piélagos), central Durango (24°56'20"N 105°54'24"W). The illustration with woodpeckers to choose from was not available during this interview but Mr. Soto gave a convincing description of the Imperial Woodpecker. *Around 1945 the Imperial Woodpecker was still common. It disappeared gradually, last birds seen in the vicinity of Parajito between 1980 and 1982.* Recent occurrence of the Imperial Woodpecker in the Piélagos region is confirmed by report 7 as well as possible workings found in 1995.

accepted reports and possible workings 1991-1995

(6) Genaro Quintana Pérez, born 1933. Rancho La Tinaja de Moreno, northern Sonora (30°05'47"N 108°41'58'W, figures 18 and 28). Identification & description correct. The Imperial Woodpecker disappeared in the surroundings of Ciénaga de Horcones (30°11'12"N 108°37'42"W), where Mr. Quintana grew up, in 1948 when the forest was first cut there. Since 1973 Mr. Quintana lives at Rancho La Tinaja de Moreno and rides daily through the forest of Sierra Tabaco, looking after his cattle. *According to Mr. Quintana, the Imperial Woodpecker was never a resident bird in Sierra Tabaco. He came upon wandering solitary Imperial Woodpeckers there in 1977, 1990 and 1993. The woodpeckers of 1990 and 1993 had black crests (so females, possibly the same bird). In 1993 the bird was seen sometime between February and May. It disappeared to the south.* Mr. Quintana showed the sites of the last two sightings (the site of the 1977 sighting had now been logged). Both were snag-rich patches of old-growth forest in shallow canyons on the eastern slope of Sierra Tabaco. There were no workings that could be attributed to foraging Imperial Woodpeckers. In the whole Sierra Tabaco there is only 3 km^2 of this type of forest, scattered in shallow canyons. The region is very dry in general. In the highest part of Sierra Tabaco, as well as on the western slope, only low oak forest is found. Sierra Tabaco holds the only old-growth pine-oak forest in the wide surroundings, although mature (not primary) pine forest had been cut in the range south of El Macho (at 29°46'32" N 108°47'12" W), approximately 30 km to the south-west, in 1993. In this recently logged forest the snags had not been cut. Acorn Woodpecker granary trees had been plundered by some animal, though the wood fragments hacked or worked loose were not as big as the chips found at granaries in Piélagos (see report 7).

This report is considered credible because Mr. Quintana mentioned coming upon the Imperial Woodpecker in recent years rather nonchalantly, when we had not yet shown any special interest in the bird. His quick selection and description of the Imperial Woodpecker were totally convincing. Besides, the Pale-billed Woodpecker and Lineated Woodpecker do not occur in this part of Mexico. Mr. Quintana made the impression of being a sincere man and a careful observer. The habitat where he saw his last Imperial Woodpeckers fits the requirements of the species well (although the patches are small). Since Mr. Quintana rides daily through the forest and came upon the bird only twice in the past five years, it is understandable that such an occasionally visiting bird would leave no traces. Mr. Quintana was told by Rafael Romero from Nuevo Casas Grandes that he saw an Imperial Woodpecker, with a red crest, near Rancho Los Lobos (29°52'00"N 108°48'50"W, 23 km SWS of Sierra Tabaco) in 1994. The forest in that area is all logged. Mr. Romero could not be traced. Experience shows that such secondary reports are highly inaccurate.

(7) Jesus Martínez, born 1918. Arrancabarbas (24°45'22"N 105°55'48"W, near Piélagos, figure 14). Identification & description correct. *After not having seen Imperial Woodpeckers for several decades, Mr. Martinez saw a pair of Imperial Woodpeckers at Mesa Potrillos (24°46'00"N 105°54'39"W), in April or May 1993. The birds were wary and could not be approached closer than 80 m, while Imperial Woodpeckers used to be rather tame. At the time of the sighting, snags were abundant at Mesa Potrillos but they were cut a year later.*

One reason this report is convincing is that already in 1993, Mr. Martinez had told our guide, Armando Corral, about the sudden reappearance of the Imperial Woodpecker (the report was first heard of via Mr. Corral). Furthermore, the report is supported by the following: 6 km south of Mesa Potrillos, and west of the village of Piélagos, 12 km^2 of old-growth mesa pine-oak forest was found in April 1995. In this forest, workings were abundant that could be attributed only to a very large woodpecker. Most of the workings were excavations in pine snags and fallen logs with large -on average 10 cm- wood chips hacked out (W. L. Rhein observed Imperial Woodpeckers foraging on fallen logs [Tanner 1964], this in contrast to the Ivory-billed Woodpecker) From a few pines bark had been scaled in large flakes, and large chips had been excavated from the underlying wood. The outer wood layer of most granary trees of Acorn Woodpecker had been scaled, with wood fragments up to 40 cm removed (plate 8). Later, five of the informants on the Imperial Woodpecker (from three different villages) reported that Imperial Woodpeckers would

plunder the acorns from the granaries of Acorn Woodpeckers, under their loud protest. The workings were not older than a few months: the wood chips were of a fresh white or yellow colour and must therefore have been excavated after the rainy season that ended in November 1994.

It is highly unlikely that the workings were made by a Pale-billed Woodpecker *Campephilus guatemalensis*. This bird usually stays at elevations below 1500 m. Occasionally it can be found up to 2200 m, but always stays in humid corridors along streams. The workings, however, were found on a relatively dry mesa at an elevation of 2500 m. Moreover, the sheer dimensions of the chips and wood fragments looked too big even for a Pale-billed Woodpecker. No Pale-billed Woodpeckers were observed during 27 days of field work on the mesa. Plundering of Acorn Woodpecker granary trees by Pale-billed Woodpeckers has never been reported, even though the two species occur sympatrically over a wide range (northern Mexico to Panama). The Lineated Woodpecker *Dryocopus lineatus* can be ruled out altogether as the source of the foraging signs: this bird is never found at elevations above 1600 m.

During 27 days of fieldwork, between 30 March and 5 May 1995, in this forest and its wide surroundings no Imperial Woodpecker was seen or heard. No new workings appeared; their producer apparantly was no longer in the area. Possibly one of the woodpeckers from the Piélagos forest was seen approximately 20 km to the north-west in March 1995 by Gerónimo Ramírez (age 19). The drawing with the woodpeckers of the Sierra Madre Occidental was not available during the interview with Gerónimo. He did not know what kind of a bird a *pitorreal* was. When hinted it was a big woodpecker, Gerónimo told he had just once seen an unusual big woodpecker, a month before, along a mountain stream called El Porvenir. It was black with a lot of white in the wings and a red crest. When asked if it was the whole head that was red (as with the Pale-billed Woodpecker) Gerónimo answered no, only the crest. He indicated the bird was the size of an Imperial Woodpecker. It sat in a *cahuite* tree (*Pseudotsuga* ?) and never made a sound. Gerónimo tried to shoot the bird twice with a pistol but missed. The area of this sighting (approximately at 24°51'48"N 105°57'25" W, no GPS available during the fieldwork there) appeared to hold some uncut forest, about 1 km^2, with a few snags but no workings were found there.

With the hope that a wandering Imperial Woodpecker would return to the 12 km^2 of old-growth near Piélagos, the best habitat in the wide surroundings, this site was again visited in October 1995. More than half of the old-growth had been logged by then, and the rest was being opened up. There were no new workings.

rejected reports 1966-1993

(8) Higinio Ríos García, born 1935. Salsipuedes, northern Durango (26°04'23"N 106°05'12"W, figure 15). Identification & description correct. *When the birds were already gone for 20 years in the surroundings of Salsipuedes, Mr. Ríos García saw many Imperial Woodpeckers during a trip in the neighbourhood of Rancho Perez, near Bajío de Tarahumar, south of Quebrada de Río Colorado in 1973* (at approx. 25°37'N 106°19'W). One has to be sceptical with these "far away" reports, especially if it is about *many* Imperial Woodpeckers in the 1970s. Inhabitants of Bajío de Tarahumar region had earlier reported that the last Imperial Woodpeckers were seen there in the 1950s.

(9) Manuel Ríos García, born 1940. Salsipuedes, northern Durango (26°04'23"N 106°05'12"W, figure 15). Identification & description correct. *In 1965 the Imperial Woodpecker was still common in Salsipuedes, in 1975 the last one or two pairs were present in the area.* Several other people in Salsipuedes (e.g. the brother of Manuel Ríos García, report 8), as well as everybody else in other villages in this region, stated the Imperial Woodpecker was gone by the 1950s. Mr. Ríos García suggested that one or two pairs could still be seen regularly in 1975, so this rules out a chance encounter that other inhabitants might have missed. Moreover, Mr. Ríos García did not make the impression of being a person who would spend much time out in the mountains.

(10) Agustín Ramos (Tarahumar), born 1929. Gumercindo Torres interpreted. Pino Gordo, southern Chihuahua (26°32'20"N 107°00'37"W, figure 16). Description correct,

but Mr. Ramos did not choose a woodpecker in the illustration. *He saw his last Imperial Woodpecker south-east of Pino Gordo more than 10 years ago* (early 1980s ?). If Imperial Woodpeckers could still be seen in the vicinity of Pino Gordo in the early 1980s, younger people in Pino Gordo should also be familiar with the Imperial Woodpecker, which was not the case. Mr. Ramos said the wolf disappeared after the Imperial Woodpecker, and others in Pino Gordo (e.g. Porfirio Díaz Ramos) said the wolf disappeared more than 30 years ago.

(11) Filiberto Palomares, born 1955. Maíz Gordo, southern Durango (23°13'30"N 104°55'17"W, figure 10). Mr. Palomares was interviewed with a group of older men who had already selected and described the Imperial Woodpecker correctly. *He saw his only Imperial Woodpeckers, a pair, near El Marlote between 1980 and 1982.* At that spot there was no suitable habitat left in 1980 and the general opinion of the inhabitants of this region is that the Imperial Woodpecker was gone before 1965.

(12) Agustín Alvarez, born approx. 1945. Chachámuri, central Chihuahua (28°40'05"N 108°16'48"W). Identification & description correct. *The last Imperial Woodpeckers were seen in the vicinity of Chachámuri five or six years ago, maybe longer.* For Mr. Alvaréz "five or six years ago" seems to be synonymous with "a long time ago", since the time span in which Wolves and Black Bears had disappeared was described that way as well. Chachámuri is 18 km NW of Yahuirachic and the last Imperial Woodpeckers were seen there around 1970 (see report 2.)

(13) Crecencio Riveras (born 1935). Guanaceví, northern Durango (26°56'15"N 105°57'25"W). Identification & description correct. *In 1990 Mr. Riveras saw a group of five Imperial Woodpeckers at arroyo Las Trenjas, near Salsipuedes and Chaquaco. He heard of a sighting of three Imperial Woodpeckers near Ventana north of Ciénaga de la Vaca in 1994.* The report of the occurrence of Imperial Woodpeckers in the Salsipuedes region in 1990 is not supported by the information we got in Salsipuedes (see report 9). Besides, a group of five Imperial Woodpeckers in 1990 seems hardly credible. Mr. Riveras could not remember who would have seen the 1994 birds, and nobody else in this region ever heard of the sighting.

(14) Arturo Cordero (born approx. 1952). La Ciudad, western Durango (23°44'00"N 105°41'20"W). The Deputy Delegate of Environmental Affairs in Durango, Ing. Moreno, has a copy of Dana Gardner's illustration of the Imperial Woodpecker (Skutch 1985) on his office wall. Pointing at this illustration, *Mr. Cordero from La Ciudad said he had seen an Imperial Woodpecker (with a red crest) on several occasions in the southern extension of Quebrada de San Juan* (23°46'41"N 105°37'58"W) *in April 1994.* He described the correct size for the bird and said there was a large hole in a dead pine near the spot where he saw it in April 1994. In the field the habitat at this site appeared to be dry cut-over forest dominated by oaks with only a few thin pines. The hole was of the small Acorn Woodpecker *Melanerpes formicivorus* and now Mr. Cordero indicated the size of the bird he saw as about 35 cm. Two men who saw the same bird were interviewed independently. Without hesitation, they pointed at the Imperial Woodpecker in the drawing but described the size as about 35 cm. All observers said the bird had a red crest. After April 1994 the bird was not seen again, despite frequent visits to the area.

The habitat where the bird was seen seems totally inappropriate even for a wandering Imperial Woodpecker to have spent some time. Mr. Cordero's description of the Imperial Woodpecker was "polluted" by him being familiar with an illustration of the bird and at least his description of the size of the woodpecker hole was exaggerated. It is puzzling that the other two witnesses (who most likely were not familiar with an illustration of the bird) selected the Imperial Woodpecker correctly in our illustration. Although the size of the bird they indicated, seemed too small for an Imperial Woodpecker, later experiences showed that inhabitants of the Sierra Madre often indicate the size of only the body (the edible part) of a bird. The report is rejected on the basis of the unlikely habitat and the inconsistencies in Mr. Cordero's story.

Conclusions

Judging from interviews and the scant literature, the Imperial Woodpecker was a bird of the relatively flat plateaus in the highest parts of the Sierra Madre Occidental and the western part of the Central Volcanic Belt. The bigger pines and the large snags, on which the bird depended for both foraging and nesting, were present only in these parts of the sierras. Unfortunately, the mesas could easily be exploited by the logging industry. Nowhere in the Sierra Madre Occidental, today, does there remain a continuous old-growth mesa forest as large as 26 km^2, the average area estimated to be required by one pair of Imperial Woodpeckers (Tanner 1964).

In some cases, logging and the cutting of snags (which meant a sudden removal of all foraging and breeding sites) seems to have been the main cause of the local extinction of the bird. More often, before all old-growth and snags were logged, Imperial Woodpecker populations had been decimated by loggers and settlers who were armed with affordable .22 rifles. The main motivations for killing Imperial Woodpeckers were shooting for fun and the idea that parts of the birds had curative powers. Any chance for recovery from the large scale shooting was cut off by the ensuing modification of 99.4 % of the pine-oak habitat in the Sierra Madre Occidental.

Imperial Woodpeckers were often seen in groups. Most of the reported groups are too big to relate to a pair with the offspring of the year. Possibly groups of Imperial Woodpeckers, which were not necessarily related, could better exploit patchily distributed concentrations of dead pines with briefly peaking beetle larvae abundance. The occurence of Imperial Woodpeckers in groups does imply that the impact of habitat destruction and hunting could have been severe in an early stage. Larger old-growth forests would be required for groups than for pairs, while the hunting of a few individuals meant the end of group structure and functionality.

The pine-oak habitat within the original range of the Imperial Woodpecker measured some 103,420 km^2 and could have held 8,000 individuals or 1060 groups of seven to eight woodpeckers. This small population dwindled fast. The peak of local extinctions was between 1946 and 1965, when 60 % of the witnesses saw their last Imperial Woodpecker.

There are seven convincing reports of Imperial Woodpecker sightings after 1965, two of which stem from the 1990s. In central Durango, foraging signs were found that were possibly made by an Imperial Woodpecker during the winter of 1994-95. Putting the indications together, it seems possible that two solitary Imperial Woodpeckers survived at least up to 1993 and 1995, respectively. These last reported Imperial Woodpeckers appear loosely associated with two of the main old-growth fragments in the Sierra Madre Occidental (one of which has now been logged). They would be widely separated from each other - a distance of 730 km between central Durango and northern Sonora. The woodpeckers would be forced to wander over large areas for foraging, while nowhere does a sufficiently large, continuous area of optimal habitat remain. It is unlikely that there are more lonely wanderers besides the two reported birds, since no indication for the recent existence of Imperial Woodpeckers was found in the other remaining old-growth fragments in the Sierra Madre Occidental. There is no reason to expect the situation to be any better in the western part of the Central Volcanic Belt. In short, a few Imperial Woodpeckers may still exist, but nevertheless extinction of the species seems inevitable.

In all likelihood, all that will be left of the Imperial Woodpecker are some 120 skins in the museum collections of the world (Collar *et al.* 1992). There are no photos of living birds or sound recordings. Nelson (1898) will remain the main source on the biology of the species. Some of the information from local inhabitants who have known the Imperial Woodpecker, a source that is dying out, has been recorded in Fleming and Baker (1963), Tanner (1964) and this study. As far as the habitat of the bird is concerned, efforts are being made to conserve the only remnant of mesa forest, El Carricito near Bolaños in Jalisco (figure 7). Bolaños is also the probable locality where the type specimens of the Imperial Woodpecker were collected (see Nelson 1898 and Collar *et al.* 1992 for a discussion). If El Carricito can be effectively protected, future generations will at least be able to see the kind of forest in which the Imperial Woodpecker lived. Appropriately, this monument is located in the very area where the species' brief and fatal encounter with modern civilization began.

Notes on the distribution and conservation of the Thick-billed Parrot *Rhynchopsitta pachyrhyncha*

The Thick-billed Parrot *Rhynchopsitta pachyrhyncha* is endemic to the pine-oak mountain forests of north-west Mexico and, historically, Arizona and New Mexico. Year-round its food consists mainly of pine seeds. During the winter season nomadic groups of Thick-billed Parrots range south into the western part of the Central Volcanic Belt, i.e. to Jalisco and Michoacán and possibly even Estado de México and Veracruz (Collar *et al.* 1992). The Thick-billed Parrot breeds in holes, mostly in standing dead pines, at altitudes above 2300 m in the northern part of the Sierra Madre Occidental (Lanning and Shiflett 1983). Originally the breeding range may have extended north into southern Arizona, where reintroduction has been attempted since 1986 (Snyder *et al.* 1994). The Thick-billed Parrot has probably declined sharply in the course of the 20th century, the most serious threat being the removal of nesting sites through the cutting of snags and mature pines (Collar *et al.* 1992).

During the fieldwork of the Mexican Mountain Forest - Imperial Woodpecker Project the status has been assessed of the pine-oak habitat throughout the Sierra Madre Occidental. Furthermore, observations have been made of Thick-billed Parrots both in the winter and in the breeding season (June to October; Lanning and Shiflett 1983). The additional information thus obtained on the distribution and conservation status of the Thick-billed Parrot will be discussed here.

Methods

In the non-breeding season of the Thick-billed Parrot fieldwork was carried out in northern Jalisco and southern and central Durango, from November 1994 to May 1995. Thick-billed Parrots were looked for during the ground-truthing of predicted old-growth and snag-rich areas. Local inhabitants were interviewed on the occurrence of Thick-billed Parrots. Some confusion arose from both the Thick-billed Parrot and the Lilac-crowned Parrot *Amazona finschi* being called 'perico' in southern Durango (see appendix 6). Asking whether the birds occur in large groups (as only Thick-billed Parrots do) and if the birds can be taught to 'talk' (only Lilac-crowned Parrot) proved more clarifying than the use of an illustration. In the breeding season nesting locations were searched by following leads from interviews, from central western Durango to northern Chihuahua and Sonora. Furthermore, six out of the 10 nesting locations found by Lanning and Shiflett (1983) were either searched in the field or information on the continued presence of Thick-billed Parrots was obtained from local inhabitants and forestry people.

Foraging and breeding locations were recorded with the aid of a GPS. Nesting and feeding trees were identified following Perry (1990). From 3 to 13 July 1995 drinking and bathing Thick-billed Parrots were observed and photographed from a blind at a waterfall in northern Chihuahua.

Observations during the winter season

Judging from interviews, foraging Thick-billed Parrot groups do occasionally visit almost any spot in the pine-oak zone of the Sierra Madre Occidental. This includes the Sierra de los Huicholes in northern Jalisco. A notable exception is the relatively warm region at altitudes below 2200 m on the Pacific slope in southern Durango (e.g. El Gallo and La Formación, figure 11). Yet during 91 days of fieldwork in potential wintering grounds of the Thick-billed Parrot, only four foraging groups were observed. This indicates that the Thick-billed Parrot is not at all abundant, at least as a winter visitor in the southern part of the Sierra Madre Occidental. The groups consisted of 30, about 40, about 32 and 13 Thick-billed Parrots respectively (see appendix 1). A group of 120 Thick-billed Parrots has been reported near San José de las Causas, western Durango, in January 1995 (J.R. Bacon pers. comm.). Historically, wintering groups seem to have been bigger: Smith (1907) reported a flock of 700 to 1000 parrots and many elder inhabitants of the Sierra Madre Occidental remember groups of that size. Two of the groups (of about 32 and about 40) were observed in the same general area, around San Blas in western Durango, near the proposed reserve Las Bufas. The group of about 32

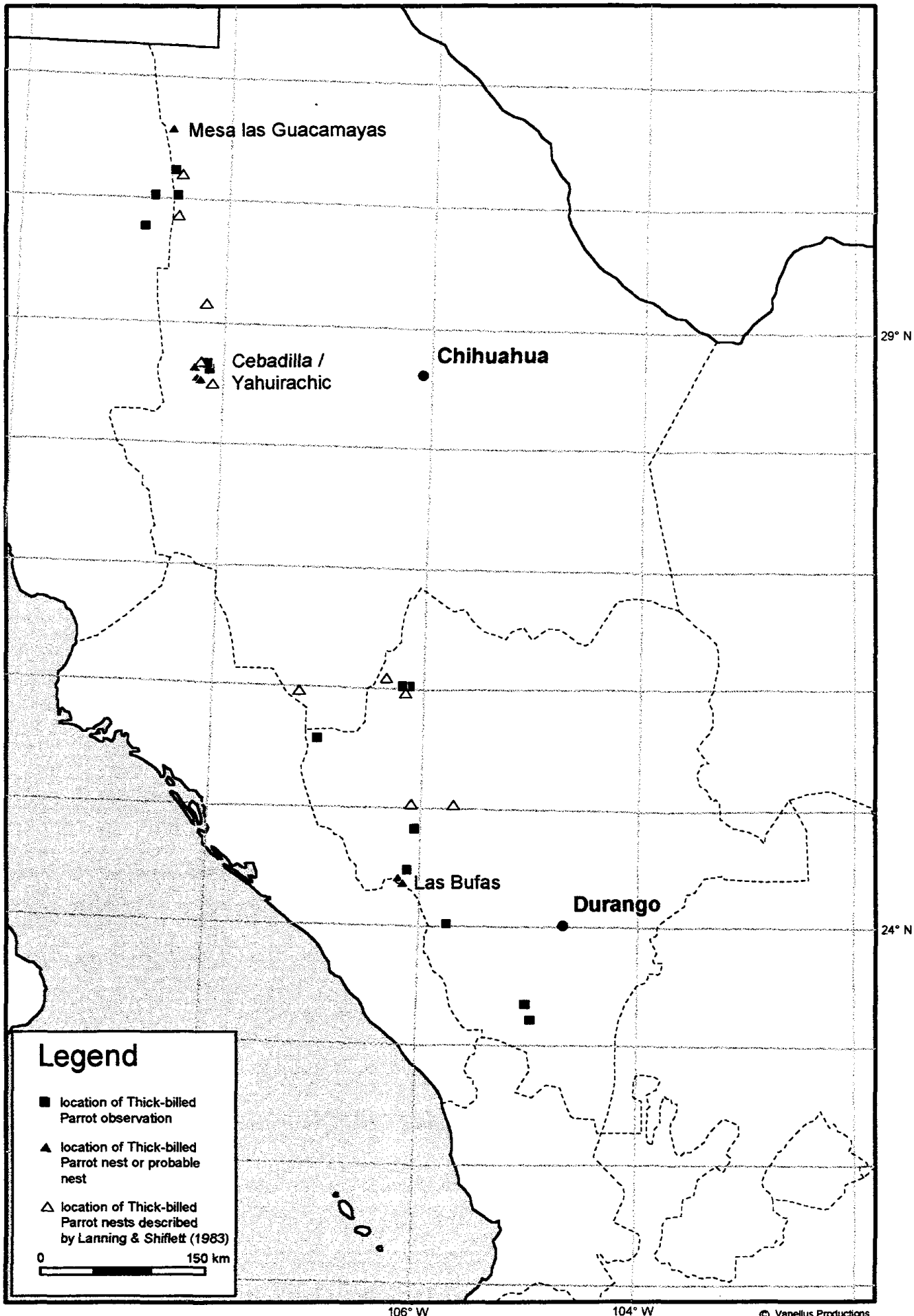


Figure 22. Locations of Thick-billed Parrot observations and nests, and the nesting locations reported by Lanning and Shiflett (1983). For details, see appendix 1

Figura 22. Ubicación de las observaciones y los nidos de Cotorra Serrana, así como las localidades de anidación reportadas por Lanning y Shiflett (1983). Para más detalles ver el apéndice 1

was seen to go roosting just under the summit of one of the highest mountains (2540 m) in the region, probably in pines although the distance was too great to judge where they landed. Thick-billed Parrots were observed feeding on the seeds of *P. cooperi* (J.R. Bacon pers. comm.), *Pinus lumholtzii* (plate 10), *P. engelmanii* and *P. chihuahuana*. In August Thick-billed Parrots were foraging on green cones of *Pinus ayacahuite* that dripped with resin. All foraging observations were made in selectively-logged or secondary pine-oak forest.

Observations during the breeding season

Figure 22 shows the nesting and other observation locations found, as well as the breeding locations reported by Lanning and Shiflett (1983). The northernmost site where Thick-billed Parrots currently breed in Mexico most probably is Mesa Las Guacamayas in northern Chihuahua, at 84 km from the US border and in the northernmost extension of the Sierra Madre Occidental. The southernmost breeding location found is Las Bufas in western Durango. Further south local inhabitants said Thick-billed Parrots were known as winter visitors only. Fleming and Baker (1963) obtained similar information at Rancho Las Margaritas, southern Durango.

There apparently is a gap in the breeding distribution in southern Chihuahua, where no nests have been found despite several searches (Uranga-Thomas and Venegas-Holguín 1995, N.F.R. Snyder *in litt.*, E. Bustillos and R. Gingrich pers. comm., this study). This gap may be caused by habitat modification: the southern Chihuahua region belongs to the most disturbed areas in the Sierra Madre Occidental, and even in the old-growth forest of Pino Gordo nearly all snags have been cut manually for fire wood. An alternative explanation is that the natural forest characteristics in southern Chihuahua do not suit the requirements of breeding Thick-billed parrots. Most of the forest in southern Chihuahua is rather poor, stunted forest on a rocky soil. In contrast, the three breeding areas studied all lay in relatively humid and well developed forest. Perhaps only in such areas is there an adequate supply of seeds in terms of variety and quantity.

Las Bufas (figure 27) may be the only area where Thick-billed Parrots can be observed year-round. Within that region, there are probably altitudinal movements between the seasons: the nesting snags were found at altitudes of 2720 and 2820 m, while the two foraging groups in March were seen around 2100 m.

Information was obtained on the current occurrence of breeding Thick-billed Parrots at six of the 10 breeding areas located by Lanning and Shiflett (1983). No efforts were made to find as many nests as possible at these sites: because Lanning and Shiflett did not locate all nests, a comparison for trends would not be possible. From north to south the findings at the localities are as follows (with Lanning and Shiflett's numbers of nests between brackets):

Azules (2): one Thick-billed Parrot was seen and a second individual was heard. José Jurado showed several former breeding holes but none of these seemed occupied.
Madera (13): Ing. Alfonso Domínguez of the forestry unit in Madera reported that many Thick-billed Parrots breed in a region west of Madera at approx. 29°07'N 108°25'W.
Cebadilla (18) and Vallecillo (2) region: three nests were found. Furthermore, many more Thick-billed Parrots were heard or seen there, with the biggest groups consisting of 12 at Cebadilla and 38 birds near Yahuirachic.
Cócono (5): according to Mónico Cano, Thick-billed Parrots became increasingly scarce with the cutting of snags. The last parrots bred in 1993.
Vacas (= Ciénaga de la Vaca ?) (6): no Thick-billed Parrots could be found at several spots where Crecencio Riveras, a local deer hunter, had known nests in previous years. A group of 25 Thick-billed Parrots was seen at Quebrada de Peñol, 20 km NNE of Ciénaga de la Vaca.

The only locality where Thick-billed Parrots seem to have disappeared since the fieldwork by Lanning and Shiflett in 1979 is Cócono, due to habitat destruction. The areas where the largest numbers of nests were found, Madera and the Cebadilla, still support relatively high numbers of Thick-billed Parrots. Breeding locations may therefore be more stable then suggested in Collar *et al.* (1992), who speculated that the parrots

breed opportunistically wherever a good pine crop is available. Information from local inhabitants and the name of one breeding area, Mesa las Guacamayas ("Thick-billed Parrot Mesa") indicate that breeding sites can be traditional.

At Mesa las Guacamayas there was only one probable breeding pair found in early August, with five other pairs moving around in the region. These pairs were inspecting many different tree cavities but did not seem attached to one specific hole. They were probably non-breeders since the latest laying date reported by Lanning and Shiflett (1983) was late July. A possible explanation for the failure of these birds to breed may be food shortages caused by the severe drought in northern Chihuahua and Sonora in the summer of 1995. Snyder *et al.* (1994) reported that such droughts resulted in poor pine seed crops in Arizona; yet some pairs of introduced Thick-billed Parrots attempted to breed but failed. A group of 38 Thick-billed Parrots observed on 21 August near Yahuirachic were not necessarily non-breeders since breeding Thick-billed Parrots have been observed to join flocks (D.V. Lanning *in litt.*).

Near Rancho El Gavilán drinking and bathing Thick-billed Parrots were observed and photographed at a waterfall of approximately 23 m of height (plate 9). The parrots visited the waterfall on 14 occasions between 3 and 13 August 1995, the largest group consisting of 23 birds. The parrots usually disappeared to the north-west and flew at least a few kilometres. Their breeding locality may be the Ojo Negro site of Lanning and Shiflett (1983). This waterfall is probably the same waterfall in the northern Sierra Madre Occidental that Marshall (1957) was told of as a spot where thousands of Thick-billed Parrots come to drink.

The four occupied nesting snags that were found (appendix 1) all fell within the range of characteristics reported by Lanning and Shiflett (1983).

Habitat status and threats

The mesa forests at altitudes above 2300 m, where Thick-billed Parrots breed, are easily accessible to the logging industry and have been all but completely exploited. Extensive areas have been turned into young secondary forest by repeated cutting and offer no potential breeding sites. All Thick-billed Parrots now breed in selectively logged forest where some or all snags have been left. Large scale exploitation of snags still occurs (plate 6). In Chihuahua, there seem to be restrictions among some forestry units resulting from a state level guideline. Such initiatives fortunately include the Thick-billed Parrot breeding areas of Cebadilla / Yahuirachic and Madera. Three important breeding areas of Thick-billed Parrots -Mesa las Guacamayas, Cebadilla /Yahuirachic and Cócono / La Medalla- have now been proposed to be protected from the exploitation of snags (figures 29 to 31). This protection has been implemented by SEMARNAP (Secretary for Environmental Affairs, Natural Resources and Fishery) in Durango for the Cócono / La Medalla area in 1996. Deforestation rarely occurs in the Sierra Madre Occidental and young pines with seeds for foraging seem widely available to the parrots. Yet it cannot be ruled out that an altered species composition and age distribution of these pine forests negatively influences the availability of feeding sources.

In Las Bufas, a group of loggers had cut down a nesting tree to obtain young for the pet trade, though the parrots died in the crash. This is reportedly a common practice in the region. No shooting of Thick-billed Parrots was heard of anywhere.

Two times it was observed that foraging flocks of Thick-billed Parrots grouped in the air when a Red-tailed Hawk *Buteo jamaicencis* flew over; the hawks did not attack. Snyder *et al.* (1994) reported predation on introduced Thick-billed Parrots by Red-tailed Hawks. The grouping behaviour seems an effective anti-predator strategy that would be diminished if parrot numbers dwindle further.

A PhD study including fieldwork on the Thick-billed Parrot, with funding from WWF, is now set up under the supervision of Dr. E. Enkerlin of the Technical University of Monterrey.

Conclusions

There are several indications that populations of the Thick-billed Parrot have sharply declined: the scarcity of encounters with Thick-billed Parrots during the winter season, the small size of the winter groups and low numbers at the waterfall in northern

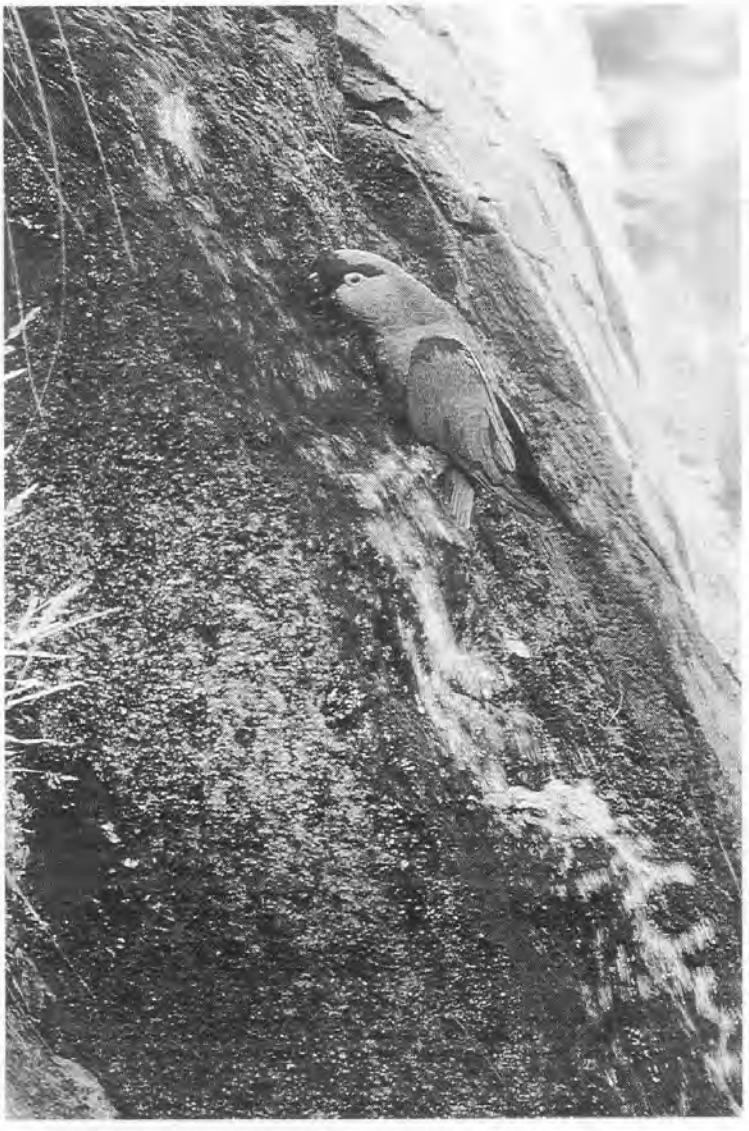


Plate 9. Thick-billed Parrot *Rhynchopistta pachyrhyncha* drinking at waterfall, Rancho El Gavilán, northern Chihuahua, July 1995
Lámina 9. Cotorra Serrana Rhynchopsitta pachyrhyncha *abrevando en una cascada, Rancho El Gavilán, norte de Chihuahua, julio de 1995*

Plate 10. Thick-billed Parrots foraging on seeds of Lumholtz pine *Pinus lumholtzii*. San Blas, western Durango, March 1995
Lámina 10. Cotorras Serranas alimentandose con semillas de Pino Triste Pinus lumholtzii, *San Blas, occidente de Durango, Marzo de 1995*

Plate 11. Female Eared Trogon *Euptilotis neoxenus* at entrance of nest hole, Mesa las Guacamayas, northern Chihuahua, August 1995
Lámina 11. Hembra de Coa Silbadora Euptilotis neoxenus *a la entrada de una cavidad de anidación, Mesa las Guacamayas, norte de Chihuahua, Agosto de 1995*

Plate 12. Tufted Jay *Cyanocorax dickeyi*, Carboneras, western Durango, March 1995
Lámina 12. Urraca Pinta Cyanocorax dickeyi, *Carboneras, occidente de Durango, Marzo de 1995*

Chihuahua (both compared to historical records). The breeding range is limited to the high mesa forests from northern Chihuahua and Sonora to central Durango, with an apparent gap in southern Chihuahua. Many of these forests have been turned into secondary forest without suitable snags for breeding. Thick-billed Parrots now breed in selectively logged forest where some or all snags remain. They do show fidelity to breeding sites located in 1979 (Lanning and Shiflett 1983).Three important breeding areas of Thick-billed Parrots have been proposed for restriction of exploitation of snags. Las Bufas in western Durango, a proposed totally protected reserve, may be the only area where Thick-billed Parrots breed and can be seen throughout the year. This would be a prime locality for further studies of the species. A guess for the current total population of the Thick-billed Parrot would be between 500 and 2000 pairs.

Distribution, habitat and status of the Eared Trogon *Euptilotis neoxenus*

The Eared Trogon *Euptilotis neoxenus* represents a monospecific genus that is endemic to the pine-oak forests of the Sierra Madre Occidental, the western part of the Central Volcanic belt and, incidentally, southern Arizona and New Mexico. It is a year-round resident, showing some post-breeding wandering, that breeds in snags. Collar *et al.* (1994) listed the Eared Trogon as Endangered, based on the impression that the species is "very locally distributed", "very uncommon" and "threatened by the wide-spread destruction (or modification) of its habitat".

During the fieldwork of the Mexican mountain Forest - Imperial Woodpecker Project the status of the pine-oak forest in the Sierra Madre Occidental has been assessed and Eared Trogons were observed throughout the region. Combining the information on the distribution and habitat of the Eared Trogon, and status of the pine-oak forests, insight has been gained into the conservation status of the Eared Trogon.

Methods

Eared Trogons were looked for during ground searching for old-growth and snag-rich areas from November 1994 to October 1995. The birds were located often only by their calls. Locations of observations were registered with the aid of a GPS, along with a short description of the habitat. Pines were identified following Perry (1990). Interviews did not prove very helpful in the case of the Eared Trogon, since local people in general make no distinction between the three similar trogons of the Sierra Madre Occidental (appendix 6). From 5 to 7 August 1995 observations and slides were made from a blind near a nest.

Distribution and habitat

Eared Trogons were observed at 55 locations throughout the Sierra Madre Occidental (figure 23, appendix 2). In fact, it is hard to find an area where no Eared Trogons occur. Table 2 gives the number of Eared Trogons encountered per 100 observation hours in three different forest types within the pine-oak zone: canyon forest, dry-open forest and

	canyon forest	dry-open forest	mesa forest	X^2
Oct. -March	(45/130) **34.6**	(11/116) **9.5**	(2/61) **3.3**	34.7, ***P*<0.01**
April -June	(9/56) **16.1**	(3/40) **7.5**	(6/92) **6.5**	5.5, **N.S.**
July-Sept.	(14/68) **20.6**	(2/47) **4.3**	(0/0) **----**	10.7, ***P*<0.01**
Jan.-Dec. (year-round)	(68/254) **26.8**	(16/203) **7.9**	(8/153) **5.2**	20.8, ***P*<0.01**

Table 2. Eared Trogon numbers observed per 100 hours in primary canyon, dry-open and mesa forests within the pine-oak zone of the Sierra Madre Occidental. Between parenthesis are the number of Eared Trogons observed and number of hours spent in each forest type and season. October to March is the non-breeding season and the weather is cool and dry. April to June is the mating season (whistling can be heard often), the weather is warm and dry. July to September is the nesting season, the weather is warm with afternoon thunderstorms

Tabla 2. Número de Coas Silbadoras observadas durante un periodo de 100 horas en bosque maduro de cañones, bosque maduro abierto y seco, así como en bosque maduro de mesa dentro la zona de pino-encino de la Sierra Madre Occidental. Entre paréntesis está el número de Coas Silbadoras y el número de horas pasado en cada tipo de bosque y en cada temporada. De octubre a marzo es la temporada no reproductiva y el tiempo es fresco y seco. De abril a junio es la temporada de apareamiento (el silbido puede escucharse a menudo), el tiempo es cálido y seco. De julio a septiembre es la epoca de anidación, el tiempo es cálido con tormentas vespertinas

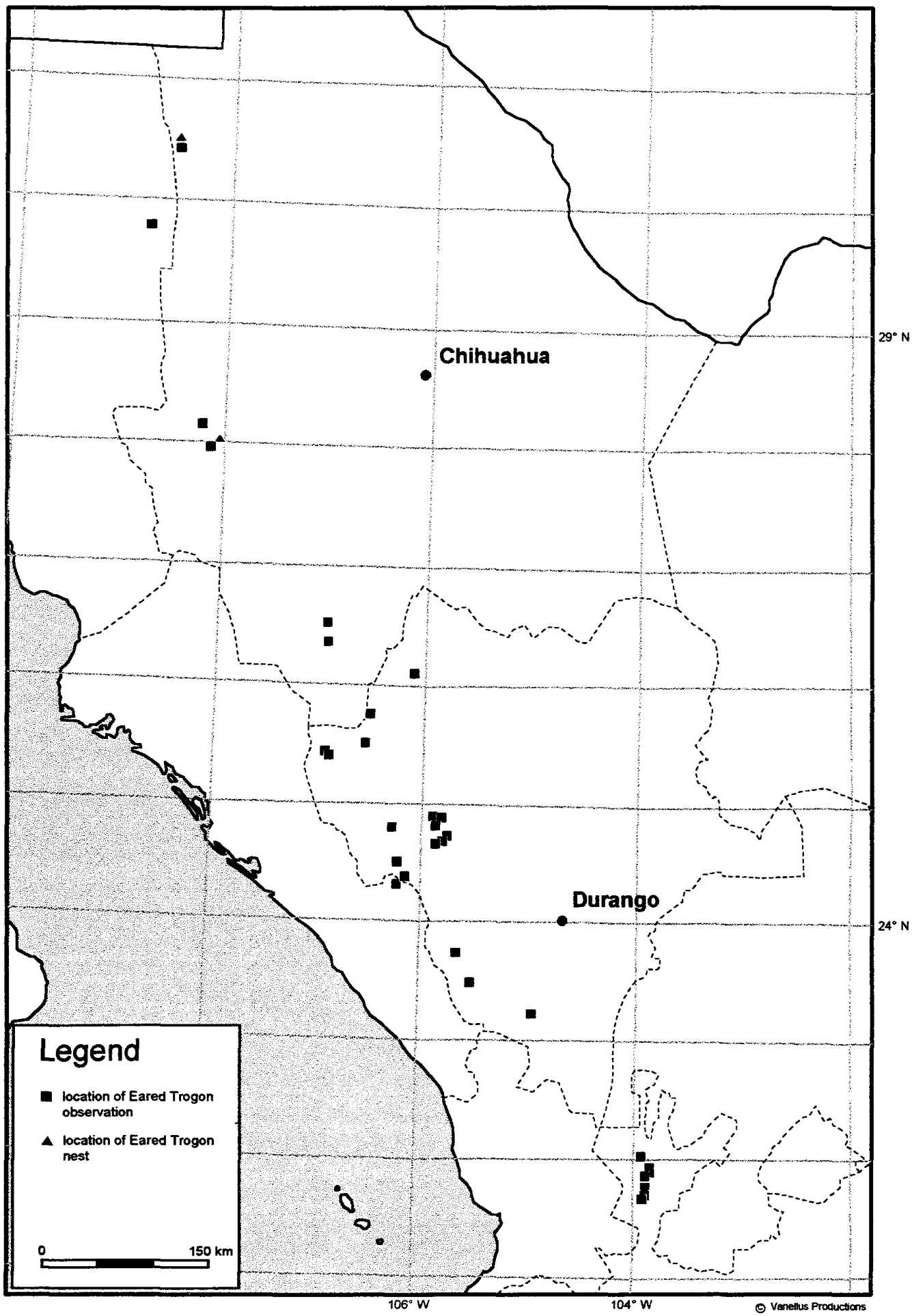


Figure 23. Locations of Eared Trogon observations and nests. For details see appendix 2
Figura 23. Ubicación de las observaciones y los nidos de Coa Silbadora. Para más detalles ver el apéndice 2

mesa forest. For a description of these forest types, see page 12. In all seasons, more Eared Trogons were observed in canyon forest than in the other forest types. This bias is significant for the non-breeding season (October to March) and the nesting season (July to September), as well as for the year-round total. Only observations in uncut areas have been considered here. It can not be ruled out that more Eared Trogons were observed in primary canyons because nearby mesas had been logged. However, few Eared Trogons were found in old-growth mesa forest (table 2). It is therefore unlikely that the high numbers found in canyon forest are made up mainly of "refugees" from logged areas. In canyon pine-oak forest, a solitary Eared Trogon, pair or group is encountered on average every 9 hours, i.e. each full day of fieldwork. In its proper habitat the Eared Trogon is a common bird.

Besides the 33 locations for the Eared Trogon that have been identified in primary forest, there are also 21 locations in disturbed forest. Most of these were found through incidental road side observations. It is therefore not possible to express the effort to find Eared Trogons in disturbed habitat in hours, so a comparison of the relative abundance in disturbed and undisturbed habitat, or between different disturbed forest types, cannot be made. Clearly, however, it is not unusual to find the Eared Trogon in disturbed pine-oak habitat. Seven of the locations were in secondary forest and 13 in selectively-logged forest.

Two active nests were found during this study; both were located in pine snags in undisturbed riparian corridors in canyons, with the nearby mesa forest logged (plate 3). No details on the habitat of the few previously described nests is given in Collar *et al.* (1992). The ability, and probable preference, of the Eared Trogon to breed in riparian corridors may well be the explanation why it can still be found even in largely logged areas. Corridors in canyons are often inaccessible and untouched. Furthermore, at least on paper, riparian corridors are protected from logging to avoid erosion. The Eared Trogon is a bird of moderate size for which relatively small snags and the small holes of the ubiquitous Acorn Woodpecker *Melanerpes formicivorus* suffice. Altogether, the Eared Trogon is much less vulnerable to the impact of logging operations than the other snag-dependent endemic birds of the Sierra Madre Occidental, the Imperial Woodpecker and the Thick-billed Parrot. For habitat parameters of the nesting locations found, see appendix 2.

Behaviour

The Eared Trogon appears to be a shy bird which often cannot be approached closer than 100 m. This wariness may be the explanation why few Eared Trogons have been reported previously: Collar *et al.* (1992) list a total of only 32 registrations for the Sierra Madre Occidental. Eared Trogons are most easily found by their calls. Year-round the *wheeeuh chk* call and *ka-ka-kak* flight call can be heard. Whistling series are produced by both males and females, from March to October.

In the non-breeding season, two large groups of Eared Trogons were observed: at least 16 on 26 January 1995 and at least 10 on 5 March 1995. Another four groups of three to four birds, and two pairs, were observed in the period October to March. Thus it seems that Eared Trogons mostly occur in groups during the non-breeding season. Only solitary birds and pairs were observed between April and September.

On one occasion was an Eared Trogon observed foraging. A male started from a horizontal branch and caught a moth with a wing span of approximately 6 cm after a short, upward fluttering sally ("sally-stall", Remsen and Robinson 1990) from between the green pine needles of another branch. It took the moth to a second horizontal branch, where it beat the moth a few times against the branch, then ate it completely. This was in selectively logged forest. The overview given in Collar *et al.* (1992) shows that most feeding involves insects and fruits (especially madrones). Sufficient amounts of such food items likely can be found in selectively logged forest.

A nesting pair that was observed from a blind from August 5 to 7, 1995, probably was breeding: no begging calls were heard from the nest hole. The female spent 54 % of the observation time (1478 daytime minutes in total) on the nest, the male 33 %, while the nest was left unoccupied 13 % of the time. During the night the nest was occupied by the female, who was released by the male between 5 minutes before, to 25 minutes after

sunrise. When the male announced its arrival by *wheeeuh chk* and flight calls, the female would whistle softly from within or close to the nest.

Conclusions

The Eared Trogon appears to be widely distributed throughout the Sierra Madre Occidental. It is a common bird in primary canyon forest within the pine-oak zone. Eared Trogons were also frequently observed in disturbed forest. Nests were found, within largely logged areas, in inaccessible riparian corridors in canyons. The ability to breed in riparian corridors is the probable reason why the Eared Trogon is still common despite nearly total modification of the pine-oak habitat. The erroneous notion that the Eared trogon is a local and rare species must stem from the paucity of field studies in the Sierra Madre Occidental and the wariness of the bird, which means it is mostly to be detected by its vocalizations. Since no exploitation of riparian corridors is to be expected in the near future, populations of the Eared Trogon can be regarded as stable. Still, this species would benefit from a forest management that favours the retention of snags. In view of the findings, the Eared Trogon could be removed from the list of threatened birds.

Notes on some other birds and mammals

Tufted Jay *Cyanocoarax dickeyi*

The spectacular Tufted Jay, a co-operative breeder, is found only in a limited area in the southern part of the Sierra Madre Occidental. It occurs in humid canyons on the Pacific slope of the sierra, from southern Durango and Sinaloa to northern Nayarit. The distribution given in Crossin (1967) runs only 210 km from north to south, with the Río de Presidio river as northern limit. However, in this study Tufted Jays were found in Las Bufas, 64 km north-west of the nearest stretch of the Río Presidio (figure 24). The actual northern limit of the range is probably formed by the San Lorenzo / Los Remedios river complex, just north of Las Bufas. Further north no Tufted Jays were found. The extended range of the Tufted Jay measures about 295 km from north to south, still a very limited distribution.

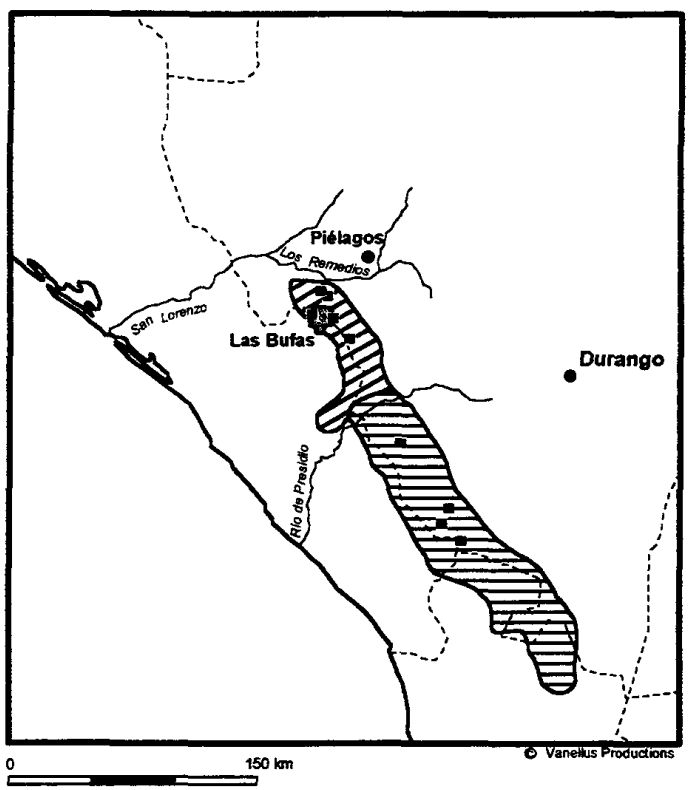


Figure 24. Distribution of the Tufted Jay
Figura 24. Distribución de la Urraca Pinta

The Tufted Jay is listed in Collar *et al.* (1994) as "near-threatened". This seems a good judgement of the status of the species. Although it may be vulnerable because of its limited distribution, the canyons where Tufted Jays occur are hardly accessible to logging operations. Groups of Tufted Jays occasionally wander into the mesa forests at higher altitudes but do not seem to avoid heavily logged areas. Ceballos-Lascurain (1987) proposed a reserve of 2.9 km^2 in Calaveras for the Tufted Jay (figure 11), which was

approved by the state of Durango in 1995. Mexiquillo (figure 12) holds 9.7 km^2 of protected Tufted Jay habitat. In the proposed reserve of 'Las Bufas' (figures 13 and 27) 91.4 km^2 of canyon forest with Tufted Jays is included.

In contrast to Crossin (1967), who only once saw a Tufted Jay on the ground, in Calaveras Tufted Jays foraged in the litter on the forest floor on five occasions.

Spotted Owl *Strix occidentalis*

The Spotted Owl occurs in the western U.S.A. and in northern Mexico. The Mexican subspecies *S.o.lucida* is known to tolerate warmer and drier environments - up to bare rocky canyons in the Utah desert- than the subspecies *S.o. caurina* from the Pacific coast forests in the north-western U.S.A. (D.W. Willey pers. comm.). In heavily logged, secondary pine-oak forest in Sierra los Ajos, an estimated population of 14 pairs of Spotted Owl is found (M. Cirett pers. comm.; Sierra Los Ajos is an isolated mountain range in northern Sonora, 80 km north-west of the main Sierra Madre Occidental). During the fieldwork in the Sierra Madre Occidental, Spotted Owls were heard at four locations. Two were in old-growth canyon forest (Las Bufas and Monte Oscuro, figures 13 and 10), one in old-growth mesa forest (El Carricito, figure 7) and one in secondary mesa forest (appendix 3). The first three locations are included in the system of proposed protected areas. The low number of observations indicates that the Spotted Owl is distributed rather locally in the Sierra Madre Occidental, though no systematic efforts -e.g. play-back of calls- for an inventory were made.

Golden Eagle *Aquila chrysaetos*

The Golden Eagle has a holarctic distribution. It is listed as endangered in Mexico (Anonymous 1994 a). Extensive studies funded by the state of Durango have been made to assess the status of the Golden Eagle (e.g. Casillas-Orona 1991, Nocedal-Moreno 1993). The Golden Eagle suffers from eating poisoned bait for Coyotes and from hunting, because people think Golden Eagles kill small domestic animals (Rodríguez-Estrella and Nocedal-Moreno 1985). In the Sierra Madre Occidental, Golden Eagles were observed on five locations during this study, always near steep rock walls (appendix 3).

Black Bear *Ursus americanus*

The Black Bear has been eliminated from most of its historic range in the Sierra Madre Occidental. It still occurs in extreme north-eastern Sonora and north-western Chihuahua. In this region, tracks of Black Bears were found near El Macho (10 km south-west of Mesa Tres Ríos, figure 18). Local reports come from Sierra Tabaco (figure 18), Rancho El Gavilán, Ciénaga de Horcones (figure 28), Los Azules and Mesa las Guacamayas (figure 29). The southernmost report in Chihuahua is from the Cebadilla / Yahuirachic region in the centre of the state (figure 30). An estimated population of six Black Bear is found in Sierra los Ajos in northern Sonora (M. Cirett pers. comm.; see account on Spotted Owl). Other isolated Black Bears are reported from two sites in Durango. Several people told of bears occuring in Quebrada de Peñol (figure 15), though no tracks were found during three days of fieldwork there. In the southern part of Durango, Mr. Venegas from Las Espinas reported a "brown" bear in an area known as "Cordon Cielos del Aguila" or "Joya del Arado". Both remain untraced but must be in the Las Espinas / Taxicaringa region. There are also rumours of the occurrence of Black Bear in the canyons on the west side of El Carricito (figure 7).

It is unclear why the Black Bear is able to hang on in the northern part of the Sierra Madre Occidental while the mountains there are no less inhabited or exploited than further south. Possibly the population in the north is made up in part of wandering animals from the U.S.A..

Although the study area is within the historic range of the Grizzly Bear *Ursus horribilis*, none of the informants had any recollection of this species. The Grizzly Bear is supposed to be extinct since around 1958; the last reports came from Sierra los Nidos in northern Chihuahua. Several people indicated that two different kinds of bear were to be found in a given area, but they were almost certainly referring to different colour phases of Black Bear since the colour of the pelt was the only difference mentioned.

Mexican Wolf *Canis lupus baileyi*

The most recent reports of Mexican Wolves came from Sierra Tabaco (figure 18) and Rancho El Gavilán, 20 km east of there, where they were known in the early 1970s. Intensive poisoning campaigns with "1080" succeeded in exterminating the wolf from most of the Sierra Madre Occidental by the 1960s. One of the last reports is from 1985 in Durango (Servín-Martínez 1986).

Steinhart (1995) describes an incident near Mesa Tres Ríos, northern Sonora, involving a cow supposedly killed by wolves in 1991. While investigating this story during the fieldwork in Sonora, another case was reported of a cow being killed by wolves in 1993. Both cases were reported by relatively young men with no experience with wolves. They were convinced by Jesus Ruiz, an older rancher who has since died, that the cowes were killed by wolves. However, they could give no clear reason or evidence for why they believed the cows' deaths to have been caused by wolves, and not Mountain Lions *Felis concolor*. All elder informants in this region agreed that the Mexican Wolf was eliminated by 1960. Until these two incidents there had been no reports of wolves, neither has there been any since.

Though the wolf might be less affected by the widespread modification of the pine-oak habitat than the snag-dependent endemic birds, it was persecuted directly by the inhabitants of the Sierra Madre. Since these mountains appear to be inhabited everywhere, and most inhabitants hold free ranging cattle, it is unlikely that even the smallest population of wolves could have escaped persecution. The only chance for the Mexican Wolf lies in reintroduction of captive animals, of which about 130 are held (García-Moreno *et al.* 1996). The wilderness around Sierra Tabaco (figure 28) would be a prime area for such initiatives.

Priority areas for conservation in the Sierra Madre Occidental

Only very few old-growth areas remain in the Sierra Madre Occidental (figure 4). These forests are the last intact remnants of a habitat that is now recognized for its high biological diversity and endemism. The sites are all threatened by logging in the near future, so protective measures are urgently needed. Below a system of reserves is proposed that includes the three most important areas. Together they hold the largest old-growth remnants of the main forest types within the pine-oak zone. Moreover, protection against logging of these areas will secure the future of the endemic Tufted Jay and Eared Trogon, as well as the Mexican Spotted Owl. Thick-billed Parrots breed in the proposed Las Bufas reserve, but snags for nesting must also be available in other parts of the breeding range. A ban on the exploitation of snags is proposed for three important breeding areas. Ideally, snags should be left in the pine-oak forests throughout the Sierra Madre Occidental. This would benefit not only the parrots, but also the Eared Trogon, woodpeckers and other organisms that depend on dead wood and tree cavities, e.g. bats, wasps, birds, beetles and other arthropods.

Likewise, the total protection of the three reserves is of importance not just for birds, but for the whole biome with its endemics. The old-growth forests are a monument to the wilderness that once stretched from Jalisco to Sonora. The climax vegetation can serve as a reference for forestry technicians as well as biologists, and as a gene pool for future forestry projects.

Conservation

There are three strategies to obtain a protected status for the old-growth remnants. First, protection can be sought by implementation of Mexican legislation via SEMARNAP (Secretaría de Medio Ambiente, Recursos Naturales y Pesca). The Mexican law "Norma Oficial Mexicana NOM-059-ECOL-1994" lists species and subspecies that are endangered, threatened or rare. In addition, "Norma Oficial Mexicana NOM-061-ECOL-1994" provides that logging of areas where these species occur is not allowed unless a study is presented that shows that the species will not be affected by the planned activities. Since logging permits have to be signed by SEMARNAP as well, this secretary can, in theory, prevent exploitation of areas where species occur that are listed in Norma 59. Thick-billed Parrot, Military Macaw and Golden Eagle are listed as "Endangered", Eared Trogon, Tufted Jay and Spotted Owl as "Threatened". In the proposed reserves two to five of these species occur. Implementation of Normas 59 and 61 depends in practice on the local branches of SEMARNAP in each of the states. In Durango, Ing. A. Moreno and F. Casillas of this department used the Normas to protect 2.9 km^2 of Tufted Jay habitat that was proposed as a reserve by Ceballos-Lascurain (1987). The same procedure has now been started for the 147 km^2 highland forest of Las Bufas, as well for the 8.2 km^2 Monte Oscuro area (figure 10).

In the long run, a firmer basis for conservation may be found in the creation of Biosphere Reserves or protected areas classified as "Zona Ecologica Protegida". However, a proposal for such reserves requires a detailed inventory of flora and fauna as well as a management plan and a socio-economic plan. For El Carricito, Jorge Rojas and Patricia Escante of CIPAMEX have just started a project to carry out the required studies, with funding from the Biodiversity Support Program, the Netherlands Embassy, ABC American Bird Conservancy, CONABIO and the CZS Chigago Zoological Society. For Las Bufas there is a similar proposal by Roger Otto and the Instituto de Ecología in Durango. A Biosphere Reserve or Zona Ecologica Protegida involves a core area which is totally protected and a buffer zone in which limited, sustainable use is allowed. In each case of the areas described below, the mapped areas should be core areas. These forests already are only a fraction of the original biome and should therefore be totally protected. Sustainable use programmes can be developed in the surrounding selectively logged forests.

The reserves proposed here are largely uninhabited. They are, however, owned by ejidos or communities and the owners should be compensated for restrictions. This is an additional requirement that remains essential even if areas are protected per decrete.

Otherwise, upset owners may burn a reserve. A recurrent problem is that boundaries of properties are usually disputed, which makes negotiations difficult. Valuable timber is found in the priority areas and it is hard to find equivalent profits for local inhabitants from other sources in the area. Some ecotourism might be developed but the old-growth sites are remote and the threatened endemics are not as attractive as, for instance, Resplendent Quetzal or Horned Guan. A solution would be to use a very small part of the profits from the vast extent of production forest in the Sierra Madre Occidental to pay for the protected areas. Alternatively, funds can be sought from national or foreign conservation funds, which also is attempted for El Carricito.

Priority areas

The following key areas should be set aside to conserve a representative sample of the different habitats in the Sierra Madre Occidental. These areas are also of major importance for the threatened species of the region.

A tentative estimate is given for the value of the land in the projected reserves. This is based on information from forestry engineers of Unidad 9 "La Flor" in Durango (which is not associated with one of the areas where reserves are projected). The estimate is that land with dry open pine-oak forest, secondary mesa forest or canyon forest is worth 1000 USD per ha and that land with old-growth mesa forest is worth 1500 USD per ha. This is not an exaggerated estimation, since such sums were indeed paid to the ejiido of Piélagos for the logging of old-growth mesa forest. Land in remote parts of the sierra without pine forest is worth only 60 USD per ha (Ing. Quezada, Unidad Forestal Nuevo Casas Grandes pers. comm.). In all cases, the price of forest areas would have to be negotiated with the owners and may show significant variation. For instance, in case of El Carricito negotiations indicate it may be possible to obtain the forest at 100 to 300 USD per ha.

1. **El Carricito del Huichol,** northern Jalisco
Figures 25 and 26.

area: 149 km^2

altitude: 1520 to 2720 m

habitat: mesa pine-oak forest (20.6 km^2), dry open pine-oak forest (117.9 km^2), oak-pine forest (1.1 km^2).

birds:

species	status NOM-059-ECOL-1994	occurrence
Thick-billed Parrot *Rhynchopsitta pachyrhyncha*	endangered / en peligro de extinción	large wintering groups reported by local inhabitants
Golden Eagle *Aquila chrysaetos*	endangered /en peligro de extinción	two birds seen at cliffs on eastern edge mesa
Eared Trogon *Euptilotis neoxenus*	threatened / amenazada	large numbers found in Nov. - Dec. 1994
Spotted Owl *Strix occidentalis*	threatened / amenazada	one bird heard near biggest old-growth patch

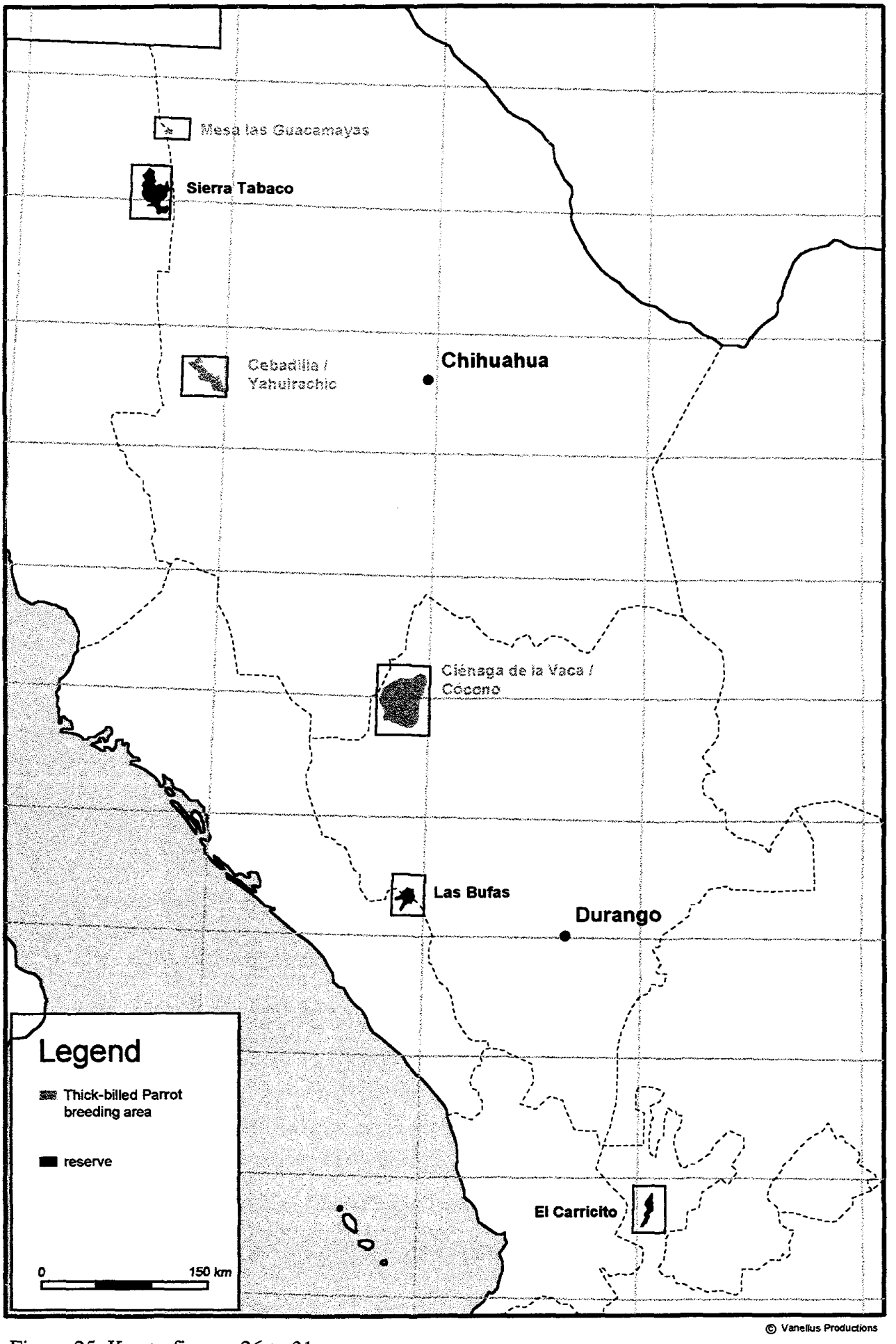
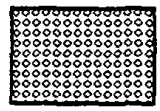
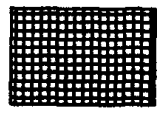


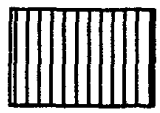
Figure 25. Key to figures 26 to 31
Figura 25. Clave para las figuras 26 a la 31



high altitude oak forest (oaks forming the canopy)

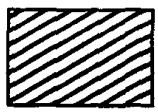


old-growth pine-oak forest on mesa

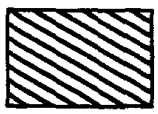


logged pine-oak forest on mesa

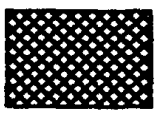
old-growth canyon pine-oak forest



dry open pine-oak forest



dry canyon country with oaks and shrubs



lowland tropical deciduous forest

road

river

provincial border

contour line

village

Legend to figures 26 to 28

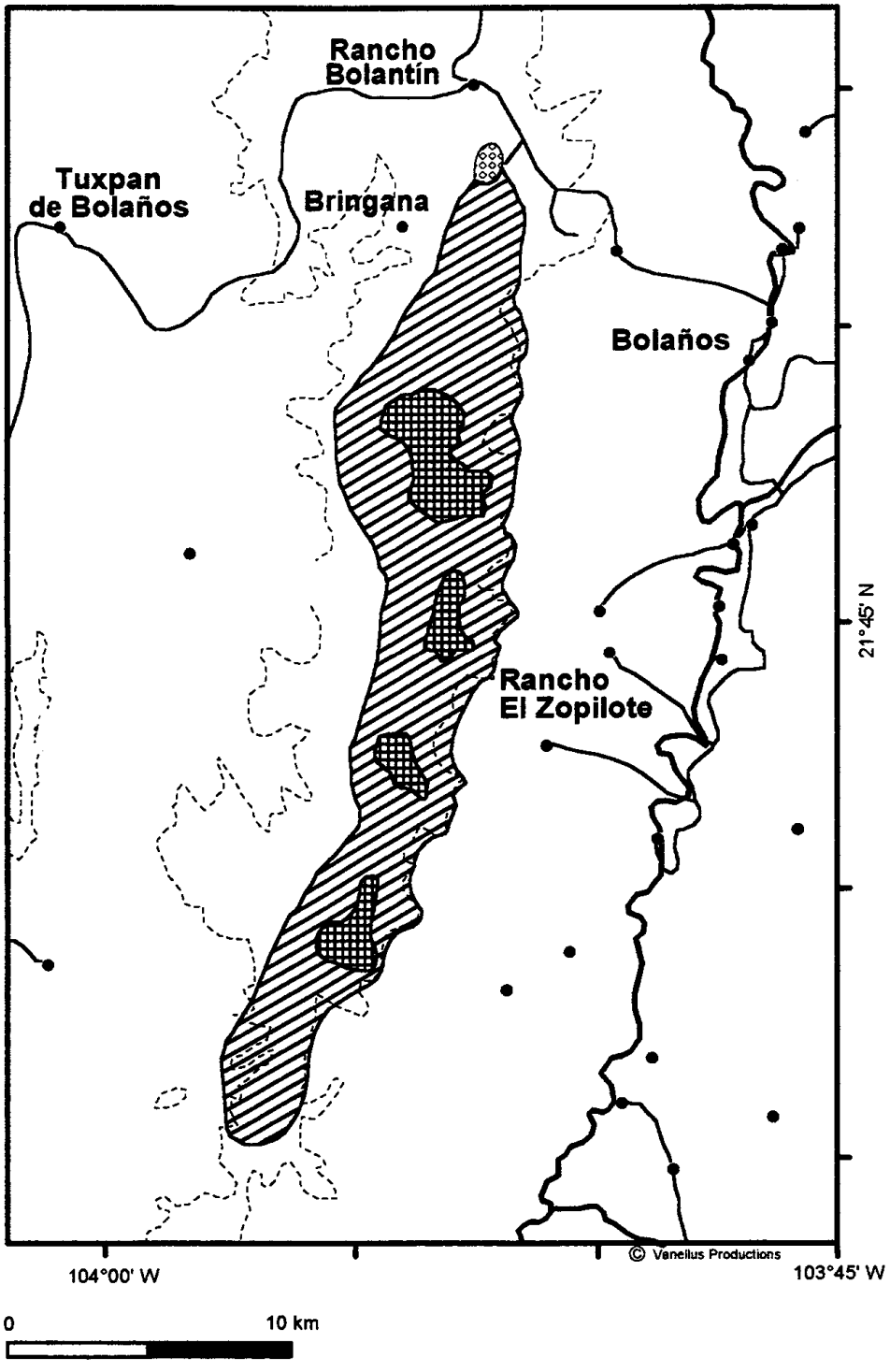


Figure 26. Proposed reserve El Carricito. The area west of the reserve is inhabited by Huichols

Figura 26. Reserva propuesta para El Carricito. El área al occidente de la reserva está habitada por Huicholes

important features: El Carricito del Huichol holds the only considerable extent of old-growth mesa forest that remains in the entire Sierra Madre Occidental. There are four patches of this forest type that lay close together along the highest ridge of the Sierra. The total area of this highly threatened habitat is almost 21 km^2. Pines *(Pinus michoacana)* up to 1.2 m d.b.h. are found in the old-growth patches. The mesa forests, together with the surrounding dry open pine-oak forest, also make the area the biggest unroaded and uninhabited highland forest left. The site is especially important for the Eared Trogon: it holds the largest continuous population encountered during the study. El Carricito del Huichol is rich in the game species Wild Turkey *Meleagris gallopavo* and White-tailed Deer *Odocoileus virginianus*. The latter is especially important for the Huichol community, which has many traditional rites based on deer. Mountain Lion *Felis concolor* is found in the area and there are unconfirmed reports of Black Bear *Ursus americanus* in the canyons west of El Carricito.

current owners: Although Huichols from Rancho Bolantín and Tuxpan de Bolaños said the northernmost and largest mesa forest patch is property of the Huichol community, recent information from the state of Jalisco indicates it is not. Only 5 to 10 % of the proposed reserve is owned by the Huichol community. Their land is found along the westernmost edge of the reserve and holds only dry-open forest. Most of the land of the proposed reserve is in hands of 18 small property holders. The second (from north) mesa forest patch is property of the brothers Jesus and Luis Correa Sandoval of Rancho El Zopilote (figure 26). The boundaries between the properties are disputed. Although according to most maps the reserve is located within the state boundaries of Jalisco, the southernmost third of the proposed reserve is apparantly owned by seven property holders from Puente de Camotlán, Nayarit. Both Huichols and others occasionally hunt through the whole area.

threats: A logging company from Durango, Lider Forestal, is attempting to reach consensus among current owners to exploit the area. Far less urgent threats to El Carricito are poaching and occasional manual cutting of snags to obtain ocote (resin rich pine wood used for starting cooking fires). There is relatively intensive foot and mule traffic on a trail that cuts through the area, following the highest ridge from north to south. Several free ranging cattle herds graze in the old-growth forest.

conservation: SEMARNAP on state level in Jalisco, as well as on national level, have agreed not to issue a logging permit for El Carricito to Lider Forestal. With funding from the Biodiversity Support Program and others, further biological surveys have been carried out in July and August 1996 to complete the required inventories for a reserve proposal. A decrete on state level, issuing El Carricito as Zona Ecologica Protegida is expected in November 1996.

Huichols in Ratontita and Tuxpan de Bolaños are sympathetic to the plans for a reserve. The idea that one of their last hunting grounds for White-tailed Deer would be fully protected is especially appealing. The Huichol community should be allowed to hunt deer in the projected reserve, preferably with a quota based on a population study.
Jesus Correa, who together with his brother Luis owns the second patch of mesa forest in El Carricito said he would be happy to sell the land on top of the mesa because that would spare his cattle and himself from the rigorous 1500 m climb to his forest area.
Although roaming cattle have relatively low impact on the forest, allowing such activities seems impropriate in this exceedingly rare habitat.

In case El Carricito is turned into a Biosphere Reserve, the described area should be the core area, with a buffer zone extending to the Bolaños - Tuxpan de Bolaños road in the north, to the 1500 m elevation line in the east (where the steep cliffs form a natural barrier), and with a 5 km wide belt to the west and south.

estimated value land:
15,9 million USD according to the estimate from forestry engineers in Durango
3,0 million USD based on current negotiations with owners

An alternative approach would be to buy only the northern most quart of the area and, by not allowing roads to be built through it, making the southernmost patches inaccessible.

contacts:
Horacia Fajardo S.
San Pío 823, Col. San Vicente, Guadalajara
- the doctor in Tuxpan de Bolaños, with strong contacts among the Huichol community and opposed to the logging plans

Jesús and Luis Correa Sandoval
Rancho El Zopilote (see figure 26)
Mpio. San Martín de Bolaños
c.p. 46350
- owners of the second (from north) mesa forest patch. Favourably inclined to selling.

Asención Hara de la Cruz
Rancho Bolantín
c/o Horacia Fajardo (see above)
- recommended as guard and guide

Filiberto Bañuelos
Tuxpan de Bolaños
c/o Horacia Fajardo (see above)
- one of the elected members of the "consejo de ancianos" that represent the Huichol community of Tuxpan / San Sebastián. In favour of plans for reserve.

2. **Las Bufas**, central- western Durango.
Figures 25 and 27.

area: 147 km^2, or with adjacent Pacific slope 206 km^2.

altitude: highlands 1500 - 2960 m, Pacific slope 450 - 1500 m.

habitat: logged mesa pine-oak forest (41 km^2), canyon pine-oak forest (93 km^2), dry open pine-oak forest (11 km^2), humid high altitude oak forest (1.4 km^2). Adjacent Pacific slope with lowland tropical deciduous forest and transition (to pine-oak) forest (59 km^2).

birds:

species	status NOM-059-ECOL-1994	occurrence
Thick-billed Parrot *Rhynchopsitta pachyrhyncha*	endangered /en peligro de extinción	possibly up to 25 pairs breeding in mesa forest, large wintering groups
Military Macaw *Ara militaris*	endangered /en peligro de extinción	reported on Pacific slope by local inhabitants
Eared Trogon *Euptilotis neoxenus*	threatened / amenazada	numerous in canyon forest
Tufted Jay *Cyanocorax dickeyi*	threatened / amenazada	fairly common in canyon forest
Spotted Owl *Strix occidentalis*	threatened / amenazada	one bird heard in canyon forest

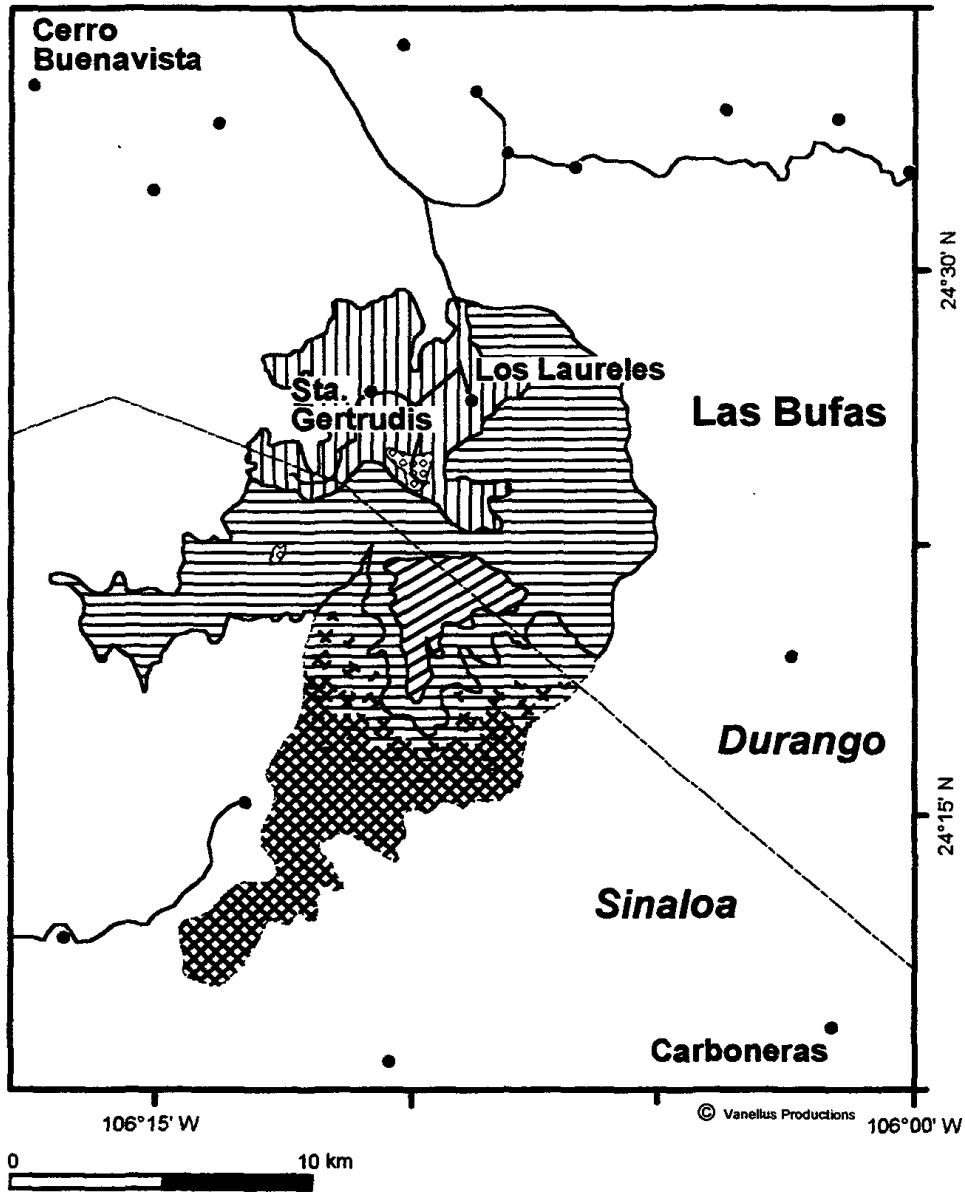


Figure 27. Proposed reserve Las Bufas. The lowland extension is indicated by a dotted line

Figura 27. Reserva propuesta para Las Bufas. La extensión de tierras bajas se indica mediante una línea de puntos

important features: In Las Bufas there is an altitude difference of 2510 m within a distance of 12 km. This means that many different vegatation types are compromized in a small area, resulting in a high biodiversity. Most of the forest (106 km^2 or with the lowlands 165 km^2) is old-growth. Due to the proximity to the coast and high slopes the forests are humid and exceptionally well developed. In the highest part, the mesa forest has unfortunately been selectively logged. However, the mesa forest still holds numerous big conifers (*Abies* and *Pseudotsuga*) and has not been exploited for dead wood. At an altitude of 2700 m there is 1.4 km^2 of uncut forest where big oaks form the canopy. This is the only such forest encountered in the Sierra Madre Occidental during this study (usually oaks make up the understory in highland forest).

The area holds at least five threatened birds species, more than any of the proposed reserves. In Las Bufas the northermost extension of the distribution of the Tufted Jay meets the southermost extension of the breeding range of the Thick-billed Parrot. The Thick-billed Parrots breed pine snags in the selectively logged mesa forest. The four nests found were at altitudes above 2700 m; the logged forest that is proposed for protection includes all land above 2500 m in the region and should cover the nesting grounds of the parrots. Las Bufas is an important wintering area as well for Thick-billed Parrots. Of the wintering parrots encountered during the fieldwork in the months November 1994- May 1995, 63 % was found in Las Bufas. In the uncut canyon forest Tufted Jay, Spotted Owl and Eared Trogon occur, and in the lowlands Military Macaw is reported by local inhabitants.

current owners: The highland area is divided between the ejido of El Maguey (Mun. San Dimas, Durango) , the community of San Isidrio (Mun. Tamazula, Durango) and one or more ejidos or communities on the Sinaloa side. The lowland extension is entirely on the Sinaloa side.

threats: The forestry people of the UCODEFO in San Miguel de Cruces said that the canyon forest is scheduled to be logged within the next five years. With the current costs of transport and low profits of dead wood, there are no plans to cut the snags of the mesa forest where the Thick-billed Parrots breed, but this seems a fragile base for protection. Local people and logging crews are said to cut down nesting trees of Thick-billed Parrots to obtain the young for the pet trade. The three settlements in the area (Sta. Gertrudis, El Alamito and Los Laureles) were all founded in the last 20 years and are as yet very small (two to 15 houses). There are large numbers of children, in proportion to the overall population, so these settlements can be expected to boom in the next decades.

conservation: The scheduled logging of the canyon forest and further degradation of the altered mesa forest must be prevented. This could be achieved by implementing Normas 59 and 61and / or purchasing the area from the current owners. In the case of Las Bufas it would be recommendable to try to buy out the people now living in the villages of Sta. Gertrudis, Los Laureles and El Alamito. Only by moving these people out of the projected reserve is effective protection of the area possible. Now is the time to take such steps since the villages are yet small with relatively low costs involved. The dirt roads on the high mesa should be closed so the area becomes less accessible and the forest can recuperate.

SEMARNAP in Durango will issue a restriction on logging in Las Bufas based on Norma 59 and 61. The Instituto de Ecología in Durango would be the obvious institute to carry out the studies required for a Biosphere Reserve proposal, but has shown no interest so far. Roger Otto submitted a proposal to the Biodiversity Support Program that aimed to obtain community support for the reserve and carry out more biological surveys.

The Las Bufas area has potential for ecotourism. Trips can be made starting on the Pacific slope and climbing to the highland forests, going through a wide variety of old-growth forest types and with attractive birds as Military Macaw, Pale-billed Woodpecker, Black-throated Magpie Jay, Tufted Jay, Eared Trogon and Thick-billed Parrot. Mammals that are found in the area include Mountain Lion *Felis concolor*, Javalina *Pecari angulatus* and White-tailed Deer *Odocoileus virginianus*. In case Las Bufas would become a

Biosphere Reserve, the described area should be the core area with a buffer zone of 5 km width around it.

estimated value land :

9.8 million USD, or with adjacent Pacific slope 11.3 million USD.

contacts :
Casimiro Astorga
Los Laureles, Ejido El Maguey
Mun. San Dimas
- knows area well, recommended as guard

Ing. J. Ramos Astorga and Ing. Martinez
Unidad no. 3 "San Miguel de Cruces"
Madero no. 401 "A" sur, despacho 101
3400 Durango, Durango
- UF 3 would provide the required study before logging the canyon forest of ejido El Maguey. Ing. Martinez is at the Unidad's office in San Miguel de Cruces

3. **Sierra Tabaco - Río Bavispe**, northern Sonora
Figures 25 and 28.

area: 515 km^2

altitude: 1200 - 2360 m

habitat: canyon pine-oak forest (4.3 km^2), rocky canyon country with oaks and shrubs (511 km^2).

birds:

species	status NOM-059-ECOL-1994	occurrence
Thick-billed Parrot *Rhynchopsitta pachyrhyncha*	endangered /en peligro de extinción	two birds heard in July 1995; the species is reported by local inhabitants as well. Probably does not breed in the area.
Golden Eagle *Aquila chrysaetos*	endangered /en peligro de extinción	reported by J. G. Bejerano of Rancho Las Cuevas

important features: This proposed reserve is the largest roadless area left in the Sierra Madre Occidental. Within it, 4.3 km^2 of old-growth canyon forest is found with big pines (*Pinus arizonica*) up to 1.2 m d.b.h.. Thick-billed Parrot and Golden Eagle occur in the area. Possibly one of the last wandering individuals of the nearly extinct Imperial Woodpecker *Campephilus imperialis* occasionally visits the old-growth (see page 38). Sierra Tabaco holds a few Black Bear *Ursus americanus*. Wild Turkey *Meleagris gallopavo*, White-tailed Deer *Odocoileus virginianus* and Mountain Lion *Felis concolor* are relatively abundant. This vast roadless area could be a prime locality for reintroduction of the Mexican Wolf *Canis lupus baileyi*. In Sierra Tabaco numerous 600-800 year old cliff dwellings of Mogellon indians are found.

current owners: The two northernmost old-growth patches and surrounding canyon country are property of ejido Agua Fría / Ciénaga de Horcones. The southern patches and adjacent canyon country are owned by the Bejerano brothers from Nuevo Casas Grandes (see below). The western half of the proposed reserve is divided between various other owners.

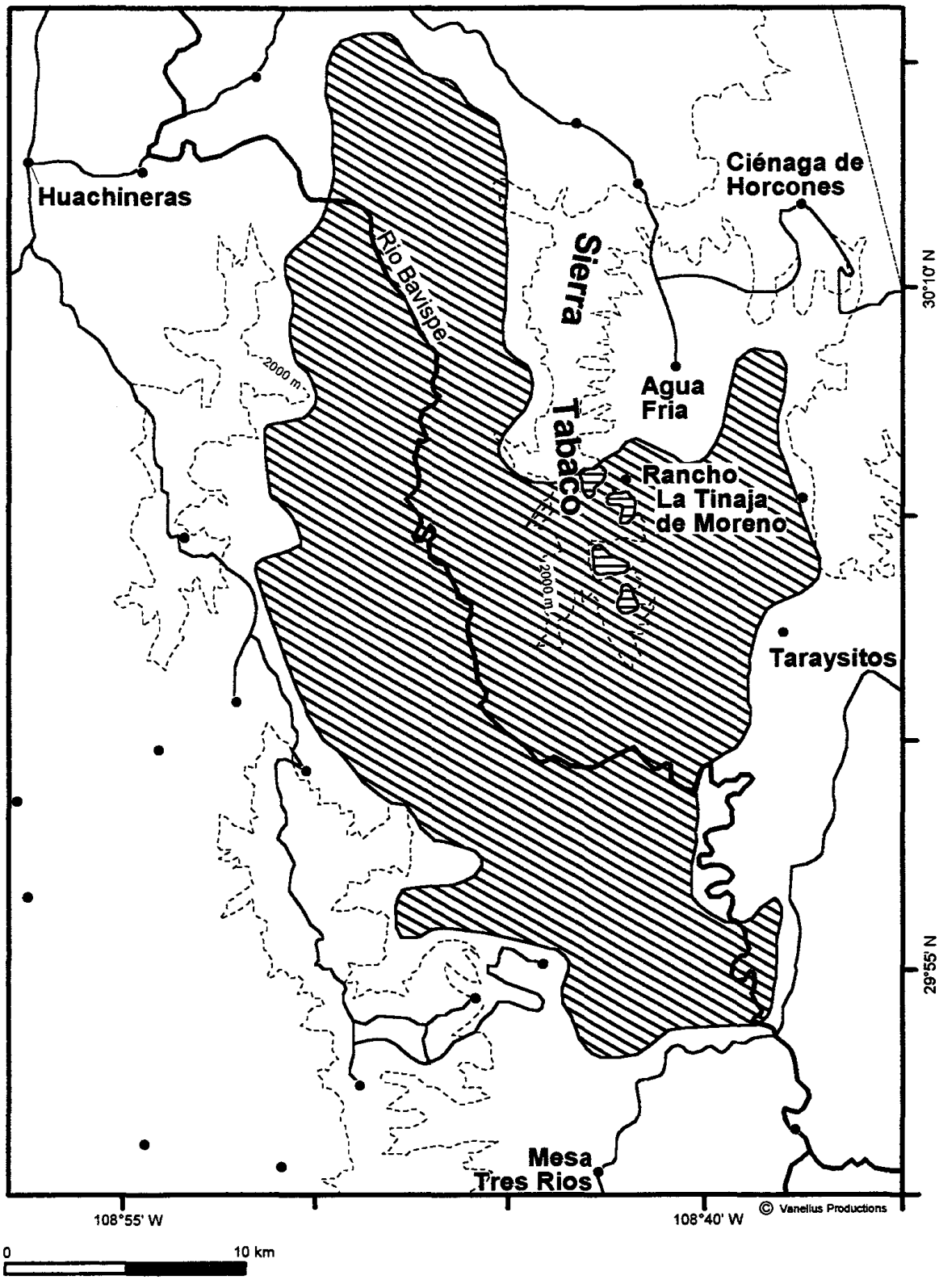


Figure 28. Proposed reserve Sierra Tabaco
Figura 28. Reserva propuesta para Sierra Tabaco

threats: The rocky canyon country is not urgently threatened by development, but the old-growth patches of Sierra Tabaco are. A logging contract has been obtained by Mauricio Whetten for the southernmost two patches, about 150 ha. Logging had not started yet in June 1995 only because of logistic difficulties involved with building a logging road from Taraysitos.

conservation: The planned logging of the old-growth of Sierra Tabaco must be stopped, so a wide variety of primary habitats remains in this wilderness. Guadalupe Bejerano, the representative of the owners of the southernmost patches, said he is not very happy with his pre-devaluation contract with Whetten. Bejerano said he would be interested in another option. There clearly is an urgent need to purchase the Sierra Tabaco old-growth patches now. Later, when reintroduction of the Mexican Wolf comes into view, negotiations with the owners of the canyon land can start. The Sierra Tabaco / Río Bavispe reserve has been promoted to SEMARNAP both on national level as well as on state level in Sonora. So far this had not let to any protective measures.

The Sierra Tabaco / Río Bavispe area has potential for ecotourism. The vast unroaded canyon country with the old-growth and the cliff dwellings has a "Wild West" atmosphere. It would be a suitable site for horse back tours or float trips down the Bavispe river.

estimated value land:

old-growth forest 300,000 USD
(for the moment, there is an urgent need only for this investment)

canyon country 3,2 million USD

contacts:
Mauricio Whetten, productos y servicios forestales.
km 8.5 Carr. a Colonia Juárez s/n.
Casas Grandes, 31850 Chihuahua
tel. 24017, fax 24093
- obtained contract for logging Sierra Tabaco old-growth, is trying to build a logging road in.

José Guadalupe Bejarano Olivas
Calle Albaro Obregon 3105
Nuevos Casas Grandes, Chihuahua.
tel. 41714
-representative of Bejarano brothers, who own the southernmost patches of old-growth in Sierra Tabaco. Willing to sell to conservationists.

Don Genaro Quintana
Rancho Tinaja de Moreno (figure 28)
Agua Fría
ejido Ciénaga de Horcones, Sonora. Recommended as guard and guide. In favour of protecting old-growth, is convinced that the old forest draws rain to this drought plagued part of the country.

Thick-billed Parrot breeding areas

Besides the described three key areas, where complete protection is needed, there are regions with altered forest that are important as breeding grounds for the endangered Thick-billed Parrot. The parrots depend for breeding on pine snags and other dead trees at altitudes above 2300 m (Lanning and Shiflett 1983). However, snags have been cut on a large scale all over the Sierra Madre Occidental for the production of paper pulp. A total ban on the exploitation of dead trees is asked for on a national level for the following areas. All are known to hold large numbers of breeding Thick-billed Parrots. Protection of the dead trees in these areas would benefit the Eared Trogon and other fauna as well.

At the state level in Durango, a ban on the exploitation of snags will be issued from 1996 onward for the Cócono / Ciénaga de la Vaca area, as well as in Camellones.

area	location	area	figure
Mesa las Guacamayas	northern Chihuahua	29 km^2	29
Cebadilla /Yahuirachic	central Chihuahua	351 km^2	30
Cócono / Ciénaga de la Vaca	north-west Durango	1521 km^2	31

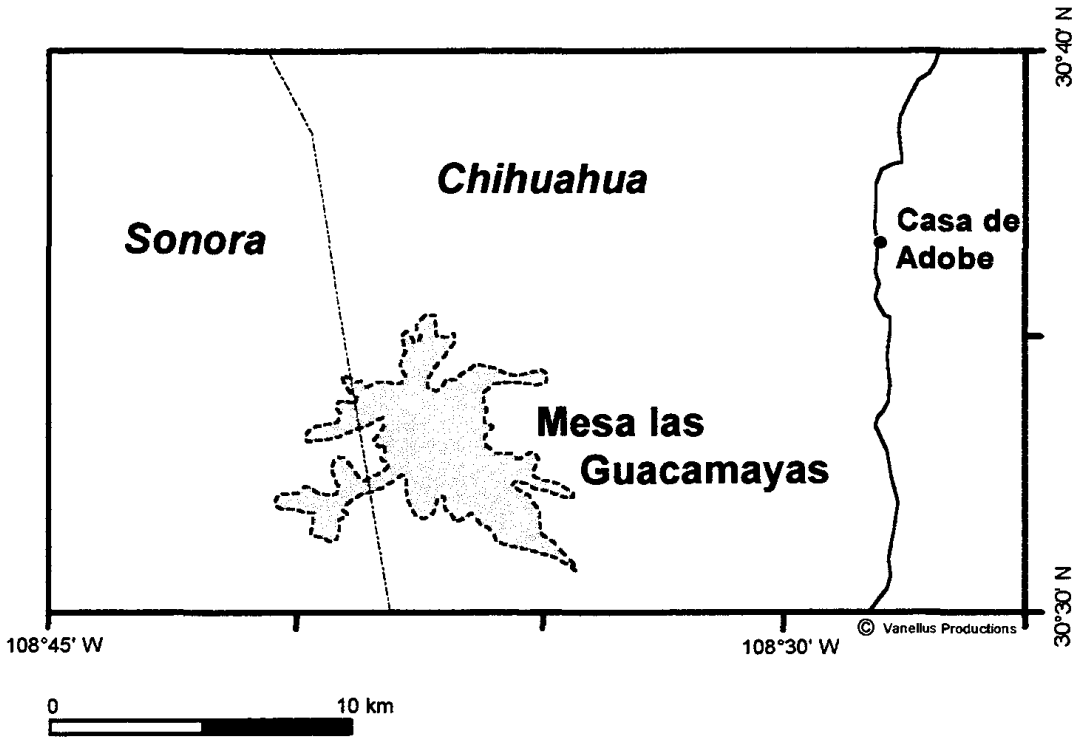


Figure 29. Thick-billed Parrot breeding area "Mesa las Guacamayas"
Figura 29. Área de anidación de Cotorra Serrana "Mesa las Guacamayas"

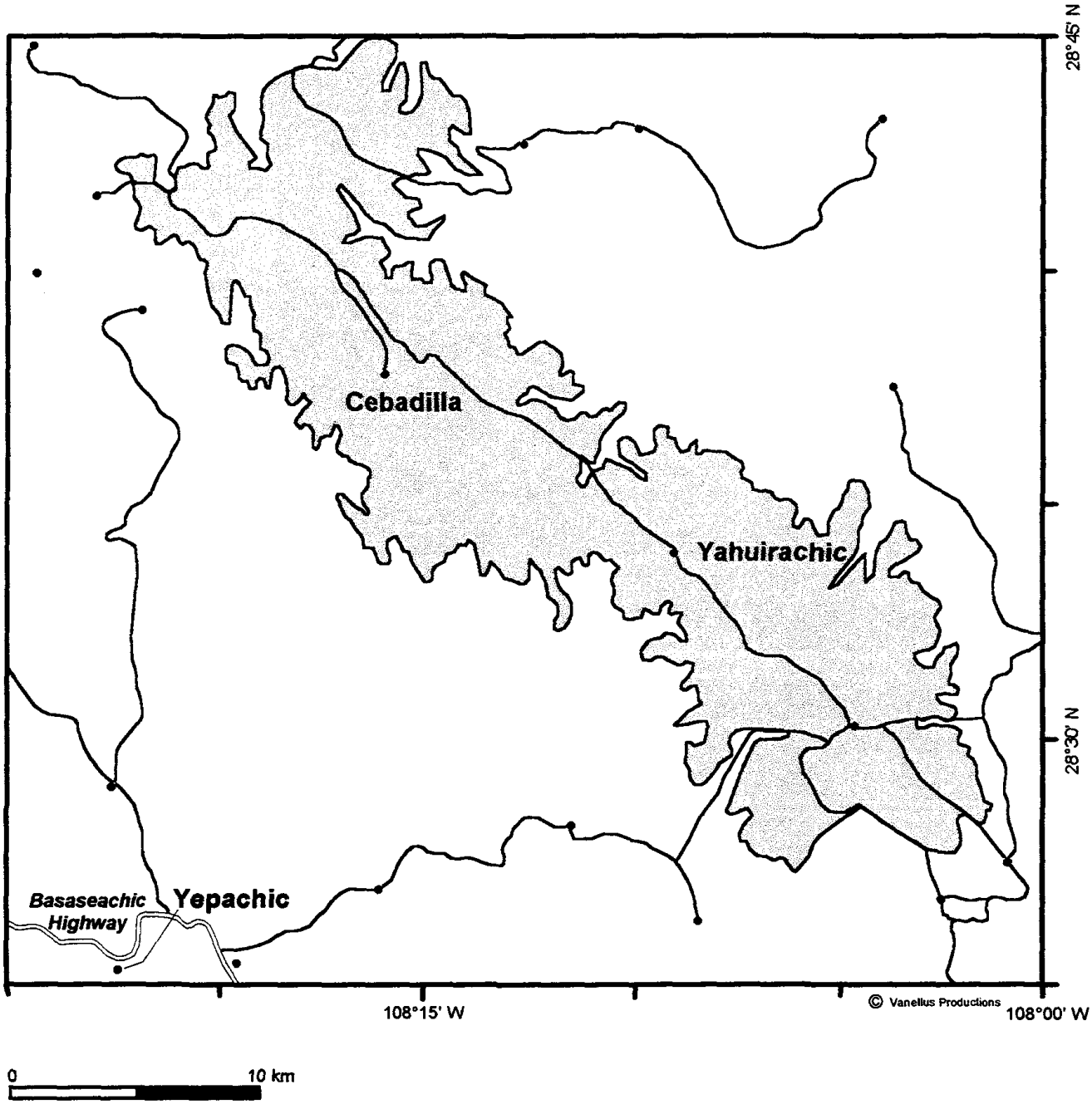


Figure 30. Thick-billed Parrot breeding area "Cebadilla / Yahuirachic"
Figura 30. Área de anidación de Cotorra Serrana "Cebadilla / Yahuirachic"

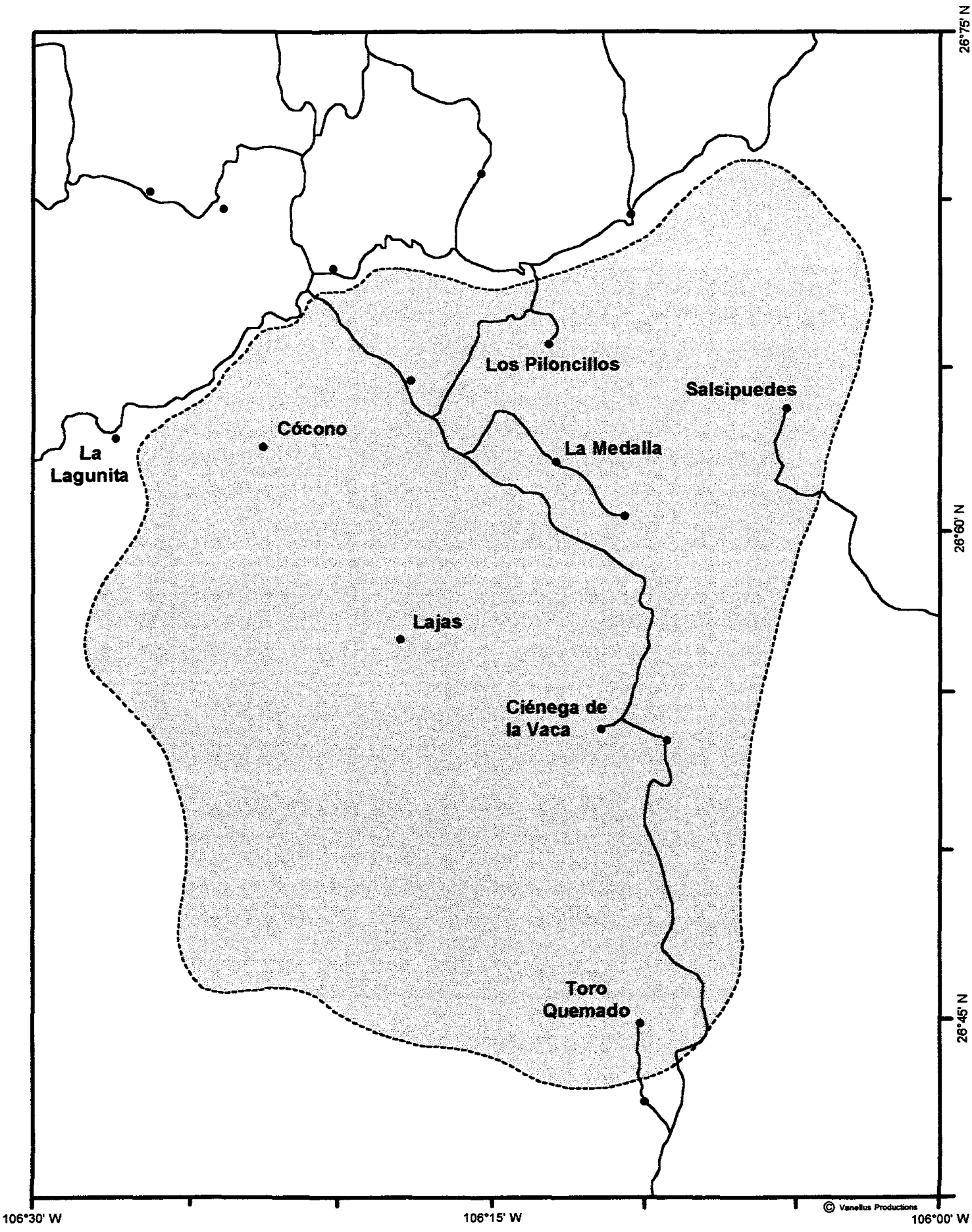


Figure 31. Thick-billed Parrot breeding area "Cócono / La Medalla / Ciénaga de la Vaca"
This map should be enlarged to 111 % to reach scale 1 : 250 000
Figura 31. Área de anidación de Cotorra Serrana "Cócono / La Medalla / Ciénaga de la Vaca"

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appendix 1: Thick-billed Parrot observations

Included in this list are two reports (2 and 4) from other observers.

Southern Durango
1) Monte Oscuro (figure 10) 23°17'52"N 104°58'23"W, 2300 m. 25 January 1995 at 11.25 hrs. Group of 30 parrots flying around and screaming loudly. Perched briefly in dead pine. Disappeared out of the canyon at 11.35 hrs, did not spend the night there. Old-growth pine-oak canyon forest.

2) Just south of Cerro Gordo (figure 10), approximately at 23°12'03"N 104°56'10"W, 2900 m. 26 November 1992. Two groups of Thick-billed Parrots, about 50 in total, foraging on the cones of *Pinus lumholtzii*. Observed by Ing. Julián Bautista, Roger Otto and Federico Casillas. Recently cut-over mesa forest.

Western Durango
3) San Blas 24°27'56"N 106°08'40"W, 2160 m.15 March 1995 at 17.20 hrs. Group of about 40 birds foraged on the cones of *Pinus lumholtzii* 200 m west of village. At 17.55 hrs. an over flying Red-tailed Hawk caused panic among the parrots, who flew and grouped in the air. Probably a different group of about 32 Thick-billed Parrots was seen to go roosting on a steep slope facing NW at approximately 24°27'18"N 106°07'48"W, 2500 m of elevation (just below a 2540 m top). Due to the great distance it was not possible to see if the birds went to sleep in pines or on the cliffs. Probably the same group of about 30 flew over San Blas the next morning at 6.55 hrs, heading north. At 7.30 hrs a bigger group, possibly the 40 of 15 March, perched and foraged on cones of *Pinus lumholtzii* pines at the north edge of the village. At 8.15 it started moving to the north-west. Village surrounded by secondary pine-oak forest, with tropical influences (e.g. palms in canyons) from nearby Pacific slope.

4) San José de las Causas 24°01'20"N 105°46'33"W, 2440 m. Second week of January 1995. Group of 120 parrots foraging on the cones of *Pinus cooperi.* Possibly the same group was seen earlier the same day 9 km to the east, also foraging on *Pinus cooperi*, at 24°02'00"N 105°41'20"W, 2650 m of elevation. Observers Ing. Javier Emilio Saenz and Jeffrey R. Bacon. Secondary pine-oak forest.

5) Las Bufas (figure 13) 24°21'18"N 106°09'48"W, 2820 m. 28 September 1995. Casimiro Astorga showed large hole in big pine snag where he saw two Thick-billed Parrots two days earlier. A group of 6 Thick-billed Parrots flew over. Selectively cut mesa forest.

6) Las Bufas (figure 13) 24°22'55"N 106°11'37"W, 2720 m. 2 October 1995. Carmelo Meraz from Sta. Gertrudis showed 2 snags with holes where Thick-billed Parrots bred last year. Four parrots flew over. Selectively cut mesa forest.

NW Durango
7) Near La Tableta 25°36'17"N 106°59'50"W, 2090 m. 13 May 1995 at 14.35 hrs. Approximately 13 Thick-billed Parrots feeding on the cones of *Pinus engelmanii.* The parrots cut leaves around cones with their beaks to obtain better access to the cones. Selectively cut pine-oak forest.

8) Quebrada de Peñol 26°04'31"N 106°07'00"W, 2588 m. 11 September 1995 at 9.30 hrs. Group of 25 parrots flying north through canyon. On 13 September a group of 6 to 8 parrots flying north. Old-growth canyon pine-oak forest with *Pinus arizonica* and *P. lumholtzii* on steep slopes.

9) La Quebrada 26°01'01"N 106°09'49"W, 2600 m.14 September 1995 at 12.33 hrs. Four Thick-billed Parrots feeding on cones of *Pinus chihuahuana.* Secondary mesa pine-oak forest.

Central Chihuahua

10) Comeraque 28°36'31"N 108°10'30"W, 2400 m. 11 June 1995 at 12.30 hrs. Two birds foraging in unidentified pine. Selectively cut pine-oak forest.

11) West of Chachámuri 28°40'27"N 108°10'43"W, 2000 m. 11 June 1995 at 14.48 hrs. Group of 12 birds flying over. Selectively cut pine-oak forest.

12) Cebadillita 28°35'25"N 108°12'05"W, 2500 m. 22 and 23 August 1995. Nest in dead top of *Pinus ayacahuite*. Apart from the pair at the nest, four more birds were seen flying around. Selectively cut pine-oak forest with many snags left.

13) Near Cebadilla (figure 30) 28°35'30"N 108°13'14"W, 2500 m. 23 August 1995. Pair with nest in *Pinus ayacahuite* snag. Selectively cut pine-oak forest with many snags left.

14) Cebadilla (figure 30) 28°38'38"N 108°15'57"W, 2700 m. 23 August 1995. Pair with nest in dead top of *Pinus ayacahuite*. Selectively cut pine-oak forest with many snags left.

Northern Chihuahua

15) Rancho El Gavilán 30°01'55"N 108°30'39"W, 1800 m. 3 July - 13 July 1995. Pairs and groups visited a 23 m high waterfall on 14 occasions, mostly between 18.00 and 19.00 hrs but also in the morning. The largest group consisted of 23 birds on 12 July at 7.45 hrs. Dry secondary pine-oak forest.

16) Los Azules 30°14'06"N 108°33'01"W, 2200 m. 19 July 1995 at 11.00 hrs. One parrot flying east to a spot where a second bird was calling. Secondary and selectively cut pine-oak forest.

17) Mesa Las Guacamayas (figure 29) 30°33'07'N 108°36'50"W, 2610 m. 2 August 1995 at 9.32 hrs. Two Thick-billed Parrots hanging around snag with hole, spending some time in hole (feeding young ?). 3 August at. 8.30 hrs. Same pair going in and out hole. Five other pairs inspecting holes: non-breeders? 4 August pair at same hole. Clear-cut and secondary pine-oak forest interspersed with old-growth *Pseudotsuga* stands.

Northern Sonora

18) Near El Macho 29°46'32"N 108°47'12"W, 1850 m. 15 July 1995 at 12.17 hrs. Parrots (probably two) were heard calling. Selectively cut pine-oak forest.

19) Rancho La Tinaja de Moreno (figure 28) 30°06'05"N 108°41'29"W, 1900 m. 21 July 1995 at 11.14 hrs. Thick-billed Parrots (probably two) were heard calling to the south. Old-growth dry open pine-oak forest with large pines in canyons.

location (report)	Mesa las Guacamayas (17)	Cebadillita (12)	near Cebadilla (13)	Cebadilla (14)
altitude	2610 m	2500 m	2500 m	2700 m
snag or stub	snag	stub	snag	stub
species	*Pseudotsuga* sp.	*Pinus ayacahuite*	*Pinus ayacahuite*	*Pinus ayacahuite*
height tree	22.7 m	16.6 m	20.1 m	25.7 m
height nest	21.8 m	14.4 m	14.8 m	20.3 m
diameter tree at breast height	1.10 m	0.51 m	0.49 m	0.64 m
proportion of trunk covered in bark (estimated)	80 %	90 %	65 %	70 %
orientation slope	31°	180°	284°	48°
estimated inclination slope	25 %	45 %	35 %	2 %
vegetation (number of trees higher than 2 m in a circular plot with a diameter of 20 m around nesting tree)	*P. ayacahuite* 11, *P.leiophyla* 5, *Pseudotsuga* sp. 11. Dense undergrowt.	*P. ayacahuite* 11, *P.arizonica* 9, *P. lumholtzii* 5, *Arbutus arizonica* 1, *Pseudotsuga* sp. 3, *Quercus* sp. 11	*P. ayacahuite* 4, *P.arizonica* 23, *Pseudotsuga* sp. 7, *Quercus* sp. 14	*P. ayacahuite* 6, *P.arizonica* 46, *P. lumholtzii* 5, Abies sp.1, *Pseudotsuga* sp. 3, *Quercus* sp.5 *Juniperus* sp. 2

Table 3. Measurements of Thick-billed Parrot nest trees
Tabla 3. Medidas de los árboles con nidos de Cotorra Serrana

appendix 2: Eared Trogon observations

Northern Jalisco
1) Rancho Bolantín 21°55'00"N 103°52'18"W, 2520 m. 13 December 1994 at 7.50 hrs. Two birds calling, both seen. Were shy. Dry open selectively cut forest, with some tall pines left.

2) Bajío del Tule 22°01'00"N 103°54'36"W, 2450 m. 11 December 1994 at 11.30 hrs. Two birds calling, heard only. Steep NW slope with open and dry pine-oak forest. Some standing dead pines with holes of smaller woodpeckers (potential nest holes for Eared Trogon). Hundred m higher on the same slope active logging was going on.

3) Bajío del Tule 22°01'04"N 103°54'21"W, 2550 m. 11 December 1994 at 12.30 hrs. Three birds calling, two of them seen. Were very shy. One of the calling birds possibly was a female. This spot is only a few hundred meters from location 2 and might well involve the same birds. Dry open secondary pine-oak forest, active logging going on. Sample of tree species collected at this spot: *Pinus lumholtzii*, *Pinus chihuahuana*, *Pinus oocarpa*, *Quercus* sp.

El Carricito (figure 26)
4) 21°51'50"N 103°53'28"W, 2020 m. 27 November 1994 at 16.45 hrs. One bird calling, heard only. Selectively cut pine-oak forest, at steep slope near small stream, with dense undergrowth of small oaks and bushes.

5) 21°49'00"N 103°54'06"W, 2200 m. 28 November 1994 at 17.45 hrs. One bird calling, heard only. Old-growth pine-oak forest, at steep slope near small stream, with dense undergrowth of small oaks and bushes. At the same locality one Eared Trogon was heard on 1 December 1994 at 7.45 and 11.30 hrs.

6) 21°43'24"N 103°53'50"W, 2420 m. 18 December 1994 at 14.10 hrs. One bird calling, heard only. Dry open old-growth pine-oak forest.

7) 21°42'38"N 103°54'22"W, 2475 m. 18 December 1994 at 17.05 hrs. One bird calling, heard only. Old-growth dry open pine-oak forest on steep slope. The following morning a tape with the call of the Eared Trogon was played here but no reaction came. This locality is 1250 m from locality 6 but probably involves another bird since it was at the other side of a high mountain top.

8) 21°39'46"N 103°54'59"W, 2600 m. 19 December 1994 at 16.30 hrs. One bird calling, heard only. Old-growth dry open pine-oak forest with tall trees on steep N slope of barranca. Running water was found 150 m lower.

9) 21°41'56"N 103°53'49"W, 2500 m. 19 December 1994 at 10.30 hrs. Two or three birds calling, two of them seen. Secondary dry open pine-oak forest on W slope. On 21 December at 12.10 hrs one Eared Trogon was calling 150 m to the north on this slope, probably one of the same birds.

10) 21°44'25"N 103°53'33"W, 2520 m. 21 December 1994 at 17.00 hrs. One bird calling, heard only. Selectively cut pine-oak forest with tall trees (both pines and oaks) left, at border of large clearing. On 22 December at 17.30 hrs an Eared Trogon was calling 200 m to the west, at the other side of the clearing. On 23 December at 7.50 hrs two or three Eared Trogons were heard calling at the same spot as the 21 December location.

11) 21°45'13"N 103°52'42"W, 2375 m. 22 December 1994 at 9.50 hrs. One bird calling, heard only. Old-growth dry open pine-oak forest on steep W slope.

12) 21°46'01"N 103°53'19"W, 2475 m. 23 December 1994 at 10.00 hrs. One bird calling, heard only. Dry open pine-oak forest on steep slope.

13) 21°51'22"N 103°52'25"W, 2440 m. 19 October 1995. One bird calling and 'whistling'. Old-growth dry open pine-oak forest with *Pinus durangensis* and *P. michoacana.*

14) 21°54'29"N 103°52'21"W, 2450 m. 19 October 1995. Two birds heard calling, a third Eared Trogon with a greyish head and upper neck (probably juvenile) was seen. Humid oak forest with large oaks forming the canopy.

Southern and Central Durango

15) Monte Oscuro (figure 10) 23°17'50"N 104°58'42"W, 2050 m. 25 January 1995 and 26 January 1995, and 8 August 1996. In January the shy trogons moved in a group and were almost constantly calling. On 25 January there were at least 8 individuals, on 26 January at least 16 at the same spot. FMCO heard an Eared Trogon 'whistling' within 500 m of this locality on 8 August 1996. Lush riparian forest (old-growth) along mostly dry stream. Big pines, firs and hardwoods, among them 'capulín'. Temperature in this forest considerably higher than in surroundings. Forest on slopes of surrounding canyon dry open old-growth pine-oak forest, with small *Pinus lumholtzii* pines.

16) Chomonques, near La Formación (figure 11) 23°27'19"N 105°29'33"W, 2200 m. 12 February 1995 at 10.00 hrs. One bird calling, heard only. Steep slope with dry open pine-oak forest, on N-edge of village Chomonques.

17) Mexiquillo (figure 12) 23°42'12"N 105°40'02"W, 2200 m. 5 March 1995 at 10.10 hrs and 14.30 hrs. Group of at least 10 individuals (both males and females, shy) calling and 'whistling'. Old-growth open pine-oak forest in relatively broad canyon. Big pines and firs. On steep slopes of surrounding canyon dry open pine-oak forest with *Pinus lumholtzii.*

18) Road to Cerro Buenavista (figure 13) 24°30'46"N 106°13'57"W, 2320 m. 11 March 1995 at 11.30 hrs. and on 12 March 1995 at 14.30 hrs. On both days a pair was seen on roots sticking out of a wall along a dirt road before our truck. As long as we stayed in the car the birds were not shy. On 12 March an additional 4 individuals were seen 100 m higher on the slope (the pair on the road apparently was part of a group of at least 6 individuals). Old-growth open pine-oak forest, dominated by oaks, many madroños *Arbutus arizonica.* At 200 m a stand of big firs. Steep slope.

19) La Soledad de Rodriguez, approximately at 24°57'45"N 106°17'30"W, 2300 m. 28 and 29 September 1995. Eared Trogons were heard calling. Selectively-logged mesa forest.

Piélagos region (figure 14)

20) Arroyo El Gentil , east of Piélagos 24°44'25"N 105°49'39"W, 2200 m. 1 April 1995 at 11.00 hrs. One bird was heard calling. Old-growth dry-open pine-oak forest with *Pinus engelmanii, P.lumholtzii, Juniperus* sp.

21) Canyon of Río Las Vueltas, east of Piélagos 24°43'05"N 105°48'14"W, 1800 m. 1 April 1995 at 11.30 hrs. One bird was heard calling. Very dry old-growth pine-oak forest on steep SE facing slope.

22) Canyon of Arroyo de La Canal, west of Piélagos 24°41'41"N 105°54'05"W, 2250 m. 14 April 1995 at 9.30 hrs. Three birds calling and 'whistling'. Lush riparian forest with *Juniperus* sp., *Cupressus* sp., *P. engelmanni, P. ayacahuita, P. durangensis* and *P. lumholtzii* a little above the river.

23) Canyon of Arroyo de La Canal, west of Piélagos 24°40'20"N 105°52'36"W, 2100 m. 3 May 1995 at 17.05 and 19.00 hrs. One female heard and seen calling. Lush riparian forest.

24) Arroyo Tierras Amarillas, close to junction with Arroyo de La Canal 24°40'54"N 105°51'52"W, 2200 m. 4 May 1995 at 7.30 hrs. Two birds 'whistling' and calling, one male seen. Old-growth dry open pine-oak forest.
The female from report 22 could belong to this same group.

25) Mesa west of Piélagos 24°41'34"N 105°52'19"W, 2440 m. 4 May 1995 at 8.35 hrs. One bird heard calling. Old-growth mesa forest with and *P. durangensis*.

26) Mesa west of Piélagos 24°42'11"N 105°51'54"W, 2460 m. 4 May 1995 at 9.55 hrs. One bird heard calling. Same habitat as report 24.

27) Near Piélagos - Otaez road 24°42'05"N 105°52'01"W, 2520 m. 3 May 1995. One bird heard calling. Tall selectively-cut mesa forest.

28) Canyon of Arroyo El Castillo, NE of Piélagos 24°50'12"N 105°50'30"W, 2200 m. 22 April 1995 at 9.50 hrs. One bird 'whistling'. Steep east-facing slope with old-growth dry open pine-oak forest.

29) Canyon of Arroyo El Castillo, NE of Piélagos 24°52'06"N 105°50'50"W, 2300 m. 22 April 1995 at 11.30 hrs. One bird 'whistling'. Steep east-facing slope with old-growth dry open pine-oak forest.

30) Near the main road north of Piélagos 24°47'12"N 105°54'40"W, 2680 m. 24 April 1995 at 8.00 hrs. One male calling and foraging. The bird used a short hovering flight ("sally-stall") to catch a large moth (wing span approx. 6 cm) from between the green leaves of a pine branch. It took the moth to a horizontal branch, where it banged the moth a few times to the branch and then ate it completely. Cut over mesa forest with numerous snags left.

31) Arroyo El Porvenir 24°51'48"N 105°57'25"W, 2450 m. 25 April 1995 at 10.30 hrs. One bird was heard 'whistling'. Lush riparian forest, old-growth, with *Juniperus* sp., and *Pseudotsuga* sp..

Las Bufas (figure 13)
32) 24°22'48"N 106°09'02"W, 2600 m. 27 and 29 September and 2 October 1995. No more than 2 Eared Trogons were heard at the same time, calling, flight call and 'whistling'. Near arroyo in selectively logged mesa forest with *Juniperus* sp., *Pinus ayacahuite, P. chihuahuana, Quercus* sp.

33) 24°21'56"N 106°08'00"W, 2100 m. 29 September 1995. Two birds were heard calling. Steep S-facing slope, old-growth dry open pine-oak forest with *Pinus lumholtzii, P. engelmanii*..

34) 24°21'58"N 106°06'58"W, 1850 m. 29 September 1995. One bird heard calling. Steep S-facing slope in old-growth canyon.

35) 24°22'53"N 106°07'23"W, 2230 m. 30 September 1995. One adult and one juvenile bird flushed. Old-growth pine-oak forest on ridge with *Pinus lumholtzii*.

36) 24°22'53"N 106°07'23'W, 2340 m. 1 October 1995. One bird heard 'whistling'. Old-growth canyon pine-oak forest.

37) 24°22'51"N 106°07'52"W, 2500 m. 1 October 1995. One bird heard 'whistling'. Old-growth canyon pine-oak forest.

38) 24°19'37"N 106°12'43"W, 2500 m. 2 October 1995. Two birds heard calling. Old-growth pine-oak forest on ridge with big oaks, pine snags and madrones.

NW Durango
39) La Tijera 25°32'47"N 106°34'06"W, 2350 m. 27 April 1995. One bird 'whistling'. Secondary dry-open pine-oak forest.

40) Between Osos Bravos and Sta. Gertrudis 25°27'00"N 106°56'31"W, 2430 m. 11 May 1995 at 15.08 hrs. One bird heard 'whistling'. Small fragment (< 1 km^2) of old-growth mesa forest, many snags.

41) La Tableta 25°25'47"N 106°56'31"W, 2200 m. 11 May 1995 at 16.27 hrs. Two birds heard and seen calling. Edge of small fragment (< 1 km^2) of old-growth mesa forest.

42) Cerro Pelon 25°45'17"N 107°05'29"W, 2100 m. 14 May 1995 at 9.18 hrs. One bird heard and seen calling. Edge of fragment (6 km^2) of old-growth mesa forest with many snags.

43) Mesa San Rafael 25°47'29"N 106°38'50"W, 2500 m. 15 May 1995 at 8.05 hrs. One bird 'whistling' and flying around. Village of widely interspersed houses and groups of pine trees.

44) Quebrada de Peñol 26°04'31"N 106°07'00"W, 2350 m. 11 to 13 September 1995. Several Eared Trogons were heard calling (no more than one at the time) in old-growth canyon forest with *Pinus arizonica* and *P. lumholtzii* on slopes and *Juniperus* sp. along stream.

Southern Chihuahua
45) South of Pino Gordo 26°24'07"N 106°59'59"W, 2400 m. 15 September 1995. One bird was heard whistling. Secondary pine-oak forest with *Juniperus* sp., *Pinus ayacahuite* and *P. chihuahuana.*

46) Pino Gordo (figure 16) 26°32'34"N 106°59'58"W, 2380 m. 17 September 1995. One bird was heard calling. Old-growth dry open pine-oak forest.

Central Chihuahua
47) Viewing point (mirador) at Basaseachic falls 28°10'05"N 108°12'25"W, 2140 m. 15 August 1995 at 8.45 hrs. One bird heard 'whistling' 100 m south of parking lot. Steep rocky canyon slope with *Pinus arizonica, P. lumholtzii, Juniperus* sp..

48) Near Yoquivo (figure 17) 28°01'58"N 108°02'09"W, 2400 m. 17 August 1995. One bird was heard 'whistling", also flight call. Rocky west facing slope with *Pinus ayacahuite* and *P. lumholtzii.*

49) Rancho Carconeras 28°00'33"N 108°01'41"W, 1950 m. 18 and 20 August 1995. Nest in *Pinus ayacahuite* snag.

50) Arroyo north-west of Mesa Rechánachi 27°59'36"N 108°04'16"W, 1900 m. Old-growth canyon forest with *Pinus ayacahuite* as dominating pine.

Northern Sonora
51) Near El Macho 29°46'32"N 108°47'12"W, 1850 m. 14 July 1995 at 15.18 hrs and 15 July 1995 at 11.14 hrs. One bird was heard calling on both occasions. Selectively-cut pine-oak forest where big oaks were left.

Northern Chihuahua

52) Los Azules 30°14'06"N 108°33'01"W, 2120 m. 19 July 1995 at 10.45 hrs. One bird was heard 'whistling'. Canyon with selectively-logged pine-oak forest.

53) Mesa Las Guacamayas (figure 29) 30°32'13"N 108°37'04"W, 2340 m. 1 August 1995 at 14.32 hrs. Two birds were heard 'whistling'. Canyon with selectively logged pine-oak forest surrounded by secondary forest.

54) Mesa Las Guacamayas (figure 29) 30°33'20"N 108°37'04"W, 2400 m. 2 -7 August 1995. Nest in unidentified pine snag. Breeding pair observed and photographed from blind.

55) Mesa Las Guacamayas (figure 29) 30°32'10"N 108°36'28"W, 2490 m. 2 August 1995 at 12.55 hrs. One bird heard 'whistling'. 3 August at 11.04 hrs. One bird calling, one 'whistling'. Both 200 m east of the spot of the observation of 2 August. Old-growth canyon forest dominated by *Pseudotsuga.*

location (report)	Rancho Carconeras (49)	Mesa las Guacamayas (54)
altitude	1950 m	2400 m
snag or stub	snag	snag
species	*Pinus ayacahuite*	*Pinus* sp.
height tree	18.0 m	14.0 m
height nest	17.8 m	13.1 m
diameter tree at breast height	0.50 m	0.54 m
proportion of trunk covered in bark (estimated)	60 %	70 %
orientation slope	284°	235°
estimated inclination slope	5 %	30 %
vegetation (number of trees higher than 2 m in a circular plot with a diameter of 20 m around nesting tree)	*P. ayacahuite* 18, *P.arizonica* 9, *Cupressus* sp. 3, *Arbutus arizonica* 8, *Juniperus* sp. 14, *Quercus* sp. 26	*P. ayacahuite* 6, *Pseudotsuga* sp. 22, *Quercus* sp. 5

Table 4. Measurements of Eared Trogon nest trees
Tabla 4. Medidas de los árboles con nidos de Coa Silbadora

appendix 3:

Observations of Tufted Jay, Spotted Owl and Golden Eagle

Tufted Jay *Cyanocorax dickeyi*

Southern Durango
1) Road between Cofradía and Calaveras 23°16'39"N 105°24'30"W, 2120 m. 19 February 1995 at 14.00 hrs. Group of about 10 Tufted Jays with both adults and first year birds accompanied by two Steller's Jays. Secondary open pine-oak forest.

2) El Gallo (figure 11) 23°13'14"N 105°26'55"W, 2000 m. 23 February 1995 at 15.00 hrs.. Group moving up along arroyo, two adults seen flying. Lush oak forest in dry environment. On the same spot a group of Tufted Jays was heard on 21 February at 09.30 hrs..

3) Along the road that crosses the sanctuary for the Tufted Jay near Calaveras (figure 11) 23°08'09"N 105°22'16"W, 2200 m. 20-26 February 1995. At least 5 different groups were present. Old-growth (canyon) fir forest with lush vegetation along arroyos.

Western Durango
4) Mexiquillo (figure 12) 23°42'12"N 105°40'55"W, 2200m. 5 March 1995 at 14.45 hrs.. Small group of 3 or 4 birds, silent. Old-growth canyon forest of pines and firs, more luxuriant vegetation along arroyo.

Las Bufas and surroundings (figure 13)
5) Arroyo La Vinata north of Guachimetas de Abajo 24°27'39"N 106°07'00"W, 2120 m. 15 March 1995. Two birds in riparian forest with fir *Abies* sp., no large trees.

6) Arroyo La Vinata north of Guachimetas de Abajo 24°27'26"N 106°07'06"W, 2200 m. 15 March 1995. Two birds, same vegetation as location 5.

7) Arroyo El Sacrificio east of San Blas 24°27'42"N 106°08'31"W, 2160 m.15 March 1995 at 10.15 hrs.. One bird heard and seen flying. Disturbed pine-oak forest, stands of fir.

8) Arroyo El Palmito (or El Granizo) west of San Blas 24°27'40"N 106°08'51"W, 2140 m of elevation on 15 March 1995 at 11.20 hrs.. Three birds in lush riparian forest with big pines and firs, in dry canyon.

9) Road to Carboneras 24°12'42"N 105°57'43"W, 2100 m. 16 March 1995 at 14.30 hrs. At least 3 adult birds in canyon with old-growth pine and fir forest.

10) Las Bufas 24°21'38"N 106°07'00"W, 1890 m. 29 and 30 September 1995. Group of 9 Tufted Jays, among them at least one juvenile. Old-growth canyon pine-oak forest with palms and many bromelias, *Pinus ayacahuite*.

11) Las Bufas 24°20'19"N 106°12'43"W, 2520 m. 2 October 1995. Group of 3 Tufted Jays. Ridge with old-growth pine-oak forest. Big oaks and some madroños.

Spotted Owl *Strix occidentalis*

1) Monte Oscuro (figure 10) 23°17'50"N 104°58'42"W, 2050 m. 26 January 1995 at 00.30 hrs. One bird was heard calling. Old-growth canyon forest (steep north facing slope with open pine-oak forest near lush riparian forest).

2) Las Bufas (figure 13) 24°22'53"N 106°07'23"W, 2343 m. 1 October 1995 at 5.23 hrs. One bird heard calling. Old-growth canyon forest.

3) East of Chonacata, northern Jalisco 22°09'42"N 103°53'45"W, 2500 m. 16 October 1996 at 21.30 hrs. One bird heard calling. Secondary dry-open pine-oak forest.

4) El Carricito (figure 7) 21°50'20"N 103°52'26"W, m. 18 October 1995 at 19.35 hrs. One bird was heard calling. Old-growth pine-oak forest, transition between mesa forest and dry-open forest.

Golden Eagle *Aquila chrysaetos*

SW Durango
1) La Formación (figure 11) 23°27'28"N 105°36'50"W, 2000 m. 13 February 1995 at 10.30 hrs.. Two birds flying over rocky canyons with thin pines.

2) La Formación (figure 11) 23°26'42"N 105°36'24"W, 2000 m. 13 February 1995 at 14.30 hrs.. One bird flying over a forested canyon. Might involve one of the birds seen at location 1 (distance 1.5 km). According to Mr. Hilarión Guerrero of La Formación at least two pairs of Golden Eagles breed in the vicinity of that village.

3) El Gallo (figure 11) 23°13'49"N 105°29'22"W, 1900 m. 22 February 1995 at 14.00 hrs.. One bird briefly perched, flew when harassed by two Ravens. Dry canyon country.

Central Durango
4) Piélagos, Mesa del Aguila (figure 14) 24°40'20"N 105°52'56"W, 2450 m. 29 April two birds flying, 3 May 1995 one bird flying. Steep canyon with old-growth forest in canyon and on surrounding mesa.

Northern Jalisco
5) El Carricito (figure 7) 21°47'55"N 103°53'02"W, 2450 m. 18 October 1995. Two birds flying. Steep cliffs that make up the eastern slope of the mesa of El Carricito.

In addition, Guadalupe Bejerano reported the Golden Eagle in Sierra Tabaco, northern Sonora (figure 18).

Appendix 4:

Birds observed at 12 locations in the Sierra Madre Occidental

Only locations are listed where three or more days of fieldwork were carried out, so the lists will be somewhat representative for the birds that can be found at each location. The lists are far from complete inventories, however. Even during the last of 27 days in Piélagos, new species were added to the local list. Apart from time constraints, factors that make the lists incomplete are the inexperience of the observers with the birds of the Sierra Madre Occidental, especially during the first months of the fieldwork, and seasonal influences.
English, scientific and Spanish names follow Howell and Webb (1995).

Locations

A: Sierra de los Huicholes, northern Jalisco (figure 7) 21°47'N 103°54'W.
Field days: 18 (27.11.1994 - 3.12.1994 and 17.12.1994 - 24.12.1994 and 17.10.1995-19.10.1995). Old-growth mesa pine-oak (hereafter: p-o.) forest at 2500 m, old-growth dry open p-o. forest at 2300 m, grasslands and shrubs at 1500 m.

B: La Formación, SW Durango (figure 11) 23°27'N 105°45'W.
Field days: 6 (11.2.1995-16.2.1995). Old-growth dry open p-o. forest at 2000 m.

C: Calaveras, S Durango (figure 11) 23°03'N 105°23'W.
Field days: 8 (19.2.1995 - 26.2.1995). Altered but mature p-o. forest with *Abies*.

D: La Ciudad - Mexiquillo, SW Durango (figure 12) 23°42'N 105°39'W.
Field days: 4 (1.3.1995 - 3.3.1995 and 5.3.1995). Secondary mesa forest at 2600 m and old-growth canyon p-o. forest at 2300 m.

E: Las Bufas - San Blas, central-W Durango (figure 13) 24°13'N 105°58'W.
Field days: 13 (10.3.1995 - 16.3.1995 and 26.9.1995 - 1.10.1995). Secondary mesa forest at 2700 m, old-growth p-o canyon forest at 2000 - 2500 m.

F: Piélagos, central Durango (figure 14) 24°42'N 105°54'W.
Field days: 27 (30.3.1995 - 2.4.1995 and 12.4.1995 - 5.5.1995). Old-growth mesa forest at 2500 m, old-growth canyon forest at 2100 m, grasslands around village.

G: Rancho El Gavilán, northern Chihuahua 30°02'N 108°30'W.
Field days: 13 (1.7.1995 - 13.7.1995). Secondary dry open p-o. forest at 1800 m.

H: Sierra Tabaco, northern Sonora (figure 18) 30°04'N 108°43'W.
Field days: 9 (21.7.1995 - 29.7.1995). Old-growth canyon forest at 1900 m.

I: Mesa las Guacamayas, northern Chihuahua (figure 29) 30°33'N 108°37'W.
Field days: 7 (1.8.1995 - 7.8.1995). Secondary mesa forest with mature stands of *Pseudotsuga*.

J: Mesa Rechánachi , central Chihuahua (figure 17) 27°58'N 108°04'W.
Field days: 4 (17.8.1995 - 20.8.1995). Old-growth dry open p-o. forest.

K: Quebrada de Peñol, NW Durango (figure 15) 26°05'N 106°07'W.
Field days: 3 (11.9.1995 - 13.9.1995). Old-growth canyon forest at 2300 m.

L: Pino Gordo, S Chihuahua (figure 16) 26°32'N 107°01'W.
Field days: 5 (15.9.1995 - 19.9.1995). Unlogged but altered mesa- and dry open p-o. forest at 2200 m.

			A	B	C	D	E	F	G	H	I	J	K	L
	Cathartidae													
Black Vulture	*Coragyps atratus*	Zopilote negro	x	x			x		x					
Turkey Vulture	*Cathartes aura*	Aura Cabecirroja	x	x	x	x	x	x	x	x	x	x	x	x
	Accipitridae													
Northern Harrier	*Circus cyaneus*	Gavilán Rastrero	x											
Sharp-shinned Hawk	*Accipiter striatus*	Gavilán Pajarero	x	x	x		x	x			x			
Cooper's Hawk	*Accipiter cooperi*	Gavilán de Cooper	x		x									
Northern Goshawk	*Accipiter gentilis*	Gavilán Azor						x						
Common Black Hawk	*Buteogallus anthracinus*	Aguililla Negra Menor					x	x						
Swainson's Hawk	*Buteo swainsoni*	Aguililla de Swainson					x							
Zone-tailed Hawk	*Buteo albonotatus*	Aguililla Aura			x			x		x				x
Red-tailed Hawk	*Buteo jamaicensis*	Aguililla Colirroja	x	x			x	x	x	x				
Golden Eagle	*Aquila chrysaetos*	Aguila Real	x	x				x						
	Falconidae													
Crested Caracara	*Caracara plancus*	Caracara común	x											
American Kestrel	*Falco sparverius*	Cernícalo Americano	x				x							
	Phasianidae													
Wild Turkey	*Meleagris gallopavo*	Guajolote Silvestre	x					x						
Montezuma Quail	*Cyrtonyx montezumae*	Codorniz de Moctezuma							x			x		
	Charadriidae													
Killdeer	*Charadrius vociferus*	Chorlito Tildío						x						
	Scolopacidae													
Spotted Sandpiper	*Actitis macularia*	Playero Alzacolita											x	
	Columbidae													
Band-tailed Pigeon	*Columba fasciata*	Paloma Encinera	x	x		x		x		x	x	x	x	x
Mourning Dove	*Zenaida macroura*	Paloma Huilota						x						
Inca Dove	*Columbina inca*	Tórtola Colilarga		x			x							
White-tipped Dove	*Leptotila verreauxi*	Paloma arroyera			x									
	Psittacidae													
Thick-billed Parrot	*Rhynchopsitta pachyrhyncha*	Cotorra - serrana Occidental					x		x	x	x		x	
Lilac-crowned Parrot	*Amazona finschi*	Loro Corona-violeta		x	x		x	x						
	Strigidae													
Whiskered Screech-Owl	*Otus trichopsis*	Tecolote Bigotudo			x		x	x	x	x				
Great Horned Owl	*Bubo virginianus*	Buho Cornudo									x			
Mountain Pygmy-Owl	*Glaucicdium gnoma*	Tecolotito Serrano	x		x			x						
Spotted Owl	*Strix occidentalis*	Buho Manchado	x				x							

			A	B	C	D	E	F	G	H	I	J	K	L
	Caprimulgidae													
Common Nighthawk	*Chordeiles minor*	Chotacabras Mayor							x					
Common Poorwill	*Phalaenoptilus nuttallii*	Pachacua Norteña								x				
Mexican Whip-poor-will	*Caprimulgus arizonae*	Tapacaminos Cuerporruin	x				x	x	x	x	x			x
	Apodidae													
White-throated Swift	*Aeronautus saxatalis*	Vencejo Gorjiblanco	x	x	x	x	x	x						
	Trochilidae													
White-eared Hummingbird	*Basilinna leucotis*	Colibri Orejiblanco	x	x	x	x	x	x			x			x
Magnificent Hummingbird	*Eugenus fulgens*	Colibri Magnífico					x					x		
Broad-tailed Hummingbird	*Selasphorus platycerus*	Zumbador Coliancho	x		x		x	x					x	x
Blue-throated Hummingbird	*Lampornis clemenciae*	Colibri-serrano Gorjiazul	x	x	x	x	x	x	x	x	x			
	Trogonidae													
Mountain Trogon	*Trogon mexicanus*	Trogon Mexicano	x	x	x	x	x		x					
Elegant Trogon	*Trogon elegans*	Trogon Elegante			x			x	x	x				
Eared Trogon	*Euptilotis neoxenus*	Coa Silbadora	x	x		x	x	x			x	x	x	x
	Alcedinidae													
Green Kingfisher	*Chloroceryle americana*	Martin-pescador Verde											x	
	Picidae													
Acorn Woodpecker	*Melanerpes formicivorus*	Carpintero Arlequín	x	x		x	x	x	x	x	x	x	x	x
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Chupasavia Vientre-amarillo			x									
Red-naped Sapsucker	*Sphyrapicus nuchalis*	Chupasavia Nuquirroja	x											
Williamson's Sapsucker	*Sphyrapicus thyroideus*	Chupasavia de Williamson	x					x						
Ladder-backed Woodpecker	*Picoides scalaris*	Carpintero listado	x						x					
Hairy Woodpecker	*Picoides villosus*	Carpintero-velloso Mayor					x	x			x		x	x
Arizona Woodpecker	*Picoides arizonae*	Carpintero de Arizona	x	x	x	x	x					x		
Northern Flicker	*Colaptes auratus*	Carpintero Collarejo	x	x	x	x	x	x	x	x	x	x	x	x
Pale-billed Woodpecker	*Campephilus guatemalensis*	Carpintero Piquiclaro			x									
	Dendro-colaptidae													
White-striped Woodcreeper	*Lepidocolaptes leucogaster*	Trepatroncos Blanquirrayado	x	x	x	x	x	x						

			A	B	C	D	E	F	G	H	I	J	K	L
	Tyrannidae													
Tufted flycatcher	*Mitrephanes phaeocercus*	Mosquero Penachudo	x			x	x	x				x		x
Greater Pewee	*Contopus pertinax*	Pibí Mayor	x		x	x	x	x	x	x	x	x		x
Pine Flycatcher	*Empidonax affinis*	Mosquero Pinero								x				
Cordilleran Flycatcher	*Empidonax occidentalis*	Mosquero Barranqueño									x			
unidentified *Empidonax*	*Empidonax* sp.		x	x	x			x			x			
Black Phoebe	*Sayornis nigricans*	Mosquero negro												x
Say's Phoebe	*Sayornis saya*	Mosquero Llanero	x											
Vermilion Flycatcher	*Pyrocephalus rubinus*	Mosquero Cardenal		x		x	x	x						
Dusky-capped Flycatcher	*Myiarchus tuberculifer*	Copetón Triste									x			
Ash-throated Flycatcher	*Myiarchus cinerascens*	Copetón Gorjicenizo						x						
Sulphur-bellied Flycatcher	*Myiodynastes luteiventris*	Papamoscas Vientre-amarillo							x	x	x			
Cassin's Kingbird	*Tyrannus vociferans*	Tirano de Cassin								x				
	Hirundinidae													
Violet-green Swallow	*Tachycineta thalassina*	Golondrina Cariblanca	x	x	x		x	x						x
Bank Swallow	*Riparia riparia*	Golondrina ribereña						x						
Barn Swallow	*Hirundo rustica*	Golondrina ranchera						x		x		x		
	Corvidae													
Steller's Jay	*Cyanocitta stelleri*	Chara de Steller	x	x	x	x	x	x	x	x	x	x	x	
Tufted Jay	*Cyanocorax dickeyi*	Chara Pinta			x	x	x							
Grey-breasted Jay	*Aphelocoma ultramarina*	Chara Pechigris	x	x			x	x	x	x	x		x	
Northern Raven	*Corvus corax*	Cuervo Grande	x	x	x	x	x	x	x	x		x		
	Paridae													
Mexican Chickadee	*Parus sclateri*	Paro Mexicano				x	x			x	x	x		x
Bridled Titmouse	*Parus wollweberi*	Paro Embridado	x	x			x	x		x				
	Aegithalidae													
Bushtit	*Psaltriparus minimus*	Sastrecillo									x			
	Sittidae													
White-breasted Nuthatch	*Sitta carolinensis*	Saltapalos Pechiblanco	x				x	x		x	x		x	x
Pygmy Nuthatch	*Sitta pygmaea*	Saltapalos enano						x			x			x
	Certhiidae													
Brown Creeper	*Certhia americana*	Trepador Americano	x	x		x	x	x	x	x	x			x

			A	B	C	D	E	F	G	H	I	J	K	L
	Troglodytidae													
Canyon Wren	*Catherpes mexicanus*	Saltapared Barranquero	x	x		x	x	x		x	x	x	x	
Bewick's Wren	*Thyromanes bewickii*	Saltapared de Bewick								x				
Northern House Wren	*Troglodytes aedon*	Saltapared Norteño	x	x	x			x	x	x	x	x		
	Cinclidae													
American Dipper	*Cinclus mexicanus*	Mirlo-acuático Americano	x			x		x					x	
	Turdidae													
Eastern Bluebird	*Sialia sialis*	Azulejo Gorjicanelo	x	x				x			x			x
Western Bluebird	*Sialia mexicana*	Azulejo Gorjiazul						x						x
Brown-backed Solitaire	*Myadestes occidentalis*	Clarín Jilguero	x	x	x	x	x	x		x		x		
Russet Nightingale-Thrush	*Catharus occidentalis*	Zorzalito Piquipardo	x									x		
Hermit Thrush	*Catharus guttatus*	Zorzalito Colirrufo	x	x	x	x					x			
American Robin	*Turdus migratorius*	Zorzal Petirrojo	x	x	x	x	x	x	x	x	x	x		x
Aztec Thrush	*Zoothera pinicola*	Zorzal Azteca				x	x							
	Mimidae													
Blue Mockingbird	*Melanotis caerulescens*	Mulato Azul					x							
Northern Mockingbird	*Mimus polyglottos*	Cenzontle Norteño						x						
	Ptilogonatidae													
Grey Silky	*Ptilogonys cinereus*	Capulinero Gris	x		x		x							
	Vireonidae													
Plumbeous Vireo	*Vireo plumbeus*	Vireo plomizo	x				x			x				
Hutton's Vireo	*Vireo huttoni*	Vireo de Hutton	x	x			x	x					x	
	Parulinae													
Orange-crowned Warbler	*Vermivora celata*	Chipe Corona-naranja			x		x	x						
Nashville Warbler	*Vermivora ruficapilla*	Chipe de Nashville			x									
Crescent-chested Warbler	*Vermivora superciliosa*	Chipe Cejiblanco				x	x	x						
Yellow-rumped Warbler	*Dendroica coronata*	Chipe rabadilla	x	x	x			x						
Townsend's Warbler	*Dendroica townsendi*	Chipe de Townsend	x	x			x	x					x	
Hermit Warbler	*Dendroica occidentalis*	Chipe Cabeci-amarillo	x	x	x			x					x	
Grace's Warbler	*Dendroica graciae*	Chipe de Grace			x	x	x	x		x	x			
Black-and-white Warbler	*Mniotilta varia*	Chipe trepador						x						
Wilson's Warbler	*Wilsonia pusilla*	Chipe de Wilson		x	x		x							
Red-faced Warbler	*Cardellina rubrifrons*	Chipe Carirrojo	x		x		x	x		x	x			

			A	B	C	D	E	F	G	H	I	J	K	L
Red Warbler	*Ergaticus ruber*	Chipe Rojo			x	x	x	x						
Painted Redstart	*Myioborus pictus*	Pavito aliblanco	x	x	x	x	x	x	x	x	x	x	x	
Slate-throated Redstart	*Myioborus miniatus*	Pavito Gorjigris		x	x	x	x	x			x			
Rufous-capped Warbler	*Basileuterus rufifrons*	Chipe Gorrirufo			x	x	x							
Olive Warbler	*Peucedramus taeniatus*	Chipe Ocotero	x	x			x						x	
	Thraupinae													
Blue-hooded Euphonia	*Euphonia elegantissima*	Eufonia Capucha-azul	x											
Hepatic Tanager	*Piranga flava*	Tángara Encinera	x	x	x	x	x	x	x	x			x	
Summer Tanager	*Piranga rubra*	Tángara Roja					x							
Western Tanager	*Piranga ludoviciana*	Tángara Occidental						x						
Red-headed Tanager	*Spermagra erythrocephala*	Tángara Cabecirroja					x							
	Cardinalinae													
Black-headed Grosbeak	*Pheuctites melanocephalus*	Picogrueso Tigrillo		x						x				
	Emberizinae													
Rufous-capped Brushfinch	*Atlapetes pileatus*	Saltón Gorrirufo			x		x					x		
Rufous-sided Towhee	*Pipilo erythro-phthalmus*	Rascador Ojirrojo		x	x		x	x	x	x	x			
Canyon Towhee	*Pipilo fuscus*	Rascador arroyero										x		
Chipping Sparrow	*Spizella passerina*	Gorrión Cejiblanco						x						
Rusty Sparrow	*Aimophila rufescens*	Zacatonero Rojizo									x			
Striped Sparrow	*Oriturus superciliosus*	Zacatonero rayado						x						x
Yellow-eyed Junco	*Junco phaeonotus*	Junco Ojilumbre	x	x	x	x	x	x		x	x	x	x	x
	Icteridae													
Brown-headed Cowbird	*Molothrus ater*	Vaquero Cabecicafé						x				x		
Scott's Oriole	*Icterus parisorum*	Bolsero Tunero	x		x		x							
	Fringillidae													
Red Crossbill	*Loxia curvirostra*	Picotuerto Rojo						x						
Pine Siskin	*Carduelis pinus*	Dominico Pinero					x	x						
Black-headed Siskin	*Carduelis notata*	Dominico Cabecinegro		x			x							
Lesser Goldfinch	*Carduelis psaltria*	Dominico Dorsioscuro					x							
Hooded Grosbeak	*Coccothraustes abeillei*	Pepitero Encapuchado			x		x	x						
Evening Grosbeak	*Coccothraustes vespertinus*	Pepitero Norteño										x		
House Sparrow	*Passer domesticus*	Gorrión Domestico						x						
TOTAL			59	44	47	33	67	72	25	37	36	25	22	23

Appendix 5: Ground truthing of old-growth areas predicted by analysis of Landsat images

The abbreviation SC means prediction by the supervised classification analysis (computer generated), DS means prediction by Dana Slaymaker (by expert's eye).

1) Area between Pinos Altos and Ocampo, central Chihuahua (28°13'N 108°20'W). Predicted (SC and over flight): large old-growth area. Found: selectively logged mesa forest. There was a dense network of logging roads and most larger pines and snags had been cut. The area still holds many big non-commercial conifers (*Abies*, *Pseudotsuga* and *Cupressus*) which are probably responsible for the old-growth prediction.
2) Area around and west of Santa Eduwiges, central Chihuahua (28°11'50'N 108°02'45"W). Predicted (SC and over flight): old-growth with large conifers. People living 5 km from the area told a sawmill, El Cuervo, has been operating in this area for 40 years. It seems out of the question old-growth could remain within 10 km of a paved highway.
3) Canyon of Agua Blanca, NW Durango (25°47'N 106°46'W). Predicted (DS): old-growth. Found: 2 km^2 primary canyon forest, rich in snags (this old-growth area is over 1 km^2 and should therefore have been included in the list on page 17).
4) Canyons west and south of Mesa Rechánachi -labeled 'Earlobe Mesa" by the Sonoran Institute-, central Chihuahua (27°58'N 108°04'W, figure 17). Predicted (SC and aerial survey): old-growth with very large conifers. Found: primary canyon forest with biggest conifers max. 50 cm d.b.h.. The area is scheduled to be opened and logged by the ejido of Yoquivo in 1997 or 1998.
5) Belt of canyons running from the river El Agua Fría 10 km NWN to Cerro Pelón (25°45'17"N 107°05'29"W), southernmost Chihuahua. Predicted (DS): old-growth. Found: primary canyon forest, which was being logged at the moment of visiting.
6) Area S and SE of El Tecuan , NW Durango. Predicted (DS): small pockets of old-growth. Found: three pockets of mesa forest, all smaller than 1 km^2 (between Osos Bravos and Sta. Gertrudis 25°27'00"N 106°56'31"W, La Tableta 25°25'47"N 106°56'31"W, La Soledad 25°00'20"N 106°46'00"W. In addition, the canyon just east of La Soledad holds primary forest).
7) Area between Frailecillos and Río Colorado, NW Durango (25°32'47"N 106°34'06'W). Predicted (DS): old-growth. Found: Selectively-logged dry open pine-oak forest.
8) Area just east of Quebrada de Peñol (26°07'N 106°07'W, figure 15). Predicted (DS): old-growth. Found: secondary dry-open pine-oak forest.

Existing old-growth forests in the area covered by the Landsat images <u>not</u> predicted by the analysis:

(1) Pino Gordo, figure 17. Dry open pine-oak forest 154.0 km^2, mesa forest 0.6 km^2.
(2) Quebrada de Peñol, figure 15. Canyon forest 29.8 km^2.
(3) Cerro Pelón, southernmost Chihuahua. A belt of approx. 6 km^2 of mesa forest runs from 25°45'17"N 107°05'29'W north-west to 25°48'00"N 107°06'58"W. This area was scheduled to be logged in the winter of 1995-1996.
(4) Basaseachic National Park. Dry open pine-oak forest 17.8 km^2, canyon forest 3.2 km^2.
(5) Mesa Rechánachi. Dry open pine-oak forest 9.8 km^2. The primary vegetation on "Earlobe Mesa" itself was not predicted in the analysis, only the adjacent canyon forest.

Appendix 6: local names

The phonetic descriptions follow the Spanish pronunciation rules.

Imperial Woodpecker

jútai, plural *jutáish*	Huichol language, noted in Ratontita. Known only to Akaeteamey (or Eusevio), age 88*
relao	Tarahumara language, noted in Pino Gordo (figure 16)
rilao	Tarahumara language, noted in Yerbitas, southern Chihuahua
cumecócari.	Tarahumara language, recorded by Pennington (1963)
corachica	Tarahumara language, recorded by Uranga and Venegas (1995) in the Guachochi region
rerawi	Tarahumara language, recorded by Uranga and Venegas (1995) in the Mesa de Arturo region
ua gam	Tepehuan language, noted in Santa María de Ocotán, southern Durango
pitoreal	Used all over the Sierra Madre Occidental. It is the only name used by non-indians and applied over remarkably large area. Normally there is a wide geographical variation in bird names. In 1777 this name was already used by Franciscans in southern Chihuahua (page 34). The Pale-billed Woodpecker *Campephilus guatemalensis* is often named pitoreal as well.

*) This man did not know (nor did any other Huichol) a version of a Huichol legend described by Lumholtz (1903: vol. 2, p. 108). It is about the Imperial Woodpecker and the Grey Squirrel protecting the sun during its first journey across the sky, and the woodpecker subsequently carrying the colour of the sun on his crest. Akaeteamey said in the version he knew this role is for the Vermillion Flycatcher *Pyrocephalus rubinus*, another bird with strikingly red plumage and still common today.

Thick-billed Parrot

cacáhuame, plural *cacáhuametsish*	Huichol language, noted in Rancho Bolantín (figure 7)
guacamaya, sometimes abbreviated to *guaca*	Northern Durango and Chihuahua
perico	Southern and central Durango. In this part of the country *guacamaya* is used for the Military Macaw. *Perico* is often used for the Lilac-crowned Parrot as well.

Eared Trogon

chawkwita, plural *chawkwitas*	Huichol language, noted in Rancho Bolantín (figure 7)
tucha	Tarahumara language, noted in Pino Gordo (figure 16). This is a phonetic description of the *wheeeuh chk* call.
pavillón	Yoquivo, central Chihuahua
coa	Used all over the Sierra Madre Occidental for the Eared Trogon as well as for the Mountain Trogon and Elegant Trogon, between which no distinction is made usually
coa silbadora	Noted in La Tijera, NW Durango. This seems the most natural Spanish name ("whistling trogon") and is used throughout this study in the Spanish translations