OPERATIONAL AREAS, NULLAGINE AND NORTH STAR

CONSERVATION SIGNIFICANT FAUNA MONITORING 2018

PREPARED FOR: FORTESCUE METALS GROUP

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Project ID: 1804 Project Name: Operational Areas, Nullagine and North Star | Conservation Significant Fauna Monitoring 2018	
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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Fortescue operational sites are required to undertake conservation significant fauna monitoring, as outlined in the *Conservation Significant Fauna Management Plan* (CSFMP; 100-PL-EN-0022). The Plan is required by approvals granted under Ministerial Statements 690, 899, 1033 and 1062, as well as under Controlled Actions EPBC 2005/2205, 2010/5513, 2010/5567 and 2013/7055.

Monitoring requirement for Nullagine mine site are outlined in the *Northern Quoll Management and Monitoring Plan* (NQMMP; NU-PL-EN-0001). The Plan is required by approvals granted under Controlled Actions EPBC 2009/4930 and 2013/6887.

FMG Iron Bridge's North Star project site is required to undertake conservation significant fauna monitoring as outlined in the *EPBC Listed Threatened Fauna Management Plan* (NS-PL-EN-0003). The Plan is required by approvals granted under Controlled Action EPBC 2012/6530.

Species included in this monitoring program are defined in Section 1.3. of the CSFMP and predominately comprise conservation significant fauna species which are species listed as Critically Endangered, Endangered, Vulnerable or Migratory under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) or as Schedule species under the *Western Australian Wildlife Conservation Act 1950* (WC Act)/*Biodiversity Conservation Act 2016* (BC Act).

Monitoring methods were developed to be in accordance with:

- Fortescue's Conservation Significant Fauna Management Plan 100-PL-EN-0022
- Northern Quoll Management and Monitoring Plan NU-PL-EN-0001
- EPBC Listed Threatened Fauna Management Plan NS-PL-EN-0003
- State and Commonwealth Guidelines

Monitoring methods for Northern Quoll and Greater Bilby were aligned with the methods currently used by the Department of Biodiversity Conservation and Attractions (DBCA).

Cloudbreak

Fauna monitoring completed at Cloudbreak consisted of Northern Quoll monitoring within tenement M45/1142 (outside the existing approved mine approval boundary), conservation significant birds monitoring, and fauna usage of rehabilitation sites. The dry season monitoring was completed between 25 – 30 August 2018. The wet season monitoring was completed on 2 December 2018.

Northern Quoll

Northern Quoll monitoring within tenement M45/1142 was completed during the dry season and consisted of the installation of motion cameras at three sites. Each site was monitored over four consecutive nights using ten motion cameras spaced at 100 m intervals. Each site was also searched for secondary evidence for 10-person hours. Two of the three monitoring sites (CB NQ I1 & CB NQ I2) were also monitored long-term over a three-month period. Methods and site locations were consistent with the 2017 monitoring. No Northern Quolls were recorded from the three sites during the 2018 and 2017 monitoring. To date, only one record (2016) of a male Northern Quoll is known from tenement M45/1142. Follow-up surveys did not record any other evidence of the Northern Quoll indicating temporary usage of habitats by dispersing individuals.

Conservation Significant Birds

Monitoring of conservation significant birds was completed during the wet season at three potential impact sites and three control sites. The control sites were located in habitats comparable to the potential impact sites. Each site was monitored using standardised 20 minutes ornithological surveys. No conservation significant bird species were recorded from the potential impact sites or the control sites. This is consistent with previous monitoring data. The lack of records from the potential impact sites is consistent with results from previous years from these sites and is due to the low suitability of the habitats present within the mine site. An additional three control sites were also monitored which are located in optimal wetland habitat within the Fortescue Marsh. These monitoring sites provide regional control data from the closest known migratory bird source population (only during migration periods) which may influence the migratory bird occurrence at the mine site. Two species (Common Greenshank and Common Sandpiper) were recorded from the Fortescue Marsh control sites. The data suggests that there is a slight decrease in conservation significant birds recorded from the Fortescue Marsh control sites in comparison to 2017 and 2016.

Rehabilitation Areas

Fauna usage of three rehabilitation sites was monitored within the Cloudbreak mine site during the dry season with focus on conservation significant fauna. Each site was searched for secondary evidence and one motion camera was deployed over four consecutive nights. Methods and site locations were consistent with the 2016 and 2017 monitoring. To date, no conservation significant fauna species have been recorded. However, the structure and density of native vegetation at all rehabilitation sites are considered suitable for the use by generalist fauna species which have been recorded (three species). The utilisation of rehabilitation areas by introduced species in comparison to other areas has not increased.

Compliance with Fauna Management Plans

Northern Quoll monitoring at the Cloudbreak mine is not required under the current CSFMP and therefore the Hypotheses are not required to be addressed. Monitoring was completed at tenement M45/1142 due to the record of a dispersing Northern Quoll individual in 2016 and the potential future expansion of mining activity into this area. There is currently insufficient data of conservation significant bird populations from the mine site to address Hypothesis 1-3 of the CSFMP. Conservation significant birds are more likely to utilise suitable habitats in the Fortescue Marsh and are likely to only overfly the Cloudbreak mine site as part of their travel or foraging activities.

Christmas Creek

Fauna monitoring completed at Christmas Creek included monitoring of Northern Quoll, Greater Bilby, Pilbara Leaf-nosed Bat (surveillance level only), Ghost Bat, Pilbara Olive Python, conservation significant birds, and fauna usage of rehabilitation sites. The dry season monitoring was completed between 24 – 29 August 2018. The wet season monitoring was completed between 3 – 4 December 2018, and between 10 – 19 December 2018.

Northern Quoll

Northern Quoll monitoring within the Christmas Creek mine site was completed during the dry season and consisted of the installation of motion cameras at three sites. Each site was monitored over four consecutive nights using ten motion cameras spaced at 100 m intervals. Each site was also searched for secondary evidence for 10-person hours. Motion Cameras at two of the three monitoring sites (CC NQ I2 & CC NQ I3) were left in place long-term over a three-month period. Methods and site locations were consistent with 2016 and 2017 monitoring with site locations based on previous monitoring methods (2013-2015). Northern

Quoll have not been recorded from the Christmas Creek mine site during the current monitoring nor any previous monitoring or baseline surveys. No critical habitat is present within the Christmas Creek mine with only one small rocky gorge located on the northern edge of the mine tenements which is too isolated to support a local population. More suitable habitat is present to the north of the mine site.

Greater Bilby

Occupancy monitoring of Greater Bilby was completed at Christmas Creek during both the dry and wet seasons. Methods were aligned with the DBCA Greater Bilby monitoring methods. They were consistent with the 2017 monitoring and based on site locations used in 2016. A total of 30 sites (2-hectares) were searched for secondary evidence of Greater Bilby during the dry season. A sub-set of 15 sites were re-sampled during the wet season monitoring. No evidence of Greater Bilby was recorded from the Christmas Creek mine site during the dry and wet season. A small population was recently discovered approximately 8 km south-east of the Christmas Creek mining tenements on the Roy Hill mine site. A dispersing male Greater Bilby was recorded from the Christmas Creek mine site in May 2017 and this individual is thought to have originated in the Fortescue Marsh from the same source population as the Roy Hill records. Greater Bilby were recorded from control site CC POP C1 during the wet season monitoring (approx. 30 km north of the Christmas Creek mine site).

Pilbara Olive Python

Pilbara Olive Python monitoring was completed at four potential impact sites and four control sites during the wet season. Each site was searched each night for one-person hour over a seven-night period. Forty kilometres of road transects were also searched each night. No Pilbara Olive Python were recorded in 2018. To date, the species has not been recorded during monitoring and records are limited to reports made by site personnel. Four confirmed records have been made between 2013 and 2018, one probable confirmed record exists from 2014 and one unconfirmed sighting in 2011. Critical habitat for the species is not present within the Christmas Creek mine and the infrequent records made to date confirm that the Pilbara Olive Python is not a resident species on site. The species only travels from the rocky hills north of the Christmas Creek mine site along the southerly creeklines.

Conservation Significant Bats

Monitoring for Ghost Bat and Pilbara Leaf-nosed Bat (surveillance level for PLNB only) was completed during the wet season at 12 potential impact sites and 12 control sites. One bat recorder (SM2Bat+ and SM4Bat FS) was deployed at each site over seven consecutive nights. Methods were consistent with 2017 monitoring methods and site locations were based on those used since 2016. No Pilbara Leaf-nosed Bats or Ghost Bats were recorded from the potential impact sites or control sites at the Christmas Creek mine site in 2018. The absence of the species from the mine site is consistent with the previous years of monitoring. To date, there has only been a single potential call of the Ghost Bat recorded from two control sites (CC Bat C1 in 2016 and CC BAT C3 in 2017), and one Pilbara Leaf-nosed Bat foraging call recorded from one control site (CC BAT C4 in 2017), confirming the absence of the two species from the Christmas Creek mine site.

Conservation Significant Birds

Monitoring of conservation significant birds was completed during the wet season at three potential impact sites and three control sites. Each site was monitored using ornithological surveys for 20 minutes. No conservation significant bird species were recorded from the potential impact sites, or the control sites. The lack of records from the potential impact sites is consistent with results from previous years from these sites and is due to the low suitability of the habitats present within the mine site. The Common Greenshank and Common Sandpiper were recorded from the additional Fortescue Marsh control sites which are located in

the closest optimal migratory bird habitat. The data suggests that there is a slight decrease in regional migratory bird abundance in comparison to 2017 and 2016.

Rehabilitation Areas

Fauna usage of three rehabilitation sites was monitored within the Christmas Creek mine site during the dry season with focus on conservation significant fauna. Each site was searched for secondary evidence and one motion camera was deployed over four consecutive nights. Methods and site locations were consistent with the 2016 and 2017 monitoring. To date, no conservation significant species have been recorded. The structure and density of native vegetation at all rehabilitation sites are considered suitable for the use by generalist fauna species. Seven generalist species (one mammal, five birds and one reptile) have been recorded from the sites to date. The activity of introduced species is comparable with the surrounding areas.

Compliance with Fauna Management Plans

An insufficient number of Northern Quoll, Greater Bilby, Pilbara Olive Python, Pilbara Leaf-nosed Bats, Ghost Bats and conservation significant bird individuals have been recorded to date to address hypothesis 1-3 of the CSFMP. This is due to the absence of the species or due to the presence of very low population densities. Suitable habitat for the above species is also very limited within the Christmas Creek mine site. The only record of Pilbara Olive Pythons in 2018 was made by site personnel and indicates an ongoing presence on site, satisfying hypothesis 3 of the CSFMP. Northern Quoll, Greater Bilby, Pilbara Leaf-nosed Bat and Ghost Bat are considered absent from the Christmas Creek mine site with only one confirmed record of Greater Bilby to date (2017). Conservation significant birds are likely to utilise more suitable habitats in the Fortescue Marsh and may overfly the Christmas Creek mine site as part of their travel or foraging activities.

Solomon Hub

Fauna monitoring completed at Solomon Hub included monitoring of Northern Quoll and fauna usage of rehabilitation sites. The dry season monitoring was completed between 10 – 15 July 2018. The wet season monitoring was completed between 11-20 March 2019 (delayed due to a bushfire in December 2018).

Northern Quoll

Northern Quoll monitoring within the Solomon Hub mine site consisted of trapping three potential impact sites. Each site was trapped over four consecutive nights using 50 cage traps. Five motion cameras were also deployed over four consecutive nights and searches for secondary evidence (10-person hours) completed. A total of nine Northern Quoll individuals were recorded from the three potential impact sites. Previous monitoring events recorded up to four individuals between 2012 and 2017. The number of individuals captured in 2018 is double the number of Northern Quoll individuals captured during previous monitoring. Environmental conditions on site have been favourable since 2016, resulting in increased population densities. Breeding activity were recorded in both 2017 and 2018 within 400 m of the Ore Processing Facility indicating that mining activities currently have minimal impact on the ongoing presence of the local Northern Quoll population.

Pilbara Olive Python

Pilbara Olive Python monitoring was completed at four potential impact sites and four control sites during the wet season. Each site was searched each night for one-person hour over a seven-night period. Forty kilometres of road transects were also searched each night. One Pilbara Olive Python was recorded from an opportunistic site (Kangi camp). The individual was a juvenile (hatchling from this wet season) indicating breeding continues to occur within the Solomon Hub. The species has been recorded during monitoring

from the impact areas on an ongoing basis, and site personnel continue to record the species throughout the year indicating that the Pilbara Olive Python populations continues to occur within the Solomon Hub.

Conservation Significant Bats

Monitoring for Ghost Bat and Pilbara Leaf-nosed Bat (surveillance level for PLNB only) was completed during the wet season at 12 potential impact sites and 12 control sites. One bat recorder (SM2Bat+ and SM4Bat FS) was deployed at each site over seven consecutive nights. Methods were consistent with 2017 monitoring and site locations were based on those used in 2016 and 2017. The Pilbara Leaf-nosed Bat was recorded from one potential impact site (SM Bat I7) and nine control sites at Solomon Hub during the 2018 monitoring. The Ghost Bat was recorded from one potential impact sites (SM Bat I7) over four nights. Both bat species were recorded from this potential impact site during the 2017 monitoring and it is likely that the Ghost Bat utilises this site as a temporary roost cave due to repeated records across monitoring periods, the number of calls and call timing. The two species were also recorded from an additional opportunistic site in the Fredericks mine area indicating another potential temporary roost cave present on site. During the baseline and previous monitoring, the Pilbara Leaf-nosed Bat and Ghost Bat were recorded in low numbers, similar to the 2018 monitoring.

Conservation Significant Birds

Monitoring of conservation significant birds was completed during the wet season at three potential impact sites and three control sites. Each site was monitored using ornithological surveys for 20 minutes. No conservation significant bird species were recorded from the potential impact sites, or the control sites. The lack of records from the potential impact sites is consistent with results from previous years from these sites and is due to the low suitability of the habitats present within the mine site.

Rehabilitation Areas

Fauna usage of three rehabilitation sites was monitored within the Solomon Hub mine site during the dry season with focus on conservation significant fauna. Each site was searched for secondary evidence and one motion camera was deployed over four consecutive nights. Methods and site locations were consistent with the 2016 and 2017 monitoring. One Northern Quoll was recorded from rehabilitation site SM RE 11 which is located adjacent to monitoring site SM NQ I2 (in Kangeenarina Creek) where Northern Quoll are known to occur. This record shows that the rehabilitated habitat is suitable for use by Northern Quoll for foraging purposes. Two other native mammal species have been recorded from the sites to date (Common Rock-rat and Stripe-faced Dunnart. The rehabilitation level of the sites is suitable for the utilisation by generalist species. The commonly recorded introduced species, the House Mouse was the only introduced species recorded from two sites to date, indicating that the activity level of feral fauna is not increased in comparison to the surrounding areas.

Compliance with Fauna Management Plans

The hypothesis 1-3 of the CSFMP regarding Northern Quolls and Pilbara Olive Python was satisfied. Data suggests that the population at the Solomon Hub is stable with no changes in spatial distribution (H1), an increase in relative abundance (H2), and an ongoing presence (H3). Based on site-based records of Pilbara Olive Pythons and the record of a juvenile individual from Kangi camp, hypothesis 3 of the CSFMP (ongoing presence) is satisfied. An insufficient number of Pilbara Leaf-nosed Bats, Ghost Bats and conservation significant bird individuals have been recorded to date to address hypothesis 1 and 2 of the CSFMP. This is due to the presence of very low population densities (PLNB and birds) and the limitations associated with current detection methods (Ghost Bat). However, the Ghost Bat may be using two of the potential impact

sites for temporary roosting. The Pilbara Leaf-nosed Bat and Ghost Bat continue to be present in low numbers, satisfying hypothesis 3 of the plan.

Hamersley Rail Line

Fauna monitoring completed along the Hamersley Rail Line included monitoring of Northern Quoll, conservation significant birds and fauna usage of culverts and rehabilitation sites. The dry season monitoring was completed between 24 – 29 July 2018. Culvert sites were monitored between 1 – 30 July 2018. The wet season monitoring was completed on 1 December 2018.

Northern Quoll

Northern Quoll monitoring along the Hamersley Rail Line consisted of trapping three potential impact sites. Each site was trapped over four consecutive nights using 50 cage traps. Five motion cameras were also deployed over four consecutive nights and searches for secondary evidence (10-person hours) completed. No Northern Quoll (trapping, motion camera or secondary evidence) was recorded from the three potential impact sites in 2018. This is consistent with the 2017 monitoring results. The number of Northern Quoll individuals recorded decreased between 2014 and 2015 (from five trapped individuals to one motion camera image and secondary evidence). No individuals have been recorded since 2016. A large bush fire impacted an area between two of the trap sites that recorded the majority of Northern Quolls prior to 2015 (HL NQ I2 & HL NQ I3), which potentially increased predation pressures and resulted in a local decline of the species. As a result, 10 long-term motion cameras were deployed across the monitoring sites for three months in 2018 to get a better understanding of Northern Quoll distribution and feral species numbers. The cameras did not record the presence of any Northern Quolls; however, Feral Cats were recorded from five of the ten motion cameras. The introduced predator was recorded from one motion camera during the baseline survey and has had an ongoing presence along the rail. It is likely that a combination of the bush fire and increased predation by an increasing number of Feral Cats has impacted the local Northern Quoll population. However, due to the change in camera survey effort (number of sites and trap nights) a trend of Feral Cat numbers cannot be clearly determined.

Conservation Significant Birds

Monitoring of conservation significant birds was completed during the wet season at three potential impact sites and three control sites. Each site was monitored using ornithological surveys for 20 minutes. No conservation significant bird species were recorded from the potential impact sites or the control sites associated with the Hamersley Rail Line. This result is consistent with the previous monitoring events. A decrease in migratory birds was recorded from the Fortescue Marsh control sites in 2018 indicating lower activity during the current monitoring. Grey Falcon were recorded opportunistically along the Hamersley Rail Line during the dry season monitoring.

Rehabilitation Areas

Fauna usage of three rehabilitation sites was monitored along the Hamersley Rail Line during the dry season with focus on conservation significant fauna. Each site was searched for secondary evidence and one motion camera was deployed over four consecutive nights. Methods and site locations were consistent with the 2016 and 2017 monitoring. No conservation significant species was recorded. The structure and density of native vegetation at all rehabilitation sites are considered suitable for the use by generalist fauna species. Northern Quolls were recorded in 2013 and 2014 foraging at rehabilitated areas with large granite boulder piles. Six generalist species (three mammals and three birds) have been recorded from the current sites to date. The activity of introduced species has not been recorded as increased in comparison to surrounding areas with only the House Mouse and Feral Cat recorded from one site to date.

Fauna Use of Culverts

Monitoring of fauna usage of culverts was completed during the dry season at five culverts located along the Hamersley Rail Line. Each culvert was searched for secondary evidence and a motion camera deployed for 30 days. Each culvert site was also baited using non-reward bait in the form of a fish oil-soaked cotton rope. No conservation significant fauna species were recorded from the culvert sites. At least five Feral Cat individuals were recorded on motion camera at four of the five culvert sites.

Compliance with Fauna Management Plans

The hypotheses 1-3 of the CSFMP with regards to the Northern Quoll was not satisfied. Northern Quoll populations associated with the Hamersley Rail Line have declined in distribution (H1) and abundance (H2) and no evidence was collected to suggest that the species is still present on site (H3). This trend was not recorded from any of the control sites (i.e. DBCA sites, North Star control sites). Conversely, the population sizes at the Solomon Hub, Main Line Rail and Nullagine have been stable or increased in 2018. An increase in Feral Cats and a bush fire in 2015 is considered the likely cause for the continued decline since 2016. Climatic conditions were favourable in 2017 and 2018. It is unlikely that the species has been directly impacted by the operation of the rail since the species has not been impacted by the Main Line Rail. However, the construction of the rail and the recent bush fires may have contributed to a potential increase in Feral Cat predation. The conservation significant bird data is insufficient to address the hypothesis 1 (spatial distribution) and hypothesis 2 (abundance) of the CSFMP. Hypothesis 3 is satisfied due to the continued presence of the Grey Falcon along the Hamersley Rail Line.

Main Line Rail

Fauna monitoring completed along the Main Line Rail included monitoring of Northern Quoll, Greater Bilby, Pilbara Leaf-nosed Bat, Ghost Bat, conservation significant birds, fauna usage of culverts and fauna usage of rehabilitation sites. Surveillance of introduced species, including the Red Fox, was also conducted as they were identified as a potential threatening process along the rail during a desktop assessment in 2017. The dry season monitoring was completed between 30 July – 3 August 2018. Surveillance of Red Fox and monitoring of fauna usage at culvert sites using motion cameras occurred between 1 – 30 July 2018. The wet season monitoring was completed from 28 – 31 November and 5 – 7 December 2018.

Northern Quoll

Northern Quoll monitoring along the Main Line Rail was completed during the dry season and consisted of trapping three potential impact sites. Each site was trapped over four consecutive nights using 50 cage traps. Five motion cameras were also deployed over four consecutive nights and searches for secondary evidence (10-person hours) completed. A total of five Northern Quoll individuals were recorded from two potential impact sites (MR NQ I1 & I2). Secondary evidence (scats) was recorded from site MR NQ I3. An additional two records were made from Greater Bilby monitoring sites MR GB AS I14 and MR GB OS 36. The trapping results are comparable to previous monitoring results (one record in 2016 and five records in 2017) and population trends recorded from DBCA regional control sites, North Star control sites and the Solomon Hub indicating stable populations. The population has not been impacted significantly by the operation of the rail.

Greater Bilby

Abundance and occupancy monitoring of Greater Bilby was completed along the Main Line Rail during both the dry and wet seasons. Methods were aligned with the DBCA Greater Bilby monitoring methods. They were consistent with the 2017 monitoring and based on site locations used during the 2013-2016

monitoring. A total of 40 sites (2-hectares) were searched for secondary evidence of Greater Bilby during the dry season. A sub-set of 20 sites were re-sampled during the wet season monitoring. Abundance monitoring was completed at two sites; potential impact site (MR GB AS I14) and control site (MR GB AS C16). Evidence of Greater Bilby was recorded from five occupancy monitoring sites (MR GB OS1, OS3, OS9, OS10, OS16) during the dry season monitoring event and no sites during the wet season monitoring event. Evidence of Greater Bilby was recorded from one abundance monitoring site (MR GB AS I14). A total of 23 scats were collected, of which nine yielded DNA which identified the presence of two individuals. One of the individuals is a female that has been recorded from the site since 2014. The other individual has not been recorded from this site before and is expected to be a young of the resident female. Current data indicates that there is no significant impact to the Greater Bilby populations located along the Main Line Rail. The absence of Greater Bilby from the control site MR GB AS C16 is attributed to fires that burnt the southern area of the site in 2017 and may have triggered movement of the local population away from this site.

Conservation Significant Bats

Monitoring for Ghost Bat and Pilbara Leaf-nosed Bat (surveillance level for PLNB only) was completed during the wet season at 12 potential impact sites and 12 control sites. One bat recorder (SM2Bat+ and SM4Bat FS) was installed at each site over seven consecutive nights. Methods were consistent with the 2017 monitoring and is based on the 2013-2016 monitoring methods. The 2018 results indicate that Pilbara Leaf-nosed Bats foraged at seven potential impact sites which is similar to the previous monitoring (2013-2014, 2016-2017) and the trend recorded at the Main Line Rail control sites. No Ghost Bats were recorded through bat call analysis from the potential impact sites and the control sites. Secondary evidence was recorded from three culvert sites (MR Cu 01, Cu 07 and Cu 08) indicating nocturnal feeding behaviour which is consistent with previous monitoring and reflects the lack of roost sites or caves along the rail.

Conservation Significant Birds

Monitoring of conservation significant birds was completed during the wet season at three potential impact sites and three control sites. Each site was monitored using ornithological surveys for 20 minutes. No conservation significant birds were recorded from the potential impact sites. The Grey Falcon was recorded opportunistically from along the Main Line Rail (remains of a predated individual) and from control site MR MiB C1. The data suggests that there is no change in conservation significant bird populations along the Main Line Rail and that they have not been impacted by the operation of the rail. Control site data indicate that there is a slight decrease in conservation significant birds in 2018.

Rehabilitation Areas

Fauna usage of three rehabilitation sites was monitored along the Main Line Rail during the dry season with focus on conservation significant fauna. Each site was searched for secondary evidence and one motion camera was deployed over four consecutive nights. Methods and site locations were consistent with the 2016 and 2017 monitoring. No conservation significant species were recorded whilst the structure and density of native vegetation at the three rehabilitation sites are considered suitable for the use by generalist fauna species. Despite this, no generalist species have been recorded to date. Increased activity of introduced species has not been recorded in comparison to surrounding areas with only cattle being recorded to date.

Fauna Use of Culverts

Monitoring of fauna usage of culverts was completed during the dry season at ten culverts along the Main Line Rail. Each culvert was searched for secondary evidence and a motion camera was deployed for 30 days. Northern Quoll was recorded on motion camera from one culvert site (MR Cu 04) on two occasions.

Secondary evidence of the Ghost Bat (prey remains and scats) was recorded from three culverts (consistent with 2017 locations). Feral Cats were also recorded from three culvert sites.

Red Fox Surveillance

A risk assessment in 2017 identified predation by Red Fox as a potential threatening process for Greater Bilby along the Main Line Rail. Surveillance of Red Fox was completed during the dry season at ten targeted sites and at all culvert monitoring sites located along the Main Line Rail, using a motion camera deployed for 30 days and baited with fish-oil-soaked rope (a non-reward bait). Searches for secondary evidence was also completed. No Red Fox were recorded and they are not currently a threat to Greater Bilby populations along the Main Line Rail. Future surveillance may identify the presence of Red Fox along the Main Line Rail if climatic conditions or the availability of suitable prey species increases.

Compliance with Fauna Management Plans

The hypothesis 1-3 of the CSFMP regarding Northern Quoll and Greater Bilby are satisfied. Statistical analysis of the data suggests that the populations along the Main Line Rail are stable with no changes in the species' spatial distribution (H1), relative abundance (H2), or ongoing presence (H3). The conservation significant bird records are insufficient to address the three hypotheses, although opportunistic records indicated that conservation significant birds persist on site, satisfying hypothesis 3 of the CSFMP. The use of habitat by Pilbara Leaf-nosed Bat and Ghost Bat along Main Line Rail has been consistent with previous years which comprises foraging behaviour only. Spatial distribution (H1), relative abundance (H2), and ongoing presence (H3) of the two species have been consistent, satisfying the CSFMP.

Nullagine

Fauna monitoring completed at the Nullagine mine site consisted of Northern Quoll monitoring with the site visit completed between 26 – 27 July 2018 (methods as per the NQMMP).

Northern Quoll

Northern Quoll monitoring at the Nullagine mine site was completed during the dry season across two mining areas: Bonnie East and Warrigal. Twenty motion cameras were deployed for 40 nights (800 trap nights) and searches for secondary evidence (10-person hours) completed. Northern Quolls were recorded from 17 of the 20 locations. An estimated 20 individuals were recorded over several nights indicating that a resident population has re-established after the large-scale fires between 2006 and 2009. Records indicating the occurrence of a possible resident population were made from eight locations at Bonnie East and from one location at Warrigal. Camera images also suggest the presence of several females which have not previously been recorded from the site. The 2018 data indicates the potential presence of a resident Northern Quoll population however additional monitoring during different seasons would be required to confirm this.

Compliance with Fauna Management Plans

The Objectives 1 and 2 of the NQMMP have been met by completing an ongoing monitoring program on site and by adding information to the species' regional distribution (by providing data of a potential resident population). Objective 3 of the NQMMP (monitoring of rehabilitation sites) is currently not met due to the lack of rehabilitated areas on site. The site is currently in care and maintenance and rehabilitation areas will be monitored once established.

North Star

Fauna monitoring completed at the North Star mine site included monitoring of Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python and fauna usage of rehabilitation sites. The dry season monitoring was completed between 15 – 23 August 2018. The wet season monitoring was completed between 1 – 7 December 2018.

Northern Quoll

Northern Quoll monitoring within the North Star mine site was completed during the dry season and consisted of trapping four potential impact sites and four control sites. Each site was trapped over seven consecutive nights using 25 cage traps and searches for secondary evidence (10-person hours) completed. 18 long-term motion camera sites were also monitored for two months. Two male Northern Quoll were recorded from two potential impact sites and 11 Northern Quoll (two females, nine males) were recorded from the four control sites. A local decline of Northern Quoll populations from the potential impact sites has been recorded since 2015; however, this is unlikely to be due to the mining activities. Since 2016 mining activity on site has been minimal, however an increase of Feral Cat records from the mine site (from two individuals in 2015 to four individuals in 2018, plus another four individuals from additional motion cameras in 2018) and a bush fire which impacted a large proportion of the impact area are thought to have caused a slight change in local population abundance within the impact areas. Long-term motion camera data indicates the spatial distribution of Northern Quoll populations appears to be consistent with the 2014 and 2015 monitoring.

Rehabilitation Areas

Fauna usage of seven rehabilitation sites was monitored at North Star during the dry season with focus on conservation significant fauna. Each site was searched for secondary evidence and one motion camera was deployed over four consecutive nights. No conservation significant species was recorded. The structure and density of native vegetation at all rehabilitation sites are considered suitable for the use by generalist fauna species. Six generalist species (two mammals, four birds) have been recorded from the sites to date. The activity of introduced species is comparable to areas in the surrounding region with only cattle being recorded from one site on the lower plain (NS RE 07).

Pilbara Olive Python

Pilbara Olive Python monitoring was completed at four potential impact sites and four control sites during the wet season. Each site was searched each night for one-person hour over a six-night period. Forty kilometre of road transects located between the monitoring sites were also searched each night. A total of three Pilbara Olive Python individuals were recorded from two potential impact sites (NS POP I3 and NS POP I4). Two individuals were recorded from control sites: one adult was recorded from control site NS POP C4 and one individual was recorded on a motion camera at site NS MC LT C8 in the control area. Pilbara Olive Python records are comparable with previous monitoring results indicating that the population is stable.

Conservation Significant Bats

Pilbara Leaf-nosed Bat monitoring was completed during the wet season at two potential impact sites and two control sites. Each site was equipped with one SM2Bat+ ultrasonic recorder for four consecutive nights. The recorded call patterns indicate that there may have been a slight shift in activity levels of the Pilbara Leaf-nosed Bat with an increase in call numbers at Cave 13 (NS PLNB I1) (247 calls) in comparison to previous years (2015-2017) (up to 33 calls). Call patterns and call times indicate foraging individuals. Activity levels recorded at the Chateau Cave (NS PLNB I2) reduced from 5,068 calls in 2017 to 30 calls in 2018, although this is likely due to the required altered location of the recorder due to access and safety constraints. Risks

associated with accessing the cave entrance resulted in the installation of the recorder on top of the cave entrance. Call patterns recorded from the species indicate individuals returning to a roost cave with calls being recorded as late as 5:33am (15 minutes after sunrise). Based on call activities, the use of the two caves appear to be similar to previous monitoring with Chateau Cave being used as a roost cave and Cave 13 being visited by foraging individuals.

Compliance with Fauna Management Plans

Hypothesis 1 of the TFMP (applies only to Northern Quolls) has not been satisfied due to the decrease of the local Northern Quoll population across all potential impact sites since 2016. This decrease was not recorded from the control sites at North Star and DBCA's regional control sites, nor other projects such as Solomon Hub and Main Line Rail. Environmental conditions were considered favourable in 2017 and 2018. However, it is unlikely that mining activity is the cause of this decline as the site has been in temporary suspension since 2016. An increase in Feral Cat numbers has been recorded in addition to an extensive bush fire that occurred in July 2018, approximately one month prior to monitoring. Hypothesis 2 of the TFMP (ongoing presence) has been satisfied with the persistent presence of Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python at the potential impact sites.

1. INTRODUCTION

1.1. Project Background

Fortescue Metals Group Limited (Fortescue) operates three mine sites in the Chichester Ranges; Cloudbreak, Christmas Creek and Nullagine mine sites (the Chichester Hub), two mines in the northern Hamersley ranges; the Firetail and Kings mine sites (the Solomon Hub) and associated rail and port infrastructure; Main Line Rail, Hamersley Line Rail and Herb Elliott Port. In addition, FMG Iron Bridge (Aust) Pty Ltd ('FMG Iron Bridge'), a subsidiary of Fortescue, is developing the North Star Hematite and Magnetite Project.

Fortescue requires the continued monitoring of conservation significant fauna to comply with approvals granted under various Ministerial Statements and EPBC Controlled Actions for each site. The requirements for each site are summarised below.

1.1.1. Chichester Hub

1.1.1.1. Cloudbreak

The Cloudbreak mine site is located 110 km north of Newman and 220 km south south-east of Port Hedland, within the Mulga Downs and Hillside pastoral leases (Figure 1.1).

Condition 7 of EPBC 2010/5696 (Cloudbreak Life of Mine) sets out monitoring requirements for Greater Bilby (*Macrotis lagotis*) and Night Parrot (*Pezoporus occidentalis*) at the Cloudbreak mine site. Condition 10 of Ministerial Statement 899 (Cloudbreak Life of Mine) sets out the monitoring requirements for EPBC and WC Act listed species at the Cloudbreak mine site. These conditions are addressed through the implementation of the Conservation Significant Fauna Management Plan: 100-PL-EN-0022 (CSFMP). The Greater Bilby has been excluded from the monitoring requirement due to pre-clearance surveys indicating the absence of the species (Bamford 2005a; Ecologia 2011). Monitoring of Night Parrot has been completed as a separate scope of works and is not included in this report.

1.1.1.2. Christmas Creek

The Christmas Creek mine site is located east of the Cloudbreak mine site and lies on the Roy Hill and Hillside pastoral leases (Figure 1.1).

Condition 8 of Ministerial Statement 1033 (1033 – Pilbara Iron Ore and Infrastructure Project (Christmas Creek Mine, East-West Railway and Mindy Mindy Mine – Revised Proposal) sets out requirements for the monitoring and management requirements for conservation significant fauna and requires Fortescue to implement the CSFMP (prepared to satisfy the now superseded MS 871 and MS 707. New plans have been approved; however, for consistency purposes, all methods used in 2018 followed the previous plan (which applied at the start of the annual monitoring period). Future monitoring will be aligned with the new plan. Condition 9(d) of EPBC 2013/7055 (Christmas Creek Iron Ore Mine Expansion Project) requires the implementation of Condition 8.1, 8.2 and 8.3 of MS 1033; which is also achieved through implementation of the CSFMP.

1.1.1.3. Nullagine

The Nullagine mine site is split into two areas: Warrigal and Bonnie East deposits. The project lies 23 km south-west of the town of Nullagine and 45 km north of the Christmas Creek mine site (Figure 1.1).

Condition 4 of EPBC 2009/6887 (Nullagine Iron Ore Project) sets out requirements for Northern Quoll monitoring and management. Condition 5, 6 and 7 of EPBC 2013/6887 (Nullagine Iron Ore Project) also sets out requirements for Northern Quoll (*Dasyurus hallucatus*) monitoring and management. The above

conditions are achieved through implementation of the Northern Quoll Management and Monitoring Plan: NU-PL-EN-0001 (NQMMP).

1.1.2. Solomon Hub

The Solomon Hub is located in the Hamersley Ranges, approximately 60 km north of Tom Price on the Mt Florance and Hamersley pastoral leases, as well as unallocated Crown Land (Figure 1.1).

Condition 3 of EPBC 2010/5567 (Solomon Iron Ore Project) and Condition 3(h) of EPBC 2014/7275 (Solomon Iron Ore Project Expansion) sets out the requirements for fauna monitoring and management of EPBC Act listed species (and specific conditions for Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) and Northern Quoll. Condition 12 of Ministerial Statement 1062 (Solomon Iron Ore Project) sets out the requirements for fauna monitoring and management of Pilbara Olive Python (*Liasis olivaceus barroni*), Northern Quoll and Pilbara Leaf-nosed Bat. The above conditions are achieved through implementation of the CSFMP.

1.1.3. Main Line Rail, East-West Rail and Hamersley Rail Line

The Main Line Rail, East-West Rail and Hamersley Rail Line consists of a total of 430 km of rail which connects the Christmas Creek mine site and the Solomon Hub with the Herb Elliott Port in Port Hedland (Figure 1.1).

Condition 7 of Ministerial Statement 690 (Pilbara Iron Ore and Infrastructure Project Port and North-South railway (Stage A)) sets out requirements for fauna monitoring and management of EPBC listed species on Main Line Rail and Port. Condition 2 of EPBC 2010/5513 (Additional Rail Infrastructure between Herb Elliott Port Facility and Cloudbreak Mine Site, Pilbara, WA) sets out requirements for fauna monitoring and management of EPBC listed species on Main Line Rail. Condition 3 of EPBC 2010/5567 (Solomon Iron Ore Project) and Condition 3(h) of EPBC 2014/7275 (Solomon Iron Ore Project Expansion) sets out requirements for fauna monitoring and management of EPBC listed species (and specific conditions for Pilbara Leaf-nosed Bat and Northern Quoll) on the Hamersley Rail Line. The above conditions are achieved through implementation of the CSFMP.

1.1.4. North Star (FMG Iron Bridge)

The North Star mine site is located approximately 100 km south of Port Hedland, predominately on unallocated Crown Land and partially on Wallareenya station (Figure 1.1).

Condition 2 of EPBC 2012/6530 (North Star Hematite Project) requires implementation of the EPBC Listed Threatened Fauna Management Plan: NS-PL-EN-0003 (TFMP).

Figure 1.1: Location of mine sites and rail infrastructure

1.2. Monitoring Requirements

Species included in this monitoring program are defined in Section 1.3. of the CSFMP, Section 7 of the TFMP and in the NQMMP, and predominately comprise of conservation significant fauna species which are species listed as Critically Endangered, Endangered, Vulnerable or Migratory under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) or as Schedule species under the *Western Australian Wildlife Conservation Act 1950* (WC Act)/*Biodiversity Conservation Act 2016* (BC Act).

Site-specific monitoring requirement are listed in Table 1.1.

Table 1.1: Site-specific monitoring requirements summary

Species	Cloudbreak	Christmas Creek	Solomon Hub	Hamersley Rail	Main Line Rail	Nullagine	North Star
Northern Quoll (*Dasyurus hallucatus*)	●*	●	●	●	●	●	●
Greater Bilby (*Macrotis lagotis*)	♦	●			●		
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)		S	S		S		●
Ghost Bat (*Macrodermas gigas*)		●	●		●		
Pilbara Olive Python (*Liasis olivaceus barroni*)		●	●		▲		●
Conservation Significant Birds	●	●	●	●	●		
Rehabilitation Sites	●	●	●	●	●		●
Fauna usage of Culverts				●	●		
Introduced Species	●	●	O	●	●	O	●

* Tenement M45/1142 only, O=Opportunistic sightings to be reported; S=Surveillance level only, data for Ghost Bats to be analysed for PLNB

♦ Correspondence with the regulators has indicated that the Greater Bilby monitoring at the Cloudbreak mine site is excluded from monitoring due to the absence of the species from site

▲ Pilbara Olive Python monitoring ceased due to the lack of critical habitat and lack of records along the rail (Ecologia 2014a, 2015b; Fortescue 2014)

1.2.1. Fortescue Operational Sites

The objective of the CSFMP (100-PL-EN-0022) is to identify the potential direct and indirect impacts from approved mining activities on conservation significant fauna species and develop management and monitoring measures that maximise the ongoing protection and long-term conservation of these species within and adjacent to Fortescue controlled sites.

The guiding objectives of the monitoring programs are:

- Determine presence (or absence) of conservation significant fauna within Fortescue controlled sites.
- Measure impacts of Fortescue's activities on conservation significant fauna within Fortescue controlled sites.
- Monitor and measure the success of management measures to inform an adaptive management approach.
- Monitor and measure spatial and temporal changes in the abundance and distribution of conservation significant fauna within Fortescue controlled sites.

Conservation significant fauna are those defined in Section 1.3 of the CSFMP, that is, species that are listed as Critically Endangered, Endangered, Vulnerable or Migratory under the EPBC Act or as a Schedule species in accordance with the WC Act/BC Act. Conservation significant fauna are limited to terrestrial vertebrate fauna species that meet these criteria and have been recorded within Fortescue controlled sites or where monitoring requirements have been specified in State and/or Commonwealth approval conditions.

There are three hypotheses that are to be tested by the CSFMP:

Hypothesis One: There will be no statistically significant reduction in the spatial distribution of conservation significant species across impact sites compared to control sites

Hypothesis Two: There will not be a statistically significant decline in the relative abundance of conservation significant species across impact sites compared to control sites

Hypotheses Three: Conservation significant species recorded within the area of impact for the project will continue to have an ongoing presence.

1.2.2. Nullagine Mine Site

The monitoring objectives of the Nullagine mine site are separate to the objectives described above for other Fortescue operational sites. The Nullagine mine site only requires monitoring of Northern Quoll and the monitoring objectives as outlined in the NQMMP (NU-PL-EN-0001) are:

- Monitor Northern Quoll and any potential impact of mining.
- Add to the regional ecological knowledge of Northern Quoll.
- Assess how Northern Quoll responds to rehabilitation measures.

The following targets (no hypotheses described) have been set-out in NQMMP for monitoring at the Nullagine mine site:

- No detrimental effect on Northern Quoll population as a result of mining activities.
- Establish further information on population density, preferred habitat, patterns of movement, reproductive status, population structure, morphometrics on a control population not impacted by the invasion of the Cane Toad across Queensland and the Northern Territory.
- Northern Quoll colonise rehabilitated areas within 5 years of the rehabilitation being completed.

1.2.3. North Star (FMG Iron Bridge)

The objective of the EPBC Listed TFMP (NS-PL-EN-0003) is to monitor and measure the success of management measures in protecting EPBC listed threatened fauna species. Monitoring in accordance with the TFMP is only required for Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat.

Detailed objectives of the North Star monitoring program are:

- Measure the impacts of the Project over time by undertaking ongoing annual monitoring of EPBC Act listed threatened fauna species: Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python.
- Measure the success of management measures to inform an adaptive management approach that may be implemented during construction of the remaining sections of the line (sic).

There are two hypotheses that will be tested by TFMP and comprise the following:

Hypothesis One: There will be no long-term statistically significant decline in relative abundance of Northern Quoll across impact sites compared to control sites.

Hypothesis Two: EPBC-listed fauna species previously recorded within the area of impact will continue to have an ongoing presence.

1.2.4. Additional Monitoring Objectives

1.2.4.1. Rehabilitation Areas

Monitoring of fauna use of rehabilitation sites and the suitability of the rehabilitated vegetation as fauna habitat is required at all Fortescue operation sites and the North Star mine site. The monitoring of usage by and suitability for conservation significant fauna is also required.

1.2.4.2. Rail Culverts

Culvert monitoring sites shall be monitored along the Hamersley Rail Line and Main Line Rail infrastructure to demonstrate conservation significant fauna use of culverts. Northern Quoll have been demonstrated to utilise culverts, so the focus is targeted toward other conservation significant fauna species not previously recorded using culverts (i.e. Greater Bilby).

1.2.4.3. Feral Species

All opportunistic sightings of feral species shall be reported as a component of the annual monitoring report. Any feral species scats shall be collected and sent to the Department of Biodiversity, Conservation and Attractions (DBCA). Targeted feral species searches were completed along the Main Line Rail as part of the Red Fox Surveillance, at the North Star mine site and along the Hamersley Rail Line to monitor Feral Cat numbers in response to the detection of a decrease in Northern Quolls in 2017.

1.2.4.4. Felixer Research Project

Baseline monitoring for the presence of cats to enable Fortescue's use of a Felixer (a cat baiting apparatus) at either Solomon Hub, North Star mine site or Main Line Rail (final location to be determined). Only one of these locations (North Star) will require baseline monitoring. The initial camera trap survey identified optimal locations for deployment of Felixers and provide a baseline against which changes in activity of cats and non-targets can be assessed. The Felixers are expected to be installed in 2019.

1.2.4.5. Red Fox Surveillance

Red Fox (*Vulpes vulpes*) were identified as a key risk to the Greater Bilby along Main Line Rail (Equinox, 2016). A risk assessment was completed and identified a series of recommendations to reduce the risks (Ecoscape (Australia), 2018b). The following surveillance is therefore required to be completed in the 2018 monitoring period:

- Monitor Red Fox presence along the Mainline Rail Line (including at water points), using:
  - motion cameras
  - on-ground searches for secondary evidence
  - opportunistic observations
- Determine if any feral control (rabbits and foxes) is required following review of monitoring data.

1.2.5. Legislation and Relevant Guidance

The BC Act provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. Due to the current transition period between the BC Act and the outgoing WC Act, parts of each act are enacted at this stage (1950; 2016).

Monitoring works reported in this report are intended to comply with all relevant Commonwealth and State environmental legislation, as well as with the following standards and guidelines:

- Environmental Protection Authority (EPA) Environmental Factor Guideline: Terrestrial Fauna (EPA 2016a)
- EPA Statement of Environmental Principles, Factors and Objectives (EPA 2018)
- EPA Technical Guidance – Terrestrial Fauna (2016c)
- EPA Technical Guide: Sampling methods for Terrestrial vertebrate fauna (2016b)
- EPBC Act *Referral guidelines for the Endangered Northern Quoll Dasyurus hallucatus* (Commonwealth of Australia [CoA] 2016)
- *EPBC Act Survey Guidelines for Australia's Threatened Bats* (Department of the Environment, Water, Heritage and the Arts (Department of the Environment, Water, Heritage and the Arts [DEWHA] 2010a)
- *EPBC Act Survey Guidelines for Australia's Threatened Birds* (DEWHA 2010b)
- *EPBC Act Survey Guidelines for Australia's Threatened Mammals* (Department of Sustainability, Environment, Water Population and Communities (Department of Sustainability Environment Water Population and Communities [DSEWPaC] 2011a)
- *EPBC Act Survey Guidelines for Australia's Threatened Reptiles* (DSEWPaC 2011b)

The monitoring program also take into consideration any revisions of species specific survey guidelines due to updated scientific advice and published information on the respective SPRAT profile (Department of the Environment and Energy [DotEE] 2018c).

2. METHODS

The fauna monitoring program was completed in accordance with the objectives and methods outlined in the following documents:

- CSFMP (100-PL-EN-0022) for Fortescue operational mine sites (Fortescue 2014)
- NQMMP (NU-PL-EN-0001) for the Nullagine mine site (BC Iron Nullagine, 2016a)
- TFMP (NS-PL-EN-0003_Rev0) for the North Star mine site (Fortescue 2012)

Methods applied for Northern Quoll and Greater Bilby monitoring was aligned with methods used by DBCA staff as part of their annual Pilbara wide monitoring (Dunlop, 2017; Dziminski and Carpenter, 2017) and are based on the *EPBC Act referral guidelines for the endangered northern quoll Dasyurus hallucatus* (DotE 2016) and the most recent Greater Bilby guidelines; *Verifying bilby presence and the systematic sampling of populations using the 2 ha sign-based monitoring protocol – with notes on aerial and ground survey techniques and asserting absence* (Southgate *et al.*, 2018).

Methods for Pilbara Olive Python and conservation significant bat and bird monitoring were developed for this project and are based on species specific guidelines (DEWHA 2010b; DSEWPaC 2011b, DSEWPaC 2011a). Monitoring methods and locations were kept consistent with previous monitoring wherever possible.

Annual liaison with DBCA staff (Dr Judy Dunlop and Dr Martin Dziminski) at the start of the monitoring in 2018 (and during previous monitoring) ensured that methods used were up to date and align with the Pilbara wide monitoring.

The monitoring was conducted as per the CSFMP, NQMMP and TFMP:

- Within impact zones
- Outside of direct impact zones
- Control sites (to eliminate the possibility of any other environmental factors to population decline, not related to operations)
- In rehabilitation areas (previous impact areas) in vicinity to potential habitat of significance within the project area
- At culvert monitoring sites along the Hamersley Rail Line and Main Line Rail in potential suitable habitat for the Northern Quoll and Greater Bilby

Details of the monitoring methods, timing and person hours are listed in Table 2.1.

Table 2.1: Details of site-specific monitoring methods

Species/Objective	Cloudbreak	Christmas Creek	Solomon Hub	Hamersley Rail Line	Main Line Rail	Nullagine	North Star
Site specific FMP	CSFMP		CSFMP			NQMMP	TSFMP
Northern Quoll (*Dasyurus hallucatus*)	2nd year of monitoring	6th year of monitoring	7th year of monitoring			5th year of monitoring	5th year of monitoring
	Active searches (10hrs) at 3 potential impact sites 10 motion cameras per site for 4 nights 20 Long-term cameras for 3 months		50 cage traps & 5 motion cameras for 4 nights at 3 potential impact sites Utilisation of 3 control sites and DBCA data			Motion cameras at 20 locations for 40 days. Active searches at each site	25 cage traps for 7 nights at 4 potential impact sites and 4 control sites
	Dates: 24-30 Aug 2018 Long-term Cameras: 25 Aug-2 Dec 2018		Dates: 10-15 Jul 2018	Dates: 24-29 Jul 2018	Dates: 30 Jul-3 Aug 2018	Dates: 26-27 Jun 2018 MC: 26 June-4 Aug 2018	Dates: 15-23 Aug 2018 MC: 26 Aug-9 Oct 2018
			16-20 Jul 2018 (Fortescue Control Sites)				Dates: 15-23 Aug 2018 (North Star Control Sites)
Greater Bilby (*Macrotis lagotis*)	-	3rd year of monitoring	-	-	6th year of monitoring	-	-
		Occupancy monitoring at 30 sites in dry season, re-sampled 15 sites during wet season			Abundance monitoring (DNA scat searches, food plots, 4 long-term motion cameras) at one potential impact site and one control site. Occupancy monitoring at 40 sites during dry season, re-sampling at 20 sites during wet season.		
		25-27 Aug 2018 4 Dec 2018			28 Jun-3 Jul 2018 31 Nov-1 Dec 2018		
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) Ghost Bat (*Macrodermas gigas*)	-	3rd year monitoring PLNB 3rd year monitoring GB	6th year monitoring PLNB 3rd year monitoring GB	-	6th year monitoring PLNB 3rd year monitoring GB	-	6th year monitoring PLNB GB excluded
		Bat recorder at 12 potential impact sites and 12 control sites for 7 nights	Bat recorder at 12 potential impact sites and 12 control sites for 7 nights		Bat recorder at 12 potential impact sites and 12 control sites for 7 nights		Bat recorder at 2 potential impact sites and 2 control sites for 4 nights
		10-17 Nov 2018	11-20 Mar 2019		28 Nov-5 Dec 2018		2-6 Dec 2018
Pilbara Olive Python (*Liasis olivaceus barroni*)	-	6th year of monitoring	7th year of monitoring	-	-	-	6th year of monitoring
		Active searches at 4 potential impact sites and 4 control sites Road transects >40km over 7 nights	Active searches at 3 potential impact sites and 3 control sites Road transects >40km over 7 nights				Active searches at 4 potential impact sites and 4 control sites Road transects >40km over 6 nights
		12-19 Dec 2018	11-20 Mar 2019				1-7 Dec 2018
Conservation Significant Birds	12th year of monitoring	4th year monitoring				-	-
	20-minute survey at 3 potential impact sites and 3 control sites per project area						
	2 Dec 2018	3-4 Dec 2018	11-20 Mar 2019	1 Dec 2018	31 Nov 2018		

Species/Objective	Cloudbreak	Christmas Creek	Solomon Hub	Hamersley Rail Line	Main Line Rail	Nullagine	North Star
Rehabilitation Sites	3rd year of monitoring					-	3rd year of monitoring
	Searches and motion camera set up at 3 rehabilitation sites.						Searches and motion camera set up at 7 rehabilitation sites
	Searches: 24 Aug 2018 MC: 24-29 Aug 2018	Searches: 25 Aug 2018 MC: 25-30 Aug 2018	Searches: 13 Jul 2018 MC: 13-17 Jul 2018	Searches: 25 Jul 2018 MC: 25-29 Jul 2018	Searches: 26 Jul 2018 MC: 26-30 Jul 2018		Searches: 18 Aug 2018 | MC: 18-22 Aug 2018
Fauna usage of Culverts	-	-	-	6th year of monitoring		-	-
				Searches and long-term motion cameras at 5 sites over 30 days	Searches and long-term motion cameras at 10 sites over 30 days		
				1-30 Jul 2018			
Red Fox (*Vulpes vulpes*) Surveillance	-	-	-	-	1st year of surveillance	-	-
					Motion cameras at 10 sites for 30 days Review culvert site data. Searches and sightings		
					1-30 Jul 2018		
Person Days (Total)	6	34	34	12	22	4	50
Motion Camera Days (Total)	1,432	1,432	72	522	672	800	810

2.1. Climatic Conditions

Climatic data, such as Monthly total rainfall and average temperature, from each site was utilised to indicate changes in environmental conditions between the years. Weather station data recorded from each project area was used and where required supplemented with long-term data from nearby government weather stations (Bureau of Meteorology, BoM) if local data was not available. Table 2.2 lists the weather stations relevant to each project area.

Table 2.2: Weather station locations and details

Project area	Station used for 2018 data	Station used for duration of monitoring (2012-2017)
Cloudbreak	Cloudbreak	Cloudbreak, Mulga Downs (BoM #5015), Auski (BoM #5093), Newman (BoM #7176) Marillana (BoM #5009)
Christmas Creek	Christmas Creek	Christmas Creek, Mulga Downs (BoM #5015), Auski (BoM #5093), Newman (BoM #7176) Marillana (BoM #5009)
Solomon Hub	Solomon Hub	Solomon Hub
Hamersley Rail Line	Hamersley Rail Line (chainage 241 km and 271 km)	Hamersley Rail Line (chainage 241 km and 271 km), Solomon Hub
Main Line Rail	Main Line Rail (chainage 68 km and 273 km)	Main Line Rail (chainage 68 km and 273 km)
Nullagine	Christmas Creek	Mulga Downs (BoM #5015), Auski (BoM #5093) and Marillana (BoM #5009)
North Star	North Star	North Star, Marble Bar (BoM #4106)

2.2. Site Based Records

Fortescue's Business Management System's (BMS) Plant and Animal register and Incident Register (in case of a fauna deaths) was reviewed and all conservation significant species records were collated. In 2018, all records are verified records, as determined by site environment personnel. Records were reviewed to add additional information about the presence or absence of conservation significant species, particularly when target species were not recorded during monitoring.

2.3. Northern Quoll

Northern Quoll monitoring was conducted at the Solomon Hub, Cloudbreak (tenement M45/1142), Christmas Creek, Nullagine and North Star mine sites and along the Hamersley Rail Line, Main Line Rail. The methods used to monitor Northern Quoll populations at the Solomon Hub, Hamersley Rail Line and Main Line Rail follow the requirements of the CSFMP (100-PL-EN-0022), the EPBC Act Northern Quoll referral guidelines (CoA 2016) and are aligned with the Pilbara regional monitoring currently being completed by the DBCA (Dunlop, Cook and Morris, 2014; Johnson and Anderson, 2014; Dunlop, 2017). Data collected from regional DBCA sites such as 'Indee station', 'Karijini National Park (Dales gorge)' and 'Millstream/Chichester NP' were utilised as control sites for direct comparison with results from other abundance monitoring sites (Solomon Hub, rail infrastructure areas, North Star).

The methods used to monitor Northern Quoll populations at the Cloudbreak (tenement M45/1142) and Christmas Creek mine sites are aligned with the Pilbara regional monitoring currently being completed used by DBCA for low abundance monitoring sites such as 'Hooley station' and 'Mt Florance station'. The methods are adapted from the CSFMP.

The methods used to monitor Northern Quoll populations at the Nullagine mine follow those outlined in the NQMMP (NUPL-EN-0001). Monitoring at the North Star mine site follows the requirements of the TSFMP (NS-PL-EN-0003).

Monitoring methods and site locations used at the Cloudbreak and Nullagine mine sites were consistent with 2017 monitoring. Methods used at Christmas Creek, Solomon Hub, Hamersley Rail Line and Main Line Rail have been consistent since 2016, with similar methods used at the same locations prior to 2016. Monitoring at North Star has been consistent since 2014. Comparability of methods between the project areas is listed in Table 2.3. Site locations are listed in Appendix 1 and displayed in Figure 2.1. The timing of each monitoring event is listed in Table 2.1.

All traps were baited using universal bait (peanut butter, oats and sardines) and were marked using flagging tape. Motion cameras were baited using 30ml vials filled with fish oil-soaked rags or fish oil-soaked cotton rope to meet DoE's recommendations for non-food attractants in combination with camera trapping (CoA 2016). All captured Northern Quolls were marked using Passive Integrated Transponder (PIT) tags (Model ISO 11784/11785 FDX-B), weighed (Pesola 1000g) and morphometric measurements taken (short peds, head length & caudal width) (Appendix 4). Field team leaders have been endorsed to complete the implantation of PIT tags by an experienced veterinarian (Ausvet Animal Hospital) as per the DBCA advice. DNA samples of each Northern Quoll individual were taken via an ear notch and stored in 100% ethanol (in a 1.5ml vial) to be submitted to the WA Museum/DBCA.

Table 2.3: Northern Quoll monitoring methods compared between projects

Project		High Density Population Methods | Trap nights |	Low Density Population Methods | Camera nights |
Control	Fortescue (north of Solomon)	200 x 3 sites	20 x 3 sites
	North Star	175 x 4 sites	45 x 9 sites
	Indee Station (DBCA)	200 x 1 site	
	Karijini NP (Dales Gorge)	200 x 1 site	
	Millstream/Chichester NP	200 x 1 site	
	Mt Florance (DBCA)		630 x 1 site
	Hooley Station (DBCA)		630 x 1 site
Impact	Solomon Hub	200 x 3 sites	20 x 3 sites
	Hamersley Rail Line	200 x 3 sites	20 x 3 sites*
	Main Line Rail	200 x 3 sites	20 x 3 sites
	North Star	175 x 4 sites	45 x 9 sites
	Cloudbreak		40 x 3 sites + 900 x 2 site
	Christmas Creek		40 x 3 sites + 900 x 2 site
	Nullagine		40 x 20 sites

Note: *additional 900 trap nights of long-term motion cameras not included

2.3.1. Control sites

Monitoring of Northern Quoll populations was completed at three control sites ('Fortescue') located north of the Solomon mine site (4th year of monitoring) and at four control sites ('North Star') located adjacent to the North Star mine (5th year of monitoring) as part of this monitoring program. Abundance data from one site at Indee station (5th year of monitoring), one site at Dales Gorge (Karijini National Park) (2nd year of

monitoring), and one site at Millstream/Chichester NP (5th year of monitoring) which are monitored by DBCA were also utilised (Table 2.3).

Four of the control sites ('Fortescue' control sites and DBCA's Indee station) were trapped over four consecutive nights using 50 cage traps set in two rows of 25 traps spaced 50 m apart. Five motion cameras were also deployed over four consecutive nights and searches for secondary evidence (10-person hours) completed. The four 'North Star' control sites were trapped over seven consecutive nights using 25 cage traps set in a row spaced 50 m apart.

Monitoring of low abundance Northern Quoll populations was completed at two control sites 'Hooley station' and 'Mt Florance station' by the DBCA using seven motion cameras set 100 m apart. Motion cameras were deployed for three months totalling 630 trap nights.

It should be noted that a high population density of Northern Quoll has been recorded from Indee station which is above average in comparison with other Pilbara populations (Outback 2010; Ecologia 2014e, 2015c, 2015b; Astron, 2015; Dunlop, 2017; Ecoscape 2018a) and direct comparison using this data should be made with caution. Trapping results from Indee station provides a robust dataset but should not be used as an indication for typical Northern Quoll population densities in the Pilbara region.

2.3.2. Cloudbreak Tenement M45/1142 and Christmas Creek

Monitoring of Northern Quoll populations was completed at Cloudbreak (tenement M45/1142) (2nd year of monitoring) at Christmas Creek (6th year of monitoring). The monitoring of low abundance Northern Quoll populations within each project area consisted of the installation of motion cameras at three sites. Each site consisted of ten motion cameras spaced 100 m apart which were operational over four consecutive nights. Each site was also searched for secondary evidence for 10-person hours. Two of the three monitoring sites in each project area were monitored over a long-term period (three months) to increase the potential that any Northern Quoll present would be recorded. This resulted in a total of 1,420 camera nights for each project area.

2.3.3. Solomon Hub, Hamersley Rail Line and Main Line Rail

Monitoring of Northern Quoll populations was completed at the Solomon Hub, Hamersley Rail Line and Main Line Rail (7th year of monitoring for each project). Three potential impact sites in each project area were trapped over four consecutive nights using 50 cage traps set in two rows of 25 traps spaced 50 m apart. Five motion cameras were also deployed over four consecutive nights and searches for secondary evidence (10-person hours) completed.

2.3.4. Nullagine

Monitoring of Northern Quoll populations was completed at Nullagine (5th year of monitoring). Motion cameras were deployed at 20 locations across two mining areas: Bonnie East and Warrigal. The cameras were left in situ for 40 nights resulting in a total of 800 camera nights. All sites were also searched for secondary evidence for 10-person hours.

2.3.5. North Star

Monitoring of Northern Quoll populations was completed at North Star (5th year of monitoring) with methods following the TFMP. Four potential impact sites were trapped over seven consecutive nights using 25 cage traps set in a row spaced 50 m apart. All sites were also searched for secondary evidence of Northern Quoll.

2.3.6. Statistical Analysis

Northern Quoll trapping data was analysed to determine changes in population size and population density between the years of monitoring. The program DENSITY 5.0 (Efford, Dawson and Borchers, 2009; Efford and Fewster, 2012) was used to estimate population densities using mark-recapture data; however, recaptured individuals are required for the analysis. For operational areas where suitable recapture data was recorded, site data was combined and the 95 % Confidence Interval (Upper and Lower 95 % Confidence Limit), and average (mean) calculated to indicate the estimated population size each year and changes between the years.

2.4. Greater Bilby

Monitoring of Greater Bilby populations was completed within the Christmas Creek mine site and along the Main Line Rail. The methods were adapted to align with the current DBCA Greater Bilby monitoring (Dziminski and Carpenter, 2017; Southgate *et al.*, 2018), is consistent with the 2017 monitoring, and followed the requirements of the CSFMP. The methods include both abundance monitoring and occupancy monitoring techniques.

Abundance monitoring:

- 2-hectare active searches for secondary evidence (scats, diggings, burrows, tracks)
    - Even spread of transects across the abundance site using two or more zoologists
    - Recording of all fauna activity (by-catch) at each site
- Scat transects to allow statistical analysis following DBCA's methods
- Opportunistic scat collections for genetic analysis following DBCA's instruction for scat analysis
- Three food plots per site (recording of plant species with bilby diggings)

Occupancy monitoring:

- 2-hectare active searches for secondary evidence (scats, diggings, burrows, tracks)
    - Even spread of transects across the occupancy site using two or more zoologists
    - Recording of all fauna activity (by-catch) at each site
- Occupancy site locations to be spread evenly across the project area based on previous records and habitat mapping
- Two phases of monitoring (half the sites resampled after 3 months)

All Greater Bilby scats collected were stored in desiccant filled (Silica Gel beads) 30ml plastic vials to ensure DNA viability by minimising the water content of the scats. The scats were then submitted to DBCA for DNA analysis. The analysis identified the number of individuals present at each site and also determined if previously recorded individuals were still present on site.

Occupancy site locations were kept consistent with the 2017 monitoring sites, abundance site locations were consistent with those monitored since 2013. All sites are listed in Appendix 1 and displayed in Figure 2.2. The timing of each monitoring event is listed in Table 2.1.

2.4.1. Christmas Creek

Monitoring of Greater Bilby populations was completed within the Christmas Creek mine site (3rd year of monitoring) using occupancy monitoring methods as described above. A total of 30 sites were monitored during the dry season, and a sub-set of 15 sites was re-sampled during the wet season (Appendix 1, Figure 2.2). Monitoring of Greater Bilby populations using occupancy monitoring methods was first completed in

2017 with previous monitoring consisting of active searches of suitable habitats (Ecologia 2013a; Ecoscape 2017a, 2018a).

2.4.2. Main Line Rail and East-West Rail

Monitoring of Greater Bilby populations was completed along the Main Line Rail (6th year of monitoring) using occupancy and abundance monitoring methods as described above. Occupancy monitoring was completed at 40 sites during the dry season, of which 20 were re-sampled in the wet season. Abundance monitoring was completed at two sites, one potential impact site (MR GB ASI14) and one control site (MR GB ASC16) (Figure 2.2). Both abundance sites have been monitored since 2013.

2.4.3. Statistical Analysis

Statistical analysis was undertaken on the genotyped scat data collected at the abundance monitoring sites using spatially explicit capture-recapture analyses (SECR) to determine population density present at each site (Efford, 2004, 2011; Borchers and Efford, 2008). This analysis is completed using the R package 'SECR', however the models used by DBCA (Polygon detectors and Transect detectors) were not suitable due to the low number of samples collected from the transect searches. The Cue model was instead used so that all genotyped scats that were collected could be utilised in the analysis.

2.5. Pilbara Leaf-nosed Bat and Ghost Bat

Monitoring of Pilbara Leaf-nosed Bat and Ghost Bat populations was completed at Christmas Creek, Solomon Hub and Main Line Rail. Monitoring for the two species was carried out concurrently due to the similar ecology and habitat requirements of each species. Pilbara Leaf-nosed Bat monitoring was completed at North Star. Methods align with the CSFMP and the TFMP. The site locations are consistent with previous years of monitoring. They are listed in Appendix 1 and shown in Figure 2.3. The timing for each monitoring event is listed in Table 2.1.

Conservation significant bat monitoring was completed using ultrasonic Song Meter recorders (Wildlife Acoustics SM2Bat+ and SM4Bat FS). The acoustic recordings were analysed using a published data processing pipeline consisting of several filtering and statistical steps to detect target signals from bats of conservation significance (further details in the technical report from Dr Kyle Armstrong of Specialised Zoological, Appendix 7). The identifications from automated processes were checked visually in a spectrogram (Adobe Audition CS6 version 5.0.2; for echolocation calls of the Ghost Bat and the Pilbara Leaf-nosed Bat) or by aural playback (BatSound Pro version 3.31a; for Ghost Bat social calls).

2.5.1. Christmas Creek, Solomon Hub and Main Line Rail

Monitoring of conservation significant bat populations was completed at the Christmas Creek mine site (3rd year of monitoring), Solomon Hub (6th year of monitoring for PLNB, 3rd year for Ghost Bat) and along the Main Line Rail (6th year of monitoring for PLNB, 3rd year for Ghost Bat). Acoustic recordings were collected from 24 monitoring sites (12 potential impact sites and 12 control sites) over seven consecutive nights during the wet season monitoring. Two zoologists also searched the habitat for secondary evidence such as signs and scat piles to help identify potential roost caves.

The focus of the monitoring since 2018 is on Ghost Bat populations; however, surveillance level monitoring of Pilbara Leaf-nosed Bat populations was completed as part of the Ghost Bat monitoring with acoustic recordings analysed for the presence of both conservation significant bat species.

2.5.2. North Star

Monitoring of Pilbara Leaf-nosed Bat populations was completed at the North Star mine site (6th year of monitoring), as per the TFMP. Two potential impact sites (Cave 13 and Chateau Cave) and two control sites were monitored during the wet season for four consecutive nights using one bat recorder at each site.

2.5.3. Statistical analysis

Bat calls recorded in sufficient numbers were analysed using an unequal variance two-sample t-test to identify significant differences from the potential impact sites and control sites between the years of monitoring.

2.6. Pilbara Olive Python

Monitoring of Pilbara Olive Python populations was completed at Christmas Creek, Solomon Hub and North Star mine. Monitoring methods followed the CSFMP for Christmas Creek and Solomon Hub, and the TFMP for North Star, and were consistent with previous monitoring. Site locations are consistent with previous monitoring and are listed in Appendix 1 and shown in Figure 2.4. The timing of each monitoring event is listed in Table 2.1.

All Pilbara Olive Python individuals captured were marked using PIT tags which enabled accurate identification when re-captured. In addition, each individual was weighed, and a scale clipping taken. The scale clipping was stored in 100% ethanol and submitted to the WA Museum for future DNA analysis. Field team leaders were endorsed by a veterinarian (Ausvet Animal Hospital) for the implantation of microchips (PITs) as per DBCA advice.

2.6.1. Christmas Creek and Solomon Hub

Monitoring of Pilbara Olive Python populations was completed at the Christmas Creek mine site (6th year of monitoring) and Solomon Hub (7th year of monitoring). Methods consisted of repeated road transects (>40 km) over seven consecutive nights and active searches of four potential impact and four control sites. Microhabitats suitable for Pilbara Olive Pythons (water edge, low branches, cliffs and overhangs) were searched each night by two zoologists for one-person hour. Two 200 m transects were also established at each site and searched on foot twice over the seven-night monitoring period. Start location was alternated between potential impact sites and control sites every night so that temporal variation is consistent for impact and control areas and road transects.

2.6.2. North Star

Monitoring of Pilbara Olive Python populations was completed at the North Star mine site (6th year of monitoring). Monitoring methods were similar to those used at Christmas Creek and Solomon Hub. Four potential impact sites and four control sites were searched by two zoologists for one-person hour during the wet season over six consecutive nights (as per TFMP). Repeated road transects of >40 km were also completed each night. Start locations were alternated between potential impact and control sites.

2.6.3. Statistical Analysis

Due to the low abundance and cryptic lifestyle of the Pilbara Olive Python, the collected monitoring data is limited and not considered sufficient for robust statistical tests and interpretation of the results should be made with caution.

Pilbara Olive Python monitoring data collected at North Star was able to be analysed using the program MARK (White, 2014). The dataset was combined, the two most suitable models determined (based on low

Akaike information criterion (AIC) value) and used to determine occupancy (ψA) and detection probability (p_i) at the potential impact sites and control sites. In addition to the program MARK, the naïve estimator was determined for impact and control site data at North Star and Solomon Hub.

2.7. Conservation Significant Birds

Monitoring of conservation significant bird populations was completed at Cloudbreak, Christmas Creek, Solomon Hub, Hamersley Rail Line and Main Line Rail. Methods were consistent with previous years of monitoring and follow the CSFMP. Site locations are listed in Appendix 1 and shown in Figure 2.5. Timing for each monitoring event is listed in Table 2.1.

Conservation significant bird species included in this monitoring program include all listed species, in particular the following species that have previously been recorded:

- Common Greenshank (*Tringa nebularia*)
- Wood Sandpiper (*Tringa glareola*)
- Common Sandpiper (*Actitis hypoleucos*)
- Fork-tailed Swift (*Apus pacificus*)
- Peregrine Falcon (*Falco peregrinus*)
- Grey Falcon (*Falco hypoleucos*)

2.7.1. Cloudbreak and Christmas Creek

Monitoring of conservation significant bird populations using the current monitoring methods was completed at Cloudbreak and Christmas Creek mine sites (4th year of monitoring). Monitoring for the Night Parrot was completed at the Cloudbreak mine site over the prior eight years (2005-2012) and included sightings of other conservation significant bird species (Bamford Consulting, 2005c, 2006, Bamford 2007, 2008, 2009, 2010c, 2012a).

Monitoring of conservation significant bird populations was completed at three potential impact sites in each project area and six shared control sites. Three control sites are associated with yintas located on the eastern side of the Fortescue Marsh and have been monitored since 2015. An additional set of three control sites are located north of the Christmas Creek mine site, in habitat similar to that present at the potential impact sites and have been monitored since 2017. The yinta control sites have continued to be monitored to ensure continued data collection; however, the proximity to the Fortescue Marsh and the permanent water source at these sites attracts bird species not likely to occur at the potential impact sites. The new control sites in the northern area are considered more suitable for comparison of conservation significant bird population data.

Each of the two-hectare monitoring sites was searched for 20 minutes during the wet season when conditions are potentially suitable for water birds. Bird surveys were focused on the water edges (water birds) but also on elevated structures (radio towers, power lines etc) and free aerial space (Falcons and Fork-tailed Swift).

2.7.2. Solomon Hub, Hamersley Rail Line and Main Line Rail

Monitoring of conservation significant bird populations was completed at the Solomon Hub, along the Hamersley Rail Line and Main Line Rail (4th year of monitoring). Monitoring of conservation significant bird populations was completed at three potential impact sites and three control sites associated with each project.

Each of the two-hectare monitoring sites was searched for 20 minutes during the wet season when conditions are potentially suitable for water birds. Bird surveys were focused on the water edges (water birds) but also on elevated structures (radio towers, power lines etc) and free aerial space (Falcons and Fork-tailed Swift).

2.7.3. Statistical analysis of data

Conservation significant bird species are generally rarely recorded and typically in low numbers which limits the suitability of the data set for statistical analysis. An unequal variance two sample t-test of numbers of individuals was completed wherever possible (provided the number of records is adequate). However, the sample size is very limited, and results should be interpreted with caution.

2.8. Rehabilitation Areas

Monitoring of fauna usage of rehabilitation areas was completed at all sites excluding Nullagine (3rd year of monitoring). At each of the Fortescue managed sites (Cloudbreak, Christmas Creek, Solomon Hub, Hamersley Rail Line and Main Line Rail) three rehabilitation sites were monitoring for usage by fauna with particular focus on conservation significant fauna species. At the North Star mine site, a total of seven sites were monitored.

Each monitoring site was searched by two zoologists for one-person hour and a motion camera was installed for four consecutive nights during the dry season. The searches targeted secondary evidence of conservation significant fauna and introduced fauna, but also recorded any other fauna sighted. The timing of the monitoring of rehabilitation areas is listed in Table 2.1. Site locations were consistent since 2016 and are listed in Appendix 1 and displayed in Figure 2.6. Where possible, the locations were aligned with the rehabilitation monitoring program (for LFA).

2.9. Culvert Sites

Monitoring of fauna usage of culverts was completed along the Hamersley Rail Line and Main Line Rail (6th year of monitoring). Fauna usage was monitored at a total of five culverts located along the Hamersley Rail Line and 10 culverts located along the Main Line Rail. One motion camera was installed in each culvert and left in situ for 30 days during the dry season. Each site was also searched for secondary evidence such as scats, tracks and food debris (prey items). To date, the Northern Quoll has been shown to use culverts to cross the rail infrastructure and therefore ongoing monitoring is focused on detecting the use of culverts by other conservation significant fauna species such as the Greater Bilby. Monitored culvert sites were located in proximity to habitats considered suitable for Greater Bilby.

Site locations were consistent since 2016 with some overlaps since 2013. All sites are listed in Appendix 1 and displayed in Figure 2.6. The timing of the monitoring events at culvert sites is listed in Table 2.1.

2.10. Introduced Fauna

Introduced fauna can be a threat to native fauna and monitoring of the presence and abundance of introduced predators can assist when identifying causes of decline of threatened fauna. All sightings, signs and motion camera recordings of introduced fauna was recorded during the monitoring events. In particular, the presence of introduced fauna was targeted at waste rock dumps, rehabilitation sites and across the Hamersley Rail, Main Line Rail and North Star due to a suspected increase of Feral Cats.

2.11. Red Fox

Surveillance for the presence of the Red Fox along the Main Line Rail was included in the current monitoring program. The Red Fox was previously identified as a key risk to Greater Bilby populations located along Main Line Rail (Ecoscape 2018b) and monitoring of the occurrence and distribution was implemented in 2018. Surveillance techniques to detect the presence of the Red Fox along the Main Line Rail (including water points) consisted of:

- Baited motion cameras (10 locations for 30 days).
- Baiting of motion cameras in culverts.
- On-ground searches for secondary evidence.
- Opportunistic observations.

Locations where motion cameras were deployed in 2018 were selected based on locations of previous records of Red Fox, Greater Bilby and Rabbits, as well as water points and other infrastructure that have the potential to support the dispersal of the Red Fox. Site locations are listed in Appendix 1 and displayed in Figure 2.6. The timing of the Red Fox monitoring events is listed in Table 2.1.

2.12. Permit and Field Team

The monitoring events were completed under the DBCA Regulation 17 permit no. 08-002404-2. Access to Hamersley Gorge was granted as part of the Regulation 17 (former Reg. 4) for the purpose of the installation of a control site for Pilbara Olive Python and conservation significant bat monitoring. All field staff are listed in Table 2.4.

Table 2.4: Field staff and qualifications

Name	Qualification	Experience
Damien Cancilla	BSc (Hons)	13 years
Astrid Heidrich	MSc (Biol)	11 years
Matthew Macdonald	PhD	11 years
Tim Sachse	BSc	10 years
Mel Hay	BSc (Hons)	9 years
Chris Parker	BSc	6 years
Field Assistants		
Ashleigh Harris (Fortescue)	BSc	
Todd Edwards (Fortescue)	M.Sc.	
Allison Gear (Fortescue)		
Josh Levett (Fortescue)	BSc (Hons)	
Ben Nicholson (Fortescue)	BSc	
Rachael Sharp (Fortescue)	BSc	

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INDIAN OCEAN

Indee Station

MR NQ I1

MR NQ I2

MR NQ I3

Mt Florence

HL NQ I1

HL NQ I2

HL NQ I3

Hooley Station

Karijini NP (Dales Gorge)

CB NQ I1

CB NQ I2

CB NQ I3

CC NQ I1

CC NQ I2

CC NQ I3

FC NQ C1

FC NQ C2

FC NQ C3

SM NQ I1

SM NQ I2

SM NQ I3

NS NQ C3

NS NQ C4

NS NQ I1

NS NQ I4

NS NQ I2

NS NQ I3

NS NQ C1

NS NQ C2

Glacier Valley

Six Mile Creek

Pinnacle Well

Bonnie waterholes

Mooringinya Well

Bonnie Pool

Woggles Well

Ballas Well (abandd)

Outcamp Well ruin

Whatsamatta Well

MARBLE BAR

Eighteen Mile

Daylight Rockhole

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star
- Cloudbreak
- Christmas Creek
- Fortescue (Control)
- Solomon (Impact)
- Hamersley Rail Line
- Hamersley Line Motion Camera (Long Term)
- Main Line Rail
- Nullagine
- North Star (Control)
- North Star (Impact)
- North Star Motion Camera (Control)
- North Star Motion Camera (Impact)

N

0 5 10 15 20 25 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 18-01-2019

Northern Quoll Monitoring Sites

Fauna Monitoring 2018

Prepared for Fortescue Metals Group

Figure 2.1

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INDIAN OCEAN

MR GB OS 01
MR GB OS 02
MR GB OS 03
MR GB OS 04
MR GB OS 05
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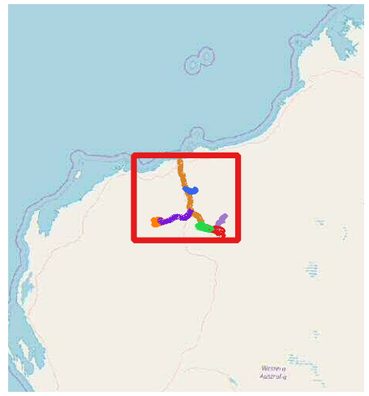
MR GB OS 07
MR GB OS 08
MR GB OS 09
MR GB OS 10
MR GB OS 11
MR GB OS 12
MR GB OS 13
MR GB OS 14
MR GB OS 15
MR GB OS 16
MR GB AS I14
MR GB OS 17
MR GB OS 18
MR GB OS 19
MR GB OS 20
MR GB OS 21
MR GB OS 23
MR GB OS 22
MR GB OS 25
MR GB OS 24
MR GB OS 26
MR GB OS 27
MR GB OS 28
MR GB OS 29
MR GB OS 30
MR GB OS 31
MR GB OS 32
MR GB OS 33
MR GB OS 34
MR GB OS 35
MR GB OS 36
MR GB OS 37
MR GB OS 38
MR GB OS 39
MR GB OS 40
MR GB AS C16
CC GB OS 06
CC GB OS 07
CC GB OS 03
CC GB OS 01
CC GB OS 04
CC GB OS 16
CC GB OS 20
CC GB OS 25
CC GB OS 30
CC GB OS 27
CC GB OS 28
CC GB OS 31

YANDEYARRA
ABORIGINAL
RESERVE
MILLSTREAM CHICHESTER NATIONAL PARK
CHICHESTER RANGE
MUNGARORNA RANGE NATURE RESERVE
PILBARA
KARIJINI NATIONAL PARK
HAMERSLEY RANGE
FORTESCUE MARSH
BLACK RANGE
SANDY DESERT
SHERLOCK BAY
PORT HEDLAND

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star
- Greater Bilby Motion Camera
- Mainline Rail Occupancy Site (Dry & Wet season)
- Christmas Creek Occupancy Site (Dry & Wet Season)
- Mainline Rail Occupancy Site (Dry season)
- Christmas Creek Occupancy Site (Dry Season)
- Abundance Site Control
- Abundance Site Impact



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Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 16-05-2019

Greater Bilby Monitoring Sites

Fauna Monitoring 2018

Prepared for
Fortescue Metals Group

Figure
2.2

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INDIAN OCEAN

MR BAT C8
MR BAT C1
MR BAT C9
MR BAT I1
MR BAT I2
MR BAT C6
MR BAT I3
MR BAT C12
MR BAT C3
MR BAT C7
MR BAT C2
MR BAT C4
MR BAT C5
MR BAT I4
MR BAT I7
MR BAT I5
MR BAT I8
MR BAT I6
MR BAT C10
MR BAT C11
MR BAT I9
MR BAT I10
MR BAT I12
MR BAT I11

NS Chateau Cave
NS Cave 13
NS PLNB C1
NS PLNB C2

SM BAT C8
SM BAT I3
SM BAT I4
SM BAT I10
SM BAT I2
SM BAT I8
SM BAT C5
SM BAT C12
SM BAT C6
SM BAT C4
SM BAT C2
SM BAT C1
SM BAT I7
SM BAT C3
SM BAT C9
SM BAT C11
SM BAT C7

CC Bat C10
CC Bat C11
CC Bat I03
CC Bat I02
CC Bat C09
CC Bat C07
CC Bat I12
CC Bat I01
CC Bat C01
CC Bat I09
CC Bat C12
CC Bat I07
CC Bat I06
CC Bat C06
CC Bat C02
CC Bat C04
CC Bat C05
CC Bat C03

YANDEYARRA
ABORIGINAL
MILLSTREAM CHICHESTER NATIONAL PARK
MUNGARCONA RANGE NATURE RESERVE
KARIJINI NATIONAL PARK
CHICHESTER RANGE
PILBARA
HAMERSLEY RANGE
FORTESCUE MARSH

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Bat Monitoring Site

- Christmas Creek (Control)
- Christmas Creek (Impact)
- Main Line Rail (Control)
- Main Line Rail (Impact)
- North Star (Control)
- North Star (Impact)
- Solomon (Control Site)
- Solomon (Impact Site)

N

0 10 20 30 40 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 16-05-2019

Pilbara Leaf-nosed Bat and Ghost Bat Monitoring Sites

Fauna Monitoring 2018

Prepared for
Fortescue Metals Group

Figure
2.3

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INDIAN OCEAN

NS POP C1
NS POP C3
NS POP C4
NS POP I3
NS POP I1
NS POP I4
NS POP I2

SM POP I1
SM POP I2
SM POP I3
SM POP C2
SM POP C3
SM POP C1

CC POP C1
CC POP C3
CC POP C4
CC POP C2
CC POP I1
CC POP I2
CC POP I3
CC POP I4

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Pilbara Olive Python Transect

- Christmas Creek
- North Star
- Solomon

Pilbara Olive Python site

- Christmas Creek Control site
- Christmas Creek Impact site
- North Star Control site
- North Star Impact site
- Solomon Hub Control site
- Solomon Hub Impact site

N

0 10 20 30 40 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 13-05-2019

Pilbara Olive Python Monitoring Sites

Fauna Monitoring 2018

Prepared for
Fortescue Metals Group

Figure
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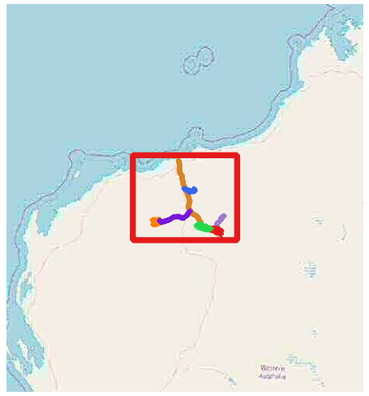
MR MiB C1
MR MiB I3
MR MiB C3
MR MiB I2
MR MiB I1
MR MiB C2
HL MiB C3
HL MiB C2
HL MiB I3
HL MiB C1
HL MiB I2
HL MiB I1
SM MiB C2
SM MiB C1
SM MiB I1
SM MiB C3
SM MiB I2
SM MiB I3
CB/CC MiB C6
CB/CC MiB C5
CB/CC MiB C4
CB MiB I3
CB MiB I2
CB MiB I1
CC MiB I1
CC MiB I2
CC MiB I3
CB/CC MiB C1
CB/CC MiB C3
CB/CC MiB C2

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Conservation Significant Bird Site

- Cloudbreak/Christmas Creek (Control)
- Cloudbreak (Impact)
- Christmas Creek (Impact)
- Hamersley Line (Control)
- Hamerley Line (Impact)
- Main Line Rail (Control)
- Main Line Rail (Impact)
- Solomon Hub (Control)
- Solomon Hub (Impact)



N

0 10 20 30 40 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 13-05-2019

Conservation Significant Bird Monitoring Sites

Fauna Monitoring 2018

Prepared for
Fortescue Metals Group

Figure
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INDIAN OCEAN

MR RF MC1
MR RF MC2
MR RF MC3
MR RF MC4
MR CU 10
MR CU 09
MR RF MC5
MR RF MC6
MR CU 04
MR RF MC7
MR RF MC8
MR RE 01
MR CU 02
MR CU 01
MR CU 05
MR CU 07
MR CU 08
MR RF MC9
MR RE 37
MR CU 03
HL CU 03
HL CU 02
MR RE 92
MR CU 06
HL RE 87
HL RE 74
HL CU 05
MR RF MC10
SM RE 06
SM RE 10
SM RE 11
HL RE 63
NS RE6
NS RE7
NS RE3
NS RE1
NS RE5
NS RE2
NS RE4
CB RE 05
CC RE 01
CC RE VAS1
CB RE Cocos WD1
CC RE 02
HL CU 01
HL CU 02
HL CU 04
HL CU 03

YANDEYARRA
ABORIGINAL
MILLSTREAM CHICHESTER NATIONAL PARK
CHICHESTER RANGE
MUNGAROONA RANGE NATURE RESERVE
PILBARA
HAMERSLEY RANGE
KARIJINI NATIONAL PARK
MARSH

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Rehabilitation Monitoring Site

- Christmas Creek
- Cloudbreak
- Hamersley Line
- Main Line Rail
- North Star
- Solomon

Culvert Monitoring Site

- Hamersley Line
- Main Line Rail

Red Fox Monitoring Site

- Main Line Rail

N

0 5 10 15 20 25 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 16-05-2019

Rehabilitation, Culvert and Red Fox Monitoring Sites

Fauna Monitoring 2018

Prepared for
Fortescue Metals Group

Figure
2.6

3. RESULTS AND DISCUSSION

3.1. Climate

Climate data relevant to the fauna monitoring program is presented in the below sections. A summary of monthly rainfall recorded at each project in comparison to the long-term average (BoM stations) was summarised in Table 3.1. Overall, the rainfall recorded in January 2018 was above average at Solomon Hub, Hamersley Rail Line, Main Line Rail and North Star, followed by a relatively dry remainder of the wet season (February and March). Christmas Creek and Cloudbreak experienced mostly below average rainfall for the entire wet season. June 2018 was unusually wet with above average rainfall recorded from all projects with rainfall between 24.6 mm and 83.8 mm above average (Table 3.1).

When comparing the rainfall recorded in 2018 to previous years of monitoring below average rainfall is typically recorded from Cloudbreak and Christmas Creek and above average rainfall recorded from the Main Line Rail, Hamersley Rail and North Star (Figure 3.1). Overall, 2014 and 2016 appear to have been the driest years since the start of the monitoring program in 2012. Rainfall recorded in 2013 was higher than during other years, followed by 2017 (Figure 3.1).

Table 3.1: Monthly rainfall at each project in comparison to the average rainfall

Project	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Cloudbreak	-35.55	-68.7	-27.7	-20.9	-18.7	24.6	-14.7	-6.15	-3.3	-4.8	-0.25	-12.65	-188.8
Christmas Creek	-23.4	36.8	-2.3	-23	-5.3	19.9	-14.0	-5.6	-3.1	-2.1	-7.6	-18.9	-48.6
Solomon	89.8	-19.8	-26.5	-11.2	-27.1	83	-13.9	-7.8	-2.9	-3.9	-9.7	-39.9	10.1
Hamersley Rail Line	200.5	-16.5	5.8	-22.5	-21.4	83.8	-12.8	-5.8	-1.7	-3.7	-7.5	-31.9	166.3
Main Line Rail (North)	62.8	-36.3	1.1	-17.3	-22.5	49.1	-8.7	-4.0	-1.5	-1.8	-3.3	-16.8	3.1
Main Line Rail (South)	36.9	81.9	-29.5	-18.1	-8.0	25.6	-8.7	-4.2	-1.5	-1.8	2.4	-25.0	60.5
North Star	255.6	-36.6	-5.9	-12.1	-14.0	60.5	-17.7	-0.5	-4.4	-3.7	1.2	0	180.6

Note: values over 10ml below or above average rainfall for the month have been highlighted

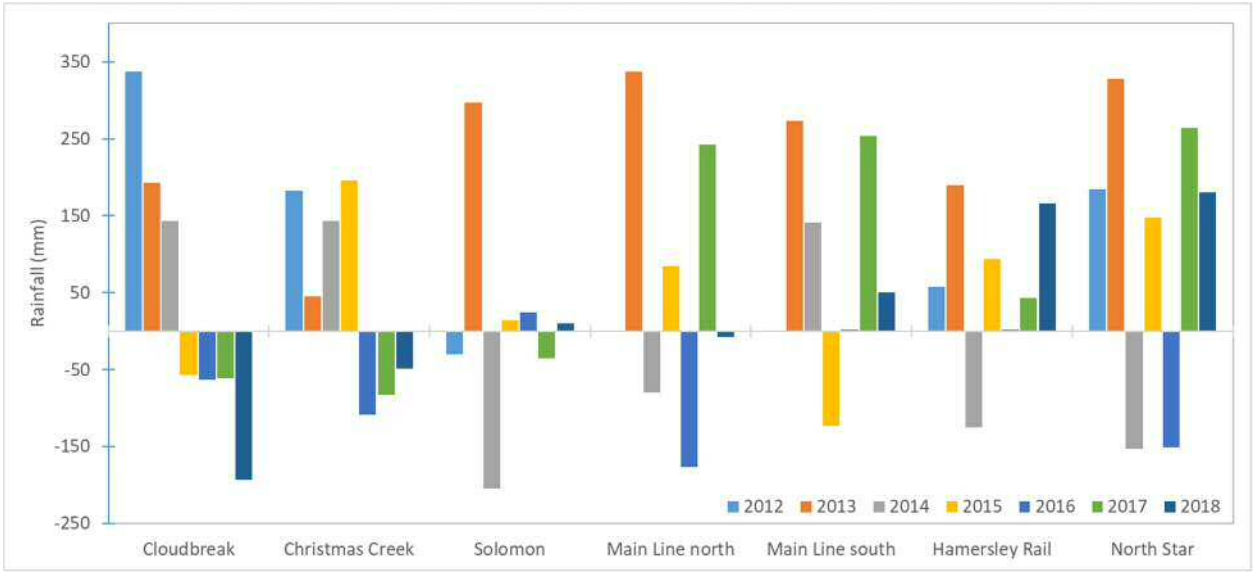


Figure 3.1: Annual Rainfall deviation from long-term average

3.1.1. Cloudbreak

The climatic conditions recorded at the Cloudbreak mine site (BoM station 'Fortescue Dave Forrest #505056) in 2018 were relatively dry during both the wet season from January to April 2018, and the dry season (May to September 2018) with an unusual winter rainfall event 7-8 June 2018 (Figure 3.2). A total of 59.8 mm was recorded during the 2018 wet season (Jan – Apr) which is 161.5 mm below the average for this timeframe (average of 221.3 mm at Marillana station #5009) (BoM 2018). The dry season between April and September was also unusually dry, except for the June rainfall event (38.6 mm), with a total of 43.6 mm which is 17 mm below the average of 60.6 mm during this period.

Long-term data shows that conditions on site were dry in 2015, 2016 and 2017, with the total rainfall lower than that recorded in 2012, 2013 and 2014 (Figure 5.1 in Appendix 2). Peak rainfall events recorded during the wetter years totalled up to 270 mm in a single month (Jan 2012, Jan 2013 and Jan 2014). These heavy rainfall events have not been recorded since January 2014 (Figure 5.1 in Appendix 2).

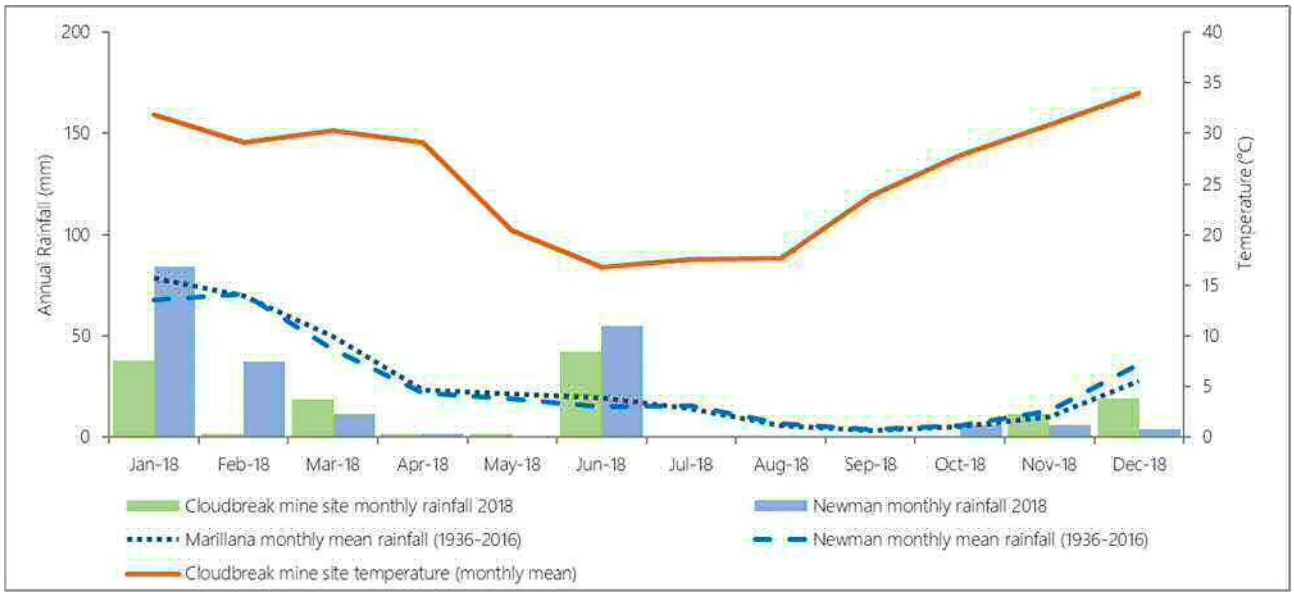


Figure 3.2: Rainfall and temperature data recorded in 2018 at Cloudbreak

3.1.2. Christmas Creek

Climatic conditions recorded at the Christmas Creek mine site (BoM station 'Christmas Creek #505049) in 2018 (Figure 3.3) were typical for the region during the wet season from January to April 2018 (BoM 2018). A total of 209.4 mm was recorded during these months which is 11.9 mm below the average for this timeframe (average of 221.3 mm at Marillana). The dry season between May and September was slightly drier than the average for this region (8.1 mm below average).

Long-term weather data recorded from the Christmas Creek mine site indicates that the past three years were relatively dry (Figure 5.2 in Appendix 2). High wet season rainfall was recorded in January 2012, January 2014, and accumulative increased rainfall between Jan – May 2015. Relatively dry wet season conditions were experienced in 2017. The years of 2013, 2016 and 2017 were dry, lacking typical wet season rainfall events.

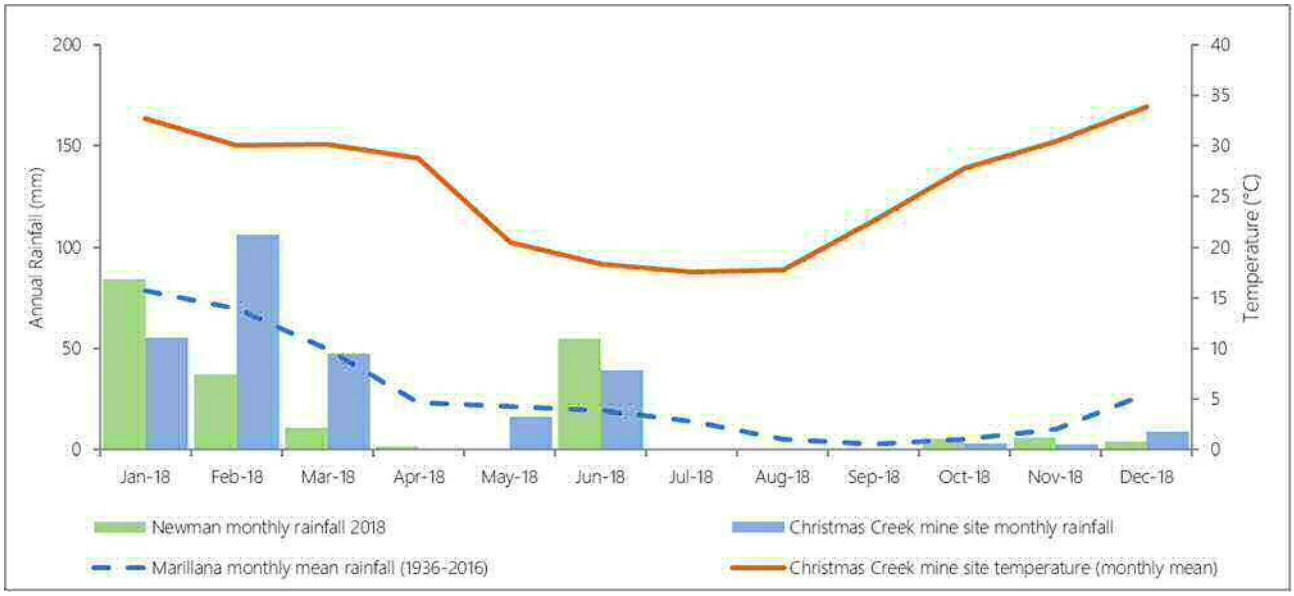


Figure 3.3: Rainfall and temperature data recorded in 2018 at Christmas Creek

3.1.3. Solomon Hub

Climatic conditions recorded at the Solomon mine site (Kings Area) in 2018 were typical for the region during the wet season of 2018 from January to April (Figure 3.4). A total of 350 mm was recorded during these months which is 32.3 mm below the average for this timeframe (average of 317.7 mm at Wittenoom). The dry season between May and September were wetter than typical for this region with untypical heavy rainfall in June 2018 (83 mm above average). The wet season in 2019 was unusually dry with below average rainfall received between January and March 2019 (Figure 3.4).

Long-term weather data recorded from the Solomon mine site indicate that the site experienced typical rainfall patterns over the past two years, with a dry period between May and November 2017. Rainfall events were slightly more scattered in 2014, 2015 and 2016 with increased dry season rainfall between May and July during those years (Figure 5.3 in Appendix 2). Overall, the annual rainfall was relatively consistent since 2014 without much fluctuation until early 2019 when the received rainfall dropped to below average.

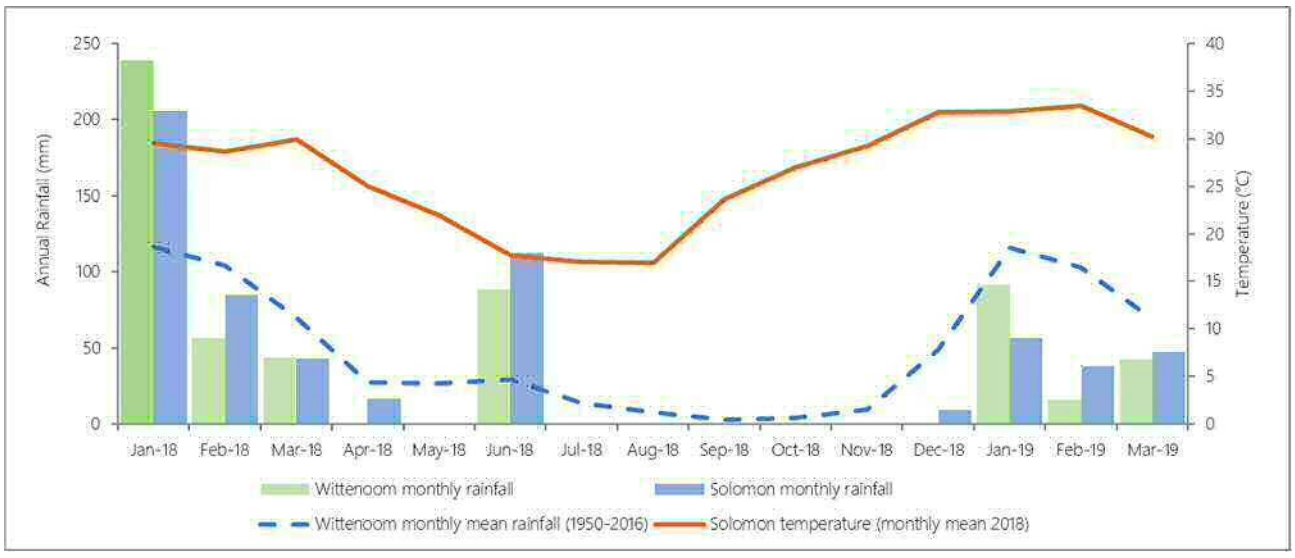


Figure 3.4: Rainfall and temperature data recorded in 2018-2019 at Solomon Hub

3.1.4. Hamersley Rail Line

Climatic conditions recorded at the Hamersley Rail Line in 2018 indicated that above average rainfall was recorded between January and April 2018 (Figure 3.5). A total of 436.4 mm was recorded during these months which is 167.3 mm above the average for this timeframe (average of 269.1 mm at Mt Florance). The dry season between May and September were wetter than typical for this region with untypical heavy rainfall in June 2018 (83.8 mm above average).

Long-term weather data recorded from the Hamersley Rail Line indicate that the site experienced a very concentrated rainfall pattern in early 2018 with increased rainfall recorded over three months, followed by no rainfall. A more typical rainfall pattern was recorded in 2017 and a more scattered pattern was recorded in 2014, 2015 and 2016. This is consistent with recordings at Solomon mine site (Figure 5.3 and Figure 5.4 in Appendix 2. The 2013 monitoring period appears to be the wettest year of monitoring to date (Figure 5.4 in Appendix 2).

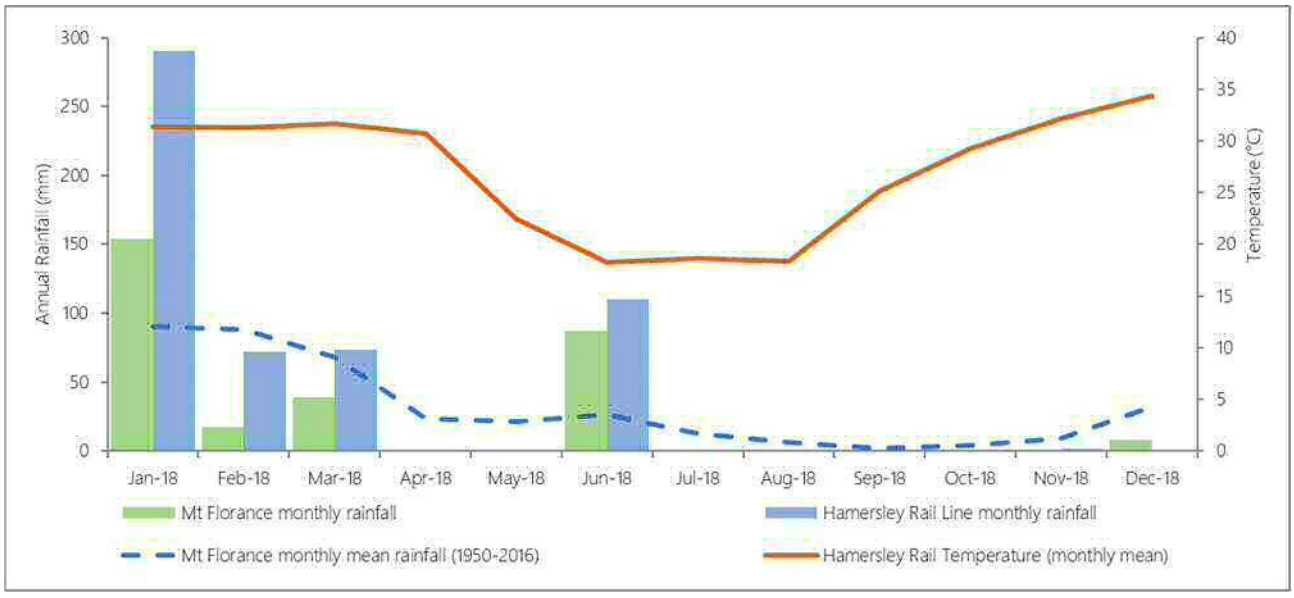


Figure 3.5: Rainfall and temperature data recorded in 2018 at Hamersley Rail Line

3.1.5. Main Line Rail

Climatic conditions recorded at the Main Rail Line in 2018 indicated that the rainfall recorded between January and April 2018 was slightly above average in the south of the project (Figure 3.6). A total of 71.2 mm above average rainfall was recorded from the south of the project, whereas 10.3 mm below the average rainfall was recorded from the south of the Main Line Rail during this period. (average of 269.1 mm at Wallareenya). The dry season was wetter than typical for this region with untypical heavy rainfall in June 2018 (52.5-76.0 mm).

Long-term weather data recorded from the Main Line Rail indicate that the 2018 was drier than 2017. The lowest annual rainfall was recorded in 2014 and 2016 (north), whereas the south of the project was drier in 2014, 2015 and 2016 (Figure 5.5 and Figure 5.6 in Appendix 2).. The 2013 and 2017 monitoring periods appear to be the wettest years of monitoring to date.

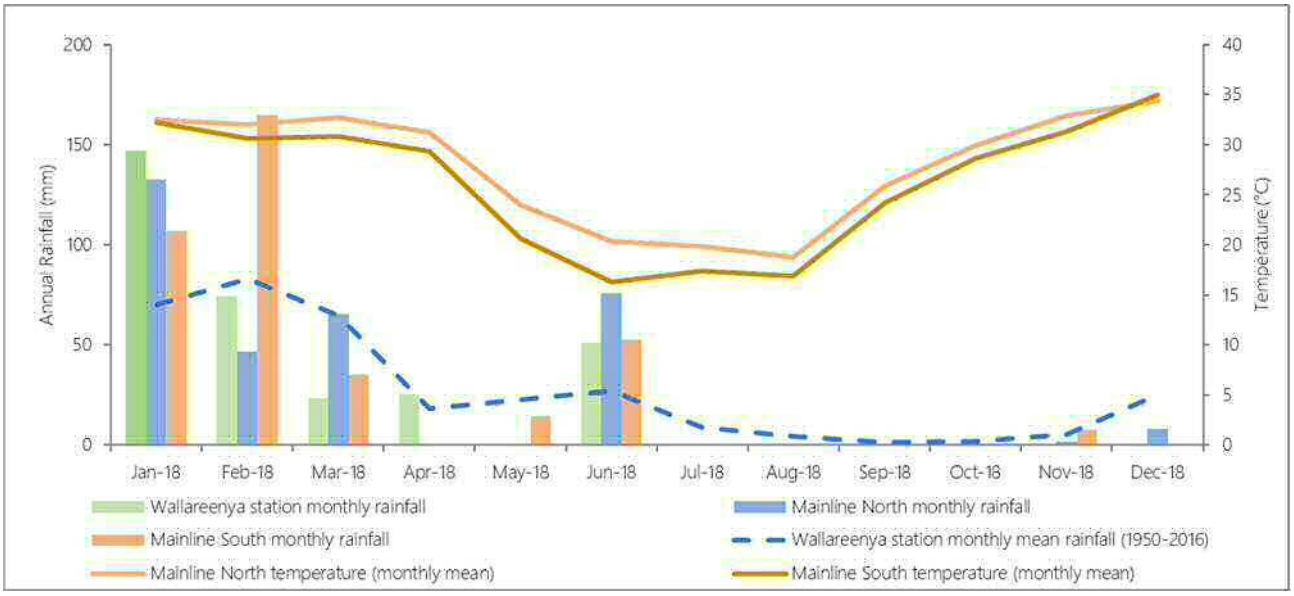


Figure 3.6: Rainfall and temperature data recorded in 2018 at Main Line Rail

3.1.6. North Star

The climatic data recorded from the North Star mine indicates that the rainfall total was above average in January 2018, followed by three months of slightly below average. Some untypical high June rainfall was recorded which is consistent with data recorded from across the Pilbara (sections 3.1.1-3.1.5). Overall, 2018 was a relatively wet year with 180.6 mm above average rainfall.

Long-term data suggests that 2014 and 2016 were dry years with below average rainfall and untypical rainfall pattern, with wet season rain almost limited to the month of January in 2014, and low rainfall spread over six months (January to June) in 2016. Rainfall recorded in 2013 and 2017 was particularly high with 328.5 mm and 263.6 mm above the annual total respectively (Figure 5.7 in Appendix 2).

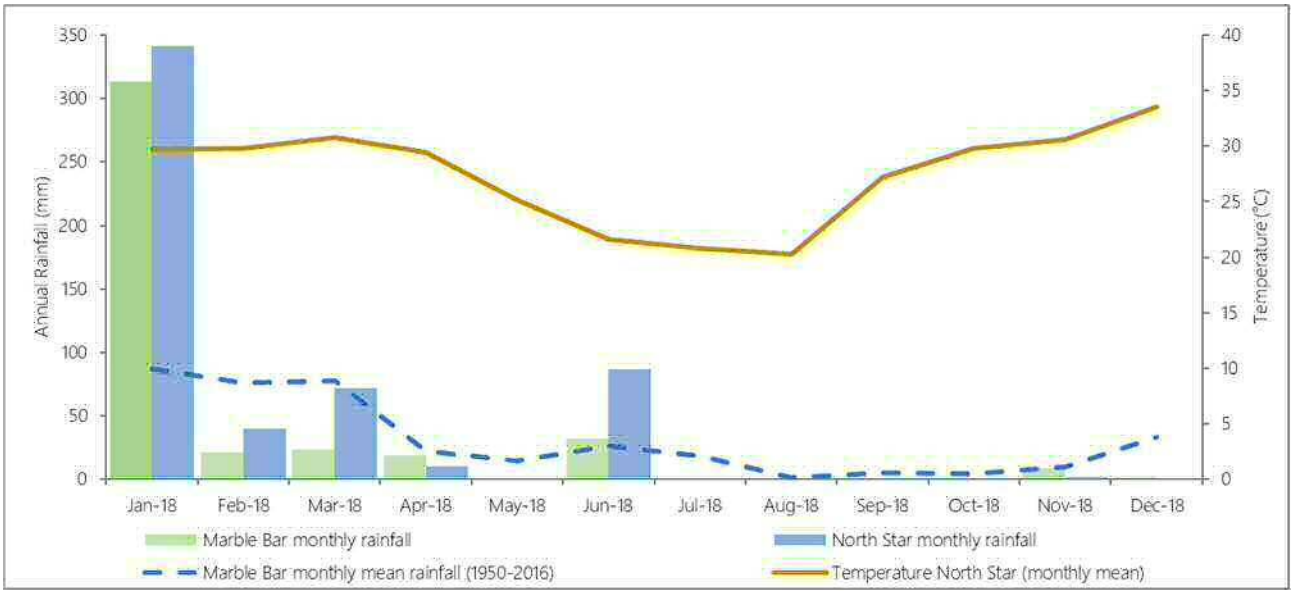


Figure 3.7: Rainfall and temperature data recorded in 2018 at North Star

3.1.7. Nullagine

There is no weather station located at the Nullagine mine site. The closest weather station is situated at Christmas Creek and weather conditions are expected to be similar due to the relatively close proximity (35 km). It should be noted that rainfall events in the Pilbara can be very localised (e.g. differences between Cloudbreak and Christmas Creek) and that the recorded weather data at Christmas Creek are used as an indication for climatic conditions at Nullagine mine site.

3.2. Site Based Records

All conservation significant fauna recorded from each site in 2018 were entered into the Fortescue's BMS Plant and Animal Register or Incident Register (in case of a fauna deaths). All are verified records, as determined by site environment personnel, typically by sighting, photographic evidence or discussions with those reporting sightings. The details of each record are presented in Table 5.2 (Appendix 3).

3.2.1. Cloudbreak

No conservation significant fauna species were recorded by site personnel in 2018. In 2016, one Grey Falcon was recorded which is likely to be a foraging individual due to the single record to date. No other conservation significant fauna has been recorded by site personnel to date.

3.2.2. Christmas Creek

One conservation significant fauna species were recorded in 2018 by site personnel (Appendix 3). In April 2018, one Pilbara Olive Python (PAR-2114) was recorded from the Christmas Creek mine (CCY2 Workshop). This confirmed record is the fourth record of Pilbara Olive Python since 2011 in addition to one probable confirmed (2014) and one unconfirmed record (2011). The timing of the 2018 record coincides with the Pilbara Olive Python mating season and the recorded individual is likely to be a roaming male that moved into the mining footprint searching for females. The temporally scattered records of this species from Christmas Creek indicates that whilst their presence continues records are uncommon and of single individuals moving through the area.

In May 2017, a Greater Bilby was recorded (PAR-1905) from the infrastructure in the east of the mine. No other records of the species on site have been made since then.

3.2.3. Solomon Hub

Two conservation significant fauna species were recorded in 2018 by site personnel (Appendix 3). A total of five Northern Quolls were recorded by site personnel from the Trinity Mine, Firetail South and Kings OPF in 2018 compared with seven individuals recorded in 2017 and four individuals recorded in 2016. This is considered a relatively high number of records in comparison to the other mine sites and is an indication of the abundance of Northern Quolls on site.

In addition, Pilbara Olive Python was recorded on three occasions in 2018 from Firetail South, Kangeenarina creek and the Kings mine area. One additional record was made from a juvenile individual that was recorded at Kangi camp during the wet season monitoring and relocated at Kangi creek (17 March 2019). The individual was recorded from a road in Kings on 30 March 2019.

In 2017, seven Pilbara Olive Python individuals were recorded by site personnel from the Solomon Hub. The records confirm the species ongoing presence on site and that habitats are utilised in a similar manner between the years.

3.2.4. Hamersley Rail Line and Main Line Rail

No conservation significant fauna were recorded by site personnel from the Hamersley Rail Line and Main Line Rail in 2018. The lack of records is thought to be due to the very limited movement of site personnel along the rail lines compared with mine sites.

3.2.5. North Star

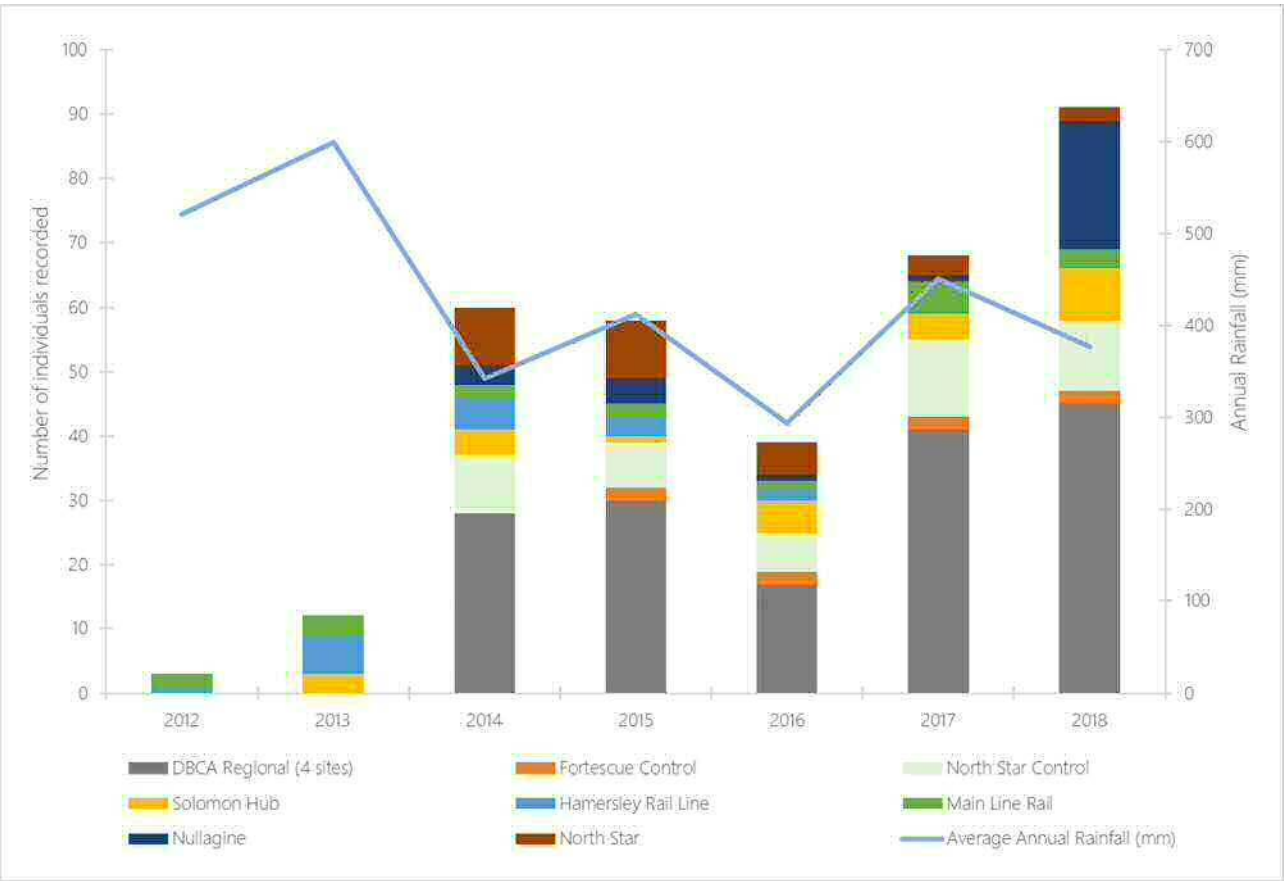
One Northern Quoll was recorded by site personnel from west of the southern control sites in 2018. Previous records indicated that species was more often sighted in 2015 which coincides with the higher level of traffic on site. Traffic and activity levels on site have significantly reduced since 2016. No Pilbara Olive Pythons, Pilbara Leaf-nosed Bats or Ghost Bats were recorded in 2018, but were recorded during previous years (Appendix 3).

3.3. Northern Quoll

The number of Northern Quoll individuals recorded from each monitoring site to date is listed in Table 3.2 and displayed in Figure 3.8 showing general trends across all sites and a likely correlation with rainfall recorded prior to the monitoring (averaged across all sites). An increase in annual rainfall and Northern Quolls recorded (3 individuals to 12 individuals) was recorded between 2012 and 2013 (Figure 3.8). The 2014 data included additional sites so that the overall number of Northern Quolls appears greater during this year. However, data from the sites monitored in 2012-2013 (Solomon, Hamersley Rail and Main Line Rail) show a slight decrease from 12 individuals in 2013 to 11 individuals in 2014) which correlates with the decrease in annual rainfall.

Conditions appear to have been favourable in 2015 (slight increase in rainfall) and Northern Quoll records remained stable however a change in monitoring methods (use of motion cameras only at Solomon, Hamersley Rail and Main Line Rail) resulted in a slight reduction in the number of Northern Quoll individuals recorded. Trapping methods were re-implemented in 2016 and both rainfall and Northern Quoll records decreased in 2016 and increased in 2017 (Figure 3.8). Rainfall decreased between 2017 and 2018 whereas the Northern Quoll data recorded in 2017 and 2018 appear consistent at each site, with a significant increase in the number of records from the Nullagine mine site (Figure 3.8). As expected, Northern Quoll records appear to increase with increased rainfall and improving environmental conditions that occurs during wetter seasons and the associated increased survival of young Northern Quolls.

Monitoring results and statistical analysis of capture data from each project area are described in the sections below. Details of each captured Northern Quoll individual including microchip number, sex, capture date, trap number, measurements, weight, reproductive status and health condition are recorded in Table 5.3 (Appendix 4). Estimates for population size, capture probability and density were determined for sites with sufficient recapture data. Data from each operational area was analysed separately, and the results presented in Table 5.4 in Appendix 5. This approach provides a good estimate for each site during each monitoring event; however, due to the lack of recapture data at some sites during some of the years a comparison between years is often difficult. A trend of population sizes often could not be determined. For this reason, capture data from a number of sites was combined where practical (e.g. North Star control sites), based on appropriate groupings (location, functionality and suitability of data for statistical analysis). The results are presented in Table 5.5 (Appendix 5).



Note: Monitoring of DBCA sites, North Star and Nullagine started in 2014 and Fortescue control sites in 2015. Methods used at Solomon, Hamersley Rail Line and Main Line Rail consisted of motion cameras only in 2015. Northern Quoll have not been recorded from Cloudbreak or Christmas Creek.

Figure 3.8: Northern Quoll monitoring records compared with average annual rainfall

Table 3.2: Total number of Northern Quoll recorded from each project area

Project/Site	Individuals recorded						
	2012	2013	2014	2015	2016	2017	2018
Control Sites							
Fortescue control sites							
SM NQ C1	-	-	-	P	1	P	S
SM NQ C2	-	-	-	P	1	P	2
SM NQ C3	-	-	-	-	0	0	0
Total Fortescue control	-	-	-	2	2	2	2
North Star control sites							
NS NQ C1	-	-	2	2	2	4	1
NS NQ C2	-	-	5	1	1	3	3
NS NQ C3	-	-	1	0	0	4	2
NS NQ C4	-	-	1	4	3	5	5
Total North Star control	-	-	9	7	6	16	11

Project/Site	Individuals recorded						
	2012	2013	2014	2015	2016	2017	2018
DBCA control sites							
Indee station	-	-	22	25	13	23	32
Dales Gorge (Karijini NP)	-	-	-	-	-	4	4
Mt Florance station	-	-	6	5	3	11	8
Hooley station	-	-	0	0	0	3	1
Total DBCA			28	30	17	41	45
Total control sites	**-**	**-**	**37**	**39**	**25**	**59**	**58**
Potential Impact Sites							
Solomon Hub							
SM NQ I1	0	3	3	P	4	2	6
SM NQ I2	0	0	1	0	0	2	1[MC]
SM NQ I3	0	0	0	-	1	0	3[R]
Total Solomon Hub	0	3	4	1*	4 [R]	4	9
Hamersley Rail Line							
HL NQ I1	0	P	1	P	0	0	0
HL NQ I2	1	1	2	P	P	0	0
HL NQ I3	0	4	2	P	P	0	0
Total Hamersley Rail Line	1	6	5	3*	2	0	0
Main Line Rail							
MR NQ I1	0	P	0	P	0	0	1
MR NQ I2	P	2	1	0	0	2	4
MR NQ I3	P	0	1	P	1	3	P
Total Main Line Rail	2	3	2	2*	1	5	6
North Star							
NS NQ I1	-	-	2	3	4	0	0
NS NQ I2	-	-	3	1	1	1	1[R]
NS NQ I3	-	-	2	2	0	0	0
NS NQ I4	-	-	2	3	0	2	1
Total North Star			9	9	5	3	2
Total impact sites	**3**	**12**	**20**	**15**	**11**	**12**	**17**

P= Presence of species recorded through secondary evidence only, for count purposes the record has been counted as one individual.
S = Northern Quoll skull recorded indicating historic presence of species
* no trapping conducted during this year, use of motion cameras and searches did not allow for individual count
[MC] Recorded on motion camera only; [R] One individual was previously trapped at another site

3.3.1. Control Sites

3.3.1.1. DBCA sites

The 2018 Pilbara-wide Northern Quoll monitoring conducted by DBCA indicated an increase in the Northern Quoll population at Indee station, a stable population size at Dales Gorge (Karijini NP), and a slight decrease in Northern Quoll records at Mt Florance station, Hooley station and Millstream/Chichester NP in comparison to 2017 data (Table 3.2).

The number of individuals recorded at Indee station was relatively consistent between 2014 and 2015 (22 and 25 individuals) before decreasing to 13 individuals in 2016 and then increasing up to 23 individuals in 2017 (Figure 3.9). The 2018 monitoring recorded the continuation of an increasing population size with 32 individuals recorded from this site (Table 3.2). This trend is supported by the results of the statistical analysis which also indicates an overall increase in population size between 2014 and 2018, with a decrease in population size recorded in 2016 (Table 5.4 and Table 5.5 in Appendix 5; Figure 3.9). The estimated population size (95% Confidence Interval) recorded from Indee station each year indicates that there is a correlation between the total rainfall recorded 12 months prior to the trapping and the number of Northern Quoll recorded (Figure 3.9). Annual rainfall recorded in 2014 and 2015 was significantly reduced which coincides with a decrease in the number of Northern Quoll recorded in 2016 (following the two years). Increased rainfall was then recorded between 2016 and 2017, which also coincided with an increase in the number of Northern Quoll recorded in 2017 (Figure 3.9). Overall, this trend indicated that good climatic conditions occurred between 2016 and 2017 resulting in a regional increase in Northern Quoll populations in 2017 and 2018. The site itself has not been impacted by bush fires, with adjacent sandplain habitats being burnt in 2013 (prior to start of monitoring) and November 2014 (six months post trapping) (NAFI 2018). The site itself is likely to have been used as refuge, providing shelter and food resources amongst the granite boulders and river vegetation. To date, only two records of Feral Cats have been made on motion camera in 2017.

Dales Gorge (Karijini NP) was only monitored in 2017 and 2018 with four individuals recorded from this site during each of the monitoring events. The site was impacted by bush fires in December 2016 (NAFI 2018). No data is available from the site prior to the fire so it is unknown if and to what extent the local population was impact by the bush fire. Future trapping data may assist in identifying impacts by the fire on the local population (e.g. an increase in population size).

Northern Quolls recorded from DBCA's Millstream/Chichester NP monitoring site indicated that the local populations underwent a decline since the start of the monitoring in 2014 (Figure 3.10). A total of nine individuals (seven males, two females) were recorded in 2014. Approximately three months prior to the start of the monitoring (April 2014) a bush fire impacted the monitoring site (Figure 3.13). In 2015, the Northern Quoll captures decreased to one individual which remained consistent in 2016. The two records consisted of roaming males. This result is likely a response to the bush fire impacting the site, which was also amplified by a decrease in rainfall amount between 2014 and 2016 (Figure 3.10). A second bush fire was recorded north of the site in June 2016 (one month prior to monitoring). Northern Quoll numbers appeared to have recovered in 2017 following above average rainfall conditions. Three captures were made, all of which were males indicating that a breeding population was located nearby with dispersing males foraging at the site (Figure 3.10). This also indicates that the second fire did not impact the local population (possibly because the fire did not impact the site directly) and that Northern Quoll recruitment was continuous. This trend is comparable with the trend observed at Indee station where the local population appears to be mainly impacted by rainfall conditions. In 2017, two records of Feral Cat were made from the site which represent

the first records of the feral predator from this site. In 2018, no Northern Quolls or Feral Cats were recorded from the Millstream/Chichester NP site.

At Hooley station, Northern Quolls were recorded for the first time in 2017 with three individuals recorded which then decreased to only one individual recorded in 2018. Previous monitoring (2014, 2015 and 2016) did not record any Northern Quoll from this site (Table 3.2). The increase in records in 2017 is most likely due to the change in methods from abundance monitoring in 2014-2016 (200 cage trap nights) to low abundance monitoring (630 camera nights) in 2017 and 2018 (Table 3.2). Due to the use of motion cameras, it is unknown if the population consists of roaming males or resident females. The site has not been impacted by bush fire since the start of the monitoring (NAFI 2018). In 2018, Feral Cats were recorded for the first time on three motion cameras over the three-month monitoring period. Future monitoring will indicate if Feral Cat are impacting the Northern Quolls recorded from this site.

Northern Quoll records at Mt Florance station were relatively stable between 2014 (six individuals) and 2015 (five individuals) despite an extensive bush fire impacting the site in October 2014 (five months after the first trapping event) (NAFI 2018) (Figure 3.12, Table 3.2). Quoll numbers then decreased in 2016 from five individuals in 2015 to three individuals in 2016 (1.5 years after the fire) and then almost tripled between 2016 and 2017 (four individuals in 2016 to 11 individuals in 2017). This increase is most likely due to the methods changing from abundance monitoring to low abundance monitoring in 2017 which resulted in an increase in the number of nights monitored (Table 3.2). The 2018 monitoring recorded eight individuals on motion cameras which is a slight decrease from 2017 (Figure 3.11). This is likely associated with a slightly lower rainfall and moderate conditions recorded between 2017 and 2018. Two records of Feral Cats were made in 2017 (first record on site) which is potentially a contributing factor to the slight decline. One more record of the introduced predator was made in 2018 indicating that the species persists on site. Future monitoring will assist in determining abundance and trends of the two species on sites. Due to the change in methods, statistical analysis of the data is limited.

Overall, it appears that Northern Quoll populations are influenced by a combination of bush fires, seasonal rainfall, and the presence of Feral Cats. Based on data collected to date, impacts from bush fires appear to be relatively short-term or even minimal with recovery times of two or three years observed if the site itself has been impacted (Millstream/Chichester NP and Mt Florance). Fires that impact adjacent habitats only, may not impact the site (Indee station). Seasonal rainfall and environmental conditions may play a significant role in this recovery time (Millstream/Chichester NP). Another key aspect may be the distance of the site to the nearest source (breeding) population which dictates the recruitment process. If during this recovery time, Feral Cats are present on site, the impact on quolls appear to be amplified (Millstream/Chichester NP).

Some studies have shown that Feral Cats are attracted to fire scars and are more likely to be recorded post bush fires. The studies suggest that Feral Cats venture long distances to fire scars (preferably within 90 days after intense fires) before retracting back to their original territory (McGregor *et al.*, 2016). A clear preference for dispersal along linear infrastructure such as roads has not been shown to date (Thwaites, 2017). The data collected from Millstream/Chichester NP indicates that a combination of successive fires, below average rainfall and the arrival of Feral Cats can have a significant impact on Northern Quoll numbers (Figure 3.10). Future monitoring will indicate if Northern Quoll are repopulating sites or if Feral Cats are remaining at the site and continuing to impact the local Northern Quoll population. It has been suggested that some areas can still be occupied by Northern Quolls one year post fire and even after two high intensity bush fires if the individuals' entire home range has not been burnt (DELWP 2016). The Northern Quoll has been found to suffer from higher predation levels in areas where vegetation cover forms the main refuge, in comparison to rocky gorges with abundant refuges (Oakwood, 2000; DELWP 2016).

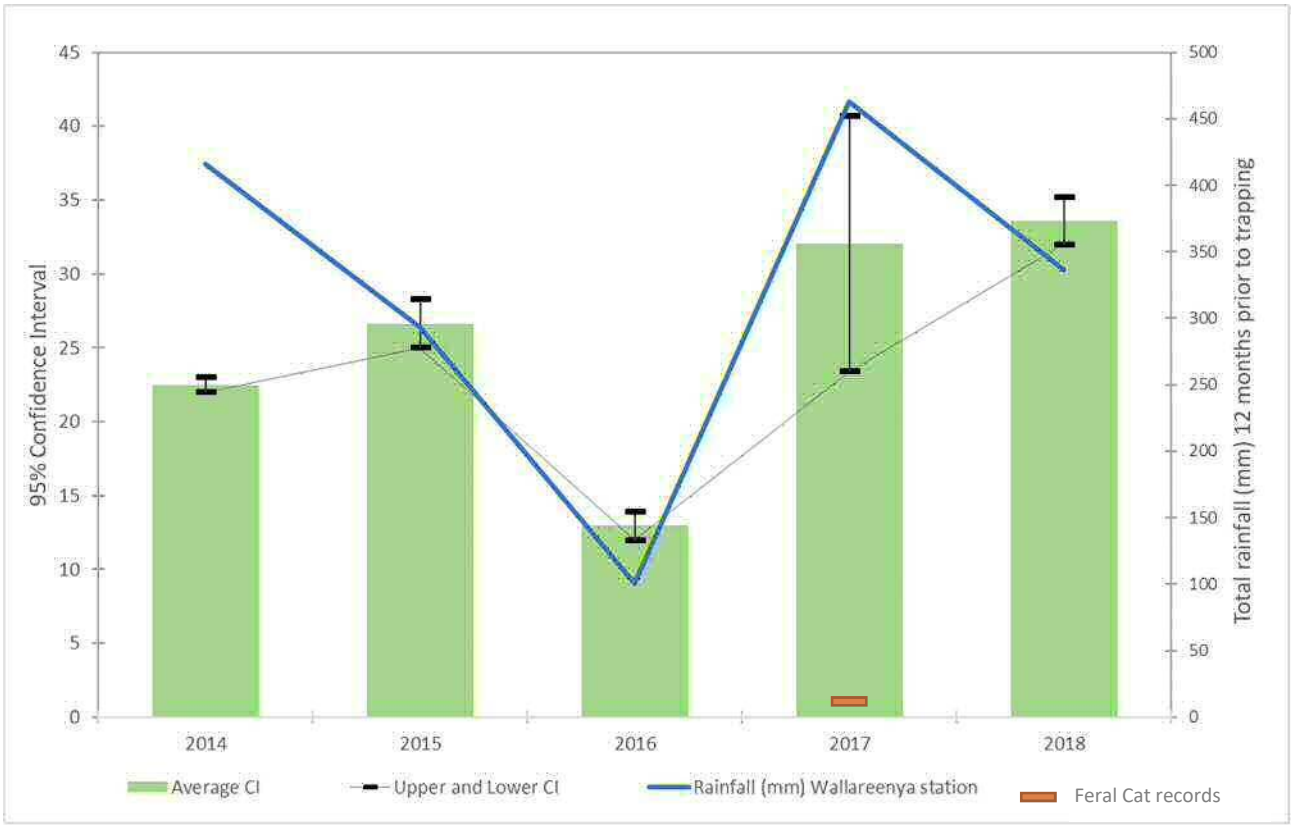


Figure 3.9: Northern Quoll population size and rainfall from Indee Station (DBCA)

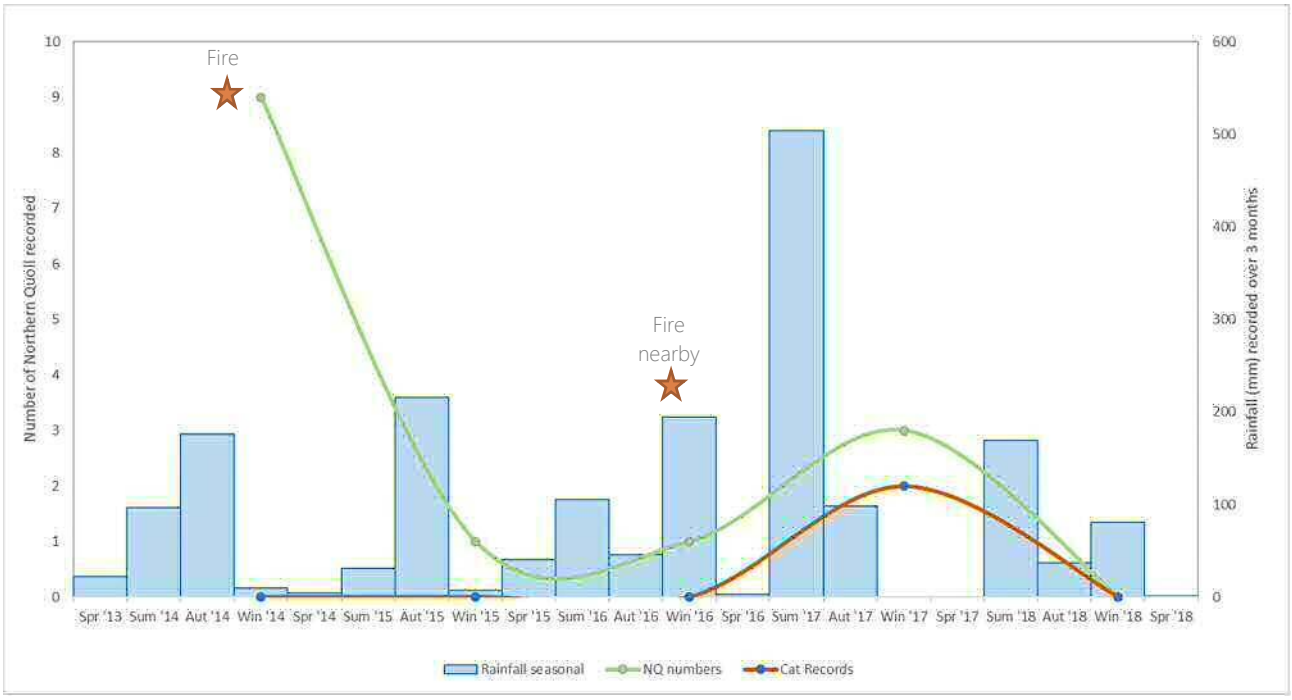


Figure 3.10: Northern Quoll, Feral Cats and seasonal rainfall at Millstream/Chichester NP (DBCA)

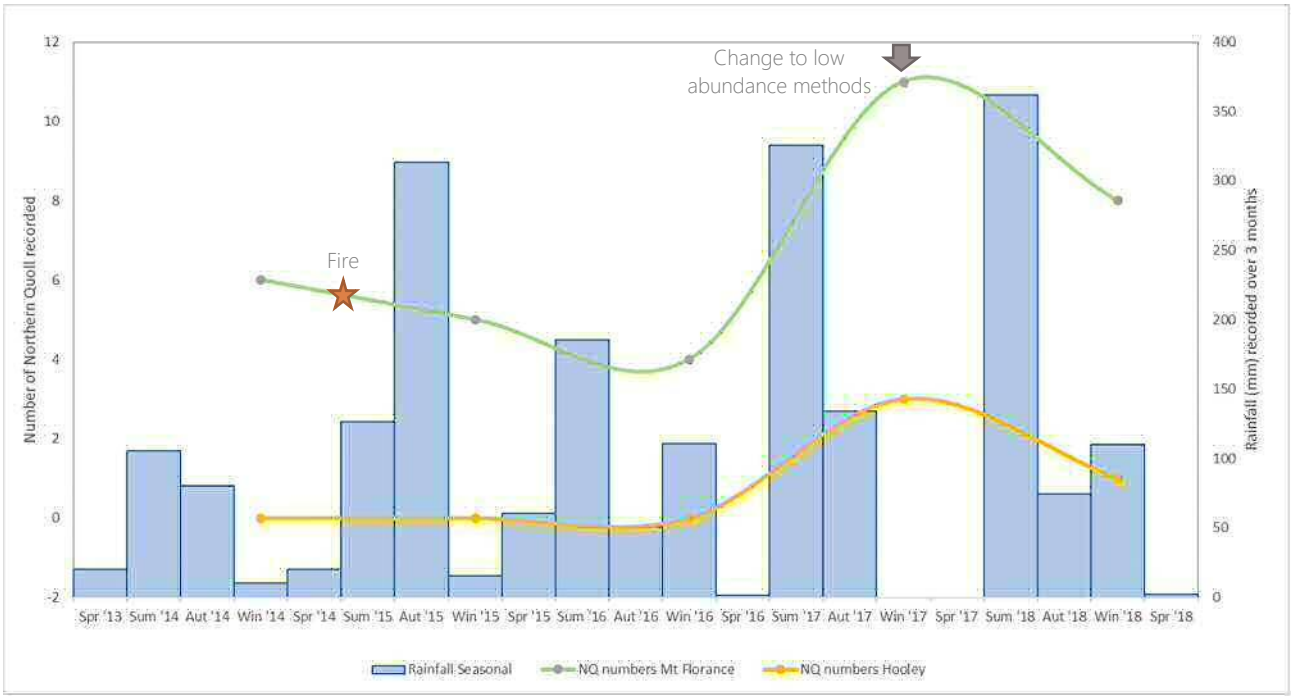


Figure 3.11: Northern Quoll recorded from Mt Florance and Hooley station (DBCA)

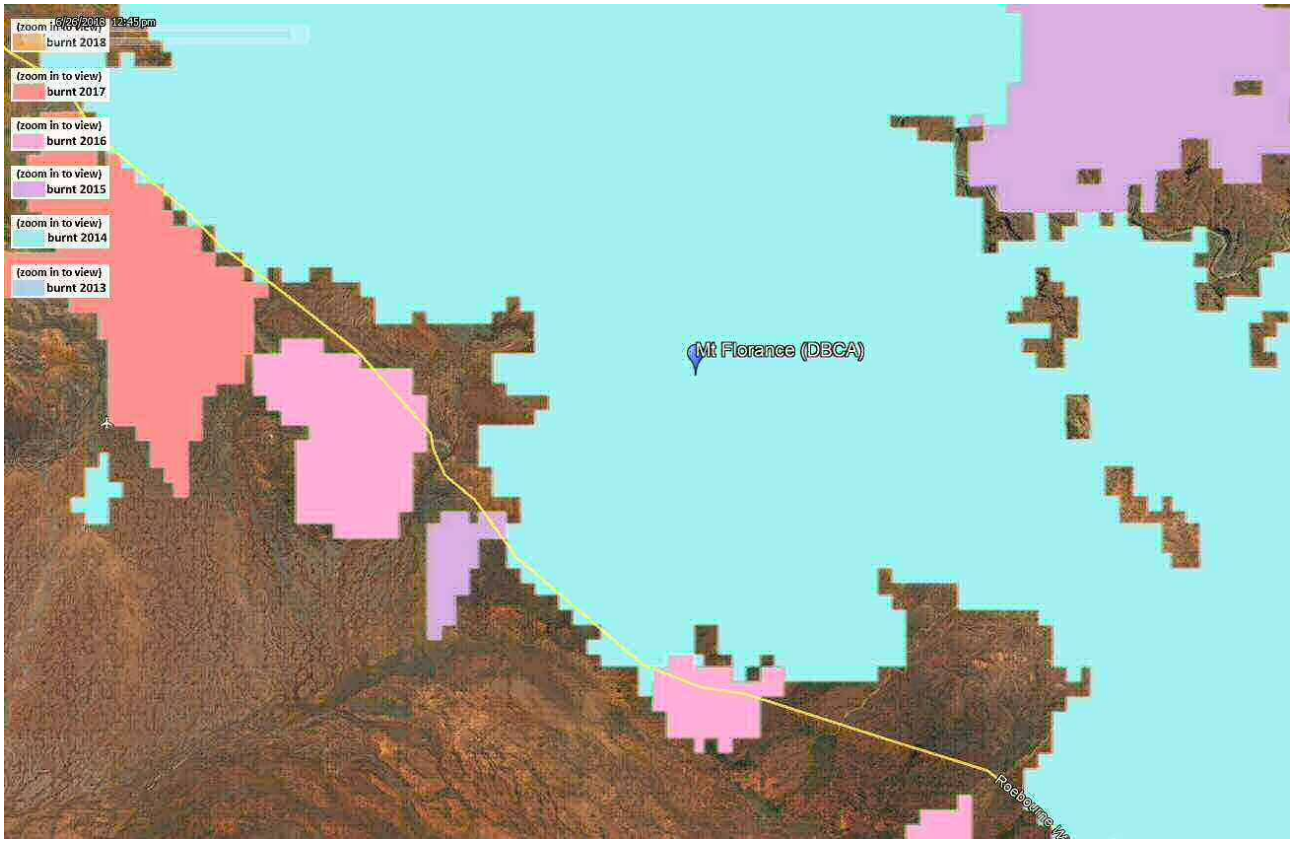


Figure 3.12: Fire history at Mt Florance Station (DBCA) (NAFI 2018)

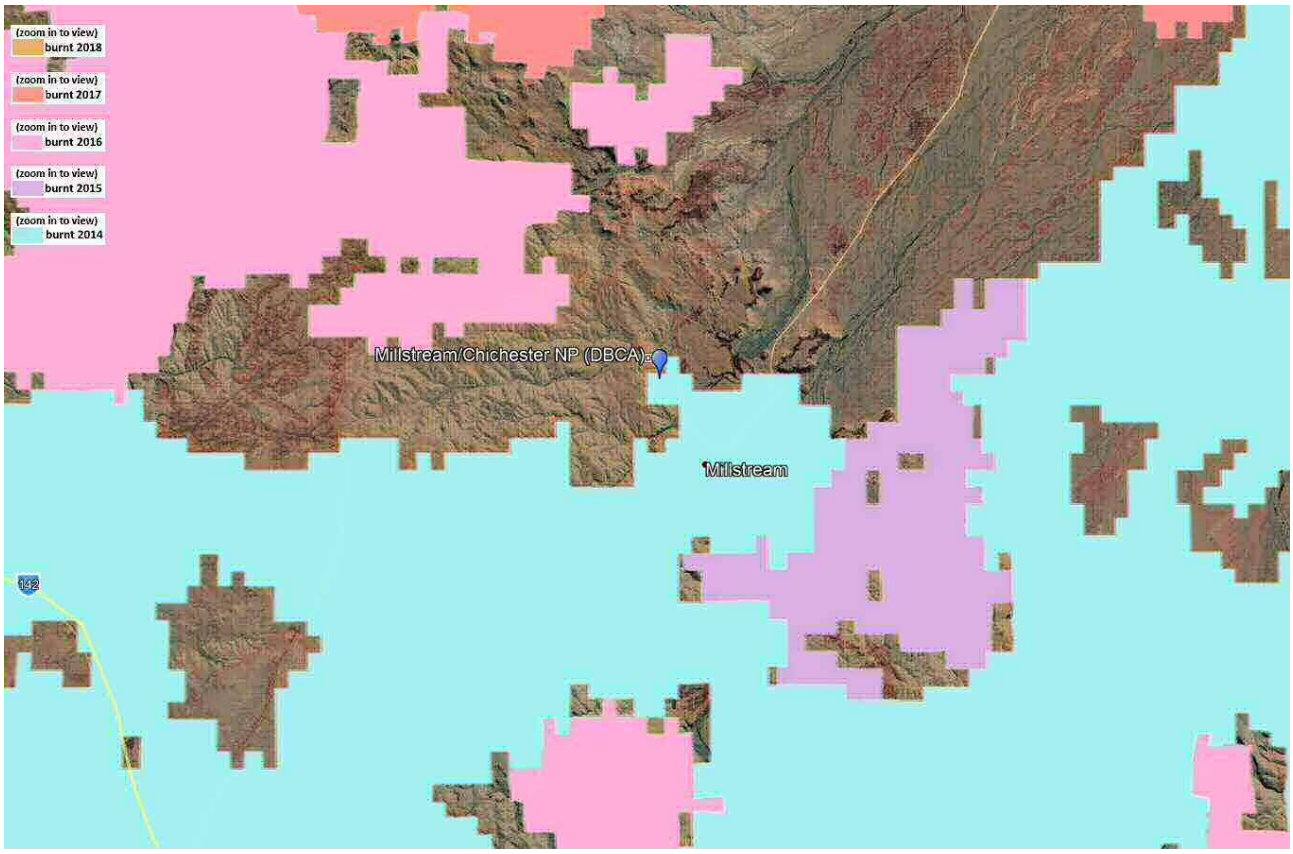


Figure 3.13: Fire history at Millstream/Chichester NP (DBCA) (NAFI 2018)

3.3.1.2. Fortescue control sites

In 2018, one male was captured from the Fortescue control site FC NQ C2 and an additional individual (based on individual spot pattern and absence of ear notch) was recorded on two motion cameras from the same site (Figure 3.14). Northern Quoll were not recorded from the remaining two Fortescue control sites. A Northern Quoll skull was recorded from site FC NQ C1 which provides additional evidence of the previous presence of the species. Northern Quolls were recorded from the site in 2016 and 2017 (one capture and secondary evidence, respectively). Searches did not record any other evidence of the species from this site. Previous monitoring recorded secondary evidence or captured one male individual at the two control sites FC NQ C1 and FC NQ C2 (Table 3.2). The slight increase of records in 2018 may indicate a slight population increase between 2017 and 2018 at one of the sites (FC NQ C2).

A small bush fire was mapped by NAFI in October/November 2015 (NAFI 2018) which impacted the surrounding areas, but due to the sheltered position of the sites along deep gorges, the vegetation was not impacted directly. An extensive fire cleared large areas to the north of the two control sites in November 2017, followed by another fire to the west of the sites in November 2018 (NAFI 2018). Environmental conditions in 2017 and 2018 were considered generally favourable (section 2.1) and are expected to have caused the slight increase of Northern Quoll records (Figure 3.16). The bush fire therefore does not appear to have had a significant impact.

Statistical analysis of the capture data was only possible for site FC NQ C2 using data from 2016 and 2018 (recapture data) and indicates that the population size has remained stable with an estimated two individuals present on site during the two monitoring events (Table 5.4 in Appendix 5). Similarly, the estimates for capture probability (50 %) and density (0.24 ML/ha) remained consistent across the two years. Due to a lack

of Northern Quoll captures, data collected during other monitoring events and from the remaining two sites is not sufficient for statistical analysis.

One Feral Cat was recorded on a motion camera at site FC NQ C2 in 2018. No other records of this species or other fauna species were made from the control sites. However, the data is not sufficient for conclusions on Feral Cat populations to be made, other than that the population size appears to be relatively low.

The trend of Northern Quoll records from the Fortescue control sites appear to indicate that the population has been stable since 2015 with no significant changes in the population size.

Figure 3.14: Northern Quoll recorded on two motion cameras at site FC NQ C2

Figure 3.15: Northern Quoll skull recorded from FC NQ C1

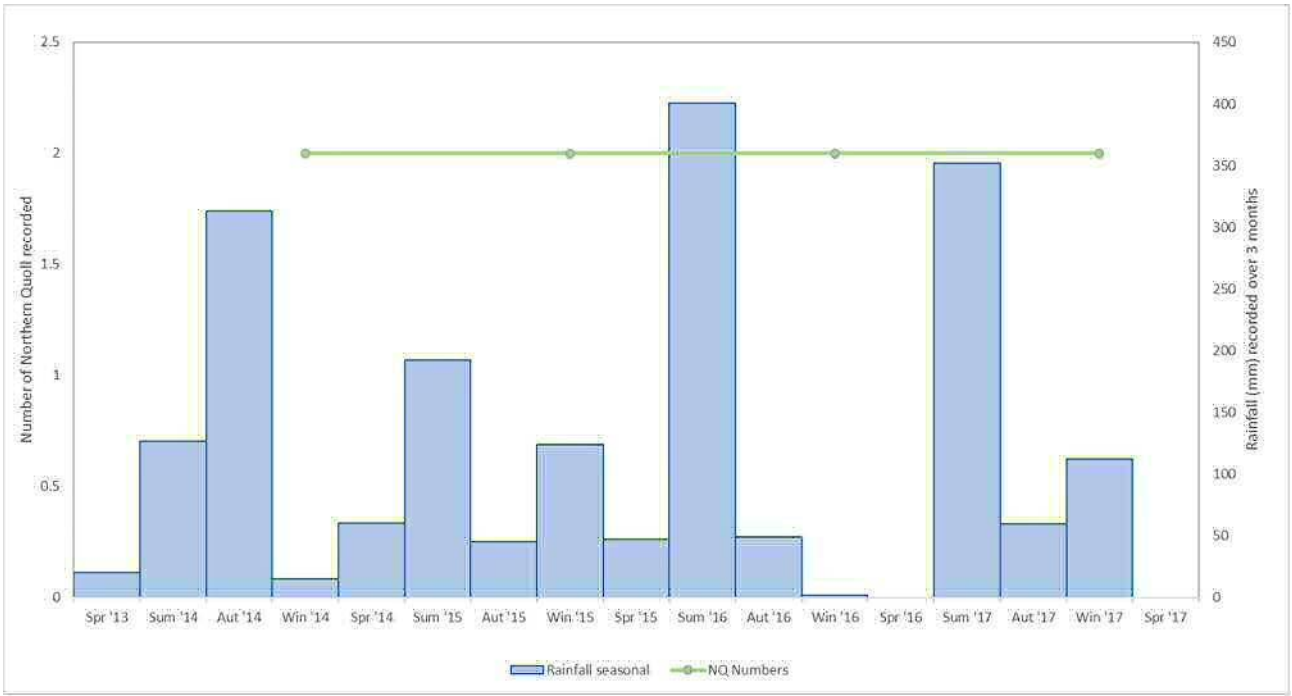


Figure 3.16: Number of Northern Quolls Recorded at Fortescue's Control Sites (including signs)

3.3.1.3. North Star control sites

Eleven Northern Quoll individuals (two females, nine males) were recorded from the four control sites associated with the North Star project. One male (PIT 991003000174886) was recaptured at NS NQ C1 over three consecutive nights after which the site was partially closed to avoid recapturing the individual a fourth time. The fourth night the individual was trapped at potential impact site (NS NQ I2) located approximately 2 km north of the control site, before returning to NS NQ C1 on the fifth night after which site NS NQ C1 was closed completely. Two males and a female quoll were recorded from site NS NQ C2 (Figure 3.29). One male and one female were recorded from NS NQ C3 with the female (PIT 941000017452032) being a recapture from 2017 at the same site. Five male quolls were captured repeatedly from NS NQ C4 with the site being closed after four nights due to successive recapture of several quolls (required as per the guidelines).

Previous records from the North Star control sites indicate there was a slight increase in Northern Quolls recorded in 2017 in comparison to previous years (from between 6 to 9 individuals up to 16 individuals), which was then followed by a slight decrease in numbers recorded (from 16 to 11 individuals) in 2018 (Table 3.2). However, the 2018 captures are still higher than the first years' captures and indicate that the populations at the control sites are relatively stable.

Statistical analysis of capture data required the North Star control sites to be combined. Data collected from the two southern control sites NS NQ C1 and NS NQ C2 were combined, and data collected from the two northern control sites NS NQ C3 and NS NQ C4 were also combined. The northern control sites are located within a separate area of habitat located approximately 6.5 km north of the impact area, whereas the southern control sites are situated within habitat that's is continuous to the impact area (located along the same mesa) and in relatively close proximity (within 3 km) to the potential impact sites. The southern control sites were originally selected to determine if individual Northern Quolls were moving south along continuous habitat away from mining activities and because baseline data from 2011 was available. Recent trapping data indicates that Northern Quolls are able to move between the impact and southern control sites. Combining the data from the control sites provides a more robust dataset than comparing single monitoring sites, in

particular for statistical data analysis. Northern Quoll data for the potential impact sites at North Star was also combined in a similar manner (section 3.3.8).

Statistical analysis of the Northern Quoll capture data recorded in 2018 from the southern North Star control sites (NS NQ C1 & C2) suggests that the population size decreased slightly since 2017 but was still slightly higher than in 2015 and 2016 (Figure 3.17). Rainfall recorded on site indicates that there may be a correlation with the number of Northern Quolls captured during the monitoring events, with the exception of records made in 2015. The reduced number of captures in 2015 does not correlate with the recorded increase in rainfall 12 months prior to trapping (Figure 3.17). The cause for this is unknown since no Feral Cats were recorded prior to 2016 and no bush fire occurred on site (NAFI 2018). The 2016, 2017 and 2018 results indicate a correlation with the recorded total of rainfall. The number of Feral Cats recorded from the southern control area increased in 2016; however, there is no evidence that the Feral Cats numbers have impacted the Northern Quoll trapping trends at the two control sites (Figure 3.17).

Statistical analysis of the captured data recorded from the northern control sites at North Star (NS NQ C3 & NS NQ C4) indicate that there was a slight increase of population size overall since 2014 (two individuals in 2014 to seven individuals in 2018) (Figure 3.18). In 2016, an extensive bush fire burnt across the surrounding region which resulted in an increase in Northern Quoll captures in 2017, possibly due to the sheltered locations (in deep gorges) which were not impacted by the fire directly forming refuge habitat.

Overall, the estimated population size at the North Star control sites has been stable with a slight increase since the start of the monitoring in 2014. The capture rates recorded at North Star appear to have some relationship with the rainfall trends recorded during the 12 months prior to trapping, in particular when considering the Lower Confidence Limit which represents the actual number of trapped quolls. Years of above average rainfall events correlated with an increase in Northern Quoll captures (2015 and 2017), as compared with drier years which appear to also correlating with a decrease in capture rates (2016 and 2018) (Figure 3.18).

Statistical analysis of recapture data at each site is presented in Table 5.4 in Appendix 5. Comparison of results between years should be taken with caution due to the lack of sufficient recapture data (no recaptures).

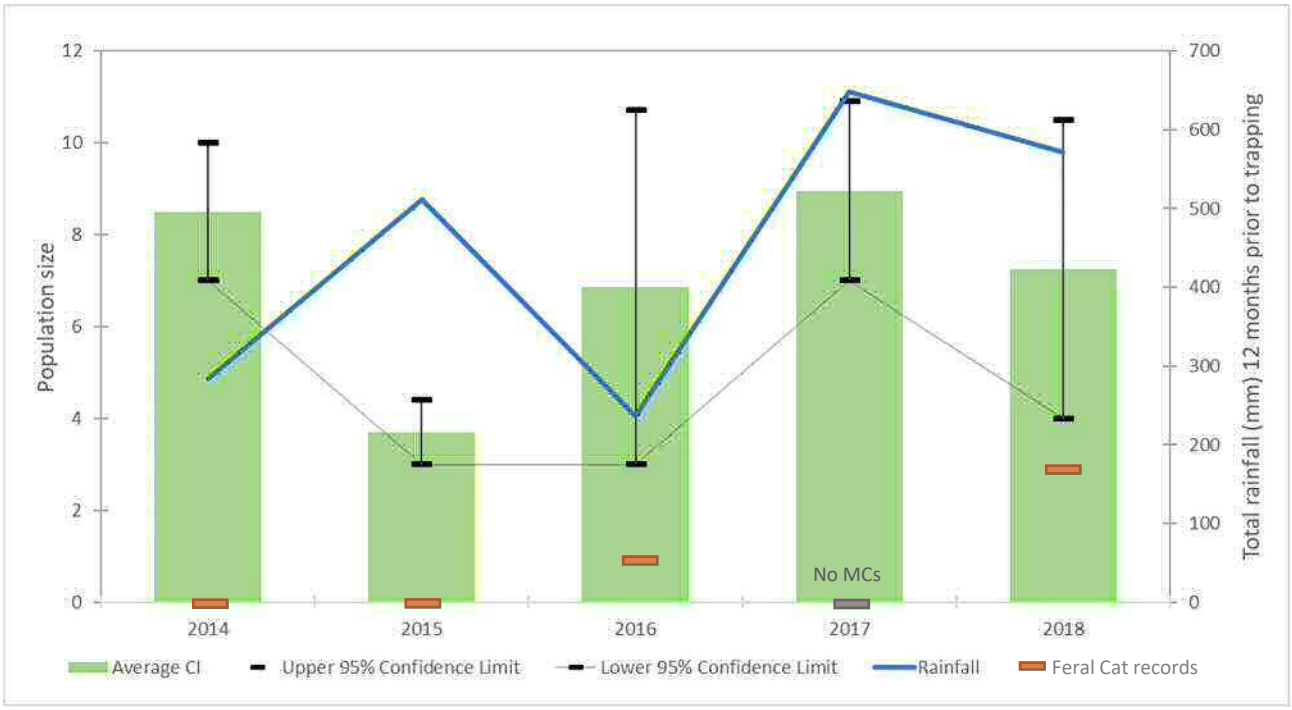


Figure 3.17: Northern Quoll population size, Feral Cats and rainfall at control sites NS NQ C1 & C2 (North Star)

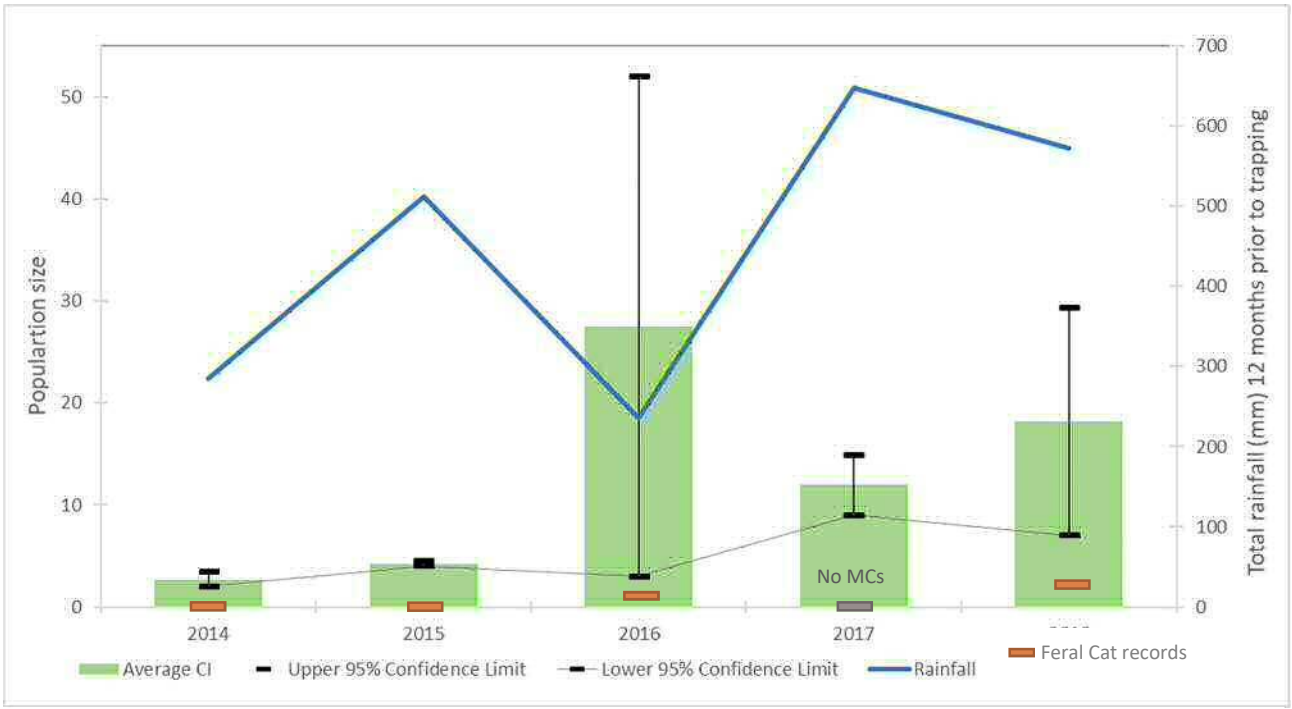


Figure 3.18: Northern Quoll population size, Feral Cats and rainfall at control sites NS NQ C3 & C4 (North Star)

3.3.2. Cloudbreak Tenement M45/1142

Low abundance monitoring of Northern Quoll populations did not record any evidence of the species from the Cloudbreak tenement M45/1142 in 2018 or the previous monitoring completed in 2017.

To date a very low number of Northern Quolls have been recorded from the tenement and the surrounding region. One male Northern Quoll was recorded during a targeted survey from tenement M45/1142 in 2016 which represents the only record of the species from the tenement itself to date (Ecoscape 2017e). Two following surveys as part of a radio-tracking program did not record the individual again, indicating that the individual had moved through the area as part of the male's dispersal behaviour during the mating season. No evidence of a permanent population or additional individuals were recorded. A potential scat was also recorded in 2005 from the vicinity of the Cloudbreak airport (ATA 2006). Extensive subsequent baseline surveys and monitoring events did not record any evidence of Northern Quoll from the Cloudbreak mine site which is adjacent to tenement M45/1142 (Bamford 2005a, 2005b, 2005c, 2006, 2007, 2010c, 2012c; Outback 2013; Ecoscape 2017b). No denning habitat or evidence of a local population is present at either the Cloudbreak mine site or tenement M45/1142.

3.3.3. Christmas Creek

No evidence of Northern Quoll were recorded from the Christmas Creek mine site in 2018 or during the previous five years of monitoring (2013-2017) (Ecologia 2013a, 2014b; Ecoscape 2016a, 2017b, 2018a). The species was also not recorded during the baseline surveys (Biota 2005; ENV 2012a) or by site personnel to date (section 3.2.2).

No critical or denning habitat is present within the Christmas Creek mine site. A small section of rocky gorge habitat was mapped to the north of the Christmas Creek mine site (ecologia 2013a) which is considered too small and isolated to support a local population. Denning and foraging habitat is present north of Christmas Creek at the Nullagine mine site. Northern Quolls are unlikely to travel into the Christmas Creek mine site due to the lack of suitable habitat. The monitoring to date has shown an absence of Northern Quoll from the Christmas Creek mine site.

3.3.4. Solomon Hub

A total of nine Northern Quoll individuals (three females, five males) were recorded from the three potential impact sites at the Solomon Hub in 2018. Six individuals were captured at site SM NQ I1, two individuals were captured at site SM NQ I3 and one individual (not trapped at the site nor recorded from any other site based on individual spot pattern) was recorded on motion cameras at site SM NQ I2 (Figure 3.19, Table 3.2, Table 5.3 in Appendix 4). All three females were trapped at site SM NQ I1, one of which was previously recorded from this site in 2017 (PIT 941000019576548). Three of the captured individuals were also recorded on motion cameras deployed at the monitoring sites. No additional individuals were recorded on motion cameras.

All captured Northern Quolls were in a 'very good' health condition with males showing no signs of fighting and females only showing the early stages of pouch development. This indicates the start of the breeding season was in mid-July. The average weight of male Northern Quolls was 816 g which is 137.8 g heavier than the average male weight recorded during previous trapping programs (Table 5.3 in Appendix 4). Females were also heavier by approximately 90 g (average of 495 g in 2018 vs. 406 g in 2017). The locations of capture are displayed on Figure 3.28.

The number of Northern Quoll recorded in 2018 (nine individuals) is double the number of quolls recorded during any of the previous monitoring events (2012 to 2016) which varied between zero and four individuals

(Table 3.2, Figure 3.20). The first year of monitoring did not record any individuals, and three to four individuals were captured during the trapping completed in 2013, 2014, 2016 and 2017. Traps were replaced by motion cameras and active searches in 2015 which is likely the cause for the reduced number of records in 2015 (secondary evidence only) (Figure 3.20). The significant increase in Northern Quolls in 2018 is not consistent with trends recorded from control sites (Fortescue, DBCA's Indee station and North Star) where the numbers in 2018 were lower than the peak recorded in 2017 and higher than the low recorded in 2016 (considered to be in response to dry conditions (Figure 3.17, Figure 3.18, Figure 3.20).

Environmental conditions appear to have been favourable since 2014 after a peak in rainfall in 2013 (section 3.1.3, Figure 3.20) which has resulted in a high number of Northern Quoll individuals being recorded in 2018. Individuals were also heavier and in better condition in comparison to previous monitoring events conducted at the same time of the year (Table 5.3 in Appendix 4). It is thought that the accumulative effect of relatively stable rainfall conditions since 2014 (annual rainfall varied only slightly) has provided the local Northern Quoll population with optimal conditions and a high survival rate of young (Figure 3.20). In comparison, the annual rainfall at the DBCA sites and the North Star control sites fluctuated more between the years which correlated to a fluctuation of Northern Quoll captures (Figure 3.17, Figure 3.18, Figure 3.20). Additionally, no fire has impacted the site since 2009 (NAFI 2018).

In addition to rainfall, other factors such as the presence of permanent surface water along Kangeenarina Creek, subsequent increased availability of food resources, the old fire history and reduced predation levels by introduced species are also likely to play a role at the Solomon mine. The number of Feral Cats recorded from the Solomon Hub has been relatively low with one individual trapped in 2012 and another one captured in 2013 (Figure 3.20). A Feral Cat was recorded on a motion camera in 2015 from potential impact site SM NQ I1 (Ecoscape 2016a). Secondary evidence in the form of prey remains (feathers) was recorded from the Kangeenarina Creek in 2017 and 2018 (not included in Figure 3.20), no individuals were captured or recorded on motion camera during the last two years. This may indicate that the number of Feral Cats at the monitoring sites is relatively low.

Northern Quolls were recorded within 400-900 m of the active mining infrastructure (Kings Ore Processing Facility) during the current monitoring and also during previous monitoring. The continued presence of breeding females at Kangeenarina Creek in 2017 and 2018 indicates that the mining activities are having minimal direct impact on the local Northern Quoll populations, and that climatic conditions have been suitable and stable (as indicated in Figure 3.20).

Figure 3.19: Northern Quoll recorded on motion camera at SM NQ I2

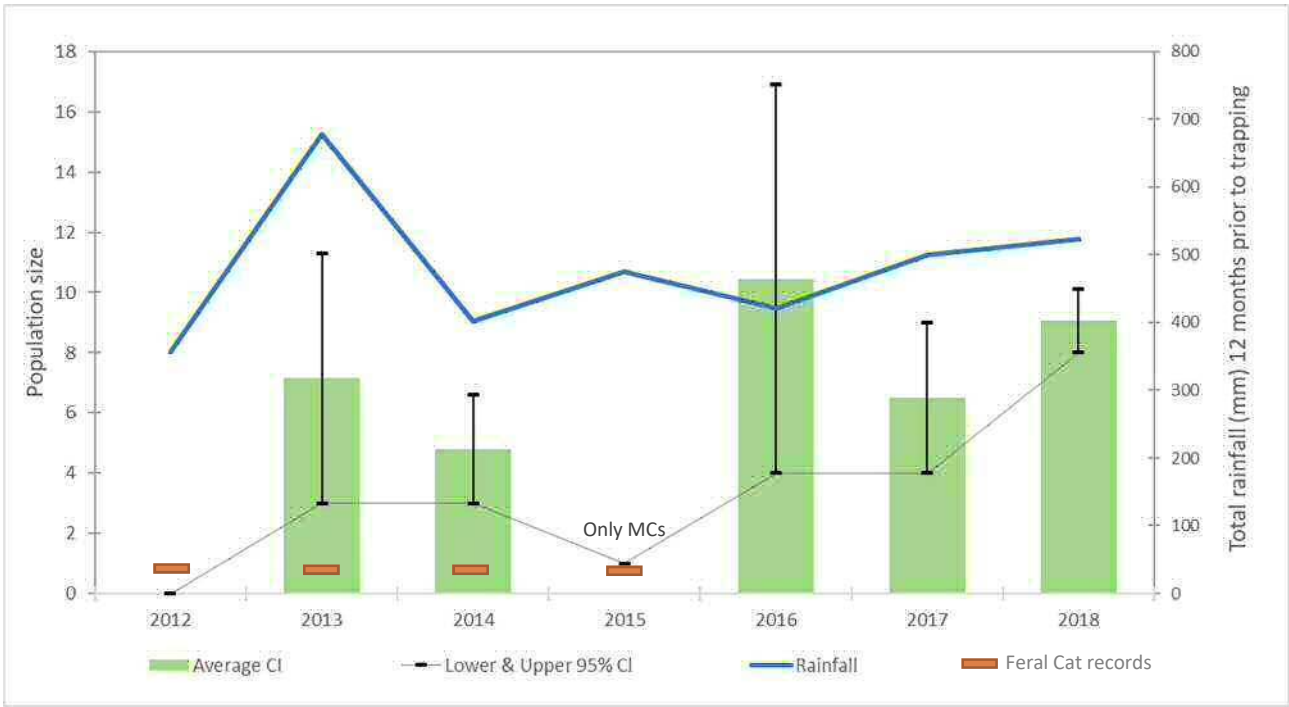


Figure 3.20: Northern Quoll population size, Feral Cats and rainfall at Solomon Hub

3.3.5. Hamersley Rail Line

Northern Quolls were not recorded from the potential impact sites located along the Hamersley Rail Line in 2018. Due to the lack of records, ten motion cameras were deployed long-term (3 months) across the three monitoring sites, however Northern Quoll were again not recorded. Feral Cats were recorded on five of the ten long-term motion cameras, in particular from the two monitoring sites HL NQ I2 and HL NQ I3, where the Northern Quoll was recorded during previous monitoring events.

Previous monitoring data indicated Northern Quoll populations were present in low abundance in 2012 (1 individual) with the number of captured individuals peaking at five individuals in 2013 (plus secondary evidence) and in 2014 (Table 3.2, Figure 3.21). In 2015, motion cameras images and secondary evidence of Northern Quoll was recorded from all three potential impact sites although no trapping was conducted. In 2016, no individuals were trapped, and only secondary evidence was recorded from two sites. No evidence of Northern Quoll was recorded in 2017 and 2018 (Figure 3.21).

The decline in Northern Quoll records in 2017 and 2018 to the point where no evidence was recorded has only been observed at one of the control sites: Millstream/Chichester NP. The four DBCA sites with continuous data and the North Star control sites indicate that environmental conditions in 2017 and 2018 were favourable for Northern Quoll. Data recorded at DBCA's control site at Hooley station (13 km north-west of the potential impact site HL NQ I3) indicate that although occurring in low abundance, the local population increased between 2016 and 2017 (from zero individuals to three individuals). No fire has impacted the site to date. In 2018, one individual was recorded from the site indicating that Northern Quoll are still present at the site. Matching trends were recorded at other controls sites. The only site where bush fires, poor environmental conditions and the arrival of Feral Cat has shown an impact is Millstream/Chichester NP.

Climatic conditions as a cause for the decline of Northern Quolls at the Hamersley Rail Line is unlikely due to the annual rainfall being consistent and above average since 2015 (Figure 3.1, Figure 3.21) including in 2018 (166.3 mm above average). In comparison to similar rainfall conditions recorded from the Solomon

Hub, the Northern Quoll captures from the Hamersley Rail Line sites are expected to be comparable. The correlation of rainfall and Northern Quoll captures at the control sites (three DBCA sites and North Star) and the Solomon Hub lead to the expectation that Northern Quoll records at the Hamersley Rail Line should be comparable with the records made in 2013 when six individual quolls were captured after 189.88 mm above average rainfall was recorded (Figure 3.21).

Potential causes for the decline of Northern Quoll populations along the Hamersley Rail Line may be two-fold. A large fire occurred adjacent to both HL NQ I2 and HL NQ I3 in November 2015 (Figure 3.22) which would reduce the amount of available foraging habitat and reduce available vegetation cover which would then increase predation pressures (NAFI 2018). Another fire occurred in the vicinity in 2018 further reducing the value of the habitat for Northern Quolls (Figure 3.22). The negative effects that bush fires can have on Northern Quoll populations was noted from three sites (Millstream, Mallina Station and Millstream/Chichester NP) during DBCA's Pilbara wide Northern Quoll monitoring (Dunlop, 2017). The variability of capture rates between sites and years reflecting the natural boom and bust life cycle of the Northern Quoll in response to factors such as rainfall and fire (Dunlop, 2017) is expected to play a role in the recorded decline.

An increase in Feral Cat numbers recorded from the Hamersley Rail Line are also thought to be a cause for the local decline in Northern Quoll populations. Feral Cats are likely to be a major risk to Northern Quolls in Western Australia (Woinarski *et al.*, 2008; Dunlop, Cook and Lees, 2013; Dunlop *et al.*, 2015; Henderson, 2015), and the DBCA is focusing future research projects on the relationship between the survival of the Northern Quoll and fire history, predation by Feral Cats and Foxes (Dunlop, 2017). Data recorded to date shows that Feral Cats were recorded during the baseline survey in 2011 (Coffey 2011). Further recorded were made from the monitoring sites for the first time in August 2014, which appears to be unrelated to fire history since the only substantial bush fire in the area occurred in November 2015 (after the first monitoring record). Two individuals were recorded in 2014, followed by one record in 2015 and 2016 (Figure 3.21). No records were made in 2017 apart from secondary evidence (tracks) from site HL NQ I1 (not included in Figure 3.21). In 2018, three individual Feral Cats were recorded on motion camera from two Northern Quoll sites (HL NQ I2 & HL NQ I3) with one of those individuals also being trapped at site HL NQ I3. It should be noted that the increase in Feral Cats records in 2018 (to three individuals) is potentially due to the increase in motion camera trap nights (as a response to the lack of Northern Quoll records in 2017), although the low number of records in 2015-2017 may be due to the shorter time period that monitoring activities were conducted. Additional records of Feral Cats were made from culvert sites but have not been included in this count due to the different locations of the records. A trend of Feral Cat numbers at culvert sites will be discussed in section 3.10.1. Northern Quoll records from along the Hamersley Rail Line have not correlated with the annual rainfall (and good climatic conditions) after 2014 but instead have decreased steadily (Figure 3.21).

By-catch records were compared across the monitoring however no correlation was detected with the appearance of Feral Cats at the sites indicating increased predation levels (Ecologia 2013b, 2014f; Ecoscape 2016b, 2017b). No evidence has been detected to suggest that Feral Cat numbers have an indirect (food competition) impact on local Northern Quoll populations as potential prey items (small mammals as by-catch) have persisted at the sites despite the presence of Feral Cats since 2014. It is however likely that Feral Cats on site have direct impacts (predation) on the Northern Quoll.

Capture data collected from two of the three potential impact sites are insufficient for statistical analysis due to the lack of captures/recaptures. Data recorded from the remaining site HL NQ I3 in 2013 and 2014 was

analysed and the results indicated a slight population size decrease from four individuals (±0.3) in 2013 to two individuals (±0.8) in 2014 (Table 5.4 in Appendix 5).

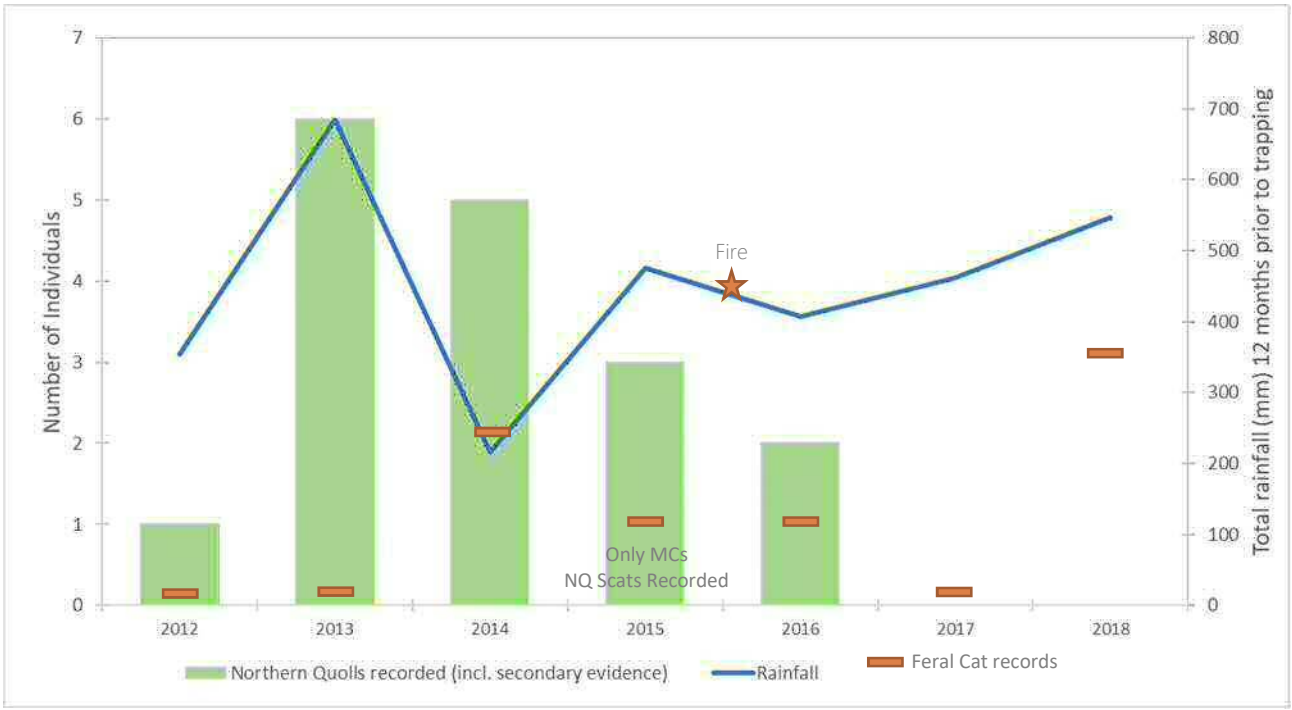


Figure 3.21: Rainfall, Northern Quolls and Feral Cats recorded at Hamersley Rail Line

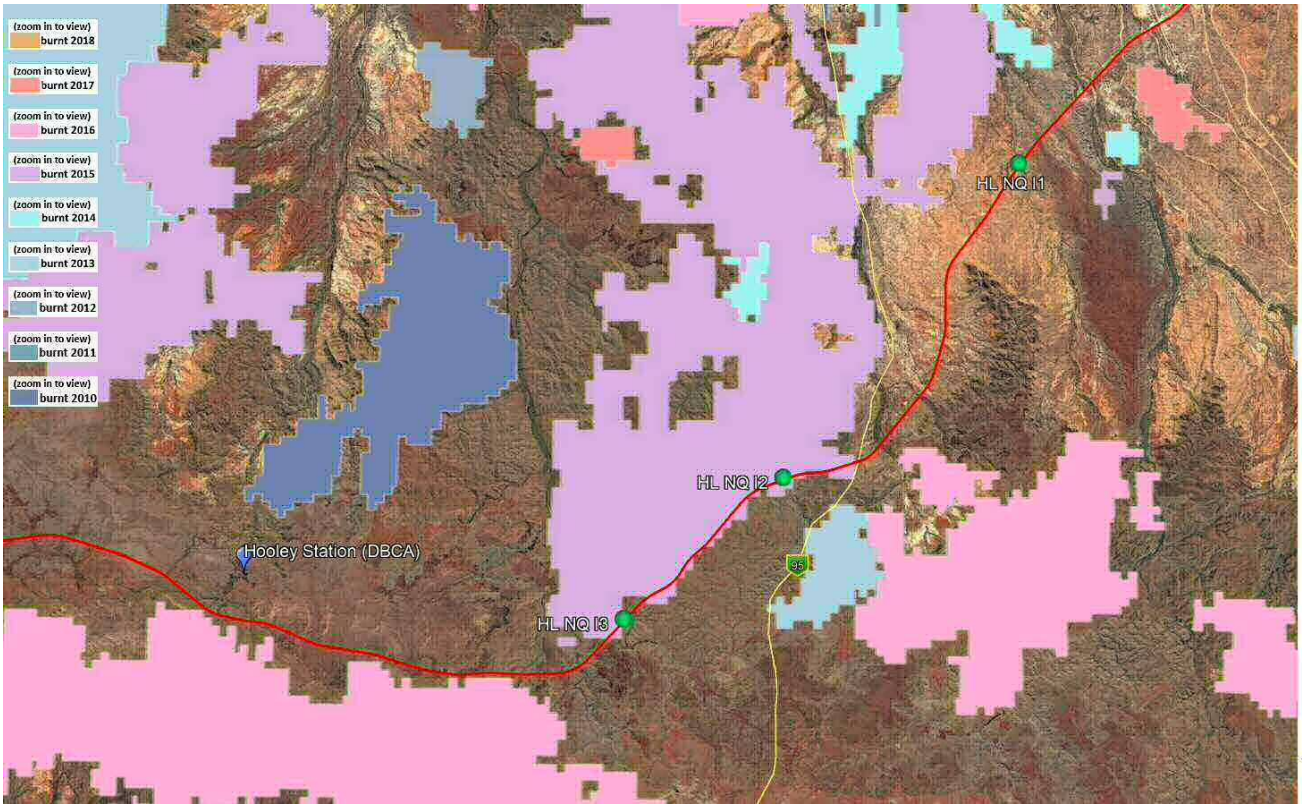


Figure 3.22: Fire history at Hamersley Rail Line sites (NAFI 2018)

3.3.6. Main Line Rail

A total of five Northern Quoll individuals were recorded from two potential impact sites in 2018. Four individuals (three males and one female) were captured at site MR NQ I2, and one male Northern Quoll was captured at site MR NQ I1. Northern Quoll scats were also recorded from site MR NQ I3. During the Greater Bilby monitoring, a motion camera image was captured at the abundance site MR GB AS I14 (4/10/18) indicating a roaming male, and a Northern Quoll scat was also recorded from a culvert located adjacent to Greater Bilby occupancy site MR GB OS36 (727320e, 7557060n, Zone 50K) (Figure 3.28).

The number of Northern Quolls recorded in 2018 is comparable with the 2017 monitoring results with a slight increase in spatial distribution (Table 3.2). Northern Quoll was recorded from two sites (MR NQ I2 & MR NQ I3) in 2017 and evidence was recorded from all three monitoring sites in 2018. Northern Quoll was captured from site MR NQ I1 for the first time in 2018 indicating an increase in spatial distribution.

During the first three years of the monitoring (2013-2015) two to three individuals were recorded (through secondary evidence and trapping) which then decreased to one individual in 2016. This was followed by an increase to five individuals captured at two sites in 2017. The data matches the trends recorded from control sites (Figure 3.17, Figure 3.18, Figure 3.20) and other potential impact sites suggesting that the population along the Main Line Rail is variable in response to environmental conditions but stable.

Statistical analysis of the capture data detected a decrease between 2013 and 2016 and an increase in 2017 and remaining stable in 2018 (Figure 3.23). Methods used in 2015 were not sufficient to allow statistical analysis (motion cameras only) and in 2016 only one individual was recorded on one occasion which is not adequate for statistical analysis. The correlation between rainfall recorded over the 12 months prior to trapping and the number of trapped Northern Quolls was again detected at these sites (Figure 3.23). The decrease in rainfall between 2013 and 2016 is reflected in the decrease in quoll captures. The increase in rainfall correlates to an increase in capture rates in 2017 and 2018.

Feral Cats have been recorded from the Main Line Rail monitoring sites since 2013. The records indicate that a small population persists at the monitoring sites however they have not impacted the ongoing persistence of Northern Quoll populations at the monitoring sites. Additional records were made from culvert sites and will be discussed in section 3.10.2. There is no evidence to suggest that the local Northern Quoll population is significantly impacted by Feral Cats on site (Figure 3.23). Suitable habitats along the Main Line Rail are utilised by Northern Quolls for denning, breeding and foraging during years of good environmental conditions. Reproductive females have been recorded using the rock armour associated with the rail bridge infrastructure and males have been recorded dispersing and foraging along the major rivers and granite outcrops in the vicinity of the rail. It is thought that the presence of the Feral Cats along the Main Line Rail has not impacted Northern Quoll populations because of the extensive areas of suitable habitats in the surrounding region that enable a large stable population of Northern Quolls to persist which can withstand predation pressures exerted by the local Feral Cat population.

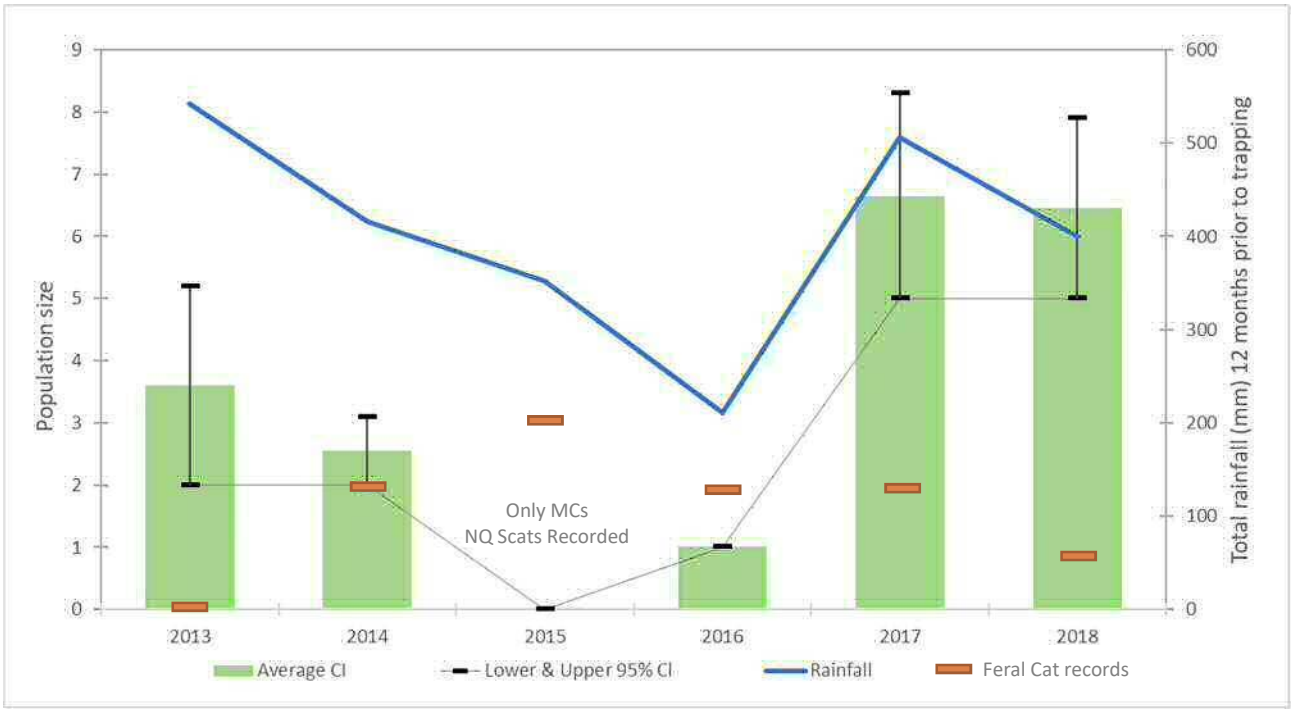


Figure 3.23: Northern Quoll population size, Feral Cats and Rainfall at Main Line Rail

3.3.7. Nullagine

Motion cameras deployed within the Nullagine mine site recorded Northern Quolls from 17 of the 20 camera locations in 2018 (Figure 3.30). The recordings comprised single records (images) of individuals as well as records of individuals over several nights indicating that the Northern Quolls potentially constitute a resident population. Records indicating the presence of a potential resident population were made from eight locations at Bonnie East and from one location at Warrigal (Table 3.3).

An estimated total of 20 individuals were recorded across all motion camera sites. Individual spot pattern could only be identified on some images and therefore the total number of Northern Quolls recorded represents a conservative estimate. One scat was also recorded during the 2018 monitoring at camera site AUD-04. Motion camera trapping is not a suitable method to identify the gender of Northern Quolls nor collect biological information about the local population; however, females were tentatively identified based on skull shape, scratches/missing fur on their hind legs caused by mating behaviours or other indicative signs from recorded images (e.g. Figure 3.24).

Previous surveys from Nullagine in 2008 recorded a total of 12 individuals; however, an extensive bush fire burnt through the area in 2009 (Bamford 2008). Fire scar data indicates that large bush fires impacted the area in both 2006 and 2008 (Figure 3.25) (North Australian Fire Information, 2018). Follow up surveys and monitoring events completed between 2010 and 2013 did not record any individuals from both cage trapping sites and motion cameras (Bamford 2010a, 2011, 2012b, 2014b). A low number of individuals (1 - 2 individuals) were recorded during subsequent targeted survey and monitoring events completed between 2014 and 2017 (Table 3.4).

Monitoring completed in 2018 indicates that a potential resident population has re-established within the Nullagine mine site, the majority of which was recorded from Bonnie East. During years of sub-optimal conditions post bush fires (2006, 2008) only roaming males were recorded from the Nullagine mine. Improved climatic conditions over 2017 and 2018 have resulted in a significant increase in the abundance of

Northern Quoll recorded from the Nullagine mine site with the presence of females tentatively identified in 2018 from several locations.

The number of recorded Northern Quolls indicates the presence of a potential resident population which may trigger actions as outlined in section 6.5.2 of the NQMMP and will require additional monitoring techniques to be used in the future (BC Iron Nullagine, 2016a). Actions that may be considered include the installation of additional motion cameras in locations where Northern Quolls were considered to be resident, and the re-implementation of scat surveys to provide further evidence. Consideration should be given to implement additional actions in the late wet season when the presence of young could confirm the presence of a resident population.

Figure 3.24: Female Northern Quoll identified on motion cameras at Nullagine (missing fur from mating)

Table 3.3: Northern Quoll recorded from Nullagine in 2018

Site name	Estimated number of NQ recorded	Estimated number of resident NQ	Dates of recordings
Bonnie East			
BCI-11	3	2	26/6, 28/6, 29/6, 30/6, 1/7, 3/7, 8/7, 9/7, 17/7, 29/7, 2/8
BCI-07	2	1	27/6, 28/6, 29/6, 30/6, 1/7, 5/7,6/7, 17/7, 18/7, 19/7, 20/7, 24/7, 25/7, 30/7, 2/8, 3/8, 4/8
BCI-08 south	1	Unsure (spot pattern not visible)	27/6, 28/6, 30/6, 1/7, 8/7, 14/7, 28/7
AUD-04	3	2	26/6, 29/6, 1/7, 3/7, 9/7, 16/7, 31/7, 2/8
AUD-8	3	3	2/7, 3/7, 5/7, 13/7, 17/7, 23/7, 26/7, 29/7, 4/8
BCI-03	2	2	27/6, 28/6, 30/6,4/7, 13/7, 21/7, 24/7
AUD-05	2	1	27/6, 30/6, 4/7, 16/7, 17/7
Spypoint	1	0	26/6, 6/7, 30/7

Site name	Estimated number of NQ recorded	Estimated number of resident NQ	Dates of recordings
HRC-08	3-4	2	27/6, 28/6, 29/6, 6/7, 14/7, 16/7, 17/7, 18/7, 24/7, 25/7, 28/7, 29/7, 1/8, 3/8, 4/8
AUD-02	2	2	2/7, 5/7, 6/7, 7/7, 12/7, 18/7, 24/7, 25/7, 29/7, 31/7, 1/8
Warrigal			
BCI-04	3	2	27/6, 28/6, 30/6/18, 7/7, 8/7, 9/7, 11/7, 13/7, 15/07, 28/7, 30/7
BCI-13	1	0	06/07
BCI-15	1	0	06/07
BCI-10	1	0	19/07
BCI-14	1	0	02/07
BCI-06	0	0	-
BCI-12 north	1	0	28/06 & 06/07
BCI-09	1	0	19/07
BCI-11 north	0	0	-
BCI-12	0	0	-

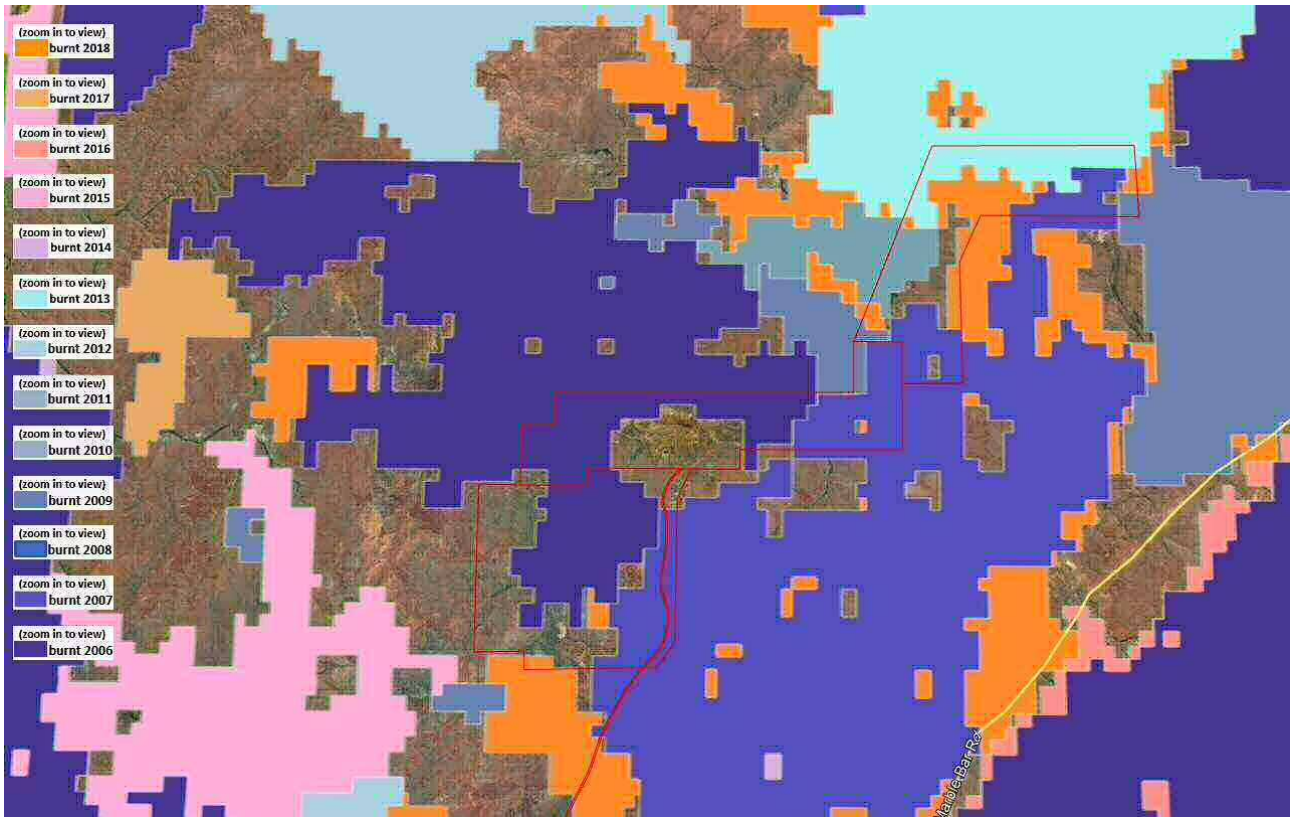


Figure 3.25: Fire history associated with Nullagine (NAFI 2018)

Table 3.4: Northern Quoll records at Nullagine

Management	Survey/Monitoring event	Date	Individuals recorded	Area
BC Iron	Baseline survey (Bamford 2008)	Jun & Oct 2008	12 individuals	Warrigal
	Monitoring Stage 1 (Bamford 2010a)	Sep 2010	0	-
	Monitoring Stage 2 (Bamford 2011)	Jun 2011	0 (scats only)	South of Nullagine, near Bonnie East
	Monitoring Stage 3 (Bamford 2012b)	May 2012	0 (scats only)	West of Nullagine (control)
	Targeted Survey (Bamford 2012c)	Dec 2011	0 (scats from 10 locations)	Coongan, Bonnie East
	Monitoring Stage 4 (Bamford 2013)	May 2013	0	-
	Targeted Survey (Expansion) (Bamford 2014a)	Mar – Apr 2014	1 individual	Warrigal
	Monitoring (BC Iron 2016b)	Apr-May 2014	1 individual on 1 MC	Warrigal
		Jun-Oct 2014	2 individuals on 4 MCs	Warrigal
		Mar-Oct 2015	2 individuals on 5 MCs	Warrigal
		Aug-Oct 2015	2 individuals on 4 MCs	Warrigal & Bonnie East
		Jul-Oct 2016	1 individual on 1 MC	Bonnie East
Fortescue	2017 Monitoring (Ecoscape 2018a)	June 2017	1 individual on MC, 1 scat	Bonnie East
	2018 Monitoring	June 2018	13 individuals, 1 scat	Bonnie East
			7 individuals	Warrigal

3.3.8. North Star

Two Northern Quoll individuals (both males) were recorded from two potential impact sites (NS NQ I4 and NS NQ I2) located in the North Star mine site. One individual was repeatedly trapped over three nights at monitoring site NS NQ I4 before the site was closed due to ethical considerations. The second individual was originally captured on three consecutive occasions at control site NS NQ C1 and was then recaptured at potential impact site NS NQ I2 when the traps at the control site (initial captures) were closed to prevent additional consecutive recaptures of the individual.

Previous data suggest that there has been a continuous decline in Northern Quoll numbers between 2015 and 2018 regardless of the environmental conditions (Table 3.2, Figure 3.26). Favourable conditions recorded across the Pilbara and other Fortescue sites (Solomon Hub, Hamersley Rail, Main Line Rail, DBCA sites and North Star control sites) have resulted in an increase in Northern Quoll captures at DBCA's sites, North Star control sites, Solomon Hub and Main Line Rail (Table 3.2, Figure 3.9, Figure 3.17, Figure 3.18, Figure 3.23, Figure 3.26) in 2017 and 2018. This trend was not recorded from the potential impact sites at the North Star mine and it is unlikely that the decrease in Northern Quoll numbers is caused by mining activities since mining activities on site have significantly reduced since 2016. Additionally, radio-tracking data of Northern Quolls in 2015 and 2016 indicated that the species was not impacted by the activities associated with the active mining infrastructure on site and Northern Quoll have been recorded breeding adjacent to active mining infrastructure at the Solomon Hub mine site (section 3.3.4).

One theory for the decline in Northern Quoll numbers recorded from the potential impact sites is the apparent increase in the number of Feral Cats recorded from the site since 2015 (Figure 3.26). Long-term motion cameras installed across both the impact and control sites in 2015 recorded the introduced predator from three potential impact sites. Prior to September 2015, no Feral Cats were recorded from the North Star mine site despite the use of motion cameras during the baseline surveys in 2011 and monitoring in 2014 (Ecologia 2012, 2014d). In 2015 and 2016, Feral Cats were then recorded from two potential impact sites (Ecoscape 2016a, 2017b) (Figure 3.26). The use of the long-term motion cameras was discontinued in 2017 (as it was not a requirement of the TFMP); however, the cameras were re-installed in 2018 to determine Feral Cat presence and abundance following sightings in 2016 and apparent decline in Northern Quoll numbers. The data showed that the Feral Cat was recorded from four potential impact sites and five control sites. In addition, ten motion cameras were installed as part of a Felixer trial project. The cameras were deployed at two potential impact sites (NS NQ I1 and NS NQ I3) which recorded eight individual Feral Cats during a three-month period. And additional 16 individuals were identified during the Felixer (cat control device) baseline assessment from Northern Quoll baseline motion camera surveys completed over an extended period in 2018 (Spectrum Ecology, 2018). This provided evidence that a significant number of feral cats may be present despite only a small number of individuals being recorded during surveys or monitoring projects. This increase in Feral Cat records may also be associated with the recent bush fire which impacted large areas of the impact area in July 2018 (NAFI 2018). Feral Cats have been shown to be attracted to fire scars, particularly within 90 days after the fire (McGregor *et al.*, 2016).

Increases in Feral Cat numbers have been shown to be a direct threat to Northern Quoll populations and as a result the persistence of stable Northern Quoll populations can potentially be threatened (Woinarski *et al.*, 2008; Dunlop, Cook and Lees, 2013; Dunlop *et al.*, 2015; Henderson, 2015). The bush fire recorded in July 2018 (1 month prior to monitoring) burnt through a large proportion of the impact area and the southern control area (Figure 3.27). This is likely to have increased the pressures on the local quoll population by decreased the available foraging habitat and increased the predation pressure on Northern Quolls by reducing available vegetative cover and increased accessibility for Feral Cats.

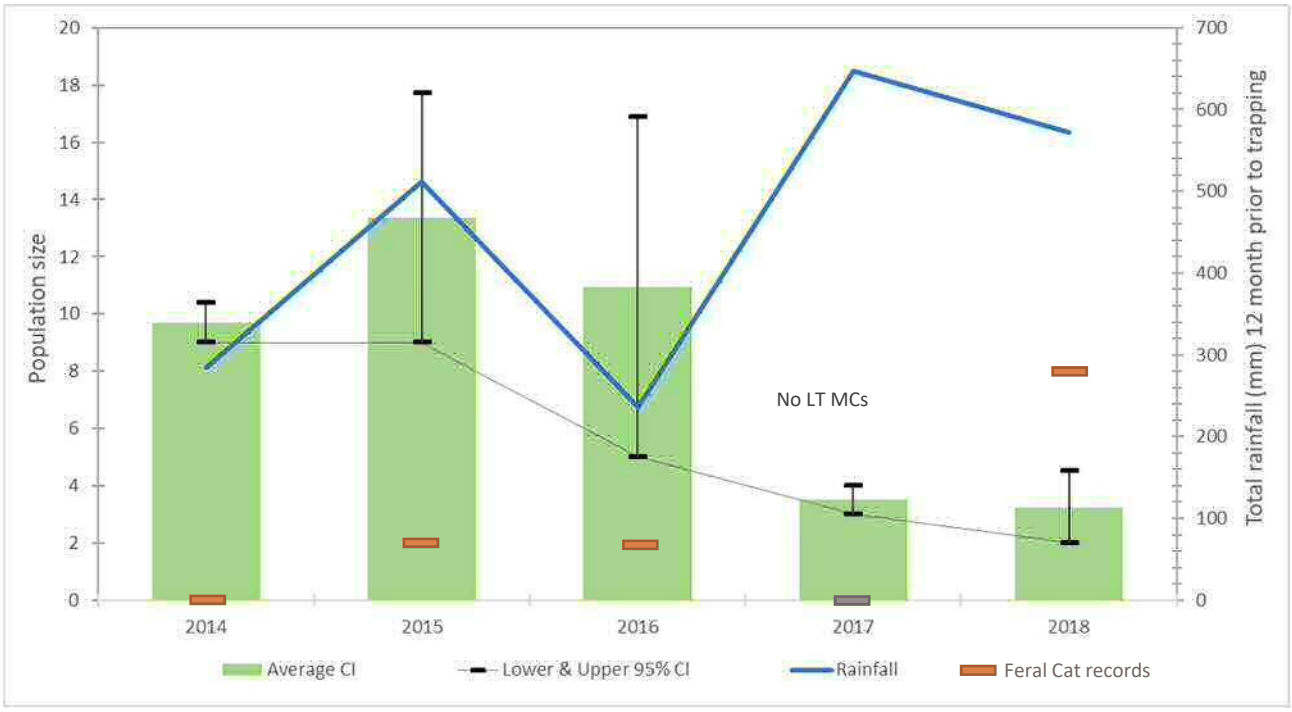


Figure 3.26: Northern Quoll population size, Feral Cats and Rainfall at North Star

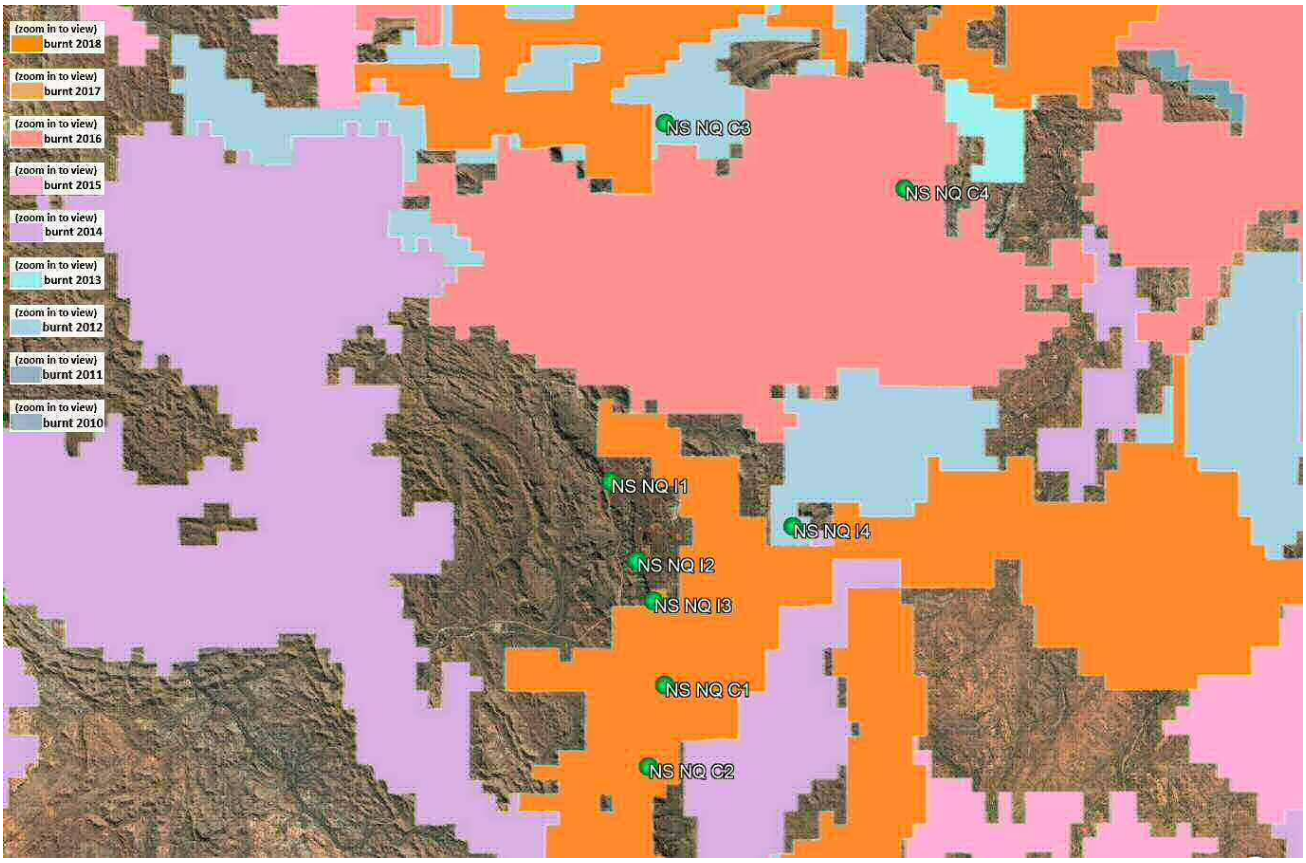


Figure 3.27: Fire history associated with North Star

3.3.8.1. Long-term Motion Camera

Long-term motion cameras (total of 18 cameras) recorded Northern Quolls from five potential impact sites and seven control sites (Table 3.5).

Northern Quolls were previously recorded from five potential impact sites in 2014 and 2015 which then decreased to two sites in 2016. The 2018 data is similar to the first two years of monitoring (2014 and 2015). All five sites recorded the Northern Quoll during previous years of monitoring (Table 3.5). The majority of records were made over a one to two nights with the exception of a Northern Quoll recorded over six nights between 14 September and 28 September 2018 at site NS MC LT I7. The majority of records in 2014, 2015 and 2016 were also made over a single night.

The consistent motion camera records in 2018 in comparison with the 2014 and 2015 indicate that there is no significant change in spatial distribution of Northern Quolls in the wider impact area.

Data collected from the control sites indicate a slight increase in Northern Quoll recordings in comparison to 2014 (an estimated 12 individuals in 2018 in comparison to six individuals in 2014) (Table 3.5). Recordings decreased from five sites in 2014 to two sites in 2015. This number increased to five sites in 2017 and peaked in 2018 with seven sites. Six of the seven sites that recorded Northern Quolls in 2018, previously recorded the species. The motion camera data from the control site is comparable with the trapping data and suggests a stable population across the wider control area.

Table 3.5: Northern Quoll Records on Long-term Motion Cameras at North Star

Site	2014	2015	2016	2018	Coordinates	
					Easting	Northing
Impact Sites						
NS MC I2	-	-	1 night	1 night	713164	7648148
NS MC I3	2 nights (2 individuals)	1 night (female)	-	1 night (not previously captured)	716114	7648059
NS MC I4	3 nights (3 individuals)	1 night (female)	-	2 nights (not previously captured)	712243	7648686
NS MC I6	2 nights (2 individuals)	2 nights (previously captured female)	-	1 night (1 individual)	711680	7650946
NS MC I7	1 night	2 nights (2 individuals)	-	6 nights (2-3 individuals)	711695	7650618
NS MC I9	2 nights (2 individuals)	1 night	1 night (previously captured)	-	713230	7648232
Estimated Total	**8**	**6**	**2**	**6**		
Control Sites						
NS MC C2	-	-	1 night	8 nights (2 individuals)	714542	7655526
NS MC C3	1 night	-	-	2 nights (2 individuals)	713314	7657098
NS MC C4	-	-	-	3 nights (1-2 individuals)	717005	7654105
NS MC C5	2 nights (2 individuals)	1 night	1 night (previously captured)	7 nights (2 individuals)	718296	7655613
NS MC C6	1 night	-	Single night	10 nights (2 individuals, 1 female)	715887	7654732
NS MC C7	1 night	2 nights (1 male individual)	-	2 nights (1 female individual)	713280	7643833
NS MC C8	1 night	-	1 night	-	713237	7645594
NS MC C9	1 night	-	1 night (previously captured)	8 nights (2 individuals, 1 female)	713451	7643392
Estimated Total	**6**	**2**	**5**	**12**		

500000

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800000

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7600000

7500000

SM NQ I1

SM NQ I3

SM NQ I2

SM RE 06

PILBARA

CHICHESTER RANGE

HAMERSLEY RANGE

FORTESCUE MARSH

MILLSTREAM CHICHESTER NATIONAL PARK

KARIJINI NATIONAL PARK

MUNGARRIDJINA NATURE RESERVE

YANDYARRA ABORIGINAL RESERVE

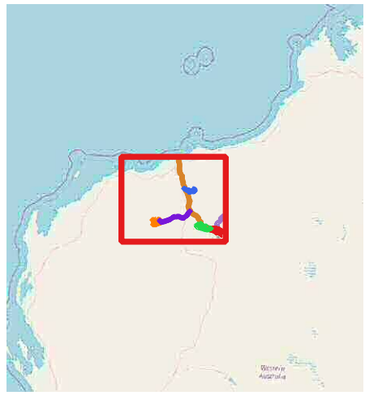
HANCOCK RANGE

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Northern Quoll records

- Female (initial capture)
- Female (recapture)
- Female (recapture, 2nd year)
- Male (initial capture)
- Male (recapture)
- Motion Camera
- Motion Camera (multiple records)
- Motion Camera (Rehabilitation site)
- Secondary evidence
- Motion Camera (single record)



N

0 5 10 15 20 25 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 26-02-2019

Northern Quoll captures (Operational Sites)

Fauna Monitoring 2018

Prepared for
Fortescue Metals Group

Figure
3.28

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OCEAN

Warrigal

Bonnie East

WANDEYARRA

RESERVE

CHICHESTER RANGE

PILBARA

KARIJINI NATIONAL PARK

MARBLE BAR

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Northern Quoll records

- Female (initial capture)
- Female (recapture)
- Female (recapture, 2nd year)
- Male (initial capture)
- Male (recapture)
- Motion Camera
- Motion Camera (multiple records)
- Motion Camera (Rehabilitation site)
- Secondary evidence
- Motion Camera (single record)

N

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Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 26-02-2019

Northern Quoll captures (Nullagine)

Fauna Monitoring 2018

Figure

3.29

Prepared for
Fortescue Metals Group

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NS NQ C3

NS NQ C4

NS NQ I2

NS NQ C1

NS NQ C2

OCEAN

PORT HEDLAND

YANDEYARRA

ABORIGINAL

RESERVE

MUNGAROONA RANGE NATURE RESERVE

CHICHESTER RANGE

HAMERSLEY RANGE

FORTESCUE

KARIJINI NATIONAL PARK

PILBARA

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Northern Quoll records

- Female (initial capture)
- Female (recapture)
- Female (recapture, 2nd year)
- Male (initial capture)
- Male (recapture)
- Motion Camera
- Motion Camera (multiple records)
- Motion Camera (Rehabilitation site)
- Secondary evidence
- Motion Camera (single record)

N

0 5 10 15 20 25 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 26-02-2019

Northern Quoll captures (North Star)

Fauna Monitoring 2018

Figure 3.30

Prepared for
Fortescue Metals Group

3.4. Greater Bilby

3.4.1. Christmas Creek

Monitoring of Greater Bilby populations during the 2018 dry season did not record any evidence of the species presence within the Christmas Creek mining tenements. Previous monitoring events have also not recorded the presence of the species on site. To date, only one confirmed record of the Greater Bilby has been reported from the Christmas Creek mine site. One individual (a male) was recorded in May 2016 on a haul road in the vicinity of creekline habitat located in the eastern section of the mine site. The male is thought to have travelled along creekline habitats and other potentially suitable dispersal habitat from the Fortescue Marsh where other records of this species have been made.

Evidence of Greater Bilby was also recently recorded 8 km east of the Christmas Creek mine site and 500 m north of the Fortescue access road (on Roy Hill mining tenement) indicating the presence of a small population in the Fortescue Marsh. The male recorded at Christmas Creek is likely to have travelled from a related source population. There is no mapped habitat recorded from within the Christmas Creek mine site (Ecoscape 2017a). However, the habitat being utilised by the local Roy Hill population is similar to the Mulga woodland habitat found across the southern side of the Christmas Creek tenements. Future monitoring and information from the Roy Hill population will assist in analysing the movements of Greater Bilbies populations within the Christmas Creek mine site.

3.4.2. Main Line Rail

Monitoring of Greater Bilby populations during the 2018 dry season recorded evidence from one abundance monitoring site (MR GB AS I14) and five occupancy monitoring sites (MR GB OS1, OS3, OS9, OS10, OS16). Three of the five occupancy sites (OS3, OS10, OS16) showed no recent evidence of Greater Bilby presence with only old diggings and burrows being recorded. Recent activity was noted at two occupancy sites (MR GB OS01 & OS9) from which evidence of the species' presence was also recorded in 2017 (Table 3.6, Figure 3.31). No signs of Greater Bilby were recorded from occupancy sites during the wet season monitoring. The decrease in evidence of the species between the dry season and wet season monitoring is consistent with the data recorded in 2017 (Table 3.6, Figure 3.31).

Table 3.6: Greater Bilby records from occupancy sites

Site	2017		2018	
	Dry Season	Wet Season	Dry Season	Wet Season
MR GB OS1			•	
MR GB OS3			O	
MR GB OS6	•			
MR GB OS8	•			
MR GB OS9	•		•	
MR GB OS10			O	
MR GB OS16			O	
MR GB OS22	•			
MR GB OS24		R		
MR GB OS39	•			
Total	**5**	**1**	**5**	**0**

R – Greater Bilby skull found under Whistling Kite nest, O – Old diggings recorded

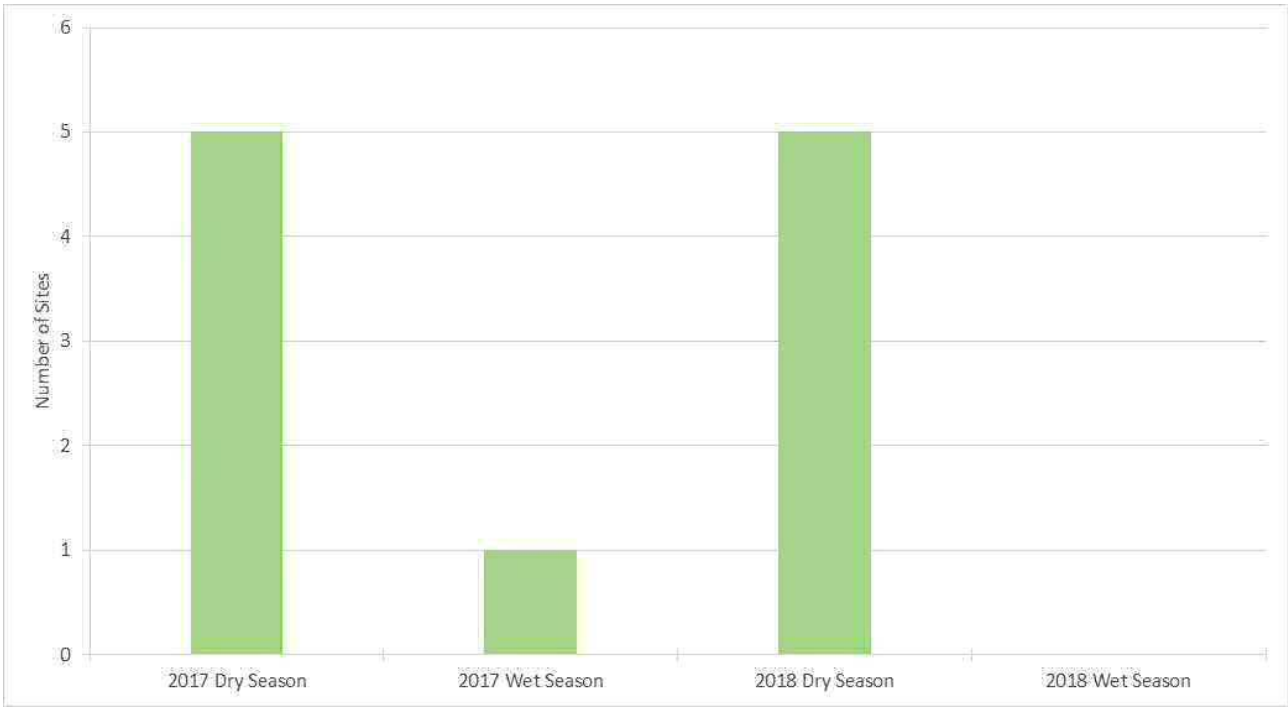

Figure 3.31: Number of sites recording evidence of Greater Bilby

A total of 23 scats were recorded from the abundance site MR GB AS I14, nine of which were fresh and yielded DNA. This number of old and fresh scats is comparable with previous years (Table 3.7). Analysis of the scats identified two individuals to be present on site. One of the individuals was a female that has been recorded from this site annually since 2014 (Ecologia 2015b, 2015a; Ecoscape 2016a, 2017a, 2018a) and has been shown to be genetically related (the mother) to juveniles recorded from the site. The second individual has not been recorded before and is likely to be a juvenile from the resident female. The ongoing presence of the female indicates that the local population has been stable and is not impacted by the rail infrastructure.

Population density estimates using the cue data function in SECR resulted in estimates of 0.01 – 0.03 individuals per hectare. These results should be viewed with caution due to the relatively high standard error values and low number of data points available to be included in the analysis. Efford (2011) indicates that the precision of the results in usually inadequate for ecological studies using less than 20 repeat detections, and the number of suitable scats collected from the monitoring sites has always been below this amount (Table 3.7). The low statistical power is a reflection of the small population size present on site and is not associated with inadequate monitoring methods.

No recent evidence of Greater Bilby populations was recorded from the control site MR GB ASC16 which was previously occupied by the species (Ecologia 2015b; Ecoscape 2017b, 2018a). Some old evidence in the form of diggings were observed. Long-term motion cameras installed in 2017 within 1 km of the site did not record the species. Previous data suggested that one individual was present at this site in 2017. Prior to this, no fresh scats were recorded in 2015 and 2016, whereas four individuals were recorded from this site in 2014 (Table 3.7). Despite the low number of fresh scats recorded between 2015 and 2018 (maximum of three in 2017), there was numerous diggings, burrows and old scats recorded from the site. In 2018, the lack of any evidence is a strong indication that the Greater Bilby was absent from the control site for the first time since the start of the monitoring in 2014. The absence of the population from the control site is attributed to fires that burnt the southern area of the site in 2017 and may have triggered movement of the local population away from this site.

No control site data is available for 2018 from DBCA sites due to the ceasing of monitoring at abundance sites in the Pilbara region (Dziminski and Carpenter, 2018). Current monitoring only includes Occupancy monitoring data.

Table 3.7: Greater Bilby scats and individuals recorded

	MR GB AS I14			MR GB AS C16		
Year	Scats (total)	Scats (fresh)	Individuals (DNA)	Scats (total)	Scats (fresh)	Individuals (DNA)
2014	50	19	2	49	16	4
2015	19	6	1	3	0	n/a
2016	40	5	2	1	0	n/a
2017	21	6	1	17	3	1
2018	23	9	2	0	0	0

n/a=DNA analysis was not possible due to the lack of DNA yielding scats.

Table 3.8: SECR results using Cue data and polygon detectors – MR GB AS I14

Year	# individuals	# scats	Density (per ha)	SE	lcl	ucl
2016	2	5	0.028	0.023	0.0066	0.1158
2017	1	6	0.012	0.015	0.0016	0.0827
2018	2	8*	0.024	0.020	0.0060	0.0970

* one scat that yielded DNA was collected outside of the monitoring and was excluded.

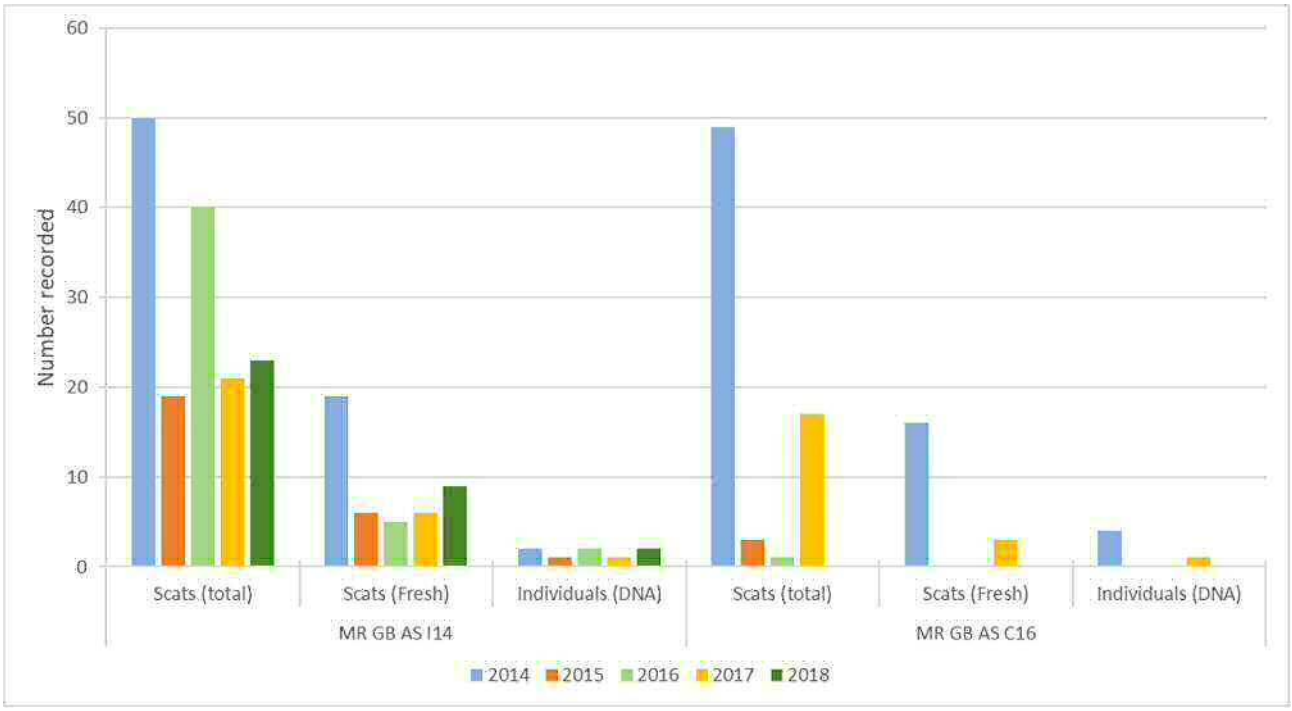

Figure 3.32: Greater Bilby evidence recorded from the Abundance Sites

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MR GB AS I14

YANDEYARRA

ABORIGINAL

RESERVE

MUNGAROORA RANGE NATURE RESERVE

CHICHESTER RANGE

HAMERSLEY RANGE

PILBARA

KARIJINI NATIONAL PARK

FORTESCUE MARSH

HANCOCK RANGE

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Greater Bilby records

- Active Burrow
- Diggings
- Scat
- Scats, Tracks and Diggings
- Tracks and Diggings

N

0 5 10 15 20 25 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 26-02-2019

Greater Bilby Records

Fauna Monitoring 2018

Prepared for
Fortescue Metals Group

Figure
3.33

3.5. Pilbara Leaf-nosed Bat

3.5.1. Control Sites

In 2018, no Pilbara Leaf-nosed Bats were recorded from the Christmas Creek control sites. A single call was recorded in 2017 from site CC Bat C4 which represents the only record of the species from the control sites to date (Ecoscape 2017a, 2018a).

A total of 514 calls of the Pilbara Leaf-nosed Bat records were detected from nine Solomon mine control sites in 2019. This is an increase between 2018 and 2019 at both, number of sites and number of calls at the monitoring sites (Table 3.9). The call patterns are indicative of foraging behaviour at all sites. The timing of the monitoring event in 2019 was slightly later than during previous monitoring (March instead of January) due to a bush fire in December 2018 in the vicinity of the Solomon Hub. The timing in March 2019 coincides with the time when young and adult Pilbara Leaf-nosed Bats disperse (Churchill, 2009). This is likely the cause of the increase in geographical spread and number of recorded calls.

The Pilbara Leaf-nosed Bat was recorded from six control sites associated with the Main Line Rail. In 2017, the species was recorded from seven control sites. The call patterns recorded indicate foraging behaviour which is consistent with the data recorded to date (since 2013) (Ecologia 2014a, 2015b; 2016a, Ecoscape 2017a, 2018a). The number of calls decreased at four sites in 2018 (MR Bat C4, C6, C10, C11) whereas call numbers increased significantly at site MR Bat C12 from 32 calls to 110 calls (Table 3.9). The site is located in the vicinity of the Turner River East and the habitat consists of suitable foraging habitat.

At the North Star control sites, there was an increase in Pilbara Leaf-nosed Bat activity at the two monitoring control sites between 2017 and 2018, but comparable to call numbers recorded in 2015 (Table 3.9). Call patterns at the two sites indicate foraging individuals from a nearby roost. Calls were recorded throughout the night with the earliest at 7:53 pm and the latest at 4:38 am (Appendix 7). The data suggests similar conditions and usage of the monitoring site habitat in 2018 in comparison to 2015 and 2016.

An increase in Pilbara Leaf-nosed Bat records was detected at the Solomon Hub control sites and Main Line Rail control sites between 2016 and 2017 (Table 3.9), however this was due to a wider geographical spread of the control site locations in 2017. There was a further increase in call numbers in 2018 across the control sites in comparison to 2017. The reason for this increase in unknown. Table 3.9 lists all sites from which Pilbara Leaf-nosed Bats have been recorded to date. The remaining monitoring sites have not recorded the species. A detailed bat call analysis report is provided in Appendix 7.

Table 3.9: Pilbara Leaf-nosed Bat records from Control Sites

Site	2013	2014	2015	2016	2017	2018	2018 Record Details	
							Date	Detection time
Christmas Creek								
CC Bat C4	n/a	n/a	n/a	n/a	1	0	-	-
Total	n/a	n/a	n/a	n/a	1	0	-	-
Solomon Hub								
SM Bat C1	0	0	n/a	0	0	1	13/3/19	0:55
SM Bat C2	0	0	n/a	0	2	0	-	-
SM Bat C3	0	0	n/a	0	5	35	12-18/3/19	19:52-5:10
SM Bat C4	n/a	n/a	n/a	n/a	0	1	17/3/19	0:21
SM Bat C5	n/a	n/a	n/a	n/a	0	6	12-14/3/19	20:05-4:24

SM Bat C6	n/a	n/a	n/a	n/a	0	11	12-14/3/19	21:34-4:38
SM Bat C7	n/a	n/a	n/a	n/a	7	454	12-18/3/19	19:41-5:21
SM Bat C8	n/a	n/a	n/a	n/a	0	1	12/3/19	0:47
SM Bat C9	n/a	n/a	n/a	n/a	15	4	18/3/19	21:30-1:02
SM Bat C10	n/a	n/a	n/a	n/a	74	1	13/3/19	2:42
Total	n/a	n/a	n/a	0	96	514	-	-
Main Line Rail								
MR Bat C1	61	3	n/a	1	2	1	3/12/18	23:45
MR Bat C2	0	0	n/a	3	0	0	-	-
MR Bat C3	0	0	n/a	1	0	0	-	-
MR Bat C4	n/a	n/a	n/a	n/a	13	1	30/11/18	20:38
MR Bat C5	n/a	n/a	n/a	n/a	2	1	30/11/18	21:10
MR Bat C6	n/a	n/a	n/a	n/a	9	1	28/11/18	23:13
MR Bat C9	n/a	n/a	n/a	n/a	0	2	2-3/12/18	22:07-1:05
MR Bat C10	n/a	n/a	n/a	n/a	11	0	-	-
MR Bat C11	n/a	n/a	n/a	n/a	3	0	-	-
MR Bat C12	n/a	n/a	n/a	n/a	32	110	29-30/11/18	20:22-3:44
Total	61	3	n/a	5	72	116	-	-
North Star								
NS PLNB C1	n/a	n/a	115	128	5	140	3-6/12/18	20:10-4:38
NS PLNB C2	n/a	n/a	40	198	0	25	3-6/12/18	19:53-4:24
Total	n/a	n/a	155	326	5	165	-	-

3.5.2. Christmas Creek

In 2018, no records of Pilbara Leaf-nosed Bat were made from the Christmas Creek mine site. The species has not been recorded from the Christmas Creek to date. Baseline surveys and monitoring events have not recorded the species (ENV 2012b; Ecoscape 2017b, 2018a) and current monitoring was therefore completed at a surveillance level only. No roost habitat has been recorded from the mine site and the monitoring completed to date was sufficient to confirm the absence of the species from the site.

3.5.3. Solomon Hub

The Pilbara Leaf-nosed Bat was recorded from one potential impact site (SM Bat I7) at the Solomon Hub during the 2018 monitoring. The species was recorded from this site in 2017, with a total of 678 calls (Table 3.10). The records indicate that the species uses this site for foraging during the night. No activity pattern that is indicative of a roost site was recorded from site.

An additional site was equipped with a bat recorder in 2018 (Figure 3.34). The cave is located within a heritage site in the Fredericks mine area. Six calls of the Pilbara Leaf-nosed Bat were recorded between 22:13 and 22:18 from the site during one of the four nights monitored (18 March 2019). The record indicates a foraging individual that occasionally visits this site. This site will be included in future monitoring programs to monitor the use of the cave by the species.

Previous monitoring detected Pilbara Leaf-nosed Bat from two sites at the Solomon Hub (Table 3.10). A single foraging call was recorded in 2013 from potential impact site SM Bat I2 (Valley of Queens), and a total

of 678 foraging calls were recorded from site SM Bat I7 (cave south of the Solomon Hub infrastructure) in 2018.

Environmental conditions were considered favourable between 2015 and 2018 and it is likely that the species has extended their distribution as part of a natural expansion. Above average rainfall conditions allow the species to travel longer distances as part of their annual dispersal behaviour (Armstrong, 2001; DotE 2018b). There was an increase in Pilbara Leaf-nosed Bat records at the Solomon Hub control sites between 2018 and 2019. This increase was likely due to the change in timing of the monitoring in 2019 (due to a bush fire in December 2018). The later timing coincided with the dispersal of young and adult Pilbara leaf-nosed Bats. The increased activity at the control sites was not recorded at the potential impact sites which is likely to be due to the lack of roost sites in the vicinity of the mine. To date, there are no records of a diurnal roost or maternity roost sites from the Solomon Hub. All records made are indicative for foraging individuals.

Figure 3.34: Additional bat recorder site (cave) at Fredericks mine

Table 3.10: Pilbara Leaf-nosed Bat records from Solomon Hub Sites

Site	2013	2014	2016	2017	2018	2018 Record Details		
						Date	Detection time	No. calls
SM Bat I2	1	0	0	0	0	-	-	-
SM Bat I7	n/a	n/a	n/a	678	6	12/3/19 13/3/19 15/3/19	0:44 20:54 2:00	1 2 3
SM OPP	n/a	n/a	n/a	n/a	6	18/3/19	22:13-22:18	6
Total	1	0	0	678	12			

3.5.4. Main Line Rail

The Pilbara Leaf-nosed Bat was recorded from seven potential impact sites in 2018 (Table 3.11). All records indicate foraging activities with a slight decrease in call numbers at four potential impact sites (MR BAT I4-I7) and a slight increase at four other potential impact sites (MR Bat I1, I8, I11 and I12) (Table 3.11). The results indicate that the Pilbara Leaf-nosed Bat activity has been comparable to previous years and to control sites associated with the Main Line Rail. To date, only foraging individuals have been recorded and no roost habitat is present along the Main Line Rail (Ecoscape 2017a).

Previous monitoring indicates that there was an increase in Pilbara Leaf-nosed Bat activity in 2017 which was attributed to the increase in geographical spread of the monitoring site locations (Table 3.11). Activity of Pilbara Leaf-nosed Bats remains consistent across the rail monitoring sites with activity increasing and decreasing slightly across the potential impact sites (e.g. MR Bat I1). The reduction in activity at potential impact site MR Bat I7 was due to technical issues which resulted in only one night of data being available in 2018. Overall the data suggests that the Pilbara Leaf-nosed Bat has not been impacted by the operation of the rail and that the foraging levels on site are similar to previous years.

Table 3.11: Pilbara Leaf-nosed Bat records from Main Line Rail Sites

Site	Previous name	2013	2014	2016	2017	2018	2018 Record Details	
							Date	Detection time
MR Bat I1	MR PLNB I1	3	2	4	2	37	28/11-5/12/18	21:05-3:18
MR Bat I2	MR PLNB I2	18	11	1	2	0	-	-
MR Bat I3	MR PLNB I3	0	0	1	0	0	-	-
MR Bat I4	-	n/a	n/a	n/a	60	42	29/11-1/12/18	20:07-3:37
MR Bat I5	-	n/a	n/a	n/a	24	0	-	-
MR Bat I6	-	n/a	n/a	n/a	15	3	29-30/11/18	20:39-2:39
MR Bat I7	-	n/a	n/a	n/a	335	1	29/11/18	20:16
MR Bat I8	-	n/a	n/a	n/a	12	32	29-30/11/18	20:11-3:25
MR Bat I11	-	n/a	n/a	n/a	0	7	29-30/11/18	20:53-2:51
MR Bat I12	-	n/a	n/a	n/a	0	1	30/11/18	2:39
Total		21	13	6	450	123	-	-

3.5.5. North Star

The Pilbara Leaf-nosed Bat was recorded from both potential impact sites during the 2018 wet season monitoring. A total of 247 calls were recorded from Cave 13 and 30 calls were recorded from Chateau Cave over the four-night period. Calls recorded from Cave 13 were made between 7:57pm and 4:26am indicating foraging or nocturnal roosting behaviour. The pattern recorded from Chateau Cave showed Pilbara Leaf-nosed Bat activity limited to the early morning periods, between 2:12am and 5:33am (Appendix 7). This indicates individuals returning to a roost cave which is consistent with the activity recorded during previous monitoring. In 2018, the bat recorder was installed on top of Chateau Cave above the cave entrance due to safety risks associated with accessing the cave. Previous data was recorded from the cave entrance. Therefore, call numbers recorded in 2018 are lower than those recorded during previous years (5,068-8,099 calls) (Table 3.12). The activity at Cave 13 appears to have increased in 2018 with a total of 247 calls recorded over a four-night period. Previous years indicated that activity was lower with up to 33 calls recorded. Activity levels determined from the number of calls recorded is not a reliable representation of the number of

individuals present on site with a low number of Pilbara Leaf-nosed Bats passing the recorder a high number of times, giving the same result as a high number of individuals passing the recorder a few times.

The bush fire in July 2018 impacted large areas of North Star, including the areas surrounding of the two caves (NAFI 2018). A slight shift in habitat usage may have occurred at the two sites with a slight decrease of activity at Chateau Cave and an increase in activity at Cave 13, however, the call patterns indicate similar usage of the two caves compared with previous monitoring.

Data recorded to date indicates that Chateau Cave has been consistently used, mostly as a diurnal roost cave and possible maternity cave, and that Cave 13 appears to have been utilised as a nocturnal roost and foraging cave (Ecoscape 2017a, 2018a).

It should be noted that any direct comparison of call pattern and numbers between previous monitoring events should be undertaken with care. Survey timing varied between March (2015) and December (2016 and 2017) and coincide with difference stages of the reproductive behaviour (giving birth and dispersal). Timing has been consistent since 2016, with a change in microhabitat in which the recorder was installed at Chateau cave in 2018.

The Ghost Bat was also recorded from Cave 13 on 04/12/18. Two detections were made from this site, at 10:40pm and 3:18am (Appendix 7). It is likely the species used the cave for foraging and nocturnal roosting. The species was also recorded during the two nights from control site NS PLNB C2, with two of the detections within 1 hour after sunset (7:24pm and 7:38pm) (Appendix 7). The recorder was installed on top of the mesa ridge and it is likely the recorded Ghost Bat was leaving a nearby cave. Monitoring for the Ghost Bat will be included during future monitoring under the new conservation significant fauna management plan.

Table 3.12: Pilbara Leaf-nosed Bat records from North Star Sites

Site	2015	2016	2017	2018	2018 Record Details	
					Date	Detection time
NS PLNB I1 (Cave 13)	33	5	0	247	2-5/12/18	7:57pm-4:26am
NS PLNB I2 (Chateau Cave)	82	8,094	5,068	30	2-4/12/18	2:12am-5:33am
Total	115	8,099	5,068	277	-	-

600000

700000

800000

7700000

7600000

7500000

SM BAT C8
1 call

SM BAT C6
11 calls

SM Bat C5
6 calls

Additional cave (Frec
6 calls

SM BAT I7
6 calls

SM BAT C9
4 calls

30 calls
Chateau cave

NS Cave 13
247 calls

NS PLNB C1
140 calls

NS PLNB C2
25 calls

Hamersley

Two Mile Bore

Cattle Well

Eight Mile Well

Ridge Bore

Four Corners Bore

McRaes Well

Marlathana Well

Fortescue River

CHICHESTER RANGE

PILBARA

HAMERSLEY RANGE

KARIJINI NATIONAL PARK

MILLSTREAM CHICHESTER NATIONAL PARK

MUNGAROONA RANGE NATURE RESERVE

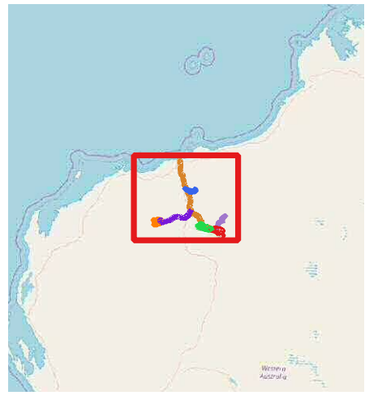
YANDEYARRA ABORIGINAL RESERVE

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Pilbara Leaf-nosed Bat records

- Control Site Main Line Rail
- Impact Site Main Line Rail
- Control site Solomon
- Impact Site Solomon



N

0 10 20 30 40 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 16-05-2019

Pilbara Leaf-nosed Bat Records

Fauna Monitoring 2018

Figure

Prepared for
Fortescue Metals Group

3.35

3.6. Ghost Bat

3.6.1. Control Sites

The Ghost Bat was not recorded from the control sites associated with Christmas Creek, Solomon Hub and Main Line Rail in 2018.

Previous monitoring results indicate the species was present at two of the control sites associated with the Christmas Creek mine (Table 3.13). Detection of the Ghost Bat can be difficult using acoustic recorders, in particular when they are installed along foraging habitat (Ecoscape 2018a). The species typically relies on visual senses instead of echolocation when hunting. Social calls can be recorded when leaving roost caves and other structures (e.g. culverts). For this reason, records are typically a conservative indication of the presence of the species. A lack of records does not necessarily indicate the absence of the species and records should also not be used to determine abundance data of the species.

Table 3.13: Ghost Bat records from Control Sites

Site	2013	2014	2015	2016	2017	2018	2018 Record Details	
							Date	Detection time
Christmas Creek								
CC Bat C1	n/a	n/a	n/a	1	0	0	-	-
CC Bat C3	n/a	n/a	n/a	n/a	1	0	-	-
Total	n/a	n/a	n/a	n/a	1	0		
North Star								
NS PLNB C1	n/a	n/a	n/a	0	0	0	-	-
NS PLNB C2	n/a	n/a	n/a	0	0	2	04/12/18	22:20, 3:18
Total	n/a	n/a		0	0	2		

3.6.2. Christmas Creek

The Ghost Bat was not recorded from the Christmas Creek mine during the 2018 monitoring and has not been recorded during previous monitoring events. Two potential records were made from the control sites in 2016 and 2017. Ghost Bat was recorded via mist netting during a baseline survey near the Fortescue Marsh (Bamford 2010b) and a potential roost cave was identified to the east of the Christmas Creek mine and south of the Fortescue Marsh (ENV 2009, 2012b). Roost habitat has not been mapped from the Christmas Creek mine site and the likelihood of a maternity roost occurring has been identified as unlikely (ENV 2009, 2012b). Based on the baseline survey and monitoring results to date, the species is not thought to occur on site.

3.6.3. Solomon Hub

The Ghost Bat was recorded from one potential impact site (SM Bat I7) at the Solomon Hub during the 2018 monitoring. The species was recorded over four nights (12-15 March 2019) with calls as early as 7:03 pm (42 minutes after sunset) and as late as 5:28 am (36 minutes before sunrise) (Table 3.14). The Ghost Bat was also recorded from this site during the 2017 monitoring (Ecoscape 2018a) and the data collected to date suggests that the cave has the potential to be used as a roost cave, at least on a temporary basis.

One additional site was equipped with a bat recorder in the Fredericks mine area during the 2018 monitoring. The Ghost Bat was recorded from this site at sunset (18:58 & 0:27) during two of the four nights of recording (19 & 20 March 2019). The timing of the calls around sunset indicates that the site may be used as a diurnal

roost site. The cave is located within 100 m of the Fredericks Haul Road. This site will be included into future monitoring to monitor the use of the cave by Ghost Bats.

The Ghost Bat was recorded from the Solomon Hub during the baseline survey in 2010 (Ecologia 2010) and from one potential impact site in 2017 (SM Bat I7) from which the species was also recorded during the 2018 monitoring (Table 3.14). One additional record in the form of a scat pile was made in 2016 from a cave in the Trinity area (Ecoscape 2017b). Environmental conditions in 2018 were favourable (section 3.1.3). The two potential impact sites SM Bat I7 and SM OPP are located in caves and are likely to be used as temporary roost sites. Future monitoring will confirm the consistency of this behaviour over time.

Table 3.14: Ghost Bat records from Solomon Hub Sites

Site	2013	2014	2016	2017	2018	2018 Record Details		
						Date	Number of calls	Detection time
SM Bat I7	n/a	n/a	n/a	11	10	12/3/19 13/3/19 14/3/19 15/3/19	1 6 1 2	5:24 21:03, 5:21-5:28 19:03 5:14-5:20
SM OPP					2	19/3/19 20/3/19	1 1	18:58 0:27
Total	0	0	0	11	12	-	12	-

3.6.4. Main Line Rail

No Ghost Bats were recorded during the 2018 monitoring. During the dry season monitoring, evidence of the Ghost Bat was recorded from three locations along the Main Line Rail (Table 3.15). Scats and the remains of prey species (bird wings and rodent carcass remains) were recorded from three culverts (MR Cu 01, Cu 07 and Cu 08). The species was recorded at the same locations in 2017 indicating the ongoing use of these culvert sites as nocturnal feeding roosts.

In 2017, a potential call was recorded from one potential impact site (MR Bat I8); however, no calls were recorded from this site in 2018 (Table 3.16). The rail corridor does not contain any potential roost habitat and the area is only used for foraging and temporary nocturnal roosts as observed during five years of monitoring (2013-2014, 2016-2018). Ghost Bats are generally difficult to detect when foraging due to their 'sit and wait' strategy and use of visual senses when hunting instead of the use of active echolocation whilst flying (Tidemann *et al.*, 1985). Social calls are typically only recorded when leaving roost caves (K. Armstrong, pers. comms. 2017, Ecoscape 2018) which makes the detection of the species along the Main Line Rail difficult (no roost habitat present).

Table 3.15: Ghost Bats recorded during dry season monitoring

Site	2017	2018	Co-ordinates	
	Dry Season	Dry Season	Easting	Northing
MR Cu 01	Scats and prey remains	Scats and prey remains	692867	7634878
MR Cu 07	Scats and prey remains	Scats and prey remains	695248	7626242
MR Cu 08	Scats and prey remains	Scats and prey remains	696138	7622709
GhB Opp1	Scats and prey remains	-	694457	7628788
GhB Opp2	Scats and prey remains	-	695414	7625578

GhB Opp3	Scats and prey remains	-	696766	7606698

Table 3.16: Ghost Bat records from Main Line Rail Sites

Site	2013	2014	2016	2017	2018	2018 Record Details	
						Date	Detection time
MR Bat I8	n/a	n/a	n/a	1	0	-	-
Total	0	0	0	1	0		

600000

700000

800000

7700000

7600000

7500000

INDIAN OCEAN

NS Cave 13

NS PLNB C2

MR CU 01

MR CU 07

MR CU 08

Additional cave (Fredericks)

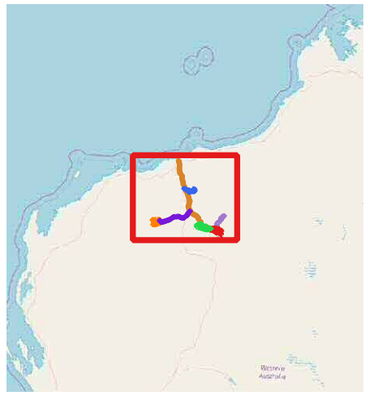
SM Bat 17

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Ghost Bat records

- Potential Call recorded
- Prey remains and scats



N

0 10 20 30 40 km

Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 16-05-2019

Ghost Bat Records

Fauna Monitoring 2018

Figure

Prepared for
Fortescue Metals Group

3.36

3.7. Pilbara Olive Python

3.7.1. Christmas Creek

Pilbara Olive Python was not recorded from the Christmas Creek potential impact sites in 2018. This result is consistent with the previous five years of monitoring (2013-2017). No records were made from the control sites to date. One individual was recorded by site personnel on 20 April 2018 from the CCY2 Workshop (section 3.2.2, Appendix 3). Records of this species to date are limited to sightings made by site personnel. Four confirmed records have been made between 2013 and 2018, one probable confirmed record exists from 2014 and one unconfirmed sighting was recorded in 2011 (section 3.2.2, Appendix 3). Critical habitat for the species is not present within the Christmas Creek mine site and the sporadic records made to date indicate that the Pilbara Olive Python is not a resident on site and that individuals move into the site from habitats outside of the mine area.

3.7.2. Solomon Hub

One juvenile individual Pilbara Olive Python (PIT 991 0030 0017 4907) was recorded opportunistically from Kangi camp during the wet season monitoring (Figure 3.37). The small size of the individual indicates that it hatched in the wet season 2018/2019 indicating a nearby breeding site. Site personnel relocated the Pilbara Olive Python to Kangi creek. The individual was recorded again on a road in Kings mine on 30 March 2019. No other Pilbara Olive Pythons were recorded during the monitoring in 2018.

Previous monitoring events indicated that the Pilbara Olive Python population was stable at the Solomon mine with between one and two individuals recorded each year (Appendix 3). Captures peaked in January 2013 and January 2016 with two individuals recorded from two potential impact sites over numerous nights (Ecoscape 2018a). The peaks coincide with above average rainfall received in January 2013 and average wet season rainfall received in January 2016 (after 7 months without rain) resulting in overall good conditions on site (section 3.1.3, Figure 5.3). Site based records show that Pilbara Olive Pythons were recorded on three occasions in 2018 from Firetail South, Kangi creek and the Kings mine area confirming the continued presence of the species within the Solomon Hub mine site.

In late 2018, an extensive bush fire impacted large areas of the Solomon Hub, including adjacent areas of site POP I1 and POP I2 (Figure 3.38). This may have impacted the local population of the Pilbara Olive Python by reducing prey availability through habitat destruction Despite this, ongoing presence of the species including successful breeding has been recorded from site within 3 months post fire.

Figure 3.37: Juvenile Pilbara Olive Python recorded from Kangi camp (PIT 991 0030 0017 4907)

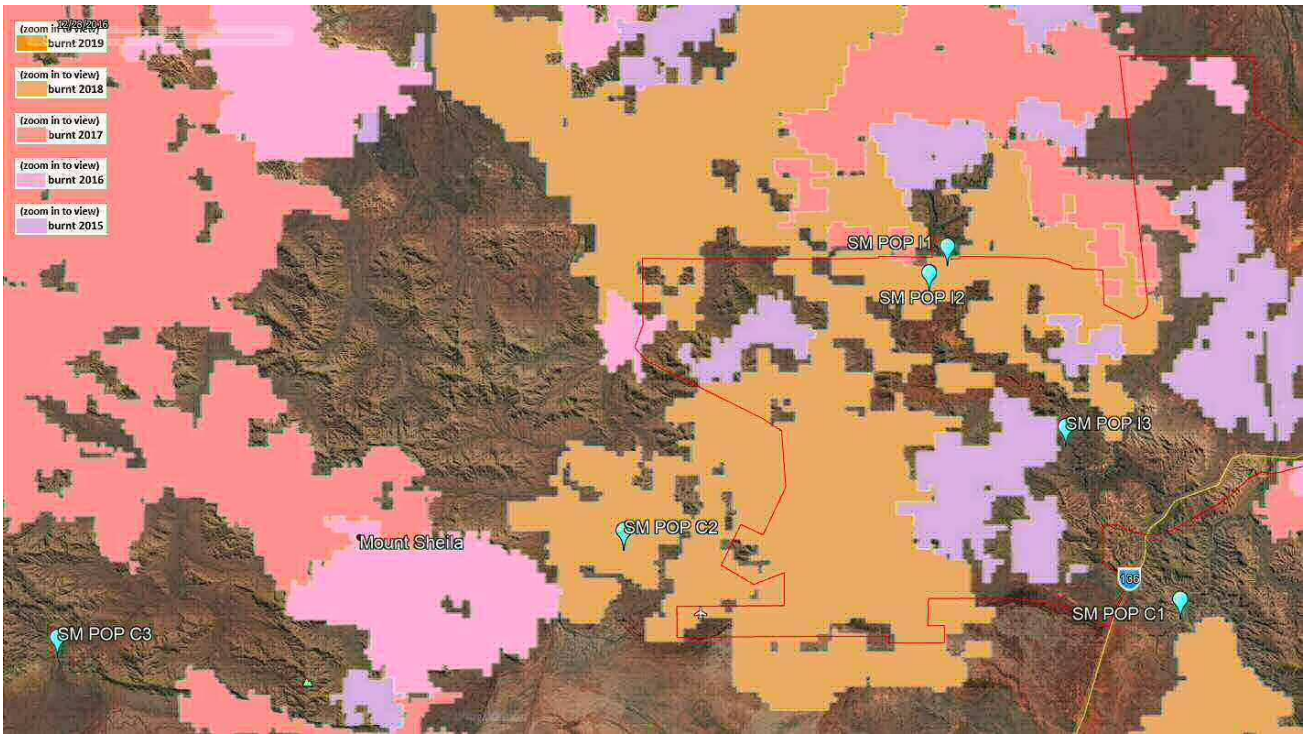


Figure 3.38: Fire scars at Solomon Hub in 2018 (NAFI 2019)

3.7.3. North Star

A total of four Pilbara Olive Python individuals were recorded from two potential impact sites (NS POP I3 & NS POP I4) and one control site (NS POP C4) during the wet season monitoring (Figure 3.42). One juvenile individual and one young adult were recorded from potential impact site NS POP I4 and one adult individual was recorded from site NS POP I3 (Figure 3.39). Two of the three individuals were recorded over multiple nights during the wet season monitoring. A large adult individual was recorded over four nights from control site NS POP C4. Details of each capture are listed in Appendix 8. In addition, one individual Pilbara Olive Python was recorded on a long-term motion camera at control site NS MC LT C8 during the dry season monitoring. The individual was recorded hunting birds at a water pool in a gorge located along the main mesa and then after it successfully captured a bird it was recorded leaving the water pool.

The record of three Pilbara Olive Python individuals from the potential impact sites is comparable with the three individuals recorded in 2017. In 2015 and 2016, the number of recorded Pilbara Olive Python was lower with one individual recorded during each wet season monitoring period (Figure 3.41). In comparison, Pilbara Olive Pythons were recorded each year from the control sites with a maximum of two individuals recorded during four of the six monitoring events (Figure 3.41). The 2016 and 2018 monitoring represent the lowest capture rate with one individual recorded from the control sites. The data appears to not correlate with the annual rainfall recorded immediately or within 12 months prior to the monitoring events (Figure 3.41). Two of the potential impact sites and three of the control sites have permanent water present and therefore are suitable for Pilbara Olive Python to be present regardless of the local rainfall levels.

Results of the statistical analysis is presented in Appendix 8 however the low number of capture/recapture data points used in the analysis limits the usefulness of the results for meaningful interpretation.

Overall, the Pilbara Olive Python population at the potential impact sites and the control sites appear to be stable and have not been impacted by mining activities to date (Figure 3.41).

Figure 3.39: Pilbara Olive Pythons recorded from potential impact sites NS POP I3 and NS POP I4

Figure 3.40: Pilbara Olive Python recorded from control site NS MC LT C8

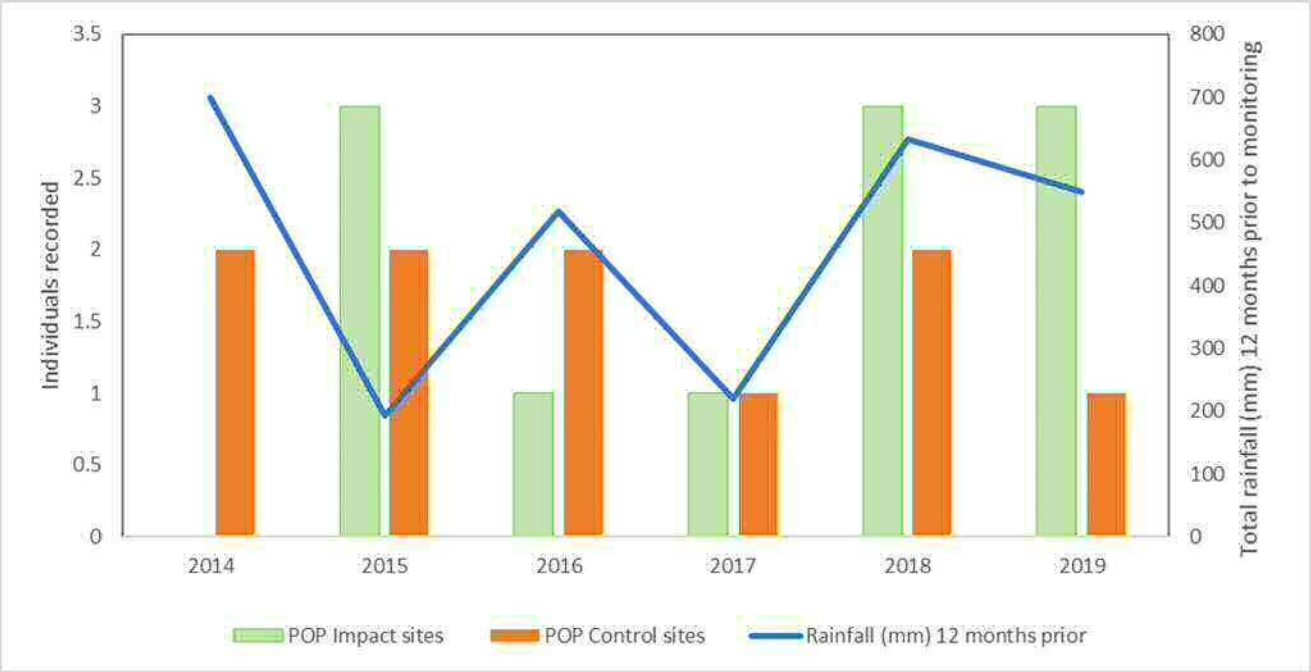


Figure 3.41: Number of Pilbara Olive Pythons and rainfall recorded at North Star

600000
700000
800000
7700000
7600000
7500000

OCEAN
PORT HEDLAND
YANDEYARRA
ABORIGINAL
RESERVE
MUNGARODINA RANGE
NATURE RESERVE
CHICHESTER RANGE
HAMERSLEY RANGE
PILBARA
KARIJINI NATIONAL PARK
FORTESCUE
MARSH

NS POP C4
NS POP I3
NS POP I4
NS MC LT C8

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Pilbara Olive Python

- Initial capture
- Motion Camera
- Recapture

N

0 5 10 15 20 25 km

Scale 1:1 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 13-05-2019

Pilbara Olive Python Records

Fauna Monitoring 2018

Figure

Prepared for
Fortescue Metals Group

3.42

3.8. Conservation Significant Birds

3.8.1. Control sites

Conservation significant bird species (Grey Falcon) were only recorded from one control site located along the Main Line Rail (MR MiB C1 (Oakover River)) in 2018. No other conservation significant birds were recorded in 2018 from the control sites associated with Cloudbreak, Christmas Creek, Solomon Hub, Main Line Rail and Hamersley Rail.

The control sites are located in habitat similar to that found within the potential impact sites associated with the project areas such as major creeklines and rivers. The sites are predominantly vegetated by larger trees and shrubs. Surface water can be present at the sites after heavy rainfall events but is reliant of significant rainfall events. Conditions may be sub-optimal during dry periods and the lack of conservation significant bird records at these sites may not be unusual during these times.

The sighting of the Bush Stone-curlew at surface water pools along the Hamersley Road (south of Solomon Hub) over three consecutive nights (14-16 March 2019) indicates that conditions were optimal for migratory birds to occur. However, no species of significance were recorded in 2018.

An additional three control sites (Fortescue Marsh) associated with the Chichester Hub were monitored to provide regional control data from the closest known migratory bird source population (only during migration periods) which may influence migratory bird occurrence at the mine site. Conservation significant bird activity at the Chichester Hub control sites CB/CC MiB C1-C3 have been recorded at relatively high levels (2015-2018) in comparison to other control sites and potential impact sites. This is due to their location at yintas (deep pools that maintain water for extended periods) located within the Fortescue Marsh where conditions are optimal for the majority of the year and attract a large number of water birds and migratory birds, including conservation significant species (Ecoscape 2017d, 2017c). A total of eight conservation significant birds have been recorded from these sites to date: Common Greenshank, Marsh Sandpiper, Oriental Plover, Gull-billed Tern, Glossy Ibis, Wood Sandpiper, Red-necked Stint and Grey Falcon. Two species (Common Greenshank and Common Sandpiper) were recorded in 2018 which is slightly lower than the four species recorded in 2017 (Gull-billed Tern, Red-necked Stint, Glossy Ibis, Oriental Plover) and the five species recorded in 2016 (Glossy Ibis, Common Sandpiper, Wood Sandpiper, Marsh Sandpiper, Common Greenshank) (Figure 3.43, Table 3.17).

Previous monitoring of the control sites indicated that the level of conservation significant bird activity in 2018 was similar to previous years (2015-2017) across the majority of control sites with the exception of the Fortescue Marsh control sites (CB/CC MiB C1-C3). Migratory bird activity was higher in 2016 and 2017 in comparison to 2018. The 2015 results were comparable, though slightly lower than the 2018 results (Table 3.17).

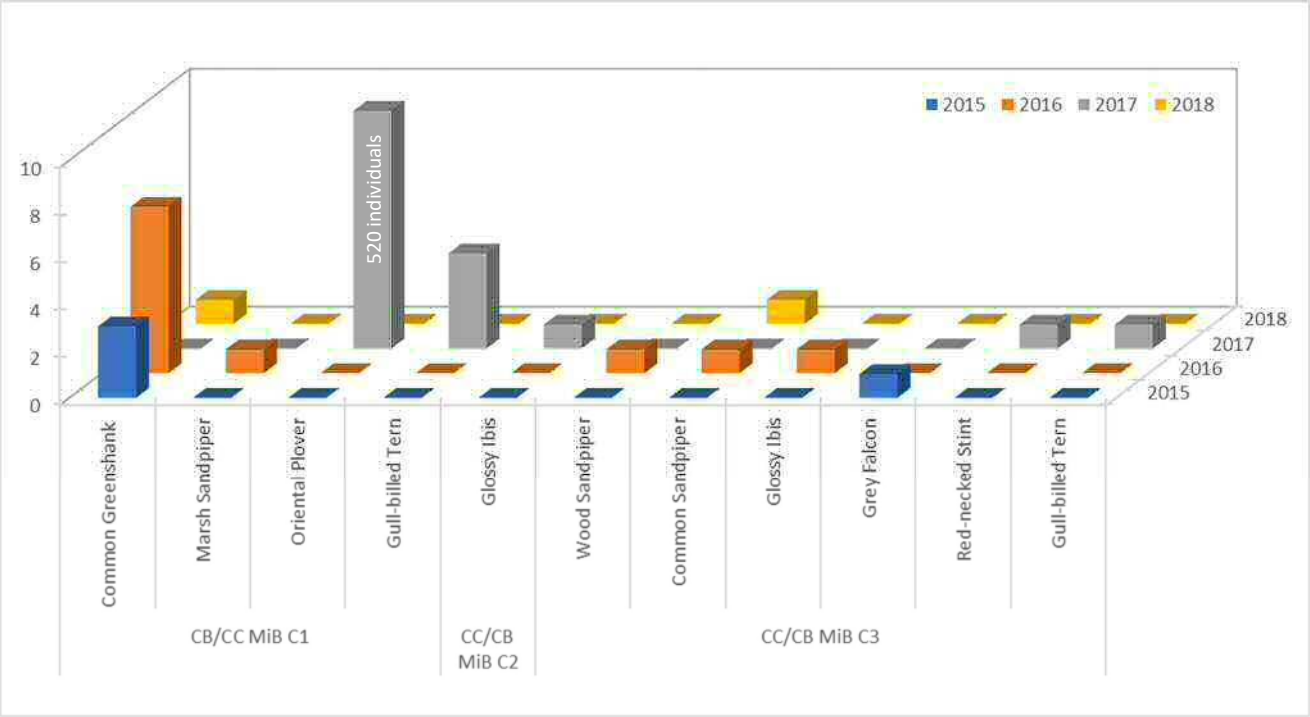


Figure 3.43: Conservation significant bird records at control sites - Chichester Hub

3.8.2. Cloudbreak

No conservation significant birds were recorded from the potential impact sites at the Cloudbreak mine in 2018. The conditions were hot and dry during the monitoring and no surface water was present at the sites. No conservation significant birds have been recorded from the bird monitoring sites at Cloudbreak during previous monitoring events (Table 3.17). The Grey Falcon has previously been recorded opportunistically from the mine site and is known to occasionally visit creekline habitats at the Cloudbreak mine (Bamford 2005a; Ecoscape 2018a). Additionally, the Common Sandpiper and Peregrine Falcon were recorded from mine voids across the Cloudbreak mine in 2017 (Ecoscape 2018a) and the Peregrine Falcon was also recorded during the baseline survey (from Minga Well) (Bamford 2005a). The occurrence of the two species can be very infrequent and is typically limited to habitats that provide surface water for foraging purposes (DPaW 2019). Dry weather conditions in late 2018 did not provide suitable conditions for many of the conservation significant bird species that could potentially occur on site (section 3.1.1).

The lack of records made from the potential impact sites is consistent with the new Chichester Hub control sites CB/CC MiB C4-6 and Hamersley Rail Line control sites (Table 3.17). The lack of conservation significant bird records from the potential impact sites to date is due to the relatively low suitability of the habitat present at the sites (creeklines without surface water) and the proximity of these sites to the Fortescue Marsh which provides optimal conditions for the majority of the year. Waterbirds are attracted to the Fortescue Marsh and may not utilise the potential impact sites on a regular basis. There is no decrease in conservation significant bird activity level recorded from the potential impact sites at the Cloudbreak mine, indicating no significant impact to date by the operation of the mine.

Data collected from the Cloudbreak control sites CB/CC MiB C1-3 indicates that there is a slight decrease in conservation significant bird activity at the control sites in 2018 in comparison to 2016 and 2017, and similar activities to the 2015 monitoring.

3.8.3. Christmas Creek

No conservation significant birds were recorded from the potential impact sites located within the Christmas Creek mine in 2018. The environmental conditions were hot and dry during the monitoring and no surface water was present. No conservation significant birds were recorded from the potential impact sites during previous monitoring events or baseline surveys (Table 3.17) (ENV 2012b).

The lack of records made from the potential impact sites is consistent with the data from the new Chichester Hub control sites CB/CC MiB C4-6 and Hamersley Rail Line control sites which are located in comparable habitats to the potential impact sites at Christmas Creek (Table 3.17).

Conservation significant birds have not been recorded from the potential impact sites at the Christmas Creek mine during the monitoring. The habitats at the Christmas Creek mine site are not suitability for waterbirds and conservation significant falcon species are rarely recorded.

Data collected from the Christmas Creek control sites CB/CC MiB C1-3 indicates that there is a slight decrease in conservation significant bird records at the control sites in 2018 in comparison to 2016 and 2017 although similar to the number recorded during the 2015 monitoring.

3.8.4. Solomon Hub

Conservation significant birds were not recorded from the potential impact sites located at the Solomon Hub in 2018. The majority of the impact area, including two of the three potential impact sites were burnt during a bush fire in late 2018 (Figure 3.44).

Two species, the Peregrine Falcon and Fork-tailed Swift were the only two species recorded during the baseline survey; both of which have been sighted infrequently on site. The Fork-tailed Swift has an entirely aerial lifestyle and the Peregrine Falcon has been seen on two occasions in 2012 from Zalamea and in 2017 from Kangeenarina Creek north, indicating that the species is not a resident and only visits infrequently. No other conservation significant birds have been recorded from the Solomon Hub potential impact sites during previous monitoring (Table 3.17). Water pools are present along Kangeenarina creek with dense riparian vegetation. Waterbirds of conservation significance potentially occurring in the wider area (Common Sandpiper, Marsh Sandpiper, Common Greenshank, Oriental Plover) prefer open shallow water with muddy banks and a minimal vegetation cover such as clay pans, billabongs, lakes and dams (DotEE 2018b, 2018a). This habitat type has not been recorded from the Solomon Hub and waterbirds are therefore not likely to occur.

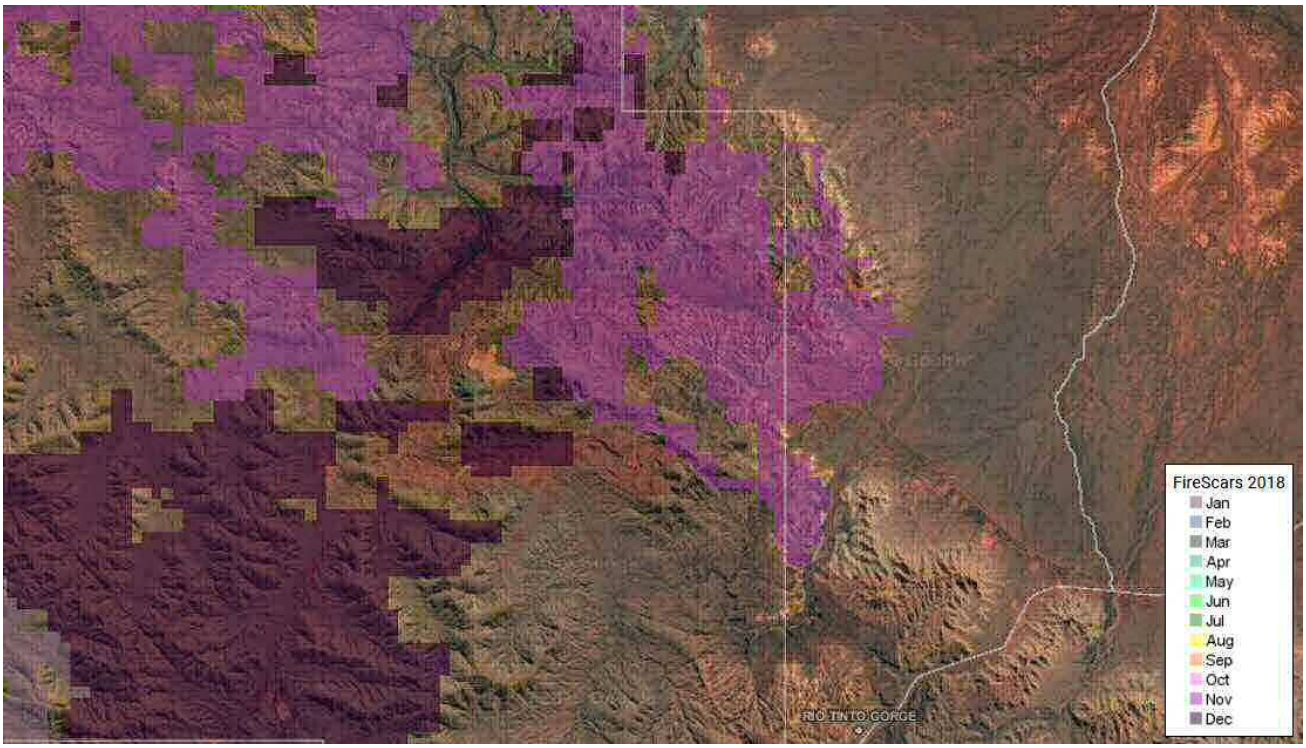


Figure 3.44: Fire scar at Solomon Hub in 2018 (NAFI 2019)

3.8.5. Hamersley Rail Line

No conservation significant birds were recorded from the potential impact sites located along the Hamersley Rail Line in 2018. A Grey Falcon was opportunistically recorded from the Northern Quoll site HL NQ I2 (686635e 7567151n, Zone 50K) during the dry season Northern Quoll monitoring event and to date, this is the only conservation significant bird species recorded from the Hamersley Rail Line. Grey Falcons have previously been recorded opportunistically from the Hamersley Rail Line (Ecologia 2014c).

The lack of conservation significant bird records in 2018 is consistent with the results from previous monitoring events and from the Hamersley Rail Line control sites (Table 3.17). The monitoring sites are located along major creeklines without surface water. The conditions for migratory waterbirds are sub-optimal and only conservation significant falcon species are likely to be recorded on an occasional basis when foraging in the wider area. Data collected from potential impact sites is consistent with the Cloudbreak and Christmas Creek potential impact sites, as well as Chichester Hub control sites CB/CC MiB C4-6 and Hamersley Rail Line control sites.

3.8.6. Main Line Rail

Conservation significant birds were not recorded from the potential impact sites located along the Main Line Rail in 2018. The Peregrine Falcon and the Grey Falcon were the only conservation significant birds recorded during the baseline survey (ATA 2007). Both species are typically recorded infrequently due to their large hunting grounds and the ability to travel long distances (Olson and Olson, 1986; Schoenjahn, 2011). Breeding habitat is only present for the Grey Falcon in the form of repeater towers. During previous monitoring events, the Grey Falcon and the Common Sandpiper were recorded from potential impact site MR MiB I2 (Table 3.17). The Grey Falcon and the Wood Sandpiper have also been recorded from opportunistic sites during previous years of monitoring (2013, 2015 and 2017) (Ecologia 2014a). The Common Sandpiper and Wood Sandpiper migrate to the Pilbara in the wet season when conditions are suitable and surface water is present (Ecoscape 2017d, 2017c). During the dry season monitoring the remains of a Grey

Falcon were also recorded from a Greater Bilby monitoring site (MR GB OS39). The species was previously recorded along the Main Line Rail and is likely a resident (Ecologia 2014a). Grey Falcon was also recorded from the Main Line Rail control site MR MiB C1 in 2018 (Table 3.17).

Data recorded from the Main Line Rail potential impact sites in 2018 are comparable to the results recorded during previous monitoring (Figure 3.45). When data only from the potential impact sites is analysed, one species was recorded in 2015, no conservation significant bird species were recorded in 2016, followed by one species in 2017 and no records in 2018. This trend is comparable to the data recorded from the Main Line Rail control sites, as well as control sites at the Hamersley Rail Line and Chichester Hub.

There was very limited surface water present during the monitoring event in 2018 which likely influenced the number of migratory birds recorded. Overall, the number of records in 2018 from inside the impact area is very low, but also comparable with previous years (Table 3.17).

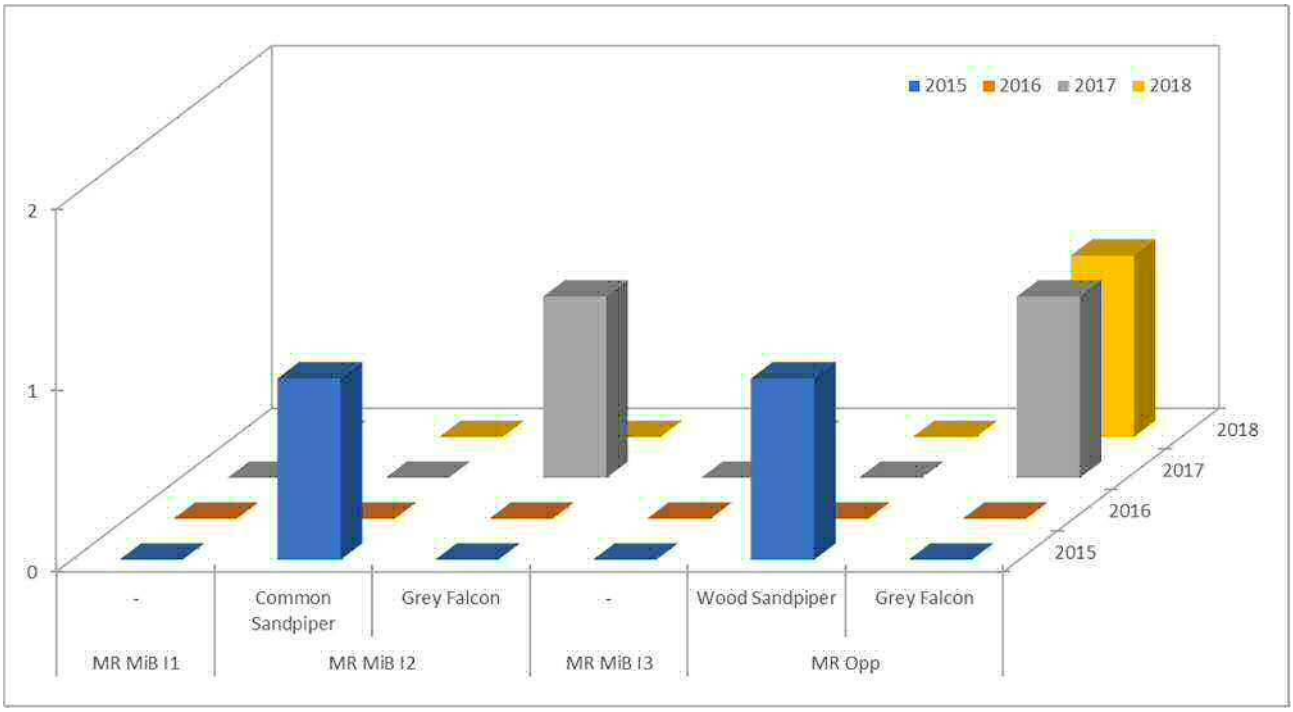


Figure 3.45: Conservation significant bird records at potential impact sites - Main Line Rail

Table 3.17: Conservation Significant Birds recorded

Project	Site	Species	Records			
			2015	2016	2017	2018
Marsh Control Sites						
Chichester Hub Control	CC/CB MiB C1	Common Greenshank	3	7	-	1
		Marsh Sandpiper	-	1	-	-
		Oriental Plover	-	-	520	-
		Gull-billed Tern	-	-	4	-
	CC/CB MiB C2	Glossy Ibis	-	-	1	-
	CC/CB MiB C3	Wood Sandpiper	-	1	-	-
		Common Sandpiper	-	1	-	1
		Glossy Ibis	-	1	-	-
		Grey Falcon	1	-	-	-
		Red-necked Stint	-	-	1	-
		Gull-billed Tern	-	-	1	-
	CC/CB MiB C4	-	n/a	n/a	n/a	-
	CC/CB MiB C5	-	n/a	n/a	n/a	-
	CC/CB MiB C6	-	n/a	n/a	n/a	-
Control Sites						
Solomon Hub Control	SM MiB C1	-	-	-	-	-
	SM MiB C2	-	-	-	-	-
	SM MiB C3	-	-	-	-	-
	SM C OPP	Oriental Plover	-	-	1	-
		Peregrine Falcon	-	-	1	-
Hamersley Rail Control	HL MiB C1	-	-	-	-	-
	HL MiB C2	-	-	-	-	-
	HL MiB C3	-	-	-	-	-
Main Line Rail Control	MR MiB C1	Grey Falcon	-	-	-	1
	MR MiB C2	-	-	-	-	-
	MR MiB C3	-	-	-	-	-

Project	Site	Species	Records			
			2015	2016	2017	2018
Potential Impact Sites						
Cloudbreak	CB MiB I1	-	-	-	-	-
	CB MiB I2	-	-	-	-	-
	CB MiB I3	-	-	-	-	-
Christmas Creek	CC MiB I1	-	-	-	-	-
	CC MiB I2	-	-	-	-	-
	CC MiB I3	-	-	-	-	-
Solomon	SM MiB I1	-	-	-	-	-
	SM MiB I2	-	-	-	-	-
	SM MiB I3	-	-	-	-	-
	SM OPP	-	-	-	-	-
Hamersley Rail Line	HL MiB I1	-	-	-	-	-
	HL MiB I2	-	-	-	-	-
	HL MiB I3	-	-	-	-	-
	HL OPP	Grey Falcon	-	-	-	1
Main Line Rail	MR MiB I1	-	-	-	-	-
	MR MiB I2	Common Sandpiper	1	-	-	-
		Grey Falcon	-	-	1	-
	MR MiB I3	-	-	-	-	-
	MR Opp	Wood Sandpiper	1	-	-	-
		Grey Falcon	-	-	1	1*

*remains recorded

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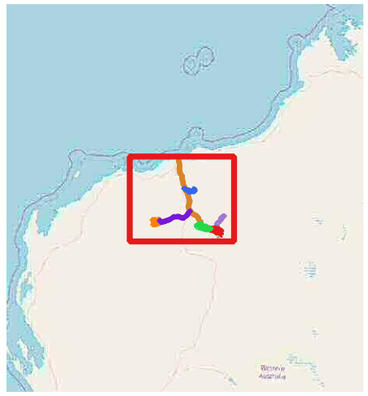
Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Conservation Significant Birds

- Common Greenshank
- Common Sandpiper
- Grey Falcon
- Grey Falcon (remains)



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Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 13-05-2019

Conservation Significant Bird Records

Fauna Monitoring 2018

Figure

Prepared for
Fortescue Metals Group

3.46

3.9. Rehabilitation Areas

Details and results of the fauna monitoring at rehabilitation sites are presented in the below sections (2018 results only) and summarised in Table 3.18.

3.9.1. Cloudbreak

No conservation significant fauna species were recorded from rehabilitation sites located within the Cloudbreak mine site. Two species, the Euro (*Osphranter robustus*) and the European Cattle (*Bos taurus*) were recorded from the sites. The sites are located outside of mapped conservation significant fauna habitat, thus conservation significant fauna is not expected to occur. The vegetation regrowth recorded from the rehabilitated sites is considered suitable for generalist fauna species, as indicated by the four species recorded to date (Table 3.18).

3.9.2. Christmas Creek

No conservation significant fauna species were recorded from rehabilitation sites located within the Christmas Creek mine site. The Euro and European Cattle were the only two species recorded from two of the sites in 2018. The sites are located outside mapped conservation significant fauna habitat, thus conservation significant fauna is not expected to occur. The vegetation regrowth recorded from the rehabilitated sites is considered suitable for generalist fauna species, as indicated by the eight species recorded to date (Table 3.18).

3.9.3. Solomon Hub

A Northern Quoll was recorded from rehabilitation site SM RE 06 which is located adjacent to Northern Quoll habitat in the form of Kangeenarina creek. The other two rehabilitation sites are located outside mapped conservation significant fauna habitat, thus conservation significant fauna is not expected to occur. The vegetation regrowth recorded from the rehabilitated sites is suitable for generalist species, but also the Northern Quoll at one site (SM RE 06) (Figure 3.47 and Figure 3.28). Three other mammal species have also been recorded from the three sites to date (Table 3.18).

Figure 3.47: Northern Quoll recorded from rehabilitation site SM RE 06

3.9.4. Hamersley Rail Line

No conservation significant fauna species were recorded from the three rehabilitation sites located along the Hamersley Rail Line. The vegetation regrowth recorded from the rehabilitated sites is suitable for generalist species, as indicated by the eight species recorded to date (Table 3.18). The Feral Cat was also recorded from one site; however, the species was recorded from culvert sites and Northern Quoll monitoring sites and occurs along the Hamersley Rail Line.

3.9.5. Main Line Rail

No conservation significant fauna species were recorded from the three rehabilitation sites at the Main Line Rail. The current sites are located outside mapped significant habitat. Diggings of the Greater Bilby were previously recorded adjacent to another rehabilitation sites not included in this monitoring program (Ecoscape 2018a). The vegetation regrowth recorded from the rehabilitated sites is suitable for generalist species (Table 3.18). The Cattle is the only introduced species that has been recorded from the rehabilitation sites to date.

3.9.6. North Star

No conservation significant fauna species were recorded from the seven rehabilitation sites at North Star mine site. Five of the seven sites are located adjacent to mapped conservation significant fauna habitat. The vegetation regrowth recorded from the rehabilitated sites is suitable for generalist species. Feral species were not recorded and no increased activity of introduced predators has been recorded from the sites. Seven common species have been recorded from the sites to date (Table 3.18).

Table 3.18: Fauna usage of rehabilitation sites

Site	Habitat	Year of Rehabilitation	Suitability of habitat to support fauna	Suitability of habitat to support conservation significant fauna	Usage by introduced fauna species	Fauna species recorded to date
Cloudbreak						
CB RE Cocos CB01.1	Waste Dump (Cocos), low shrubland over grassland.	2014	Advanced stages of regrowth, suitable for generalist fauna species.	Site is outside significant habitat, no con sig fauna expected	No increased activity of introduced fauna recorded as a result of rehabilitation.	Ring-tailed Dragon (*Ctenophorus caudicinctus*) Sheep Frog (*Cyclorana maini*) Cattle (*Bos taurus*)
CB RE Cocos CB01.2	Waste Dump (Cocos), low shrubland over grassland.	2014	Advanced stages of regrowth, suitable for generalist fauna species.	Site is outside significant habitat, no con sig fauna expected	No increased activity of introduced fauna recorded as a result of rehabilitation.	Red Kangaroo (*Macropus rufus*) Cattle (*Bos taurus*)
CB RE 05	Rocky plain with mixed shrubland over grasses.	2014	Advanced stages of regrowth, suitable for generalist fauna species.	Site is outside significant habitat, no con sig fauna expected	No increased activity of introduced fauna recorded as a result of rehabilitation.	Red Kangaroo (*Macropus rufus*)
Christmas Creek						
CC RE VAS1	Rocky plain with advanced stages of mixed shrubland.	n/a	Early stages of regrowth, suitable for generalist fauna species.	Site is outside significant habitat, no con sig fauna expected	No increased activity of introduced fauna recorded as a result of rehabilitation.	Rufous Whistler (*Pachycephala rufiventris*) Torresian Crow (*Corvus orru*) Fairy Martin (*Petrochelidon ariel*) Zebra Finch (*Taeniopygia guttata*) Painted Finch (*Emblema pictum*) Ring-tailed Dragon (*Ctenophorus caudicinctus*)
CC RE 02	Rocky plain with advanced stages of mixed shrubland.	2014	Early stages of regrowth, suitable for generalist fauna species.	Site is outside significant habitat, no fauna of conservation significance expected.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Red Kangaroo (*Macropus rufus*) Cattle (*Bos taurus*)
CC RE 01	Rocky plain with advanced stages of mixed shrubland.	2014	Early stages of regrowth, suitable for generalist fauna species.	Site is outside significant habitat, no fauna of conservation significance expected.	No increased activity of introduced fauna recorded as a result of rehabilitation.	-
Solomon Hub						
SM RE 10	Lower slope with advanced stages of open shrubland over small patches of early stages of *Triodia* grassland.	2012	Habitat open but suitable for the suitable for generalist fauna species.	Site is outside significant habitat, no fauna of conservation significance expected.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Stripe-faced Dunnart (*Sminthopsis macroura*)
SM RE 11	Rocky plain adjacent to major drainage, advanced stages of open shrubland.	2014	Habitat suitable for generalist fauna species.	Area in close proximity to significant habitat; Northern Quoll recorded, course rocks provide foraging habitat	No increased activity of introduced fauna recorded as a result of rehabilitation.	Northern Quoll (*Dasyurus hallucatus*) Common Rock-rat (*Zyzomys argurus*) House Mouse (*Mus musculus*)
SM RE 06	Rocky plain with *Triodia* grassland adjacent to road.	2014	Good spinifex grassland developing, suitable for generalist fauna species.	Site is outside significant habitat, no fauna of conservation significance expected.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Common Rock-rat (*Zyzomys argurus*) House Mouse (*Mus musculus*)
Hamersley Rail Line						
HL RE 63	Rocky plain with advanced stage of mixed shrubland over small patches of early stages of *Triodia* grassland.	2012	Advanced stages of shrub regrowth, habitat suitable for generalist fauna species.	Area in proximity to mapped foraging habitat; no fauna of conservation significance expected.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Zebra Finch (*Taeniopygia guttata*) Common Rock-rat (*Zyzomys argurus*) House mouse (*Mus musculus*) Planigale (*Planigale* sp.) Little Button Quail (*Turnix velox*) Brown Honey-eater (*Lichmera indistincta*)

Site	Habitat	Year of Rehabilitation	Suitability of habitat to support fauna	Suitability of habitat to support conservation significant fauna	Usage by introduced fauna species	Fauna species recorded to date
HL RE 74	Rocky plain with advanced stage of mixed shrubland.	2012	Advanced stages of shrub regrowth, habitat suitable for generalist fauna species.	Area in proximity to mapped foraging habitat; no fauna of conservation significance expected.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Euro (*Osphranter robustus*) Little Button Quail (*Turnix velox*) Common Rock-rat (*Zyzomys argurus*)
HL RE 87	Rocky plain with advanced stage of mixed shrubland over small patches of early stages of *Triodia* grassland.	2012	Advanced stages of vegetation regrowth, habitat suitable for generalist fauna species.	Site is adjacent to significant habitat, no fauna of conservation significance recorded.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Feral Cat (Felis catus) Euro (*Osphranter robustus*) Zebra Finch (*Taeniopygia guttata*) Common Rock-rat (*Zyzomys argurus*)
Main Line Rail						
MR RE 01	Moderate stages of *Triodia* regrowth and scattered shrubs on sandy/loamy soil.	2012	Moderate vegetation regrowth, habitat suitable for generalist fauna species.	Site is adjacent to significant foraging habitat, no fauna of conservation significance recorded.	No increased activity of introduced fauna recorded as a result of rehabilitation.	-
MR RE 37	Moderate stages of *Triodia* regrowth and scattered shrubs on loamy soil.	2011	Moderate vegetation regrowth, habitat suitable for generalist fauna species.	Site is adjacent to significant foraging habitat, no fauna of conservation significance recorded.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Cattle (*Bos taurus*)
MR RE 92	Advanced stages of *Triodia* regrowth and scattered shrubs on loamy soil, adjacent to creekline.	2008	Habitat suitable for generalist fauna species.	Site is adjacent to significant foraging habitat, no fauna of conservation significance recorded.	No increased activity of introduced fauna recorded as a result of rehabilitation.	-
North Star						
NS RE 01	Top of mesa, early stages of shrub regrowth on rocky	2015	Early stage of regrowth, habitat suitable for generalist fauna species.	Site is adjacent to significant habitat. Northern Quolls previously recorded in surrounding.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Planigale sp. (*Planigale* sp).
NS RE 02	Top of mesa, stony plain with scattered shrubs	2015	Early stage of regrowth, habitat suitable for generalist fauna species.	Site is adjacent to significant habitat. Northern Quolls previously recorded in surrounding.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Common Rock-rat (*Zyzomys argurus*) Torresian Crow (*Corvus orru)*
NS RE 03	Top of mesa, stony plain with scattered shrubs	2015	Early stage of regrowth, habitat suitable for generalist fauna species.	Site is adjacent to significant habitat. Northern Quolls previously recorded in surrounding.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Common Rock-rat (*Zyzomys argurus*)
NS RE 04	Top of mesa, stony plain with scattered shrubs	2015	Early stage of regrowth, habitat suitable for generalist fauna species.	Site is adjacent to significant habitat. Northern Quolls previously recorded in surrounding.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Common Rock-rat (*Zyzomys argurus*)
NS RE 05	Top of mesa, stony plain with scattered shrubs	2015	Early stage of regrowth, habitat suitable for generalist fauna species.	Site is adjacent to significant habitat. Northern Quolls previously recorded in surrounding.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Grey Shrike-thrush (*Colluricincla harmonica*)
NS RE 06	Rocky plain adjacent to creekline, open *Triodia* grassland	2015	Early stage of regrowth, habitat suitable for generalist fauna species.	Site is nearby to foraging habitat, no fauna of conservation significance recorded.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Singing Honey-eater (*Gavicalis virescens*)
NS RE 07	Rocky plain adjacent to creekline, open *Triodia* grassland	2015	Early stage of regrowth, habitat suitable for generalist fauna species.	Site is nearby to foraging habitat, no fauna of conservation significance recorded.	No increased activity of introduced fauna recorded as a result of rehabilitation.	Cattle (*Bos taurus*) Painted Finch (*Emblema pictum*)

*Usage of Feral Fauna is assessed in comparison to areas in the surrounding

3.10. Culvert Sites

3.10.1. Hamersley Rail Line

Conservation significant fauna species were not recorded from the culvert site located along the Hamersley Rail Line. The Northern Quoll is the most likely conservation significant fauna species to utilise the culverts along the Hamersley Rail Line. The species has been recorded to utilise culverts along the Hamersley Rail Line in 2013 and 2014, and subsequently the number of culvert sites was reduced. The Greater Bilby is the only other species that has not been recorded from culverts to date. However, the Greater Bilby is not known from the vicinity of the Hamersley Rail Line and is therefore not expected to be recorded from the culvert sites.

Seven additional species (Common Rock-rat, the skink *Egernia formosa*, Planigale, Diamond Dove, Willie Wagtail, Variegated Fairy-wren and House Mouse) were also recorded from the culvert sites, indicating that the methods used were appropriate.

3.10.2. Main Line Rail

Northern Quoll was recorded utilising one culvert site (MR Cu 04) on two occasions (Figure 3.48). During the Greater Bilby monitoring a Northern Quoll scat was also found inside a culvert at site MR GB OS36. Secondary evidence of Ghost Bat was also recorded from culverts during the dry season monitoring (see section 3.6.4). Ghost Bat was recorded utilising the culverts as regular nocturnal foraging roost sites, as indicated by scat piles and prey remains, which is supported by the consistency of locations and records made during the 2017 and 2018 monitoring. Locations of records is presented in Figure 3.49.

The Greater Bilby is the only other species that is known to occur along the Main Line Rail but has not been recorded to utilise the culverts to date. Especially female Greater Bilby are relatively sedentary and may very rarely use culverts when they disperse. In addition, the population size at the Main Line Rail is relatively small, limiting the encounter chance during the culvert monitoring.

No other conservation significant fauna was recorded using culverts. The Feral Cat was also recorded on motion camera at three culvert sites (MR Cu 04 – Cu 06). One record shows a Feral Cat carrying a predated goanna (Figure 3.48) (Appendix 9). The Dog/dingo was recorded from two culvert monitoring sites (MR Cu 01 & MR Cu 03) in 2018. The species was recorded from culvert sites in relatively low numbers during previous monitoring events: one record in 2017 (MR Cu 08), on record in 2016 (MR Cu 05) and no records in 2015 from the culvert sites (Ecoscape 2016a, 2017a, 2018a) (Appendix 9).

An additional four species, the Euro, Diamond Dove, Sandy Inland Mouse and Variegated Fairy-wren were also recorded from culvert sites along the Main Line Rail, indicating that the methods were appropriate.

Figure 3.48: Northern Quoll (MR Cu 04) and Feral Cat (MR Cu 05) utilising culverts at Main Line Rail

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YANDEYARRA

ABORIGINAL

RESERVE

MILLSTREAM CHICHESTER NATIONAL PARK

MUNGAROONA RANGE NATURE RESERVE

PILBARA

CHICHESTER RANGE

HAMERSLEY RANGE

KARIJINI NATIONAL PARK

HANCOCK RANGE

FORTESCUE MARSH

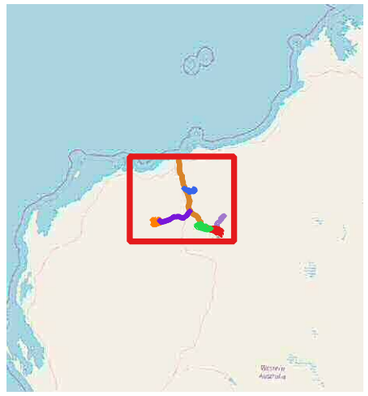
SANDY DESERT

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Recorded Species

- Dingo/Dog
- Feral Cat
- Ghost Bat
- Northern Quoll



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Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 13-05-2019

Conservation Significant Fauna and Feral Predators at Culvert sites

Fauna Monitoring 2018

Prepared for
Fortescue Metals Group

Figure

3.49

3.11. Introduced Fauna

A total of eight species were recorded from across all sites in 2018: Rabbit, House Mouse, Feral Cat, Dog/Dingo, Cattle, Donkey, Horse and Camel. All species have been recorded during previous monitoring events. Details from each site are summarised in Table 3.19 and detailed in Table 5.9 in Appendix 9.

Cattle was the most abundant species (only a small percentage of sightings and secondary evidence is actually recorded) with records made from all sites during previous monitoring and in 2018 (Table 3.19). This species has been observed impacting important habitats such as creeklines and habitats associated with pools of surface water.

Introduced predators recorded in 2018 included the Dog/Dingo and the Feral Cat. The Dog/Dingo appears to have been present at all sites in relatively small numbers. The majority of evidence in the form of tracks was recorded from eight Greater Bilby occupancy sites, although the actual number of individuals present is unknown (Appendix 9, Figure 3.52). A family of Dog/Dingos were recorded on a motion camera at Christmas Creek with multiple recordings of three pups.

Feral Cat appears to have increased in numbers along the Hamersley Rail, Main Line Rail and North Star (Figure 3.50, Figure 3.51). At the Main Line Rail, individuals were recorded on motion cameras from three culvert sites (MR Cu 4-6), one Greater Bilby abundance site, 13 Greater Bilby occupancy sites and six Red Fox surveillance camera sites located in 2018 (Figure 3.52, Appendix 9). The number of culvert sites has varied between the years and the number of trap nights due to completing its original target to record conservation significant species utilising culverts. More recently, these sites have then been used to give an indication for Feral Cat numbers and Red Fox Surveillance. Despite the variation in trap night numbers, Figure 3.51 shows that Feral Cat numbers have increased at the Hamersley Rail Line, Main Line Rail and North Star in comparison to trapping effort.

At the North Star mine, four individual Feral Cats were recorded from four motion cameras at North Star mine in 2018. This is an increase since 2016, when the species was recorded from two motion camera sites. No camera traps were used in 2017. An additional 10 long-term cameras were installed as part of the Felixer baseline study in 2018 which recorded an additional four individual Feral Cats from site (included in the total of eight individuals shown in Figure 3.50). A total of 24 individuals were identified during additional data analysis associated with the Felixer project (Spectrum Ecology, 2018).

Feral Cats were recorded from four culvert sites located along the Hamersley Rail Line in 2018. One individual was trapped at site HL NQ I3. Feral Cat records per trap night have increased since the start of the monitoring (Figure 3.51). It is not known if this increase is a response to the bush fire that occurred on site in 2015 or if other components play a role, such as the linear infrastructure allowing easier movement through the region as suggested in some previous studies (Doherty, Bengsen and Davis, 2014; Raiter, 2016). The Feral Cat is a known threat to native wildlife including threatened species (Dunlop, 2017; DotEE 2018a) and control measure and management are advisable. However, due to a high level of environmental management currently in place and the lack of Feral Cat supporting infrastructure (such as waste dumps), additional control measures may be limited to direct controls such as trapping or baiting.

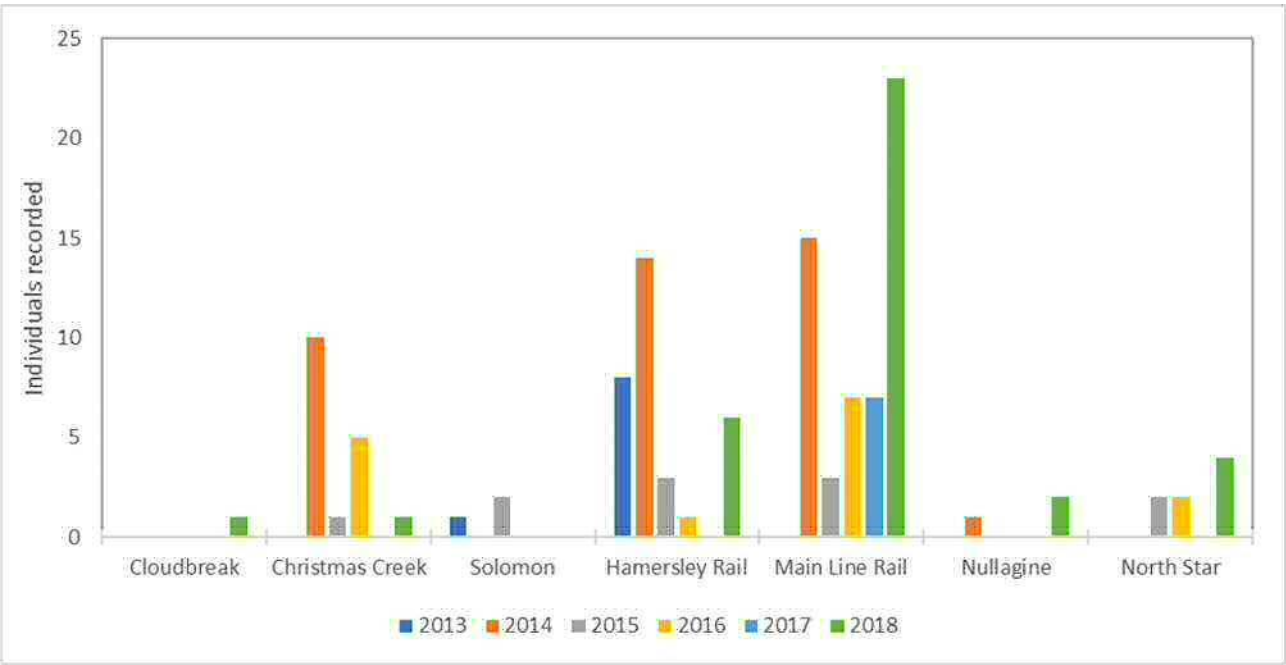

Figure 3.50: Feral Cat records across all sites

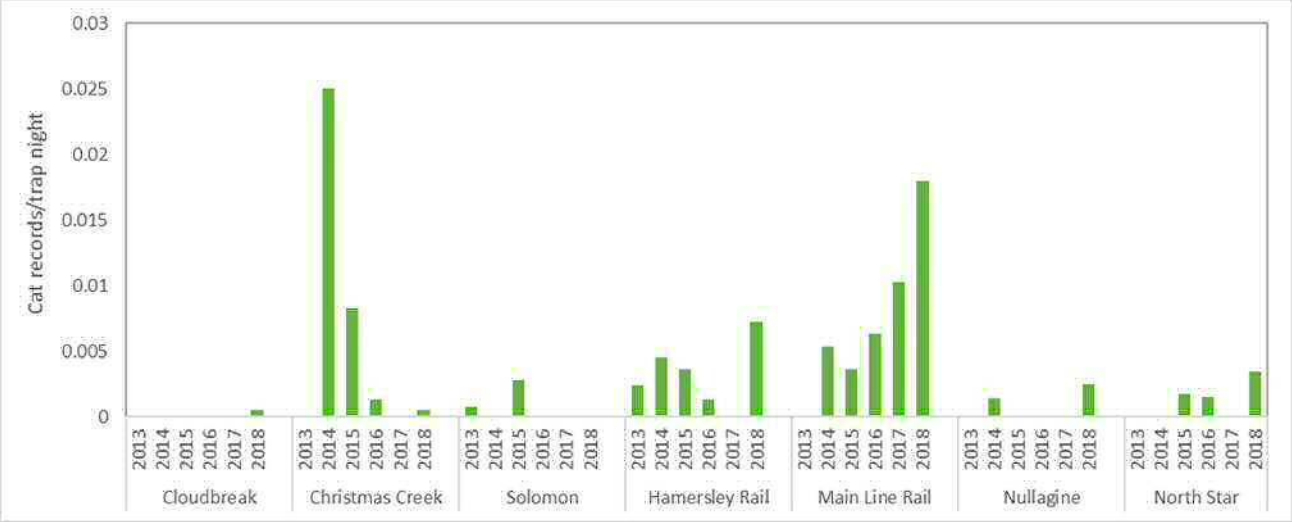

Figure 3.51: Number of Feral Cat records in relation to survey effort

Table 3.19: Introduced Fauna recorded from each project area

Species	Cloudbreak		Christmas Creek		Solomon Hub		Hamersley Rail Line		Main Line Rail		Nullagine		North Star	
	To date	2018	To date	2018	To date	2018	To date	2018	To date	2018	To date	2018	To date	2018
Rabbit (*Oryctolagus cuniculus*)	•		•							•				
House Mouse (*Mus musculus*)					•	•	•							
Feral Cat (*Felis catus*)		•	•	•	•	•	•	•	•	•		•	•	•
Dog/Dingo (*Canis lupus*)	•		•				•		•	•			•	•
European Cattle (*Bos taurus*)	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Donkey (*Equus asinus*)							•		•	•				
Horse (*Equus caballus*)			•				•							
Camel (*Camelus dromedaries*)										•			•	•

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ABORIGINAL

RESERVE

MILLSTREAM CHICHESTER NATIONAL PARK

CHICHESTER RANGE

MUNGAROONA RANGE NATURE RESERVE

PILBARA

HAMERSLEY RANGE

KARIJINI NATIONAL PARK

HANCOCK RANGE

FORTESCUE MARSH

SANDY DESERT

Legend

- Cloudbreak
- Christmas Creek
- Solomon
- Hamersley Rail Line
- Main Line Rail
- Nullagine
- North Star

Feral Records

- Dingo/Dog (Motion Camera)
- Dingo/Dog (Secondary evidence)
- Dingo/Dog (Sighting)
- Feral Cat (Capture)
- Feral Cat (Motion Camera)
- Feral Cat (Secondary evidence)
- Feral Cat (Sighting)

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Scale 1:1000000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: MM Approved: DC Date: 13-05-2019

Feral Predator Records

Fauna Monitoring 2018

Figure

Prepared for
Fortescue Metals Group

3.52

3.12. Red Fox Surveillance

Surveillance monitoring for the presence and potential appearance of Red Fox along the Main Line Rail from 20 sites (10 surveillance and 10 culverts points) did not record any evidence of the Red Fox. Feral Cats were recorded from six Red Fox monitoring sites (Appendix 9). Anecdotal records exist from the Main Line Rail at Chainage 220 and from Chainage 39. Some sightings have been reported from along the coast near Port Hedland and along the Great Northern Highway approximately 90 km south of Port Hedland (DPaW 2019).

During the desktop assessment in 2017 the presence of rabbits was identified as one of the key requirements for the Red Fox dispersal and presence (Ecoscape 2018b). During the current monitoring, secondary evidence of the rabbit (scats) was recorded from one site during the Greater Bilby monitoring (MR GB OS36) which is located north of Chainage 220. Control measures may be considered and implemented; however, the occurrence of Rabbits is likely dependent on adequate food resources (herbs and grasses). Rabbits have been recorded from around the Fortescue Marsh where the is an increased availability of food resources (DPaW 2019). Red Fox have not been previously recorded from along the Main Line Rail and are relatively rarely recorded along the coast near Port Hedland (DPaW 2019). Future surveillance may identify the presence of Red Fox along the Main Line Rail if climatic conditions or the availability of suitable prey species increases.

3.13. Limitations

No significant limitations were identified during the 2018 monitoring. Three Northern Quoll monitoring sites at the North Star mine site were closed early due to the repeated capture of individuals which is an ethical consideration highlighted in the Northern Quoll guidelines which requires the closure of traps if one or more individuals are captured more than twice (CoA 2016). NS NQ C4 was closed after four nights of trapping, NS NQ C1 was closed after five nights and NS NQ I4 was closed after six nights of trapping (Table 5.3 in Appendix 4).

Half of the Solomon Hub monitoring site SM NQ I3 was relocated in 2018 to an area adjacent to the monitoring site due to restricted access to the top of 'The Joff' mesa. Traps were relocated to the bottom of the hill (along the access track) where access was possible (Figure 3.53) (new trap locations in brown, old trap locations in blue).

One bat monitoring site (SM Bat I5) was relocated at the Solomon Hub due to the construction of Fredericks Haul Road and the inaccessibility of the site. The site was relocated to an area adjacent to Kangi camp where access is very likely to continue in the future.

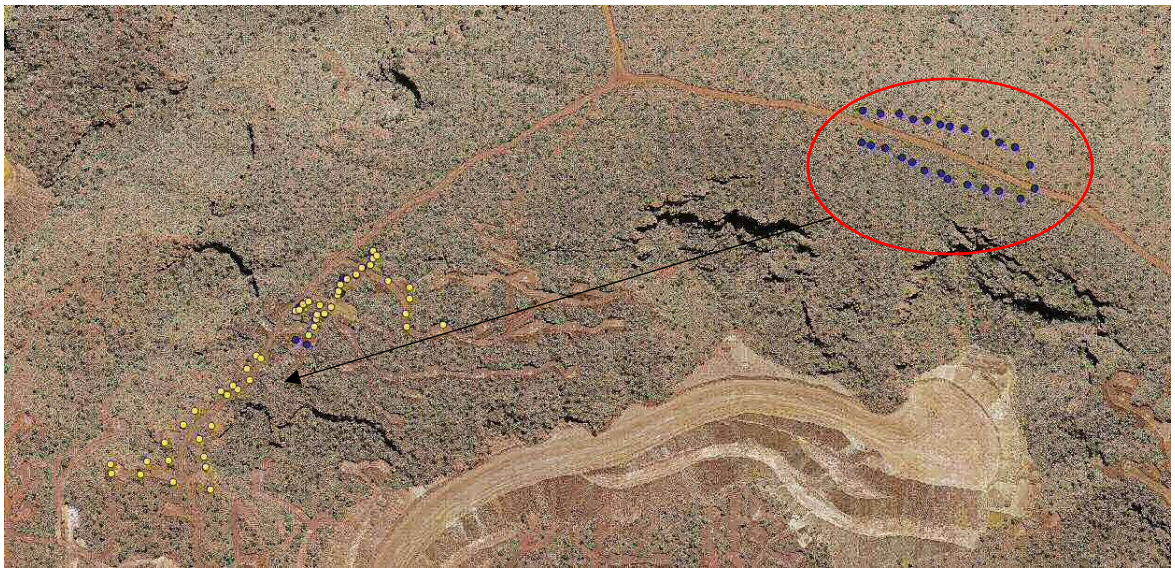

Figure 3.53: Relocation of traps at SM NQ I3 in 2018

4. COMPLIANCE WITH FAUNA MANAGEMENT PLANS

4.1. Fortescue's Operational Sites

Compliance with each hypothesis of the CSFMP at the projects is summarised in Table 4.1 and Table 4.2.

The Red Fox surveillance along the Main Line Rail is not subject of the hypothesis of the FMP and is therefore excluded from this table.

The number of recorded Northern Quolls from the Nullagine Mine site indicate the possible presence of a resident population which if confirmed, would trigger the actions outlined in section 6.5.2 of the NQMMP requiring additional monitoring in the future (BC Iron Nullagine, 2016a). Actions proposed in the NQMMP include the installation of additional motion cameras in areas where likely resident quolls have been identified and the completion of additional searches for secondary evidence (BC Iron Nullagine, 2016a). Additional monitoring will be required to confirm the presence of a resident population.

Table 4.1: Compliance with hypotheses/objectives of CSFMP - Fortescue Operational Sites

Project/Species	H1: No statistically significant reduction in spatial distribution	H2: No statistically significant decline in relative abundance across impact sites vs control sites	H3: Conservation significant fauna species recorded inside the impact area continue to be present	Fauna usage of rehabilitation sites	Fauna usage of culvert sites
Cloudbreak					
Northern Quoll (M45/1142)	Tenement M45/1142 is outside Cloudbreak and species is not covered under FMP for Cloudbreak mine site.			Rehabilitation sites are used by common species. Sites outside mapped critical habitat	n/a
Conservation significant birds	Insufficient data, no records made during monitoring events.	Insufficient data, no records made during monitoring events.	Insufficient data, conservation significant birds not recorded from potential impact sites. Opportunistic records persist (mine voids).		
Christmas Creek					
Northern Quoll	Species absent from site – hypothesis cannot be addressed.			Rehabilitation sites are used by common species. Sites outside mapped critical habitat	n/a
Greater Bilby	Possibly satisfied - Detection level very low; populations occur outside mining tenements; very low number of individuals occur on very irregular basis on site.				
Pilbara Leaf-nosed Bat	Species absent from site – hypothesis cannot be addressed.			n/a	
Ghost Bat	Species absent from site – hypothesis cannot be addressed.			n/a	
Pilbara Olive Python	Partially satisfied - no records made during monitoring events to date. Sporadic records from site personnel consistent – insufficient data to address H1.	Partially satisfied - no records made during monitoring events to date. Sporadic records from site personnel consistent – insufficient data to address H2.	Satisfied – records made by site personnel persist.	n/a	

Project/Species	H1: No statistically significant reduction in spatial distribution	H2: No statistically significant decline in relative abundance across impact sites vs control sites	H3: Conservation significant fauna species recorded inside the impact area continue to be present	Fauna usage of rehabilitation sites	Fauna usage of culvert sites
Conservation significant birds	Insufficient data, no records made during monitoring events.	Insufficient data, no records made during monitoring events.	Insufficient data, conservation significant birds not recorded from potential impact sites. Opportunistic records persist (mine voids).	n/a	
Solomon Hub					
Northern Quoll	Satisfied – species occurs in consistent areas.	Satisfied – increased abundance in areas of impact.	Satisfied – species continues to be present.	Northern Quoll recorded from one rehabilitation sites. Remaining sites are outside mapped critical habitat	n/a
Pilbara Olive Python	Satisfied – species occurs in similar areas.	Satisfied – no changes in abundance.	Satisfied – species continues to be present (including breeding).	Sites are outside mapped critical habitat	
Pilbara Leaf-nosed Bat	Insufficient data, very few records made during monitoring events. Data suggests no reduction.	Insufficient data, very few records made during monitoring events. Data suggests no reduction.	Satisfied – species continues to be present on site. No data collected to date that is indicative of roosting.		
Ghost Bat	Insufficient data, few recordings of the species due to limitation of detection methods. Continued records suggest no reduction.	Insufficient data, few recordings of the species due to limitation of detection methods. Continued records suggest no reduction.	Satisfied – species continues to be present on site and potentially roosting.		

Project/Species	H1: No statistically significant reduction in spatial distribution	H2: No statistically significant decline in relative abundance across impact sites vs control sites	H3: Conservation significant fauna species recorded inside the impact area continue to be present	Fauna usage of rehabilitation sites	Fauna usage of culvert sites
Conservation significant birds	No records made from monitoring sites.	No records made from monitoring sites.	Insufficient records from monitoring sites.		
Hamersley Rail Line					
Northern Quoll	Not Satisfied - Species declined in distribution and abundance since 2016. Likely due to bushfires in 2015 and increased number of Feral Cats on site. Climatic conditions were favourable in 2017 and 2018. It is unlikely that the species has been directly impacted by the operation of the rail.			Rehabilitation sites are used by common species. Sites outside mapped critical habitat	Increased Feral Cat abundance. No conservation significant fauna recorded in 2018.
Conservation significant birds	Insufficient data - no records made during monitoring events.	Insufficient data - no records made during monitoring events.	Conservation significant birds not recorded from potential impact sites. Opportunistic records indicate continued presence (Grey Falcon).		n/a
Main Line Rail					
Northern Quoll	Satisfied – no significant change in spatial distribution.	Satisfied – increased abundance in 2017, consistent abundance since 2017.	Satisfied – species continues to be present.	Rehabilitation sites are suitable for generalist species. Sites outside mapped critical habitat.	Northern Quoll recorded using culverts.
Greater Bilby	Satisfied – no change in spatial distribution in areas of impact.	Satisfied – no change in abundance at potential impact sites.	Satisfied – species continues to be present.		No record of Greater Bilby to use culvert to date.

Project/Species	H1: No statistically significant reduction in spatial distribution	H2: No statistically significant decline in relative abundance across impact sites vs control sites	H3: Conservation significant fauna species recorded inside the impact area continue to be present	Fauna usage of rehabilitation sites	Fauna usage of culvert sites
Pilbara Leaf-nosed Bat	Satisfied – no change in spatial distribution in areas of impact, foraging habitat only.	Satisfied – no change in abundance (activity levels) at potential impact sites, species active at a comparable number of sites, foraging habitat only.	Satisfied – species continues to be present (foraging only).	n/a	n/a
Ghost Bat	Satisfied – data suggests no change in spatial distribution in areas of impact, foraging habitat only.	Satisfied – data suggests no change in abundance at potential impact sites, foraging habitat only.	Satisfied – species continues to be present (foraging only).	n/a	Ghost Bat uses culverts as feeding ground on permanent basis.
Conservation significant birds	No records made from monitoring sites.	No records made from monitoring sites.	Insufficient records from monitoring sites. Opportunistic records persist (Grey Falcon).	n/a	n/a

Table 4.2: Compliance with Objectives of NQMMP - Nullagine

Project/Species	O1: Monitor Northern Quoll and potential impacts	O2: Add to regional ecological knowledge of NQ	O3: Assess how the species responds to rehabilitation measures
Northern Quoll	Northern Quoll population increased significantly in 2018. Data strongly suggests that residents are present and additional monitoring (cameras and searches) is recommended post wet season. Potential impacts are minimal as the mine site is currently in care and maintenance. Results indicate no impact on Northern Quolls to date.	Northern Quoll population located in an area that was not monitored otherwise. Potentially resident population discovered as part of this monitoring. Additional monitoring methods will confirm if a resident population exists. Outcomes of additional research to be determined.	Rehabilitated areas are not currently monitored.

4.2. Iron Bridge's North Star

The compliance with each hypothesis of the TSFMP at North Star is summarised below (Table 4.3).

The number of Northern Quolls appear to have undergone a short-term decline based on statistical analysis of the trapping data. One theory is that the Northern Quoll population size at the potential impact sites may be impacted by the increased number of Feral Cats. In addition, a bush fire impacted the potential impact sites and southern control sites NS NQ C1 and NS NQ C2 in July 2018 (approximately 1 month prior to monitoring) (NAFI 2018). Overall, environmental conditions were favourable in 2017 and 2018 with above average rainfall recorded.

Table 4.3: Compliance with Hypotheses of TFMP – North Star

Project/Species	H1: No long-term statistically significant decline in relative abundance of NQ across impact sites vs control sites	H2: EPBC listed species previously recorded within area of impact continue to be present
Northern Quoll	Potential decline has been identified at the impact areas, likely due to increase of Feral Cat activity and/or recent fires across the impact areas and southern control sites. Spatial distribution appears to be consistent with 2014 and 2015 monitoring. Impacts from the mine are unlikely as the mining activities on site have been significantly reduced since 2016	Satisfied – species persists
Pilbara Olive Python	H1 does not apply to Pilbara Olive Pythons	Satisfied – species persists on site in comparable numbers
Pilbara Leaf-nosed Bat	H1 does not apply to Pilbara Leaf-nosed Bats	Species continues to be present on site

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Appendix 1: Site Locations

Table 5.1: Monitoring Site Locations

Site Name	Site Type	Easting	Northing	Details
Northern Quoll Control Sites				
DBCA				
Indee Station	Northern Quoll Control Site	664996	7690585	50 cage traps over 4 nights
Hooley Station	Northern Quoll Control Site	668179	7563440	7 motion cameras over 3 months
Mt Florance Station	Northern Quoll Control Site	594422	7591931	7 motion cameras over 3 months
Karijini NP (Dales Gorge)	Northern Quoll Control Site	660747	7513634	50 cage traps over 4 nights
Fortescue control sites				
FC NQ C1	Northern Quoll Control Site	588370	7560407	50 cages, 5 MCs over 4 nights
FC NQ C2	Northern Quoll Control Site	590495	7559891	50 cages, 5 MCs over 4 nights
FC NQ C3	Northern Quoll Control Site	583627	7556307	50 cages, 5 MCs over 4 nights
North Star control sites				
NS NQ C1	Northern Quoll Monitoring Site	713436	7646350	25 cages over 7 nights
NS NQ C2	Northern Quoll Monitoring Site	713098	7644804	25 cages over 7 nights
NS NQ C3	Northern Quoll Monitoring Site	713573	7656856	25 cages over 7 nights
NS NQ C4	Northern Quoll Monitoring Site	718106	7655617	25 cages over 7 nights
Conservation Significant Bat Control Sites				
Christmas Creek				
CC Bat C1	Conservation Significant Bats (PLNB & GB)	805203	7524007	1 x ARU for 7 nights
CC Bat C2	Conservation Significant Bats (PLNB & GB)	193732	7510135	1 x ARU for 7 nights
CC Bat C3	Conservation Significant Bats (PLNB & GB)	202156	7501204	1 x ARU for 7 nights
CC Bat C4	Conservation Significant Bats (PLNB & GB)	204831	7502645	1 x ARU for 7 nights
CC Bat C5	Conservation Significant Bats (PLNB & GB)	200823	7499695	1 x ARU for 7 nights
CC Bat C6	Conservation Significant Bats (PLNB & GB)	193931	7510868	1 x ARU for 7 nights
CC Bat C7	Conservation Significant Bats (PLNB & GB)	805636	7524319	1 x ARU for 7 nights
CC Bat C8	Conservation Significant Bats (PLNB & GB)	803612	7526412	1 x ARU for 7 nights
CC Bat C9	Conservation Significant Bats (PLNB & GB)	802947	7527915	1 x ARU for 7 nights
CC Bat C10	Conservation Significant Bats (PLNB & GB)	802748	7530597	1 x ARU for 7 nights
CC Bat C11	Conservation Significant Bats (PLNB & GB)	802795	7528482	1 x ARU for 7 nights
CC Bat C12	Conservation Significant Bats (PLNB & GB)	191239	7516517	1 x ARU for 7 nights
Solomon Hub				
SM Bat C1	Conservation Significant Bats (PLNB & GB)	601547	7538247	1 x ARU for 7 nights
SM Bat C2	Conservation Significant Bats (PLNB & GB)	571541	7539027	1 x ARU for 7 nights
SM Bat C3	Conservation Significant Bats (PLNB & GB)	547166	7536913	1 x ARU for 7 nights
SM Bat C4	Conservation Significant Bats (PLNB & GB)	547214	7537420	1 x ARU for 7 nights
SM Bat C5	Conservation Significant Bats (PLNB & GB)	571799	7544634	1 x ARU for 7 nights
SM Bat C6	Conservation Significant Bats (PLNB & GB)	572692	7546865	1 x ARU for 7 nights
SM Bat C7	Conservation Significant Bats (PLNB & GB)	563809	7531641	1 x ARU for 7 nights
SM Bat C8	Conservation Significant Bats (PLNB & GB)	588929	7556482	1 x ARU for 7 nights
SM Bat C9	Conservation Significant Bats (PLNB & GB)	574977	7538119	1 x ARU for 7 nights
SM Bat C10	Conservation Significant Bats (PLNB & GB)	599880	7540825	1 x ARU for 7 nights

Site Name	Site Type	Easting	Northing	Details
SM Bat C11	Conservation Significant Bats (PLNB & GB)	600908	7537687	1 x ARU for 7 nights
SM Bat C12	Conservation Significant Bats (PLNB & GB)	601796	7544314	1 x ARU for 7 nights
Main Line Rail				
MR Bat C1	Conservation Significant Bats (PLNB & GB)	795870	7519181	1 x ARU for 7 nights
MR Bat C2	Conservation Significant Bats (PLNB & GB)	776353	7525491	1 x ARU for 7 nights
MR Bat C3	Conservation Significant Bats (PLNB & GB)	762541	7525641	1 x ARU for 7 nights
MR Bat C4	Conservation Significant Bats (PLNB & GB)	800663	7517005	1 x ARU for 7 nights
MR Bat C5	Conservation Significant Bats (PLNB & GB)	798497	7517639	1 x ARU for 7 nights
MR Bat C6	Conservation Significant Bats (PLNB & GB)	791951	7517007	1 x ARU for 7 nights
MR Bat C7	Conservation Significant Bats (PLNB & GB)	787819	7516252	1 x ARU for 7 nights
MR Bat C8	Conservation Significant Bats (PLNB & GB)	790208	7517532	1 x ARU for 7 nights
MR Bat C9	Conservation Significant Bats (PLNB & GB)	785302	7517861	1 x ARU for 7 nights
MR Bat C10	Conservation Significant Bats (PLNB & GB)	774817	7523238	1 x ARU for 7 nights
MR Bat C11	Conservation Significant Bats (PLNB & GB)	767083	7524495	1 x ARU for 7 nights
MR Bat C12	Conservation Significant Bats (PLNB & GB)	764015	7525175	1 x ARU for 7 nights
North Star				
NS PLNB C1	PLNB monitoring site	713251	7645461	1 x ARU for 4 nights
NS PLNB C2	PLNB monitoring site	713434	7643381	1 x ARU for 4 nights
Pilbara Olive Python Control Sites				
Christmas Creek				
CC POP C1	Pilbara Olive Python monitoring site	775880	7556395	Nocturnal searches for 7 nights
CC POP C2	Pilbara Olive Python monitoring site	785545	7553911	Nocturnal searches for 7 nights
CC POP C3	Pilbara Olive Python monitoring site	789497	7555277	Nocturnal searches for 7 nights
CC POP C4	Pilbara Olive Python monitoring site	793650	7553058	Nocturnal searches for 7 nights
Solomon Hub				
SM POP C1	Pilbara Olive Python monitoring site	601607	7538288	Nocturnal searches for 7 nights
SM POP C2	Pilbara Olive Python monitoring site	574716	7541803	Nocturnal searches for 7 nights
SM POP C3	Pilbara Olive Python monitoring site	547051	7537533	Nocturnal searches for 7 nights
North Star				
NS POP C1	Pilbara Olive Python monitoring site	712586	7655834	Nocturnal searches for 6 nights
NS POP C2	Pilbara Olive Python monitoring site	714541	7655513	Nocturnal searches for 6 nights
NS POP C3	Pilbara Olive Python monitoring site	713209	7657188	Nocturnal searches for 6 nights
NS POP C4	Pilbara Olive Python monitoring site	718288	7655586	Nocturnal searches for 6 nights
Conservation Significant Bird Control Sites				
Chichester Hub				
CB/CC MiB C1	Conservation Significant Birds	784372	7507872	20 minutes bird survey
CB/CC MiB C2	Conservation Significant Birds	804850	7492836	20 minutes bird survey
CB/CC MiB C3	Conservation Significant Birds	794452	7503100	20 minutes bird survey
CB/CC MiB C4	Conservation Significant Birds	793650	7553058	20 minutes bird survey
CB/CC MiB C5	Conservation Significant Birds	791592	7553224	20 minutes bird survey
CB/CC MiB C6	Conservation Significant Birds	775767	7556499	20 minutes bird survey
Solomon Hub				
SM MiB C1	Conservation Significant Birds	590610	7559785	20 minutes bird survey
SM MiB C2	Conservation Significant Birds	589665	7558887	20 minutes bird survey

Site Name	Site Type	Easting	Northing	Details
SM MiB C3	Conservation Significant Birds	572512	7546766	20 minutes bird survey
Hamersley Rail				
HL MiB C1	Conservation Significant Birds	646178	7569894	20 minutes bird survey
HL MiB C2	Conservation Significant Birds	688763	7589596	20 minutes bird survey
HL MiB C3	Conservation Significant Birds	689343	7598875	20 minutes bird survey
Main Line Rail				
MR MiB C1	Conservation Significant Birds	654404	7730055	20 minutes bird survey
MR MiB C2	Conservation Significant Birds	677450	7651200	20 minutes bird survey
MR MiB C3	Conservation Significant Birds	658031	7704864	20 minutes bird survey
Cloudbreak				
CB NQ I1	Northern Quoll monitoring	744180	7532841	10 LT MCs (3 months) and searches
CB NQ I2	Northern Quoll monitoring	745826	7532417	10 LT MCs (3 months) and searches
CB NQ I3	Northern Quoll monitoring	748466	7531717	10 MCs (4 nights) and searches
CB Re 05	Rehabilitation Site	748902	7528856	1 MC and searches
CB Re Cocos WD1	Rehabilitation Site	758142	7527251	1 MC and searches
CB Re Cocos WD2	Rehabilitation Site	758165	7527259	1 MC and searches
CB MiB I1	Conservation Significant Birds	752146	7520886	20 minutes bird survey
CB MiB I2	Conservation Significant Birds	740165	7525365	20 minutes bird survey
CB MiB I3	Conservation Significant Birds	733727	7529757	20 minutes bird survey
Christmas Creek				
CC NQ I1	Northern Quoll monitoring	768257	7523639	10 MCs (4 nights) and searches
CC NQ I2	Northern Quoll monitoring	791498	7525156	10 LT MCs (3 months) and searches
CC NQ I3	Northern Quoll monitoring	800916	7517216	10 LT MCs (3 months) and searches
CC Re 01	Rehabilitation Site	774789	7525354	1 MC and searches
CC Re 02	Rehabilitation Site	772741	7524428	1 MC and searches
CC Re VAS 01	Rehabilitation Site	781264	7526431	1 MC and searches
CC GB OS 01	Greater Bilby Occupancy site (dry season)	764101	7518887	Searches
CC GB OS 02	Greater Bilby Occupancy site (dry season)	784419	7510023	Searches
CC GB OS 03	Greater Bilby Occupancy site (dry & wet season)	795406	7518979	Searches
CC GB OS 04	Greater Bilby Occupancy site (dry season)	771147	7519643	Searches
CC GB OS 05	Greater Bilby Occupancy site (dry season)	776267	7514208	Searches
CC GB OS 06	Greater Bilby Occupancy site (dry season)	770283	7517266	Searches
CC GB OS 07	Greater Bilby Occupancy site (dry & wet season)	768337	7517720	Searches
CC GB OS 08	Greater Bilby Occupancy site (dry season)	771977	7524199	Searches
CC GB OS 09	Greater Bilby Occupancy site (dry & wet season)	775587	7524055	Searches
CC GB OS 10	Greater Bilby Occupancy site (dry & wet season)	764101	7518887	Searches
CC GB OS 11	Greater Bilby Occupancy site (dry season)	776267	7514208	Searches
CC GB OS 12	Greater Bilby Occupancy site (dry season)	777966	7519653	Searches
CC GB OS 13	Greater Bilby Occupancy site (dry & wet season)	781855	7519233	Searches
CC GB OS 14	Greater Bilby Occupancy site (dry season)	780675	7518041	Searches
CC GB OS 15	Greater Bilby Occupancy site (dry season)	779549	7516335	Searches

Site Name	Site Type	Easting	Northing	Details
CC GB OS 16	Greater Bilby Occupancy site (dry season)	779756	7513217	Searches
CC GB OS 17	Greater Bilby Occupancy site (dry & wet season)	782490	7515924	Searches
CC GB OS 18	Greater Bilby Occupancy site (dry & wet season)	785442	7517801	Searches
CC GB OS 19	Greater Bilby Occupancy site (dry & wet season)	784551	7514706	Searches
CC GB OS 20	Greater Bilby Occupancy site (dry & wet season)	765401	7522271	Searches
CC GB OS 21	Greater Bilby Occupancy site (dry season)	783182	7510356	Searches
CC GB OS 22	Greater Bilby Occupancy site (dry & wet season)	788486	7512306	Searches
CC GB OS 23	Greater Bilby Occupancy site (dry & wet season)	787834	7516200	Searches
CC GB OS 24	Greater Bilby Occupancy site (dry season)	790696	7518513	Searches
CC GB OS 25	Greater Bilby Occupancy site (dry season)	790895	7520573	Searches
CC GB OS 26	Greater Bilby Occupancy site (dry & wet season)	792419	7517203	Searches
CC GB OS 27	Greater Bilby Occupancy site (dry & wet season)	793844	7515467	Searches
CC GB OS 28	Greater Bilby Occupancy site (dry & wet season)	794205	7511051	Searches
CC GB OS 29	Greater Bilby Occupancy site (dry & wet season)	795406	7518979	Searches
CC GB OS 30	Greater Bilby Occupancy site (dry season)	796660	7521386	Searches
CC GB OS 31	Greater Bilby Occupancy site (Roy Hill tenement)	802504	7507219	Searches
CC BAT I1	Conservation significant bat site	795870	7519181	1 x ARU for 7 nights
CC BAT I2	Conservation significant bat site	776353	7525491	1 x ARU for 7 nights
CC BAT I3	Conservation significant bat site	762541	7525641	1 x ARU for 7 nights
CC BAT I4	Conservation significant bat site	800663	7517005	1 x ARU for 7 nights
CC BAT I5	Conservation significant bat site	798497	7517639	1 x ARU for 7 nights
CC BAT I6	Conservation significant bat site	791951	7517007	1 x ARU for 7 nights
CC BAT I7	Conservation significant bat site	787819	7516252	1 x ARU for 7 nights
CC BAT I8	Conservation significant bat site	790208	7517532	1 x ARU for 7 nights
CC BAT I9	Conservation significant bat site	785302	7517861	1 x ARU for 7 nights
CC BAT I10	Conservation significant bat site	774817	7523238	1 x ARU for 7 nights
CC BAT I11	Conservation significant bat site	767083	7524495	1 x ARU for 7 nights
CC BAT I12	Conservation significant bat site	764015	7525175	1 x ARU for 7 nights
CC POP I1	Pilbara Olive Python monitoring site	760101	7525314	Nocturnal searches for 7 nights
CC POP I2	Pilbara Olive Python monitoring site	773786	7523248	Nocturnal searches for 7 nights
CC POP I3	Pilbara Olive Python monitoring site	781779	7519004	Nocturnal searches for 7 nights
CC POP I4	Pilbara Olive Python monitoring site	795860	7519042	Nocturnal searches for 7 nights
Solomon Hub				
SM NQ I1	Northern Quoll monitoring	590555	7555578	50 cages, 5 MCs over 4 nights
SM NQ I2	Northern Quoll monitoring	589673	7554272	50 cages, 5 MCs over 4 nights
SM NQ I3	Northern Quoll monitoring	593431	7554949	50 cages, 5 MCs over 4 nights
SM Re 06	Rehabilitation Site	589783	7554092	1 MC, searches
SM Re 10	Rehabilitation Site	599259	7552177	1 MC, searches
SM Re 11	Rehabilitation Site	598377	7551853	1 MC, searches
SM POP I1	Pilbara Olive Python monitoring site	590162	7554805	Nocturnal searches for 7 nights
SM POP I2	Pilbara Olive Python monitoring site	589100	7553518	Nocturnal searches for 7 nights
SM POP I3	Pilbara Olive Python monitoring site	596668	7546469	Nocturnal searches for 7 nights
SM MiB I1	Conservation significant bird site	590526	7555667	20 minutes searches
SM MiB I2	Conservation significant bird site	589396	7553859	20 minutes searches

Site Name	Site Type	Easting	Northing	Details
SM MiB I3	Conservation significant bird site	596184	7546647	20 minutes searches
SM Bat I1	Conservation significant bat site	586863	7550251	1 x ARU for 7 nights
SM Bat I2	Conservation significant bat site	580680	7551311	1 x ARU for 7 nights
SM Bat I3	Conservation significant bat site	590379	7556082	1 x ARU for 7 nights
SM Bat I4	Conservation significant bat site	580599	7552811	1 x ARU for 7 nights
SM Bat I5	Conservation significant bat site	592138	7543529	1 x ARU for 7 nights
SM Bat I6	Conservation significant bat site	586148	7548516	1 x ARU for 7 nights
SM Bat I7	Conservation significant bat site	582503	7541580	1 x ARU for 7 nights
SM Bat I9	Conservation significant bat site	587903	7548878	1 x ARU for 7 nights
SM Bat I10	Conservation significant bat site	590831	7555243	1 x ARU for 7 nights
SM Bat I11	Conservation significant bat site	596157	7546582	1 x ARU for 7 nights
SM Bat I12	Conservation significant bat site	595823	7546955	1 x ARU for 7 nights
Hamersley Rail Line				
HL NQ I1	Northern Quoll monitoring	694647	7577143	50 cages, 5 MC over 4 nights
HL NQ I2	Northern Quoll monitoring	686430	7566458	50 cages, 5 MC over 4 nights
HL NQ I3	Northern Quoll monitoring	681031	7561782	50 cages, 5 MC over 4 nights
HL Re 63	Rehabilitation Site	606745	7546194	1 MC, searches
HL Re 74	Rehabilitation Site	642821	7561263	1 MC, searches
HL Re 87	Rehabilitation Site	686970	7566681	1 MC, searches
HL Cu 01	Culvert Monitoring	700703	7583200	1 MC over 30 days, searches
HL Cu 02	Culvert Monitoring	700703	7583170	1 MC over 30 days, searches
HL Cu 03	Culvert Monitoring	700561	7582773	1 MC over 30 days, searches
HL Cu 04	Culvert Monitoring	700562	7582778	1 MC over 30 days, searches
HL Cu 05	Culvert Monitoring	681042	7561816	1 MC over 30 days, searches
HL Cu 06	Culvert Monitoring	681036	7561814	1 MC over 30 days, searches
HL NQ LT MC 01	Long-term Northern Quoll Motion Camera	694348	7577619	1 MC over 3 months, MC60
HL NQ LT MC 02	Long-term Northern Quoll Motion Camera	694359	7577578	1 MC over 3 months, MC61
HL NQ LT MC 03	Long-term Northern Quoll Motion Camera	687349	7567185	1 MC over 3 months, MC68
HL NQ LT MC 04	Long-term Northern Quoll Motion Camera	687429	7567216	1 MC over 3 months, MC69
HL NQ LT MC 05	Long-term Northern Quoll Motion Camera	686588	7566910	1 MC over 3 months, MC63
HL NQ LT MC 06	Long-term Northern Quoll Motion Camera	686574	7567031	1 MC over 3 months, MC62
HL NQ LT MC 07	Long-term Northern Quoll Motion Camera	686529	7566562	1 MC over 3 months, MC64
HL NQ LT MC 08	Long-term Northern Quoll Motion Camera	680558	7561782	1 MC over 3 months, MC65
HL NQ LT MC 09	Long-term Northern Quoll Motion Camera	680386	7561496	1 MC over 3 months, MC66
HL NQ LT MC 10	Long-term Northern Quoll Motion Camera	680280	7561500	1 MC over 3 months, MC67
HL MiB I1	Conservation significant bird site	680568	7561821	20 minutes searches
HL MiB I2	Conservation significant bird site	686560	7566910	20 minutes searches
HL MiB I3	Conservation significant bird site	694972	7576498	20 minutes searches
Main Line Rail				
MR NQ I1	Northern Quoll monitoring	674438	7686309	50 cages, 5 MCs over 4 nights
MR NQ I2	Northern Quoll monitoring	675989	7680654	50 cages, 5 MCs over 4 nights
MR NQ I3	Northern Quoll monitoring	677097	7674953	50 cages, 5 MCs over 4 nights
MR Cu 01	Culvert	692867	7634878	1 MC over 30 days, searches
MR Cu 02	Culvert	685705	7650710	1 MC over 30 days, searches

Site Name	Site Type	Easting	Northing	Details
MR Cu 03	Culvert	694952	7593164	1 MC over 30 days, searches
MR Cu 04	Culvert	675256	7682298	1 MC over 30 days, searches
MR Cu 05	Culvert	694480	7628790	1 MC over 30 days, searches
MR Cu 06	Culvert	709501	7572421	1 MC over 30 days, searches
MR Cu 07	Culvert	695248	7626242	1 MC over 30 days, searches
MR Cu 08	Culvert	696138	7622709	1 MC over 30 days, searches
MR Cu 09	Culvert	667690	7704540	1 MC over 30 days, searches
MR Cu 10	Culvert	666505	7708560	1 MC over 30 days, searches
MR Re 01	Rehabilitation Site	684792	7654808	1 MC, searches
MR Re 37	Rehabilitation Site	694150	7594920	1 MC, searches
MR Re 92	Rehabilitation Site	703012	7577854	1 MC, searches
MR GB AS I14	Greater Bilby Abundance Site	693132	7635001	Scat Searches, DNA collections, Food plots
MR GB AS I14.MC1	Greater Bilby Abundance Site – MC1	693364	7635487	1 MC for 3 months
MR GB AS I14.MC2	Greater Bilby Abundance Site – MC2	692955	7635026	1 MC for 3 months
MR GB AS I14.MC3	Greater Bilby Abundance Site – MC3	693129	7634797	1 MC for 3 months
MR GB AS I14.MC4	Greater Bilby Abundance Site – MC4	693594	7635025	1 MC for 3 months
MR GB AS C16	Greater Bilby Abundance Site	744994	7606827	Scat Searches, DNA collections, Food plots
MR GB AS C16.MC1	Greater Bilby Abundance Site – MC1	745076	7607851	1 MC for 3 months
MR GB AS C16.MC2	Greater Bilby Abundance Site – MC2	744422	7607566	1 MC for 3 months
MR GB AS C16.MC3	Greater Bilby Abundance Site – MC3	745270	7607016	1 MC for 3 months
MR GB AS C16.MC4	Greater Bilby Abundance Site – MC4	744749	7605899	1 MC for 3 months
MR GB OS 01	Greater Bilby Occupancy site (dry & wet season)	664978	7738793	Searches
MR GB OS 02	Greater Bilby Occupancy site (dry & wet season)	666011	7734412	Searches
MR GB OS 03	Greater Bilby Occupancy site (dry & wet season)	665811	7728810	Searches
MR GB OS 04	Greater Bilby Occupancy site (dry & wet season)	665346	7724914	Searches
MR GB OS 05	Greater Bilby Occupancy site (dry & wet season)	665308	7723235	Searches
MR GB OS 06	Greater Bilby Occupancy site (dry & wet season)	665355	7717547	Searches
MR GB OS 07	Greater Bilby Occupancy site (dry & wet season)	666984	7707994	Searches
MR GB OS 08	Greater Bilby Occupancy site (dry & wet season)	668345	7703461	Searches
MR GB OS 09	Greater Bilby Occupancy site (dry & wet season)	671469	7701023	Searches
MR GB OS 10	Greater Bilby Occupancy site (dry & wet season)	677239	7675108	Searches
MR GB OS 11	Greater Bilby Occupancy site (dry season)	677789	7670399	Searches
MR GB OS 12	Greater Bilby Occupancy site (dry & wet season)	681423	7662812	Searches
MR GB OS 13	Greater Bilby Occupancy site (dry & wet season)	682349	7659703	Searches
MR GB OS 14	Greater Bilby Occupancy site (dry season)	683010	7657601	Searches
MR GB OS 15	Greater Bilby Occupancy site (dry & wet season)	686904	7648294	Searches
MR GB OS 16	Greater Bilby Occupancy site (dry season)	690321	7641579	Searches
MR GB OS 17	Greater Bilby Occupancy site (dry season)	693652	7632357	Searches
MR GB OS 18	Greater Bilby Occupancy site (dry season)	695581	7625885	Searches
MR GB OS 19	Greater Bilby Occupancy site (dry season)	697245	7618985	Searches
MR GB OS 20	Greater Bilby Occupancy site (dry season)	697388	7617800	Searches
MR GB OS 21	Greater Bilby Occupancy site (dry season)	697329	7614240	Searches

Site Name	Site Type	Easting	Northing	Details
MR GB OS 22	Greater Bilby Occupancy site (dry & wet season)	697210	7609650	Searches
MR GB OS 23	Greater Bilby Occupancy site (dry & wet season)	696765	7607938	Searches
MR GB OS 24	Greater Bilby Occupancy site (dry & wet season)	696400	7605206	Searches
MR GB OS 25	Greater Bilby Occupancy site (dry season)	695689	7601843	Searches
MR GB OS 26	Greater Bilby Occupancy site (dry & wet season)	694129	7599083	Searches
MR GB OS 27	Greater Bilby Occupancy site (dry season)	694083	7595222	Searches
MR GB OS 28	Greater Bilby Occupancy site (dry season)	698556	7587334	Searches
MR GB OS 29	Greater Bilby Occupancy site (dry season)	699884	7584979	Searches
MR GB OS 30	Greater Bilby Occupancy site (dry & wet season)	701192	7582678	Searches
MR GB OS 31	Greater Bilby Occupancy site (dry season)	702409	7578415	Searches
MR GB OS 32	Greater Bilby Occupancy site (dry & wet season)	704879	7576178	Searches
MR GB OS 33	Greater Bilby Occupancy site (dry & wet season)	708396	7573020	Searches
MR GB OS 34	Greater Bilby Occupancy site (dry season)	713331	7571520	Searches
MR GB OS 35	Greater Bilby Occupancy site (dry season)	725667	7559469	Searches
MR GB OS 36	Greater Bilby Occupancy site (dry season)	727225	7557025	Searches
MR GB OS 37	Greater Bilby Occupancy site (dry season)	730136	7553728	Searches
MR GB OS 38	Greater Bilby Occupancy site (dry season)	731775	7551253	Searches
MR GB OS 39	Greater Bilby Occupancy site (dry season)	734031	7548185	Searches
MR GB OS 40	Greater Bilby Occupancy site (dry season)	736327	7540651	Searches
MR RF MC 01	Red Fox camera	665627	7736516	1 MC, searches
MR RF MC 02	Red Fox camera	665717	7730989	1 MC, searches
MR RF MC 03	Red Fox camera	665282	7724316	1 MC, searches
MR RF MC 04	Red Fox camera	665539	7714402	1 MC, searches
MR RF MC 05	Red Fox camera	668256	7703400	1 MC, searches
MR RF MC 06	Red Fox camera	673722	7689097	1 MC, searches
MR RF MC 07	Red Fox camera	677670	7670689	1 MC, searches
MR RF MC 08	Red Fox camera	678372	7667074	1 MC, searches
MR RF MC 09	Red Fox camera	696814	7606563	1 MC, searches
MR RF MC 10	Red Fox camera	725677	7559715	1 MC, searches
MR MiB I1	Conservation significant bird site	677370	7673848	20 minutes searches
MR MiB I2	Conservation significant bird site	677234	7674941	20 minutes searches
MR MiB I3	Conservation significant bird site	666803	7707622	20 minutes searches
MR Bat I1	Conservation significant bat site	677136	7675074	1 x ARU for 7 nights
MR Bat I2	Conservation significant bat site	677439	7670246	1 x ARU for 7 nights
MR Bat I3	Conservation significant bat site	686046	7650043	1 x ARU for 7 nights
MR Bat I4	Conservation significant bat site	692843	7634865	1 x ARU for 7 nights
MR Bat I5	Conservation significant bat site	695426	7625692	1 x ARU for 7 nights
MR Bat I6	Conservation significant bat site	696139	7622889	1 x ARU for 7 nights
MR Bat I7	Conservation significant bat site	694452	7628789	1 x ARU for 7 nights
MR Bat I9	Conservation significant bat site	695515	7625511	1 x ARU for 7 nights
MR Bat I10	Conservation significant bat site	696784	7606739	1 x ARU for 7 nights
MR Bat I11	Conservation significant bat site	696717	7605210	1 x ARU for 7 nights
MR Bat I12	Conservation significant bat site	695630	7601880	1 x ARU for 7 nights
Nullagine				

Site Name	Site Type	Easting	Northing	Details
NL NQ BE MC 01	Northern Quoll Monitoring Site BCI-11	799381	7558310	1 MC, searches
NL NQ BE MC 02	Northern Quoll Monitoring Site BCI-07	799548	7558173	1 MC, searches
NL NQ BE MC 03	Northern Quoll Monitoring Site BCI-08 south	800323	7558732	1 MC, searches
NL NQ BE MC 04	Northern Quoll Monitoring Site AUD-08	800279	7559322	1 MC, searches
NL NQ BE MC 05	Northern Quoll Monitoring Site BCI-03	800253	7559532	1 MC, searches
NL NQ BE MC 06	Northern Quoll Monitoring Site AUD-4	799785	7559398	1 MC, searches
NL NQ BE MC 07	Northern Quoll Monitoring Site Spypoint	799936	7560051	1 MC, searches
NL NQ BE MC 08	Northern Quoll Monitoring Site AUD-05	799927	7560148	1 MC, searches
NL NQ BE MC 09	Northern Quoll Monitoring Site AUD-02	800582	7560516	1 MC, searches
NL NQ BE MC 10	Northern Quoll Monitoring Site HRC-02	800480	7560254	1 MC, searches
NL NQ W MC 01	Northern Quoll Monitoring Site BCI-04	807543	7563826	1 MC, searches
NL NQ W MC 02	Northern Quoll Monitoring Site BCI-05	808045	7564649	1 MC, searches
NL NQ W MC 03	Northern Quoll Monitoring Site BCI-13	808227	7565028	1 MC, searches
NL NQ W MC 04	Northern Quoll Monitoring Site BCI-10	808805	7565840	1 MC, searches
NL NQ W MC 05	Northern Quoll Monitoring Site BCI-14	808722	7566065	1 MC, searches
NL NQ W MC 06	Northern Quoll Monitoring Site BCI-06	808839	7566397	1 MC, searches
NL NQ W MC 07	Northern Quoll Monitoring Site BCI-12 north	809249	7566879	1 MC, searches
NL NQ W MC 08	Northern Quoll Monitoring Site BCI-09	809615	7567062	1 MC, searches
NL NQ W MC 09	Northern Quoll Monitoring Site BCI-11 north	810506	7566512	1 MC, searches
NL NQ W MC 10	Northern Quoll Monitoring Site BCI-12	810449	7565913	1 MC, searches
North Star				
NS NQ I1	Northern Quoll Monitoring Site	712464	7650155	25 cages over 7 nights
NS NQ I2	Northern Quoll Monitoring Site	712928	7648666	25 cages over 7 nights
NS NQ I3	Northern Quoll Monitoring Site	713238	7647910	25 cages over 7 nights
NS NQ I4	Northern Quoll Monitoring Site	715886	7649262	25 cages over 7 nights
NS RE 01	Rehabilitation Site	713827	7648406	1 MC, searches
NS RE 02	Rehabilitation Site	713584	7644561	1 MC, searches
NS RE 03	Rehabilitation Site	712501	7650606	1 MC, searches
NS RE 04	Rehabilitation Site	713436	7648796	1 MC, searches
NS RE 05	Rehabilitation Site	712998	7649557	1 MC, searches
NS RE 06	Rehabilitation Site	711392	7653577	1 MC, searches
NS RE 07	Rehabilitation Site	697314	7649466	1 MC, searches
NS Fe MC 01	Felixer pre-field Motion camera	712306	7650386	1 MC for 3 months
NS Fe MC 02	Felixer pre-field Motion camera	712498	7650380	1 MC for 3 months
NS Fe MC 03	Felixer pre-field Motion camera	712356	7650300	1 MC for 3 months
NS Fe MC 04	Felixer pre-field Motion camera	712499	7650196	1 MC for 3 months
NS Fe MC 05	Felixer pre-field Motion camera	712620	7650183	1 MC for 3 months
NS Fe MC 06	Felixer pre-field Motion camera	713233	7647998	1 MC for 3 months
NS Fe MC 07	Felixer pre-field Motion camera	713503	7647991	1 MC for 3 months
NS Fe MC 08	Felixer pre-field Motion camera	713483	7647941	1 MC for 3 months
NS Fe MC 09	Felixer pre-field Motion camera	713371	7647871	1 MC for 3 months
NS Fe MC 10	Felixer pre-field Motion camera	713493	7647811	1 MC for 3 months
NS MC LT I1	Long-term Motion camera	711442	7653629	MC83, 1 MC for 46 days
NS MC LT I2	Long-term Motion camera	713164	7648148	MC92, 1 MC for 46 days

Site Name	Site Type	Easting	Northing	Details
NS MC LT I3	Long-term Motion camera	716114	7648059	MC85, 1 MC for 46 days
NS MC LT I4	Long-term Motion camera	712243	7648686	MC89, 1 MC for 46 days
NS MC LT I5	Long-term Motion camera	710081	7654709	MC82, 1 MC for 46 days
NS MC LT I6	Long-term Motion camera	711680	7650946	MC88, 1 MC for 46 days
NS MC LT I7	Long-term Motion camera	711695	7650618	MC76, 1 MC for 46 days
NS MC LT I8	Long-term Motion camera	713806	7651410	MC75, 1 MC for 46 days
NS MC LT I9	Long-term Motion camera	713230	7647232	MC81, 1 MC for 46 days
NS MC LT C1	Long-term Motion camera	710162	7656606	MC79, 1 MC for 46 days
NS MC LT C2	Long-term Motion camera	714542	7655526	MC80, 1 MC for 46 days
NS MC LT C3	Long-term Motion camera	713314	7657098	MC90, 1 MC for 46 days
NS MC LT C4	Long-term Motion camera	717005	7654105	MC77, 1 MC for 46 days
NS MC LT C5	Long-term Motion camera	718296	7655613	MC91, 1 MC for 46 days
NS MC LT C6	Long-term Motion camera	715887	7654732	MC78, 1 MC for 46 days
NS MC LT C7	Long-term Motion camera	713280	7643833	MC87, 1 MC for 46 days
NS MC LT C8	Long-term Motion camera	713237	7645594	MC86, 1 MC for 46 days
NS MC LT C9	Long-term Motion camera	713451	7643392	MC84, 1 MC for 46 days
NS POP I1	Pilbara Olive Python monitoring site	716035	7649291	Nocturnal searches for 6 nights
NS POP I2	Pilbara Olive Python monitoring site	713315	7647875	Nocturnal searches for 6 nights
NS POP I3	Pilbara Olive Python monitoring site	711670	7650610	Nocturnal searches for 6 nights
NS POP I4	Pilbara Olive Python monitoring site	711133	7648580	Nocturnal searches for 6 nights
NS PLNB I1 (cave 13)	Pilbara Leaf-nosed Bat monitoring site	713368	7647895	1 x ARU for 4 nights
NS PLNB I2 (chateau cave)	Pilbara Leaf-nosed Bat monitoring site	[redacted]		1 x ARU for 4 nights

Appendix 2: Long-Term Climate Data

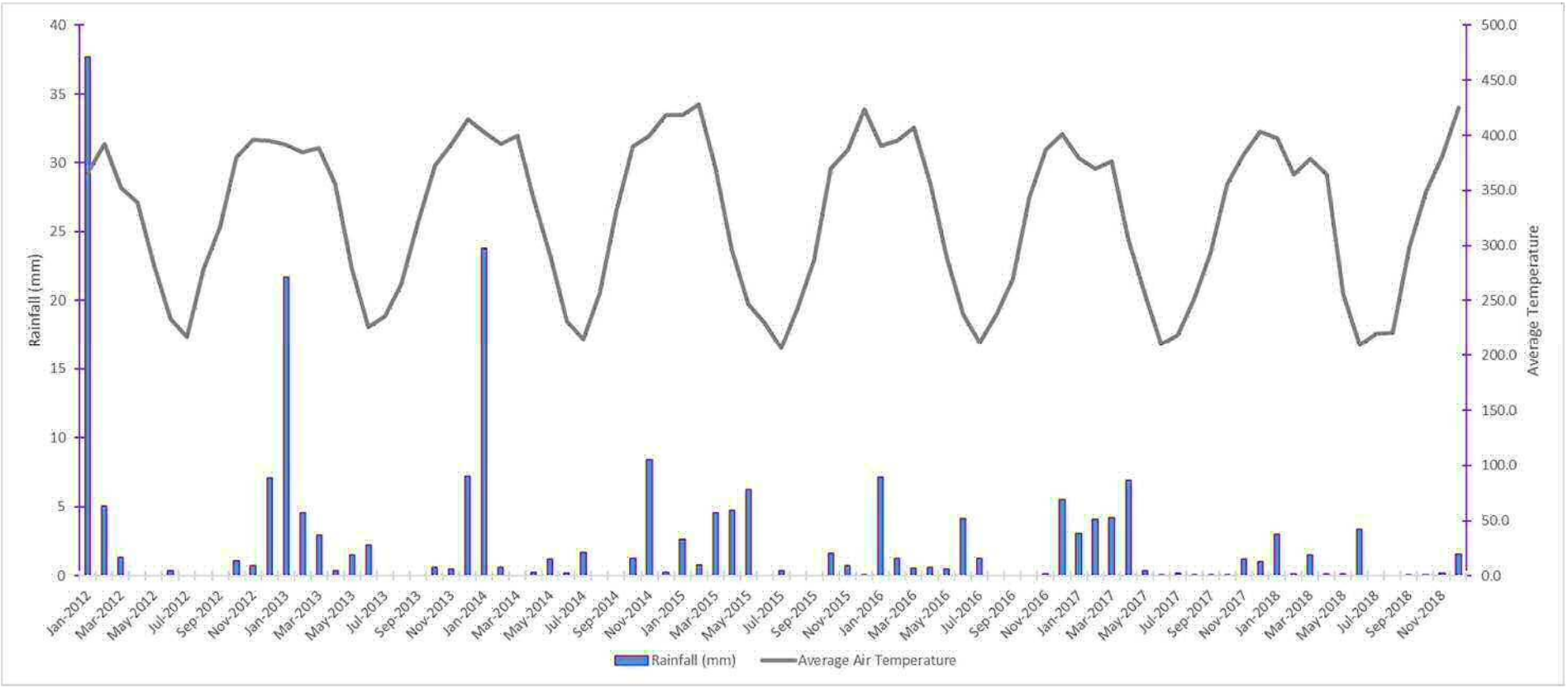

Figure 5.1: Rainfall and temperature data recorded at Cloudbreak 2012-2018 (Fortescue and BoM #5009, 5093 and 5015)

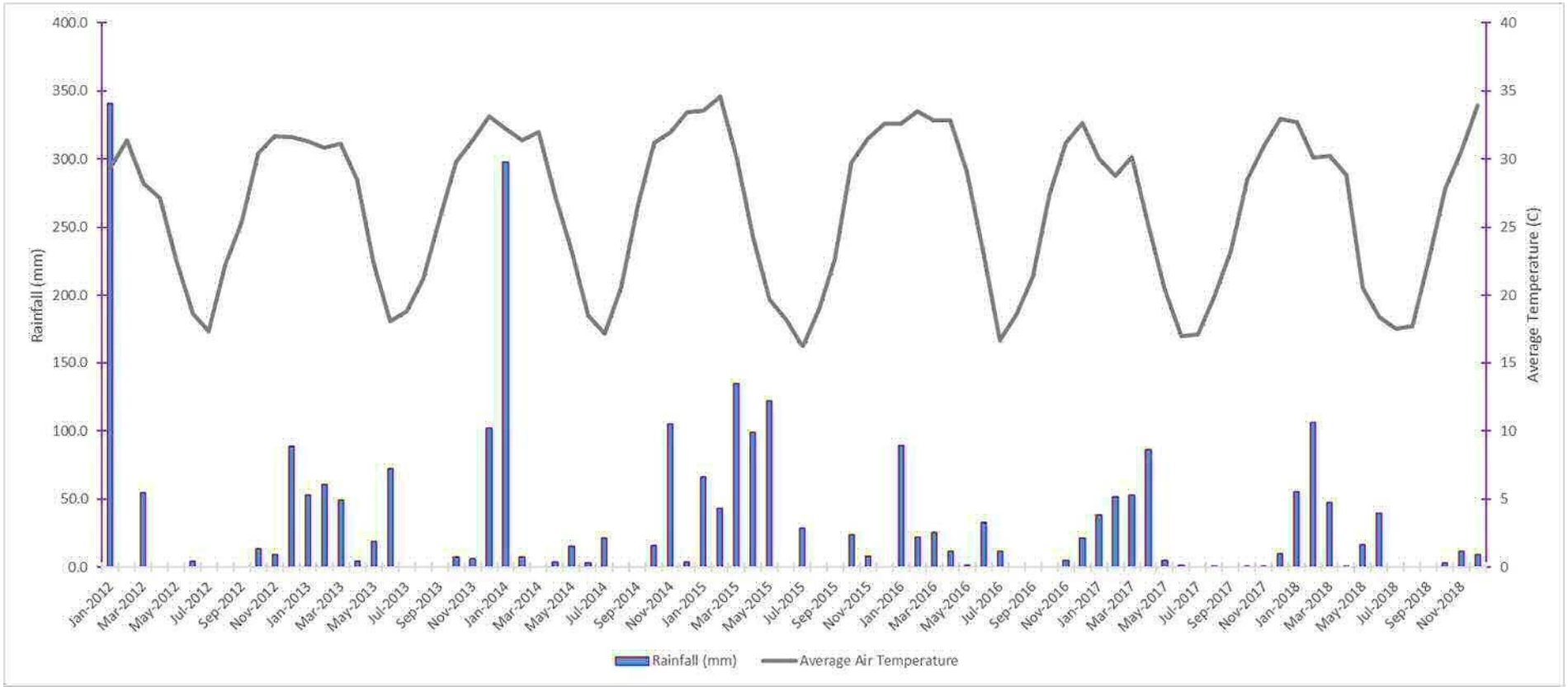

Figure 5.2: Rainfall and temperature data recorded at Christmas Creek 2012-2018 (Fortescue, BoM #5009 and 5026)

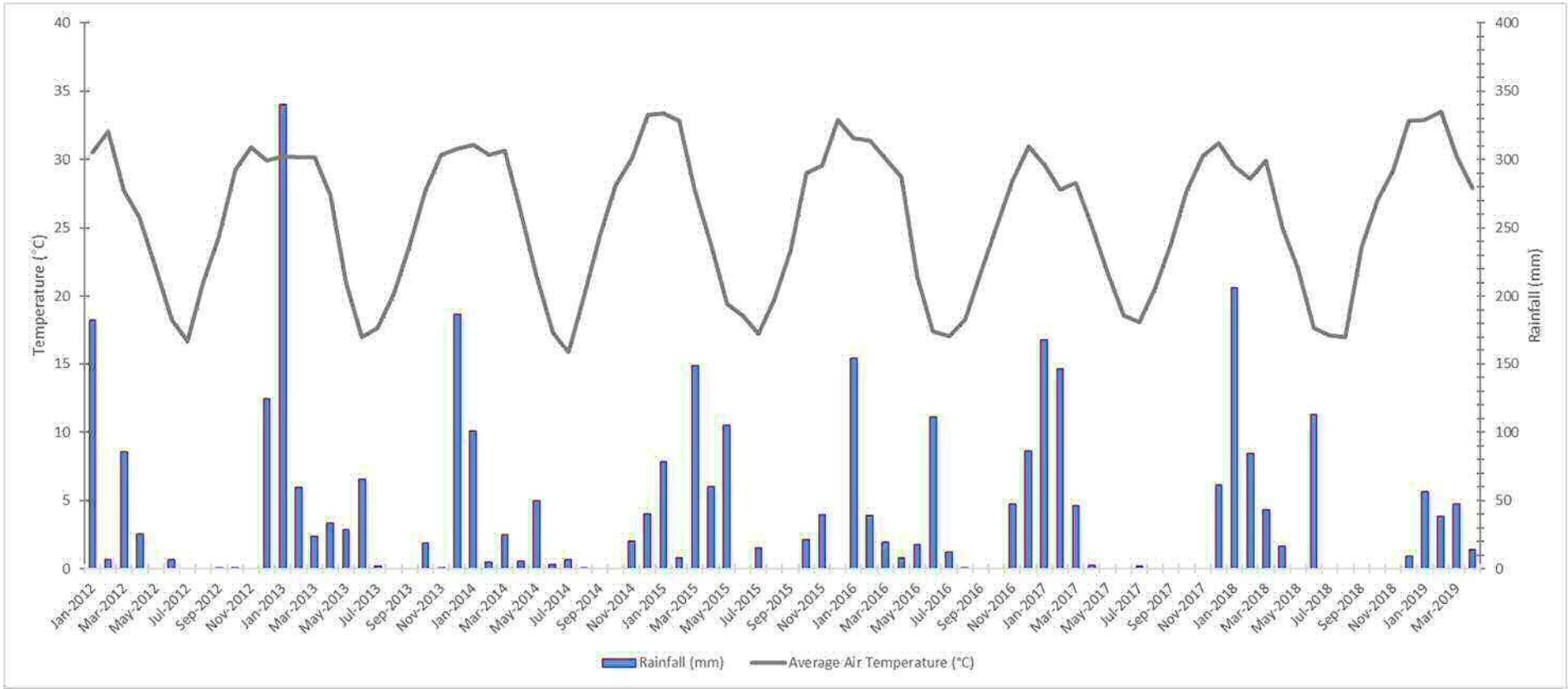

Figure 5.3: Rainfall and temperature data recorded at Solomon Hub (2012-2019) (Fortescue)

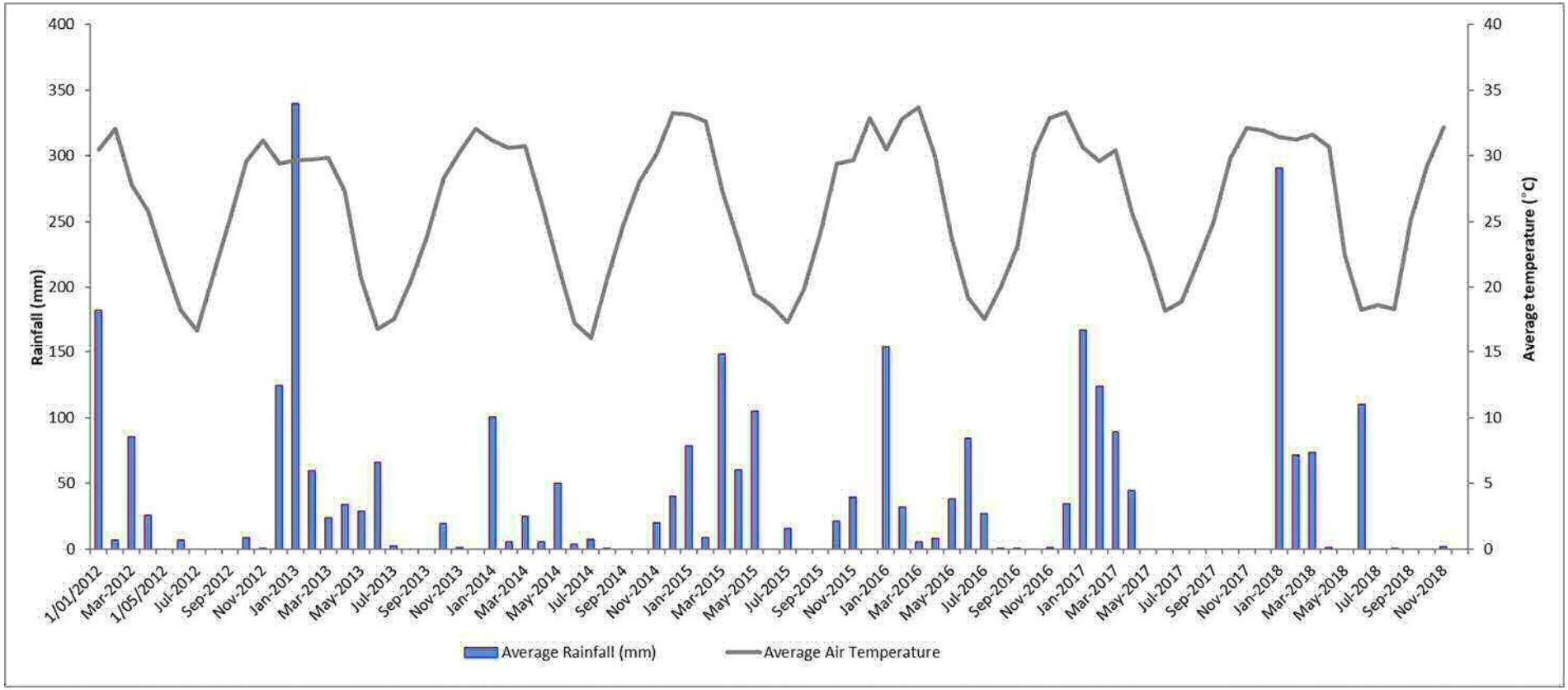

Figure 5.4: Rainfall and temperature data recorded at Hamersley Rail Line 2012-2018 (Fortescue)

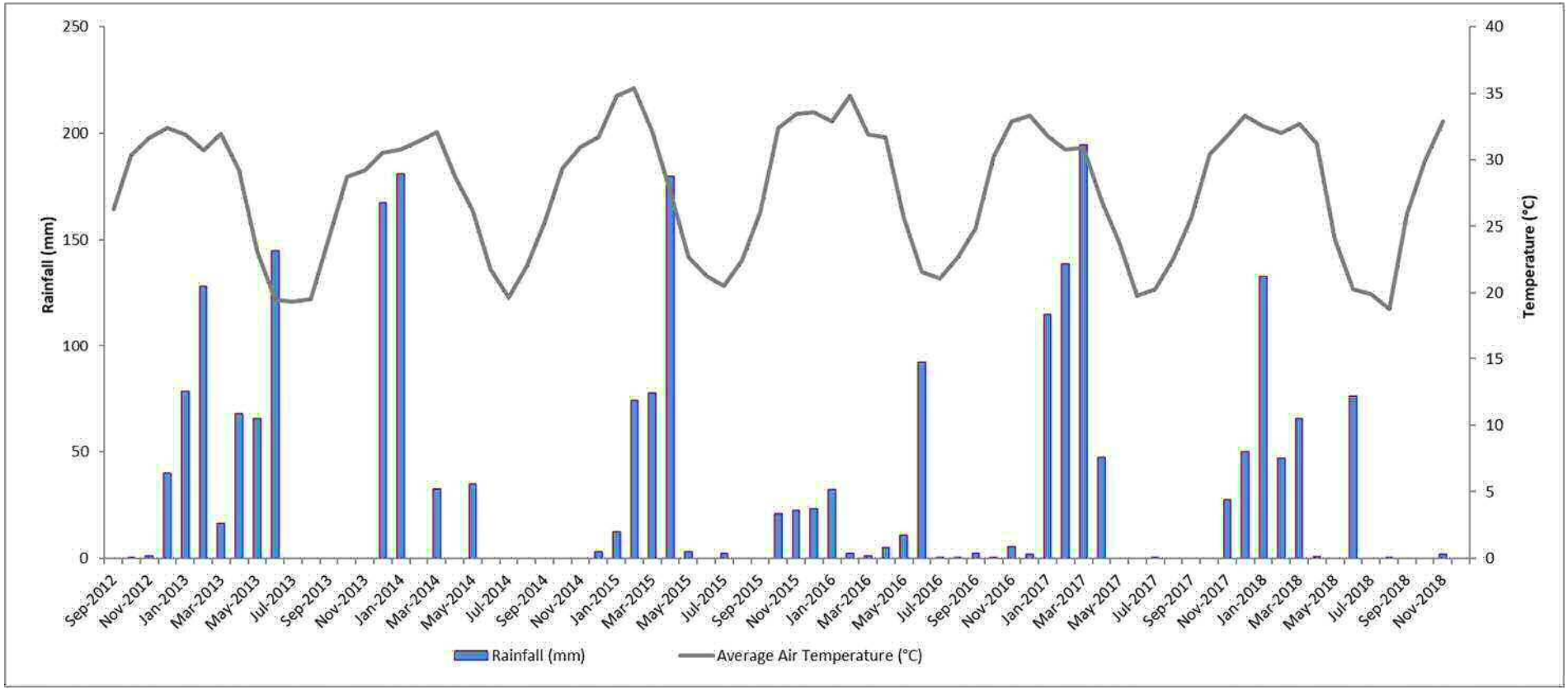

Figure 5.5: Rainfall and temperature data recorded at Main Line Rail north 2012-2018 (Fortescue and BoM #4016)

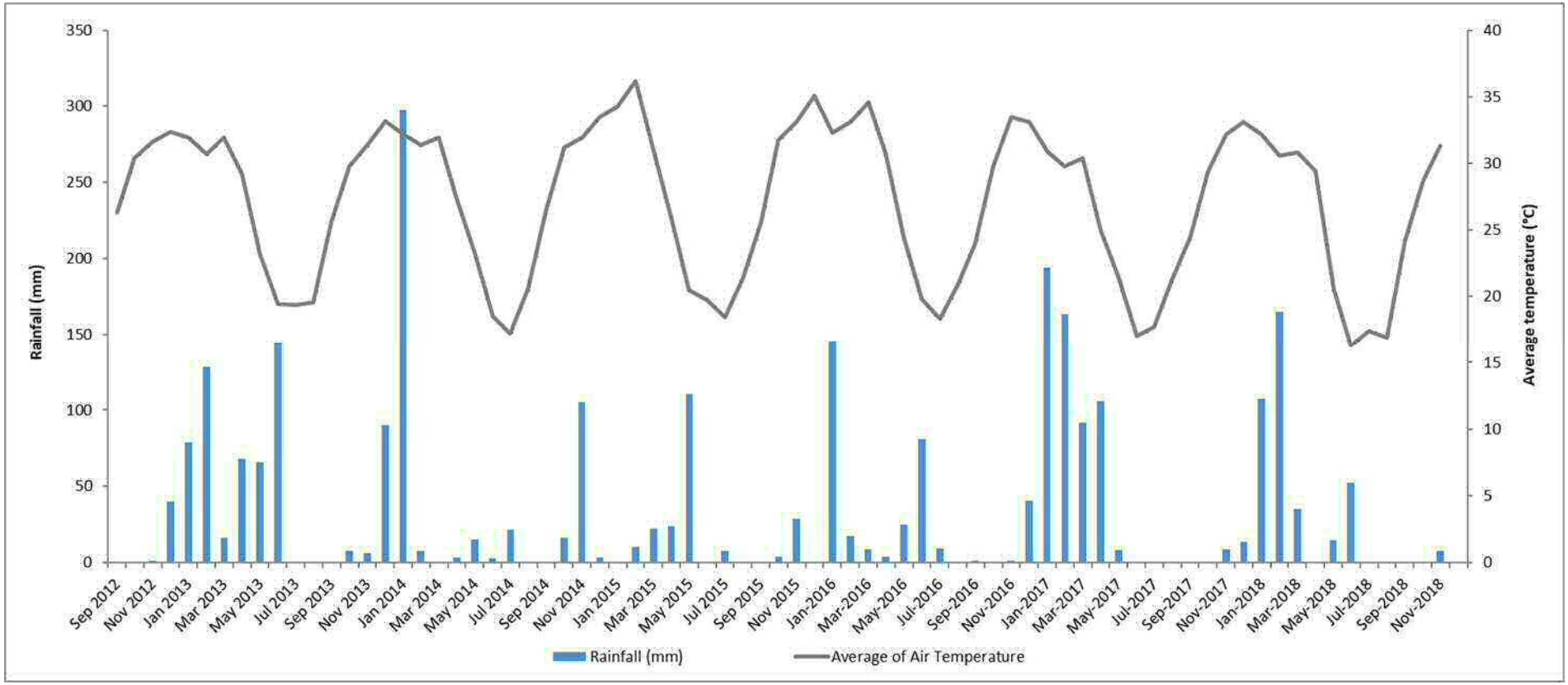

Figure 5.6: Rainfall and temperature data recorded at Mainline Rail Line south 2012-2018 (Fortescue)

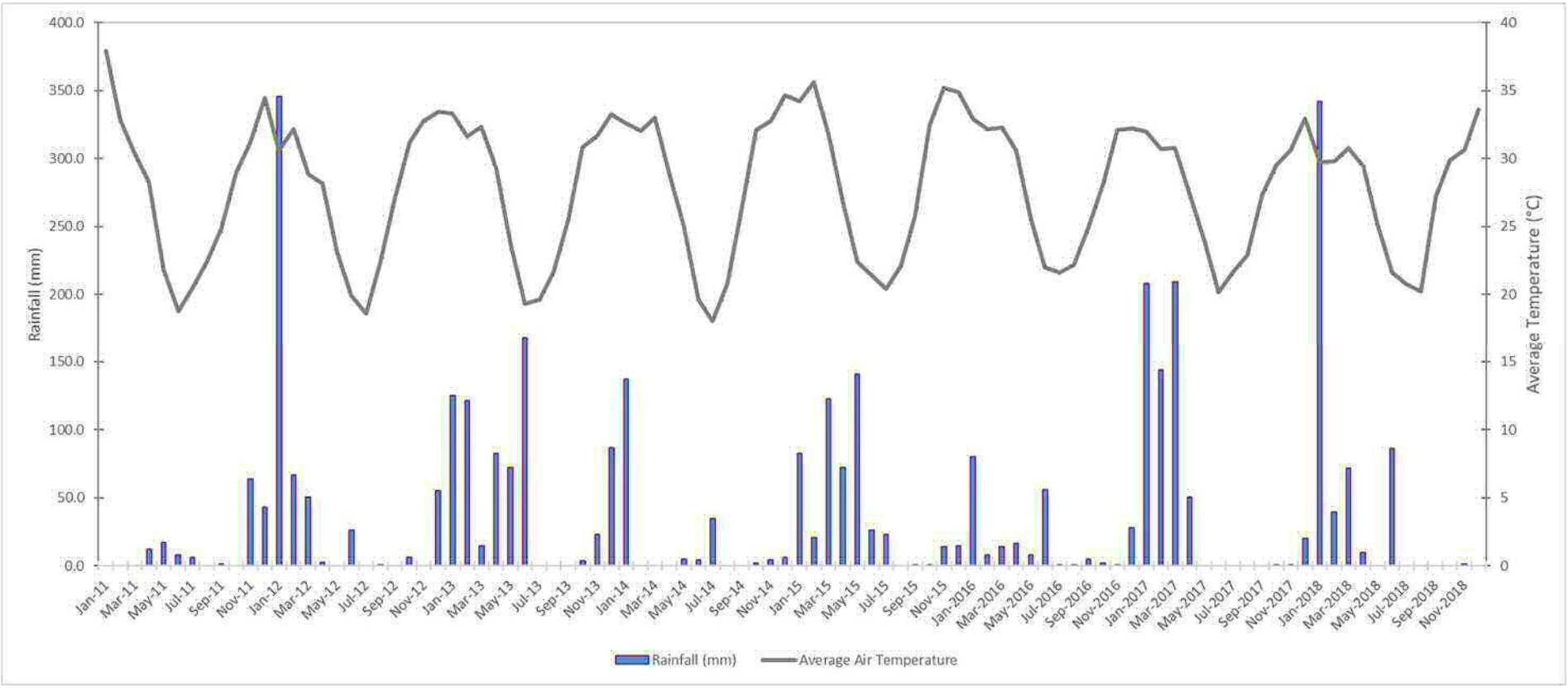

Figure 5.7: Rainfall and temperature data recorded at North Star 2011-2018 (North Star weather station)

Appendix 3: Site Based Records (BMS)

Table 5.2: Site-based records of fauna species of conservation significance

Species recorded	Incidence number	Location	Date	Easting	Northing	Details	Verified
Cloudbreak							
Grey Falcon	PAR-1758	Pit/Norfolk	22/11/16	736574	7530562	Sighting	Probable confirmed
Rainbow Bee-eater	PAR-630	Minga Well	27/5/13	733734	7529744	Sighting	Probable confirmed
Christmas Creek							
Pilbara Olive Python							
Pilbara Olive Python	PAR-258	Roads	4/8/11	-	-	1 individual	Unconfirmed
Pilbara Olive Python	PAR-702	Mokare Pit	8/10/13	768158	7519769	1 individual	Confirmed
Pilbara Olive Python	PAR-770	Karntama Camp	5/3/14	-	-	1 individual	Probable confirmed
Pilbara Olive Python	PAR-1629	-	5/5/16	792409	7521611	Individual relocated	Confirmed
Pilbara Olive Python	PAR-1887	-	14/4/17	786269	7525412	Sighting	Confirmed
Pilbara Olive Python	PAR-2114	CCY2 Workshop	20/4/18	789662*	7517430*	Relocation	Confirmed
Greater Bilby							
Greater Bilby	PAR-1905	Christmas Creek	17/5/17	790140	7519160	Sighting	Confirmed
Grey Falcon							
Grey Falcon	PAR-1643	Christmas Creek	28/5/16	790081	7517741	Sighting	Probable confirmed
Solomon Hub							
Northern Quoll							
Northern Quoll	PAR-1608	Between Trinity Fuel Farm and Trinity Overpass	31/3/16	588919	7552971	1 individual	Unconfirmed
Northern Quoll	INC-52451	Kings OPF	5/5/16	590928*	7554466*	1 individual died in hydrocarbon bin	Confirmed
Northern Quoll	PAR-1760	Kings OPF, Crib	29/11/16	590350*	7554616*	Sighting	Unconfirmed
Northern Quoll	PAR-1763	Kings OPF, compound 2	2/12/16	590350*	7554616*	Sighting	Unconfirmed
Northern Quoll	INC-61299	Trinity Mine Area	6/10/17	588624*	7553134*	Fauna Death (Female)	Confirmed
Northern Quoll	PAR-2142	Kings OPF	26/5/17	590520	7554631	Sighting	Confirmed
Northern Quoll	INC-58966	Firetail South	27/05/17	593289	7553166	Fauna Death (Male)	Confirmed
Northern Quoll	PAR-1958	Castle Road	2/8/17	588646	7552714	Sighting	Unconfirmed
Northern Quoll	PAR-1946	Trinity Drive	18/7/17	588930	7552980	Sighting	Unconfirmed
Northern Quoll	INC-60700	Firetail South	1/9/17	592422	7552599	Fauna Death (Male)	Confirmed
Northern Quoll	INC-61299	Trinity/Apostle LV Access Road	6/10/17	-	-	Fauna Death	Confirmed
Northern Quoll	INC-63547	Trinity Tunnel	11/2/18	588968	7552919	Fauna Death	Confirmed
Northern Quoll	PAR-2090	Kings OPF	26/3/18	590413	7554711	Sighting	Probable confirmed
Northern Quoll	PAR-21110	Trinity Mine	15/4/18	588753	7552892	Sighting	Confirmed
Northern Quoll	INC-64731	Firetail South	18/4/18	592420	7552828	Fauna Death (Male)	Confirmed

Species recorded	Incidence number	Location	Date	Easting	Northing	Details	Verified
Northern Quoll	PAR-2228	Overland Conveyor	18/9/18	-	-	Sighting	Probable confirmed
Pilbara Olive Python							
Pilbara Olive Python	INC-44892, PAR-1178	Trinity Drive	2/3/15	587358	7551848	1 individual	Unconfirmed, fauna death
Pilbara Olive Python	PAR-1237	Craigies gorge	14/4/15	597153	7553206	1 individual	Probable confirmed, relocated
Pilbara Olive Python	PAR-1432	Kangi Village (Ring Road adjacent Wet Mess)	14/10/15	583803*	7542706*	1 individual	Probable confirmed, relocated
Pilbara Olive Python	PAR-1432	Kangi Village (Ring Road adjacent Wet Mess)	14/10/15	583803*	7542706*	1 individual	Probable confirmed, relocated
Pilbara Olive Python	PAR-1483	Firetail	19/11/15	597450	7551552	2 individuals	Probable confirmed, relocated
Pilbara Olive Python	PAR-1556	Explosives Storage Facility	7/2/2016	585490	7552283	1 individual	Probable confirmed, relocated
Pilbara Olive Python	PAR-1752	Kings Mining	11/11/16	590642	7549015	1 individual	Confirmed
Pilbara Olive Python	PAR-1804	Kangi Camp	20/1/17	583560	7542359	1 individual	Confirmed
Pilbara Olive Python	PAR-1819	Kings OPF	6/2/17	582003	7551289	Relocation	Confirmed
Pilbara Olive Python	PAR-1844	Kangi Camp	6/3/17	583749	7542526	Relocation	Confirmed
Pilbara Olive Python	PAR-1858	Dally Camp	18/3/17	585408	7543632	Relocation	Confirmed
Pilbara Olive Python	PAR-1891	Kings OPF	26/4/17	590375	7554652	Sighting	Confirmed
Pilbara Olive Python	PAR-2008	Simpson Drive	2/12/17	-	-	Sighting	Unconfirmed
Pilbara Olive Python	PAR-2017	Solomon	24/12/17	588290	7559174		
Pilbara Olive Python	PAR-2086	Firetail south	25/3/18	-	-	Sighting	Probable confirmed
Pilbara Olive Python	PAR-2131	Kangi creek, near OPF	14/5/18	590311	7554774	Relocation	Confirmed
Pilbara Olive Python	PAR-2168	Kings	3/7/18	589693	7550233	Relocation	Confirmed
Pilbara Olive Python[1]	PAR-2463	Kings	30/3/19	589077*	7552680*	Relocation	Confirmed
Pilbara Leaf-nosed Bat							
Pilbara Leaf-nosed Bat	PAR-1598	Solomon	15/3/16	573663	7541495	Sighting	Unconfirmed
Peregrine Falcon							
Peregrine Falcon	INC-49550	Firetail OPF	25/11/15	-	-		Probable confirmed, fauna death
Main Line Rail							
-							
Hamersley Rail Line							
-							

Species recorded	Incidence number	Location	Date	Easting	Northing	Details	Verified
Nullagine							
Care and Maintenance – no traffic							
North Star							
Northern Quoll							
Northern Quoll	PAR-1197		21/3/15	7647791	712555	1 individual	Probable confirmed
Northern Quoll	INC-44740		24/2/15	712542	7647772	Female road kill (PIT 941000016595479)	Confirmed, microchip scanned
Northern Quoll	INC-48890		19/10/15	712221	7649994	Male road kill (PIT 941 000017452061)	Confirmed, microchip scanned
Northern Quoll	INC-51653		15/3/16	712469	7648013	Female road kill, no microchip	Confirmed, submitted to DPaW
Northern Quoll	PAR-2296	West of southern control area	14/12/18	709597	7645073	Sighting	Probably confirmed
Pilbara Olive Python							
Pilbara Olive Python	INC-43357		26/12/14	-	-	1 individual (2m TL), road kill on haul road	Confirmed
Pilbara Olive Python	PAR-1128		25/1/15	7648451	708829	1 individual	Confirmed
Pilbara Olive Python	PAR-1133		26/1/15	7650318	713354	1 individual	Confirmed
Pilbara Olive Python	PAR-1180		10/2/15	708186	7648219	3 individuals, relocated to 711068mE, 7647951mN	Probable confirmed
Pilbara Olive Python	PAR-1179		24/2/15	708152	7648236	1 individual, relocated to 711046mE, 7647980mN	Confirmed
Pilbara Olive Python	PAR-1254		24/4/15	7647975	706327	1 individual	Confirmed
Pilbara Olive Python	PAR-1712		16/9/16	713241	7643861	Sighting	Confirmed
Pilbara Olive Python	PAR-1814		2/2/17	708110#	7646951#	Relocation	Confirmed
Pilbara Olive Python	INC-60631		25/8/17	-	-	-	Confirmed?
Pilbara Leaf-nosed Bat							
Pilbara Leaf-nosed Bat	INC-61532		14/6/17			Death of animal during Environmental Survey (Radio-tracking)	Confirmed
Ghost Bat							
Ghost Bat	PAR-1937		29/6/17	n/a	n/a	Sighting	Unconfirmed
Ghost Bat	PAR-1862		21/3/17	n/a	n/a	Sighting	Unconfirmed

Datum GDA94, Zone 50K, *estimated coordinates, #relocation coordinates (original site unknown)

[1] individual was previously recorded during monitoring (PIT 991 0030 0017 4907) and relocated to Kangi creek

Appendix 4: Northern Quoll Details

Table 5.3: Details of Northern Quoll records at each site to date

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
Control Sites													
Control Sites – North Star													
2014													
941000016595482	Male	26/08/14	capture	NS NQ C1	C4	713392	7646226	860	40.0	16.5	-	adult male, reproductive	
		28/08/14	recapture		C17	713099	7646318						
		27/08/14	recapture		C18	713087	7646363						
941000016595486[F2-1]	Female	24/08/14	capture	NS NQ C1	C9	713247	7646030	340	17.4	17.4	4	-	
		25/08/14	recapture		C5	713371	7646193						
		28/08/14	recapture		C9	713247	7646030						
941000016595485	Male	26/08/14	capture	NS NQ C2	C19	713106	7644714	580	38.0	12.0	3.5		
941000016595495	Male	28/08/14	capture	NS NQ C2	C10	713236	7644684	635	34.0	16.5	3.5	Average, missing fur on tail	
		30/08/14	recapture		C21	713223	7644656						
941000016595497[F3-1]	Female	28/08/14	capture	NS NQ C2	C4	713509	7644697	385	26.0	11.5	4	No pouched young	
		29/08/14	recapture		C8	713322	7644657						
		30/08/14	recapture		C8	713322	7644657						
941000016595498	Female	28/08/14	capture	NS NQ C2	C18	713101	7644777	365	28.0	14.0	3.5	-	
941000016202871	Male	24/08/14	capture	NS NQ C2	C19	713106	7644714	725	27.5	16.5	5	-	
		25/08/14	recapture		C8	713322	7644657						
		28/08/14	recapture	NS NQ C1	C18	713087	7646363						
941000016595535	Male	25/08/14	capture	NS NQ C3	C1	713202	7657203	560	23.5	14.0	3	-	
941000016595534	Male	25/08/14	capture	NS NQ C4	C3	718449	7655567	480	21.0	9.2	3.5	Young male, missing fur on tail but no sign of fighting	
		26/08/14	recapture		C4	718429	7655572						
		27/08/14	recapture		C4	718429	7655572						
		28/08/14	recapture		C5	718387	7655606						
2015													
941000016595486[F2-2]	Female	23/08/15	capture	NS NQ C1	C25	713219	7646475	426	32.0	17.0	4	recapture from previous year, pouched, good condition	
		24/08/15	Recapture		C17	713099	7646318						
		25/08/15	Recapture		C18	713087	7646363						
941000016595533	Female	23/08/15	capture	NS NQ C1	C11	713191	7646070	337	27.0	13.0	4	none	
		26/08/15	recapture		C11	713191	7646070						
941000016595497^ [F3-2]	Female	24/08/15	capture	NS NQ C2	C6	713503	7644693	446	35.0	15.0	4	none	
		25/08/15	recapture		C14	713283	7644663						
941000017452062	Male	23/08/15	capture	NS NQ C4	C7	718404	7655595	406	36.0	16.0	3	fur missing	
		24/08/15	recapture		C17	718182	7655616						
		26/08/15	recapture		C21	718110	7655604						
		27/08/15	recapture		C25	718062	7655604						
941000017452068	Male	22/08/15	capture	NS NQ C4	C9	718359	7655616	622	37.2	17.5	3.5	fur missing	
		26/08/15	recapture		C7	718404	7655595						
985170002967064	Male	21/08/15	capture: MWH recapture	NS NQ C4	C1	718547	7655513	489	37.0	13.0	2.5	few fight wounds	

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
		25/08/15	recapture		C6	718424	7655577						
		26/08/15	recapture		C12	718289	7655612						
985170002971079	Male	21/08/15	capture: MWH recapture	NS NQ C4	C8	718381	7655612	522	35.0	12.0	3	few fight wounds	
		22/08/15	recapture		C4	718458	7655554						
		23/08/15	recapture		C12	718289	7655612						
		24/08/15	recapture		C13	718272	7655599						
		25/08/15	recapture		C10	718338	7655602						
		26/08/15	recapture		C5	718445	7655570						
		27/08/15	recapture		C13	718272	7655599						
2016													
94100016595533 [F5-2]	Female	13/08/16	Recapture	NS NQ C1	C11	713191	7646070	418	27.0	13.0	5	Developed pouch, no young. Good condition, recaptured for 2nd year	
		15/08/16	Recapture		C10	713226	7646073						
94100016595486 [F2-3]	Female	14/08/16	Recapture	NS NQ C1	C18	713087	7646363	540	30.8	17.0	5	No missing fur, developed pouch but no young, recaptured foo 3rd year	
		15/08/16	Recapture		C11	713191	7646070						
941000017452048	Male	17/08/16	Capture	NS NQ C2	C16	713204	7644642	650	37.3	16.0	4	Some missing fur from fighting	
		19/08/16	Recapture		C17	713173	7644646						
941000016202843	Female	17/08/16	Capture	NS NQ C4	C24	718079	7655593	460	23.2	14.0	5	Developed pouch, no young, healthy	
941000017452057	Male	18/08/16	Capture	NS NQ C4	C24	718079	7655593	550	36.0	16.0	5	Very good health, no signs of fighting	
		19/08/16	Recapture		C21	718110	7655604						
941000017452047	Female	19/08/16	Capture	NS NQ C4	C24	718079	7655593	370	32.3	16.0	5	Developed pouch, no young, healthy	
2017													
941000017452025	Female	22/08/17	Capture	NS NQ C1	C12	713140	7646110	405	34.0	12.0	4	Good condition, small amount of hair loss on flanks, immature, no pouch developed	
		24/08/17	Recapture		C17	713099	7646318						
		25/08/17	Recapture		C13	713118	7646163						
941000019576554	Male	24/08/17	Capture	NS NQ C1	C12	713140	7646110	590	36.7	14.8	3	Patches of fur missing	
941000019576555	Male	23/08/17	Capture	NS NQ C1	C21	713116	7646422	620	38.3	15.4	3	Patches of missing fur	
941000019576557	Male	23/08/17	Capture	NS NQ C1	C15	713111	7646234	595	38.4	13.1	3	Missing fur over bottom half of body	
		24/08/17	Recapture		C19	713096	7646405						
		25/08/17	Recapture		C11	713191	7646070						
		27/08/17	Recapture	NS NQ C2	C12	713340	7644651						
		28/08/17	Recapture		C13	713310	7644655						
941000017452028	Male	23/08/17	Capture	NS NQ C2	C13	713310	7644655	720	38.8	12.8	3	Some signs of fighting	
941000017452058	Male	23/08/17	Capture	NS NQ C2	C12	713340	7644651	665	38.6	15.6	3	Patches of fur missing	
		24/08/17	Recapture		C8	713449	7644674						
		24/08/17	Recapture		C14	713283	7644663						
941000019576556	Male	24/08/17	Capture	NS NQ C2	C15	713255	7644672	810	39.3	15.0	3	Missing patches of fur	

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
941000017452032	Female	24/08/17	Capture	NS NQ C3	C3	713265	7657127	625	32.0	9.0	4	Developed pouch and pouch young present	
		29/08/17	Recapture		C5	713320	7657089						
941000017452033	Male	24/08/17	Capture	NS NQ C3	C16	713667	7656755	830	40.0	18.0	2	Significant fur loss, signs of fighting	
		25/08/17	Recapture		C22	713414	7656999						
		26/08/17	Recapture		C22	713414	7656999						
941000019576553	Male	25/08/17	Capture	NS NQ C3	C1	713219	7657189	670	38.5	13.0	3	Loss of fur along shoulder and flanks	
941000019576551	Male	27/08/17	Capture	NS NQ C3	C3	713265	7657127	570	36.7	13.3	3	Missing patches of fur	
941000017452031	Male	23/08/17	Capture	NS NQ C4	C24	718079	7655593	670	41.0	18.0	3	Missing fur along flanks, mature male	
		24/08/17	Recapture		C25	718062	7655604						
		25/08/17	Recapture		C25	718062	7655604						
		28/08/17	Recapture		C4	718464	7655559						
		29/08/17	Recapture		C3	718492	7655536						
941000017452026	Male	24/08/17	Capture	NS NQ C4	C9	718359	7655616	755	36.0	15.0	3	Small areas of fur loss on back and flanks	
		25/08/17	Recapture		C12	718289	7655612						
		26/08/17	Recapture		C12	718289	7655612						
943094322007681	Female	25/08/17	Capture: MWH recapture	NS NQ C4	C15	718226	7655613	345	33.4	11.4	4	Six small pouch young, <10mm each	
941000017452029	Female	28/08/17	Capture	NS NQ C4	C1	718547	7655513	580	34.0	15.0	4	Six small pouch young, <10mm each	
943094322007659	Male	28/08/17	Capture: MWH recapture	NS NQ C4	C5	718445	7655570	625	36.0	17.0	2	Significant loss of fur	
2018													
991 0030 0017 4886	Male	17/08/18	Capture	NS NQ C1	C14	713095	7646197	480	36	17	3	Some evidence of fighting. Some missing fur and small bite marks	Very quiet animal
		18/08/18	Recapture	NS NQ C1	C12	713140	7646110	510					
		19/08/18	Recapture	NS NQ C1	C15	713111	7646234	530					
		21/08/18	Recapture	NS NQ C1	C18	713087	7646363						
991 0030 0017 4890	Male	19/08/18	Capture	NS NQ C2	C3	713560	7644656	545	32	15.2	4		
941 0000 1957 6577	Female	21/08/18	Capture	NS NQ C2	C12	713340	7644651	385	29.2	15.2	2	Pouch undeveloped	Fur patchy, 50% missing. Not in good condition
991 0030 0017 4875	Male	20/08/18	Capture	NS NQ C2	C18	713159	7644676	555	33	16	3	Some signs of fighting	Substantial bite wounds to front right dorsal surface just behind neck.
941 0000 1745 2032[F6-2]	Female	21/08/18	Capture	NS NQ C3	C1	713219	7657189	390	30.8	11.3	4	Pouch developed however still furry and no young. Hips missing patches of fur indicates recent mating behaviour	Recapture from previous monitoring
991 0030 0017 4895	Male	20/08/18	Capture	NS NQ C3	C2	718547	7655513	650	34.8	13.1	4	Several patches of fur missing indicating recent fighting	
991 0030 0017 4896	Male	17/08/18	Capture	NS NQ C4	C10	718338	7655602	770	34.1	14.2	4	Some evidence of fighting. Missing fur patches and bite marks on neck	
		18/08/18	Recapture	NS NQ C4	C25	718062	7655604						
		19/08/18	Recapture	NS NQ C4	C14	718254	7655603						

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
991 0030 0017 4894	Male	17/08/18	Capture	NS NQ C4	C24	718079	7655593	800	36.2	19.9	5	Really healthy. Little indication of fighting but might just be very successful.	Animal slightly stressed on 17/8 so chipped and released. Measurements taken on 19/8
		19/08/18	Recapture	NS NQ C4	C24	718079	7655593						
991 0030 0017 4882	Male	18/08/18	Capture	NS NQ C4	C22	718094	7655603	590	35.6	14.1	4	Little evidence of fighting.	
		19/08/18	Recapture	NS NQ C4	C18	718160	7655607						
991 0030 0017 4906	Male	18/08/18	Capture	NS NQ C4	C24	718079	7655593	690	15.6	37.4	4	Few patches of fur missing. Some evidence of fighting.	
991 0030 0017 4904	Male	19/08/18	Capture	NS NQ C4	C23	718090	7655592	770	34.3	19.1	4	Signs of fighting	Some fur patches missing
Control Sites – Fortescue													
2012													
NQ 1	-	22/08/12	Motion camera	MC C	-	578019	7546548						
2013													
NIL													
2014													
NIL													
2015													
Secondary evidence	-	29/07/15	Motion Camera	FC NQ C1	C01	588532	7560316						
Secondary evidence	-	8/08/15	Motion Camera	FC NQ C1	C02	588566	7560202						
Secondary evidence	-	29/07/15	Motion Camera	FC NQ C1	C05	588511	7560348						
Secondary evidence	-	1/08/15	Motion Camera	FC NQ C1	C06	588447	7560404						
Secondary evidence	-	4/08/15	Motion Camera	FC NQ C1	C07	588463	7560432						
Secondary evidence	-	3/08/15	Motion Camera	FC NQ C1	C09	588474	7560455						
Secondary evidence	-	5/08/15	Motion Camera	FC NQ C1	C10	588588	7560161						
Secondary evidence	-	5/08/15	Motion Camera	FC NQ C1	C03	590076	7559696						
Secondary evidence	-	6/08/15	Motion Camera	FC NQ C2	C09	590087	7559677						
2016													
Secondary evidence	-	3/07/16	Motion Camera	FC NQ C1	MC68	588499	7560338						
Secondary evidence	-	4/08/16	Scats	FC NQ C1	C31	588404	7560380						
941000017452037	Male	5/08/16	Capture	FC NQ C1	C19	588484	7560548	420	36.5	14.5	4	Small male, a bit skinny, no signs of fighting	
941000017452041	Male	1/08/16	Capture	FC NQ C2	C12	590501	7559882	400	36.8	19.5	5	Small male, no signs of fighting	
		2/08/16	Recapture		C12	590501	7559882						
Secondary evidence	-	31/07/16	Motion Camera	FC NQ C2	MC63	590467	7559908						
Secondary evidence	-	2/08/16	Motion Camera	FC NQ C2	MC64	590496	7559884						
941000017452046	Female	3/9/16	Capture	FC CR1.3	C04	589726	7556898						
		14/9/16	Recapture		C08	589731	7556981						
941000017452051	Male	2/9/16	Capture	FC CR1.3	C05	589717	7556919						
2017													
Secondary evidence		6/08/17	-	FC NQ C1	opp	588462	7560438						
Secondary evidence		4/08/17	-	FC NQ C2	opp	590433	7559916						
2018													
991 0030 0017 4873	Male	17/07/18	Capture	FC NQ C2	C47	589967	7559653	920	36.5	22	5		

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
		18/07/18	Recapture		C29	590055	7559646					No signs of fighting, really big male with lots of body fat	
		19/07/18	Recapture		C25	590021	7559590						
		20/07/18	Recapture		C36	590132	7559753						
No ID	-	19/07/18	Motion Camera	FC NQ C2	MC54	590432	7559933	-	-	-	-	-	Individual not previously captured (no ear notch)
No ID	-	19/07/18	Motion Camera	FC NQ C2	MC55	590478	7559899	-	-	-	-	-	
No ID	-	17/07/18	Skull	FC NQ C1	opp	588454	7560429	-	-	-	-	-	
Potential Impact Sites													
Solomon Hub													
2012													
NIL													
2013													
M1	Male	4/09/13	Capture	SM NQ I2	T6	590498	7555850	790	34	-	1	Obvious signs of fighting, large areas of fur missing, poor condition	
		6/09/13	Recapture	SM NQ I2	T3	590419	7555993						
M2	Male	6/09/13	Capture	SM NQ I2	T43	589600	7554102	720	38	-	1	Obvious signs of fighting, large areas of fur missing	
M3	Male	8/09/13	Capture	SM NQ I2	T4	590447	7555941	650	65	-	1	Obvious signs of fighting, large areas of fur missing, scar between shoulder blades	
		9/09/13	Recapture	SM NQ I2	T3	590419	7555993						
2014													
941000016202857	Male	24/07/14	Capture	SM NQ I2	T5	590472	7555902	860	36.0	74.0	4	Good health, no signs of fighting	
		28/07/14	Recapture		T4	590447	7555941						
94100001659557	Male	24/07/14	Capture	SM NQ I2	T22	590457	7554931	840	40.0	72.0	4.5	Good health, no signs of fighting	
		25/07/14	Recapture		T21	590490	7554989						
941000016595572	Male	25/07/14	Capture	SM NQ I2	T43	589600	7554102	870	38.0	60.0	4.5	Good health, right ear torn	
		30/07/14	Recapture		T47	589458	7553905						
941000016595536	Male	29/07/14	Capture	SM NQ I1	T20	592575	7554667	600	36.0	64.0	4	Small, young male in good condition. No signs of fighting	
2015													
Secondary evidence	-	3/08/15	Secondary evidence	SM NQ I2	Opp	590623	7555921	-				Skull	
2016													
941000017452043	M	28/07/16	Capture	SM NQI1	C10	590546	7555580	610	34.1	21.8	5	Some early signs of fighting, good condition	Equipped with radio collar 1
		2/09/16	Recapture	SM CR1.3	C06	589717	7556949	490					
		5/09/16	Recapture		C03	589732	7556875						Dropped collar VHF150.099
		14/09/16	Recapture	SM CR2.2	C01	589735	7556816						
941000017452036	M	28/07/16	Capture	SM NQI1	C40	590574	7555562	640	38.2	20.0	5	Healthy and angry, no signs of fighting	
		31/07/16	Recapture		C42	590565	7555653						
		31/08/16	Recapture	SM CR1.1	C06	590534	7555127						
		14/09/16	Recapture	SM CR2.1	C04	590537	7555151						

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
941000017452042	M	28/07/16	Capture	SM NQI1	C26	590489	7555001	510	32.1	16.0	5	Some early signs of fighting, good condition	Equipped with radio collar 2 (VHF 150.119)
		2/09/16	Recapture	SM CR1.5	C01	590491	7555019						Collar retrieved
941000017452039	M	30/07/16	Capture	SM NQI1	C45	590523	7555813	740	40.5	21.1	5	Healthy, no signs of fighting. Equipped with radio collar 3 (VHF 150.139)	
		4/08/16	Recapture	SM NQI3	C32	592724	7554820						
941000017452027	M	15/09/16	Capture	SM CR2.4	C05	591021	7555454	450	35.2	13.4	4	Missing fur	
		16/09/16	Recapture		C10	590876	7555743						
941000017452024	M	15/09/16	Capture	SM CR2.4	C01	590903	7555362	524	33.9	17.6	5	Healthy, no signs of fighting	
2017													
941000019576548	Female	2/08/17	Capture	SM NQ I1	C33	590551	7555212	400	34.0	14.0	4	Equipped with radio collar (150.240), fur loss, no pouch young	
		30/08/17	Recapture	SM CR 1	C20	590481	7555204					Pouch young developed in pouch	
941000019576547	Female	5/08/17	Capture	SM NQ I2	C19	589604	7554182	420	34.0	12.5	4	Developed pouch but no young, attached collar 150.200	
		7/08/17	Recapture	SM NQ I2	C17	589581	7554132						
		02/09/17	Recapture	SM CR 2	C33	589558	7554222	430	-	-	4	Developed pouch with pouch young. Had lost collar.	
N/A (Not chipped)	Male	5/8/17	Capture	SM NQ I2	C27	589744	7554208	570	36.0	11.0	4	Mature male, very aggressive, could not take tissue sample or insert microchip	
		7/08/17	Recapture	SM NQ I2	C44	589364	7553751						
941000017452044	Male	6/08/17	Capture	SM NQ I2	C33	589622	7554042	545	36.0	12.2	4	Loss of fur and scratches, signs of fighting	
		8/08/17	Recapture	SM NQ I2	C9	589457	7553931						
941000019576558	Male	31/08/17	Capture	SM CR 1	C1	590423	7555026	610	30.0	18.0	2	Lots of missing fur, very poor condition due to advanced breeding season	
941000019576543	Female	02/09/17	Capture	SM CR 2	C35	589541	7554191	400	-	-	5	Regrown fur, pouch young	
2018													
941 0000 1957 6578	Male	11/07/18	Motion Camera	SM NQ I1	MC61	590465	7555186	870	37.1	18.2	5	Really healthy and good conditions, lots of body fat, no signs of fighting	
		12/07/18	Capture		T24	590399	7555060						
		13/07/18	Recapture		T21	590463	7555180						
		14/07/18	Recapture		T20	590481	7555204						
		15/07/18	Recapture		T18	590530	7555290						
941 0000 1957 6548[F1-2]	Female	12/07/18	Capture	SM NQ I1	T19	590515	7555254	580	34.0	14.0	4	Developed pouch, no pouch young	Female caught in 2017. Recaptured in 2018 at same trap site
		13/07/18	Motion Camera		MC61 & MC62	590504	7555271						
		14/07/18	Recapture		T17	590551	7555325						
		15/07/18	Recapture		T20	590481	7555204						
941 0000 1957 6544	Female	14/07/18	Capture	SM NQ I1	T21	590463	7555180	440	35.0	17.0	5	Early stages of pouch development, fur inside.	

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
												No pouch young or signs of mating (missing fur)	
941 0000 1957 6572	Female	12/07/18	Capture	SM NQ I1	T15	590561	7555403	465	27.1	14.0	5	Developed pouch but no pouch young	
		13/07/18	Recapture		T17	590551	7555325						
		14/07/18	Recapture		T18	590530	7555290						
941 0000 1957 6573	Male	12/07/18	Capture	SM NQ I1	T49	590410	7556000	830	39.0	17.5	5	Some signs of fighting, localised fur loss. Otherwise healthy and good condition	
		15/07/18	Recapture	SM NQ I3	T30	590532	7555121						
941 0000 1957 6574	Male	14/07/18	Capture	SM NQ I3	T16b	592572	7554678	850	35.0	15.0	5	Heavy individual but could have some more body fat, fairly lean.	
941 0000 1957 6550	Male	12/07/18	Capture	SM NQ I1	T27	590504	7555029	870	34.5	19.0	5	Good body condition	
		13/07/18	Motion Camera		MC62 & MC63	590510	7555311						
		14/07/18	Motion Camera		MC61	590465	7555186						
		15/07/18	Recapture		T21	590463	7555180						
941 0000 1957 6549	Male	15/07/18	Capture	SM NQ I3	T14b	592533	7554656	660	36.0	15.5	5	No signs of fighting, healthy. Could have some more body fat	
		16/07/18	Recapture		T13b	592551	7554644						
No ID	unknown	13/07/18	Motion Camera	SM NQ I2	MC54, MC55 & MC57	592578	7554696	-	-	-	-	-	
Hamersley Rail Line													
2012													
M1	Male	30/08/12	Capture	HL NQ I2	C13	688138	7567662	400	37.2	14.2	2	Signs of fighting, missing fur	
Secondary evidence	-	01/09/12	Tracks	HL NQ I3	Opp	689742	7569490	-	-	-	-	Tracks	
2013													
M1a	Male	22/08/13	Capture	HL NQ I3	C17	680393	7561494	650	36.0		3	Patches of hair loss on tail and body from fighting	
		23/08/13	Recapture		C12	680581	7561745						
		25/08/13	Recapture		C20	680256	7561498						
M2	Male	22/0/13	Capture	HL NQ I3	C20	680286	7561493	550	36.0		3	Minimal tail fat, obvious scars from sighting and fur loss	
		23/08/13	Recapture		C15	680519	7561596						
M3	Male	23/08/13	Capture	HL NQ I3	C13	680555	7561695	570	39.0		3	Reproductive male, signs of fighting, limited body fat	
		25/08/13	Recapture		C18	680333	7561485						
		26/08/13	Recapture		C21	680256	7561498						
		27/08/13	Recapture		C22	680224	7561504						
M4	Female	23/08/13	Capture	HL NQ I3	C19	680286	7561493	320	32.0		3	Pouch empty, some scars from mating behaviour, limited body fat	
		25/08/13	Recapture		C21	680256	7561498						
		27/08/13	Recapture		C6	680555	7561827						
M5	Male	23/08/13	Capture	HL NQ I2	C2	688422	7567168	695	37.0		3	Some body fat	
2014													
941000016595546	Male	23/06/14	Capture	HL NQ I1	C12	694647	7577189	635	40	-	4		

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
		24/06/14	Recapture		C8	694471	7577471					Good condition. No signs of fighting	
		25/06/14	Recapture		C20	694436	7577540						
941000016595490	Male	25/06/14	Capture	HL NQ I2	C49	686230	7566417	765	38.0	-	5	Young male, good condition	
941000016202856	Female	25/06/14	Capture	HL NQ I2	C47	686410	7566459	455	36.0	-	5	Good condition	
941000016202859	Female	21/06/14	Capture	HL NQ I3	C2	680761	7561840	380	32.0	-	4	Small individual, but healthy	
		24/06/14	Recapture		C3	680706	7561821						
941000016202858	Female	25/06/14	Capture	HL NQ I3	C3	680709	7561843	415	32.0	-	4	Good conditions but small	
2015													
Secondary evidence	-	16/08/15	Tracks	HL NQ I1	-	694389	7577564	-	-	-	-	-	
Secondary evidence	-	20/08/15	Scats, Motion Camera	HL NQ I2	-	686237	7566416	-	-	-	-	-	
Secondary evidence	-	13/08/15	Scats, Motion Camera	HL NQ I3	-	680987	7561766	-	-	-	-	-	
2016													
Secondary evidence	-	02/08/16	Scats	HL NQ I2	-	687258	7567193						
Secondary evidence	-	21/12/16	Motion Camera	HL NQ I3	-	590583	755584						
2017													
Nil	-												
2018													
Nil-	-												
Main Line Rail													
2012													
MR M1	Male	17/08/12	Capture	5B	E4	696624	7605329	865	40	21.0	2	Sternal gland present indicating male territorial marking	
MR M2	Male	20/08/12	Capture	5B	E8	696610	7605140	755	41	24.5	4	Evidence of fighting	
MC 1	-	Aug 2012	Motion Camera	-		677268	7674893	-	-	-	-	-	
MC 2	-	Aug 2012	Motion Camera	-		677140	7674954	-	-	-	-	-	
MC 3	-	Aug 2012	Motion Camera	-		675916	7680865	-	-	-	-	-	
MC 4	-	Aug 2012	Motion Camera	-		677554	7674763	-	-	-	-	-	
MC 5	-	Aug 2012	Motion Camera	-		677149	7675051	-	-	-	-	-	
MC 6	-	Aug 2012	Motion Camera	-		675951	7680739	-	-	-	-	-	
MC 7	-	Aug 2012	Motion Camera	-		674098	7697778	-	-	-	-	-	
MC 8	-	Aug 2012	Motion Camera	-		692952	7634867	-	-	-	-	-	
MC 9	-	Aug 2012	Motion Camera	-		671697	7700806	-	-	-	-	-	
2013													
MR F3	Female	02/09/18	Capture	MR NQ I2	C16	675893	7680929	395	32.0	13.5	3.5	Patches of fur loss regrowing. Looks healthy, 5 x pouch young (10mm)	
		03/09/18	Recapture		C15	675909	7680957						
		07/09/18	Recapture		C18	675907	7680863						
MR M4	Male	07/09/18	Capture	MR NQ I2	C14	675921	7680973	405	34.6	13.1	3		
2014													

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
941000016202838	Male	23/08/14	Capture	MR NQ I3	C15	677035	7675062	750	38.0	-	3.5	Reasonably healthy, missing some fur and some body fat	
941000016202839	Male	23/08/14	Capture	MR NQ I2	C7	676022	7680857	720	41.0	-	3.5	Reasonably healthy, missing some fur and some body fat	
		24/08/14	Recapture		C20	675916	7680805						
		25/08/14	Recapture		C19	675899	7680840						
		26/08/14	Recapture		C18	675907	7680863						
2015													
Secondary evidence	-	30/08/15	Scats	MR NQ I1	Opp	674504	7686726	-	-	-	-	-	
Secondary evidence	-	30/08/15	MC	MR NQ I3	MC05	677403	7674826	-	-	-	-	-	
Secondary evidence	-	30/08/15	MC	MR NQ I3	MC07	677496	7674802	-	-	-	-	-	
2016													
941000017452	Male	31/07/16	Capture	MR NQ I3		677757	7674743	538	34.0	16.0	3	Skinny but no fur loss	
Secondary evidence	-	31/07/16	Scat	MR NQ I3	Opp	677136	7674729	-	-	-	-	-	
Secondary evidence	-	31/07/16	Scat	MR NQ I3	Opp	677440	7674623	-	-	-	-	-	
2017													
941000019576564	Male	12/08/17	Capture	MR NQ I2	C24	675999	7680856	800	39.0	17.0	4	Some fur loss but good condition	
941000019576563	Male	13/08/17	Capture	MR NQ I2	C28	676024	7680788	840	37.0	17.0	4	Some fur loss but good condition	
941000019576561	Female	11/08/17	Capture	MR NQ I3	C46	677139	7675050	490	34.0	17.0	5	Pouch slightly developed	
		12/08/17	Recapture	MR NQ I3	C2	677152	7674930						
		13/08/17	Recapture	MR NQ I3	C48	677076	7675059						
941000019576559	Male	11/08/17	Capture	MR NQ I3	C35	677644	7674888	730	37.0	15.0	4	Tail tip missing, some signs of fighting	
		12/08/17	Recapture	MR NQ I3	C3	677202	7674934						
941000017452030	Male	11/08/17	Capture	MR NQ I3	C46	677139	7675050	800	37.0	15.0	4	Was pulling on hessian bag whilst female trapped in cage. Entered the cage ibce the females was released and was processed.	
		12/08/17	Recapture	MR NQ I3	C3	677152	7674930						
2018													
941 0000 1957 6546	Male	02/08/18	Capture	ML NQ I1	C22	674464	7686687	790	15	32	4	Some signs of fighting, small patches of fur missing	
		03/08/18	Recapture		C24	674483	7686618						
991 0030 0017 4885	Male	30/07/18	Capture	ML NQ I2	C10	675910	7680832	720	15.4	36	4	very healthy. no evidence of fighting	
		31/07/18	Recapture		C17	675976	7681022						
		01/08/18	Recapture		C18	675980	7681016						
991 0030 0017 4888	Male	31/07/18	Capture	ML NQ I2	C33	676040	7680700	780	15.2	35.8	4	no signs of fighting	
		02/08/18	Recapture		C31	676035	7680743						
991 0030 0017 4889	Female	31/07/18	Capture	ML NQ I2	C10	675910	7680832	430	15.9	29.6	5	pouch development minimal	
		01/08/18	Recapture		C15	675925	7680971						
991 0030 0017 4876	Male	02/08/18	Capture	ML NQ I2	C12	675895	7680890	720	15.3	33.9	4	two small patches missing, some signs of fighting	

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
Secondary evidence	Scats	29/07/18	Secondary evidence	ML NQ I3	opp	677310	7674849						
Secondary evidence	Scats	29/07/18	Secondary evidence	ML NQ I3	opp	677278	7674900						
Secondary evidence	MC	04/10/18	Motion Camera	MR GB AS I14	opp	692955	7635026						
North Star													
2014													
941000016595571[F1-1]	Female	27/08/14	Capture	NS NQ I1	C21	712261	7650571	395	27.5	11.0	2.5	-	
		29/08/14	Recapture		C17	712230	7650449						
		30/08/14	Recapture		C5	712303	7650321						
941000016595479	Female	29/08/14	Capture	NS NQ I2	C18	712924	7648751	360	3.77	17.0	3.5	appears to have been mated, no young in pouch, large scars on both thighs, small patch of hair missing on back	
941000016202872	Male	25/08/14	Capture	NS NQ I1	C21	712261	7650571	275	36.5	11.5	4	Slender and small	
		26/08/14	Recapture	NS NQ I2	C18	712924	7648751						
		27/08/14	Recapture		C17	712924	7648726						
		28/08/14	Recapture		C16	712928	7648696						
		29/08/14	Recapture		C14	712934	7648633						
		30/08/14	Recapture		C14	712934	7648633						
941000016595484	Male	31/08/14	Capture	NS NQ I2	C18	712924	7648751	640	32.0	20.0	4		
941000016595499	Male	29/08/14	Capture	Site office	Additional	712658	7650700	530	37.3	15.0	3.5	signs of combat suggesting reproductive -	
		30/08/14	Recapture	NS NQ I2	C18	712924	7648751						
941000016595477	Male	26/08/14	Capture	NS NQ I2	C6	713065	7648513	800	38.5	15.5	4	Equipped with radio collar	
		28/08/14	Recapture	NS NQ I3	C4	713383	7647871						
		30/08/14	Recapture		C6	713319	7647876						
		31/08/14	Recapture		C6	713319	7647876						
941000016595575	Female	25/08/14	Capture	NS NQ I3	C5	713352	7647875	375	27.0	15.5	3.5	Healing wound	
		27/08/14	Recapture		C4	713383	7647871						
		29/08/14	Recapture		C12	713192	7647903						
		30/08/14	Recapture		C5	713352	7647875						
941000016595478	Male	25/08/14	Capture	NS NQ I4	C17	715813	7649275	560	21.3	17.0	3.5	reproductive male, signs of combat, missing fur on head and tail	
		29/08/14	Recapture		C15	715837	7649277						
941000016595496	Male	26/08/14	Capture	NS NQ I4	C19	715772	7649294	370	34.5	11.0	4.5	-	
		27/08/14	Recapture		C19	715772	7649294						
		28/08/14	Recapture		C15	715837	7649277						
		29/08/14	Recapture		C15	715837	7649277						
2015													
941 000016595571[F1-2]	Female	22/08/15	Capture	NS NQ I1	C12	712296	7650382	410	30.0	15.0	4	mated and has missing fur on sides, developed pouch, very grumpy mood	
941 000017452055^	Female	25/08/15	Capture	NS NQ I1	C24	712443	7650130	403	32.0	15.0	4	developed pouch with small embryos in it,	

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
												some sores and signs of fighting	
941 000017452056^	Male	26/08/15	Capture	NS NQ I1	C18	712350	7650282	524	36.0	14.0	3	some fighting and mating some fighting and fur missing, not much fat	
941 000016202842	Female	24/08/15	capture	NS NQ I2	C1	712924	7648751	345	33.0	13.0	4	developed pouch, missing fur on both sides indicating signs of mating	
		25/08/15	Recapture		C5	712934	7648633						
941 000017452061	Male	22/08/15	Capture	NS NQ I3	C7	713295	7647886	613	36.0	15.0	3	wounds	
941 000017452064	Female	24/08/15	Capture	NS NQ I3	C9	713264	7647912	445	40.9	15.0	4	developed pouch, no pouch young, good condition	
941 000017452060	Male	23/08/15	Capture	NS NQ I4	C6	716171	7649355	565	36.0	12.0	3.5	skinny	
		24/08/15	Recapture		C6	716171	7649355						
		25/08/15	Recapture		C5	716198	7649334						
941 000017452063	Female	25/08/15	Capture	NS NQ I4	C8	716106	7649354	347	31.0	10.0	4	good, developed pouch	
941 000017452071	Male	22/08/15	capture	NS NQ I4	C13	715935	7649279	547	48.9	15.5	3.5	fleas, mating and fighting, some hair loss	
		23/08/15	Recapture		C13	715935	7649279						
		25/08/15	Recapture		C19	715813	7649275						
		26/08/15	Recapture		C18	715815	7649288						
		27/08/15	Recapture		C21	715772	7649294						
2016													
941000017452045	Male	14/08/16	Capture	NS NQ I1	C9	712242	7650438	550	33.7	13.3	4	No bite marks or signs of fighting	
		15/08/16	Recapture		C10	712251	7650421						
941000017452052	Male	15/08/16	Capture	NS NQ I1	C9	712242	7650438	710	39.0	17.0	4	No bite marks	
		18/08/16	Recapture		C23	712415	7650185						
941000017452049	Male	15/08/16	Capture	NS NQ I1	C3	712202	7650547	616	32.9	15.8	4	Some fur missing	
		16/08/16	Recapture		C9	712242	7650438						
94100016595571 F1-3	Female	16/08/16	Recapture	NS NQ I1	C12	712296	7650382	475	30.0	15.0	4	Developed pouch, no young. Captured for 3rd year	
941 000017452064 F4-2	Female	12/08/16	Recapture	NS NQ I2	C3	712202	7650547	500	44.5	15.0	5	Captured for 2nd year, Pouch developed but no young, no hair loss	
2017													
941000016595532	Male	23/08/17	Capture	NS NQ I2	C25	713115	7648237	540	37.0	13.0	4	Signs of fighting	
		24/08/17	Recapture		C25	713115	7648237						
943094322007308	Male	23/08/17	Capture	NS NQ I4	C4	716221	7649311	575	38.3	16.0	4	Skinny, missing patches of fur	
		24/08/17	Recapture		C9	716064	7649328						
		25/08/17	Recapture		C9	716064	7649328						
		26/08/17	Recapture		C13	715935	7649279						
		29/08/17	Recapture		C6	716171	7649355						
941000017452028	Male	26/08/17	Recapture	NS NQ I4	C24	715706	7649304	720	38.8	12.8	3	Sign of fighting	
		27/08/17	Recapture		C25	715690	7649309						

ID (Microchip)	Sex	Date	Capture	Site	Trap	Co-ordinates		Weight	Short Pes (mm)	Caudal (mm)	Health Rating (1-5)	Reproductive Status	Comments
						Easting	Northing						
2018													
991 0030 0017 4871	Male	17/08/18	Capture	NS NQ I4	C17	713035	7647984	545	13.8	32	4	Signs of fighting	
		18/08/18	Recapture	NS NQ I4	C19	712958	7648002						
		19/08/18	Recapture	NS NQ I4	C18	712998	7648002						
991 0030 0017 4886	Male	20/08/18	Recapture	NS NQ I2	C24	713109	7648262						Individual captured at control site NS NQ C1 prior and post this record

Appendix 5: Statistical Analysis of Northern Quoll Data

Table 5.4: Statistical Analysis of Northern Quoll data using DENSITY

Site	Estimated population size ± SE								Capture probability (%)						Density (ML^{-1}/ha)						
	2012	20013	2014	2015	2016	2017	2018	2012	2013	2014	2015	2016	2017	2018	2012	2013	2014	2015	2016	2017	2018
Control Sites																					
DBCA																					
Mt Florance Station	-	-	6 ± 0.2 (6.0-6.7)	5 ± 0.7 (5.0-7.9)	3 ± 0.0 (3.0-3.4)	*	*	-	-	0.75	0.50	0.83	*	*	-	-	0.44	0.38	0.19	*	*
Indee Station	-	-	22 ± 0.3 (22.0-23.0)	25 ± 0.9 (25.0-28.3)	12 ± 0.6 (12.0-13.9)	29 ± 4.0 (23.4-40.7)	32 ± 0.9 (32.0-35.2)	-	-	0.74	0.59	0.60	0.32	0.61	-	-	0.68	0.81	0.31	0.60	0.72
Hooley Station	-	-	0	0	0	*	*	-	-	0	0	0	*	*	-	-	0	0	0	*	*
Fortescue																					
FC NQ C1	-	-	-	*	*	*	*	-	-	-	*	*	*	*	-	-	-	*	*	*	*
FC NQ C2	-	-	-	*	2 ± 1.4 (2.0-8.4)	*	2 ± 0.4 (2.0-3.2)	-	-	-	*	0.50	*	0.50	-	-	-	*	0.24	*	0.24
FC NQ C3	-	-	-	-	*	*	*	-	-	-	-	*	*	*	-	-	-	-	*	*	*
North Star																					
NS NQ C1	-	-	3 ± 0.5 (3.0-4.9)	2 ± 0.2 (2.0-3.1)	2 ± 0.4 (2.0-4.5)	4 ± 0.6 (4.0-6.7)	1 ± 0.0 (1.0-1.4)	-	-	0.39	0.63	0.50	0.50	0.80	-	-	0.25	0.17	0.19	0.40	0.09
NS NQ C2	-	-	5 ± 1.0 (5.0-11.8)	1 ± 0.3 (1.0-4.2)	1 ± 0.4 (1.0-5.3)	5 ± 2.0 (4.0-20.7)	*	-	-	0.38	0.50	0.29	0.17	*	-	-	0.52	0.18	0.17	0.87	*
NS NQ C3	-	-	-*	-*	-*	4 ± 1.0 (4.0-11.0)	*	-	-	-*	-*	-*	0.25	*	-	-	-*	-*	-*	1.98	*
NS NQ C4	-	-	2 ± 0.4 (2.0-3.2)	4 ± 0.1 (4.0-4.5)	4 ± 2.3 (3.0-52.0)	5 ± 0.7 (5.0-8.0)	5 ± 1.0 (5.0-11.6)	-	-	0.50	0.57	0.14	0.31	0.53	-	-	0.37	0.75	1.98	2.46	2.46
Potential Impact Sites																					
Solomon																					
SM NQ I1	*	3 ± 0.9 (3.0-11.3)	3 ± 0.7 (3.0-6.6)	*	4 ± 3.5 (4.0-81.1)	*	6 ± 0.5 (6.0-7.7)	*	0.23	0.28	*	0.20	*	0.58	*	0.02	0.02	*	0.32	*	0.32
SM NQ I2				*	*	3 ± 0.5 (3.0– 5.5)	*				*	*	0.50	*				*	*	0.26	*
SM NQ I3	*	*	*	*	*	*	4 ± 2.2 (3.0-41.0)	*	*	*	*	*	*	0.25	*	*	*	*	*	*	1.17
Hamersley Rail Line																					
HL NQ I1 (former NQ I3)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
HL NQ I2 (former NQ I6)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
HL NQ I3 (former NQ I1)	*	4 ± 0.3 (4.0-5.0)	2 ± 0.8 (2.0-16.4)	*	*	*	*	*	0.5	0.3	*	*	*	*	*	0.24	0.12	*	*	*	*
Main Line Rail																					
MR NQ I1	*	*	*	*	*	*	2 ± 0.5 (2.0-5.2)	*	*	*	*	*	*	*	*	*	*	*	*	*	*
MR NQ I2	*	2 ± 0.5 (2.0-5.2)	*	*	*	*	4 ± 0.6 (4.0-6.7)	*	0.3	*	*	*	*	0.5	*	0.59	*	*	*	*	1.19
MR NQ I3	*	*	*	*	*	3 ± 0.5 (3.0-5.5)	*	*	*	*	*	*	0.50	*	*	*	*	*	*	0.12	*
North Star																					

NS NQ I1	*	*	2 ± 0.5 (2.0-5.2)	*	4 ± 0.9 (4.0-10.5)	*	*	*	*	0.38	0.40	*	0.50	*	*	*	1.083	0.361	*	0.72	*
NS NQ I2	*	*	3 ± 0.4 (3.0-4.4)	1 ± 0.3 (1.0-4.7)	*	2 ± 1.4 (2.0-8.4)	*	*	*	0.38	*	*	*	*	*	*	0.496	*	*	*	*
NS NQ I3	*	*	2 ± 0.1 (2.0-2.7)	-*	*	-*	*	*	*	0.60	0.50	*	0.50	*	*	*	0.488	0.731	*	0.48	*
NS NQ I4	*	*	2 ± 0.1 (2.0-2.8)	3 ± 0.2 (3.0-3.9)	*	2 ± 0.1 (2.0-2.7)	2 ± 0.7 (2.0-4.0)	*	*	0.38	0.40	*	0.50	0.5	*	*	1.083	0.361	*	0.72	0.48

*Data or Monitoring methods are not suitable for statistical analysis using MARK (e.g. no captures or no recaptures)
ML=Maximum likelihood per hectare

Table 5.5: 95 % Confidence Interval of Northern Quoll population estimate (combined sites)

Site	95 % Confidence Interval						
	2012	20013	2014	2015	2016	2017	2018
Control Sites							
DBCA							
Indee Station	-	-	22.0-23.0	25.0-28.3	12.0-13.9	23.4-40.7	32.0-35.2
Fortescue							
FC NQ C2	-	-	-	NC	2.0-8.4	NC	2.0-3.2
North Star							
NS NQ C1 & C2	-	-	7.0-10.0	3.0-4.4	3.0-10.7	7.0-10.9	4.0-10.5
NS NQ C3 & C4	-	-	2.0-3.4	4.0-4.5	3.0-52.0	9.0-14.9	7.0-29.3
Potential Impact Sites							
Solomon							
SM NQ I1 – SM NQ I3	No captures	3.0-11.3	3.0-6.6	Methods not suitable	4.0-16.0	4.0-9.0	8.0-10.1
Main Line Rail							
MR NQ I1 – MR NQ I3	No captures from the current sites	2.0-5.2	2.0-3.1	Methods not suitable	Data insufficient for statistical analysis	5.0-8.3	5.0-7.9
North Star							
NS NQ I1 – NS NQ I4	*	*	9.0-10.4	9.0-17.7	5.0-16.9	3.0-4.0	2.0-4.5

NC=No Captures

Appendix 6: Greater Bilby records

Table 5.6: Greater Bilby records

Record ID	Type of recording	Date	Easting	Northing
Control Sites				
MR GB AS C16				
2013/2014				
MR GB2	Motion Camera	Jun'14	744761	7606937
2014/2015				
BB C3	Active Burrow	Jun'2015	744845	7607229
BB C4	Active Burrow	Jun'2015	744848	7607299
BB C5	Active Burrow	Jun'2015	744890	7606942
BB C6	Active Burrow	Jun'2015	744892	7606932
2015/2016				
BB C7	Active Burrow	Jun'2015	744777	7607302
BB C8	Active Burrow	Jun'2015	744780	7607298
BB C9	Active Burrow	Jun'2015	744975	7606777
BB C10	Active Burrow	Jun'2015	745080	7606861
BB C11	Active Burrow	Jun'2015	745171	7606915
2016/2017				
BB C12	Active Burrow	Jun'2016	701065	7614184
BB C13	Active Burrow	Jun'2016	744892	7606942
BB C14	Active Burrow	Jun'2016	744892	7606941
BB C15	Active Burrow	Jun'2016	744899	7606839
BB C16	Active Burrow	Jun'2016	744956	7606774
BB C17	Active Burrow	Jun'2016	745080	7605863
2017/2018				
BB C18	Active Burrow	Jun'2017	744850	7607231
2018/2019				
Nil				
Potential Impact Sites				
MR GB AS I14				
2013/2014				
F2	Female captured	4/6/14	692889	7634869
BB I5	Active Burrow	3/6/14	693126	7634935
	Active Burrow	3/6/14	693166	7634939
	Active Burrow	3/6/14	693352	7634971
2014/2015				
BB I6	Active Burrow	Jun'15	693097	7634937
BB I7	Active Burrow	Jun'15	693154	7634998
BB I8	Active Burrow	Jun'15	693226	7635207
2015/2016				
BB I9	Active Burrow	Jun'16	693009	7634972
BB I10	Active Burrow	Jun'16	693055	7634975
BB I11	Active Burrow	Jun'16	693104	7635056

BB I12	Active Burrow	Jun'16	693138	7634942
BB I13	Active Burrow	Jun'16	693271	7634936
BB I14	Active Burrow	Jun'16	693291	7635207
2016/2017				
BB I15	Active Burrow	Jun'16	692964	7634950
BB I16	Active Burrow	Jun'16	693010	7634977
BB I17	Active Burrow	Jun'16	693038	7635021
BB I18	Active Burrow	Jun'16	693047	7634975
BB I19	Active Burrow	Jun'16	693069	7635011
BB I20	Active Burrow	Jun'16	693138	7634982
BB I21	Active Burrow	Jun'16	693151	7634999
BB I22	Active Burrow	Jun'16	693156	7635160
BB I23	Active Burrow	Jun'16	693259	7635134
BB I24	Active Burrow	Jun'16	693755	7632573
BB I25	Active Burrow	Jun'16	693808	7632604
2017/2018				
BB I26	Active Burrow	Jun'17	693325	7635186
BB I27	Active Burrow	Jun'17	693193	7634947
BB I28	Active Burrow	Jun'17	693310	7635162
BB I29	Active Burrow	Jun'17	693252	7635042
BB I30	Active Burrow	Jun'17	6935081	7635081
2018/2019				
BB I31	Active Burrow	Jun'18	693168	7634939

Appendix 7: Bat Identifications

Bat call identification from Christmas Creek, North Star and Mainline Rail, Western Australia

Type:	Acoustic analysis
Prepared for:	Spectrum Ecology Pty Ltd
Date:	18 February 2019
Job No.:	SZ482

Prepared by:

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This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2019). Bat call identification from Christmas Creek, North Star and Mainline Rail, Western Australia. Acoustic analysis. Unpublished report by Specialised Zoological for Spectrum Ecology Pty Ltd, 18 February 2019, Job number SZ482.

Summary

Bat identifications from acoustic recordings are provided from the Christmas Creek, North Star and Mainline Rail project areas, in the Pilbara region of Western Australia. The identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics. Ten species of bat were identified as being present (**Tables 1–4**), though a species-level determination of identity was not possible for calls attributed to one or more long-eared bat species (*Nyctophilus* spp.). Two bat species of conservation significance were recorded—Ghost Bat *Macroderma gigas* (North Star project area), and Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Mainline Rail and North Star project areas). The activity of the Pilbara Leaf-nosed Bat is summarised in **Tables 5** and **6**, and **Appendices 1** and **2**. The activity of the Ghost Bat is summarised in **Table 7**. Representative echolocation calls for each identification are illustrated (**Figures 1** and **2**), as recommended by the Australasian Bat Society (ABS 2006). Further information is available should verification be required.

Methods

Data provided for analysis was recorded in full spectrum WAV format (sampling rate of 384 kHz) with Wildlife Acoustics SM2BAT+ and SM4BAT bat detectors.

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong and Aplin 2014; Armstrong et al. 2016) was applied to the recordings made on the survey. Firstly, the WAV files were scanned for bat echolocation calls using several parameter sets in the software SCAN'R version 1.8.3 (Binary Acoustic Technology), which also provides measurements (in "SCAN'R output") from each putative bat pulse. The output was then used to determine if putative bat pulses measured in SCAN'R could be identified to species. This was done using a custom [R] language script that performed three tasks: 1. undertook a Discriminant Function Analysis on training data from representative calls from the Pilbara region; 2. from the measurements of each putative bat pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the echolocation call types derived from the analysis of training data, and plotted these resulting coordinates over confidence regions for the defined call types; and 3. facilitated an inspection in a spectrogram of multiple examples of each call type for each recording night by opening the original WAV files containing pulses of interest in Adobe Audition CS6 version 5.0.2. Species were identified based on information in McKenzie and Bullen (2009) and the authors' unpublished resources; and nomenclature follows Jackson and Groves (2015).

Limitations

The identifications presented in this report have been made within the following context:

1. The information provided herein is based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to identifying all bat species present in the recordings from their echolocation calls, especially bat species of conservation significance. Further comment on these species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was not set up and supplied by Specialised Zoological. The equipment was operated by the third party during the surveys.
4. Specialised Zoological has not made site visits to observe the habitats available for bats, nor have we visited the specific project area on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of these bat surveys, recording site placement, nor the degree of recording site replication.
6. While Specialised Zoological has provided the information contained in this report to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.

References

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Table 1. Species identified in the present survey from all sites combined.

MEGADERMATIDAE	
Ghost Bat	*Macroderma gigas*
RHINONYCTERIDAE	
Pilbara Leaf-nosed Bat	*Rhinonicteris aurantia*
EMBALLONURIDAE	
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Common Sheath-tailed Bat	*Taphozous georgianus*
VESPERTILIONIDAE	
Gould's Wattled Bat	*Chalinolobus gouldii*
Little Broad-nosed Bat	*Scotorepens greyii*
Finlayson's Cave Bat	*Vespadelus finlaysoni*
Ambiguous	
Unidentified Long-eared Bat	*Nyctophilus* sp.
MOLOSSIDAE	
Greater Northern Free-tailed Bat	*Chaerephon jobensis*
Northern Free-tailed Bat	*Ozimops lumsdenae* (=*Mormopterus beccarii*)

Table 2. Species identifications from the Christmas Creek project area, with the degree of confidence indicated by a code. See Table 1 for full species names. Note that sites not listed below either had no data in folders, or else data was recorded at a sampling rate of 16 kHz, which is not suitable for bat echolocation.

		C. gouldii	*C. jobensis*	*M. gigas*	*Nyctophilus sp.*	*O. lumsdenae*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Song Meter serial	**Site**										
OE01	**CC Bat C11**										
12/12/2018		◆	◆	—	—	—	—	◆	◆	—	—
13/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
14/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
15/12/2018		◆	◆	—	—	◆	—	◆	◆	—	◆
16/12/2018		◆	◆	—	—	—	—	◆	◆	—	◆
17/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
18/12/2018		◆	—	—	—	◆	—	—	◆	—	◆
3873	**CC Bat C09**										
11/12/2018		◆	◆	—	—	—	—	—	◆	—	◆
12/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
13/12/2018		◆	◆	—	—	—	—	—	◆	—	◆
14/12/2018		◆	—	—	—	—	—	—	◆	—	—
15/12/2018		—	—	—	—	—	—	—	◆	—	◆
16/12/2018		◆	—	—	—	—	—	—	◆	—	◆
17/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
18/12/2018		◆	—	—	—	—	—	—	◆	—	◆
3897	**CC Bat C12**										
11/12/2018		—	—	—	—	—	—	—	◆	—	—
12/12/2018		—	—	—	—	—	—	—	◆	—	◆
13/12/2018		—	—	—	—	—	—	—	◆	—	—
14/12/2018		—	—	—	—	—	—	—	◆	—	◆
15/12/2018		—	—	—	—	—	—	—	◆	—	—
16/12/2018		—	◆	—	—	—	—	—	◆	—	◆
17/12/2018		—	◆	—	—	—	—	—	◆	◆	◆
18/12/2018		—	—	—	—	—	—	—	◆	—	—
4058	**CC Bat C07**										
11/12/2018		—	—	—	—	—	—	—	◆	—	◆
12/12/2018		—	—	—	—	—	—	—	◆	—	◆
13/12/2018		—	—	—	—	—	—	—	◆	—	—
14/12/2018		—	—	—	—	—	—	—	◆	—	—
15/12/2018		◆	—	—	—	—	—	—	◆	—	◆
16/12/2018		—	—	—	—	—	—	—	◆	—	◆
17/12/2018		—	—	—	—	—	—	—	◆	—	◆
18/12/2018		—	—	—	—	—	—	—	◆	—	◆
6081	**CC Bat I10**										
10/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
11/12/2018		◆	—	—	—	—	—	—	◆	—	—
12/12/2018		—	◆	—	—	—	—	—	◆	—	◆
13/12/2018		—	—	—	—	◆	—	—	◆	—	◆

Song Meter serial	Site	*C. gouldii*	*C. jobensis*	*M. gigas*	*Nyctophilus sp.*	*O. lumsdenae*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
14/12/2018		◆	—	—	—	—	—	—	◆	—	—
15/12/2018		◆	—	—	—	—	—	—	◆	—	—
16/12/2018		◆	—	—	—	—	—	—	◆	—	—
17/12/2018		—	—	—	—	—	—	—	—	—	—
6186	**CC Bat C10**										
11/12/2018		◆	—	—	—	—	—	—	◆	◆	◆
12/12/2018		◆	—	—	—	—	—	—	◆	—	—
13/12/2018		—	—	—	—	—	—	—	—	—	—
14/12/2018		—	—	—	—	—	—	—	◆	—	—
15/12/2018		◆	—	—	—	—	—	◆	◆	—	—
16/12/2018		◆	—	—	—	—	—	◆	◆	—	—
6252	**CC Bat I02**										
10/12/2018		◆	—	—	—	—	—	—	◆	—	—
11/12/2018		—	—	—	—	—	—	—	◆	—	—
12/12/2018		◆	—	—	—	—	—	—	◆	—	—
13/12/2018		—	—	—	—	—	—	—	◆	—	—
14/12/2018		—	—	—	—	—	—	—	◆	—	—
15/12/2018		—	◆	—	—	—	—	—	◆	—	—
16/12/2018		—	◆	—	—	—	—	—	—	—	—
17/12/2018		—	—	—	—	—	—	—	—	—	—
6253	**CC Bat I09**										
10/12/2018		—	—	—	—	—	—	—	◆	—	—
11/12/2018		—	◆	—	NC	—	—	—	—	—	—
12/12/2018		—	—	—	NC	—	—	—	◆	—	—
13/12/2018		—	—	—	NC	—	—	—	◆	—	—
14/12/2018		◆	—	—	—	—	—	—	◆	—	—
15/12/2018		◆	—	—	NC	—	—	—	◆	—	—
16/12/2018		—	—	—	NC	—	—	—	◆	—	—
17/12/2018		—	—	—	NC	—	—	—	◆	—	—
6253	**CC Bat I09**										
11/12/2018		◆	—	—	—	—	—	—	◆	—	—
12/12/2018		—	—	—	—	—	—	—	◆	—	—
13/12/2018		—	—	—	—	—	—	—	◆	—	—
14/12/2018		—	—	—	—	—	—	—	◆	—	—
6257	**CC Bat I05**										
11/12/2018		—	—	—	—	—	—	—	—	—	—
12/12/2018		—	—	—	—	—	—	—	◆	—	—
13/12/2018		◆	—	—	—	—	—	—	◆	—	—
14/12/2018		—	—	—	—	—	—	—	◆	—	◆
15/12/2018		—	—	—	—	—	—	—	◆	—	—
16/12/2018		◆	—	—	—	—	—	—	◆	—	◆
17/12/2018		◆	—	—	—	—	—	—	◆	—	—
6259	**CC Bat C01**										
11/12/2018		—	—	—	—	—	—	—	◆	—	—
12/12/2018		—	—	—	—	—	—	—	◆	—	◆

Song Meter serial	Site	*C. gouldii*	*C. jobensis*	*M. gigas*	*Nyctophilus sp.*	*O. lumsdenae*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
13/12/2018		—	—	—	—	—	—	—	—	—	—
6260	**CC Bat C06**										
11/12/2018		—	—	—	—	—	—	—	◆	—	—
12/12/2018		—	—	—	—	—	—	—	◆	—	—
13/12/2018		◆	—	—	—	—	—	—	◆	—	—
14/12/2018		—	—	—	—	—	—	—	◆	—	—
15/12/2018		—	—	—	—	—	—	◆	◆	—	—
6261	**CC Bat C03**										
11/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
12/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
13/12/2018		—	—	—	—	—	—	—	◆	—	—
14/12/2018		◆	—	—	—	—	—	◆	◆	—	—
15/12/2018		◆	—	—	—	—	—	—	◆	—	—
6262	**CC Bat I08**										
11/12/2018		◆	—	—	—	—	—	—	—	—	—
12/12/2018		◆	◆	—	—	—	—	—	—	—	—
13/12/2018		◆	—	—	NC	—	—	—	—	—	—
14/12/2018		—	◆	—	—	—	—	—	—	—	—
15/12/2018		◆	—	—	—	—	—	—	◆	—	—
16/12/2018		—	—	—	—	—	—	—	◆	—	—
17/12/2018		—	—	—	—	—	—	—	—	—	—
6266	**CC Bat I01**										
11/12/2018		◆	—	—	—	—	—	—	◆	—	—
12/12/2018		◆	—	—	—	—	—	—	◆	—	◆
13/12/2018		◆	◆	—	—	—	—	—	◆	—	◆
14/12/2018		◆	—	—	—	—	—	—	◆	—	◆
15/12/2018		—	—	—	—	—	—	—	◆	—	◆
16/12/2018		◆	—	—	—	—	—	—	◆	—	◆
17/12/2018		◆	—	—	—	—	—	—	◆	—	◆
6269	**CC Bat I04**										
11/12/2018		◆	—	—	—	—	—	—	◆	◆	◆
12/12/2018		◆	—	—	—	—	—	—	◆	◆	◆
13/12/2018		◆	—	—	—	—	—	—	◆	—	◆
14/12/2018		◆	—	—	—	—	—	—	◆	—	◆
15/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
6270	**CC Bat I03**										
10/12/2018		—	—	—	—	—	—	—	◆	—	—
11/12/2018		—	—	—	—	—	—	—	◆	—	◆
12/12/2018		—	—	—	—	—	—	—	◆	—	—
6272	**CC Bat C04**										
11/12/2018		◆	—	—	—	—	—	—	◆	—	—
12/12/2018		◆	—	—	—	—	—	◆	◆	—	—
13/12/2018		◆	—	—	—	—	—	◆	◆	—	—
14/12/2018		◆	—	—	—	—	—	◆	◆	—	—
15/12/2018		◆	—	—	—	—	—	—	◆	—	◆

Song Meter serial	Site	*C. gouldii*	*C. jobensis*	*M. gigas*	*Nyctophilus sp.*	*O. lumsdenae*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
6273	**CC Bat I07**										
10/12/2018		◆	—	—	—	—	—	—	◆	—	—
11/12/2018		◆	—	—	—	—	—	—	◆	—	—
12/12/2018		◆	—	—	—	—	—	—	◆	—	—
13/12/2018		◆	—	—	—	—	—	—	—	—	—
14/12/2018		—	—	—	—	—	—	—	◆	—	—
15/12/2018		—	—	—	—	—	—	—	◆	—	—
16/12/2018		◆	—	—	—	—	—	—	◆	—	—
17/12/2018		—	—	—	NC	—	—	—	—	—	—
6282	**CC Bat I06**										
11/12/2018		—	—	—	—	—	—	◆	◆	—	—
12/12/2018		—	—	—	—	—	—	◆	◆	—	—
13/12/2018		◆	—	—	—	—	—	—	◆	—	◆
14/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
15/12/2018		◆	—	—	—	—	—	—	—	—	—
16/12/2018		—	—	—	—	—	—	◆	◆	—	◆
17/12/2018		—	—	—	—	—	—	◆	◆	—	◆
6285	**CC Bat I12**										
10/12/2018		◆	◆	—	—	—	—	—	◆	—	◆
11/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
12/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
13/12/2018		◆	—	—	—	—	—	—	◆	—	◆
14/12/2018		◆	—	—	—	—	—	—	◆	—	—
15/12/2018		◆	—	—	—	—	—	◆	◆	—	◆
16/12/2018		—	◆	—	—	—	—	◆	◆	—	◆
17/12/2018		—	—	—	—	—	—	—	—	—	—

Definition of confidence level codes:

— Not detected.

◆ Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or a DNA sequence.

NC Needs Confirmation. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the *Comments on identifications* section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

Table 3. Species identifications from the North Star project area, with the degree of confidence indicated by a code. See Table 1 for full species names, and Table 2 for an explanation of confidence level codes. Note that sites not listed below either had no data in folders, or else data was recorded at a sampling rate of 16 kHz, which is not suitable for bat echolocation.

		C. gouldii	*C. jobensis*	*M. gigas*	*Nyctophilus sp.*	*O. lumsdenae*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Song Meter serial	**Site**										
14827	**NS Bat C2**										
3/12/2018		—	—	—	—	—	◆	—	◆	◆	◆
4/12/2018		◆	—	—	—	—	◆	—	◆	◆	◆
5/12/2018		—	—	—	—	—	◆	—	◆	◆	◆
6/12/2018		—	—	—	—	—	◆	—	◆	◆	◆
14897	**Chateau Cave**										
2/12/2018		◆	—	—	—	—	◆	—	◆	◆	—
3/12/2018		◆	—	—	—	—	◆	—	◆	◆	◆
4/12/2018		—	—	—	—	—	◆	—	—	◆	◆
5/12/2018		◆	◆	—	—	—	—	—	◆	◆	◆
7975	**NS Bat C3**										
3/12/2018		—	—	—	—	—	◆	—	—	◆	◆
4/12/2018		—	—	◆	—	—	◆	—	◆	◆	—
5/12/2018		—	—	◆	—	—	◆	—	—	◆	◆
6/12/2018		—	—	—	—	—	◆	—	—	◆	◆
14654	**Cave 13**										
2/12/2018		—	—	—	—	—	◆	—	—	—	◆
3/12/2018		—	—	—	—	—	◆	—	—	—	◆
4/12/2018		—	—	◆	—	—	◆	—	◆	◆	◆
5/12/2018		—	—	—	—	—	◆	—	◆	—	◆
6/12/2018		—	—	—	—	—	◆	—	◆	—	◆

Table 4. Species identifications from the Mainline Rail project area, with the degree of confidence indicated by a code. See Table 1 for full species names, and Table 2 for an explanation of confidence level codes. Note that sites not listed below either had no data in folders, or else data was recorded at a sampling rate of 16 kHz, which is not suitable for bat echolocation.

		C. gouldii	*C. jobensis*	*M. gigas*	*Nyctophilus sp.*	*O. lumsdenae*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Song Meter serial	**Site**										
OE01	**MR Bat C09**										
28/11/2018		◆	—	—	—	—	—	—	—	—	—
29/11/2018		◆	—	—	—	—	—	—	—	—	—
30/11/2018		—	—	—	—	—	—	—	—	—	—
1/12/2018		—	—	—	—	—	—	—	—	—	—
2/12/2018		◆	—	—	—	—	◆	—	—	—	—
3/12/2018		◆	—	—	—	—	◆	—	—	—	—
4/12/2018		◆	◆	—	—	—	—	—	◆	—	◆
OE08	**MR Bat C08**										
28/11/2018		◆	—	—	—	—	—	—	◆	—	—
29/11/2018		◆	—	—	—	—	—	—	◆	—	—
30/11/2018		◆	—	—	—	—	—	—	◆	—	—
1/12/2018		—	—	—	—	—	—	—	◆	—	—
2/12/2018		—	—	—	—	—	—	—	◆	—	—
3/12/2018		◆	—	—	—	—	—	—	◆	—	—
4/12/2018		◆	—	—	—	—	—	—	◆	—	—
OE09	**MR Bat C01**										
28/11/2018		◆	◆	—	—	—	—	—	—	—	—
29/11/2018		—	◆	—	—	—	—	—	◆	—	—
30/11/2018		◆	—	—	—	—	—	—	—	—	—
1/12/2018		—	—	—	—	—	—	—	◆	—	—
2/12/2018		—	—	—	—	—	—	—	—	—	—
3/12/2018		—	—	—	—	—	◆	—	—	—	—
4/12/2018		◆	—	—	—	—	—	—	◆	—	—
3873	**MR Bat C06**										
28/11/2018		—	—	—	—	—	◆	—	—	◆	—
29/11/2018		—	—	—	—	—	—	—	◆	◆	—
30/11/2018		—	—	—	—	—	—	—	◆	◆	—
2/12/2018		◆	—	—	—	—	—	—	—	—	—
3/12/2018		◆	—	—	—	—	—	—	◆	—	—
4/12/2018		◆	—	—	—	—	—	—	◆	—	—
3897	**MR Bat C07**										
28/11/2018		—	—	—	—	—	—	—	—	—	—
29/11/2018		—	—	—	—	—	—	—	—	—	—
30/11/2018		—	—	—	—	—	—	—	—	—	—
1/12/2018		—	—	—	—	—	—	—	—	—	—
2/12/2018		—	—	—	—	—	—	—	—	—	—
3/12/2018		—	—	—	—	—	—	—	—	—	—
4/12/2018		—	—	—	—	—	—	—	—	—	—

Song Meter serial	Site	*C. gouldii*	*C. jobensis*	*M. gigas*	*Nyctophilus sp.*	*O. lumsdenae*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
4058	**MR Bat I01**										
28/11/2018		◆	◆	—	—	—	◆	—	◆	◆	—
29/11/2018		◆	◆	—	—	—	◆	—	◆	◆	—
30/11/2018		◆	◆	—	—	—	◆	—	◆	◆	—
1/12/2018		◆	◆	—	—	—	◆	◆	◆	◆	—
2/12/2018		◆	◆	—	—	—	◆	◆	—	—	—
3/12/2018		◆	◆	—	—	—	◆	◆	—	—	—
4/12/2018		◆	◆	—	—	—	◆	—	◆	◆	—
5/12/2018		◆	◆	—	—	—	◆	—	◆	◆	—
6081	**MR Bat I11**										
29/11/2018		◆	—	—	—	—	◆	—	◆	—	—
30/11/2018		—	◆	—	—	—	◆	—	—	—	—
1/12/2018		—	—	—	—	—	—	—	—	—	—
6252	**MR Bat I06**										
29/11/2018		◆	—	—	—	—	◆	—	—	◆	—
30/11/2018		—	—	—	—	—	◆	—	—	◆	—
6253	**MR Bat C12**										
29/11/2018		◆	—	—	—	—	◆	—	—	—	—
30/11/2018		◆	—	—	—	—	◆	—	—	◆	—
6256	**MR Bat I03**										
28/11/2018		◆	—	—	—	—	—	—	—	—	—
29/11/2018		◆	—	—	—	—	—	—	—	—	—
30/11/2018		◆	—	—	—	—	—	—	—	—	—
1/12/2018		—	—	—	—	—	—	—	◆	—	—
2/12/2018		—	—	—	—	—	—	—	◆	—	—
6260	**MR Bat I08**										
29/11/2018		◆	—	—	—	—	◆	—	—	—	—
30/11/2018		◆	—	—	—	—	◆	—	◆	—	—
1/12/2018		—	—	—	—	—	—	—	—	—	—
6266	**MR Bat I04**										
29/11/2018		◆	—	—	—	—	◆	—	◆	—	—
30/11/2018		◆	—	—	—	—	◆	—	◆	—	◆
1/12/2018		◆	—	—	—	—	◆	—	◆	—	—
6269	**MR Bat C02**										
28/11/2018		—	—	—	—	—	—	—	—	—	—
29/11/2018		—	—	—	—	—	—	—	—	—	—
6270	**MR Bat I07**										
29/11/2018		—	—	—	—	—	◆	—	—	—	—
6272	**MR Bat C04**										
29/11/2018		—	—	—	—	—	—	—	◆	◆	—
30/11/2018		—	—	—	—	—	◆	—	—	◆	—
1/12/2018		—	—	—	—	—	—	—	—	◆	—
2/12/2018		—	—	—	—	—	—	—	—	—	—
6273	**MR Bat C05**										
29/11/2018		—	—	—	—	—	—	—	—	—	—

		C. gouldii	*C. jobensis*	*M. gigas*	*Nyctophilus sp.*	*O. lumsdenae*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Song Meter serial	**Site**										
30/11/2018		—	—	—	—	—	◆	—	—	—	—
1/12/2018		—	—	—	—	—	—	—	—	—	—
6282	**MR Bat I12**										
29/11/2018		◆	—	—	—	—	—	◆	◆	◆	◆
30/11/2018		◆	—	—	—	—	◆	—	◆	—	◆
1/12/2018		◆	—	—	—	—	—	—	◆	—	—
6285	**MR Bat C03**										
29/11/2018		—	—	—	—	—	—	—	—	—	—
30/11/2018		—	—	—	—	—	—	—	—	—	—

Table 5. Summary of the activity of the Pilbara Leaf-nosed Bat in the North Star project area (see Appendix 1 for further details). Blue shading aids inspection for different recording units.

Recorder	Recording night	Time of first detection	Time of last detection	Total bat passes
14827	2018-12-03	20:10:39	04:30:39	27
14827	2018-12-04	21:31:08	04:34:54	46
14827	2018-12-05	20:49:01	04:38:29	31
14827	2018-12-06	22:17:29	03:33:10	36
14897	2018-12-02	03:24:48	05:30:05	8
14897	2018-12-03	02:12:26	05:33:47	13
14897	2018-12-04	02:32:02	03:51:15	9
7975	2018-12-03	19:53:19	03:03:23	8
7975	2018-12-04	21:46:34	04:24:20	8
7975	2018-12-05	20:28:27	02:55:04	4
7975	2018-12-06	19:58:19	02:49:46	5
14654	2018-12-02	20:41:05	03:55:05	52
14654	2018-12-03	20:19:57	04:21:01	112
14654	2018-12-04	19:57:16	04:07:48	40
14654	2018-12-05	20:54:01	04:26:26	43
14654	2018-12-06	20:16:02	02:45:40	30

Table 6. Summary of the activity of the Pilbara Leaf-nosed Bat in the Mainline Rail project area (see Appendix 2 for further details). Blue shading aids inspection for different recording units.

Recorder	Recording night	Time of first detection	Time of last detection	Total bat passes
OE01	2018-12-02	22:07:00	22:07:00	1
OE01	2018-12-03	01:05:58	01:05:58	1
OE09	2018-12-03	23:45:44	23:45:44	1
S4U03873	2018-11-28	23:13:13	23:13:13	1
S4U04058	2018-11-28	21:05:46	01:09:21	5
S4U04058	2018-11-29	21:45:27	02:58:51	5
S4U04058	2018-11-30	23:03:44	02:57:54	3
S4U04058	2018-12-01	21:52:19	00:59:08	5
S4U04058	2018-12-02	22:09:29	02:39:45	4
S4U04058	2018-12-03	21:53:21	01:00:14	5
S4U04058	2018-12-04	22:14:14	03:18:27	4
S4U04058	2018-12-05	22:45:27	03:07:14	6
S4U06081	2018-11-29	20:53:20	02:51:36	4
S4U06081	2018-11-30	00:20:20	02:32:07	3
S4U06252	2018-11-29	23:26:06	02:39:23	2
S4U06252	2018-11-30	20:39:55	20:39:55	1
S4U06253	2018-11-29	20:28:16	03:37:00	49
S4U06253	2018-11-30	20:22:52	03:44:42	61
S4U06260	2018-11-29	20:15:05	03:25:44	12
S4U06260	2018-11-30	20:11:47	03:18:06	20
S4U06266	2018-11-29	20:25:38	03:17:50	14
S4U06266	2018-11-30	20:37:23	03:37:29	23
S4U06266	2018-12-01	20:07:40	21:24:52	5
S4U06270	2018-11-29	20:16:04	20:16:04	1
S4U06272	2018-11-30	20:38:57	20:38:57	1
S4U06273	2018-11-30	21:10:09	21:10:09	1
S4U06282	2018-11-30	02:39:12	02:39:12	1

Table 7. Summary of the activity of the Ghost Bat in the North Star project area.

Recorder	Night of recording	Times detected
7975	2018-12-04	21:05:46
7975	2018-12-05	19:34:17 19:38:18
14654	2018-12-04	22:40:02 03:18:26

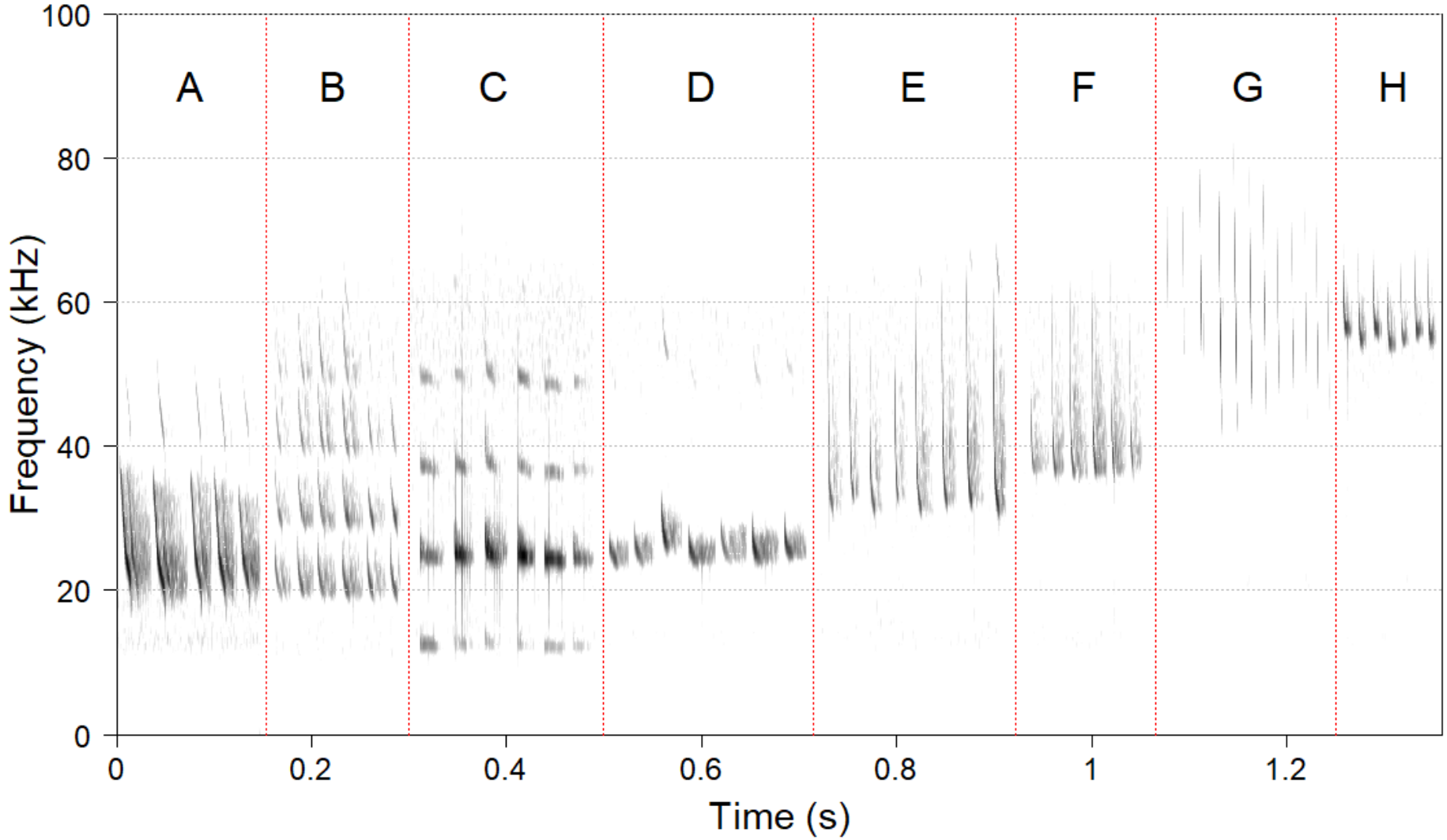

Figure 1. Representative echolocation calls of the species identified (**A**: *Chaerephon jobensis*; **B**: *Saccolaimus flaviventris*; **C**: *Taphozous georgianus*; **D**: *Ozimops lumsdenae*; **E**: *Chalinolobus gouldii*; **F**: *Scotorepens greyii*; **G**: *Nyctophilus* sp.; **H**: *Vespadelus finlaysoni*; time is compressed between pulses).

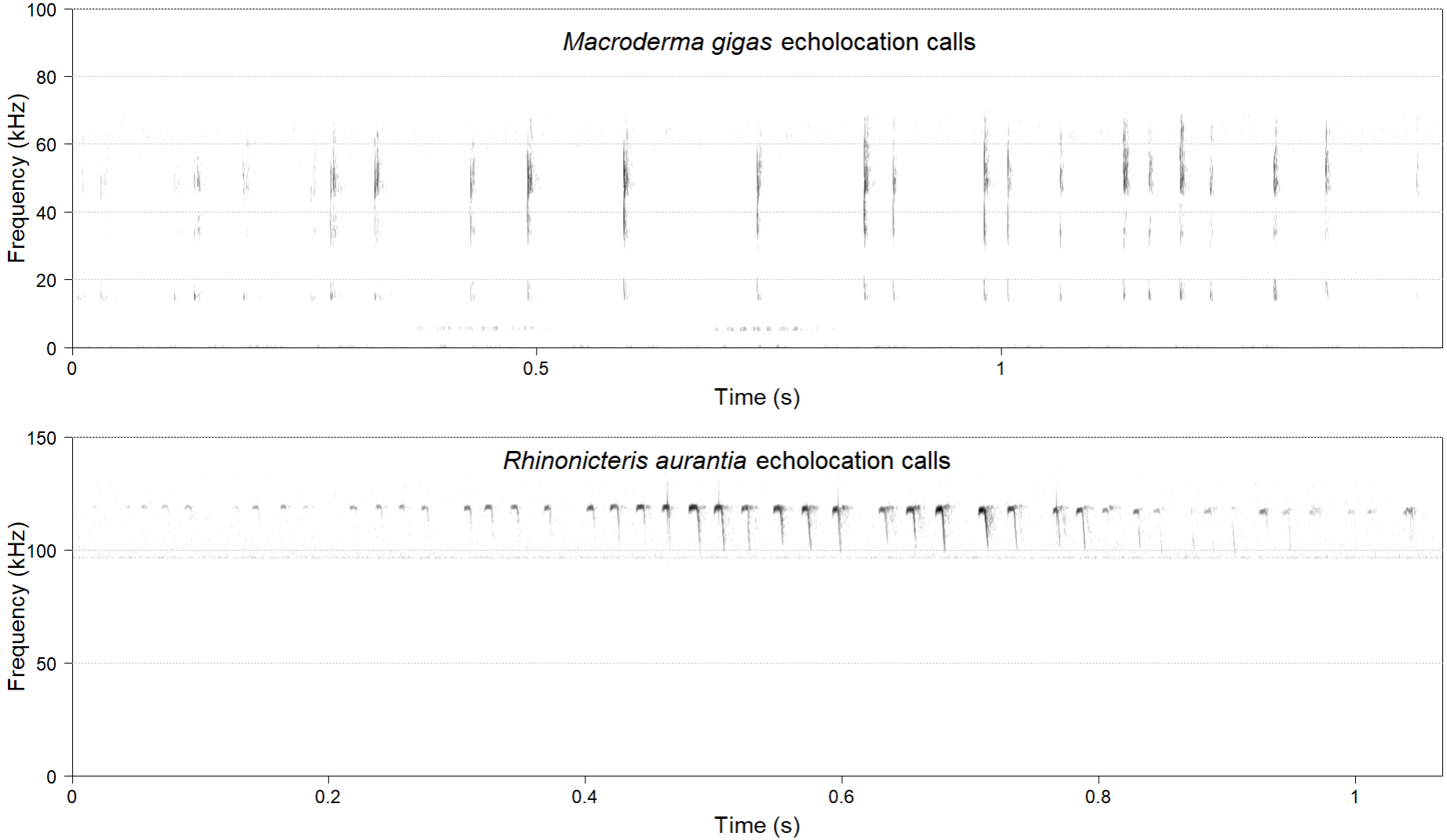

Figure 2. Representative echolocation calls of the Ghost Bat *Macroderma gigas* and Pilbara Leaf-nosed Bat *Rhinonicteris aurantia*.

Appendix 1. Summary of the activity of the Pilbara leaf-nosed Bat from the North Star project area, suitable for plotting.

,,14827,14827,14827,14827,14897,14897,14897,7975,7975,7975,7975,14654,14654,14654,14654,14654
X,start_time,2018-12-03,2018-12-04,2018-12-05,2018-12-06,2018-12-02,2018-12-03,2018-12-04,2018-12-03,2018-12-04,2018-12-05,2018-12-06,2018-12-02,2018-12-03,2018-12-04,2018-12-05,2018-12-06
1,17:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
2,18:00:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
3,18:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
4,19:00:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
5,19:30:00,0,0,0,0,0,0,0,1,0,0,1,0,0,2,0,0
6,20:00:00,1,0,0,0,0,0,0,2,0,1,0,0,1,5,0,14
7,20:30:00,0,0,1,0,0,0,0,0,0,0,0,1,3,5,1,3
8,21:00:00,0,0,0,0,0,0,0,0,0,0,0,2,2,0,0,0
9,21:30:00,0,15,4,0,0,0,0,0,1,0,0,6,5,0,0,0
10,22:00:00,0,0,7,4,0,0,0,0,0,0,0,0,6,1,6,0
11,22:30:00,0,1,1,3,0,0,0,0,0,0,0,9,4,4,0,0
12,23:00:00,0,2,2,0,0,0,0,0,0,0,0,6,0,1,16,0
13,23:30:00,0,1,1,0,0,0,0,0,0,0,1,0,5,0,1,0
14,00:00:00,2,3,0,0,0,0,0,0,0,0,0,3,4,0,0,2
15,00:30:00,3,2,1,0,0,0,0,0,1,0,0,0,12,8,0,0
16,01:00:00,12,1,0,0,0,0,0,0,0,0,0,0,6,3,1,0
17,01:30:00,0,3,2,2,0,0,0,0,0,0,0,5,7,1,3,2
18,02:00:00,2,6,3,9,0,1,0,3,1,0,1,2,3,1,4,2
19,02:30:00,1,3,1,6,0,1,2,1,2,3,2,6,0,1,0,7
20,03:00:00,0,5,1,11,2,2,3,1,1,0,0,8,14,1,2,0
21,03:30:00,3,0,0,1,1,0,4,0,1,0,0,4,35,6,2,0
22,04:00:00,2,3,4,0,2,2,0,0,1,0,0,0,5,1,7,0
23,04:30:00,1,1,3,0,0,3,0,0,0,0,0,0,0,0,0,0
24,05:00:00,0,0,0,0,2,3,0,0,0,0,0,0,0,0,0,0
25,05:30:00,0,0,0,0,1,1,0,0,0,0,0,0,0,0,0,0
26,06:00:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
27,06:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0

Appendix 2. Summary of the activity of the Pilbara leaf-nosed Bat from the Mainline Rail project area, suitable for plotting.

,,OE01,OE01,OE09,S4U03873,S4U04058,S4U04058,S4U04058,S4U04058,S4U04058,S4U04058,S4U04058,S4U04058,S4U06081,S4U0608
1,S4U06252,S4U06252,S4U06253,S4U06253,S4U06260,S4U06260,S4U06266,S4U06266,S4U06266,S4U06270,S4U06272,S4U06273,S4U0
6282
X,start_time,2018-12-02,2018-12-03,2018-12-03,2018-11-28,2018-11-28,2018-11-29,2018-11-30,2018-12-01,2018-12-02,2018-12-03,2018-12-
04,2018-12-05,2018-11-29,2018-11-30,2018-11-29,2018-11-30,2018-11-29,2018-11-30,2018-11-29,2018-11-30,2018-11-29,2018-11-30,2018-
12-01,2018-11-29,2018-11-30,2018-11-30,2018-11-30
1,17:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
2,18:00:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
3,18:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
4,19:00:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
5,19:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
6,20:00:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,4,5,2,0,2,1,0,0,0
7,20:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,1,5,1,3,2,1,2,2,0,1,0,0
8,21:00:00,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,1,4,0,2,2,1,1,0,0,1,0
9,21:30:00,0,0,0,0,2,1,0,1,0,1,0,0,0,0,0,0,3,3,1,1,1,2,0,0,0,0,0
10,22:00:00,1,0,0,0,0,1,0,0,1,1,1,0,0,0,0,0,2,4,1,1,0,1,0,0,0,0,0
11,22:30:00,0,0,0,0,0,0,0,0,1,0,0,0,1,0,0,0,0,4,4,0,1,2,0,0,0,0,0
12,23:00:00,0,0,0,1,1,0,1,0,1,0,1,1,0,0,1,0,10,4,0,1,0,1,0,0,0,0,0
13,23:30:00,0,0,1,0,0,0,0,2,0,0,0,2,0,0,0,0,8,4,0,0,0,4,0,0,0,0,0
14,00:00:00,0,0,0,0,0,0,0,0,0,0,2,0,0,0,1,0,0,2,0,0,0,0,3,0,0,0,0,0
15,00:30:00,0,0,0,0,0,0,1,0,1,0,0,0,0,0,0,0,0,3,1,0,0,0,4,0,0,0,0,0
16,01:00:00,0,1,0,0,1,0,0,0,0,1,0,0,0,1,0,0,3,3,0,0,1,1,0,0,0,0,0
17,01:30:00,0,0,0,0,0,0,0,1,0,1,0,0,0,0,0,0,0,1,4,0,1,1,1,0,0,0,0,0
18,02:00:00,0,0,0,0,0,0,1,0,0,0,0,1,1,0,0,0,0,2,7,0,0,0,1,0,0,0,0,0
19,02:30:00,0,0,0,0,0,0,1,1,0,1,0,0,0,3,1,1,0,3,11,0,1,3,0,0,0,0,0,1
20,03:00:00,0,0,0,0,0,0,0,0,0,0,0,1,1,0,0,0,0,0,7,3,5,1,1,0,0,0,0,0
21,03:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,3,0,0,0,1,0,0,0,0,0
22,04:00:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
23,04:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
24,05:00:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
25,05:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
26,06:00:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
27,06:30:00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0

Bat call identification from Solomon, Western Australia

Type:	Acoustic analysis
Prepared for:	Spectrum Ecology Pty Ltd
Date:	14 May 2019
Job No.:	SZ492
Prepared by:	Dr Kyle Armstrong and Yuki Konishi Specialised Zoological ABN 92 265 437 422 Tel 0404 423 264 kyle.n.armstrong@gmail.com http://szool.com.au

This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2019). Bat call identification from Solomon, Western Australia. Acoustic analysis. Unpublished report by Specialised Zoological for Spectrum Ecology Pty Ltd, 14 May 2019, Job number SZ492.

Summary

Bat identifications from acoustic recordings are provided from the Solomon project area, in the Pilbara region of Western Australia. The identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics. Nine species of bat were identified unambiguously as being present (**Tables 1** and **2**). Both the Ghost Bat *Macroderma gigas* (Megadermatidae) and the Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Rhinonycteridae) were detected. The detections of the Ghost Bat are summarised in **Table 3**, and those of the Pilbara Leaf-nosed Bat are summarised in **Table 4**. Representative echolocation and social calls for each identification are illustrated (**Figure 1**), as recommended by the Australasian Bat Society (ABS 2006). Further details are available should verification be required.

Methods

The data provided were recorded in full spectrum WAV format with Wildlife Acoustics SM4BAT bat detectors (sampling rate 384 kHz, set to turn on automatically at sunset and off at sunrise).

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong and Aplin 2014; Armstrong et al. 2016) was applied to the recordings made on the survey. Firstly, the WAV files were scanned for bat echolocation calls using several parameter sets in the software SCAN'R version 1.8.3 (Binary Acoustic Technology), which also provides measurements (SCAN'R parameters) from each putative bat pulse. The outputs were then used to determine if putative bat pulses measured in SCAN'R could be identified to species. This was done using a custom [R] language script that performed three tasks: 1. undertook a Discriminant Function Analysis on training data from representative calls from the Pilbara; 2. from the measurements of each putative bat pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the echolocation call types derived from the analysis of training data, and plotted these resulting coordinates over confidence regions for the defined call types; and 3. facilitated an inspection in a spectrogram of multiple examples of each call type for each recording night by opening the original WAV files containing pulses of interest in Adobe Audition CS6 version 5.0.2. The [R] language script also included a separate process that repeated the above steps using training data that included signals from Pilbara cave roosting bat species to assist with the detection of echolocation calls of the Ghost Bat *Macroderma gigas*.

Species were identified based on information in McKenzie and Bullen (2009) and the author's own unpublished material; and nomenclature follows Jackson and Groves (2015).

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing information on the identification of bat species in bulk ultrasonic recordings. Further comment on these species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was not set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Other than the general location of the study area, Specialised Zoological has not been provided with detailed information of the survey area, has not made a visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.
6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.
8. The analysis of ultrasonic recordings is one of several methods that can be used to survey for bats, and comprehensive surveys typically employ more than one method. If an identification in the present report is ambiguous or in question, a trapping programme would help to resolve the presence of the possibilities in the project area.
9. Potential Ghost Bat roosts should be further examined with non-invasive video recordings to confirm diurnal occupancy and estimate colony size (see **Table 3** for further details).

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Table 1. Species identified in the present survey from all sites combined.

MEGADERMATIDAE	
Ghost Bat	*Macroderma gigas*
RHINONYCTERIDAE	
Pilbara Leaf-nosed Bat	*Rhinonicteris aurantia*
EMBALLONURIDAE	
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Common Sheath-tailed Bat	*Taphozous georgianus*
VESPERTILIONIDAE	
Gould's Wattled Bat	*Chalinolobus gouldii*
Little Broad-nosed Bat	*Scotorepens greyii*
Finlayson's Cave Bat	*Vespadelus finlaysoni*
MOLOSSIDAE	
Greater Northern Free-tailed Bat	*Chaerephon jobensis*
Northern Free-tailed Bat	*Ozimops lumsdenae (=Mormopterus beccarii)*

Table 2. Species identifications, with the degree of confidence indicated by a code. Date and serial/unit number correlates with site; see Table 1 for full species names; blue shading indicates species of conservation significance.

Recording unit	Dates	*C. gouldii*	*C. jobensis*	*M. gigas*	*O. lumsdenae*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
OE01	12-19/3/2019	◆	◆	—	—	—	—	◆	◆	◆
OE09	12-18/3/2019	◆	◆	—	—	◆	◆	◆	◆	◆
3873	12-19/3/2019	◆	◆	—	NC	◆	◆	◆	◆	◆
3897	11-18/3/2019	◆	◆	—	—	—	◆	◆	◆	◆
4058	12-18/3/2019	◆	◆	—	◆	◆	◆	◆	◆	◆
6081	12-18/3/2019	◆	◆	—	—	—	—	◆	◆	◆
6174	13-19/3/2019	◆	◆	—	◆	—	◆	◆	◆	◆
6186	11-19/3/2019	◆	◆	—	◆	—	◆	◆	◆	◆
6252	11-18/3/2019	◆	◆	—	—	—	—	◆	◆	◆
6253	14-19/3/2019	◆	◆	—	—	—	—	◆	◆	◆
6256	11-14/3/2019	◆	◆	—	—	—	◆	◆	◆	◆
6257	12-19/3/2019	◆	◆	—	◆	◆	◆	◆	◆	◆
6259	18-20/3/2019	◆	◆	◆	—	◆	—	—	◆	◆
6260	12-16/3/2019	◆	◆	—	—	◆	—	◆	◆	◆
6261	12-16/3/2019	◆	◆	—	—	◆	—	◆	◆	◆
6262	12-18/3/2019	◆	◆	—	—	◆	—	◆	◆	◆
6266	11-17/3/2019	◆	—	—	—	—	—	◆	◆	◆
6269	12-14/3/2019	◆	◆	—	—	◆	—	◆	◆	◆
6270	11-12/3/2019	◆	◆	—	—	◆	—	◆	◆	◆
6272	12-16/3/2019	—	—	◆	—	◆	—	◆	◆	◆
6273	12-18/3/2019	◆	—	—	—	—	◆	◆	◆	◆
6282	13-18/3/2019	—	◆	—	—	—	◆	◆	◆	◆
6285	13-19/3/2019	◆	—	—	—	—	—	◆	◆	◆

Definition of confidence level codes:

— Not detected.

◆ Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or a DNA sequence.

NC Needs Confirmation. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the *Comments on identifications* section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

Table 3. Summary of detections of the Ghost Bat (Mg). Note sunset and sunrise times for the survey period are: 18:17–18:23 and 06:05–06:07. Diurnal roosts and colony size of the Ghost Bat should be confirmed with video recordings, rather than making assessments based on times of detections because this species does not necessarily linger at roost entrances during twilight periods.

Unit	Night of	Detection times	No. sequences in detection time period	Likelihood of Mg roost
6259	19/03/2019	18:58:06	1	Possible
	20/03/2019	00:27:03	1	Possible
6272	12/03/2019	05:24:34	1	Possible
	13/03/2019	21:03:11	1	Possible
	13/03/2019	05:12:01 – 05:28:39	5	Possible
	14/03/2019	19:03:57	1	Possible
	15/03/2019	05:14:51 – 05:20:58	2	Possible

Table 4. Summary of detections of the Pilbara Leaf-nosed Bat ('Ra'; blue shading designates different units for ease of inspection; a 'pass' is one sequence of calls in a single WAV file).

Unit	Night of	Time of first detection	Time between sunset and first detection	Time of last detection	Time between last detection and sunrise	No. passes	Likelihood of Ra roost
OE09	12/03/2019	20:05:09	01:42:09	04:24:50	01:40:10	3	Unlikely
	13/03/2019	01:09:08	06:47:08	01:09:08	04:55:52	1	Unlikely
	14/03/2019	01:59:29	07:38:29	04:17:59	01:47:01	2	Unlikely
3873	12/03/2019	02:40:34	08:17:34	02:40:34	03:24:26	1	Unlikely
	14/03/2019	20:40:24	02:19:24	04:40:40	01:24:20	26	Unlikely
	15/03/2019	20:09:29	01:49:29	04:59:38	01:06:22	181	Unlikely
	16/03/2019	19:42:49	01:23:49	05:21:55	00:44:05	157	Unlikely
	17/03/2019	22:20:14	04:02:14	05:12:13	00:53:47	27	Unlikely
	18/03/2019	19:41:25	01:24:25	05:05:12	01:01:48	62	Unlikely
4058	18/03/2019	21:30:24	03:13:24	01:02:33	05:04:27	4	Unlikely
6257	12/03/2019	20:30:35	02:07:35	04:43:33	01:21:27	10	Unlikely
	13/03/2019	23:41:49	05:19:49	04:34:12	01:30:48	8	Unlikely
	14/03/2019	22:23:29	04:02:29	04:50:48	01:14:12	3	Unlikely
	15/03/2019	20:06:28	01:46:28	02:49:26	03:16:34	5	Unlikely
	16/03/2019	19:52:52	01:33:52	04:58:36	01:07:24	3	Unlikely
	17/03/2019	01:03:42	06:45:42	05:07:55	00:58:05	2	Unlikely
	18/03/2019	20:43:20	02:26:20	05:10:31	00:56:29	4	Unlikely
6259	18/03/2019	22:13:39	03:56:39	22:18:03	07:48:57	6	Unlikely
6260	13/03/2019	02:42:52	08:20:52	02:42:52	03:22:08	1	Unlikely
6261	13/03/2019	00:55:51	06:33:51	00:55:51	05:09:09	1	Unlikely
6262	17/03/2019	00:21:43	06:03:43	00:21:43	05:44:17	1	Unlikely
6269	12/03/2019	21:34:49	03:11:49	04:38:41	01:26:19	3	Unlikely
	13/03/2019	22:36:09	04:14:09	22:36:09	07:28:51	1	Unlikely
	14/03/2019	23:51:02	05:30:02	23:52:14	06:12:46	7	Unlikely
6270	12/03/2019	00:47:57	06:24:57	00:47:57	05:17:03	1	Unlikely
6272	12/03/2019	00:44:00	06:21:00	00:44:00	05:21:00	1	Unlikely
	13/03/2019	01:59:45	07:37:45	02:00:10	04:04:50	2	Unlikely
	15/03/2019	20:54:17	02:34:17	20:56:39	09:09:21	3	Unlikely

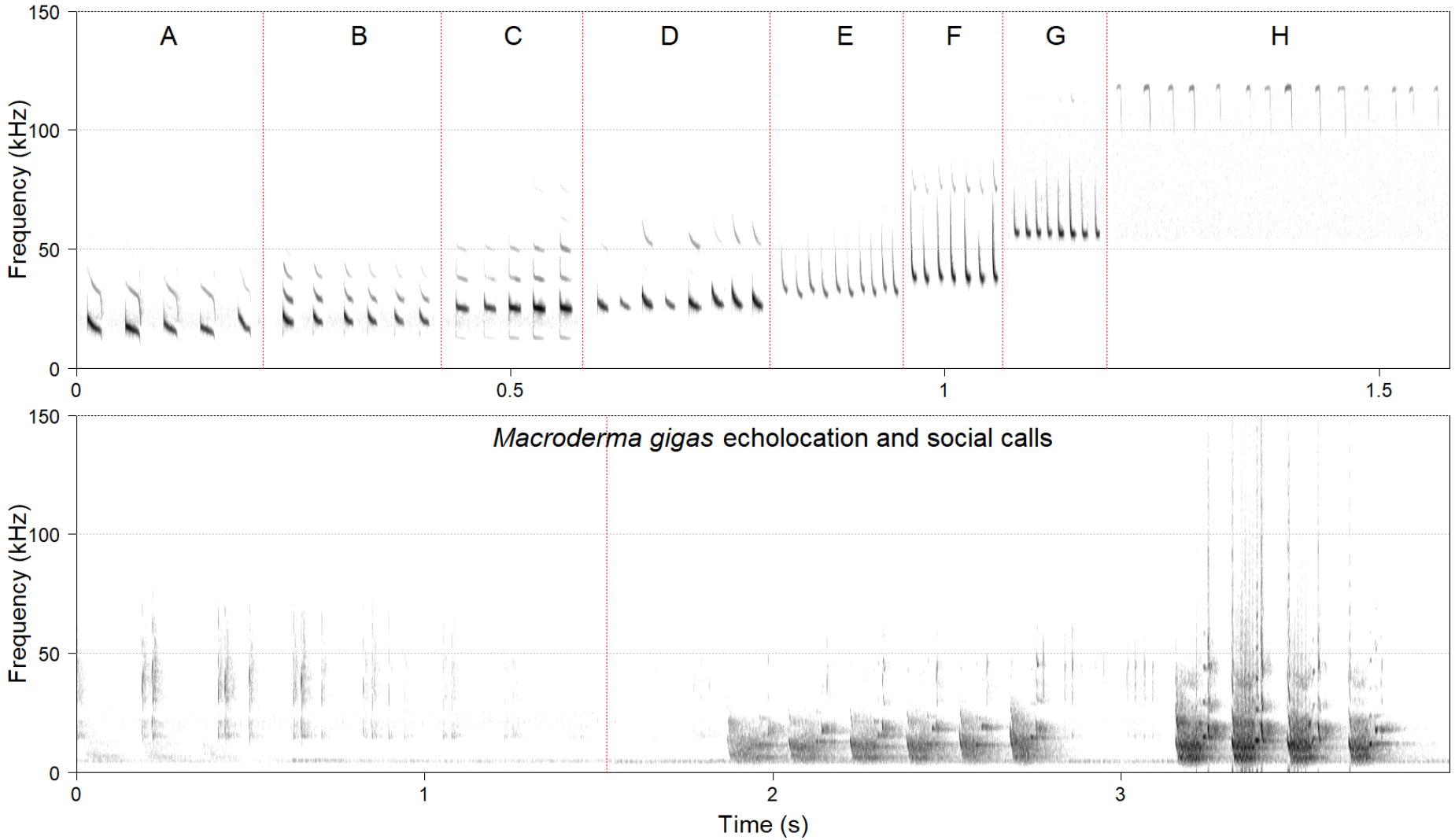

Figure 1. Representative echolocation call sequence portions of the species identified (**Top**: **A**: *Chaerephon jobensis*; **B**: *Saccolaimus flaviventris*; **C**: *Taphozous georgianus*; **D**: *Ozimops lumsdenae*; **E**: *Chalinolobus gouldii*; **F**: *Scotorepens greyii*; **G**: *Vespadelus finlaysoni*; **H**: *Rhinonicteris aurantia*; time between pulses has been compressed; **Bottom**: echolocation and social calls of *Macroderma gigas*).

Appendix 8: Pilbara Olive Python records

Table 5.7: Details of Pilbara Olive Python records at each site to date

ID (Microchip)	Capture	Sex	Site	Date	Co-ordinates		Weight	Length (cm)	Health rating (1-5)	Veg conditions	Comments
					Easting	Northing					
Control Sites											
Control Sites– Solomon											
2012/2013											
POP SM C-1	Initial Capture	-	NS POP C2	20/01/13	636165	7536764	-	200	4	Excellent	
POP SM C-2	Initial Capture	-	NS POP C1	18/01/13	601700	7538315	-	210	3.5	Very good	
	Recapture			19/01/13	601650	7538317					
	Recapture			20/01/13	601691	7538320					
2013/2014											
Nil											
2014/2015											
Nil											
2015/2016											
Nil											
2016/2017											
941 000 1745 2050	Initial Capture	Juvenile	NS POP C1	11/01/17	601737	7538335	154	100	4	Very good	
2017/2018											
941 0001957 6541	Initial Capture	Male (subadult)	NS POP C1	15/01/18	601673	7538321	280	120	4	Very good	
Control Sites – North Star											
2011											
POP 4	Initial Capture	-	Opportunistic / NS POP C4	18/10/11	717827	7655606					
2014											
941000016202864	Initial Capture	Female	NS POP C4	06/04/14	718305	7655591	3,295	240	5	Excellent	
941000016202865	Initial Capture	Female	NS POP C2	06/04/14	714539	7655508	1,845	200	3.5 (little body fat)	Good	
	Recapture			07/04/14	714542	7655517					
	Recapture			08/04/14	714547	7655523					
	Recapture			09/04/14	714547	7655523					
941000016202860#	Initial Capture	Male	NS NQ C3	25/08/14	713613	7656809	1,260	240	5	Good	Recorded during dry season
2014/2015											
941000016595541	Initial Capture	Juvenile	NS POP C1	22/02/15	712588	7655823	125	80	5 (fed recently)		

ID (Microchip)	Capture	Sex	Site	Date	Co-ordinates		Weight	Length (cm)	Health rating (1-5)	Veg conditions	Comments
					Easting	Northing					
941000016202865	Recapture from 2014	Female	NS POP C2	19/02/15	714547	7655523	1,500	210	3.5 (little body fat)		
	Recapture			20/02/15	714547	7655523					
2015/2016											
941000016202860	Recapture from 2015	Male	NS NQ C3	28/08/15	713667	7656755	-	-	4 (little body fat)	Excellent	
941 000016595531	Initial Capture	Female	NS POP C2	07/12/15	714540	7655512	1,250	180	4.5	Good	
941 000017452069	Initial Capture	Male	NS POP C4	11/12/15	718287	7655586	1,125	190	2 (scars & spinal disfigurement from injury)	Excellent	
2016/2017											
NS POP C-7	Capture (remains)	-	NS POP C4	11/12/16	718288	7655586		200	-	Good	
2017/2018											
941 000019576552	Initial Capture	Male	NS NQ C2 C16	28/08/17	713204	7644642				Excellent	
941 00019576542	Initial Capture	unknown	NS POP C1	7/12/17	712586	7655834				Excellent	
941 000019576588	Initial Capture	unknown	Opportunistic	7/12/17	712309	7655740				Excellent	
2018											
991 003000 174901	Initial Capture	Female	NS POP C4	2/12/18	718370	7655598	-	3,000	5	Excellent	
	Recapture			4/12/18	718440	7655591					
	Recapture			5/12/18	718348	7655599					
	Recapture			6/12/18	718348	7655599					
No ID	Motion Camera	Unknown	NS MC LT C8	18/09/18			-	-	-	Excellent	Recording on motion camera of feeding individual in rock pool
Impact Sites											
Impact Sites – Solomon											
2012/2013											
POP I-1	Initial Capture	Juvenile	SM POP I4	20/01/13	596668	7546469	-	100	5	Excellent	
2013/2014											
00066ACE53 (POP I-2)	Initial Capture	Female	SM POP I4	5/09/13	596166	7546564		310	2.5	Excellent	

ID (Microchip)	Capture	Sex	Site	Date	Co-ordinates		Weight	Length (cm)	Health rating (1-5)	Veg conditions	Comments
					Easting	Northing					
POP I-3	Motion Camera	-	Opportunistic	31/08/13	583408	7550201		-	-	Excellent	
2014/2015											
941000016595540 (POP I-4)	Initial Capture	Male	Opportunistic Road spotting	28/01/15	583745	7541556	-	-310		Degraded	
2015/2016											
941 000017452067	Initial Capture	Female	SM POP I3	15/01/16	596668	7546469	4000	2.4	4	Good	
	Recapture			16/01/16							
	Recapture			19/01/16							
941 000017452054	Initial Capture	Female	SM POP TI2	16/01/16	589904	7554325	879	1.6	4	Degraded	
2016/2017											
941 000 1659 5529	Initial Capture	Female	SM POP I1	6/1/17	589100	7553518	684	150	5	Good	
2017/2018											
Nil											
2018/2019											
991 0030 0017 4907	Initial Capture	Juvenile	Opp (Kangi Camp)	17/3/19	583828	7542383	120	90	5	Completely Degraded	
Impact Sites – North Star											
2011											
POP 1	Initial Capture	unknown	NS12/POP I1	17/10/14	716113	7649224		-	-	Excellent	Few cattle closeby
POP 2	Initial Capture	unknown	NS12/POP I1	17/10/14	716313	7649424		-	-	Excellent	Few cattle closeby
POP 3	Initial Capture	unknown	NS12/POP I1	17/10/14	716213	7649324		-	-	Excellent	Few cattle closeby
POP 5	Initial Capture	unknown	Opportunistic/POP I4	28/10/14	711107	7648592		-	-	Excellent	Few cattle closeby
2014											
Nil											
2014/2015											
9410000017452072	Initial Capture	Female	NS POP I2	22/02/15	713368	7647866	475	160	4	Excellent	
941000016595537	Initial Capture	Juvenile	NS POP I3	20/02/15	711680	7650632	500 (including prey)	125	4.5 (fed recently)	Excellent	
941000017452073	Initial Capture	Juvenile	NS POP I4	21/02/15	711098	7648587	150	90	4 (scar on neck)	Excellent	
2015/2016											

ID (Microchip)	Capture	Sex	Site	Date	Co-ordinates		Weight	Length (cm)	Health rating (1-5)	Veg conditions	Comments
					Easting	Northing					
941 000017452059	Initial Capture	Male	NS POP I4	12/12/15	711133	7648580	2,875	220	5	Excellent	
2016/2017											
941000019576565	Initial Capture	Male	NS POP I1	10/12/16	712586	7655834	1,370	210	3	Good	
2017/2018											
941 000019576587	Initial Capture	unknown	NS POP I1	8/12/17	716035	7649291	1,340	180	4	Good	
941 0000 19576586	Initial Capture	unknown	NS POP I1	8/12/17	716035	7649291	1,610	200	4	Good	
	Recapture			9/12/17	716035	7649291					
	Recapture			11/12/17	716035	7649291					
	Recapture			12/12/17	716035	7649291					
941 0000 19576585	Initial Capture	unknown	NS POP I4	10/12/17	711133	7648580	1,780	180	4		
2018											
991 003000 174899	Initial Capture	Female?	NS POP I3	4/12/18	711710	7650743	-	1500			
	Recapture			5/12/18	711704	7650641					
	Recapture			6/12/18	711681	7650627					
	Recapture			7/12/18	711681	7650630					
991 003000 174903	Initial Capture	Juvenile	NS POP I4	4/12/18	711135	7648612		1.1			Had just preyed on a bird or bat
	Recapture			5/12/18	711083	7648598					
991 003000 174909	Initial Capture	Female	NS POP I4	7/12/18	711124	7648572		1900			

Table 5.8: MARK Parameters for Pilbara Olive Pythons

Parameter	2013	2014	2015	2015/2016	2016/2017	2017/2018	2018
Impact Sites							
North Star							
ψA (SE)	-	0.10 ± 0.00	0.75 ± 0.22	0.25 ± 0.21	0.51 ± <0.01	0.55 ± 0.26	0.71 ± <0.15
Pi (SE)	-	>0.01 ± 0.00	1.00 ± <0.01	0.59 ± 0.01	0.55 ± 0.23	0.75 ± 0.22	0.49 ± 0.35
NED (overall)	-	0 (0)	0.75 (0.75)	0.25 (0.75)	0.25 (1.0)	0.5 (1.0)	0.5 (1.0)
Control Sites							
North Star							
ψA (SE)	-	0.39 ± 0.15	0.59 ± 0.22	0.50 ± 0.25	0.49 ± 0.38	0.63 ± <0.01	0.52 ± 0.10
Pi (SE)	-	0.52 ± 0.26	0.75 ± 0.54	0.98 ± <0.01	0.70 ± <0.01	0.50 ± 0.25	0.78 ± 0.18
NED (overall)	-	0.50 (0.50)	0.50 (0.75)	0.50 (0.75)	0.25 (0.75)	0.33 (1.0)	0.25 (1.0)

NED=Naïve estimator during the monitoring season (and across all years of monitoring)

Appendix 9: Introduced Species Recorded

Table 5.9: Introduced Species recorded

Species	Site	Date	Co-ordinates		Comments
			Easting	Northing	
Cloudbreak					
Cattle	Cocos WD1	20/8/18	758142	7527251	Motion Camera recording
Cattle	Cocos WD2	20/8/18	758165	7527259	Motion Camera recording
Feral Cat	CB NQ I3	20/8/18	748466	7531717	Camera recording on 4 MCs
Feral Cat	CB NQ I2	30/10/18	745826	7532417	Camera recordings on 5 MCs
Feral Cat	CB NQ I1	10/11/18	744180	7532841	Camera recordings on 4 MCs
Christmas Creek					
Cattle	CC Re2	20/8/18	772741	7524428	MC73, camera recording
Cattle	CC NQ I1	20/8/18	768072	7524101	Camera recording on 3 MCs
Cattle	CC NQ I3	20/10/18	800916	7517216	Camera recording on 3 MCs
Feral Cat	Camp	01/07/18	775324	7527079	1 individual
Feral Cat	CC NQ I2	20/10/18	791498	7525156	Camera recordings on 9 MCs (2 individuals)
Feral Cat	CC NQ I3	20/10/18	800916	7517216	Camera recordings on 1 MC (1 individual)
Dog/Dingo	CC NQ I3	20/10/18	800916	7517216	Camera recordings on 4 MCs (Family/3 pups)
Solomon Hub					
Cattle	SM NQ I2	10/07/18	589751	7554154	Scats/tracks
Feral Cat	SM NQ I2	12/07/18	589217	7553808	Plugged Feathers/prey remains
Feral Cat	FC NQ C2	16/07/18	590478	7559899	Motion Camera
House Mouse	SM NQ I1	07/07/18	590532	7555121	Capture
Hamersley Rail Line					
Cattle	HL NQ I2	05/07/18	686430	7566458	Tracks & individuals
Feral Cat	HL Cu 01	05/07/18	700703	7583200	1 individual
Feral Cat	HL Cu 03	13, 15, 24/08/18	700561	7582773	3 individuals
Feral Cat	HL Cu 04	07 & 15/08/18	700562	7582778	2 individuals
Feral Cat	HL Cu 05	01 & 07/08/18	681042	7561816	2 individuals
Feral Cat	HL NQ I3	25/07, 29/07/, 31/08, 07/09	681031	7561782	2 individuals recorded on motion camera
Feral Cat	HL NQ I2	28/07, 02/08, 05/08, 06/08, 30/08	686612	7567025	1 individual on motion camera
Feral Cat	HL NQ I3	02/8/18	681031	7561782	1 individual trapped
Feral Cat	HL Re87	20/07/18	686970	7566681	Motion camera recording
Dog/Dingo	HL NQ I1	30/9/18	694647	7577143	Camera recording on 1 MC
Dog/Dingo	HL NQ I2	30/10/18	686430	7566458	Camera recording on 2 MCs
Dog/Dingo	HL NQ I3	25/10/18	681031	7561782	Camera recording on 1 MC
Main Line Rail					
Donkey	MR GB OS16	01/07/18	690321	7641579	Scats
Donkey	MR GB OS31	01/07/18	702409	7578415	Scats
Donkey	Opp	01/07/18	697181	7613768	4 individuals (incl. Judas Donkey)
Cattle	MR GB OS39	01/07/18	734031	7548185	Tracks
Cattle	MR GB OS37	01/07/18	730136	7553728	Tracks

Cattle	MR GB OS31	01/07/18	702409	7578415	Tracks
Cattle	MR GB OS30	01/07/18	701192	7582678	Tracks
Cattle	MR GB OS28	01/07/18	698556	7587334	Tracks
Cattle	MR GB OS27	01/07/18	694083	7595222	Tracks
Cattle	MR GB OS28	01/07/18	698556	7587334	Tracks
Cattle	MR GB OS21	01/07/18	697329	7614240	Tracks
Cattle	MR RE 37	25/07/18	694150	7594920	Motion Camera recording
Cattle	MR NQ I3	05/09/18	677097	7674953	Motion Camera recording
Cattle	MR RF 09	20/07/18	696814	7606563	Motion Camera recording
Cattle	MR RF 07	20/07/18	677670	7670689	Motion Camera recording
Camel	MR GB OS22	01/07/18	697210	7609650	Tracks
Rabbit	MR GB OS36	01/07/18	727225	7557025	Scats
Feral Cat	MR GB AS I14	18/7/18	692955	7635026	2 individuals on motion camera
Feral Cat	RC 145	01/07/18	697989	7612470	1 kitten
Feral Cat	MR GB OS1	01/07/18	664978	7738793	Scats/tracks
Feral Cat	MR GB OS22	01/07/18	697210	7609650	Tracks
Feral Cat	MR GB OS26	01/07/18	694129	7599083	Tracks
Feral Cat	MR GB OS27	01/07/18	694083	7595222	Tracks
Feral Cat	MR GB OS28	01/07/18	698556	7587334	Tracks
Feral Cat	MR GB OS30	01/07/18	701192	7582678	Tracks
Feral Cat	MR GB OS31	01/07/18	702409	7578415	Tracks
Feral Cat	MR GB OS32	01/07/18	704879	7576178	Tracks
Feral Cat	MR GB OS33	01/07/18	708396	7573020	scats
Feral Cat	MR GB OS35	01/07/18	725667	7559469	Kill remains
Feral Cat	MR GB OS38	01/07/18	731775	7551253	scats
Feral Cat	MR GB OS39	01/07/18	734031	7548185	Kill remains (Grey Falcon)
Feral Cat	MR GB OS40	01/07/18	736327	7540651	Tracks
Feral Cat	MR Cu 04	04, 14, 15, 17, 19, 22/07/18	675256	7682298	1 individual (several recordings)
Feral Cat	MR Cu 05	01-24/07/18	694480	7628790	3 individuals (several recordings)
Feral Cat	MR Cu 06	29/06/18	709501	7572421	1 individual
Feral Cat	MR RF 01	05 & 10/07/18	665627	7736516	2 individuals
Feral Cat	MR RF 02	06, 08 & 22/07/18	665717	7730989	3 individuals
Feral Cat	MR RF 05	03, 05, 06, 21/07/18	668256	7703400	3 individuals
Feral Cat	MR RF 06	04/07/18	673722	7689097	1 individual
Feral Cat	MR RF9	19/07/18	696814	7606563	1 individual
Feral Cat	MR RF10	30/06/18	725677	7559715	1 individual
Dog/Dingo	RC 145	01/07/18	697989	7612470	1 individual
Dog/Dingo	MR GB OS1	01/07/18	664978	7738793	Scats/tracks
Dog/Dingo	MR GB OS3	01/07/18	665811	7728810	Scats/tracks
Dog/Dingo	MR GB OS10	01/07/18	677239	7675108	Tracks
Dog/Dingo	MR GB OS16	01/07/18	690321	7641579	Tracks
Dog/Dingo	MR GB OS21	01/07/18	697329	7614240	Tracks
Dog/Dingo	MR GB OS26	01/07/18	694129	7599083	Tracks
Dog/Dingo	MR GB OS28	01/07/18	698556	7587334	Tracks

Dog/Dingo	MR GB OS31	01/07/18	702409	7578415	Tracks
Dog/Dingo	MR Cu 01	05/07/18			Camera recording
Dog/Dingo	MR Cu 03	01/07/18			Camera recording
Dog/Dingo	MR RF 09	01/07/18	696814	7606563	Camera recording on 2 MCs
Nullagine					
Cattle	Opp	28/06/18	799262	7557914	Sightings
Cattle	NL NQ BE MC9	28/06/18	800582	7560516	AUD-02
Cattle	NL NQ W MC1	28/06/18	807543	7563826	BCI-04
Feral Cat	NL NQ W MC3	28/06/18	808227	7565028	Motion camera recording BCI-13
Feral Cat	NL NQ W MC5	28/0/18	808722	7566065	Motion camera recording BCI-014
North Star					
Cattle	Camp	20/08/18	708176	7648223	Sightings
Cattle	NS MC LT I5	12/09/18	710081	7654709	MC recording
Dog/Dingo	NS MC LT I5	05/09/18	710081	7654709	MC recording
Dog/Dingo	NS MC LT I7	10/09/18	711695	7650618	MC recording
Dog/Dingo	NS MC LT C8	01/09/18	713237	7645594	MC recording
Feral Cat	NS NQ LT I3	20 & 31/08/18	716114	7648059	Sighting & MC recording
Feral Cat	NS NQ LT I6	29/08/18	711680	7650946	MC recording
Feral Cat	NS NQ LT I7	8/09/18	711695	7650618	MC recording
Feral Cat	NS NQ LT I9	22/08/18	713230	7647232	MC recording
Feral Cat	NS NQ LT C3	23/08/18	713314	7657098	MC recording
Feral Cat	NS NQ LT C6	24/09/18	715887	7654732	MC recording
Feral Cat	NS NQ LT C7	28/09/18	713280	7643833	MC recording
Feral Cat	NS NQ LT C8	18, 27, 28/08/18, 1, 3, 5, 22/09/18	713262	7645642	MC recording
Feral Cat	NS NQ LT C9	4/09/18	713451	7643392	MC recording