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Chapter 2

General Principles for Parrot Conservation

Preliminary remarks

The overriding goal of parrot conservation should be the maintenance of viable wild populations of all species within their native ranges and natural ecosystems. Captive populations are not an end-point of conservation efforts. Although in extreme cases it may be necessary to depend on an intermediate stage in captivity to achieve viable wild populations, as a rule wild populations should be sustained continuously if at all feasible. In large part, this is because the difficulties in re-establishing wild populations from captivity can be especially daunting for species such as parrots in which many important behavioural characteristics are learned and can be quickly modified or lost under captive conditions (see Snyder *et al*. 1996). By retaining a strong focus on wild populations at all stages of the conservation process, the chances of simultaneously sustaining the species and preserving essential habitat are maximised. Reduction of fundamental causes of endangerment in the wild must remain the primary goal of conservation efforts.

Defining viable wild populations is not a simple task. Criteria for viability can include both genetic and demographic considerations, and can involve time scales ranging from a few years to the indefinite future. It is difficult to justify any particular minimum population size as a goal applicable to all parrot species, considering the variations among species in overall range, natural population fluctuations, life history parameters, and sensitivity to environmental threats. Nevertheless, there is probably broad agreement that viable wild populations should have the following characteristics:

1. Populations remain stable (or increase) over time,
2. Subpopulation numbers remain stable (or increase) over time,
3. The range of the species remains stable (or increases) over time, and
4. Populations are large enough and subdivided enough to minimise threats posed by inbreeding and catastrophic events.

Implicit in this last characteristic is a general goal of maintenance of multiple self-sustaining subpopulations of the species in as wide a geographic distribution as is feasible. In cases where abundant demographic data are available for a species, it is also sometimes possible to define viable populations in terms of probabilities of extinction (e.g., <5% in l00 years), based on modelling studies. Application of these concepts will vary among species, but should include consideration of both short- and long-term time scales.

Status assessment

Without accurate status assessments – specifying population sizes, ranges, and trends – there is no reliable way to determine which species deserve conservation attention and no way to measure progress in conservation programmes. All three characteristics are important, as a single determination of population size and range provides only an instantaneous "snapshot" of a species, and cannot reveal very much about its conservation status. A tiny population that is stable or increasing is a very different conservation entity than a tiny population that is rapidly declining, and repeated monitoring efforts are necessary to determine just which situation exists. All populations fluctuate to a greater or lesser extent, and distinguishing between short-term fluctuations due to chance events and long-term trends is of major importance. The measures employed for population recovery must be tailored to the severity of the crisis.

Just as single, short-duration assessments of population size and range have limited utility in determining whether populations are declining, they are also generally inadequate for identifying either the causes of population decline or appropriate conservation measures on more than a provisional basis. What appear to be obvious causes of decline, sometimes turn out on careful study to be only minor problems, while truly important causes can sometimes be missed in short-term assessments. Thus, while population size and range assessments are essential in conservation efforts, they can be easily misinterpreted if they are not carried out at biologically meaningful intervals and if they are not coupled with comprehensive biological studies.

The dangers involved in failing to follow all these paths simultaneously can be seen clearly in an example from another group of birds – the California condor (*Gymnogyps californianus*). This species was known to occur in very low and declining numbers for a period of decades, but research on behalf of the species was limited largely to surveys of population size and range until the 1980s, when comprehensive biological studies were begun (see Snyder and Snyder 1989). These latter studies quickly revealed that the presumed main cause of decline, habitat destruction, was in fact a minor problem in the near term, while the most important cause, mortality from lead poisoning, had not been recognised or addressed. Because the conservation efforts of many decades, primarily habitat protection, had failed to address the principal cause of decline, the species continued to decline and eventually reached such low numbers that captive breeding was the only remaining viable near-term conservation option. The important point of this discussion is that had the proper biological studies been initiated earlier, there is a real chance the species' decline could have been reversed in the wild and without the enormous expense associated with current efforts (well over US$1 million annually).

Although various methods for monitoring parrot populations are available, the utility of these methods is not uniform among species because of species differences in behaviour and ecology. Among the methods that have been used with various parrots are roost counts, nest enumerations, river transects, mark-resighting studies, and fixed lookout counts. All have weaknesses of one sort or another, and only direct field experience is likely to reveal the most useful and practical techniques for a particular species. All methods have key assumptions that need to be met for applications to be reliable (see Casagrande and Beissinger 1997).

Roost counts have been used with good success in achieving population counts for some species [e.g., the Bahama parrot (*Amazona leucocephala bahamensis*) (Gnam and Burchsted 1991), and the Puerto Rican parrot (*Amazona vittata*) (Snyder *et al.* 1987)], but proper use of such counts necessitates finding all significant roosts for the population in question and determining which time of year the birds tend to clump most consistently in roosts. Preferably, all roosts should be monitored simultaneously, although this requirement can be relaxed for species whose roost-use tends to be stable over long periods.

Maroon-fronted parrot, *Rhynchopsitta terrisi*, Mexico.

Ernesto Enkerlin

Unfortunately, some species do not clump together in obvious roosts, while others approach and leave roosts in the subcanopy, making them difficult to enumerate accurately. Others change roost locations so frequently that it can be difficult to keep current on roost locations. Thus, while roost counts can be a very good method with species that do not present the above problems, it is not a method that can be used effectively with others.

Nest enumeration is currently being employed in status work on the maroon-fronted parrot (*Rhynchopsitta terrisi*), a species that nests colonially in cliffs (Enkerlin *in litt.* 1997). As with roost counts, success in using this method as a population monitoring technique depends on locating all significant colonies of the species and determining which time of year is best for counting. The maroon-fronted parrot also roosts communally, but frequent changes in roost locations make monitoring of roosts difficult. Moreover, the habitat of this species is sufficiently difficult to access that getting close enough to count some roosts poses severe logistic problems. Nevertheless, results of roost counts to date show clearly that a large fraction (perhaps on the order of 80%) of the population does not show up in nest enumerations. While long-term monitoring of the size of the nesting population appears to be a relatively practical goal and may prove to be an important component of efforts to follow the overall health of the population it appears unlikely to track total population numbers closely on a year to year basis, because of large fluctuations in food supplies with this species. Nest enumerations may well give more useful population trend information on the basis of longer time spans. The optimal monitoring strategy with this species appears to be efforts to utilise both roost counts and nest enumerations, despite the practical difficulties in roost counts.

For species that nest in dispersed fashion, nest enumeration often has little potential for overall monitoring of populations because it is often extraordinarily labour-intensive to locate nests for such species. Nevertheless, nest enumeration has proved useful in tracking the population health of the dispersed-nesting golden-shouldered parrot (*Psephotus chrysopterygius*), which utilises termite mounds for breeding (which can be located with some efficiency). The density and distribution of nests of this species are monitored annually over 250 square kilometres of terrain as a measure of effectiveness of conservation actions (Garnet and Crowley 1995).

Counts of birds assembling at clay licks or waterholes can also be useful, particularly when they can be converted into density figures or total population counts. Such

Macaws provide a colourful spectacle for tourists at a clay lick in Peru.

conversions, however, require knowledge of the areas serviced by such features and the frequency of visitation by individuals. Waterhole counts tend to be most useful for species in relatively arid habitats, especially during the dry season when the number of water sources is minimal, forcing the birds to concentrate on relatively few sites. However, since individuals may visit water sources more than once a day or move between water sources, to extrapolate such counts to population counts some individual birds must be marked (for example with radio-tags) to ascertain frequency of visits. As with roost counts and nest enumerations, efforts have to be made to locate all water holes in use and to monitor them simultaneously. Counts at clay licks, coupled with individual identifications of birds achieved through photography, have been used to generate population density figures for certain macaws (Munn 1992).

Moving transects (line transects), such as counts from boats along rivers, can give useful indices of abundance of some species. They are often very difficult to convert into accurate population estimates, however, as the areas serviced and the detection efficiencies can be difficult to specify. Moreover, behavioural characteristics of some species may strongly bias their detectability by such methods. Nevertheless, such counts can be used to compare species abundances in different areas of similar habitat, to gain trend information on specific populations, and to document seasonal changes in habitat use (Munn 1992, Renton 1994, Robinet *et al*. 1996).

Under some circumstances, counts from stationary locations can give useful monitoring data, particularly if stations are established along important flight lines. The problems here are that parrots are often highly patchy in distribution, and it is often difficult to establish how representative the observation points are and what areas are effectively covered in the counts. Such counts are often most useful as indexes of abundance if carried out over long periods of time, but they are difficult to convert into absolute abundances accurately. Flight lines of species can change, seasonally or more permanently, relative to changes in distributions of food supplies, so counts in fixed locations can give spurious trend information if not coupled with other indices of abundance. Point surveys can often be expected to be more biased than line transect counts, but there are circumstances where they are a preferable technique (see Casagrande and Beissinger 1997).

Mark-resighting techniques are potentially useful with some species (Casagrande and Beissinger 1997), but such methods are highly labour-intensive compared to other methods and often are impractical because of difficulties in capturing birds for marking. In addition, there can also be an increased risk of predation for marked animals in some species (see Saunders 1988).

The aforementioned methods are not the only methods that might be applied to parrots. For example, variable circular plot methodology has been used in many studies in Asia and Africa, and offers a number of advantages in some contexts. However this method, like some others, often yields such wide variability for population sizes that it is sometimes of limited value in monitoring population trends.

Although it is highly desirable and valuable to develop techniques that may give accurate total population counts for any endangered species, this may simply not be feasible for some parrots. In such cases, it may alternatively be possible to devise ways of indexing abundance that can give reliable trend information over the long term. This is usually the most important information for conservation purposes. Additionally, relative differences in density between areas may be important, and even order of magnitude estimates for poorly known species may be better than no estimates at all. Mail surveys have been used successfully to monitor declines in populations of species that were once common and widespread in Western Australia. This method is cheap, quick, and well suited to species that are readily recognised and familiar to amateurs (see Mawson and Long 1996). In addition, information on trade volume can sometimes be used to infer population trends, provided certain assumptions about harvest intensity and reporting uniformity are met.

The literature on bird censusing is large, and the reader should consult general reviews on bird censusing methods, such as Ralph and Scott (1981), Davis (1982), Verner (1985), Taylor *et al*. (1985), Seber (1986), and Bibby *et al*. (1992) for a critical discussion of other methods that may have value with some species. Accurate censusing of wild bird populations remains one of the more difficult tasks confronting researchers and conservationists. There is no one universal method for estimating bird abundances and densities, and appropriate methods vary according to species, time, and location. The desire to find a single technique that might work well for all parrot species will surely remain unfulfilled.

Regardless of how accurate the population and trend estimates may be for any species, conservation efforts must proceed on the best available information. Actions on behalf of critically endangered species should not be postponed simply because of uncertainties as to exact population size and trends.

Determining causes of population decline

If monitoring efforts with a species show that it is under continuous decline, it is important to establish causes of the decline through more detailed demographic investigations. This is usually accomplished via quantitative evaluations of both reproduction and mortality. Stresses on species may arise in either sphere, or in both, and if effective conservation is to take place, it is essential that the major factors causing decline are identified so that they can be countered effectively.

Intensive research to determine causes of decline may entail some risks to individuals of the species. But, the risks to populations are the most important concern, and they cannot be reduced reliably without a comprehensive understanding of the causes of decline. It is a fundamental mistake to adopt a policy of always minimising risks to individuals, if in so doing one remains ignorant of the true causes of a species' decline. As a concrete example of faulty risk analysis, the California condor programme was hobbled for decades by fears that intensive research would be too risky for individuals. Thus radio-telemetry of condors was delayed until the population was almost lost, and yet it was only through radio-telemetry that lead poisoning, the most important cause of decline, was finally identified (see Snyder and Snyder 1989). Up to that point, conservation strategies for the species were aimed in the wrong direction and the species continued to decline rapidly toward extinction.

When dealing with endangered species, every action or lack of action carries risks. It is essential that programmes retain a focus on overall risk reduction for populations, which often entails small, carefully monitored risks for individuals. Often, the worst enemy in conservation programmes can be mistaken assumptions about the causes of decline. As Caughley (1994), and Caughley and Gunn (1996) discuss, failure in conservation management efforts often traces to lack of sufficient information about basic natural history features of the species in question and incorrect identification of main causes of endangerment.

Current debates over conservation of Lear's macaw (*Anodorhynchus leari*) provide an instructive example of how concerns for individuals can be in conflict with concerns for populations (see Munn 1995a). Major conservation efforts on behalf of this species have been mobilised on the assumption that inadequate food supplies have been a crucial limiting factor. Yet, it is not certain that food scarcity has been as important as assumed, and Munn has called for intensive research to clarify the situation. However, the detailed studies of nesting birds that appear to be necessary to resolve the issue have been vigorously opposed by parties concerned about possible impacts of intensive research on nesting individuals. More recent information (Reynolds 1997) suggests that at least at present the major limiting factor for Lear's macaw may be poaching for the bird trade. If so, efforts to increase food supplies at best may fall far short of what it is needed to preserve the species.

Biodiversitas

Adult pair and juvenile Lear's macaw, *Anodorhynchus leari*, Brazil.


Gideon Climo

Hand-reared kakapo “Hoki”, *Strigops habroptilus*.

Reproduction

Reproductive studies normally entail locating adequate samples sizes of potential nesting pairs and determining both the fraction that fail to breed and the success rates of the ones that do. In some species, such as the kakapo (*Strigops habroptilus*), Puerto Rican parrot (*Amazona vittata*), yellow-headed parrot (*A. oratrix*), and many macaws, major problems lie in failures to lay eggs; while in others, problems may lie mainly in poor success of egg-laying pairs (Snyder *et al*. 1987, Munn 1992, Elliott 1996, Enkerlin *in litt.* 1997). Thus, it is important to study both factors.

In some species which show low breeding effort (frequent failures to lay eggs), the problem can be traced to low availability of nest sites. This can sometimes be remedied by providing additional sites. For example, red-tailed black-cockatoos (*Calyptorhyncus banksii*), which are believed to face low nest-site availability, have quickly occupied artificial sites (Emison *et al*. 1994b). In other species where such problems have been suspected, however, artificial sites have not been accepted, and it has been necessary to improve deficient natural cavities to attract nesting birds (e.g., red-fronted parakeet *Cyanoramphus novaezelandiae* – see Hicks and Greenwood 1989). In still other species which reject artificial sites, even massive provision of improved natural sites has not cured chronic problems with low breeding effort (e.g., the Puerto Rican parrot). Here, causes of low breeding effort have remained elusive, perhaps lying with food limitations of one sort or another, or with other factors such as unbalanced sex ratios in extremely small populations.

Poor nest success can be determined only by comprehensive nest monitoring efforts, which normally will include periodic nest inspections to determine growth and development characteristics of nestlings and to determine if the nestlings are affected by parasite or disease problems. With basic precautions, such inspections can usually be done without significant negative effects on nesting success, and the benefits obtained from the information gathered normally far exceed any risks entailed.

Species affected by food limitations may show slow-growth effects or brood-reduction effects. For instance in south-western Australia the growth rates of a food-stressed and declining population of Carnaby’s cockatoo (*Calyptorhynchus latirostris*) were lower than those in a stable one (Saunders 1986). Species affected primarily by nest predation problems will generally exhibit total losses of broods, and here it may be necessary to initiate intensive nest observations to determine the culprits and possible means of thwarting them. Habitat deterioration problems are perhaps most likely to manifest themselves in effects on food supplies or nest availability, and thus be reflected in low reproductive effort, reduced clutch size, poor nestling growth rates, and/or low fledging success.

In many regions the primary nest predator will turn out to be man, as revealed by damage to nest sites or other clues (e.g., spike marks on trees). But in some species, where nest contents are easily accessible from entrances, few signs of human depredations may be evident even when such depredations are a major problem. Other principal threats to nest success include non-human nest predators and competitors, such as various snakes and lizards, pearly-eyed thrashers (*Margarops fuscatus*), brush-tailed possums (*Trichosaurus vulpecula*), and feral rats and cats. On occasion nest parasites such as various bot flies and soldier flies can be a major stress. In some instances the impacts of such natural and unnatural enemies can prove adequate in themselves to account for population declines. Island parrots (e.g., the kakapo *Strigops habroptilus*) have proved to be especially susceptible to nest losses caused by introduced predators.

Mortality

Mortality studies are often more difficult, expensive, and time-consuming to conduct than reproductive studies, but especially with very long-lived species, good quantitative estimates of mortality rates may be crucial for diagnosing whether the species is stressed by excessive mortality. A number of techniques have been used successfully. For example, many species exhibit strong fidelity in nesting territories, and if individuals can be recognised by idiosyncratic characteristics or by artificial marks, such as bands, adult turnover rates in known territories can be determined over a period of years (see Snyder *et al*. 1987). Although such rates are not strictly equivalent to adult mortality rates (as there may be some movement of birds out of known territories to unknown locations) they can provide a good upper boundary on adult mortality rates and in many cases are very close to adult mortality rates.

Mortality rates of fledgling birds can sometimes be determined by close study of family groups, as fledglings of some species remain closely associated with their parents for long periods – sometimes to the beginning of the next breeding season. By determining the numbers of young fledging in a reasonable sample of territories and by later determining the numbers of surviving young, mortality rates of fledglings can be calculated in a straightforward manner.

However, in some species young do not stay with their parents for long after fledging, or families disperse from breeding territories soon after fledging and do not return as families later. For such species the above method cannot be used, and determining fledgling mortality rates may necessitate marking samples of young (e.g., with radiotags) to follow their survival directly. Similarly, survival rates of adults in species that do not exhibit territory fidelity may not be determinable without marking techniques. Radio-telemetry attachments have now been tested on many of the larger parrots with success, and units are now available that have lifetimes of several years. Radio-telemetry, however, is a relatively expensive technique and entails some risks associated with capture and handling of birds. Where it is possible to gain mortality information without it, this is sometimes a preferable option. However, radio-telemetry is often the only way to determine exact causes of mortality, and can also often provide other very useful information (e.g., on range use, foraging behaviour, and migration behaviour) that often cannot be obtained by other means.

St Lucia Parrot, *Amazona versicolor*, at Government aviaries St Lucia.

Nick Reynolds

Another technique that has been used successfully to obtain mortality rate information is patagial tags (see Rowley and Saunders 1980, Saunders 1988, and Smith and Rowley 1995), although risks and benefits of these tags vary for different species. Banding (ringing) is useful as a marking technique for only certain species, as in many parrots feathers cover the tarsus sufficiently to obscure vision of bands, except when birds are in the hand. Banding with standard flat bird bands also poses risks of damage to legs in many species because of shape of the tarsus, and should always be tested carefully with captives before widespread implementation.

Adults and fledglings do not represent all age classes in a population, but they can normally be expected to represent the groups with the lowest and highest mortality rates, respectively. Mortality rates of intermediate-aged birds can sometimes be inferred from accurate data on population figures, reproductive rates, and mortality rates of adults and fledglings (see Snyder *et al.* 1987). They can also be determined directly by means such as radio-telemetry.

Expected mortality rates for the species under study can be estimated by comparisons with other species with similar demographic characteristics, such as age of first breeding, clutch size, etc. If the rates with the species in question appear excessively high, it is crucial to identify specific causes of mortality, and here radio telemetry may be essential. With some species hunting or trapping for the bird trade may cause excessive mortality. With others, there may be unusual situations regarding disease, toxic materials, or exotic non-human predators.

Demographic analyses

Once basic demographic information is available for a species, including good quantitative data on age of first breeding, reproductive effort and success, and age-specific mortality rates, it becomes possible to pinpoint where the primary weak points in the life equation lie. Population viability analyses (PVAs) can be useful at this point in helping identify which aspects of the life equation need primary attention in conservation actions and in setting goals to be achieved in reducing stress factors. PVAs can also help reveal which demographic characteristics need the most accurate quantification to achieve reliable conclusions.

However, PVAs should be conducted only after population size and demographic parameters, and their year-to-year variations, have been determined with reasonable accuracy (Beissinger and Westphal 1998). Good information on frequency, severity, and effects of catastrophic events, such as hurricanes, is also needed for species vulnerable to such events. These various data are available for extraordinarily few species overall, let alone parrot species, so at the present time conservation efforts for the vast majority of parrot species cannot be expected to benefit from PVAs.

Poor population data and inaccurate estimates of demographic parameters pose substantial risks of generating erroneous conclusions regarding population viability (Reed *et al*. 1998). PVAs based on such data can potentially redirect resources toward unwarranted conservation actions with a false sense of confidence that these actions rest on rigorous science. From both a cost and risk standpoint, scarce conservation resources are generally better allocated to accumulation of good demographic data than to premature PVA symposia.

When enough data are accumulated to make PVA analyses legitimate and worthwhile, they should be conducted using a variety of models. Because alternative PVA models vary in their assumptions and internal structure, and can provide markedly different results from the same set of demographic data (Mills *et al*. 1996), the results must be interpreted conservatively.

With many declining parrot populations, the principal problem is likely to be excessive mortality. Parrot species are often (but not always) characterised by delayed sexual maturity and long life expectancies, and population size is typically influenced far more by changes in adult mortality than by changes in reproductive rates. In fact, if mortality problems can be reduced with such species they may be able to recover reasonably rapidly, even if reproductive statistics are relatively poor. Preliminary data suggest that such a situation may apply to the case of the St Lucia parrot (*Amazona versicolor*), a species that was suffering greatly from hunting mortality until massive education and legal efforts were made on its behalf starting in the late 1970s. Studies in recent years suggest that reproduction in this species is quite modest, as many pairs do not lay eggs and egg-laying pairs produce few fledglings. Nevertheless the species is clearly recovering steadily, and populations are being re-established in various parts of the island where parrots have been absent for many years. The effective cessation in hunting pressure on this species has very likely reduced mortality rates to very low levels and appears to have been the principal direct conservation action benefiting the species.

For some long-lived species where excessive mortality is not the major problem, inadequate reproduction can be masked by the very longevity of individuals. Population declines may not be obvious for many years until they finally become relatively rapid as senescence of individuals increases, a situation that may apply, for example, to certain populations of Carnaby's cockatoo (*Calyptorhynchus latirostris*).

Designing conservation actions

This Action Plan strongly endorses the formation of capable advisory recovery teams to develop recommendations for conservation efforts with threatened parrots, especially with respect to the process of making choices among conservation alternatives. Recovery teams are not the same thing as occasional international symposia of outside experts to provide input on species conservation, but are locally-based functional teams that work to design research and conservation strategies on a continuing basis. There is a growing literature on how such teams should be set up to achieve efficiency and progress in recovery (see Clark and Westrum 1989, Clark *et al*. 1994, Westrum 1994), and it is crucial that teams are set up properly if they are to function productively.

Principles to be followed here include the concepts that all major parties with a stake in conservation of the species and all major researchers involved with the species should

Carlos Yamashita checking hyacinth macaw (*Anodorhynchus hyacinthinus*) chick.

World Parrot Trust

be participants. Teams should be charged with designing effective conservation efforts for the species as their major goal and should be insulated as much as possible from the influences of special interests. Although their role obviously cannot be to usurp authority from responsible government wildlife agencies, their purpose should be to provide these agencies with the best independent advice relating to conservation of the species in question on a continuing basis. To this end teams should not be dominated by government agencies and should include the best biological expertise available. Teams should not be expected to produce immutable "recovery plans" but to generate focused documents at appropriate intervals that reflect changing knowledge about the species in question and the best ways to conserve them.

Notwithstanding the values of well-constituted recovery teams, it is important to recognise the fact that success in recovery programmes often traces in large measure to on-the-ground efforts of particularly well-motivated and skilful individuals. There is no formula for locating such individuals, but when they are discovered by whatever means, their importance can often outrank most other factors in the conservation process. Truly talented conservation "maestros" (see Westrum 1994), deserve to be given a high level of independence and authority in programmes. Programmes left in the care of pedestrian workers or unmotivated managers can easily fail even with the best of advice from well-constituted advisory groups.

Although a variety of general techniques have been used to assist the conservation of threatened parrots, not all techniques will be effective for every species or in every local situation. Ideally, in implementing a conservation programme for any species, the techniques selected should meet the following criteria:

1. They should be appropriate to the biology of the species in question and be effective in promoting survival and recovery;
2. They should be economical;
3. They should be compatible with the local human political, economic, and social environment; and
4. They should benefit multiple species and promote biodiversity conservation in general.

To be effective actions, the solutions chosen must address the basic causes of decline operating within the species. If, for example, problems are primarily ones of mortality due to hunting or poaching, these stresses will have to be reduced by whatever effective means can be devised. No amount of habitat protection will be adequate to save such species in itself, and while habitat protection is normally a very positive aspect of conservation in the long run, in the short run it can sometimes represent a diversion from crucial efforts to reduce sources of mortality.

Conservation actions vary greatly in cost, and where choices are available, cost-effectiveness is an important consideration. For many years, captive breeding was proposed as an important aspect of conservation of the Lesser Antillean amazons (e.g., Berry 1980, Jeggo 1980, Noegel 1980). But captive breeding is relatively expensive, especially because of the long time-scales often involved, and full-scale programmes to implement this technique were never established with these species. Instead, major efforts were made to counter the principal perceived threats to these species through enhanced education, habitat protection, and law enforcement initiatives (see Butler 1992). These efforts were both economical and effective, and populations of all four amazons in the Lesser Antilles are now believed to be increasing significantly.

To the extent that habitat protection turns out to be important in conserving a species, one can expect to see major benefits for many other associated species in pursuing this goal. Properly designed education programmes that emphasise the ecosystem dependencies of charismatic species can also be expected to benefit many other sympatric species. In contrast, other conservation techniques may have no spin-off benefits for other species. For example, captive breeding per se helps only the species in question, and thus represents a less favourable technique in many contexts, especially if it draws resources away from more productive techniques. Captive breeding at best represents only an interim and partial solution to species preservation. For it to be successful, it has to be tightly coupled with other actions that ensure survival of the species in the wild. It is true that under some circumstances captive breeding can attract funds toward *in situ* efforts that would not otherwise be available, but it should not represent an end in itself and should always be properly integrated with efforts actually leading to wild population conservation.

Politically viable solutions are ones that come to enjoy widespread public support, and in this sense it is almost always advisable for there to be a significant public education component in any species' conservation programme. Often national and local pride can be the key element for generating the necessary political support, but politically viable solutions need to be very carefully crafted in the local social context and can be very difficult to achieve if there is no significant local participation in the conservation programme.

With the aforementioned caveats in mind, the specific strengths and weaknesses of various major conservation techniques that have been used and suggested for parrots are discussed in more detail below.

Habitat preservation and restoration

The great majority of endangered parrots face some degree of threat from habitat change, destruction, and fragmentation, so habitat preservation and restoration clearly represent the most fundamental and important

Paul Jepson

Logging in the Low Forests of Tanimbar, Indonesia.

overall solution to problems of endangerment of the group. Further, where choices in conservation strategies are available, it is reasonable to favour those that do the most good for the maximum number of species. Often this means that habitat protection and/or restoration should be a priority feature of the strategies adopted. However, where species are suffering most from factors additional to habitat degradation, such as trade or hunting, habitat protection alone cannot be expected to provide a full solution. Many parrot species are, in fact, relatively tolerant of habitat degradation per se, and can persist in highly modified habitats if stress factors such as trade, hunting, and loss of specialised nest sites can be controlled (see Beissinger and Snyder 1992, Enkerlin-Hoeflich 1995, Munn 1995b).

Thus, while parrot declines are commonly correlated with habitat deterioration, one should not simply assume that this proves a primary cause and effect relationship without further supporting data, as increases in many other stress factors are also commonly correlated with the declines, and in some cases these other stresses may be more important than habitat factors. However, it is important to recognise that important effects of habitat degradation can sometimes be very difficult to detect, as habitat degradation can stress the welfare of endangered parrots indirectly through primary effects on other competitor species, predators, parasites, diseases, etc. For example, Garnett and Crowley (1997) suggest that habitat changes may be significantly increasing the vulnerability of golden-shouldered parrots (*Psephotus chrysopterygius*) to predation by pied butcherbirds and that this may be an important factor in the decline of the species.

In cases where habitat deterioration has been a primary cause of a species' decline, and adequate habitats no longer exist, it may be necessary to implement habitat restoration efforts, commonly focused on recreating critical habitat features missing from wild or semi-wild environments. These efforts may be focused on expanding crucial food supplies, nest sites, roost sites, or water supplies. A good understanding of the limiting factors faced by the species in question is essential for determining and remedying such deficiencies. Not all parrots are nest site limited, food limited, roost-site limited, or water supply limited, so habitat restoration efforts cannot be expected to benefit all species.

Quite often, parrots are among the most charismatic species to be found in ecosystems under threat, and they can serve as a successful focus for habitat preservation efforts, attracting public support more easily than other less charismatic species, yet providing habitat protection for many of these less charismatic species simultaneously. Thus the Puerto Rican parrot (*Amazona vittata*) has proved to be a crucial flagship species in preventing the cutting of rainforest habitat in the Caribbean National Forest in Puerto Rico, and has provided protection for numerous other plant and animal species as a consequence. Because long-term survival of all species is ultimately tied to adequate amounts of suitable habitat, habitat protection and/or restoration should be pursued as a component of almost all parrot conservation programmes. Even in circumstances where the species in question is not a strict habitat specialist, or where habitat protection alone will not address the immediate causes of decline, habitat protection is normally warranted. And in some cases, habitat protection alone may be adequate in itself to assure survival of a species.

Efforts to prioritise habitat protection efforts in such a way as to benefit the largest numbers of species, be they parrots in part or not, make considerable sense, but are not the only factor to be considered. Habitat protection efforts sometimes succeed because the appeal of only a single charismatic species is sufficient to attract the support of a few key donors or politicians who would be reluctant to support biodiversity conservation per se. It can thus be debated whether more biodiversity conservation will be accomplished in the long run by concentrating on protecting habitats for as many charismatic species as possible or by concentrating on trying to sell biodiversity on its own merits independent of the existence of charismatic species.

In pursuing habitat protection, it is important that all important habitats used by the species in question receive attention. Wintering habitat is as crucial as breeding habitat in migratory species, and habitat used on migratory routes may also be essential for survival. Determining what habitats are essential for the species and why, is a necessary precondition for successful design of a habitat protection plan. This determination needs to be made for each important subpopulation of the species. Radio-telemetry can often be one of the quickest ways to gain this information in species that move substantial distances during the annual cycle [e.g., great-green macaw (*Ara ambigua*) in Central America].

Habitat protection can be pursued in a variety of ways, including outright land purchase, development of appropriate management strategies for publicly owned lands, and purchase of conservation easements. The costs of habitat protection vary enormously, but this approach is often more cost effective in the long run than are other more intensive conservation solutions (see Balmford *et al.* 1995). When efforts to conserve habitat are properly integrated with other conservation actions, such as development of education programmes and ecotourism programmes, they sometimes can pay for themselves.

The most common mistake with habitat protection efforts is that once targeted areas are formally gazetted as reserves, meaningful conservation actions may be halted, and the crucial steps of funding comprehensive management plans and providing adequate resources for continuing management and protection efforts are neglected. Paper parks do little to conserve species. Recent efforts to protect habitat have generally attempted to integrate conservation and development objectives. Biosphere reserves, multiple-use areas, buffer zones, and large-scale planning units such as regional conservation areas are all efforts designed to link biodiversity conservation with social and economic betterment of local communities (Wells and Brandon 1992). Without such linkage, many habitat protection efforts may ultimately fail. In Australia parrot conservation is increasingly being undertaken on private lands, integrating sound conservation management with best practices in agriculture (Garnett and Crowley 1995).

In exceptional circumstances, habitat manipulation may be required to protect highly specialised species, although this may not benefit other species. For example, regular burning of the heathland may be necessary to maintain some populations of the ground parrot (*Pezoporus wallicus*) in southern Australia, even though the burning regimes may be detrimental for certain other species.

Education, laws, and law enforcement

A large fraction of the conservation problems faced by parrots trace to direct and indirect impacts of mankind, and the solutions to these problems commonly lie in changing attitudes of people toward the species and/or the ecosystems that it occupies. In part this effort may involve changing laws, or changing the willingness of people to obey existing laws. The penalties for not obeying laws need to be meaningful and applied in a just fashion. But much more importantly, people need to come to understand and support the need for such laws as being in their own best interests in the long term.

Two widespread threats for which education and legal action are frequently crucial components of conservation are illegal bird trade and hunting. While laws prohibiting such activities are easy to pass and are on the books in most all countries, enforcement often proves difficult, especially where the illegal activities remain socially acceptable at the local level. Bird trade, both international

David Woolcock

The "Jacquot Express" educational bus. A focus for the conservation of the St Lucia parrot (*Amazona versicolor*).

and domestic, continues to be a pressing threat for many species (Collar and Juniper 1992) despite legal efforts to curtail and regulate it [e.g., the 1992 Exotic Wild Bird Conservation Act of the USA and the Convention on International Trade in Endangered Species (CITES)].

CITES lists all parrot species on its appendices. But, while it has evidently been an important force in controlling and curtailing legal trade in threatened parrots (judging from recent substantial declines in the overall volume of reported international parrot trade), it has not been uniformly successful in curbing illegal international trade in some highly valued species. In some cases, CITES listing may even have exacerbated trade problems for particular species. The profits involved in trade have led to widespread parrot smuggling and, so long as these profits exist, the solution to the trade problem may be elusive.

By analogy with successful historical efforts to end the plume-bird trade, the most effective solution could be a campaign to destroy demand by concerted education efforts, especially within avicultural societies, aimed at ending the social acceptability of private ownership of endangered parrots. However, given the long history of keeping parrots in captivity, their strong attractions as pets and status symbols, and the public's general inability to distinguish endangered from non-endangered species, this could be a very difficult task. Stiff penalties for convicted traffickers, and wide publicity given to their transgressions can be a significant deterrent. IUCN/UNEP/WWF Caring for the Earth (1991) has urged countries to legislate against private ownership of internationally threatened species except under tightly controlled conditions. But, so long as the private ownership of such birds remains socially acceptable, the problem will probably remain in spite of such efforts.

Where international bird trade is a major component of the problem, efforts to reduce trade in threatened parrots need to be mounted in both exporting and importing countries. However, it is essential to recognise that for many species, a very large fraction of the trade problem is internal within source countries and is not an international issue. The enforcement capabilities of many source countries for parrots have not been comprehensive enough to provide effective deterrence to parrot harvest, although such capabilities are improving rapidly in some countries. In addition, as governments have increased their enforcement efforts, they have faced new problems in how to handle volumes of confiscated birds (see Re-introduction section below).

To some extent, commercial captive breeding may have the potential to reduce the profits obtainable in trade and reduce pressures on wild populations. Indeed, deliberate efforts to reduce the market price for Naretha blue bonnets (*Psephotus haematogaster narethae*) by captive breeding have more than halved the retail price for this species in just three years (Peter Mawson *in litt*. 1997). Similar efforts are now also being tried with Carnaby's cockatoo (*Calyptorhynchus latirostris*). Nevertheless, the costs of captive breeding tend to be much higher than those of wild harvest. So long as substantial cost disparities remain, wild harvest will likely continue. In view of the small amounts of money that are sufficient to motivate parrot harvest by poor rural people (who face virtually no costs in the process), commercial captive-breeding efforts cannot be expected to depress prices enough to remove this motivation unless conducted under major subsidy to cover the economic costs necessarily involved. In the absence of subsidy, commercial captive breeding operations must have price levels that exceed costs to be able to survive.

It must also be recognised that the conservation problems of some parrot species stem from perceived overabundance rather than scarcity. Crop depredations by parrots have been a relatively common problem, and control programmes for parrots have been formally and informally instituted in many countries (see Bucher 1992). In many instances, these control efforts have not been based on sound ecological studies, and have been driven by exaggerated perceptions of damage. At local levels, even rare parrot species can be the targets of control efforts (e.g., the red-fronted macaw *Ara rubrogenys*, as a pest of maize crops in Bolivia). Designing appropriate management efforts, laws, and education efforts, as they may apply to pest species, pose some of the most difficult conservation problems to be faced with parrots, and achieving politically viable solutions that permit both survival of these species and satisfactory minimisation of depredations can be a challenge. Crop substitutions (e.g., seedless oranges for seeded varieties) can sometimes provide adequate solutions, but crop substitutions are not always economically attractive.

Whether the problems are primarily due to trade, hunting, or other human impacts, education efforts are often among the most important components of successful conservation programmes. For a good appreciation of the potential impacts of such efforts, the reader should consult Butler (1992) and Jacobson (1995). When compared to other conservation options, education efforts can often be surprisingly economical and effective, and can successfully promote biodiversity conservation well beyond the particular species in question.

The case of the St Lucia parrot (*Amazona versicolor*) is a prime example where effective conservation has resulted from a combination of education efforts, changed regulations, and comprehensive law enforcement (Butler 1992). Although chances for recovery had formerly appeared slim, largely because of widespread shooting (Wingate 1969), the numbers and range of this parrot have now increased substantially, and the species can no longer be considered Critically Endangered. The parrot has become a principal feature in expanding ecotourism on the island, and the Forestry Department has become a major income earner for the government as a result. This entire effort has been accomplished with only a minimum of costs, and it stands as a model effort that could potentially be replicated in other locales with other parrot species.

In designing education programmes of the sort that have worked well in St Lucia, it is important to keep in mind a number of general principles to maximise success:

1. Programmes should be locally implemented. Long term reliance on external technical assistance does not provide local conservationists/educators with lasting tools to enact or continue their work; and when external assistance is necessary it must contain a training component to ensure that efforts can be sustainable. Programmes must help identify and work with local institutions and businesses to provide tangible financial and/or material support for the campaigns. Local involvement builds local and national pride.
2. Programmes should promote optimism and positive attitudes. When people get the feeling of hopelessness, they lack the incentive to change. Programmes that build pride and focus on what can be achieved at the individual level are more likely to succeed. Education and training must emphasise a problem-solving approach, so that people can be empowered to make connections between their behaviour and possible impacts on the environment.
3. Programmes should promote co-operation and collaboration. The problems caused by environmental degradation and resource misuse are so complex and pervasive that they can only be tackled when individuals, local communities, national governments, and international donor agencies work together. Environmental education programmes should foster such co-operation and strive to involve as many people and agencies as possible. Often, rather than being imposed from the outside, education programmes should be based on local knowledge and understanding, and build on existing philosophies of environmental care. Any programme that relies exclusively on external aid is doomed to failure when its funds are exhausted. Where feasible, partnerships should be developed between similar programmes or projects in adjacent areas to maximise available financial and technical resources.
4. Programmes should help the targeted audience discover and understand not just the symptoms of any given environmental problem but also their underlying causes. An education programme on declining parrot populations should, for example, also focus attention on the root causes of habitat destruction, the effects of human population growth and consumption, etc. It must strive to relate the role of the individual to such causes and stress the positive results that can be achieved through changing behaviour.
5. Programmes should provide new skills. If real change is to be achieved, it is important to teach both "why" and "how", and to train local people in new skills and techniques. Where new conservation initiatives are needed, efforts should be made to maximise local participation in both design and implementation of these initiatives (see Saunders 1990a).
6. Programmes should incorporate a diverse range of outreach techniques, each targeted to a specific group. No one technique will affect change across all age and socio-economic groups. Successful education campaigns are a mosaic of many activities each carefully aimed at a specific group. The formal education system (primary, secondary, and to a lesser extent tertiary education) is a formidable institution in most countries of the world. Traditionally, teachers are regarded as pillars of society, and like other community leaders, exert considerable influence. Because of this, and because curriculum is at the heart of formal education, it is important that environmental education programmes make inroads into this system. Environmental education should be included in, and should run throughout, the other disciplines of the formal education curriculum to foster a sense of responsibility for the state of the environment and to teach students how to monitor, protect, and improve it.

   Nevertheless, reaching out to children is not enough, and successful programmes must also target the entire public sector to get the message across to farmers, resource users, and the local leaders that write the legislation, enforce the laws and influence behaviour. To this end, lectures, town meetings, posters, billboards, theatre, song, dance, and church sermons can all play a role; a good programme should encompass both "formal" and "informal" approaches (see Butler 1992).
7. Programmes should incorporate assessment mechanisms to monitor and evaluate changes in knowledge, attitudes, and behaviour. Recognising that public attitudes can influence political decision-making, it is important that environmental education programmes incorporate mechanisms to analyse clearly and document their successes. These can be used to fine tune campaigns and encourage decision makers to rally to the cause.
8. Programmes should be replicable, with success documented and disseminated to others in the field. There is a natural tendency among people "to do one's own thing", but time is the enemy of conservation. By using proven methods, it is often possible to save time in achieving the goals of saving endangered species and their natural environment. The techniques and success of programmes with a proven track record must be documented and disseminated to other conservationists. This is not to deny the potentials for valuable innovations, but to ensure that successful lessons and techniques are remembered and utilised whenever and wherever appropriate.

Ecotourism

Many species of parrots are large and spectacular, and have good potentials to serve as a focus for ecotourism development. As a conservation technique, ecotourism can give economic benefits to local communities and cause them to value and protect the ecosystems on which the parrots depend. However, potentials for ecotourism do not extend equally to all parrot species, as many lack the charisma to make them major attractions, while others are too unpredictable in movements to allow reliable viewing in specific locations. Thus while the maroon-fronted parrot (*Rhynchopsitta terrisi*) offers excellent potentials for ecotourism because of its concentrated nesting in spectacular and consistently-used cliff colonies, the same potentials do not exist for the maroon-fronted parrot's close relative, the thick-billed parrot (*R. pachyrhyncha*). Although spectacular enough in appearance, the thick-bills nest in dispersed fashion in trees, and are notable for their erratic presence in specific areas. Thick-billed parrots also nest in a range currently troubled by widespread cultivation of illicit drugs, rendering the safety of ecotourism in some question and presenting some difficulties in attracting tourists to the area.

Perhaps the most successful example of ecotourism centred on parrots is that developed for viewing of large macaws at clay licks of south-eastern Peru (Munn 1992). The clay-lick spectacle is reliable and massive and a proven tourist attraction, despite the difficulties of getting to the area (which may actually be part of the attraction). Further, it represents a major income-producing phenomenon for local communities and has been practical to connect with the need to preserve the rainforest habitat of the species involved. Overall, ecotourism represents the third most important economic activity for south-eastern Peru (Munn 1992), and this potential may continue to grow.

Wherever charismatic parrots exist and concentrate for whatever reasons (clay licks, waterholes, waterfalls, colonial nesting sites, reliable roosting sites, etc.), the possibility of ecotourism needs to be considered as a conservation option. But this needs to be done with full knowledge of the weaknesses and risks of this approach. If implemented improperly, ecotourism can lead to regrettable consequences of a variety of sorts, including degradation of the very resources on which it depends and disruption of local human cultures (see Brandon 1996).

Of principal concern is the proper distribution of economic benefits to be derived from the ecotourism. If the benefits do not stay substantially in local communities, then one cannot expect to see the development of local support for preservation of the ecosystems involved. Even if the benefits do remain largely local, the connection with needs for ecosystem protection may be missed without proper education efforts, or may simply be ignored if benefits are not substantial enough (see Brandon 1996). Unfortunately, in many cases of ecotourism development, the benefits have wound up primarily in the hands of extranationals or nationals that are far removed from the actual scene. Proper structuring of the economic benefits is something that should be addressed at the very outset of ecotourism development, and not simply be left to chance. To minimise exploitation and corruption as much as possible, the economic benefits should be controlled and realised by local communities as a whole rather than by individuals.

Another weakness of the ecotourism approach is the fact that it can be expected to be vulnerable to unpredictable fluctuations in international economies, changes in

L. Porter

Party with cameras at hyacinth macaw site in Piani, Brazil.

currency exchange rates, and changes in perceptions of the risks of visiting various parts of the world. A few well-publicised bombings and kidnappings have the potential to sabotage the basic viability of tourism wherever it is developed for whatever purposes. Nevertheless, it is clear that many developing countries are turning to ecotourism as a major economic benefit (e.g., Costa Rica). In many cases, it works reasonably well to generate income, even if it does not always benefit conservation efforts.

Thus far, the overall track record of ecotourism in aiding conservation has been disappointing, although positive potentials still exist, assuming structural changes can be implemented in the way the industry generally operates (see Brandon 1996). The main problem to be corrected is that economic returns do not substantially benefit local communities in many cases. In addition, visitor fees to protected areas, at least for non-nationals, are often underpriced and could easily be increased to generate more substantial benefits. Another change that can make a significant difference is gaining the co-operation of governments in channelling funds raised from public reserves back into reserve maintenance and protection.

Captive breeding

Captive breeding has served a crucial function in the recovery of a number of species of critically endangered wildlife, and has a role to play in the recovery of certain parrots. However, there are significant limitations to this technique when it is used to breed birds for ultimate release to the wild. In general, the technique is advisable only as a short-term measure when other preferable conservation options are not immediately available. Employed properly in recovery programmes, captive breeding can provide a critical boost for some severely threatened populations. Employed improperly, it can lead to greatly increased recovery costs and risks rather than benefits. It is important, therefore to identify when captive breeding should or should not be used as a recovery measure and how it should be implemented.

Captive breeding also has other values that are less directly related to species recovery, such as providing birds for exhibit, conservation education, and fund-raising purposes. Captive populations can also provide an important resource for fundamental biological research and research training which cannot be accomplished with wild individuals. The precautions that should be observed in captive breeding for recovery purposes (i.e., release to the wild) are different from and more stringent than those that are acceptable for captive breeding for these other purposes.

When captive breeding is properly integrated into a species recovery programme, it can offer a number of advantages. Most importantly, it can serve as a safety net for species whose wild populations face a high probability of extinction. With species that breed readily in captivity, it is sometimes possible to greatly increase the rate of reproduction through techniques such as multiple-clutching and speed the recovery of wild populations through releases of captive-bred birds. Releases can serve a number of purposes such as increasing extant populations, correcting sex-ratio imbalances (if these are determined to be unnatural and detrimental), re-establishing extirpated populations, and/or establishing new populations in natural or altered habitats (see Greenwood 1996 for discussion of the echo parakeet *Psittacula eques* programme). Captive breeding can sometimes also make it possible to minimise losses of genetic diversity from critically threatened populations and minimise chances of catastrophic loss of populations.


World Parrot Trust

Echo parakeet chick, *Psittacula eques*. Captive breeding has been part of the recovery programme.

Captive populations have an important role to play in species recovery when pressures on wild populations are so large in the short term that there is no way to sustain wild populations. In such cases, captive breeding can provide a short-term reprieve, buying time for preparation of re-introduction sites that may permit re-establishment of wild populations.

Nevertheless, the potentials of captive breeding in aiding species recovery are limited by a number of important considerations (see Derrickson and Snyder 1992, Snyder *et al*. 1996):

1. **Difficulties in breeding certain species.** Most psittacines have been bred in captivity, but sustained and quantitatively adequate captive production has remained an elusive goal for many species (see Clubb 1992). For others, satisfactory production has been attained only by hand-rearing. Unfortunately, hand-reared birds are generally of lesser value than parent-reared birds for re-introduction purposes, and in some

cases they may be impossible to re-establish in wild environments.

2. **Difficulties in re-introducing many species to the wild.** Re-introduction programmes for vertebrates to date have been relatively unsuccessful when limited to captive-bred stock – averaging 11–38% successful in recent major surveys by Beck *et al*. (1994) and Griffith *et al*. (1989). Re-introductions of captive-bred parrots often face problems with behavioural deficiencies resulting from a large component of learning in parrot behavioural repertoires and a difficulty in producing adequately normal behaviour in captive environments. Unless captive-bred individuals are re-introduced by fostering to wild pairs or are released in predator-free or predator-deficient environments, many re-introductions may fail because of problems such as inadequate flocking behaviour and poor habitat recognition abilities (see Snyder *et al*. 1994). The bottleneck in using captive breeding successfully in species recovery often lies in problems in re-introduction rather than in captive breeding itself.
3. **High costs in facilities and personnel.** The costs of properly-run captive-breeding programmes, including isolated, well-sited facilities, comprehensive disease control, and the manpower needed to maintain and care for adequate-sized captive populations, are substantial, sometimes running on the order of a half million dollars US per year. Over the time needed for conservation programmes, such costs can sometimes far exceed those of other potential conservation methods. Techniques such as habitat preservation (which automatically benefits far more species than the single parrot species under consideration) are often far more economical (see Balmford *et al*. 1995).
4. **Disease risks.** Parrots are susceptible to over 30 known pathogens and disease syndromes, many of which are widespread in captive collections and some of which cannot be reliably detected in carrier birds by presently available tests or standard quarantine procedures. Of course, diseases also occur in wild populations. However, wild populations are relatively well adapted to deal with indigenous diseases through natural immunities. The greatest risks occur when species are exposed to novel, exotic diseases. Such exposure risks are especially great whenever birds are transported or held in large numbers in multispecies, especially *ex situ*, environments. Unless captive breeding is conducted under carefully controlled conditions, the risks of disease to captive, re-introduced, and wild populations are substantial. Ideally, to minimise these risks, captive breeding of endangered parrots for recovery purposes should occur in:
   a) closed, single-species facilities,
   b) facilities within the natural range of the species,
   c) facilities in which staff do not have contact with other species of wildlife, either professionally or avocationally,
   d) facilities that are sited as much as possible in areas free from arthropod disease vectors and feral populations of exotic birds,
   e) facilities where established protocols include rigorous disease prevention methodologies, such as scrub downs of personnel entering the facilities, and regular health examinations of captive stock.

   To minimise the chances of introducing disease problems into wild populations, captive-breeding stocks for recovery of endangered parrots should generally be assembled directly from wild populations or from stocks held in closed single-species facilities with good records of disease prevention, and should not be formed from stocks that have been held in open multispecies facilities. Birds intended for re-introduction should be subjected to state-of-the-art disease screening when entering or leaving captive-breeding facilities, even though such screening cannot be expected to reveal the presence of all diseases of importance.

   Observing the above standards is often expensive, but should be recognised as one of the inherent costs of comprehensive captive breeding conducted for recovery purposes (Wilson *et al*. 1994). The consequences of not observing such precautions include substantially increased risks of permanent establishment of new disease stress factors in already threatened wild populations and, in some cases, extinction or near-extinction of wild populations (see Jacobson 1993; Woodford and Rossiter 1994).
5. **Managing genetic and behavioural changes.** When captive populations are established for conservation and recovery purposes, the preservation of extant genetic variation and species typical behaviour assumes paramount importance. Over the past decade, considerable attention has been given to the preservation of genetic diversity in small populations. Modern, conservation-oriented breeding programmes attempt to ameliorate the genetic effects of inbreeding, drift, and adaptation to the captive environment through the deliberate and careful control of reproduction, population size, and population demography (Foose and Ballou 1988, Lacy 1987, Allendorf 1993). This is a challenging task, however, given:
   a) the practical limitations in controlling population size and reproduction,
   b) the dynamic nature of evolutionary forces in small populations,
   c) the types of genetic variation to be maintained, and,
   d) the uncertain nature of selection in the captive environment (see Lande 1988, Simberloff 1988).

In low-fecundity taxa, like most parrots, careful preparation of stud books and pedigree breeding to equalise progeny number in family lines can minimise genetic drift and adaptation to captivity (Allendorf 1993). However, it must be recognised that breeding programmes for endangered parrots have often failed to secure consistent reproduction and have been unable to equalise progeny numbers in family lines or pursue any other consistent genetic strategies, even after years of effort. Further, some stocks in captivity have been genetically debased by ill-advised cross-breeding with other races and do not constitute acceptable stocks for release on genetic grounds (see Triggs and Daugherty 1996).

Much less attention has been given to the preservation of species-typical behavioural traits. Behavioural traits, especially those that are learned or culturally transmitted, are prone to rapid loss in captivity. The behavioural repertoires of many parrot species include many learned components, and problems with behavioural deficiencies have already been encountered in attempts to re-introduce captive-bred individuals of several species to the wild (see Wiley *et al*. 1992, Snyder *et al.* 1994). Because the cultural transmission of information across generations appears to be essential for the survival of wild populations of some highly social species such as parrots (Toft 1994), breeding programmes for re-introduction must focus careful attention on behavioural management in the captive environment. Clearly, this aspect of captive management deserves much more scientific investigation than it has received, and will have to be undertaken on a species-by-species basis.

6. **Problems in ensuring continuity of programmes.** Captive breeding represents a relatively unstable and input-intensive approach to conservation that is difficult to sustain over the several decades often needed for the recovery of endangered species. Changes in personnel, institutional priorities, and financial resources can frequently leave long-term programmes without adequate support and expertise. The Puerto Rican parrot captive programme, for example, has suffered several periods of substantial difficulty in maintaining optimal efficiency over the more than 25 years of its existence. Of course, problems with continuity are not unique to captive breeding programmes, and can affect complex *in situ* conservation efforts as well.
7. **Pre-emption of other, better techniques.** Captive breeding can sometimes pre-empt attention and resources from better, long-term conservation solutions. The existence of a captive population can give the impression that the species is "safe" and allow agencies to ignore long-term solutions that are often more difficult politically, though much more effective and beneficial biologically (see discussion and examples in Snyder *et al*. 1996).

Because of the risks and limitations of captive breeding, it should be invoked as a species recovery approach only under carefully defined circumstances. The decision to start captive breeding for this purpose should be made only on a case-by-case basis and only following a comprehensive evaluation of conservation alternatives at the field level. It should not be made simply because some individuals are already in captivity and numbers of the species seem relatively low. Further, it should not be made when resources to conduct captive breeding comprehensively and humanely are unavailable.

In general, captive breeding can be justified as a desirable recovery approach when: (1) species are so rapidly approaching extinction that they cannot be expected to survive without intensive intervention of some sort and either effective conservation alternatives are clearly unavailable in the short term or sufficient time to investigate alternatives does not exist; or (2) all or nearly all individuals of a species are already in captivity and it is deemed worthwhile to attempt re-establishment of wild populations; or (3) other conditions prevail that make captive breeding and re-introduction absolutely essential for preservation of the species in the wild.

When captive breeding should begin for species in decline is often a point of vigorous controversy. Clearly, waiting too long before starting will risk genetic deterioration and potential failure in developing adequate husbandry techniques, especially if technology for captive breeding of the species or closely related species has not previously been researched. However, starting too soon can represent unnecessary expense, can accentuate genetic and behavioural management problems, and can focus resources in non-crucial directions, pre-empting other approaches that can offer potentials for more stable, long-term benefits.

Population trends are often far more important than absolute numbers in making decisions as to whether and when captive breeding is warranted. Steeply declining species are cause for special concern, and care needs to be taken not to wait too long in establishing captive populations if effective alternatives are unavailable. In making such decisions it is crucial to recognise the difference between ephemeral short-term population fluctuations and pervasive long-term population trends. Well-constituted recovery teams weighing the many factors that need to be considered are probably the best mechanism for determining whether and when captive breeding is needed for a particular species. The decision should not be delegated to parties, such as private captive breeders, who have a personal stake in the captive breeding.

Captive-breeding programmes for species recovery should not be established independent of efforts to develop alternative, long-term conservation solutions for wild populations. In general, wild populations should be sustained at the time captive populations are established so that research into limiting factors can take place and problems in the wild can be identified and corrected. Also, existing wild populations can present a valuable link for re-introduced individuals.

Finally, captive breeding efforts for species recovery should proceed only when endorsed by the governments of the countries involved. Although extranationals may be useful in helping launch such programmes and in providing training, programmes should primarily involve participation by local conservationists. It is crucial that birds involved in captive breeding efforts be under the control of integrated conservation programmes so that disputes as to ownership of birds and as to the management and fate of birds do not disrupt progress toward conservation goals. Captive and wild populations of a species must be managed as one interactive entity under control of a single conservation authority.

Re-introductions

Re-introductions, in the broad sense of re-establishing or bolstering wild populations with releases of birds held in captivity, can utilise either wild-caught or captive-reared stocks. Potentially, such releases can enhance the status of endangered parrots in several ways:

1. When releases are made in former habitat of the species, they can either re-establish the species or significantly increase its range in the wild and by so doing increase the overall security of the species.
2. When releases are made into weakened wild populations of the species, they can reinvigorate the wild populations through increasing genetic diversity and correction of imbalanced sex ratios.
3. In carefully selected cases, the potential also exists to establish wild populations in formerly unoccupied habitat when habitat in the original range is no longer adequate for survival of the species. Here, the re-introduction programme for the kakapo (*Strigops habroptilus*) comes immediately to mind (Merton 1997).

Wiley *et al*. (1992) presented a review of a variety of parrot re-introductions from prehistoric times to the early 1990s and should be referred to for background information. For a discussion of criteria for re-introduction in general see Kleiman *et al*. (1994) and IUCN (1998), and for a more specific treatment of avian re-introductions see Black (1991).

In general, re-introduction programmes have received a tremendous amount of publicity in recent years, and have been proposed for many species without a careful consideration of whether re-introductions are truly appropriate. Re-introductions should serve a direct conservation benefit for wild populations and pose a minimum of risks. They should have a clearly defined conservation goal and be terminated once that goal is reached. Continuous release programmes that never achieve self-sustaining wild populations of the target species are not legitimate re-introduction programmes from a conservation standpoint. However, legitimate re-introduction programmes may include carefully designed surrogate release efforts using less critically endangered species as models to develop techniques to use subsequently on a target species. Because of certain risks posed (see below) releases should not be undertaken solely for the purpose of disposing of confiscated birds or excess captive-reared birds.

While improvements in technology can be expected, the success rate of re-introductions of captive-bred animals

Thick-billed parrot *Rhynchopsitta pachyrhyncha*. Experimental re-introductions of captive bred thick-billed parrots were largely unsuccessful.

to the wild has not been impressive to date. Using rigorous criteria, Beck *et al.* (1994) reported an overall success rate of only 11% in some 145 re-introduction programmes utilising captive-bred stocks, mostly involving vertebrates, while Griffith *et al.* (1989) reported a 38% success rate using different criteria for success. Success rates have generally been much higher for translocations of wild-caught animals from one region to another [e.g., 75% in the study of Griffith *et al.* (1989)]. This difference in success very likely traces in large measure to behavioural deficiencies of captive-bred stocks relative to wild-raised stocks.

Examples of well-documented parrot re-introductions are few, which makes it difficult to evaluate success rates of captive-bred vs. wild-caught stocks. However, experimental releases of thick-billed parrots (*Rhynchopsitta pachyrhyncha*) in Arizona indicated that wild-caught birds survived much better than captive-reared birds (Snyder *et al.* 1994). Nevertheless, short-term success has been achieved in releases of hand-reared macaws (*Ara ararauna*, *A. chloroptera*, and *A. macao*) and yellow-shouldered parrots (*Amazona barbadensis*) into local healthy populations from which they were taken (Munn 1994, Sanz and Grajal 1998). Much of the difference in success rates between these studies may trace to the extent of predator pressure faced by the released birds in the different situations. The potentials for success in releases of captive-reared birds are presumably maximised if releases are conducted in low-predation environments hosting existing wild populations of the species concerned.

As a general guideline, re-introductions should utilise wild-caught stocks in preference to captive-reared stocks, especially when a proposed release is not into an existing wild population from which naive captive-reared birds can learn appropriate behaviour. One of the most successful ways to link captive-reared birds to wild populations is through fostering of eggs or nestlings into wild nests (Snyder *et al.* 1987), a technique that demands close co-ordination of captive and wild-population efforts. Unfortunately, fostering opportunities may often be limited in endangered species programmes, and reliance may have to be placed on releases of flighted birds in many instances. Cross-fostering of eggs or nestlings into nests of other species can pose severe problems of imprinting the released birds on inappropriate species and subsequent problems with hybridisation (e.g., Harris 1970). It should normally be avoided.

Three risks of re-introductions need to be emphasised: (1) disease contamination, (2) unintended ecological effects, and (3) cultural/genetic pollution of wild populations. Re-introductions can pose severe risks to wild populations by the inadvertent introduction of exotic diseases (see Woodford and Rossiter 1994, Snyder *et al.* 1996). Re-introductions should utilise stocks that can be confidently assessed as disease-free, and use of disease-suspect stocks should be entirely avoided, particularly when releases are being made into existing wild populations. Many parrot diseases have long latency periods and are virtually impossible to detect in carrier individuals, so releases of birds in which the histories of exposure to disease are unknown are unwise. Thus, confiscated birds should be avoided in general, as should birds from open multi-species captive environments, especially those held in facilities outside the range of the species.

Wild-caught birds are a relatively safer source for re-introduction, especially with respect to exotic diseases, but only if they are held separately from other stocks before release and undergo adequate quarantine with thorough pre-release screening for diseases that can be detected by available tests. Captive-bred birds from closed, single-species facilities within the natural range of the species are also good candidates for release from a disease standpoint, provided there has been an exemplary history of disease prevention at the facilities. However, even in isolated facilities shielded from contact from other species, disease problems can emerge if rigorous food handling practices are not practised and if staff servicing captives have contact with other birds outside the facilities.

Unintended ecological effects are a special concern when releases are attempted outside the historical range, as here the species is being placed in an environment where other species have not evolved any adaptation to deal with it. Harmful distortions of ecological relationships can easily occur under such conditions, as has been demonstrated repeatedly around the world with feral populations of exotic pest species. Releases into non-native regions should only be considered under extreme circumstances, as previously recommended by the IUCN (1987). Yet the technique has been used with apparent success and absence of detrimental side effects with a variety of bird species island to island in the New Zealand region (see Armstrong and McLean 1995).

A third risk of re-introductions is that when captive-bred stocks are used they may introduce genetic and cultural traits evolved in captivity into a wild population where such traits are not adaptive. Through learning and interbreeding, these traits may be of harm to the wild populations, especially if the wild populations are highly depressed in numbers relative to the numbers of released individuals. Such problems have been especially of concern in releases of hatchery-reared fishes (e.g., Fleming 1994, Philippart 1995), but there is no reason to expect such effects would not occur in parrots as well. An intact culture, where behaviours are transmitted through learning between generations, appears to be essential for the survival of populations of highly social species such as parrots (Toft 1994).

A consideration of the potential benefits and risks of re-introductions leads to the following general recommendations regarding parrot re-introductions:

1. Re-introduction should not be considered as a conservation option until the factors causing endangerment or extirpation of the population in question have been corrected or are being corrected. This means that a thorough ecological study should be conducted to determine what factors may be limiting the particular species, and programmes directed at reversing limiting factors should be implemented before any consideration is given to re-introductions. If wild populations still exist, correction of limiting factors may be sufficient to achieve recovery without any need for re-introductions. This should be evaluated prior to initiation of any releases.
2. The potential release site should be thoroughly evaluated. If birds of the species to be released exist at the site, the population should be studied, the carrying capacity estimated, and a re-introduction plan developed around that population. Attention should be paid to re-introducing only the appropriate subspecies. If birds are to be released into an area where there is no existing wild population, great care should be given to assessing the suitability of the habitat and the possible effects of the release on other species.
3. Release programmes should follow all national and international laws, treaties, and regulations. It is imperative that all permits are in order so the success of the programme will not be jeopardised by improper paperwork.
4. Appropriate levels of co-operation and collaboration with local interests must be secured. Success of re-introduction can be expected to depend heavily on involvement of local people in release and monitoring efforts and in keeping local communities informed about the programme and gaining their support through educational programmes conducted simultaneously with and prior to the releases.
5. Sufficient numbers of birds to give reasonable hope of success should be available for release. A certain level of mortality will take place in any release, so there is no benefit in releasing such a small number of birds that normal flocking behaviour and/or pairing is unlikely to occur.
6. Stock for release should be chosen from disease-free sources and be shielded from exposure to exotic pathogens by proper siting of holding facilities. Release candidates should also all be sexed and screened for known diseases prior to release.
7. Adequate pre-release acclimatisation and training must be implemented. Conditioning prior to release should include flight training, socialisation within flocks, acclimatisation to local conditions, and experience with local foods. Whenever possible, releases should provide subsidies of food and water until birds are fully competent in the wild. Predator aversion training may be necessary with captive-reared birds, though should be unnecessary with wild-caught birds.
8. Resources should exist to monitor the results of releases comprehensively and to conduct quantitatively adequate follow-up releases. All birds should be banded and, finances permitting, have microchips implanted. If possible, a portion of released birds should be radio-tagged, at least during experimental phases, since this is the most effective way to monitor the success of the release.

Confiscated birds

Although the above recommendations regarding re-introductions are straightforward and reasonable, many recent release efforts with parrots have been initiated without conforming to these recommendations. In particular, releases have become a common way to dispose of confiscated birds in many Latin American countries. These releases often are made into populations for which the releases pose unnecessary risks and no clear potential benefits, and without comprehensive monitoring of results. Some of the programmes initiated have been designed precisely to rehabilitate and release confiscated birds and are financed by international organisations or by scarce conservation resources of government agencies. Most often, these programmes have involved common, rather than endangered, species, but the risks posed are not limited to the common species released.

The reason many of these programmes have been started is that with increased law enforcement activities, the governments of many countries have been faced with a difficult problem of what to do with birds confiscated from illegal trade. The options for dealing with these birds are unfortunately limited, and all have drawbacks. Primary options include:

1. Donations or sale to zoos and other similar institutions,
2. Donations or sale to research institutions,
3. Auction to anyone willing to purchase them,
4. Release to the wild, and
5. Euthanasia.

Donations or sale to zoos and other similar institutions provide an obvious and generally acceptable solution to the disposal problem for confiscated animals. However, the capacities of such institutions to absorb the quantities of birds available are generally minimal. The species available from confiscations are often ones that have only limited exhibit potential, and zoos simply do not have the space or desire to handle large numbers of such animals. Furthermore, because confiscated animals usually have unknown histories of exposure to disease, such institutions take a gamble on bringing them into

Margaret Kinnaird

Citron-crested cockatoos, *Cacatua sulphurea citrinocristata*. Confiscated birds have often been exposed to other captive birds, sometimes from around the world. Experience has shown that they are often carriers of serious avian diseases.

their facilities, even after quarantine and screening for known diseases.

Donations or sale to research institutions similarly provide an obvious and generally acceptable solution, but in general these institutions are even less capable than zoos of absorbing the quantities of birds available. While this option should be encouraged, it cannot be expected to provide a full solution to the problem.

Auction to anyone willing to buy is another solution that has been commonly employed in the past, but it often results in the birds being bought back by the very people from whom they have just been confiscated. At auction prices, these people are still able to make substantial profits on the birds on resale, and since they are now legal as a result of auction, they can move them freely in commerce. This has obviously not been a very beneficial way to dispose of confiscated birds. Auction also represents a source of disagreement between authorities in different countries, especially when the status of the species or authorised uses are different between the country of origin and the country in which confiscation takes place. At most, auction should be encouraged as a solution only when a floor to sale prices is established that is at or close to retail value.

Release to the wild has been recently adopted as a preferred way to dispose of confiscated parrots by many governments. Most of the releases that have been conducted have not been for the purpose of re-establishing wild populations, nor have they been needed for bolstering wild populations – they have been implemented simply to dispose of birds that agencies do not know what to do with. Unfortunately, releases of confiscated birds pose serious risks of disease introduction into formerly disease-free wild populations. Unfortunately, the diseases involved are often ones for which no diagnostic tests exist. There is no reliable way to avoid the potential of introducing serious diseases into wild populations when such birds are released. Whether such disease problems have been developing in many of the confiscated bird release programmes is unknown, because there has been virtually no follow-up study done after releases. While the releases being conducted allow participants to feel they are doing something worthwhile, in most cases they only represent added risks for wild populations and often inhumane death for released birds. Only in the very unusual circumstances where history of disease exposure of confiscated birds is known and is determined to be benign, where there is a true conservation need for releases, and where there are resources for a comprehensive release programme is it advisable to utilise confiscated birds in releases.

Unfortunately, determining the history of disease exposure to be benign in confiscated birds is usually impossible. Such a determination is generally limited to cases where confiscations have been made right at the source of birds, before they are moved to other links in the chain of commerce. Confiscations are rarely made at this level, and even confiscations made directly from people harvesting birds from the wild may involve disease-compromised birds, as for example birds exposed to poultry diseases in the homes of the collectors involved. In practical terms, nearly all confiscated birds should be considered highly suspect, regarding disease considerations.

Euthanasia is a relatively simple method of disposing of confiscated birds and poses no risks to wild populations, but this solution can pose serious political risks of opposition from segments of the public that oppose such methods on principle. Where this solution can gain political support, it represents a preferable solution to releases to the wild. In any case, where birds have been exposed to or suffer from untreatable diseases, euthanasia is clearly warranted.

Thus, while this Action Plan cannot propose a universally applicable solution to the problem of disposal of confiscated birds, release to the wild is normally the least favourable conservation option and should generally be avoided.

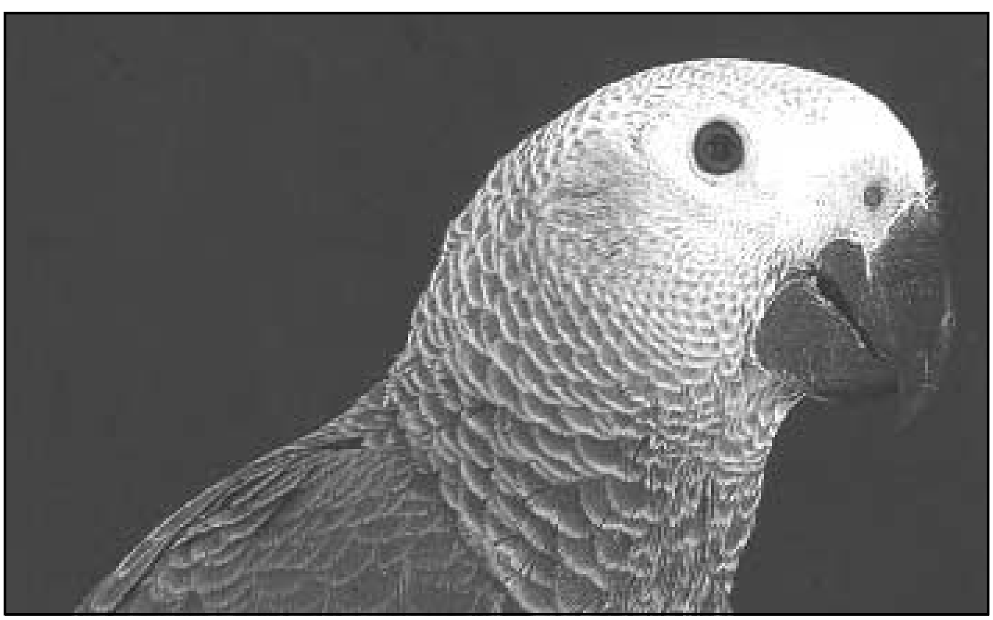
Sustainable harvest

Parrots, by virtue of their bright colours, their capacities to imitate human speech, and their adaptability to captive conditions, have been favoured as human pets as far back as historical records extend. Unfortunately, this very popularity has been a major cause of the conservation woes of psittaciforms worldwide. As human populations have grown, wild parrot populations have been overharvested in many regions, many to the point of local extirpation and some to the verge of total extinction. In their review of conservation status of parrots in the New World, Collar and Juniper (1992) concluded that approximately half of the 42 threatened species in the region were endangered primarily or secondarily by trade.

The prices commanded by the larger and more colourful species have commonly represented a significant source of income for rural human populations. Revenues from harvesting parrots have not usually been sole sources of income, but have been valued as supplementary income to be gained when opportunities arise. Unfortunately, the harvest has rarely been conducted on anything approaching a sustainable basis, largely because the resource has usually been a "commons" where any forbearance in harvest is perceived only as money in someone else's pocket.

In theory, the economic values commanded by parrots might represent a means to their conservation if the socio-economic environment could be restructured enough to promote truly *sustainable* utilisation of wild parrot populations. If implemented properly and conservatively, sustainable harvesting could provide advantages for conservation, aviculturists, the pet industry, and local human populations. Conservation could gain by the maintenance of healthy wild populations of parrots, and by the accruing of economic values to the habitats occupied by the parrots, which could result in conservation of many associated species. For example, if parrots could be sustainably harvested from tropical rainforests, this would provide another commodity that might help to make extractive reserves more economically valuable than clearing forest for timber harvest, cattle grazing, or intensive crop production. For many species of parrot, sustainable harvesting would require that substantial areas of land be maintained as mature forest. Aviculturists could purchase new genetic stock for their breeding programmes from birds harvested sustainably. The pet industry would have a steady but small flow of legally imported birds already conditioned to captivity. Finally, the profits from these programmes could be directed to the local people in need of ways to support themselves.

No demonstrably successful sustainable harvesting projects with free-flying parrots have been established to date. Because most parrots have low reproductive potentials and long life spans, they are highly vulnerable to overharvesting, and conservative approaches to harvesting appear warranted. These include approaches such as harvesting only nestlings and not adults, and



African grey parrot, *Psittacus erithacus*.

harvesting primarily nestlings that are produced in excess of natural productivity as a result of management programmes. Maximising sustainable nestling harvest levels requires management to achieve robust numbers of nesting pairs, which may in some cases approach the carrying capacity of the environment.

The biological characteristics of some parrot species appear to lend themselves to sustainable harvesting programmes. For example, brood reduction occurs regularly in some parrot species, so it should be possible to practice early partial brood removals (last-hatched chicks) without greatly affecting productivity in these species. Further, even where brood reduction may not be a regular phenomenon, biological data suggest that there is a potential to harvest some parrots in a sustainable manner if overall productivity can be increased through the use of nest boxes (Beissinger and Bucher 1992a,b; Stoleson and Beissinger 1997). However, these approaches to sustainable harvest are not applicable to many parrot species, as they lack regular brood reduction, are not nest-site limited, or are reluctant to accept nest boxes. Sustainable harvest of such species may be difficult without development of other means of increasing reproduction or reducing mortality of wild populations.

Realising the potential benefits of trade requires a degree of control over harvesting that promises to be difficult and expensive to achieve. Solving the biological problems associated with sustainable harvest of parrots is challenging enough, and presupposes that sensitive and reliable means of population monitoring may be available for the species in question. Even more challenging are the associated social, political, and economic problems. Examples of the latter include:

1. Illegal laundering of non-sustainably harvested birds through the programmes;
2. Continued poaching of birds by people outside of the programmes; and
3. A tendency for programmes to skimp on the costs of monitoring wild populations and to overharvest to maximise short-term profits.

If there is to be a trade in parrots, it must be conducted on a sustainable basis. A commonly accepted biological basis for sustainable use of renewable resources is that harvest should not take more than excess individuals over the numbers needed to replenish the population and should not have negative effects on other components of the ecosystem. The best way to determine what harvest levels are sustainable is to conduct continuing detailed biological studies of the natural history, demography, movements, and population size and trends of the species to be harvested. Quotas set without such information will have little biological justification.

Further, national and international regulation of harvest and trade must shift from the practice of national quotas to local harvest quotas based on scientific management plans. Using national quotas to regulate harvests does not tie harvest levels into local conditions and provides no impetus for ecosystem conservation. Harvest quotas must be developed on a site-by-site basis, with harvest levels linked directly to local changes in population productivity and habitat conditions.

Unfortunately, without truly effective controls over harvesting programmes, attempts at sustainable harvesting run a significant risk of exacerbating conservation problems, rather than solving them. Once species are viewed primarily as items of legal trade, the primary concerns in free capitalistic economies commonly become maximising short-term profits, rather than ensuring long-term sustainability (Hawken 1993). Historically, attempts to harvest wildlife resources for profit include numerous examples of overexploitation and of species driven to the verge of extinction (see Geist 1988, Ludwig *et al.* 1993, Talbot 1993).

One of the few apparently successful wildlife harvesting efforts, from the standpoints of sustainability and conservation, is butterfly ranching. Butterfly ranching, however, has two unusual characteristics:

1. It is often cheaper and easier to ranch butterflies than to collect them from the wild by other means; and
2. The trade quality of ranched butterflies is much better than that of wild-caught butterflies (both with respect to parasite incidence in pupae and wing damage in adults).

Both of these factors greatly decrease economic incentives to "launder" wild-caught stocks through ranching programmes or to invest efforts in harvesting wild stocks outside ranching programmes.

In contrast, non-ranched parrots may be much less costly to harvest than sustainably ranched parrots because they do not entail monitoring costs, nest box costs, etc. This is especially true when finding of nests is incidental to other economic activities, such as herding livestock, and does not represent a substantial additional time investment. Further, non-ranched parrots can be of equal trade quality to ranched parrots when they are harvested as nestlings. They can be as tame and as good speakers as ranched parrots, and in fact have no intrinsic features to allow their differentiation from ranched parrots. Thus, despite legal ranching efforts, there may be substantial economic incentives favouring continued illegal harvesting of wild parrots and substantial difficulties in detecting illegal non-ranched parrots in trade.

It is possible to reduce the attractiveness of laundering birds by setting up systems of bird identifications based on various DNA techniques. However, such techniques substantially increase costs of operations, and unless governments want to subsidise operations, these costs presumably would have to be borne by the ranchers themselves, reducing their abilities to compete with illegal harvest. Presumably all nesting individuals in ranching operations would have to be DNA sampled to make such systems work, and with many species this could present formidable practical problems because of difficulties in capturing adult birds for sampling.

Other concerns posed by sustained harvest as a means of parrot conservation include:

1. An inherent tendency of this approach to work against alternative approaches that seek reductions in human uses as a means toward conservation;
2. A fear that placing primary importance on economic values of wild parrots as a means to their conservation will lead ultimately to a distortion of wildlife management efforts to favour only those species with high trade values at the expense of efforts to sustain general biodiversity values; and
3. A fear that once sustainable harvesting schemes are in place, the primary goal of operations can be expected to shift from conservation to maximising profits and sustaining employment of participants, even if this means overharvesting resources. History has shown that governments can be expected to be generally sympathetic to these latter goals and to be under great pressure to value them more than conservation goals.

Sustainable harvesting for an international export trade poses the additional risk of continued export of wildlife diseases to foreign countries. It also increases the potentials for establishment of additional feral populations of exotic parrots in foreign countries. These are extremely important threats, especially when exported species have the potential to become pests in non-native countries. Despite these risks, pressures continue to surface for Australia to export pest cockatoo species as an alternative to other control measures. The prudent assumption that should be made is that any species exported in numbers to a foreign country may have the potential to establish feral populations in that country.

The above problems, coupled with the substantial problems in solving the biological, social, political, and economic difficulties associated with effectively controlling sustainable harvest, raise substantial concerns as to whether this option might be successfully implemented with parrots. Demonstrated mechanisms to control such problems do not currently exist and promise to be challenging to develop. Until such mechanisms are developed, however, attempts to implement sustainable harvesting for parrot conservation seem likely to result in greater problems than they solve.

Unfortunately, the various monitoring and management efforts that must be practised for sustainable harvest of parrots to work all represent substantial costs. Pressures to forgo or minimise these costs and to overharvest in order to maximise profits or even to compete with illegal trade in the same species could eventually undermine any initially successful sustainable harvesting ventures.

At best, sustainable harvest would appear to have relevance only to the select group of species that are popular in trade and in countries that have the administrative and enforcement capacities to effectively regulate trade. At worst, it could result in greatly diminished conservation prospects for many harvested species. Because of the risks and uncertainties involved, species with low numbers locally or globally should not be considered candidates for sustainable harvest until their wild populations have recovered to healthy levels. Thus at the present time it is unwise to attempt sustainable harvest as a recovery technique for threatened psittacines and this Action Plan does not recommend such attempts.

Strong hopes should not be placed in sustainable harvesting as a conservation strategy until several demonstration projects can prove the feasibility of controlling anticipated problems. Substantial funds will be needed to find ways of enforcing harvest and trade regulations in such projects in both exporting and importing countries. Comprehensive enforcement can be expected to be a necessity before potential exploiters will take harvest regulations seriously, and in many countries such enforcement may be an unrealistic goal.

Furthermore, even if solutions to many of the above problems might be achieved, sustainable harvesting schemes may have difficulty surviving economically because of the tendency for single products to fluctuate greatly in value through time. Economics of the live-bird trade are governed by the vagaries of supply and demand. As a species becomes readily available, whether through poaching or successful captive breeding or sustainable harvesting, demand for that species tends to decline and the price falls, often dramatically. In a free market international economy, it is doubtful that any sustained harvest programme or export scheme can be maintained in the long term; supply and demand for the harvested or exported species will likely not be under the full control of local participants. Where profits are to be made, supplies can be expected to increase from all possible sources. But, as supplies increase, prices and thus profits will drop, potentially to levels that will not support comprehensive harvest operations, especially with the costs of scientific management included. In part this outcome can be anticipated because many of the birds produced and sold in aviculture are priced below their real cost. Many aviculturists sell these birds simply to reduce the economic losses in their collections and not to gain a profit. Sustained harvest efforts will have to compete with birds from such sources as well as birds from illegal wild harvest produced at very low cost.

In overview, sustainable harvesting of parrots for trade should not presently be proposed for threatened species, although this conclusion does not preclude the possibility that this technique might have some future role in conservation of such species. Sustainable harvest can only serve a conservation purpose if robust parrot populations and long-term habitat preservation result. But, it cannot contribute to species or habitat conservation without availability of sound ecological information and effective methods to regulate harvesting and trade. Solving the economic and political problems associated with sustainable harvest promises to be a formidable task.

Summary of conservation options

Most conservation programmes for parrots will utilise more than one conservation technique. The combination best suited for a particular species must be determined on a case by case basis and reflect the limiting factors faced by that species. In designing an optimal mix of techniques, it is important to keep in mind the advantages and disadvantages of various choices, and to ensure that the programme furthers overall goals of economic effectiveness, benefiting associated species, and political viability.

As a general view, nearly all conservation programmes will benefit from comprehensive habitat protection and education components. Some will be well suited to development of ecotourism, while others will not. Relatively few will benefit from captive breeding and re-introduction approaches, and at the present time it is wise to be extremely cautious about attempting sustainable harvesting schemes.

Other more specific conservation remedies will undoubtedly be needed for the conservation of many species, as determined from comprehensive biological studies. The threats facing parrots are diverse. While the issues of trade and habitat deterioration loom as overarching threats to the group as a whole, they are by no means the only problems. The best solutions will vary with the species, and the local social, economic, and political context.

Good biological knowledge about the species in question and thorough local involvement in designing and carrying out conservation programmes are essential for success. No one can successfully plan, let alone implement, a conservation programme for a species from afar. Nevertheless, productive international partnerships can often speed and facilitate the conservation process, particularly where sufficient resources are unavailable at the local or regional level.

Some final remarks

Endangered species programmes commonly represent excellent opportunities for international collaboration, but at the same time they pose considerable challenges for all involved parties (Foster 1993). Some of the failures in conservation programmes can be traced to breakdowns in collaborations and understanding between extranational scientists/conservationists (mostly with good intentions and frequently also good data and good financial resources) and local scientists/conservationists (also with good intentions, but sometimes lacking technical expertise, and usually lacking financial resources). Differences in expectations and resources are commonly involved. Scientists and organisations from developed countries are often confronted with a highly-competitive publication-driven environment that to some extent demands priorities in actions that are not entirely focused on effective conservation actions. Scientists/conservationists in developing countries, who are commonly underpaid and over-committed to too many conservation projects, often have difficulty understanding why so much effort goes into scientific research, which is sometimes perceived as relatively trivial, compared with the needs for action based on intuitive appreciation of the nature of species' problems. Tensions can easily arise from basic conflicts over how much documentation is needed before actions should be initiated.

In addition, there are clearly cases where persuasive apostles of particular conservation approaches are able to convince local participants and colleagues that certain courses of action (e.g., alluring re-introduction programmes) are necessary conservation actions, when they may not be. Once these programmes are started, they may be self-perpetuating with little or no benefits for conservation. We believe strongly that the best safeguards against abuse lie in major efforts to achieve mutual understanding and respect among all parties and in maximising participation by diverse points of view in recovery efforts. In any conservation programme there should always be an open forum for discussion of potential strategies that involves all interested parties and a process of consensus development based on reasoned argument and the best data available.