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*“Conserving Sumatran Wildlife Heritage
for Sustainable Livelihood”*



Institute for Research and Community Service
University of Lampung

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“Conserving Sumatran Wildlife Heritage for Sustainable Livelihood”

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PREVENTION MODELS TOWARDS HUMAN - TIGER CONFLICT (HTC) IN BUKIT BARISAN SELATAN NATIONAL PARK (BBSNP), LAMPUNG

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ABSTRACT

The population of Sumatran tigers (*Panthera tigris sumatrae* Pocock, 1929) is having fairly high pressure because of the forest habitat reduction. Human-tiger conflict (HTC) and its management in Sumatra have become a challenge in the means of tiger conservation because they generate material loss and deaths, that eventually reduce community tolerance towards its conservation attempt. Attack and predation towards cattle by tigers have made local community in some suburb villages of Taman Nasional Bukit Barisan Selatan (TNBBS / Bukit Barisan Selatan National Park) to develop some non-lethal control conventional approaches in order to protect their cattle and to prevent higher conflict to occur. Seven research location villages around TNBBS give important information in HTC prevention used by community in Bukit Barisan Selatan landscape. Questionnaire survey and structured interview have been done on 154 respondents. Some general local prevention models are anti-tiger attack cage or Tiger Enclosure Proof (TPE), fireplace around the cage, lighting or lamp in the cage, high platform cage, and night patrol and guard. From the questionnaire done, TPE model is evaluated effective in preventing tigers to enter the cage by local community. From 48 respondents stating that they have built TPE, there are 4 TPE respondents (8.3 %, n=48) having disruption and predation after TPE is built. The analysis result of Generalized Linear Model (GLM) shows that TPE model is the best modeling that reducing the number of conflicts with delta value of Akaike's Information Criterion' (AIC = 28,638), which is the smallest criterion value. Modeling interpretation defines that more TPEs built by a village of conflict area will decrease the number of occurring conflict frequencies.

Keywords: sumatran tiger, human, conflict, TPE, GLM

1. INTRODUCTION

Sumatran tiger (*Panthera tigris sumatrae* Pocock, 1929) is one of species key remaining on Sumatra Island. The threat of losing its existence is due to anthropogenic factors. This subspecies tigers very depend on the existence of forest [19] and they are having quite high pressure because of the reduction of forest habitat in Sumatra as the result of land use conversion and the increasing human population, so there is a conflict because of human activities around and inside forest [17]. "Critically Endangered" status is embedded on this species [12], considering of its population in Sumatra that is less than 250 individuals left from the newest assessment [21].

Human-Tiger Conflict (HTC) and its management in Sumatra become a challenge in tiger conservation means because they create material loss and deaths that eventually reduce community tolerance towards its preservation means. This conflict is also a factor triggering community to catch and even kill tigers [17]. HTC is divided into three types based on the effects appearing, the first type is that tigers are visible around the habitation, although they do not cause any deaths, they create fear among people. The second type is that tigers prey on cattle. In this type, the risk over tigers is increasing along with the existence of possible vengeance from the community. The third type is that tigers attack human, where the risk towards their existence is much higher to be relocated or even to be killed by people [5;6].

Bukit Barisan Selatan National Park (BBSNP) in the province of Lampung is one of landscapes for tiger conservation (TCL / Tiger Conservation Landscape) that is stated in Strategy dan Rencana Aksi Konservasi Harimau Sumatera (STRAKOHAS/ Strategy and Plan of Sumatran Tiger Conservation Action)(Soehartono *et al.*, 2007), that cannot be separated from the challenge of HTC management. There are 85 incidents of HTC recorded in BBSNP between years of 1998 – 2011, but there were no attacks or deaths.

Initiation of treatment through HTC mitigation in Bukit Barisan Selatan National Park (BBSNP) has been done in the areas of Talang Sebelas and Talang Kalinda (a cluster in the area of Desa Rajabasa, District of Bengkunt, Lampung Barat Regency) since 2005 by conservation agency of Wildlife Conservation Society – Indonesia Program (WCS-IP). Human and tiger conflict occurs with high frequency intensity, firstly recorded on 16th of December 2005, with the missing of goats from their cage [1]. The search based on data of WCS-IP camera trap shows that their predators are Sumatran tigers. Up to 2007, they are recorded that 14 goats and a dog were the victims of tiger predation in Talang Sebelas, Desa Rajabasa, Bengkunt, Pesisir Barat [18].

The attack and predation on cattle by tigers have make local community in some suburb areas of BBSNP developing some conventional approaches that are non-lethal control for protecting their cattle and preventing higher level of conflict to occur. Moreover, WCS-IP has also developed a design of cattle cage that is tiger proof enclosure / TPE with a prototype that has been tested since 2005 in one of HTC hotspots surrounding BBSNP which are Desa Sukamaju and Rajabasa, Pesisir Barat Regency. The cage with this special design uses barbed wire to prevent tigers from entering, climbing, and jumping over the cage. Cage plank installation is done by nailing from inside to avoid the damage of plank by tigers. Some cattle predation cases show that tigers are able to pull planks installed from outside of the cage.

Conservation intervention is needed to build understanding and tolerant attitude of community on the existence of tigers, so they are not always considered as a threat for human life in suburb area surrounding BBSNP. The understanding on the relationship of the risk living side by side with the forest and conditions that will prevent and reduce the conflict risks between two entities, as well as the tolerant attitude towards wildlife existence such as tigers that certainly need forest as their life support is expected can create low conflict risk and the presence of tigers that is still maintained. The aim of this study is to set an effective model of human-Sumatran tiger conflict prevention based on non-lethal control approach that has been done by community during this time in villages that are affected by conflict surrounding BBSNP.

1. MATERIALS AND METHODS

2.1 Study area

Bukit Barisan Selatan National Park (BBSNP) was first established as a wildlife sanctuary because this area is home for several protected wildlife species (see Biological Conditions). During the third World National Park Congress on October 14, 1982 in Bali, the area was formally gazetted as national park based on Decree of the Minister of Agriculture No.736/Mentan/X/1982 (BBSNP 1999). BBSNP is a chain of the southern Barisan ranges located in southern Bengkulu and extending to southern Lampung. BBSNP is part of West Lampung, West Coast, and Tanggamus Regencies, Lampung Province and Kaur Regency (Bengkulu Province). Geographically, the park lies between the coordinates 4°29' - 5°57' S and 103°24' - 104°44' E. BBSNP covers an area of approximately 356,800 ha.

Study activity is done in seven villages listed in conflict data of time series WCS-IP Wildlife Response Unit since 2008 – 2015 as HTC locations in suburb of BBSNP which are Desa Sukamaju, Rajabasa, Way Sindi, Pagar Agung, Enclave Way Haru, Enclave Kubu Perahu, and Tampang (Figure 1). The selection of those seven villages is based on the highest HTC frequency in suburb area of BBSNP since 2008 up to now.

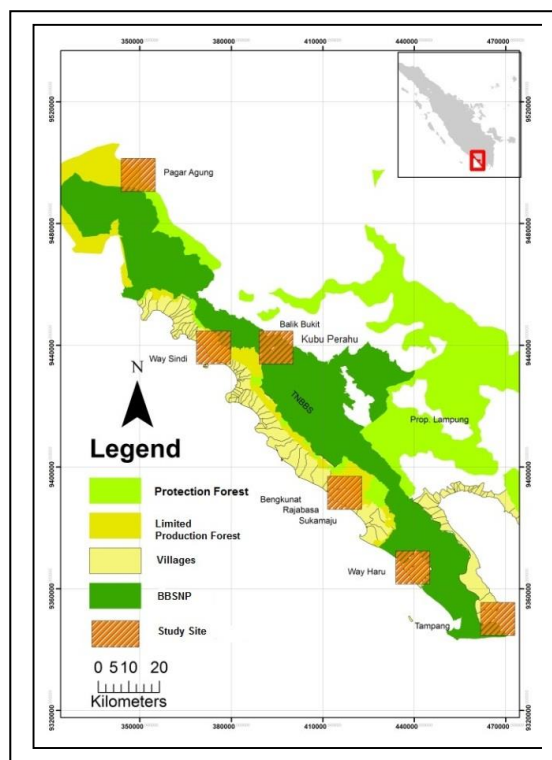


Fig 1. BBSNP landscape with the location of study site.

2.2 Methods

There are two approaches conducted to investigate which prevention model that has been done by community in study site. The first is by using supporting data (secondary) on conflict record in suburb area of BBSNP since 2008 obtained from conservation agency of Wildlife Conservation Society - Indonesia Program (WCS-IP) and which village that has built Tiger Proof Enclosure (TPE) as part of the means of conflict prevention, while primary data are extracted directly by using survey questionnaire and direct interview with local community about local prevention model that they have applied and its effectiveness level in preventing or reducing cattle predation risk by tigers. Respondent sample referred is local community affected by HTC, both in the first conflict level (directly see, hear, find sign of tiger presence, and others) and the second conflict level(having attack or predation toward their cattle). Time of study is done in January – March 2016.

1.3. Data Analysis

Questionnaire form completed will be decoded and put in to software application Minitab 17.0 to be processed as descriptive statistic data. Pearson Correlation Test, as well as using Generalized Linear Model (GLM) on data variable grouping is done including key topic of prevention model on conflict frequency occurring during this time in the village or conflict location. Data and information obtained will be tabulated, summarized, and presented in the form of table and graph. The result obtained will be recommendation for cattle owner in the village having conflict with Sumatran tigers.

1.4. Generalized Linear Model (GLM).

Generalized linear model (GLM) is a method used in quantification of relationship between response variable and predictor variable in a model. The use of GLM can be a model to explain the changing process between values from predictor variable towards response variable. Conflict event or specifically predation even on cattle has varied contributing causative factors that are. The best model selection in GLM is done to investigate which predictor variable that will be preventing factor in the conflict through the smallest AIC delta value.

Predictor Linear Model:

$$\eta_i = \alpha + \beta_1 x_{1i} + \dots + \beta_j x_{ji}$$

η = Response Variable

α = Intercept Value

β = Coefficient Value

x = Predictor Variable (categorical, nominal, discrete, continuous)

1.5. AIC Method in GLM

AIC method is a method used in selecting the best correlation model found by Akaike [7]. This method is based on maximum likelihood estimation (MLE).

To count AIC value, the formulation used is as the following:

$$AIC = \frac{2k}{n} + \ln \left(\frac{\sum_{i=1}^n \hat{u}_i^2}{n} \right)$$

k = the number of parameter estimated in correlation model

n = the number of observations

$e = 2,718$

u = Residual

According to AIC method, the best regression model is the model that has **the smallest** value of AIC [3].

2. RESULT AND DISCUSSION**3.1. Local Wisdom in Preventing Human – Tiger Conflict.**

Seven villages of study site give important information in preventing human and tiger conflict used by community is Bukit Barisan landscape. Questionnaire survey and structured interview have been done on 154 respondents. Some general local prevention models are Tiger Proof Enclosure (TPE), fireplace around the cage (Perun), lighting or lamps in the cage, high platform cage, and night patrol or guard. There are 48 active TPEs and 28 high platform cages that have been built by community in seven study sites since 2006. Generally, the condition of the habitat surrounding the cage is still in the form of coffee plantation and shrub cover that have not been cropped for a long time, so it potentially becomes crawling and hiding place for tigers.

In management of human and tiger conflict, prevention is an important part in order to reduce conflict. [17] stated that the principle of specific area describing conflict prevention method in an area cannot always be used in other areas. [4] added that for a long time human has been responded to wildlife disturbance by building varied methods for a long period of time.

In India, [8] reported that a fence and a field guard dog can reduce plant loss as the result of wildlife release such as elephants from the forest, but did not show significant result for reducing loss on cattle predation. Meanwhile, [13] also explained that fences surrounding the village are quite good for preventing the entering of cattle predators such as leopards (*Panthera pardus*).

TPE is a barbed wire fence model designed by WCS-IP since 2005 in Sumatra [18]. Modification of TPE is adjusted to local natural condition and the existence predators. For goat cage, it is standardized with the height of the cage (2.5 m) that is surrounded by barbed wire on the wall, base of the cage, top gaps, and other gaps. For cow and buffalo cage (Fig 2), barbed wire is installed as outer fence up to the height of 2.5 m so that tigers are not able to jump over it [11]. Outer fence pole

wrapped around barbed wire can be made of a log with diameter > 10 cm in order to have resistance when wildlife such as tigers and bears are not easily able to push or ruin it. Generally people use cottonwood log (*Ceiba pentandra*) that can be hedges and can be used as cage shade at the same time.

According to [17], environment surrounding TPE must also be more open and brighter, the presence of bushes around TPE can be crawling place for tigers. As comparison in India, [13] stated that habitat modification includes weeding, such as lantana (*Lantana camara*), is effective to prevent the entry of cattle predators such as leopards (*Panthera pardus*). [21] reported that TPE that is also introduced by WCS-IP in Southern Aceh, Gunung Leuser National Park (GLNP), and combined along with awareness activity, is proven reducing the number of cattle predation by tigers, and increasing local support in conservation of Sumatran tigers. [11] also evaluated that TPE has effectiveness in cattle protection at night time so that farmers are able to do activities conveniently at day time.

TPE cage making that is in accordance with standard design developed from initial prototype will protect cattle from tiger enclosure. From the questionnaire survey done, TPE model is evaluated effective in preventing the entry of tigers into cage by village community. From 48 respondents stating that they have built TPE, there are 4 TPE respondents (8.3 %, n=48) (Fig 3.) having disturbance and predation on their cattle after TPE is built. It is because barbed wire is not maximally installed, wire is not installed in rooftop gaps, and gaps underneath the cage is not dense, so it can be reached by tigers by breaking the plank from the bottom of the cage and pulling the cattle inside. Other effectiveness evident is that tiger tracks around TPE cage are frequently found by residents in the morning. It can be predicted that tigers try to enter the cage at night from all sides, but cannot pass through because they are blocked by barbed wire. [21] also informed that in Southern Aceh in 2007 – 2010, the number of conflicts that must be handled is reduced up to 60%, even though there were still some conflicts, at least only encounter indicating the presence of tigers.

TPE is initially modified from high platform cage, without protecting wire, and is other choice for community in suburb area of Bukit Barisan Selatan landscape for preventing tigers to prey their goats. Cost limitation makes some residents are able to make only low cage without platform, that is sometimes not an ideal cage (Figure 2), so tigers are frequently able to prey their cattle, and some of them eventually decide to sell all of their cattle because they feel there are no solutions on conflict problems happen.

The challenge in conflict management is the awareness to community of the importance of cage condition that is good and fulfills standard criteria of TPE design. It relates to support in compensation program over cattle that becomes the casualty of tiger predation. [14] explained that to get full compensation over cattle casualties, it must be ensured the criteria of cattle in the cage that is well maintained in order to be protected especially at night time.



Fig 2. (A) TPE with outer fence model in Desa Pagaragung, (B) high platform cage type, (C) conventional cage in Enclave Kubu Perahu.

Other prevention model done by community is lighting in the cage in the form of electrical lamps, kerosene or oil lamps, or fireplace nearby the cage. [16] reported that in Jangkat and Birun, Kerinci Seblat National Park (KSNP), the use of confounding stimulation coming from the light can prevent the arrival of tigers to the cattle cage and human habitations, even though it is not permanent.

Moreover, [2] informed that the use of light, especially Light Emitting Diode (LED), has effect on behavior change of predator on its prey. The use of light has not been a choice that can be used by all community members. It is calculated from 7 villages in study site, only 3 villages having electrical power facilities which are Desa Sukamaju, Rajabasa, and Kubu Perahu, while 4 other villages still use traditional lighting of kerosene or oil lamps with limited fuel.

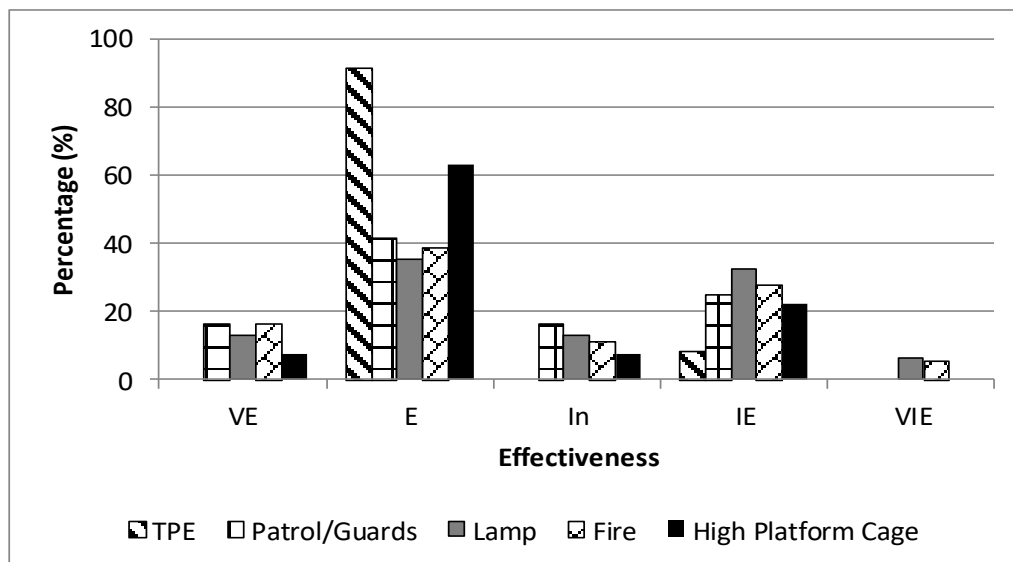


Fig 3. Perception of Respondent Community towards Local Prevention Model

Note: VE = Very Effective, E = Effective, In = Indifferent, IE = Ineffective, VIE = Very Ineffective

The fireplace is made by burning garbage or dried grass from cleaning the cage, the smell from the combustion is believed by local people will be keep wildlife away, even though it has not been known its effectiveness level. The use of chemistry material as prevention (chemical repellent) of wildlife presence, both synthetic and natural, is also used in other areas in the case of non-lethal conflict management application. Among others are pepper (*Piper nigrum*) and Lithium Chloride (LiCl), they are used in Kerinci Seblat National Park (KSNP) to prevent tiger predation on cattle, but other innovations must be done before wildlife predator getting used to those stimulants [16]. The type of predator also becomes differentiating factor for stimulant effectiveness. [15] reported that the use of LiCl is evaluated effective to reduce the conflict level on fox predator in America, but it is not used in Africa.

Active prevention management in human and wildlife conflict is by involving human resources. [17] stated the importance of a conflict prevention team to deal with wildlife conflict. [8] also stated that night patrols done in conflict villages in three national park landscapes in India (Ranthambore, Kanha, and Nagarhole) have positive correlation to reduce wildlife conflict.

Quick response team is formed in conflict hotspot in Sundarband, Bangladesh, that is a new approach to reduce human-tiger conflict in Sundarband. They recruited volunteers from the village to be Tiger Conflict Response Team and train them to overcome tiger entering the village [10]. Initiation of conflict response team and patrol formation actually was firstly introduced in Bukit Barisan Selatan Landscape through Wildlife Response Unit (WRU) built by WCS – IP along with Balai Taman Nasional Bukit Barisan Selatan / Bukit Barisan Selatan National Park Office and Balai Konservasi Sumber Daya Alam Propinsi Lampung / Natural Resources Conservation Office of Lampung Province since 2006. The role of this wildlife response team is quite significant in conducting conflict mitigation or reducing the loss effect caused by human and tiger conflict surrounding Bukit Barisan Selatan Landscape by conducting protection along with community when the conflict is detected.

3.2. Predicting Factor of Conflict Prevention

Pearson Correlation Test is done to see variable having relationship towards the number of conflicts in each study site. Variable total conflict (predictor) is related to some variables (covariate) of

prevention which are independent variables (number of TPEs, number of cattle, patrol response intensity, number of cage lighting users, number of cages using fireplace, number of platform cages, type of habitations, type of plantation habitat, type of bush habitat in each study site).

Initial analysis using Pearson correlation shows that variable number of TPE has the strongest negative correlation and is significantly different ($r_s = -0.930$, $P < 0.01$) (Fig 4; Table 1.). It means that there is relationship (although not cause and effect) which is more number of TPEs will relate to the number of human-tiger conflict occurring in a village. The presence of TPE does not absolutely reduce the number of conflict because there were 4 incidents of cattle predations recorded still occurring in the cage designed by using TPE. However, the number of cattle loss is reduced because the cage usually is protected with barbed wire that cannot be entered by tigers. The presence of tiger's tracks is still found around the TPE indicating that the conflict prevention has success value and still keeps the existence of tigers. [16,9] stated that "lethal control" or conflict controlling by killing wildlife is a matter must be avoided in conflict management, and is only the last choice because it will not solve the problems. [17] explain that the lethal control make them lose an important entity in the ecosystem, namely the existence of the sumatran tiger as a natural balance.

High platform cage is also a variable that has strong negative correlation and is significantly different ($r_s = -0.88$, $P < 0.01$) (Fig 4). The number of platform cagedoes not have significant value in reducing conflicts because gaps in the cage still can be passed through by tigers to prey the cattle inside.

The number of conflict response and patrol that can be done in each village has strong negative correlation value, and is significantly different ($r_s = -0.80$, $P < 0.05$) (Fig 4; Table 1.), because night patrol and guard responses are done collectively and rotating among community groups when there is any conflict information in a village, and when conducive situation is perceived, the patrol is not done.

Analysis using Generalized Linear Model (GLM) is done to see wider relationship between response variable, which is conflict and other covariates that are predicting factor (Table 2). All of variable obtained from questionnaire surevy, with additional data from WCS patrol for conflict respon during 2008 – 2015. Settlement area, paddy field, field (dominated by coffe and cocoa), and shrubs considered as environmental covariat that influences and also affect the incidence of conflict. Analysis result shows that TPE presence factor is to most influencing factor on the number of conflict frequency among other factors (number of cattle, platform cage, fireplace, cage lighting, and guarding patrol).

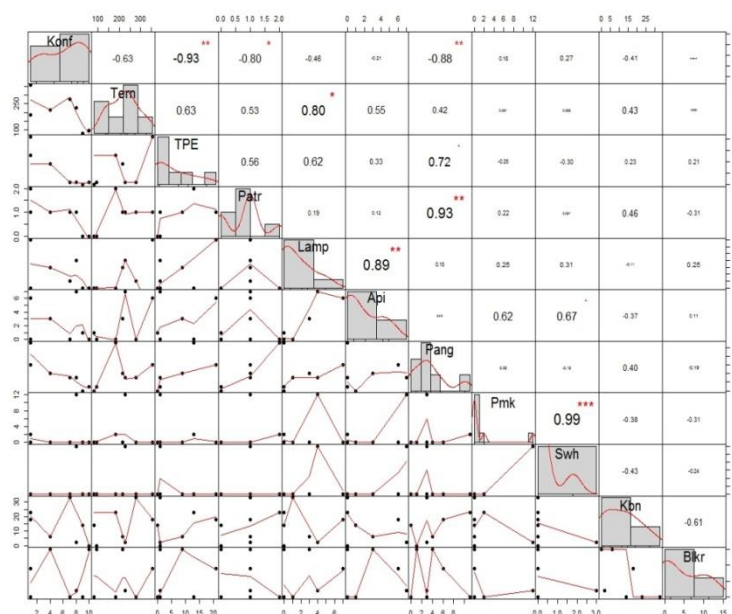


Fig 4. Pearson correlation test for all variables in GLMsSignif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

Tabel 2. Variables in Generalized Linear Model (GLM)

Variable	Type Data	Sumber
Conflict Freq.	Integer	Questionnaire
Number of cattle	Integer	Questionnaire
TPE	Integer	Questionnaire
Patrol	Integer	Questionnaire, WCS Data
Lighting	Integer	Questionnaire
Fireplace	Integer	Questionnaire
High cage platform	Integer	Questionnaire
Settlement	Nominal	Questionnaire
Paddy field	Nominal	Questionnaire
Field	Nominal	Questionnaire
Shrubs	Nominal	Questionnaire

Tabel 3. Model Selection of GLM among Variables

Model	Predictor	AIC	Delta AIC	ModelLik	ModelWt
Model 2 bbs	TPE	28.638	0	1	0.709
Model 6 bbs	High Cage	30.643	2.005	0.367	0.26
Model 3 bbs	Patrol	35.406	6.767	0.034	0.024
Model 1 bbs	Number of cattle	39.023	10.385	0.006	0.004
Model 4 bbs	Lighting	41.532	12.894	0.002	0.001
Model 9 bbs	Field	42.412	13.774	0.001	0.001
Model 0 bbs	Null Model	42.991	14.352	0.001	0.001
Model 8 bbs	Paddy field	44.023	15.384	0	0
Model 5 bbs	Fireplace	44.319	15.681	0	0
Model 7 bbs	Settlement	44.547	15.909	0	0
Model 10 bbs	Shrubs	44.99	16.352	0	0

Note : Bold font: TPE selected as the best model fits with the smallest *Akaike's Information Criterion* (AIC) delta criteria[3].

Tabel 4. The best three models by GLM's

Coefficients :	Estimate	Std Error	Z value	Pr(> z)
(Intercept)	2.23077	0.18105	12.321	< 2e-16 ***
TPE	-0.11932	0.03714	-3.213	0.00131 **
Model 2: Conflict = 2.23077 + (-0.11932.TPE)				
(Intercept)	2.3034	0.2161	10.66	< 2e-16 ***
Patrol	-0.8011	0.2679	-2.99	0.00279 **
Model 3: Conflict = 2.3034 + (-0.8011. Patrol)				
(Intercept)	2.4312	0.2218	10.961	< 2e-16 ***
High plat. cage	-0.2313	0.0707	-3.272	0.00107 **
Model 6: Conflict = 2.4312 + (-0.2313.High platform cage)				

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Analysis result of GLM shows TPE model as the best modeling (Table 3) that reducing the number of conflicts (AIC = 28.638 and Delta AIC = 0), which is the smallest criterion value among others. Modeling interpretation interprets that more TPEs made in a conflict area, the number of conflict

frequency occurring is reduced. This statistic value give illustrate that the relationship among the various models are more complicated than the correlation. TPE which was built with standard design provide safeguards system. There is no gap enclosure that can be entered by tiger. The best model selection can be formulated as **model 2: conflict frequency ~ 2.23077 + (-0.11932.TPE)** (Table 4.). TPE combined with livestock management and socialization of personal safety were successful enough to decrease the incidence of conflict, there are no tigers or humans are killed, death of livestock can be reduced [20].

3. CONCLUSION

Pearson correlation test result shows that TPE has the strongest negative correlation and significantly very different ($r_s = -0.93$, $P < 0.01$) toward the reduction of conflict frequency, the result based on GLM analysis also makes conclusion that prevention model considered the best to prevent or to reduce the number of conflict is by using Tiger Proof Enclosure (TPE) cage, the more TPEs made in a conflict area, the number of conflict frequency occurring is reduced.

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