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# Conflict between humans and leopards (*Panthera pardus melas* Cuvier, 1809) in Western Java, Indonesia

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**Abstract.** *Gunawan H, Iskandar S, Sihombing VS, Wienanto R. 2017. Conflict between humans and leopards (*Panthera pardus *melas Cuvier, 1809) in Western Java, Indonesia. Biodiversitas 18: 652-658.* Conflict between the Javan leopard (*Panthera pardus melas* Cuvier, 1809) and humans occupying the same region have tended to increase in the last decade in proportion to increase in deforestation followed by fragmentation and habitat loss. The objectives of this research were to study the leopard-human conflict and to analyze the causes in order to formulate recommendations for mitigation. Literature study, structured interviews, and field surveys were carried out to collect data on leopard-human conflict. Spatial modeling using weighted overlays generated a map of conflict potential in Western Java. The results showed that in the last 15 years 71 cases of leopard-human conflict had been recorded, with a tendency to increase over time. There have been 75 records of occurrence of the Javan leopard population in Western Java, of which 30% are assessed to have had a high potential for conflict; 25% had moderate potential, and 46% had low potential. There are indications that leopard-human conflict has occurred in villages around degraded forest areas due to human encroachment and cultivation. Consequently, a special forest management strategy must be implemented on a landscape scale, crossing the boundaries of conservation forest, productive forest, protected forest and other land uses.

**Keywords**: Conflict, degradation, fragmentation, habitat, leopard

## INTRODUCTION

Javan leopard (*Panthera pardus melas* Cuvier, 1809) population management in Indonesia is facing many challenges. In the last two decades, the population of Javan leopard has drastically declined due to impacts of habitat loss, fragmentation and hunting of both leopard and its prey. This is leading to conflict between leopards and humans. As a result, the population of Javan leopard is threatened with extinction in some locations (Gunawan 2010). Due to its declining status, in 2008, the Javan leopard was placed on the IUCN Redlist as Critically Endangered (IUCN 1996; Cat Specialist Group 2002; Ario et al. 2008).

As human populations expand and encroach ever further into natural habitats, humans and wildlife increasingly compete for living space and food. Asian big cats are suffering not only from significant habitat loss, but also from a decline in their prey species within the habitat that remains. As a result, cats are moving into more marginal areas searching for food, finding easy prey in domestic livestock and attack humans as well. (WWF-International 2016).

Extensive forest conversion, both legal and illegal, have directly increased the likelihood of local extinction of Javan leopard in some forest fragments (Gunawan 2010). Types of land use and spatial planning that ignore the principle of ecosystems in unity with landscape have resulted in forest fragmentation which leads to demographic and genetic isolation of the leopard population, rendering it vulnerable to further threats of extinction from *inbreeding* (Gunawan 2014). As the fragmentation, degradation, and loss of habitat increases, so the likelihood of conflict between humans and leopard enlarges (Gunawan and Wiennato 2015; Partasasmita et al. 2016).

According to IUCN (2005), human-wildlife conflict occurs when wildlife requirements encroach on those of human populations, with costs both to residents and wild animals. The conflict between humans and wild animals occur when either the needs or behavior of wildlife impact negatively on human livelihoods, or when humans pursue goals that impact negatively on the needs of wildlife (Makindi et al. 2014). The WWF (2005) defined human-wildlife conflict in broader terms, as any interaction between humans and wildlife that results in negative impacts on human social, economic or cultural life; on the conservation of wildlife populations; or on the environment. Human-wildlife conflict results in a range of negative effects. Major outcomes of human-wildlife conflict are injury and loss of life to humans and wildlife, predation on livestock, predation on managed wildlife stock, damage to human property, trophic cascades (e.g. disruption down the food chain), destruction of habitat, collapse of wildlife populations, and reduction of their geographic range (Woodroffe et al. 2005).

Frequently, the conflict between humans and leopards ended with killing the leopards or trapping them and sending them to the nearest zoos (Gunawan and Wiennato 2015). The increased trend towards conflict between

human and leopards needs to be resolved through insightful management which aims to reduce potential harm to animals and man through the measures to protect human life and leopard population, to maintain habitat and general biodiversity, and to minimize damage to property.

Reducing conflict between wildlife and people is considered a top conservation priority (Karanth et al. 2012), particularly in landscapes where high densities of people and wildlife co-occur. Empirical information about the conflict between humans and wildlife is important in population management and is regarded as a priority in *Population and Habitat Viability Analyses* (CBSG 2010a,b). Research on human-wildlife interactions often investigates ecological or social indicators that predict the potential for conflict (Morzillo et al. 2014). Our research was conducted to provide data regarding the conflict between humans and leopard in Western Java and to generate recommendations for reducing the vulnerability to conflict and for mitigating its effects.

## MATERIALS AND METHODS

Secondary data was collected from relevant sources including journal, thesis, and research reports. Data of conflicts have been collected since 2011 through reports compiled from the nature resources conservation agencies, national park offices, district forest services and Perum Perhutani offices. Digital maps of forest function, topography and elevation were collected from the Directorate General of Forest Planology, Ministry of Environment and Forestry. The maps will be used for composing a spatial model of habitat vulnerability to leopard-human conflict.

A standard questionnaire was used to collect primary data from respondents including field staff of the conservation agency, forest service, Perum Perhutani management, and local residents living around the conservation areas. The questionnaire included questions on local conditions, culture and social economic characteristics of local communities including their distance from forest area boundaries, human-wildlife, and livestock-wildlife interactions, and dependence of local communities on forest resources and forest land. Questions were also aimed at gaining insight into the perceptions of local people on conservation efforts and forest management in general.

In-depth interviews with key persons were also arranged to collect information about policies of local government and conservation management in their efforts to mitigate human-leopard conflicts. Camera traps were used in conflict areas for confirming the presence of leopards. GPS was used for pinpointing the localities where leopards exist and where incidents of conflict occurred. The research domain covered the western part of the Island of Java, which includes West Java Province and Banten Province, Indonesia.

Data from both primary and secondary sources was processed and analyzed using Microsoft Excel. Both descriptive and analytical procedures were used in the data analysis. The analyses were carried out to assess the trend in the incidence of conflict and to determine the potential causes of conflict in the relationship between human attitudes and forest conditions. A conflict vulnerability model was generated through spatial modeling of the vulnerability of forest areas to human disturbance including variables of forest function status, topography, and elevation above sea level. All three maps of forest function, topography and elevation were overlaid on the geographic map with the following weightings:0.40 (forest function); 0.33 (topography); and 0.27 (elevation). All factors were scored (Table 1; Figure 1) according to criteria derived from (Gunawan 2010).

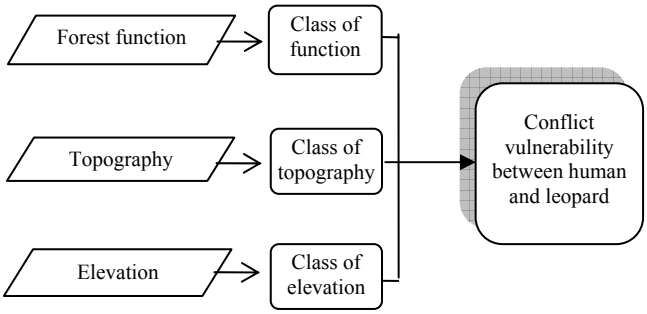


**Figure 1.** Overlay procedure to assess habitat vulnerability to leopard-human conflict

**Table 1.** Scores of habitat factors for modeling the level of risk of leopard-human conflict

| Criteria | Score | Indicators | Vulnerability to conflict | Weight |
|---|---|---|---|---|
| Forest functions | 1 | Production forest | High | 0.40 |
| | 5 | Limited production forest | Moderate | |
| | 10 | Conservation forest and protected forest | Low | |
| Topography | 1 | < 15 % slope | High | 0.33 |
| | 5 | 15% -25 % slope | Moderate | |
| | 10 | > 25% slope | Low | |
| Elevation | 1 | < 500 m above sea level | High | 0.27 |
| | 5 | 500 -1000 m above sea level | Moderate | |
| | 10 | > 1000 m above sea level | Low | |

## RESULTS AND DISCUSSION

### Trends in the conflict between humans and leopards in Western Java

Lamarque et al. (2009) categorized human-wildlife conflicts into five types; human deaths and injuries; destruction of crops; attacks on domestic animals; transmission of diseases to livestock and/or humans; and adverse interaction with other species (endangered or highly valuable). In Western Java, most of the human-leopard conflicts were triggered by cases of livestock depredation and terror caused by the appearance of leopards in human settlements. There are three main types of interaction between humans and leopards in Western Java (Figure 2). Most of this conflict between humans and Javan leopards in Western Java can be classified as "attacks on domestic animals". There were 48 cases (69% of the total number) of predation on livestock by Javan leopards during the last 15 years in Western Java.

The number of cases of conflict between human and leopards has been increasing in the last 15 years (Figure 3). During that period a total of 71 cases were reported, but it was assessed that there were additional cases that had not been reported by local people due to reasons such that, there were no victims or that the leopards were illegally killed by local people. When leopards are trapped and killed, people prefer not to report it to conservation managers or local government to avoid law enforcement.

The incidents of conflict were recorded across nine regencies; i.e. Ciamis, Garut, Bogor, Tasikmalaya, Sukabumi, Kuningan, Cianjur, Bandung Barat and Lebak (Figure 4). The highest frequency of conflict between human and leopards occurred in Ciamis District, with 48 cases reported. The leopards were frequently entering human settlements and in many cases, they killed livestock such as goats, sheep, and chickens as well.

It has been hypothesized that the increase in a number of incidents of leopards straying into settlements in Western Java is correlated with an increase in the population of Javan leopards while the carrying capacity has remained relatively constant; thus forcing new individuals to exit from their original habitat in search of new suitable habitat. An alternative hypothesis is that there has actually been habitat loss and degradation due to deforestation, conversion, and fragmentation, leading to a decline in carrying capacity, again forcing some leopards out of their original habitat to find new habitats. Under conditions where carrying capacity becomes insufficient to support leopard populations, male individuals, which normally exhibit territorial behavior, will compete with other males to conquer the habitat to increase their territory. The leopards that lose out in the competition for territory -usually old males, young males, and weak individuals -will be the ones forced out. The facts support the idea that there is competition for territory, actually, most of the leopards that are forced out of their habitats are young males under three years of age, and weak males suffering from disease or wounds.

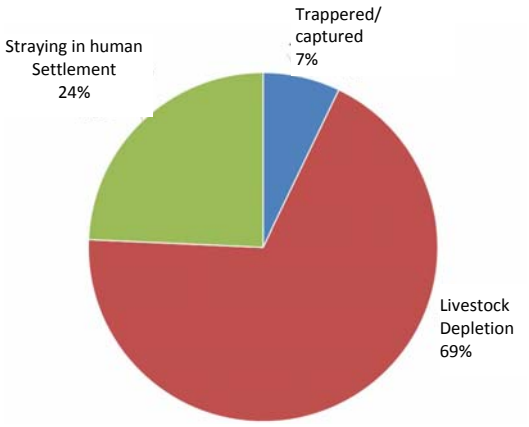


**Figure 2.** Typology of conflict between human and leopards in Western Java, Indonesia

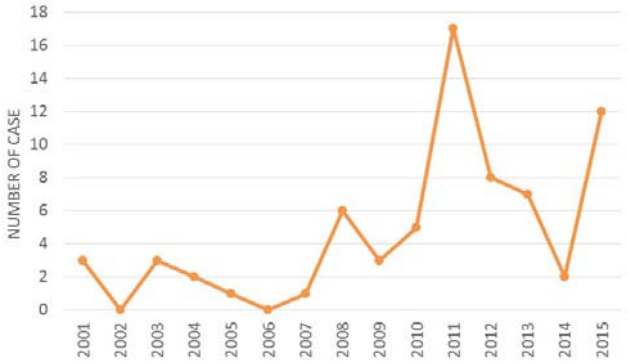


**Figure 3.** Trend of conflict between human and leopards in Western Java, Indonesia

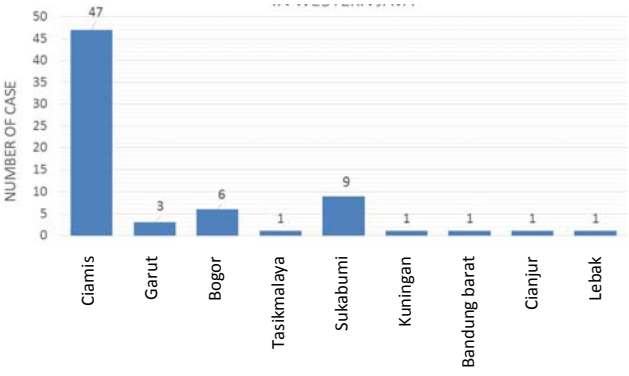


**Figure 4.** Distribution of conflict between humans and leopards in Western Java, Indonesia

Leopards which enter the human settlements in Ciamis District are assumed to have come from Mount Sawal forest. The core area of Mount Sawal functions as a wildlife sanctuary which is managed by the Nature Resources Conservation Agency. At the outer edge of the wildlife sanctuary, there is production forest and protected forest managed by Perum Perhutani (State Forestry Business Unit). Production forest and protected forest around the wildlife sanctuary play a role as a buffer zone functioning as an extension of the habitat and a refuge area for wildlife.

In recent decades, the production forest and protected forest were deforested due to reformation euphoria which motivated people to encroach upon and occupy the forest area. In fact, most of the production forest and protected forest which previously functioned as a buffer zone for the wildlife sanctuary, is now being planted with *Coffea robusta*. This coffee plantation has been legalized through the Community-Based Forest Management (CBFM) Program. However, the CBFM program was not implemented properly, and the composition of forest species and agricultural species in the program does not support the sustainable functioning of the forest and agricultural species that dominate the area and are planted after initial forest cutting and land clearing. Young trees of *Pinus merkusii* are planted sparsely amongst the coffee plantation.

The conflict between humans and leopards is rising as deforestation is increasing for agricultural use. In 2006, there were 1.608,45 hectares cultivated land around Mount Sawal Sanctuary which have been increased became 1.724,95 hectares in 2014 (Figure 5). This is in line with the increase of conflict between leopards with human around the Mount Sawal Sanctuary. The evidence suggests that the number of incidents of leopards entering into human settlements around Mount Sawal is are rising as a result of the extensive encroachment into and cutting off the production forest and protected forest zones around the wildlife sanctuary. The forest floor cover of natural vegetation which can provide a variety of forage for herbivores is vanishing as the coffee plantation is extensively developed. The cover vegetation that arises under the coffee plantation is unintended and has become weedy, so it must be eradicated even through environment unfriendly methods such as the application of chemical herbicides.

The presence of leopards in the vicinity of human habitations is assumed to result from the leopards cruising their home range in pursuit of prey which extend their foraging and grazing area as their natural habitat has been changed into coffee plantation without a floor cover crop. Deforestation and forest conversion into monoculture plantation have resulted in negative impacts on the leopard's prey population with the consequence that the leopards tend to widen their home ranges by including the private land available in the vicinity of human settlements.

The general assumption that conflict between humans and leopards rises as an impact of dry seasons is not supported by the data. Figure 6 describes the trend in the number of incidents of conflict in the period 2001-2015 which included several cycles of dry and wet/rainy seasons. The peaks in the number of conflicts appeared in the wet seasons, which are commonly the seasons of abundant prey. We conclude that factors other than seasonal effects are determining the pattern in the frequency of conflict. Territorial behavior is strongly indicated as the cause of the conflict between humans and leopard. Most of the leopards which came out from their original habitat were male individuals under three years of age. According to Van Houten (2003), the new generation which has just separated from their mothers and must seek their own territories. New males must compete with other existing stronger males (included their fathers) to get hold of territory. Unfortunately, most young male leopards are weak and less experienced due to this reason most of them become losers and must depart from their habitat. This leads to the conflict with humans.

**Figure 5.** Deforestation of natural forest (left) and plantation forest (right) around the Gunung Sawal Wildlife Sanctuary, which is then followed by coffee plantations

**Conflict vulnerability**

Mapping of habitat vulnerable to conflict between humans and leopards is very important for population management of the Javan leopard. We assumed that a more restrictive forest function status results in a habitat that is more secure for the Javan leopard, so the risk of conflict is lessened. A steeper topography reduces the opportunity of human entrance into the forest, so it reduces the risk of conflict. In general, forest located at higher elevations is far from highly populated human settlements which are mostly distributed in lowland areas. Consequently, we can assume that higher elevation lowers the risk of conflict. The results of spatial modeling showed that there were 22 sub-populations (30%) with high potential for conflict between humans and leopards (Figure 8). Sub-populations of leopard vulnerable to conflict are generally distributed near or directly close to human settlements and cultivated land. Conflicts between humans and leopards frequently occur as the forested area has been changed into the non-forest land which is unsuitable habitat for leopards and their prey. These cases of conflict occurred around Mount Sawal wildlife sanctuary (Ciamis District), Cikepuh wildlife sanctuary (Sukabumi District), and Leuweung Sancang wildlife sanctuary (Garut District).

Almost one-third of the Javan leopard population in Western Java is vulnerable to conflict with humans (Figure 7). One of the causes is that the leopard's habitats are mostly too close to human settlement and cultivated land. This assumption is supported by the evidence that cases of conflict between human and leopards are most frequent in those villages that are in direct proximity to the leopard's habitats. Specifically, the conflicts mostly occur in villages close to the deforested area of the Mount Sawal forest complex.

The map of habitat vulnerable to the conflict between humans and leopards (Figure 4) can be used as the basis for mitigation efforts to prevent and reduce such conflict in the future. Leopard carrying capacity of the localities that are vulnerable to the conflict have been decreased due to their increasing populations and/or decreasing quality and quantity of habitat which in turn forces the leopard out of the forest to find new home range and prey.

Most of the leopard population in Western Java (63%) is distributed in production forests with monoculture plantations intensively managed by Perum Perhutani (Gunawan and Wiennanto 2015). This means that 63% of the leopard population is facing threats from forest cutting, cultivation, conversion, and other disturbances from human activities inside forest areas. On the other hand, there are seven populations in the 'nonequilibrium' population network that are vulnerable to conflict and have a high risk of local extinction (Gunawan 2016). These 'nonequilibrium populations' need to be monitored and managed properly to avoid local extinction. Small populations also need special treatment in management due to their high vulnerability to local extinction that arises from the risk of diseases, disasters, and inbreeding.

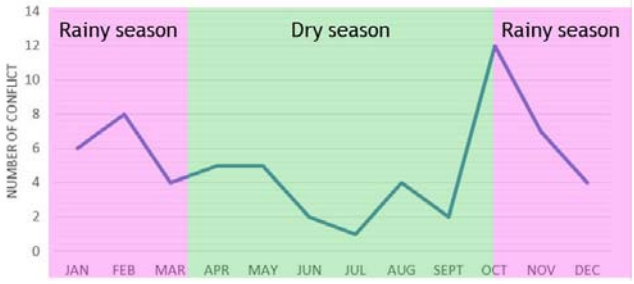


**Figure 6.** Seasonal pattern of conflict between humans and leopards in Western Java (period 2001-2015)

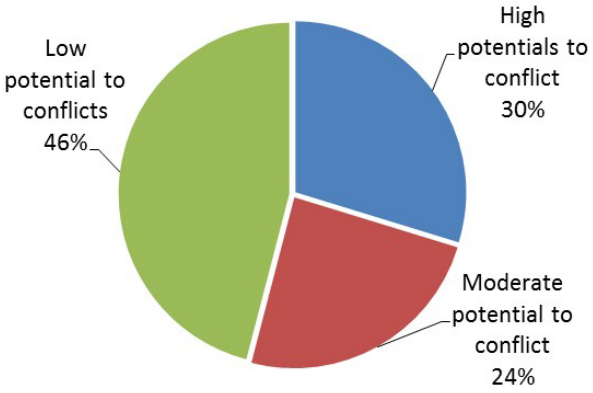


**Figure 7.** The distribution of the Javan leopard population in Western Java categorized according to the degree of vulnerability to conflict with humans

Special treatment in managing production forests that are part of the existing habitat of leopards is needed in order to ensure that cutting of the forests, cultivation, and conversion for other human uses do not result in significant forest degradation, fragmentation, and habitat loss. Coordinated management between conservation managers and other land-use managers involving all stakeholders, is essential to protect the leopard habitat on a landscape scale.

In general, almost half of the leopard population in Western Java is located far away from the human settlement and agricultural land, so is at low risk of conflict with humans. These populations are distributed in the interior or core zones of big conservation forests, such as Gede-Pangrango National Park, Halimun-Salak National Park, and also in big protected forests like Mount Tangkuban Perahu, Mount Papandayan, and Mount Patuha landscapes.

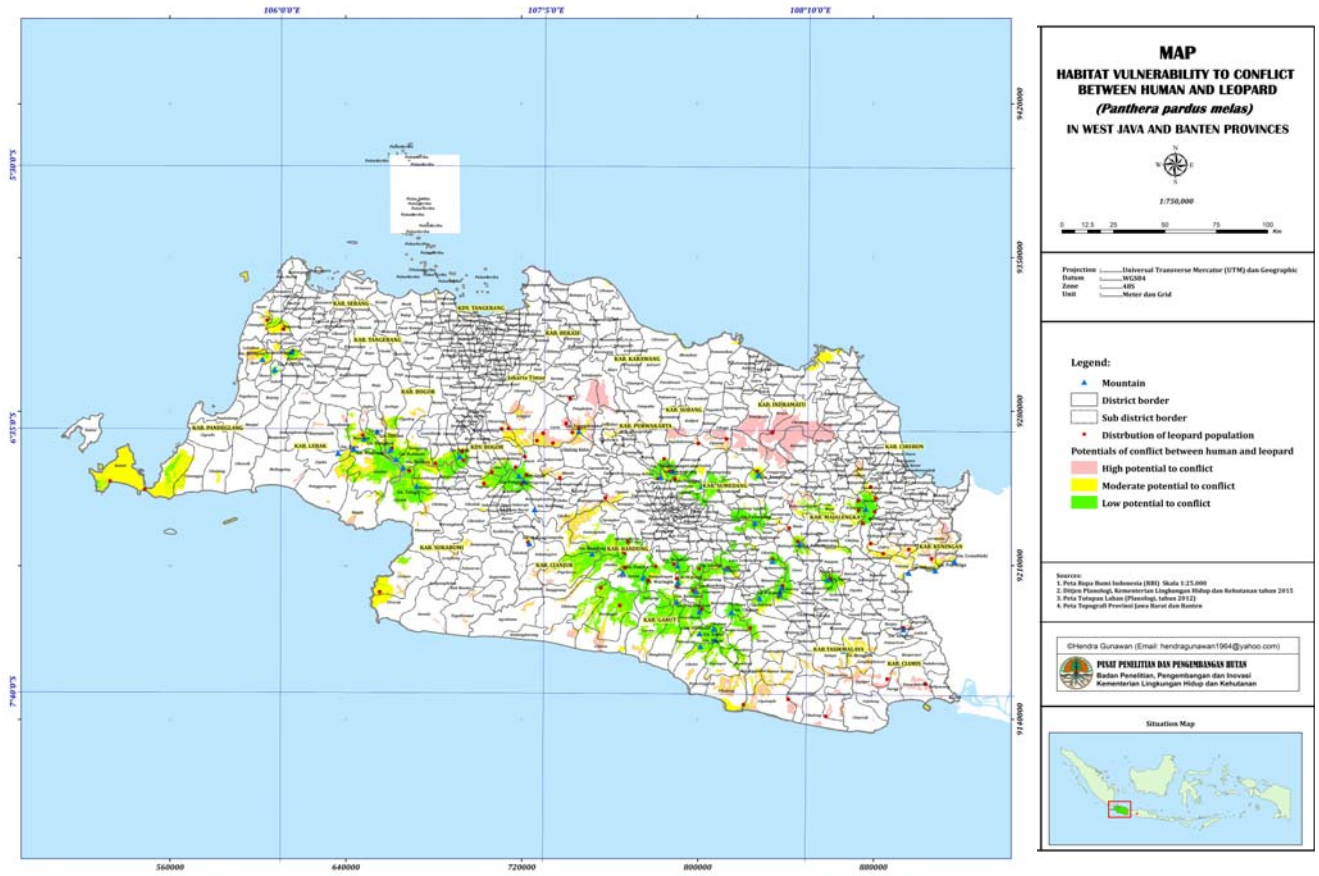


**Figure 8**. Map of the risk of potential conflict between humans and leopards in Western Java

**Management implication**

The conflict between humans and leopards is rising and becoming a national issue. It is a significant problem because of the cost in lives, both human and wildlife, and in threatened livelihoods. It is also a threat to long-term conservation goals such as the securing protected areas and the building of an awareness of the importance of biodiversity conservation. Systematic, comprehensive and integrated efforts are immediately needed to manage and if possible prevent conflict between humans and leopards in the future. A protocol of conflict resolution and management is essential. On the one hand, populations of leopards that are vulnerable to conflict need to be managed, and on the contrary, the understanding and awareness of local people regarding leopard conservation must be raised.

Human-leopard conflict can be managed through a variety of approaches. Our map of Western Java assessing degrees of vulnerability to the conflict between humans and leopards can be used to identify potential hotspots requiring particular efforts to mitigate conflict. Socialization about ways of resolving and managing human-leopard conflict is required in villages adjacent to vulnerable habitat. Captured leopards need to be released to suitable habitats as soon as possible after rehabilitation and a health check-up in a sanctuary. Feasibility studies of suitable habitat and destinations for reintroduction into the wild of captured leopards must be conducted before relocation.

WWF-International (2016) offers six techniques for mitigating human-Asian big cat conflicts. They are livestock compensation schemes; livestock insurance schemes; improving the protection of livestock from predation; improving livestock husbandry; relocation and alternative income generation schemes with specific links to Asian big cat-human conflict mitigation. In many cases, two or more of the methods are incorporated into a larger program of work which is tailored to suit the specific needs and requirements of the region. Effective management of conflict will have to strike a balance between minimizing serious conflict (i.e. leopards attacking people) and the long-term conservation of the leopard species (Athreya and Belsare 2007).

To conclude, the conflict between humans and leopards has been increasing in the last 15 years. This fact indicates that the carrying capacity of the leopard's habitats is no longer adequate to support the existing leopard population. The conflict arises in villages close to degraded habitats of the leopard. The increasing number of incidents of conflict between humans and leopards is alarming the conservation managers, who seek to take action to resolve or mitigate such conflict. A map of zones of potential conflict between human and leopards can be used to identify areas of

heightened risk of conflict. This map will guide mitigation efforts and in the socialization of villagers at risk around leopard habitat. Systematic, comprehensive, and integrated efforts are immediately needed to prevent and manage conflict between humans and leopards in the future.

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