

# Attitudes, knowledge and practices affecting the Critically Endangered Mariana crow *Corvus kubaryi* and its conservation on Rota, Mariana Islands

ADRIENNE F. SUSSMAN, RENEE ROBINETTE HA and HILARY E. HENRY

**Abstract** The population of the Critically Endangered Mariana crow *Corvus kubaryi* on the island of Rota, Commonwealth of the Northern Mariana Islands, has decreased dramatically in recent years. It is unclear to what extent negative practices by people, such as inappropriate land use or persecution of crows, have contributed to this decline. We conducted a public opinion survey to document ongoing practices towards the crows on Rota, to assess residents' knowledge of and attitudes towards the birds, and to gauge potential responses to a government-instituted land incentive programme. Enumerators administered surveys in person during August 2011. Most of the 573 respondents were native Chamorro residents (75%) and more than half were landowners (62%). A majority of respondents (72%) considered environmental issues 'very important' and 76% knew of the Mariana crow's Critically Endangered status. Fewer respondents (55%) expressed concern about the bird going extinct. A number of respondents condoned shooting and chasing crows (17 and 52%, respectively), suggesting that residents may be harassing the birds. Chamorro landowners on the island were more likely to have negative attitudes towards the crows and to know people who persecute the crows than other island residents. Education was positively correlated with knowledge and concern about the crow and environmental issues, suggesting that new educational programmes on Rota may help improve residents' attitudes towards the species. In addition, we recommend a revision of current land-use regulations and implementation of a monetary compensation programme for owners of crow nesting habitat to improve landowners' attitudes and practices.

**Keywords** Attitudes, *Corvus kubaryi*, crow, threatened, incentive, landowner, Mariana Islands, Rota

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## Introduction

The small size and isolation of island ecosystems makes their native bird species particularly vulnerable to extinction (Newton, 1998; Steadman, 2006). Loss and degradation of habitat, predation or competition from introduced species, and human persecution are the major causes of decline for island birds (Butchart et al., 2006). All these factors have affected bird populations in the Commonwealth of the Northern Mariana Islands, which are home to a unique endemic avifauna that includes many threatened species. Most dramatically, on Guam the introduction of a predator, the brown tree snake *Boiga irregularis*, has decimated several bird species (Savidge, 1987). Bird populations on the neighbouring island of Rota have also suffered declines, and two species are Critically Endangered (IUCN, 2011): the Mariana crow *Corvus kubaryi* and the Rota white-eye *Zosterops rotensis*. The brown tree snake has never been reported on Rota, suggesting that the reasons for the decline of these species are distinct from those on Guam (Amar et al., 2008).

The Mariana crow population on Rota has declined precipitously, from an estimated adult population of 1,350 in 1982 (Engbring et al., 1986) to c. 120 in 2008 (Zarones et al., 2014). Although nesting success has not changed significantly over this time (Zarones et al., 2014), first year mortality is extremely high (Ha et al., 2010). This suggests that the primary cause of the decline is yearling and adult mortality, perhaps a result of predation by feral cats and persecution by humans (Ha et al., 2010; Zarones et al., 2014). From February 2010 to February 2013 University of Washington researchers tracked 27 Mariana crows, using radio telemetry, and recovered 12 carcasses. Ten of the 12 carcasses were confirmed as feral cat predations by a veterinarian, a pathologist, and several biologists familiar with avian remains (R. Ha, pers. comm.). Human persecution is probably also a factor in the decline of the crow. Anecdotal evidence from researchers on the island suggests that harassment of the crows, especially chasing them away from nesting sites, is common. Crows have occasionally been shot (Morton et al., 1999) out of frustration with the land-use regulations for crow protection or, less frequently, for food. With the declining crow population, reports of crows killed by humans have become rare.

Current land-use regulations on Rota create tension between threatened birds and the human inhabitants of the

island. Because of the declining Mariana crow population much of the island has been declared critical habitat and is protected by the Endangered Species Act, requiring inhabitants to obtain a permit for building, developing or homesteading on their lands. Although some more recent regulations have attempted to ease regulations for homesteaders (Schroer, 2005), the regulation process is not transparent. In practice, regulations require that all landowners on the island obtain a permit for any development of their lands. This regulation is intended to protect crow habitat, but the rules are applied even to areas of the island that crows do not use. In the Mariana Islands only native Chamorro residents can own private land; foreigners can only lease land. As Chamorro residents make up the majority of landholders on the island, they are the group most affected by land-use regulations.

Mariana crows require primary limestone forest as nesting habitat and forage selectively in other areas (Morton et al., 1999; Ha et al., 2011). Limestone forest makes up the majority of the island (Fig. 1a), although some of this habitat is not primary growth. The majority of the island is public or government-owned lands (Fig. 1b). A portion of the public land is designated as wildlife sanctuaries (the western peninsula and central mountain), and there is a small protected area on the south coast. The area on the south coast has several nesting crow pairs but the mountain and peninsula areas are not good nesting habitat for the species. Wildlife sanctuaries therefore protect little crow habitat on Rota. All other public lands are, in practice, commons, which residents use for hunting, and for obtaining fuelwood and, especially, fence posts for their farms.

Despite the apparent abundance of nesting habitat (Fig. 1), crows tend to breed on the perimeter of the island, most likely because of the favourable weather and elevations. It is unknown what percentage of the limestone habitat has been fragmented or destroyed by farming, development and typhoons, but it is likely that habitat loss and degradation, leading to reduced foraging and nesting opportunities, is an additional factor in the decline of the crow (Plentovich et al., 2005; Amar et al., 2008). Typhoon damage can take several years to repair if it is primarily to foliage, and decades if entire trees are lost. We suspect that the current land-use regulations are only moderately effective in protecting core crow habitats, and may foster negative attitudes and promote harassment of the birds.

Other programmes have found it useful to assess public opinion and knowledge of an ecological problem before implementing management solutions (Messmer et al., 1999). We conducted a survey of Rota residents to determine current attitudes and knowledge regarding threatened birds, especially the Mariana crow, and whether practices of the residents could be affecting the birds. We also asked for residents' responses to potential incentive programmes, as such programmes have been effective in other areas

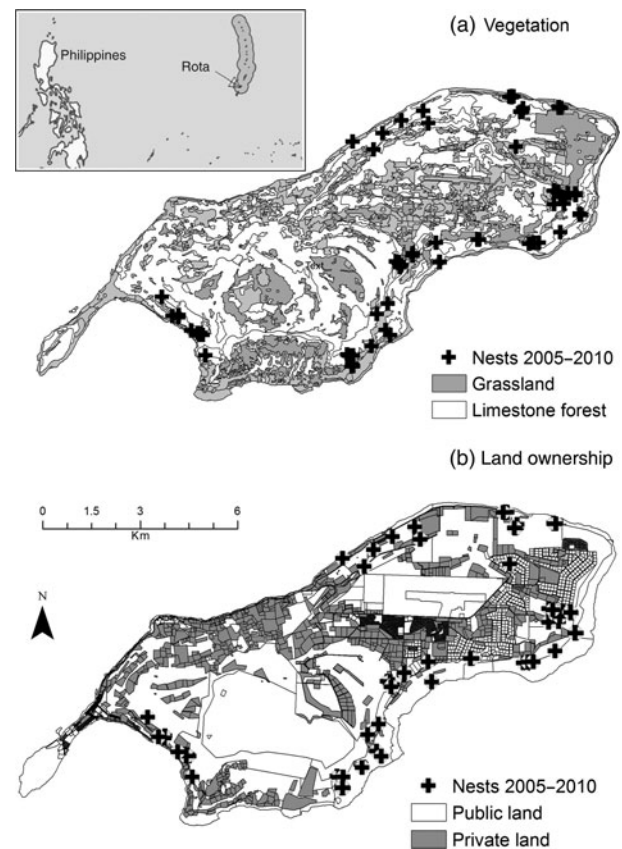


FIG. 1 Rota, showing confirmed crow nests (2005–2010) and (a) the vegetation (grassland and limestone forest), and (b) land ownership (public and private-owned land). Note that not all private landowners permitted researchers to enter their land, and therefore searches for nests were mainly on public land.

(Wilcove & Lee, 2004). We hope that a better understanding of the relationship between people and birds on Rota will help guide future conservation efforts and policy.

## Methods

### Survey

The survey was developed in consultation with colleagues at the University of Washington and the Mariana Islands Division of Fish and Wildlife. Preliminary versions of the survey were tested for clarity with Chamorro-speakers on the nearby island of Saipan, in the Mariana Islands. The survey consisted of 72 questions, organized into five sections (Supplementary Material 1). Questions about the Mariana crow referred to this species by both its common and Chamorro name, *aga*.

Sixteen local residents on Rota administered the surveys in person during 11–19 August 2011. The 2010 U.S. Census estimate for the population of Rota was 2,527, suggesting our sample size of 573 would provide a 95% confidence

TABLE 1 Eigenvalues and percentage variance explained of the seven components of the PCA, with Varimax rotation, of the survey response data (see text for details).

	1	2	3	4	5	6	7
Eigenvalue	2.88	2.04	1.83	1.66	1.61	1.38	1.26
% variance explained	12.53	8.86	7.95	7.23	6.99	6.01	5.47

interval of  $\pm 3.6\%$  for the most ambiguous results. We targeted the survey to Chamorro landowners, as these residents would be most affected by any land incentive programme, and are most likely to affect Mariana crow populations through their decisions about land use. We also included some non-landowners, many of whom are not Chamorro and have lived on Rota for a limited time. Survey enumerators were encouraged to survey their friends, family and acquaintances. We also advertised the survey in public locations around the island, so that any interested residents could take the survey in a central location. All respondents were over the age of 18, and no more than two respondents from the same household could participate, to reduce bias. Despite efforts to make the survey available to all island residents, our sample may not be representative of the entire island population, and we therefore limit our generalizations of the results beyond the survey respondents. Surveys were collected from enumerators daily, and transcribed and coded appropriately.

### Statistical analyses

We report two types of results: a summary of the raw survey responses based on all 72 questions, and analyses of components obtained through a principal components analysis (PCA), used to identify inter-correlated responses that could be represented by a single component. We performed iterative PCAs, using a varimax rotation to create orthogonal components, removing variables with low extraction values ( $< 0.3$ ) and low component scores ( $< 0.4$  on all components). This process led us to discard several variables and retain 23 of the original survey questions. We then used parallel analysis to determine the number of components to retain (Zwick & Velicer, 1986). As this analysis suggested our data supported up to seven significant components we repeated the PCA, specifying seven components, and calculated those components' scores using the regression method.

The resulting components were well defined, with each variable contributing to only one component with a score of 0.45 or higher (the eigenvalues are in Table 1 and the 23 variables included in the analysis, and their loading scores, in Table 2). We interpreted the resulting seven components

based on the contributing variables. Each component summarized the responses of several related questions (Table 3).

We calculated correlations of these seven components with education level (years in school) and stated income. We also used one-way ANOVAs to examine ethnicity and land ownership effects on responses, with post-hoc Tukey's HSD (honest significant difference) tests to identify significant differences. Ethnicity and land ownership were described by a single categorical variable. As only Chamorro residents can own land on Rota, land ownership rates varied significantly by ethnicity,  $\chi^2(df = 1, n = 561) = 88.74, P < 0.001$ . A small number of respondents ( $n = 21$ ) identified as non-Chamorro landowners. Because of the small size of the group we did not include these respondents in land ownership and ethnicity analyses. Thus, our three categories for ethnicity/land ownership were: Chamorro landowner, Chamorro non-landowner, and non-Chamorro non-landowner. The proportion of landowners did not differ significantly by gender,  $\chi^2(df = 1, n = 553) = 2.69, P = 0.10$ . All analyses were performed with *Excel 2010* (Microsoft, Redmond, USA) and *SPSS 2010* (IBM, Armonk, USA), with  $\alpha = 0.05$  for all analyses.

### Results

The 573 respondents were primarily Chamorro (74.9%, 14.0% Filipino) and more than half were male (51.8%, 42.9% female, 5.3% did not respond). Most respondents were 30–50 years old (mean  $39.25 \pm SD 12.68$  years) and had lived on Rota for 15–45 years (mean  $30.21 \pm SD 14.76$  years). Households consisted of 2–3 adults (mean  $2.59 \pm SD 1.14$ ) and 1–2 children (mean  $1.65 \pm SD 1.60$ ). The majority of respondents (69.2%) described themselves as involved in household decisions. Of the 60.2% of those who stated their annual household income, the median annual income was USD 10,000–19,000. A large number of respondents (62.4%) were landowners.

Environmental issues were much less important than political and economic concerns for most respondents, with 4.5% of respondents ranking environmental issues as the most important problem on Rota, compared with 34.0% for political and 43.3% for economic concerns. Despite this, 73.5% of respondents still considered the environment 'very important'. Litter and waste management were the most commonly mentioned environmental issues (52.2% of surveys). Most respondents (52.3%) felt that environmental conditions on the island were deteriorating.

More than three quarters of respondents (76.2%) were aware that the Mariana crow is threatened, and 81.0% knew it is endemic to Rota. Many respondents (42.2%) had seen the bird before, and 72.3% were able to distinguish it from similar-looking birds on the island. As discrimination from similar looking birds was not perfect, reported

TABLE 2 The 23 survey questions retained (see text for details) in the PCA (Table 1), with their loading value and principal component (1–7). Variables that contribute with a loading of  $>|0.50|$  are shown in bold (Jolliffe, 2002).

Question	Loading value	Principal component
If the <i>aga</i> were to become extinct on Rota, how much would it bother you?	−0.46	1
Having native crows on Rota makes me feel proud to live here.	−0.50	1
Under some circumstances, it is OK to shoot a crow.	0.57	1
The needs of people always come before the needs of animals.	0.46	1
I would be happy to have a crow nesting on my property.	−0.71	1
I would be pleased if there were no crows on Rota.	0.68	1
It's okay to chase crows away from my property.	0.69	1
It's sometimes okay to build without using a permit.	0.80	2
People should have the right to do whatever they like on their own property.	0.54	2
People should be able to develop their property even if there are threatened species on their land.	0.61	2
I would apply for a permit before building on my land.	−0.64	2
Living on Rota is an important part of my identity.	0.83	3
I feel connected to the land on Rota.	0.80	3
About how many times did you see a crow in the last month?	0.78	4
About how many times did you see a Rota white-eye in the last year?	0.77	4
Chosen rank of environmental issues, in order of most important concerns	−0.57	5
Are environmental issues important to you?	0.60	5
Number of birds correctly identified as threatened/not threatened	0.50	5
Number of pictures of black birds correctly identified	0.58	5
Do you agree with the laws about the environment on Rota?	0.77	6
People should not be allowed to use their land in ways that put animals in danger.	0.50	6
I know people who shoot crows or chase them off their land.	0.68	7
Most people on Rota think that the crows are a bother.	0.45	7

crow sightings may be inflated. Familiarity with the Mariana crow was much greater than with Rota's other threatened native bird, the Rota white-eye. Only 29.6% of respondents knew that the Rota white-eye is threatened.

Only half of respondents (55.0%) stated they would be somewhat or very bothered if the Mariana crow were to go extinct, and 20.5% would not be bothered at all. Some respondents also condoned shooting crows (16.9%), or chasing them away from their property (51.9%).

Most respondents (68.3%) believed there was too much government involvement in people's lives on Rota. About two-thirds of respondents (66.8%) agreed ('somewhat' or 'very much') that people should have the right to do whatever they like on their own property and 44.9% agreed that people should be allowed to use their land in ways that could harm threatened species.

Although only 17.6% of landowners felt that the presence of the Mariana crow on their property cost them money in missed development opportunities, the estimated amount of money lost was substantial, averaging c. USD 10,000 per year. The majority of all respondents (79.9%) felt that the government should compensate people who cannot develop their land because of the presence of threatened species, and most landowners (54.2%) agreed that an incentive programme would make the situation feel fairer. Given the option of three possible incentives for protecting threatened species, 39.7% of landowners preferred money, 38.1% preferred a land-swap for land outside crow habitat, and

22.2% preferred free fencing. Fencing is expensive on Rota and deforestation for fence posts is common.

The PCA analysis showed that respondents with higher levels of education tended to have a more positive attitude towards the Mariana crow and may be more tolerant of building and development regulations (Table 3). Respondents with higher incomes were more likely to say that being from Rota was an important part of their identity, showed greater concern about environmental issues, and had a greater knowledge of threatened species (Table 3).

The ANOVA analysis showed that Chamorro residents had significantly more negative attitudes towards the *aga* and land development than did non-Chamorros (Table 4, Fig. 2). Landowners were more likely than non-landowners to have seen threatened birds, and of non-landowners, Chamorros had seen more threatened birds than non-Chamorros. Chamorro landowners showed significantly more concern and greater knowledge about environmental issues than Chamorro non-landowners but neither group differed in this respect from non-Chamorro non-landowners (Fig. 2).

## Discussion

The survey revealed that residents of Rota felt a mixture of concern and frustration regarding environmental issues and legislation on their island. Although respondents were



TABLE 3 Correlations of the seven principal components (with their interpretation) obtained for the survey data (Tables 1 & 2) with education and income level. Significant correlations ( $P < 0.05$ ) are shown in bold.

Principal component	Interpretation	Correlation with	
		Education (n = 338)	Income (n = 421)
1	Attitudes about the <i>aga</i> (high scores indicate more negative attitudes)	<b>-0.11</b>	0.01
2	Attitudes about development (high scores indicate more frustration with land-use regulations)	<b>-0.11</b>	0.02
3	Rota identity (high scores indicate that being from Rota is important to the respondent's identity)	0.001	<b>0.16</b>
4	Bird sightings (high scores indicate that the respondent reported seeing threatened birds frequently)	-0.08	0.03
5	Attitudes/knowledge about environmental issues (high scores indicate greater stated importance of environmental issues & greater knowledge of threatened species on the island)	0.05	<b>0.15</b>
6	Environmental values (high scores indicate greater agreement with current land use laws on Rota)	0.03	0.01
7	Assessment of others' attitudes regarding <i>aga</i> (higher scores on this component suggested the respondent believed other residents had negative attitudes/practices)	<b>0.11</b>	0.03

TABLE 4 Results of one-way ANOVAs comparing ethnicity/land ownership for the seven principal components obtained for the survey data (Tables 1 & 2). See Table 3 for full interpretation of each component. Ethnicity/land ownership categories are Chamorro landowners, Chamorro non-landowners, and non-Chamorro non-landowners. Significant effects are shown in bold, and effect sizes are measured as partial  $\eta^2$ . All significant main effects were at  $P = 0.01$ . 95% confidence intervals for differences between groups were calculated using post-hoc Tukey–Kramer tests for all comparisons with significant main effects. Significant pairwise comparisons are shown in bold.

Principal component & interpretation	$F(2)$	$\eta^2$	Chamorro landowners vs Chamorro non-landowners	Chamorro landowners vs non-Chamorro non-landowners	Chamorro non-landowners vs non-Chamorro non-landowners
(1) Attitudes about the <i>aga</i>	<b>5.23</b>	0.0	<b>0.10–0.78</b>	-0.23–0.32	<b>0.01–0.78</b>
(2) Attitudes about development	<b>8.29</b>	0.03	<b>0.19–0.86</b>	-0.22–0.33	<b>0.20–0.97</b>
(3) Rota identity	<b>14.15</b>	0.06	<b>0.11–0.64</b>	<b>0.32–0.97</b>	-0.11–0.64
(4) Bird sightings	<b>29.16</b>	0.11	<b>0.003–0.53</b>	<b>0.67–1.31</b>	<b>0.35–1.09</b>
(5) Attitudes/knowledge about environmental issues	<b>5.97</b>	0.03	<b>0.12–0.66</b>	-0.19–0.47	-0.13–0.63
(6) Environmental values	0.54	0.002			
(7) Assessment of others' attitudes about the <i>aga</i>	0.56	0.002			

aware of environmental issues and the fate of the Mariana crow, many believed these issues were secondary to economic and governmental problems plaguing the island. A large number of respondents were proud of their island and its natural heritage but others expressed negative attitudes regarding the Mariana crow, and condoned practices that are harmful to the species. These results suggest that negative attitudes towards the crow are pervasive on the island, especially among Chamorro landowners. On the other hand, our results showed that respondents with more education were less likely to hold negative attitudes about the *aga*, and disagreed less with land-use regulations.

The negative correlation between education and disapproval of land-use regulations illustrates the role of education in generating support for conservation programmes

in general. Comments from the survey also show that many of the respondents do not have a strong understanding of the Mariana crow's value or ecological needs. For example, a number of respondents suggested that the crow should be confined to a single area of the island, or moved to another island. A better understanding of the birds' breeding and foraging behaviour, including their need for separate territories in primary limestone forest, could help residents understand why certain pieces of privately owned land need to be maintained as crow habitat.

In other conservation programmes, public outreach and education, such as marketing campaigns that foster pride in threatened animals, have proven effective for improving public attitudes (Butler, 2000). In some cases, environmental education and awareness alone has been sufficient to

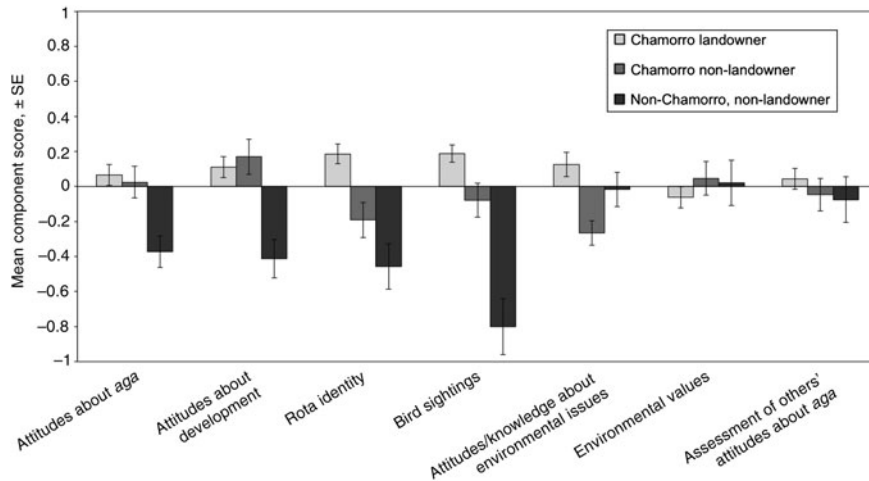


FIG. 2 Scores for the seven principal components (Table 3) for each of the three ethnicity/land ownership categories (Chamorro landowner, Chamorro non-landowner, Non-Chamorro, non-landowner). High scores for 'Attitudes about *aga*' and 'Attitudes about development' indicate negative attitudes.

change behaviour (Butler, 2000; Damerell, 2010; van der Ploeg et al., 2011). At the time of the survey we had already begun several outreach efforts. These focused primarily on the Mariana crow, which could explain why many Rota residents recognized the crow, but not the Rota white eye, as a threatened species. Expansion of education about threatened species on Rota could build on the success of these previous programmes and help establish threatened species as an important part of Rota's identity. Many survey respondents felt pride in being a resident of Rota but did not necessarily associate this pride with the crow. Given that landowners identify strongly with Rota, making the crow an element of Rota's identity could be important for the conservation of the species.

Economists note that in most areas, however, education and legal restrictions are not sufficient to ensure compliance by private landowners, especially when those restrictions create losses of time or money (Mayer & Tikka, 2006). The survey found that despite the protection afforded to the Mariana crow by current threatened species regulations and education programmes, some residents still harass and shoot crows. Market incentives of some kind may therefore be necessary to promote protection of threatened species on Rota. Market incentives can create contentious situations, as only certain community members suffer the costs of lost development or reap the benefits of payments, but are a necessity when species must be protected on privately owned lands (Polasky et al., 1997). The interests of private landowners and the public are often at odds in these scenarios, as threatened species represent a common good whereas the inability to develop land represents a personal cost (Polasky et al., 1997). On Rota, Chamorro residents had less favourable attitudes towards the Mariana crow than other people. As Chamorro residents are more likely to own land, this could be because they carry a disproportionate burden for the protection of the species. Although incentives could create tension in the community, they could also

help ameliorate the negative feelings Chamorro residents have towards the crow.

Our results suggest that respondents would be open to some sort of government incentive programme. In ranking landowners' preferences for three potential compensation programmes (monetary compensation, a land swap or a free fencing programme) we found that landowners slightly preferred money to land, but that the sums requested were, in general, unrealistically large (the median requested sum was USD 10,000; the annual income on the island is USD 10,000–19,000). Comments showed that most landowners who cannot develop their land wish to use it for farming or to develop it for tourism. Although some preferred a land exchange programme, Rota is a small island and such a programme would be difficult in practice. Giving undeveloped land to landowners as compensation would promote the development of that land, and with two threatened bird species on the island such a programme would be a large environmental risk. The slight preference for money over land, and the complicated and risky logistics of a land exchange programme, lead us to recommend a monetary compensation programme over the other available options. Despite the islanders' frequent need for fence posts, few survey respondents were interested in this option, probably making it an ineffective conservation incentive.

The implementation of any monetary compensation programme on Rota would need to occur jointly with a revision to the island's land-use regulations. To win the residents' support for conservation of the Mariana crow negative attitudes and resentment towards the birds need to be reversed. Making the land-use regulations and compensation process as transparent as possible could help ensure that the community accepts them. Conservation efforts often fail when the community does not understand the measures, feels they are ineffective, or is not involved in their administration (Webber et al., 2007). To make regulations clear and meaningful for Rota residents we propose that development

should only be regulated on lands that are primary crow nesting habitat, as identified by Ha et al. (2011). Simple, clear rules about land usage, backed by data, could reduce much of the frustration towards the Mariana crow without greatly affecting the species. In turn, improving public perception of the species could reduce some harmful practices, such as shooting, chasing and harassing.

Opening non-essential areas of crow habitat to landowners would also reduce the number of residents reimbursed in an incentives programme. If only the landowners with crows actively nesting on their land need to be compensated, discussions about monetary compensation may become more reasonable. Little of the Mariana crow nesting habitat is good farmland, so it is likely that the most extravagant payment requests came from landowners of other properties, who would not actually be eligible for compensation. With a smaller pool of landowners involved, the necessary compensation would probably be less than suggested by our survey respondents, but ideally still large enough to satisfy landowners and improve sentiments towards the government and the crow. A smaller monetary incentive could also be made available for residents without key nesting habitat who nevertheless choose to maintain their property for crow foraging.

We believe three steps are required to improve attitudes and practices towards the Mariana crow on Rota: improve education about the species, clarify land-use regulations, and institute a monetary compensation programme. These steps will not only curtail human persecution of the Mariana crow but will also help turn residents into advocates for the species. With a declining population the crow's only chance for recovery is through enlisting the people of Rota as environmental stewards who recognize the importance and value of the species.

The results of this survey were presented to the Department of Fish and Wildlife in 2011, and an experimental land incentive programme was implemented in mid 2012. Owners of viable crow habitat are given an annual sum of USD 500 as long as they allow access for population monitoring and feral cat control on their land for that year. We do not have data on the status of the programme but we hope to conduct a follow-up survey to assess whether residents' attitudes and knowledge have changed since the implementation of the programme. Other conservation efforts on the island have increased since the survey was launched, including a large-scale feral cat control programme. There is some initial evidence that the decline of the Mariana crow population has slowed.

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