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CITATION:

Vincenot, Christian Ernest ...[et al]. Public awareness and perceptual factors in the conservation of elusive species: The case of the endangered Ryukyu flying fox. *Global Ecology and Conservation* 2015, 3: 526-540

ISSUE DATE:

2015-01

URL:

<http://hdl.handle.net/2433/196069>

RIGHT:

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Contents lists available at ScienceDirect

## Global Ecology and Conservation

journal homepage: [www.elsevier.com/locate/gecco](http://www.elsevier.com/locate/gecco)

Original research article

## Public awareness and perceptual factors in the conservation of elusive species: The case of the endangered Ryukyu flying fox

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## ARTICLE INFO

## Article history:

Received 23 October 2014

Received in revised form 7 February 2015

Accepted 7 February 2015

Available online 13 February 2015

## Keywords:

Public attitude

Fruit bat

Megabat

Biophilia

Contingent valuation

Social survey

## ABSTRACT

The success of biological conservation initiatives is not solely reliant on the collection of ecological information, but equally on public adherence to protection programs. Awareness and perception of target species condition the intensity and orientation of public involvement in conservation initiatives. Their evaluation is critical in the case of elusive animals, for which incertitude surrounding public attitude is maximized. This study featured the first assessment of public awareness and perceptual factors of a megabat (*Pteropodidae*). We investigated inhabitants' feelings, knowledge, and frequency of sightings related to the solitary Ryukyu flying fox (*Pteropus dasymallus*) on Ishigaki island, Japan. The willingness to protect this species and mitigate its impact on agriculture was evaluated through contingent valuation. This fruit bat was not credited with aesthetic or scientific values, yet atypically did not trigger negativistic attitude. While respondents were reasonably aware of its existence, they were largely ignorant of its ecological importance. An overall lack of interest for this species was revealed by a low willingness-to-pay for its protection. The rejection of lethal control as means to protect orchards was, however, unequivocal. The success of *P. dasymallus* preservation may depend on the prior implementation of education programs focusing on aesthetic, ecological and utilitarian values.

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## 1. Introduction

Environmental attitude has been shown to be an indicator of support for wildlife conservation (Knight, 2008; Sharp et al., 2011) and one of the leverage points for successful policies (Clark and Wallace, 1998; Zinn et al., 1998). Actually, social psychological and philosophical explanatory variables, such as environmental attitudes, ethical positions, biophilic factors, and social norms, have proven to be superior predictors of the willingness-to-pay (WTP) than those of socio-economy (Martín-López et al., 2007; Spash et al., 2009). This fact has become clear to environmental sociologists and economists in recent decades, yet it has not been fully integrated in the fields of conservation biology and wildlife management (Aldrich et al., 2007; Ojea and Loureiro, 2007). While attitudinal studies have been undertaken to evaluate public perception of a particular species for conservation purpose (see early works on large predators, e.g. Kellert, 1985), economic valuations

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**Fig. 1.** Physical characteristics of the Ryukyu flying fox. Belonging to the megabats, this fruit bat is phenotypically and behaviorally distinct from most microbats. It is comparatively much larger, has a fox-like face, vocalizes within the human hearing range, and feeds mainly on fruits.

(e.g. through revealed or stated preference methods) seem to remain the principal metrics sought and relied on. The latter offer an efficient way to evaluate public interest in a species and, in some cases, estimate appropriate budget allocations in conservation programs (e.g. Jakobsson and Dragun, 2001 and Becker et al., 2007). Nonetheless, lumped economic valuations provide little information on the psychological incentives for public adherence or rejection and fail to identify particular socio-cultural issues linked with the species of interest. Studies on perceptual factors are therefore important for the case of elusive species, in which uncertainty surrounding potential explanatory variables (e.g. awareness, knowledge, and affect) exists. To date elusive animals have received limited attention in the literature (e.g. Oli et al., 1994), though an understanding of perceptual factors may enhance conservation success for these species.

In this study, we used a social survey to investigate public awareness and perceptual factors in the case of an endangered solitary fruit bat inhabiting subtropical Japanese islands, the Ryukyu flying fox (*Pteropus dasymallus*, Temminck 1825). A contingent valuation (CV) component was also included in our survey instrument in order to assess the willingness to act to conserve this species.

## 2. Background

### 2.1. Target species

The Ryukyu Flying Fox (*Pteropus dasymallus*) is a medium-sized island fruit bat (140 mm forearm length, 80 cm wingspan, ca. 450 g) of the Pteropodidae family (Fig. 1). It is endemic to the Ryukyu archipelago in Japan, to Taiwan, and to three islands of the Philippines. Unlike most flying foxes species, which live in large colonies, *P. dasymallus* is remarkably solitary

(Nakamoto et al., 2012). With a broad phytophagous diet and high metabolism, it is one of the main pollinators and the most important seed disperser on these islands (Funakoshi et al., 1993; Lee et al., 2009). Based on knowledge gained on other flying fox species (Cox et al., 1991; Fujita and Tuttle, 1991), the conservation of *P. dasymallus* may be crucial for the survival of native plant species (e.g. *Erythrina variegata* and *Ficus* spp.) as well as for forest regeneration and the fauna that depends on it.

In the last decades, this species has suffered a strong demographic decline over its whole geographic range, mainly due to deforestation, to extreme climatic events, and, in some parts of its range, to hunting (Heaney et al., 2008; Ota, 1992). For instance, in Taiwan, it has been driven close to extinction, with only small numbers surviving in the wild (ibid.). This has led to the classification of this species as near-threatened (NT) by the IUCN. In Japan, several allopatric subspecies are recognized, which are considered from near-threatened (NT) to critically endangered (CR) in national and prefectural lists, and with some of them (*P.d. daitoensis* and *dasymallus*) elevated to the status of Natural Monument (DoD, 2000; Okinawa Prefecture, 2012a; RDB, 2012). However, no conservation plan or public information campaign has been devised to this date.

Recently, increased predation by flying foxes on orchards and agricultural crops has attracted the attention of local media and has prompted Okinawa Prefecture to launch an investigation, which is still underway (Okinawa Prefecture, 2012b). The extent of the damage remains unclear, but, for instance, preliminary figures from governmental sources, not published in the academic literature, stated 19 million yen damage on citrus orchards in the two villages surveyed (Motobu and Nago) on Okinawa island (Isa, 2013). Most farmers openly consider flying foxes as pest and would support the culling of this endangered species to protect crops (Vincenot, pers. obs.).

## 2.2. Factors influencing public awareness and perception

The ecological value of *P. dasymallus* may engender public support for its conservation (Czech and Krausman, 2001; Czech et al., 1998), but this may be offset by the potential awareness of ongoing conflicts with farmers. In addition, bats have historically been shown to trigger aversion and generally have a poor likeability (Knight, 2008). Finally, knowledge and information level could strongly condition the general public opinion. *P. dasymallus* is, on one hand, solitary, nocturnal, roosts in high trees deep in the tropical forest, and generally avoids close contacts with humans. On the other hand, it has the size of a large bird, covers relatively long distances (commonly over 30 km from pers. obs.) daily, intensely vocalizes when fighting conspecifics for access to fruiting trees, and, most importantly, periodically visit sparse urban areas. These contrasted characteristics make it challenging to foresee the level of awareness of the population as regards this species, which is elusive yet often in plain sight.

## 3. Methodology

### 3.1. Survey design and administration

We selected Ishigaki, the largest island in the Yaeyama group, to serve as case study. With about 48'000 inhabitants for a total area of 242 km<sup>2</sup>. Ishigaki City Ward (2013), it features a population and territory large enough to get quantitative information, while keeping the rural attributes typical of other islands of the Ryukyu chain. Also, the local *P. dasymallus* population is reportedly one of the largest and densest of all (Heaney et al., 2008; Vincenot, pers. obs.), thus increasing the likelihood that respondents on this island have higher knowledge and information levels than in other areas. Lastly, agriculture represents an important sector of activity for Ishigaki, resulting in the island's arable land being covered mainly with sugarcane, pineapple, and banana plantations.

Our target population consisted of all adults residents. We decided to exclude foreign nationals because they represented a negligible proportion of the population (less than 0.5%). We sampled randomly based on geographic location. We estimated that the best data collection method would involve sampling at workplaces by personal delivery of the questionnaires and pick up a few days later. Proceeding this way was time-consuming but proved to increase the quality of responses in preliminary trials.

### 3.2. Survey constructs

The questionnaire was revised to reduce navigational errors (Groves et al., 2009) on the basis of feedback from three pilot runs. The final version began with a section on respondent socio-demographics, including sex, age, place of residence, professional sector of activity, time lived on the island, salary. The survey then aimed at assessing the following aspects through discrete choice questions grouped in dedicated sections:

1. Awareness of flying foxes and frequency of contacts.
2. Feelings toward flying foxes.
3. Perception of the threats faced by flying foxes.
4. Awareness of conflicts with farmers.

Then, following a one-page information page about the Ryukyu flying fox (i.e. basic information, conservation status, conflicts with humans, and governmental actions; with important information in bold font):

5. Opinion about governmental actions.
6. Willingness to act for the protection of flying foxes and local agriculture.
7. Trust in institutions.

Answers to specific questions were only required from the respondent if they were relevant to his previous declarations; this was enforced through visual aids to navigation (e.g. arrows) and additionally through indications (e.g. “if you answer X, proceed directly to page Y”).

As regards point 6 (“Willingness to act...”), one discrete choice question inquiring about the acceptance of flying fox culling was preceded by a contingent valuation (CV) component (Carson and Hanemann, 2005) designed using the recommendations of the National Oceanic and Atmospheric Administration (NOAA) Panel on CVM (Arrow et al., 1993). Two hypothetical scenarios were proposed for consideration sequentially (i.e. the respondent was asked to read the first scenario and answer questions relevant to it before being subjected to the second scenario). In the first one (CVM1), the respondent was asked to imagine that the government would have no choice but to introduce a tax to finance a management plan that would guarantee the survival of *P. dasymallus* for the next century, and would decrease by 30% the amount of crop destruction by this species. The terms of the second scenario (CVM2) were essentially the same, except that the management program would aim only to reduce crop destruction without any action to conserve *P. dasymallus*. In each case, the respondent was then asked to state whether his household would accept this tax. In case of acceptance, two classic double-bounded dichotomous choice questions with linear bids (Carson and Hanemann, 2005; Hanemann et al., 1991) followed to estimate superior and/or inferior limits for the amount that the respondent’s household would accept to pay per year for a duration of 10 years. The bid amounts were distributed randomly among questionnaires. Bids were assumed to represent the household willingness-to-pay rather than the individual (Jakobsson and Dragun, 2001).

If the respondent declared no willingness to pay for the provision of the good in the introductory yes/no question, he was asked to choose a reason among the following list (for CVM1):

1. I do not want to pay for flying fox conservation.
2. Society has more important problems than these.
3. I do not care about flying fox conservation and crop damage.
4. The government should deal with this with existing funds (\*).
5. I do not have enough information to decide (\*\*).
6. I object to the way the question is asked (\*).
7. I cannot afford to pay.
8. Others (\*).

In the case of the CVM2 scenario, only two answers were modified, namely:

1. I do not want to pay for a program not involving also flying fox protection.
3. I do not care about crop damage.

Multiple choices were accepted. The simple asterisk marks choices considered as protest bids. If the respondent chose points representing both zero bids and protest bids, we considered him as zero-bidder on the basis that, even if freed from his protest motives, he would logically still not wish to pay. We realized during the study that reason 5 (“I do not have enough information to decide”), which is normally meant as a way to indicate perceived flaws in the survey instrument and is traditionally considered as a protest bid, was here “hijacked” by many zero-bidders, who used it as fallback option. During follow-up interviews to investigate the matter, none of the interviewees having had chosen reason 5 pointed out data missing to take a decision. Most of them confessed, however, not wishing to pay, but feeling that only reason 5 would be indirect enough to allow them to convey their choice without “giving a bad image of themselves” and would therefore be the only culturally acceptable reply. Taking into consideration this unexpected socially desirable responding (SDR) bias (Johnson et al., 2010), we decided to report two WTP estimates: (i) the optimistic estimate (i.e. we consider only positive bids and clear zero bids, and we ignore all protest bids), and (ii) the conservative estimate (i.e. we consider positive bids, zero bids, and treat any protest bid, incl. reason 5, as zero bid). This treatment of protest bids follows best practices (Halstead et al., 1992) and provides the largest range of WTP estimates possible.

### 3.3. Data analysis

Survey data was input in a database using a form to ensure correct codification of answers and reduction of processing errors. We performed post-survey adjustments to identify outliers in the data. Barplots were used to study the distribution of answers among the sample. Correlations between variables were also systematically explored using the Spearman test based on pairwise complete observations.

For CVM calculations, the ContingentValuation CRAN package by Morawetz (2012) was used to compute an interval data model. This model performed bivariate probit regressions with linear functional form, in which coefficients of both dichotomous choice payment questions of the double-bounded valuation were identical and the covariance between the



**Table 1**

Awareness of respondents about flying foxes in general (QII.1) and the Ryukyu flying fox more particularly (QII.2). This contingency table was created by cross-classifying the yes/no answers to the set of questions QII.1 (“Have you heard of flying foxes?” and “Have you ever seen a flying fox?”) and QII.2 (“Have you heard of flying foxes living on Ishigaki island?”, and “Have you ever seen flying foxes on Ishigaki island?”).

QII.1	QII.2		
	Never heard	Heard	Heard & Seen
Never heard	45	0	0
Heard	7	18	0
Heard & Seen	0	0	101

two errors was considered null (i.e. the WTP is assumed not to change between the first and second dichotomous choice payment question) (Alberini, 1995). We evaluated two different models. In the first model, the WTP function regressed the bid response (coded as 1 for yes and 0 for no) on the bid amount as well as on the income:  $q1+q2 \sim bid1+bid2|income$ , with  $q1$  and  $q2$  being the answer of the respondent to dichotomous choice payment question 1 and 2 resp.,  $bid1$  and  $bid2$  being the bid amount for each dichotomous choice question. In the second model, we increased the set of explanatory variables to include personal information about the respondent as well as the answers to question 2.1 (“Have you heard of/Have you ever seen flying foxes?”) and to the pre-CVM questions (i.e. 4.1 & 4.2, about the opinion of the respondent regarding current conservation and crop protection measures respectively):  $WTP = q1 + q2 \sim bid1 + bid2|Sex + Birthyear + Experience + Income + Household + q21 + q41 + q42 + BidAmount$ . Since both models gave similar WTP estimations, with only a narrowing of the confidence interval, we discuss hereafter the values returned by the second model only.

## 4. Results

### 4.1. Response rate and sample quality

After post-processing, we obtained 171 complete observations, which represent a unit response rate of 86.5%. Considering the small target population, this sample size conferred a theoretical 8% confidence interval (95% C.L.), which was sufficient given that most of our answers follow a coarse ordered response scale. In terms of representativeness, observed distributions fit well with expected ones for most variables (e.g. sector of activity,  $p = 0.76$  (Fisher)). Bias was visible in the age distribution of our sample, in which people over 70 years old were underrepresented. This can be explained by the fact that many people this age were living in retirement homes, which we did not have access to. We recognize the potential effect of this bias and acknowledge that we cannot, with our current data, formally determine its magnitude.

### 4.2. Awareness of flying foxes and frequency of contacts

QII.1: Have you heard of flying foxes? [Yes/No]

Have you ever seen flying foxes? [Yes/No]

QII.2: Have you heard of flying foxes living on Ishigaki island? [Yes/No]

Have you ever seen flying foxes on Ishigaki island? [Yes/No]

59% of the respondents reported having seen *P. dasymallus*, whereas 30% had not even heard of it (Table 1). The set of questions also showed that the people’s main source of knowledge regarding flying foxes in general was linked with the presence of *P. dasymallus* on Ishigaki island (Table 1).

QIII.2 How often to you spot flying foxes? [n /day... 1/year]

Respondents who reported in QII.2 having seen flying foxes on Ishigaki island were asked to estimate the frequency at which sightings occur by selecting among class intervals ranging from “several times a day” to “less than once a year”. Half of the respondents of this subsample declared seeing *P. dasymallus* several times a month or more frequently, indicating that the people who see flying foxes see them relatively often (Fig. 2).

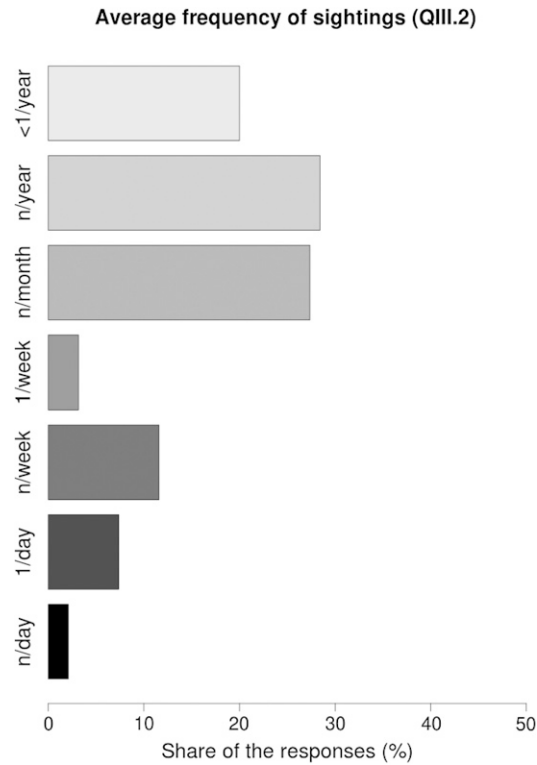
### 4.3. Feelings toward flying foxes

This part of the questionnaire aimed at understanding the traits and psychological affect respondents linked to flying foxes. Respondents (who reported knowing about flying foxes) were asked to score the fitness of various descriptors of the animal using a scale ranging from 0 (not at all) to 5 (high) (Fig. 3).

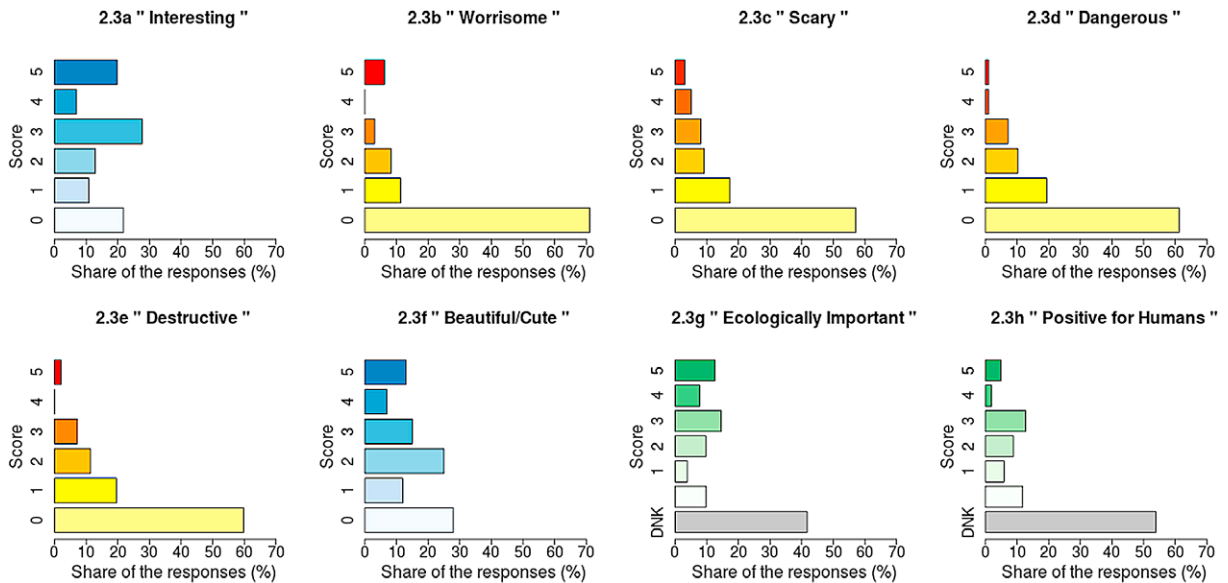
#### 4.3.1. Aesthetic and scientific value

When suggested the adjectives “Interesting” to describe the Ryukyu flying fox, the distribution of the scores proved roughly uniform (mean 2.47, s.d. 1.77). This suggests the absence of real opinion in the sample, either due to variable sensitivities to the question, or due to poor knowledge about the species.

The respondents again scored rather uniformly the “beauty and/or cuteness” of the animal (mean 2.0, s.d. 1.69), but this time with a clearer tendency toward low values as shown by 65% of the respondents giving a score of 2 or less.



**Fig. 2.** Frequency of sighting of *P.dasymallus* (in class intervals ranging from *n/day* to less than 1/year) (*n* = 95).



**Fig. 3.** Assessment of the affect of respondents toward the Ryukyu flying fox. Scores ranging from 0 (not at all) to 5 (high) were attributed for various adjectives used to describe the species (*n* = 101).

#### 4.3.2. Negative prejudices

We tested for several foreseeable prejudices about *P. dasymallus*. First, “scary” seemed like an obvious instinctive reaction to the physical appearance and life style of this species. In the same vein, “dangerous” seemed legitimate for the same reasons, and also possibly because of the public health concerns that have emerged in other countries with recent epidemics of fatal contagious diseases borne by flying foxes (e.g. Nipah in the Pacific, Hendra in Australia, Ebola in Africa, and Lyssaviruses worldwide). Taking into consideration potential awareness of damage to crops, interviewees were also asked

to score the attribute “destructive”. Lastly, “worrisome” was also directly mentioned to cover at once the whole spectrum of anxiogenic factors.

Surprisingly, all these attributes engendered the same kind of negatively skewed distribution with very low mean values.

#### 4.3.3. Benefit from flying foxes

To assess the intrinsic ecologicistic and utilitarian value of *P. dasymallus*, the respondent was asked to rate to what extent he considers this species to be “ecologically important” and more globally “positive for humans”. The most striking feature of the answers collected is the large proportion of respondents who answered that they did not know (DNK) (resp. 42% and 54%). The scores attributed to the ecological importance of *P. dasymallus* were uniformly distributed (mean 2.77, s.d. 1.7). Furthermore, the value of flying foxes for humans was judged mediocre (mean 2.0, s.d. 1.6).

#### 4.4. Perception of the threats faced by flying foxes

We asked the respondents (who had reported seeing flying foxes) about their opinion on the demographic status and trend of the population on Ishigaki island. The intention behind asking the lay public’s vision on this matter was not to get a rigorous ecological estimate, but instead to understand how the threats faced by the population were generally perceived.

*QIII.1 What do you think of the size of the flying fox population? [Too large/Large/Fine/Small/Too small]*

To this question, half of the people answered that they did not know. While 29% answered “Fine”, the population seemed to be judged as rather small (with 17% answering “Small”, and 2% “Too small”). On the other end of the spectrum, only 1% answered “Large” and, interestingly, nobody answered “Too large”, which at the same time indirectly reveals that people do not feel bothered by *P. dasymallus* (Fig. 4, left).

*QIII.3 Compared to the past, how has your frequency of sightings of flying foxes progressed? [Much increased/Increased/Stable/Decreased/Much decreased]*

This was as an indirect way to query the feeling of demographic trend of the flying fox population. Only 13% of the respondents were optimistic (12% answered “Increased” and 1% “Much increased”) (Fig. 4, right). When filtering out the observations by time lived on the island by the respondents, this feeling of decline became even more pronounced. Selecting only inhabitants with over 10 years experience on the island, 10% were transferred from the “Stable” to “Decreased” category. When tightening further the filtering to >25-year residents, the share of respondents thinking that the population has declined grew to 62.5% (with 10% of “Much declined”), against only 3% who answered that it “Increased” (and nobody that it “Much increased”). This illustrates that, while the majority of respondents reported a decreasing trend of the population, the most experienced residents perceived this phenomenon the most strongly. This link between feeling of demographic decline and length of residency was also statistically conspicuous ( $\rho = -0.3, p < 0.05$ ). Moreover, there was a significant correlation between this feeling and the frequency of sightings ( $\rho = -0.38, p < 0.01$ ), showing that people who are the most conscious and knowledgeable about flying fox abundance reported a stronger sense of decline.

#### 4.5. Awareness of conflicts with farmers

In a separate survey built upon targeted interviews with farmers, we showed that flying foxes have been sporadically damaging crops on Ishigaki island, yet generally with little impact on local agriculture, especially compared to usual pests. Here, we wanted to assess the awareness of this issue by the public.

*QIII.5: In your opinion, do flying foxes damage agricultural crops? [Yes/No/DNK]*

Once more, the prevalent reply (68%) was “I do not know” (DNK). Furthermore, 21% believed that flying foxes were not damaging crops, leaving only 11% aware of this fact.

#### 4.6. Opinion about governmental actions

As mentioned earlier, all the questions discussed from this point forward were submitted to the respondent after requesting from him to read a summary about *P. dasymallus* (incl. state of knowledge about conflicts with farmers, and actions taken by the authorities so far). Therefore, we considered henceforth that the respondent was equipped with sufficient information to express opinions and make choices in regard to this topic.

*QIV.1: Based on your own knowledge complemented by the information given previously in this document, what do you think of the actions taken by authorities to conserve the Ryukyu flying fox? [Very good/Good/Fine/Insufficient/Very insufficient/DNK]*

*QIV.2: Based on your own knowledge complemented by the information given previously in this document, what do you think of the actions taken by authorities to assist farmers in protecting their crops? [Very good/Good/Fine/Insufficient/Very insufficient/DNK]*

In the face of our previous assumption, the proportion of respondents expressing no opinion to these two questions was high (60% and 69% resp.) (Fig. 5). This may be due to the amount or type of information provided. Though the survey was piloted, some respondents may have had difficulty forming an opinion based on the information provided in the survey questionnaire. Another explanation may be that Japanese culture traditionally promotes collectivism and



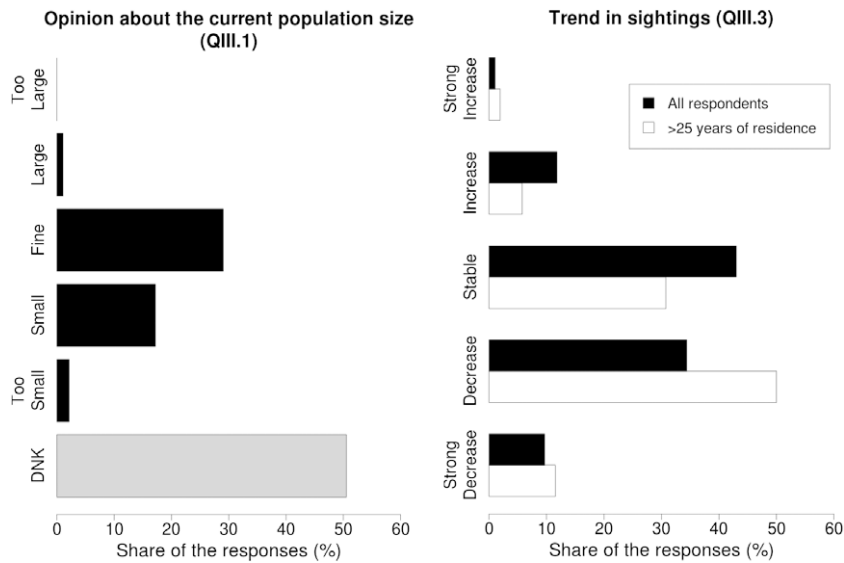


Fig. 4. Assessment of the perception of the *P. dasymallus* population ( $n = 95$ ). (Left) General opinion about the current size of the population (Right) Trend in sightings reported by all respondents (in black) and by respondents having spent over 25 years on the island (in white).

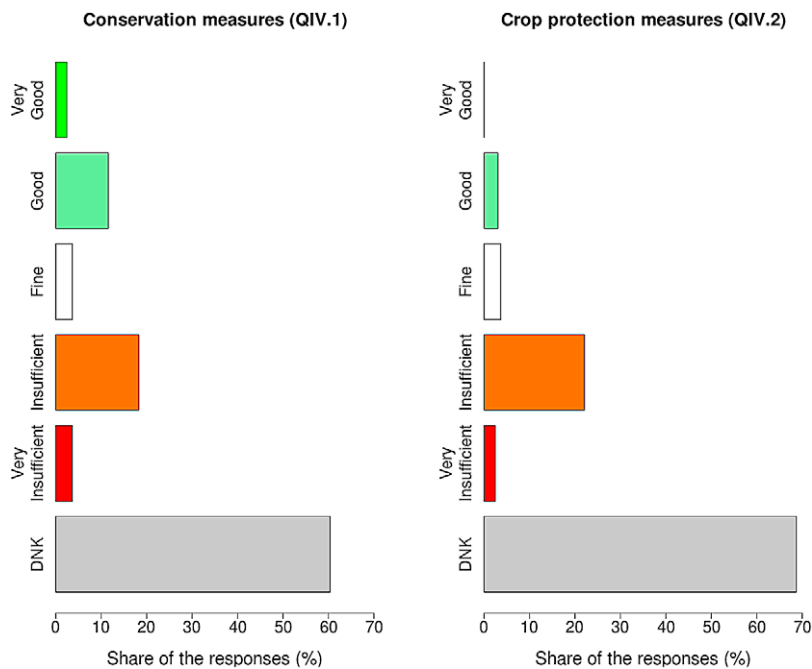


Fig. 5. Opinion about actions taken by authorities to this date as regards *P. dasymallus* conservation (left) and crop protection (right) ( $n = 157$ ).

undermines individual initiative (Harzing, 2006). Besides dialectic thinking, an acquiescence bias results in people being more prone to understatement, middle-response style, and to falling back to “socially-safe” indecisive responses (Hamamura et al., 2008; Horler and Yamasaki, 1986). In answers to both questions, the very low proportions of people stating extreme points of view (i.e. from 0 to 3% for “Very good” or “Very insufficient”) may corroborate this lack of will to take position.

Beside these joint observations, a bimodal pattern of answers (“Good” and “Insufficient”, 11% and 18% resp.) is visible for the first question. In contrast, for the second question, actions by the authorities to help farmers protect their crops were unambiguously judged “Insufficient” (22%, against ~3% for each of the other categories, except “Very good”, which noticeably did not gather a single vote).

**Table 2**

Results of WTP estimation using two different regression models for both valuation scenarios (CVM1 and CVM2). CVM1 refers to the scenario in which both flying fox conservation and crop protection are hypothetically implemented. CVM2 inquires the WTP in the case of crop protection only. Two WTP values are reported here. The optimistic WTP was calculated on the basis of positive bids and zero bids only, whereas the conservative WTP expresses the value obtained when accounting also for protest bids, no-bids without reason given, and ambiguous bids (as described in Section 4.7.1). The 95% confidence interval is given in parenthesis following each estimate.

	CVM1					CVM2				
	Estimate	StdErr	t.value	p.value	Sig.	Estimate	StdErr	t.value	p.value	Sig.
<b>Model 1</b>										
(Intercept)	1.013	0.463	2.189	0.036	*	1.161	0.502	2.314	0.030	*
Income	-0.019	0.107	-0.173	0.864		0.002	0.115	0.021	0.983	
bid1 = bid2	0.000	0.000	6.019	0.000	***	0.000	0.000	5.366	0.000	***
LogLik			-61					-42		
WTP—optimistic			1441 (968–1895)					1135 (776–1494)		
WTP—conservative			943 (634–1240)					730 (499–962)		
<b>Model 2</b>										
(Intercept)	-4.078	2.014	-2.025	0.055	***	-3.460	3.265	-1.060	0.312	
Sex	0.163	0.497	0.328	0.746		0.951	0.695	1.370	0.198	
Birthyear	0.063	0.024	2.571	0.017	*	0.008	0.039	0.197	0.847	
Experience (i.e. years on the island)	0.010	0.021	0.496	0.625		0.096	0.034	2.797	0.017	*
Income	-0.038	0.132	-0.285	0.778		0.330	0.155	2.132	0.056	***
Household size	0.064	0.169	0.378	0.709		0.045	0.232	0.192	0.851	
2.1 (Awareness)—Answer 1: Knows FF	0.382	0.796	0.480	0.636		-3.809	1.528	-2.494	0.030	*
2.1 (Awareness)—Answer 2: Knows & Seen FF	-0.531	0.645	-0.823	0.419		-2.110	1.083	-1.949	0.077	***
4.1 (Opinion conservation measures)	0.042	0.146	0.290	0.775		0.535	0.186	2.874	0.015	*
4.2 (Opinion crop protection measures)	0.350	0.174	2.010	0.057	***	0.343	0.231	1.481	0.167	
Bid Amount	0.000	0.000	1.561	0.133		0.001	0.000	3.148	0.009	**
bid1 = bid2	0.001	0.000	5.254	0.000	***	0.001	0.000	4.622	0.001	***
LogLik			-42					-26		
WTP—optimistic			1491 (1142–1803)					1131 (923–1344)		
WTP—conservative			976 (748–1180)					728 (594–865)		
Likelihood ratio test statistic			38					32		
p-value			1.74E–05					1.99E–04		

Signif. codes: 0.

- \* 0.05.
- \*\* 0.01.
- \*\*\* 0.001.
- \*\*\*\* 0.1.

#### 4.7. Willingness to act for the protection of flying foxes and local agriculture

##### 4.7.1. Contingent valuation

The CV component of this study comprised two valuation scenarios. The first one questioned about the value attributed to both flying fox conservation and crop protection (CVM1), while the second was restricted to crop protection (CVM2). This differential approach aimed at elucidating in a concise manner the respective importance given to flying fox conservation and crop protection. Item non-responses were removed from the dataset.

##### CVM1: Flying fox conservation and crop protection

Considering ambiguous bids (i.e. answer 5 discussed in Section 3.2, as well as refusal to pay without specifying a reason), the effective share of protest bids represented at most a third of the observations, which lies within ranges reported in other valuation studies in the field of conservation (Halstead et al., 1992; Jakobsson and Dragun, 2001). A significant proportion of the remaining answers were zero bids (33 obs.), which already indicated a strong unwillingness to pay. The optimistic WTP reached 1491 yen/household/year (1142–1803, 95% C.I.) for a period of 10 years, whereas the conservative WTP was estimated around 976 yen/household/year (748–1180) for the same duration.

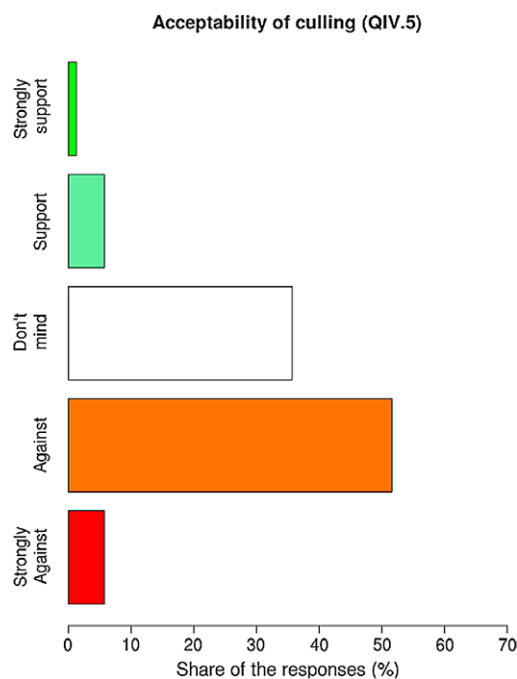
##### CVM2: Crop protection only

When the scenario was restricted to a tax aimed at protecting crops only, the number of positive bids decreased significantly (29 bids only) while 13 respondents refused to pay for a program not involving flying fox conservation (reason 1). The mean optimistic WTP dropped to 1131 yen/household/year (923–1344, 95% C.I.) and in the conservative case 728 yen/household/year (594–865) (see Table 2).

##### 4.7.2. Acceptability of killings

QIV.5: If a management program that involved killing flying foxes to protect crops was proposed, what would you think of it? [Much agree/Agree/Do not mind/Disagree/Strongly disagree]

The aim of this question was to understand how respondents would react in the face of systematic culling of flying foxes to protect crops as requested by farmers. It seemed important to evaluate this point in anticipation of possible proposals by



**Fig. 6.** Acceptability of the killing of *P. dasymallus* to protect agricultural crops (QIV.5: “If a management program that involved killing flying foxes to protect crops was proposed, what would you think of it?”) ( $n = 157$ ).

**Table 3**

Stepdown hierarchical regression of the factors leading to willingness to contribute to the first contingent valuation scenario (CV1: flying fox conservation & crop protection) (QIV.3) and to the acceptance of culling by farmers (QIV.5). The maximal model included all relevant information collected through the questionnaires.

QIV.3	Logit model	Variables	Estimate	Std. error	z value	Pr(>  z )	
Willingness to contribute		(Intercept)	-0.7513	0.2933	-2.561	0.01043	*
		Beauty/Cuteness (II.3f)	0.8738	0.3057	2.858	0.00426	**
		Ecological value (II.3g)	0.4924	0.2919	1.687	0.09164	****
	Model fitness	AIC				92.81 (down from 194.1)	
		p-value				0.001	
		Hoslem test				0.95	
QIV.5	ANOVA model	Variables	Estimate	Std. error	t value	Pr(>  t )	
Attitude toward culling		Awareness (II.1)	-0.30405	0.09971	-3.049	0.0031	**
		Interest (II.3a)	-0.34362	0.08298	-4.141	8.43E-05	***
		Worry (II.3b)	0.23007	0.08122	2.833	0.00582	**
		Scare (II.3c)	0.19038	0.0875	2.176	0.0325	*
		Utilitarian value (II.3h)	-0.18021	0.08123	-2.218	0.02933	*
		Scary × Worry (II.3b * II.3c)	-0.11662	0.05274	-2.211	0.02983	*
	Model fitness	AIC				191.61 (down from 204.25)	
Adj. R <sup>2</sup>					0.41		
p-value					6.54E-09		

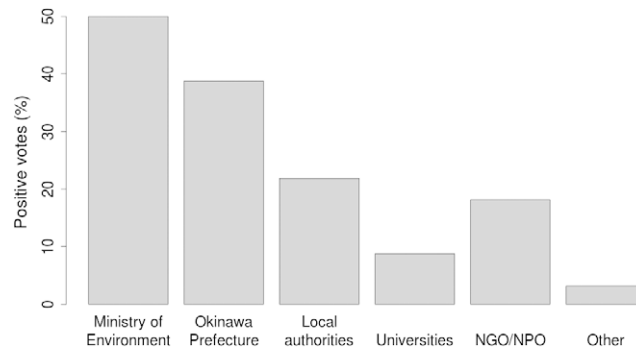
Signif. codes: 0.

- . 0.05.
- \*\* 0.01.
- \*\*\* 0.001.
- \*\*\*\* 0.1.

Okinawa Prefecture following their 5-year program in response to agricultural damage. The responses were unequivocal—only 6.9% respondents were in favor of such a program, whereas 57.4% opposed it (Fig. 6).

#### 4.7.3. Comparison between contingent valuation and attitude as regards culling

The result obtained to the question assessing the acceptability of flying fox killings astonishingly contrasted with the high prevalence of zero bids (and low economic price put on the protection of this species) in the CV component of this study, and suggested that two different psychological processes may be at work here. We performed correlation tests followed by stepdown hierarchical regression with all the explanatory variables available in the survey form to elucidate the



**Fig. 7.** Trust in institutions. Respondents were requested to choose who they would trust to administer a fund aimed at managing the Ryukyu flying fox. Multiple choices were accepted. Results are reported here in share of respondents having voted for each organization ( $n = 225$  votes from 160 respondents).

psychological factors that could explain this reply pattern (Table 3). In the case of the willingness to financially contribute to a conservation program (QIV.3, the primary yes/no question asking whether the respondent would be ready to contribute to the tax), the species' "beauty/cuteness" (QII.3f) was the strongest and only significant factor. Another explanatory variable was selected by stepdown regression, namely "Ecological Value" (QII.3g), but remained weaker and insignificant ( $p = 0.09$ ). The attitude toward the culling of *P. dasymallus*, on the other hand, was not influenced by these factors but was most dependent on awareness (QII.1) and scientific interest (QII.3a). The utilitarian value of the species (QII.3h) also proved important, as were negativistic attitudes (QII.3b and QII.3c).

#### 4.8. Trust in institutions

*QIV.6: If a fund as stated in question IV.3 was raised for the conservation of flying foxes and the reduction of damage on crops, who would you like for its administration? (Multiple choices accepted)*

This question was asked at the end of the questionnaire to judge the trust that respondents had in institutions. The motive underlying this inquiry was that the Ryukyu islands, which used to be an independent kingdom until the beginning of Showa expansionism at the end of the 19th century, has historically been oppressed and discriminated against by mainland Japan (Taira, 2009). While efforts have been made in recent years by the central government to develop Okinawa prefecture in particular, the region remains the poorest in the country. This, combined with other recent political concerns, perpetuate certain defiance against national authorities. It seemed then interesting to see whether the provision entity would be important here. The Ministry of Environment received the largest support, but, despite that multiple choices were accepted, exactly half of the respondents did not vote for it. Okinawa prefecture followed with 39% of positive respondents (Fig. 7).

## 5. Discussion

### 5.1. Public perception

As a solitary frugivorous bat, *P. dasymallus* is naturally elusive. Yet, at the same time, it is geographically spread throughout this rural insular territory, on which it travels long distances every night and regularly ventures into populated areas. Half of the respondents reported seeing a flying fox on Ishigaki island, with a median encounter rate of ca. 1/month. More remarkable was that around one-third of the residents surveyed had never even heard of the existence of this species. This represents a significant part of the population that needs to be taken into consideration in the design of environmental education programs.

The evaluation of public perception of this flying fox confirmed some prejudices but also revealed interesting peculiarities. It should be noted that respondents were largely unaware of depredation caused by flying foxes (QIII.5). This suggests that conflicts between farmers and *P. dasymallus* cannot motivate the people's current attitude toward the species.

First, respondents assigned a medium to low aesthetic and scientific value to this species. These were foreseeable dispositions regarding a bat, and, together with answers to questions about its ecological and anthropocentric value (cf. 4.3.3), can be interpreted as a general lack of knowledge about the key role of flying foxes in the island's ecosystem and the benefits (e.g. medical insights to fight contagious viruses; see Wang et al., 2011 and Zhou et al., 2014) that can be gained through their study. Accordingly, in face-to-face follow-up interviews done randomly, flying foxes were mostly considered useless and rare were the interlocutors who had even a vague idea of what they could be good for. This is arguably the most crucial finding of this study, and the strongest leverage point to gain public support for conservation policies as shown

through the tight link between the perceived interest and utilitarian value and the opposition to culling as solution to conflicts with farmers (cf. Section 4.7.3).

Surprisingly, respondents clearly expressed a total lack of anxiety and negativistic attitude toward flying foxes. This state of mind was well epitomized by the 71% people assigning a 0 to “worrisome” as qualifier. This was very much unforeseen given conclusions of previous studies on bats (Knight, 2008; Thiriet, 2010). Flying foxes have notable phenotypic and behavioral characteristics that distinguish them from most other bats (Fig. 1; see also Altringham, 2011), which may offer an explanation for these unexpected findings. Size (Bitgood et al., 1988) as well as morphological and behavioral similarity to humans (Plous, 1993) have been shown to provoke a positive affect. More generally, our results push for caution when generalizing results on microbats to megabats and calls for sequel social studies on *Pteropodidae*.

Lastly, the pattern of answers regarding demographic health and trend in sightings demonstrates that respondents perceived that flying foxes have been threatened. Incidentally, with no hard data (e.g. ecological population survey) backing up the consecutive IUCN and local assessments, the observation in this study of a general feeling of endangerment among residents comes as a support for the listing of this species.

## 5.2. Support for management policies

### 5.2.1. Public opinion about current governmental actions

When asked about their opinion on current flying fox conservation and crop protection measures, respondents in majority avoided taking a stand on both matters (Section 4.6). Among clear-cut answers, while current conservation measures receive a mixed evaluation, respondents judged more unanimously and severely the quality of crop protection actions by the government. This shall come as a surprise for ecologists, as no real conservation plan for the species has actually ever been proposed by Japanese authorities, and even research remains scarce (Heaney et al., 2008; Lee et al., 2009; Ota, 1992). On the other hand, the most authoritative action so far has been the 5-year Wildlife Protection Plan decided in 2012 by Okinawa prefecture, which focuses solely on the collection of data about crop damage by flying foxes and the design of possible “pest control” policies (Okinawa Prefecture, 2012b). As such, there seems to be a gap between legitimate expectations by conservation biologists as regards the situation of this endangered species, and the purely socio-economically-driven course of actions taken by authorities, which proves here to be endorsed by respondents. Such misalignment between expert and public conservation priorities has recently been reported elsewhere (Rogers et al., 2013) and stresses once more the importance of investigating non-market values in conservation planning.

### 5.2.2. Support for potential management plans

As mentioned earlier, people seem relatively aware of the presence of *P. dasymallus* on the island and do not seem to debate its endangerment status. Consequently, it would have been legitimate to expect a significant willingness to act for its protection. However, the high proportion of zero bids in the CVM1 scenario could already be interpreted as a preliminary indicator of poor willingness to pay for the protection of *P. dasymallus*. This was then backed up by even the optimistic WTP (equivalent to 14.6 USD/household/year at the exchange rate of March 2014), which was low compared to values observed in other studies (cf. Wallmo and Lew, 2012 or Loomis and White, 1996 for concurrent valuations of several species). For instance, with very similar methodology, Jakobsson and Dragun (2001) reported a WTP of 29 USD/year for Leadbeater's possum (also an arboreal mammal), while even the Puget Sound Chinook salmon, which obtained the lowest WTP in Wallmo and Lew's 2012 assessment, was credited with several times the WTP observed here (ca. 40 USD/year for 10 years). Furthermore, it should be noted that, compared to these studies, the present hypothetical scenario proposed to finance not only flying fox conservation, but also crop protection.

Arguably, results observed with CVM2 can be seen as a confirmation of the low willingness to act for species conservation. The amplitude of the decrease (about a quarter of the value) in comparison with the reduction in good could be interpreted as a sign of relatively low valuation of *P. dasymallus* conservation. Based on the numerical estimates of these WTPs, one could conclude that people value three times more the protection of crops than the conservation of *P. dasymallus* (the latter reaching then only a WTP of about 300 yen/household/year). This would contrast with studies in other countries, which generally show interest in environmental protection over economic gains (Clark and Wallace, 1998).

As a matter of fact, Japanese perception of wildlife has been repeatedly shown to lack ecologicistic and moralistic bases in favor of dominionistic and negativistic attitudes (Kellert, 1991, 1997). This transpired again in the present work. With this cultural background and growing public pressure from farmers to allow the hunting of Ryukyu flying foxes approaching orchards on Okinawa island, policy makers may be tempted to yield to culling requests in spite of their ecological dubiousness and proven inefficiency in other regions of the world (DAFF, 2009; Thiriet, 2010). This study revealed that, in spite of the prevalent dominionistic attitude, any attempt to lethally control this species for economic reasons would meet a sharp rejection by the people (QIV.6).

What dictated the WTP for protection and the rejection of killings differed markedly. While scientific interest and the perceived value of the species for human were determinant in the latter, aesthetic value was in the former. Roughly speaking, respondents were willing to pay for the conservation of the species for aesthetic reasons, while they wished to prevent its killing for scientific and utilitarian reasons. This is interesting to put in the context of the debate in the community around the main incentive for conservation, with some scientists proposing the “cuteness” of the species (Knight, 2008; Martín-López



et al., 2007; Stanford Environmental Law Society, 2001; Thiriet, 2010; Verbrugge et al., 2013) whereas others argue for its ecological (Czech and Krausman, 2001; Czech et al., 1998) or utilitarian value (Serpell, 2004). This study may suggest that two psychological mechanisms, subtly different, might be observed concurrently, namely the willingness to act to preserve and the willingness to prevent killings, and that the failure to decouple them might explain contradictory results reported in other studies.

### 5.3. Future actions advocated

To our knowledge, this is the first study to investigate public vision of an Old World fruit bat and hypothetical engagement for its management. Thus, no relevant study has been published that could serve as baseline and judge quantitatively of the relative awareness and public perception in the case of our target species. Nonetheless, it seemed that social awareness and general knowledge about *P. dasymallus* in the local population were substandard and insufficient to gain public support for possible conservation programs. Moreover, the perceived inutility of flying foxes coupled with emerging media coverage of conflicts with farmers (and possibly recently public health concerns in other countries) could further undermine such attempts. Such a complex social context has arisen in Australia and has engendered strong socio-political interferences in species conservation decisions (Thiriet, 2010), which could still be avoided in Japan, where the situation is comparatively at an early stage.

Our first recommendation is therefore to start an environmental education campaign to inform residents about *P. dasymallus*. On top of usual outreach activities, this shall also possibly take the form of a better promotion of the species, which is for instance largely absent from touristic brochures. Visual attractiveness was correlated with support for conservation in this study, and more generally, emphasizing cuteness has been shown to be an important vector of sensitization in Japanese culture under the so-called “Kawaii effect” (Nittono et al., 2012). Still, based on the present study, the main efforts in terms of public information should remain focused on advertising the importance of *P. dasymallus* for the local fauna and flora as well as for humans. The utilitarian value has also been reported as one of the top factors influencing consistently attitude toward wildlife across cultural boundaries (e.g. about Japan, see Kellert, 1991). Furthermore, as also mentioned in Czech and Krausman (2001), communicating on the threats that the species faces is crucial. On the contrary, it does not seem necessary to put much effort in convincing people that this bat should not be seen as scary, dangerous, or destructive, because this state of mind has clearly proven to be already prevalent in the population.

Our second recommendation is to start a management program for this species before the situation worsens. Although it was not the focus of this study, the listing of *P. dasymallus*, which was made on the basis of expert opinions only, was backed up here in the lay public by a clear feeling of demographic decline in the Ryukyu flying fox population. Still, considering the scarcity of information available on this species, ecological research projects and population surveys especially are urgently needed to confirm its precise threat level. The present study also calls for investigations on crop damage by flying foxes. Respondents expressed a relatively higher interest in protecting crops than simply preserving *P. dasymallus*. Therefore, it is mandatory to clarify and tackle this issue to gain public support for a management project. Most importantly, policy makers should be aware that the public is strongly opposed to the killing of flying foxes to defend crops, and consequently they should resist the temptation of allowing such measures under the lobbying by a minority.

Finally, the results of this study did not reveal any alarming distrust in national authorities or defiance toward governmental actions. Still, respondents showed an inclination for local forms of administration for wildlife conservation issues (cf. Section 4.8). Hence, management programs for the Ryukyu flying fox may be more readily accepted by the population if prescribed by (or in collaboration with) Okinawa prefecture or local authorities.

### Acknowledgments

The authors wish to thank the people of Ishigaki island, who have kindly accepted to take part in this survey, and Ishigaki City Hall for providing population census data. They are also grateful to Yammie Leung, Takuya Koizumi, Hideaki Nishizawa, and Takuji Noda for their advice regarding the translation of the survey form. The present project was partly financed by a Postdoctoral Fellowship of the Japanese Society for the Promotion of Science (JSPS KAKENHI Ref. 24-02084).

### Glossary

Attitude typology follows Kellert (1997).

**Aesthetic attitude:** Primary interest in the artistic and symbolic characteristics of animals.

**Contingent valuation method (CVM):** Survey-based technique for the valuation of non-market resource. This method relies on stated-choice as the respondent is openly asked whether he would be willing-to-pay for the protection of a resource in a hypothetical scenario.

**Double-bounded dichotomous valuation:** Valuation in which the upper and lower boundaries of the WTP are estimated through the use of a first yes/no question (e.g. “Would you be willing to pay 2000 yen per year?”) and the subsequent use of an adapted follow-up question (e.g. if the respondent answered “No” to the first question, then “Would you be willing to pay 1000 yen per year?”). The bid amount varies between questionnaires.

**Dominionistic attitude:** Primary satisfactions derived from mastery and control over animals, typically in sporting situations.

**Ecologistic attitude:** Primary interest in the environment as a system, in interrelationships between wildlife species and natural habitats.

**Linear bid design:** The different bid amounts used in the contingent valuation question follow a linear function (e.g. 1000, 2000, 3000, 4000, etc.).

**Moralistic attitude:** Primary concern for the right and wrong treatment of animals, with strong opposition to exploitation of and cruelty toward animals.

**Naturalistic attitude:** Primary interest in and affection for wildlife and the outdoors.

**Negativistic attitude:** Primary orientation is an active avoidance of animals due to indifference, dislike or fear.

**Scientific attitude:** Primary interest in the physical attributes and biological functioning of animals.

**Utilitarian attitude:** Primary concern for the practical and material value of animals.

**Willingness-to-pay amount (abbrev. WTP):** Amount of money that the respondent would be willing to pay to contribute in the hypothetical valuation scenario.

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