Threatened Species Recovery Hub

National Environmental Science Programme

Progress Report 4:

Strategic Planning for the Far Eastern Curlew

December 2018

Charles Darwin University
The University Of Queensland Australia
Darwin Port Part of the Landbridge Group
Larrakia Nation
In partnership with Northern Territory Government

Progress Report 4: Strategic Planning for the Far Eastern Curlew

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December 2018

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Front cover: Mud flats in Darwin Harbour. Photo: Michael Lawrence-Taylor

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Amanda Lilleyman during shorebird surveys at Port of Darwin. Photo: Michael Lawrence-Taylor

Project overview

The Far Eastern Curlew (FEC) is the largest migratory shorebird in the world. It is listed as Critically Endangered under the *Environment Protection Biodiversity Conservation Act 1999* in Australia with numbers rapidly declining. Recent research has highlighted the importance of high quality non-breeding habitat to migratory shorebirds, but it is difficult to provide strategic guidance to developers and decision-makers because too little is known regarding the ecological requirements of the bird. Currently little is known about their exact feeding and roosting habitat needs. While coastal development can negatively impact populations, they are known to use some artificial habitat for roosting. This project will provide the knowledge needed to develop strategic guidelines for Far Eastern Curlew conservation.

Migration of tagged Far Eastern Curlew

The two tagged Curlew were tracked on their return migration flights during the austral winter/northern hemisphere summer of 2018 (Figure 1). Curlew 17007 was tagged in November/December 2017 in Darwin and departed Darwin in late April 2018, spent one week on the coast off Shanghai, China (pink track in Figure 1). It then continued north to the south-east coast of Liaoning, China, then spent 4.5 months along the coast of the Yellow and Bohai Seas with some exploratory trips to central Liaoning and Inner Mongolia. It migrated south and arrived in Darwin in late October 2018, back to where it was first caught and tagged. Curlew 17004 was Tagged in November/December 2017 in Darwin and departed Darwin in April 2018 and migrated through the Democratic People's Republic of Korea (white track in Figure 1). It spent 1 month on the mudflats of Incheon Airport Island, Republic of Korea and then flew north to Kamchatka Peninsula, Russia and nested for 2 months before migrating back to the Republic of Korea and staging on the Airport Island mudflats for 2.5 months. It then migrated south and arrived in Darwin in late October 2018, back to where it was first caught and tagged. Both birds arrived back in Darwin within the same week, despite different behaviours during the northern hemisphere breeding season. Both birds have since spent their time in Darwin Harbour roosting at East Arm Wharf and feeding nearby.

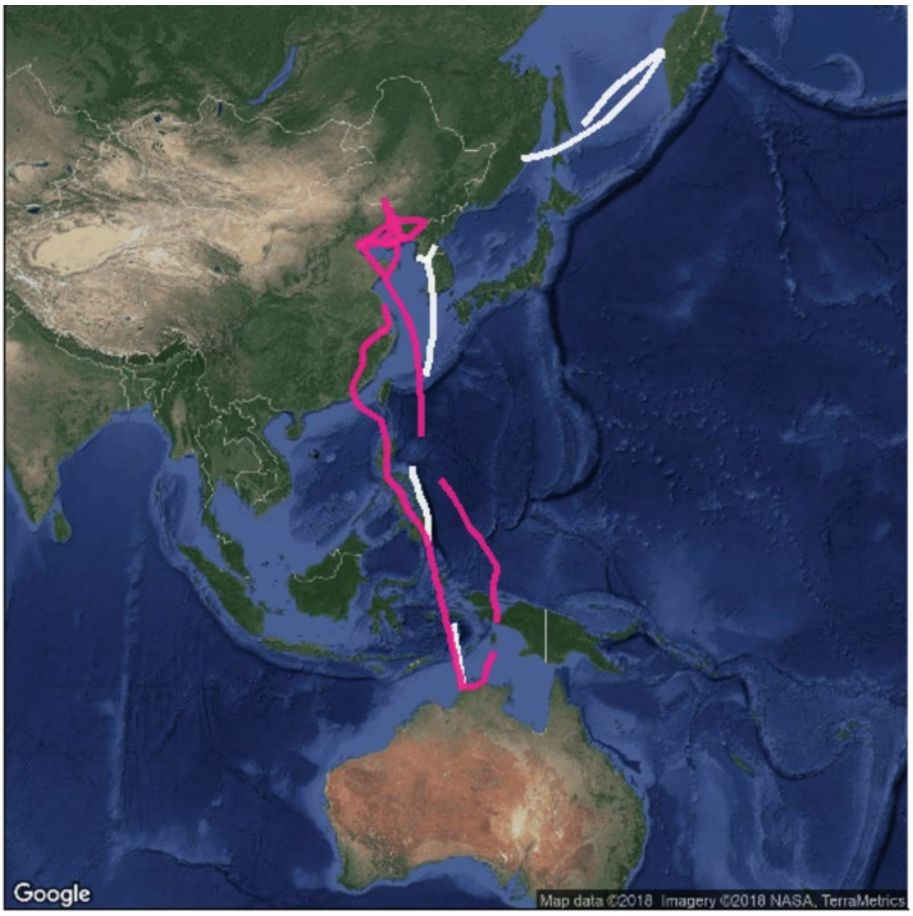


Figure 1. Full migration tracks for both Far Eastern Curlew. Pink = Curlew '17007', White = Curlew '17004'. Map credit: Kahle and Wickham (2013).

Habitat use at East Arm Wharf at high tide

It is useful to examine monitoring data to determine the frequency of occurrence for each species at each pond. Once trends are determined for each pond then we can provide management recommendations on the importance of the ponds, and create a list of criteria required to replicate those habitat features.

We examined count data for 19 species of migratory shorebird that have been monitored at East Arm Wharf using the same survey methods from 2013 – 2018 (species' graphs presented in the appendices). We used a generalised linear model with a negative binomial distribution for the count data to look at trends over time and inspected how trends changed at each pond. We included month, year, time of day, pond and species as covariates in the model. We used the 'glm.nb' function in the 'MASS' package in R 3.5.1 (Venables 2002, R Core Team 2018). The full model with all covariates was the best model and we found that overall there was a positive linear relationship between shorebird numbers over time (P=0.0001). Shorebird counts increased at ponds D, E, K but not at pond B. Overall, shorebird counts were higher in the afternoons/evenings (P=0.003). There were higher counts in ponds D and K from the evenings, whereas pond E had higher counts recorded in the mornings. Shorebird counts increased from August through to February, and then were significantly lower during the dry season months of the year (April, May, June, July). Shorebird counts by month and pond are shown in Figure 2 with a linear trend line to help guide the eye.

Pond B

There were 8 species of migratory shorebird recorded in Pond B during the years 2013 – 2018. The highest count for this site was a total of 271 shorebirds from September 2013. Numbers reduced from 2015 through to 2016, and there were no birds recorded in Pond B during 2017 and 2018. Pond B fills with rainwater from the wet season and stormwater from nearby drains. This is a freshwater pond and when it dries up then birds stop using it.

Pond D

There were 18 species of migratory shorebird recorded in Pond D during the years 2013 – 2018. The highest count for this site was a total of 1493 shorebirds from October 2013. Numbers of shorebirds have been steady over the survey years. Pond D is a freshwater pond and fills from rain during the wet season. Shorebirds stop using it when it dries up then.

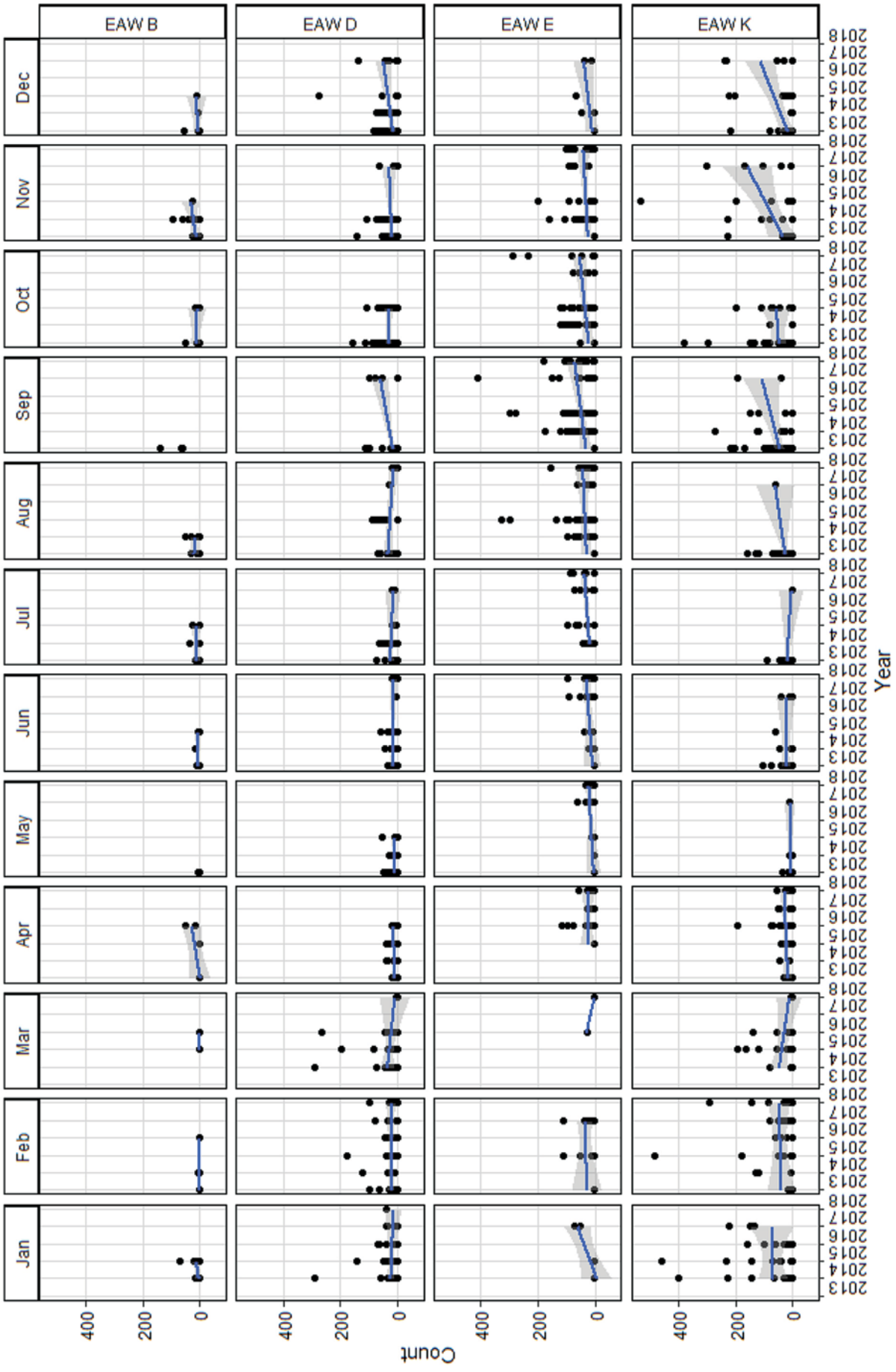
Pond E

There were 18 species of migratory shorebird recorded in Pond E during the years 2013 – 2018. The highest count for this site was a total of 2109 shorebirds from September 2015. Pond E is used more frequently by shorebirds from July onwards as at this time of the year it is usually the only pond with some standing water available as Ponds B, D and K dry up. Conversely, this pond is not used by as many shorebirds during the wet monsoon months as it usually floods with excess rainwater and tidal water filling the pond. This is a saltwater pond and is a permanent waterbody at EAW. The pond is sectioned by a bund wall and the western-most side of Pond E is smaller than the northern-most side. The western side has consistently had a pair of Pied Oystercatcher nesting in it. This is an Australian resident breeding shorebird.

Pond K

There were 19 species of migratory shorebird recorded in Pond K during the years 2013 – 2018. The highest count for this site was a total of 1855 shorebirds from September 2013. The highest counts of all shorebirds from EAW have been recorded in Pond K. Shorebirds use this pond for roosting when there is some shallow standing water present. This is a freshwater pond and when it dries up then birds stop using it.

Figure 2. Counts of all migratory shorebirds for each month for years 2013 – 2018 at each pond in East Arm Wharf



Attraction to East Arm Wharf from across Darwin Harbour

We examined the times and directions of shorebirds arriving to the different ponds at East Arm Wharf and found that generally, most shorebirds that arrived on the incoming high tide went to Pond K and some species such as Whimbrel, Greater Sand Plover, and Bar-tailed Godwit went to Pond D (Figure 3 and 4). A mix of species went to Pond E during some of the survey months, but these counts were much lower than those from Ponds D and K. Most of the records of arriving birds came from the south-east (Figure 3) and was predominantly made up of Far Eastern Curlew and Whimbrel. There were also many records of Far Eastern Curlew and Whimbrel arriving from the north and north-east areas.

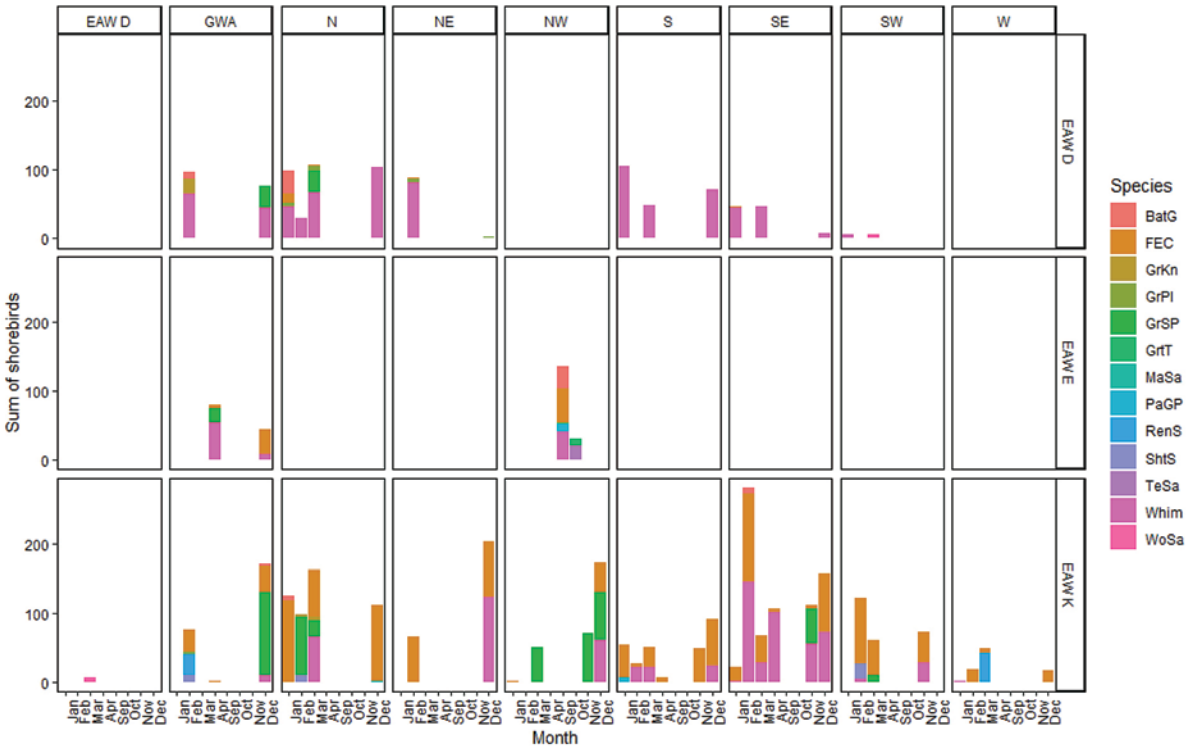


Figure 3. Sum of counts for shorebird arrivals to Ponds D, E, K at East Arm Wharf for survey years 2015 – 2018. Species codes listed below:

Bar-tailed Godwit	BatG
Far Eastern Curlew	FEC
Great Knot	GrKn
Grey Plover	GrPl
Greater Sand Plover	GrSP
Grey-tailed Tattler	GrtT
Marsh Sandpiper	MaSa
Pacific Golden Plover	PaGP
Red-necked Stint	RenS
Sharp-tailed Sandpiper	ShtS
Terek Sandpiper	TeSa
Whimbrel	Whim
Wood Sandpiper	WoSa

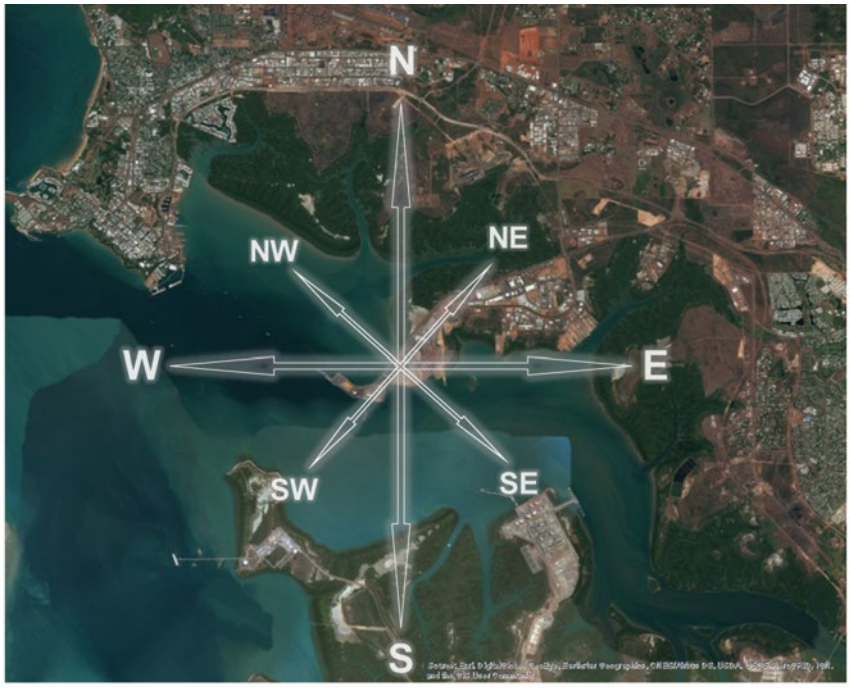


Figure 4. Map of Darwin Harbour with compass bearings based around East Arm Wharf.

We modelled the counts of shorebirds as they arrived at the different ponds at EAW using a Generalised Additive Model with a smoothing function on the tide height from when birds arrived. We used this modelling method because the relationship between counts of arriving birds and tide height was non-linear. We used the 'gam' function in the 'mgcv' package in R 3.5.1 (Wood 2011) and applied a poisson distribution to the data, with a default thin plate regression spline as the smoother.

The timing of arrival at EAW in relation to the tide height was significantly non-linear in its relationship with the number of birds arriving (P=0.0001; EDF = 8.78). The EDF value of 8.78 is an indication of how complex the smoothing calculation is that determines the shape of the curve (Zuur 2012). This function can be used to show where peaks occur for when birds arrive at EAW. At Pond D there is a peak in bird arrivals at 7.5 m and at Pond K, there is a peak at 7.6 m (Figure 5). These peaks provide an indication of when saltpans and other roosting habitat becomes unavailable and birds move to other suitable available habitat (i.e.: EAW). As it stands, EAW is the main suitable roost site for many shorebirds in Darwin Harbour. Beyond this, birds would have to commute greater distances to sites on the northern beaches (e.g.: East Point, Lee Point).

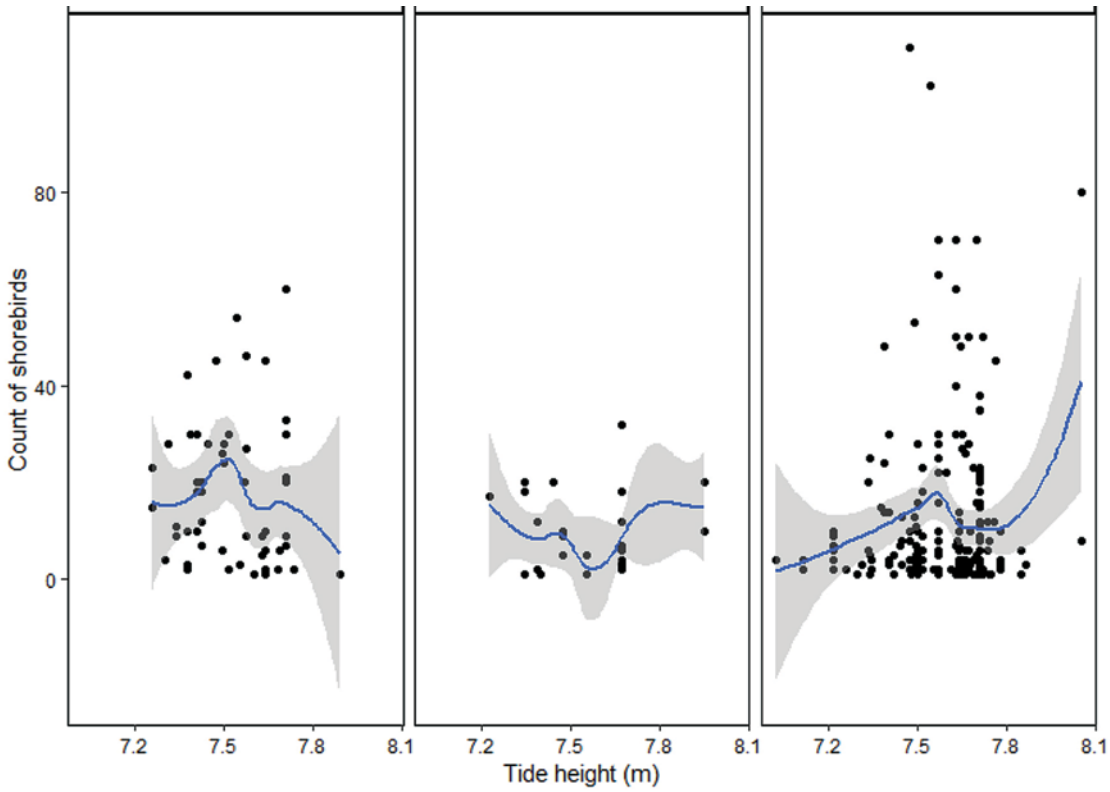


Figure 5. Counts of all shorebirds as they arrived at Ponds D, E, K at East Arm Wharf from 2015 – 2018 with a LOESS smoother to help guide the eye of the non-linear trend.

We examined the relationship between tide height at arrival time and count of shorebirds for the Far Eastern Curlew and again found that the relationship was highly non-linear (P=0.001, EDF = 8.63). Most Curlew that arrived at EAW went straight to Pond K (Figure 6). There was a peak in Curlew numbers arriving at Pond K at 7.55 m (Figure 7).

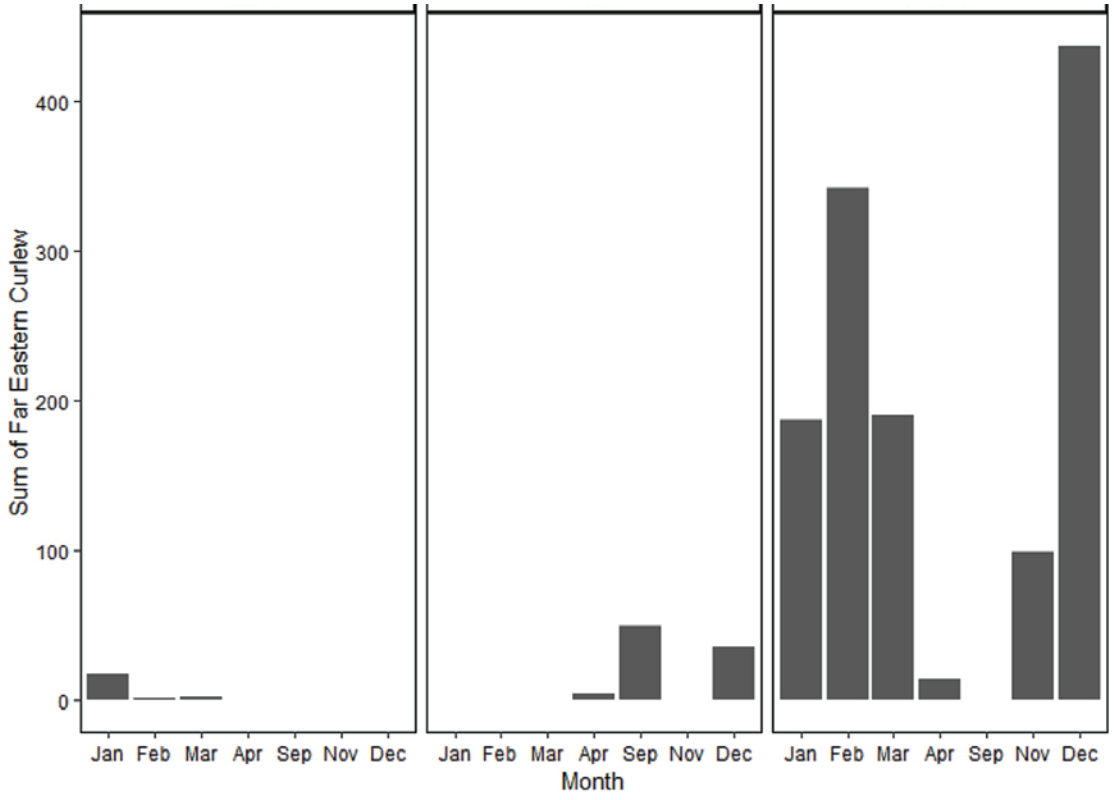


Figure 6. Sum of counts for Far Eastern Curlew arrivals to Ponds D, E, K at East Arm Wharf for survey years 2015 – 2018.

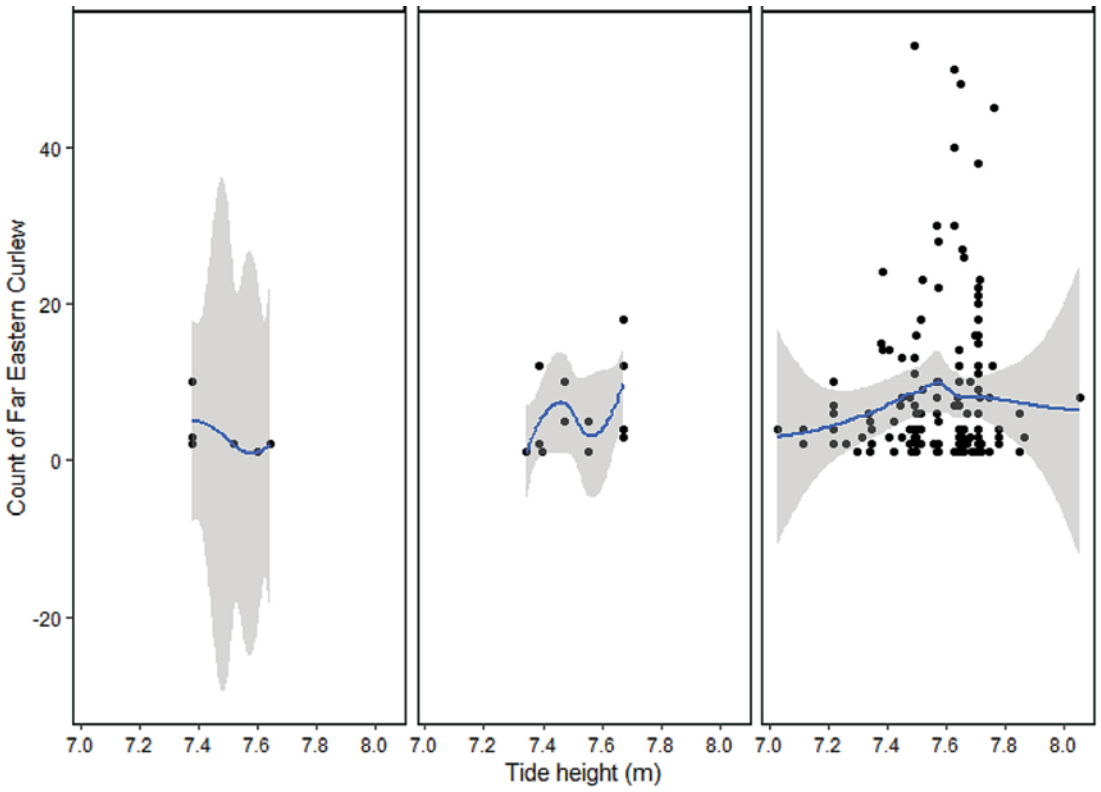


Figure 7. Counts of Far Eastern Curlew as they arrived at Ponds D, E, K at East Arm Wharf from 2015 – 2018 with a LOESS smoother to help guide the eye of the non-linear trend.

Habitat use in Darwin Harbour at low tide

The Darwin region is macrotidal with a tidal range of 0.1 to 8.1 m. The area experiences spring and neap tide cycles and the highest tides occur during the full moon spring tides, which happen once per month. These tides occur when the sun, moon and earth are all aligned and the gravitational pull is at its maximum. The immense tidal amplitude means that during the spring tide cycles there is greater intertidal area exposed during low tides than during the low tides that occur during a neap tide cycle. There are three sub-areas within the Darwin Harbour study area – Darwin Harbour, the northern beaches from Mindil to Casuarina to Lee Point, and the Shoal Bay area (Figure 8). These three areas are demarcated based on records of shorebirds at roosting and feeding sites in the total area. Recent research has shown that there is limited movement of shorebirds from the Darwin Harbour (proper) sites to the northern beaches sites (unpublished data, AL).

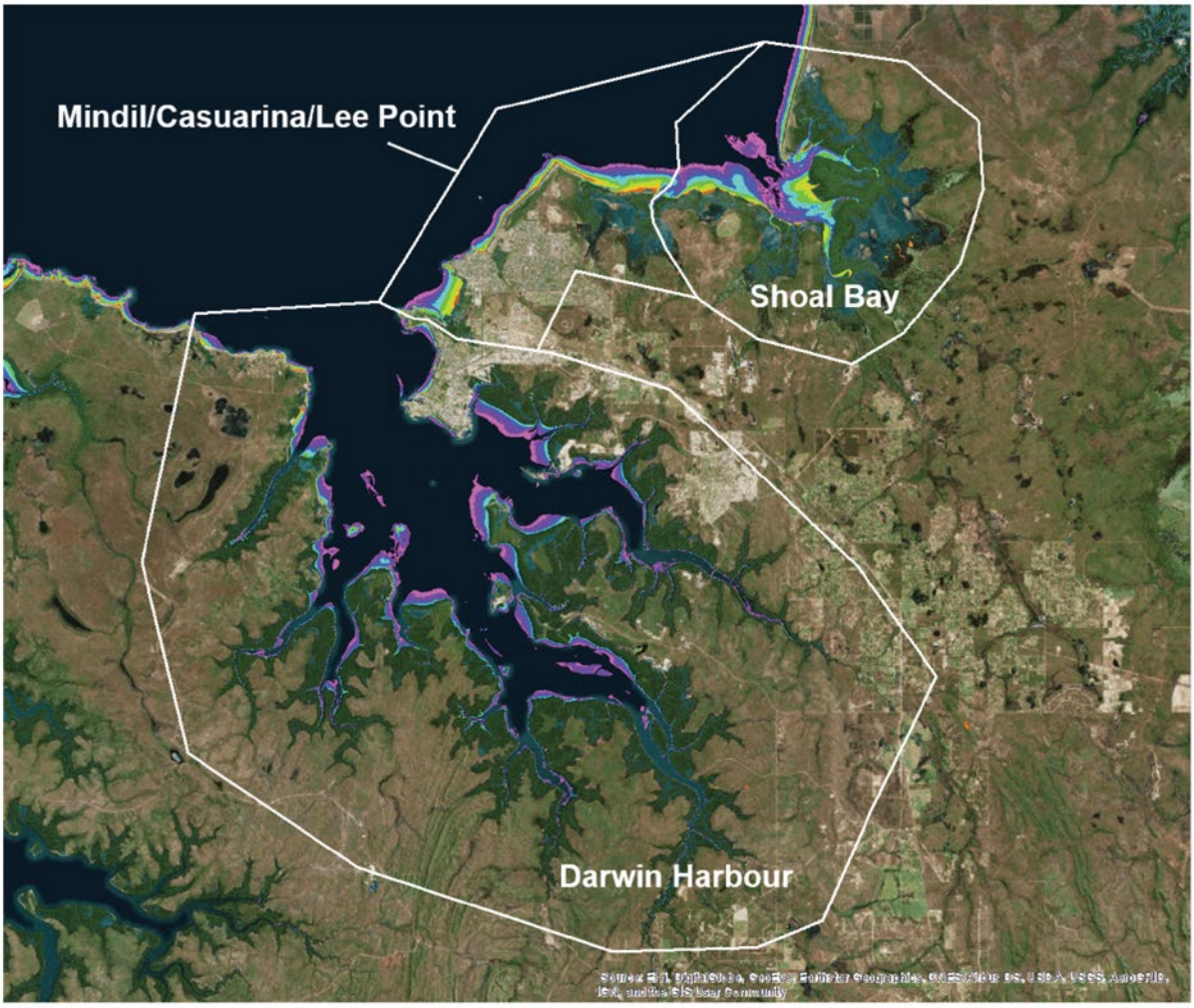


Figure 8. Total study area and sub areas for migratory shorebirds with intertidal zone shown as a colour gradient.

The cumulative area of exposed intertidal zone is shown in Figure 9 for all study areas in the Darwin Harbour study region, and is broken down by sub-areas in the Darwin Harbour study region (Figure 10).

During the lowest tide of spring tide cycles, there is a minimum of 123 km2 of intertidal substratum exposed and this occurs when the tide is in the bottom 10% of the observed tidal range (Table 1) representing a vast area in which shorebirds can forage (Figure 8). The largest intertidal areas in Darwin Harbour are near Charles Darwin National Park, East Arm and Wickham Point. The exposure of the intertidal flats appears linear for the northern beaches area, whereas the Darwin Harbour curve appears logarithmic in its exposure pattern. This is most likely because the bottom topography is flatter closer to the sea causing a greater increase in available intertidal area per decile.

By 30% of the observed tidal range more than half of the full intertidal area is exposed, thus for a foraging shorebird the tide must be at least 70% 'out' to access 50% of the total intertidal area. By half of the observed tide, almost 90% of the full extent of the intertidal area is exposed. The next report will explore the seasonal availability of habitat during the day as this represents the true area available to shorebirds. We may then be able to identify the key feeding areas for shorebirds around Darwin Harbour with greater accuracy.

Table 1. Area of exposed intertidal substratum at each decile interval of observed tidal range (OTR).

Band	Sub stratum	Colour band in Figure 8	Total area of band in study site (km^2)	Cumulative area (km^2)	Band description	Proportion of full extent exposed during particular decile %	Cumulative proportion %	Inverse cumulative proportion %
0	Sea		1394.63		Area always under water during OTR			
1	Intertidal		26.01	26.01	Area exposed at 0-10% of OTR	21	21	100
2	Intertidal		29.44	55.45	Area exposed at 10-20% of OTR	24	45	79
3	Intertidal		23.71	79.16	Area exposed at 20-30% of OTR	19	64	55
4	Intertidal		19.52	98.68	Area exposed at 30-40% of OTR	16	80	36
5	Intertidal		9.94	108.62	Area exposed at 40-50% of OTR	8	88	20
6	Intertidal		7.10	115.72	Area exposed at 50-60% of OTR	6	94	12
7	Intertidal		3.06	118.78	Area exposed at 60-70% of OTR	2	97	6
8	Intertidal		4.24	123.01	Area exposed at 70-80% of OTR	3	100	3

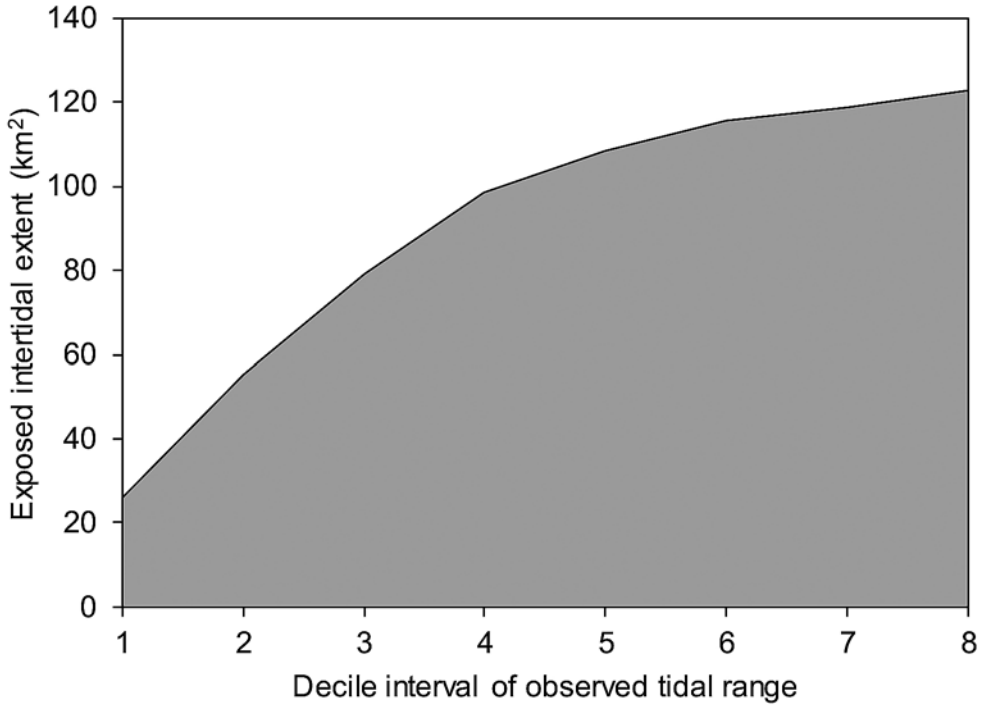


Figure 9. Extent of intertidal substratum exposed at different stages of the tide for the total study area of Darwin Harbour. Highest observed tide on the left and lowest observed tide on the right.

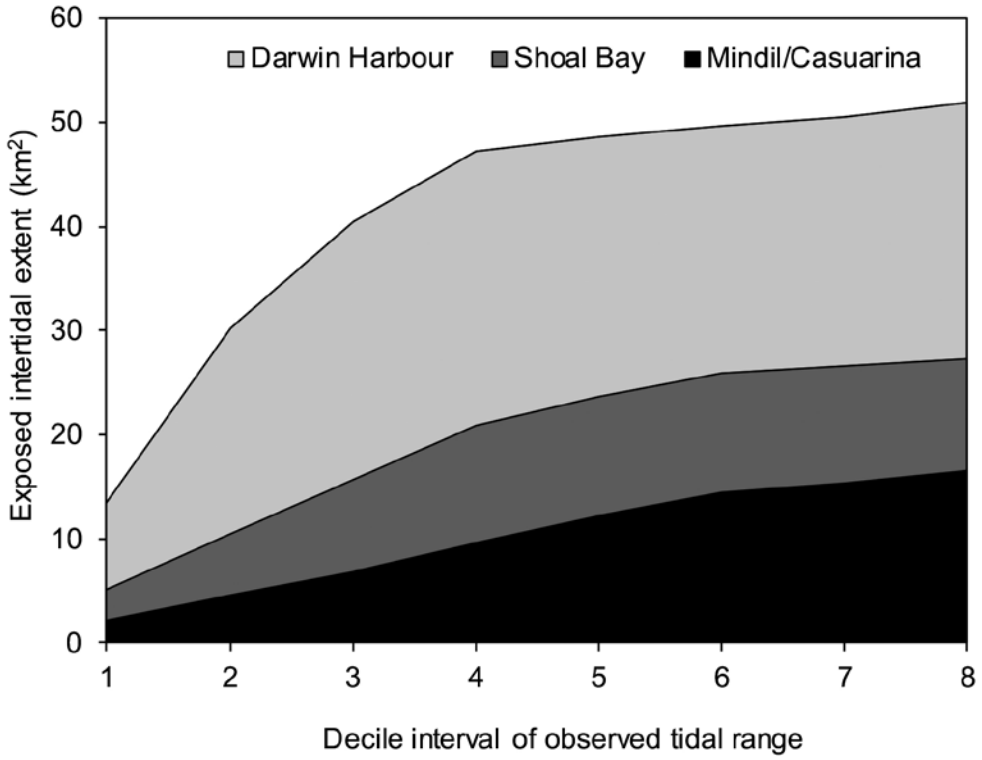


Figure 10. Extent of intertidal substratum exposed at different stages of the tide for three sub-areas in the total study area of Darwin Harbour. Highest observed tide on the left and lowest observed tide on the right.

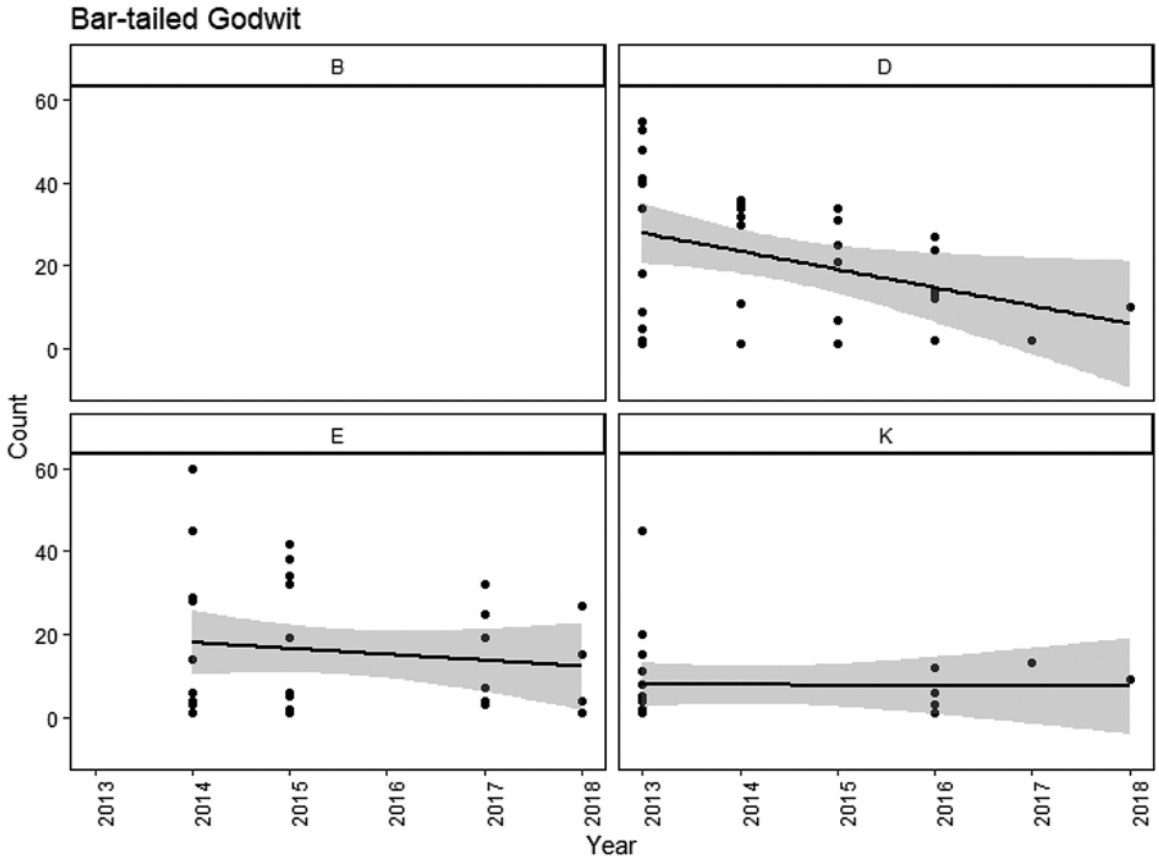
Future work

- Our next progress report will build on this report and continue examining habitat use at East Arm Wharf with the aim of understanding the habitat requirements of the shorebirds that roost at the site to develop successful criteria for artificial habitat. We also hope to conduct temporary experimental plots within Pond D to alter the current state of the pond and record the responses of shorebirds to various conditions.
- The results presented in this current report point to the growing importance of Pond K for Far Eastern Curlew, and out next step will involve understanding what, if any, thresholds there might be on the use of this pond by the species.
- We will also host a workshop on birds in ports and artificial habitat at the Australasian Ornithological Conference in Darwin, July 2019. The workshop will aim to document the successes of artificial habitat creation, outline the ecological requirements of all shorebirds that use EAW and how to meet those requirements through habitat creation.

Acknowledgements

We acknowledge the harbour's Traditional Owners, the Larrakia People, and their elders past and present. We thank our project partners Darwin Port. Thanks to the National Environmental Science Programme Threatened Species Recovery Hub for funding this project on Far Eastern Curlew (Project 5.1.1). Thanks to Ian Leiper for his fantastic GIS mapping skills and enthusiasm for working on The Curlew Project. Thanks also to Hayley Gayle for final checks. Special thanks to Gavin O'Brien and Damien Stanioch, both are excellent volunteers and without their help we would not have GPS tags on Curlews. We also thank the Australasian Wader Studies Group.

Appendices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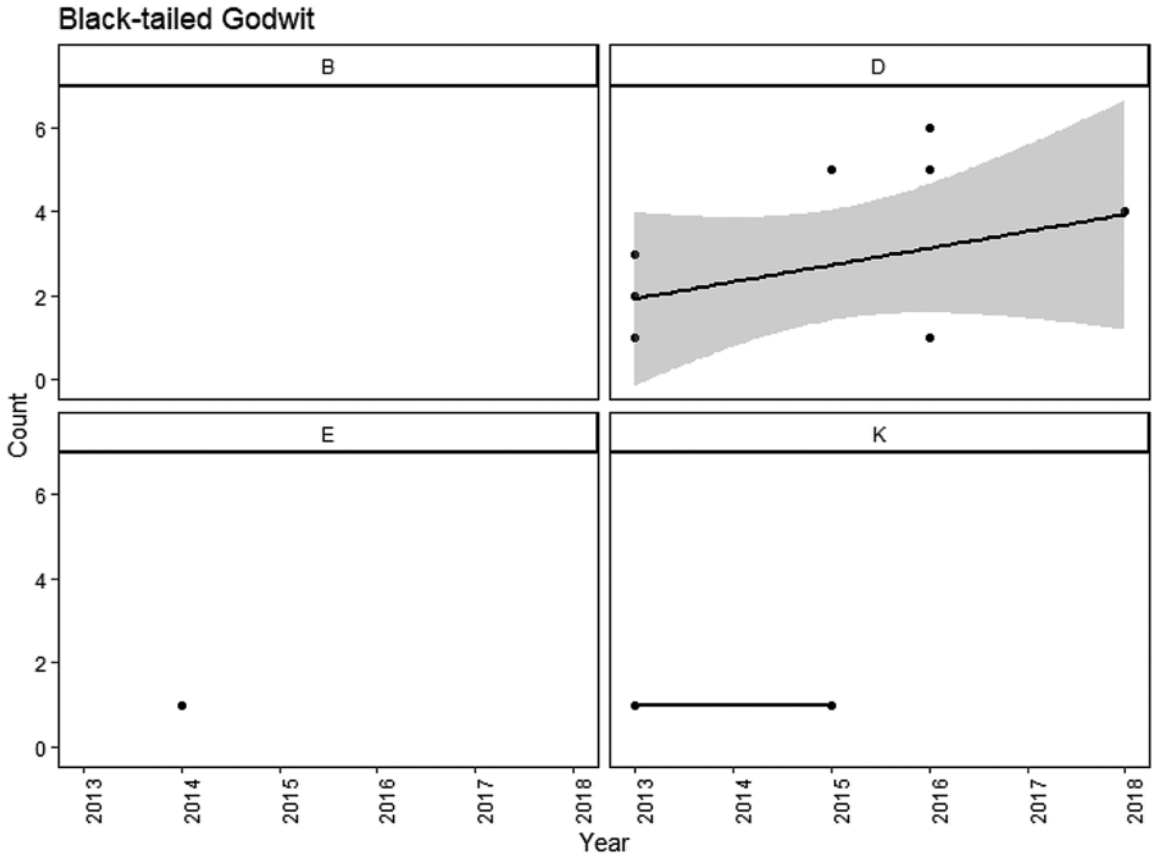
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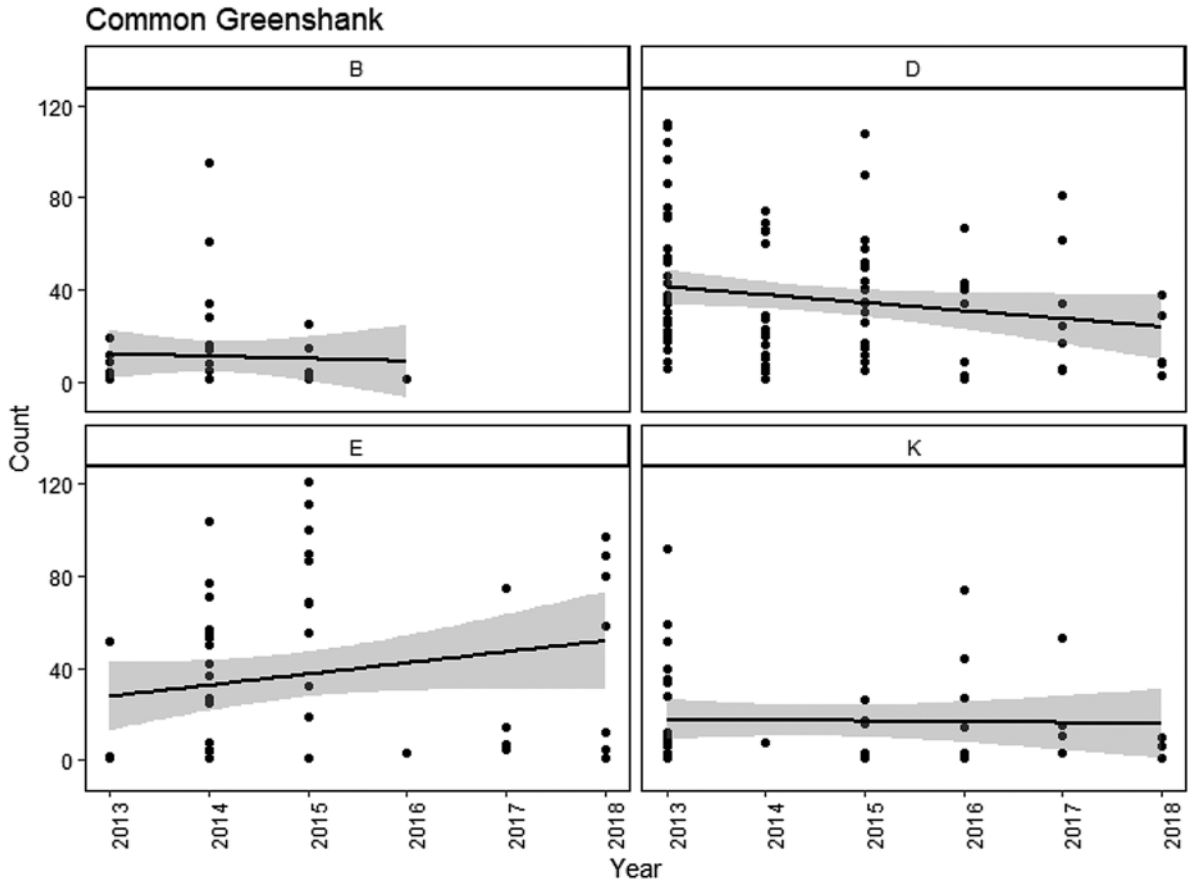
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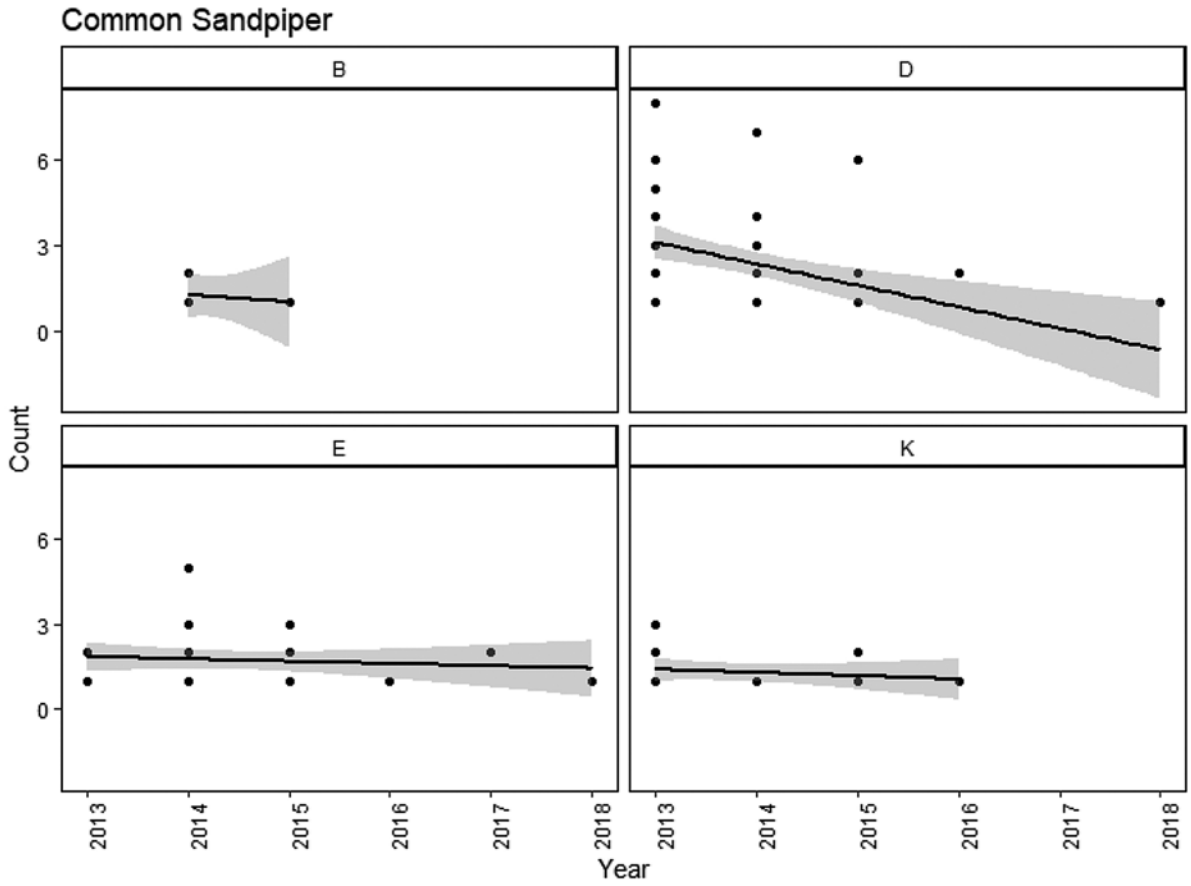
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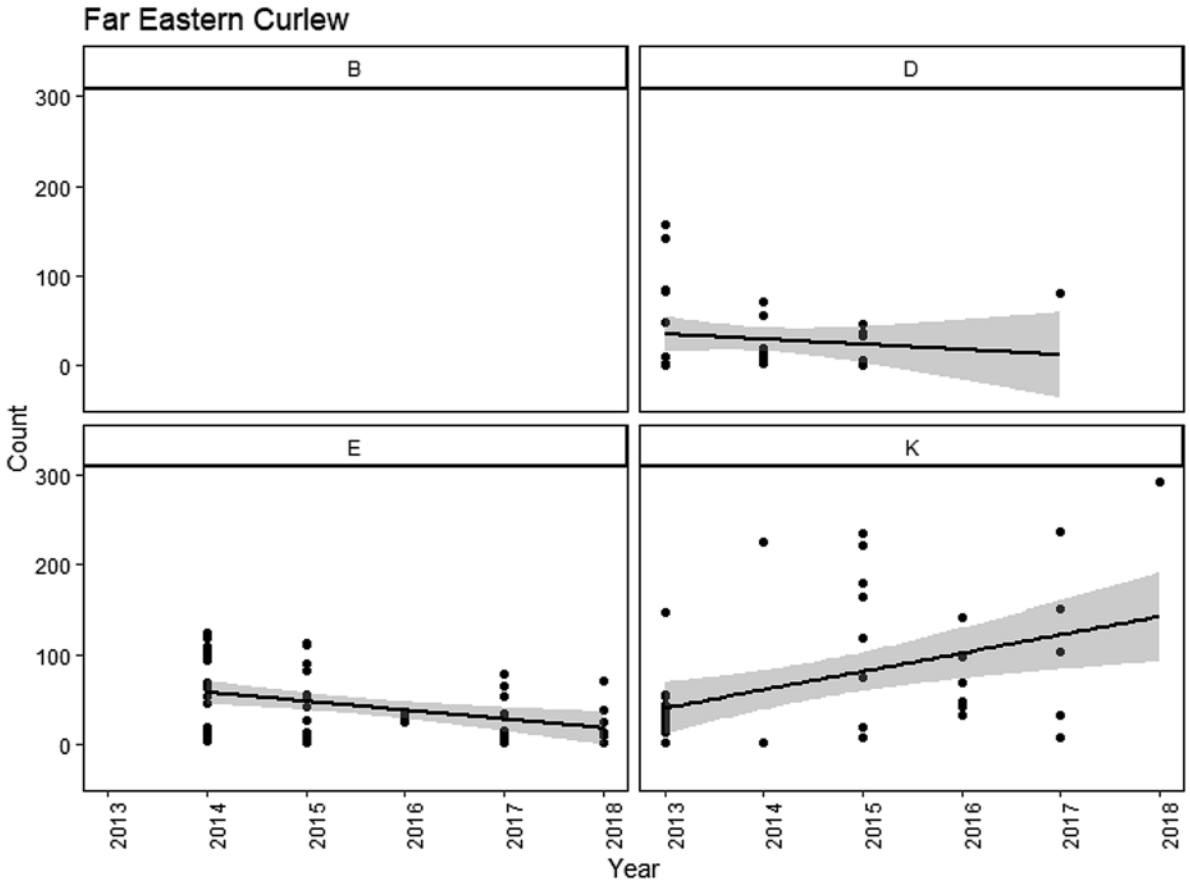
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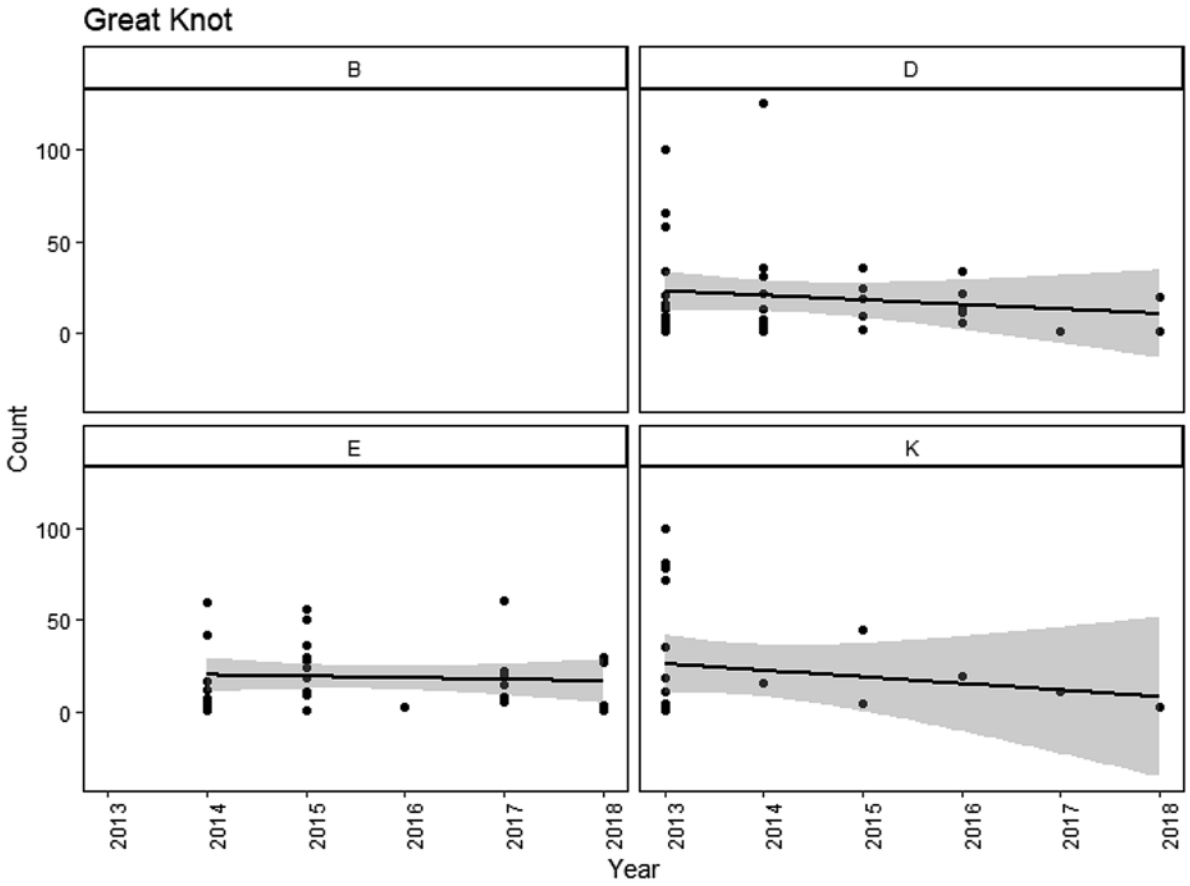
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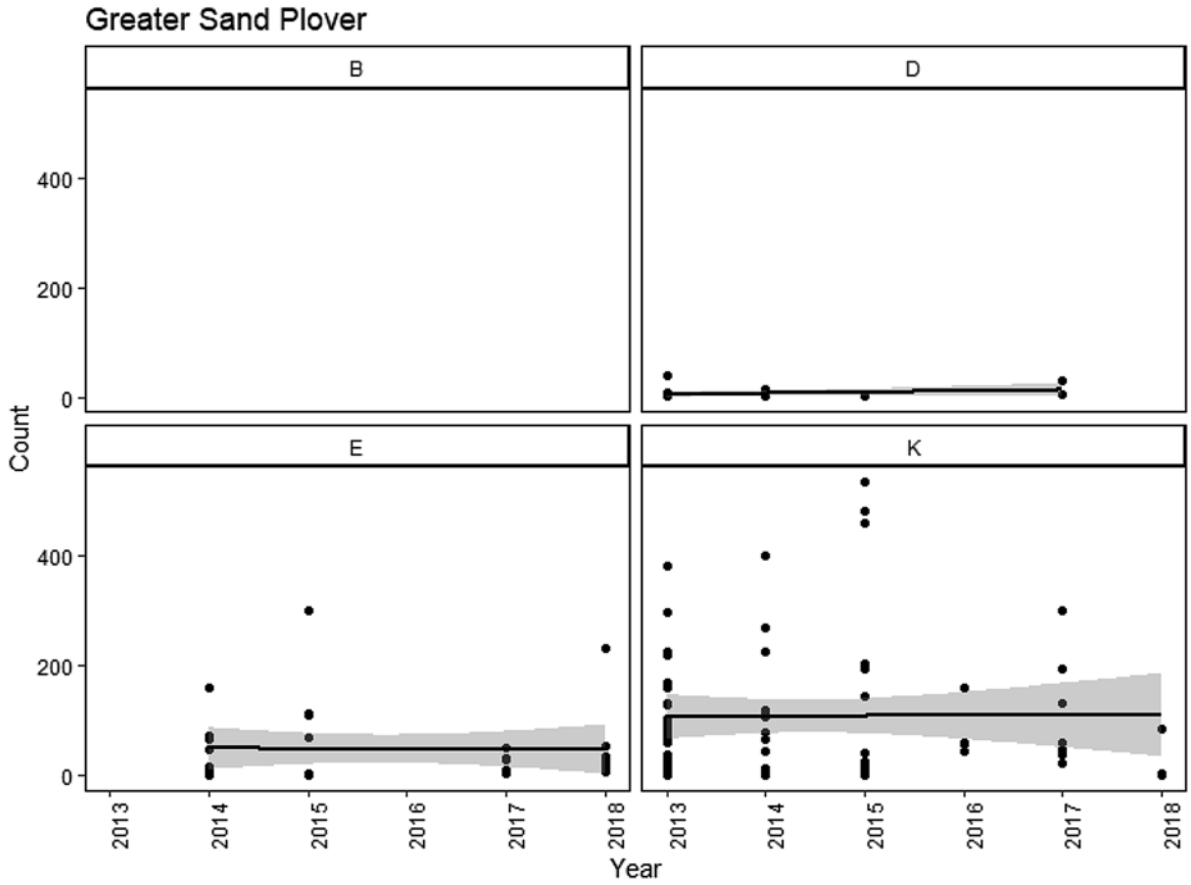
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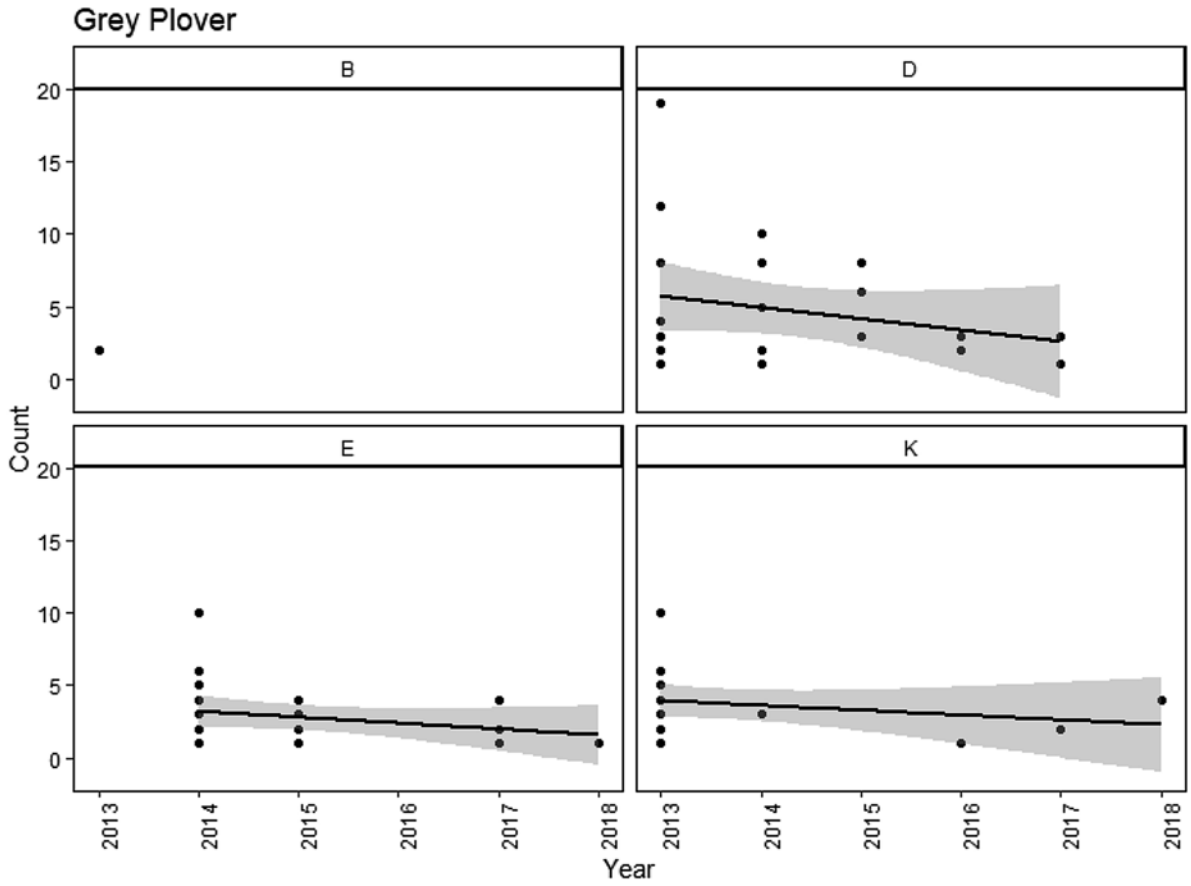
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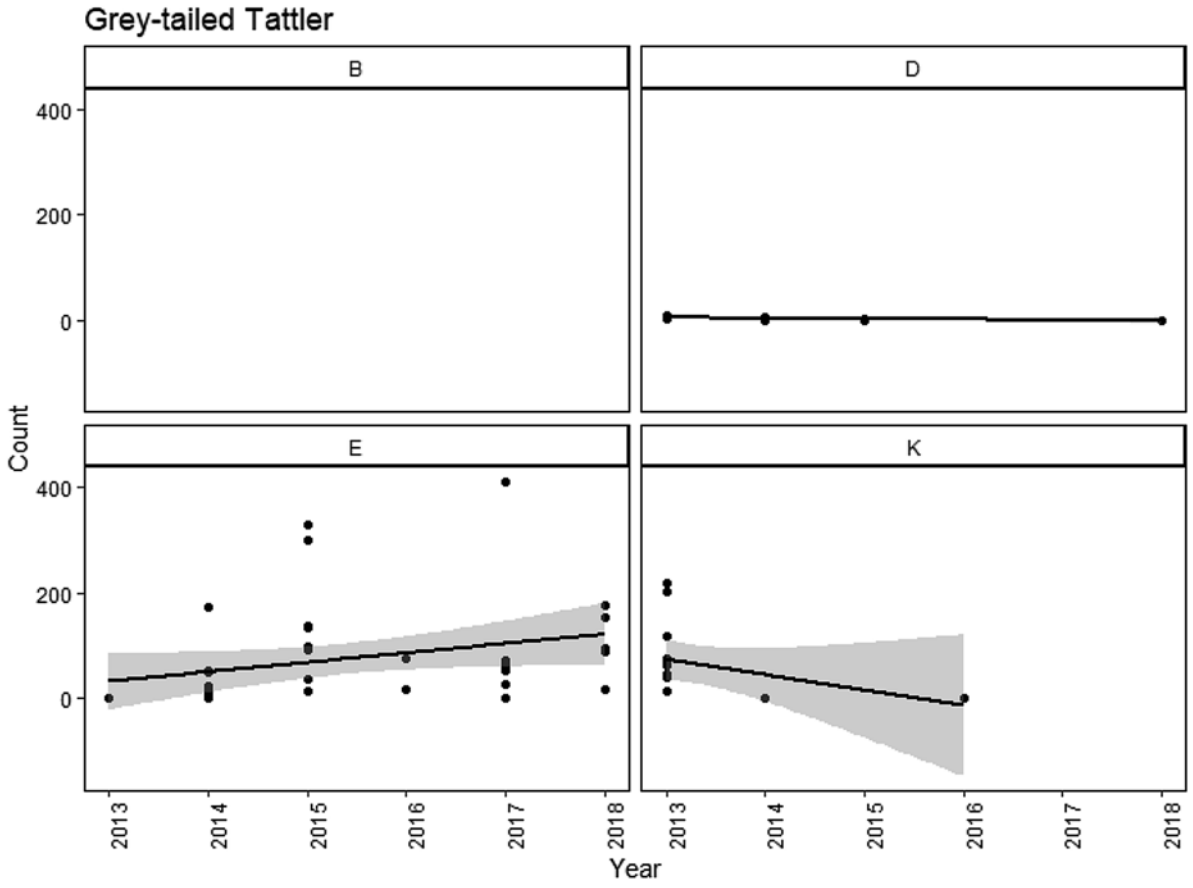
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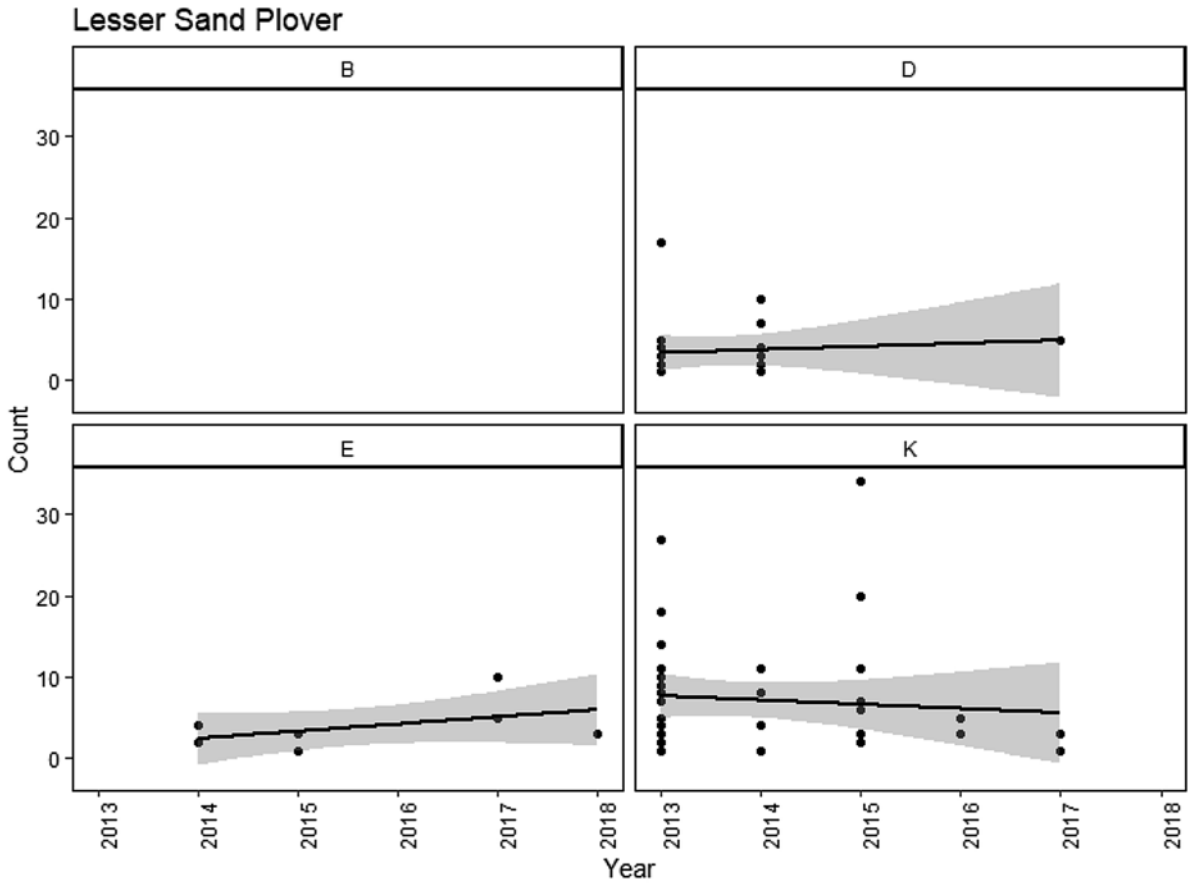
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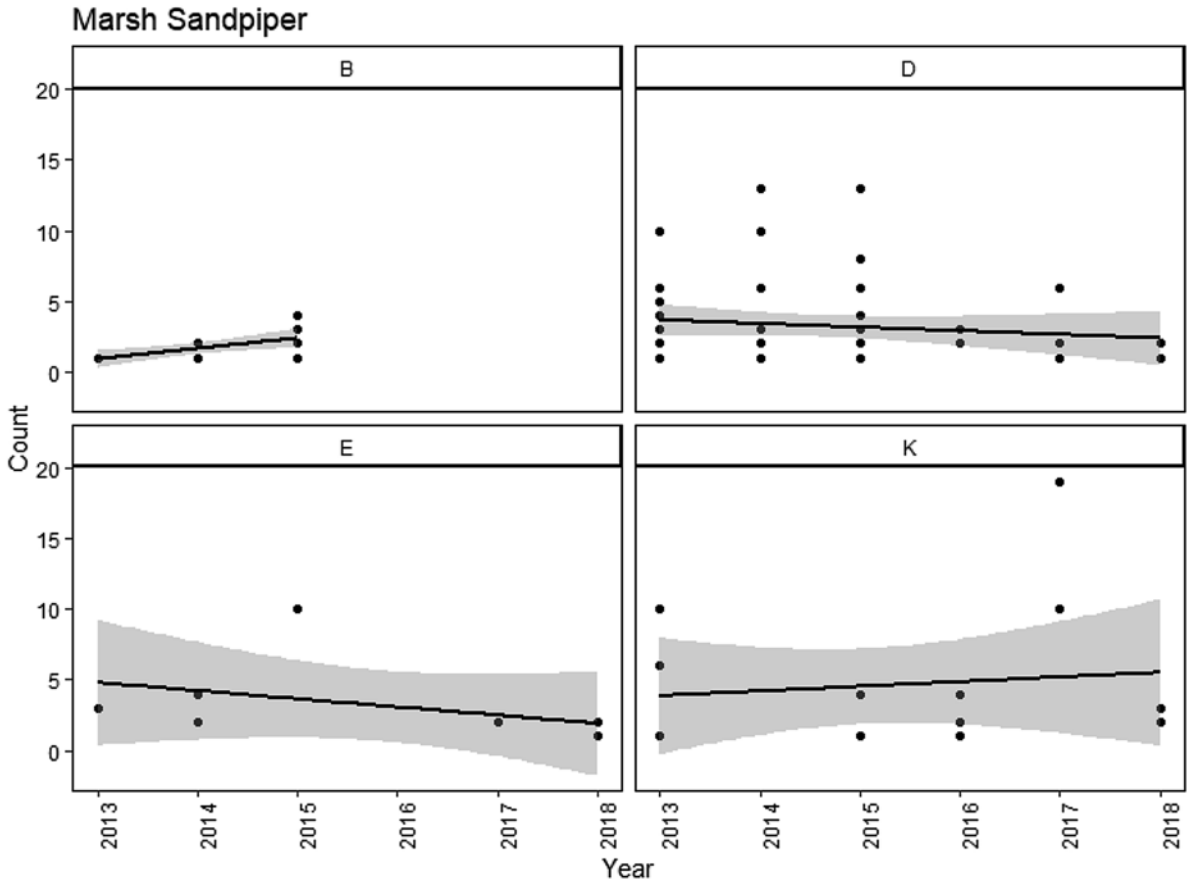
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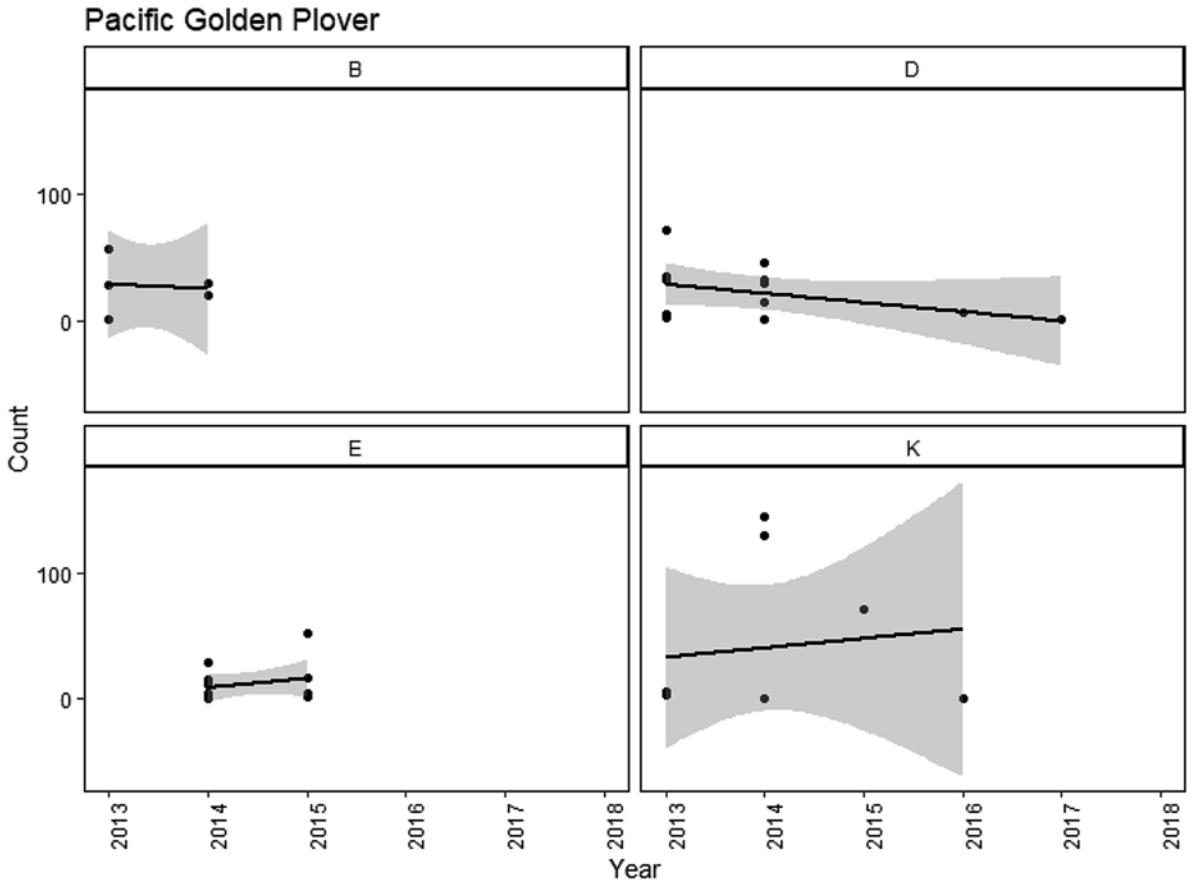
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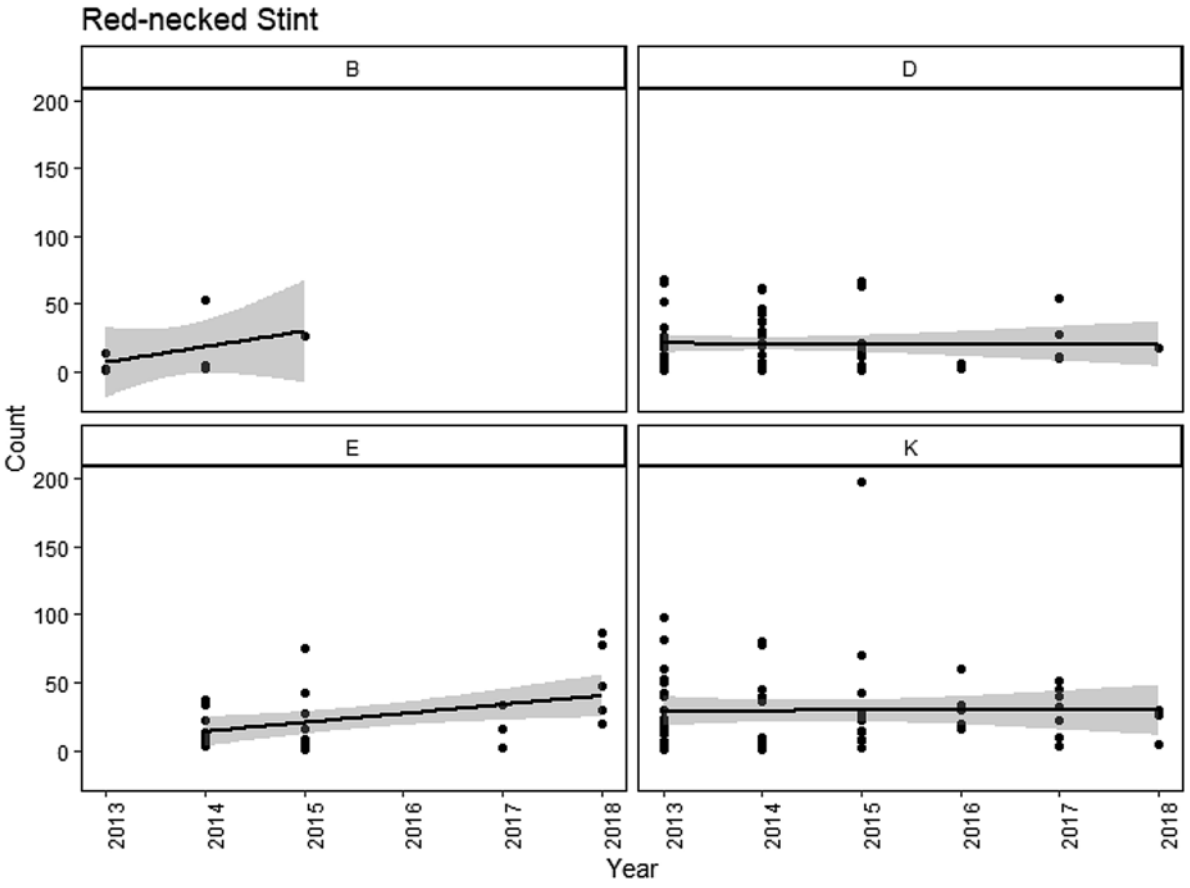
Red-necked Stint
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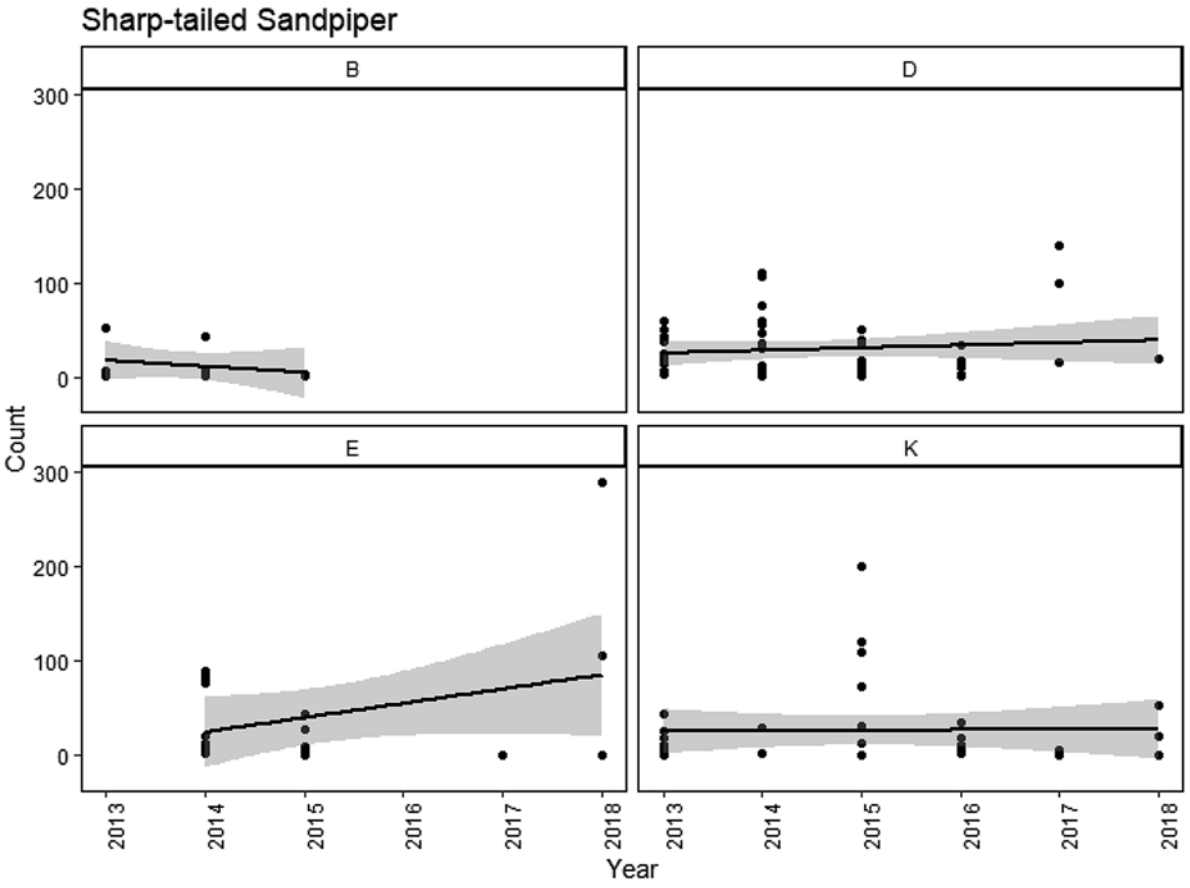
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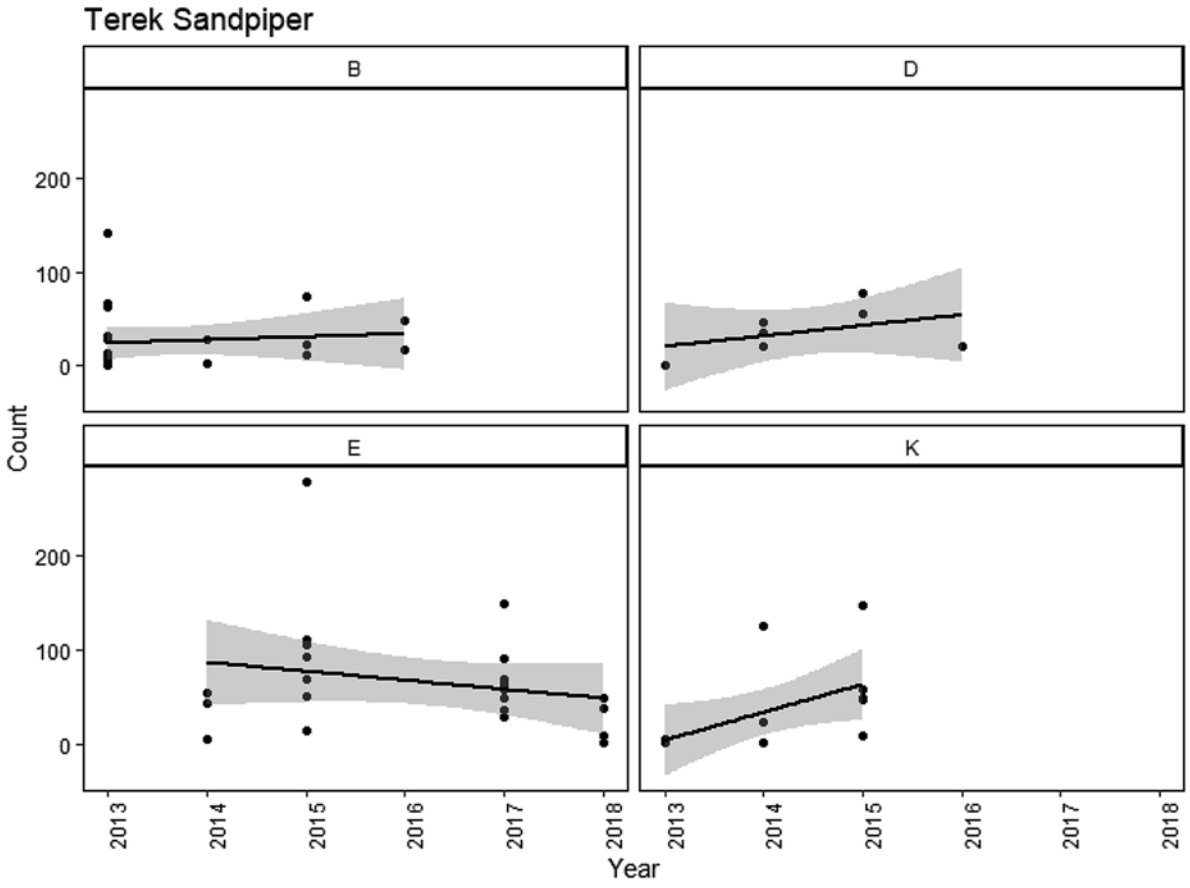
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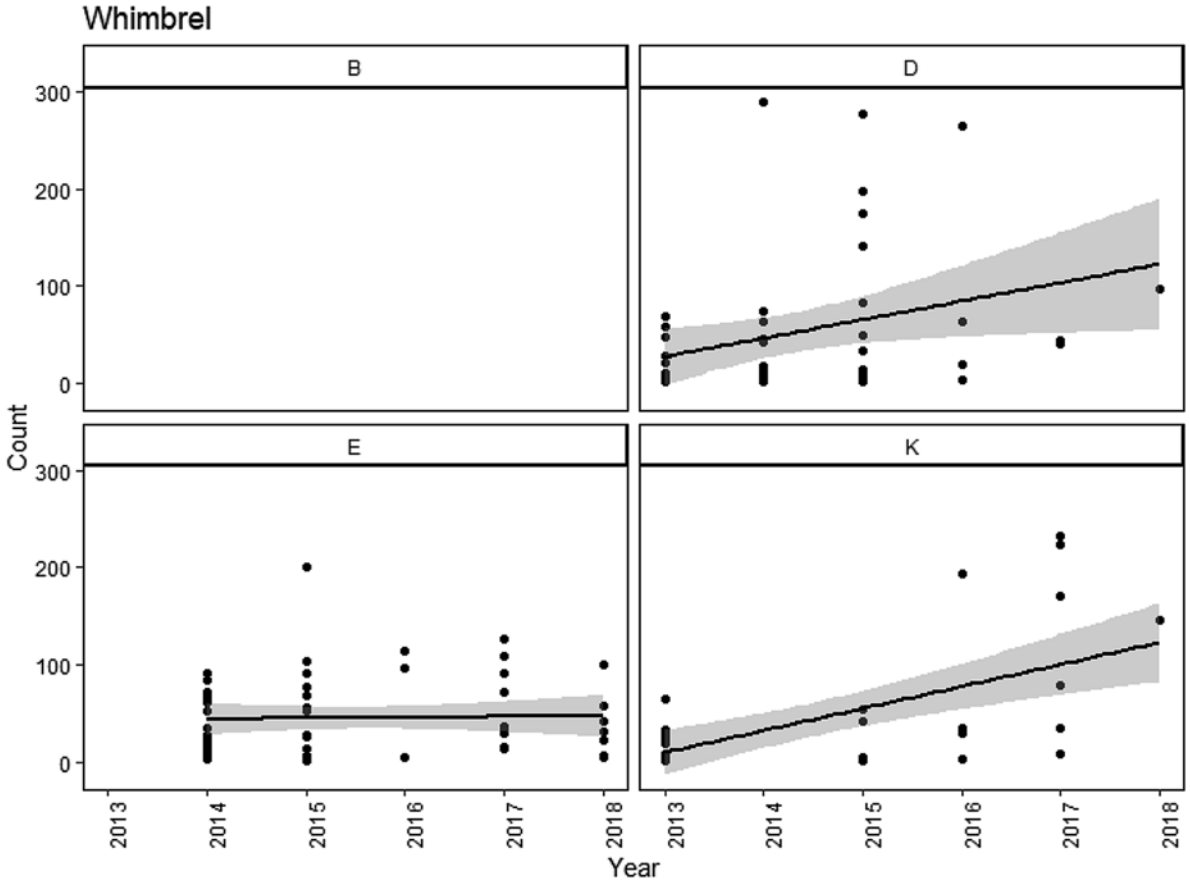
Whimbrel
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Count
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2013
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2018
Year

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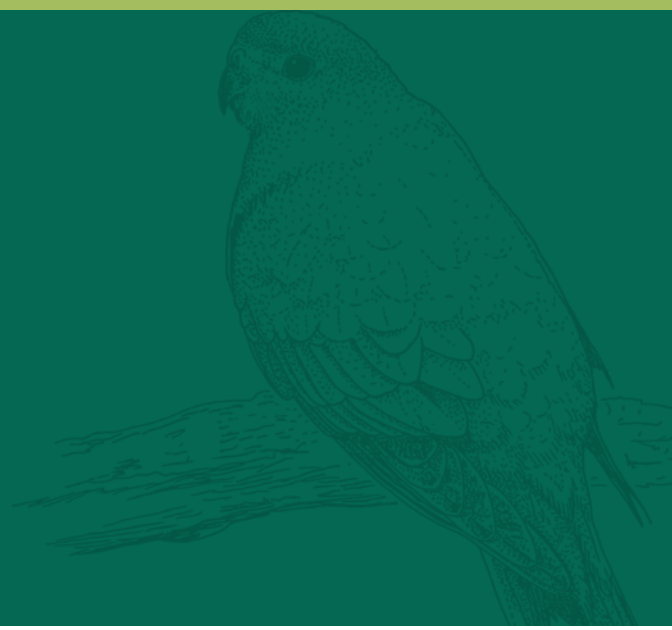
Further information:
http://www.nespthreatenedspecies.edu.au/



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Threatened Species Recovery Hub

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