TWEED SHIRE COUNCIL

Common planigale (*Planigale maculata*) monitoring at Koala Beach Estate 2020

January 2021

Revision History

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1	1/02/2021	Draft for review	David Hannah And Greg Lollback		
2	11/02/2021	Final	David Hannah And Greg Lollback	Marama Hopkins	Marama Hopkins

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Executive Summary

Tweed Shire Council has been surveying for planigales at Koala Beach Estate (KBE) since, 2007, as recommended by the Common Planigale Plan of Management (PPoM). The Design Unit (Engineering Division) undertook a seventh sampling event in November 2020. Sampling comprised of pitfall traps at 10 long-term monitoring sites within native vegetation in varying proximity to residences. As recommended by the PPoM, artificial cover objects (ACOs) were also employed to sample planigales. Artificial cover objects were established in August 2020 and after a settling period of five weeks were visited four times at fortnightly intervals before pitfall trap sampling commenced. During the four nights of pitfall trap sampling, two planigales were caught. While no planigales were detected under an ACO during the pitfall trap sampling period, one planigale was detected using this method in September. Overall, planigale encounter rate was low compared to past survey events, but not exceptionally low.

Planigale capture rate was too low in 2020 to be modelled. Hence, occupancy modelling that occurred in Hannah and Lollback (2016) is still relevant. That is, an unrealistically large amount of effort would be required to obtain a high level of precision in an occupancy estimate, which is required to detect population trends. Due to the low detection rate using ACOs, it is suggested that pitfall trapping is the best method to sample planigale at KBE. Additionally, because ACOs have already been established and sampling can occur rapidly, ACO sampling should occur once per month. Because a La Niña commenced in late 2020, it is suggested that the next pitfall trapping survey event occur in 2022 for the purpose of gaining more information about the species' ecology.

Introduction

Monitoring of flora and fauna within the Koala Beach Estate (KBE), Pottsville, was conducted both prior to and during various stages of residential development. Common planigales (*Planigale maculata*) have been recorded in the area since 1994, when land use was predominantly agricultural. Monitoring undertaken in response to proposed development detected the species in several locations (Callaghan *et al*. 2005). In response, the Common Planigale Plan of Management (PPoM) was written and adopted by Tweed Shire Council in 2005.

The overall objective of the PPoM was to monitor and maintain the status of the planigale population within KBE over the next 10 years (commencing in 2005) and beyond (Callaghan *et al*. 2005). The PPoM summarised results from targeted surveys undertaken in 2002 using pitfall traps, Elliott traps, hair tubes and artificial cover objects (ACOs). The PPoM also recommended management actions which included monitoring planigales within KBE into the future. Consequently, ten pitfall monitoring stations were established in spring 2005 targeting known and representative habitats adjacent to development at Koala Beach. Since 2005, there has been an additional five monitoring events; the last being spring 2015.

Planigales belong to the subfamily Sminthopsinae, which includes other small carnivorous marsupials such as dunnart, kultarr and ningaui. Common planigales have a broad distribution that extends from Cape York to Newcastle in eastern Australia (Redhead 1995; NPWS 2000; Menkhorst and Knight 2001). The species also occurs in the northern parts of Western Australia and the Northern Territory. Although occupied habitat over its distribution is wide, it appears to occur mostly in low-lying flat and undulating areas of the coastal plains in northern NSW (Gilmore and Parnaby 1994).

The common planigale is an unspecialised predator that forages mainly on insects, other invertebrates, small vertebrates, and occasionally nectar (Callaghan *et al*. 2005 and references therein). This species is generally most active from slightly before dusk to before sunrise, interspersed with rest periods and periods of high activity, and is capable of eating the equivalent of its own body weight in food daily (Van Dyck 1979). It has the ability to enter torpor in response to food deprivation (Van Dyck 1979) or cold weather (Morton and Lee 1978). Introduced predators of the common planigale include cats (Redhead 1995), dogs (Fleay 1981) and foxes (Glen *et al*. 2006). There is limited movement data available for common planigales although other members of this genus are widely recognised as having

a shifting home range in response to local climatic conditions and food resources (Denny 1982; Read 1982; Read 1988; Miller 1998).

The Common Planigale is currently listed as 'Vulnerable' on Schedule 1 of the NSW *Biodiversity Conservation Act 2016*. This elevated conservation ranking is based on the following: "Population and distribution suspected to be reduced; poor recovery potential; threatening processes moderate; ecological specialist". Principally, these threats arise from land use practices which reduce the extent of understorey vegetation and fallen log cover, particularly those adjoining water (NPWS 1998).

Aims

This report aims to summarise the results of Planigale monitoring that was undertaken in 2020 and provide context with previous monitoring events.

Methods

Monitoring took place within KBE. Ecological surveys within KBE commenced in 1994, before planning approvals. The Estate now consists of six residential stages, all of which are complete, covering an area of approximately 64 ha, with about 300 ha set aside as environmental zoned land. A seventh stage consisting of a large lot subdivision is located to the north of Stage 5 and except for access road development and a koala research station (construction commenced in 2020), has not had any further infrastructure development.

The topography of the study area consists of a combination of undulating hills and alluvial plains, the latter of which are seasonally inundated. The area drains to Cudgera Creek or to constructed (cane) drains which in turn drain to Cudgera Creek or via Christies Creek and then to Cudgera Creek. Geology is primarily metamorphics on hills supporting cleared and regenerating wet sclerophyll forests or Pleistocene sand sheets overlying peat and alluvium on plains dominated by swamp sclerophyll forests.

Vegetation is comprised of melaleuca and she-oak swampland, sclerophyll forest, and modified swamp and bushland (Figure 1) and the area was historically cleared and grazed prior to 1944. Development of the KBE commenced in 1996.

Survey Design

The Planigale pitfall monitoring sites were first established by others in 2005. Limited information could be obtained regarding the Planigale monitoring in 2005 other than the surveys were undertaken during a period of heavy rainfall in Spring 2005 and that no planigales were captured (pers. comm. R. James, 2007). At that time, ten pitfall trapping stations were established in similar locations to the current locations.

The ten survey sites were monitored again in 2007 and in 2012. Two of the original survey sites were excluded during the 2012 survey due to access constraints (refer to the 2012 monitoring survey report for further discussion). Two new sites were included in the 2013 monitoring survey; a site within Stage 7 and a site at Lower Grey Gum Gully. Both sites aimed to sample fringing habitat to development; Lower Grey Gum Gully has also been subject to assisted bush regeneration activities. These new sites in addition to the existing 8 original sites were surveyed annually from 2012 to 2015 resulting in a total of 6 monitoring events between 2005 and 2020 (Table 1). Site locations are shown in Figure 1.

Figure 1. Site locations with vegetation type within Koala Beach Estate.

Pitfall trapping was always conducted in spring and undertaken over a four-night period. Each pitfall line comprised between four (2005 and 2007 surveys) and five (2012 and all subsequent surveys) 20 litre plastic buckets measuring 28 cm in diameter and 40 cm deep. Buckets were buried into the ground, spaced at 4-5 m intervals and interconnected with a 40 cm high polythene drift fence. A summary of pit trapping effort per site and sites monitored during respective years is presented in Table 1.

At the completion of each trapping event, pitfall buckets were cleaned of all debris, sealed with a tightfitting lid, weighed down with rocks and soil, and left in-situ. Pitfall buckets were individually marked using high visibility flagging tape so they could be located during subsequent trapping events.

Pitfall traps were checked early on each morning of the survey with all fauna identified to species level using standard nomenclature and released approximately 10 m from the capture point. Fine and coarse litter and a foam pad were placed within pitfall buckets to provide shade and shelter for captured individuals. All pitfall traps were dry (i.e. no preservative added). Planigales captured during the survey were processed to record their age class, sex and weight.

The PPoM presented capture data from pitfall traps and ACOs. While the timing and extent of survey time for each method differed, it appeared that the ACOs had a higher capture rate compared to using pitfall traps. The PPoM recommended that future monitoring should incorporate ACOs. Hence, to test the efficiency of ACOs, ACOs were established at the 10 sites that are currently used for pitfall trapping and at site 9 in mid-August 2020. After consultation with John Callaghan, an author of the PPoM and an ecologist who first installed the ACOs within KBE, ACO setup in 2020 was similar to that used in 2004. That is, a piece of tin approximately 155 cm long and 83 cm wide was laid on the ground and secured in one corner by hammering in a star picket (Figure 2). Each ACO was located approximately 10 m away from a pit-line. One ACO was installed at site 9, which did not have an active pit-line installed. After a five-week settling period, ACOs were checked once every two weeks for a total of four times before pitfall trapping commenced. ACOs were also checked within the trapping period and once after the trapping period.

Table 1. Summary of planigale pitfall trapping monitoring effort (PTN) between 2005 and 2020, Koala Beach Estate. – denotes no trapping at site. PTN = Pitfall trapping nights calculated as the number of pitfall buckets per site: 2007 survey = 4 pits per site x 10 trapping sites x 4 trapping nights = 160 PTN; 2012 survey = 5 pits x 8 trapping sites x 4 trapping nights = 160 PTN; 2013-2020 survey = 5 pits x 10 trapping sites x 4 trapping nights = 200 PTN.

Site Number	**2005**	**2007**	**2012**	**2013**	**2014**	**2015**	**2020**	**Total effort per site**
1	16	16	20	20	20	20	20	132
2	16	16	20	20	20	20	20	132
3	16	16	20	20	20	20	20	132
4	16	16	20	20	20	20	20	132
5	16	16	-	-	-	-	-	32
6	16	16	20	20	20	20	20	132
7	16	16	20	20	20	20	20	132
8	16	16	20	20	20	20	20	132
9	16	16	-	-	-	-	-	32
10	16	16	20	20	20	20	20	132
11	-	-	-	20	20	20	20	80
12	-	-	-	20	20	20	20	80
Total effort	**160**	**160**	**160**	**200**	**200**	**200**	**200**	**1280**

Figure 2. A lifted artificial cover object (ACO). Note the dead vegetation that is located under a resting sheet of tin. This ACO is located at site 8.

Analysis

The frequency of planigale captures for each trapping session was correlated against rainfall for the previous three and six months using the Pearson method (Zar 1998). Rainfall was taken from the Tweed Heads Golf Club, which is situated approximately 17 km away from the study site. The weather data was downloaded from www.bom.gov.au.

Single-season occupancy modelling (MacKenzie *et al*. 2005) of presence/absence data has been conducted on data from 2007, 2013 and 2015 (Hannah and Lollback 2016). Multi-seasonal occupancy modelling was attempted on the data from 2007 to 2015, but a lack of detections resulted in parameter estimates that were unreliable. Additionally, occupancy modelling was not conducted on 2020 data due to the lack of detections. Therefore, the occupancy analysis results presented in Hannah and Lollback (2016) have not changed.

Results

Pitfall trapping

Pitfall trapping occurred from 23rd November to 28th November, 2020. One adult female planigale was caught at site 8 on day 1 and one adult male planigale was caught at site 4 on day 2. No other planigales were caught during the trapping period. Capture results are compared with previous years in Table 2. With an average capture rate of 6.2 animals and a coefficient of variation equalling 75.1% in previous years, a capture rate of 2 animals per session is not extraordinary.

Table 2. Site capture frequencies for trapping sessions at Koala Beach Estate.

	2007	2012	2013	2014	2015	2020	Total
1. Dunghir Reserve	6	0	0	0	1	0	**7**
2. Swamp Oak	2	0	0	0	0	0	**2**
3. Control West	1	0	0	0	1	0	**2**
4. Control East	0	0	0	0	0	1	**1**
5. Barrage	1	0	-	-	-	-	**1**
6. Stage 5/6 Gully	0	3	0	1	0	0	**4**
7. Link Rd	0	0	0	0	0	0	**0**
8. GBC	0	0	2	0	3	1	**6**
9. Stage 7 Rainforest	0	0	-	-	-	-	**-**
10. Blackbutt	0	0	1	0	1	0	**2**
11. Lower GGG	-	-	0	0	5	0	**5**
12. Stage 7 New	-	-	2	0	1	0	**3**
Total	**10**	**3**	**5**	**1**	**12**	**2**	**33**

Only two sites have not recorded planigales over the trapping period: sites 7 and 9. Figure 3 shows relative occurrence of planigales between seasons. There were three sites where planigales were caught in only one out of six seasons, three sites where planigales were caught in two seasons out of six seasons and two sites where planigales were caught in half the sampled seasons.

Occupancy modelling

Occupancy modelling results are shown in Hannah and Lollback (2016). To summarise, chosen models comprised of constant occupancy between sites and a constant detection rate throughout the survey period. Estimated occupancy (SE) for 2007, 2013 and 2015 was 0.37 (0.20), 0.53 (0.40) and 0.69 (0.20), respectively. Corresponding estimated detection

rate (SE) was 0.34 (0.17), 0.19 (0.16) and 0.40 (0.12). Estimated occupancy and detection rate is likely to be an overestimate because other years with fewer detections could not be analysed. Further occupancy analysis indicated that between 26 and 960 sites would be required to reach an occupancy precision level of 0.1 (SE), given a similar range of occupancy and detection rates displayed over the years of sampling at KBE.

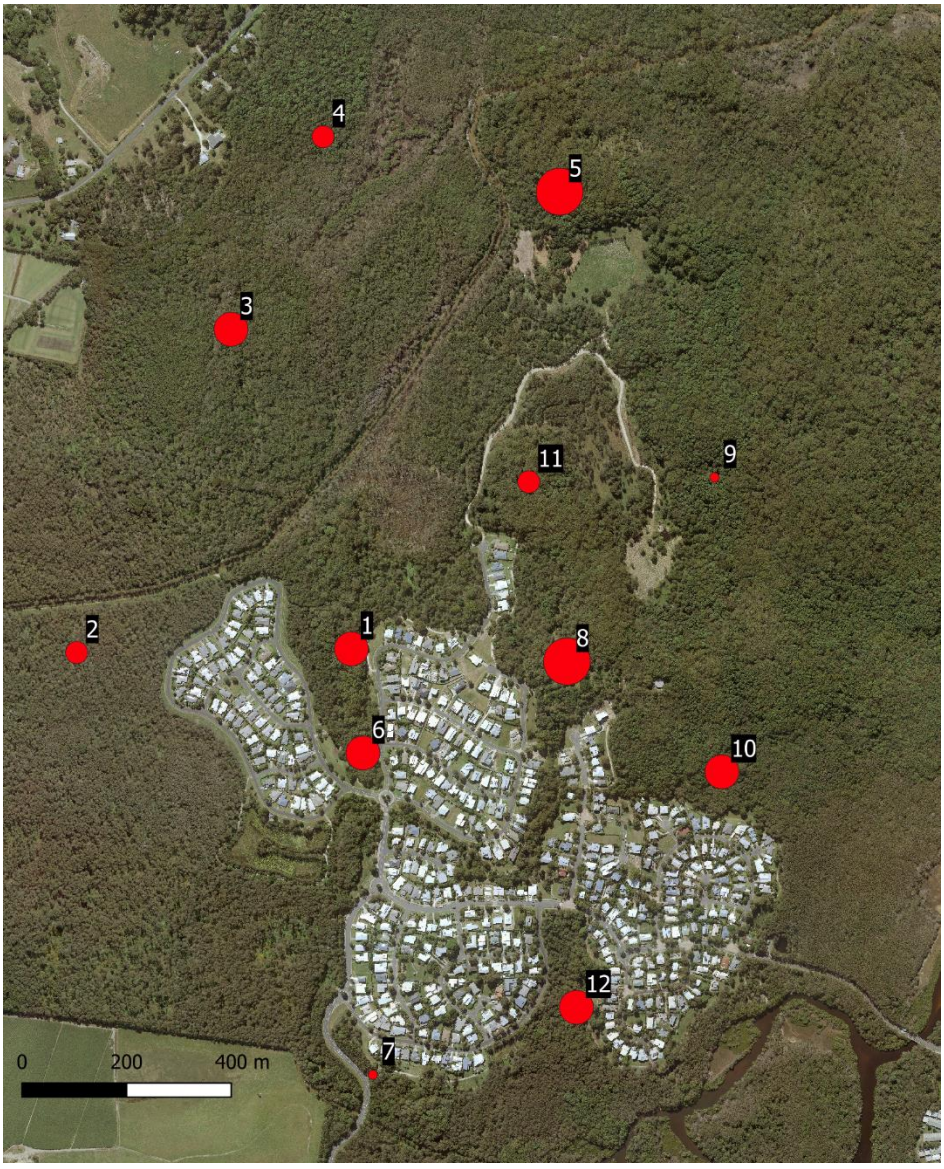

Figure 3. Proportion of trapping seasons that planigale were caught at each site. There are two sites without captures (sites 7 and 9) and other capture proportions are 1/6, 1/3, and 1/2. Site identification numbers correspond with those shown in Tables 1 and 2.

Correlation analysis

There was no correlation between the total number of planigale captures and three-monthly (r = 0.46, P = 0.35) or six-monthly (r = 0.02, P = 0.97) accumulated rainfall prior to sampling.

By-catch

By-catch for the 2020 sampling period is included in Appendix 1. Species caught include *Cryptoblepharus virgatus*, *Lampropholis amicula*, *L. delicata*, *Limnodynastes peronii*, *Mus musculus*, *Pseudophryne coriacea*, *Ramphotyphlops* sp., *Rhinella marina* and *Saiphos equalis*.

Artificial Cover Objects

Artificial Cover objects (ACOs) were checked three times in roughly fortnightly intervals before pitfall trapping began and three times during the pitfall sampling. A post-pitfall survey of the ACOs also took place ten days after pitfall trap sampling finished. See Appendix 2 for a complete detection history using the ACO methodology. One adult male planigale was detected using this method, at site 4 during the first round of ACO surveys on 21st September. Note that a male planigale at site 4 was also found when pitfall trapping. No other planigales were detected at sites using ACOs. By-catch detected using ACOs is listed in Appendix 3.

Discussion

There were two planigale caught at KBE over four nights of sampling using pitfall traps in late November, 2020. Methodology used was consistent with that used since 2007. The number of planigale caught is low given the capture rate of previous years, but the results are not exceptionally low. Sampling from previous years display a wide variation in capture rate. Generally, detection rate of the planigale is low.

The low detection rate across sampling periods makes it hard to draw conclusions about species population trends, as discussed in Hannah and Lollback (2016). The species is typically hard to detect and even with a low capture rate this year, the KBE trapping event still has the highest capture rate in scientific literature (Table 3). To summarise, the variable capture rate of planigale could be because the common planigale likely has a small home range, the potential to go into torpor and be influenced by ambient temperatures (Morton and Lee 1978) and has a short lifespan with a large potential reproductive output (Aslin 1975). That is, biology and ecology of the common planigale is reflected in a variable capture rate. Occupancy analysis undertaken in Hannah and Lollback (2016) indicates only an unrealistically high sampling regime would overcome these challenges.

Table 3. Details of studies that captured the Common Planigale. All animals were caught in pitfall traps. Capture rate = number of Planigales caught/PTN. PTN = Pitfall trap nights = number of sites x number of pitfall traps per site x number of nights surveyed. * = studies conducted within or close to the Tweed Shire.

Study	Number of sites	No. of pitfall traps per site	PTN	No. Planigales captured	Capture rate
This study*	10-12	4-5	1280	33	0.03
Catling *et al*. 1997*	51	8	1652	2	0.003
Lewis 2005*	15	5	600	3	0.005
Milledge 1991*	15	34	2040	7	0.003
Garden *et al*. 2007	59	5	1650	2	0.001
Legge *et al*. 2010	≤147	8	3528	56	0.01

The common planigale has been recorded at 10 of the 12 sampled sites within KBE over the years of sampling. While habitat type does vary, most sites are located close to water or lowlands that hold water, which the species appears to prefer (Gilmore and Parnaby 1994). The only two sites where the species has not been recorded are site 9, which is within a rainforest gully and site 7, which is adjacent a road (<20 m away), but within suitable habitat that is in close proximity to water. It is likely that future sampling will record patchy records with occurrences recorded over the range of sites, with less confidence of the species being recorded in sites 7 and 9.

Within the PPoM, ACO sampling recorded 42 captures over a period of four months, which is a very high number of captures. While there were 16 ACO sites surveyed in 2004, capture rate from that study could not be estimated because overall effort is unknown. If sampling occurred for the whole four months on a weekly basis, the planigale capture rate would be 0.15. If sampling occurred fortnightly, the capture rate would be 0.29. The capture rate for planigales using ACOs in 2020 is 0.01, which is lower than the long-term pitfall trap capture rate. Furthermore, no planigales were detected under ACOs when pitfall trapping was running in 2020.

Artificial cover objects have been used extensively to sample reptiles and amphibians (Hampton 2007) and have been rarely used to capture small mammals in Australia (Homan 2012; Murphy 2016). A benefit of ACOs is the effort required for setup and maintenance, which is substantially lower compared to a pitfall trap line. Examples of use in Australia to catch mammals have been in vegetation with low tree cover, which makes an ACO an attractive alternative for a small mammal with a long list of potential predators. However, the

sites at KBE have canopy cover and ground cover provided by grass, bark, logs and leaf litter. Grazing has been eliminated from the area and fire frequency appears to be low. It is likely ground cover has increased in some sites since ACO were first used in 2004, which may have reduced the attraction of the ACOs. Additionally, there were 16 ACO sites in 2004, while there were 11 sites used in 2011. Another possible reason trapping was better in 2004 may be because the trapping season in 2020 occurred soon after a harsh drought, while the annual rainfall in 2003 was 1,986 mm, which was above average rainfall. The annual accumulated rainfall for 2019 was 961 mm. Being an insectivore, it is likely planigale abundance declined during the drought.

Recommendations

Recommendations stated in Hannah and Lollback (2016) apply to the current situation. With stable environmental management and a species that has a low detection rate, there is little knowledge gained by frequently surveying for the common planigale using intensive survey methods such as pitfall traps. It is suggested that sampling re-occur close to the end of the current La Niña event. La Nina events often run for more than one summer (see http://www.bom.gov.au/climate/enso/lnlist/) and to account for population response lag, it is recommended that sampling using pitfall traps reoccurs in 2022. While it is difficult to quantify the effects of rainfall on occupancy rates, large-scale events such as La Niña may indeed influence the species. Sampling in 2022 may help elucidate influences on planigale occupancy rates.

The current results do not suggest replacing pitfall trap sampling with ACOs. While ACOs have logistic appeal, recent capture results suggest pitfall trap sampling is the best way to catch planigales. To fully assess the value of using ACOs to monitor planigales at KBE, at least five more shelters (more if possible) should be installed and monitored on a regular basis over at least two years. Longer and regular monitoring may also provide data on climatic or stochastic events such as rainfall, flooding or fire. Monitoring intensity can easily change after such events because of the low effort required to sample ACOs.

In conclusion, the population of planigale at KBE survived a severe drought and is extant at KBE. It is recommended that sampling of pitfall traps occur in 2022 and sampling of established ACOs occur one per month.

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Appendix 1. By-catch caught in pitfall traps 2020

Species name	Common name	Sites caught	Frequency caught
Cryptoblepharus virgatus	Wall skink	3	2
Lampropholis amicula	Friendly sunskink	1, 7, 8	5
Lampropholis delicata	Garden skink	All sites	14
Limnodynastes peronii	Striped marsh frog	1, 2, 3, 4, 6, 11	11
Mus musculus	House mouse	3	1
Pseudophryne coriacea	Red-backed toadlet	10	1
Ramphotyphlops spp	Blind snake	1	1
Rhinella marina	Cane toad	1, 3, 6, 7, 8, 10, 11, 12	19
Saiphos equalis	Three-toed skink	4	1

Appendix 2. 2020 planigale capture history using artificial cover objects

Site	21/09	12/10	26/10	09/11	25/11	26/11	27/11	08/12
Site 1	0	0	0	0	0	0	0	0
Site 2	0	0	0	0	0	0	0	0
Site 3	0	0	0	0	0	0	0	0
Site 4	1	0	0	0	0	0	0	0
Site 6	0	0	0	0	0	0	0	0
Site 7	0	0	0	0	0	0	0	0
Site 8	0	0	0	0	0	0	0	0
Site 9	0	0	0	0	-	-	0	0
Site 10	0	0	0	0	0	0	0	0
Site 11	0	0	0	0	0	0	0	0
Site 12	0	0	0	0	0	0	0	0

Appendix 3. 2020 artificial cover by-catch

Species	Sites
Cacophis krefftii	3, 6
Cryptophis nigrescens	3
Lampropholis delicata	1, 3, 7, 10
Rhinella marina	3, 12
Tiliqua scincoides	1

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