Understanding the Scaly Anteater: A Management Plan for the Sunda pangolin in Southeast Asia (2019-2069)

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May 2019

An adult Sunda pangolin (*Manis javanica*)

A paper submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Fisheries and Wildlife – Wildlife Concentration at Paul Smith's College of Arts and Sciences

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Executive Summary

The Sunda pangolin (*Manis javanica*) is one of four pangolin species found in Asia. Known as the scaly anteater, it is native throughout southeast Asia and is considered to be the most illegally trafficked mammal in the world. The Sunda pangolin can be found in primary and mature secondary forests, and feeds mainly on ants and termites. Major ecological conservation issues for the Sunda pangolin include loss of habitat through deforestation for the palm oil industry in southeast Asia. Conservation issues involving economic and sociocultural aspects are that many Asian cultures believe that pangolin scales possess medicinal properties, and the pangolin is also a delicacy in many Asian cultures causing them to be heavily poached. The International Union for Conservation of Nature (IUCN) Red List of Threatened Species has the Sunda pangolin listed as critically endangered because of the lack of information available on this species. The goal of this management plan is to create a better understanding of the biology and ecology of Sunda pangolins and gather information on the status of the population of Sunda pangolins in southeast Asia from 2019-2059. Objectives of this goal include: gain an understanding of Sunda pangolin ecology, biology and behavior in southeast Asia in fifteen years, publishing five peer reviewed scientific papers, assess 75% of Sunda pangolin population throughout southeast Asia in ten years, create awareness in local communities and collaborate with relevant agencies to commit to the conservation of Sunda Pangolins in twenty-five years. With proper management of the Sunda pangolin valuable knowledge of this species will be gained and steps can be made to save the population in southeast Asia.

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Manis javanica

History

The Sunda pangolin is listed as critically endangered on the International Union for Conservation (IUCN) Red List of Threatened Species. The Sunda pangolin has a large range that spans the entirety of southeast Asia. A lack of information on this species throughout its range creates difficulties when planning conservation efforts. Because of the elusive nature of this mammal information is hard to find, and often scarce, making it hard to create any population estimates for the Sunda pangolin. Most of the information available on the species focuses on the ecology, but even that information is lacking. As more research in conducted on Sunda pangolins there will be more conservation efforts.

Pangolins are specialists in terms of diet, feeding primarily on ants and termites (Gong et al. 2015). They have been known to feed on other insect species as well (Gong et al. 2015). Sunda pangolins live in primary and mature secondary forests where trees have a DBH greater than 50 cm (Lim and Ng 2008). Large trees are used to make dens where female pangolins raise their young. Sunda pangolins typically breed once a year and only have one cub at a time (Gong et al. 2015). Pangolins have an average lifespan of eight years (Gong et al. 2015). Pangolins are hard to raise in captivity and are easily stressed when in captivity (Gong et al. 2015). The Sunda pangolin population in southeast Asia has decreased 50% in the last 15 years mainly due to over

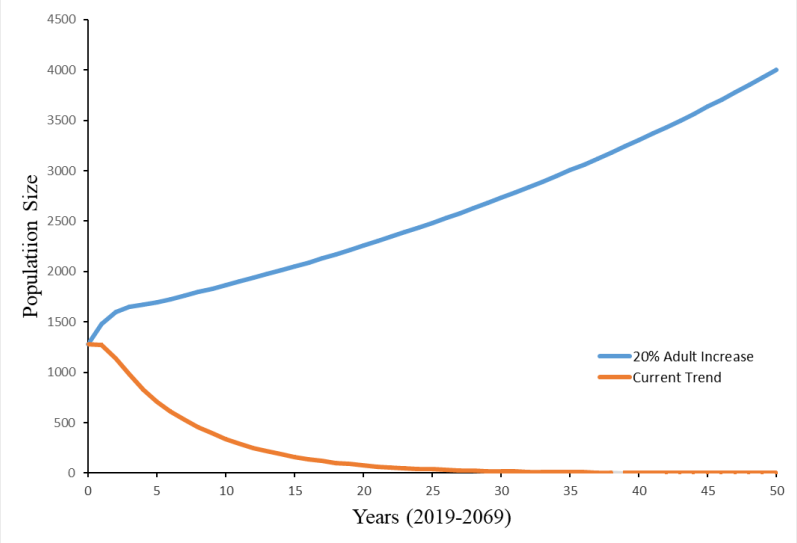

Figure 1. Projected Sunad pangolin populaiton with no management (orange) and with a 20% adult survival increase (blue).

exploitation from illegal poaching and habitat loss (Withaningsih et al. 2018). With no management of the Sunda pangolin they would become potentially extinct within 40 years (Figure 1).

Natural History

Species Identification

Sunda pangolins typically range from 79-88 cm in length including their tail (Breen 2003). Males typically weigh 4.9 kg and females are slightly smaller weighing 3.66 kg on average (Sulaiman et al. 2017). They are covered in many rows of scales starting just above their nostrils and ending at the tip of the tail. On average they have up to 19 rows of scales on their body and no more than 20 rows on their tail (Breen 2003). Sunda pangolin scales are olive-brown in color and their underside is covered in light brown hair and skin that is grayish in color (Breen 2003). They have small conical shapes heads with small eyes. Pangolins lack teeth but have very long sticky tongues that can extend up to 25 cm (Breen 2003). Sunda pangolins have big digging claws on their front feet that are stronger and longer than their hind feet (Breen 2003).

Figure 2 Adult Sunda pangolin on a tree limb. (Photo credit: Dan Challender)

Distribution

International Union for Conservation of Nature (IUCN) Red List, 2019

Figure 3 Distribution of the Sunda pangolin.

Breeding

Female Sunda pangolins have been observed giving birth to young throughout the year. This suggests that Sunda pangolin breeding is aseasonal (Zhang et al. 2015). Sunda pangolins reach sexual maturity and reproductive age between one and two years old (Zhang et al. 2015). The gestation period of Sunda pangolins in approximately six months long. The young will stay in the den for several weeks after birth and are completely weaned from their mother after around four months. Young Sunda pangolins stay with their mother until they are sexually mature then are independent after that (Zhang et al. 2015).

There is a complete lack of information on the survivability rates and fecundity rates for Sunda pangolins. A surrogate species was used to create a population model for this management

plan. The nine-banded armadillo (*Dasypus novemcinctus*), although not related to the Sunda pangolin is very similar in terms of natural history features. Based on a study preformed in Florida on a population of 1,292 nine-banded armadillos (Loughry et al. 2013). Data from this study suggests that the survivability of den cubs (0-4 months) and cubs (4 months- 1 year) is 0.541. Survivability for juveniles (1-2 years) is 0.664 and 0.753 for sub adults (2-3 years) and adults (3-7 years) (Loughry et al. 2013). Based on this data and the sensitivity matrix (Appendix C) the most stage of life to manage for are the adults (3-7 years). the population model graph (Appendix C) suggests that with a 20% increase in adult survivorship the population, based on the nine-banded armadillo study, could double in the next 45 years. Although slow this would be progress in the right direction to raise the Sunda pangolin population in southeast Asia. In the last 15 years the Sunda pangolin population has decreased by 50% (Withaningsih et al. 2018).

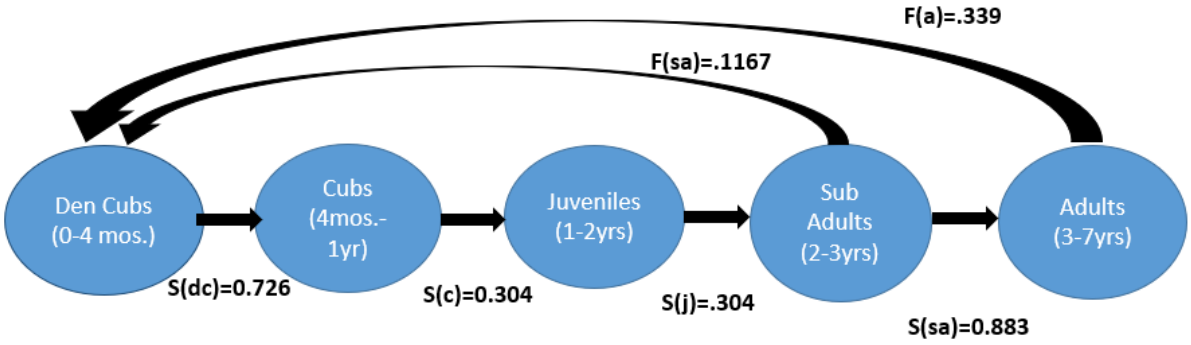

Figure 4. Life History diagram with survival rates for each stage and fecundity rates for the breeding stages.

Diet

Sunda pangolins are highly specialized eaters, feeding on primarily ants and termites (Gong et al. 2015). Pangolins are mainly nocturnal and have many adaptations for their specialized feeding habits. These adaptations include a conical-shaped head that allows the snout

to reach into holes in trees or in the ground to forage, lack of teeth, a tongue that is very long and sticky to lick up ants and termites, and long powerful claws for digging and breaking up ant nests and termite mounds (Lim and Ng 2008). Their long tongue is covered in sticky saliva and passes through the chest cavity and then anchors to the pelvis which allows the tongue to be extended 25 cm (Breen 2003).

Field studies have shown that pangolins also feed on other insect species, such as bee pupa, flies, worms, crickets, and other insect larvae (Gong et al. 2015). Some sand or small pieces of gravel may be swallowed to aid in digestion due to pangolins lack of teeth (Gong et al. 2015). Gong et al. (2015) explains that pangolins have a diet that is high in proteins and fats, and high in calories.

The composition of the pangolins diet changes seasonally in terms of whether ants or termites are more available (Gong et al. 2015). In the summer, ants are the main food source for pangolins because they are found on the ground, while termites remain in tunnels below the surface. Meanwhile in the winter, ants avoid cold temperatures and move underground, and pangolins prefer to depredate termite nests, which have a greater biomass than ants (Gong et al. 2015). Pangolins play an important ecological role because of their diet in that they regulate insect populations in their habitat. A pangolin that is three kilograms in weight can eat 300-400 grams of termites in a single feeding (Gong et al. 2015). It is estimated that an adult pangolin may consume 70 million insects or more in the course of a year (Gong et al. 2015). The breaks down to nearly 192,000 ants and termites consumed daily. This has a tremendous impact on termite populations and serves as a method of conservation of the pangolin's habitat (Gong et al. 2015). More research should be conducted to determine specific amounts of food consumed by Sunda pangolins as well as the amount of time used for foraging.

Cover

The Sunda pangolin is a terrestrial species that inhabits the primary and mature secondary forest types in southeastern Asia. Wilcove et al. (2013) defines primary forests as forests that have never been logged, and mature secondary forests as secondary forests that exhibit the structural characteristics of a primary forest (Wilcove et al. 2013). Pangolins spend much of their time in their burrow; burrows are also referred to as dens or nests. A study done in West Java, Indonesia suggests that pangolins build and utilize several types of nests, rock nests, ground nests, and tree nests (Withaningsih et al. 2018).

Based on their study Withaningsih et al. (2018) suggests that rock nests were the most common nest type used in the study area. Rock nests in the area were typically 16-170 cm in length, 8-98 cm wide, and 77cm to 3 m deep (Withaningsih et al. 2018). Withaningsih et al. (2018) also suggests that the nests used by pangolins may have been previously used by porcupines (Withaningsih et al. 2018). In this study ground nests were described as being on average 8-100 cm long, 15-73 cm wide, and 50 cm to 3 m deep (Withaningsih et al. 2018). Tree nests were on average 21 cm to 1 meter in length, 12-15 cm wide, and 1-3 m deep (Withaningsih et al. 2018).

One study following a mother Sunda pangolin with a cub suggests that when with a cub female pangolin will use several dens at once (Lim and Ng 2008). In this study the female used three dens all in hollows of trees that had a DBH greater than 50 cm (Lim and Ng 2008). The dens did not seem to have any other similarities. One was described to have an underground burrow that lead to the hollow of a dead tree with only one entrance (Lim and Ng 2008). Another was in the hollow of a live tree that had two entrances and was 1.3 m above ground (Lim and Ng 2008). The last was in a dead tree that had fallen and had one entrance at the base of the tree (Lim and Ng 2008). On average the dens were used for a period of 9.3 ± 2.7 days at a time (Lim

and Ng 2008). The female in this study only left the den for no more than 30 minutes at a time. The highest levels of activity occurred from 3 AM to 6 AM and only spent on average 127 minutes outside of the den per day (Lim and Ng 2008).

More research should be done to determine territory size and whether habitat change seasonally based on the dietary restrictions of the Sunda pangolins.

Disease

Due to a lack of research and information little is known about the diseases that Sunda pangolins and other pangolin species may carry. It is known that pangolins in captivity often die of gastrointestinal disease, pneumonia, skin disease, and parasites (Gong et al. 2015). At the Taipei Zoo in Taiwan it was recorded that 50% of the pangolins at the zoo died of pneumonia and gastric ulcer lesions (Chin and Yang 2008). It is common to find bacterial dermatitis beneath the scales of pangolins that have been confiscated from illegal trade (Clark et al. 2015). Mohapatra et al. (2015) compiled a list of parasites (ecto and endo) and bacteria found in and on pangolins. The purpose of this list is to concentrate the available information into one source because the information on disease in pangolins is so limited (Mohapatra et al. 2015). The list showed that one protozoa species, four species of helminth, three tick species, and one species of bacteria were reportedly found on Sunda pangolins (Mohapatra et al. 2015). The data was collected from pangolins in captivity, in the wild, and from pangolins confiscated from illegal trade (Mohapatra et al. 2015).

Gastrointestinal Coccidiosis is commonly found in pangolins confiscated from illegal wildlife trade. Coccidia are contagious between animals and are host specific protozoan parasites that affect the intestines of infected animals (Clark et al. 2015). Symptoms of coccidiosis include diarrhea, fever, weight loss, lack of appetite, and can lead to death (Clark et al. 2015).

Coccidiosis is seen in animals that are kept in overcrowded areas with poor sanitation, and poor nutrition (Clark et al. 2015). In the illegal trade of pangolins individuals are often transported in a curled-up position in tightly tied sacks (Clark et al. 2015). They are then packed tightly into crates where the pangolin gets covered feces and urine and coccidia are spread (Clark et al. 2015). Humans can contract coccidiosis, but it is caused by a different species of coccidia that is found in pangolins (Clark et al. 2015). The species of coccidia found in pangolin can be transmitted to some domestic animals if they come in contact with the feces of an infected pangolin (Clark et al. 2015). The best way to control the spread would be to create a more practical way of transportation to refuge centers that involves better sanitation and nutrition efforts (Clark et al. 2015).

Conservation Needs

Ecological

Deforestation is the leading ecological threat to Sunda pangolins (*Manis javanica).* Much of the primary forests in southeast Asia have decreased by 23,000 km^2 (Wilcove et al. 2013). Forest conversion is the main cause of deforestation in southeastern Asia. Wilcove et al. 2013 explained that 90% of palm oil plantation expansion from 1990 to 2010 came at the expanse of some other type of forest. Timber operations for pulp and paper are also a cause for deforestation in the area. Indonesia alone had 4.9 million ha of timber plantations that produced seven million tons of pulp and 10.5 million tons of paper in 2010 (Wilcove et al. 2013). Sunda pangolins use trees from primary forest as nest sites. Wilcove et al. (2013) defines a primary forest as forests that have never been logged. Sunda pangolins are found to have three types of nests, ground nests, rock nests, and most commonly tree nests (Withaningsih et al. 2018). Withaningsih et al.

(2018) describes a tree nest of a Sunda pangolin to be 21 cm to one meter in length, 12-15 cm wide, and 1-3 meters deep.

Economic and Sociocultural

The Sunda pangolin is currently listed as critically endangered on the IUCN Red List (Challender et al. 2014) and its populations continue to decrease. Currently there are no population estimates for the Sunda pangolin, but populations have been reported as decreasing by the IUCN. The rapid decrease in the population of Sunda pangolins is a result of the current sociocultural issues that affect the species in southeast Asia include wild meat trade and medicinal uses (Challender 2019, Shairp et al. 2016). Vietnam government has addressed the issue of illegal and unsustainable consumption of species by enacting legislation to regulate harvest, trade and consumption of wildlife (Shairp et al. 2016). They have also tried to combat illegal trade by promoting captive breeding of Sunda pangolins and other species that are targeted by illegal trade (Shairp et al. 2016).

Legal

In Singapore the Sunda pangolin is protected by the Wild Animals and Birds Act (Cap. 351), which is the main legislation that protects the species there and in surrounding countries (Vinayagan 2011). The Wild Animals and Birds Act prohibits the unlicensed killing, taking, and keeping of any wild animal by any means. The Endangered Species Act (Cap. 92A) makes the Convention on International Trade in Endangered Species of Wild Fauna and Flora ('CITES') effective in Singapore. The Sunda pangolin was up listed to CITES Appendix 1 at the 17th meeting of the CITES Conference of the Parties in 2016 (CITES, 2016a). This makes the commercial trade of the Sunda pangolin and its parts and products strictly prohibited (CITES,

2016b). Most of the legal and legislative information regarding Sunda pangolins comes from legislation acts in Singapore.

Sunda pangolins are protected in other parts of southeast Asia as well. In Malaysia they are listed in the Wildlife Protection Ordinance 1998 and the Wildlife Protection Act 1972 (Pantel 2010). Pangolins are protected in Indonesia under the Conservation on Biodiversity and Ecosystems Act No. 5 of 1990 and the Government Regulation on Conservation on Flora and Fauna Order of 2007 (Pantel 2010). Each country in southeast Asia have different legislations protecting Sunda pangolins, some are stricter than others. Having universal legislation protecting Sunda pangolins would be a huge step forward in the management of the species.

Statement of Need

The ecological, economic and sociocultural, and legal issues that require a need for management of the Sunda pangolin are discussed above. Another issue regarding the need for management of the Sunda pangolin is the lack of understanding of this species. There are limited resources of information on the species along with the other species of pangolin. Management of the Sunda pangolin is needed to gain vital knowledge in all aspects of the species.

Management

Goal

Gain an understanding of the biology and ecology of Sunda pangolins and gather information on the status of the population of Sunda pangolins in Southeast Asia from 2019-2069.

Objectives

Objective 1- Increase understanding of Sunda pangolin ecology, biology and behavior in Southeast Asia in fifteen years publishing five peer reviewed papers.

Objective 2- Assess 75% of Sunda pangolin population throughout southeast Asia in ten years.

Objective 3- Create awareness in local communities and collaborate with relevant agencies to commit to the conservation of Sunda Pangolins in twenty-five years.

Actions

Objective 1- Increase understanding of Sunda pangolin ecology and breeding behavior in Southeast Asia in fifteen years publishing five peer reviewed scientific papers.

Action 1.1. Using camera traps in areas of known Sunda pangolin activity would be an appropriate way to collect data on Sunda pangolin ecology, and the specific forest type and species composition that they prefer. Several camera traps should be placed throughout areas of known activity (Withaningsih et al. 2018). This will allow data to be collected on Sunda pangolin distribution throughout the area. Camera traps should be placed near and in active dens which will allow data collection on preferred denning conditions as well as activity levels throughout the day (Lim and Ng 2008).

Action 1.2. Visual observations should be made during the day and at night. Visual observation sites should be set up near dens and known areas of feeding activity. Visual observations will allow for data collection on specific denning preferences (Withaningsih et al. 2018), feeding behaviors and favorite prey items (see Diet), as well as give an insight to breeding behaviors in the wild.

Action 1.3. Data from camera traps used in action 1.1 and observations taken in action 1.2 should be used to determine specific species of plants, especially trees, to help understand the specific habitat of the Sunda pangolin (Withaningsih et al. 2018). This will allow managers to determine specific forest types to manage for and possibly create protected areas for Sunda pangolins in the future.

Action 1.4. Observations of Sunda pangolins breeding in captivity should be done in zoos that have Sunda pangolins (Gong et al. 2015). Observations should also be done at pangolin rehabilitation centers where confiscated pangolins are cared for. These observations will allow information to be collected on breeding rituals and mate selection.

This action will not be implemented into this management plan because of the difficulties when dealing with captive pangolins. Pangolins are hard to keep captive because they are easily stressed and rely heavily of their natural ecosystem (Gong et al. 2015). Sunda pangolins adapt poorly to captive environments and proper diet is not often met which adds to the stress of captivity (Gong et al. 2015).

No Action - If no action would be taken and no advancements were made in gaining an understanding of the ecology and breeding behavior of Sunda pangolins the void of information known about this species would not be filled. To effectively understand and protect the Sunda pangolin it must be observed and evaluated in its natural habitat. The lack of information about this species does not allow for proper management of the species.

Final Course of Action: Actions 1.1, 1.2, and 1.3

Assessment Protocol: Objective 1 will be successfully completed when there is an increase in knowledge and understanding of the ecology and breeding behavior of Sunda pangolins by publishing five peer reviewed scientific papers in fifteen years. This will be assessed by setting camera traps, recording visual observations, as well as examining all existing literature and scientific papers on the ecology and breeding habits of Sunda pangolins in southeast Asia.

If this objective is not successful in fifteen years, the next step would be to evaluate why the research was not completed to write five peer reviewed papers. Failure to complete the research could be due to insufficient funds. A study done in the United States stated that an increase of one million dollars in federal research funding resulted in an increase of 10 articles (Payne and Siow 2003). Then next step in completing this objective would be to obtain federal funding for Sunda pangolin research.

Objective 2- Assess 75% of Sunda pangolin population throughout southeast Asia in ten years.

Action 2.1. Areas with known Sunda pangolin activity will be designated throughout the range of the species. Sunda pangolins should be caught by hand and radio transmitters will be fitted onto scales on the pangolins tail similar to Lim and Ng's (2008) study. When pangolins sense the presence of humans they often scurry away or freeze in their tracks (Lim and Ng 2008). Pangolins move slowly and catching them by hand ensures a

safe way to handle that animal (Lim and Ng 2008). Transmitters should be lightweight and have a long-lasting battery life (Lim and Ng 2008). The transmitters should be fastened onto the selected scales using screws and bolts (Lim and Ng 2008). Radio transmitters will allow data to be collected on interactions between individuals along with home range size and the potential to map out territories.

Action 2.2. Areas with known Sunda pangolin activity will be designated throughout the range of the species. Sunda pangolins should be caught using live traps like havahart traps (Sulaiman et al. 2017). Mark and recapture techniques will be used to determine a population density in a given area which will be compared to populations densities in other areas. The captured pangolins should be marked with tags that will help identify different individuals. The tags should be fastened to selected scales using screws and bolts or a strong weather resistant glue. Mark recapture techniques will allow data to be collected that will help created population estimates for the Sunda pangolin.

No Action- If no action is taken the population of Sunda pangolins will remain a mystery. Population estimates are a vital component in managing for any species, especially when creating population models and management based on reproductive rates and the survivorship of a species.

Final Course of Action: Action 2.1 and 2.2

Assessment Protocol: Upon successful completion of objective 2 an assessment of 75% of the Sunda pangolin population in southeast Asia will be done. Visual observations of the marked individuals should be taken continuously throughout the ten-year timeline. This will ensure that new individuals will be marked and added to the data. Following the marked individuals will give insight to the population dynamics of the species, providing even more information about the Sunda pangolin. Once the population has been assessed and an estimate has been made, an attempt should be made to increase the adult survivorship of Sunda pangolins by 20% (Figure 1).

If this objective is not completed in the ten years allotted to do so the next step would be to raise Sunda pangolins in captivity and release them in to areas of known pangolin activity in the hopes that they would breed, and populations would increase. The goal would be to increase adult Sunda pangolin survivorship by 20%. Although pangolins are hard to keep in captivity due to stress, malnourishment, and the fact that they rely heavily on their natural habitat (Gong et al. 2015) if the right conditions were met this could be a viable action to help study and increase Sunda pangolin populations.

Objective 3- Increase awareness and acceptance in local communities and collaborate with relevant agencies to commit to the conservation of Sunda Pangolins in twenty-five years.

Action 3.1. Before any management practices are put into place the communities in areas where actions will take place should be informed about the project. Informational flyers (Appendix A) should be distributed to the affected communities throughout the Sunda pangolins range. Public forums at town halls should also be conducted to provide any

additional information and address any concerns the public may have about the project. Public opinion should be taken seriously when managing wildlife, much like the National Park Service did when restoring wolves in Yellowstone National Park (National Park Service 2017).

Action 3.2. Relevant agencies should be contacted with information about the project. Support from these agencies could help with obtaining support from the affected communities. These agencies could also help enforce existing protections for the Sunda pangolin such as CITES (CITES 2016). Letters should be from project members and community members that support the project should be sent to relevant agencies.

Action 3.3. A sighting form (Appendix B) to document Sunda pangolin sightings should be available year-round for all members in affected communities. Information from this form will allow data to be collected on the population of Sunda pangolin. This information will help wildlife managers determine if new individuals are moving to that area, if pangolins are reproducing, and will give an insight to any changes in the population size in that area.

No Action- If no action is taken then the communities affected by this project will be uninformed about the management of Sunda pangolins. This could lead these communities to not support the project. Public support a key element when implementing wildlife management projects.

Final Course of Action: Action 3.1, 3.2, 3.3

Assessment Protocol: Obtaining the support of local affected communities and relevant agencies will be considered successful in completing objective 3. If there is no support from the affected communities, then the implementation of this management plan will be near impossible. If there is support from relevant agencies that could help persuade non-supportive communities into supporting the management of Sunda pangolins.

If this objective is not completed in the twenty-five-year timeline the next step would be to continue educating affected communities on the ecological importance of this species. Another step would be to go back to the affected communities and interview the residents to get information on why this project was not supported and what changes could be made to get more support (Withaningsih et al. 2018).

Conclusion

This management plan has been constructed specifically for the Sunda pangolin and the ecosystem that is inhabits throughout southeast Asia. For this plan to be successful the public needs to be educated on Sunda pangolins and the role that they play in their ecosystem. Habitat loss, poaching for bush meat and medical uses, and the lack of knowledge of Sunda pangolins are all reasons why their population in southeast Asia needs to be managed for and researched. Implementing the final courses of action in this plan will allow for vital knowledge to be gained and for the status of the population to be assessed and managed for, ultimately achieving the goal of this management plan.

Acknowledgments

I would like to thank Dr. Ross Conover and the students in FWS 470- Wildlife Management. I would also like to thank all the professors who have helped me throughout my time at Paul Smiths College while completing my Bachelor of Science in Fisheries and Wildlife Science. Lastly, I would like to thank my family and all my friends for their support through my college career.

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Appendix A

Sunda Pangolin Management in Your Community

It is important for you, the community, to be informed on the details of the management of Sunda pangolins in your community. Your support of this management will make conservation of Sunda pangolins so much easier.

Identifying a Sunda Pangolin:

- 79-88 cm long
- Covered in many rows of brown scales
- Underside covered in light brown hair and grayish skin
- Small conical head with small eyes

Why manage for them:

- Sunda pangolins are important to their ecosystem.
- They control the impacts of forest termites
- Critically endangered on the IUCN Red List
- There are no current population estimates

Details of Management near you:

- Sunda pangolins are being studied to gain knowledge on their ecology and behavior.
- Population status is being evaluated to eventually increase Sunda pangolin populations.

Appendix B

Sunda pangolin (*Manis javanica*) Sighting Form

This for is to be filled out when every time there is a Sunda pangolin sighting in your community. The data collected from these forms will create information on the population of Sunda pangolins in your community, which is vital for their management.

1. Date of sighting. _____
2. Location. _____
3. Time of day.
    a. Morning
    b. Afternoon
    c. Evening
    d. Other: _____
4. Where did you see the Sunda pangolin?
    a. Forest
    b. Road
    c. Other: _____
5. Were there any visible tags or marking on the Sunda pangolin?
    a. Yes
    b. No
    c. If yes, please describe the tag or marking:
    _____
    _____

Thank you for completing and returning this form. The information that you have provided will greatly impact the management of Sunda pangolins.

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Appendix C

	F (dc)	*F* (c)	*F* (j)	*F* (*sa*)	*F* (*a*)
Den Cubs (0-4 m):	0	0	0	0.3211545	0.3211545
Cubs (4m-1yr):	0.541	0	0	0	0
Juveniles (1-2yrs):	0	0.541	0	0	0
Subadults (2-3yrs):	0	0	0.664	0	0
Adults (3-7yrs):	0	0	0	0.853	0.753

Stage structure matrix model for Sunda pangolin (*Manis javanica*)

	Sensitivity matrix				
		F (c)	*F* (*j*)	*F* (*sa*)	*F* (*a*)
Den Cub	0.2060	0.0569	0.0357	0.0275	0.2159
Cub	0.1445	0.0907	0.0569	0.0439	0.3439
Juveniles	0.2302	0.1445	0.0907	0.0699	0.5479
Subadults	0.2988	0.1876	0.1177	0.0907	0.7111
Adults	0.2677	0.1681	0.1055	0.0813	0.6371
	Elasticity matrix				
	F(*dc*)	*F* (c)	*F* (*j*)	*F* (*sa*)	*F* (*a*)
Den Cub	0	0	0	0.010263238	0.080450358
Cub	0.090713596	0	0	0	0
Juveniles	0	0.090713596	0	0	0
Subadults	0	0	0.090713596	0	0
Adults	0	0	0	0.080450358	0.556695257

Top: Sensitivity matrix showing that the adult fecundity has the biggest effect on the population.
Bottom: Elasticity matrix for the Sunda pangolin.

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