

Raptor Studies in Madagascar's Rain Forest

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The Peregrine Fund's Madagascar Project comprises two major components: 1) studies and management of the endangered Madagascar Fish Eagle *Haliaeetus vociferoides* along Madagascar's west coast, and 2) studies of tropical rain forest raptors on the Masoala Peninsula in north-eastern Madagascar. The objective of the rain forest raptor studies is to develop the use of raptors as tools and indicators for resource management, monitoring and conservation, and to answer significant scientific questions about the biology and ecology of raptors. Studies are of two broad types: i) autecological studies that provide an understanding of spatial, habitat, and other resource requirements, and ii) raptor community monitoring that provides an understanding of species composition and relative abundance in relation to rain forest degradation from virtually pristine through degraded and second growth (*savoka*). The rationale for using raptors as a conservation tool, the methods used and progress to date will be presented.

INTRODUCTION

Madagascar

Madagascar, the fourth largest island in the world (587,044 km²), is unusual for the high degree of endemism that exists among its flora and fauna (Guillaumet 1984). Once attached to Africa, Madagascar has been separated for about 160 million years (Rabinowitz *et al.* 1983), an isolation that has contributed to the evolution of many species unique to the island. Many of the endemic species are dependent on forests that, until recently, covered extensive parts of the island. Now less than 20% of the island is forested and only 4.4% is primary growth (FAO 1981) suitable for survival of the majority of endemic species. Slash and burn cultivation of "dry-land" rice, annual grassland burning and charcoal production are the main causes of deforestation countrywide (Jolly & Jolly 1984). Political and social isolation from the West during the 1960s and '70s contributed to environmental degradation through impoverishment of economic and human resources.

Recognizing these problems, in 1988 Madagascar developed its *Environmental Action Plan* with four major goals: develop human resources, conserve biodiversity, develop sustainable resource use and improve standard of living. The Peregrine Fund's unique organisational abilities and highly focused approach will contribute significantly to this. We will assist development of human resources, at the same time helping to conserve biodiversity and contribute to sustainable resource use as follows.

Focus on raptors

As predators, raptors may be some of the most biologically significant and sensitive indicators of the health of the forest (Robinson & Wilcove 1989). Predators are believed to be key elements in the maintenance of equilibria in tropical communities where predation pressure is one of the fundamental determinants of population structure, life history traits and demography (Taylor 1984; Wilcove 1985; Smythe 1987; Greene 1988; Terborgh 1988). Tropical raptors usually exist at low density and are widely dispersed, have low reproductive rates and are sensitive to disturbance and habitat fragmentation. Maintaining viable populations of raptors should insure the survival of the entire ecosystem and provide the justification for the size and location of parks and reserves (Thiollay 1989). Their place at the top of the food chain makes the study of raptor ecology suitable for understanding the forest ecosystem and all that affects it, which makes these birds ideal subjects for training field biologists, resource personnel and students. As spectacular examples of the diversity of fauna, we have found that raptors provide excellent tools for instruction of the public and for generating public support for forest conservation. For example, the direct and indirect impact of deforestation on the Madagascar Fish Eagle is similar to the impact on humans and provides a sobering illustration of the future for humans in Madagascar. Not only do Fish Eagles lose essential nesting habitat as deforestation occurs along lakes, rivers and coastlines, but deforestation in watersheds hundreds of kilometres away leads to high sediment loads and degradation of the rivers and lakes on which the species depends for food.

Fourteen raptor species inhabit Madagascar, eight are endemic, all are seen rarely, and **three are considered among the most endangered raptors in the world** (Langrand & Meyburg 1984). The Madagascar Fish Eagle has been reduced to fewer than 50 known pairs, and its range is limited to the central- to north-west coast where it does not benefit from habitat protection (Langrand 1987; Langrand & Meyburg 1989). The Madagascar Serpent Eagle *Eutriorchis astur* and the Madagascar Red Owl *Tyto soumagnei* inhabit eastern rain forests. The latter has not been seen for over 30 years (Jenkins 1987) but there is recent evidence that the Serpent Eagle may still exist (Langrand, pers. comm.; Safford & Duckworth 1990; Sheldon & Duckworth 1990). If these two species still exist, they benefit from some protection because parts of their former range are within reserves. Nothing is known of their ecological requirements, to determine whether existing reserves are large enough to maintain viable populations. The status of the remaining forest species is: Banded Kestrel *Falco zoniventris* - very rare; Madagascar Cuckoo Falcon *Aviceda madagascariensis* - not known; Bat Hawk *Machaeramphus alcinus* - seen rarely; Madagascar Sparrowhawk *Accipiter madagascariensis* - seen rarely and poorly known; Henst's Goshawk *Accipiter henstii* - very rare.

GOALS AND OBJECTIVES

The Peregrine Fund Programme in Madagascar

Working in co-operation with local organisations and individuals we can apply much of what we have learned in Central America and around the world. Using a similar plan and focusing on raptors, we can achieve the following programme:

1) Support and provide training for Malagasy conservation personnel and students:

Education in conservation biology, wildland management, and related areas are essential for scientists and natural resource managers (Ehrenfield 1989). We are providing a hands-on training programme modelled on our Central American Maya Project, that includes:

- (i) field training of local NGO or government agency (e.g. *Direction des Eaux et Forêts*) personnel with limited formal education to collect information and monitor resources;
- (ii) undergraduate and technical training in co-operation with the University system of Madagascar. Trained personnel will contribute to the training of others and/or fill low- to high-level governmental and non-governmental posts as the present staff retires and conservation efforts are expanded;
- (iii) awareness education of the local populace in co-operation with the zoo (*Parc Botanique et Zoologique de Tsimbazaza*), parks (e.g. forest stations such as Ivalouine

or the new Ranomafana National Park), NGOs (e.g. WWF, Conservation International, Madagascar Faunal Group and others), and focal communities near target conservation areas (currently Masoala Peninsula and Lake Ankerika complex).

2) Conservation of tropical forest and other ecosystems:

We are providing the expertise and supervision to train Malagasy biologists, students and conservation personnel, as well as resources necessary to initiate and continue the project:

Environmental monitoring involves measuring ecological parameters to detect change, establish its direction and measure its extent or intensity, in order to determine compliance with an *a priori* standard, or deviation from an expected norm. Monitoring in forest conservation areas aims to serve as an early warning of significant change. In complex habitats or extensive sites, the behaviour and responses of a single component of the ecosystem must serve as an indicator of the community as a whole. The presence of group of species commonly found together has considerable value for assessing habitat or environmental quality when their indicator value is known (Goldsmith 1991).

Raptors are one such group which may be used to derive quantitative measures, such as diversity (distribution of numbers or biomass between species), or production (a dynamic measure defined in total biomass per unit time) that indicate ecosystem type, quality and change. Such parameters are the nearest approach to the ideal single key measure for monitoring. For most groups of organisms, such measurements are demanding of human resources. We are developing methods to make these measurements on tropical forest raptors in Central America that are low-cost, low-technology and reliable. Census methods include acoustic luring with recorded vocalisations, point counts from emergent trees or other prominent vantage points, and foot surveys (Whitacre *et al.* 1991). Results provide a description of habitat and species composition, and raptor species distribution and relative abundance. As the area and types of habitat surveyed (primary and modified forest) are expanded, we will learn what species can be expected and at what relative abundance under various habitat and environmental conditions. We are testing the same methods in the eastern rain forests of Madagascar, will modify them as necessary, and apply them in conjunction with Integrated Conservation and Development Programmes (ICDP) being tested in Madagascar.

ICDPs are based on the premise that conservation of biodiversity arises from the ability of sustainable development successfully to relieve human pressure on natural areas. In contrast, success at sustainable development is not dependent on conservation of biodiversity, and implementation of development techniques does not necessarily lessen human impacts on natural areas if these techniques also increase human population size (Kremen *in press*). Continuous monitoring of both the development and conservation aspects of ICDP is needed to evaluate and test the hypotheses. Monitoring provides feedback that allows changes to be made in ICDP methods to cope better with dynamic changes in the human population and its resource use, as well as changes caused by human disturbance in the natural processes of the conservation area.

3) Develop use of resource requirements of raptors as indices for reserve design and management:

From autecological studies we are collecting biological and ecological information on forest raptors, including home range and territory size, habitat utilization, reproductive rates, turnover rates and behaviour (e.g. Berkelmann, *this volume*). We will determine population dynamics and resource requirements for species' survival and the effects of ecosystem changes on species and their associated community.

From species-specific studies we can estimate the number of breeding pairs and the area and quality of forest needed to sustain populations of raptors. Thus size of parks or reserves can be, in part, based on and justified by these data, with raptors serving as the standard for the entire ecosystem. Recommendations will be made to the *Direction des Eaux et Forêts* as data become available to determine whether the size, locality and quality of existing and planned reserves are sufficient to sustain viable raptor populations.

Using data from species-specific studies and community monitoring we can define ways in

which forests can be managed to preserve raptor populations and their associated biotic communities. As larger areas of forest are protected more stringently, demands for some economic gain will increase. As we learn more about tropical raptors, recommendations will be developed on how forests can be managed for gain while preserving bio-diversity. Information will be published as data become available and we will work directly with local government and non-government agencies to develop sustainable resource utilisation, using raptors as a monitoring tool.

4) Identify priority areas:

We are identifying ecologically unique or special areas (high species diversity, high population density, or areas that support species with very limited distribution) of critical importance for protection. Predators are excellent indicators: typically, when predators are present in high densities this indicates that unique environmental conditions exist. Surveys for raptors and habitats will detect such areas for conservation. We will work with the USAID-funded Biodiversity Planning Service systematically to survey Madagascar for raptors and make recommendations to *Direction des Eaux et Forêts* as data become available.

5) Conserve biodiversity by preventing the extinction of raptor species:

We are providing expertise and supervision to train Malagasy personnel, as well as resources necessary to initiate and continue an endangered species management programme, including techniques such as the captive breeding and release that we have successfully used with 21 other species of eagles, hawks, falcons and owls. This will be accomplished in co-operation with the *Direction des Eaux et Forêts* and *Association Nationale pour la Gestion des Aires Protégées* (ANGAP) for those species threatened with extinction, initially the Madagascar Fish Eagle.

METHODS AND PROGRESS

Train Malagasy personnel

The success of any conservation programme is dependent on human resources that allow long-term sustainability. The aim of The Peregrine Fund programme is to develop the local human resources accordingly. Malagasy personnel are receiving training as the project progresses and form a core team of field biologists capable of collecting the data needed, as well as of training other field biologists. Three Malagasy have been trained in the first year, five will be trained in the second, and eight in the third to fifth years. In addition, two students from the University of Antananarivo are participating in the training and studies, so that these future administrators will have an understanding of the need and value of ecological monitoring.

Rain forest conservation and raptor research on Masoala Peninsula

The Masoala Peninsula, on the north-east coast of Madagascar, supports the last remaining coastal rain forest, as well as untouched montane and sclerophyllus rain forest and fringing coral reefs. Masoala is currently not protected. About half of the peninsula remains in a pristine state because topography limits its agricultural value, but there are increasing signs of subsistence level exploitation from villages that fringe the coast and rivers of the peninsula. Much of the flatter eastern area is already dominated by slash and burn cultivation. As the human population doubles in the next 20 years, demands on this area will increase. A 300,000ha reserve is planned for the peninsula, and the peninsula is the object of one of the "Integrated Conservation and Development Programs" funded by U.S. Agency for International Development.

Working in co-operation with Missouri Botanical Garden and collaborating with The Xerces Society and Center for Conservation Biology, the Peregrine Fund's goals are to (1) survey for raptors on the Masoala Peninsula; (2) develop low-technology methods to use raptors as indicators of forest health; and (3) establish criteria needed for monitoring and management of protected forests.

Raptor community and habitat surveys

Working from our small field station, about 6km south of the village of Ambanizana at the mouth of the Andranobe River, we marked routes along water courses and ridges to penetrate the forest inland and ascend mountains to an altitude of just over 700m. From these routes we conducted raptor surveys, using point observations from emergent trees, acoustic luring and listening surveys (Whitacre *et al.* 1991). Each trail was surveyed a minimum of three times during the breeding season (September to February). Surveys lasted from one hour before dawn for five hours to optimize our ability to detect nocturnal, crepuscular and diurnal species. Point counts were also tested throughout the day from sunrise at 05h00 to dusk at 18h00.

1) Raptor census:

The Peregrine Fund developed the following raptor census protocol in Central America (Whitacre *et al.* 1991): Raptors are surveyed using a one-hour pre-dawn listening census, a four-hour visual (point count) census from a canopy emergent viewpoint, and an acoustic luring census along a 1km transect starting at the point count site. Point counts consistently view an arc of 120 degrees, the orientation of which is designated for each viewpoint to allow a 1km uninterrupted view. All raptors sighted within 1km (area of 1,047 km²) are recorded in five minute intervals (a perching bird being recorded every five minutes), and their position in the survey are described, using a grid system. No two observation arcs overlap. To improve statistical independence of counts, points are spaced to maximize distance between them, within the constraints of accessibility. The number of observation points used are limited by the number of personnel available, accessibility and time available during the breeding period. Ten points have been set up and used repeatedly on Masoala, and another ten will be established in the next season's work.

Initial results from January and February 1992 (Table 1) show that observations made in the early morning reveal highest numbers of species (6), but a lower rate of observation of individuals (0.67 birds per hour). When this season's data collection is complete in May 1992, results will be used to modify methods to maximize counts of species and individuals.

2) Vegetation analysis:

The use of raptors for environmental monitoring is dependent on understanding the relation between raptor population and community parameters and habitat modification. Quantitative analysis of habitat (mainly vegetation physiognomy) has been developed by The Peregrine Fund (Whitacre *et al.* 1991) as follows. To maximize capture of heterogeneity within the vegetation of the point count arc, data are collected along a 1km linear transect centred through the arc from the observation point to the arc's perimeter. Data are collected using two methods, (i) point-quarter sampling at 20 sites located at 80 and 100m, 180 and 200m etc. from the observation point, and (ii) 1.5m x 20m transect sampling between point-quarter sites.

Point-quarter sampling measures canopy density, ground aspect and slope, density of grasses/sedges within 3m of point, mean canopy height in 5m classes, canopy height above the point, height of tallest tree within 30m, human disturbances in four classes, nature of human disturbance, diameter at breast height (dbh) and distance from point of nearest tree of > 10cm dbh in each quarter around the point, tree species name, and topographic positions (flat, slope, hilltop, hill foot, valley).

Transect sampling measures ground cover density from 25 presence/absence samples, number of tree-fall gaps intersected, length and width of tree-fall gaps, number and height of woody plants in 5dbh classes up to > 10cm dbh, number of vines in 5 dbh classes, and number of dead, hanging vegetation in 5 dbh classes.

Multivariate analysis will be applied to all data collected in both pristine and modified forest over the three-year study period to identify key features of the raptor community that are suitable parameters for monitoring ecological change. Criteria for monitoring and management of protected forests will be based on natural variance of this parameter found in pristine forest and established after the first three-year period, but as long-term data are collected and analyzed, criteria will be reviewed and changed if necessary.

Table 1. Number of individuals of each species seen in three time periods during the day during January and February 1992.

Species	Time of day		
	05h00 - 10h00	10h00 - 14h00	14h00 - 18h00
<i>Buteo brachypterus</i>	29	25	15
<i>Polyboroides radiatus</i>	6	12	2
<i>Accipiter francesii</i>	2	0	1
<i>Falco newtoni</i>	0	0	1
<i>Falco zoniventris</i>	1	0	0
<i>Falco concolor</i>	1	2	0
<i>Asio madagascariensis</i>	1	0	0
Number of observation hours	60	30	32
Number of birds seen per hour	0.67	1.30	0.59

Species Specific Studies

The Madagascar Buzzard *Buteo brachypterus* was chosen as the first species to study because it is one of the larger, more common species inhabiting rain forest and other habitats in Madagascar (Berkelman, *this volume*). Studies will provide information on spatial and habitat resources needed by this species, that can be used as a first step towards developing the use of raptors as indices for reserve design and management.

IDENTIFICATION OF CRITICAL SITES

1) Ambatovaky

Ambatovaky Special Reserve (49°04' - 49°25'E and 16°57' - 16°36'S) is the largest Special Reserve in the country, consisting of 60,050ha primary lowland rain forest, moist montane forest and some slash-and-burn cultivation. It is of special value because it is the only area to have recent (1989) tangible evidence of the endangered Madagascar Serpent Eagle (Langrand *pers. comm.*) in the form of a fresh skull of the species. Ambatovaky is also known to sustain six threatened and five near-threatened bird species, and about 50 endemic forest dependent birds, making it one of the most important rain forests in Madagascar. Although a Réserve Spéciale, Ambatovaky's protected status is not enforced. Much of the southern boundary has been cleared for tavy (slash and burn cultivation); Iampirano village is within the reserve, and in this area tavy extends up to 8km inside the reserve (Raxworthy *et al.* 1990). Ambatovaky may benefit from an integrated development and conservation programme such as those now funded by USAID. The Peregrine Fund has the knowledge and expertise to collect baseline data, evaluate and monitor a programme for conservation of biodiversity. We are planning to work as partners with a development organisation to plan and carry out a conservation programme that incorporates local inhabitants.

2) Lake Ankerika Complex

The Antsalova district on the west coast of Madagascar, due west of the capital, Antananarivo, was identified in 1970 at the International Conference on the conservation of Nature (Resolution

No. 8, Langrand & Meyburg 1984) as an area in need of protection because of its importance for many water birds including the endangered Madagascar Fish Eagle and Madagascar Teal *Anas bernieri*. Despite efforts to include it as a world Heritage Area under the UNESCO programme, it is not listed as such (Thorsell, *pers. comm.*) and currently is not protected. We will work with the UNDP in Madagascar to develop sustainable protection of this area.

SUPPORT FOR SPECIES SURVIVAL

Madagascar Fish Eagle

The Madagascar Fish Eagle (also known as the Madagascar Sea Eagle) is listed as an endangered species (Collar & Stuart 1985), and is considered one of the rarest birds of prey in the world (Meyburg 1986). A population survey in 1985 estimated the entire breeding population to be 45 to 50 pairs, patchily distributed along the central- to north-west coast of Madagascar (Langrand & Meyburg 1989). None of the known pairs are nesting in protected areas. Causes of population decline are thought to be deforestation, silting of water, and shooting, the latter largely due to unawareness of the species' plight. The small population size and clumped distribution of the species has left it vulnerable to extinction from random catastrophic events, such as hurricane or serious disease epidemic.

One goal of The Peregrine Fund's project is to prevent the extinction of the Madagascar Fish Eagle by increasing the species' distribution and abundance, ensuring that a significant number of birds nest in protected areas and increasing public understanding about the need to protect the species and conserve its nesting and foraging habitat. The first objective will be achieved through species management, such as captive breeding and release techniques; the second will be achieved by working with the UN Development Programme to establish a protected area in the Antsalova region incorporating the Lake Ankerika complex. Objective three will be achieved through public education.

Little is known about the species' ecology. Before appropriate management can be planned, we need a basic understanding of its behaviour, breeding biology, population dynamics and factors affecting these. We can then identify ways to increase the species' distribution and abundance. While management can be based on some minimal information about behaviour and breeding biology, understanding its effects requires more detailed, long-term information. We will census the species' population to determine if it has changed in the seven years since the last estimate. In doing so, we will establish baseline data using standardized methods that will be used to monitor the population and evaluate the success of our management programme. Research was begun in 1991 and will provide the data needed by the end of 1992.

CONCLUSION

The Peregrine Fund's programme in Madagascar started in 1991 to contribute to Madagascar's *Environmental Action Plan* by using birds of prey as a focus for conservation. We are developing local human resources by training Malagasy personnel. We are conducting species specific studies that will help develop the use of raptors as indicators for reserve design and management. We are doing raptor community and habitat surveys on Masoala Peninsula to develop use of raptor community and population parameters for monitoring conservation management. We are doing studies to design and initiate an endangered raptor management programme, focusing first on the Madagascar Fish Eagle.

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