Woolgoolga to Ballina Pacific Highway upgrade

Coastal Emu Monitoring Program
Annual Report 2020

Construction Phase (Year 4) and Commencement of Operation

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Coastal Emu Monitoring Program – Annual Report (2020)

Construction Phase Year 4
Commencement of Operation

Final

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Transport for NSW

W2B Biodiversity Monitoring

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Contents

1. Introduction

1.1 Background and objectives

The Pacific Highway upgrade from Woolgoolga to Ballina (W2B) was approved in 2014 under the NSW *Environmental Planning and Assessment Act,* 1979 and the Commonwealth *Environment Protection and Biodiversity Conservation Act*, 1999. The conditions of approval included preparation and implementation of a Coastal Emu Management Plan (Plan). This Plan outlines objectives and a methodology for undertaking a monitoring program to monitor the effectiveness of mitigation measures planned for Coastal Emus (*Dromaius novaehollandiae*). The monitoring program commenced prior to construction of the upgrade to gather baseline (pre-construction) data and is to continue through the construction and early operational stages of the highway. The results of the monitoring are required to inform any adaptive mitigation measures and thereby assist with the ongoing management of any identified impacts to Emus as a result of the project.

The monitoring program aims to determine if the mitigation measures for Emus have been effective in the long-term and therefore achieve the mitigation goals outlined in the plan. The underlying objectives of the program are to:

- Further understand and monitor distribution, abundance and habitat use by Emus near the road corridor.
- Identify temporal trends in the relative abundance of Emus in impact and control areas during the different stages of the project to identify if the project is having a negative impact on Emu presence.
- Evaluate the success of mitigation measures largely designed to allow Emu's safe passage across the highway corridor (i.e. temporary and permanent crossing structures, exclusion and hybrid fences and habitat revegetation for Emus).

Pre-construction monitoring was conducted between December 2013 and December 2016 over 13 monitoring events and the results reported in three pre-construction phase annual reports (Jacobs 2014; 2015; 2016). Construction of the W2B upgrade for Section 4 commenced in mid-2016 and in Section 3 in January 2017 (Year 1). The construction phase of the Emu monitoring program commenced concurrently. This report outlines the methods and results of continued Emu monitoring through to the fourth and final year of construction ending in May-June 2020 (i.e. 3.5-year construction phase). The report also presents early phase operational monitoring for the first 6 months (June to December 2020).

1.2 Overview of the monitoring program

The Management Plan outlines an adaptive and responsive management approach, whereby information on the occupancy of Emus within and adjacent to the project area will be used to inform the effectiveness of mitigation measures and ongoing monitoring. The program is based on a BACI approach (Before, After, Control, Impact), monitoring Emu presence at impact sites in proximity to the highway and control sites in coastal areas to the east of the highway. The program compares the 3-year baseline dataset with monitoring data collected seasonally during construction and operational monitoring and will continue for five years after opening which will be subject to performance review with possible extension to at least 7 years (RMS 2015, Section 7.2.1).

Results from the monitoring program during construction and operation are analysed after each sampling period and annually. Regular analysis of the data is conducted to allow improvements and refinements in the survey design to be incorporated into future monitoring activities. Indicative triggers for the monitoring program are reported in the management plan and are to be reviewed and assessed with consideration of baseline data. These triggers relate to a notable decline in Emu activity in the project area compared to control sites, the extent of normal decline in activity will be determined using the baseline data.

Impact sites are in the vicinity of Section 3 of the W2B upgrade. Sites have been selected to survey both forest and floodplain grazed habitats within proximity to the project corridor, and particularly east and west of identified likely Emu crossing zones (heightened bridges). Control sites were selected in coastal forest and grassland habitats which resemble the impact sites and are expected to have regular Emu presence, all sites are

greater than 15 km from the project. Additional observational data is collected and stored as a register of Emu sightings near the project corridor maintained during construction for both Section 3 and 4 of the W2B upgrade. These data are also discussed in the annual report and used to inform management decisions.

Aspects of the pre-construction study included an experimental trial to test the effectiveness of temporary fencing for future use as road exclusion mitigation and as a means of directing Emus to future crossing zones and a provision of early Emu crossing areas to educate Emus to cross the future highway at dedicated locations that align with the final bridge designs. Temporary fencing and emu crossing zones were found to be effective, and the results are reported in Jacobs (2017).

Monitoring of a subset of the Emu crossing zones continued during construction where purpose-built Emu races were provided to monitor if emus were able to cross the construction corridor. A number of raised bridge structures have been constructed at Emu crossing zones to facilitate crossing below the highway during operation. These structures are combined with permanent exclusion fencing and will be monitored during operation in conjunction with emu occupation surveys east and west of the project corridor.

Operational phase monitoring began in the June 2020 and has incorporated a program to monitor eighteen bridge structures within Section 3 and Section 4 of the highway and the adjacent exclusion fences to determine the effectiveness of these mitigation measures for facilitating movements of Emus across the highway corridor.

The management plan identifies mitigation goals for each phase of the project from pre-construction, through construction and operation. The degree to which these goals are achieved, or fail is referred to as 'performance' and is measured through monitoring and implementing corrective actions where performance criteria are not met. The specific mitigation goals relevant to the coastal Emu monitoring program are:

- Zero rate of traffic related Emu mortality in Sections 3 and 4 of the Pacific Highway after 10 years.
- Post-mitigation occupation in the study area is similar to pre-road construction occupation after 5 years.
- Post-mitigation presence on both sides of the road is similar to pre-road construction presence.
- Zero or reduced rate of Emu deaths from dog attacks in vicinity of crossing structures in Section 3 and 4 of Pacific Highway in years 1-5.

The monitoring program aims to determine if the mitigation measures for Emus have been effective in the long-term and therefore achieve these mitigation goals.

2. Methods

2.1 Site occupation surveys

2.1.1 Study area

Monitoring Emu site occupancy commenced in 2013 and has continued at impact and control sites focused on five survey areas:

1) Pillar Valley west (PV), including land east and west of the Tucabia-Tyndale Road and portions of the Coldstream River floodplain, and lower catchment of Pillar Valley Creek and Black Snake Creek (project Section 3).
2) Tucabia south (MR) between Mitchell Road and Firth Heinz Road (project Section 3)
3) Tucabia north (TN) from Bostock Road to Sommervale Road and west to Pine Brush State Forest, including Champions Creek floodplain (project Section 3)
4) Yuraygir south (YS) at two locations around Diggers Camp and Minnie Waters (Control)
5) Yuraygir north (YN) at two locations around Brooms Head and Taloumbi (Control).

2.1.2 Survey transects

The intent of the sampling is to monitor Emu presence over time within each of these survey areas relative to the different project phases rather than a comparison between areas. This is achieved by repeat sampling of between 2 and 5 transects in each survey area using transects that range between 800 and 2000 metres in length. In total 24.7 km of transects are sampled from 13 impact sites and 7 control sites (Table 1). Sites were stratified to sample a range of different habitat types including pastoral land, forest, riparian and wetland areas. The location of survey areas is shown on Figure 1 and the location of impact transects in relation to the highway corridor and bridge locations is shown on Figure 2.

As the Emu population in the study area is small and occupies large areas, the absence of emu sign from a transect over time may not necessarily reflect the absence of emus in the study area, but rather a shift in emu activity away from the transect. To account for this, transects are occasionally modified to improve the detectability of emus. This may also occur where access permission to private property has changed over the course of the program. This has included extending transect lengths, combining transects and in some cases, adding new transects. Where this has occurred, effort has been made not to distort the integrity of the data by keeping transects in the same proximal area and similar transect lengths and search areas.

Table 1 : Study areas, survey sites and details of Emu monitoring transects

Survey area	Transect	Status	Habitat	Transect length (m)	Search area (ha) based on 10 m transect width	Transect position relative to road	Adaptive monitoring approaches
Pillar Valley West (PV)	PV-A	Impact	Grazing / forest	840	0.84	West	
	PV-B	Impact	Grazing / wetland	1300	1.30	West	
	PV-C	Impact	Grazing / forest	1655	1.65	East	Shifted start of transect to neighbouring property to east in 2020
	PV-D	Impact	Grazing / forest	2425	2.42	East	
			Total	*6220 m*	*6.2 ha*		
	MR-A	Impact	Open forest	825	0.82	East	

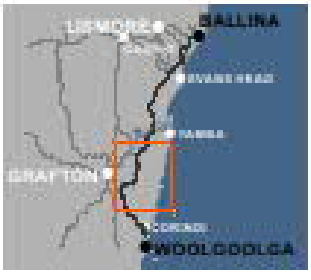
Survey area	Transect	Status	Habitat	Transect length (m)	Search area (ha) based on 10 m transect width	Transect position relative to road	Adaptive monitoring approaches
Tucabia South (MR)	MR-B	Impact	Open forest	965	0.96	West	
	MR-C	Impact	Open forest	755	0.75	West	
	MR-D	Impact	Swamp forest	700	0.70	West	Shifted 300 m south to new fence line in 2019
	MR-E	Impact	Open forest	1400	1.40	East	Shifted 200 m to the north from easement to riparian corridor in 2019
			Total	*4645 m*	*4.6 ha*		
Tucabia North (TN)	TN-A	Impact	Open forest	2080	2.08	West	
	TN-B	Impact	Open forest / wetland	645	0.64	West	
	TN-C	Impact	Open forest	1365	1.36	East	Start of transect moved to edge of new road in 2018
	TN-D	Impact	Open forest	1200	1.20	East	
			Total	*5290 m*	*5.28 ha*		
Yuraygir South (YS)	YS-A	Control	Forest / heath	1155	1.15	-	
	YS-B	Control	Forest / heath	1255	1.25	-	Transect extended further 500 m
	YS-C	Control	Open forest	1030	1.03	-	
	YS-D	Control	Open forest	730	0.73	-	YS-D and YS_E combined in 2019
	YS-E	Control	Open forest	1250	1.25	-	YS-E changed to new location
			Total	*5420 m*	*5.4 ha*		
Yuraygir North (YN)	YN-A	Control	Forest / heath	1850	1.85	-	
	YN-B	Control	Open forest	1270	1.27	-	
			Total	*3120 m*	*3.1 ha*		

Legend

- Approved Project Boundary
- State Forest
- NPWS Reserve
- Survey transects

1:250,000 @ A4

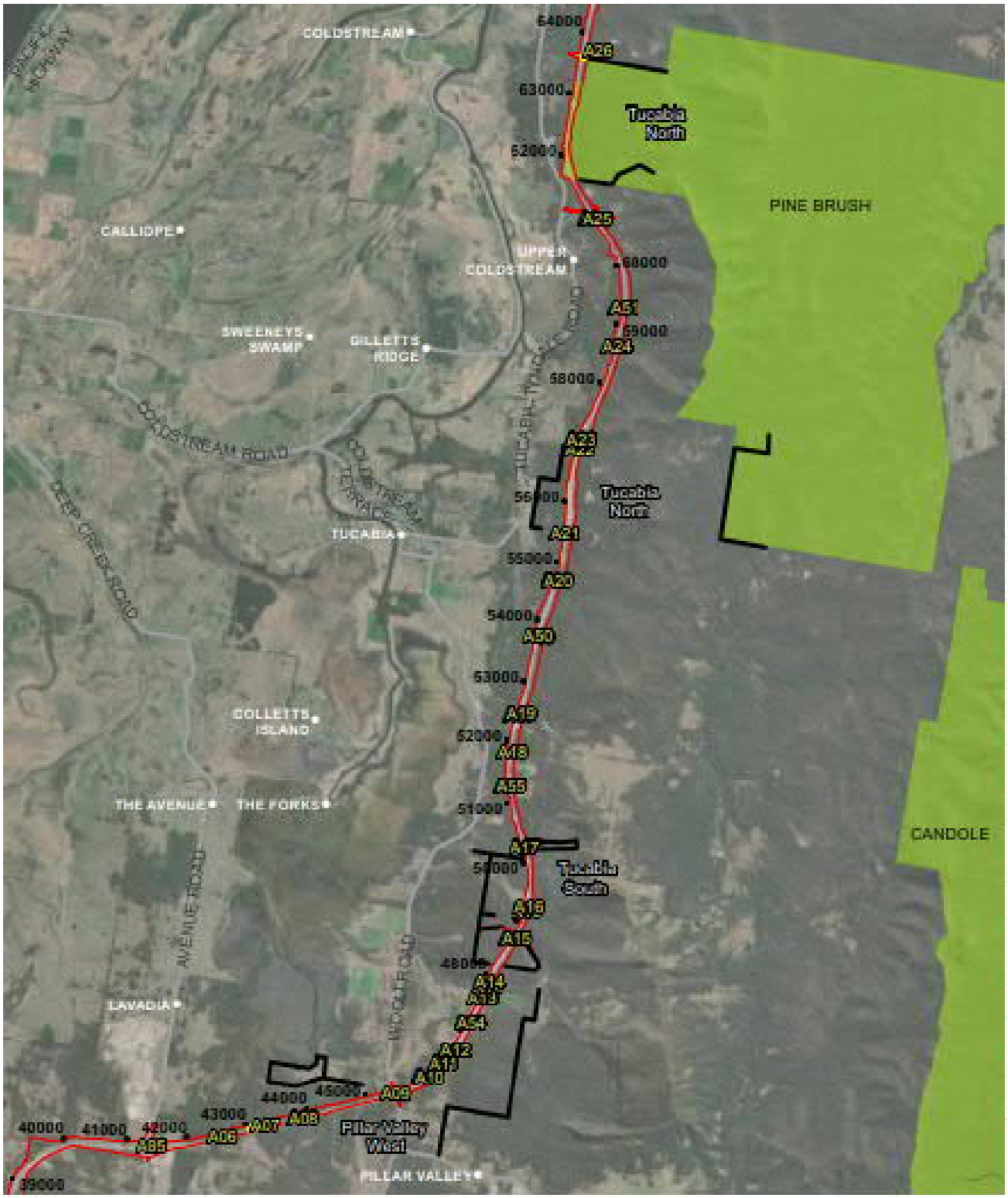
0 6 12 km



Data sources

Jacobs 2017, Pacific Complete 2017, LPI 2017, Imagery Service Layer Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 1 | Coastal Emu monitoring survey areas



Data sources

Jacobs 2017, Pacific Complete 2017, LPI 2017, Imagery Service Layer Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 2 | Impact Transects

2.1.3 Timing

Monitoring of the spatial and temporal presence of Emus relied on two methods centred on each transect and included 1) searches for Emu signs and 2) camera trapping. Sign searches and the download of photographs from camera traps is conducted at four quarterly events targeting the last week of each season (i.e. February, May, August, and November). In this way evidence of Emu presence and captured photographs was collated for each season.

2.1.4 Sign searches

Each of the 20 transects is walked once over a week-long (5 days) survey during each season and sampling period. Transects are searched throughout daylight hours (0730 to 1700) and involve a single observer walking slowly along the designated transect route and actively searching for signs of Emu presence (i.e. droppings, feathers, and footprints) concentrated over a 10 m wide search area centred over the transect (refer plates 1-4 for examples of Emu sign). Transects were purposefully positioned along fence lines where possible, as barbed wire has been found to be an effective means of snagging feathers from Emus passing through the fence (refer Jacobs 2014) and hence a reliable method of observing signs to monitor presence at a site.

The number of signs detected is counted and then removed from each transect. For footprints this means raking over sand and mud and for feathers and droppings removing from the transect. This is done in order to capture fresh sign over the following season and sampling period. In addition to recording signs, any actual observations of Emus in the vicinity of transects during the survey week are recorded and contact with landowners where possible during the course of the survey week to document any observations of Emus made by the property owner since the last monitoring event.

Plate 1. Example of Emu feathers 'snagged' on barbed wire

Plate 2. Emu dropping with *Gahnia sieberiana* seed

Plate 3. Example of muddy transect where Emu tracks are apparent

Plate 4. Example of sandy transect where Emu tracks are apparent

2.1.5 Camera trapping

The use of motion sensor cameras provides a second technique for confirming presence and also captures information on actual date present on the transect, confirms whether multiple birds were present and breeding success through recording images of juveniles with adult males. Camera trapping used fixed cameras (Stealth Cam GN45), triggered by motion sensors, to 'trap' images of passing Emus. Up to two camera traps were maintained semi-systematically along each transect, to provide a total of between 4-12 cameras per survey area. Cameras are occasionally moved to new locations along transects during subsequent surveys if found to be unsuccessful from the preceding survey period or stolen or in response to finding Emu signs.

Details on camera trapping effort during each project phase are summarised in Table 2.2. The summary data shows a comparison of the trap effort during the construction years with the 3-year pre-construction baseline dataset. In general, the mean number of trapping days per camera and total camera trap effort recorded during construction has been comparable across each survey area with the pre-construction surveys.

Traps were placed on trees at a height of approximately 1.5 metres above ground and were not baited. Cameras were set to take pictures 12 hours per day in daylight hours, with a 5 second delay between exposures to minimise repeat photographs of the same animal while allowing continuous recording to capture additional Emus in the case of multiple birds or juveniles.

The date and time of each exposure are recorded and used to determine if multiple pictures were taken of the same animal to discard consecutive observations. Cameras were left in the field continuously and batteries and storage cards replaced at each survey week (quarterly) as discussed previously in timing. Broken, malfunctioning and stolen cameras are replaced as required.

Cameras are also used to detect the presence and trap rates of wild dogs within each study area. This information is used to understand any correlation between the presence/absence of Emus and monitor changes in dog activity around crossing zones.

Table 2.2: Summary and comparison of camera trapping effort during the course of the monitoring program

Sampling period	Survey effort	Impact areas			Control areas	
		Pillar Valley west	Tucabia south	Tucabia north	Yuraygir north	Yuraygir south
Pre-construction (data shown is the means recorded over 13 quarterly monitoring sessions)	Camera monitoring days per season	90.3	90.3	90.3	90.3	90.3
	No. successful cameras	6.1	8.8	5.1	3.2	6.3
	Mean trapping days per camera	71.9	70.5	71.8	69.2	64.7
	Total camera trap effort (days)	*438.5*	*637.8*	*380.6*	*232.6*	*429.5*
Year 1 of construction (data shown is the mean recorded over 4 quarterly (seasonal) monitoring sessions)	Camera monitoring days per season	89.5	89.5	89.5	89.5	89.5
	No. successful cameras	6.0	8.8	6.5	4.0	6.8
	Mean trapping days per camera	65.7	71.8	84.1	75.1	61.7
	Total camera trap effort (days)	*405.5*	*685.0*	*538.0*	*316.5*	*412.3*
Year 2 of construction (data shown is the mean recorded over 4 quarterly (seasonal) monitoring sessions)	Camera monitoring days per season	91.0	91.0	91.0	91.0	91.0
	No. successful cameras	6.7	8.7	7.7	3.7	6.5
	Mean trapping days per camera	73.9	74.2	80.5.1	86.2	70.0
	Total camera trap effort (days)	*495.3*	*645.5*	*619.5*	*318.9*	*460.2*
Year 3 of construction (data shown is the mean recorded over 4 quarterly (seasonal) monitoring sessions)	Camera monitoring days per season	99.7	112	99.7	99.7	99.7
	No. successful cameras	6.3	9.8	6.5	2.8	6.3
	Mean trapping days per camera	70.8	93.9	88	91.2	96.3
	Total camera trap effort (days)	*442.8*	*916.3*	*615.8*	*250.8*	*625.8*
Year 4 of construction (data shown is the mean recorded over 2 quarterly (seasonal) monitoring periods	Camera monitoring days per season	84	84	84	84	84
	No. successful cameras	6.5	11.0	7.0	4.0	10.0
	Mean trapping days per camera	*79*	*77*	*63*	*63*	*67*
	Total camera trap effort (days)	*549.5*	*848.0*	*566.0*	*597.4*	*674.5*
Year 1 operation (data shown is the mean recorded over 2 quarterly (seasonal) monitoring periods	Camera monitoring days per season	98	98	98	98	98
	No. successful cameras	7	10.5	8.5	10	3
	Mean trapping days per camera	*94.9*	*92.8*	*88.6*	*70.6*	*97.5*
	Total camera trap effort (days)	*664*	*1020.5*	*797.5*	*282.5*	*975.5*

2.1.6 Data analysis and limitations

We correlated camera trapping rates of Emus with densities estimated from counts of signs made along the search transects. Two indexes of abundance were calculated using:

- Number of signs for each transect divided by the search area (transect length x 10 m) reported as density of Emu signs per hectare.
- Camera trapping rate, defined as the ratio of Emu photographs to the number of trap days multiplied by 100. This provided a comparable index of density as individual recognition of photographed Emus and hence capture-recapture analysis was unfeasible. Where multiple pictures were taken of the same animal at the same time these were discarded from the trapping rate calculations. Multiple Emu photos in the same frame were counted as separate Emu photos.

From the combined sign, camera trapping data and observed birds we created an Emu detection history at each transect consisting of binary values with '1' indicating Emu detected during the sampling period and '0' indicating non-detection. We analysed the detection history to identify the proportion of impact and control sites occupied in each study area during each sampling event (i.e. site occupation rates).

Data on density of Emu signs, and trap rates of Emus during the construction and operational phases were compared with pre-construction baseline data at impact and control sites to identify any significant changes using Analysis of Variance (ANOVA). Occupations rates were compared using a t-test analysis.

Where possible transects have been placed along fence lines, and 3 and 4 strand barbed wire fences are particularly effective at 'snagging' feathers from birds, and hence identifying Emu presence. Not all transects were able to be located on suitable fence lines, which is limited where plain wire is present or there is no fence. However, this factor does not affect the long-term comparison of results, as the conditions have not changed from the baseline survey. Occasionally fences have been replaced or sections removed and resulting in a change to the effectiveness of the transect at detecting Emu presence. To overcome this limitation, small changes or additions have been made to the transect, while still maintaining a similar search length and area of the transect as discussed previously.

2.2 Monitoring crossing zones

2.2.1 Temporary crossings (construction)

A set of eight temporary Emu crossing zones were established across the construction corridor in Section 3 in 2017 and maintained during construction in compliance with the Emu Management Plan. These are referred to in the Emu Management Plan as 'Emu races'. An Emu race consisted of a temporary fenced passageway running perpendicular and below the width of the construction corridor for the purpose of providing Emus an opportunity to cross the road corridor during construction. The objective of the races was to maintain Emu connectivity across the highway corridor in key locations during the lengthy construction phase. Specifically, Section 5.3.4 of the Emu Management Plan states:

Given a potential lengthy construction period for Section 3 of the project, the Stage 2 construction phase must make available a number of options for Emus to cross the corridor during construction. The objective is to maintain functional crossing zones during construction where possible.

Emu races were reportedly closed during construction hours using temporary fencing (gates) positioned along the road boundary, to restrict Emus from moving onto the construction corridor while work is being conducted and therefore at risk of collision. These gates are then routinely removed outside of construction hours (i.e. each evening through to early morning and every Sunday), effectively opening up the Emu race. The position of the eight Emu races were aligned with known crossing locations (temporary fence gaps trialled for 12 months prior to construction) to provide some certainty that these locations are suitable (refer Table 2.3 for details). The Emu race at chainage 47.000 was removed in 2019 to complete the final stage of construction, monitoring continued for the remaining seven Emu races.

Table 2.3: Details of Emu races maintained during construction phase of the highway

Emu Crossing Zone	Station (Chainage)	Description/ waterway/ habitat	Emu race details and monitoring details
T1	46.055	Bridge A10 Pillar Valley Creek Bridge 1 – Floodway adjacent to Pillar Valley Creek / riparian habitat	Established 1st Quarter 2017 (Year 1 Construction). Typical width 10 metres (range 2.5 m to 15 m). 4 cameras set 21.2.2017 were maintained continuously through year 1 and then changed to 2 cameras on the west and east perimeter of the crossing in 2018, continued through 2019 and up to May 2020.
T2	46.325	Bridge A11 Pillar Valley Creek Bridge 2 – Pillar Valley Creek / riparian habitat	Established 2nd Quarter 2017 (Year 1 Construction), typical width 12 metres (range 8 m to 16 m). 4 cameras set 23.05.2017 and maintained continuously through year 1, then changed to two cameras, one on the eastern side and one in the centre in 2018 and continued through 2019 and up to May 2020.

Emu Crossing Zone	Station (Chainage)	Description/ waterway/ habitat	Emu race details and monitoring details
T3	46.647	Bridge A12 Pillar Valley Creek Bridge 3 – Black Snake Creek / riparian habitat	No, race has been substituted with the race at 47.000. Closed during construction
T4	47.000	North of Black Snake Creek / cleared grazing land habitat	Established 1st Quarter 2017 (Year 1 construction), new race established to compensate for loss of T3 (T4A). Typical with 4 m (range 4 m to 7 m). 2 cameras set 21.02.2017 and maintained continuously. This temporary crossing and race were later closed during 2018 and no further monitoring has occurred in 2019 or 2020.
	47.125	A54 Twin Bridge for Emu Crossing 1 – Floodway / cleared grazing land habitat	Established 3rd Quarter 2017 (Year 1 construction), typical width 3.5 m (range 1.5 m to 5 m) (T4B). 2 cameras set 21.8.2017 and maintained continuously through year 1 to year 4.
T5	47.643	Bridge A13 Pillar Valley Creek Bridge 4 – Floodway / cleared grazing land habitat	Established 4th Quarter 2017 (Year 1 construction), typical width 4 metres (range 2.5 m to 4 m), 2 cameras set 21.08.2017 and monitored continuously through year 1 to year 4.
T6	47.925	Bridge A14 Pillar Valley Creek Bridge 5. Un-named creek / swamp forest habitat.	Established 1st Quarter 2017 (Year 1 Construction), typical width 12 metres, 4 cameras set 21.2.2017 and maintained continuously through year 1, changed to 2 cameras in year 2 and monitored continuously through year 1 to year 4.
T9	49.246	Bridge A16 North of Pillar Valley Creek Bridge 1 – Floodway / cleared grazing land	Established 4th Quarter, typical width 2.5 metres (range 1.5 m to 8 m), 2 cameras set 21.08.2017 and monitored continuously through year 1 to year 4.
T10	50.280	Bridge A17 North of Pillar Valley Cree Bridge 1 – un-named creek / swamp forest habitat	Established 1st Quarter 2017, typical width 3 metres (range 3 m to 4 m) 2 cameras set 21.2.2017 and monitored continuously through year 1 to year 4.

Monitoring of Emu usage across each race commenced as installation of the temporary structure was completed. This involved the placement of camera traps (Stealth Cam GN45) at the eastern and western entrance of the race, consisting of between 2-4 cameras depending on the width of the race. The number and configuration of cameras at each race aimed to confirm Emu usage and determine the frequency of Emu passes through the race. The cameras were set for continuous operation in daylight hours between 0500 and 2000 hours (1800 during winter) and set to take still images with a trigger interval of 5 seconds in attempt to capture direction of travel and groups of Emus or juveniles.

During the camera checks at each quarterly survey period, the length of race was also walked to search for fresh signs of Emu activity (scats, tracks and feathers) to determine if Emus used the race but were not photographed in the event of a camera failure. Bridges structures were gradually completed during 2018 and early 2019, and fencing installed in some locations during the latter part of 2019. Monitoring of the temporary construction zones ceased in mid-2020 with the start of operational monitoring.

2.2.2 Permanent structures (operation)

Crossing structures and exclusion fencing targeted at Emus have been provided between chainage 42.500 and 74.500 (Section 3 and 4 of the project) and include:

- Raised bridges with a minimum height of 3.6 metres and a minimum width of 4 metres of dry passage retained along both banks of the creek channel and abutments

- Purpose built exclusion fencing strategically located in areas surrounding the crossing structures to direct emus to the structure, and elsewhere in emu habitat areas to prevent emus from entering the highway corridor.

According to the Emu Management Plan, the monitoring program is to be designed to compare a range of crossing types to determine their effectiveness and inform management decisions, this would include:

- Structure type (raised versus non-raised bridges)
- Landscape type (riparian habitat, cropping land, open grazed landscapes, and plantings)
- Attractant type (cleared easement or tracks leading to bridge, and no attractants)

Thirty potential crossing locations are identified in the Coastal Emu Management Plan (Table 5-1), this included 21 bridges over creeks, drains and floodplain and 9 incidental structures such as road overpasses, property access and culverts which may potentially be used by emus to cross the highway. From these, the operational monitoring focuses on 18 bridge structures in locations where emus have historically been recorded between the Coldstream River in the south (Section 3), north to Shark Creek (Section 4). Structures have been selected to maximise the chance of recording emus on motion detection cameras, considering bridge location relative to landscape / habitat, comparing structure size and attractants, as follows

- Of the 18 structures, 14 of these have been designed with a minimum 3.6 m clearance from ground. Bridges in Section 3 of the project were raised above their functional requirements to allow for emu passage (raised bridges), and 4 bridges retained a standard functional design, that were not designed specifically for targeting emu passage (non-raised bridges).

- A range of landscape and habitat types was selected for monitoring, including Swamp Forest (2 sites), Dry Forest (3 sites), Riparian Forest (2 sites), Grazing Land (4 sites), Cropping Land (3 sites), and mixed forest and grazing land occurring east and west of the structure (4 sites).

- There are no sites with obvious tracks or attractants secured to the bridge structure, although 18 sites have used landscape plantings targeting emu food plants and this has been considered an attractant for the purpose of monitoring usage. . Consideration of additional attractants may occur as the program progresses and if structures are found not to be effective.

- Four sites comprise rural stock fencing parallel with and below the road and bridge, which is used for excluding cattle entering different property owners on both sides of the highway, or selective exclusion of cattle from un-grazed areas. These are referred to as ‘Emu Hybrid Fencing’ have been designed as 4 strand fences with adequate spacing to allow emu passage and exclude cattle, and two of these sites have included an ‘Emu Gate’ as part of the hybrid fence design.

Details of the structures selected for the operational phase monitoring are presented in Table 2-4.

Table 2.4: Details of bridges monitored during first 6 months operational phase of the highway (* identifies Emu / Cattle hybrid fence is associated with structure)

Site no.	Design ref	Section (Chainage)	Waterway	Landscape/ Habitat type	Bridge / site specifications and monitoring details	Design raised for emu passage	Emu food plants used in landscaping^	No. cameras (Dec 2020)
A	Bridge A08	S3 (43.881)	None, floodplain	Swamp forest	200 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining. Monitoring commenced end of 2nd Quarter 2020 (26.05)	Yes	Yes	2 (A1, A2)
B	Bridge A10	S3 (46.325)	Pillar Valley Creek.	Swamp forest	80 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining. Corresponds with T1 construction monitoring site. Monitoring commenced end of 2nd Quarter 2020 (26.05) two cameras.	Yes	Yes	2 (B1, B2)
C	Bridge A11	S3 (46.342)	Pillar Valley Creek	Grazing land	93 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining. Corresponds with T2 construction monitoring site. Monitoring commenced end of 2nd Quarter 2020 (26.05) two cameras.	Yes	Yes	2 (C1, C2)
D	Bridge A12	S3 (46.628)	Black Snake Creek	Grazing land	60 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining. Corresponds with T3 construction monitoring site. Monitoring commenced end of 2nd Quarter 2020 (26.05) one camera, then second camera 25.08.2020.	Yes	Yes	2 (D1, D2)
E	Bridge A54	S3 (47.190)	None, floodplain	Grazing land	20 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining. Corresponds with T4 construction monitoring site. Monitoring commenced end of 2nd Quarter 2020 (26.05) two cameras.	Yes	Yes	2 (E1, E2)
F	Bridge A13	S3 (47.620)	Unnamed creek, open flats	Grazing land	60 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining. Corresponds with T5 construction monitoring site. Monitoring commenced end of 2nd Quarter 2020 (26.05) two cameras.	Yes	Yes	2 (F1, F2)
G	Bridge A14	S3 (47.841)	Unnamed creek	Riparian forest	72 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining. Corresponds with T6 construction monitoring site. Monitoring commenced end of 2nd Quarter 2020 (26.05) two cameras.	Yes	Yes	2 (G1, G2)

Site no.	Design ref	Section (Chainage)	Waterway	Landscape/ Habitat type	Bridge / site specifications and monitoring details	Design raised for emu passage	Emu food plants used in landscaping^	No. cameras (Dec 2020)
H	Bridge A16*	S3 (49.228)	None, floodplain	Grazing land on west, forest on east	80 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining, and hybrid emu fence parallel with north bound carriage. Corresponds with T9 construction monitoring site. Monitoring commenced end of 2nd Quarter 2020 (26.05) four cameras.	Yes	Yes	4 (H1-H4)
I	Bridge A17	S3 (50.259)	Unnamed creek	Dry forest	45 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining, and hybrid emu fence parallel with south bound carriage. Corresponds with T10 construction monitoring site. Monitoring commenced end of 2nd Quarter 2020 (26.05) two cameras.	Yes	Yes	2 (I1, I2)
J	Bridge A55*	S3 (51.2900)	None, floodplain	Grazing land on east, forest on west	62 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining, and hybrid emu fence parallel with south bound carriage including emu gate. Monitoring commenced end of 3rd Quarter 2020 (25.08) one camera.	Yes	Yes	1 (J1)
K	Bridge A19*	S3 (52.423)	Chaffin Creek	Riparian and dry forest	78 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining, and hybrid emu fence parallel with south bound carriage including emu gate. Monitoring commenced end of 3rd Quarter 2020 (25.08) one camera.	Yes	Yes	1 (K1)
L	Bridge A50	S3 (53.758)	Unnamed creek	Dry forest	20 m, unknown ground clearance dual carriageways with opening between bridges. Monitoring commenced end of 2nd Quarter 2020 (26.05) one camera.	No	Yes	1 (L1)
M	Bridge A20	S3 (54.696)	Unnamed creek	Dry forest	75 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining. Monitoring commenced end of 3rd Quarter 2020 (25.08) two cameras.	Yes	Yes	2 (M1, M2)
N	Bridge A23*	S3 (57.015)	Champions Creek	Dry forest east, grazing land west	90 m x 3.6 m ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining and emu hybrid fence parallel with north bound carriage. Monitoring commenced end of 2nd Quarter 2020 (28.05) one camera.	Yes	Yes	1 (N1)

Site no.	Design ref	Section (Chainage)	Waterway	Landscape/ Habitat type	Bridge / site specifications and monitoring details	Design raised for emu passage	Emu food plants used in landscaping^	No. cameras (Dec 2020)
O	Bridge A51	S3 (59.286)	Unnamed creek	Riparian forest	20 m, unknown ground clearance dual carriageways with opening between bridges. Exclusion fencing adjoining. Monitoring commenced end of 3rd Quarter 2020 (25.08) one camera.	No	Yes	1 (O1)
P	Bridge A31	S4 (70.433)	Constructed drain / floodplain	Cropping land	29 m bridge over constructed drain, with 2.5 m between top of drain and bridge abutment. Opening between bridges. Monitoring commenced end of 3rd Quarter 2020 (25.08) one camera.	No	No	1 (P1)
Q	Bridge A33	S4 (73.380)	Constructed drain / floodplain	Cropping land	35 m bridge x 2.9 height over constructed drain, with 2.5 m between top of drain and bridge abutment. Opening between bridges. Monitoring commenced end of 3rd Quarter 2020 (25.08) one camera.	No	No	1 (Q1)
R	Bridge A34	S4 (74.400)	Shark Creek / floodplain	Cropping land	448 m twin bridges x 3.6 m ground clearance with opening between bridges. Exclusion fencing adjoining. Future monitoring proposed via searches for tracks and camera monitoring	Yes	No	1 (R1)

Monitoring of Emu usage at each structure commenced from June 2020 as the highway became operational (in the 3rd and 4th Quarters of 2020). This involved the placement of camera traps (Stealth Cam GN45) below each structure, consisting of between 2-4 cameras depending on the width of the structure. The number and configuration of cameras at each structure aimed to confirm Emu usage and determine the direction and frequency of Emu passes below the structure. The cameras were set for continuous operation in daylight hours between 0500 and 2000 hours (1800 during winter) and set to take still images with a trigger interval of 5 seconds in attempt to capture direction of travel and groups of Emus or juveniles. The number of cameras set in the first two quarters is identified in Table 2-4, this was a reconnaissance period, with the intention being to progressively increase the number of cameras over future monitoring events in early 2021 in line with determining best camera locations and avoiding flooding of equipment during high rainfall events.

During the camera checks at each quarterly survey period, the area below the bridge was also walked to search for fresh signs of Emu activity (scats, tracks and feathers) to determine if Emus used the structure but were not photographed in the event of a camera failure.

2.2.3 Fence and roadkill monitoring

During each quarterly camera inspection, exclusion and hybrid fences were walked north and south of the crossing structure to search for evidence of emu presence or passing through emu hybrid fences. Camera traps were also positioned facing the active emu gates. Care was taken to search for emu roadkill in the vicinity of the crossing structures, using vehicle searches, and during fence inspections.

2.3 Emu sightings construction register

A register of Emu sightings is maintained during construction by on-site personnel associated with the construction contractor. The register has been maintained since the commencement of early works in Section 4 in mid-2016 and throughout the first three years of construction (2017-19). The register is a database for documenting sightings and observations of Emus within or adjacent to the construction corridor and has three objectives:

1) Manages potential impacts to Emus that may result from a collision with construction vehicles.
2) Informs environmental managers where additional mitigation or corrective actions may be required.
3) Provides supplementary Emu presence data to inform the monitoring program.

Section 5.3.2 of the Management Plan states:

Workers on site to actively note and report Emu sightings daily by recording number and location of Emus on map to be provided. Important to identify time and date, and number of birds including which side of the construction corridor Emus sighted.

The register was maintained as a manually recorded excel database for the majority of 2017, towards the end of the year a mobile spatial application was released by Pacific Complete (Arc Collector) as a more efficient means of collecting Emu observational data. This app has been maintained through the remainder of the construction phase (2018-20). With the end of construction in mid-2020, no further dedicated register has been retained, although sightings of emus near the highway has been maintained by the author during monitoring periods and is reported to the author by Environmental Officers from Transport for NSW.

During the operational phase, sightings of Emus will be maintained largely through direct observations captured during monitoring activities, as well as observations provided by TfNSW staff while driving sections of the highway, and other observations provided by landowners accessed during monitoring. These opportunistic observations will continue to be reported.

3. Results

3.1 Emu presence

3.1.1 Sign searches

Signs of Emu presence were recorded from each of the impact and control survey areas in at least one season during the three and half year-construction period, with the exception of the Yuraygir south survey area (control). For the first six months of the operational period, Emu sign was observed at the Tucabia north impact survey area (east of the highway) and the Yuraygir north control area.

Emu sign was confirmed both east and west of the highway corridor during the construction monitoring period up until March 2019, after this date no signs were recorded west of highway in the last 15 months of construction ending in June 2020. Although Emus have been observed in cane fields on the west side of the highway in Section 4 during this period.

The density of Emu sign during the three and half years of construction declined from all three 'impact' survey areas compared with the 3-year pre-construction period from the same locations (Figure 3). This was most notable from the Pillar Valley west transects. A similar pattern of decline in Emu sign during the construction phase was also noted in the 'control' survey areas, with a complete absence of Emu sign recorded in the Yuraygir south transects and a marked decline c.50 % from the Yuraygir North transects during the 4-year construction period (

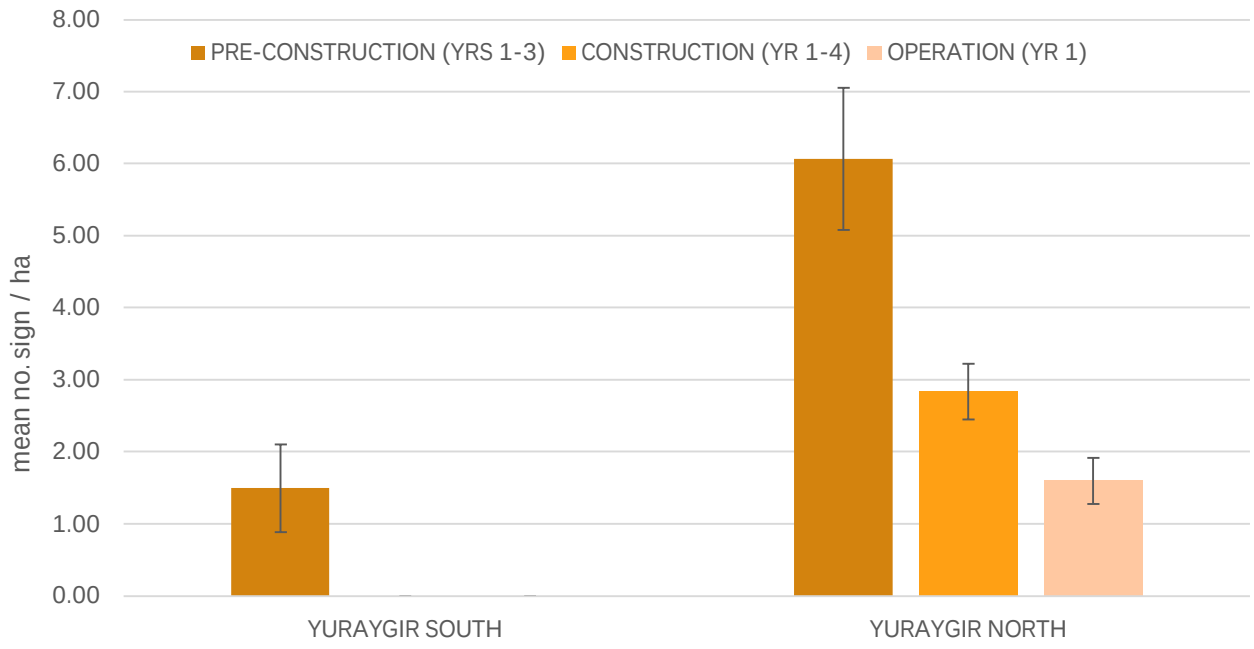


Figure 4).

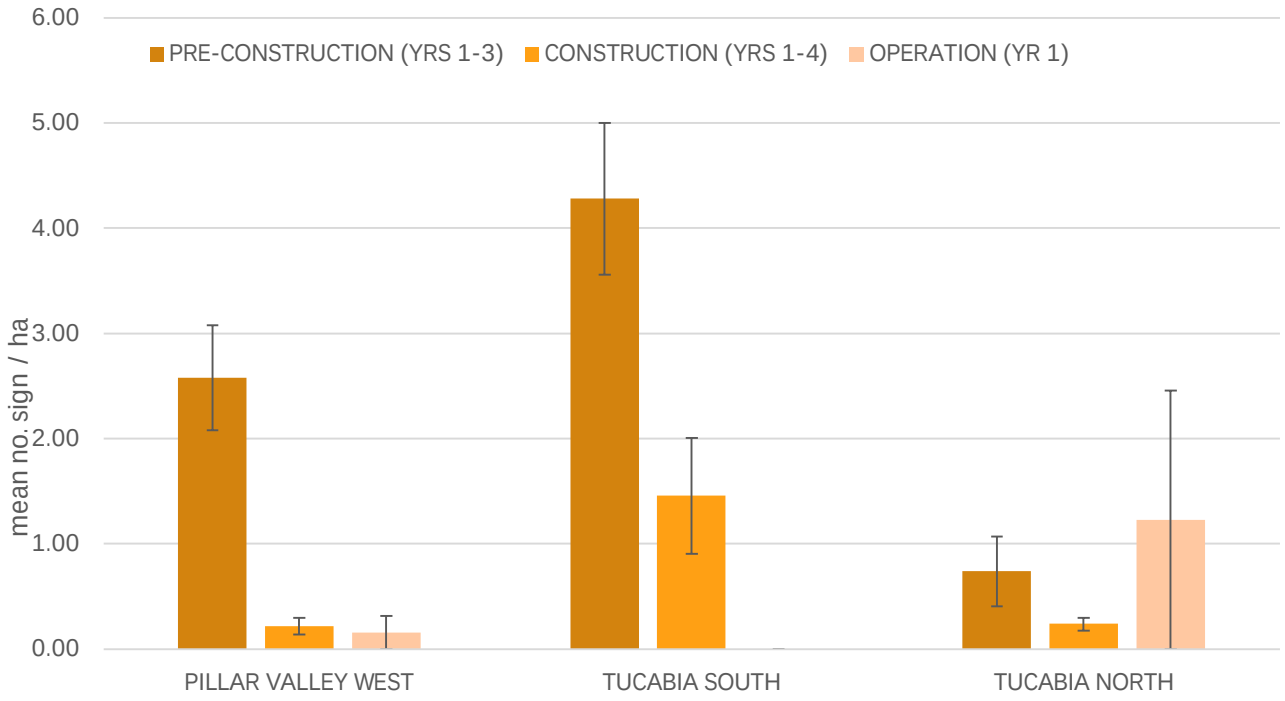


Figure 3: Mean density of Emu sign (no./ ha) at impact sites comparing pre-construction (2014-16) and construction (2017-20) and operation (June-Dec 2020)

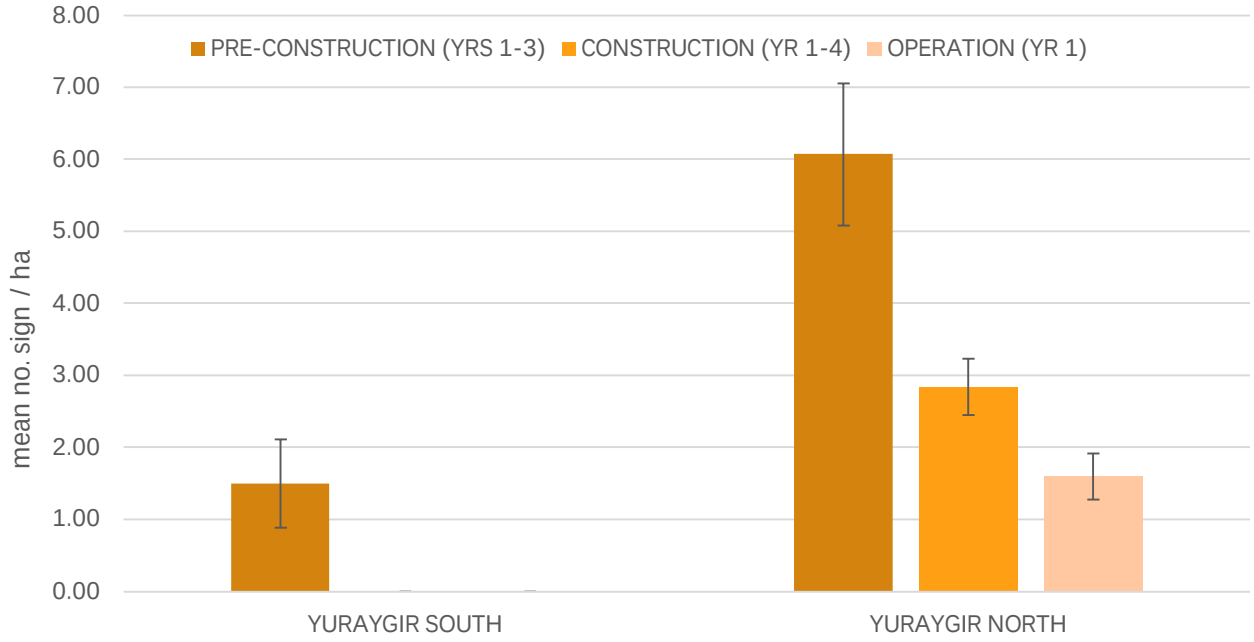


Figure 4: Mean density of Emu sign (no./ ha) at control sites comparing pre-construction (2014-16) and construction (2017-20) and operation (June-Dec 2020)

The decline in sign data during construction has been interpreted with consideration of the temporal patterns of Emu sign observed across the three impact study areas since 2014 which includes pre-construction and construction years. The density of Emu sign within each survey area has varied between season and years irrespective of construction (These data suggest a shift in emu activity away from the transects on the three impact survey areas, and that this commenced from the start of monitoring in 2014, prior to construction. It is unknown whether the declining density of emu sign is due to actual lower Emu numbers over the 6-year monitoring period or whether the individuals previously occupying these areas shifted away from the survey area to other nearby habitat with the range of the population. The presence of construction activity may have influenced the shift in emu activity away from the monitoring transects.

The density of Emu signs has declined significantly in the Yuraygir (north and south) control survey areas since collation of baseline data in 2014 (Table 3.2). A significant difference between the pre-construction and construction years has been noted for the southern control area ($P = 0.01$) and northern control area ($P = 0.006$). These data suggest either a decline in Emu numbers at the control sites or alternatively a shift away from these specific survey areas or transects to other proximal habitat areas within the range of the population.

The data from the control areas suggest that Emu presence in localised areas can change over time, likely in response to changing environmental conditions and associated resource availability or behavioural traits. As this is the last construction monitoring report, focus will now be on whether Emus return to the impact areas during the operational phase and compare with Emu presence at control locations. for this early stage of operation, Emus have been reported at the Pillar Valley west transects, which a positive sign that birds are returning to impact areas where there has been an absence during the final 18 months of construction.

Table 3.1). For example, pre-construction sign density was highest in 2014 before declining in 2015 and 2016 (prior to construction commencing in 2017). Monitoring during construction occurred in 2017-2020 and the general trend of declining Emu sign that was noted prior to construction commencing, has continued.

A one-way ANOVA (analysis of variance) was performed on the annual sign density values comparing the pre-construction (before) survey events (n=12) with the construction (after) survey events (n=14) and control versus impact areas. These data indicate a significant decline in Emu activity has occurred in the Pillar Valley West survey area, a trend which was first noted prior to construction (*P = 0.001*). There was also a significant decline between 2015-16 (pre-construction) and 2017-18 (construction) (*P = 0.003*). These data suggest that the decline in Emu sign at the Pillar Valley west survey area had started prior to construction and was consistent over the last five years. A significant decline has also been noted at the Tucabia south survey area between baseline and construction (*P = 0.004*), while a decline has also been noted in the Tucabia north survey area, although not significant (*P = 0.05*). Importantly, an increase in sign has been observed for Tucabia north in the first short period of operation and will continue to be monitored throughout the operational phase.

These data suggest a shift in emu activity away from the transects on the three impact survey areas, and that this commenced from the start of monitoring in 2014, prior to construction. It is unknown whether the declining density of emu sign is due to actual lower Emu numbers over the 6-year monitoring period or whether the individuals previously occupying these areas shifted away from the survey area to other nearby habitat with the range of the population. The presence of construction activity may have influenced the shift in emu activity away from the monitoring transects.

The density of Emu signs has declined significantly in the Yuraygir (north and south) control survey areas since collation of baseline data in 2014 (Table 3.2). A significant difference between the pre-construction and construction years has been noted for the southern control area (*P = 0.01*) and northern control area (*P = 0.006*). These data suggest either a decline in Emu numbers at the control sites or alternatively a shift away from these specific survey areas or transects to other proximal habitat areas within the range of the population.

The data from the control areas suggest that Emu presence in localised areas can change over time, likely in response to changing environmental conditions and associated resource availability or behavioural traits. As this is the last construction monitoring report, focus will now be on whether Emus return to the impact areas during the operational phase and compare with Emu presence at control locations. for this early stage of operation, Emus have been reported at the Pillar Valley west transects, which a positive sign that birds are returning to impact areas where there has been an absence during the final 18 months of construction.

Table 3.1: Density of Emu sign per ha recorded at the three impact study areas separated into years of pre-construction (2014-16 purple), construction (2017-20 green) and early phase of operation (June-Dec 2020 orange)

Sampling period	Pillar Valley west (2014-2020)								Tucabia south (2014-2020)								Tucabia north (2014-2020)							
	14	*15*	*16*	*17*	*18*	*19*	*20*	*20*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*20*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*20*
Summer	2.56	2.56	0.64	0.32	0.48	0.32	0.00	-	6.52	7.61	3.26	6.52	1.09	0.22	0.00	-	0.00	0.95	0.19	0.57	0.19	0.00	0.00	-
Autumn	3.68	0.80	1.44	0.96	0.48	0.00	0.00	-	9.78	5.87	1.52	4.78	0.43	0.00	0.00	-	0.00	0.19	0.19	0.57	0.38	0.00	0.00	-
Winter	3.52	2.24	1.28	0.32	0.00	0.00	-	0.32	5.87	3.26	2.17	3.48	1.74	0.00	-	0.00	3.22	0.00	0.00	0.19	0.00	0.19	-	0.00
Spring	6.40	1.92	-	0.16	0.00	0.00	-	0.00	1.74	3.48	-	1.30	0.87	0.00	-	0.00	1.52	0.19	-	0.57	0.38	0.38	-	2.46
Summer	5.60	0.96	-	-	-	-	-	-	1.96	2.61	-	-	-	-			3.22	0.00	-	-	-	-		
Mean	*4.35*	*1.7*	*1.12*	*0.44*	*0.24*	*0.08*	*0.00*	*0.16*	*5.17*	*4.57*	*2.32*	*4.02*	*1.03*	*0.06*	*0.00*	*0.00*	*1.59*	*0.27*	*0.13*	*0.48*	*0.24*	*0.14*	*0.00*	*1.23*
SE	*0.71*	*0.35*	*0.19*	*0.18*	*0.14*	*0.08*	*0.00*	*0.16*	*1.51*	*0.94*	*0.39*	*0.98*	*0.27*	*0.06*	*0.00*	*0.00*	*0.72*	*0.18*	*0.05*	*0.08*	*0.09*	*0.09*	*0.00*	*1.23*

Table 3.2: Density of Emu sign per ha recorded at the two control study areas separated into years of pre-construction (2014-16 purple), construction (2017-20 green) and early phase of operation (June-Dec 2020 orange)

Sampling period	Yuraygir south								Yuraygir north							
	2014	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2020*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2020*
Summer	5.53	0.18	0.00	0.00	0.00	0.00	0.00	-	1.28	7.37	2.88	5.77	1.28	1.92	1.68	-
Autumn	4.42	0.00	0.00	0.00	0.00	0.00	0.00	-	5.13	4.81	5.13	4.49	1.60	2.24	4.81	-
Winter	3.87	0.00	0.00	0.00	0.00	0.00	-	0.00	4.81	3.85	6.73	2.88	3.53	1.92	-	1.92
Spring	4.61	0.00	-	0.00	0.00	0.00	-	0.00	11.54	5.77	-	4.17	1.92	1.60	-	1.28
Summer	0.92	0.00	-	-	-				14.74	4.81	-	-	-	-		
Mean	*3.87*	*0.04*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*7.50*	*5.32*	*4.91*	*4.33*	*3.21*	*2.78*	*3.25*	*1.60*
SE	*0.78*	*0.04*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2.45*	*0.59*	*1.12*	*0.59*	*0.56*	*0.41*	*1.57*	*0.32*

3.1.2 Camera trapping

During the construction phase of the program Emus were photographed at 6 of the 20 transects surveyed (33 %) in the first year (2017); 4 of the 20 transects (20 %) in the second year (2018) 1 of the 20 transects (5 %) in the third year (2019) and in the last 6 months of construction (Jan-June 2020) were photographed at 2 of the 20 transects (10 %). This is compared with 61.1 %, 40 % and 30 % recorded during the 3-year pre-construction monitoring period. These data are consistent with the trends observed from the Emu sign data. Emus were not photographed from impact transects in 2019 or 2020, coinciding with the last 18 months of construction.

The Yuraygir North control area recorded Emu photographs during the final 6-month construction monitoring periods in 2020, particular in the autumn period which coincided with the pre-breeding season. This pattern of emu presence continued for the latter half of 2020 and coinciding with the first 6 months of the operational phase. Importantly, Emus were photographed from the Yuraygir South control area in October 2020, which is the first-time evidence of Emus has been reported since 2015.

Mean camera trap rates in impact and control areas are shown in Figure 5, these show an overall comparison of the pre-construction data (2014-2016) with the three and half years of construction (2017-2020). There has been a trending decline in Emu trap rates from pre-construction through to end of construction at both impact and control areas (81 % and 43 % respectively). Accounting for the first 6 months of operation, the difference between pre-construction and construction at the control sites has reduced slightly to 34 %.

There were no Emu photos captured at Pillar Valley west or Yuraygir south during construction and this is consistent with the low density of Emu sign reported in these areas. Emus were photographed in Tucabia north and south during 2017 and 2018, but not in the final 18 months of construction (2019-2020).

No chicks or juvenile Emus were photographed at the impact or control study areas in 2020, however land-owner sightings at the Yuraygir north control study area report evidence of breeding.

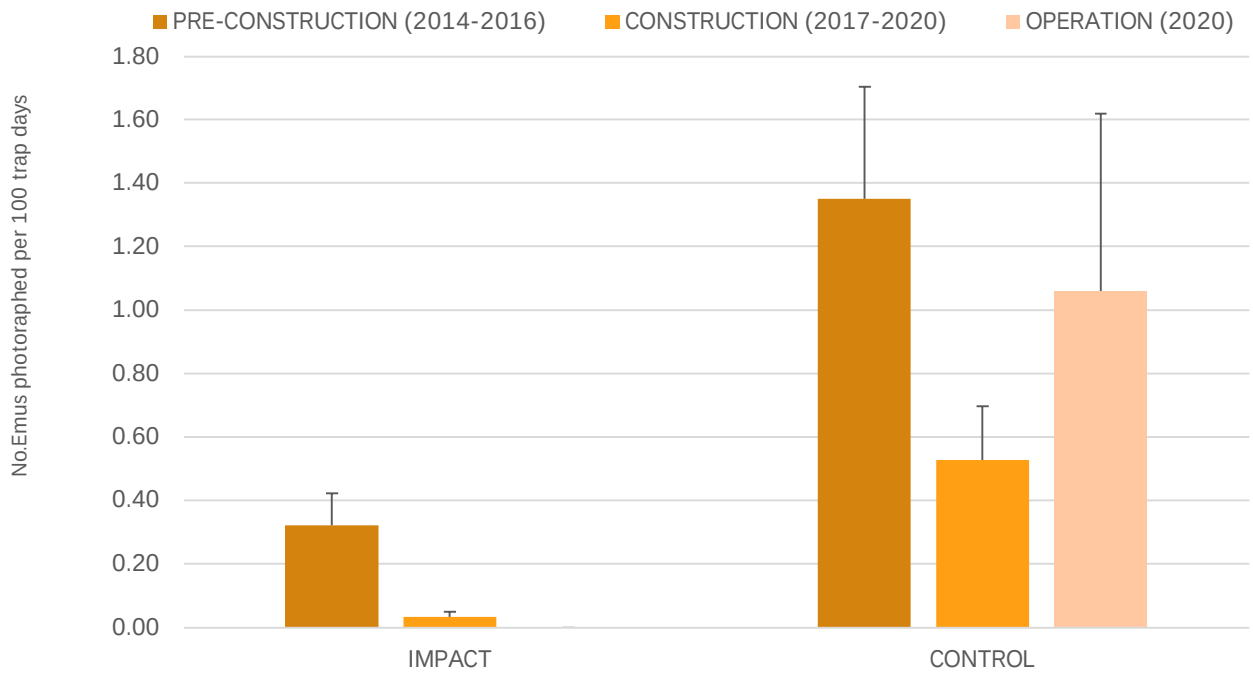


Figure 5: Mean camera trap rates (no. Emus photographed per 100 trap days) at impact and control study areas for pre-construction period (2014-16), construction period (2017-20) and start of operation (Jun-Dec 2020)

The camera trapping data is consistent with the declines noted in the sign density discussed previously. These data are presented in Camera trap rates of wild dogs were also recorded to monitor temporal change in dog presence in Emu survey areas. Dogs were found to be present on all transects both during the pre-construction phase and construction phase, indicating dogs and Emus co-exist within impact and control areas. Interestingly, there has been a notable reduction in the presence of dogs during the construction phase compared with the baseline data, however this has also been noted from controls areas and the factors relating to this are unknown.

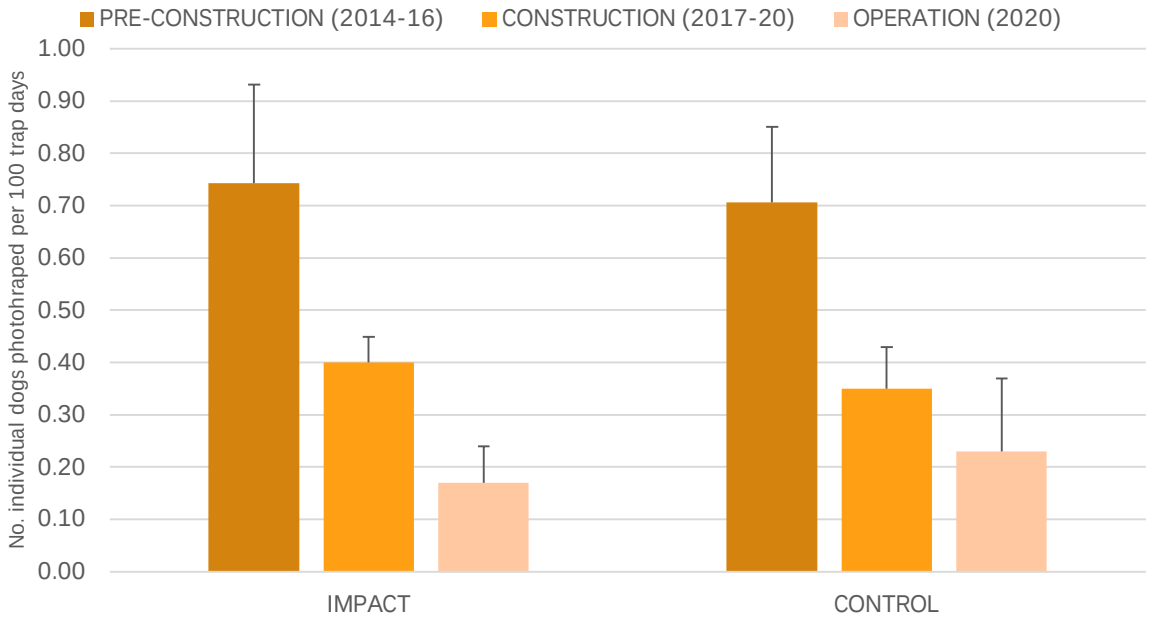


Figure 6: Mean camera trap rates (no. dogs photographed per 100 trap days) at impact and control study areas for 3-year pre-construction period (2014-16), 3.5-year construction period (2017-20) and first 6 months of operation (2020)

Plate 5. Yuraygir North control area December 2020

Plate 6. Yuraygir north control area September after fire

Table 3.3 and Table 3.4 and show a decline in trap rates in the impact areas of between 36 – 80 % recorded in the pre-construction years (baseline).

A one-way ANOVA (test of variance) was performed on the annual camera trap rates comparing each of the six and half years and then comparing the pre-construction years (before) with the construction years (after). Future analysis of operation data will be included at end of Year 1 operation. These data indicate no significant differences in mean camera trap rates between years, except for the Yuraygir south control study area where no Emus have been photographed after 2014. However, when considering analysis of the complete dataset (3 years baseline and 3.5 years construction) trap rates have declined significantly in impact areas (*P=0.016*), but not control areas (*P=0.15*), this is a factor of the lack of photographs recorded during construction in the Yuraygir south control transects.

Camera trap rates of wild dogs were also recorded to monitor temporal change in dog presence in Emu survey areas. Dogs were found to be present on all transects both during the pre-construction phase and construction phase, indicating dogs and Emus co-exist within impact and control areas. Interestingly, there has been a notable reduction in the presence of dogs during the construction phase compared with the baseline data, however this has also been noted from controls areas and the factors relating to this are unknown.

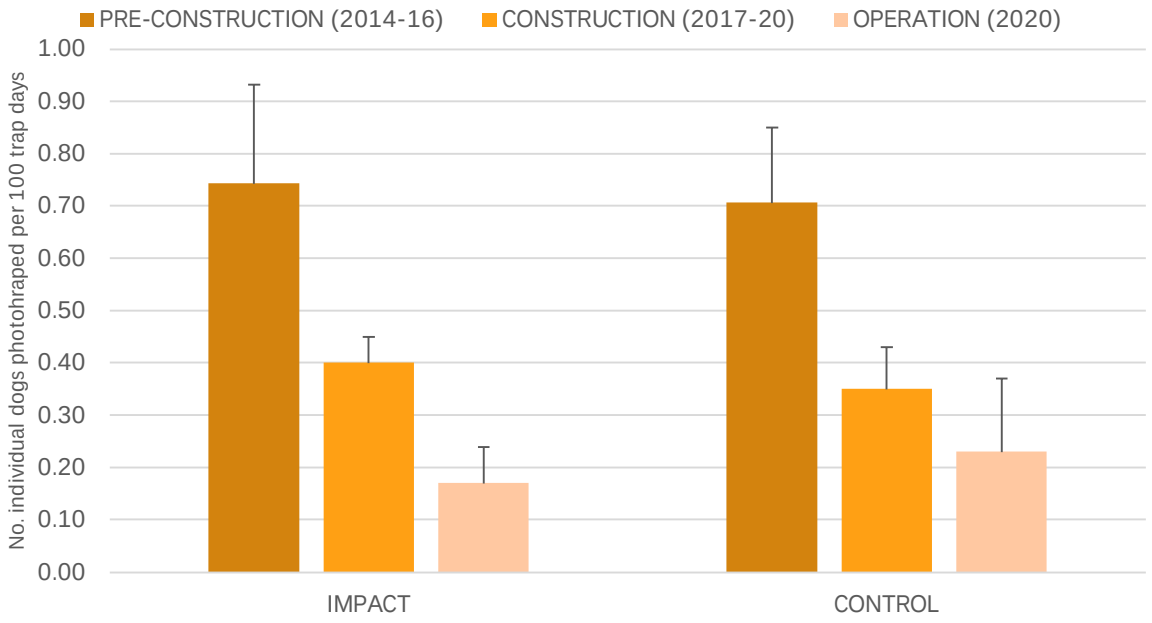


Figure 6: Mean camera trap rates (no. dogs photographed per 100 trap days) at impact and control study areas for 3-year pre-construction period (2014-16), 3.5-year construction period (2017-20) and first 6 months of operation (2020)

Plate 5. Yuraygir North control area December 2020

Plate 6. Yuraygir north control area September after fire

Table 3.3: Camera trap rate (no. Emu photos / 100 trap days) per study area recorded at the three impact study areas for three years pre-construction (2014-16) and three-half years construction (2017-20), and first 6 month of operation (2020)

Sampling period	Pillar Valley west (2014-2020)								Tucabia south (2014-20)								Tucabia north (2014-20)							
	14	*15*	*16*	*17*	*18*	*19*	*20*	*20*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*20*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*20*
Summer	0.00	0.00	0.19	0.00	0.00	0.00	0.00		2.99	1.51	0.51	0.17	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Autumn	0.92	0.00	0.00	0.00	0.00	0.00	0.00		0.96	0.12	0.41	0.54	0.18	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter	1.16	0.00	0.17	0.00	0.00	0.00		0.00	0.24	0.00	0.19	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00
Spring	0.13	0.99		0.00	0.00			0.00	0.54	0.43		0.15	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
Summer		0.00								0.14								0.00						
Mean	*0.55*	*0.20*	*0.12*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*1.18*	*0.44*	*0.37*	*0.22*	*0.05*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.04*	*0.00*	*0.00*	*0.00*	*0.00*
SE	*0.29*	*0.20*	*0.06*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.62*	*0.28*	*0.09*	*0.11*	*0.05*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.04*	*0.00*	*0.00*	*0.00*	*0.00*

Table 3.4: Camera trap rate (no. Emu photos / 100 trap days) per study area recorded at the two control study areas for three years pre-construction (2014-16) and three-half years construction (2017-20) and first 6 months of operation (2020)

Sampling period	Yuraygir south (2014-20)								Yuraygir north (2014-20)							
	14	*15*	*16*	*17*	*18*	*19*	*20*	*20*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*20*
Summer	1.85	0.00	0.00	0.00	0.00	0.00	0.00		1.75	1.1	0.36	1.23	1.78	0.88	0.66	
Autumn	2.23	0.00	0.00	0.00	0.00	0.00	0.00		0.97	2.06	0	1.92	1.28	0.00	0.91	
Winter	1.54	0.00	0.00	0.00	0.00	0.00		0.00	6.38	0	4.35	2.92	1.79	0.34		1.09
Spring	1.01	0.00		0.00	0.00	0.00		0.52	4.67	2.74		0.99	0.95	0.15		2.61
Summer		0.00								1.42						
Mean	*1.66*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.26*	*3.44*	*1.46*	*1.57*	*1.77*	*1.45*	*0.34*	*0.79*	*1.85*
SE	*0.26*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.26*	*1.26*	*0.46*	*1.39*	*0.22*	*0.1*	*0.19*	*0.12*	*0.76*

3.1.3 Site Occupation

Data from the sign survey and camera trapping for each period of monitoring were combined to identify temporal site occupation (i.e. the proportion of transects occupied by Emus within each survey area and each treatment). As the home range and distance travelled by Coastal Emus is not well known, the data analysis has relied on the assumption that separate individuals or groups occupy the impact and control study areas. For example, it is feasible for the three impact survey areas that the same Emus could be detected on any of the thirteen transects sampled. Therefore, for the purpose of comparing site occupation rates, the impact site data was assessed as one whole survey area and the two control areas were assessed as separate survey areas. This is because the control areas are spatially separated from the impact areas and therefore there is a low likelihood that the same Emus from the impact area would be detected in either of the control areas.

The number of sites occupied in any one survey period varied across season with more notable fluctuations in impact areas versus control areas (Figure 7 compares the mean occupation rate for each survey area (impact and control areas), comparing 12 pre-construction surveys (3-year baseline) with 14 construction phase surveys (3.5-years) and 2 operation phase surveys (6 months). The pre-construction and construction means were compared using an independent t-test with the dependent variable being occupation rate and the independent variable being time (pre-construction and construction). Future annual reports will aim to also compare operational data as data from more survey periods is gathered.

When comparing the mean site occupation for 3 years before construction with mean site occupation for 3.5 years during construction, the proportion of impact sites occupied by Emus has declined by 39.2 %, while the proportion of control sites occupied by Emus has declined by 28.9 %. This equates to a small difference between the impact and control treatments of only 7.3 %.

Importantly, for the impact sites there was a notable decline in occupation rates during the 3 pre-construction years of 47.4 % (prior to any disturbance) which is comparable with the decline during the 3.5 construction years (55.8 %). The decline is observable across the 3.5 construction years, with occupancy means recorded as low as 7.7 % in winter 2018 and 2019 and an absence of Emus in autumn and spring 2019 and summer through winter in 2020 (Table 3.5). For the control sites there has also been a decrease in occupation rates during the pre-construction years (65.7 %) and the construction years (3.6 %). This decline was first noted in late 2015 during the pre-construction phase, associated with the absence of Emu activity in the Yuraygir south control sites. The mean decline is a factor of the higher occupation rates in the first year of the program commencing in 2014 through the latter two pre-construction years (2015 and 2016).

With the commencement of operational phase monitoring (first 6 months), interestingly Emus were detected again at the impact sites in spring 2020 after an absence during the last 12 months of construction.

Table 3.5). These variations are likely to reflect seasonal movements of Emus around the project area in response to the availability of food resources rather than impacts from construction. Emus were found to continually occupy the Yuraygir north transects (YNA and YNB) in all seasonal survey periods, and this may be related to the presence of reliable annual food resources. The only absence recorded during the 3.5-year construction phase, was likely a result of fire across the transect and subsequent loss of camera and sign data.

Interestingly, the occupation data shows Emus returning to some impact areas after periods of absence, which was evident at Tucabia north (TNB) where Emus were confirmed in winter 2019 after 12 months absence and then returning again in spring 2020 after a further 12 months absence, and following completion of the highway. These data may reflect annual movements of Emus in response to the availability of resources and demonstrate that coastal Emus may return to locations annually after long periods of absence, or that new individuals may move into suitable habitat that is not occupied.

Figure 7 compares the mean occupation rate for each survey area (impact and control areas), comparing 12 pre-construction surveys (3-year baseline) with 14 construction phase surveys (3.5-years) and 2 operation phase surveys (6 months). The pre-construction and construction means were compared using an independent t-test with the dependent variable being occupation rate and the independent variable being time (pre-construction and construction). Future annual reports will aim to also compare operational data as data from more survey periods is gathered.

When comparing the mean site occupation for 3 years before construction with mean site occupation for 3.5 years during construction, the proportion of impact sites occupied by Emus has declined by 39.2 %, while the proportion of control sites occupied by Emus has declined by 28.9 %. This equates to a small difference between the impact and control treatments of only 7.3 %.

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With the commencement of operational phase monitoring (first 6 months), interestingly Emus were detected again at the impact sites in spring 2020 after an absence during the last 12 months of construction.

Table 3.5: Site occupation rates (proportion of transects occupied) recorded seasonally at the impact and control study areas comparing 3 years pre-construction (2014-16 purple), 3.5 years construction (2017-20 green) and first 6 months of operation (2020 orange)

Sampling period	Impact								Control							
	14	*15*	*16*	*17*	*18*	*19*	*20*	*20*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*20*
Summer	85.60	84.60	30.80	61.50	46.20	23.10	0.00	-	91.60	42.90	28.60	28.60	28.60	28.60	28.60	-
Autumn	90.00	46.20	46.20	53.80	38.50	0.00	0.00	-	100.00	28.60	28.60	28.60	28.60	14.30	28.60	-
Winter	90.90	38.50	46.20	61.50	7.70	7.70	-	0.00	100.00	28.60	28.60	28.60	28.60	28.60	-	28.57
Spring	92.30	69.20	46.20	46.20	23.10	0.00	-	7.69	85.70	28.60	28.60	28.60	14.30	28.60	-	42.86
Mean	*89.70*	*59.60*	*42.30*	*55.80*	*28.80*	*7.69*	*0.00*	*3.85*	*94.30*	*32.20*	*28.60*	*28.60*	*25.00*	*25.00*	*28.60*	*35.71*
SE	*1.45*	*10.60*	*3.85*	*3.68*	*8.53*	*5.44*	*0.00*	*3.85*	*3.39*	*3.58*	*0.00*	*0.00*	*3.52*	*3.57*	*0.00*	*7.14*

Figure 7: Mean site occupation rates (±se) for impact and control sites comparing pre-construction (2014-16) with construction (2017-20) and operation (2020)

3.2 Crossing zones

3.2.1 Temporary crossings (construction)

Camera monitoring equipment was installed at the Emu races in February 2017 at the commencement of construction, with the number of cameras at each site gradually increased over subsequent months as each race was completed. Monitoring continued in 8 races during construction in 2018 and 7 races in 2019 and 2020. Mitchell Road (T8) was no longer monitored and at T3 a race was not established, and at T4 a temporary race was removed to complete construction. Up to 18 cameras continually functioned within the remaining 7-8 races during each of the 14 construction monitoring periods (2017-2020). This resulted in a total of 2,231 camera trapping days and 47,048 photos taken from the emu races in the final 6-month period of construction from January-June (2020). Most of the photos taken were of construction workers finishing construction, tidying up sites, and conducting landscape plantings, and this reflects the daily construction activity which has been consistent with other years 2017-2019 and has hindered the effectiveness of the construction monitoring period in emu races. In addition, cattle are commonly photographed using the Emu races, as well kangaroos and occasional wild dogs.

An Emu was reported using race T4 in 2017 within months of the commencement of construction, however no further use was confirmed through to the end of construction in mid-2020. No Emus signs have been observed in the temporary crossings during construction, although this could be factor of the very high use by construction workers and cattle. In general monitoring of the races has been compromised by the high degree of construction activity throughout the entire period 2017-20, including the presence of vehicles and workers and cattle and this is reflected by the very large number of photos taken of non-target items. As a result, it is possible that Emus have used a race after the 2017 observation and that this has not been detected.

Plate 5. Completed hybrid fence and emu gate Section 3 Chaffin Creek (chainage 52423)

Plate 6. Completed Emu crossing zone Pillar Valley Creek floodplain Section 3 (chainage 47841)

Plates 7 and 8. Completed crossing zones at end of construction showing fauna furniture and exclusion fencing to prevent emus entering the road corridor and direct to crossing zones

3.2.2 Permanent structures (operation)

Monitoring of Emu usage at each structure commenced from June 2020 as the highway became operational (in the 3rd and 4th Quarters of 2020). The number of cameras set in the first two quarters was a designed as a reconnaissance period, with the intention being to progressively increase the number of cameras in Quarter1 2021 after review of the initial results to inform best camera locations and density while avoiding flooding of equipment during high rainfall events. This resulted in 19 structure cameras operational in the third quarter of 2020 for a total of 1,522 trap days and 29 cameras operational in the last quarter of 2020 for a total of 2,748 trap days. No Emus were recorded crossing below the permanent structures during this period. Crossings were used regularly by cattle and kangaroos. Also, no wild dogs were found to be using the crossing structures, if the first 6 months of operation.

3.2.3 Fence and roadkill monitoring

No road killed emus were recorded during the monitoring periods and no damaged exclusion fencing in the vicinity of the crossing locations. A section of hybrid emu fence location in Section 3 at chainage 51.2900 has bene modified by the landowner adjoining the fence. Wire mesh fencing has been attached to the fence and emu gate possibly to prevent sheep or goats from leaving the property, this has compromised the ability of Emus to pass through the fence as intended.

Plate 9. Emu gate blocked using mesh fencing wire to keep in sheep or goats.

Plate 10. Emu hybrid fence has bene compromise with mesh fencing wire to manage sheep or goats on adjoining property

3.3 Construction sightings register

As this report is the final construction monitoring report, details of sightings of Emus reported by construction teams have been maintained up to the end of 2019. In the final 6 months of construction through to June 2020, general activities and workers were scaled back considerably as most work complete and not further data is reported in the register after December 2019. Operational sightings from the highway are reported in Section 3.4.

A total of 275 separate Emu observations were recorded by W2B construction workers between January 2016 and December 2019, this encompasses the early works activities in Section 4 which commenced in 2016 through to clearing and construction activities commencing in 2017 and monitoring through to the end of 2019 (year 3 of construction).

These records account for 640 individual Emus sighted (although multiple records of the same birds have been made on the same or consecutive days by different recorders). There were 46 observations of juveniles with an adult male, and this ranged from between 1 and 6 juveniles and 19 observations of more than one adult bird together. Most observations (93.5 %) were recorded in Section 4 of the project in the area between the Tyndale and Maclean interchanges, while 6.5 % were made south of Tyndale to Pillar Valley (8 Mile Lane) in Section 3. In 2018 and 2019 all observations were reported in Section 4. This bias made reflect the greater opportunity of spotting emus in the open areas around Section 4 by construction workers, rather than a direct result of emu abundance.

Emus were recorded during the construction years in all months, with peaks in May (autumn) and September-October (spring) around the cane properties north of Tyndale (Section 4). In Section 3 more birds were recorded in summer and winter (Figure 9 and Figure 10) than Section 4. Soybean is grown in rotation with the sugarcane crop cycle and is typically sown in summer (Dec-Jan) with crops maturing and developing bean pods in April-May and are harvested early winter. Juveniles may be present with adult birds from June through to November. It appears that birds are less likely to be around cropping areas in winter (after soy harvest) and summer (soy

sowing), and more often sighted in grazing land and natural habitats during this period. This is reflected in the 2019 data which shows no observation around the cane in the winter months (June-August).

During the 3.5-year construction period, Emus were sighted both east and west of the project corridor sometimes as close as 20 metres from the boundary and birds were observed either on the construction corridor or attempting to cross the corridor on 12 occasions in 2017-19, with 6 of these occasions during the early works phase (June-August 2016) when construction traffic was largely absent, or minimal. Two observations were in October 2016 and January 2017, preceding the vegetation clearing stage and increase in construction traffic and 3 observations were made in September 2018 and 1 in September 2019. All Emus observed near construction areas were managed in accordance with the Emu Management Plan, and there were no reported Emu incidents or mortalities associated with construction from 2016 to the end of 2019.

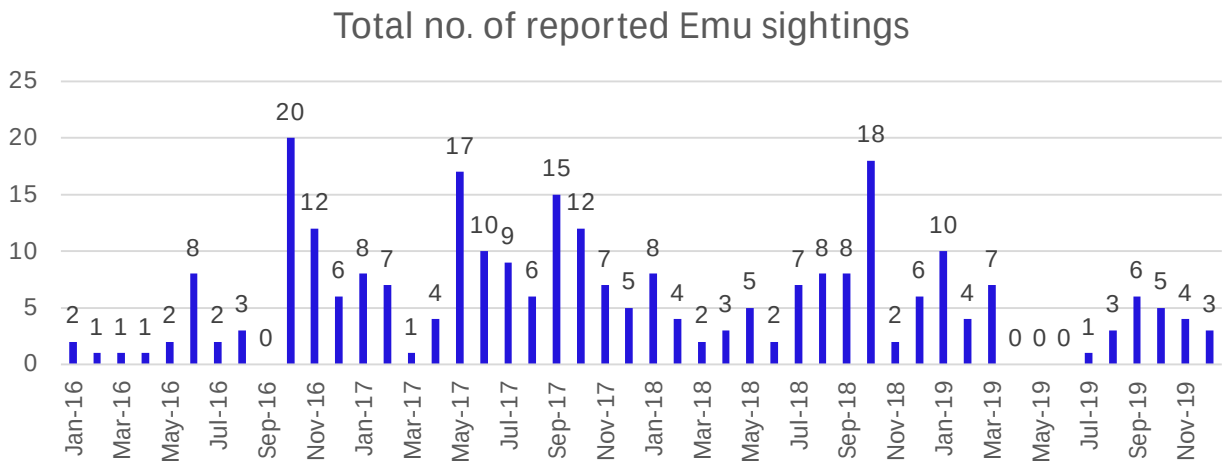

Figure 8: Total number of reported Emu sightings reported on construction register (May 2016 – December 2019)

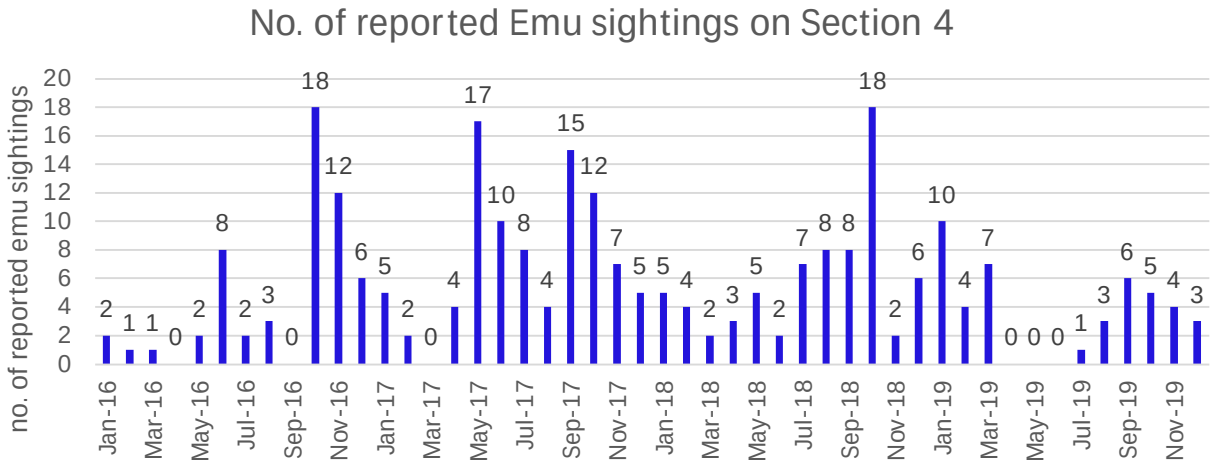

Figure 9: Number of reported Emu sightings in Section 4 of the W2B upgrade during construction (May 2016 – December 2019)

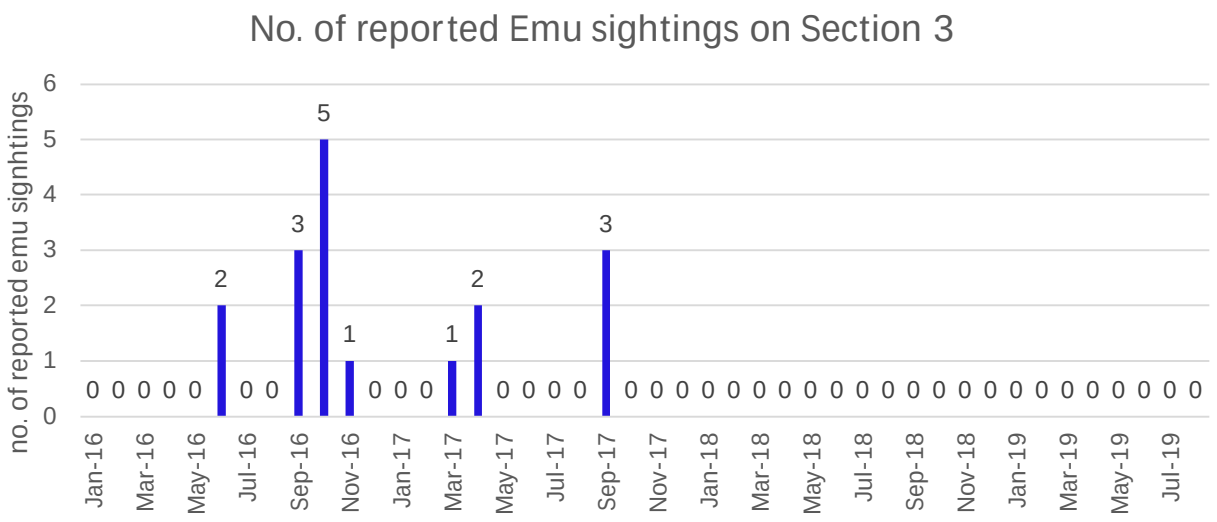

Figure 10: Number of reported Emu sightings in Section 3 of the W2B upgrade during construction (May 2016 – December 2019)

3.4 Emu sightings from operational highway

With June 2020 marking the end of construction, the mitigation measure associated with recording Emu sightings during construction has ceased. During the operational phase, sightings of Emus will be maintained largely through direct observations captured during monitoring activities, as well as observations provided by TfNSW staff while driving sections of the highway, and other observations provided by landowners accessed during monitoring. These opportunistic observations are noted in Table 3.6, and do not represent all occurrences of Emus near the project.

Table 3.6: Opportunistic Emu observations made during the first 6 months operation of the highway in 2020

Date	Observation	Location	Section
15/06/2020	1 adult	Pillar Valley west, adjoining transect PVC	3
30/07/2020	1 adult	200 m east of highway in cane paddock south side of Shark Creek	4
27/08/2020	2 adult	Edge of cane drain on west side Shark Creek bridge	4
10/11/2020	2 adult	250 m West of highway in paddock south side of shark creek	4
10/11/2020	1 adult	300 m East of highway in paddock south side of Shark Creek	4
29/11/2020	1 adult	300 metres east of highway, south of Shark Creek bridge	4
10/12/2020	1 adult	300 metres east of highway, south of Shark Creek bridge	4

4. Discussion

4.1 Monitoring Emu presence

This report describes the methods and results of monitoring of Coastal Emus conducted in 2020, which includes the final 6 months of construction (Jan-June) and the first 6 months for operation of the new highway (June-Dec 2020). The results are discussed in the context of monitoring data developed during the entire 3.5-year construction period for Section 3 and 4 of the W2B upgrade (2017-2020). Monitoring aligned with the aims of the Coastal Emu Management Plan in that data was collected at impact and control areas before construction and compared data collected from the same survey areas during construction. Future annual reporting will allow more focus on comparison with operational monitoring as further data is collected.

Monitoring between 2014 and 2020 has shown a decline in Emu presence from both impact and control survey areas, which was first noted during the pre-construction years (2014-16) and has continued to decline during the construction years (2017-2020). The number of sites occupied by Emus in any one survey period varied temporally and across seasons in both impact areas and control areas. These variations are likely to reflect typical nomadic or annual movements of Emus in response to the availability of food resources rather than impacts from construction. This is supported by the fact that at some impact sites Emus returned after periods of long absence, which was evident to the north of Tucabia where Emus have returned after 12 -month absences on two occasions., and mostly recently six months after construction was completed. Emus were detected in spring 2020 at the Yuraygir South control area after a 5-year absence from the survey area.

The declines noted during construction have been interpreted with consideration of the temporal patterns of Emu presence observed in impact and control areas since 2014 (starting 3 years before construction) and continuing through the pre-construction and construction years. The density of Emu signs and trapping rates has varied over season and years and site occupation of Emus was highest in 2014 before declining in 2015 and 2016 (prior to construction). Monitoring during construction commenced in 2017 at which point the general trend of declining Emu presence in Section 3 has continued through 2017-2020. The Yuraygir south control area comprised an abundance of Emu activity data and indeed breeding birds in 2014 before a complete absence of activity in late 2015 for a period of 5 years.

The reduced detection of emus could be attributed to two possible causes, 1) either a direct decline in the Emu population affecting the presence at the impact and control survey areas, or 2) individuals have shifted from the survey transects to other proximal areas outside the survey area. The latter is suggesting that the presence of Coastal Emus in localised areas can change over time in response to changing environmental variables, including the presence and seasonality of resources. As Emus are nomadic and move in response to the availability of resources, a decline in activity at one location may not reflect a decline in population density rather this may be associated with individual birds moving through the landscape and away from the monitoring locations and associated with either breeding movements or resource availability or both. This is supported by the return of Emus in some transects and survey areas after reported absence and the same pattern of decline at impact and control areas.

In the cane properties surrounding section 4 of the project, Emu presence has been reported throughout the duration of the construction period with no decline (although data has relied on observation only). Emus were recorded during the construction years in all months, with peaks in May (autumn) and September-October (spring). Soybean is grown in rotation with the sugarcane crop cycle and is typically sown in summer (Dec-Jan) with crops maturing and developing bean pods in April-May and are harvested early winter. It appears that birds are less likely to be around cropping areas in winter (after soy harvest) and summer (soy sowing) and may move to natural habitats and grazing land during this period. This is reflected in the construction sightings data which shows no observations of Emus around the cane in the winter months (June-August). Emus have continued to utilise portions of cane properties from the start of operation of the highway with a number of birds regularly observed east and west of the highway in proximity to the Shark Creek bridge.

To provide some context to the declines noted, a review of the status of the Coastal Emu population is provided in a NPWS coordinated annual citizen-based Coastal Emu survey, which was conducted between 2006 and 2017.

The emu count data is shown in Figure 11. These data report the actual number of emus observed over a two-day survey and not individuals observed before or after the survey. The data is only intended to provide a relative abundance estimate and is not based on total counts. This is because the survey is largely restricted to road areas, the number of observers and hence survey effort varied from year to year and emus are widespread and difficult to count. These data report a decline in Emus by around 50 % between 2012 and 2014, which coincides with the commencement of the W2B pre-construction monitoring period (i.e. 3-5 years prior to construction).

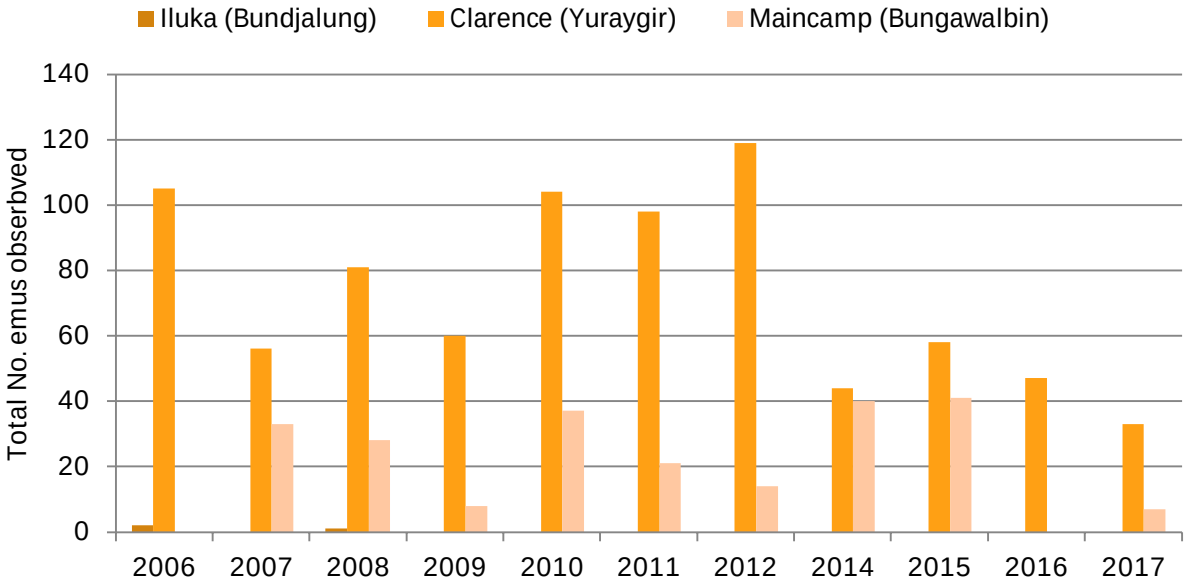

Figure 11: Relative population data collated from the annual coastal emu citizen survey (2006-2017 source: NPWS)

The annual population survey ceased in 2017 was subsequently been replaced by an emu sighting online register maintained by Clarence Valley Council. The online register in conjunction with Bionet Atlas data has reported 365 sightings in 2018, 394 sightings in 2019 and 72 sightings up to May 2020. There has been no more monitoring data after this period. This accounts for multiple observations of the same birds. The grouped data from different sources was analysed by these authors who estimated there to be at least 26 coastal emus remaining in 2020, comprising 18 birds in the Clarence Valley LGA. This analysis considered the date and time of observations and plausible distances travelled by Emus to filter duplicate records (Clarence Valley Council 2020). These numbers report a population decline of 74 % from the 100 birds estimated in 2006.

4.1.1 Performance thresholds and corrective actions

The project mitigation measures have been designed to minimise the impacts of habitat loss and fragmentation on Coastal Emus and the potential barrier effect of the highway. The monitoring of emu presence has been designed to provide a baseline of emu presence and activity prior to construction, and then continually monitoring this presence during construction. The Monitoring Program outlined in the Emu Plan (s.7.2.4) identifies two key performance thresholds that are to be measured during construction and operational monitoring, namely:

- Greater than 15% decline in Emu activity (through signs and detection rates) comparing impact and control areas and before and after data.
- No evidence of breeding through sightings of chicks and sub-adults between impact and control areas and before and after data.

Discussion on the reported outcomes from the construction stage monitoring in 2020 are provided in Table 4.1.

Table 4.1: Appraisal of the reported outcomes of construction phase monitoring against the performance thresholds documented in the Emu Management Plan for the longer-term monitoring program

Performance thresholds	Timing and corrective actions	Reported outcomes
▪ Greater than 15% decline in Emu activity (through signs and detection rates) comparing impact and control areas and before and after data. ▪ No evidence of breeding through sightings of chicks and sub-adults between impact and control areas and before and after data.	▪ The 15% threshold was set prior to conducting baseline surveys. It will be necessary to review this trigger against pre-construction data to identify normal changes in activity that are occur over time irrespective of the highway disturbance. The threshold would be reviewed and revised where required at the end of the pre-construction monitoring. ▪ Emu activity would be compared with the baseline data at the end of each monitoring event during the construction phase. Regular evaluation and review would be conducted at the end of each monitoring event. ▪ If decline noted after the first 12 months of the post-construction (operational) monitoring, review and modify the monitoring program, to consider different monitoring locations. ▪ Review transects locations and cross reference with performance monitoring of the Emu crossing structures and fencing strategy. ▪ Investigate Emu habitat adjoining the highway and consider improving habitat condition and connectivity. ▪ If decline still noted after a further 12 months operational monitoring (2-years operation) engage with EPA and consider provisional measures. ▪ Further monitoring of provisional measures would be planned at this stage.	▪ Monitoring has shown a decline in Emu activity at both impact and control areas over the duration of the monitoring program (both before and during construction) suggesting there are additional factors unrelated to the highway construction. There has been comparatively greater decline in Section 3 and the southern control area, compared to more stable Emu presence in Section 4 and the northern control area. ▪ When comparing the mean occupation for three years before construction with mean occupation during 3.5 years of construction, the proportion of impact sites occupied by Emus has declined by 42.6 %, while the proportion of control sites occupied has also declined by 35.2 % (a difference of 7.3 %). ▪ When interpreted as comparing impact and control areas the difference equates to 7.3 % and is below the 15 % threshold. ▪ Evidence of breeding was noted in Section 4 through multiple observations of juvenile birds during 2017-2020 as reported in the Emu sightings register. ▪ Monitoring has only been conducted for the first 6 months of operation, the 2021annual monitoring report will consider performance for the first 12 months of operation, as per the corrective action, if decline noted after the first 12 months of the post-construction monitoring (operational), then review and modify the monitoring program, to consider different monitoring locations. At this stage, the decline is below the performance threshold ▪ The review should consider additional monitoring in Section 4, to account for the fact that construction monitoring will cease, and the fact that emu presence is now more reliable in Section 4. The review should also consider fire history and target area

4.2 Construction management measures

Three key mitigation measures documented in the Emu Management Plan were implemented during construction and their effectiveness monitored. This included 1) the installation of temporary fencing in important Emu areas, 2) the installation of Emu races to maintain active crossing zones during construction and 3) the collection of data on Emu sightings during construction.

The three key mitigation measures were deemed to be effective. Monitoring of emu crossing zones (races) continued during the entire 3.5-year construction period, at this time the final constructed crossing zones were complete. The temporary crossing zone monitoring identified an Emu effectively crossing the construction corridor in 2017, prior to the bridges being constructed. After this observation, a combination of declining emu activity around the project, and the volume of construction activity and human presence around the emu cameras, resulted in no further records of emus crossing. Operational monitoring has commenced in 2020 and focuses on camera monitoring to determine the effectiveness of permanent fencing and key emu crossing structures in Sections 3 and 4 of the project.

The emu sighting register was successfully maintained during construction (3.5 years) and provided valuable data and insights into Emu presence and movements near the highway. While Emus were reported on several occasions close to the project boundary in late 2020, or appeared to be trying to cross the corridor, corrective actions were quickly applied, and there were no reported Emu mortalities during the 3.5-year construction period.

It has been difficult to effectively monitor the Emu races during construction and this is directly a result of the very high level of construction activity and lower chance of detecting Emus from the camera traps. In all survey periods cameras captured high levels of construction activity, or cattle crossings, which affected data storage and battery capability. As a result, it is possible that other Emus used temporary crossings, and this has not been detected. Despite the issues with monitoring crossing zones, Emus were recorded both east and west of the project corridor during construction, it is unknown whether these were birds moving across the corridor or have remained on one side only.

4.2.1 Performance thresholds and corrective actions

The construction mitigation measures for Coastal Emus were designed to avoid and minimise harm to Emus during the clearing of vegetation and habitat, minimise impacts to emu movements through the provision of opportunities to cross the construction corridor, and revegetate disturbed areas to provide emu food plants in key areas impacted during construction.

To monitor the effectiveness of these measures, the Emu Management Plan identifies thresholds for measuring the performance of the mitigation. Where a threshold is not achieved, corrective actions are required. Discussion on the reported outcomes of the construction stage monitoring in 2017-20 against the performance thresholds identified in the Emu Management Plan is provided in Table 4.2. Construction of the project ended in mid-2020 and this report is the final discussion on the performance of construction mitigation measures.

Table 4.2: Appraisal of the reported outcomes of construction phase monitoring against the performance thresholds documented in the Emu Management Plan

Main goals for management	Management measure	Performance thresholds	Reported outcomes in 2019 annual report	Corrective actions if performance threshold not reached
No injuries to Emus during clearing of vegetation.	▪ Documented procedure for clearing of vegetation. ▪ Documented procedure for emergency management if Emu is encountered during clearing works. ▪ Procedure developed in consultation with WIRES and NPWS. ▪ Project ecologist evaluates situation and approach on each occasion.	Emu injured or killed during clearing works.	Ecologists were used during clearing operations in Section 3 and 4 in 2017. No Emus were reported injured or killed	No corrective actions were required
No injuries to Emus from collisions with construction vehicles.	▪ All vehicles to stay within the construction corridor and no entry into exclusion zones. ▪ Comply with construction vehicles speed limits designated in the CEMP. ▪ Implement a daily inspection of Emu crossing zones and fence integrity. ▪ Comply with protocol developed for Wave 3 early works (Section 4) Section 5.3.2	▪ Emu injured during construction. ▪ Single Emu sighted in Wave 3 early works corridor during construction ▪ 3 Emu encounters in one day	A register of Emu sightings has been maintained from 2016-2020 while Emus were reported in the construction corridor or adjacent to the boundary on multiple occasions, management measures were implemented quickly and there were no reported injuries or mortalities to emus during the 3-year construction period.	No corrective actions were required. Where emus were sighted in proximity to the project, measures were quickly implemented to halt work and move emus away
No damage to Emu habitat within exclusion zones in Section 3 and 4 during construction.	▪ Implement the Emu fencing strategy prior to construction. ▪ Fencing to be erected concurrently with clearing procedure in Section 3 and 4.	Breach in exclusion zone by construction vehicle of personnel.	Temporary and permanent exclusion fences were completed concurrently with the clearing procedure.	No corrective actions were required
No change in pre-construction Emu movements across the construction corridor.	▪ Adopt Emu fencing strategy ▪ Construction infrastructure and access tracks located to avoid lengthy interruption to Emu movements. ▪ Avoid extended activities in or adjacent to known Emu habitat, watering points, or crossing zones.	After four construction monitoring events there is a demonstrated change from pre-construction Emu movements across the project corridor.	Emus were reported on multiple occasions crossing the construction corridor during the pre-construction fence trial. In contrast during construction (14 monitoring events between 2017 and 2020) there was only one confirmed crossing by an Emu in 2017 and emus were not recorded crossing the corridor in 2018-2020	The monitoring methodology for the temporary Emu crossings was continually evaluated and revised to improve captures of Emus. This technique was compromised by high levels of construction activity, that was not able to be controlled

Main goals for management	Management measure	Performance thresholds	Reported outcomes in 2019 annual report	Corrective actions if performance threshold not reached
	▪ As soon as bridge construction completed, bridge to be tied in with exclusion fence and site remediated to open the crossing zone. ▪ Provide and maintain an Emu race across 9 crossing zones between Wooli Road and south of Firth Heinz Road, to be opened outside of work hours		indicating a demonstrated change from the pre-construction movements. However, the described management measures were implemented to a degree, including temporary fencing and the provision of Emu races. The negative change in reported emu movements across the corridor, is expected to be related to a number of facts, 1) emu races were only able to be opened during night periods and only 1 day of the week (Sunday). 2) a reported general decline in emu activity over the monitoring years, and 3). the difficultly in effectively monitoring the Emu races during construction as a result of the very high level of construction activity and lower chance of detecting Emus no cameras and signs. The installation of Emu permanent fencing commenced in 2019 and completed mid-2020, Emus have been reported east and west of the construction corridor during the construction phase monitoring. Operational monitoring will occur in a time of less human activity below the crossing structures.	and there are no corrective actions required, Permanent fencing is now in place and based on Emu Fencing strategy, particularly in hybrid fence locations. The Emu hybrid fence constructed at chainage 49228 does not meet the hybrid design described in the emu fence strategy, this is due to property owner requesting 5 strand fence. The stock gate here is frequently left open for cattle and there are small sections of the fence that are likely permeable to Emus. . A hybrid fence and emu gate has been constructed in Section 3 at chainage 51.2900 as per fence strategy. The adjoining landowner has since modified the fence, by attaching mesh, and the fence is not effective for emu passage. The property oner at this location has modified fence due to grazing sheep, and TfNSW are unable to rectify this.
Cover crops established within 3 months of completion of the bridge construction in Section 3 and 4.	Implement revegetation and rehabilitation to commence immediately on completion of construction activity completion and to be staged to avoid lengthy disruption to Emu movement corridors.	Event based, incident reporting in CEMP	Some minor planting of riparian vegetation commenced in Section 3 in 2018 however the success was hindered in some places due to trampling and grazing by cattle. Corrective measures were implemented to fence off plantings from cattle without compromising the crossing zones for emus.	No corrective actions required Continue revegetation in crossing zones where bridge construction is complete in 2020 Monitor survivorship of plantings and replace where necessary until

Main goals for management	Management measure	Performance thresholds	Reported outcomes in 2019 annual report	Corrective actions if performance threshold not reached
			Further revegetation and plantings were conducted in 2019 and ensured the use of Emu food plants.	established, this activity continues during the early phase of operation
Methods for rehabilitation of Emu habitat adjacent to the road is documented in the landscape design.	▪ Roadside plantings in Emu habitat (Section 3 and 4) avoid Emu food plants to prevent Emus being attracted to road edges. ▪ Landscape plantings under Emu crossing zones in Section 3 and 4 to use native grasses or low ground covers suitable to the location and avoid dense plantings of trees and shrubs. ▪ Revegetation in roadside areas disturbed during construction to restore the original habitat type at each location.	Evidence of Emu specific revegetation to be captured in the landscape design.	Landscape plantings in Section 3 and 4 to date have appropriately used native and exotic grasses and not known emu food plants that would attract emus. This is good outcome for roadside landscape plantings	No corrective actions required

4.3 Operational management measures

Three key mitigation measures documented in the Emu Management Plan are to be implemented during operation and their effectiveness monitored. This included 1) maintenance of exclusion fences 2) maintenance of habitat revegetation and 3) wild dog control

The three key mitigation measures were deemed to be effective in 2020, noting that there was no evidence of wild dogs using the permanent emu crossing zones in the first 6 months of the program and therefore wild dog control was not required. There were no reported Emu road kills in the period June-December 2020 or breach of the emu exclusion fence.

4.3.1 Performance thresholds and management corrective actions

The operational mitigation measures for Coastal Emus were designed to avoid and minimise harm to Emus during operation of the highway through maintaining emu exclusion fencing and also maintaining revegetation areas. Wild dog control is required as necessary, if dogs are found to be preying on emus using crossing structures.

To monitor the effectiveness of these measures, the Emu Management Plan identifies thresholds for measuring the performance of the mitigation. Where a threshold is not achieved, corrective actions are required. Discussion on the reported outcomes of the operation stage monitoring in 2020 (June-December) against the performance thresholds identified in the Emu Management Plan is provided in 4.3. Operation of the project commenced in mid-2020 and this report discusses only the first 6 months of operation when assessing the performance of construction mitigation measures.

Table 4.3: Appraisal of the reported outcomes of operational phase monitoring against the performance thresholds documented in the Emu Management Plan (Table 6-2)

Main goals for management	Management measure	Performance thresholds	Reported outcomes in 2020 annual report	Corrective actions if performance threshold not reached
Zero rate of traffic related emu mortality in Section 3 and 4 of the project after 10 years	▪ Periodic monitoring and maintenance of exclusion fencing for the lifetime of the project. ▪ Slashing weeds near fences and repair breaches in fence or replace broken fences	Emu death reported in Section 3 and 4 within operational years 1-10	No Emus were reported injured or killed on highway within the first 6-month operation (June-December 2021)	No corrective actions were required
Maintain habitat revegetation areas on TfNSW owned land in Section 3 and 4 post-construction until performance threshold has been met.	▪ Regular monitoring and reporting on revegetation work and keeping Logbook of Maintenance	▪ >30% mortality of planted native vegetation sites determined from monitoring quadrants ▪ Treatment of weed infestation.	▪ Maintenance of revegetation areas commenced in last quarter of 2020, and involved replacing lost tube stock due to mortality, and slashing weeds around plantings, and will continue periodically until plants have established ▪ Plant mortalities were noted as a result of cattle grazing, at this stage TfNSW introduced temporary fencing around	A number of affected revegetation sites were fenced off from cattle for around 6-9 months using temporary fencing to allow time for plants to establish, and dead plants were replaced during this time No further corrective actions required

Main goals for management	Management measure	Performance thresholds	Reported outcomes in 2020 annual report	Corrective actions if performance threshold not reached
Zero or reduced rate of reported deaths from dog attacks in vicinity of crossing structures in Section 3 and 4 in years 1-5.	▪ Conduct ongoing monitoring at crossing zones as per methods in chapter 7 of the Emu Management Plan	Emu death near crossing zone attributed to a dog attack as evidenced by dog activity (as per methods in Chapter 7).	No Emu deaths reported at a structure location during 2020. Dogs activity monitoring, has not identified wild dogs using structures at this early stage	No corrective actions required

5. Recommendations

This report is the final construction monitoring assessment, an appraisal of the emu presence data and the construction mitigation monitoring data over the entire 3.5-year construction period (2017-20) has now been completed. Monitoring has indicated that performance thresholds have been largely met.

At one location in Section 3 (chainage 51.29000) a hybrid emu fence and gate has been modified by the adjacent landowner to prevent stock from leaving the property. The modification has compromised the likely effectiveness of the fence and gate, that were designed to allow emu passage. Consultation with the property owner is required, with a view to restoring the function of the fence.

Table 5.1: Recommendation following Year 3.5 monitoring and Transport for NSW response.

No.	Recommendation	Transport for NSW
1	Restore the modified hybrid emu fence and gate constructed across chainage 51.2900 to remove mesh wire in consultation with the landowner	TfNSW has made contact with the landowner to explore opportunities to adjust fencing to restore the emu hybrid fence, however the landowner has advised that the netting is required for sheep exclusion. There is currently no opportunity to rectify this section of fence

6. References

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Appendix A. Camera monitoring data temporary Emu crossing zones construction years (2017-2020)

Table A.1: Details and results of camera traps placed on Emu crossing zones during three-year construction period (2017-20)

Monitor period	Temp Crossing zone ID	Camera	Posi	Start date	End date	No cam days	No. photos taken	No. emu photo	Other fauna using race
C2 (Autumn 2017)	T1	1	East	21/02/2017	20/04/2017	58	4159	0	1 dog
		2	East	21/02/2017	1/05/2017	69	462	0	
		3	West	21/02/2017	17/03/2017	24	3635	0	
		4	West	21/02/2017	7/03/2017	14	2286	0	
	T4B	1	East	21/02/2017	23/05/2017	91	655	1	Cattle
		2	West	21/02/2017	malfunction	0	0	0	Cattle
	T6	1	East	21/02/2017	22/02/2017	1	335	0	Cattle
		2	West	21/02/2017	3/03/2017	10	4903	0	Cattle
		3	Mid	21/02/2017	23/05/2017	91	2068	0	
C3 (Winter 2017)	T1	1 to 4	removed for construction of piling pads			0	0	0	
	T2	1	East	23/05/2017	22/08/2017	91	2205	0	Cattle
		2	East	23/05/2017	22/08/2017	91	936	0	Cattle
		3	West	23/05/2017	15/06/2017	23	3797	0	Cattle
		4	West	23/05/2017	14/07/2017	52	2324	0	Cattle
	T4B	1	East	23/05/2017	22/08/2017	91	526	0	Cattle
		2	West	23/05/2017	22/08/2017	91	485	0	Cattle
	T6	1	East	23/05/2017	22/08/2017	91	405	0	Cattle
		2	West	23/05/2017	28/06/2017	36	5913	0	Cattle
		3	Mid	23/05/2017	22/08/2017	91	3800	0	Cattle
C4 (Spring 2017)	T1	1	East	21/08/2017	22/09/2017	32	4105	0	Cattle
		2	East	21/08/2017	7/11/2017	78	7719	0	Cattle
		3	West	21/08/2017	5/09/2017	15	5052	0	Cattle
	T2	1	East	21/08/2017	7/11/2017	78	917	0	Cattle and kangaroos
		2	West	21/08/2017	malfunction	0	0	0	Cattle
	T4A	1	East	22/08/2017	9/10/2017	48	4964	0	Cattle
		2	West	22/08/2017	29/10/2017	68	2140	0	Cattle
	T4B	1	East	21/08/2017	24/08/2017	3	1090		Cattle
		2	West	21/08/2017	7/11/2017	78	311	0	Cattle
	T5	1	East	21/08/2017	7/11/2017	78	2239	0	Cattle and kangaroos
		2	West	21/08/2017	20/10/2017	60	9077	0	Cattle and kangaroos
	T6	1	East	22/08/2017	8/11/2017	78	499	0	Cattle
		2	West	22/08/2017	5/10/2017	44	3081	0	Cattle
		3	Mid	22/08/2017	27/10/2017	66	1232	0	Cattle
	T9	1	East	21/08/2017	7/11/2017	78	283	0	Cattle and kangaroos
		2	West	21/08/2017	30/09/2017	40	1977	0	Cattle and kangaroos
	T10	1	East	22/08/2017	5/10/2017	44	901	0	Cattle
		2	West	22/08/2017	25/10/2017	64	1924	0	cattle
C5 (summer 2018)	T1	1	East	removed during construction		0	0	0	Cattle and kangaroos
		2	West	7/11/2017	6/02/2018	91	46666	0	

	T2	1	East	7/11/2017	12/02/2018	97	2143	0	Cattle and kangaroo
		2	West	7/11/2017	12/02/2018	97	1272	0	cattle
	T4A	1	East	removed during construction		0	0	0	
		2	West	7/11/2017	6/02/2018	91	106	0	Cattle
	T4B	1	East	6/11/2017	12/02/2018	98	280	0	Cattle
		2	West	6/11/2017	12/02/2018	98	16	0	Cattle
	T5	1	East	6/11/2017	13/02/2018	99	459	0	Cattle
		2	West	malfunction - no data		0	0	0	
	T6	1	East	6/11/2017	12/02/2018	98	3081	0	Cattle
		2	West	6/11/2017	12/02/2018	98	1232	0	Cattle
	T9	1	East	6/11/2017	12/02/2018	98	368	0	Cattle and kangaroos
		2	West	6/11/2017	12/02/2018	98	2038	0	Cattle and kangaroos
	T10	1	East	6/11/2017	12/02/2018	98	9	0	Cattle
		2	West	6/11/2017	12/02/2018	98	53	0	Cattle
C6 (Autumn 2018)	T1	1	East	1/01/2018	18/02/2018	49	3645	0	Cattle
		2	West	13/02/2018	22/05/2018	98	199	0	
	T2	1	East	13/02/2018	22/05/2018	98	1226	0	
		2	West	13/02/2018	21/04/2018	67	996	0	
	T4A	1	East	13/02/2018	27/03/2018	24	2871	0	
		2	West	Stolen		0	0	0	
	T4B	1	East	14/02/2018	22/05/2018	97	3270	0	Cattle and kangaroos
		2	West	16/02/2018	9/04/2018	52	382	0	Cattle and kangaroos
	T5	1	East	13/02/2018	20/05/2018	96	289	0	Cattle
		2	West	13/02/2018	20/05/2018	96	1339	0	Cattle
	T6	1	East	Missing data		0	0	0	
		2	West	Missing data		0	0	0	
	T9	1	East	13/02/2018	20/05/2018	96	182	0	
		2	West	13/02/2018	3/03/2018	18	2034	0	
	T10	1	East	13/02/2018	22/05/2018	98	133	0	
		2	West	13/02/2018	13/02/2018	1	62	0	
C7 (Winter 2018)	T1	1	East	22/05/2018	28/08/2018	98	346	0	
		2	West	22/05/2018	28/08/2018	98	515	0	
	T2	1	East	22/05/2018	28/08/2018	98	1166	0	Cattle and kangaroos
		2	West	22/05/2018	28/08/2018	98	305	0	
	T4A	Temporary crossing that is now closed. “T4B” will now be referred to as “T4”							
	T4	1	East	22/05/2018	28/08/2018	98	157	0	
		2	West	22/05/2018	24/07/2018	63	1443	0	
	T5	1	East	22/05/2018	28/08/2018	98	815	0	Cattle
		2	West	22/05/2018	28/08/2018	98	149	0	Cattle
	T6	1	East	22/05/2018	28/08/2018	98	4997	0	Cattle
		2	West	22/05/2018	28/08/2018	98	57	0	
	T9	1	East	22/05/2018	17/08/2018	87	27	0	
		2	West	22/05/2018	28/08/2018	98	1972	0	Cattle
	T10	1	East	22/05/2018	28/08/2018	98	82	0	Cattle
		2	East	22/05/2018	28/08/2018	98	310	0	
		3	West	22/05/2018	28/08/2018	98	29	0	
	T1	1	East	28/08/2018	6/11/2018	70	2213	0	Cattle
		2	West	28/08/2018	6/11/2018	70	553	0	

C8 (Spring 2018)	T2	1	East	28/08/2018	6/11/2018	70	27	0	Cattle and kangaroos
		2	West	28/08/2018	6/11/2018	70	38	0	
	T4B	1	East	28/08/2018	6/11/2018	70	1	0	
		2	West	28/08/2018	6/11/2018	70	4173	0	
	T5	1	East	28/08/2018	6/11/2018	70	660	0	
		2	West	28/08/2018	6/11/2018	70	70	0	Cattle and kangaroos
	T6	1	East	28/08/2018	26/10/2018	58	2494	0	
		2	West	28/08/2018	6/11/2018	70	6	0	
	T9	1	East	28/08/2018	6/11/2018	70	1070	0	Cattle
		2	West	28/08/2018	1/11/2018	65	2066	0	Cattle and kangaroos
	T10	1	East	28/08/2018	13/09/2018	16	928	0	
		2	West	28/08/2018	6/11/2018	70	127	0	
C9 (Summer 2019)	T1	1	East	6/11/2018	23/12/2018	47	4150	0	
		2	West	6/11/2018	26/02/2019	112	0	0	malfunction
	T2	1	East	6/11/2018	26/02/2019	112	1116	0	
		2	West	28/08/2019	4/12/2018	28	600	0	
	T4B	1	East	6/11/2019	26/02/2019	112	74	0	
		2	West	6/11/2019	26/02/2019	112	2751	0	
	T5	1	East	6/11/2018	26/02/2019	112	1116	0	
		2	West	6/11/2018	4/12/2018	28	600	0	Cattle and kangaroos
	T6	1	East	6/11/2018	26/02/2019	112	975	0	
		2	West	6/11/2019	26/02/2019	112	4246	0	
	T9	1	East	6/11/2019	26/02/2019	112	230	0	Cattle
		2	West	6/11/2019	28/11/2019	22	1067	0	Cattle and kangaroos
	T10	1	East	6/11/2019	26/02/2019	112	0	0	
		2	West	6/11/2019	26/02/2019	112	769	0	
C10 (Autumn 2019)	T1	1	East	26/02/2019	28/05/2019	91	0	0	malfunction
		2	West	26/02/2019	28/05/2019	91	28	0	
	T2	1	East	26/02/2019	28/05/2019	91	550	0	cattle
		2	West	26/02/2019	28/05/2019	91	1432	0	
	T4B	1	East	26/02/2019	28/05/2019	91	19	0	
		2	West	26/02/2019	28/05/2019	91	1850	0	
	T5	1	East	26/02/2019	28/05/2019	91	620	0	
		2	West	26/02/2019	28/05/2019	91	70	0	Cattle and kangaroos
	T6	1	East	26/02/2019	24/05/2019	87	439	0	Cattle and kangaroos
		2	West	26/02/2019	28/05/2019	91	971	0	
	T9	1	East	26/02/2019	28/05/2019	91	1070	0	
		2	West	26/02/2019	12/03/2019	18	22	0	
	T10	1	East	26/02/2019	28/05/2019	91	1380	0	
		2	West	26/02/2019	28/05/2019	91	98	0	
C11 (Winter 2019)	T1	1	East	28/05/2019	20/08/2019	84	835	0	
		2	West	28/05/2019	20/08/2019	84	41	0	
	T2	1	East	28/05/2019	20/08/2019	84	371	0	Cattle and kangaroos
		2	West	28/05/2019	20/08/2019	84	2104	0	
	T4B	1	East	28/05/2019	20/08/2019	84	829	0	
		2	West	28/05/2019	20/08/2019	84	834	0	
	T5	1	East	28/05/2019	20/08/2019	84	0	0	malfunction

		2	West	28/05/2019	20/08/2019	84	12	0	Cattle and kangaroos
	T6	1	East	28/05/2019	20/08/2019	84	542	0	
		2	West	28/05/2019	26/06/2019	29	2180	0	
	T9	1	East	20/05/2019	20/08/2019	112	1748	0	Cattle
		2	West	20/08/2019	10/12/2019	112	1914	0	Cattle
	T10	1	East	28/05/2019	20/08/2019	84	2094	0	
		2	West	28/05/2019	20/08/2019	84	492	0	
C12 (Spring 2019)	T1	1	East	20/08/2019	10/12/2019	112	1756	0	Cattle and kangaroos
		2	West	20/08/2019	10/12/2019	112	40	0	
	T2	1	East	20/08/2019	10/12/2019	112	73	0	cattle
		2	West	20/08/2019	10/12/2019	112	394	0	
	T4B	1	East	20/08/2019	10/12/2019	112	132	0	
		2	West	20/08/2019	22/09/2019	33	1281	0	
	T5	1	East	20/08/2019	10/12/2019	112	0	0	malfunction
		2	West	20/08/2019	10/12/2019	112	3354	0	Cattle and kangaroos
	T6	1	East	20/08/2019	10/12/2019	112	306	0	
		2	West	20/08/2019	10/12/2019	112	286	0	
	T9	1	East	20/08/2019	10/12/2019	112	1748	0	
		2	West	20/08/2019	10/12/2019	112	1914	0	
	T10	1	East	20/08/2019	12/09/2019	23	2094	0	Kangaroos and dog
		2	West	20/08/2019	12/12/2019	112	288	0	Kangaroo
C13 (Summer 2020)	T1	1	East	10/12/2019	25/02/2020	77	3390	0	Cattle and kangaroos
		2	West	10/12/2019	25/02/2020	77	288	0	
	T2	1	East	10/12/2019	25/02/2020	77	1	0	cattle
		2	West	10/12/2019	25/02/2020	77	543	0	
	T4B	1	East	10/12/2019	25/02/2020	77	1730	0	
		2	West	10/12/2019	29/12/2019	19	948	0	
	T5	1	East	10/12/2019	2/02/2020	54	5020	0	malfunction
		2	West	10/12/2019	25/02/2020	77	6	0	Cattle and kangaroos
	T6	1	East	10/12/2019	25/02/2020	77	756	0	
		2	West	10/12/2019	25/02/2020	77	1858	0	
	T9	1	East	10/12/2019	25/02/2020	77	467	0	
		2	West	10/12/2019	25/02/2020	77	473	0	
		3	East	10/12/2019	25/02/2020	77	133	0	
		4	West	10/12/2019	25/02/2020	77	1943	0	
	T10	1	East	10/12/2019	25/02/2020	77	874	0	Kangaroos and dog
		2	West	10/12/2019	25/02/2020	77	288	0	Kangaroo
C14 (Autumn 2020)	T1	1	East	25/02/2020	26/05/2020	91	1866	0	Cattle and kangaroos
		2	West	25/02/2020	26/05/2020	91	932	0	
	T2	1	East	25/02/2020	26/05/2020	91	406	0	cattle
		2	West	25/02/2020	26/05/2020	91	1176	0	
	T4B	1	East	25/02/2020	4/04/2020	39	4157	0	
		2	West	25/02/2020	26/05/2020	91	776	0	
	T5	1	East	25/02/2020	9/04/2020	44	5007	0	malfunction
		2	West	25/02/2020	1/04/2020	36	1868	0	Cattle and kangaroos
	T6	1	East	25/02/2020	26/05/2020	91	147	0	
		2	West	25/02/2020	4/04/2020	39	1057	0	
	T9	1	East	25/02/2020	8/03/2020	12	16	0	
		2	West	25/02/2020	26/05/2020	91	4895	0	

		3	East	25/02/2020	26/05/2020	91	824	0	
		4	West	25/02/2020	26/05/2020	91	1235	0	
	T10	1	East	25/02/2020	20/04/2020	55	2100	0	Kangaroos and dog
		2	West	25/02/2020	1/04/2020	36	1868	0	Kangaroo