Universitat de Girona
Facultat de Ciències

# Enclosure modification effects on zone usage and activity patterns of a captive ocelot (*Leopardus pardalis*)

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I want to thank Natuwa for bringing me the opportunity to carry out this project, ocelots are not a common species one can encounter and I had the honor to carry out a behavior experiment on their captive ocelot. Thanks to Oriol, the head of biology volunteers, for helping me plan and develop this project, Roberto for taking care of wielding and preparing the platforms for the new enclosure, and all the volunteers that entered the enclosure with me aiming to modify the enclosure for an animal's wellbeing. Special thanks to friends and family that supported me throughout the project, from Costa Rica all the way back at home.

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# RESUM

Els animals que resideixen en santuaris, s'hi troben per la seva incapacitat de retorn a la natura a causa de lesions permanents o processos d'humanització. Se sap des de fa temps que els animals en captivitat mostren estereotípies, aquestes es troben relacionades negativament amb el seu benestar, com per exemple les autolesions, excés d'empolainar o el pacing. El pacing es descriu com un moviment repetitiu, ambulatori sense funció o objectiu aparent. Tot i que el pacing es troba relacionat amb l'estrès, els factors d'estrès no sempre provoquen un augment del pacing, a vegades fins i tot el redueixen. La relació entre els factors d'estrès que desencadenen una resposta fisiològica i el comportament observat encara és ambigu en la familia Felidae, hi ha estudis que mostren que els factors d'estrès, com l'efecte del visitant, poden generar un augment, disminució o cap resposta. Aquest estudi busca reduir el pacing d'un ocelot en captivitat modificant el recinte en el qual es troba. Les modificacions inclouen l'explotació de la verticalitat, la instal·lació de noves plataformes, una nova i més densa vegetació i la construcció d'una petita cabanya, mantenint les dimensions del recinte. Es proposa que el pacing és un comportament no natural desenvolupat pels animals en captivitat gràcies al seu estat en captiveri, de manera que per reduir el pacing d'un individu hem de modificar el seu recinte. Es van recopilar dades abans i després de la modificació del recinte mitjançant gravacions de l'ocelot al llarg de sis zones horaries. Els resultats ens mostren una distribució similar de les accions en ambdós recintes, tot i això, el pacing va disminuir significativament en el nou recinte, a més d'un augment significatiu dels comportaments de descans i una diversificació de l'ús de les zones. La nova cabanya i algunes de les noves plataformes es van usar en gran manera, diversificant la relació entre l'acció i la zona. Es creu que les noves característiques enfocades en el descans van tenir un impacte en el descans de l'ocelot, augmentant-lo i diversificant-lo, reduint el pacing en conseqüència. Les zones de descans són essencials pel benestar dels gats, així que la implementació d'aquestes zones per l'ocelot li va brindar un lloc on no pogués ser vist, allunyat dels factors d'estrès com ara els visitants, el personal del santuari o els sorolls forts.

## RESUMEN

Los animales que residen en santuarios se encuentran allí debido a su incapacidad de retorno a la naturaleza debido a lesiones permanentes o procesos de humanización. Se sabe desde hace tiempo que los animales en captividad muestran estereotipias, estas están relacionadas negativamente con su bienestar como por ejemplo autolesiones, exceso de acicalado o pacing. El pacing se describe como un movimiento repetitivo, ambulatorio sin aparente objetivo ni función. Aunque el pacing está relacionado con el estrés, los factores de estrés no siempre dan lugar a un aumento de pacing, a veces hasta lo reducen. La relación entre los factores de estrés que desencadenan una respuesta fisiológica y el comportamiento observado sigue siendo ambiguo en la familia Felidae, estudios han mostrado que factores de estrés como el efecto del visitante generan un aumento, una disminución o ningún efecto sobre el pacing. Este estudio busca reducir el pacing de un ocelote en captividad modificando el recinto en el que se encuentra. Las modificaciones incluyen explotar la verticalidad, instalación de nuevas plataformas, nueva y más densa vegetación y la construcción de un pequeño fuerte, manteniendo las dimensiones del recinto. Se propone que el pacing es un comportamiento no natural desarrollado por animales en captividad debido a su estado de captividad, de manera que para reducir el pacing de un individuo, se debe modificar su recinto. Se recopilaron datos antes y después de la remodelación del recinto mediante grabaciones del ocelote a lo largo de seis zonas horarias. Los resultados muestran una distribución similar de las acciones para ambos recintos, aun así, el pacing disminuyó significativamente en el nuevo recinto, además de un aumento significativo en los comportamientos de descanso y la diversificación del uso de las zonas del recinto. El nuevo fuerte y algunas de las nuevas plataformas fueron usadas en gran medida, diversificando la relación entre la zona y la acción. Se cree que las nuevas características enfocadas en el descanso tuvieron un impacto en el descanso del ocelote, aumentándolo y diversificándolo, reduciendo el pacing en consecuencia. Las zonas de descanso son esenciales para el bienestar de los gatos, así que la implementación de estas zonas para el ocelote le brindó un sitio donde no pudiera ser visto, alejado de los factores de estrés como los visitantes, personal del santuario o sonidos fuertes.

# ABSTRACT

Captive animals kept in animal sanctuaries are found due to their inability to return to wildlife because of permanent damage or humanization. Those captive animals have long displayed stereotypical behaviors, these are linked to welfare issues such as self-injuries, excessive grooming or pacing. Pacing is described as a repetitive, ambulatory movement with no apparent function or goal. Although pacing is linked to stress, stress factors not always display an increase of pacing, sometimes they even reduce it. Direct link between stress factors that generate a physiological response, and their behaviors is still ambiguous on the Felidae family, studies have shown stress factors such as visitor effect decreasing, increasing or having no response at all on pacing. This study aims to reduce stereotypical pacing on a captive ocelot by modifying the enclosure he is captive in. Modifications include vertical exploitation, new platforms, new and denser vegetation and building a small fort, maintaining the enclosure dimensions unchanged. It is proposed that stereotypical pacing is a non-natural behavior developed by captive animals because of their captivity status, therefore efforts on reducing their pacing should be done on the enclosure. Data was gathered from the enclosure before and after modifications by recordings of the ocelot over six time zones. Results showed a common distribution for both enclosures for the actions performed on them, though significant decrease in pacing in the new enclosure was seen, as well as significant increase in resting behaviors and zone usage diversification. The new fort and some of the new platforms achieved great usage, diversifying the link between zone and action. New resting behavior features are thought to have an impact on the ocelot resting behavior, increasing it and diversifying it, as a result, pacing was reduced. Resting areas are essential for cat’s well-being, thus their implementation granted the ocelot a retreat space where he could not be seen, away from the stress factors such as visitors, staff or loud noises.

## THOUGHT ON ETHICAL CRITERA

Animal sanctuaries feature enclosed wild animals which cannot be returned to wildlife due to their inability to survive by themselves. This may be the consequence of humanization process, malformations or permanent damage. Once in captivity these centers may house investigators that may take advantage of the situation and carry out behavioral research on those animals, publishing scientific papers that will improve their career. This opens a debate whether is ethic using the animal captivity status to pursue scientific research on them. Personally, I would approach regarding the animal side, I think that experiments involving the least amount of interaction between animal and investigator should be carried out after its approval from an external committee regarding its methodology, thus ensuring that the animal remains unaffected of the experiment.

## THOUGHT ON SUSTAINABILITY CRITERIA

Natural habitat for wild animals is on regression due to its conversion from forests to cropland (Andrade-Núñez & Aide, 2010) pushing them to new environments. These anthropogenic pressures are having a negative impact on animal wildlife; thus, a new sustainable approach must be considered. Habitat conservation projects may pursue a balance between giving land to fulfill the food demand for the increasing population and the conservation of key areas. Conservation of those areas is important to secure future generations habitats' and to maintain the biodiversity. Personally, I think conservation projects are on everyone's interest, every animal plays a crucial role in the ecosystem, and we have yet to discover the negative impact of missing species.

## THOUGHT ON GENDER EQUALITY CRITERIA

Throughout my internship in an animal sanctuary in Costa Rica I got the pleasure to meet Janet, a regional veterinarian that came to our center once a week to check the health of the animals. She gave me a broad perspective on the female role of this center, since then, I always interacted with male dominated positions such as veterinarian, biologists and physical labors, while the female roles were delegated to cleaning, cooking and administrative labor such as receptionist. Janet brought us a role model to look up to as she had a different point of view due to her experience on different animal centers, that enabled her to deeply understand enclosed animals and taught us deeper knowledge on the subject.

## INTRODUCTION

*Leopardus pardalis*, commonly known as ocelot, belongs to the Felidae family and it has two subspecies: *Leopardus pardalis pardalis* and *Leopardus pardalis mitis* (Kitchener *et al*., 2017). Its geographical distribution goes from southern Texas in the USA (Haines *et al*., 2006), passing through continental Central America, all the way down to northern Argentina, except Chile (Nagy-Reis *et al*., 2020). Ocelot's current classification is Least Concern (LC) on the IUCN Red List, although its population trend is to decrease because of habitat destruction and fragmentation by anthropogenic pressures, such as logging and agricultural activities (Paviolo *et al*., 2016). Roads also, present a physical barrier between its natural habitat, and therefore a major threat of roadkill. A study conducted in Mexico showed that 10 of the 25 states sampled (40%) reported road killed ocelots (González-Gallina & Hidalgo-Miharti, 2018). In addition, habitat fragmentation leads to the isolation of the populations, losing genetic diversity due to genetic drift and inbreeding (Janecka *et al*., 2014).

Wild cats as the ocelot have long been on illegal market for pet, fur and skin trading (Antunes *et al*., 2016), some of them don't achieve its destination and are confiscated by the authorities thanks to local whistleblowers. On Costa Rica a sue is issued through MINAE's (Ministerio de Ambiente y Energía) Integrated System of Attention and Procedure of Environmental Sues (SITADA). SITADA has reported an increase trend on issued sues from 2013 to 2021, 2022 for instance had a decrease, this trend was also seen on the number of solved reports, except 2022 which maintained the trend (Zavala, 2022). Once in MINAE's custody the animal is evaluated whether it can be returned to wildlife and sent to proper animal center. On the subject's case, a male ocelot named "El Gato", was issued from MINAE to an animal sanctuary called Natuwa, which is regulated by SINAC as a sanctuary type non-commercial zoo (SINAC, 2022). Animal sanctuaries cannot return animals to wildlife; thus, the ocelot was placed on an enclosure as a kitten.

Over the years staff observed pacing, this stereotypic behavior is defined as being invariant, regularly repeated and having no apparent goal or function (Mason, 1991a). Although this abnormal repetitive behavior in captive animals is commonly linked to welfare issues such as deprivation and stress (Mason & Rushen, 2006), there is no such evidence in ocelots. For instance, stereotypical pacing was less likely to be observed by resident felids as a group during an exhibit construction (Chosy *et al*., 2014), similar results were observed under construction activities and noise exposure, where captive snow leopards (*Uncia uncia*) spent more time in the rear of the exhibit and resting on noisy days (Sulser *et al*., 2008), thus prompting the idea that stressing factors decrease captive felid activity.  Pacing may vary depending on individual and it might be whether the animal is using pacing as a coping mechanism (Chosy *et al*., 2014), referred nowadays as the reaction of the organism to regain homeostasis under a stress factor that threatens it (Chrousos, 2009). Furthermore, stereotypic behaviors warn us that the animal may be on a frustrating environment, thus having negative effects on his welfare (Mason, 1991b) which may not be associated with changes in adrenocortical activity (Carlstead *et al*., 1993b). Feeding on a predictable schedule and its possible delays appears to be stressful for stump-tailed macaque (*Macaca arctoides*) (Waitt & Buchanan-Smith, 2001) whilst temporal and spatial variation on a random schedule revealed positive behavioral benefits for cheetahs (*Acinonyx jubatus*) (Quirke & O'Riordan, 2011). Another stressing factor that captive animals face is visitor effect, which has long been hypothesized to induce stress in zoo animals (Maki *et al*., 1987; Wormell *et al*., 1996;

Wells, 2005; Pifarré *et al*., 2012). Reported increase in biomarkers of stress such as glucocorticoids or cortisol on captive animals due to visitor effect (Carlstead & Brown, 2005; Davis *et al*., 2005; Todd *et al*., 2007) support this hypothesis, although further research is needed on other animal groups (Davey, 2007; Fernandez *et al*., 2009). On felids, potentially stressful events increase cortisol (Carlstead *et al*., 1992; Bonier *et al*., 2004; Moreira *et al*., 2007) but no clear relation has been established between stressful events that increase stress biomarkers and an activity response. Negative correlation between urine cortisol and hiding time on domestic cats (*Felis catus*) (Carlstead *et al*., 1993a) and a reduction of pacing while increase of glucocorticoids during construction (Chosey *et al*., 2014) clashes with studies carried by Wielebnowski et al. (2002) on clouded leopards (*Neofelis nebulosa*), where they found that excessive pacing, hiding and sleeping, as well as self-injuring behaviors were associated with higher glucocorticoid concentrations. This might be explained by their taxonomy, as domestic cats belong to the subfamily Felinae whereas clouded leopards belong to the subfamily Pantherinae, further research linking cat response with glucocorticoid level considering taxonomy may be pursued. Furthermore, Sellinger & Ha (2005) found that visitor effect had an increase on stereotypical pacing and time spent hiding on two captive jaguars (*Panthera onca*), but no correlation was seen by the visitor density and frequency, which was later related on a study that compared the amount of time jaguars dedicated to pacing to the number of visitors around their cages, concluding on a positive relation between pacing and number of visitors (Vidal *et al*., 2016). Visitor effect also presented different effects on the Felidae family, as captive leopards (*Panthera pardus*) exhibited higher levels of resting behavior on zoo open-days and higher levels of active behavior on visitor-absence days, additionally on festival days leopards switched from resting behavior to high levels of stereotypic pacing (Mallapur & Chellam, 2002). Suárez et al. (2016, in press) found a significant variation in the distribution of activities of felid species when the zoo was open to the public: bobcats (*Lynx rufus*) and ocelots (*Leopardus pardalis*) increased time sleeping and spent less time on complex behaviors such as playing, walking and abnormal stereotypies, whereas the jaguar was more active and was even seen exhibiting playful behavior towards the visitors. On the other hand, Margulis et al. (2003) found no significant variation of visitor effect on the behavior of six captive felid species: lion (*Panthera leo*), amur leopard (*Panthera pardus orientalis*), siberian tiger (*Panthera tigris altaica*), snow leopard (*Panthera uncia*), clouded leopard and fishing cat (*Prionailurus viverrinus*).

Aware of the unclear connection between stress factors that trigger a physiological response to stress and its consequent behavior on the Felidae family, it is proposed that stereotypical pacing on captive ocelots may be from its captivity status, understood as a long-term stress where the inability to regulate homeostasis due to enclosure limitation triggers a non-natural behavior. Stereotypical pacing may not be seen as an immediate response to stress factors, but more like a long-term consequence of captivity. Addressing the enclosure instead of preventing possible visitor effect on the ocelot may decrease its stereotypical pacing and increase other behaviors in consequence. It's expected a reduction on pacing and zone usage is expected to diverse after the renovation as it is suspected to be polarized towards one side of the enclosure.

## OBJECTIVES

- Reduce stereotypical pacing of the ocelot

- Diversify the zone usage of the enclosure

## MATERIALS AND METHODS

The study was conducted on an animal sanctuary named Natuwa on Pitahaya, Costa Rica (10° 2' 52.728" N, 84° 48' 17.568" W), from 22nd July to 23rd August 2023. It consists of behavior research on a six-year-old male captive ocelot (13kg) before and after enclosure renovations using handheld camera (Sony DSCH 400) recordings that were later analyzed. A total of 108 hours were recorded spared on the two different enclosure states and over 6 time zones scattered from morning to noon. Although wild ocelots exhibit crepuscular and nocturnal activity periods (Leonard, 2016) or diurnal when not challenged by natural predators (Pereira *et al*., 2012), this may not be the case for captive ones, as night activity is related to its major prey activity (Gray *et al*., 2024) which is erased once in captivity. Considering this fact and previous studies like Weller & Bennet (2001) reporting two peaks of activity on captive ocelots at 7:00h and at 17:00h, six time zones were designated: 6:00h-7:00h, 8:00h-9:00h, 10:00h-11:00h, 12:00h-13:00h, 14:00h-15:00h and 16:00h-17:00h. One hour gap was left between time zones to increase coverage. A total of 9 hours per time zone were recorded per enclosure which will be later assessed as replies to carry out statistical analysis. The enclosure state before renovations will be addressed as old enclosure, and the one after renovations will be addressed as new enclosure. Once the first 54 hours were recorded, staff and volunteers entered the enclosure to begin the renovations while the ocelot was placed on an adjacent zone of the enclosure. Inside the enclosure, measurements of enclosure dimensions and features were taken before and after renovations for later development of scale maps of both enclosures on two dimensions. Old enclosure (figure 1) featured 10 main zones and its subdivisions, adding a total of 29 zones, featuring lateral logs (G1L, J1L), one vertical log (D1L), lower platforms (<2 meters)(C1P, C2P, C3P, C4P, C5P, C6P, E2P, E3P, G2P, G3P, H1P), one high platform (≥2 meters)(H2P), wood steeps (E1S, H3S, J2S) and a trough (A1T). During recordings of the old enclosure, uneven distribution of enclosure space usage was seen on the main zones and platforms. Space usage is used as a method to determine positive or negative features on enclosures (Ross *et al*., 2009), suggesting that underused zones had negative traits and overused zones had positive traits. Considering this, the new enclosure was designed to offer new high platforms away from visitors, a small fort for hiding, platform connections and new and denser vegetation to conceal the ocelot. Enclosure dimensions remain unchanged: A – 1.06m x 3.00m, B to J – 12.00m x 6.00m, F – 3.00m x 0.96m + 0.3m x 0.96m, granting a total area of 78.35 $m^2$, additionally the area delimited from B to J, except F, exhibited a height of 6 meters that was not vertically exploited. Features such as hiding locations and height usage have found positive changes in glucocorticoid metabolite concentrations on felids (Fanson & Wielebnowski, 2013) (Wielebnowski *et al*., 2002), thus prompting the idea that it may have a positive impact on the ocelot's welfare. New enclosure (figure 2) featured 10 main zones and its subdivisions, adding a total of 46 zones, featuring lateral logs (G1L, J1L), lower platforms (B3P, C1P, C2P, C3P, C4P, C5P, C6P, D1P, D2P, E2P, E3P, H1P, J2P), high platforms (B1P, B2P, C7P, D3P, G3P, H3P, H5P, I1P, I3P), wood steeps (C8S, D4S, E1S, E4S, G2S, H2S, H4S, H6S, I2S, I4S), one fort (J3F) and one trough (A1T). New enclosure featured 10 more platforms, 7 more steeps and a new small fort. After all recordings have been done an ethogram was built (table1) regarding the actions performed by the ocelot and their definition, not visible is also applied to the zone data as the subject may not be visible, so can be his location. Data collected from the recordings was done by focal animal sampling, which consists of sampling the action and zone of the animal in intervals of a pre-established duration over a period of time (Bosholn & Anciães, 2022), in our case the period of time was one hour, and the intervals of time were 30 seconds apart, resulting in 120 samples for every hour recorded, amounting a total of 12960 samples. For the statistical analysis a new variable named counts was created, this variable grouped the number of times an action and zone were registered for each enclosure. Additionally, data was copied and grouped by their action group, and zones were grouped by their main zone (e.g. C4P was converted into C). To evaluate the effect of the enclosure on the number of counts for each action, zone, grouped actions and grouped zones, a GLM model was fitted with Poisson distribution (Dreassi, 2014) controlling for the 6 different time zones. Estimated marginal means (EMMs) for the two enclosures were computed for each factor, together with the corresponding standard errors. Different boxplots were generated as well as a table featuring variable means, standard errors and p-values. Variables were filtered by their minimum sample size, regarding a minimal observation-to-variable ratio of 5:1 and a preferred 15:1 or 20:1 (Hair et al., 2018), a threshold of 10 observations per variable was created. This was true for all variables except zones from the new enclosure, where the bar was lowered to the minimum observation-to-variable ratio of 5:1 as the total possible zones were 47 (including not visible), thus requiring a minimal sample of 11045, less than our total sample of 12960. Only significant p-values with filtered variables were seen as significative.

| **Group** | **Action** | **Definition** |
|---|---|---|
| Active | Alert | Stopping any action to pay attention to something. Eyes and ears pointed towards the trigger |
| | Climb | Vertical movement up or down substrate. Claws are used to grasp substrate |
| | Hide an object | Burying or covering an object |
| | Jump | Subject leaps from one point to another, either vertically or horizontally. |
| | Pace | Slightly rapid, repetitive, unvarying ambulatory movement, unique to each cat |
| | Walk | Quadrupedal locomotion, movement of opposite limbs, two limbs on the ground, movement with an objective or destiny defined. |

| | | |
|---|---|---|
| Resting | Lie asleep | Settled on substrate, either sternally, laterally, or on back. Eyes are closed |
| | Lie awake | Settled on substrate, either sternally, laterally, or on back. Eyes are open, subject is alert. |
| | Sit | Subject is resting on haunches, forelegs are braced |
| | Stand | Subject is stationary. Subject may be in quadrupedal position, or may be in bipedal position, with front legs resting against vertical surface |
| Exploration | Flehmen | Curling of the upper lip to expose gums as part of an olfactory investigation |
| | Investigate | Searching, pawing at, or trying to reach item |
| | Sniff | Smelling an object by inhaling air through the nose |
| Housekeeping | Cheek rub | Cheek is rubbed against an object |
| | Groom | Licking or cleaning himself using tongue or teeth |
| | Lick | Tongue out moving on a surface |
| | Scrape | Scraping or rubbing hind feet alternately on ground |
| | Scratch | Back limb scratching his head or ears, usually sit |
| | Sharpen Claws | Front claws are used to scratch an object |
| | Spray | Animal sprays urine on objects or plants in the enclosure, tail-lifting and ball sack raising |
| | Stretch | Subject extends his forelegs while curving its back inwards |
| | Yawn | Opens mouth widely, sticks tongue slightly out and closes its eyes as inhales |
| Feeding | Drink | Ingestion of water by lapping up with the tongue |
| | Eat | Mastication and swallowing of food |
| Excretion | Defecate | Subject is stationary, back and tail lifted, turds exit anus |
| | Urinate | Subject is stationary, back and tail lifted, urine exit urethra |
| Vocalization | Growl | Vocal deep sound, mouth closed |
| Not visible | Not visible | Subject cannot be seen by observer. Location of the subject may or may not be known |

Table 1: Ethogram of the behaviors of the captive ocelot used on this study

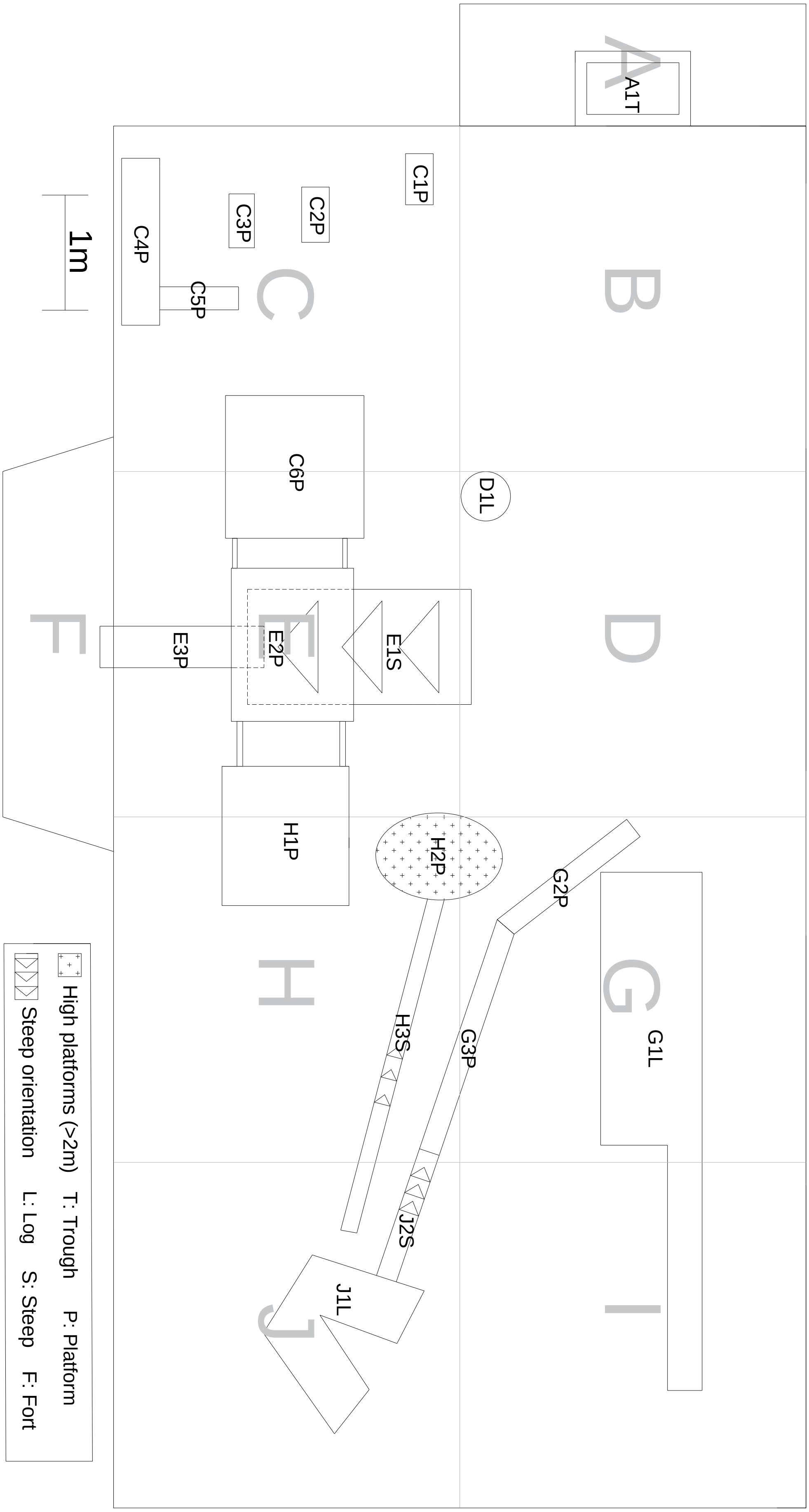


Figure 1. Scale map of the old enclosure.

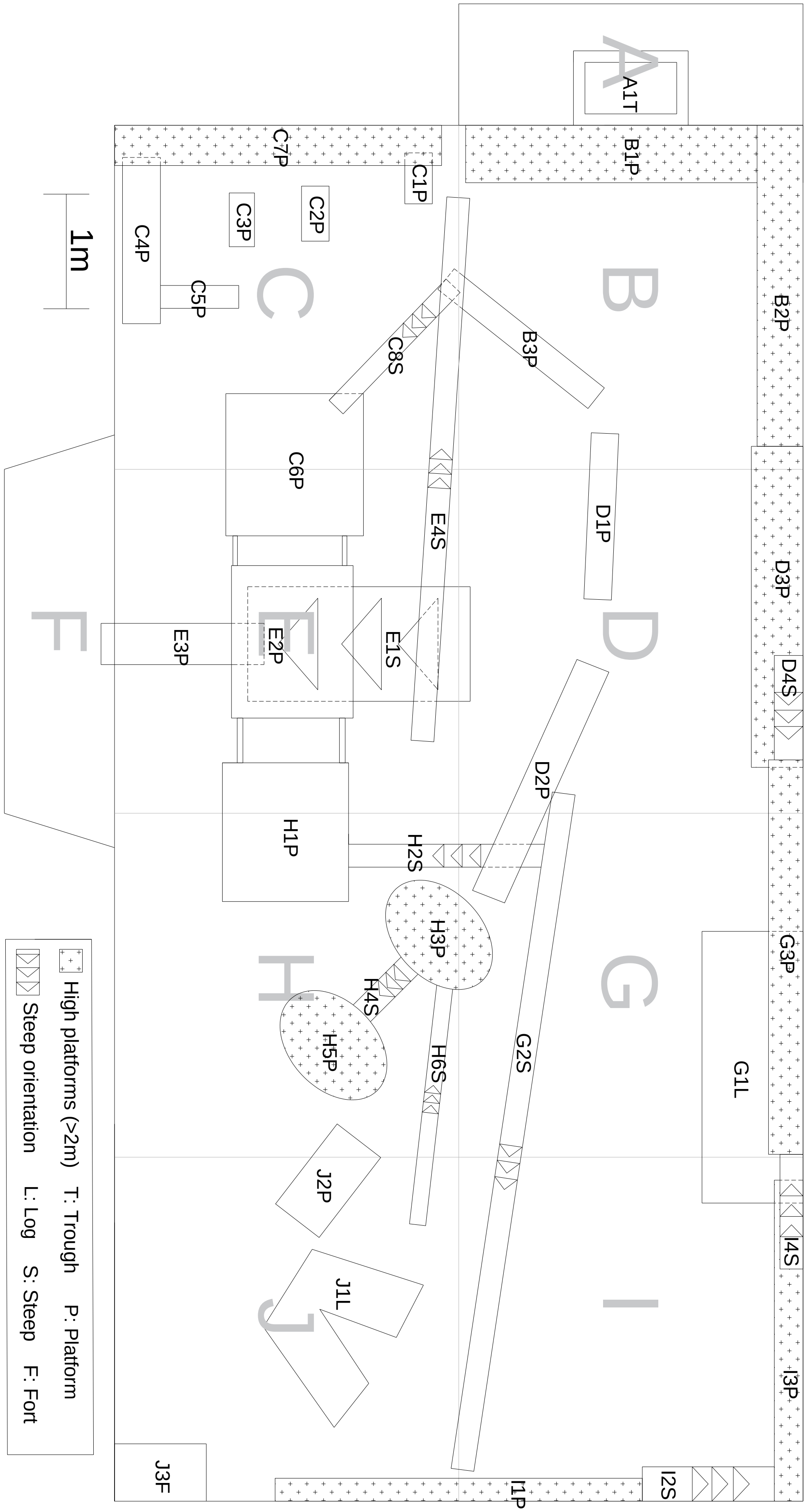


Figure 2. Scale map of the new enclosure.

## RESULTS

Actions distribution on the old enclosure (Figure 3) show three main actions (LIE ASLEEP, LIE AWAKE, PACE) and seven minor actions. LIE ASLEEP was the most registered action on this enclosure (35.12% out of the total actions) followed by PACE (25.2%) and LIE ASLEEP (22.02%), these three actions accounted for 82.34% of the activities on the old enclosure. On the new enclosure (Figure 4) three main actions (LIE ASLEEP, LIE AWAKE, PACE) and seven minor actions are shown. LIE ASLEEP was the most registered action on this enclosure (41.08%) followed by LIE AWAKE (27.94%) and PACE (14.58%), these three actions accounted for 83.61% of the activities on the new enclosure. Similar data distribution can be seen on both enclosures, the main and minor actions repeated with a change in its values, PACE fell off 10.61%, LIE ASLEEP and LIE AWAKE went up by 5.9% each.

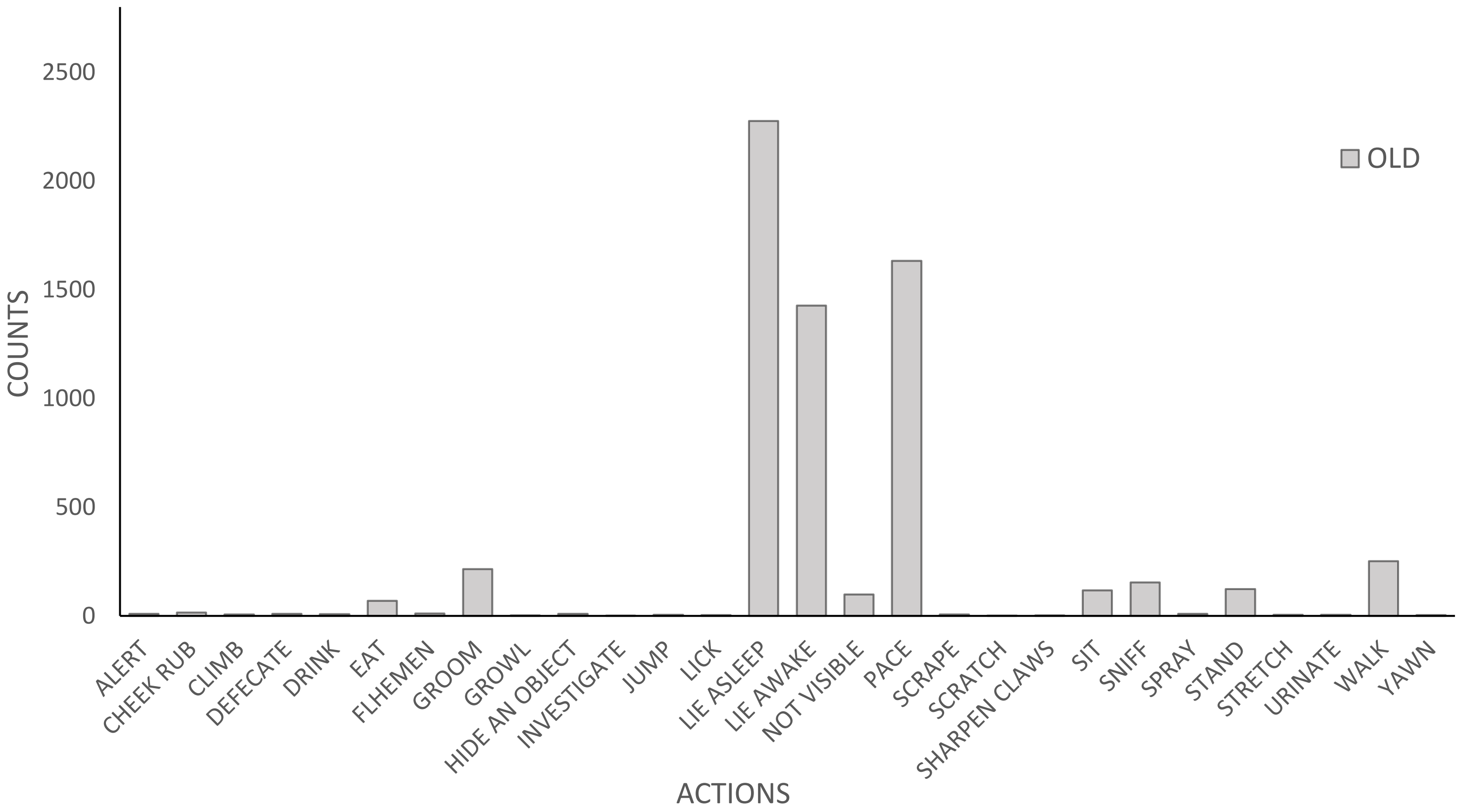


Figure 3. Bar plot of the count of action on the old enclosure.

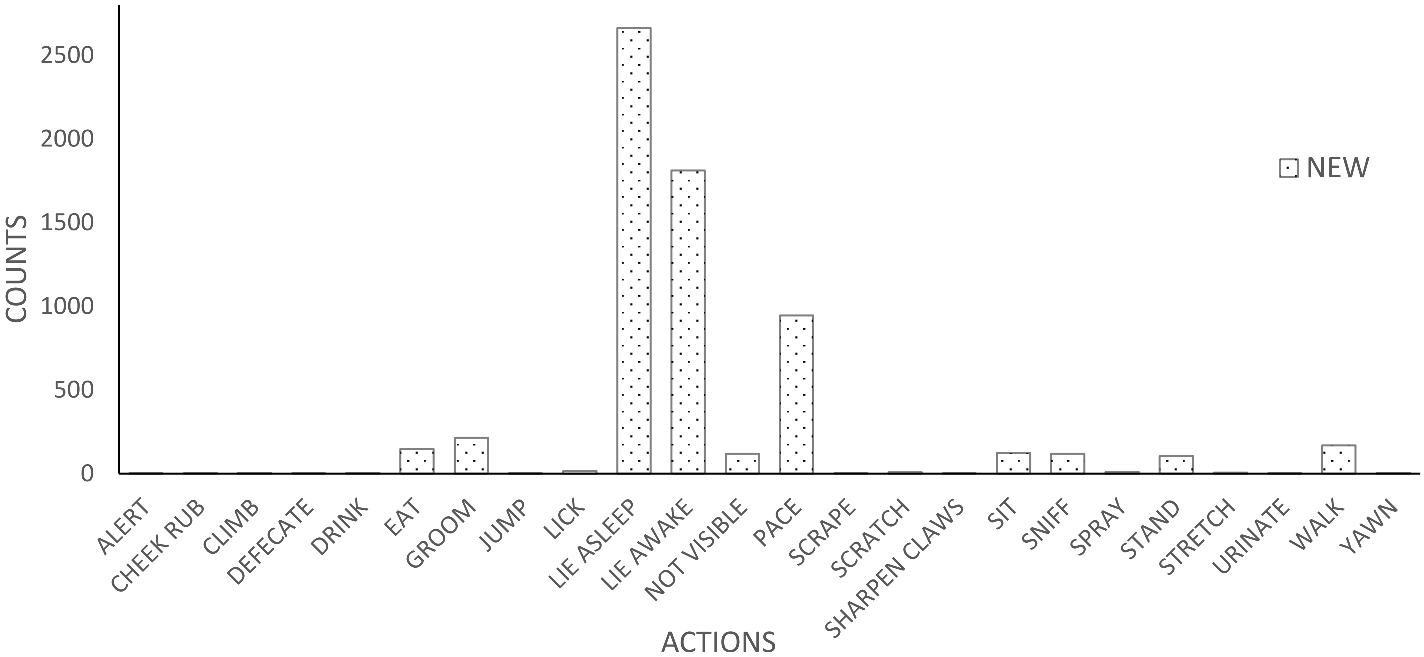


Figure 4. Bar plot of the count of action on the new enclosure.

Zone distribution on the old enclosure (Figure 5) features two main zones (B, C4P) accounting for more than half of the zone data (63.59%). On the new enclosure (Figure 6) one main zone (J3F) accounts for one quarter of the whole data (25.43%) while seven minor zones (>4% of total counts) account for more than half of the zone data (55.72%), showing a diversification on the zone usage on the new enclosure.

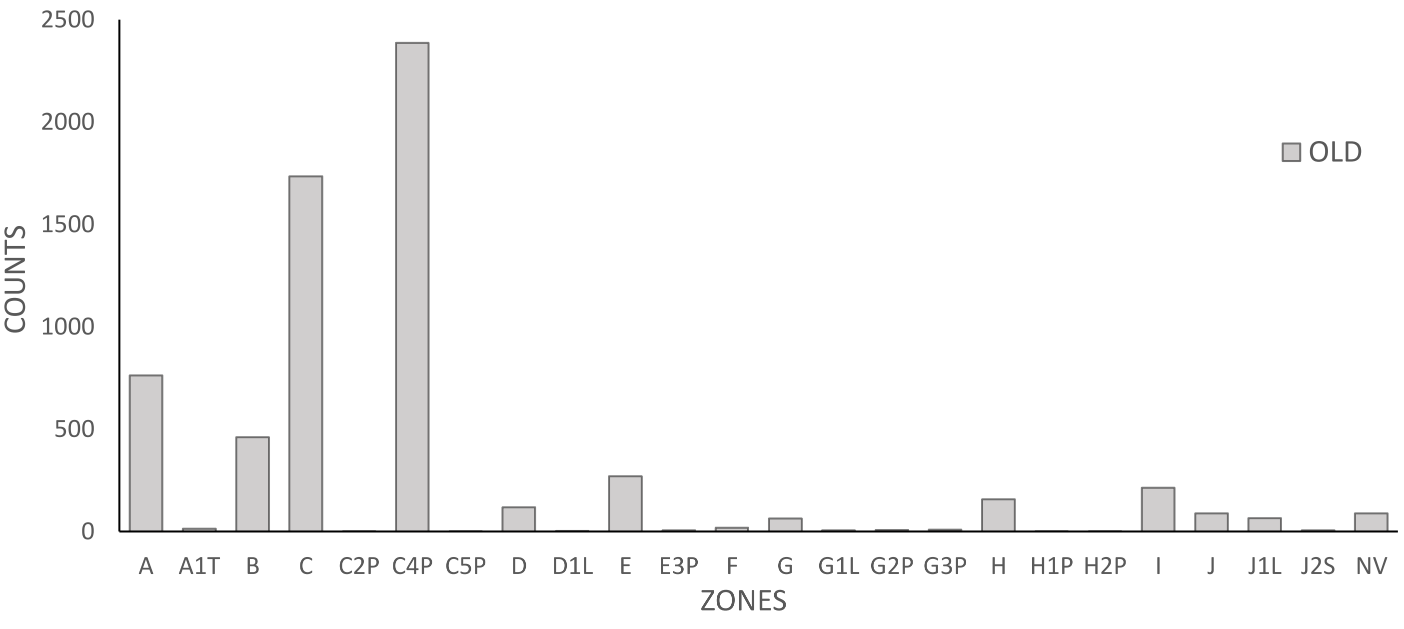


Figure 5. Bar plot of the count of zone on the old enclosure.

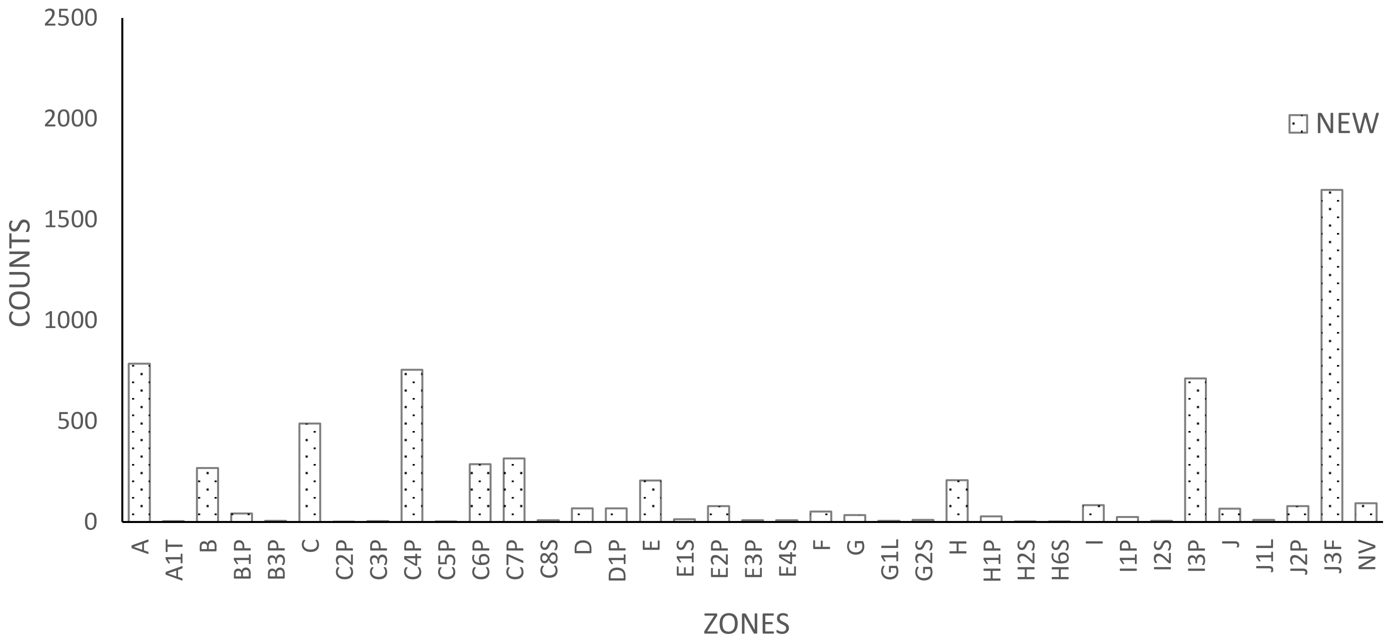


Figure 6. Bar plot of the count of zone on the new enclosure.

Grouped actions (figure 7) displayed significant increase in NOT VISIBLE (p-value < 0.05) and RESTING (p-value < 0.05) whilst significantly reducing ACTIVE (p-value < 0.05). Deeper analysis on the variables that form ACTIVE and RESTING (Figure 8) behaviors show significant increases in LIE ASLEEP, LIE AWAKE (p-value < 0.05) and significant decrease in PACE (p-value < 0.05). NOT VISIBLE had a significant increase (p-value < 0.05) on grouped variables, but when considering all the actions without groping them the increase was no longer significant.

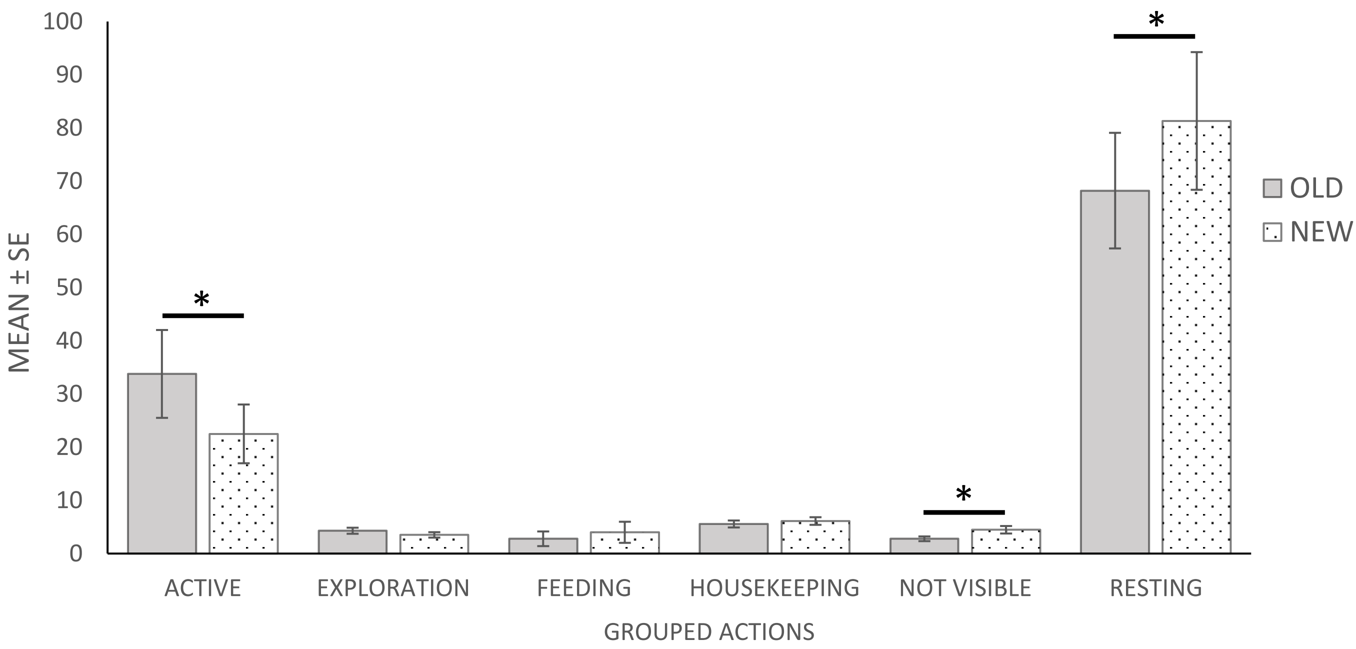


Figure 7. Bar plot grouped actions mean comparison over old and new enclosures.

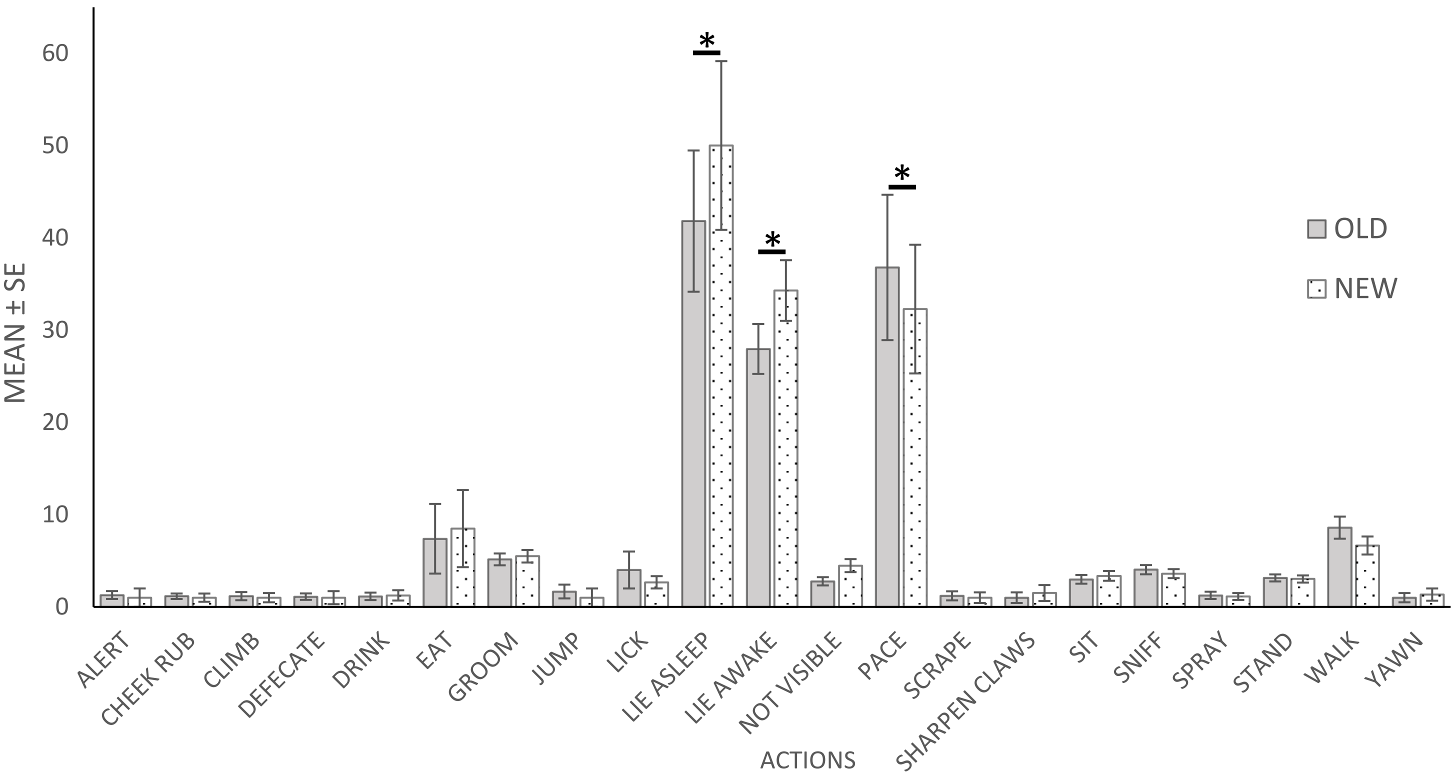


Figure 8. Bar plot actions mean comparison over old and new enclosures.

Grouped zones (figure 10) display significant decrease on C and B (p-value < 0.05) and significant increase on A, D, E, F, H, I and J (p-value < 0.05). Not grouped zones (figure 9) comparation show significant decrease on C, C4P and B (p-value < 0.05) and significant increase on A (p-value < 0.05). Significant increases on grouped zones are not displayed on their not grouped variables, due to the GLM comparing same variables, new variables such as I3P and J3F are not shown for comparison, but when grouped with their main zone they show significant differences between enclosures.

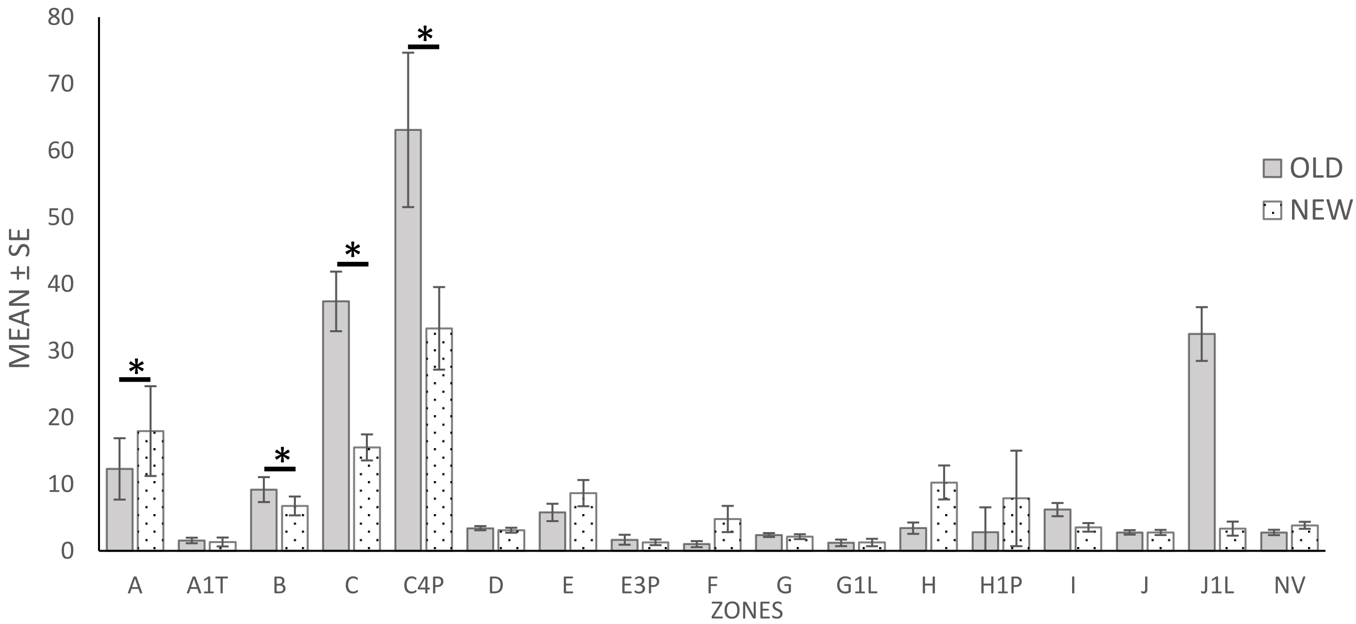


Figure 9. Bar plot zone mean comparison over old and new enclosures.

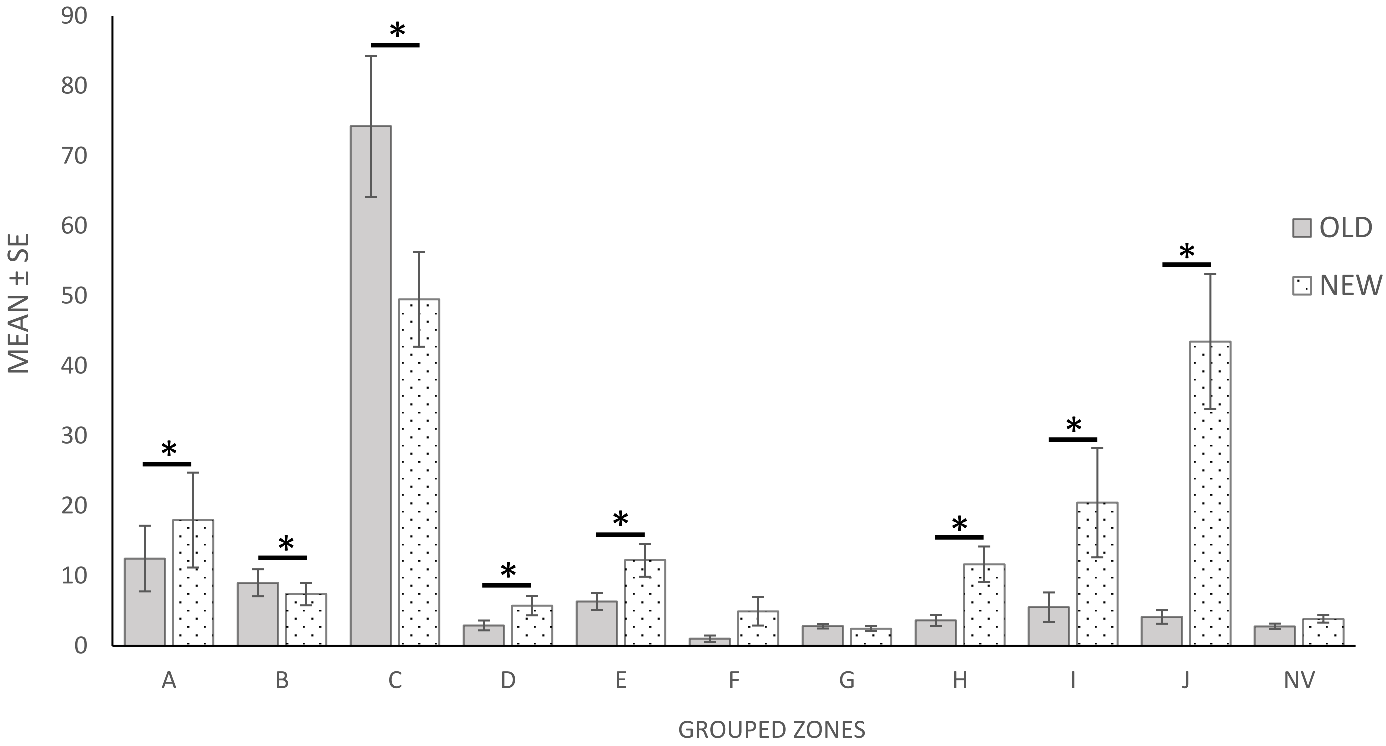


Figure 10. Bar plot grouped zones mean comparison over old and new enclosures.

PACE distribution over the time zones and enclosures (Figure 11) features new enclosure decrease on hour 14-15 and similar results on 16-17, on the other hand from early hours to noon pacing has drastically decreased in the new enclosure, except hour 6-7 where it increases. 14 to 15 was the highest pacing hour of the old enclosure with a mean of over 75% of the total hour activities (120), this was reduced to a mean of 50% on the new enclosure. Resting behaviors such as LIE AWAKE (Figure 12) have suffered an increase on the new enclosure in the first hour (6-7) and in the afternoon (14-15, 16-17), the rest of hours (8-9, 10-11, 12-13) display similar boxplots, additionally 10-11 presents the higher distribution of data for this action on both enclosures. Another resting behavior that had significant changes is LIE ASLEEP (Figure 13), an overall increase on the new enclosure is seen on all hours except 16-17. From 10-11 and 12-13 the mean of the action almost doubles between enclosures, the rest of the hours remains similar between enclosures, although between hours this resting behavior has two main features on the new enclosure, from 6-7 to 12-13 the mean remains almost always above 50% of the total amount and from 14-15 to 16-17 it drops below 25%. Zone A (Figure 14) had a mean increase of usage on the new enclosure on the hours 6-7, 12-13, 16-17, the most notable being 12-13 which also increased its distribution greatly. Two main zone usage states can be seen, a lower usage on early hours (6-7 to 10-11) and a higher usage from noon (12-13 to 16-17). The zone B (Figure 15) has suffered an overall reduction on its zone usage over the time zones, new enclosure registered less data on all hours except 8-9, where little data is seen for the new enclosure. In the old enclosure a trend is seen to increase zone usage over the time, peaking at 16-17. C4P (Figure 16) registered high means (>50% of total zone usage) from early hours to noon on old enclosure. The new enclosure features a reduction of the mean on all hours for this zone, most notably at hours 6-7 and 8-9 where it drops roughly 60% and more than 60% respectively. High data distribution is seen on both enclosures.

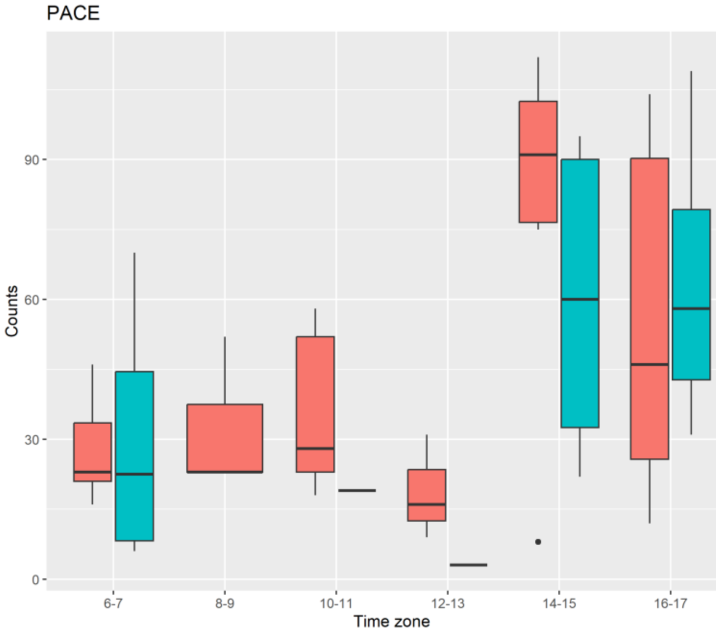


Figure 11. Boxplot of PACE spared over time zones of old and new enclosures.

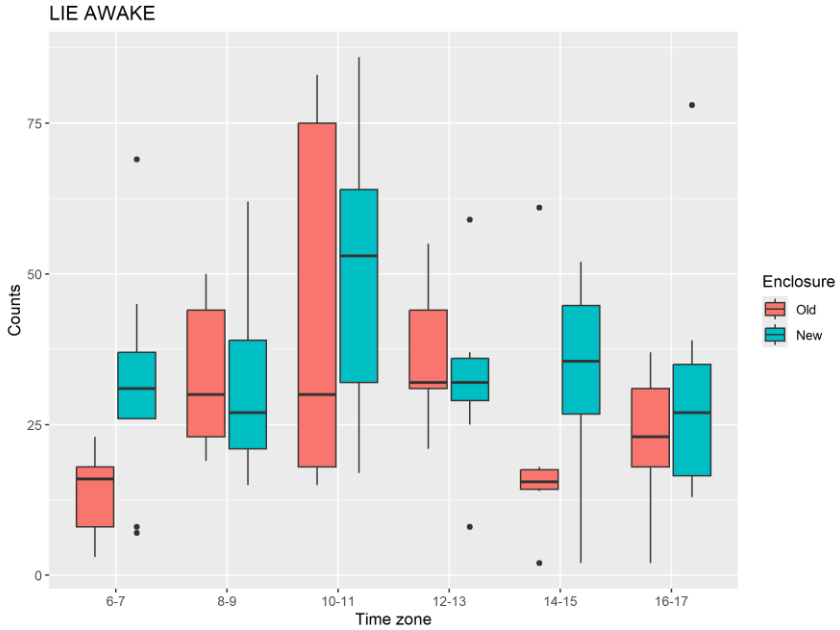


Figure 12. Boxplot of LIE AWAKE spared over time zones of old and new enclosures.

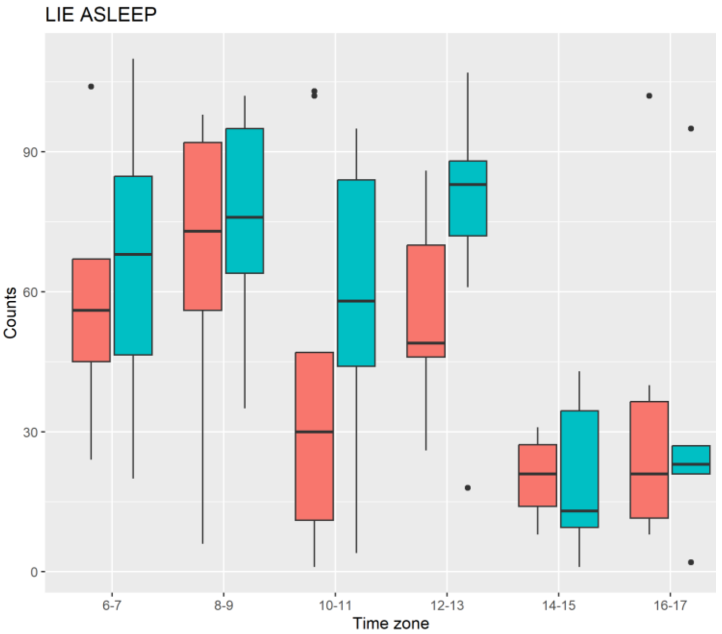


Figure 13. Box plot of LIE ASLEEP spared over time zones of old and new enclosures.

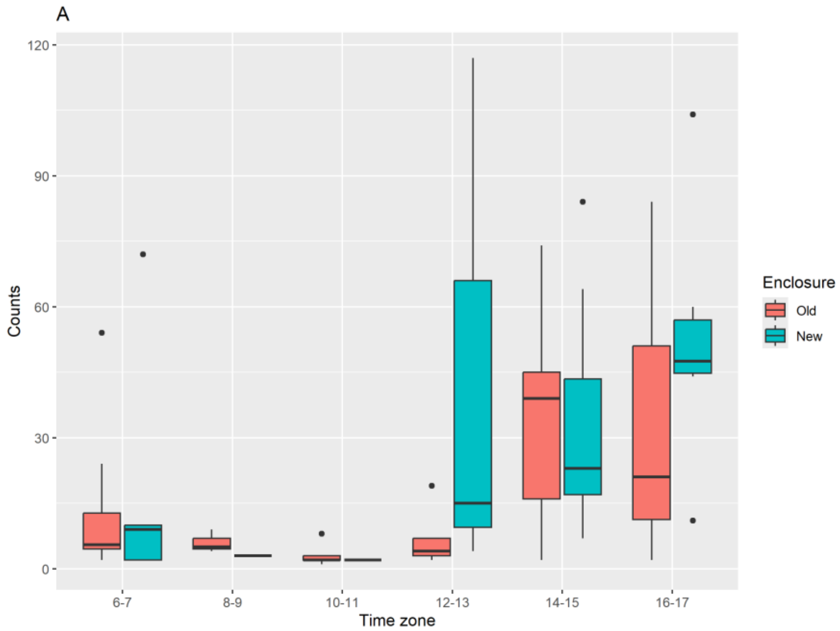


Figure 14. Boxplot of A spared over time zones of old and new enclosures.

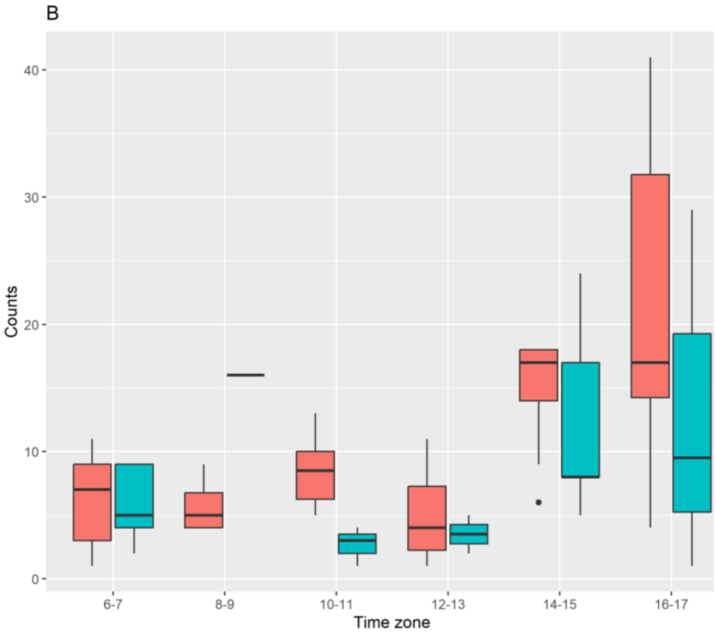


Figure 15. Box plot of B spared over time zones

of old and new enclosures.

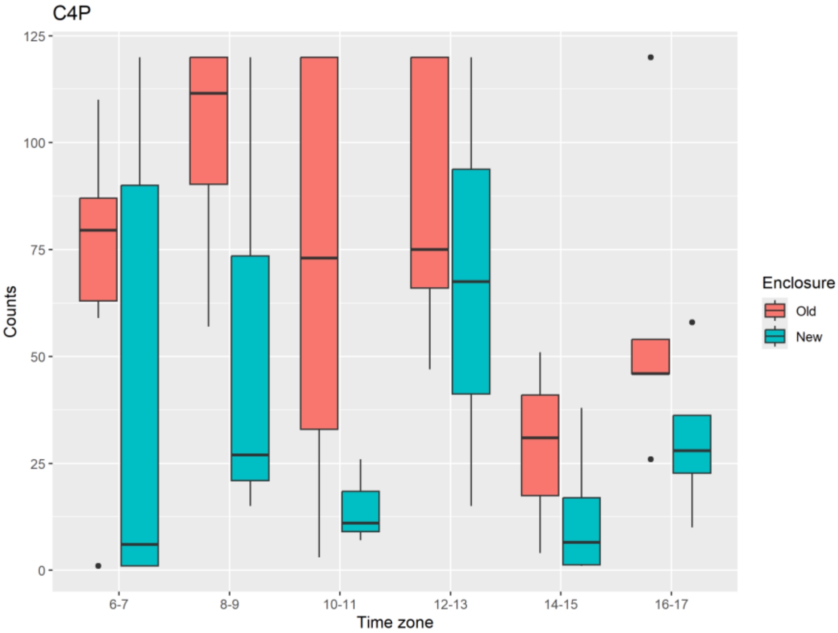


Figure 16. Boxplot of C4p spared over time zones of

old and new enclosures.

C (Figure 17) displays a reduction on zone usage on the new enclosure for all time zones except 8-9, reducing also its distribution. Old enclosure seems to follow an increase mean trend until noon and then a decrease trend until 16-17. ACTIVE behavior (Figure 18) has drastically decreased on hours 8-9 and 10-11 on new enclosure. This behavior shows two high counts, one at the start of the day (6-7) where then it decreases until a second rise at 14-15. RESTING counts on the old enclosure (Figure 19) displays two main peaks of counts at zone C4P and C, C4P alone holds 57.06% of the RESTING zone usage, followed by C which holds 29.77%, combined they account for 86.84% of the RESTING behavior zone distribution. On the old enclosure, RESTING zone distribution (Figure 20) presents three main zone usages for the behavior: C4P, I3P and J3F, each zone accounts for 15.02%, 14.87% and 3.26% respectively. In total the three zones account for 63.15% of the zone usage for this behavior.

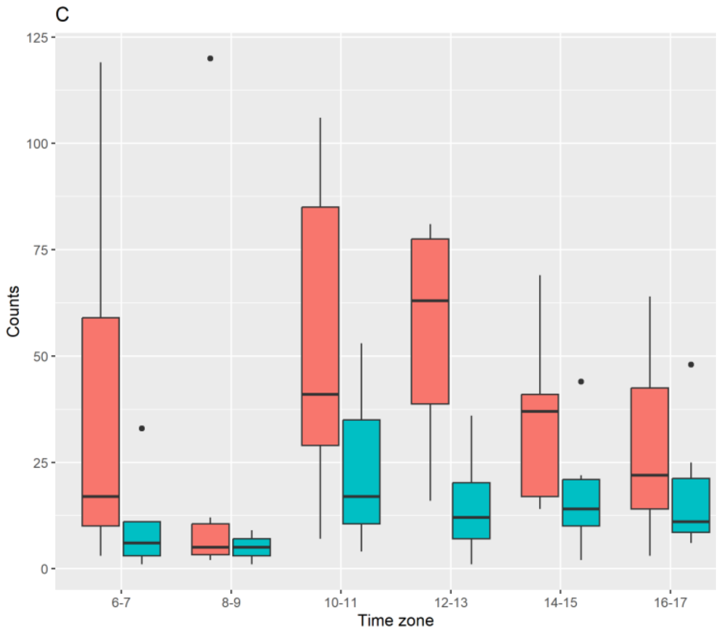


Figure 17. Box plot of C spared over time zones of new and old enclosures.

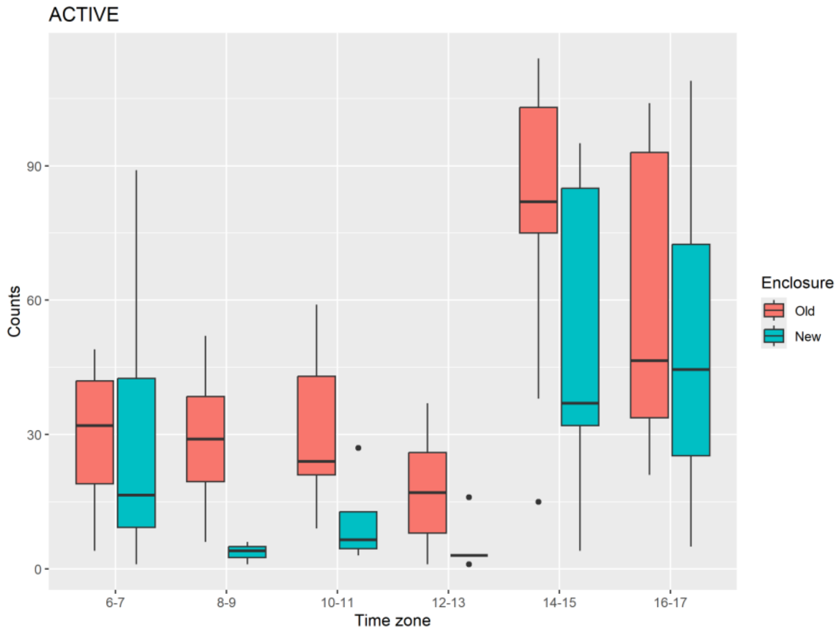


Figure 18. Box plot of ACTIVE spared over time zones of new and old enclosures.

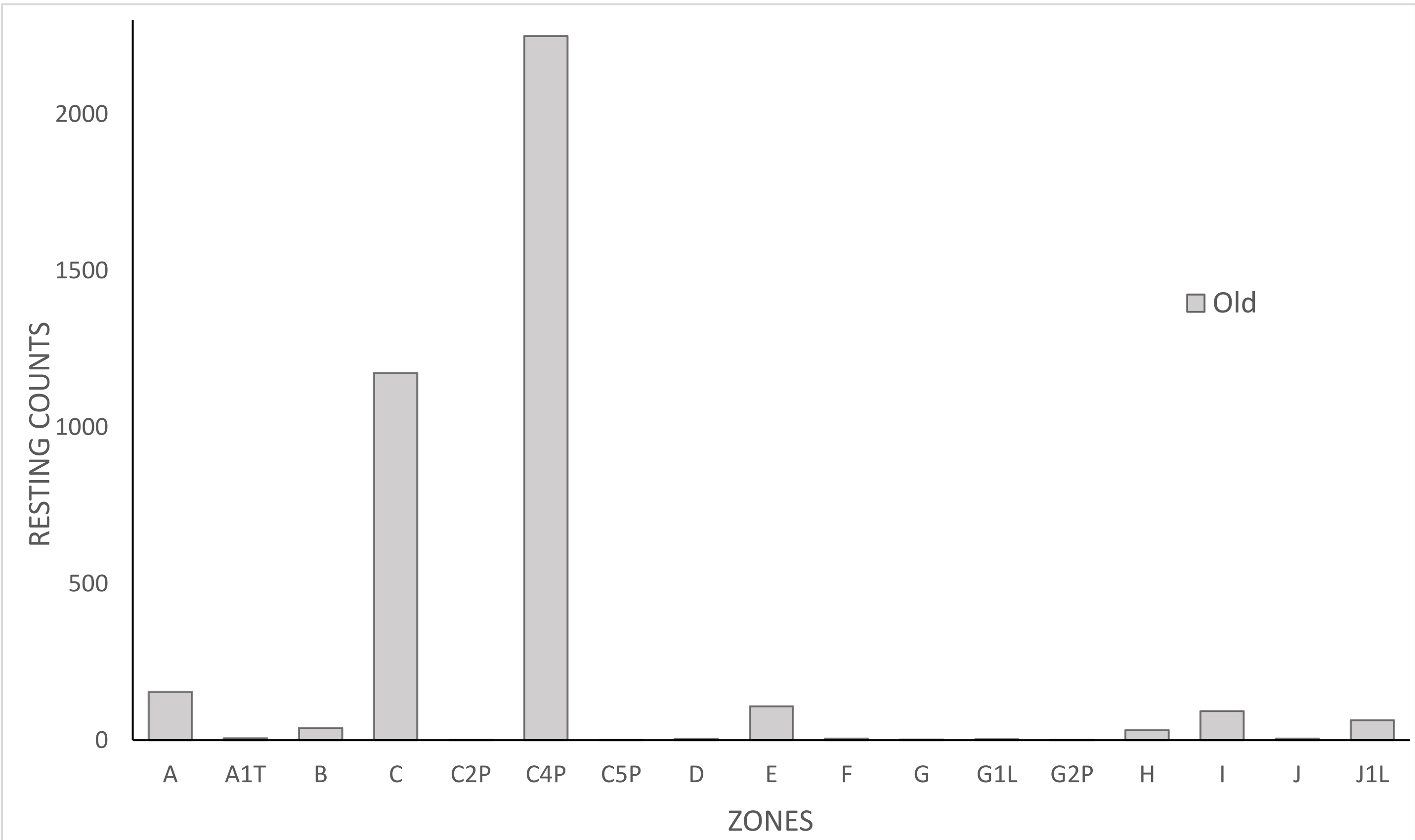


Figure 19. Bar plot of RESTING counts on the old enclosure.

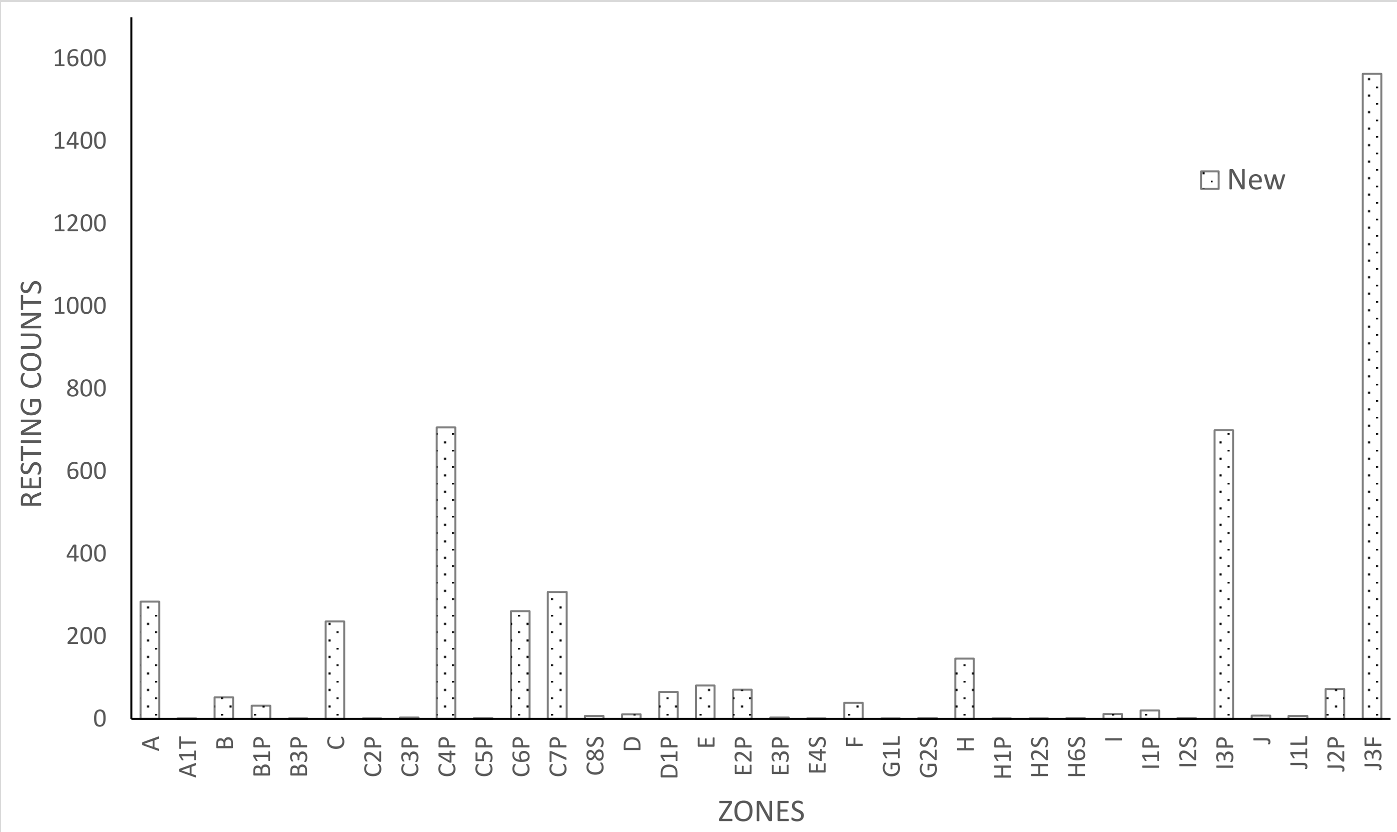


Figure 20. Bar plot of RESTING counts on the new enclosure.

## DISCUSSION

This study faces the main problem that only one ocelot was sampled, thus results of this study are anecdotic and may not be extrapolated nor compared to neither other captive ocelots nor wild ones. Still, this study may further push the narrative to address the enclosure instead of other variable stress factors such as visitor effect on reducing stereotypical pacing in captive animals, which remains an unclear connection with physiological stress.

Exploratory charts generated in this study suggest that action distribution on captive ocelots may follow a pattern (Figure 3, Figure 4), as both enclosures feature similar result distribution regarding actions performed in both enclosures. The enclosure had a significant effect on grouped actions carried on them (Figure 7): Resting increased in the new enclosure, active behavior decreased, and the subject was less visible in the new enclosure. Ungrouping these variables, we see that the reduction of active behavior is mainly due to the significant drop in counts on the variable pace, rise of resting behavior is mainly due to significant increase in counts of the variables lie asleep and lie awake (Figure 8). Not visible had a significant increase in the new enclosure, although when ungrouped and analyzed with more variables loses significance. Increase in not visible was expected as the new enclosure featured new and denser vegetation and many new features that permitted the ocelot to conceal from visitors and the observer, thus increasing the counts for not visible. Implementation of new zones shifted zone usage from two main zones on the old enclosure (Figure 5) to one main zone and seven minor zones on the new enclosure (Figure 6), diversifying the zone usage on the enclosure. Two of the new zones are highlighted for their zone usage: I3P and J3F, which greatly match with zone resting behavior counts (Figure 20). I3P is a cornered high platform located on the opposite side of visitors that brings a large view of the enclosure, J3F is a one-way entry fort that conceals the ocelot away from visitors, granting a safe space to rest without being seen. Carlstead *et al*. (1993a) found that hiding behavior in domestic cat (*Felis catus*) occurs in response to changes in the environment and to avoid interactions, thus enough rest areas in which cats can retire and stay hidden are essential for the cat's wellbeing (Rochlitz, 1999). Results on zone usage for the new enclosure show that high platforms and the fort built helped diversify zone usage of the enclosure and brought new resting areas that were preferred over the resting areas of the old enclosure (Figure 19), thus prompting the idea that those areas may be responsible for the increase of resting behavior of the ocelot, reducing its stereotypical pacing in consequence. Additionally, further studies should consider not only their features but their enclosure dimensions, as they affect stereotypical behaviors such as pacing (Bashaw *et al*., 2007). Additionally, this shift in zone usage reinforces the idea that higher platforms and a hiding spot were needed, as their usage can be seen as a method to determine whether features are positive or negative on the enclosure (Ross *et al*., 2009), in this case being positive. Comparison on grouped zones further prompt this idea (Figure 10), as a significant decrease in zone C and B leads to a significant increase on all the other zones except F, G and NV (Not visible). Ungrouped zones (Figure 9) only feature comparable zones that exist in both enclosures, thus I3P or J3F are not shown for comparison, still the significant reduction of C zone usage is due to the reduction of C4P and C, which are both significant decreases. B maintains the significant decrease as grouped and ungrouped variable and A features a significant increase as ungrouped variable. Grouped zones had significantly increased their zone usage, diversifying the subject's location on the enclosure because of the new enclosure features brought in during modifications, significant increase in grouped zones is lost when compared with ungrouped zones as these must be common in both enclosures, which leaves only maintained zones over the modifications comparable. Pace had an overall reduction in the new enclosure, specifically on hours 8-9, 10-11 and 12-13 where it was reduced drastically (Figure 11). 6-7 maintained the mean on both enclosures, 14-15 suffered a reduction in pace, although an increase on distribution, and 16-17 had an increase on pace. Before the enclosure modifications, pace seems to present high activity hours displayed on 14-15 and 16-17, and low activity hours displayed on 6-7, 8-9, 10-11, 12-13. These activity hours are opposite to the ones displayed by lie asleep (Figure 13), which feature high activity hours from 6-7 to 12-13, and low activity hours on 14-15 and 16-17. Additionally, lie asleep features an increase on all hours except 14-15 where it decreases, and 10-11 and 12-13 display an almost double of counts on the mean of the new enclosure. These hours (10-11, 12-13) seem to be associated with resting hours, specially 10-11, as lie awake displays a peak on this hour (Figure 12) in the new enclosure. These results fit with active behavior distribution (Figure 18), which shows two peaks of activity early in the morning (6-7) and after noon hours (14-15, 16-17) and one bottom at 12-13. Similar results were found by Weller & Bennet (2001), reporting two peaks of activity at 7:00h and 17:00h. Although ocelot activity is related to its major prey activity (Gray *et al*., 2024), which is erased during captivity, leading to an early peak of activity in the morning, and another in the afternoon, another possibility may be that human activity cycle may be also interfering on the captive animal's day-night cycle. Significant change in zone usage has been observed over the enclosures, C4P usage has dropped on all hours (Figure 16), specially on 8-9 and 10-11, with decreases over 50% each. C4P was highly associated with resting on the old enclosure and presented high values from the morning hours to noon (6-7 to 12-13), new enclosure featured new resting areas thus reducing its zone usage drastically except for 12-13. Similar results were seen on zone C, the second main zone where the ocelot displayed resting behavior on the old enclosure. C displays a reduction of counts on all hours on the new enclosure and a reduction on data distribution (Figure 17). The significant increase in zone usage of A in the new enclosure is mainly acquired on afternoon hours (Figure 14), 16-17 being the hour that increased the most usage of the zone. From noon to 16-17 zone A counts increase in comparison to the morning hours, this may be because of pacing being developed on these hours. B had a significant decrease in zone usage in the new enclosure which can be seen on all hours except 8-9 (Figure 15), where little variation is seen for the new enclosure due to only two replies containing B zone usage from the nine replies were gathered.

## CONCLUSIONS

Concluding this study, it appears that the new enclosure features, especially the higher platforms such as I3P and the fort built in the enclosure, provided new resting areas that were preferred over the ones used on the old enclosure, diversifying the zone usage of the enclosure and increasing its resting behavior, thus decreasing stereotypical pacing. The implementation of new resting areas is key to ensure the animal's well-being, as the lack of sufficient retreat space is a significant potential stressor for captive animals (Morgan & Tromborg, 2007).

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