STATUS AND CONSERVATION OF THE *VINI* LORIKEETS OF FRENCH POLYNESIA





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EXECUTIVE SUMMARY

Owing to their naturally small population sizes, susceptibility to environmental changes and introduced species and contracting populations all three Vini *lorikeets that occur in French Polynesia are threatened with extinction. The decline in numbers and contraction of each species range has closely paralleled the spread black rats to islands across the Pacific. Black rats, as nest predators, are considered the main threat to the survival of the genus.*

This study is the second of two pilot studies aiming to assess the status and conservation requirements for Vini lorikeets in French Polynesia. The first was conducted in 2002 focussing on the ultramarine lorikeet in the Marquesas Islands. The general aims of the present study were to establish the status and examine threats and conservation actions required for protecting the blue lorikeet in the region and to assess preliminary efforts introduced to protect the ultramarine lorikeet in 2002.

A review of the literature and recent records revealed that the blue lorikeet is now found on only 9 of up to 26 islands it was known to occur on at the time of European discovery of the region. Eight of these islands are located in French Polynesia. Surveys in the Tuamotu archipelago revealed that populations are relatively robust, though fragmented, on at least 4 of the 5 atolls it occurs on. We estimate population sizes on each of the five atolls as follows: Apataki 1258 (±351), Arutua 2546 (±485), Kaukura 778 (±157), Rangiroa 1249 (±173) and Tikehau 49 (±24), resulting in a total population estimate for the Tuamotu of 5879 (±643). Comparisons of past to present estimates suggest that at least some of these populations have contracted. Incorporating estimates from the four other islands the species occurs on, a global population estimate for the species ranges between 7186-9022. Analogous assessments of black rat presence/absence on the islets of each atoll in the Tuamotu revealed that lorikeet abundance and presence was closely related to absence of rats.

In the Marquesas Islands, our aims were to confirm the continued black rat-free status of Ua Huka, re-survey the ultramarine lorikeet populations on Ua Huka and Ua Pou, assess the efficacy of nest boxes and rat control efforts introduced in 2002, and scope the potential for more intensive and continued conservation efforts for the species in the future.

This preliminary study, in conjunction with the 2002 study, provides a solid foundation for planning and prioritising future research and conservation work for the Vini lorikeets in French Polynesia. Preventing the establishment of rats on islands where lorikeets occur is the highest conservation priority for all species. In addition, consideration should be given to translocation of populations, particularly the Ultramarine lorikeet, to rat-free islands, and where feasible eradicating rats from islands. Further research to examine the relationships of rats and lorikeets in the Tuamotu atolls may yield useful information that may guide in situ *conservation efforts for all Vini lorikeets and other, similarly threatened birds in the Pacific.*

RÉSUMÉ EXÉCUTIF

En raison de la taille naturellement petite de leurs populations, de leur hypersensibilité aux changements environnementaux et aux espéces introduites, les trois lori de genre Vini *qui se trouvent en Polynésie française sont menaces d'extinction. Le déclin en nombre et la reduction de la répartition de chaque espèce à suivi en parallèle la progression des rats noirs dans les îles du Pacifique. Les rats noirs, en tant que prédateurs des nids, sont considérés comme la menace principale a la survie des loris.*

Cette étude est la seconde de deux études pilote qui visent a évaleur la situation et les besoins en conservation pour les Vini en Polynésie française . La premiere a été menèe en 2002 et s'est concentré sur le lori ultramarin dans les iles Marquises. Les objectifs généraux de la présente étude etaient d'établir la situation et d'examiner les menaces et les actions de préservation nécessaires pour protéger le lori nonnette dans la région et évaleur les efforts préalables mis en place en 2002 pour protéger les lori ultramarin.

Un examen de la literature et des récentes données a révéle que le lori nonnette ne se trouve plus maintenant que sur 9 des 26 îles sur lesquelles il est connu qu'il se trouvait au moment de la découverte européenne de la région. Des études dans l'archipel de Tuamotu ont révéle que les populations sont relativement robustes, bien que fragmentees, sur au moins 4 des 5 atolls sur lesquels on en trouve. Nous estimons la taille relative des populations sur chacun des 5 atolls comme suit: Apataki 1258 (±351), Arutua 2546 (±485), Kaukura 778 (±157), Rangiroa 1249 (±173) et Tikehau 49 (±24), atteignant une population totale estimée à 5879 (±643) pour Tuamotu. Des comparaisons entre les présentes estimations et des informations du passé suggerent que la plupart de ces populations se sont réduites. En intégrant les estimations provenant des 4 autres îles sur lesquelles l'éspece est connue, une estimation globale de la population pour ces éspeces atteint entre 7186-9022. Cependant, nous précisions que cette estimation globale est base sur des estimations quelque peu perimées, ce qui requére un certain degré de prudence au moment de l'interprétation. Des évaluations analogues de l'absence/presence du rat noir dans les îlots de chaque atoll a révéle que l'abondance et la presence de lori etaient directement liées a l'absence de rats.

Dans les îles Marquises, nos objectifs etaient de confirmir la situation sans rats de Ua Huka, de ré-étudier les populations de lori ultramarins sur Ua Huka et Ua Pou, d'évaluer l'éfficacite des nids artificiels et des mesures de controle des rats introduites en 2002, et de repérer le potential pour des efforts de conservation plus intensifs et continus pour ces espèces dans le futur.

Cette etude préalable, en conjonction avec l'etude de 2002, fournit une base solide pour la planification et la prioritisation des recherches futures et du travail de conservation pour les lori en Polynésie française . Prévenir l'establissement des rats sur les îles ou les les lori se trouvent est la priorité de conservation la plus importante pour toutes les espèces. De plus, il faudrait considérer la translocation des populations, particulièrement du lori ultramarin, sur des îles sans rats, et ou c'est possible, l'eradication des rats sur les îles. Une recherche supplméntaire pour examiner les relations entre les rats et les lori dans les atolls de Tuamotu porrait fournir de l'information utile qui pourrait guider les efforts de conservation in situ *pour tous les Vini et autres oiseaux du Pacifique menaces pareillement.*

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Photos front cover: (L-R) Taeoo motu, Rangiroa (M.Ziembicki), blue lorikeet (G.McCormack), Papaoa motu, Kaukura (M.Ziembicki), ultramarine lorikeet (P.Odekerken), Ua Pou landscape (P.Ehrel)

ACRONYMS

SOP – Société d'Ornithologie de Polynésie
CITES – Convention on International Trade of Endangered Species
IUCN – International Union for the Conservation of Nature
WSSE – Whitney South Seas Expedition

CITATION & CONTACT DETAILS

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INTRODUCTION

Of the five existing species of *Vini* lorikeets in the South Pacific four are considered endangered or vulnerable to extinction (IUCN 2006). Two other species, *Vini sinotoi* and *V. vidivici*, have become extinct since human occupation of the region began (Steadman 1989). The susceptibility of *Vini* lorikeets is a function of their naturally small population sizes, their confinement to islands that may be subject to rapid environmental changes and their vulnerability to introduced predators or competitors of continental origin.

All three species in French Polynesia are threatened. The threats they face are familiar and include habitat loss and alteration, hunting and collection for the pet trade and the effects of introduced species (Steadman 1989; Seitre and Seitre 1992; McCormack and Kuenzle 1996; Ziembicki and Raust 2003). Black Rats *Rattus rattus* in particular, through nest predation and competition, have decimated populations of various birds on islands throughout the Pacific and beyond (Atkinson 1985; Hay 1986; Seitre and Seitre 1992). Rats are considered a principal threat to *Vini* populations and their decline has closely paralleled the spread of rats across the lorikeets' ranges (Seitre & Seitre 1992; Ziembicki & Raust 2003).

This study focuses on two species: the blue lorikeet *Vini peruviana* of the Tuamotu and Society archipelagos and the ultramarine lorikeet *Vini ultramarina* of the Marquesas Islands. The blue lorikeet was formerly widespread in the Tuamotu and Society Islands but has disappeared from most of the islands it was recorded from in the past (Holyoak and Thibault 1984). Accordingly, it is listed as Vulnerable and on CITES Appendix II (IUCN 2006). Current information for the species is either out-dated (the most up-to-date information for many islands dates back to the 1970s) or is incomplete given that some islands have never been surveyed at all (Juniper and Parr 1998; Wilson 2000; BirdLife International 2006). Including a population on Aitutaki in the Cook Islands, to where it may have been introduced, total global population estimates for the species range broadly between 2500-9,999, reflecting the poor knowledge of the species' status (Birdlife International 2006). Similarly, there have been no detailed studies of the blue lorikeet and its biology remains poorly known. In this study, we focus on surveying populations in the Tuamotu archipelago and opportunistically collect information on the species foraging and nesting preferences. Additionally, we identify and propose required actions for the species conservation and further research.

The Ultramarine lorikeet is one of the most threatened of lorikeets and considered of high conservation priority both regionally (Sherley 2001) and internationally (Wilson 2000). It is represented by one population on the small island of Ua Huka and populations on the verge of local extinction on two other islands (Ziembicki and Raust 2003; Ziembicki et al. 2003). In 2002, the first stage in a conservation and research project for the species was initiated aiming to assess its status, study its basic ecology and trial preliminary measures aimed at its conservation (Ziembicki & Raust 2003). The present study aims to build on this work by assessing the progress of these efforts, collecting further ecological data for the species and investigating potential for implementing conservation actions on a larger scale.

The third *Vini* lorikeet found in French Polynesia is Kuhl's Lorikeet *Vini kuhlii*, though it is not an explicit focus of this report. The species occurs on Rimatara in the Austral Islands, and three islands in the Line Islands of Kiribati (Teraina, Tabuaeran and Kiritimati). It was formerly more widely distributed and included populations in the Cook Islands (Watling 1995; McCormack and Kuenzle 1996). The population on Rimatara numbering approximately 900 individuals is

believed to be stable (McCormack and Kuenzle 1996; Blanvillain 2002). While Rimatara is currently considered black rat-free, increased traffic to the island may make the island more susceptible to invasion. To safeguard the species in the region a translocation project planned from Rimatara to Atiu in the Cook Islands is due to take place in 2007.

OBJECTIVES

This project represents the second of two pilot studies aiming to collate information regarding the status and conservation requirements of the *Vini* lorikeets in the region. The first was conducted in 2002 focussing on the ultramarine lorikeet in the Marquesas Islands (see Ziembicki and Raust 2003). The overall objective of these projects was to develop a foundation for developing longer term, larger-scale conservation programs for the *Vini* genus in French Polynesia and beyond.

The specific aims of this project were to:

1. collate all published and unpublished data regarding the blue lorikeet's current and historic distribution including information on the state of the natural history of its islands,

2. determine the current status and distribution of blue lorikeet populations within the Tuamotu and Society islands,

3. document the current distribution and degree of threat posed by black rats on each of the islands within the blue and ultramarine lorikeets' range,

4. collate information on habitat use and ecology by the blue lorikeet with particular emphasis on nesting and feeding requirements,

5. assess the feasibility of future translocation programs for both *Vini* species within their historic ranges,

6. assess the feasibility of rat control programs on islands within the Tuamotu archipelago,

7. introduce permanent facilities for minimising the establishment of rats on the island of Ua Huka and assess the feasibility of introducing such measures on other un-infested islands in the region,

8. assess the effectiveness of preliminary conservation efforts trialled for the ultramarine lorikeet in the past, and,

9. raise awareness among local island communities of the status of lorikeet populations and issues relating to introduction of alien species.

PROJECT SITES

The study focussed on islands in the northern Tuamotu archipelago and the Marquesas Islands of French Polynesia (Figure 1).

Tuamotu archipelago

The Tuamotu archipelago consists of 76 coral atolls and islands spread over more than 1800 kilometres making it the largest chain of atolls in the world. The total land area is about 885 km^2 with elevations ranging from the usual 1 to 2 m to 5 or 6 m. Individual atolls generally consist of lagoons surrounded by varying numbers and sizes of motu*. The substrates of these atolls primarily comprise loose coral sand and gravel that are low in nutrients resulting in relatively low floral diversity and a certain uniformity of vegetation. The majority of motu on inhabited atolls, including those surveyed in this study, have been extensively altered and planted with coconut palms *Cocus nucifera*.

Our objectives in the Tuamotus were to assess the status and distribution of blue lorikeet populations, concentrating on five atolls where the species was known to occur in the past but population estimates were not available or out-of-date. Surveyed atolls included Apataki, Arutua, Kaukura, Rangiroa and Tikehau in the northern Tuamotu (Figure 2). We aimed to visit as many motu on each atoll as possible given time and logistical constraints. However, where not all motu on each atoll could be visited those with favourable habitat and those surrounding core lorikeet areas were surveyed preferentially.

Logistical constraints precluded surveys of the three islands in the western Society group where blue lorikeets are known to occur, namely, Motu One (Bellinghausen), Manuae (Scilly) and Mopelia.

Marquesas Islands

Our efforts in the Marquesas Islands were concentrated on the islands of Ua Huka and Ua Pou (Figure 3). Ua Huka is characterised by a variety of habitats including dry woodland and shrublands, hibiscus forests, high elevation cloudforests, and mixed coconut and banana plantations and other introduced plant species (Meyer 1996). In contrast to other inhabited islands, the island has no direct docking facilities for vessels and, perhaps somewhat fortuitously, no blacks rats. Consequently, the island accommodates the only robust population of the ultramarine lorikeet (Ziembicki & Raust 2003).

Ua Pou is characterised by ridges covered in rainforest and native forest radiating out from the island's centre. In the populated valleys are numerous plantations of cultivated food plants while the lower slopes of the island are largely bare due to introduced herbivores or covered in thickets of *Leucaena leucocephala*. The island has a wharf and rats are believed to have become established on the island in the early-mid 1980s. Its lorikeet population has since declined drastically and is now on the verge of local extinction.

* Motu is the word for island in several Polynesian languages and is used here to refer to the small islets surrounding the lagoon of an atoll

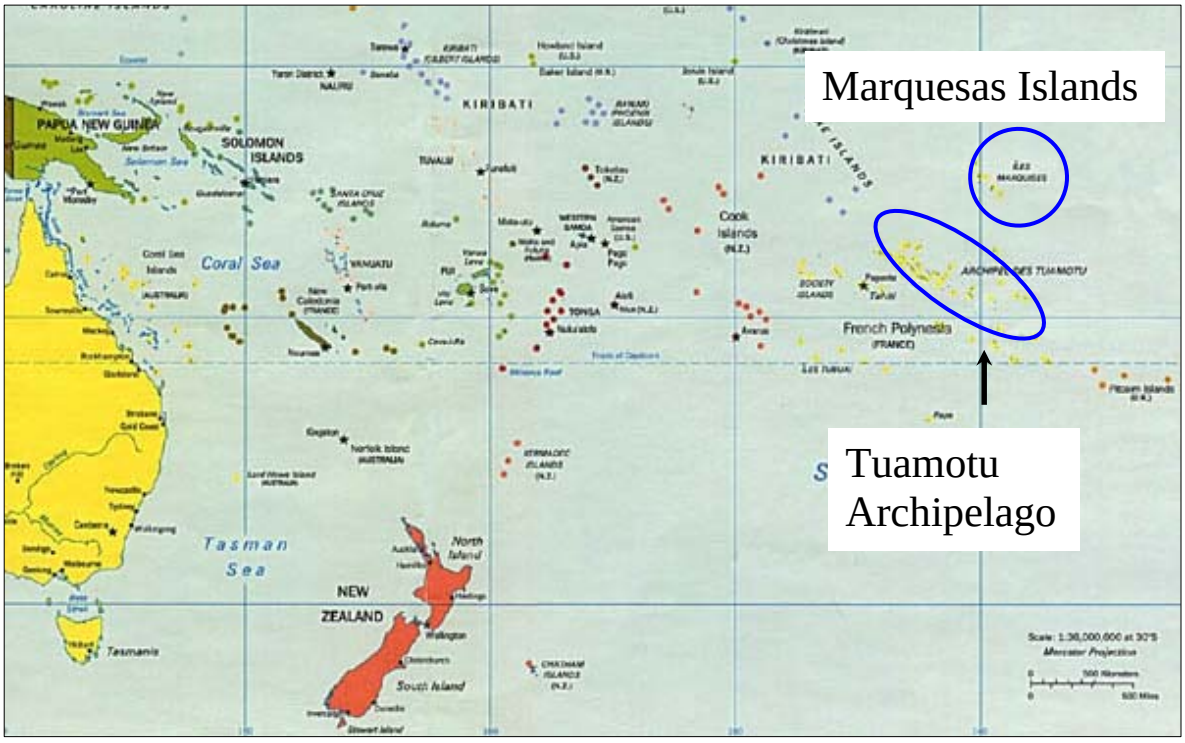

Figure 1: Location of the Marquesas Islands and the Tuamotu archipelago in the South Pacific.

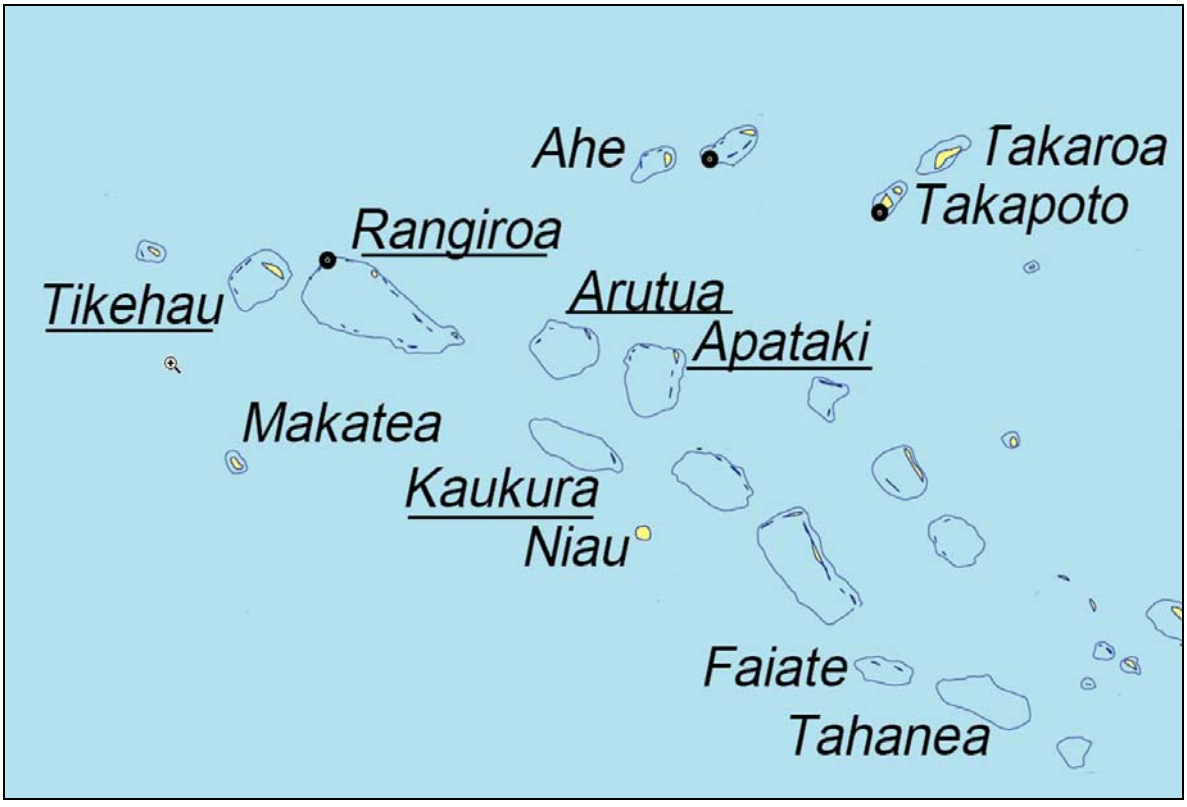

Figure 2: Tuamotu Islands mentioned in the text. Underlined atolls were surveyed during this study.

Figure 3: The main islands of the Marquesas archipelago, French Polynesia.

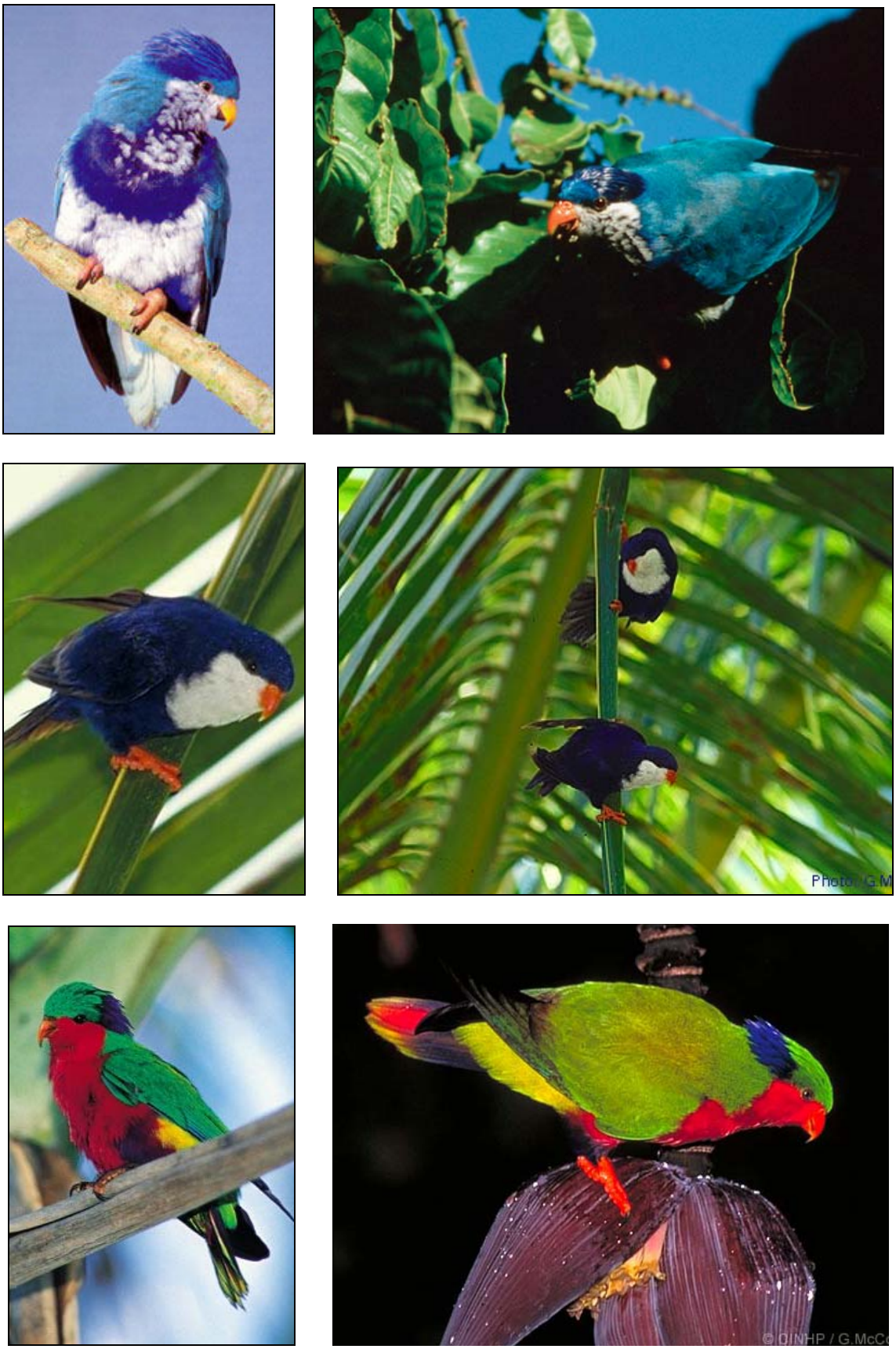

Figure 4: The Vini lorikeets of French Polynesia (from top): ultramarine lorikeet (photos: P.Odekerken – top left; T.Laman), blue lorikeet (G.McCormack), and Kuhl's Lorikeet (C.Blanvillian; G.McCormack – bottom right)

METHODS

Historical and contemporary records of *Vini peruviana* in the South Pacific

A literature search of published and unpublished sources was conducted to collate historical and contemporary records of *Vini peruviana* in French Polynesia. An aim was to determine where further survey work was required and to facilitate, as far as possible, a comparison of the current and former status and distribution of the species in the region and identify potential islands for future re-introduction and rat control programs.

Distribution and population estimates for *V. peruviana* in the Tuamotu

Survey protocol and population estimates

Point count distance surveys were used to estimate lorikeet densities on the five atolls surveyed in the Tuamotu archipelago following Marsden (1999). Blue lorikeets are active and vocal throughout the day hence surveys were conducted at any time of day, although the middle two hours of the day were usually avoided. Search effort was restricted to within 50m of the plot's centre and counts were conducted for 5 minutes at each station. The plot was then searched for up to a further 5 minutes to include birds that may have been undetected during the initial count. All birds that were perched or had been initially flushed from the plot by the observer were recorded and included in the analyses. The distance from the plot's central point to each lorikeet encounter was estimated to the nearest metre but for the purpose of analyses allocated to a 5 metre distance band afterwards. All visual and vocal records were combined for analyses. The distance between point count stati ons was at least 200 metres. Surveys were generally conducted by MZ, except on Tikehau and Rangiroa where PR conducted half of the surveys.

Point count surveys were assigned to three sampling categories; favourable and marginal habitat on motu without signs of black rats and favourable habitat on motu with rats. Favourable habitat generally consisted of coconut plantations or mixed forests with an open or closed canopy. Marginal habitat was dominated by scrub with or without only intermittent trees or coconut palms. An effort was made to consistently chose between the two distinct habitat types rather than ecotones between densely forested and open areas. Observations indicated that lorikeets were either absent or at such low densities in marginal habitat on motu infested with black rats that surveys in these areas were unlikely to yield sufficient information on lorikeet densities given time constraints. Accordingly, for the purposes of calculating overall population estimates, we assumed that there were no lorikeets in these habitats.

Survey data were analysed using the program Distance 5.01 (Thomas *et al.* 2005). Density estimates were derived separately for favourable habitat on each atoll but for marginal habitat and favourable habitat with rats counts were pooled across all motu from all five atolls because of low sample number to increase precision of estimates. Akaike's Information Criterion (AIC) was used to select a model for the detection function following trials with all key functions and series expansions. Population estimates were calculated by multiplying density estimates for each of the three sampling units by the total area of each habitat unit. Area of each habitat type was determined from IKONOS imagery for Arutua, Apataki and Kaukura using the ArcMap GIS software package. IKONOS imagery was unavailable for Rangiroa and Tikehau. Area of available habitat for these atolls was derived by calculating total area of motu occupied by lorikeets for each atoll from 1:50000 topographic maps. The relative area of marginal to favourable habitat for each atoll was assigned according to the mean proportion of each habitat

type occurring on the three other atolls for which IKONOS imagery was available (i.e., marginal habitat = 24.4%; favourable habitat = 75.6%).

Age structure and flock size

The proportion of adults to juveniles was recorded to assess the age structure of populations on Apataki, Rangiroa and Tikehau. Juveniles are distinguished from adults by uniformly greyish-black underparts except for slight white markings on the chin, black bill and dark brown legs. Only individuals that were definitively identified at relatively close range were included in estimates. This excluded a large proportion of general sightings. Flock sizes were recorded for all atolls.

Status and distribution of rats

Three rat species occur in French Polynesia, the Pacific rat *Rattus exulans*, the black rat *Rattus rattus* and the Norwegian rat *Rattus norvegicus.* Additionally, the introduced house mouse *Mus musculus* is common to many islands. Of these it is the black rat, on account of its aggressiveness, agility and arboreal nature, that is regarded the dominant threat to *Vini* populations as nest predators and competitors.

Tuamotu

The presence of rodents was determined as far as possible for each motu visited in the Tuamotu by trapping (using snap traps baited with grilled coconut and peanut butter), direct visual sightings, presence of characteristic signs (i.e., scats or eaten coconuts), interviews with locals and presence of tin-banded coconut palms (bands are used by locals to prevent black rats scaling palms to eat coconuts and are therefore a good indicator of their presence on a motu) (see figure 5). Time and logistical constraints limited opportunities to conduct detailed surveys of rats by trapping as would have been preferred. We acknowledge that some of these techniques may potentially lead to erroneous identifications and qualify our findings accordingly. The presence of eaten or partially eaten coconuts (Figure 6) was most commonly used as a surrogate indicator of black rat presence.

Marquesas

Our aims in the Marquesas Islands concerning rats were twofold: i) to determine whether black rats occur at higher altitudes on Ua Pou, and ii) to confirm the continued black rat-free status of Ua Huka. Snap traps were used at two sites along ridges in the vicinity of Pumaka Peak on Ua Pou at an elevation of approximately 600m over two nights (n = 12 traps per night). On Ua Huka trapping was concentrated in the village and valley of Vaipaee and signs of rats were searched for in the villages and valleys of Vaipaee and Hokatu, in the botanic gardens and the 'lotissement' housing development. Additionally, residents of all three villages and employees of the agriculture department were questioned about their knowledge of the presence of rats.

Figure 5: Farmers protect their coconut palms from black rats by placing metal bands around trunks

Figure 6: The presence of eaten or partially eaten coconuts is a sign of the presence of black rats.

Habitat associations, behaviour and food sources of the blue lorikeet

Habitat characteristics

Basic habitat characteristics were measured at each survey plot at the time of census. Tree density (trees per hectare) was calculated for each tree species using a circular plot method employing a Bitterlich gauge (Friedel and Chewings 1988). At each plot the percentage of shrub cover vegetation was estimated according to four categories (<25%, 25-50%, 50-75%, >75%). Mean tree height was estimated for an area of 20m radius from the plot's centre and the number of potential nest trees (i.e., trees with hollows) in the plot was counted.

Data analysis

The relationship between lorikeet abundance and habitat was investigated by generalised linear modelling in Statistica (Statsoft 2003). Number of lorikeets was used as the dependent variable. A list of explanatory variables used are presented in Table 1. Akaike's information criterion (AIC) was used to determine the best model. The best model was selected on the basis of low AIC score and parsimony (number of terms in the model).

Table 1: Original explanatory variables used in the Generalised linear model

Variable	Description
Tree species richness	Number of tree species in plot
Mean canopy height	Estimated for an area of radius 20m from centre of plot
# nest trees	Number of trees in plot with hollows potentially usable for nesting
% understory cover	Estimated proportion of plot covered by shrub layer to 3 metres in height (according to four categories: <25%, 25-50%, 50-75%, >75%)
TBA Coco	Total Basal Area of *Cocus nucifera*
TBA Kah	Total Basal Area of *Guettarda speciosa*
TBA Toh	Total Basal Area of *Tournefortia argentea*
TBA Pandanus	Total Basal Area of *Pandanus* sp.
TBA Cord	Total Basal Area of *Cordia subcordata*
TBA shrub	Total Basal Area of shrub species
TBA dead	Total Basal Area of *Pandanus*
TBA total	Total Basal Area of all trees/shrubs

Behaviour and food resources

We endeavoured to opportunistically collate as much extra information regarding the behaviour and food resources of the blue lorikeet. However, given time constraints our efforts were limited.

Identification of sites for lorikeet translocation and rat control programs

Franklin and Steadman (1991) suggest a framework for assessing potential translocation sites for birds in Polynesia based on the natural ranges of species (as determined from archaeological evidence), and habitat assessments, based on knowledge of a species habitat requirements. They also cite a preference for translocation to islands uninhabited by humans. Taking these factors into account, our assessments of locations for future translocation programs in the Marquesas and Tuamotu Islands also considered several other social and environmental prerequisites. Note however, that our knowledge of the detailed habitat requirements of *Vini* is limited and further knowledge of each lorikeet's biology is required to properly inform potential efforts.

Social considerations

- Local community interest and support
- Local capacity, including competent and committed leadership, or at least opportunity to build local capacity
- Access to funding, resources and technical expertise
- Uninhabited or area of limited use

Environmental considerations

- Black rat free status of island or at least potential for rat eradication
- Island/motu size
- Appropriate habitat and resources
- Configuration and connectedness of motu

Priority sites for rat control or eradication are those where such measures are practical and that will maximise benefit to lorikeet populations. Complete eradication of rats on islands other than motu on atolls is practically impossible within the historic ranges of *Vini* lorikeets. However, rat control measures on larger islands, although labour intensive, may limit the influence of rats in important areas.

RESULTS & PROJECT ACHIEVEMENTS

Historic and contemporary records of *Vini peruviana*.
Our review found that the blue lorikeet has been definitively recorded from 21 islands in the South Pacific since Europeans first arrived in the region (Table 2). If we accept additional, unverified records (i.e., reports from locals on the islands of Faaite and Tahanea) and the assumption that the species formerly occurred on all Society Islands (BirdLife International 2006), then the blue lorikeet occurred on up to 26 islands at the time of European arrival. Today, it is known from 9 islands (five in the Tuamotu archipelago, three in the western Society Islands and from Aitutaki in the Cook Islands).

Current status and distribution of blue lorikeet populations
Tuamotu archipelago
The distribution of blue lorikeets on each of the five atolls surveyed in the Tuamotu is illustrated in figures 7 to 11. Dates and time spent surveying motu on each atoll are presented in Table 3. On no atoll were lorikeets found on every motu, even where habitats were otherwise favourable. Their distribution on three out of five atolls was discontinuous, most notably on Rangiroa where the two populations are separated by over 80 kilometres. Population estimates indicated that Arutua had the highest overall population size, while Tikehau's population is the smallest and most restricted (Table 4).

The proportion of young to adult lorikeets and mean flock sizes are presented in Table 5.

Society Islands
A stated objective of this study was to assess the population status of lorikeets in the Society Islands. This was to include populations on the islands of Motu One (Bellinghausen), Manuae (Scilly) and Mopelia. However, due to the remoteness of the islands, absence of regular transport and expense of chartering a vessel we were unable to visit this region. Efforts will be made to secure funding to survey these islands in the future.

Total population estimates
Our overall total global population estimate (table 4) is based on the assumptions that populations on Manuae and Aitutaki have remained stable since they were last surveyed and that Holyoak and Thibault's (1984) assertion that, if population densities on Motu One are similar to those of Manuae, then the Motu One population numbers in the vicinity of 250 couples. There is no population estimate for Mopelia, though it is not likely to be large or comparable to that of the other two Society islands in the vicinity (Holyoak and Thibault 1984; Sanford 2000). Excluding Mopelia's population we estimate the Tuamotu atolls and French Polynesia on the whole accommodate approximately 69% and 87% of the world's population of the species respectively.

Rat status and distribution
Tuamotu
Black rats were found on all five atolls surveyed in the Tuamotu. Their distribution varied between atolls in terms of the proportion of motu occupied (Figures 7-11). Somewhat striking was the degree to which the presence of rats reflected an absence of lorikeets. In a small number of cases rats and lorikeets co-occurred. This was often on motu adjacent to rat-free motu where lorikeet numbers were high. In all instances of co-occurrence lorikeet abundance was significantly lower than on adjacent rat-free motu. Pacific rats were definitively trapped or observed on a small number of motu (indicated in Table 3). However, their distribution is

undoubtedly much more widespread than our observations suggest given the limited scope of the current surveys.

Marquesas Islands
We found no evidence of black rats on Ua Huka. Similarly, though based on very limited sampling, no black rats were found at high elevation on Ua Pou, despite their presence at lower elevations. Two Pacific rats were trapped at the site on Ua Pou.

Habitat use of the Blue lorikeet in the Tuamotu
Blue lorikeets were observed feeding on nectar from the flowers of *Cocos nucifera, Guettarda speciosa, Pemphis acidula, Suriana maritima, Morinda citrifolia, Tournefortia argentea, Scaevola* spp. and *Musa* sp. In addition, they have been recorded foraging on the ground and searching for insects among leaves (Juniper and Parr 1998). A single observation of lorikeets using a hollow on top of a coconut palm was observed on Motu Panao, Kaukura.

The best model to explain blue lorikeet abundance was 'Total basal area of *Cocus nucifera* + Total basal area of *Tournefortia argentea*.' This model has an AIC_c weight of 31% and explained 19.1% of the deviance. This was a positive relationship with bue lorikeet abundance increasing with density of mixed stands of coconut palms and *Tournefortia argentea*.

Table 2: Summary of historic and contemporary records for the blue lorikeet in the South Pacific.

ISLAND GROUP	ISLAND	RECORDS	MOST RECENT POPULATION ESTIMATES	REFERENCE
SOCIETY	MANUAE (SCILLY)	Specimens collected and nest found by the Whitney South Seas Expedition (WSSE) in 1921 [1,2]. An estimate of 350-400 pairs in 1973 [3]. None were seen in 2000 but only a few hours were spent on the island [4]	350-400 pairs in 1973[2]	[1] Amadon (1942) [2] Holyoak & Thibault (1984) [3] (Thibault 1974) [4] (Sanford 2000)
SOCIETY	MOTU ONE (BELLINGHAUSEN)	Holyoak & Thibault postulated that if the density of the species is the same as that on Manuae then there were would be in the vicinity of 250 couples on the island. However, they did not assess this population[1]. During a short visit in 2000, 15 were sighted on two small motu [2].	250 pairs in 1970s but a speculative estimate	[1] (Holyoak & Thibault 1984) [2] (Sanford 2000)
SOCIETY	MOPELIA (MAUPIHA'A)	The WSSE collected specimens in 1921[1]. Thibault did not record them in 1973 and believed them absent from this island during the 20thC [2]. However, Drissner noted 10 individuals on the main island and one on Motu Tavae in 1999 [3]. Sanford did not record any in 2000 but locals reported to him they had seen a few pairs in previous two years [4].	No estimate	[1] (Amadon 1942) [2] (Holyoak & Thibault 1984) [3] (Drissner 1999) [4] (Sanford 2000)
SOCIETY	TAHITI	Discovered by Commerson on 1767-1769 voyage. Painted by artists during Cook's three voyages to Tahiti. Probably extinct before 1900 because not seen by Seale 1902 or Wilson 1904 [1] or since.	Extinct	[1] (Holyoak & Thibault 1984)
SOCIETY	BORA BORA	The explorer/naturalist Andrew Garrett collected specimens in the 19th C [1]. Townsend & Wetmore observed the species in 1899 [2]. Wilson collected specimens in 1904 [3]. The species was noted by the WSSE in 1922 [4]. Holyoak & Thibault suggest the species became locally extinct around 1930 as a result of introduction of *Circus approximans*, but this reason is questioned (see discussion)[4].	Extinct	[1] (Holyoak & Thibault 1984) [2] (Townsend and Wetmore 1919) [3] (Wilson 1907) [4] (Holyoak & Thibault 1984)
SOCIETY	HUAHINE	Gould had an old specimen in his collection from Huahine. Garrett estimates the species disappeared ca.1874 [1]	Extinct	[1] Holyoak & Thibault (1984)
SOCIETY	MOOREA	Peale, Garrett and probably others collected specimens in the 19th C [1,2]. Wilson had good reason to believe the species was still present a few years before 1904 [3] but it hasn't been found there since.	Extinct	[1] Holyoak & Thibault (1984) [2] (Peale 1848) [3] Holyoak & Thibault (1984)
SOCIETY	MAUPITI	Greenway suggested the species still survived on "Mopiti" in the 1960s [1], however, this record is questionable [2]. None were seen by Thibault in 1973 and the locals were unaware of the species there [2].	Extinct	[1] [Greenway, 1967 #1881] [2] Holyoak & Thibault 1984

SOCIETY	MEHETIA	Peale noted presence in 1848 [1]. However, neither Townsend in 1899 [2] or the WSSE in 1921 found the species, suggesting it disappeared in the second part of the 19thC [3].	Extinct	[1] Peale (1848) [2] (Townsend & Wetmore 1919) [3] Amadon (1942)
SOCIETY	RAIATEA	Garrett estimates the species disappeared ca.1874 [1]. An individual was seen by Anne Gourni very briefly in 2003[2]. Possible explanations for this observation are that it is a result of: 1) a relict population (though this is unlikely), 2) an introduction, possibly an escaped pet, or 3) a vagrant from Mopelia region [2]. There have been no reports from locals in the recent past.	Extinct?	[1] Holyoak & Thibault (1984) [2] (Gourni 2003)
SOCIETY	TAHAA	Garrett estimates the species disappeared from this island ca.1874	Extinct	Holyoak & Thibault (1984)
TUAMOTU	AHE (AHII)	WSSE collected specimens in 1921 [1] but it appears the species may have disappeared from the atoll soon after [2]	Extinct	[1] Amadon (1942) [2] Holyoak & Thibault (1984)
TUAMOTU	APATAKI	WSSE found it abundant on the east coast and collected specimens [1,2]. Lovegrove reported approximately 300 in 1989 on a motu they called Tiamanu [3]. However, the exact location of this islet on the atoll is uncertain and locals questioned during this study were unable to identify it.	Minimum 300 in 1989 on one motu. No overall estimate for the atoll.	[1] Amadon (1942) [2](Holyoak & Thibault 1984) [3] (Lovegrove et al. 1991)
TUAMOTU	ARUTUA	Several specimens were collected by WSSE in 1923 [1] and lodged in the Musée de Tahiti. Several individuals that were kept as pets by the archdiocese in Tahiti between 1973-75 were from this island [2]. Albert Varney observed the species on the island in 1995 but no estimate was given[3].	No estimate	[1] Amadon (1942) [2] Holyoak & Thibault (1984) [3] (Varney 1995)
TUAMOTU	FAAITE	A local reported seeing an individual on this island in 2001[1]. However, its presence had not been recorded on this atoll in the past[2,3]. The observation may have been of an escaped pet or vagrant and requires verification.	Unknown	[1] (Hauata 2001) [2] Amadon (1942) [3] Holyoak & Thibault (1984)
TUAMOTU	KAUKURA	The WSSE found them in abundance in 1923[1]. They collected specimens that were lodged with the Musée de Tahiti [2]. Thierry BOHNENSTENGEL reported 6 individuals in 2002 [3]	No estimate	[1] Holyoak & Thibault (1984) [2] (Raust 2000) [3] (Bohnenstengel 2002)
TUAMOTU	MAKATEA	Peale noted and collected the species here in 1848 [1]. No mention of the species in an 1899 visit [2], but a specimen was collected in 1901-2 by Seale who noted the species as scarce [3]. None were recorded by the WSSE suggesting it disappeared altogether between Seale's visit and 1921[4]. No other reports since.	Extinct	[1] Peale (1848) [2] (Townsend & Wetmore 1919) [3] (Seale unknown) [4] (Thibault and Guyot 1987)

TUAMOTU	NIAU	Collected by Garrett in 19th C[1] but not seen by WSSE in 1921[2] or recorded elsewhere[3] or since.	Extinct	[1] Holyoak & Thibault (1984), [2] Amadson 1942 and [3] Holyoak & Thibault1984
TUAMOTU	RANGIROA	Recorded by Townsend in 1899 [1]. Specimens collected by WSSE in 1923 [2], Bruner stated there were small numbers on the south coast in 1972 [3]. Holyoak & Thibault recorded from locals that significant numbers found in extreme east of the atoll [4]. Estimate of less than 200 pairs on the atoll in 1991[5]. More than 200 individuals estimated in the Lagon Bleu area in 2001[6].	<200 pairs in 1991[5] >200 lorikeets in Lagon Bleu area in 2001[6]	[1] (Townsend & Wetmore 1919) [2] Amadon 1942 [3] Holyoak & Thibault (1984) [4] Holyoak & Thibault(1984) [5] (Thibault et al. 1991) [6] (Blanvillain and Salducci 2001)
TUAMOTU	TAKAPOTO & TAKAROA	Byron noted a large number of parrots on one of these islands in 1765 but did not give details[1]. The WSSE did not record the species here in the early 1920s [1,2]	Extinct	[1] Holyoak & Thibault (1984) [2] Amadon 1942
TUAMOTU	TAHANEA	According to elders that once lived on this atoll the species occurred there in the past [1]. However, there are no other records in the ornithological literature or other recent reports.	Unknown	[1] (Victor 2002)
TUAMOTU	TIKEHAU	Specimen collected by WSSE in 1923[1]. Total atoll estimate of 30 pairs in 1984[2]. Estimated at over 50 individuals in 2001 on Motu Mamaa[3]	Total of 30 pairs in 1984[2] and 50+ individuals on one motu in 2001[3]	[1] Amadon 1942 [2] (Poulsen et al. 1984) [3] (Serra 2001)
COOK ISLANDS	AITUTAKI	May have been introduced to the region by Polynesians in the past. Specimens were collected in 1899 [1] and by the WSSE in 1921[2]. Numbers have been estimated at between 750-1200 individuals [3,4], the range in estimates possibly due to differing census techniques [4].	750-1200 individuals in the 1990s	[1] Townsend & Wetmore (1919) [2] Amadon 1942 [3] (Wilson 1993) [4] (McCormack 2005)

Table 3: Details of motu visited on atolls in the Tuamotu archipelago including dates of visits, time spent surveying (rounded to closest quarter hour) and presence of *R.exulans* (X = present; O absent). (*indicates small motu not shown in figures 7-11 but found in the vicinity of the other listed motu).

Atoll	**Motu**	**Dates visited**	**Duration (hours)**	***R.exulans* trapped**
Apataki	Niutahi	14-15/1	4.0	
	Taaroa	15/1	1.0	
	Ravaru	15/1	1.0	
	Teavaatika	15/1	1.0	
	Nuutina	16-17/1	6.0	
	Tapae	18/1	0.5	
	Naminami	18/1	1.5	
	Roto Ava	18-19/1	2.5	
	Tehere	19/1	1.0	
	Topitinana	19/1	1.0	
	Motu 1	19/1	0.75	
	Opupu	19/1	1.0	
	Tehiva	19/1	1.0	
	Teonemahina	19/1	1.0	
	Aavere	19/1	0.75	
	Parao	19-20/1	2.5	
	Tamaro	20/1	0.75	
	Totoro	20/1	0.75	
	Omiro	20/1	0.5	
Arutua	Rautini	26&31/12	3.0	
	Motu 1	27/12	2.0	
	Motu 2	27/12	2.25	
	Tuaiva	28/12	2.0	
	Tikaran	28-29/12	3.0	X
	Okurumago	29/12	0.75	
	Motu 4	29/12	1.0	
	Motu 3	29/12	1.0	
	Tae	29/12	3.5	
	Uvarat	30/12	1.0	
	Okihi	30/12	1.25	
	Purahuri	30/12	1.0	
	Tenihinihi	31/12	1.5	
Kaukura	Panao	19/12	2.75	
	Tahuna Puna	19-20/12	3.25	X
	Mahia	20/12	2.5	
	Faro	20-21/12	3.5	
	Mataitau perua	21/12	0.5	
	Puehaa	21/12	0.5	
	Papatanifa	21/12	0.5	
	Patainure	21/12	0.75	
	Paia	21/12	0.75	
	Hapenoa	22/12	0.5	
	Teaturoa	22/12	1.5	

Atoll	Motu	Dates visited	Duration (hours)	*R.exulans* trapped
	Moturaa	22/12	1.25	
	Vehivehi	22/12	0.5	
	Tapiite	22/12	0.5	
	Papaoa	22/12	0.5	
	Tumu Afata	22/12	1.0	
	Tihai	22/12	0.75	
	Maava	22/12	0.75	
	Eraro	22-23/12	0.75	
	Umarei	23/12	0.5	
	Nuumeha	23/12	0.75	
	Raitahiti	23-24/12	2.5	
Rangiroa	Avatoru	2&8/1	1.5	
	Tevaiohie	2&8/1	3.5	
	Onetere	3/1	2.0	
	Tetaputa	3/1	2.5	
	Papaina	3/1	1.0	
	Atiati Rai	3/1	1.0	
	Rama	3/1	0.5	
	Ovete	3/1	2.5	
	Teu	3-4/1	4.0	X
	Otetou*	4/1	0.5	
	Terereamanu	4/1	2.5	
	Otepipi	4/1	2.0	
	Tehaare	4/1	2.25	
	Omai	4/1	2.0	O
	Taereere	4-5/1	4.25	O
	Utuhou	5/1	1.5	
	Ahua	5/1	3.0	
	Taeoo	5/1	1.5	
	Nato Nato	5/1	1.25	
	Oparapara*	5/1	0.5	
	Temoe*	5/1	0.5	
	Taumaha*	5/1	0.5	
	Toaiai*	5/1	0.5	
	Tereia	5-6/1	2.75	
	Kofai	5-6/1	1.25	X
	Matatahi	6/1	1.5	
	Hararu	6/1	0.5	
	Iore	6/1	1.5	X
	Pomariorio	6-7/1	4.5	
	Tivaru	7/1	1.5	
	Teohiti	7/1	1.0	

Table 3 (continued)

Atoll	Motu	Dates visited	Duration (hours)	*R.exulans* trapped
Tikehau	Tuherahera	8-12/1	5.5	
	Piro	9/1	0.5	
	Mamaa	9/1	4.25	
	Ura	9/1	0.5	
	Iore	9/1	0.75	
	Matiti	9/1	1.25	
	Teava	9/1	1.25	
	Teonai	9/1	1.0	
	Puafa	9/1	1.0	
	Teoparapara	9/1	1.25	
	Hararu	10/1	1.5	
	Teavatia	10/1	1.5	
	Taa	10/1	1.0	
	Temaropapahia	10/1	3.0	
	Oeoe	10/1	0.5	
	Puarua	10/1	0.75	
	Ohini	11/1	1.0	
	Marae	11/1	0.25	
	Faarua	11/1	1.25	
	Amehuri	11/1	1.5	
	Mahere Hauone	11/1	1.5	
	Tavararo	11/1	1.25	

Table 4: Population estimates for *Vini peruviana* for known extant populations and density estimates and available habitat areas on lorikeet occupied motu of the Tuamotu atolls. ([1]Holyoak & Thibault, [2]McCormack 2005).

Island group	Island	Area of available habitat (ha) and population density estimates (with ±SE) in brackets			Population estimates (±SE for Tuamotu populations)
		Favourable	Marginal	Favourable (with rats)	
Tuamotu	Apataki	315.8 (3.4 ± 1.1)	112.4 (0.9 ± 0.49)	207.3 (0.4 ±0.2)	1258 ± 351
	Arutua	443.6 (5.8 ± 1.2)	185.2 (0.9 ± 0.49)	88.1 (0.4 ±0.2)	2546 ± 485
	Kaukura	311.0 (2.3 ± 0.5)	69.3 (0.9 ± 0.49)	0	778 ± 157
	Rangiroa	247.5 (4.7 ± 0.7)	80.7 (0.9 ± 0.49)	32.9 (0.4 ±0.2)	1249 ± 173
	Tikehau	34.1 (0.9 ± 0.7)	11.1 (0.9 ± 0.49)	21.0 (0.4 ±0.2)	49 ± 24
Total Tuamotu					**5879 ± 643**
Society	Motu One		-		500[1]
	Manuae		-		700-800[1]
	Mopelia		-		?
Total French Polynesia					**6436 - 7822**
Cook	Aitutaki		-		750-1200[2]
TOTAL GLOBAL ESTIMATE					**7186 - 9022**

Table 5: Age structure and mean flock size of blue lorikeet populations in the Tuamotu (*data not collected for these atolls)

Atoll	Proportion of young birds in population (n= # sightings)	Mean flock size (including largest flock size)
Apataki	10.2 (n = 54)	2.1 (12)
Arutua	- *	1.8 (10)
Kaukura	- *	2.3 (22)
Rangiroa	2.2 (n = 93)	1.9 (11)
Tikehau	8.3 (n = 13)	1.9 (3)

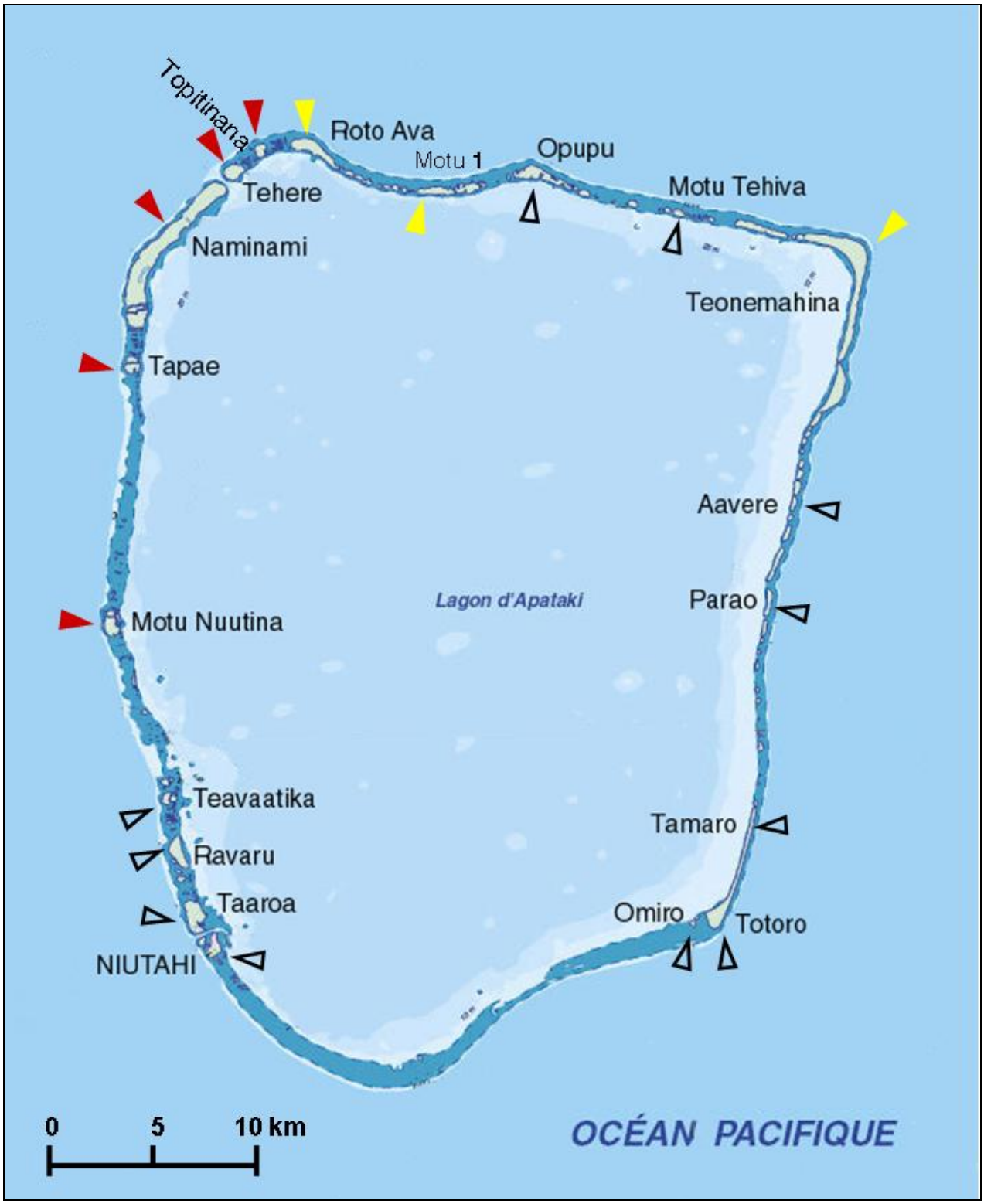

Figure 7: Distribution of the blue lorikeet on Apataki atoll in relation to presence/absence of Black Rats Rattus rattus. (Red arrow = lorikeet present/rat absent; yellow arrow = lorikeet present/rat present; black arrow = lorikeet absent/rat present).

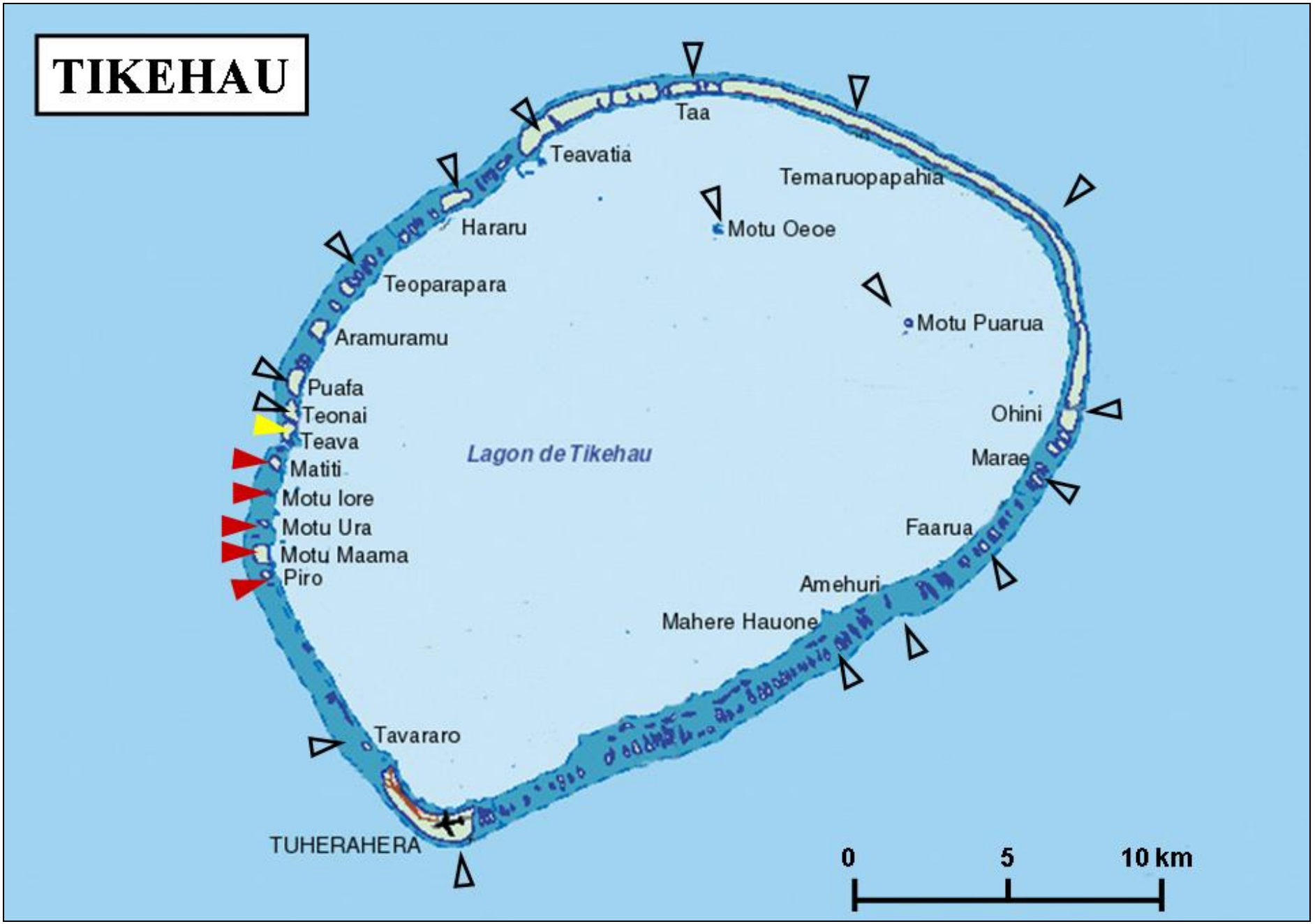

Figure 8: Distribution of the blue lorikeet on Tikehau atoll in relation to presence/absence of black rats. (Red arrow = lorikeet present/rat absent; yellow arrow = lorikeet present/rat present; black arrow = lorikeet absent/ rat present).

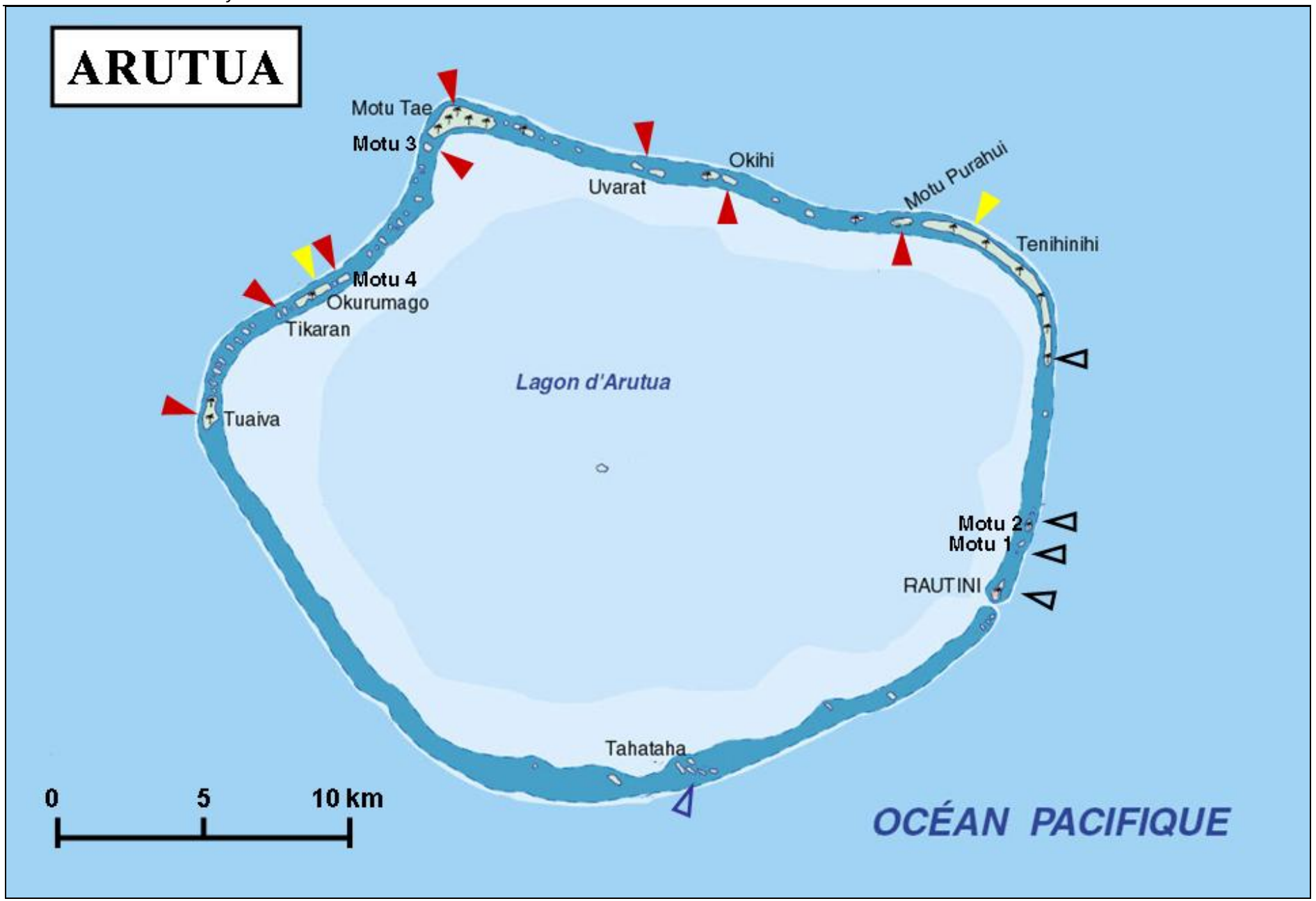

Figure 9: Distribution of the blue lorikeet on Arutua atoll in relation to presence/absence of black rats (Red arrow = lorikeet present/rat absent; yellow arrow = lorikeet present/rat present; black arrow = lorikeet absent/rat present).

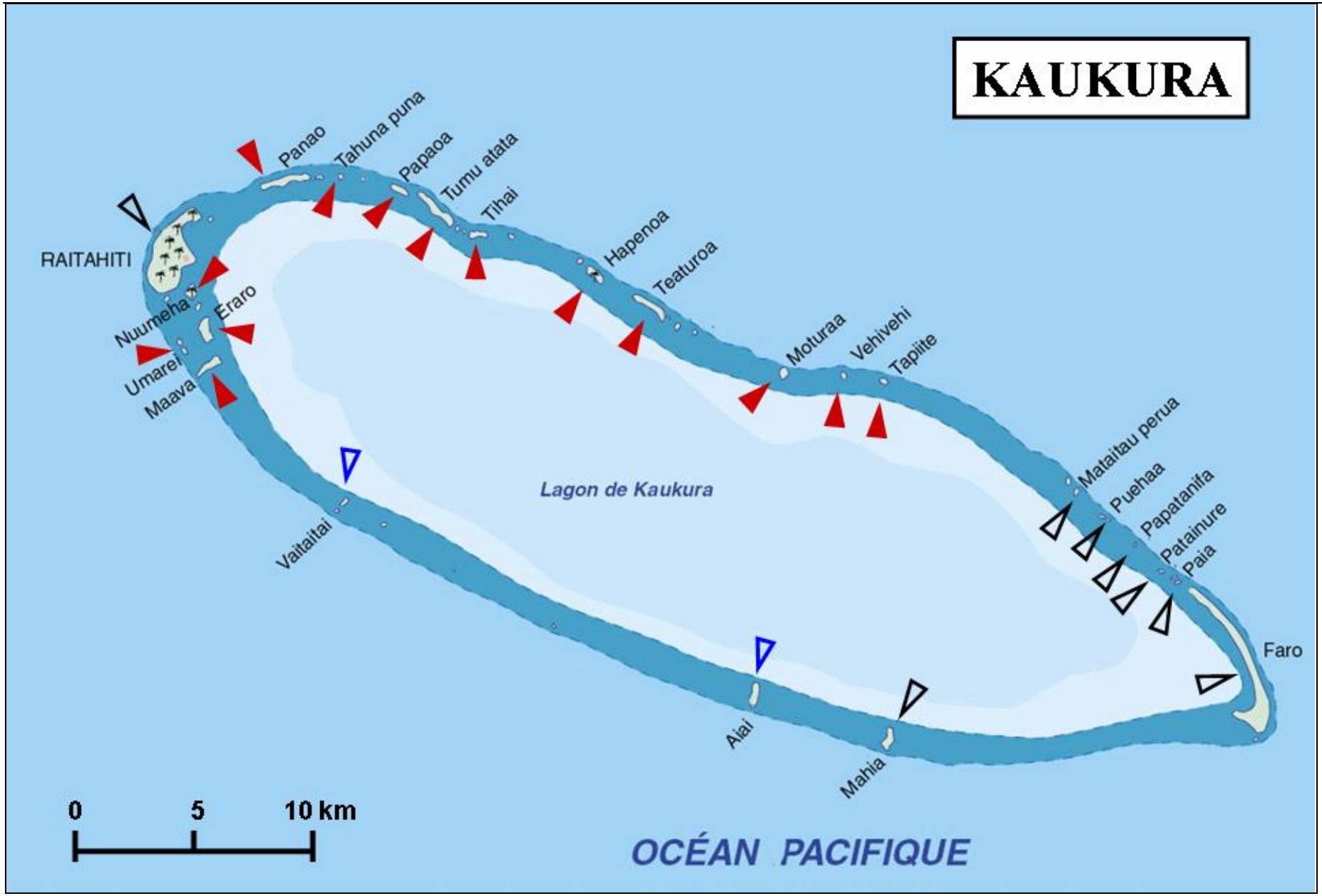

Figure 10: Distribution of the blue lorikeet on Kaukura atoll (Red arrow = lorikeet present/rat absent; black arrow = lorikeet absent/rat present; blue arrow = lorikeet absent according to locals but motu not visited on this occasion).

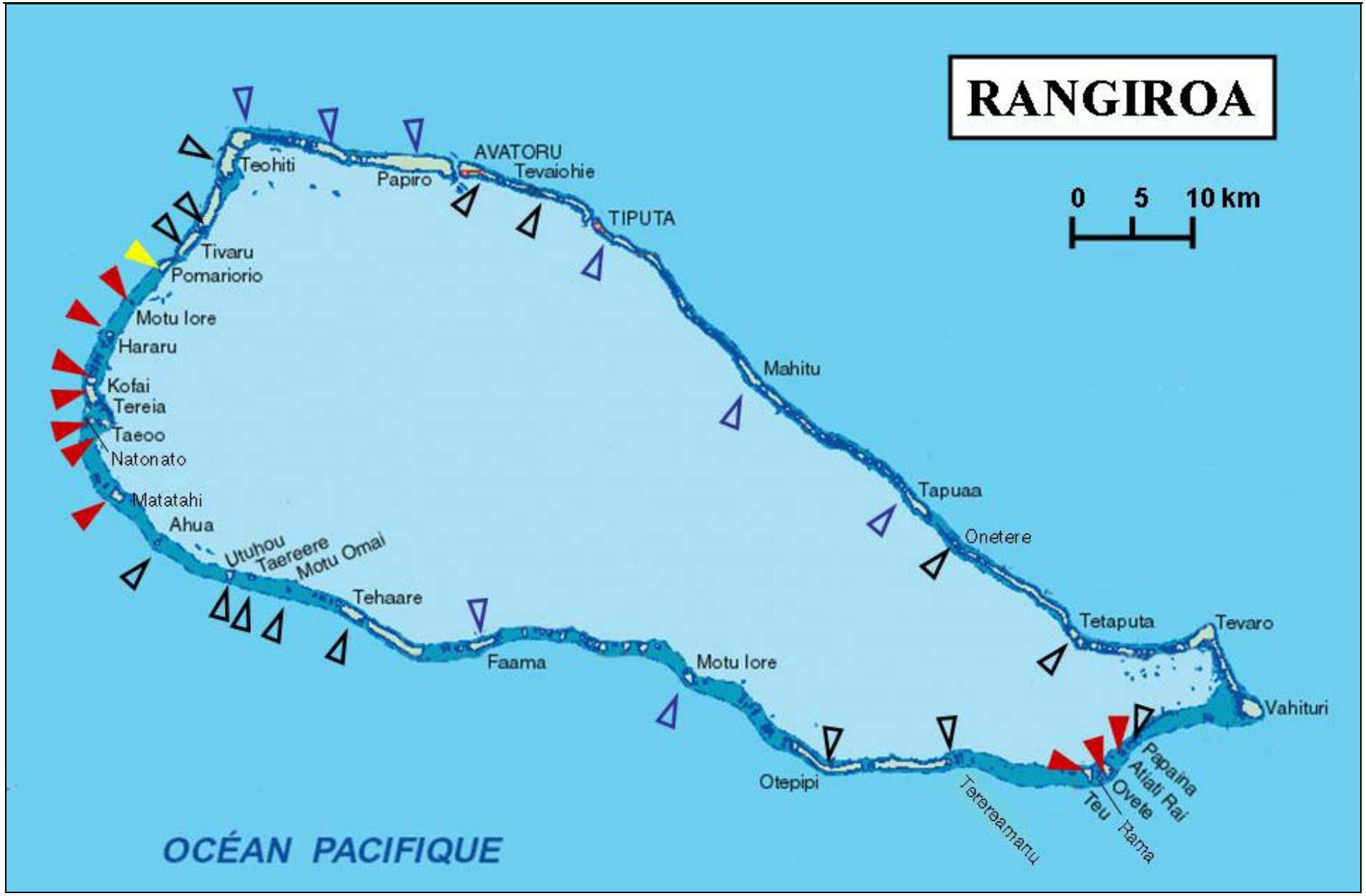

Figure 11: Distribution of the blue lorikeet on Rangiroa atoll in relation to presence/absence of black rats (Red arrow = lorikeet present/rat absent; yellow arrow = lorikeet present/rat present; black arrow = lorikeet absent/rat present; blue arrow = lorikeet absent according to locals but motu not visited on this occasion).

DISCUSSION

The blue lorikeet: past and present status and aspects of ecology

While the overall blue lorikeet population is large enough and widely enough distributed on several islands to suggest it is not under immediate threat of extinction, the species has disappeared from almost two-thirds of the islands it was formerly known from. Furthermore these declines continue. There is direct evidence for contemporary declines on Apataki where the Whitney South Seas Expedition recorded the species as common along the eastern side of the atoll in the 1920s (Amadon 1942). Today the species is absent from this part of the atoll. Similarly, anecdotal evidence suggests similar contractions on Tikehau where the population is confined to a few small motu in the west. Here, locals report lorikeets were formerly more widespread occurring on the main islets of Tuherahera and Temaruopapahia about 30-40 years ago. Further local extirpations have been observed from motu on Kaukura where lorikeets disappeared from Faro in the early 1980s.

The progressive reduction in lorikeet populations and current patterns of distribution are closely related to the presence/absence of black rats. Of all remaining populations on atolls in the Tuamotu, nowhere are lorikeets found on all islets, even where habitat is favourable. There is no reason to believe that in the past lorikeets were not found on all islets with favourable habitat. Almost invariably, wherever there are rats there are no or very few lorikeets. These patterns are particularly obvious on the atolls of the Tuamotu but are also repeated on other island groups (for example, where rats have become established in the Marquesas Islands populations of Ultramarine lorikeets have been decimated (Ziembicki and Raust 2003)). Lorikeets are particularly susceptible to black rats because of their use of tree hollows for nesting. Black rats, owing to their agility as climbers, compete for tree hollow nests and readily predate on the eggs and young of lorikeets, as well as possibly adults at nests.

In a small number of cases both lorikeets and rats co-occur on islets. Invariably, the density of lorikeets in these cases is significantly lower than on surrounding rat-free islets. Given the apparently strong negative relationship between rat and lorikeet presence the reasons for this co-existence are unknown. Possibly, lorikeets are temporarily visiting infested areas from nearby rat-free areas or rat infestations are recent and there hasn't been sufficient time for them to exert their full influence (the low densities of lorikeets observed here being a final step towards their imminent extirpation). Alternately, the presence of lorikeets may be due to low rat densities on a given motu or there are other conditions under which lorikeets are able to tolerate rats. Significantly, Watling (1995) notes the apparent survival of one small population of Kuhl's lorikeet in the presence of black rats for possibly up to 70 years on an islet of Tabuaeran atoll (Kiribati). He speculates that the possible persistence of lorikeets may be due to their use of habitats outside of areas of high rat density i.e., *Pandanus*-dominated woodland as opposed to coconut plantations. Indeed, if there are then particular conditions or thresholds under which lorikeets are able to persist in the presence of rats (perhaps at some threshold of rat density in relation to density of nests or particular habitat availability) then there are important implications for future conservation programs for the group (and other birds similarly susceptible to rats in the Pacific). For example, several *Vini* populations, such as the Ultramarine lorikeet on Ua Pou, persist on some islands at high altitude. It is currently impractical to eradicate rats from high, rugged islands. If lorikeets are able to persist at low rat densities with adequate nesting resources then it may be possible to target particularly important areas on such islands for rat control and supplement nest resources by protection of nesting trees and provision of artificial rat-proof nest boxes. Unfortunately, our preliminary

experiments with nest boxes for *V. ultramarina* in the Marquesas failed on technical grounds (see below). However, further investigation of the relationships between rats and *Vini* lorikeets and the utility of rat control and nest supplementation efforts are warranted. An excellent opportunity exists for such research on the islands of the Tuamotu where the many discrete and floristically and topographically simple islets surrounding the atolls' lagoons provide an excellent natural laboratory for experimentally assessing the effects of rats on lorikeet populations.

Assessment of preliminary efforts to safeguard ultramarine lorikeet populations

Previous efforts introduced to safeguard Ultramarine lorikeet populations concentrated on the islands of Ua Huka and Fatu Iva in the Marquesas (Ziembicki & Raust 2003). These efforts focussed on preventing and controlling the spread and effects of black rats and facilitating safe nesting conditions. These efforts were essentially exploratory, restricted by the short nature and limited scope of the study. Nonetheless, they provide direction for future, more comprehensive efforts.

Prevention of rat establishment on Ua Huka

The most important priority for conservation of the ultramarine lorikeet in the Marquesas is to prevent the establishment of rats on Ua Huka. Ua Huka remains one of the few islands in the Marquesas without direct docking facilities for visiting cargo ships. Partly for this reason, but also partly due to good fortune, the island has thus far remained black rat-free. However, the risk of invasion by stowaway rats in cargo remains high. In 2002, traps were provided to local quarantine officers to deploy along wharves in the main villages when cargo ships visited. However, these are no longer consistently used. While we found no evidence of black rats on Ua Huka during the current survey, there is an urgent need to establish a more comprehensive and permanent strategy to prevent colonisation in the future. SOP in collaboration with Birdlife International plans to initiate comprehensive actions in the near future to facilitate this. Actions planned will include awareness raising activities and provision of permanent rat bait stations around entry points including possibly introducing rat baiting on cargo boats visiting the island.

Rat control on Fatu Iva

In 2002, SOP commenced a rat control program in the Punahitani valley on Fatu Iva in an effort to control rat numbers in a small area identified as favourable breeding habitat for the Fatu Iva Monarch and the ultramarine lorikeet (Blanvillian & Ziembicki 2002; Ziembicki & Raust 2003). This program employs a local inhabitant from the village of Omoa to check and re-bait bait stations once per week. Unfortunately, budget and logistical constraints prevented a return to Fatu Iva on this occasion. However, as part of the Fatu Iva Monarch recovery program a member from the SOP visits the island annually to assess the status of the species there. Previous visits suggest that due to baiting, rat numbers in Punahitani Valley remain low, however, there is no indication that lorikeets have bred successfully in the area. A more comprehensive effort to assess the status of lorikeets on Fatu Iva is required.

Use of artificial nest boxes

Nest boxes were constructed and installed in 2002 on the islands of Ua Huka and Fatu Hiva. The nests consisted of PVC pipes 17cm in diameter and 35cm in length with a 5cm diameter entrance hole. Each nest was fitted with an internal ladder, perch and capped with a plastic top (Figure 12). Inspection of nests in the botanic gardens on Ua Huka revealed that by early 2006 the plastic caps used to seal the nests had either fallen off or were badly damaged on most

nests. Employees of the gardens observed that this had begun 12-18 months after they were installed. Although we were unable to visit Fatu Iva it is probable that many of the nests there were similarly affected. This design fault prevented their use by lorikeets after the first 12 months following their installation and we were unable to determine whether lorikeets had began using nest prior to being damaged. Nonetheless, artificial PVC nest boxes have been successfully used for other similar sized psittascid species elsewhere (White 2005). With appropriate modifications and more comprehensive trials similar nest boxes may remain a viable option for facilitating lorikeet nesting in areas affected by rats.

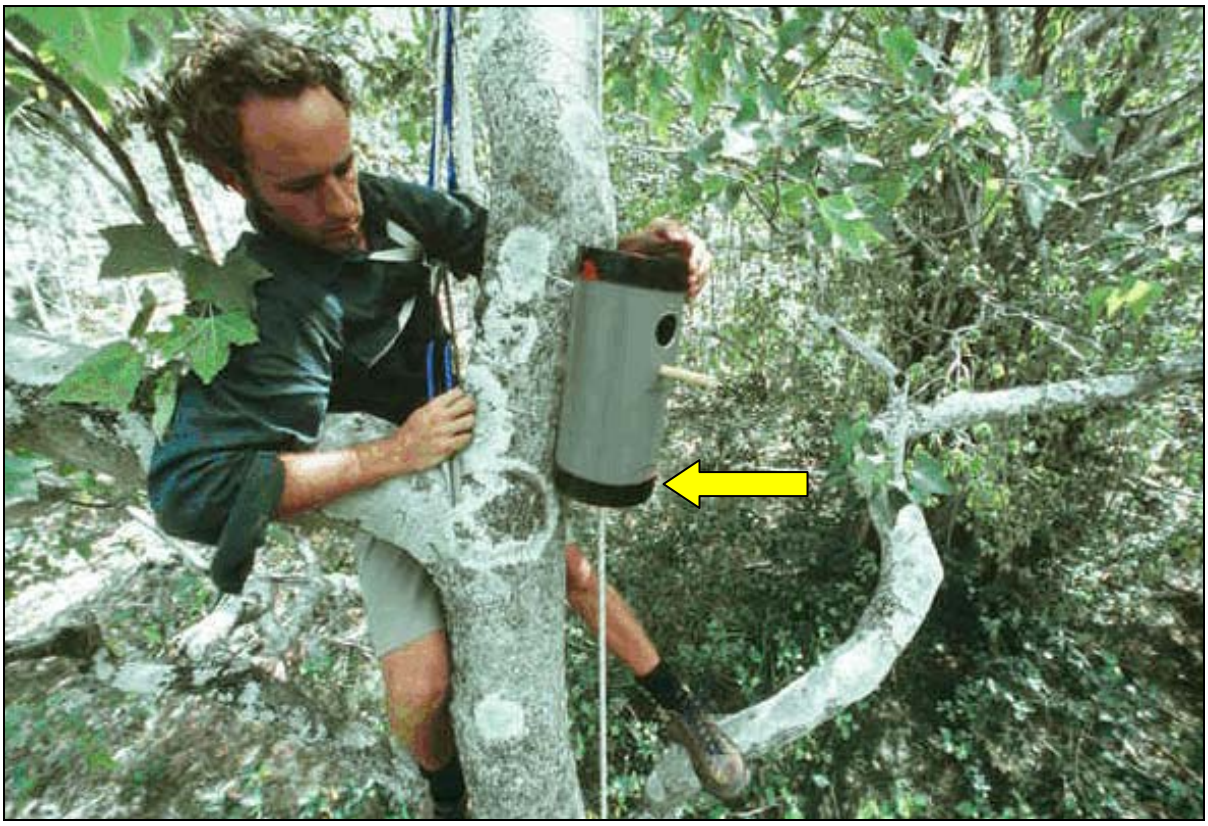

Figure 12: Installing a PVC nest box in the botanic gardens on Ua Huka. Yellow arrow points to plastic caps used to seal the ends of nests.

Conservation and research requirements

The present study, in conjunction with the 2002 assessment of status and conservation requirements of the ultramarine lorikeet in the Marquesas Islands, provide a solid foundation for developing further more comprehensive research and conservation programs for the *Vini* in French Polynesia.

Habitat alteration and loss

Island environments in Polynesia have been significantly altered since the arrival of the first human settlers to the region. Among the more pervasive changes is the conversion of large areas of natural forests to plantations of food plants and gardens. Such changes are particularly apparent on low lying atolls that in most cases are now dominated by coconut palm plantations. *Vini* lorikeets generally benefit by such changes because of the greater and more consistent availability of food resources (Kuehler et al. 1997; Ziembicki and Raust 2003). However,

there is often a reduction in nesting resources in such areas because of the removal of dead or unproductive trees that often contain hollows. Lower availability of potential nests in such environments may also exacerbate the effects of black rats. Educating and encouraging landholders to retain hollow bearing trees on their properties would be a useful step towards increasing nesting opportunities for the lorikeets.

Translocation, rat control and eradication

Mohotani remains the only suitable translocation location for the ultramarine lorikeet in the Marquesas. Besides Ua Huka this island is the only relatively large island that remains black rat-free. It is currently uninhabited by humans and accommodates many of the ultramarine lorikeet's favoured feeding resources. However, sheep and goats occur on the island and should be eradicated prior to any translocation attempts. Consideration should be given to establishing the island as a protected reserve.

Protection of existing populations, as opposed to establishing new populations of blue lorikeets elsewhere, is a priority. Implementing rat eradication programs from motu surrounding core lorikeet areas is likely to help populations expand naturally. Specific notes and recommendations for blue lorikeets on each atoll in the Tuamotu archipelago follow.

Apataki

Although Apataki's lorikeet population is relatively robust it occupies less than half of the available area of the atoll. Lorikeets have disappeared from the eastern side of the atoll where they were formerly common. The majority of the extant population is found between Naminami and Motu Nuutina (see Figure 7). With the passes at Tehere and Niutahi acting as natural barriers to the dispersal of rats the region between Naminami and Taaroa is a priority for action on Apataki. Preventing the spread of rats to Naminami and Nuutina and eradicating rats from the southern motu in this region including Teavaatika, Ravaru and Taaroa are priorities. The motu extending in a clockwise direction from Tehere to Totoro are all connected by sandbars and exposed reefs at low tides facilitating the movement of rats from the north-west part of the atoll to the far south-east. Efforts at controlling or eradicating rats over this entire region would require significant effort. However, working eastwards from the Tehere pass rats could be eradicated progressively from each motu as resources were available and bait stations deployed intensively along the eradication frontier at locations that are more challenging for rats to traverse (e.g., long expanses of exposed sandbars). The co-occurrence of lorikeets and rats on several motu on Apataki, particularly the observation of small numbers on Teonemahina, is of significant interest and warrants further investigation.

Tikehau

Tikehau's lorikeet population remains relatively small and is restricted to six small motu on the atoll's western side (most of the population occurs on Motu Mamaa). Black rats are widespread on the atoll occurring on all islets from Taeva, (immediately north of the atoll's main pass) in a clockwise direction to Tavararo (see Figure 8). The most effective strategy for safeguarding this population is to minimise the potential for rat establishment on motu south of the pass (facilitated by deployment of permanent bait stations on motu immediately south of the pass and at landing areas on Motu Mamaa and Matiti). A rat eradication program beginning at Taeva and progressively working north should be initiated. Fortunately, there is considerable interest, aided by strong and competent community leadership, on Tikehau for developing sustainable environmental practices on the island, including control of rats and protection of the lorikeet population. For these reasons Tikehau is considered a priority for blue lorikeet conservation in the Tuamotu.

Arutua

The largest population of blue lorikeets occurs on Arutua. However, our observations suggest that black rats occur on Okurumago (Figure 9). This motu had very low lorikeet numbers compared to adjacent motu. This motu is therefore the potential of spread of rats to adjacent islets is high. Confirming the status of this island with respect to black rat presence and if relevant eradication of rats from this motu is a priority action for Arutua. Only one lorikeet was sighted in the north-west part of Tenihinihi, and locals recounted that they were only occasionally seen there. Consideration could be given to eradication of rats from Tenihinihi. However, given its size (note also that it is connected by a sand bar all the way to Rautini) this would require significant resources.

Kaukura

Locals reported that lorikeets formerly occurred on Faro motu but had not been seen there since the 1983 cyclone. At around this time black rats are thought to have arrived on the motu. Faro is owned by several families, many of whom expressed support for a rat eradication program on the motu. Such an effort would contribute significantly to the Kaukura lorikeet population given the size of Faro and predominance of favourable habitat.

Rangiroa

The two populations that occur on Rangiroa are separated by approximately 80 kilometres (Figure 11). While lorikeets are strong fliers the degree of interaction between these two populations is unknown. We believe that movements between these areas are likely to be limited given no records in the current or previous surveys (Thibault *et al.* 1991) on motu visited between Teu and Matatahi. Besides one report of a single individual on Otepepi "a few years back" locals questioned on several motu in the region have never seen lorikeets between these two zones. The south-eastern population occupies a small number of small motu. This area receives occasional human traffic and is largely isolated from nearby rat-infested motu. Minimising the arrival of rats to this area is important. A priority SOP project at present concerns the conservation of the critically endangered Society Ground Dove *Gallicolumba erythroptera*. This species is restricted to two small motu in the south-west of Rangiroa, (Utuhou and Taereere). Pacific rats were recently successfully eradicated from neighbouring Omai in preparation for a translocation of the dove to the islet. Future work is planned to continue eradicating rats along this southern region. This may also facilitate the expansion of the blue lorikeet's range from the population on the west coast.

Further research

In addition to the need to examine the relationships between lorikeets and rats as described above, basic research is required to examine seasonal patterns of habitat use, including nesting and feeding requirements, and movements of all *Vini* species in French Polynesia. Such information will inform future translocation and rat control options by helping select appropriate islands or habitats to concentrate rat control efforts in. Although lorikeets readily moved between motu (some were observed crossing 5 kilometre stretches of water between motu) they seldom ranged into areas inhabited by rats. Better knowledge of the ranging behaviour and dispersal of lorikeets will help inform where and how best to target rat control efforts in the Tuamotu and elsewhere.

Community education and local capacity building

Community education and building of local capacity are essential components of any conservation program in the region. While not a primary focus for this project we took the opportunity to speak of the project and environmental issues with local islanders whenever possible. Young locals were hired as guides on some islands and to help with rat trapping on Ua Pou and Ua Huka (Figure 13). Other awareness raising activities included a visit to the local primary school on Tikehau (Figure 14), the production of an information booklet about the birds of the Tuamotu, interviews for local radio and television programs and a newspaper article about *Vini* lorikeets (see Appendix 1).

A more concerted education project is planned by the SOP for the near future with the help of BirdLife International. This will focuss on informing local islanders about the birds on their islands and the threats they face, including what they can do to minimise the spread of rats and other invasives.

Education and awareness raising highlighting the plight of the region's birds and impacts of introduced species and other threats should underpin any future conservation and research initiatives for *Vini* in the region.

Figure 13: Local guides Gerome and Matthieu setting traps for rats on Ua Pou

Figure 14: Philippe Raust talks to school children about the birds of the Tuamotu Islands at a primary school on Tikehau.

CONCLUSIONS & RECOMMENDATIONS

The Société d'Ornithologie de Polynésie, in collaboration with existing partners and networks in French Polynesia and beyond, is the best placed organization for administering and facilitating future conservation and research efforts, and the recommendations summarised below.

Blue lorikeet

Although blue lorikeet is the least threatened of the three Vini in French Polynesia it has great potential as a focal species for research that may inform conservation programs for the genus and other birds threatened by rat species across the Pacific. Its occurrence on different atolls in the Tuamotu, and its disparate distribution between motu, presents unique opportunities for assessing the relationships of *Vini* to habitat variables, rat densities, rat control measures, etc.

1. Initiate a detailed research program targeting the ecology of the species in the Tuamotu and its relationships to introduced rats with the view of developing *in situ* conservation programs that may include translocating populations to appropriate islands and targeting specific islands for rat control or eradication.

2. Facilitate local capacity by developing local expertise in bird and rat survey methodology and rat control.

3. Facilitate the provision of rat prevention and control facilities on relevant islands.

4. Develop education campaigns targeting the need to prevent the spread of rats and other invasive species to islands and the status of endemic birds

5. Survey the populations of Motu One, Manuae and Mopelia in the Society Islands.

Ultramarine lorikeet

Recommendations for the conservation of the ultramarine lorikeet essentially remain the same as those presented in Ziembicki & Raust (2003). They are:

1. Establish a coordinated program to prevent the introduction of black rats to Ua Huka and a strategy for dealing with a potential introduction.

2. Translocation of lorikeets from Ua Huka to Mohatani following an appraisal of the island's suitability and eradication of introduced sheep and goat.

3. Further research to document nesting requirements and seasonal feeding and habitat use patterns of the species to increase our understanding of its requirements and inform potential translocation programs.

4. Following further research to determine relationships between lorikeets and black rats (e.g., blue lorikeet in the Tuamotu) consideration may be given to an intensive rat control program in Hakehetau valley (Ua Pou) in view of re-introducing the lorikeet to this valley.

5. Employment of a dedicated field officer to oversee conservation projects in the Marquesas.

OTHER COMMENTS

Several initiatives are planned by the SOP for 2006 and 2007 that address some of the unrealised aims in the current study and recommendations listed above.

- A visit to Mohatani in the Marquesas Islands to assess its suitability for a translocation program for the pihiti is planned by the SOP later this year.

- Annual visit to Fatu Iva to assess progress with the Fatu Iva Monarch Conservation program will allow for checking the status of the pihiti population.

- Introduction of permanent rat bait stations at entry points on Ua Huka to minimise the potential of rats becoming established on the island (in collaboration with Birdlife International).

LPF ASSISTANCE REQUEST

There are two specific potential projects that the LPF could be a vital contributor to:

1. Translocation of *Vini ultramarina* from Ua Huka to Mohotani
   -LPF requested to potentially provide funding (or part-funding) and practical expertise in housing, transporting, release and monitoring of lorikeets between Ua Huka and Mohotani. Suitability of Mohotani to be confirmed and introduced sheep, cattle and goats to be eradicated. This project would necessarily be collaborative with other partners of SOP and local communities with the view of establishing Mohotani as a protected reserve.

2. Ecology of *Vini peruviana* in the Tuamotu and relationships with introduced species
   -Funding and input to study design to focus on examining the relationships between lorikeets and rats and cats on selected atolls in the Tuamotu.

OUTPUTS OF THE PROJECT

Outputs to date:

- Newspaper article about Vini lorikeets published in French Polynesia's main weekend newspaper *La Depeche Dimanche* (Appendix 1).
- Interview for a local television station regarding the project's work in the Marquesas Islands.
- Publication of salient findings in SOP MANU's newsletter *Te Manu*.

Planned outputs:

- Scientific journal papers and popular science articles

WORKSHEET

Table X: Project activities including dates, locations, activities and personnel
(MZ – Mark Ziembicki; PR – Philippe Raust; GS – George Sanford; LB – Ludwig Blanc)

Date	Location	Personnel	Activities
12 – 18 Dec 2005	Tahiti	MZ PR	• Organisation of visits and logistics for outer islands (i.e., transport, accommodation, local contacts, permission, etc.) • Collation of published and unpublished records of blue lorikeet in French Polynesia
19 – 24 Dec 2005	Kaukura	MZ	• Survey of blue lorikeet and rats • Assessment of sites for translocation • Interviews with locals
26 – 31 Dec 2005	Arutua	MZ	• Survey of blue lorikeet and rats • Assessment of sites for translocation • Interviews with locals
2 – 9 Jan 2006	Rangiroa	MZ PR GS LB	• Survey of blue lorikeet, Tuamotu Islands Ground Dove and rats • Assessment of sites for translocation/ rat eradication • Interviews with locals
9-12 Jan 2006	Tikehau	MZ PR	• Survey of blue lorikeet and rats • Assessment of sites for translocation • Interviews with locals • School workshop
14 – 21 Jan 2006	Apataki	MZ	• Survey of blue lorikeet and rats • Assessment of sites for translocation • Interviews with locals & community leaders
22 – 26 Jan	Ua Pou	MZ	• Search for *Vini ultramarina* and rat surveys • Meetings with local community leaders regarding opportunities for further work • Interview for local TV station
26 Jan – 3 Feb 2006	Ua Huka	MZ	• Survey of *Vini ultramarina* • Rat surveys • Assessment of nest box use • Meetings with local community leaders regarding opportunities for further work
4 – 6 Feb	Tahiti	MZ PR	• Wrap-up • Preparation of report • Project report to SOP MANU members • Media (newspaper article – PR) • Preparation of educational materials (PR)

EQUIPMENT

N/A

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APPENDIX 1: Published article regarding *Vini* lorikeets in French Polynesia's weekend newspaper *La Depeche Dimanche*

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MAGAZINE

Rencontre avec un ornithologue

Les vinis : des loris pas comme les autres

Si l'on vous dit "vini", vous pensez immédiatement à téléphone portable ! Eh bien, quand on dit "vini" à Philippe Raust, il vous raconte la légende du Rimatara, la petite perruche "voleuse de couleurs", il vous décrit l'habitat de l'ultramarin de la famille et enfin vous explique pourquoi le Lori nonnette est menacé. Tendez l'oreille et vous entendrez peut-être le gazouillis d'un vini.

La Dépêche Dimanche : Vous êtes ornithologue à l'association Manu, parlez-nous du vini...

■ **Philippe Raust :** "Linnéairement, "vini" signifie "exotérique". Il s'agit de petites perruches endémiques de Polynésie française. Le vini appartient à la famille des loris. En Polynésie on distingue trois vinis protégés par des conventions internationales. Le lori nonnette, également appelé Vini peruvianus, le Lori des Marquises (l'ultramarin de la famille) et le vini de Rimatara. Ces oiseaux mesurent environ 18 cm. Ils sont très colorés, le Peruvianus est bleu nuit, le collier blanc, les pattes et le bec orange. Le Lori des Marquises est bleu lagon, enfin le Rimatara est couleur de l'arc-en-ciel, jaune, vert, bleu, rouge, bec et pattes orange."

Vous vous, il y a quelques semaines à Tikehau et à Rangiroa, pourquoi avoir fait ce déplacement aux Tuamotu ?

■ *"Pour le lori nonnette. Ce vini a disparu aujourd'hui des îles Sous-le-Vent de Tahiti et de Moorea (taiti : il serait néanmoins présent sur trois atolls à l'extrême ouest des îles Sous-le-Vent). On le trouve aujourd'hui uniquement dans cinq îles des Tuamotu : Tikehau, Apataki, Arutua, Kaukura et Rangiroa. Mais attention, il n'est présent que sur certaines zones, 10 % de la surface de Rangiroa et 5 % de Tikehau. Nous organisons avec un confrère australien une mission de recensement et de comptage des populations du lori nonnette dans l'archipel. Cette opération a été rendue possible grâce à l'aide financière de la fondation Loro Park de Ténérife (îles Canaries). La mission se poursuivra actuellement : d'ici à quelques semaines, nous pourrons à l'analyse des données recueillies. Il faudra attendre début mars pour obtenir les premiers chiffres probants."*

Pourquoi le vini est-il présent sur des zones si réduites ?

Le Vini peruviana également appelé le Lori nonnette

■ *"A cause des rats noirs. On trouve le petit oiseau dans des zones que le rat n'a pas encore investies. Les habitants des atolls doivent être vigilants lorsqu'ils transportent des matériaux ou de la nourriture et veiller à ne pas transporter des rats dans les sites de vie du lori qui sont bien en place. C'est la même chose pour les pandanus morts. Les connaître nous aident, le penser qu'il y a une prise de conscience de l'importance de la préservation de la faune, mais les mentalités doivent encore évoluer. Si on ne fait rien, le vini disparaîtra."*

Quelle est la particularité de cet oiseau ?

■ *"Contrairement aux perroquets le lori nonnette est nectarivore. Il lèche le nectar des fleurs dont il recouvre ses plumes. Il remplit le rôle des colibris d'Amérique du sud et des abeilles en assurant la pollinisation des fleurs, il est donc "utile."*

Y a-t-il des élevages de vinis ?

■ *"Il y a une population connue et légale en captivité au zoo de Santiago en Californie. La reproduction en captivité est très difficile. Nos moyens des actions de sensibilisation en direction des enfants, très réceptifs à la protection de la faune et de la flore, nous intervenons quand nous le pouvons dans les écoles. Une catégorie leur est d'ailleurs réservée sur notre site."*

C'est toute la biodiversité des espèces qui est en danger. Il y a 32 espèces d'oiseaux terrestres en Polynésie française, 28 sont endémiques. En comparaison en France, il y a une espèce endémique, la sittelle qui vit en Corse.

Cl. Chanlaud

Les Vinis peruviana nichent dans les trous des cocotiers et des pandanus morts. Il faut laisser les arbres en place pour préserver l'espèce et favoriser la reproduction.

Lors de son déplacement à Tikehau, Philippe Raust est intervenu dans une classe afin de parler des actions de l'association Manu.

"Nous disposons d'une bonne cartographie des lieux de vie du vini peruviana qui est présent dans cinq îles des Tuamotu. Ce qui ne signifie pas qu'il est visible sur tout le territoire, au contraire, il ne vit que dans des zones très restreintes (5 % de Tikehau et 10 % de Rangiroa) et surtout inaccessibles pour le rat noir, son prédateur", explique Philippe Raust, ornithologue de l'association Manu.

Le vini Rimatara... voleur de couleurs !

"Autrefois, il y a très longtemps, la ravissante Moho était l'oiseau le plus beau de tous ceux qui peuplaient l'île de Rimatara et tous l'admiraient pour ses couleurs chatoyantes. Son plumage multicolore était rouge, bleu, vert, jaune... La perruche Uru était grise et terne, personne ne l'appréciait malgré ses cabrioles dans les fleurs de bananiers et ses sifflements aigus. Le Uru devint triste et jaloux du Moho : sa beauté l'obsédait, il fallait qu'il obtienne d'aussi belles plumes que celles de son rival. Mais comment s'emparer des couleurs du Moho, toujours en éveil ? Il fallait ruser et profiter d'un moment opportun. Guettant le bel oiseau, le Uru attendit que celui-ci s'endorme pour se désaltérer aux heures chaudes de la journée. S'approchant sans bruit, il commença par s'emparer du vert des ailes, puis s'enhardissant, il subtilisa le jaune du dos. Le Moho ne bougeant toujours pas, il lui prit le rouge de la poitrine. Encore quelques minutes, et il volait le bleu de la tête. Mais alors qu'ivre d'un tel forfait, il voulait prendre la couleur rouge des yeux, le Moho sortit le bec du Uru sur sa poitrine et se réveilla brusquement. Il

ait ce qui lui était arrivé et, se trouvant honteux sans son magnifique plumage, l'a se cacher dans le marécage. Depuis ce jour, le Moho vit, qui a gardé son œil rouge et ses pattes oranges ne se montre plus aux autres oiseaux et reste terre sous les hautes herbes ne sortant qu'au crépuscule pendant que le Uru batifole haut dans les branches, pratiquant à sa tête pour attirer l'attention et faire admirer sa beauté."

Fausse alerte à la grippe aviaire !

Dans le cadre de l'étude sur le *Vini peruviana*, Philippe Raust de l'association Manu était présent à Rangiroa une semaine avant que la rumeur sur une mystérieuse "importante" d'oiseaux morts, il y a quelques semaines, la Une des journaux. "Dès que l'on m'a contacté sur le sujet, j'ai rassuré mes interlocuteurs, je n'avais rien remarqué d'anormal sur place.

Excepté la floraison de quelques légèrement appelé le Pisonia grandis) grand arbre qui produit des graines recouvertes de poils et de matière collante sur lesquels les oiseaux s'emplument les plumes." Affolés, les oiseaux tombent et sont des proies faciles pour les chats et les rats. Ce qui peut expliquer aussi "les restes d'oiseaux trouvés sur place". "Cet épisode m'a rappelé

un précédent qui date de 1996. À l'époque, la mortalité avait été relevée au Mato Atoll de Opoa à Rimatara. On avait, on imaginait qu'une terrible fièvre s'était abattue sur les oiseaux. Le mystère n'a pas fait long feu, Emile Brotherton, agent et guide du service du développement rural de Rautéka, a vite percé le cœur du problème ... la floraison du pisonia !"

Concernant les craintes de voir le virus de la grippe aviaire faire des ravages en Polynésie française, Philippe Raust fait référence à l'avis de l'agence française de sécurité sanitaire des aliments : "La probabilité de contamination des volailles et des porcs domestiques élevés en plein air est nulle à négligeable, que l'introduction du virus soit le fait d'un tiapé direct ou indirect. En conséquence, il n'est pas recommandé de mesures particulières."

Des Oiseaux et des Hommes

La Société d'ornithologie de Polynésie "Manu", fondée en juillet 1990 par quelques amateurs passionnés par les oiseaux de Polynésie française, a pour but d'œuvrer pour la protection des oiseaux, de leurs habitats et de la biodiversité en travaillant avec la population dans le cadre d'une gestion durable des ressources naturelles. Elle compte aujourd'hui 80 adhérents. Pour en savoir plus, rendez-vous sur le site internet : www.manu.pf

Pratique et pédagogique, ce site est accessible aux amateurs et aux professionnels, petits et grands amoureux des oiseaux y trouveront des clefs pour préserver les oiseaux de Polynésie française.

Adhérent possible à l'association Manu : 5 000 FCFP

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Vous rencontrez les membres de Manu lors des réunions du bureau organisée chaque premier vendredi du mois à 16h30 au local de la SOP, au premier étage du 16 de la rue Jean Gilbert, quartier piétonnier du commerce à Papeete. Il y a plusieurs sorties par semaine. ■