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Environmental factors and patterns of behaviour in zoo-housed Sumatran tigers, *Panthera tigris sumatrae*

Jayne, K.

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The Plymouth Student Scientist
University of Plymouth

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APPENDICES

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Appendix A

Profile Pictures of Male Tiger



Figure 28. Photograph of male tiger, Tenang.

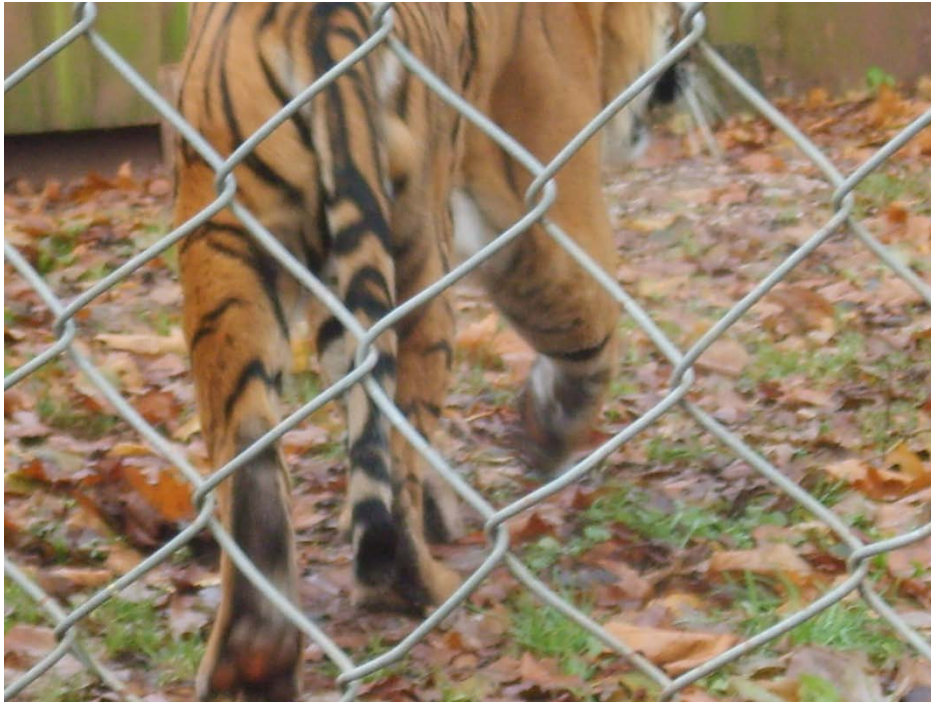


Figure 29. Identifying male tiger by stripe patterns on tail.

Appendix B

Profile Pictures of Female Tiger



Figure 30. Photograph of female tiger, Banda.



Figure 31. Identifying female tiger by stripe patterns on tail.

Appendix C

Paddock Enclosure Area



Figure 32. Tiger enclosure paddock area



Satellite image courtesy of Google Earth:
<http://maps.google.co.uk/maps?hl=en&q=paignton+zoo&ie=UTF8&ll=50.425733,-3.58216&spn=0.00076,0.002736&t=h&z=19>
Accessed 28/10/2008

Figure 33. Satellite image of tiger paddock area, courtesy of Google Earth.

Appendix D

Enclosure Viewing Areas

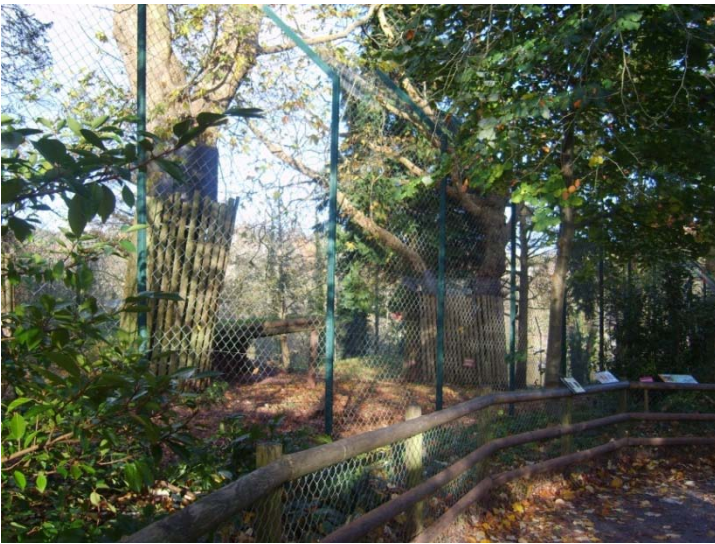


Figure 34. Fence viewing area.



Figure 35. Window viewing area.



Figure 36. Platform viewing area.

Appendix E

Check Sheet (final version)

Environmental factors and patterns of behaviour in zoo-housed Sumatran tigers, *Panthera tigris sumatrae*.

DATE: _____ TIME 0 = _____

WEATHER (circle): Wet / Dry Warm / Cold Other weather: _____

OTHER INFORMATION: _____

Minute	Busyness (1-5)	Crowd Size (SML)	Crowd Noise (QML)	Staff Present	Individual Animal	Area (A,B,C,D)	Enclosure Section	Not Visible	Sleeping	Inactive Alert (SML)	Self-maintenance	Locomotion	Pacing	Investigating	Marking	Feeding	Enrichment-Directed Behaviour	Staff-Directed Behaviour	Visitor Directed Behaviour	Agonistic Behaviour	Social Activity	Vocalisation (QML)	Stop and gaze	Direction of gaze	Other Factors or Comments	
1					M																					
2					F																					
3					M																					
4					F																					
5					M																					
6					F																					
7					M																					
8					F																					
9					M																					
10					F																					
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27					M																					
28					F																					
29					M																					
30					F																					

Figure 37. Check sheet containing all final behaviour categories and sections.

Appendix F

Behaviour Categories and Definitions

Check Sheet Categories	Definitions
Busyness (1-5)	Overall impression of the how much animal activity is going on within the visible area of the focal animals' enclosure. 1 = Very quiet, 2 = quiet, 3 = moderate, 4 = busy, 5 = very busy. Relates to occupants collectively, not to individuals.
Crowd Size (SML)	Estimate as Small, Medium or Large compared to the size of the viewing area. If there is no crowd leave the box blank. Do not include observers in the count.
Crowd Noise (QML)	Estimate as Quiet, Medium, or Loud compared to the size of the viewing area. If there is no crowd leave the box blank but note any environmental noise in the Other Factors column.
Staff Present	Note if any staff are conducting duties at the enclosure – includes only persons with visible staff attributes. Tick box if present.
Individual Animal	Column indicating the focal animal of observation for the minute. M=Male, F=Female.
Section of Enclosure (ABCD)	Note the section of the enclosure in which the animal resides on the sample interval. If the animal is across boundaries note the section as the area in which the front portion of the animal's body is located. The enclosure sections are A, B, C and D as indicated by the enclosure boundaries and map.
Not Visible	When the animals are obstructed from view for the duration of the sample interval. For example, when the animal is in an area of the enclosure that cannot be seen by the observer or when the animal is obstructed from view, for example, by long grass.
Sleeping	Animal is lying sternally, laterally or on back. Eyes are closed and the animal's body is relaxed showing little or no response to stimuli.
Inactive Alert (SML)	Animal is not moving, remaining in one location, not engaging in any other activity, but eyes are open, for the duration of the sample interval of one minute. The level of alertness should also be recorded: Small = animal is lying down sternally, laterally or on back and is inactive and not asleep but shows minimal responses to external stimuli, eg looks around with eyes, and ears may move but otherwise little movement. Medium = animal is inactive either lying down sternally or sitting up. Animal is more responsive to external stimuli and shows steady movements of eyes, ears or head towards certain stimuli. Large = animal is inactive and is sitting up, standing, or possibly lying down sternally. Animal is very responsive to external stimuli and turns head quickly towards the source of stimuli. Ear position, eyes and head show that the animal is very alert. May involve a change in position, eg from lying down to sitting up. May be followed by a change in behavioural state, eg locomoting to investigate a stimulus. (NB Stimuli may not always be apparent to the observer but behaviour should still be recorded.)
Self-Maintenance	Any single action towards themselves, e.g. scratching, grooming, licking. Animal may use its tongue, its paw or its mouth to clean itself.
Locomotion	Activity involving movement of the whole body from one spot to another that is greater than one body length of the animal. This may include running, trotting, walking, jumping and climbing.
Pacing	Repetitive and unvarying locomotion with the same route taken at least three times in succession. Animal may walk in a figure of eight and turn the same direction.
Investigating	Exploration of environment. May involve sniffing objects or touching / scratching them (different to scratch marking). May walk with nose to the ground.
Marking	Including spray marking, scratching objects (eg. trees) with front claws, rubbing objects with head or body, scraping ground with hind legs – may or may not be followed by urination or defecation.
Feeding	Ingesting food or water into the body from the environment, or food source.
Enrichment-Directed Behaviour	Any behaviour that is directed towards an environmental enrichment object in the enclosure. This is an object that has been put into the enclosure by the keepers in addition to the usual enclosure furnishings. Objects may include novel objects, scents and puzzles. Behaviours may include moving the object with paws, body or head, carrying, holding, licking, licking, chewing, ripping, etc.
Staff-Directed Behaviour	Any behaviours that can be determined to be aimed towards, or due to the appearance of staff or attributes of staff. Does not include merely looking without a behavioural change.
Visitor-Directed Behaviour	Any behaviours that can be determined to be aimed towards, or due to visitors in close proximity to the enclosure. Does not include merely looking without a behavioural change.
Agonistic Behaviour	Visual or vocal aggressive or threatening behaviour directed at another animal or human. May include fighting, full or mock charges, lunges, bites, baring teeth (excluding flehmen), pouncing (not play) and scratching. May or may not be returned by another animal. Body may tense and ears flatten. Can also be present during mating behaviour.
Social Activity	Animal interacts in a positive way with another animal of the same species. May include head rubs, body rubs, mating, sniffing the other animal, playing, grooming the other animal.
Vocalisation (QML)	A sound or noise produced by the animal. May include purring, chuffing, roaring, growling, meowing, woofing, moaning and hissing. Estimate intensity of sound as Quiet, Medium or Loud.
Other Factors or Comments	Please use this space to record any other behaviour of note or any other factor that you may feel has influenced behaviour or your data in any way. Please note any environmental factors or events that may have affected behaviour. Also note any species specific behaviours.

Figure 38. Behaviour categories and definitions (excl. gaze behaviour and sections)

Appendix G

Enclosure Area Perimeters and Section Perimeters

Figure 1 in Method shows enclosure boundaries for areas A, B, C and D (in red), and sections (in blue). The area perimeters are described as follows as if viewed from visitor / observation area, alongside features of the enclosure section.

Area A comprises the area inside the following boundaries: From the left side of the viewing window, into the enclosure along the right edge and back of the pond, and finally along the back of the row of spindly trees to the left edge of fence. This area provides good visibility of the enclosure by the visitor viewing window and viewing platform. It contains smaller trees and one platform that is also a shelter underneath. The tigers have good visibility of the pond and visitor pathways from this section.

Area B comprises the area inside the following boundaries: From the left side of the viewing window, into the enclosure along the right edge and back of the pond, and finally along the back of the fallen tree branch to the far section of keeper area that sticks out on the right fence of the enclosure. This section is in full view from visitors. The area contains several large trees, a pond, a feeding chute (currently not in use) and a platform that also serves as a shelter from underneath. Area B provides access doors to the inside enclosure and keeper areas.

Area C comprises the area inside the following boundaries: From the far section of keeper area that sticks out and along the back of the fallen tree branch, along the back and to the right edge of the pond, and finally to the left of the row of three smaller tree stumps to the rear enclosure fencing. This area has reduced visibility by the public and keepers and contains the largest amount of foliage. The area also contains smaller trees that can be used for climbing by the tigers.

Area D comprises the area inside the following boundaries: From the far section of keeper area that sticks out and along the back of the fallen tree branch, along the back and to the right edge of the pond, and finally to the left of the row of three smaller tree stumps to the rear enclosure fencing. This section of the enclosure provides the animals with a view of the pond and backs onto the rear of a lion enclosure. The area has little foliage but is more easily viewed from the visitor viewing platform as it is on uneven ground.

The enclosure areas have been further subdivided into unequal sections according to their usage. These smaller sections are recorded in addition to the original four areas on scan-sampling basis for the animal that is being observed. The descriptions for the individual sections are detailed as follows and are pictured in Figure 1 in Method.

Sections around the perimeter of the enclosure are within 1 meter away from the fence. Different sections of the perimeter have different letters to show exactly where in the enclosure they are:

H = House: From the end of the mesh fencing along the edge of the house, including the sticking out section of fence. This section does not extend into area C.

W = Window: Section in front of the viewing window. This does not include the mesh fence leading down from the window beside the new viewing platform. If the tiger is in the section of wooden fence between the window and the mesh fencing in area B., please mark the location as F/W.

L = Lions: Section of fence in front of the large gate in area D that backs onto the lion enclosure.

F = Fence: All other sections of perimeter fence. In area B, this includes the section with the food chute.

F/W = The section of wooden fence between the window and the mesh fencing in area B.

Further sections shown extend along the visitor fence area to a depth of 4 metres. These sections include:

4 = The strip of enclosure approximately 4 metres away from the edge of the fence on the visitor viewing side of the enclosure. This does not include the space close to the fence (so in effect section *4* is actually only approximately 3 meters wide). This area runs from, level with and 4 meters in, the feeding chute, along the front of the platform, to in front of the large tree in area A, up to the fence.

H4 = The strip of enclosure approximately 4 meters away from the tiger house. This does not include section H (therefore section H4 is only 3 meters wide). This section runs from the edge of the fence that sticks out (taking into account space for section H, to level with the food chute.

Further sections include:

P = Platform: Underneath either of the platforms.

Po = Pond: The majority of the tigers body is in the pond.

I = Inside: The remaining space in the enclosure that is not any part of the above sections and does not include any particular features of note.

Appendix H

Observer Protocol (final version)

1. Using the back entrance to the Zoo, sign in and collect your research badge.

2. Find the location of subject you will be studying, the Sumatran tigers, according to a rota or as agreed with researchers. Ensure that you arrive at the enclosure in good time to get yourself ready for your allocated start time of your observations and to allow the tigers time to habituate to your presence.
3. Record the *date*, *weather*, etc on the check sheet. Circle the option of *wet* or *dry* and *warm* or *cold*. Use the *other weather* space to record any additional weather such as thunder storms, snow, very hot, etc. If working with multiple observers commence observations at exactly the same time and from the same viewing location, either the fence area, viewing window or viewing platform. If using the MP3 file to alert the time of the sample point, please use earphones.
4. Unless instructed otherwise, all observations are to be conducted on the outside enclosure area. However, observers may move between viewing areas during an observation period if this will assist in observing the movement of the focal animal.
5. Familiarise yourself with the various recording methods used. See the separate notes 'Busyness Explained' to understand the methods for recording Busyness. See the list of behaviour categories and definitions to ensure you understand their characteristics. Make sure you learn these categories so that your understanding of the behaviour is always constant with the other observers.
6. Use scan-sampling to record the item at 1 minute intervals on the check sheet. Record activity for the duration of the minute for the following (i.e. when you hear the beep for the end of the minute, record the following:

- *Busyness* of global enclosure (0 – 5);
- *Crowd Size* (S, M, L);
- *Crowd Noise* (Q, M, L);
- *Staff Present* (tick if present);

Use scan sampling to record the *area* of the enclosure in which the focal animal is located on the sample interval as *A, B, C or D* according to the mapping of enclosure boundaries. In addition, please note the *section* of enclosure area in which the focal animal is located according to the section descriptions. If the focal animal is located between multiple boundaries, select the section in which the animals head / front part of body is situated.

7. Use one-zero recording to record the behaviour of the focal animal. If the behaviour occurs at all within that minute, record it by ticking the appropriate box once. Record any *other factors or comments* that you think may be relevant by giving a brief description. Record the intensity of any *vocalisations* as *quiet, medium* or *loud*. Record the intensity of *inactive-alert* behaviour as *small, medium* or *large* in relation to focal animal but only record this item if the animal has been inactive for the whole minute. Record the maximum level observed for these items, and if you are in doubt deciding upon a level for these behaviours (e.g. debating a small or a medium) always chose the higher level. Tick *stop and gaze* as the behaviour occurs, and if possible note the *direction of gaze* in the appropriate column according to the

descriptions. Only note the animal as *not visible* if behaviour was not observable for the duration of the sample interval.

8. Each observation session will last for a period of 30 minutes, with records being made at 1 minute intervals. Another observer will take over after 30 minutes. Make sure that you time your session so that as you finish the next observer starts their session.

9. In summary, recording of behaviours listed in columns to the right of the column labelled *individual animal* (i.e. from *area of enclosure* to *direction of gaze*) will be fixed on one focal animal. This will be either the male tiger or the female tiger as indicated by the *individual animal* column. Make sure that you are able to tell the male and female tigers apart before commencing study (N.B. the tigers may only be partially visible at some times therefore you need to be able to tell the tigers apart by different parts of their bodies, and stripe patterns are useful for this but if in doubt, speak to a researcher.) If you cannot see enough of the focal tiger in order to identify them, please tick the *not visible* box.

10. Upon completion of the 30 minute observation period, find out when your next session is.

11. On exit of the Zoo, sign out and return your badge. Hand in your check sheets for analysis.

Any questions or problems speak to a researcher or Dr Phil Gee.

Thank you for your kind assistance in this study.

Appendix I

Inter-Observer Tests Information

Tests for inter-observer reliability conducted for the following early observations:

Kim and Gemma on November 11, 2008 at 14:00 hours for 30 minutes

Kim and Emma on December 11, 2008 at 16:00 hours for 30 minutes

Jo and Gemma on November 05, 2008 at 10:15 hours for 30 minutes

Jo and Emma on November 07, 2008 at 15:54 hours for 30 minutes

Gemma and Tom December 05, 2008 at 14:30, 15:30 hours for 30 minutes

Tests for inter-observer reliability were conducted for the following later observations:

Kim and Jo on December 22, 2008 at 14:00, 15:30, 16:30 hours for 30 mins

Gemma and Emma on Dec 17, 2008 at 11:00, 13:30, 14:30 hours for 30 mins.

Naomi and Jo on January 23, 2009 at 15:00, 16:00 hours for 30 minutes

Further simultaneous observations were conducted with volunteers but this data was not included in the report as was not received or received too late (Sam and Tom M).

In order to compute Cohen's kappa in SPSS the following amendments were made:

Busyness scores: Kim and Jo on December 22, 2008 – added 5 to scores

Busyness scores: Gemma and Emma on Dec 17, 2008 – added 4 to scores

Busyness scores: Jo and Naomi on January 23, 2009 – added 1 to scores

Crowd Noise scores: Kim and Jo on December 22, 2008 – added 3 to scores

Crowd Noise scores: Emma and Jo on Nov 07, 2008 – added 2 to scores

Busyness scores: Gemma and Tom on Dec 05, 2008 – added 4 to scores

Appendix J

Graphical Analysis of Low Frequency Behaviour Categories for Both Tigers

Data for behaviour categories that occurred with a low frequency over the 32 days of observations is presented in Figures 39-49 and briefly discussed in Results.

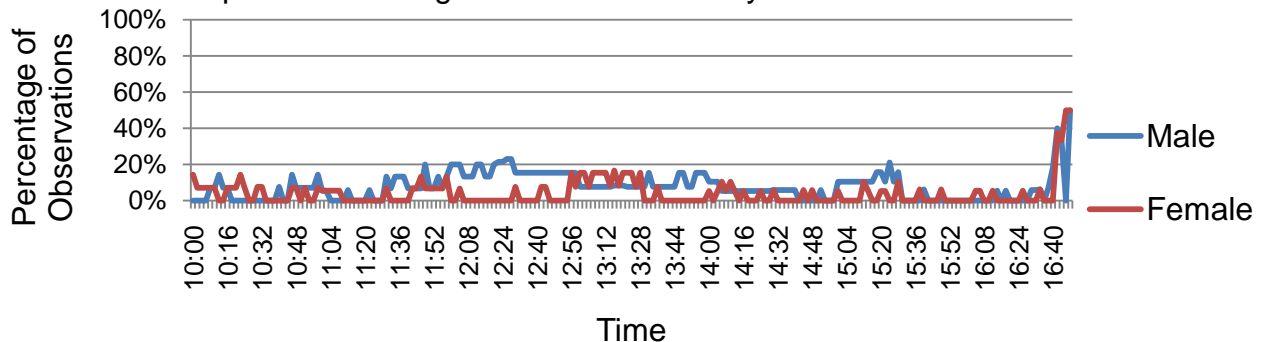


Figure 39. Scatterplot showing the proportion of observations that recorded not visible for the male and female tigers throughout a day.

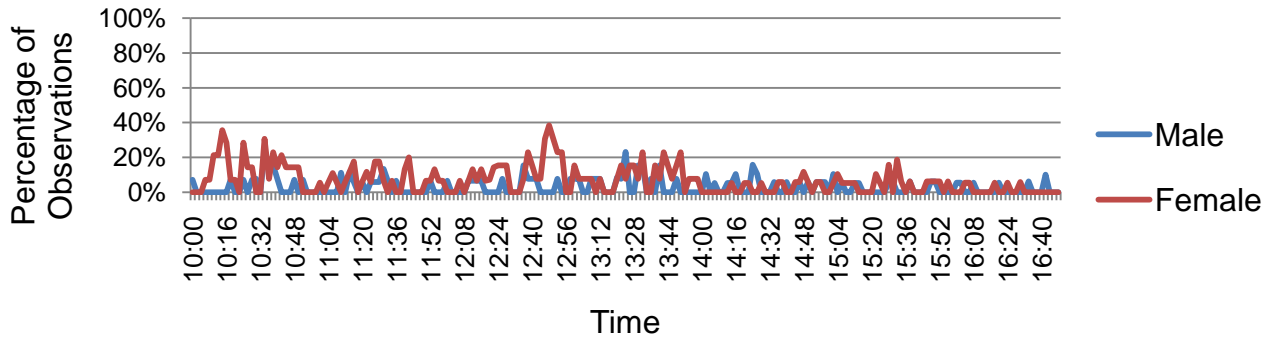


Figure 40. Scatterplot showing the proportion of observations that recorded self-maintenance behaviour in the male and female tigers throughout a day.

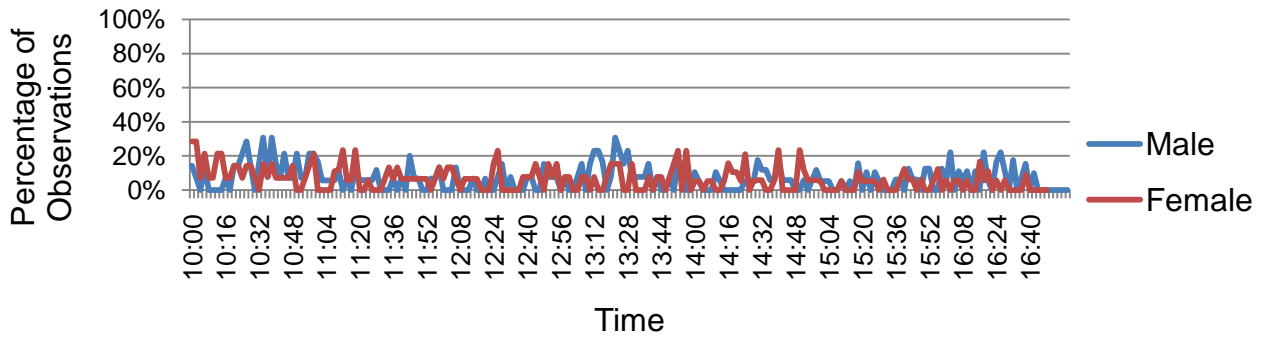


Figure 41. Scatterplot showing the proportion of observations that recorded investigative behaviour in the male and female tigers throughout a day.

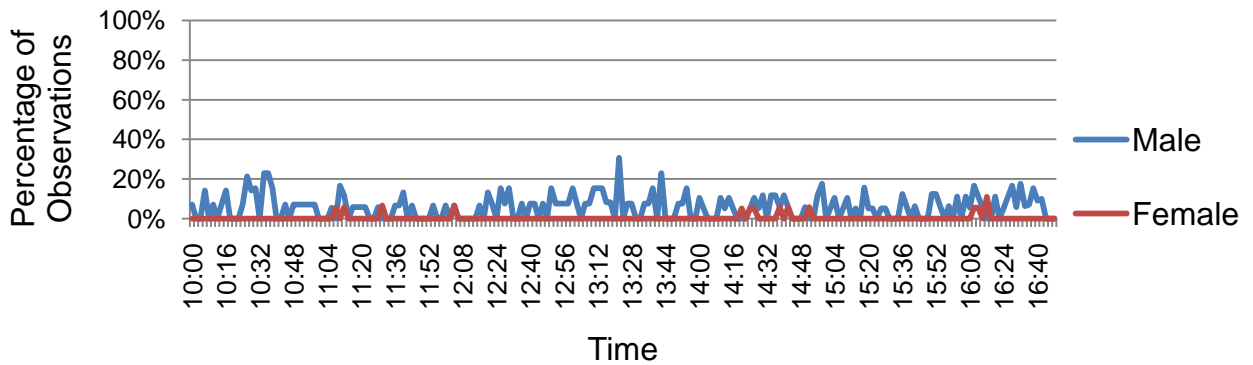


Figure 42. Scatterplot showing the proportion of observations that recorded marking behaviour in the male and female tigers throughout a day.

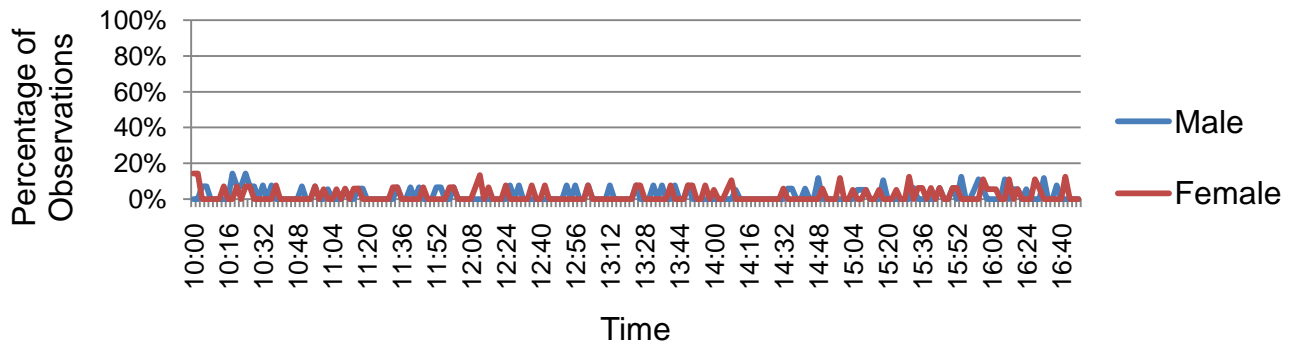


Figure 43. Scatterplot showing the proportion of observations that recorded feeding behaviour in the male and female tigers throughout a day.

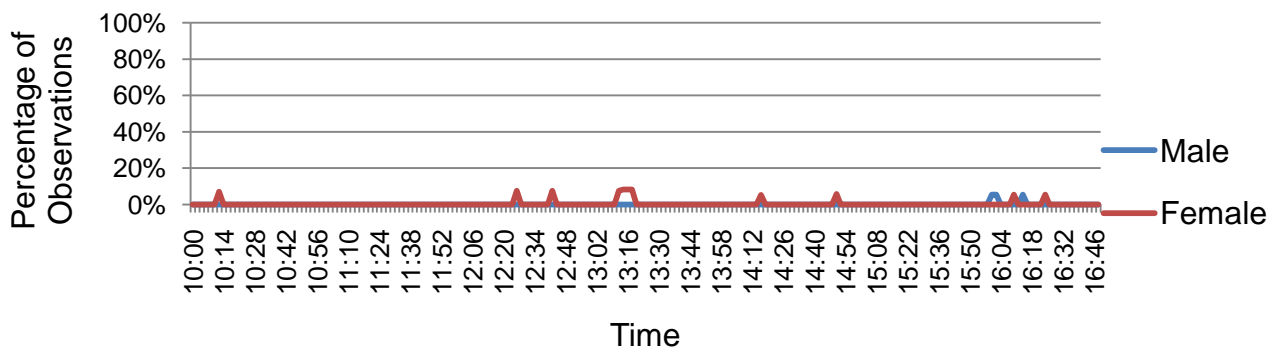


Figure 44. Scatterplot showing the proportion of observations that recorded enrichment-directed behaviour in the male and female tigers throughout a day.

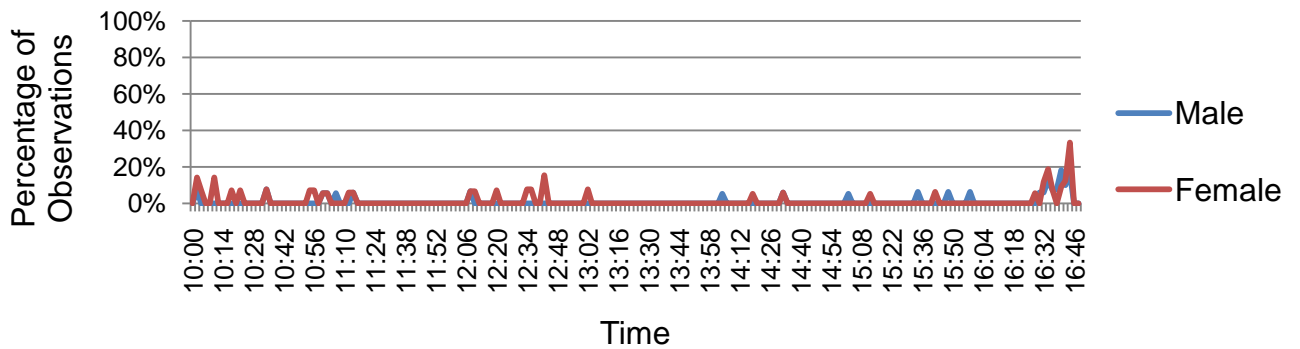


Figure 45. Scatterplot showing the proportion of observations that recorded staff-directed behaviour in the male and female tigers throughout a day.

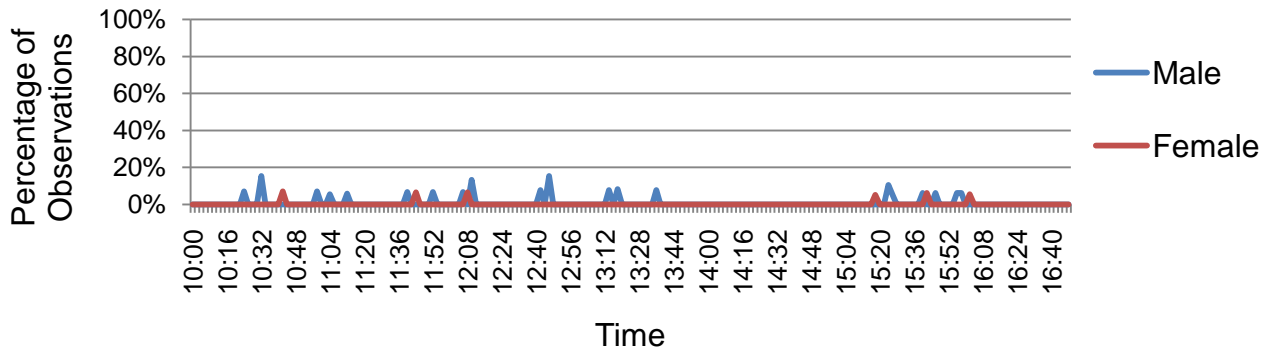


Figure 46. Scatterplot showing the proportion of observations that recorded visitor-directed behaviour in the male and female tigers throughout a day.

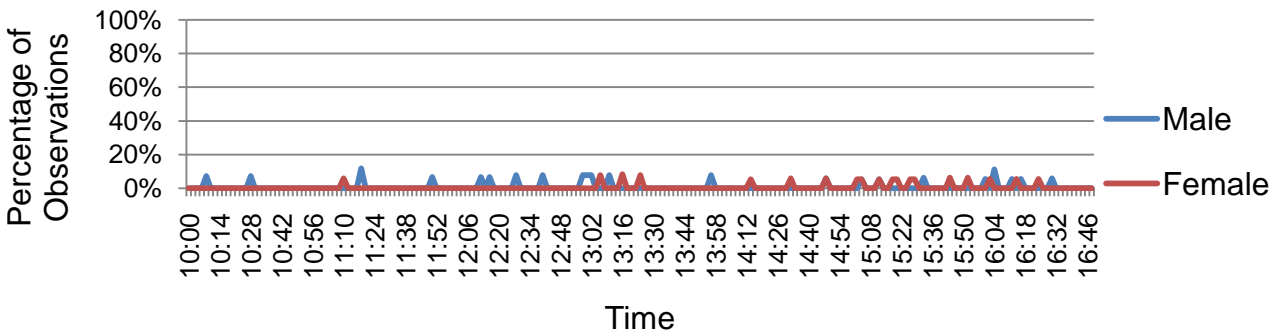


Figure 47. Scatterplot showing the proportion of observations that recorded agonistic behaviour in the male and female tigers throughout a day.

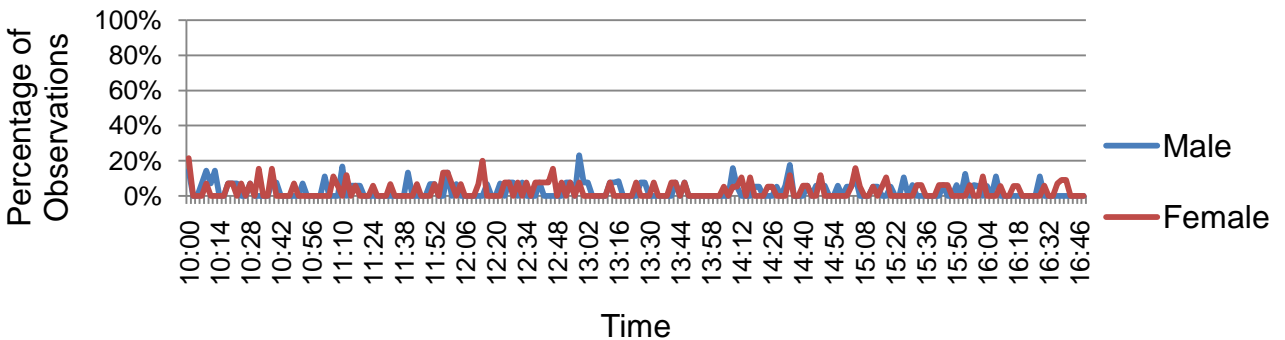


Figure 48. Scatterplot showing the proportion of observations that recorded social activity in the male and female tigers throughout a day.

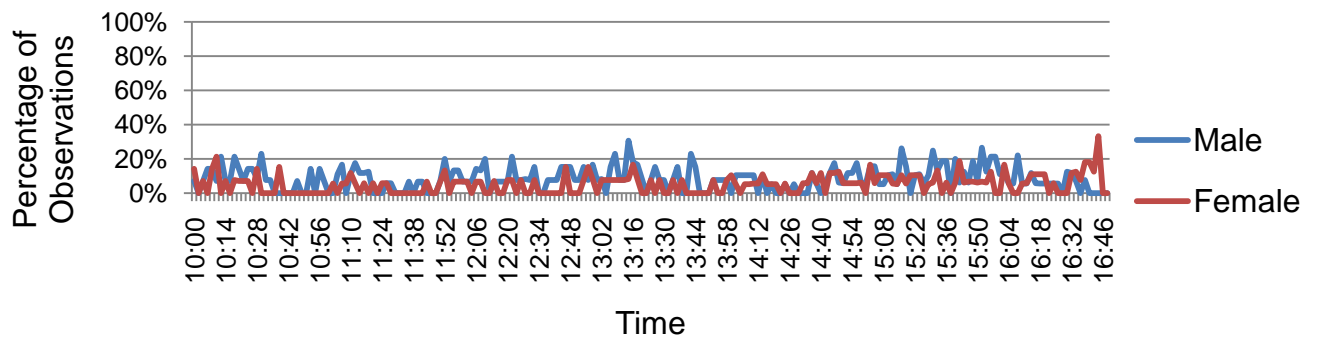


Figure 49. Scatterplot showing the proportion of observations that recorded vocalisations (excluding levels) in the male and female tigers throughout a day.