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Capturing community behavior towards fruit bats conservation in South Sulawesi

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Abstract. Fruit bats have important roles in the ecosystem serving not only as pollinator agents for various high economic values plants but also acting as seed disperser for many plants in the forests. Ecosystem services provided by the bats are still overlooked while the animals also experienced intensive hunting. Lack of knowledge on the importance of the fruit bats in the ecological chain combined with poor public perception of the animals have contributed to the decline of the bats. This research is aimed to examine knowledge, experiences, perceptions, and awareness of community on fruit bats and analyze the relationship of the four aspects towards the conservation behavior of community towards fruit bats in three different regencies of South Sulawesi (Maros, Sinjai and Soppeng). In-depth interviews using questionnaires to community living nearby the roosting habitats of fruit bats were carried out to collect data on knowledge, experience, perception, awareness and conservation behavior. Correlation analysis of Spearman rank was employed to determine the relationships between variables measured with the conservation behavior of community towards fruit bats. The results showed that on total of 90 respondents interviewed in the three regencies, there were differences on the level of knowledge, experience, perception, awareness, and behavior. It was found that Maros had the highest percentage related with conservation behaviour (78%) followed by Soppeng (76%) while Sinjai had the lowest (64%). Meanwhile, the analysis between all variables towards the conservation behavior had also shown that there were differences between variables tested on conservation behavior occurred in the three regencies. In Maros, better knowledge had positive influenced towards conservation behavior while in Sinjai low level of awareness had driven the behavior. In contrary, for Soppeng none of variables can be found influencing the variables tested and this can be due to the existence of local regulation and cultural norms which were enacted by the local government of Soppeng Regency on fruit bat's protection.

1. Introduction

Bats in general have always been overlooked by human and considered as creepy animals [1, 2]. Most people tended to grow phobias and had negative view against bats [2]. In fact, nowadays, bats were negatively viewed as the main agents in transmitting diseases and known to be reservoir hosts for viruses not only infecting human but also domestic and wild animals [3, 4, 5]. This has led to eradication of the bats in their habitat and also clearing of roosting trees by nearby communities [6]. Not many realized that bats have contributed both economic and ecological benefits for human [2]. Billions dollars of agricultural losses have been saved due to the presence of bats [7]. While fruit bats



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in particular have important roles in the ecosystem serving not only as pollinator agents for various high economic values plants but also acting as seed disperser for many plants in the forests [8, 9, 10, 11].

However, many recent studies have reported that the population of bats are declining worldwide and some species threatened including fruit bats due to anthropogenic factors [12, 13, 14, 15]. In the tropics, habitat loss due to forest clearing and land conversion together with hunting and trading for bat meat consumption had become the main causes for decreasing number of bat species [15, 16, 17]. Apart from that, in some areas, bats have been considered as crop raiders which have triggered hunting activities and eradication of some colonies as well as their roosting trees by local communities due to misperceptions on the existence of the animals.

Indonesia has the highest bat diversity in the world and is known to be the habitat of around 200 bat species of 9 families [18]. Out of 9 families, 7 families of bats - Pteropodidae (*Megachiroptera*), Megadermatidae, Vespertilionidae, Rhinolophidae, Hipposideridae, Molossidae, Emballonuridae (*Microchiroptera*) can be found roosting in the island of Sulawesi with around 75 species [19, 20]. The island is strategically located in Wallacea region and has the highest endemism in particular from Pteropodidae family of *Megachiroptera* which commonly are frugivorous [21]. Genera of Pteropodidae found in Sulawesi were *Dobsonia*, *Nyctimene*, *Neopteryx*, *Eonycteris*, *Styloctenium*, *Herpyonicterys*, *Boneia*, *Macroglossus*, *Thoopterus*, *Chironax*, *Rousettus*, *Cynopterus*, *Acerodon*, and *Pteropus* [20]. *Boneia*, *Nepteryx*, *Styloctenium*, and *Herpyonicterys* were recorded only in Sulawesi.

Combination of many factors including misconception and lack of knowledge had made positive contribution of bats ignored and therefore, this will influenced the existence of bats and its conservation in the future. Lack of support from the communities towards bats due to misperception will trigger the behaviour of the communities towards bats. In South Sulawesi Province, major habitats of fruit bats colonies in particular for the endemic Sulawesi fruit bat (*Acerodon celebensis*) and flying fox (*Pteropus alecto*) are located in 8 regencies including Maros, Soppeng, and Sinjai regencies [22]. Not different with other populations, the bats in the region have also faced threats from human and several sites have been identified to be suppliers of bat meat to North Sulawesi [22, 23, 24]. Therefore, it is important to examine pre-disposition factors of behaviour of the community (knowledge, experiences, awareness and perception) nearby the habitat of fruit bats. This study will provide some groundings for all related stakeholders in determining effective management for site-specific wildlife conservation by thorough considerations of social aspects occurring in the community in particular for fruit bats of Sulawesi.

2. Materials and methods

2.1. Study area

The study was carried out in the three regencies of South Sulawesi (Maros, Soppeng, and Sinjai) with fruit bats roosting habitats. In Maros, the roosting site was located in Jenetaesa Village (5°01'24" S and 119°39'53") nearby human settlement. The site was occupied by two species of fruit bats, *Acerodon celebensis* and *Pteropus alecto*. While in Soppeng, the roosting habitat of *P. alecto* was on the trees located in the city center (04°20'57.64" S 119°53'08.07" E). The majority of *A. celebensis* and *P. alecto* were occupied mangrove trees in Samataring Village, Sinjai (05°07'15.01" S 120°17'13.48").



Figure 1. Study area in a) Jenetaesa Village-Maros, b) the city center of Soppeng, and c) Samataring Village-Sinjai.

2.2. Data collection and analysis

Between July to October 2019, samples were taken from 90 respondents of Maros, Soppeng, and Sinjai through in-depth interview by using questionnaires targeting people living adjacent to the roosting sites in each regency. The questionnaires were designed to collect data on knowledge, experience, perception, awareness and conservation behavior towards fruit bats. To further analyses the relationship between variables measured with the conservation behavior of community towards fruit bats, correlation analysis of Spearman rank was employed.

3. Results

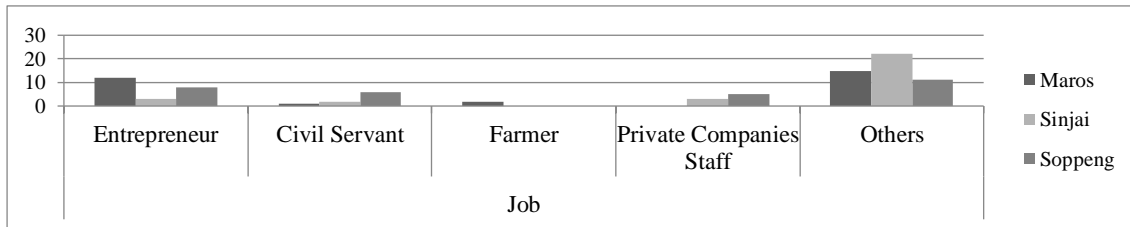
3.1. Characteristics of respondents

In general, most of the respondents in the three regencies (Maros, Sinjai, and Soppeng) has completed their education at senior high school level (40%) and only 14% graduated from elementary school (figure 2). However, there were differences between regencies where the majority of respondents with the lowest educational background was found in Sinjai Regency while higher percentage of respondents attaining university degree can be seen in Soppeng Regency. For the livelihood, most of respondents graduated from the university worked as civil servants in particular in Soppeng Regency (20%). The respondents graduated from elementary, junior and high schools were commonly become farmers, fishermen, entrepreneurs, small traders (figure 2). The age of the respondents in the three regencies were mostly in productive age between 26-65 years old. In Maros Regency, most of the inhabitants were Makassarese (21 out of 30 respondents) while in Soppeng and Sinjai, the majority of respondents were Bugisnese (more than 90%) (figure 2).

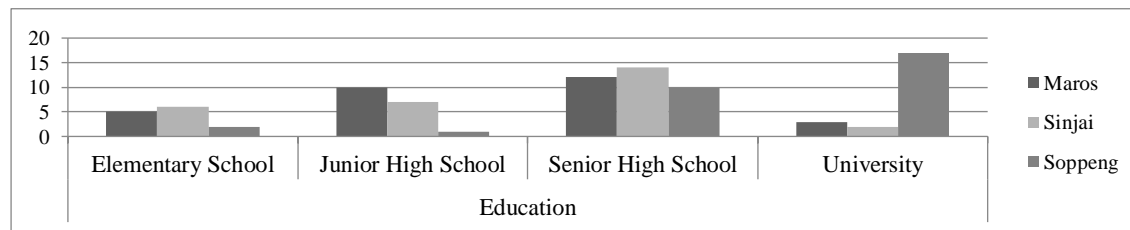
3.2. Knowledge

The results show that there was a decrease on number of fruit bats from time to time based on the observation of respondents nearby roosting areas, in particular in Sinjai and Soppeng. While in Maros, most of respondents observed no decrease, however, the respondents have realized that there were changes in number of bats in certain months (67%). In Sinjai and Soppeng, there were more than 50% of respondents had observed no changes in the population between months (figure 3a).

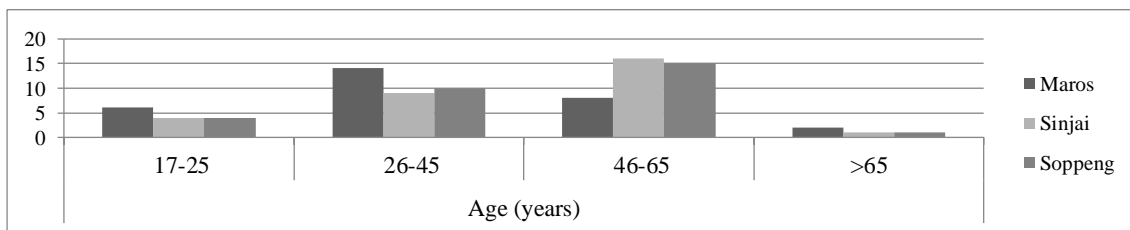
In general, the respondents had minimum knowledge on fruit bat’s physiological process in the three regencies observed (figure 3b). This can be seen from the answers provided by the respondents where more than 90% had false answers. For questions related with animal’s grouping, more than 50% of respondent in the three regencies had classified fruit bats as birds or rodents. However, as regard to flying routes, almost all respondents had answered that the bats used similar patterns every day.



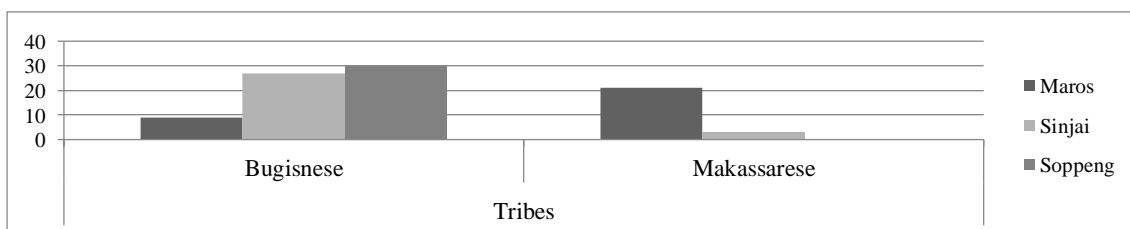
(a)



(b)



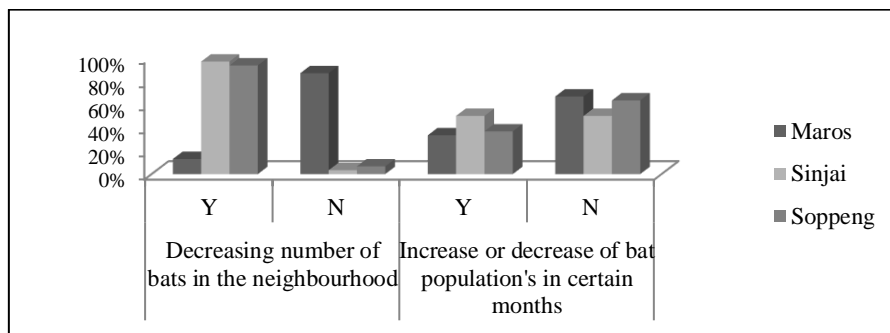
(c)



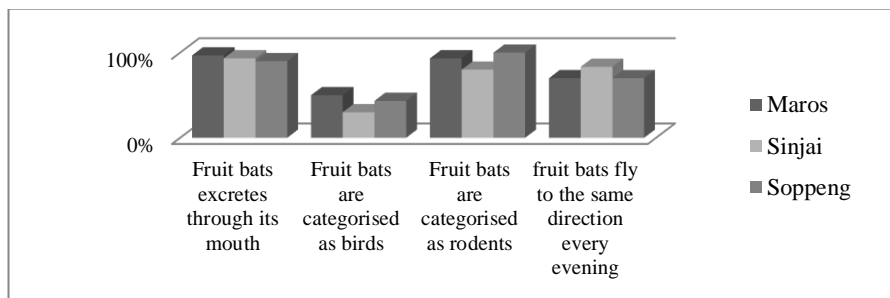
(d)

Figure 2. Characteristics of respondents surveyed in Maros, (a) Job Profile; (b) Educational Level; (c) Age; (d) Tribes in Maros, Sinjai, dan Soppeng (n=90 respondents).

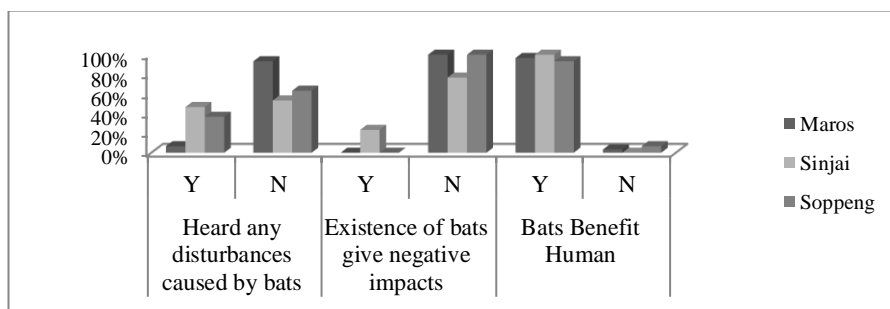
Related with disturbances caused by bats in Maros, around 93% of respondents have stated that there were no disturbances caused by the bats nearby their environment and 100% agreed that there was no negative impact existed from the bat’s presences (figure 3c). This also occurred in Soppeng where no negative impact felt by the locals with only 37% heard about bat disturbances. As regard to benefits gained from the bats, most of the respondents of the three regencies mentioned about the use of bat meats as a cure for asthma. In contrast, 50% of respondents in Sinjai felt disturbed with the presence of bats nearby their neighbourhood and 23% have stated that the bats negatively impacted their lives. However, in the three regencies studied, all respondents agreed that the bats have benefits towards human.



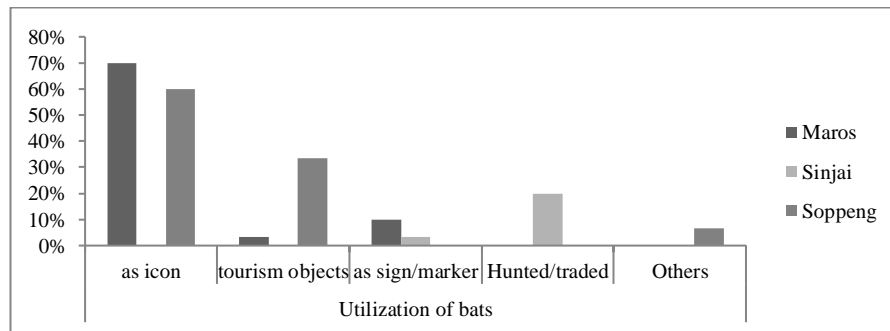
(a)



(b)



(c)



(d)

Figure 3. Knowledge of respondents on (a) population changes of fruit bats in each roosting sites; (b) physical attributes and characteristics of fruit bats; (c) impacts of bats (d) utilization of bats (Y=Yes; N=No) in Maros, Sinjai, and Soppeng.

Based on the study, it was also found that the local community considered bats as icon or village symbol, tourism object or attraction and some stated that the bats have become nature signs. Apart from those views, the locals also targeted the bats as hunting objects (figure 3d). In Maros, there were 70% of respondents viewed bats as village icon or symbol while in Soppeng it was 60%. Around 33% of respondents in Soppeng and 3% of respondents in Maros answered that the bats can be considered as tourism object or attraction. The use of bats as nature signs only found in Maros (10%) and Sinjai (3%). There were 20% of respondents in Sinjai have utilised bats as hunting targets (figure 3d).

The key points questioned to the local community in the three regencies were regarding conservation of fruit bats (Figure 4). The results showed that in general all respondents agreed to conduct conservation efforts. Maros Regency had the highest percentage with 97% followed by Soppeng with 87%. Meanwhile, Sinjai had the lowest with 77%. In terms of conservation support, on regulation enactment, Maros had the highest support with 37%. Respondents in Soppeng have suggested on replanting to be the best option (33%) while for Sinjai more than 50% have provided no answer to the question.

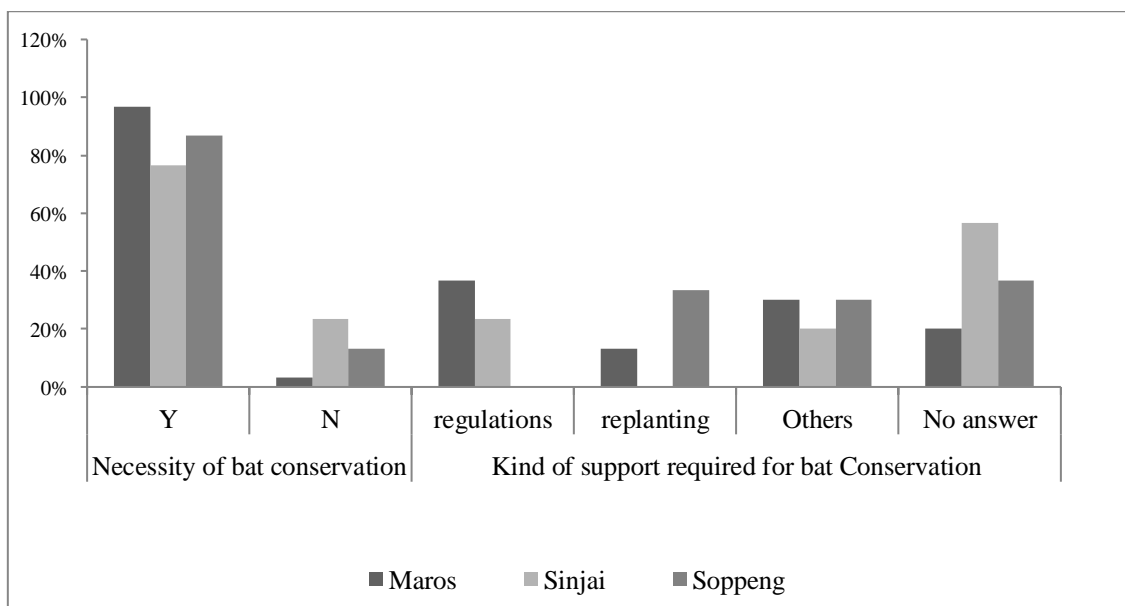


Figure 4. Responses of local community in the three regencies on conservation of bats.

3.3. Experiences

The respondents in the three regencies had different experiences in terms of bat’s existence (figure 5). In Sinjai, there were 57% of respondents claimed bat’s disturbances nearby their neighbourhood. Contrary, the majority of people in Maros had no problems with the existence of bats (63%). This was similar with Soppeng (77%). The type of disturbances experienced in Sinjai were related with bats as fruit pests (67%), bites (10%), smell of faeces (7%), noises (7%), and enter houses (3%). While in Maros, disturbances mostly related with smell of faeces (17%) and noises (13%). In Soppeng, most has complained (50%) bats as fruit pests and also the smell of faeces (13%) as problems. In general, most people in Soppeng (37%) and Maros (23%) were used to the presence of bats in their environment. Only some locals in Sinjai had attempted to expel or even hunt the bats (17%).

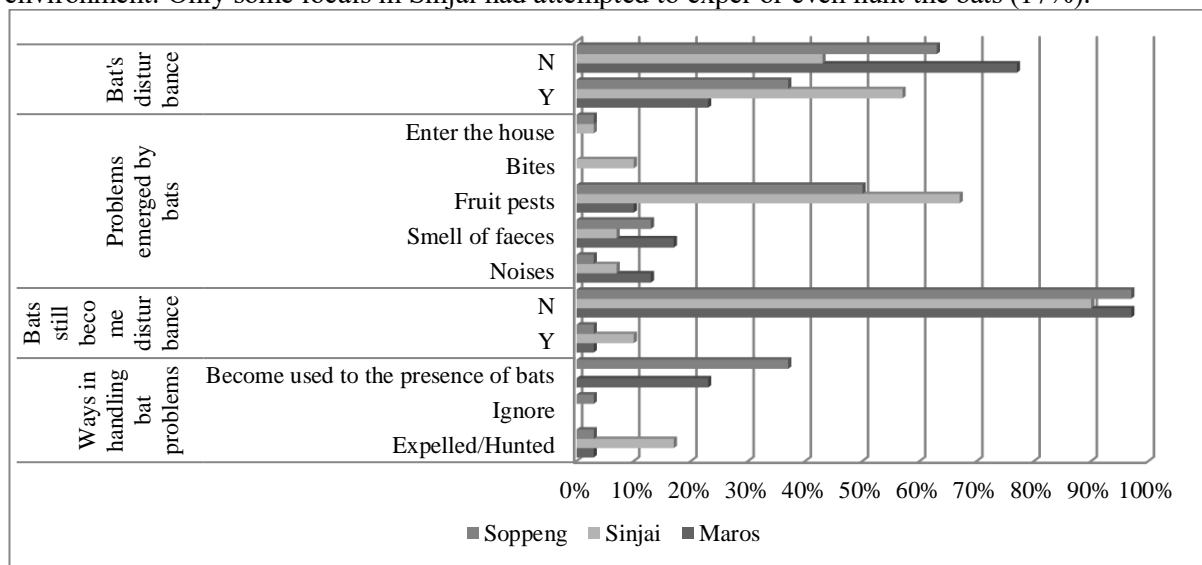


Figure 5. Experiences of respondents living nearby the roosting habitats in Maros, Sinjai, and Soppeng (Y=Yes; N=No).

3.4. Perceptions

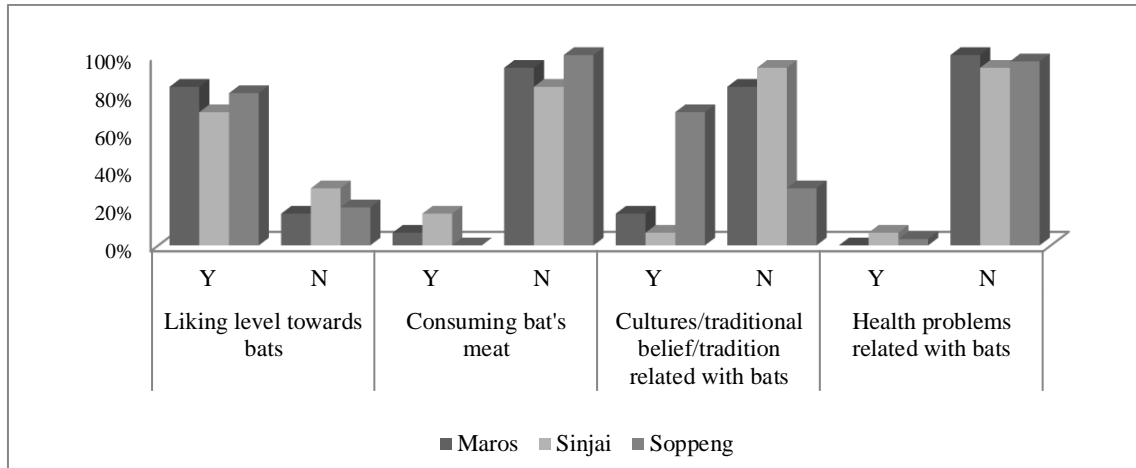
Perceptions toward bats were also measured. General public opinions on bats were conversely different with knowledge and experience variables where 70% of respondents in the three regencies stated that they liked bats (figure 6a). For consumption, there was 17% of people claimed to consume bat meat in Sinjai while in Maros 7% have also consumed the meat. However, in Maros the purpose of consuming was merely for medication (71%). With the opinion on relationship between culture and bats, only in Soppeng had shown the highest relationship (70%). Most importantly, more than 90% of the respondents in the three regencies have not been aware of the impact of bats on human health.

For hunting activities, 93% of respondents have observed hunting until present in Sinjai while in Maros around 90% have also seen the activities in the past but not occurred in the last two decades (figure 6b, 6c). It seemed that bat colonies in Sinjai have become a target of hunting with the purpose of being sold (37%). Only 7% of respondents in Maros have been involved with hunting activities. In Soppeng, only small percentage has seen hunting activities in the past and the majority have not encountered with the activities as now bats are protected under the local government’s regulation (100%).

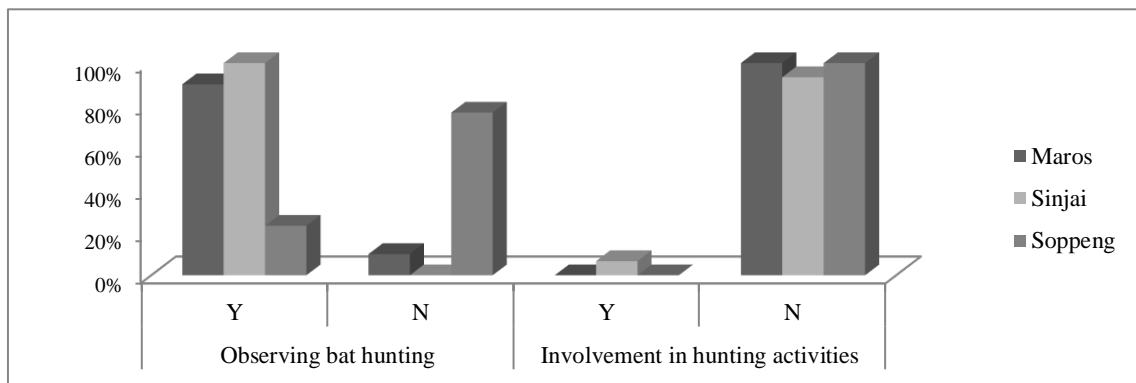
More than 90% of the respondents were disagree that bats were considered as blood-sucking, creepy animals and even posed threats in Maros, Soppeng and Sinjai. More than 90% in both Soppeng and Maros answered that the bats were not threats for humans while in Sinjai, 3% felt threatened by the presence of bats in their neighbourhood (figure 7a).

Questions were also addressed to reveal the disturbances level caused by bats in the three regencies. The disturbances were related with the existence and viewing bats flying in their

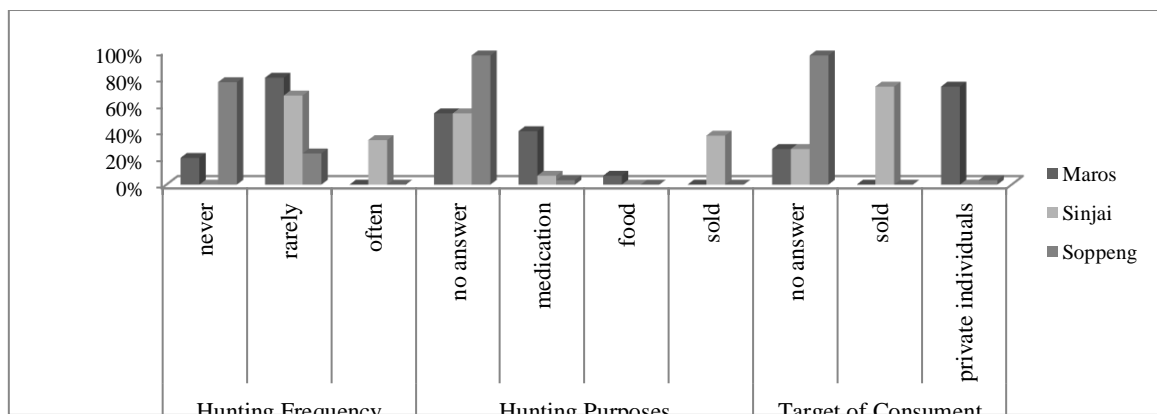
neighbourhood, bad odour from the roosting site, and also the presence of bat's faeces nearby their environment. Most of the respondents had positive to more positive perceptions on the existence of bats flying around (30-70%). However, for bad odour and faeces, more than 30% of respondents in Maros and Soppeng felt disturbed while in Sinjai the number was even higher to 50%. As to the relevance of any disturbances caused by the bats, the needs of managing bat population were also asked to the respondents (figure 7b). Both residences of Maros and Soppeng had positive to more positive perceptions on the matters while contrary the locals of Sinjai had normal to more negative perceptions with only 3% agreed to manage the bats.



(a)

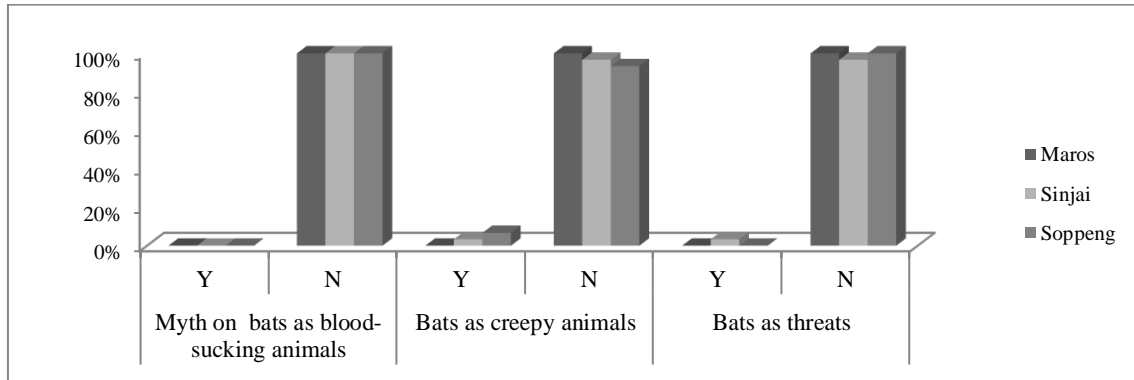


(b)

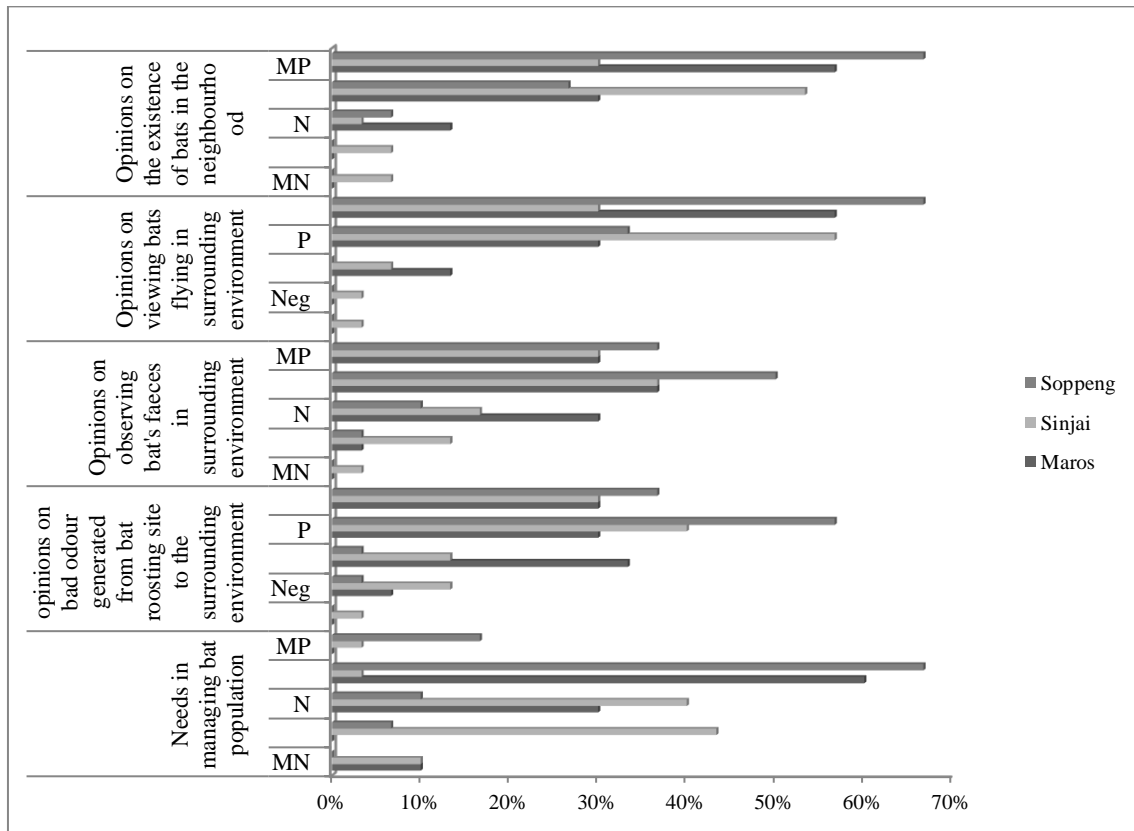


(c)

Figure 6. Public opinions on (a) bats and the relationship between issues related with consumption, culture, and health; (b) hunting activities; (c) hunting activities in Kabupaten Maros, Sinjai dan Soppeng (Y=Yes;N=No).



(a)



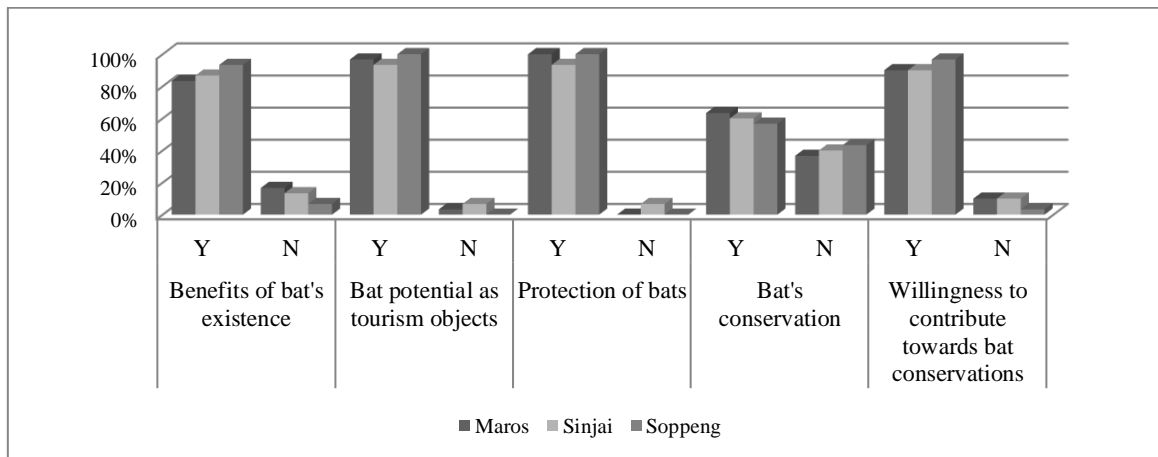
(b)

Figure 7. Perception of the local communities in (a) presence of bats; (b) disturbances in Maros and the needs to manage population of bats in Maros, Sinjai, and Soppeng (MP=More Positive; P=Positive; N=Normal; Neg=Negative, MN=More Negative).

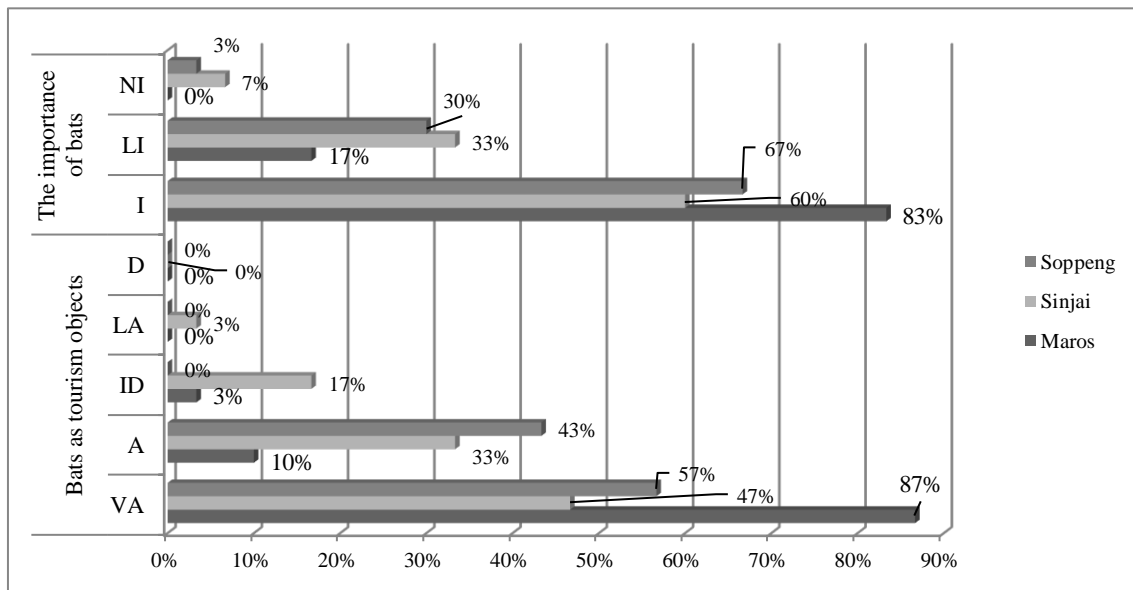
3.5. Awareness

It was found that more than 80% of the respondents in each regency agreed to have been benefitted from the presence of bats in the area. They realized that bats required protection and conservation (90%) as well as the opportunity to utilize the bats as potential tourism objects/attraction. The

willingness to participate in conservation efforts was also high in the three regencies observed (more than 90%) (figure 8a). In relation with the awareness on the importance of bats, Maros had 87% respondents agreed while in Soppeng was only 67%. Around 30-33% of respondents in Sinjai and Soppeng considered bats as less important with less than 8% thought as not important. As regard to the awareness on the potency of bats as tourism objects, most Maros people agreed with the ideas (97%). While in Sinjai less than 40% of respondents had either in doubt, less agree to disagree (figure 8b).



(a)



(b)

Figure 8. Awareness of community in the three regencies as regards to (a) potential of bats (Y = ya; T=tidak); (b) importance of bats and as tourism objects (NI=Not Important; LI=Less Important; I= imporant; D=Disagree; LA=Less Agree; ID=In Doubt; A=Agree; VA=Absolutely Agree).

To gain information on conservation perspectives of the respondents in the three regencies (Maros, Sinjai, and Soppeng), all relevant questions related with conservation were pooled in each aspects (knowledge, experiences, perception, awareness). In average, the highest conservation perspectives was recorded in Maros with 78% and followed by Soppeng with 76%. Sinjai had the lowest average in term of conservation with only 64% (table 1).

Table 1. Conservation perspectives of respondents in Maros, Sinjai dan Soppeng.

Location	Knowledge (%)	Experiences (%)	Behaviour (%)	Perceptions (%)	Awareness (%)	Average (%)
Maros	75	87	96	47	86	78
Sinjai	66	67	88	25	76	64
Soppeng	67	80	96%	55	81	76

3.6. Community behaviour towards conservation of bats

In capturing influences of variables measured (knowledge, experiences, perceptions, and awareness) towards behaviour, analysis of Spearman Rank was employed (table 2). It was shown that in Maros, only knowledge was strongly correlated with the behaviour of the local community in the area ($p=0.000$). Meanwhile in Sinjai, awareness had correlation with the behaviour shown by the locals ($p=0.027$). The two regencies had two drivers for the conservation's behaviour however, for Soppeng, there was no correlation occurred between variables and the behaviour.

Table 2. Correlation between knowledge, experiences, perceptions, and awareness toward community behaviour towards conservation of fruit bats in Maros, Sinjai, and Soppeng (**= $p<0.001$; *= $p<0.05$).

Variables	Correlation (Rs)	Sig
<i>Maros</i>		
Knowledge	0.634**	0.000
Experiences	0.053	0.779
Perception	-0.292	0.118
Awareness	0.120	0.528
<i>Sinjai</i>		
Knowledge	-0.017	0.930
Experiences	-0.328	0.077
Perception	0.013	0.947
Awareness	0.404*	0.027
<i>Soppeng</i>		
Knowledge	0.244	0.193
Experiences	0.068	0.720
Perception	-0.286	0.125
Awareness	0.238	0.206

4. Discussion

The studies in the three regencies, Maros, Sinjai, and Soppeng, have confirmed some preconceptions and also revealed some interesting findings on the existence of fruit bats and their conservation. The three regencies had different socio-demographic, economics, cultural, and ecological aspects. Adding to that, different locations of roosting site in each location have contributed towards differences in community's knowledge, experiences, perceptions, awareness and later their behaviour on bats and conservation. The roosting site in Maros was on trees nearby human settlement and agricultural area. In Soppeng, the site was found on trees surrounding the park at the centre of Soppeng city. The furthest site from human settlement (around 1 km) was located in Sinjai where the bats utilized

mangrove area. However, it was revealed that only in Sinjai negative interactions between the local community and the bats occurred which include hunting activities.

Tracing back to the profile of respondents in the three regencies observed, although all respondents were mostly in their productive ages (between 26-65 years old) but there were some differences in term of educational, occupation, and income backgrounds. Compared to others, Sinjai had higher percentage of respondents with low education and mostly had non-permanent occupation with low salary. This has triggered ignorance on conservation awareness and stimulated hunting activities of the locals as it can provide additional income. Level of awareness and behaviour direction on wildlife could be driven by socio-demographic states of the residences including level of education, income, age and gender, as well as length of stay in the area [25, 26, 27, 28].

This can be also reflected in the four aspects observed: knowledge, experiences, perceptions, and awareness gained from the respondents in the three regencies which also impacted towards the conservation behaviour. Knowledge on basic biological and physiological of fruit bats across the regencies were on average quite similar. However, as regard to knowledge on disturbances and utilization of bats, the respondents in Sinjai were considered bats as disturbances and mostly felt disturbed with the existence of bats and therefore have targeted bats as hunting objects. Confronted with the experience variables, the majority of respondents in Sinjai had also confirmed to experience negative interactions with bats. It is suspected that the negative knowledge in Sinjai also related with past experiences of the respondents related with bats where 57% claimed to experience disturbances caused by bats in particular to their crops nearby their neighbourhood. [29] have confirmed in their study regarding killing behaviour towards tiger in Sundarbans, Bangladesh that there was a relationship between negative experiences and revenge feelings to the animals which led to the intention of killing and continued with killing behaviour [30].

In contrast, apart from higher level in education and salary, both respondents in Maros and Soppeng had positive knowledge, experiences, and perception on the existence and conservation of bats. To some extent, some respondents reported disturbances due to bad odour from bats and crop raiding, but it was overlooked which might be caused by different positive stressors towards the community as regard to bats. For example, in Maros relatively secure habitat for the endemic sulawesi fruit bats (*Acerodon celebensis*) and flying foxes (*Pteropus alecto*) was created due to intensive conservation enlightenment to the community given by local NGOs, academicians, local government, and exposures from some opportunistic foreign tourists. In addition, there was a belief developed in the locals that the existence of bats was considered as a good sign.

While in Soppeng, the positive stressors came from inherited beliefs that the existence of the bats began since 12th century and it is believed that the presence of bats sometimes related with signs of getting a life time partner and forecasting disasters or calamities [31]. The strong beliefs not only embedded into the community but also to the local government of Soppeng Regency as the bats have become a symbol of the regency. Other study has revealed that spiritual beliefs and/or local religious could provide channelling for conservation of species and its habitat particularly in developing countries [32]. And therefore, the local government enacted a regulation to protect bats and its habitats in the regency. The impact of this has driven both perception and behaviour of the locals to be more positive to protect and value the bats even though without sufficient knowledge and minimum experiences. This in line with the finding by Sexton & Steward [33] that most of the respondents with bats living nearby their neighbourhood has familiarity seeing the bats but not merely having sufficient knowledge on the matter. As the results, the analysis of drivers in shaping the conservation behaviour in Soppeng has shown no correlation ($p > 0.05$) with the four variables measured as the main driver was the regulation which were enforced to the locals. In the future, this should be accompanied by adequate understanding and some logic reasonings behind the protection and conservation of the bats.

Both respondents in Soppeng and Maros had higher education level. However, there was different analysis results for conservation behaviour towards bats where the main determinant in Maros was the knowledge ($p = 0.000$). As explained previously, resourceful community of Maros on bats gained additional knowledge on bats and conservation from some external exposures (NGOs, academicians,

local government, and foreign tourists). This is in accordance with [27] who have highlighted that higher education was not a solely factor on positive attitudes towards environment and wildlife issues, nevertheless positive behaviour could be stimulated from environmental knowledge.

In Sinjai, conservation behaviour was determined by the level of awareness ($p < 0.05$). Unfortunately, the awareness expressed in the regency was low and therefore has triggered negative behaviour on bats and conservation. The low level of awareness emerged from negative knowledge, experiences, which leads to negative perception and later formed negative behaviour [34]. In addition, lower educational level and salary combined with limited access to proper jobs for the locals in Sinjai, have made a complete dependency on the existence of natural resources. Hunting and trading activities for bat meat consumption in the Northern part of Sulawesi have been reported in the area [23, 24]. The activities were carried out by some local fishermen to gain more income without knowing the consequences toward the environment. Comparing to both Soppeng and Maros, the level of conservation behaviour in this regency was the lowest and to the fact that, there was no regulation applied by the local government nor beliefs related with bats in the area. Moreover, no direct conservation exposures had also contributed to the lack of awareness in the community. Insufficient knowledge combined with negative experiences, have also driven negative perception, and created low awareness towards the existence and conservation of bats. This also occurred nearby Lake Mburo National Park (Uganda) where the local community had positive behaviour on wildlife as they have been involved in a conservation program for 7 years while for the locals who did not participate with the program were tended to pose negative behaviour by conducting wildlife hunting [35].

[33] mentioned that the higher the knowledge, the more positive the community's behavior towards bats. In three regencies, more than 90% of respondents had an understanding on the benefits of nature for human. However, this was not accompanied by adequate knowledge on the importance of the bat to the ecosystem in particular to human life and their conservation. More exposures and involvement of the community on bats and conservation of bats could develop values and knowledge which in turn elevate experiences, modify perception and change behaviour towards positive directions [36]. Emotional engagement during active participation in conservation activities may improve knowledge, attitude, and behaviour [37].

In behavioural theory, it was mentioned that the changes of human behaviour were depending on their willingness which were based on their positive perception and behaviour towards wildlife [38]. Apart from that, species of wildlife could also influence human behaviour [26], for example: tendencies of people to choose birds with beautiful colour and prefer pet animals such cat and dog compared to other animals like bats, rats, reptiles, and owls (Bjerke & Østdhal). Negative perception and behaviour formation on bats could be caused by human ignorance on particular wildlife species and to the fact that many people still perceived bats as cryptic, mystical, and frightening animals which mostly known as pests, symbol of bad luck, and even useless animals [26].

Having good perception will deliver effortless interventions for bat's conservation efforts in the area. To develop conservation efforts for bats in the three regencies, it will require different approaches. As an initial step, there is an urgent need to protect the bats in the three regencies by increasing the legal status of the fruit bats (*Acerodon celebensi* & *Pteropus alecto*). Currently, only Soppeng Regency has local legality. Active involvement approaches in various conservation activities on bats could assist in improving knowledge and experiences in shaping the future behaviour of the community. Specifically, in Soppeng, developing cultural approaches may smoothen the process of knowledge transfer. While in Maros introducing various strategies in maintaining and improving engagement between community and the bats for the sake of conservation may provide channelling to higher participation such as formulation of local regulation in Maros. Intensive approaches to the locals of Sinjai will be required to build basic foundation of knowledge together with the provision of alternative sources of income in order to gradually diminish bat hunting and trading activities. Active involvement in conservation efforts in particular for bats are needed to change the perceptions, awareness, and behaviour of the local community in Sinjai.

5. Conclusion

Generally, the three regencies had different portraits of the four aspects measured (knowledge, experiences, perceptions, and awareness) toward the existence and conservation of bats which were mainly related with differences in socio-demographic, economics, cultural, and ecological backgrounds of each regency. In relation with conservation behaviour, respondents of Maros Regency were most receptive due to adequate knowledge gained from various positive exposures related with bat conservation (NGOs, academicians, local government, foreign tourists). In Soppeng, the behaviour of the locals towards bats were not related with the four aspects measured as the main drivers were embedded positive beliefs inherited by their local ancestors together with the enforcement of regulation to protect bats and its habitat. Meanwhile in Sinjai, low awareness was indicated as the major issue impeding the process of conservation of bats in the area which was caused by complex problems related not only socio-demographic-cultural-economic factors but also due to insufficient knowledge, negative experiences which led to negative perception and then triggered controversial behaviour.

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References

- [1] Knight A J 2008 “Bats, snakes and spiders, Oh my!” How aesthetic and negativistic attitudes, and other concepts predict support for species protection *J. Environ. Psychol.* **28** 94–103
- [2] Hoffmaster E, Vonk J and Mies R 2016 Education to action: improving public perception of bats *Animals* **6** 6
- [3] Calisher C H, Childs J E, Field H E, Holmes K V and Schountz T 2006 Bats: important reservoir hosts of emerging viruses *Clin. Microbiol. Rev.* **19** 531–45
- [4] Schneeberger K and Voigt C C 2016 Bats in the Anthropocene: Conservation of Bats in a Changing World in *Zoonotic Viruses and Conservation of Bats* (Switzerland: Springer) pp 263–92
- [5] Beena V and Saikumar G 2019 Emerging horizon for bat borne viral zoonoses *Virus Disease* **30** 321–8
- [6] Phelps K L, Hamel L, Alhmod N, Ali S, Bilgin R, Sidamonidze K, Urushadze L, Karesh W and Olival K J 2019 Bat research networks and viral surveillance: gaps and opportunities in western Asia *Viruses* **11** 240
- [7] Boyles J G, Cryan P M, McCracken G F and Kunz T H 2011 Economic importance of bats in agriculture *Science (80-.)*. **332** 41–2
- [8] Ingle N R 2003 Seed dispersal by wind, birds, and bats between Philippine montane rainforest and successional vegetation *Oecologia* **134** 251–61
- [9] Fleming T H, Geiselman C and Kress W J 2009 The evolution of bat pollination: a phylogenetic perspective *Ann. Bot.* **104** 1017–43
- [10] Kunz T H, De Torrez E B, Bauer D, Lobova T and Fleming T H 2011 Ecosystem services provided by bats *Europe* **31** 32
- [11] Abedi-Lartey M, Dechmann D K N, Wikelski M, Scharf A K and Fahr J 2016 Long-distance seed dispersal by straw-coloured fruit bats varies by season and landscape *Glob. Ecol. Conserv.* **7** 12–24
- [12] Cryan P M and Barclay R M R 2009 Causes of bat fatalities at wind turbines: hypotheses and predictions *J. Mammal.* **90** 1330–40

- [13] Arnett E B, Baerwald E F, Mathews F, Rodrigues L, Rodríguez-Durán A, Rydell J, Villegas-Patraca R and Voigt C C 2016 Impacts of wind energy development on bats: a global perspective *Bats in the Anthropocene: conservation of bats in a changing world* (Springer, Cham) pp 295–323
- [14] O’Shea T J, Cryan P M, Hayman D T S, Plowright R K and Streicker D G 2016 Multiple mortality events in bats: a global review *Mamm. Rev.* **46** 175–90
- [15] Frick W F, Kingston T and Flanders J 2019 A review of the major threats and challenges to global bat conservation *Ann. NY Acad. Sci.* **1469** 5–25
- [16] Siagian R A P 2011 *Perburuan dan Perdagangan Beberapa Jenis Kelelawar di Dalam dan Sekitar Kawasan Hutan Batang Toru, Sumatera Utara* Thesis (Institut Pertanian Bogor)
- [17] Tsang S M 2015 Quantifying the bat bushmeat trade in North Sulawesi, Indonesia, with suggestions for conservation action *Glob. Ecol. Conserv.* **3** 324–30
- [18] Mickleburgh S P, Hutson A M and Racey P A 1992 An action plan their conservation in *Old world fruit bats IUCN* **263**
- [19] Suyanto A and Kartikasari S N 2001 *Kelelawar di Indonesia (Bats of Indonesia)* (Bogor: Puslitbang Biologi LIPI)
- [20] Yuliadi B, Sari T F and Handayani F D 2018 *Kelelawar Sulawesi Jenis dan Peranannya dalam Kesehatan* (Jakarta: Penerbit Badan Penelitian dan Pengembangan Kesehatan)
- [21] Koopman K F 1989 A review and analysis of the bats of the West Indies *Biogeogr. West Indies. Sandhill Crane Press. Gainesville, Fl* 635-644
- [22] Latinne A, Saputro S, Kalengkongan J, Kowel C L, Gaghiwu L, Ransaleleh T A, Nangoy M J, Wahyuni I, Kusumaningrum T and Safari D 2020 Characterizing and quantifying the wildlife trade network in Sulawesi, Indonesia *Glob. Ecol. Conserv.* **21** e00887
- [23] Liana L 2020 *Studi perdagangan kalong dan persepsi masyarakat mengenai konsumsi daging kelelawar di Sulawesi Utara (Study on fruit bats trading and community perception toward bat meat consumption in North Sulawesi)* Thesis (Universitas Hasanuddin)
- [24] Nirsyawita N 2020 *Perburuan Kelelawar Buah di Sulawesi Selatan: Study Kasus Acerodon celebensis dan Pteropus Alecto (Fruit bats hunting in South Sulawesi: A case study of Acerodon celebensis and Pteropus alecto)* Thesis (Universitas Hasanuddin)
- [25] Thornton C and Quinn M S 2009 Coexisting with cougars: public perceptions, attitudes, and awareness of cougars on the urban-rural fringe of Calgary, Alberta, Canada *Human-Wildlife Conflicts* **3** 282–95
- [26] Mahmood-ul-Hassan M and Salim M 2011 Public perceptions about the fruit bats in two horticulturally important districts of Pakistan *J. Anim. Plant Sci.* **21**
- [27] Shafie N J, Sah S A M, Mutalib A H A and Fadzly N 2017 General perceptions and awareness level among local residents in Penang Island toward bats conservation efforts *Trop. life Sci. Res.* **28** 31
- [28] Castilla M C, Campos C M, Colantonio S E and Díaz M M 2020 Perceptions and attitudes of the local people towards bats in the surroundings of the big colony of *Tadarida brasiliensis*, in the Escaba dam (Tucuman, Argentina)
- [29] Inskip C, Fahad Z, Tully R, Roberts T and MacMillan D 2014 Understanding carnivore killing behaviour: Exploring the motivations for tiger killing in the Sundarbans, Bangladesh *Biol. Conserv.* **180** 42–50
- [30] Marchini S and Macdonald D W 2012 Predicting ranchers’ intention to kill jaguars: case studies in Amazonia and Pantanal *Biol. Conserv.* **147** 213–21
- [31] Hesmariyadi H 2016 *Kepercayaan Masyarakat Kabupaten Soppeng Terhadap Keberadaan Kelelawar (Studi Sosial Budaya)* Thesis (Universitas Negeri Makassar)
- [32] Mukul S A, Rashid A Z M M and Uddin M B 2012 The role of spiritual beliefs in conserving wildlife species in religious shrines of Bangladesh *Biodiversity* **13** 108–14
- [33] Sexton N R and Stewart S C 2007 *Understanding knowledge and Perceptions of Bats Among Residents of Fort Collins, Colorado* (USA: Citeseer)

- [34] Wu W, Zhou L and Chien H 2019 Impact of consumer awareness, knowledge, and attitudes on organic rice purchasing behavior in China *J. Food Prod. Mark.* **25** 549–65
- [35] Infield M and Namara A 2001 Community attitudes and behaviour towards conservation: an assessment of a community conservation programme around Lake Mburo National Park, Uganda *Oryx* **35** 48–60
- [36] Hughes K 2013 Measuring the impact of viewing wildlife: do positive intentions equate to long-term changes in conservation behaviour? *J. Sustain. Tour.* **21** 42–59
- [37] Apps K, Dimmock K and Huveneers C 2018 Turning wildlife experiences into conservation action: Can white shark cage-dive tourism influence conservation behaviour? *Mar. Policy* **88** 108–15
- [38] Vaske J J and Donnelly M P 2007 Public knowledge and perceptions of the desert tortoise *Fort Collins, CO Color. State Univ.*