

Template

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(Draft) Elephants pre- and post-hybrid contact management

Introduction

Methods

As an overview of the elephants' activity patterns, coarse-scale activity budgets (with information provided by the keepers) were constructed to visualise differences that occurred between individuals. To better examine the change in behaviours through the constructed activity budgets, the difference in each examined behaviour between hybrid contact (HC) and protected contact (PC) was calculated. In doing so, a value below 0 represents a decrease in the proportion of the studied behaviour; vice versa, a value above 0 represents an increase in the proportion of said behaviour. This difference in the occurrence of behaviour between HC and PC was calculated for all five elephants.

In addition, the Shannon's Index of Diversity (H-index) was also calculated to characterise the behavioural diversity of the five female elephants cared under HC and PC management. For this, the overall H-index of elephants under HC and PC were calculated and presented with standard errors.

Statistical analysis

A two-way anova was performed to explain the difference in H-index values in elephants cared under HC and PC management. Here, weekly H-index values were used as a response while predictors were simply the period pertaining to the corresponding contact type (i.e., HC or PC) and the ID of the studied elephant. An interaction term between contact type and elephant ID was also included. Model selection analysis was conducted with linear mixed-model regression models to examine the influence of contact type on the weekly behavioural diversity (i.e., H-index) in the studied elephants. Elephant ID was included as the random term.

Results

Behaviour diversity

In general, minimal differences can be observed in the activity budget of the five female elephants cared between HC and PC management (Figures 1 and 2). For the most part, the proportion of exhibited behaviours decreased between 1–8 % while observations pertaining to poor visibility (i.e., “Not Visible”) increased notably for all individuals (Figure 2).

Using weekly H-indices as a response, outputs from ANOVA ($p < 0.001$; Table ??) and model selection analysis ($\Delta AIC_{c} \leq 2$; Table ??) which suggests a significant departure in H-index values when the management of Elephants moved from hybrid to full-protected contact. Seemingly, H-index values decreased (i.e., reduced diversity in behaviours; Figure 3) during the aforementioned transition. However, this observed decline in H-index is not observed in the the pair-wise comparisons within the two-way ANOVA (TukeyHSD; p value > 0.05 , all pair-wise comparisons).

##	Df	Sum Sq	Mean Sq	F value	Pr(>F)
## contact	1	0.397	0.3967	24.437	1.41e-06 ***
## Elephant	4	0.067	0.0167	1.028	0.393



Figure 1: The difference in the proportion of exhibited behaviours in five female elephants when the type of contact between elephant and keepers transitioned from hybrid to fully-protected.

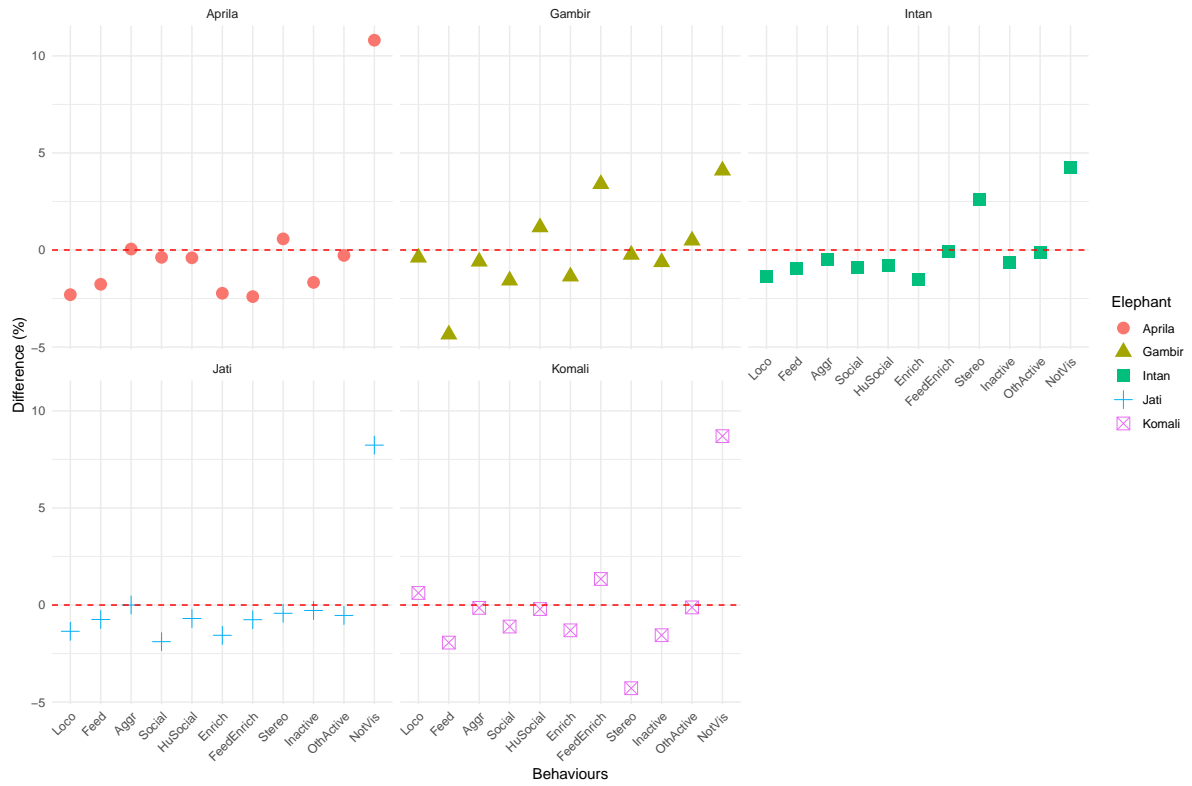


Figure 2: The difference in the proportion of exhibited behaviours in five female elephants when elephant care and management transitioned from hybrid to fully-protected contact.


```
## contact:Elephant    4  0.094  0.0236   1.454    0.217
## Residuals          250  4.059  0.0162
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Model selection table
##           (Intrc) cntct           family df  logLik   AICc delta weight
## model.1    1.831      + gaussian(identity)  4 159.648 -311.1  0.00  0.999
## model.0    1.791      gaussian(identity)   3 151.237 -296.4 14.76  0.001
## Models ranked by AICc(x)
## Random terms (all models):
## '1 | Elephant'
```

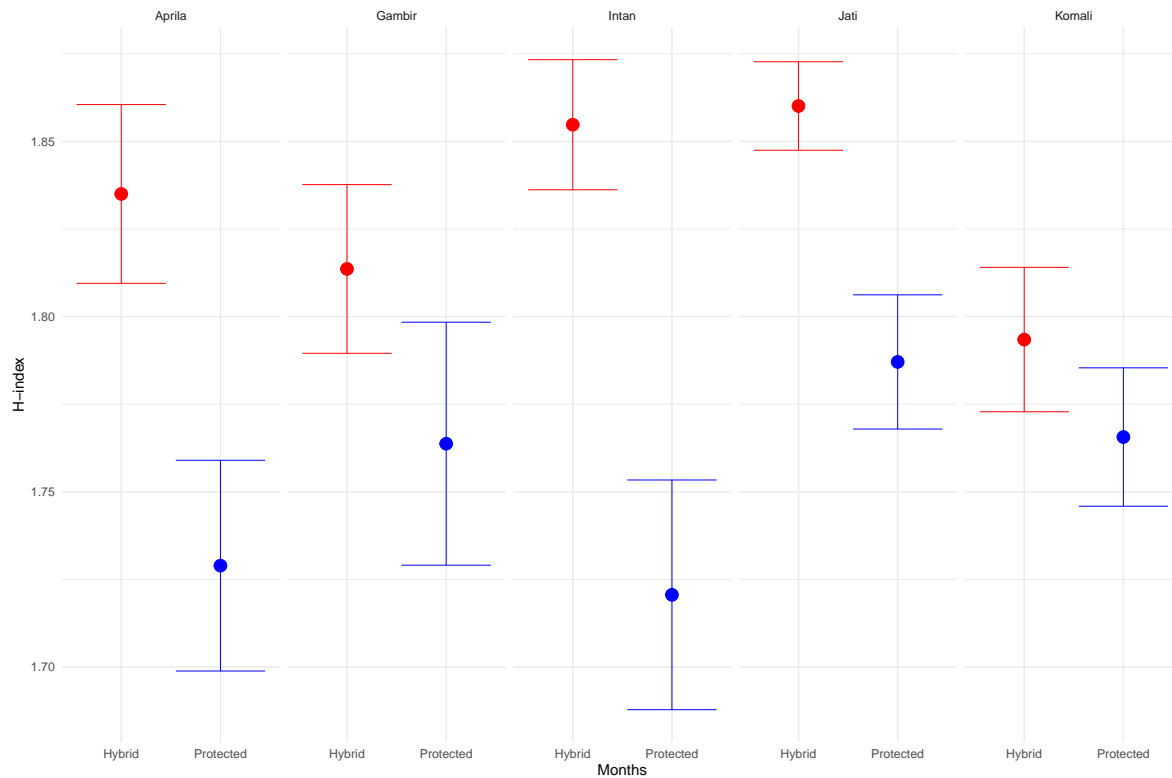


Figure 3: The Shannon's Index of Diversity (H-index) adapted to examine the behavioural diversity in 0.5 Asian elephants during hybrid and protected contact. Greater H-index values describe a greater diversity in exhibited behaviour and is suggestive of better animal welfare.

Cortisol levels (Gambir, Jati and Komali only)

Cortisol levels are a poor and unreliable indicator of H-index values (and *vice versa*) as correlations are difficult to pinpoint and likely spurious. Cortisol levels in Gambir and Komali were negatively correlated to H-index values (-0.51 and -0.65, respectively) while cortisol values from Jati were positively correlated to H-index values (i.e., 0.312).

Outcomes of the model selection analysis also showed that the change in cortisol levels was not random and the model that examines contact type (i.e., lm1) was most parsimonious (Table ??). Year to year influence on cortisol levels are present (i.e., transitory free to hybrid contact period; Figure 4) but its influence is not as definitive as contact type.

```
## Model selection table
##      (Intrc) cntct   year                family df   logLik   AICc delta weight
## lm1   41.82      +          gaussian(identity)   4 -630.790 1269.8  0.00  0.979
## lm2 8572.00      -4.226 gaussian(identity)   4 -634.636 1277.5  7.69  0.021
## lm0                                gaussian(identity)   2 -653.922 1311.9 42.07  0.000
## Models ranked by AICc(x)
## Random terms (all models):
## '1 | ID'
```

The calculation of AUC overlaps in (rescaled) cortisol levels between months detailing PC and HC management suggests a relatively degree of overlap (i.e., 76.19%; Figure 5).

Discussion

Future directions

References

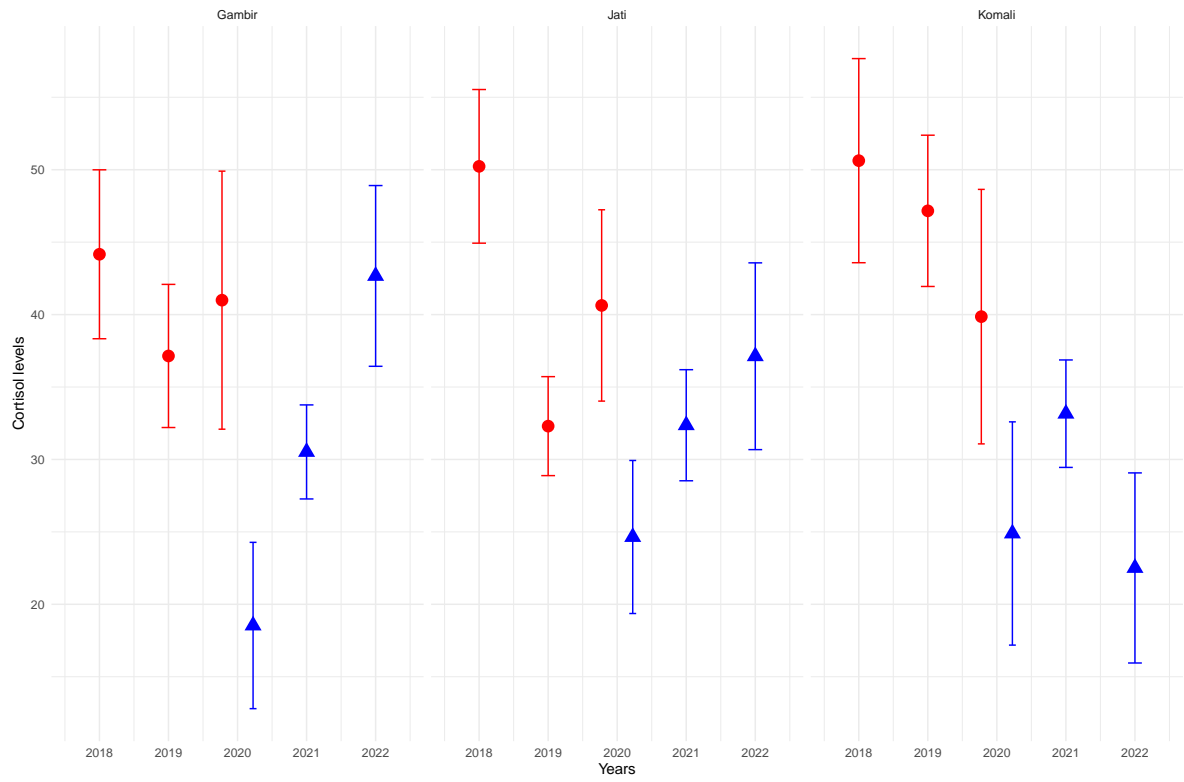


Figure 4: The yearly cortisol levels (2018–2021) of Gambir, Jati and Komali. Red and blue coloured points represents hybrid-contact and protected-contact management, respectively.

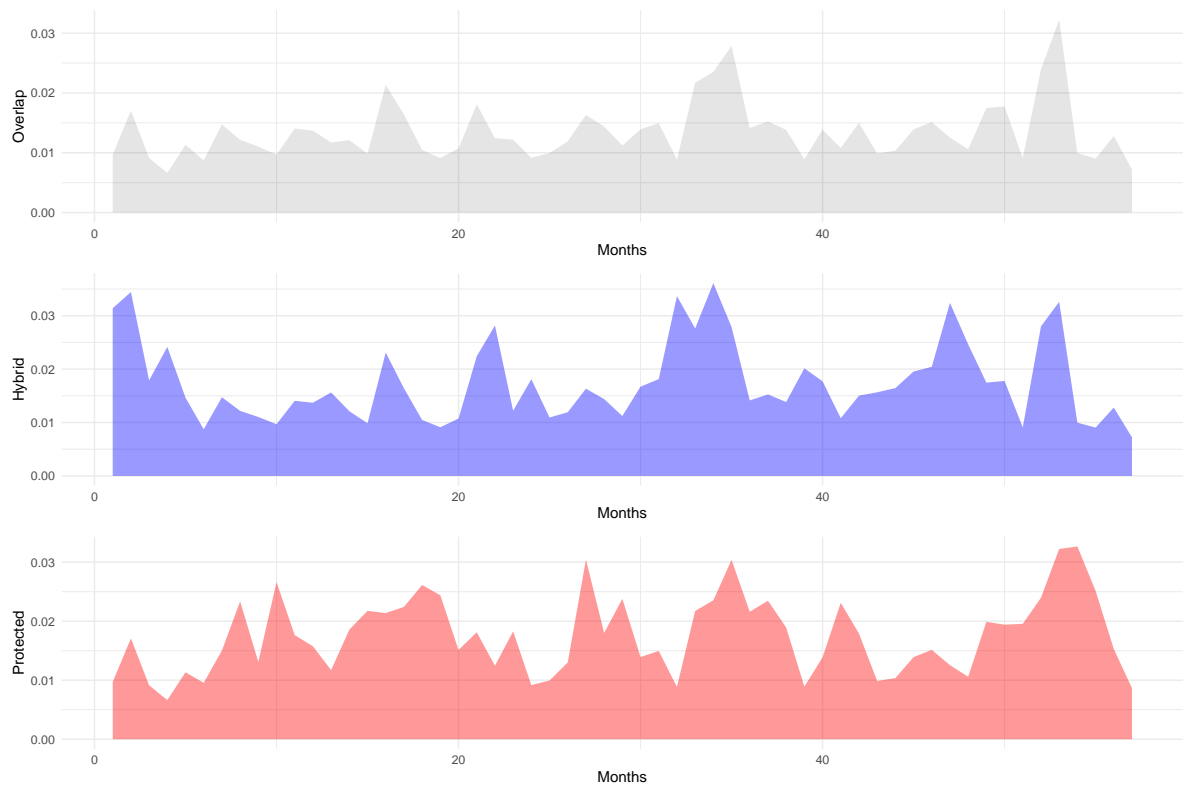


Figure 5: The overlap in (rescaled) cortisol levels between periods of HC and PC.

References