

Monitoring of the Western Ringtail Possum following Clearing along the Vasse Diversion Drain, Busselton

Year One

January 2021 – January 2022



Image 1: Western Ringtail Possum adult with juvenile using rope bridge (J Bamford)

Prepared for: Water Corporation
PO Box 210,
Mandurah, WA, 6210

Prepared by: Amanda Bamford, Joshua Bamford & Jake Bamford
M.J. & A.R. Bamford Consulting Ecologists
23 Plover Way
Kingsley, WA 6026



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Executive Summary

The Water Corporation widened the Vasse Diversion Drain in Busselton in 2020 - 2021 for flood mitigation, and since the conservation significant Western Ringtail Possum occurs in remnant vegetation that was impacted by drain widening, Bamford Consulting Ecologists was commissioned to undertake the displacement of possums prior to clearing along the drain in two areas: a northern area between Queen Elizabeth Avenue and the Busselton Bypass Road, and a southern area near the Golf Course (VROS). BCE was also commissioned to conduct ongoing monitoring of the population and their use of installed shelters and rope bridges over a ten-year period, as a condition of the approval of the drain widening project. This report covers the first year of post-disturbance monitoring (January 2021 – January 2022).

Of the 43ha project area surveyed in 2019 prior to the project's approval, where 206 dreys and at least 66 possums were recorded, only 1.9ha was cleared in 2020. Forty-one dreys and hollows and 36 possums were identified in the impact area prior to clearing. Prior to and during clearing in November 2020, all possums were successfully relocated into adjacent vegetation without mortality or injury. Of the 41 dreys found, 23 were able to be relocated, and a further 63 artificial shelters (dreys and hollows) have been installed, making a total of 87 new shelter locations (a commitment was made to provide 82 additional shelters). Rope bridges were also installed along the north side of the drain adjacent to College Avenue and Scott Street, to increase connectivity and reduce the need for possums to go to the ground to travel between trees, where they are at risk of predation by foxes, cats and dogs.

Since most possums could remain within their home ranges, handling was avoided where possible to minimise stress. In most cases, animals could be displaced into adjacent vegetation without handling them. Trees were checked and animals displaced immediately prior to clearing, to avoid them returning to the clearing area. Eleven possums had to be hand-captured and moved; four were moved without touching them, while contained within or holding onto the top of an artificial or natural drey; two were moved while within hollows; and two were moved by encouraging them to climb onto the net and carrying them to safety while perched on top of the net. The remaining 17 were displaced by gently disturbing them from their dreys and herding them to adjacent, safe trees. Clearing debris was then removed immediately to prevent animals trying to return.

Six monitoring periods were undertaken during Year One; January, March, April / May, August, September 2021, and January 2022. There were 38 possums recorded in the area adjacent to works in January 2021, following the disturbance. The numbers remained remarkably stable, with a minimum of 31 recorded in March 2021, which is consistent with the dispersal of juveniles, and had increased to 45 in January 2022. This increase may be due to the provision of additional shelters, or a result of the wet spring, which may have improved the quality of food plants available to the animals. It seems likely that many of the animals found during monitoring are those who were displaced from the impact area but have stayed within their remaining home ranges.

In January 2021 14 possums were found on branches, not associated with shelters, however by January 2022, although several animals were at the entrances of shelters or outside because of hot weather, all were associated with shelters.

Both Brushtail and Western Ringtail Possums were recorded using rope bridges, indicating that the design is successful. Future monitoring of rope bridges will determine which bridges are used most often, and the extent to which they are contributing to connectivity.

Relocated dreys were used initially then most became disused, except for two, which were still in use in September 2021. One of these was still being maintained in January 2022.

Artificial shelters were used consistently throughout the year. Twelve to 18% of possums located during monitoring periods were using artificial shelters. The lowest usage was during the September monitoring period, when mothers have large joeys, and probably prefer natural dreys which they can 'extend'. Artificial 'short hollows' were the most commonly occupied (80% were used in at least one monitoring period) with plastic filter buckets also being surprisingly popular (60%). Coconut-lined dreys were used until possums harvested the coconut for use elsewhere, after which they were less attractive. Artificial shelters lined with paperbark and coconut appear more attractive and lasted longer than coconut alone, however additional trials will need to be made to confirm this due to the small sample size (only 2 dreys due to the availability of sustainably sourced paperbark)

Unlike the results of monitoring along the Vasse Diversion Drain between Queen Elizabeth Avenue and the Busselton Bypass Road, possums have not been detected in any of the artificial dreys at the VROS since March 2021. It is likely that fragmentation of the area has made it unsuitable for possums, and this is likely to continue unless revegetation occurs in collaboration with the farmers adjacent to the site.

Tranen Revegetation SouthWest is continuing revegetation work, which will provide increased food and connectivity. Once vegetation has established, it should also provide additional locations for natural dreys to be constructed, and possibly result in an increase in the population of possums. Additional dreys and an increase in possum numbers should be detectable within the ten-year monitoring timeframe for the project.

Relocated natural dreys performed an important function immediately following displacement of the possums but will need replacement as they deteriorate to maintain the numbers of additional dreys provided, as committed to as part of approvals for the project. While this is a requirement, the possums are now constructing their own dreys, so it will be interesting to see if increasing the numbers of artificial dreys increases usage of them.

Revegetation should proceed as quickly as practical to ensure the animals continue to have sufficient food resources to support them during lean times. The increased connectivity provided by plantings will also allow possums to move between the population along the drain and the rest of Busselton, improving the species' long-term viability in the area.

Results of the first year of monitoring suggest that the displacement and disturbance due to drain works had not greatly impacted possum numbers, that artificial shelters are helping to

house the population and that rope bridges are of a suitable design to keep possums off the ground and improve connectivity. Future work will help to better assess these initial findings, and effects of revegetation work, which is likely to provide significant positive impact within the next ten years.

INTRODUCTION

The Water Corporation manages a network of drains in the vicinity of Busselton and in October 2020 – April 2021 works were undertaken to widen the Vasse Diversion Drain for flood mitigation. This widening affected some vegetation alongside the drain, but not the full width of this vegetation. An Environmental Impact Assessment conducted by GHD (2017) found that the Western Ringtail Possum *Pseudocheirus occidentalis*, which is a listed conservation significant species (Critically Endangered under both the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Western Australian Biodiversity Conservation Act 2016*) occurred in vegetation adjacent to the drain. Widening of the drain could affect >0.5ha of what might be primary corridor habitat for the species (*sensu* DEWHA 2009) and based on EPBC Act Policy Statement 3.10 (DEWHA 2009), this would be a significant impact. Therefore, the Department of Biodiversity, Conservation and Attractions requested the Water Corporation provide more information on the distribution and abundance of this species along the drain. Bamford Consulting Ecologists was commissioned to undertake this work in 2019.

The Vasse Drain Diversion Upgrade project was assessed Bilaterally by the DWER Native Vegetation branch under Part V of the EP Act [WA] and by AWE under the EPBC Act 1999 [Cwth] and the project was referred under the *EPBC Act* (Cwth). The project is a ‘*Controlled Action*,’ so all activities must be undertaken in compliance with conditions set in the EPBC 2017/7932 Approval Conditions.

Following surveys of the 43ha project area in March 2019, where 206 dreys and at least 66 possums were recorded, areas were revised and only 2.16ha was identified as the impact area to be cleared in 2020.

A Fauna Management Plan for the Vasse Diversion Drain Upgrade was developed by Bamford Consulting Ecologists as part of the Approvals process and provides a detailed description of commitments and approach, as well as a summary of current research on Western Ringtail Possums and their requirements (Bamford et al., 2020). Implementation of the plan commenced in October 2020, prior to works commencing.

The Water Corporation committed to revegetation to re-establish and improve connectivity of vegetation, and the installation of rope bridges and fauna shelters, including ten years of maintenance and monitoring with the aim that any long-term effect of the works will be a positive one. Bamford Consulting Ecologists was commissioned to undertake relocation and subsequent monitoring of fauna in response to the disturbance and amelioration activities. The agreed approach was to gently displace the animals from the clearing zone but keep them within their home ranges where possible. By avoiding or minimising handling, personnel were able to keep stress to the animals to a minimum. Cowan et al. (2020), links the poor survival of relocated animals to the stress associated with their capture, handling and transport. Studies of Western Ringtail Possums report high mortality of relocated animals (Clarke, 2011, Thompson & Thompson, 2009). Transfer of parasites (Dunlop & Watson, 2022) can also occur when animals are moved out of their home ranges. Since the disturbance

was only to affect a narrow area, displacement, rather than translocation was the preferred option.

Western Ringtail Possums are nocturnal and shelter in tree hollows, or build shelters called ‘dreys’ in which they sleep during the day. Dreys are clumps of twigs and leaves that are generally quite conspicuous and placed in the mid canopy of trees (See Images 8 & 9 in Appendix 1). A possum may have five to eight dreys across a home range of 0.5 – 1.5ha, and home ranges overlap (Jones, 2000).

Clearing works were carried out from October to December 2020 and construction was completed in April 2021. Artificial shelters were installed, Western Ringtail Possums and other fauna were displaced from the clearing areas in October and November 2020, and a survey was carried out in January 2021 to make a preliminary assessment of the shelters and the possum population following displacement. Monitoring of possums and their use of shelters and rope bridges has continued during 2021 – 2022 and this report covers Year One of the study; the period of January 2021 to January 2022.

Over its ten-year period, the monitoring program aims to determine:

- the effects of disturbance on the numbers and distribution of Western Ringtail Possums adjacent to the disturbance areas along the Vasse Diversion Drain.
- Whether artificial shelters are used by possums and can contribute to the maintenance of the population, post disturbance
- Which shelter designs are preferred by Western Ringtail Possums,
- Whether rope bridges will be used by possums and are therefore effective in improving connectivity in a disturbed landscape
- Whether revegetation is being accessed by possums and results in increased habitat for the species during a ten-year period.

This Year One report analyses data collected to date to inform these questions.

METHODS

Description of Project Area

The project area consists of land along two parts of the Vasse Diversion Drain (Figure 1). The northern area lies between the Busselton Bypass Road in the south and Bussell Highway in the north and includes some extra land in small reserves to the south of the drain. Much of the vegetation consists of Peppermint *Agonis flexuosa* forest and woodland, with varying proportions of Marri *Corymbia calophylla*, Flooded Gum *Eucalyptus rudis*, Jarrah *Eucalyptus marginata*, Coojong *Acacia saligna*, Swamp Banksia *Banksia littoralis*, Modong *Melaleuca priessiana* (Saltwater Paperbark *Melaleuca cuticularis* where the drain crosses The Broadwater), Spearwood *Kunzea* sp., and occasional other tree and tall shrub species. The understorey is generally in poor condition. Vegetation is in best condition on the south side of

the drain, between Queen Elizabeth Avenue and the Busselton Bypass Road. Open areas of weedy grasses are present, although these are being managed as part of rehabilitation.

The southern area lies adjacent to the Busselton Golf Course, east of Chapman Hill Rd and includes land on the eastern side of the drain, as well as encompassing a section of the Vasse River. This is the site of the Vasse River Overflow Structure (VROS). The vegetation is generally degraded and in places parkland cleared and grazed, with an open woodland of Peppermint and Flooded Gum, some planted, non-native eucalypts and some riparian woodland along the Vasse River. The trees which provided some connectivity through the site were removed for construction of the VROS, so the remaining vegetation is fragmented (see Figure 1c).

The total area cleared was 1.9ha (see Figure 1 a, b and c), however the project area for this study also includes sites in adjacent bushland and rehabilitation areas into which artificial shelters, relocated dreys and rope bridges have been installed, and will increasingly include the rehabilitation areas as plantings mature and become attractive to possums.

(a)



(b)



(c)



Figure 1 (a,b,c). The project areas. The northern site (a and b) stretches from Busselton Bypass Road in the south to Queen Elizabeth Avenue in the north. Figure 1(c) shows the Vasse River Overflow Structure (VROS) site. Areas that were cleared are hatched yellow.

Approach

This report covers the first year of a ten-year study following the disturbance and relocation of possums due to clearing. All relocation work was carried out in accordance with the Fauna Management Plan for the Vasse Diversion Drain Upgrade (Bamford et al., 2020) and focussed on minimal disturbance to the animals. During clearing, animals had been displaced as little as possible, ideally within their existing home ranges, while moving them from the impact area. In most cases, this was able to be done without capturing the possums, to minimise disturbance and stress to the animals. Thirty-six possums were displaced from the clearing area during operations. All animals were relocated successfully without injury or mortality. In most cases, the animals were moved no more than 20 metres and in some cases as little as five metres. Details of the displacement techniques employed are given in Bamford et al. (2021).

Since most animals were not handled, they were not individually marked, so assessment of the population is undertaken by recording numbers and locations of animals and dreys. Given the sedentary nature of most of the animals, this is likely to be an accurate measure of the impact due to clearing and means that disturbance of the animals (and confounding of the results by the impacts of handling) has been kept to an absolute minimum.

Rope bridges are monitored using motion sensitive cameras, observation and scat records to search for evidence of use.

Survey methods

Monitoring is undertaken by Amanda (Mandy) Bamford (B.Sc. Hons. Zool.) and Mike Bamford (B.Sc. Hons. Ph.D. Biol.). Mandy and Mike have many years of experience in management of the Western Ringtail Possum (hereafter referred to as possum). The work was carried out under DBCA Permit numbers TFA 2020-0149 and FR28000164, undertaken with reference to the Fauna Management Plan for the Vasse Diversion Drain Upgrade (Bamford et al, 2020) and informed by observations in Bamford et al (2021). Field assistance was provided by Jake Bamford (B.C.I.) and Joshua Bamford (B.Sc. B.Mus. Hons. M.A.), and Data Management was undertaken by Joshua Bamford.

Possum monitoring was carried out in January, March, April / May, August, and September 2021, and January 2022. Monitoring was carried on fine days once the sun was up to protect camera equipment and minimise disturbance to possums. Previous experience (Bamford pers. obs.) is that possums are often only dozing on overcast days or at first light and are easily disturbed. In bright sunlight they are usually firmly asleep and dreys may be checked without disturbing them. All artificial shelters and relocated natural dreys were checked with binoculars or a pole camera to assess their status and check for possums. Natural dreys, hollows and possums sighted out of dreys adjacent to the cleared area were also recorded opportunistically. Recognising that it was important to minimise disturbance during monitoring, the pole camera was used for the minimal time, and just close enough to check for activity and take a photo, to disturb the animals as briefly as possible. In some natural dreys, it was not possible to access the drey using the pole camera without disturbing the animal, in which case the drey was checked using binoculars.

Handling of Fauna

No fauna requires handling as part of the post disturbance monitoring phase of the project. Checking of dreys is done with minimal disturbance and cameras are unbaited, so do not alter the behaviour of the animals. Bamford Consulting Ecologists operates under Scientific Use Licence U261 2021-2022 and if animals require handling for any reason, personnel use techniques outlined in the Fauna Sampling Manual by Bamford et al. (2013).

Relocated and Artificial Dreys

As outlined in the Fauna Management Plan (Bamford et al., 2020), a range of shelter types was installed in the project area in a variety of locations to augment the shelters available in relocation areas and trial the attractiveness to possums of the different designs. The types included:

Relocated Natural Drey – a drey cut out from a tree before it was cleared and wired up into a tree outside the clearing zone.

Relocated Long Hollow – a long hollow cut from a tree in the clearing zone. There were only two of these so results are lumped with Short Hollows in this report.

Short Hollow – a short hollow log, capped at one end and chained with plastic coated chain to a tree, to minimise damage to the tree branch. Short hollows were chosen to trial as they may prove less attractive to European Honeybees *Apis mellifera* than long hollows and possums will shelter in short natural hollows.

Dome – a wire dome made from two hanging baskets wired together, with a quarter cut out for the entrance and lined with *Agonis flexuosa* leaves and twigs.*

Dome with Coconut Dome – a wire dome with matching coconut fibre liner and entrance hole. Two of these also contained paperbark*

Cup – a single hanging basket installed as a wire cup.*

Cup with Coconut – a single hanging basket lined with coconut.*

Plastic bucket – a plastic filter bucket.*

*In all cases, WA Peppermint *Agonis flexuosa* sprigs from the possum's nearest tree were added to each artificial drey to try to mimic as closely as possible the natural smell of the animal's home range. In some instances where an animal's natural drey could not be salvaged, material from the natural drey was added to an artificial drey to make the drey smell more familiar to the animal and perhaps make it more likely to be used.

Artificial shelters were installed throughout the project area, outside the impact area. Eighteen dreys and hollows were installed by Tree Surgeons WA, while they were installing the rope bridges. The remaining 68 relocated and artificial dreys were installed by Bamford Consulting Ecologists' personnel. Details of all dreys relocated and all installed shelters are given in Figures 2 and 3 and Appendices 2 and 3. Examples of shelter designs are provided in Appendix 1, Images 2 to 7.

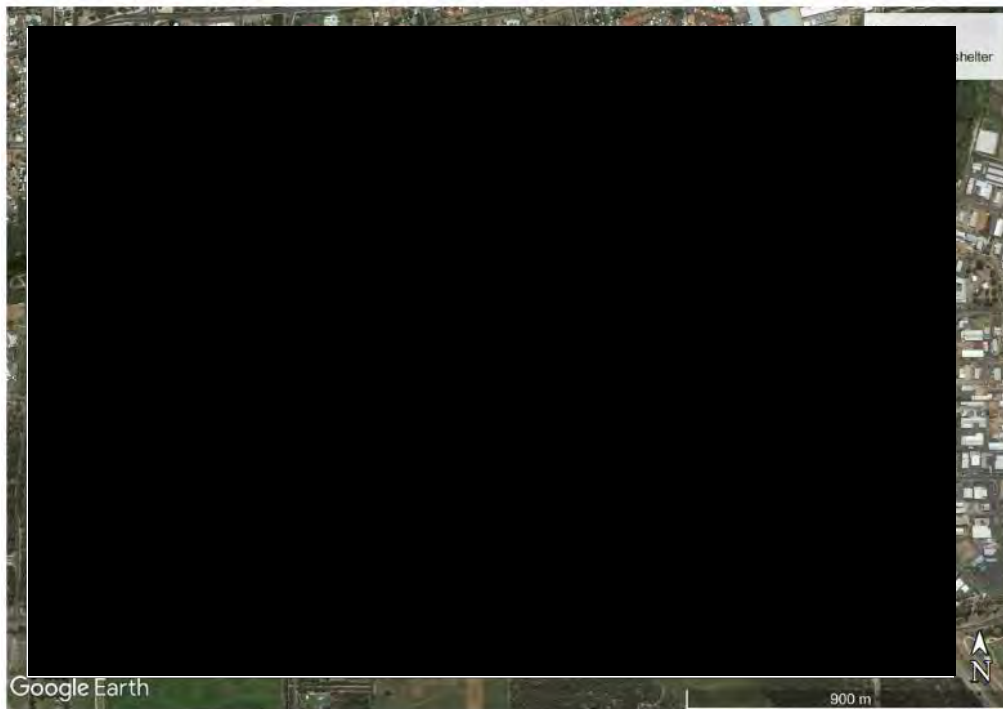


Figure 2. Locations of shelters for Western Ringtail Possums installed along the Vasse Drain in Busselton in October and November 2020.



Figure 3. The southern project area (VROS) off Chapman Hill Road along the Vasse Diversion Drain and [REDACTED], showing installed artificial shelters in red. The green marker was the location of a [REDACTED] which a possum was displaced during clearing. It ran to a hollow (marked in white), behaving as if it knew the location. This hollow immediately adjacent to works was occupied in January 2021, despite active construction taking place nearby. Since March 2021, the hollow has been unoccupied, however a new natural drey was discovered in March 2021, [REDACTED] (see Appendix 2, Figure 15)

Monitoring of Artificial Shelters

A check of all artificial shelters was carried out on six occasions throughout 2021 (January, March, April-May, August, September) and in January 2022. All locations were checked, shelters were photographed, and the state of the shelters recorded, noting any that needed repair or replacement. A pole camera was used to determine if the shelters were occupied by possums or had evidence of recent use (see Appendix 1, Image 34).

Monitoring of Natural Dreys

During the monitoring, a number of new Natural Dreys were discovered in the study area. Locations and occupancy of these dreys were recorded, and they were added to future monitoring sessions. If a natural drey became disused and fell from the tree it was excluded from future monitoring. Natural dreys that remained in trees continued to be checked, as these will sometimes be repaired and reused by possums.

Monitoring of Rope Bridges

A range of brands (Reconyx, Bushnell, Acorn, Swift Enduro) of motion sensitive cameras were trialled to monitor use of the rope bridges on three sessions of three nights during the year. The trials were undertaken to determine which cameras would appropriately target animal movement and not record the movement of ropes or branches. Three, one hour watches were also undertaken using binoculars.

When analysing camera data, groups of images of the same species taken less than five minutes apart were scored as a single instance to avoid overestimating the number of animals using the bridges.

In addition, opportunistic searches for scats underneath the rope bridges were undertaken during other monitoring activities.

RESULTS

Numbers of Possums

Figures 4 and 5 show the locations of Western Ringtail Possums prior to displacement, to provide context for interpreting the results of post-disturbance monitoring.

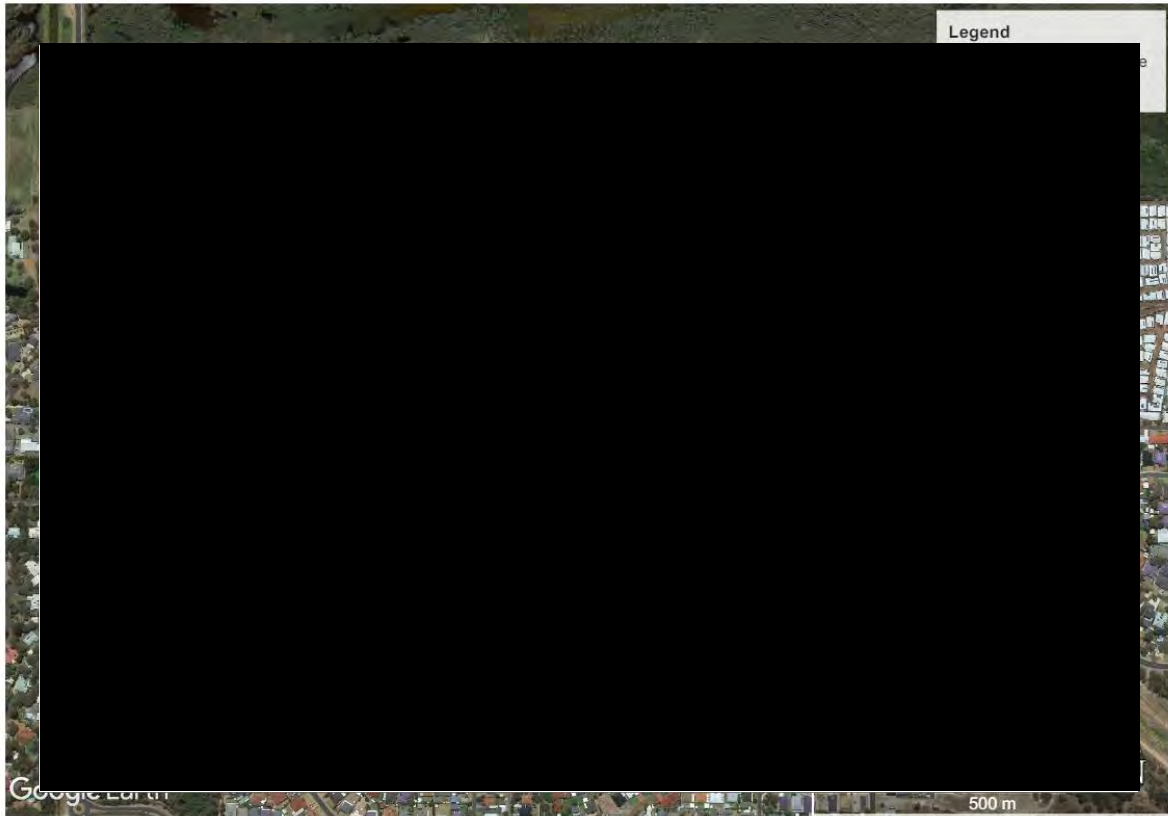


Figure 4. Locations of Western Ringtail Possums along the Vasse Drain in Busselton in October and November 2020, prior to displacement. White dots denote possums +/- joeys which were displaced, blue points indicate possums which were on the border of clearing works and were not moved as their trees were retained. Two of these retained trees contained possums in January 2021, despite being immediately adjacent to construction work, and one of them was occupied in January 2022.



Figure 5. Locations of Western Ringtail Possums in the southern (VROS) site prior to displacement in November 2020. See Appendix 2, Figure 15 for results from January 2021 onwards.

Summary tables of data for Year One of monitoring are given in Table 1 and Appendix 2. Figures 7 to 9 illustrate the usage of natural and artificial dreys, and the numbers of possums in each monitoring period.

Numbers and locations of Possums

In January 2021, 14 of 38 possums (37%) were on branches not associated with dreys while six were using artificial shelters (16%). In January 2022, eight of 45 possums (18%) were using artificial shelters and although some were outside, or in the entrance of their drey, all possums were associated with dreys (see Figure 6). The numbers of natural dreys in January 2021 was 18 but in January 2022 it was 35. The overall number of possums was also higher in January 2022 than in 2021 (38 in January 2021, and 45 in January 2022).

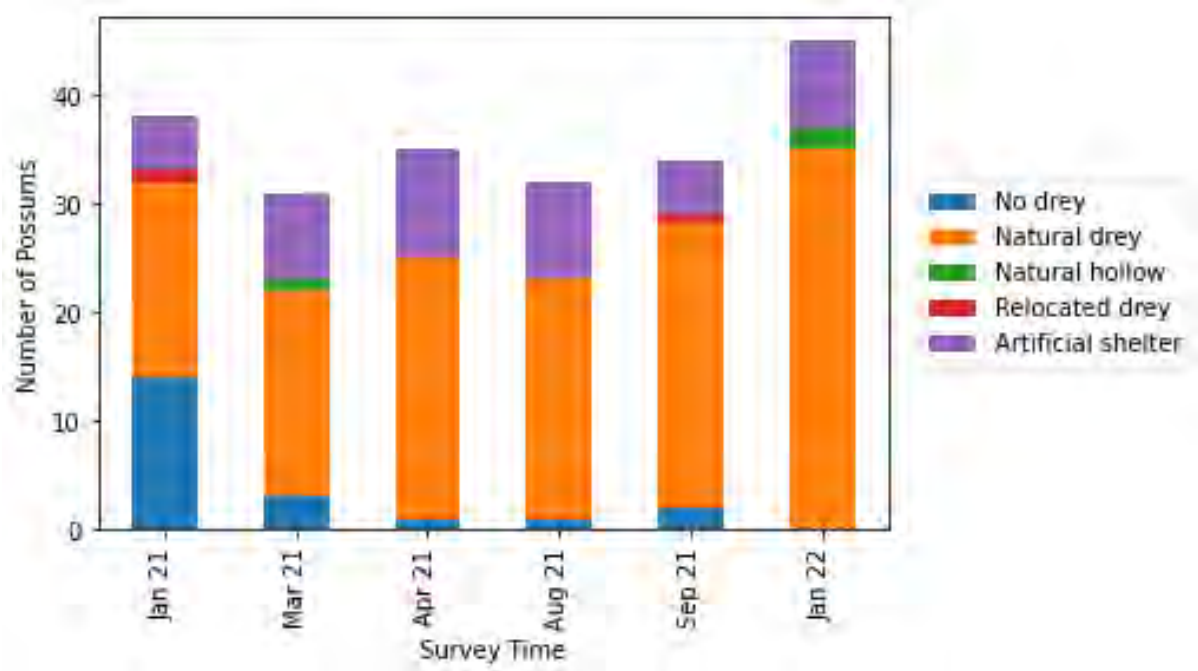


Figure 6. Use of natural and artificial shelters by Western Ringtail Possums along the Vasse Diversion Drain in Busselton between January 2021 and January 2022.

Artificial shelters were used consistently throughout the year. Twelve to 18% of possums located during monitoring periods were using artificial shelters. The lowest usage was during the September monitoring period when 12% of possums were in artificial shelters. Artificial ‘short hollows’ were the most commonly occupied (80% were used in at least one monitoring period) with 60% (4 out of 6) plastic filter buckets being used on at least one occasion (see Table 1 and Figure 7). Coconut-lined dreys were used until possums harvested the coconut for use elsewhere, after which they not used. Two artificial shelters were lined with paperbark and coconut and one of these was used in five of six monitoring periods. The second was also used and lasted longer than coconut alone, however additional trials will need to be made to confirm this due to the small sample size (only two dreys contained paperbark due to the availability of sustainably sourced material).

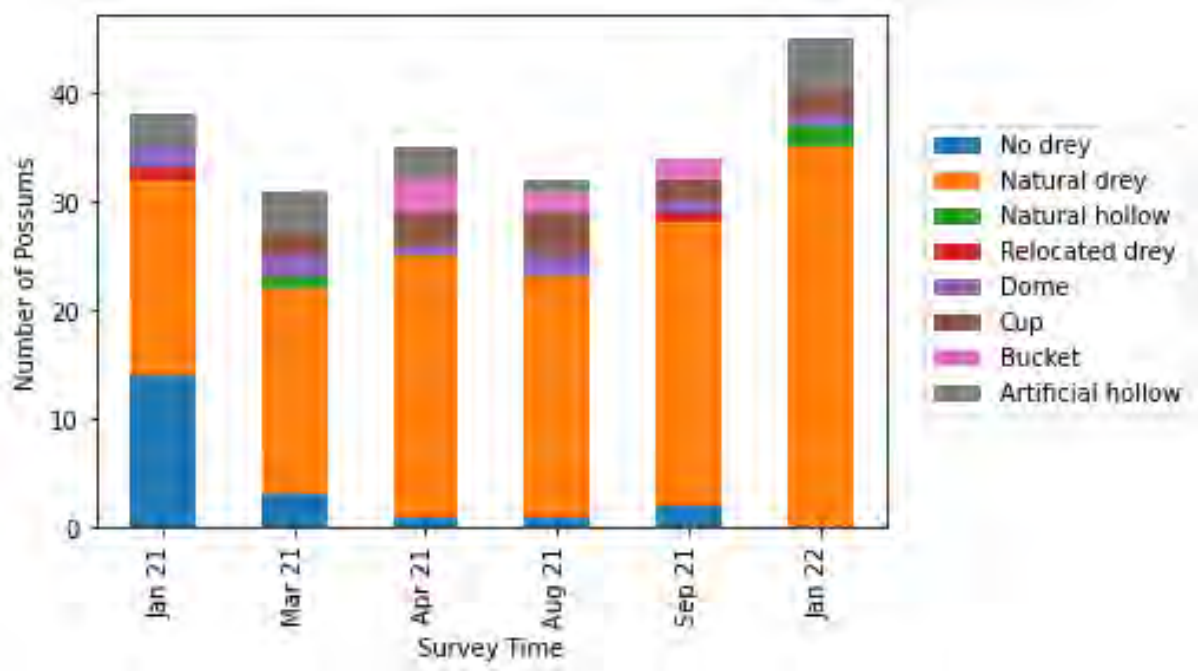


Figure 7. Comparison of the use of a range of artificial shelter designs by Western Ringtail Possums along the Vasse Diversion Drain in Busselton between January 2021 and January 2022.

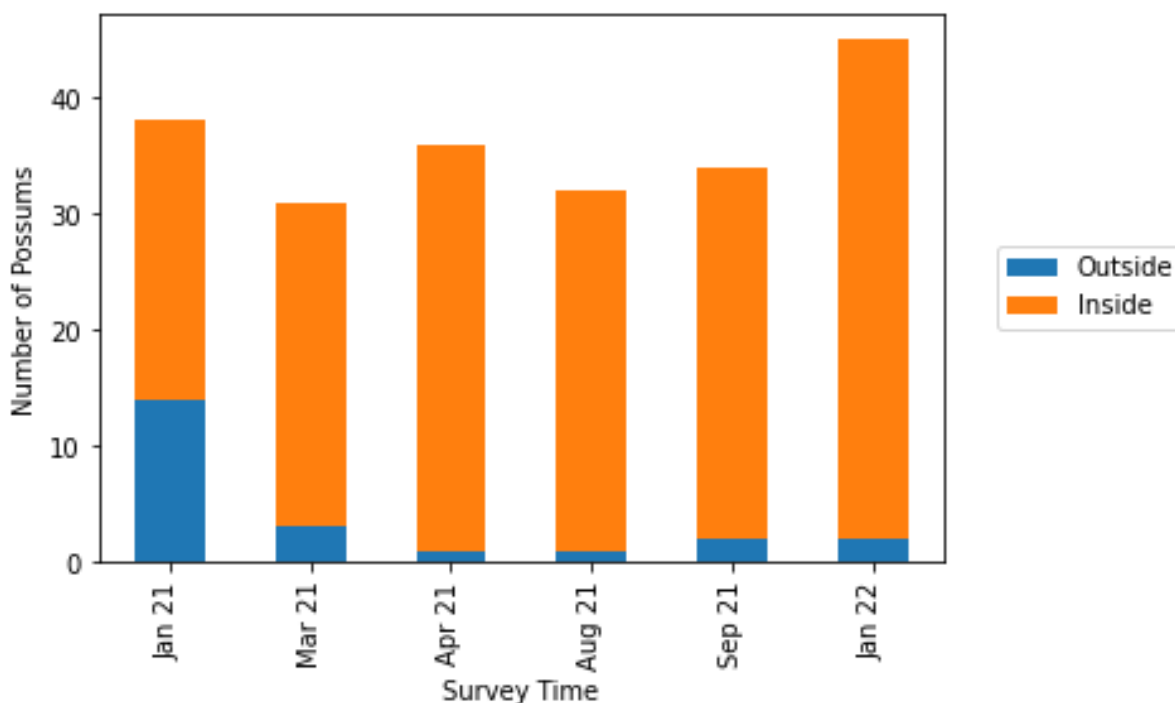


Figure 8. Comparison between possums inside and outside dreys between January 2021 and January 2022. Note that the 14 animals outside dreys in January 2021 did not appear to be associated with dreys. In March 2021, only four animals were outside, and did not appear to be associated with dreys. Subsequently, most animals were near to a natural or artificial drey. In January 2022, all animals were associated with dreys.

Table 1. Numbers and designs of artificial shelters installed along the Vasse Diversion Drain and their use by possums from January 2021 – January 2022.

Shelter type	Number installed	Number occupied in at least one monitoring period	Notes	Percentage of drey type occupied or used in at least one monitoring period
Relocated Natural Drey (NAT)	24	2	Two occupied in Sept 2021 One of these was maintained but empty in Jan 2022	2 (1%)
Dome with Coconut (DoCo)	17	4 (+1 maintained but empty when checked)	One drey was occupied in all but Jan 2022, others only occupied on one monitoring period. 2 of the 5 had paperpark as well as coconut. Most of the coconut fibre had been rearranged or removed by Jan 2022.	5 (29%)
Cup without Coconut (Cup)	12	1		1 (8%)
Cup with Coconut (CuCo)	14	6		6 (43%)
Installed or relocated Hollow (Hol)	10	8	3 hollows were occupied on 3 monitoring periods, 1 hollow was occupied twice, 3 hollows were occupied on a single monitoring period	8 (80%)
Dome without Coconut (Dom)	5	1	This drey has lots of peppermint twigs, and was open but sheltered	1 (20%)
Plastic Filter Bucket (Buc)	6	4	One was occupied in 3 of six monitoring periods	4 (60%)
Totals	87	26	1 (maintained)	27 (30%)
Totals excluding relocated dreys	63	24	1 (maintained)	38%

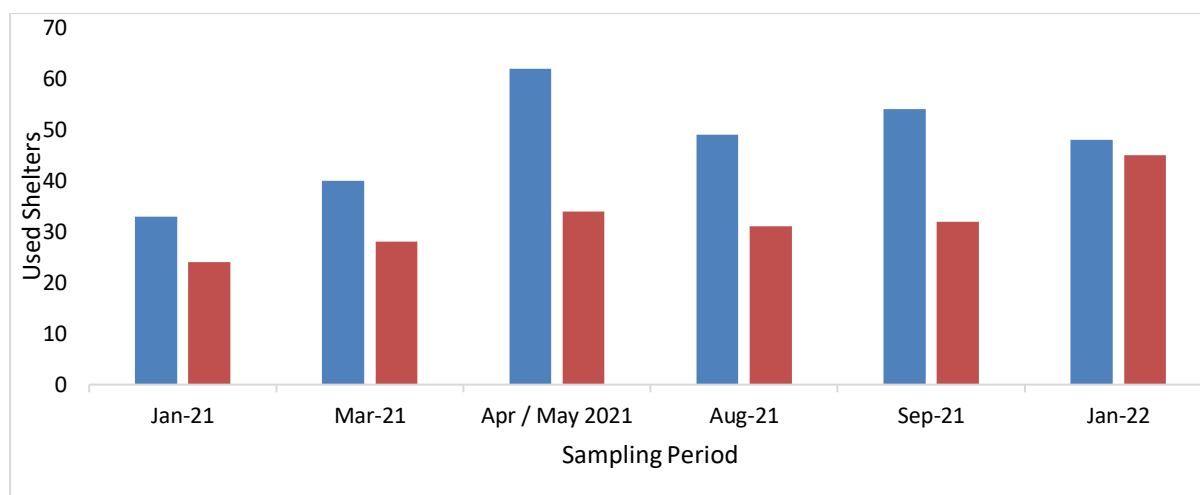


Figure 9. Numbers of shelters with evidence of use (blue) and occupied (red) during January 2021 – January 2022 monitoring periods. Used shelters included those that were occupied when checked, and those which had signs of recent use, such as fresh leaves, an obvious entrance and open area inside. This is likely an underestimate, as artificial and natural hollows are often not lined, and so recent use is difficult to determine.

Construction of Natural Dreys

Appendix 2, Figures 12 to 14 show time series with the locations of natural dreys constructed between January 2021 and January 2022. The largest number of new natural dreys was recorded in March 2021, with a small number of new ones being recorded in subsequent monitoring periods.

Use of Rope Bridges

During the first two camera sessions, sensitivity settings and movement of rope bridges and vegetation were problematic, resulting in over 24,000 photos, with no images of possums. One photo was taken of a juvenile White-faced Heron perched on one of the bridges. In January 2022 however, three instances of bridge use by possums were recorded over two nights in the revegetation area adjacent to Cook St industrial area. One was a Brushtail Possum, while the other two instances were of Western Ringtail Possums. A solitary Western Ringtail Possum was recorded on 19/01/22, and a female and joey were photographed over a five-minute period on 20/01/22, walking along, and perching on the rope. See Images 15 to 22, in Appendix 1, and on the cover of this report.

Western Ringtail Possum scats were observed under the rope bridge adjacent to Cook St industrial area in September 2021. See Image 26 in Appendix 1.

Behavioural Observations

January 2022 monitoring period (18 – 22 January 2022) occurred during an extended period of 38 degree days. A number of possums in January 2022 were observed with tails hanging out of dreys and hollows (Appendix 1, Image 31), and one was on its back with its pouch open and exposed to the air (Appendix 1, Image 30). Another hollow contained a collection of fur at the entrance which appeared to have been pulled out by the possum (see Appendix 1, Image 29).

One mother and joey were on the ground in a culvert with damp soil and green foliage when we came to check their drey, presumably keeping cool. When they saw us, they ran up the nearby tree and sat near their drey. We avoided photographing the drey and moved on quickly to minimise further disturbance.

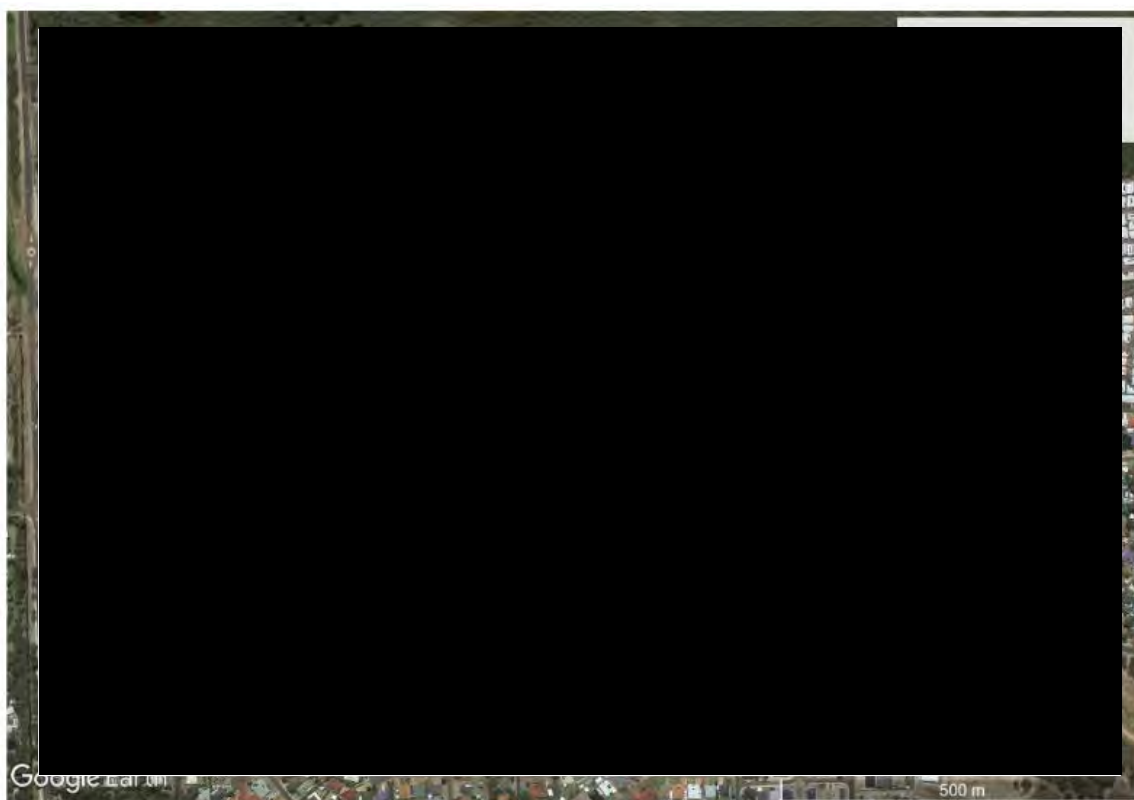


Figure 10. *Opportunistic records of Western Ringtail Possums along the Vasse Drain in Busselton during January 2021. Three of the natural dreys (white points) contained two possums. Data for other monitoring periods is displayed in Appendices 2 and 3.*



Figure 11. Use of artificial shelters by Western Ringtail Possums along the Vasse Drain in Busselton during January 2021. Red points indicate shelters which contained possums when surveyed, blue points indicate shelters which contained green *Agonis* leaves or where coconut fibre had been rearranged.

DISCUSSION

The first year of Possum monitoring following the drain widening works on the VDD and VROS has produced some encouraging preliminary results. The overall numbers of Possums have remained remarkably stable throughout the year; from 38 in January 2021, dropping to a minimum of 32 in August 2021 and increasing to 45 in January 2022. This suggests that the widening works have not had a large impact on the population numbers to date.

The use of the displacement technique outlined in the Fauna Management Plan for the Vasse Diversion Drain Upgrade (Bamford et al., 2020) to move possums from the clearing area appears to have been successful. All 36 possums were displaced from the clearing area without injury, many needing to be moved by less than 20 m. Most would only have been moved within their existing home ranges. By avoiding or minimising handling, personnel were able to keep stress to the animals to a minimum. Cowan et al. (2020), links the poor survival of relocated animals to the stress associated with their capture, handling and transport. Studies of Western Ringtail Possums report high mortality of relocated animals (Clarke, 2011, Thompson & Thompson, 2009) however observations from the first year of the present study suggest that many animals remained in the area following displacement. Ongoing surveys will better inform these preliminary observations.

Relocated dreys were probably important initially but most became disused once the possums had the opportunity to build new dreys or adopted artificial shelters. Interestingly, two relocated dreys were being used in September 2021 and one was still being maintained in January 2022 although was not occupied on the day of monitoring. Since possums have multiple dreys in their home range, the animal almost certainly uses this drey on occasions.

Artificial shelters were adopted quickly and have been used consistently throughout the monitoring period. The availability of additional shelter is likely to have supported the population of possums following displacement and may have contributed to the sustained increase in numbers of possums in January 2022 by providing additional shelter for newly independent juveniles.

While relocated dreys probably perform an important function temporarily, ultimately they will need to be replaced with additional artificial shelters, to fulfil commitments made as part of project approvals to install double the number of artificial shelters as were removed and maintaining them for ten years (DWER Clearing permit CPS 8191/1). Many new, natural dreys were constructed adjacent to the clearing area between January and March 2021, suggesting that some displaced possums had chosen a new location within their home range and built a natural drey. Smaller numbers of new, natural dreys continued to be constructed in areas adjacent to the clearing area, throughout the rest of the sampling period (Figures 12 to 15, Appendix 1), probably at a rate more consistent with the natural turnover of dreys due to disturbance caused by weather events and other non-human impacts. It will be interesting to see if increasing the numbers of artificial dreys increases usage of them in the long term, or if some animals prefer to build their own.

Many new, natural dreys were constructed across the site between January and March 2021. Some were close to maternity dreys, suggesting that juveniles had initially built dreys close to their mothers. The construction of many natural dreys during this period may also have been due to displaced animals constructing new dreys to replace the dreys that were cleared, and those relocated dreys which had begun to deteriorate. In January 2021, 14 possums were counted on branches, apparently not associated with dreys, whereas in March 2021 only four were not associated with dreys. Although three possums were out of their dreys in January 2022 (probably due to the hot weather), all of them were associated with dreys. In particular, one mother and joey were on the ground in a culvert with damp soil and green foliage when we came to check their drey, presumably keeping cool. When they saw us, they ran up the nearby tree and sat near their drey. We avoided photographing the drey and moved on quickly to minimise further disturbance. It would be interesting to compare the number of natural dreys constructed between January and March in future years, without the disturbance caused by displacement and drain widening works.

The number of possums using natural hollows is probably an underestimate, as the pole camera is not always able to detect them, if the hollow is curved. In January 2022, two animals were detected because their tails were hanging from their hollow. In some parts of their range with a greater number of trees with large hollows, Western Ringtail Possums rarely build dreys and are often difficult to detect without spotlighting transects, as they spend their days deep in hollow trees. Since the numbers of suitable natural hollows in the trees along the Vasse Diversion Drain is small, and spotlighting transects were carried out at the site before works began, the numbers of animals remaining undetected within the study site is likely to be low (less than five animals).

During the hot weather in January 2022, possums exhibited a range of behaviours probably associated with cooling. Hanging tails in the breeze, plucking hair and exposing bare skin on their tails, bellies and pouches, and seeking shelter in cool, damp vegetation are all behaviours that are likely to help the possums to manage their temperature in heat extremes. Saliva spreading has been observed to be used as a cooling mechanism in Red Kangaroos (Dawson et al., 1974). Van Helden et al. (2021) found Western Ringtail Possum abundance to be correlated to canopy cover in Albany. Revegetation and continued access to shady gardens are likely to be important to the long-term survival of the possum population in Busselton.

Artificial shelters are being used by the possums, with the preferred designs varying perhaps due to seasonal changes in weather conditions, or the breeding cycle of the animals. Artificial ‘short hollows’ were the most commonly occupied design (80% were used in at least one monitoring period). Short hollows seem to be preferred in the non-breeding season, however only one artificial hollow was observed to be used by a mother with a joey, presumably because hollows are not easily expanded to accommodate a growing joey. In Busselton, maternity dreys sometimes have a ‘granny flat’ arrangement when the juvenile is close to independence (pers. obs.), and this would be more difficult to accommodate in a short hollow. Short hollows are highly favoured at other times of year however and have the advantage over large hollows that to-date, none has attracted feral bees.

Artificial shelters were used consistently throughout the year. Twelve to 18% of possums located during monitoring periods were using artificial shelters. The lowest usage was during the September monitoring period, when mothers have large joeys, and probably prefer natural dreys which they can ‘extend’.

Black plastic buckets were initially unused but were a popular choice in August and September 2021. One bucket was occupied on three of the six monitoring periods. Domes were popular when covered with coconut but were mostly unused once the coconut was removed by the possums or had collapsed. One peppermint lined dome without coconut was also used. Two coconut-lined domes also contained paperbark. Both these domes were used, one was occupied in five of the six monitoring periods. It is possible that the waterproofing and insulating properties of paperbark, long recognised and utilised by Noongar people (Hansen and Horsfall, 2019) are also valued by the possums. Artificial shelters lined with paperbark and coconut appear more attractive and lasted longer than coconut alone, however additional trials will need to be made to confirm this due to the small sample size (only two dreys due to the availability of sustainably sourced paperbark).

Cups were used consistently and continued to be used even when coconut had deteriorated, unlike the domes, possibly because the animals could escape more easily and felt less vulnerable to predators than inside an immovable wire frame with only one exit.

These are preliminary data only on the preference of different artificial drey designs and are confounded to some extent by the short-term disturbance caused by the drain widening project, and by the deterioration in coconut, which may have changed the attractiveness and functionality of the coconut-lined cups and domes. The reduction in use of the domes may have been due to the increase in natural dreys, and the possums’ preference for sheltering in dreys they have constructed themselves, or it may simply be that they are no longer as attractive once the coconut has been removed. In some cases, the coconut was harvested by the possums to construct an alternate drey elsewhere! Additional artificial shelters are required to be added to replace the deteriorated relocated natural dreys, so it is proposed that these dreys be a selection of paperbark-lined, coconut fibre and plastic filter buckets, to provide further data on the most effective shelters to support populations of possums in disturbed areas with insufficient natural shelter. To answer this question, it would be necessary to maintain a more regular monitoring regime than has been proposed beyond Year One. This would allow additional coconut and paperbark-lined dreys, and plastic filter buckets to be progressively reintroduced and monitored throughout the site at different times of year, to account for seasonal variation in drey choice. This possibility will be discussed with the client.

VROS

Clearing in the VROS area has resulted in a highly fragmented landscape, and possums and the artificial dreys are on a ‘dead end’ without connectivity, and with less vegetation than in 2020, so are probably less attractive to possums. The artificial dreys in the VROS area were used initially, and although one possum stayed immediately adjacent to the VROS area in a natural hollow (WP1 in Figure 15, Appendix 2) throughout most of the construction period, it

was no longer in the hollow in March 2021 and a natural drey (466) was found further north along the river, which was probably constructed by this individual (see Figure 15, Appendix 2). By September 2021, this drey had deteriorated and no evidence of possums was found in the area. This is probably to be expected, given the number of trees removed and the consequent loss of habitat and connectivity. If trees are replanted outside the VROS structure, this effect could be reversed in time, however the land surrounding the VROS area is privately owned farmland, so any plantings in the area would need to be negotiated with the landowner.

Rope Bridges

Rope bridges were used by both Brushtail and Western Ringtail Possums. It is encouraging to find clear evidence of their use. Previous studies such as Yokochi and Bencini (2015) which monitored Western Ringtail Possums' use of rope bridges, found that the animals began using them within 36 days of installation. In their study the structures were heavily engineered, static bridges which move less in windy conditions, and tend to have less vegetation to interfere with the functioning of cameras. The movement of ropes and branches has made monitoring of the bridges in this study more difficult than expected, resulting in thousands of photos of non-target objects at high sensitivity, and no photos at lower sensitivity. The results of the trial of different camera brands was encouraging, with Swift Enduro demonstrating the most effective detection of possums. We will therefore deploy more Swift Enduro cameras in the coming year to better assess rope bridge usage.

Despite the difficulty of achieving consistent results, we were able to demonstrate that the bridge design is successful. Western Ringtail Possums are comfortable using the bridges and were recorded on consecutive nights in January 2022, along with a Brushtail Possum. A sequence of several minutes shows a mother and joey wandering along a bridge very securely (see Images 22 to 25 in Appendix 1).

The value of each tree

Bamford et al (2021) noted that animals were continuing to use trees retained immediately adjacent to the clearing area while work continued on site and emphasised the importance of retaining individual trees where possible. Several of the trees in the strip of vegetation immediately adjacent to the impact area continue to be used by possums. These include several trees with dreys which were marked to be cleared in November 2020. After consideration, a decision was made by the client and contractor to retain them. Three animals recorded in January 2021 were in dreys or hollows directly overlooking the construction site but the animals had persisted in them, tolerating the disturbance. These sites continued to be used during 2021 and one retained, natural drey, immediately adjacent to the drain, was still in use in January 2022. Decisions made to reduce clearing, even by a single tree, can improve the outcome for fauna.

In order to maintain the displaced animals at the site in the long term despite the reduction in habitat, it is essential that additional food resources are provided in the form of revegetation, as soon as is practical. Although food resources do not appear to be limiting at present and

all animals appear in good condition, there is a risk that drought conditions or insufficient nitrogen in leaves will begin to affect the population. The wide range of plant species selected for revegetation and being implemented by Tranen (Tranen Revegetation SouthWest, 2020), including Coojong *Acacia saligna*, *Kunzea sp.* and Marri *Corymbia calophylla*, as well as WA Peppermint *Agonis flexuosa*, and a range of understorey plants will provide the varied diet which Mathieson et al. (2020) found Western Ringtail Possums prefer. Some plants are already beginning to resprout along the fence line adjacent to the impact area and will rapidly begin to provide additional food (see Image 32, Appendix 1).

Revegetation will also re-establish and enhance connectivity, supplemented by the rope bridges which were installed by Tree Surgeons WA. Increased connectivity will allow possums to move between the population along the drain and the rest of Busselton to access food resources, expand home ranges and find mates, improving the species' long-term viability in the area. Rope bridges and revegetation will also enable possums to travel without going to the ground, avoiding the risks of Foxes and cars, both identified as major threats to the viability of the Busselton population by (Yokochi *et al.*, (2015).

An alternative explanation to the increase in numbers of possums in January 2022 could be lack of connectivity; if juveniles were unwilling or unable to disperse to other areas due to reduced connectivity. This seems unlikely, as researchers such as Yokochi et al. (2015) have suggested that stranded animals tend to go to the ground and cross roads (with associated mortality) and possums have demonstrated their ability to use the installed rope bridges.

Engaging the community

Part of the long-term success of the project will be engaging the community in areas adjacent to the drain with possum conservation, helping them to value the critically endangered species which shares their suburb. Many of the animals monitored in this study have home ranges which overlap with residential and industrial properties, and so the actions of the human occupants of their home ranges could have a huge impact of the success or otherwise of the Water Corporation's rehabilitation in the area. Encouraging residents to retain and replant native trees, provide connectivity above ground to keep possums away from domestic pets, and being prepared to accept the occasional rose bloom or nectarine being harvested by possums (or netting the trees) will help to ensure the possums' long-term survival in the suburbs. There is increasing evidence that Western Ringtail Possums survive better in suburbs than they do in remnant bushland (Van Helden et al., 2020, Busschots et al., 2021), so residents can play a vital role in the species' conservation.

Although the Vasse Diversion Drain Widening Project has caused disruption to the Busselton population of Western Ringtail Possums in the short term, it has the potential to contribute to the possums' long term survival by improving the availability of high nutrient foliage for food, increasing the availability of suitable structures for protection/breeding, and canopy continuity to escape predation and other threats, all issues identified as important by Department of Parks and Wildlife, (2017) and Bamford et al., (2019). In addition, ongoing engagement with residents adjoining the drain to encourage them to make their backyards possum-friendly will

contribute to sustaining the possum population in the long term. Future monitoring of the Western Ringtail Possum population along the drain as part of this project will help to show if this potential is realised and can be sustained.

CONCLUSIONS

While only preliminary data, the first year of possum monitoring at the VDD and VROS sites suggests that the minimal displacement method, choosing to retain trees that were on the border of the development, providing artificial shelters and rope bridges have minimised the impact on the possum population. The population has remained stable, and shown a slight increase in January 2022, suggesting a good survival of juveniles following the 2021 breeding season. The increase in numbers is probably a reflection of high rainfall in spring but may also reflect the provision of additional shelter.

Relocated natural dreys were probably important in the short term but most became disused after a few months, and most possums were found in newly constructed natural dreys, and in artificial shelters by March 2021. A small number of relocated natural dreys continue to be used however the provision of additional artificial dreys is likely to be helping to support a higher population. Artificial dreys were used by the possums at a rate of 12 to 18% (percent of possums recorded in an artificial shelter during a monitoring period), although there appeared to be a seasonal pattern in their preferred designs. Artificial hollows appeared to be favoured in the non-breeding season, whereas plastic buckets and cups with coconut were chosen at other times of year. More paperbark lined domes should be trialled once a sustainable source of paperbark is identified, as the sample size is too small at present. There is insufficient data to draw firm conclusions yet regarding drey design, because of the confounding effects of disturbance and seasonality, and harvesting of coconut by possums.

Since 41 dreys were removed during clearing, replacement of relocated natural dreys is required to meet the condition 15 of DWER Purpose Permit CPS8191/1 (Bamford et al. 2020) to increase the number of additional shelters to 82. This would require an additional 18 shelters. These could include a range of artificial designs, as well as replacing coconut in some existing dreys. Follow-up monitoring is recommended to determine whether the loss of coconut is a factor in the reduced use of domes later in the monitoring period. At present, twice yearly monitoring is to be conducted. Increasing the frequency of monitoring (ideally six, but at least three times per year) would assist in assessing the use of replenished and additional artificial dreys and would provide greater confidence in conclusions about preferred drey design.

In January 2021, a number of possums were observed without an associated drey, however in January 2022, despite numbers of possums being higher, all were associated with dreys, even if they were outside them, suggesting that they had adjusted to their altered home ranges and new shelters after 12 months. Future monitoring will demonstrate if the higher population can be maintained, with increased shelter, food plants and connectivity.

The rope bridge design has been demonstrated to be appropriate for use by possums, therefore increasing connectivity for urban possums in the area.

Once revegetation is established sufficiently to provide additional food sources for the possums, monitoring will demonstrate if possum numbers rise, and if the population expands to use additional areas of the study site which are currently unsuitable.

RECOMMENDATIONS

- A proportion of artificial shelters where coconut fibre is collapsing should be repaired. This will need to be done sequentially so as not to bias the results of the disturbance study, and to account for any seasonal effects in their use.
- Relocated Natural Dreys should be replaced with artificial shelters to bring the total back up to the 82 shelters required as part of DWER Purpose Permit CPS8191/1, condition 15. This would require an additional 18 shelters. Additional short hollows, plastic filter buckets and wire domes / cups with paperbark and coconut seem the best choice, given preliminary results.
- To gain a detailed understanding of the seasonal usage of artificial dreys, monitoring would need to be maintained at four - six times per year beyond Year One. The existing program reverts to twice yearly sampling from 2022 onwards, which will collect enough data to measure the overall population size and expansion into the revegetation areas but will not provide sufficient data to detect seasonal usage of the site, including changing preferences for artificial drey designs. This information would be valuable to collect to inform future rehabilitation projects if budget were available to maintain a more frequent monitoring regime.
- Revegetation should continue as quickly as possible to increase food resources and connectivity.
- Additional monitoring time may be required to detect and re-check all natural dreys once revegetation is advanced enough to support additional possums. This may require an additional day's monitoring for each session from the 2024 season.
- The location of the Fox den identified in Bamford et.al. (2021), south of the drain in the Council reserve is still active. This observation should be forwarded to the City of Busselton Environmental Officers for their information.
- Residents should be encouraged to plant appropriate food and shelter plants for possums to improve connectivity and support their continued occurrence in the suburbs of Busselton.
- The Busselton community should be provided with opportunities to learn more about the possums and promote their occurrence as an asset. This could include workshops to make artificial shelters, plant local plants and encourage a sense of custodianship of the possums.
- When clearing works are required in areas containing Western Ringtail Possums, displacement rather than relocation should be the preferred option to minimise disturbance to the animals, provided that sufficient habitat remains.
- Every tree is important for species such as Western Ringtail Possums. In situations where trees are on the border of a development, they should be retained if possible.

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Appendix 1. Photographs



Images 2-7. A selection of designs of Artificial Shelters: Dome – no coconut (Dom); Short Hollow (Hol); Cup with coconut (CuCo); Cup – no Coconut (Cup); Plastic Bucket (Buc); Dome with coconut (DoCo). More detailed analysis will be possible once more data has been collected.



Image 8 (left). *A platform natural drey containing a Western Ringtail Possum mother and large joey taken in October 2020.*

Image 9 (right). *A dome-shaped natural drey containing one or two possums. Numbers of possums can be difficult to determine in dome-shaped dreys without disturbing the occupants.*



***Image 10.** An example of a Relocated Natural Drey. Relocated Natural Dreys were probably an important interim measure in November 2020 for newly displaced possums. One Relocated Drey were still being maintained in January 2022 but others were disused, or had deteriorated.*



Image 11. *Relocated Natural drey in use during the September 2021 monitoring period. Although most relocated natural dreys were only used for a short period and were not maintained, two of them have continued to be maintained and used. The dark fur of the possum is visible between the twigs near the top of the drey. This drey was unoccupied when checked January 2022 but was still being so was likely still in use.*



***Image 12.** Motion sensitive cameras were attached to trees and directed towards the rope bridges. It was difficult to position them in positions without vegetation obstructing the view of the ropes, and setting the sensitivity so that they would detect possums without taking large numbers of photos of moving rope and branches.*



Image 13. *Multiple dreys in one flowering Melaleuca nesophila. Although this species is not native to the South-West, it produces abundant nectar and is a good example of the non-native food resources available in the suburbs of Busselton.*



Images 14 & 15. Possums frequently harvested coconut fibre from the coconut-lined dreys resulting in the denuding of most lined cups and dreys by January 2022. Additional lined dreys will need to be provided to augment the number of lined dreys available for Possums in this study.



Image 16. Rope Bridge along College Avenue installed by Tree Surgeons WA. Project Approvals require six rope bridges to be maintained for 10 years to help improve connectivity for possums, so they do not need to come to the ground.



Image 17. Revegetation along College Ave installed by Tranen Revegetation SouthWest. These plantings will increase connectivity, shelter and food supplies.



Image 18. Brushtail Possum on rope bridge [REDACTED] on 20 January 2022, demonstrating that the design is suitable for both species of possums.



Image 19. *Western Ringtail Possum crossing the rope bridge [REDACTED] Busselton on 19th January 2022. First in a series of three photos (Images 19 – 21)*



Image 20. *Western Ringtail Possum crossing the rope [REDACTED] Busselton on 19th January 2022. Second in a series of three photos (Images 19 – 21)*



Image 21. *Western Ringtail Possum crossing the rope [REDACTED] Busselton on 19th January 2022. Third in a series of three photos (Images 19 – 21)*



Image 22. Western Ringtail Possums crossing the rope bridge [REDACTED] This is the first in a series of four images (Images 22-25) of a mother and joey walking across and perching on the rope (selected from a group of 20 images captured on January 20 2022). The animals appeared unconcerned by the rope, very comfortable walking across and stayed on the rope for several minutes.



Image 23. *Western Ringtail Possums crossing the rope bridge [REDACTED]. This is the second in a series of four images (Images 22-25) of a mother and joey walking across and perching on the rope (selected from a group of 20 images captured on January 20 2022). The animals appeared unconcerned by the rope, very comfortable walking across and stayed on the rope for several minutes.*



Image 24. *Western Ringtail Possums crossing the rope bridge [REDACTED] This is the third in a series of four images (Images 22-25) of a mother and joey walking across and perching on the rope (selected from a group of 20 images captured on January 20 2022). The animals appeared unconcerned by the rope, very comfortable walking across and stayed on the rope for several minutes.*



Image 25. *Western Ringtail Possums crossing the rope bridge adjacent to Cook St. This is the fourth in a series of four images (Images 22-25) of a mother and joey walking across and perching on the rope (selected from a group of 20 images captured on January 20 2022). The animals appeared unconcerned by the rope, very comfortable walking across and stayed on the rope for several minutes.*



Images 26 & 27. Possum scat with boot for scale (left). One of several found on the path beneath the rope bridge south of Cook St industrial area (right) during the September 2021 monitoring period in the area to be revegetated. Scats had not been recorded along the pathway prior to the rope bridges being installed.



Image 28. *A Western Ringtail Possum in an artificial hollow in January 2022. Artificial hollows were frequently occupied by single animals outside the breeding season but held more than one animal on only one occasion. Mothers and joeys were more commonly seen in dreys, perhaps because they provide the opportunity to 'build on' extra space for the joey.*

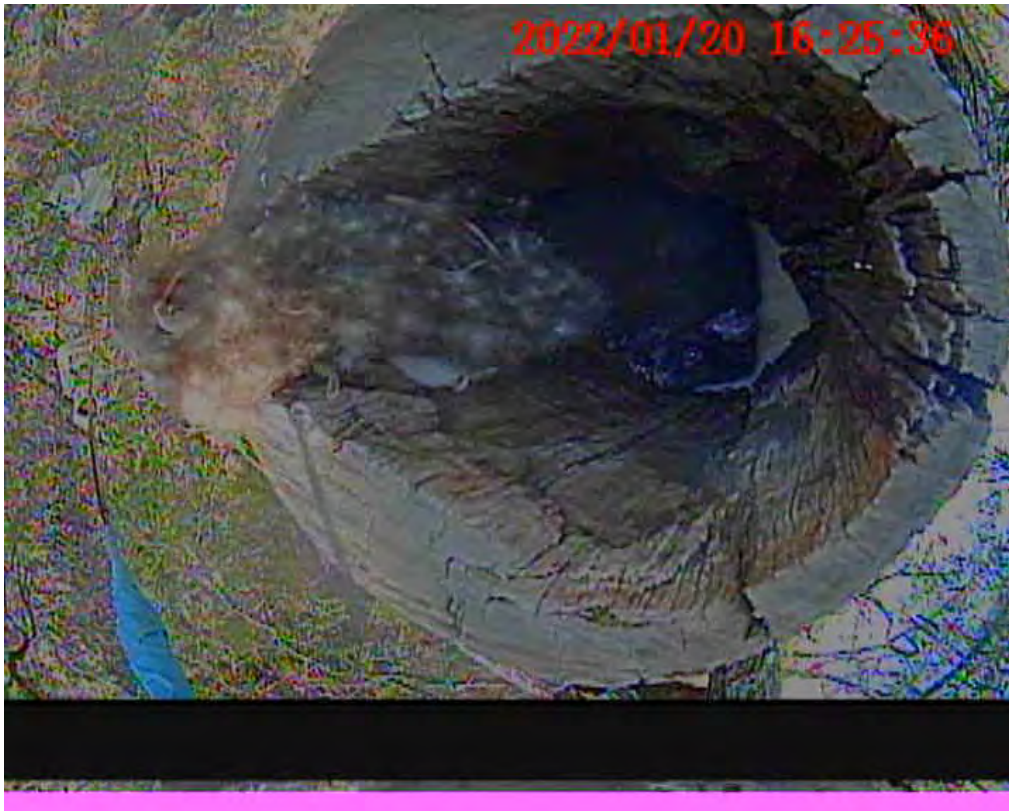


Image 29. Western Ringtail Possum in January 2022, keeping cool in 38 deg. heat. This individual appeared to have removed fur from its body, presumably to help with thermoregulation.

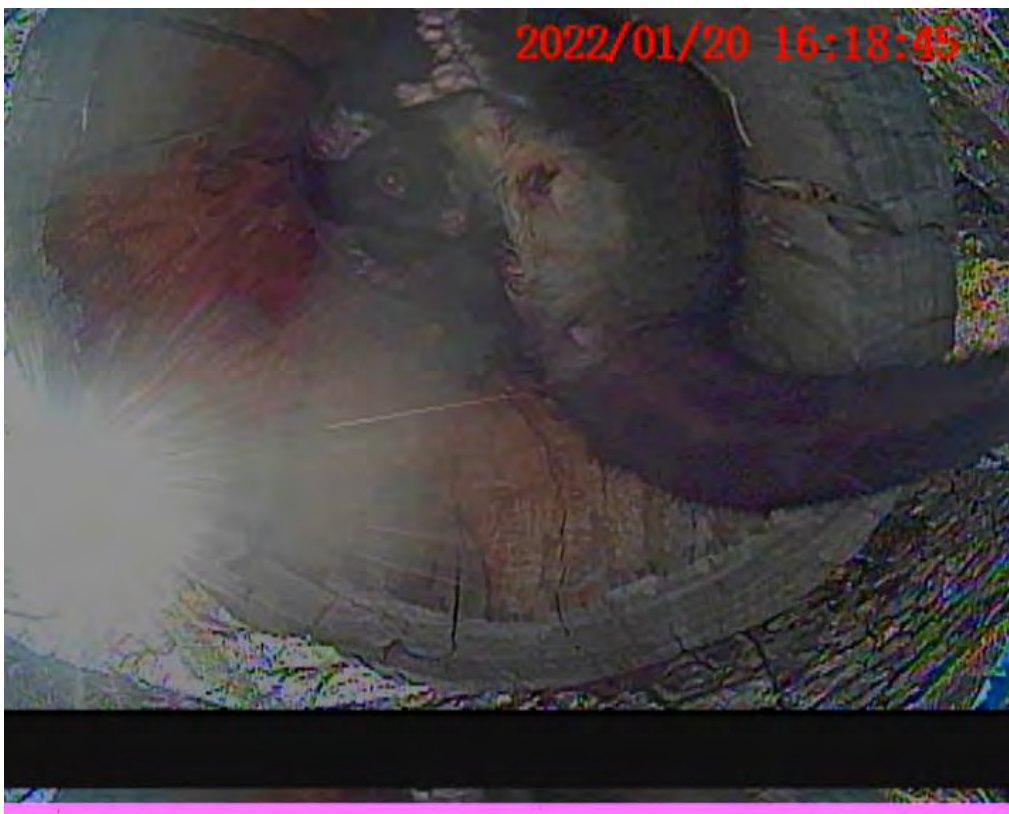


Image 30. Western Ringtail Possum in January 2022, keeping cool in 38 deg. heat. This individual appeared to be exposing the bare skin under its tail and spreading saliva on and in the pouch to help it thermoregulate.



Image 31. An occupied natural hollow at [REDACTED] in January 2022. The tail of a possum is visible, hanging from the entrance to the hollow. This behaviour was frequently observed in January 2022 when the temperature was 38 degrees. Presumably hanging the tail out of the hollow is used as a cooling mechanism.



Image 32. Retained WA Peppermint tree (*Agonis flexuosa*) containing a natural drey on [REDACTED] which contained a possum in all but two monitoring periods, even during works. A decision was made to retain this tree although it was on the edge of the clearing zone. Its continued use by a possum throughout 2021 - 2022 illustrates the importance of decisions to retain individual trees. Also visible are regenerating Coojong (*Acacia saligna*) seedlings, which will provide important, high-nitrogen forage for possums within two years.



Image 33 (left). *By January 2021, a number of the artificial shelters containing coconut had been rearranged. In this case, the possum obviously preferred to choose an alternate location to create its own shelter using coconut from the artificial drey!*

Image 34 (right). *Artificial Shelters were checked using a pole camera if necessary. Examples of pole camera images may be seen in Images 28 to 30.*

Appendix 2. Time series maps showing Natural and Artificial Dreys (January 2021) and the new Natural Dreys discovered in each subsequent monitoring period (March 2021 – January 2022).

Figure 12. Western end of the drain to Queen Elizabeth Avenue.

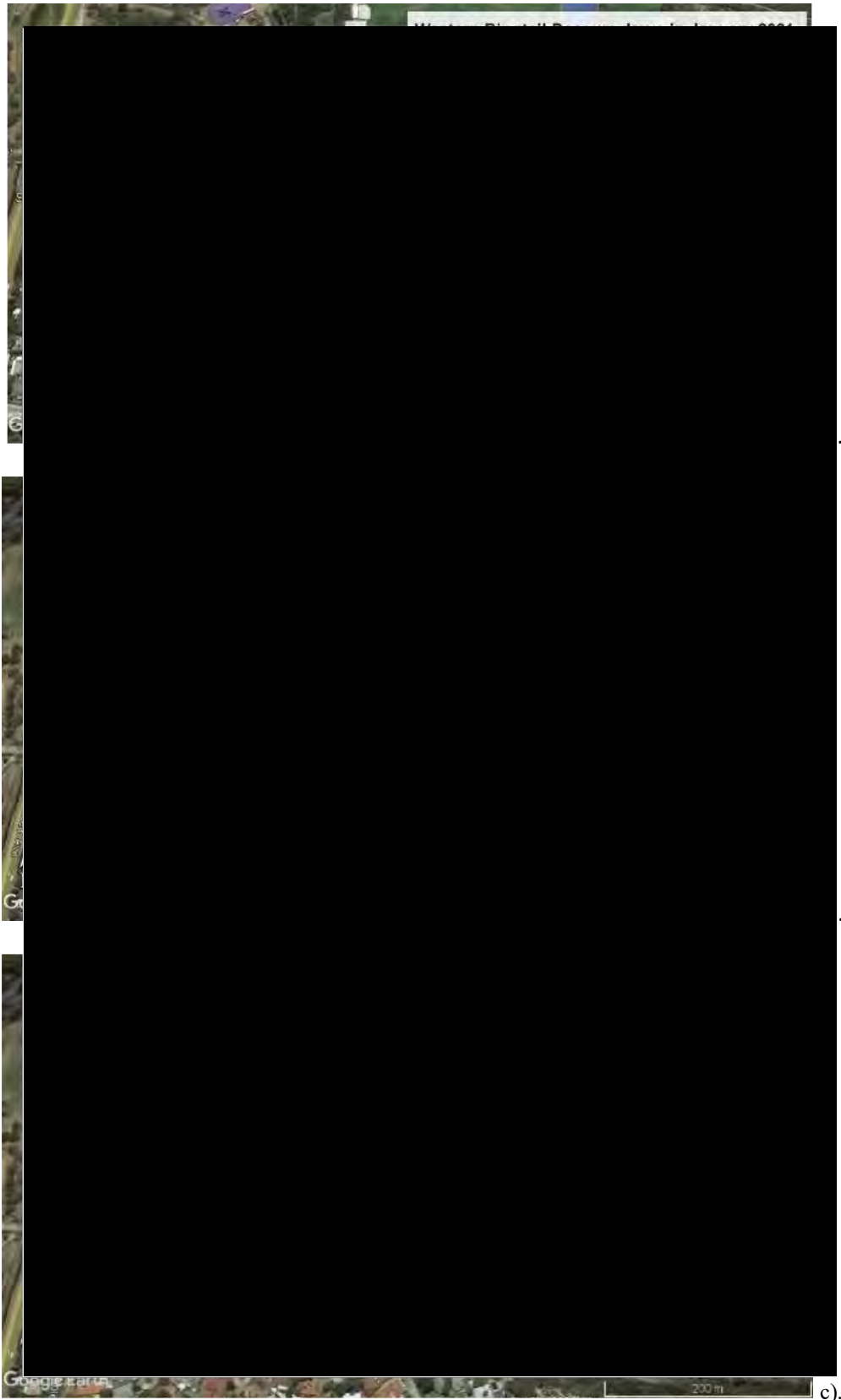


Figure 12 (cont.)



Figure 13. Central section of College Avenue. Time series maps showing Natural and Artificial Dreys (January 2021) and the new Natural Dreys discovered in each subsequent monitoring period (March 2021 – January 2022).

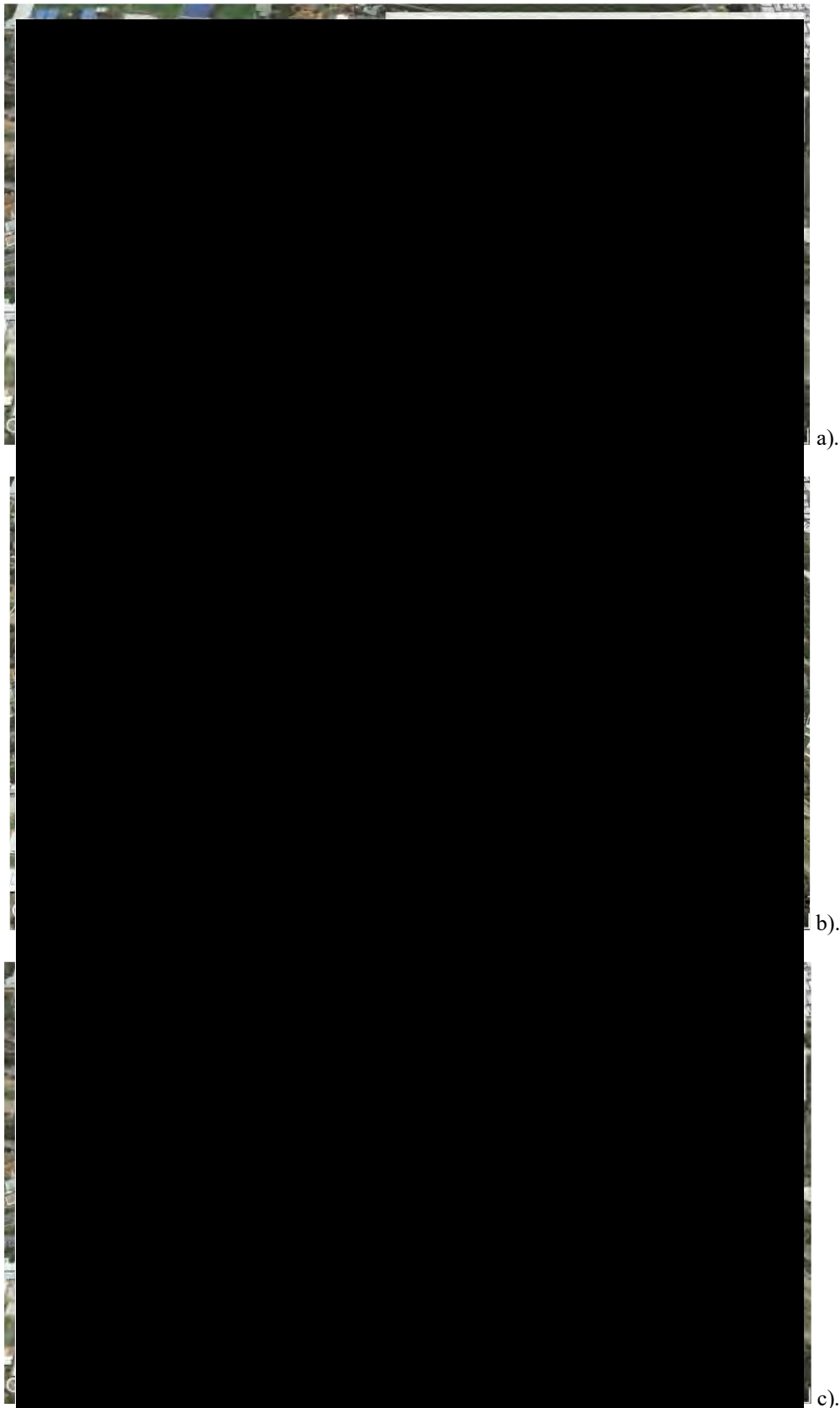


Figure 13 (cont.)

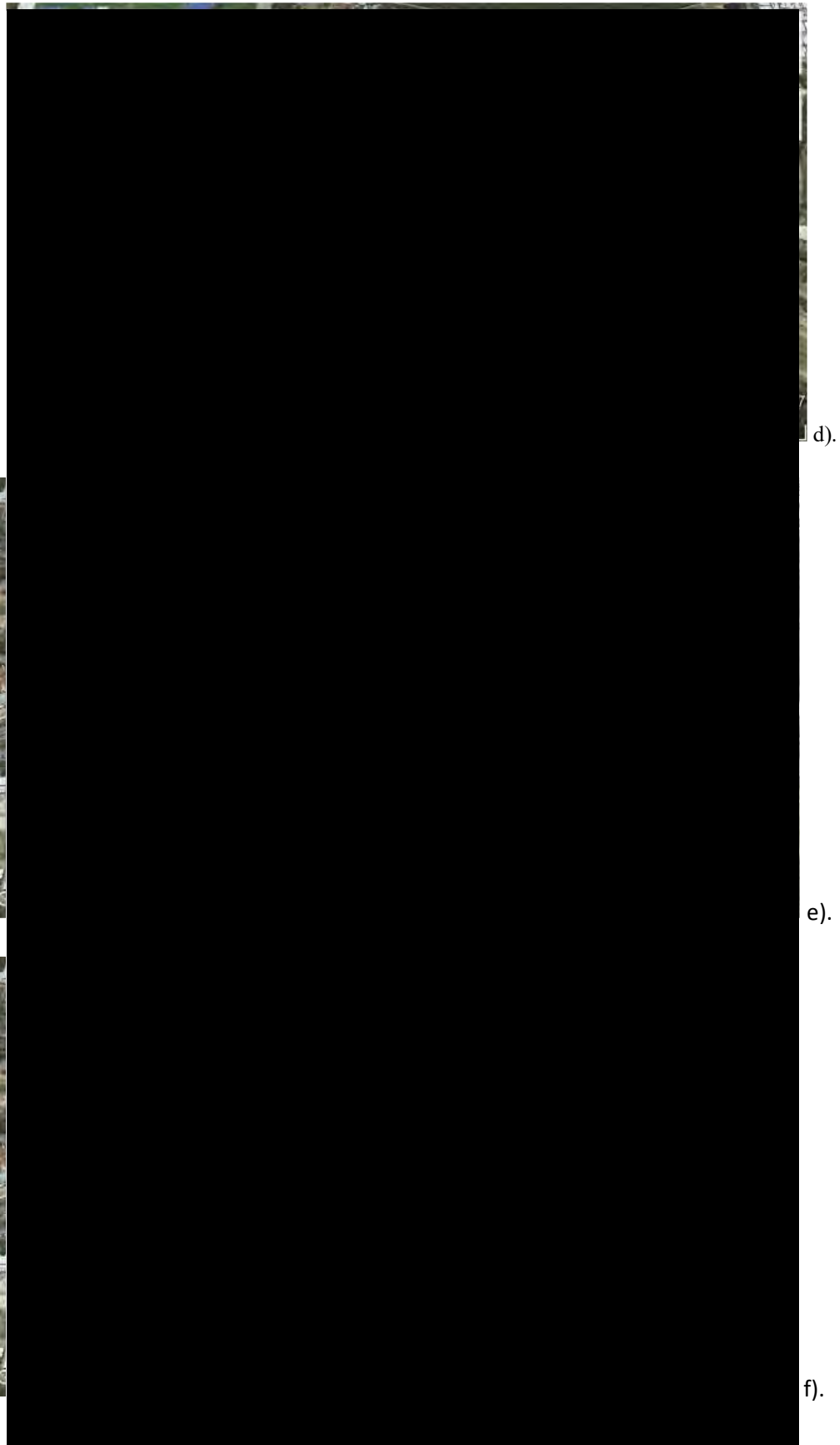


Figure 14. Eastern end of College Avenue, showing the Council reserve. Time series maps showing Natural and Artificial Dreys (January 2021) and the new Natural Dreys discovered in each subsequent monitoring period (March 2021 – January 2022).

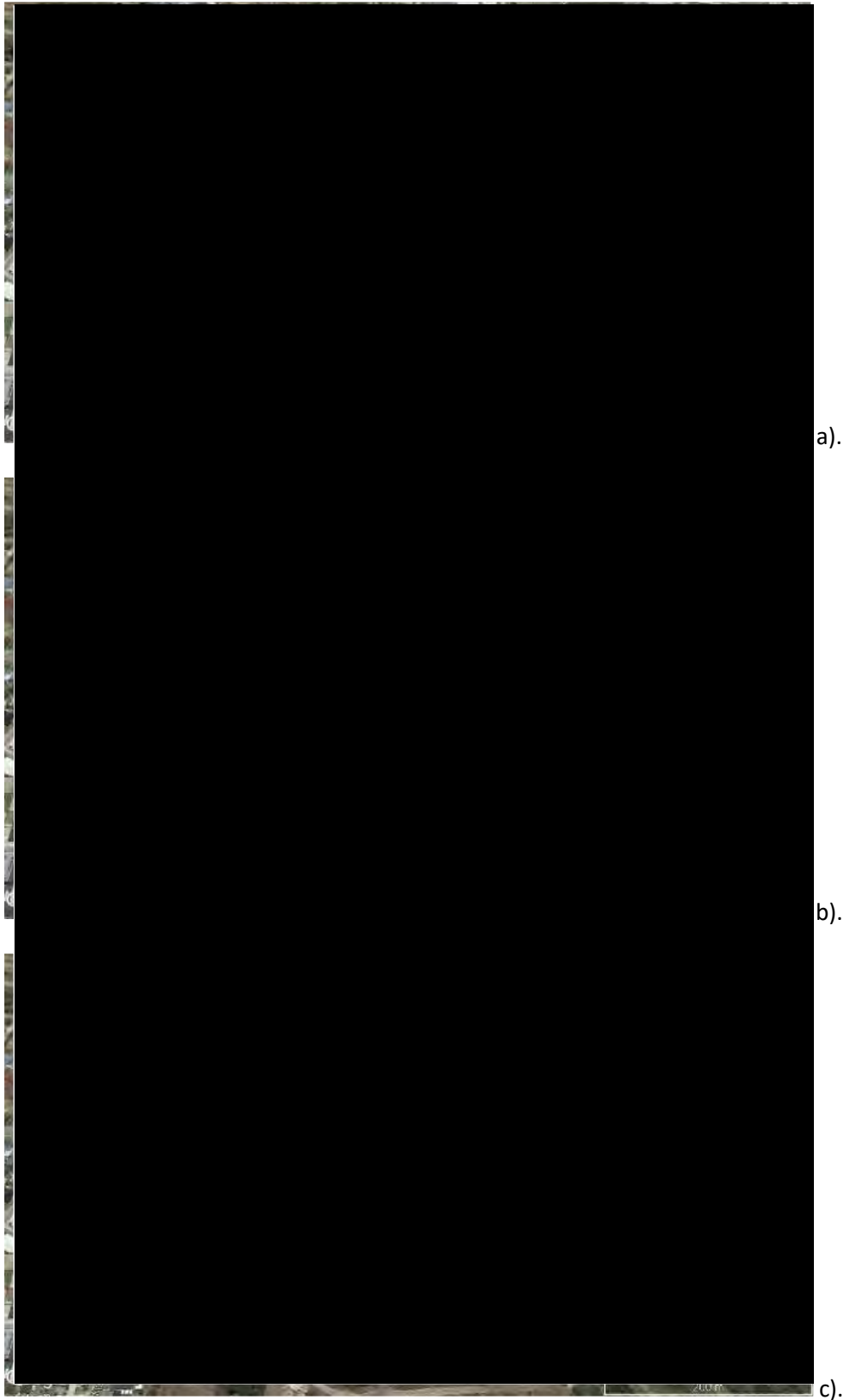
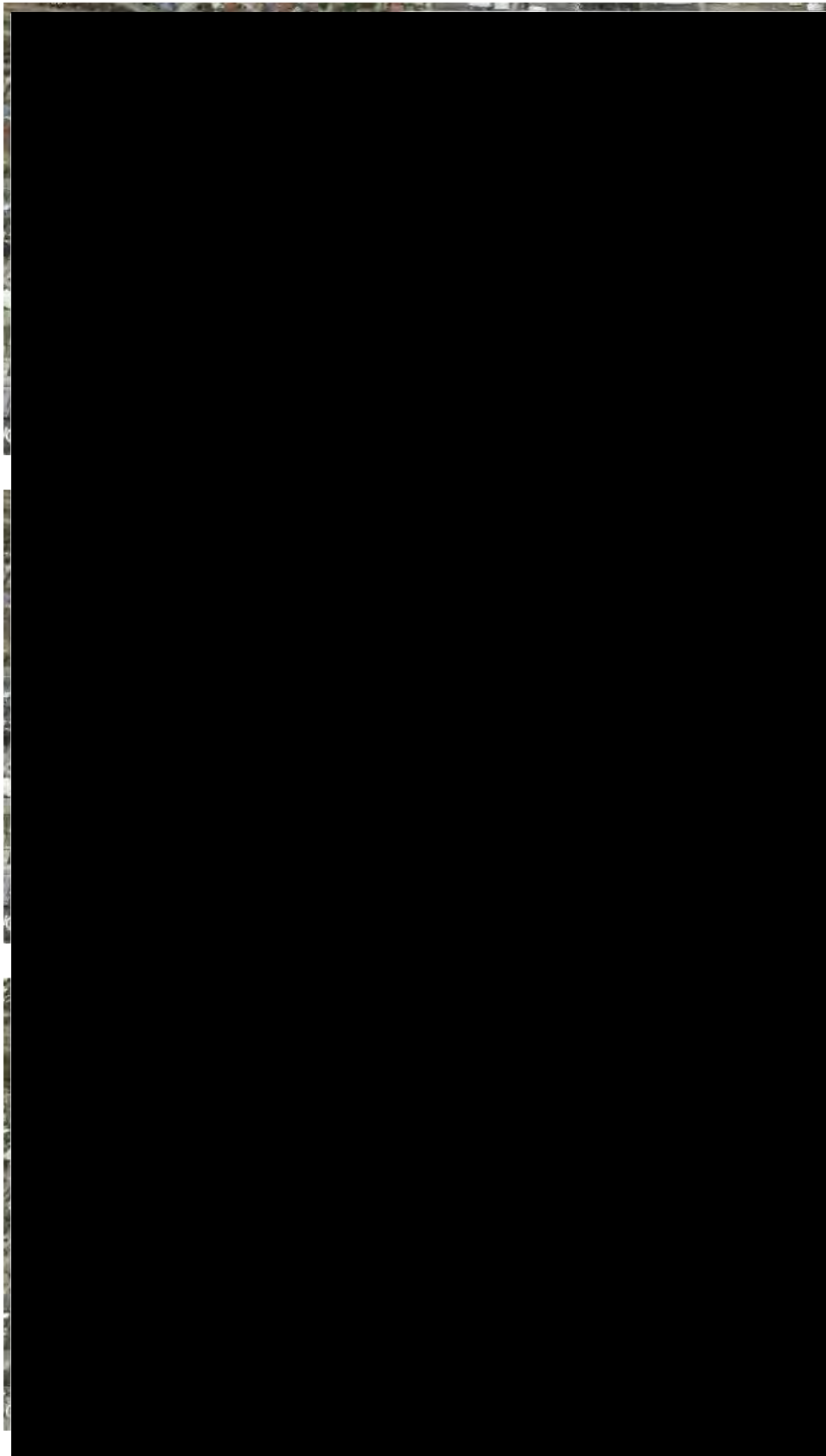


Figure 14 (cont.)

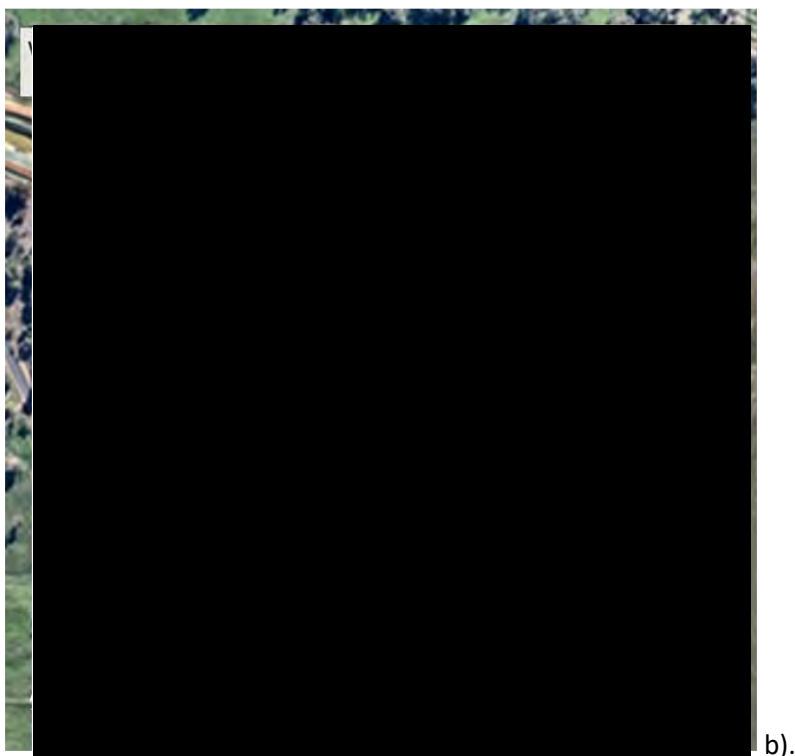
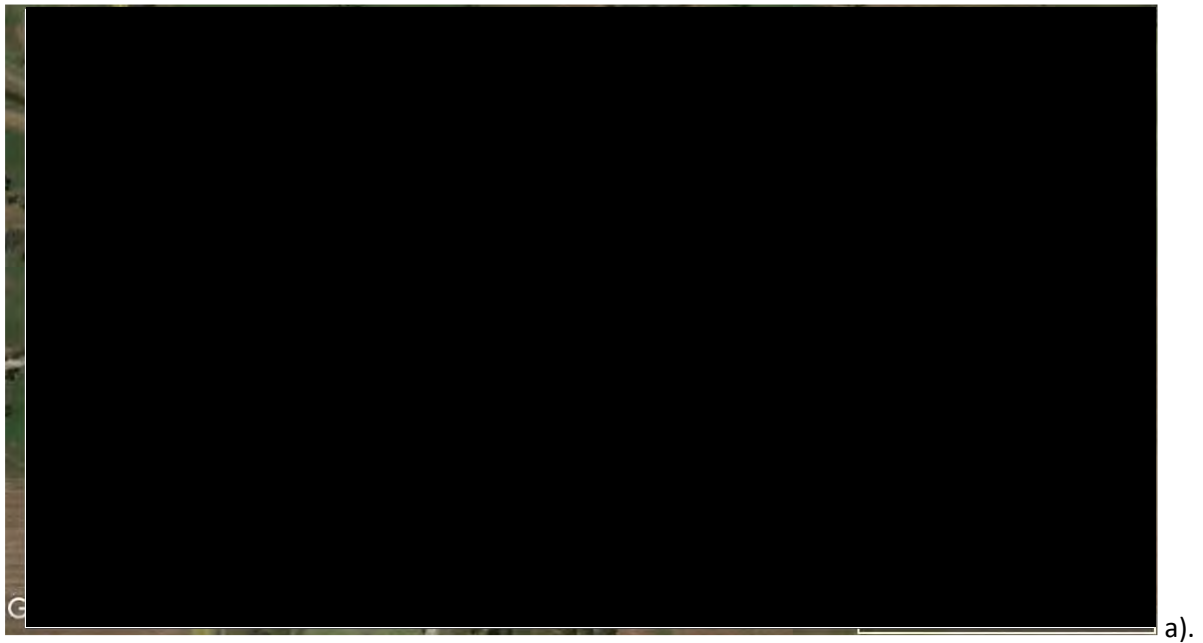


d).


e).




f).



Figure 15. Vasse River Overflow Structure (VROS) area. Time series maps showing Natural and Artificial Dreys (January 2021) and a new Natural Drey discovered in March 2021. No additional dreys were discovered at the VROS after March 2021.









Appendix 3. Table showing relocated and artificial dreys and logs installed outside the clearing zone of the project area. Types of shelters are: DoCo= Dome with coconut fibre (and Agonis leaves), Dom = Dome (with Agonis leaves only), CuCo = Cup with coconut fibre, Cup = Cup (with Agonis leaves only), Buc = Plastic Bucket, Hol = Hollow, Nat = Relocated Natural Drey. Poss. = number of Possums observed using the shelter. The locations of each shelter are plotted in Figures 4 and 5.


ID	Easting	Northing	Type	Tree	Possum numbers during 6 monitoring periods: Jan, Mar, May, Aug, Sept 2021, Jan 2022	Used	Photos	Notes
S1	██████	██████	DoCo	E. rudis	0 0 0 0 0 0	Unused		Collapsed coconut, very close to edge of works




S2		Dom	A. flexuosa	0 0 0 0 0	Unused		Very close to edge of works
S3		Dom	A. flexuosa	0 0 0 0 0	Unused		old leaves only
S4		DoCo	E. rudis	0 1 0 0 0	used		Coconut collapsed – needs repair




S5	[Redacted]	Dom	E. rudis	000001	Used		Old Agonis, Dense
S6		DoCo	C. calophylla	000000	Used		some newer Agonis leaves, likely recent use - Rattus burst out of drey when checked



								
S7			Dom	A. flexuosa	000000	Unused		Only old leaves in drey
S8			CuCo	A. flexuosa	000000	Unused		old leaves only




								
S9			Nat	A. flexuosa	00----	Unused		Blown down
S10			Nat	A. flexuosa	0-0---	Unused		Degraded, then not found




S11	[Redacted]	Cup	A. flexuosa	000000	Unused		Old leaves only
S12		Buc	E. marginata	000000	Unused		empty




								
S13			CuCo	A. flexuosa	0 1 0 0 0	Unused	 	dry Agonis leaves




S14			Cup	A. flexuosa	0 0 0 0 0	Unused		Lots of dead leaves
S15			Buc	A. flexuosa	0 0 1 1 1 0	Used		Few leaves, occupied in May, August and Sept
S16			Nat	A. flexuosa	0 0 ---	Unused		Degraded, then not found



S17	[Redacted]	CuCo	A. flexuosa	0 0 0 0 0	Unused		Lots of brown, old leaves
S18		Nat	A. flexuosa	0 0 0 0 0	Unused		Brown old Agonis

S19		Cup	A. flexuosa	000000	Unused		Exposed location
S20		Buc	A. flexuosa	000000	Unused		Dead leaves, no evidence of use
S21		CuCo	A. flexuosa	000100	Used		lots of dead Agonis leaves, pole camera photo taken. Occupied on one occasion.




S22		Nat	A. flexuosa	00----	Unused		Platform still there but disused, then not found
S23		Cup	A. flexuosa	000000	Unused		Leaves mostly gone
S24		DoCo	C. calophylla	000000	Unused		coconut collapsed




								
S25			Nat	<i>A. flexuosa</i>	0 0 0 0 0	Unused		No fresh Agonis
S26			Nat	<i>Kunzea</i> sp.	0 0 0 0 0	Unused		in good condition.



S27		Nat	Kunzea sp.	0 0 0 0 0	Unused		Collapsed
S28		Nat	Kunzea sp.	0 0 0 0 -	Used		light leaf cover but possibly used. Not found in Jan 2022
S29		Nat	A. flexuosa	0 0 0 - -	Unused		Degraded, not found in Sept 21


S30	[Redacted]	CuCo	C. calophylla	001101	Used		been used but empty. Coconut collapsed. Often used during the year.
S31		Cup	C. calophylla	000000	Unused		few leaves




S32	[Redacted]	CuCo	A. flexuosa	0 0 0 0 0	Used		may have been used
S33		Dom	A. flexuosa	0 0 0 0 0	Unused		Old leaves

								
S34			Buc	<i>A. flexuosa</i>	001010	Used		Few leaves
S35			DoCo	<i>A. saligna</i>	000000	Unused		




								
S36			Cup	<i>A. flexuosa</i>	000000	Unused		Few leaves
S37			Nat	<i>A. flexuosa</i>	000000	Unused		Falling down



S38	[Redacted]	Nat	A. flexuosa	1 0 0 0 0	Used		Only old leaves seen from outside but drey in good condition, possum inside in January 2021 then not occupied subsequently
S39		Nat	A. flexuosa	0 0 0 0 0	Unused		Old leaves but still in good condition

S40	[Redacted]	Cuco	A. flexuosa	000100	Used		Occupied in August
S41		Nat	A. flexuosa	000010	Unused		Degraded, still some Agonis leaves in it



S42		Nat	A. flexuosa	000000	Unused		Degraded
S43		Nat	A. flexuosa	000000	Unused		Large drey, good condition
S44		Buc	A. flexuosa	001000	Used		Old leaves. Occupied in April / May


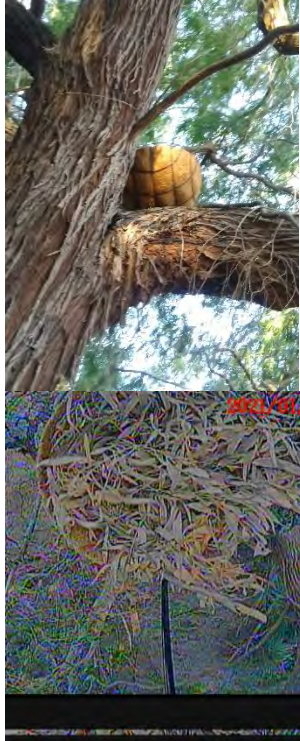
S45		Nat	A. flexuosa	0 0 0 0 0	Unused	No photo	Good condition, old leaves
S46		Nat	A. flexuosa	0 0 0 0 0	Unused		Good condition



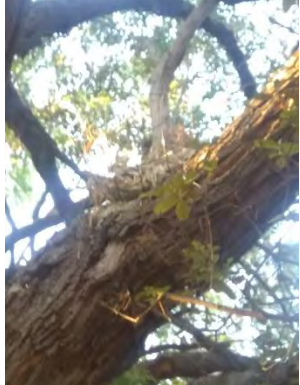
S47		Nat	A. flexuosa	0 0 0 0 0	Unused		Degraded
S48		Cup	A. flexuosa	0 0 1 0 1 0	Used		Old leaves, occupied in April / May and September
S49		CuCo	A. flexuosa	0 1 0 0 0 0	Used		Coconut Base pulled out, occupied in March



S50	[REDACTED]	8	Buc	A. flexuosa	000100	Used		Occupied in August
S51	[REDACTED]	5	Cup	A. flexuosa	000000	Unused	 	Lots of old leaves



S52	[Redacted]	CuCo	A. flexuosa	0 0 0 0 0	Unused		Few leaves left
S53		Cup	A. flexuosa	0 0 0 0 0	Unused		few leaves




S54	[REDACTED]	DoCo	A. flexuosa	0 0 0 0 0	Unused		Artificial Drey originally installed at D05R but then relocated to D23H, material had been rearranged - possible possum use but empty on 25/01/21. No subsequent evidence of use.
S55		DoCo	M. cuticularis	0 0 0 0 0	Unused		Collapsed Difficult for possum to enter – needs repair

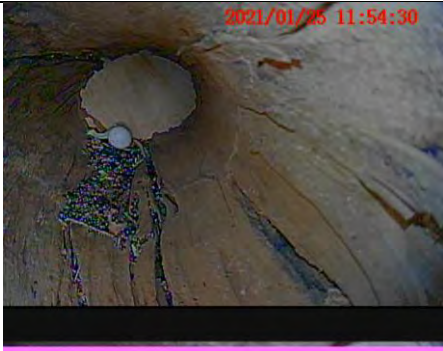


S56	[Redacted]	Nat	A. flexuosa	0 0 0 0 1 0	Used		Large Agonis. Used in September, still maintained
S57		CuCo	A. flexuosa	0 0 0 0 0 0	Unused		Large Agonis, very full, old drey inserted into shelter


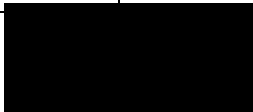


S58		Cup	A. flexuosa	000000	Used		Fresh leaves present, likely used, but empty when checked in Jan 2021. Not occupied when checked subsequently
S59		Nat	A. flexuosa	000000	Unused		Still some Agonis leaves
S60		Cup	A. flexuosa	000000	Unused		Still some Agonis leaves



S61	[Redacted]	DoCo	A. flexuosa	000000	Unused		Coconut collapsed – needs repair
S62		DoCo	A. flexuosa	000000	Unused		Coconut collapsed – needs repair



S63	[Redacted]	Hol	E. patens	0 0 0 1 0 0	Used		Approx. 8m high, relocated from E. rudis in Links Ct. Occupied in August
S64		Hol	E. patens	0 0 0 0 0 0	Unused		relocated from E. rudis in Links Ct




								
S65		DoCo	<i>A. flexuosa</i>	0 0 0 0 0 0	Unused		Coconut dome collapsed	
S66		Hol	<i>C. calophylla</i>	0 0 0 0 0 0	Unused		pigeon egg inside, another broken on ground below in Jan 2021. Nest in September 2021 (probably Bronzewing).	



								
S67			Cup	<i>E. marginata</i>	000000	Unused		few old leaves
S68			DoCo	<i>A. flexuosa</i>	000000	Used		coconut taken and placed further up tree, some blown down





								
S69		DoCo	A. flexuosa	000100	Used	 	natural drey inserted into artificial drey, Coconut collapsed in Jan 21, but occupied in August	

S70	[Redacted]	Hol	A. flexuosa	1 1 0 0 0	Used		Possum in base of log in Jan and Mar 21.
S71		CuCo	A. flexuosa	0 0 1 1 0 1	Used		coconut rearranged, removed from base, occupied in April / May, August and Jan 2022


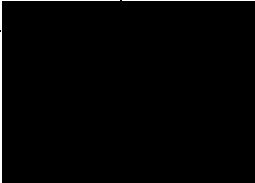

								
S72			Nat		0-0-00-		No photo	deteriorated and difficult to locate
S73			Hol	A. flexuosa	000001	Used		A few old leaves only. Occupied in Jan 2022




								
S74			DoCo	E. rudis	0 0 0 0 0	Used	 	coconut still in good condition, looks like it had been used, in January 2021, but not since.




S75	[Redacted]	Hol	A. flexuosa	0 0 0 0 1	Used		Slightly green leaves in bottom, probably used in Jan 2021, occupied in Jan 2022
S76		DoCo	A. flexuosa	1 0 0 0 0	Used		coconut rearranged – visible from the outside, possum inside. Not recorded as occupied since Jan 21




								
S77			Hol	C. calophylla	1 2 1 0 0 1	Used	 	Possum regularly recorded. The only short hollow which has recorded a mother and joey inside (Mar 21)

S78	[Redacted]	CuCo	<i>C. calophylla</i>	0 0 0 0 0	Unused		coconut collapsed. Needs repair
S79		Hol	<i>E. rudis</i>	1 0 1 0 0	Used		Possum recorded on two occasions

								
S80			DoCo	A. flexuosa	1 1 1 1 1 0	Used		Klara's Lodge. Paperbark had been rearranged – visible from outside, possum inside all but Jan 2022. One of only two dreys with Paperbark, which may be key to its success.

S81			Hol	A. flexuosa	000001	Used			Used in Jan 2022
S82			Nat	A. flexuosa	000000	Unused			Dry, collapsed
S83			Hol	C. calophylla	011001	Used			Occupied in 3 of 6 monitoring periods

S84			Nat	Ground	0 0	Unused		On ground, blown out of tree. Not found after March 21
S85			DoCo	<i>E. marginata</i>	0 0 0 0 0	Unused		Coconut collapsed – needs repair
S86			DoCo	<i>C. calophylla</i>	0 0 0 0 0	Unused		

								
S87			up	A. flexuosa	0 0 0 0 0	Unused	 	In Large Agonis
S88			up	A. flexuosa	-- 0 0 0 0	Used		Coconut removed