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CONSERVATION AND SUSTAINABLE USE OF PARROTS IN MEXICO

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This document is based on the results of the Workshops on Conservation and Sustainable Use of Wild Birds and Mammals in relation with Wildlife Management Units (known as UMAs) in Mexico[1], organized by the General Directorate for Wildlife (*Dirección General de Vida Silvestre*, SEMARNAT), the National Institute of Ecology (*Instituto Nacional de Ecología*, SEMARNAT), *Unidos para la Conservación A.C.* and Oscar Sánchez, and held on 24-26 July 2006 and 4-6 September 2006 respectively in Mexico City.

PREFACE

The current administrative framework for the sustainable use of wildlife in Mexico is based on the concept of Wildlife Management Units known as UMAs (*Unidades de Manejo para la Conservación de Vida Silvestre*). One of the main premises of this framework is that properties registered as UMAs must promote the conservation of local native biota by maintaining the natural richness of wild communities and local and regional species abundance and recruitment patterns, which contribute to the functioning of the ecosystems present. UMAs are especially responsible for guaranteeing the continuity and functionality of the local and regional populations of the target species they are interested in using.

To achieve this, technical experts in charge of UMAs and government officials overseeing the implementation of conservation programs need to have a shared framework of reference for the biological principles to consider in their respective tasks. Besides, technical staff in charge of conservation programs in UMAs also need guidelines to establish and implement programs for the assessment, management and monitoring of wild populations and their habitats within the property but also considering its surroundings. The staff must also have elements available to help them make cautious decisions about the viability – or not – of harvesting part of the populations (that the fraction observed in the UMA belongs to). If the biological viability of such harvest is fully justified, the technical staff need to have clear expertise, skills and guidelines to be able to systematically monitor the status of the target populations to observe their trends and changes, so that they can better guide their management practices towards long-term sustainability.

The ideas mentioned above were the basis for the design and development of the Workshops on Conservation and Sustainable Use of Wild Birds and Mammals in relation with

[1] DGVS, 2006. Talleres sobre conservación y uso sustentable de aves y mamíferos silvestres, en relación con las Unidades de Conservación y Manejo de Vida Silvestre (UMA) en México. INE-SEMARNAT-UPC.

Wildlife Management Units (UMAs) in Mexico. The workshops were attended by experts from academic institutions and NGOs with experience in the conservation of the conservation of the most widely used wild species in Mexico, as well as technical experts from Mexican and American government agencies working jointly on binational wildlife conservation projects.

One of the working groups in the workshops was devoted to Parrots. The results of the working group are explained below with the aim of contributing to the discussions of the Working Group on Birds of the International Expert Workshop on CITES Non-Detriment Findings.

PARROTS

The discussions of the working group were based on the model proposed by Ariel Rojo Curiel and Lizardo Cruz Romo (*Dirección General de Vida Silvestre*, SEMARNAT), which was analyzed and optimized by the participants at the Workshop.

Preparation of the document

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Introduction

The parrot family (Psittacidae) is a group represented by 352 species globally. Mexico has 22 species of parrots, which occur in practically all the states of the country (PREP, 2000). Parrots have zygodactyl feet (two toes forward, two backward), adapted to move about easily in the forest canopy. Mexican parrots have a great variety of sizes, with a length ranging from 12-14 cm in *Forpus cyanopygius* to 96 cm in *Ara macao*. Their color patterns are also very diverse, but they are generally recognized by their bright green color, which is common in the species of

the genera *Amazona* and *Aratinga*. Although they usually have little sexual dimorphism, certain species have different color patterns on their head. This also helps distinguish juveniles from adult specimens. Besides, the eyes of juveniles have a darker pigmentation than those of adults, whose eyes are usually pale or amber (Howell and Webb, 2001).

Parrot chicks are altricial (helpless at birth) and therefore require great parental care. This usually occurs in tree hollows, termite mounds or rock cavities. Availability of such cavities – a crucial aspect in the reproductive biology of this bird family – is a limiting factor. Although parrots are mainly distributed in tropical regions, two species in Mexico occur exclusively in the pine forests in the mountain ranges of the Sierra Madre Occidental and the Sierra Madre Oriental (Ceballos and Eccardi, 1996). In these regions, parrots feed mainly on seeds and fruits (Howell and Webb, 2001).

Currently, close to 31% of Neotropical parrots are at risk of extinction (Collar, 1996). The main causes that have led these species to such levels of risk are the loss, fragmentation and degradation of their habitat – mainly habitat directly related to breeding –, the harvest of individuals for the pet trade, and the killing of large groups of these and other species in crop farming areas to reduce crop losses. The reproductive biology of these species itself increases the scope of such threats, as parrots are long lived and most of them are monogamous, forming bonds that last for life in many species; they also have very specific nesting sites and their young require great parental care; finally, the breeding success of these species is usually low. For all these reasons, annual recruitment in these populations is low and should be considered as a key aspect when determining the sustainability of harvesting these species.

A. Important population aspects of the species (or groups of species) for the conservation and management of a sustainable harvest in Wildlife Management Units (UMAs)

According to the dimensions of the known home ranges of various species of parrots, the surface of most UMAs is usually not large enough to guarantee their proper management. It is important to consider that these birds move considerably throughout the year depending on the availability of resources. One of the basic parameters for responsible management is the productivity of populations, which requires knowing at least the availability of nesting sites in a given UMA, the actual occupation of such sites and effective reproductive output.

Under these considerations, two basic scales have been identified to determine the status of the populations:

- It is necessary to increase regional knowledge about each species and subspecies, including the conservation status of the habitat, densities, and the level of risk faced by the species in that region.
- On a local level, it is essential to know the density and specific productivity levels of populations in a given area.

Study methods to apply at the local level are explained below; regional management

is dealt with in Section C of this document.

The most important aspects of population biology or population ecology that should be considered when dealing with the conservation of parrots, especially regarding their management in large UMAs related to such species, are the following:

a) The baseline population size appropriate for the conservation of the species;
b) Population trends (which need to be monitored by sampling the population at least once a year; this exercise should be repeated regularly in the long term);
c) Size of the area required by the population;
d) General and specific nesting habitat requirements (critical for the natural development of every species);
e) Population demographics (productivity, mortality, age at first reproduction, and population growth rate, among others);
f) Historic and recent impacts affecting the species or the population in the UMA and the region where it is located (historic harvest level, impact of natural climatic phenomena, level of deforestation in the area, restoration activities undertaken or surface of habitat conserved in the UMA, presence of protected areas and management).

Estimated population size (surveys)

To estimate population size, we propose a protocol that defines the time frame, effort and method of analysis of data obtained through sampling:

Sampling time frame.- The recommendation is to work at the beginning and towards the end of the breeding season of each annual period (November to February) to estimate the resident population. Dates may slightly vary depending on the species dealt with and the region of the country where it occurs; however, to avoid overestimating the population size, the sampling should not be made during periods when all the individuals of the population are grouped together, including fledglings produced in the same season. Additionally, in one breeding season it is possible to observe the pairs that will try to breed in the next season, which provides information about population demographics.

Sampling effort.- For the most common species, it is recommended to use at least 100 point counts (50 point counts is acceptable if counts are made 2 or 3 times during the breeding season). Sampling effort should be increased if it is not enough to make an appropriate estimate of population density.

Sampling protocols should be designed according to the conditions of the habitat and the species studied (it is not the same to estimate the population of an *Aratinga*, whose movements cover relatively small areas, than to estimate that of a macaw, which can move around an area covering several states or even countries). The representativeness of the sampling method in analyzing the counts made can be assessed with counting software such as DISTANCE. This makes it possible to determine whether the sampling was representative for the area of interest (Buckland *et al*. 1993).

In any case, the sampling effort should always be described; that is, the number of point counts per transect, the number of transects and the length and direction of the transects. The points and transects should also be marked on a geographical map with the help of a GPS at a scale that shows their location unequivocally. To do so, it is necessary to include the UTM (Universal Transverse Mercator) coordinates of each point count and the start and finish of each transect. If the UMA has a fixed infrastructure for the point counts, such as observation towers or platforms in tall trees, such places should be clearly shown on the maps, indicating their coordinates.

Sampling schedule.- Point-distance sampling should take place in the first three hours of the morning, when parrots are most active; travel routes, roosts and feeding grounds should be avoided so as not to overestimate the population.

At each point count, the counting interval should not exceed 10 minutes; in each transect or sampling route, the points should be at least 200 or 300 m from the observation limit, that is, the farthest distance to the center of the area where an individual or group of individuals was seen (Casagrande and Beissinger, 1997; Marsden, 1999; Bibby *et al*., 2000).

Additionally, relevant data about the site should be recorded, such as the weather conditions at the time of sampling, type of habitat, time of detection, bird species, number of individuals, mode of detection (visual or call), activities such as perching, escape due to the presence of the observer or simple flight over the area. The distance between the observer and the bird should be recorded as accurately as possible. If possible, additional observations should be recorded, such as the direction of the flight or the direction observed in the bird or flock.

To calculate the density of individuals, data analysis techniques based on the algorithm of distance to the transect should be used (the DISTANCE computer package mentioned above, for example.
See http://www.ruwpa.st-and.ac.uk/distance/).
In this case, it is important to record individuals that are perched (i.e., effectively using the habitat) and measure the distance between the observer and the bird accurately to obtain a reasonable estimate of the number of individuals per unit of area.

Sampling should be stratified, that is, transects should cover the different types of representative natural habitat of the UMA. This is done by considering the surface occupied by each habitat in proportion to the total surface of the UMA. In each habitat, the point counts or transects should be placed randomly as much as possible to avoid sampling biases; such biases usually happen when transects are placed in areas with a high concentration of individuals, that is, around crop fields, migration routes or roosts (a specific technique is proposed for sampling roosts; see below). As mentioned earlier, density estimates should be based on records of individuals perched in the habitat. They should be calculated for individual species and habitat types separately. To do so, we suggest using the format included in Annex I.

Sampling roosts.- There is an additional possibility of making counts in roosts to obtain a specific estimate of the number of individuals that use the site. This involves finding the different roosts and making the counts in the morning, precisely when the

individuals leave these sites. We recommend making 5 randomly chosen counts for each of these sites in a month to obtain an estimate of the average number of individuals per roost and determine sample variation (Cougill and Marsden, 2004; Berg and Angel, 2006). Counts made in roosts must not be taken as a basis for – or lead to – an estimate of the number of individuals per area, because they do not include any information about the distance traveled by the individuals congregating in the roost. In some cases, individuals may travel up to 25 km between their roost and feeding grounds.

Sampling from high observation points.- This method can be used to estimate the relative abundance of a parrot species in the area. The following protocol should be followed in this type of observation: count the number of individuals for 10 or 15 minutes and use the average, that is, the number of individuals flying in just one direction (e.g., towards the roost). It is very important to clarify that the use of this method does not exempt the operator from monitoring the distance from the individuals detected to the transects. This leads to a better knowledge of relative density and eventually leads to determining the minimum size of the population that frequents the area. It is also important to highlight that this method should not be used alone to estimate abundances in parrot species as it may lead to population overestimates, especially when the sampling area is located near protected areas. Therefore, the result of this type of counts should be compared with fixed point monitoring, as mentioned in this document.

Local sampling efforts aimed at making population estimates can provide important information about population trends in the region in the medium term if they are conducted for several consecutive years. This is of considerable importance, as it can show declines in the abundance of parrots in specific areas (the case of certain parrot species in the state of Guerrero, for example).

Estimating the production of a population

Certain demographic parameters are necessary, not only to estimate the status and trends of a population, but also to set reasonable harvest rates every year for different species with an approach clearly based on conservation and sustainable use. The General Directorate for Wildlife (*Dirección General de Vida Silvestre,* DGVS) has already made a bibliographic review of various documents. This has been used to produce a table with the known population productivity parameters of several parrot species, with a special focus on Mexican species but also considering genera that also occur in other regions of America. Additionally, the table has made it possible to establish reference values to define a cautious harvest algorithm (Table 1).

Although there is currently abundant information for some species in certain regions of the country, it is necessary to determine the regional contribution of productivity in UMAs that manage parrots; the following method should be used to determine the productivity of the population of each UMA:

a) The method is based on counting the number of nests in the study area (UMA or region in the case of small UMAs).
b) The characteristics of the nests should be identified: tree species where the

nest is located, living or dead tree, tree diameter at breast height, tree height, height of the cavity and type of habitat. If there is a plan to place artificial nests in the UMA, it is essential to obtain key data beforehand on the characteristics of the natural cavities used (e.g., height from the ground, orientation, entrance size, shape, and depth, among others).

c) Clutch size (total number of eggs laid in each nest to calculate the average clutch size with data for several years, comparing different regions).
d) Nesting success: proportion of successful nests (nests with at least one fledged chick).
e) Productivity: number of fledglings per successful nest and number of fledglings per pair.

The previous data should be used to produce reasonable estimates of chick births and deaths. This kind of monitoring should be made during the harvest season in the nests whose harvest has been planned, to avoid disturbing the nests that are not going to be harvested each season. We recommend using the format shown in Annex I to collect data from nest monitoring.

As we already mentioned earlier, relative population density should be analyzed using the DISTANCE computer package (http://www.ruwpa.st-and.ac.uk/distance/). Distance is used to determine population density using the perpendicular distance of individuals from the transect line; this refers to the number of individuals seen (alone or in groups), their location along the transect, and their distance from the observer. The computer program also assesses the representativeness of the sample and can produce comparative values if the sampling is separated by habitat type. However, when calculating relative density with DISTANCE, a cautious criterion should be applied: only values corresponding to the lower limit of the confidence interval should be used.

Additionally, when counting individuals in roosts, it is necessary to count the average number of individuals of each species counted in each sampling. This figure will only provide a relative abundance index, so it is still necessary to determine density using distance from the observer in points along transects.
Productivity should be not only be estimated by considering the number of pairs that make nesting attempts every year. It is also necessary to consider the average number of observations of eggs, chicks – during the systematic monitoring of nests – and fledglings/successful nest every season, as well as losses at each stage of development.

Early warning signs of declining trends in a population of parrots include the following:

- Decline in population size estimates
- Three consecutive years of drought in the area
- Three consecutive years of low productivity in the population: high chick mortality or decline in clutch size or brood size
- Increase in the type, number and/or scope of threats to the population in the area, such as capture of individuals with nets, for example

B. Important habitat-related aspects of the species (or groups of species) for the conservation and management of a sustainable harvest in Wildlife Management Units (UMAs)

The most important components of the habitat for parrot species include the habitat area required by the individuals of the species for their daily activities (also known as home range); nesting habitat, that is, species and size of the trees used; foraging habitat or feeding sites; and resting areas. It is important to consider that some species are more flexible than others in using areas with a greater level of disturbance or even agricultural land. Others, however, have stricter habitat requirements and require undisturbed areas. As regards home range, the information available is limited to the few species that have been the subject of this type of study.

In a UMA, it is necessary to identify the surface occupied by the different habitat types present (forest, conserved primary habitat, regenerating secondary habitat, deforested areas and agricultural land). As a complement to this information, it is important to record vegetation types and their characteristics, as well as processes and trends in vegetation types and land use.

The following information about the habitat should be provided by the technical staff in charge of a UMA in its Management Plan:

a) Total surface of the UMA
b) Location and area covered by the various vegetation types in the UMA
c) Description of the characteristics of the vegetation types and list of tree species present in the UMA

The following procedure should be followed every year to monitor the characteristics of the habitat:

- Sample specific plots in each vegetation type, using a compass to measure the distance to the closest tree towards the four cardinal points; measure the diameter and height of the tree and identify the closest tree species (Marsden and Pilgrim, 2003);
- Record changes in land use or changes in vegetation caused by the impact of hurricanes or fire, among other causes;
- The habitat type in each UMA should be placed in its regional context, based on the information available in INEGI (the Mexican National Institute of Statistics and Geography) or the forest inventories available (SEMARNAT-INE-*Instituto de Geografía* UNAM). This will produce an index with information about the general trend of the habitat type in the region, which can be compared to those observed in the rest of the country.

Before organizing the harvest, it is necessary to generate reliable information about the habitat and area requirements of each target species to determine whether the harvest is viable. If so, the minimum requirements should be defined to guarantee a sustainable harvest of parrots at the appropriate working scale for each species. Again, we recommend using a standard format to capture data on habitat status. Our recommended format is shown in Annex I.

UMAs planning to manage parrot species for a commercial harvest must contain the necessary natural habitat to sustain stable breeding populations. This absolutely requires an assessment of the nests in the area, identifying active nests (and potential nesting sites, even if they were not active when reviewed).

Habitat management practices recommended in some cases to promote the presence of species of interest include the following:

- Reforestation with native tree species
- Increase of the forest area devoted to conservation
- Placement and monitoring of artificial nests when the species' reproductive biology makes it possible
- Protection of natural nests against predators
- Surveillance of nests to prevent nest poaching, destruction of nests and especially legal and illegal logging

We identified the following as early warning signs of habitat degradation:

- Increase in the rate of change of land use and decline of conserved forest area
- Serious drought in the region for 3-4 consecutive years
- Adverse climate forecasts for the region (e.g., increase in the intensity and frequency of hurricanes caused by habitat deforestation; loss of food resources caused by the destruction of foliage, flowers and fruits and a consequent increase in the intensity of fires in the dry season after the hurricane season – a common phenomenon over the last 10 years in the states of the Yucatan Peninsula and the Pacific side of Chiapas).
- Increase in the legal or illegal logging of important trees providing food or nesting sites for the species.

Table 1. Productive parameters in free-ranging Mexican parrots and genera shared with other countries

	Species and category in the Mexican endangered species list	Breeding population %	No. of eggs/ nest	Hatching success	Fledgling success	Nesting success (at least 1 chick)	Production of fledglings/ successful nest	Fledglings/ breeding pair	Source
Mexican species	*Amazona*		3.77	0.82					Gracida, 1998
	Amazona autumnalis		2.7	0.72	0.56	0.48		0.9	Masello & Quillfeldt, 2002
	Amazona finschi (Threatened)	15-20	2.6	0.74	0.57	0.42	2.27	0.99	Renton & Salinas, 2004.
	Amazona oratrix (Endangered)		2.6	0.94	0.33	0.22		0.3	Masello & Quillfeldt, 2002
	Amazona viridigenalis		3.4	0.84	0.47	0.48		1.4	Masello & Quillfeldt, 2002
	Aratinga strenua (Threatened)		2.8	0.91	0.5	0.5		1.3	Masello & Quillfeldt, 2002
	Rhynchopsitta pachyrhyncha (Endangered)		2.7	0.81	0.78	0.82		1.7	Masello & Quillfeldt, 2002
Non-Mexican species	*Forpus passerinus*		7	0.81	0.83	0.64		4.7	Masello & Quillfeldt, 2002
	Brotogeris versicolorus		5.4		0.41			0.5	Masello & Quillfeldt, 2002
	Amazona leucocephala		3.5	0.56	0.54			0.8	Masello & Quillfeldt, 2002
	Amazona vittata		3	0.84	0.49	0.69		1.5	Masello & Quillfeldt, 2002
	Amazona barbadensis		3.38	0.51	0.41			1.27	Sanz & Rodriguez, 2006
	Amazona aestiva	50	3.67	0.89		0.62	2.87	1.77	Banchs & Moschione, 1995
	Amazona barbadensis		3.42	0.76				1.48	Banchs & Moschione, 1995
	Amazona vittata		3	0.77			2.17	1.3	Banchs & Moschione, 1995

Note. Mexican species for which no data are available as well as *Ara militaris* and *A. macao* were omitted from the table

C. Species conservation and management of sustainable harvest in UMAs

Species considered to be potentially viable for a commercial harvest are those not listed in the current version of the Mexican Endangered Species List (NOM-059-SEMARNAT). Parrot species listed as Subject to Special Protection (*Sujetas a Protección Especial*) in the List may also be considered as potential candidates. It is not recommended to authorize the commercial harvest of species listed as Threatened (*Amenazadas*) or Endangered (*En Peligro de Extinción*) until there is certainty that the populations are stable enough to warrant their transfer to a lower risk category in the List. In any case, the regulations of the General Wildlife Act (*Ley General de Vida Silvestre*, LGVS) must be followed.

If, for any reason, the possibility of harvesting parrot species listed as Threatened or Endangered was considered, it would be absolutely necessary to carry out a thorough prior review of the General Wildlife Act and the General Act on Ecological Balance and Environmental Protection (*Ley General del Equilibrio Ecológico y Protección al Ambiente* – LEGEPA). It would also be essential to conduct population studies to obtain reliable data on primary population parameters (natality and mortality) over several years. It is important for such data and reports to be supported by people or institutions with recognition in the study and management of the species of interest (Art. 87 and 88, LGVS).

The capture of adult specimens should never be authorized, whether it involves nets, glue or decoys. As long as the harvest has been considered to be sustainable in the long term, it is only recommended to harvest 5-6 week-old chicks through an extremely careful management of the nests.

The sustainable harvest of parrots based on the precautionary principle should be determined on the basis of the information generated by the monitoring of the populations and their productivity as well as the surface of optimal habitat available for the species. According to the Mexican Program for Wildlife and Productive Diversification of Rural Areas, one of the main functions of UMAs is to provide legitimate landowners with alternative ways of obtaining income so that the natural habitat of wildlife is conserved. The rationale is to make these activities more attractive than traditional practices that often imply the clearing of natural vegetation. For this reason, only areas whose surface corresponds to the types of primary natural vegetation can be considered as optimal habitat; the consideration of optimal habitat does not apply to areas disturbed mainly by agriculture, including livestock farming, and areas with secondary vegetation on land that has not been left fallow for long. The density of individuals obtained in the sampling and calculated with DISTANCE may only be extrapolated to surfaces with primary vegetation.

For the moment, we suggest using the model proposed by the General Directorate for Wildlife to calculate wildlife harvest rates with a few modifications for parrots following the model proposed by Runge *et al*. (2004). The model is known as PBR (Potential Biological Removal) and defines the maximum possible harvest, considering a logistic relation between carrying capacity and population density, where the maximum possible harvest is equal to half of the maximum intrinsic growth rate of a population (rmax; see its calculation below). Runge *et al*. (2004) state that an uncertainty value can be introduced; they define it as Recovery Factor (Fr), which

is calculated according to the species' risk category. The formula proposed by Runge *et al*. (2004) is the following:

$$\mathbf{PBR = \tfrac{1}{2}\, r_{max}\, N_{min}\, Fr}$$

where PBR is Potential Biological Removal; rmax is the maximum value of the intrinsic growth rate; Nmin is the minimum population estimate and Fr is the recovery factor. The method to calculate each value is shown further below, and Nmin is calculated using the lower limit of the confidence interval of the relative density estimated by DISTANCE.

The model as modified by the General Directorate for Wildlife includes two basic factors for the implementation of the model – the data available about parrot species to calculate $\mathbf{r_{max}}$ and their risk category in the Mexican Endangered Species List. The lack of accurate information on the various species to calculate the value of **r** was overcome by making a bibliographic review of the birth and survival rates of parrots in general in their first stages of life. The information available was used to estimate the theoretical productivity of species of the genus *Amazona*. Although little demographical data are available on species of other genera such as *Aratinga*, it was decided to apply the same values for such species as those used for those of the genus *Amazona*, given that they are even more conservative. There is a lot of information about the remaining species, mainly those of the genera *Ara* and *Rhynchopsitta*. However, the status of their natural populations is still critical and does not make them eligible for harvest schemes.

The information obtained was used to identify the values that make it possible to determine productivity in general terms and carry out basic statistical analyses to stay within the limits of the confidence intervals authorized. The summary of the information is synthesized in Table 1. The values selected to estimate productivity are the following:

- Proportion of the population that is reproductively active in one season
- Sex ratio,
- Proportion of successful nests
- Production of fledglings, and
- Survival rate of fledglings in their first year of life (value included in the Expert Workshop held in 2006).

These values led to the following equation to calculate $\mathbf{r_{max}}$:

$$\mathbf{(Ne} \times \mathbf{C} \times \mathbf{Sn} \times \mathbf{P} \times \mathbf{Sv)} = \mathbf{r_{max}}$$

where:

Ne = Estimated proportion of the population that is reproductively active
C = 0.5 This is a constant, assuming a 1:1 sex ratio
Sn = Proportion of successful nests, expressed as a fraction
P = Production of fledglings per successful nest, expressed as the average number of fledglings produced per successful nest
Sv = Survival rate of fledglings in the first year, expressed as a fraction
$\mathbf{r_{máx}}$ = Total number of fledglings produced in a population

The values obtained from the lower limit of the confidence interval of the demographic data available were used for the species included in Table 1 (Munn, 1992; Enkerlin-Hoeflich, 1995; Renton, 1998; Masello and Quillfeldt, 2002; Renton and Salinas-Melgoza, 2004; Salinas-Melgoza and Renton, in press). The following results were obtained:

0.24 (proportion of the population that is reproductively active in one season)
0.5 (sex ratio)
0.4277 (proportion of successful nests)
1.839 (fledglings per successful nest)
0.73 (survival rate of fledglings in the first year)
r_{max} = 0.0689 (population growth rate; production of fledglings in the population per year).

The modification of the uncertainty value proposed by Runge *et al.* (2004) to adjust to the categories of the Mexican Endangered Species List including **Fr** as a recovery factor was done as follows: Runge *et al.* (2004) originally proposed assigning a value of 0.1 to Endangered species, a value of 0.5 to Threatened species, and a value of 1 to species outside these categories. In this case, it was decided to maintain the value of 0.1 for Endangered species; a value of 0.5 for Threatened species; 0.6 for those Subject to Special Protection; and 0.8 for those not included in the categories of the List. This was decided as a precautionary measure because of the little demographic information available for individual species.

Finally, it was also decided to include the harvest pressure of the previous season. This was done by calculating the minimum population estimate ($N_{mín}$) of the original PBR equation and subtracting the harvest quota authorized in the previous year from this number. The resulting value was multiplied by the PBR value calculated.

The modification of the calculation for the harvest is as follows:

$$\mathbf{(N_{mín} - Ta_{n-1})\ PBR = Ta_n}$$

where:

$\mathbf{N_{mín}}$ = Minimum population estimate
$\mathbf{Ta_{n-1}}$ = Number of individuals harvested in the previous season
PBR = Percentage of Potential Biological Removal
$\mathbf{Ta_n}$ = Harvest rate for the season

The minimum population estimate of the UMA should be made by using density, considering only the lower level of the confidence interval, estimated with the DISTANCE computer program and referring only to the forest surface conserved in the UMA.

Harvest activities

The harvest period should be determined according to the breeding pattern of each species in each region. To protect the populations, the harvest of adult specimens

should never be authorized. Therefore, the harvest should target young individuals at least 5-6 weeks old, but not subadults. Each UMA should periodically monitor its nests; based on the information obtained, its technical manager should determine the best harvest time to avoid a high mortality of individuals harvested.

The harvest should not take place in the whole UMA to make sure that the largest possible surface of natural habitats remain as conservation areas and avoid the unnecessary disturbance of nests that will not be harvested.

As mentioned before, the harvest of adult individuals should not be authorized, whether it involves nets, glue, or decoys. The recommendation is to restrict the harvest to chicks (at least 5-6 weeks old) through a direct and careful management of nests, avoiding hurting the individuals or damaging the nests in the process.

Besides, the populations should be monitored in the long term to determine the impact the harvest has caused on them. The results of the monitoring of the populations and nests of each UMA should be submitted every season. If the monitoring of local populations shows a sustained decline in the populations for more than 2 consecutive years, the harvest may be considered not viable. If so, immediate measures must be taken to encourage the recovery of the population. Special attention should also be given to nests that are no longer occupied because of reasons related to the harvest. To avoid these problems, it is recommended not to harvest the same nests continuously for more than two seasons.

Trends in the local population should be assessed on the basis of the results of the annual monitoring of nests and their populations to immediately identify changes in population trends, including breeding success. It is highly recommended to consider the possibility of reducing extractive harvest for commercial purposes; there should be a greater promotion of productive diversification, through non-extractive use and the development of activities and productive projects that do not modify the natural habitat of UMAs or their wildlife populations.

Activities carried out in UMAs should be assessed regularly and objectively so as to identify management shortcomings, activities not compatible with conservation, and actions promoting wildlife conservation, and document success stories. The assessments should be made every 3 years by the Ministry of the Environment. It is also necessary to organize regular meetings – such as this one that we were invited to – with the participation of academics involved in the study of these species to guarantee the application of current techniques and include the most recent knowledge.

It is necessary to establish and develop effective strategies to assess and regulate the activities of UMAs to prevent them from being used to launder illegal specimens. It is also key to avoid the harvest of other protected species, to control the duplication of numbered rings (it is recommended to use closed rings, which limit the possibilities of duplicating rings because they can only be placed when the birds are chicks). The General Directorate for Wildlife should establish a procedure to supply closed rings directly to large UMAs where parrots are harvested and keep a continuously updated database of authorized specimens for monitoring in coordination with PROFEPA, the Mexican law enforcement arm for wildlife protection.

Management after the harvest

The strategies used to handle captive specimens should be improved to increase their survival, by controlling the quantity and quality of food and the feeding of the chicks, their housing and transport.

Recommendation for feeding chicks:

- Use a feed made of 2 parts of corn flour and 1 part of ground dog food.
- Warm the feed to a temperature of 36-38º before feeding the chicks (Juan Cornejo, personal communication).
- Dispose of any food prepared and not used in each feeding event. Food should not be stored to reduce the incidence of infections caused by aflatoxins.
- Chicks should not be fed a second time until the crop is empty. This may take hours or minutes depending on the species, the type of food and the chick's condition.
- Everything should be very clean and hygienic – the chicks, the feeding utensils and the person in charge of feeding the chicks.
- Give the chicks fresh corn so that they can start to eat for themselves.

Recommendation for handling chicks:

- Chicks should not be taken from the nest until they are starting to fledge, preferably between the age of 5-6 weeks.
- Use thick sawdust or clean untreated wood shavings as bedding material for the chicks' boxes and change them often.
- Once the chicks have been harvested, they should be banded as soon as the rings remain in place. This is possible from the age of 3-4 weeks, although the recommendation is to harvest chicks at the age of 5-6 weeks and use only closed rings (see Table 2 for information on ring measures).
- Keep unfledged chicks near a heat source, such as an electric lamp generating a temperature of 29 to 32º C, especially in the case of chicks 25-35 days old (Reillo *et al.* 1998).
- Do not keep chicks crowded together or place chicks of different ages or species together.
- Do not house or handle parrot chicks in areas near domestic fowl or use material or equipment that has been in contact with domestic birds, unless it has previously been disinfected.

Measures should be taken to detect and prevent the spread of disease in coordination with the Health Department of the General Directorate for Wildlife, the Ministry of Agriculture and the relevant state authorities.

Table 2. Recommended ring measures for Mexican parrot species

Diameter (mm)	Commercial measure	Species
6.6	9	*Aratinga* spp.
7.16	9.5	*Aratinga* spp.
8.73	11	*Pionus senilis*
11.11	14	*Amazona finschi, A. oratrix, A. albifrons, A. autumnalis, A. auropalliata, A. farinosa*
12.7	16	*A. auropalliata, A. oratrix*
14.29	18	*Ara militaris, A. macao*

Source: L & M Bird leg bands (http://home.earthlink.net/~lmbird/sizegide.html).

D. Conclusions and recommendations

Given the status of the populations and the habitat of most parrot species in Mexico, a conservative model should be applied, with a highly cautious approach. It is important to realize that the model described here considers optimal harvest models (Runge *et al.* 2004). With such models, unless cautious modifications are made, there is a risk of overestimating certain populations of sensitive species because of the lack of information on the population dynamics of many parrots.

For this reason, we recommend considering the conservative harvest model proposed by Beissinger and Bucher (1992a, 1992b). According to the model, if the wild population is stable or growing, the implementation of management strategies to increase the species' population (artificial nests, protection of nests) can be assumed to lead to a surplus in the production of the population, which may be harvested (Beissinger and Bucher, 1992a and 1992b).

It is therefore essential to verify previously if the target population is stable and not declining through reliable samples (i.e., population surveys over several years). UMAs should also be required to establish appropriate management strategies based on current scientific knowledge to increase the breeding success of the population. At the same time, long-term studies should be conducted to determine productivity (nesting success, number of chicks per successful nest, number of chicks per breeding pair) in natural nests. The harvest can start with the chicks produced in managed nests, but the models and harvest rates should be adjusted on the basis of the results of population studies.

The harvest should be based on an approach implying the adaptive adjustment of the use of resources. When regulating the harvest of game species or live wild birds (songbirds and pet birds, including parrots) the General Directorate for Wildlife should implement an "adaptive management of natural resources" (Holling, 1978; Walters, 1986; Williams and Johnson, 1995; Johnson and Williams, 1999). This type of management explicitly recognizes that there is uncertainty about the impacts of the management of such resources and aims at providing useful information about the dynamics of the system itself over time. Uncertainty is included in the development of

other management strategies different from the original one to correct errors in a timely manner. We propose adaptive management to the General Directorate as an extension of the current process used. It is mainly focused on the long-term conservation of the species harvested and actively promotes the compilation and development of biological monitoring projects to use as a basis for decision-making. Besides, it includes a discussion on the social, economic and biological challenges of the adaptive management of natural resources.

Models should be regularly adjusted according to the results of monitoring population trends, harvest rates, threats, conservation efforts and prevailing environmental conditions, among other aspects.

Because of the exceptionally sensitive nature of the subject, the assessment and possible authorization of UMAs for the purposes of harvesting parrots should be managed and administered by the General Directorate for Wildlife at the federal level instead of being decentralized to the state governments.

An independent body should be in charge of evaluating and certifying extractive UMAs and marketing the species. An evaluating council should be set up and formed by the National Institute of Ecology (INE), the General Directorate for Wildlife (DGVS), CONABIO (the National Commission for the Knowledge and Use of Biodiversity), PROFEPA (the law enforcement arm for wildlife protection) and the Subcommittees for Priority Species. This body would be in charge of making the assessment and granting an environmental responsibility certification (i.e., a "Green Label") to technicians and extensive UMAs meeting the requirements established. UMAs and technicians should be evaluated periodically (every 2-3 years) to keep their certification. We recommend reviewing the model used by the Forest Stewardship Council (http://www.fscus.org/) as an example to guide this task.

It is necessary to design and develop a Course to train Technical Managers in their task according to the criteria currently established. The Green Label certificate would only be granted once it has been proven that they are effectively implementing the management measures suggested. The Course is urgently needed to solve the technical and administrative shortcomings that affect most UMAs where these species are being managed.

The activities and sources of income of UMAs should be diversified by implementing forms of non-extractive use (e.g., bird watching or scientific tourism. As an example, see the "Manual for Training Bird Guides in Rural Communities" developed by CAPY, Yucatan www.cnf.ca/birdguide/Bird_manual_s2.pdf) and developing programs to promote environmental education and raise awareness among local communities.

Any prospective UMA must prove that the income obtained by the harvest will be shared among all the members of the community. We propose implementing schemes such as that used in the Tres Reyes UMA, in Quintana Roo, where 70% of the income goes directly to the members of the community, who participate in the project, 20% is deposited in a community fund to ensure the future of the UMA's activities, and 10% is used to pay for technical services.

The activities carried out in UMAs should be diversified, including – as we mentioned

above – non-extractive use of the species (Article 47 of the General Wildlife Act). When the harvest is extractive, it is necessary to ensure the careful and biologically acceptable management of the nests, an effective and informed habitat reforestation and restoration (Sánchez *et al.*, 2005), as well as environmental education and awareness-raising activities in the UMAs themselves and their surroundings.

Information should flow between the various programs related to the conservation and sustainable use of parrots (established by bodies such as CONAFOR, CONANP, PRODERS, PET, PROCAMPO, and CAPY, among others). This information exchange will make it possible to determine the synergies that could strengthen the development of the local human communities and the UMAs of the area.

There is a need for independent population studies (at different scales – regional and local), which can be highly valuable tools to make comparative evaluations of specific studies carried out in UMAs. This activities could include the participation of PhD students, with the support of funding from the Ministry of Agriculture/CONACYT (National Council for Science and Technology), CONABIO or the INE, among others. It is even more important to include and develop this PhD research in longer-term projects in different universities and research centers in Mexico, such as the following: Universidad Michoacana de San Nicolás de Hidalgo, Universidad Nacional Autónoma de México (UNAM), or Tecnológico de Monterrey, among others.

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Annex I. Data capture format for the monitoring of parrots in extensive UMAs

Nombre de la UMA	ID del hábitat	Hábitat	Superficie en Ha	Punto de Observación	Tiempo de observación en minutos	Número de observación	Especie	Tamaño del grupo	Distancia al ave en metros	Actividad (perchado / volando)	Coordenadas UTM del Punto (E- N)	
El Jaguar	*1*	*Selva Mediana*	*1500*	*1*	*10*	*1*	*Aratinga nana*	*2*	*55*	*perchado*	*246720.916*	*1969510.81*
	1	*Selva Mediana*	*1500*	1	10	2	*Aamzona xantholora*	*2*	*200*	*volando*		
	1			2	10	3						
	1			3	10	4						
	1			3	10	5						
	1			3	10	6						
	1			3	10	7						
	1			3	10	8						
	1			3	10	9						
	1			4	10	10						
	1			5	10	11						
	1			5	10	12						
	1			5	10	13						
	1			5	10	14						
	1			5	10	15						
	1			5	10	16						
	1			6	10	17						
	1			7	10	18						
	1			7	10	19						
	1			7	10	20						
	1			8	10	21						

Translation of the text in the table, from left to right: Name of the UMA; Habitat ID; Habitat; Surface in Ha; Observation point; Observation time in minutes; Observation number; Species; Group size; Distance to the bird in m; Activity (perched/flying); UTM coordinates of the point (E-N); semi-evergreen forest;

a) Data capture format for population monitoring. Copy the fields in an Excel sheet and send them to the DGVS in electronic format to be analyzed. Write the sampling date, the Datum and the area of the UTM coordinates on the application.

Nest or observation point	Number	Direction	Distance from the central point to the tree (m)	Species	Height (m)	DBH (cm)
Observation point	*3*	N	*10*	*Enterolobium cyclocarpum*	*15*	*58*
		S	*2*	*Ceiba pentandra*	*19*	*103*
		E	*5*	*Manilkara zapota*	*9*	*40*
		W	*6*	*Brosimum alicastrum*	*11*	*52*
Nest	*2*	N				
		S				
		E				
		W				
		N				
		S				
		E				
		W				
		N				
		S				
		E				
		W				

b) Data capture format for habitat monitoring. Copy the fields in an Excel sheet and send them to the DGVS in electronic format to be analyzed.