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Species of white-tailed forest rats hunted and traded, their conservation status and habitat characteristics, in North Sulawesi, Indonesia

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Abstract. *Laatung S, Fuah AM, Masy'ud B, Sumantri C, Salundik 2021. Species of white-tailed forest rats hunted and traded, their conservation status and habitat characteristics, in North Sulawesi, Indonesia. Biodiversitas 22: 2778-2784.* The tradition of hunting and trading white-tailed forest rats, especially in North Sulawesi, has been practiced for generations. This poses a threat to the existence of these animals in their natural habitat leading to the extinction of some hunted species. In the past, studies on white-tailed rats being hunted and traded on Sulawesi is still lacking. Therefore, the purpose of this study is to identify the species of white-tailed forest rats hunted and traded, their conservation status and habitat characteristics in North Sulawesi. This study was conducted in April to June 2018 in Minahasa and Bolaang Mongondow District, North Sulawesi. The survey methods used involved visiting hunters, recording and taking pictures of the species of rats being hunted and traded. All samples of white-tailed rats were identified in the Zoological Laboratory, Indonesian Institute of Sciences Cibinong Bogor, West Java. Furthermore, ascertaining the general characteristics of the habitat was carried out using a general survey in locations known as distribution areas in North Sulawesi. The identification of 125 individuals consists of 8 species of white-tailed forest rats from 7 genera, which are commonly hunted. They include *Rattus xanthurus* (Gray, 1867), *Bunomy fratrorum* (Thomas, 1896), *Lenomys meyeri* (Jentink, 1879), *Paruromys dominator* (Thomas, 1921), *Echiotrix leucura* (Gray, 1879), *Taeromys taerae* (Sody, 1932), *Maxomys hellwaldi* (Jentink, 1879) and Maxomys *musschenbrooki* (Jentink, 1878). Four out of the eight species of white-tailed forest rats are protected species according to the IUCN Redlist. The white-tailed forest rats identified in this study, were caught in secondary forest and plantation, ranging from an altitude of 500 - 1.500 meters above sea level. Their main sources of feed include *Areca catechu*, *Piper aduncum*, *Ficus* spp., and *Arenga piñnata*.

Keywords: Bushmeat, conservation, hunting, Minahasa, rat

INTRODUCTION

The predominant issue in various countries including Indonesia is the excessive exploitation of natural resources (Herdiansyah et al. 2014). This threatens their sustainability, the integrity of ecosystems, and lowers the carrying capacity and extinction of biodiversity (Wu 2013; Vannevel and Goethals 2020). Since the 17th century, an estimated 2.1% of mammals and 1.3% of birds have gone extinct, and the pressure on biodiversity is exacerbated by the rapid increase in the human population (Edet et al. 2014; Di Marco et al. 2018; Verma et al. 2020). Furthermore, in order to meet human needs, there has been a transfer of land functions into residential and agricultural areas that indirectly affect the habitat of wild animals living in it (Haddad et al. 2015; Crooks et al. 2017). Habitat destruction is the main cause of mass extinction in the tropics today, and one of the most disturbing species is the rat (Alroy 2017).

Poaching and wildlife trafficking to meet the needs of humans are carried out by people living in the countryside (Pattiselanno and Mentasen 2010; Wyatt et al. 2018). Therefore, the motivation for hunting and trading wildlife meat varies. Some of them are hunted in order to be used as pets, medicinal sources and consumed to meet the protein requirement of the family (Nasi et al. 2011; Novriyanti et al. 2014; Ripple et al. 2016; Herzegovina et al. 2019; Nukraheni 2019; Mirdat et al. 2019). The rate of hunting needs to be controlled otherwise it could cause a reduced population of wildlife animals (Fulton et al. 2011; Gosselin et al. 2015; Quirós-Fernández 2017; Gray et al. 2018; Garshelis et al. 2020). Furthermore, hunting and collecting forest products has been practiced for a long time (Pattiselanno et al. 2015), and an example includes the inhabitants of North Sulawesi. The white-tailed forest rats are one of the wildlife that is targeted by residents living close to the forest borders. Due to the white color at the end of their tale, the locals call it the "white-tailed forest rat". In addition, the adult rat has a white color on the chest and abdomen. Its body size is large, forages on trees at night and makes nests in the soil during the day. They consume only the shoots of young leaves and fruits of trees in the forest. The local name of this rat varies according to its origin.

The phenomenon of scarcity and decrease in the population of white-tailed forest rats in North Sulawesi is suspected to have begun. This is partly demonstrated from the information given by the traders in one of the traditional markets in Minahasa (Tomohon Market). It was stated that in recent years, white-tailed forest rats sold in the market were obtained from forests located further away from residential areas. Currently more are obtained from those in the western area of North Sulawesi such as in Bolaang Mongondow district and even Gorontalo. The condition also applies to some other species of wildlife that are often hunted for sale or consumption, such as white-tailed forest rats, snakes, flying foxes, and wild pigs (Laatung et al. 2019), and available for sale in 73% of the markets and supermarkets in North Sulawesi (Latinne et al. 2019).

Increasing demand for the meats of the white-tailed forest rat has an important and positive meaning relating to the opportunities and prospects as an alternative protein source. High demand and prices, encourage people to increase their rate of hunting. One of the conservation efforts that could be done is to breed them in captive breeding. Therefore, alternative solutions that are appropriate in maintaining the existence of this animal and its possible development, are considered important and need to be urgently carried out.

In the past, the species of white-tailed forest rats hunted and traded in North Sulawesi, and the characteristics of their habitat have not been ascertained. However, the results of this study are expected to complement existing data and be a foundation in preserving the species of white-tailed forest rats hunted to increase their population in nature and develop their utilization sustainably through ex situ captivity. Therefore, the aim of this study is to identify the species of forest rats hunted and traded in North Sulawesi and their conservation status.

MATERIALS AND METHODS

Study area

Identification of the species of rats hunted and traded in North Sulawesi, Indonesia began with a pre-survey that was conducted for approximately two weeks. This was carried out to search for information about the presence of white-tailed rat sellers in some traditional markets. Based on the results of the pre-survey, the sampling was carried out in two locations namely Pinabetengan Village, South Minahasa District located at coordinates 01°10’26.66” LU and 124°.47’19.49” LS with an altitude of 740 to 800meters above sea level and Singsingon Village, Bolaang Mongondow District located at coordinates 00°48’16.95” LU and 124°.24’58.15” with an altitude of 941 meters above sea level (Figure 1). Based on the information from the sellers in some traditional markets, the rats that were mostly sold came from the forests around Minahasa District. Furthermore, some of them were from Bolaang Mongondow District. The time required to conduct the initial survey before sampling was approximately two months, starting from May to June 2018.

Procedures

A survey method was used in collecting all kinds of hunted white-tailed rats from hunters that were ready for sale in traditional markets. The data collection process was carried out for two weeks at each study site, and the rats were grouped according to their type and local name. Furthermore, all of the species documented here are determined from the examination of the specimen stored in the Zoologicum Bogoriense Museum, Cibinong, Java. General characteristic observations and identification of their habitats and sources were carried out in several locations.

Data analysis

The type of rat, general characteristics of the habitat, and the sources of food were recorded and pictures were also taken. Furthermore, all the results of the study were analyzed descriptively, and equipped with several photos or images. The conservation status of white-tailed forest rats was analyzed by referring to the list of IUCN Red list 2016.

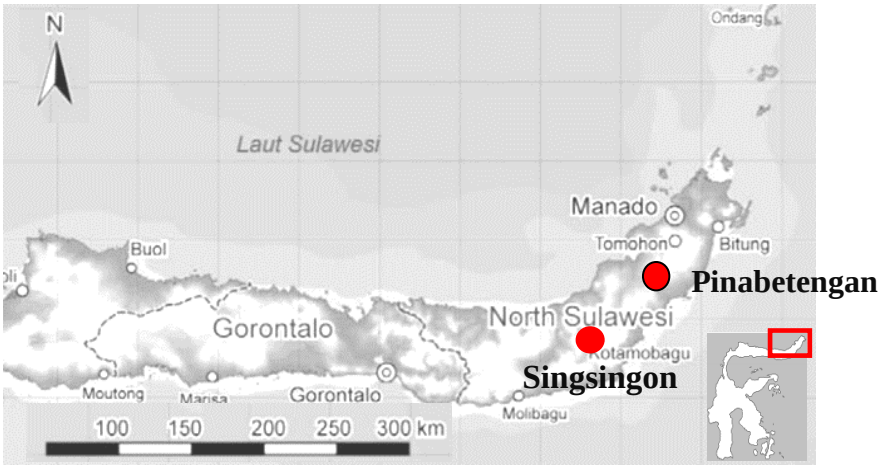

Figure 1. Study sites in Pinabetengan Village, South Minahasa District and Singsingon Village, Bolaang Mongondow District of North Sulawesi Province, Indonesia

RESULTS AND DISCUSSION

Species of white-tailed rats hunted and traded

Based on the results from the two locations, namely Pinabetengan (Minahasa District) and Singsingon Villages (Bolaang Mongondow District), 125 individuals of white-tailed rats were obtained. Eight species of the white-tailed rats, including seven genera, were hunted and traded for consumption in North Sulawesi especially Minahasa, and they all belonged to the family of Muridae (Figure 1). They include *Rattus xanthurus* (Gray, 1867), *Bunomys fratrorum* (Thomas, 1896), *Lenomys meyeri* (Jentink, 1879), *Paruromys dominator* (Thomas, 1921), *Echiothrix leucura* (Gray, 1879), *Taeromys taerae* (Sody, 1932), *Maxomys hellwaldi* (Jentink, 1979) and *Maxomys muschenbroekii* (Jentink, 1878). *R. xanthurus* is only found from northeastern Sulawesi (Musser and Carleton 2005). *B. fratrorum* found in northeast region of the northern peninsula of Sulawesi (Musser and Carleton 2005; Musser 2014). Recent studies have found it also recorded in the western part of the northern peninsula (Handika et al. 2021). *L. meyeri* is endemic to Sulawesi, found in northern, central, and southwestern (Musser and Carleton 2005). *P.* dominator is widely distributed on Sulawesi from sea level up to the tree-line (Musser and Carleton 2005). *E. leucura* also endemic to Sulawesi, and found in the northeast tip of the northern peninsula (Musser and Carleton 2005). *T. taerae* is found in the highlands of northeastern Sulawesi and likely occurs more widely than current records (Musser and Carleton 2005). *M. hellwaldi* listed as least concern, and spread throughout Sulawesi. *M. muschenbroekii* is spread throughout Sulawesi, present in several protected areas and adaptable to human disturbance (Musser and Carleton 2005). The species of white-tailed rat, local names, and the number of samples found at each location is presented in Table 1.

Furthermore, the air rifle method was used in catching the animals, however, most hunters in Minahasa use guns to hunt. Several methods and tools are used for hunting rats in Minahasa, but the most widely used is a gun (Laatung et al. 2019). They are considered easy to carry and more practical in their use, especially when hunting for arboreal animals (Wiafe 2018; Cowlishaw and Dunbar 2000). Other methods used are the installation of snares/traps and the use of pet dogs in hunting. Methods used for hunting wildlife depend on many factors such as the behavioral characteristics of hunted animals and hunting habitats (Bakarr et al. 2001; Lone et al. 2015). Bennett and Robinson (2000) define hunting as "all that is captured by humans both mammals, birds, and reptiles, whether dead or alive, regardless of the techniques used to capture hunts".

According to the results of the study by Laatung et al., (2019), the reason for hunting white-tailed forest rats is because hunters take it as a hobby, and the result of the hunt is usually consumed alone or sold for profit. Hunting is also done when there is an order or request for white-tailed forest rats to be presented on special occasions such as family thanksgiving celebrations or other religious events. Some species of rats are hunted because they are pests of plantation habitats, such as the *R. xanthurus* and *L.meyeri* species which are both found in coconut plantations. Some studies stated that in addition to consumption and selling to meet the needs of the family, rats are also hunted for damaging and consuming plantation crops. Utilization for consumption purposes has a significant contribution to the availability of animal proteins in rural areas. Furthermore, hunting usually involves members of the family or friends, especially when the location is far from the hunter's house (Laatung et al. 2019). An example of a factor that affects a large number of hunting members is relatively new hunting areas. It requires more hunters, and more methods of hunting (digging traps/holes).

The white-tailed forest rats obtained from the forest were all in a state of death. Furthermore, the ones that had been cleaned and burned, was kept in a plastic basket and taken to a nearby market. Before they are taken to the market, neighbors or villagers who want to buy usually go directly to the hunter's house in the morning and are free to choose the rats they want at a lower price than in the market. Some hunters act as sellers, and market their hunting results in several nearby traditional markets. The white-tailed rats that are sold are generally arranged in such a way based on their type and size. Furthermore, some sell by going around the market carrying baskets or plastic trays containing some rats, there are also renting certain places inside the market. The price of a white-tailed rat varies depending on its size. For small sizes, Turean weighing ± 150gr, are sold at a price of Rp.15.000 to 20.000/individuals. Medium size is (± 200gr) sold for Rp.25.000/individuals, and the largest size (> 200gr) sold at a price of Rp. 27.000 to 35.000/ individuals. Some sellers sell rats for Rp. 100,000 for 3 large rats. Special religious holidays such as Christmas, Easter, or welcoming the new year and thanksgiving for the harvest, the price of rats and other wildlife meat, would be a little more expensive, especially for large rats, sold at a price of Rp. 35.000 to 40.000/ individuals. Hunters also hunt and trade some wildlife in traditional markets in North Sulawesi such as flying foxes, snakes, birds, and wild pigs. Several studies on tropical areas stated that poaching in tropical rainforest areas is unsustainable. Therefore, wildlife resources in these forest areas are particularly vulnerable to overexploitation and would become extinct (Ripple et al. 2016; Harrison et al. 2016; Tilker et al.2018). The tradition of hunting white-tailed forest rats has been going on for generations with a high enough intensity. High hunting activity can lead to a reduction in the population of white-tailed forest rats. It is necessary to think about conservation efforts involving the government and other related NGOs (Non-Governmental Organizations), especially local people around the forest, regarding procedures to protect, conserve, and the possibility of breeding efforts. These efforts expected to be the right solution to ensure the sustainable use of white-tailed forest rats.

Table 1. Species and composition of white-tailed forest rats hunted and trade in Pinabetengan and Singsingon of North Sulawesi, Indonesia

Species	Local name	Pinabetengan, Minahasa (n)	Singsingon, B.Mongondow (n)	Total
Rattus xanthurus (Gray, 1867)	*Turean*	15	16	31
Bunomys fratrorum (Thomas,1896)	*Pangusan, Emut, Talingkoy, To'tol*	11	9	20
Lenomys meyeri (Jentink,1879)	*Tangkara, Tangkomot, Tangkilis, Kumekeles*	10	6	16
Paruromys dominator (Thomas, 1921)	*Pangaladen*	7	5	12
Echiothrix leucura (Gray, 1879)	*Tarem, Tadem*	4	4	8
Taeromys taerae (Sody, 1932)	*Sambet*	9	8	17
Maxomys hellwaldi (Jentink, 1979)	*Rentei*	4	5	9
M. muschenbroekii (Jentink, 1878)	*Kalendang, Rarampersen*	5	7	12
Total		65	60	125

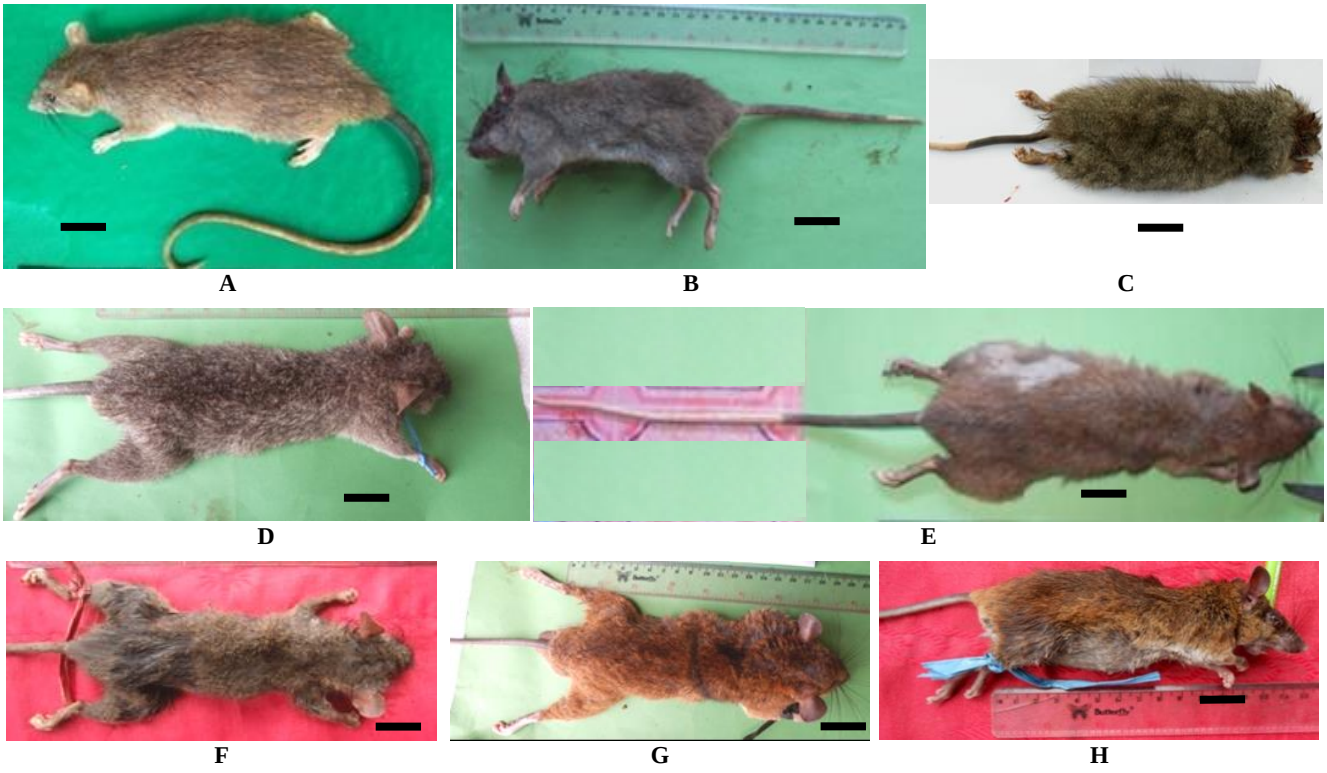

Figure 2. Species of white-tailed forest rats hunted and trade. A. *Rattus xanthurus*, B. *Bunomys fratrorum*, C. *Lenomys meyeri*, D. *Echiothrix leucura*, E. *Paruromys dominator*, F. *Taeromys taera*, G. *Maxomys hellwaldi*, H. *M. Muschenbroekii*. Bar = 3 cm

Conservation status

The population trends and conservation status of the eight species of rats outlined above according to the International Union for Conservation of Nature (IUCN) can be seen in Table 2.

According to the IUCN Red list, four species of rats are almost threatened and vulnerable, namely *Rattus xanthurus*, *Bunomys fratrorum*, *Taeromys taerae*, and *Echiothrix leucura*. The other four species are categorized as least concerned or mean low risk. The population trend for most of the identified species of rat decreases, and the biggest threats to their population are disturbed habitats such as illegal logging, the conversion of forests into farmland or plantations, and hunting that lasts from year to year for either consumption or sale.

Table 2. Conservation status of the rats according to IUCN Red list 2016

Species	Population trends	Conservation status[1]
Rattus xanthurus	Decreased	Near threatened
Bunomys fratrorum	Decreased	Vulnerable
Lenomys meyeri	Decreased	Least concern
Paruromys dominator	Stable	Least concern
Echiothrix leucura	Decreased	Endangered
Taeromys taerae	Unknown	Vulnerable
Maxomys hellwaldi	Decreased	Least concern
M. muschenbroekii	Stable	Least concern

Note: [1]The IUCN Red List 2016

Habitat

One of the components of their habitat that important is the nesting place which is very easy to recognize by experienced hunters. Furthermore, the white-tailed rat usually nests under trees or in the ground, and according to the description of the hunters, the hole where they nests could be recognized from the soil around the hole. Whenever the soil forms large clumps, it is most likely occupied by white-tailed rats. However, when the surrounding soil is small, it is most likely that a black-tailed rat lodges the hole. Some trees that are often used as nesting and sheltering places (Figure 3) are the bamboo trees and wooden flowers/boats (*Spathodea campanulata*). Temperature and humidity of the air are one of the components of abiotic factors that are important for all living things. The average temperature in Pinabetengan is 26.25°C with a high and low of 32.20°C and 21.65°C. While in Singsingon, the average temperature is 26.30°C with a high and low of 32.45°C and 2.20°C. In addition, the average relative humidity in Pinabetengan and Singsingon is 85.94% and 86.65%.

The white-tailed forest rats identified in this study, were caught in secondary forest and plantation, ranging from an altitude of 500 - 1.500 meters above sea level. Secondary forest is formed after the clearing of natural forest for livestock and agricultural activities. Secondary forest dominated by some trees like rattan (*Calamus* spp.), palm trees (Family Arecaceae), *Ficus* spp. and bamboo. Furthermore, coconut is one of the plantation plants that favor them. This plantation land was located in both research sites, making it a potential source of feed. According to the annual report 2019, the plantation land is about 99.60% in Minahasa and 60.31% in Bolaang Mongondow. The presence of rats in these habitats has been a major issue for farmers because it is considered as a pest. Some study also states that rats are also a pest on other plantation crops such as oil palm (Tipawan and Jarun 2016; Ikhsan 2020). According to the information received from hunters and residents around the research site, they also like some fruits such as papaya, bananas, corn, potatoes, and sweet potatoes. Other sources are leaves and nuts, for example, *Areca catechu*, *Piper aduncum*, *Ficus* spp, and *Arenga piñnata* (Figure 2). Rats are also like young bamboo leaves, bark, tree roots, and young leaf in the forest.

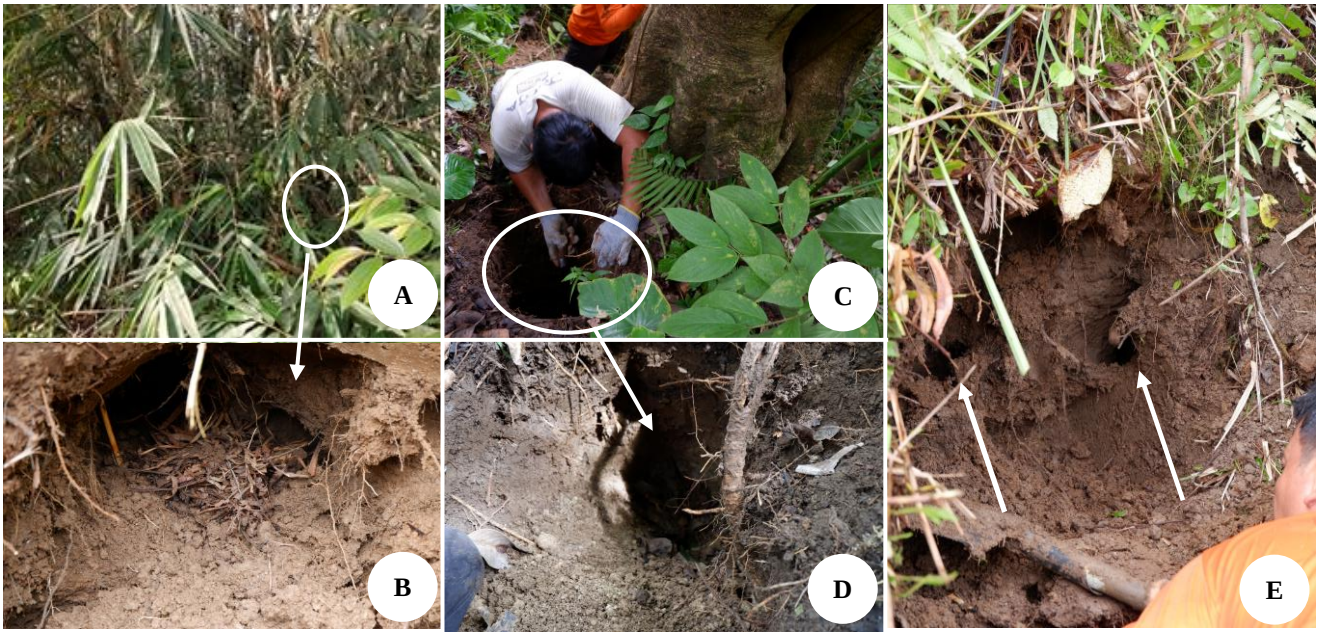

Figure 3. A-B. Nest under the bamboo trees; C-D. Nest under the trees (*Spathodea campanulate)*; E. Two-hole nests

Figure 2. Food sources of white-tailed forest rats in North Sulawesi, Indonesia. A. *Areca catechu*, B. *Piper aduncum*, C. *Ficus* spp., D. *Arenga piñnata*, E. *Cocos nucifera*

The harvest of wild meat (bushmeat) by subsistence hunters in tropical countries has resulted in high population decline and extinction on a global-local scale in some bird and mammal species (Bakarr et al. 2001; Cawthorn and Hoffman 2015; Crooks et al. 2017; Di Marco et al. 2018). Forest resources play a significant role for many people that live in or near the forest. These include remote peoples who depend on wildlife for subsistence, source of food, medicine and cultural practices. Good cooperation between local governments, ecologists, conservationists by involving local communities must be done to find the best solution.

In conclusion, the species of white-tailed forest rats hunted and traded were *Rattus xanthurus* (Gray, 1867), *Bunomys fratrorum* (Thomas, 1896), *Lenomys meyeri* (Jentink, 1879), *Paruromys dominator* (Thomas, 1921), *Echiothrix leucura* (Gray, 1879), *Taeromys taerae* (Sody, 1932), *Maxomys hellwaldi* (Jentink, 1979) and *Maxomys muschenbroekii* (Jentink, 1878). Furthermore, according to IUCN Red list, there are four species of rats categorized as near threatened (*Rattus xanthurus*), vulnerable (*Bunomys fratrorum* and *Taeromys taerae*) and endangered (*Echiothrix leucura*). Therefore, it is necessary to pay attention to the conservation efforts of the population. In general, hunted white-tailed forest rats secondary and plantation habitats, and the main sources of feed include *Areca catechu*, *Piper aduncum*, *Ficus* spp and *Arenga piñnata*.

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