Eastern Curlew Multi-Criteria Decision Analysis (MCDA)

Prepared by Morgan Thomas – Reef Catchments Project Officer

Introduction

The eastern curlew (*Numenius madagascariensis*) is the largest annual migrant shorebird that travels along the East Asian-Australasian Flyway (EAAF), to which it is endemic (Lilleyman et al. 2016). Eastern curlews are a top 20 priority bird species listed as 'Critically Endangered' and are identified as a 'Listed Migratory Species' under the *Environment Protection and Biodiversity Conservation Act 1999*. They are also one of the 110 priority species as per the Threatened Species Action Plan. After breeding in eastern Russia, Mongolia or north-eastern China, this long-haul flyer travels up to 20,000km to its non-breeding grounds in Australia (Choi et al. 2016; Lileyman et al. 2016). They then spend their non-breeding season along the coastlines and sheltered bays of Australia, where they forage on intertidal invertebrates at low tide, before retreating to high-tide roosts on beaches, mangroves, and ponds (Higgins and Davies 1996). Migratory shorebirds rely heavily on their winter non-breeding grounds for foraging potential (Finn & Catterall, 2022). Foraging success is therefore essential for them to maintain healthy body conditions and enable their successful long-distance migration to their breeding grounds to being this process again (Battley et al., 2004; Finn & Catterall, 2022; Klaassen et al., 2012). Unfortunately, over the past 30 years, Eastern Curlews global populations have declined up to 80%, meaning this already struggling shorebird is under significant threat of extinction.

Habitat destruction and reclamation of tidal mudflats are currently the biggest threats facing eastern curlews and other migratory species that depend on these staging grounds as a food source. Other threats include hunting, pollution, changes to water regimes, disturbance, and climate change on both their breeding and roosting grounds. Many populations of Eastern Curlew also face direct conflict with humans and anthropogenic activities, which can greatly impact how the birds use the resources of these landscapes. Research has consistently highlighted the importance of high-quality non-breeding habitats to migratory shorebirds like the Eastern Curlew. Therefore, understanding the habitat use and distribution of individuals across a landscape along with the influences of anthropogenic disturbance is fundamental to conserving this threatened species (Lilleyman et al., 2020).

The purpose of this project is to collate historical monitoring data into a visual habitat prioritisation asset that overlays identified Eastern Curlew roost sites, with mapping of human disturbance in the Mackay region.

Methods

Study area

The Mackay Local Government Area (LGA) is located in Central Queensland, spanning approximately 7,500 km^2 with a population of approximately 123,000. The Mackay LGA is a diverse, rural community with the majority living along the coastline. There are approximately 30 townships consisting of small rural settlements and residential areas.

Eastern curlew analysis

The GIS-based Multi-Criteria Decision Analysis (MCDA) is a modelling approach used to facilitate the consideration of multiple, often conflicting, criteria by decision-makers. MCDA transforms and combines geographical data and value judgements to solve spatial problems. Historical monitoring data of Eastern Curlew roost sites were collated by the Queensland Wader Study Group (QWSG) and provided to Reef Catchments (Mackay Whitsunday Isaac) Limited. The QWSG has been collecting data for more than 15 years in the region, which helps to reduce the risk of outlying results having a material impact.

Disturbance layers utilised for the MCDA were determined through consultation with relevant stakeholders, research and relevant data-providing bodies. The most commonly reported recreational disturbances reported in global literature are the presence of humans, exercising domestic dogs, operation of motor vehicles and recreational boating (Albores-Barajas & Soldatini 2011; Burger et al. 2004; Lafferty 2001a; Martin et al. 2015; Trulio & Sokale 2008). The six criteria used were: recreational facilities (parks, land for public recreation, car parks etc.), boat ramps, campsites, off-leash dog beaches, pathways and major transport infrastructure (harbours, coal terminals, airports). Layers were individually modified across the Mackay LGA to ensure only areas relevant to roosting sites were contained. For example, although a pathway may have been within 200m away from some sites and therefore within the buffer range, if there were any obstructions (housing, vegetation) between the roost site and the pathway, it could be assumed that the use of that pathway would have no influence given no visual line of sight, and was therefore removed. Data layers were sourced from Queensland Globe, Queensland Spatial Catalogue, and Mackay Regional Council.

Once our problem had been defined, we determined the criteria and constraints using expert opinion, research and other relevant sources. Our criteria were defined as the distances from the roosting sites, at 50m intervals from the roost, up to 200m. These values were determined based on Flight Initiation Distances (FID) by Eastern Curlews recorded in relevant research and are directly related to the anthropogenic disturbance types within our region. Using ArcGIS Pro 2.9.0, multi-ring buffers were added to each of the Eastern Curlew roosts at the above intervals. Buffers were transformed from vector to raster layers, with a cell size of 0.001, before being transformed with the Reclassify tool so that all buffers were on a scale of 1 to 4. Values were assigned as follows: within 50m = 4, within 100m = 3, within 150m = 2 within 200m = 1 and values beyond 200m were assigned the value of 0. A point intersect analysis was run to determine the level of anthropogenic disturbance relevant to each site and create additional columns for each layer within the attribute table of the data. To determine weights for each layer, experts were consulted and asked to perform an Analytical Hierarchy Process (AHP) to establish the importance of each influence on Eastern Curlew roost sites. The weightings for each of the disturbance layers were then applied to each disturbance layer within the attribute table, and each roost site was then summed to provide a final score. Each site was then symbolized based on this final weighted score to provide a visual aid for easily determining the anthropogenic influence on Eastern Curlew roosting sites in the Mackay LGA.

Pest animal control

The Conservation Detection Dog (CDD) was trained by a certified professional dog trainer on fox scent (*Vulpes vulpes*). The dog was trained to associate the scent of *V. vulpes* with a reward (e.g. food, tennis ball) and to sit ("indicate") at the location of the odour. Field trials were conducted across multiple sites during October of 2023 within the Mackay LGA. The detection team surveyed freely and the detection dog searched off-leash. Timing of field surveys was due to the increased likelihood of kits being present in dens. We were able to partner with Mackay Regional Council (MRC) to combine monitoring surveys , enabling a much wider coverage of the Mackay LGA. Some sites were selected based on MRC operational knowledge and other sites based on our MCDA analysis and a third set was based on both. For instance, Shoal Point was identified as a priority location for surveying by both MRC and our MCDA input. Through our partnership approach, we were able to treat both this site as well as the surrounding (neighbouring) area - expanding our survey coverage area. The detection team recorded the GPS location of each "indication" (i.e. each time the dog indicated that it had detected the odour and displayed a response), including latitude, longitude, time and date. During the field deployment, the CDD was fitted with a GPS tracking collar to review search patterns after field deployments. When a fox den was discovered by the CDD, dencofume was used to irradicate any animals within the den. Foothold traps were also set outside the den to capture any individuals who were not present in the den at the time, but would have returned to uncover the entrance (which was destroyed when using the dencofume).

Results

Eastern curlew results

84 non-breeding roost sites were located within the Mackay LGA, spanning from the O'Connell river in the north, to Cape Palmerston National Park in the south. The majority of roosting sites experience no anthropogenic disturbance from the layers used in this analysis, with only a small proportion experiencing medium, high and very high levels of disturbance (Table 1). The sites that scored the highest levels of disturbance were those near highly populated areas such as Bucasia, Eimeo, and South Mackay.

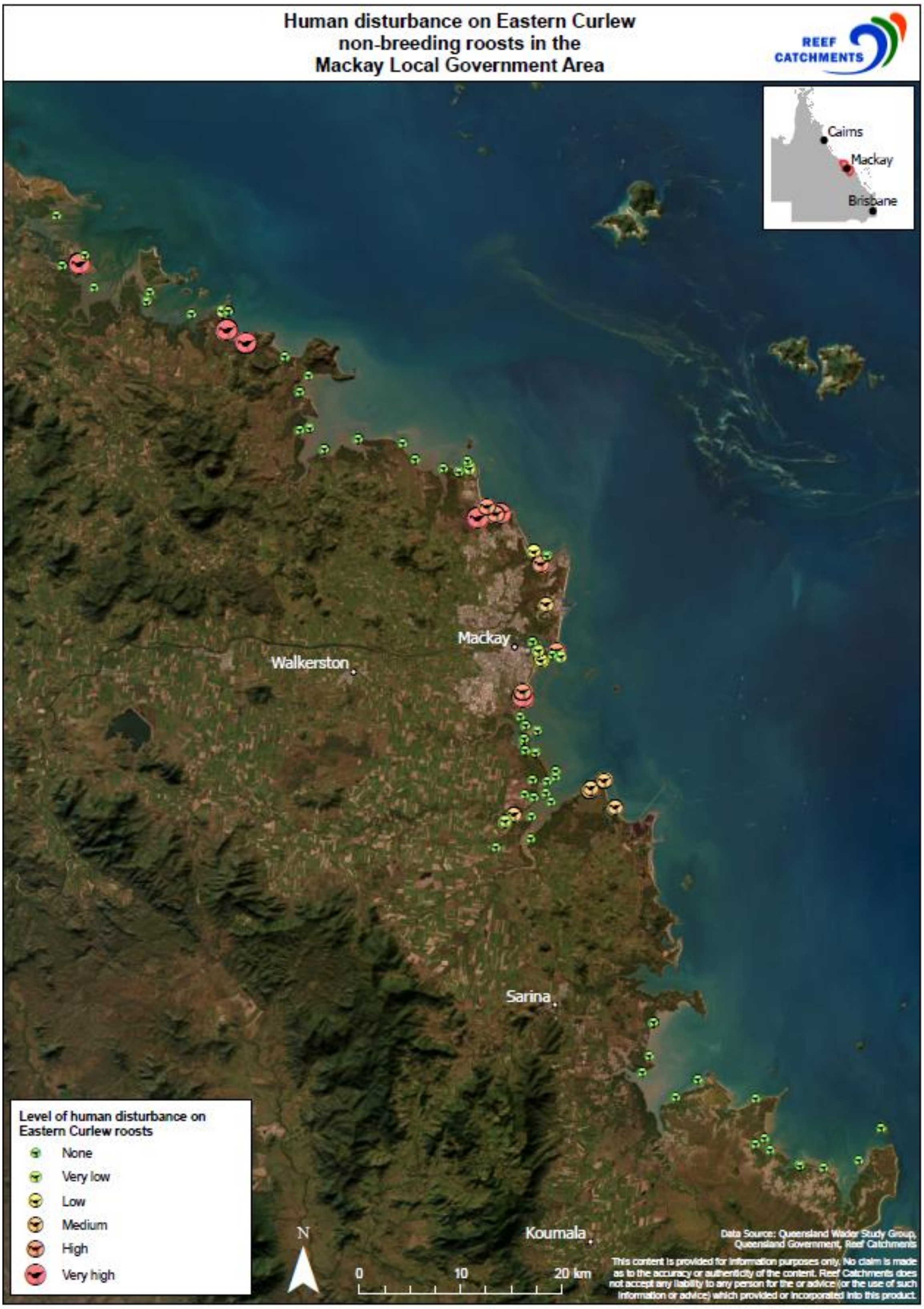

Figure 1: MCDA analysis of anthropogenic disturbance on Eastern Curlew roosting sites in the Mackay LGA.

Table 1: Number of roosting sites per level of anthropogenic disturbance in the Mackay LGA.

Anthropogenic disturbance level	Number of sites observed

None	60
Very low	5
Low	3
Medium	6
High	4
Very high	6
Total	**81**

Table 2: Number of disturbance layers intersecting with roosting sites in the Mackay LGA.

Disturbance type	Number of intersecting roosting sites
Public recreation areas	15
Campsites	0
Boat ramps	3
Pathways	14
Off-leash dog beaches	1
Transport infrastructure	6
Total	**39**

Pest animal control

During the combined CDD deployments we located seven active dens (six were fumigated and one was too difficult to fumigate so traps will be deployed by the landholder), one attempted den and seven inactive dens. Mapping of the detection dog tracks and sites can be found in the Appendix.

Discussion

The GIS-based MCDA procedure successfully estimated the levels of anthropogenic disturbance on Eastern Curlew non-breeding roost sites within the Mackay LGA based on our criteria. The results demonstrate a wide variety of disturbance levels across the Mackay LGA, with the majority having no influence or very little. However, certain sites could benefit from conservation management actions to help minimise their observed high levels of disturbance.

Of particular note were the two disturbance layers which impacted the Eastern Curlew roost sites most frequently: public recreation areas and pathways. Typically, both areas exhibit high concentrations of humans as they are linked to popular recreational activities, which can be considered major sources of anthropogenic disturbance (Gill 2007; Mayo et al., 2015; McFadden et al., 2017; Steven et al., 2011). In conjunction with the direct impacts of the increased demand for ecotourism and recreation in coastal areas, the installation of infrastructure to service that demand is similarly exacerbating the impact on shorebird populations (Clark 2018; Marasinghe 2020; Sharma & Rao 2018; Yasué & Dearden 2006). Where roosts occur within or overlapping urban and recreationally popular areas, the disturbance is expected to be high, which can have significant impacts on the suitability of the site for individuals (Chan & Dening 2007; Marasinghe 2020; Rogers 2003, Rogers et al., 2006; Smit & Visser 1993). The behavioural response of shorebirds to human disturbance is very well documented, with large flocks having been seen flying away from people and other vectors of disturbance, and areas with high visitation often have fewer birds (Stillman et al., 2007). The resulting unexpected flight response from human disturbance is postulated to negatively affect the finely tuned winter energetic balance of certain shorebirds. Along with reduced energy budgets impacting their health and survival, the loss of available foraging and feeding opportunities can also lead to adult individuals not meeting the required energy demands for their northern migration and the proceeding breeding periods (Choi et al. 2015; Leseberg et al. 2000; Marasinghe 2020).

The level of human disturbance at certain roosting sites highlights that existing management is currently failing to deter considerable disturbance to roosting birds. Effective management requires a joint strategy involving various stakeholders including councils and government bodies. Although state regulations exist to minimize disturbance on shorebirds, and local laws require dogs to be leashed on public land (other than designated off-leash areas), there is little to no enforcement of such regulations at present around Eastern Curlew roost sites (pers. obs.).

Community education regarding the value of these roost sites for Eastern Curlews and all shorebirds, is imperative for their future conservation. Providing the community with a greater understanding of the energy costs for individuals associated with disturbance, such as the potential loss of feeding habitat, the declining status of certain species, and the long-term declines of some shorebird populations, may help to address this issue (Marasinghe 2020; Rogers et al., 2006; Smit & Visser 1993). Ultimately, we must protect suitable and high-quality migratory shorebird habitats in Australia if we want to improve their chances of migration and assist with their conservation.

References

Albores-Barajas, Y. V., & Soldatini, C. (2011). Effects of human disturbance on a burrow nesting seabird. *Revista mexicana de biodiversidad*, *82*(4), 1262-1266.

Battley, P. F., Piersma, T., Rogers, D. I., Dekinga, A., Spaans, B., & Van Gils, J. A. (2004). Do body condition and plumage during fuelling predict northwards departure dates of Great Knots Calidris tenuirostris from north-west Australia?. *Ibis*, *146*(1), 46-60.

Burger, J., Jeitner, C., Clark, K., & Niles, L. J. (2004). The effect of human activities on migrant shorebirds: successful adaptive management. *Environmental Conservation*, *31*(4), 283-288.

Chan, K., & Dening, J. (2007). Use of sandbanks by terns in Queensland, Australia: a priority for conservation in a popular recreational waterway. *Biodiversity and Conservation*, *16*, 447-464.

Choi, C. Y., Nam, H. Y., & Lee, W. S. (2015). Behavioural responses of wintering black-faced spoonbills (Platalea minor) to disturbance. *Wildlife research*, *41*(6), 465-472.

Choi, C. Y., Rogers, K. G., Gan, X., Clemens, R., Bai, Q. Q., Lilleyman, A., ... & Rogers, D. I. (2016). Phenology of southward migration of shorebirds in the East Asian-Australasian Flyway and inferences about stop-over strategies. *Emu-Austral Ornithology*, *116*(2), 178-189.

Clark, J. R. (Ed.). (2018). *Coastal zone management handbook*. CRC press.

Finn, P. G., & Catterall, C. P. (2022). Towards an efficient indicator of habitat quality for Eastern Curlews on their intertidal feeding areas. *Australasian Journal of Environmental Management*, 1-22.

Gill, J. A. (2007). Approaches to measuring the effects of human disturbance on birds. *Ibis*, *149*, 9-14.

Higgins, P. J. Davies. SJJF (eds) (1996). Handbook of Australian, New Zealand and Antarctic Birds. Vol. 3. *Oxford University Press: Melbourne.*

Klaassen, M., Hoye, B. J., Nolet, B. A., & Buttemer, W. A. (2012). Ecophysiology of avian migration in the face of current global hazards. *Philosophical transactions of the Royal Society B: biological sciences*, *367*(1596), 1719-1732.

Lafferty, K. D. (2001). Disturbance to wintering western snowy plovers. *Biological Conservation*, *101*(3), 315-325.

Leseberg, A., Hockey, P. A., & Loewenthal, D. (2000). Human disturbance and the chick-rearing ability of African black oystercatchers (Haematopus moquini): a geographical perspective. *Biological Conservation*, *96*(3), 379-385.

Lilleyman, A., Bradley K. Woodworth, Richard A. Fuller, and Garnett, S. T. (2020) Strategic planning for the Far Eastern Curlew. *NESP Threatened Species Recovery Hub Project 5.1.1 final report*, Brisbane, December 2020

Lilleyman, A., Garnett, S. T., Rogers, D. I., & Lawes, M. J. (2016). Trends in relative abundance of the Eastern Curlew (Numenius madagascariensis) in Darwin, Northern Territory. *Stilt*, *68*, 25-30.

Marasinghe, S., Simpson, G. D., Newsome, D., & Perera, P. (2020). Scoping recreational disturbance of shorebirds to inform the agenda for research and management in Tropical Asia. *Tropical Life Sciences Research*, *31*(2), 51.

Martín, B., Delgado, S., De La Cruz, A., Tirado, S., & Ferrer, M. (2015). Effects of human presence on the long-term trends of migrant and resident shorebirds: evidence of local population declines. *Animal Conservation*, *18*(1), 73-81.

Mayo, T. W., Paton, P. W., & August, P. V. (2015). Responses of birds to humans at a coastal barrier beach: Napatree Point, Rhode Island. *Northeastern Naturalist*, *22*(3), 501-512.

McFadden, T. N., Herrera, A. G., & Navedo, J. G. (2017). Waterbird responses to regular passage of a birdwatching tour boat: Implications for wetland management. *Journal for Nature Conservation*, *40*, 42-48.

Rogers, D. I. (2003). High-tide roost choice by coastal waders. *Bulletin-Wader Study Group*, *100*, 73-79.

Rogers, D. I., Piersma, T., & Hassell, C. J. (2006). Roost availability may constrain shorebird distribution: exploring the energetic costs of roosting and disturbance around a tropical bay. *Biological Conservation*, *133*(2), 225-235.

Sharma, R., & Rao, P. (Eds.). (2018). *Environmental impacts of tourism in developing nations*. IGI Global.

Smit, C. J., & Visser, G. J. (1993). Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. *Wader Study Group Bulletin*, *68*(Supplement), 6-19.

Steven, R., Pickering, C., & Castley, J. G. (2011). A review of the impacts of nature based recreation on birds. *Journal of environmental management*, *92*(10), 2287-2294.

Stillman, R. A., West, A. D., Caldow, R. W., & DURELL, S. E. L. V. D. (2007). Predicting the effect of disturbance on coastal birds. *Ibis*, *149*, 73-81.

Trulio, L. A., & Sokale, J. (2008). Foraging shorebird response to trail use around San Francisco Bay. *The Journal of Wildlife Management*, *72*(8), 1775-1780.

Yasué, M., & Dearden, P. (2006). The potential impact of tourism development on habitat availability and productivity of Malaysian plovers Charadrius peronii. *Journal of Applied Ecology*, *43*(5), 978-989.

Appendix

Figure 2: Conservation detection dog survey tracks at Armstrong Beach

Figure 3: Conservation detection dog survey tracks at Blacks Beach and Wetland Walkabout showing Eastern Curlew roost sites and fox dens located.

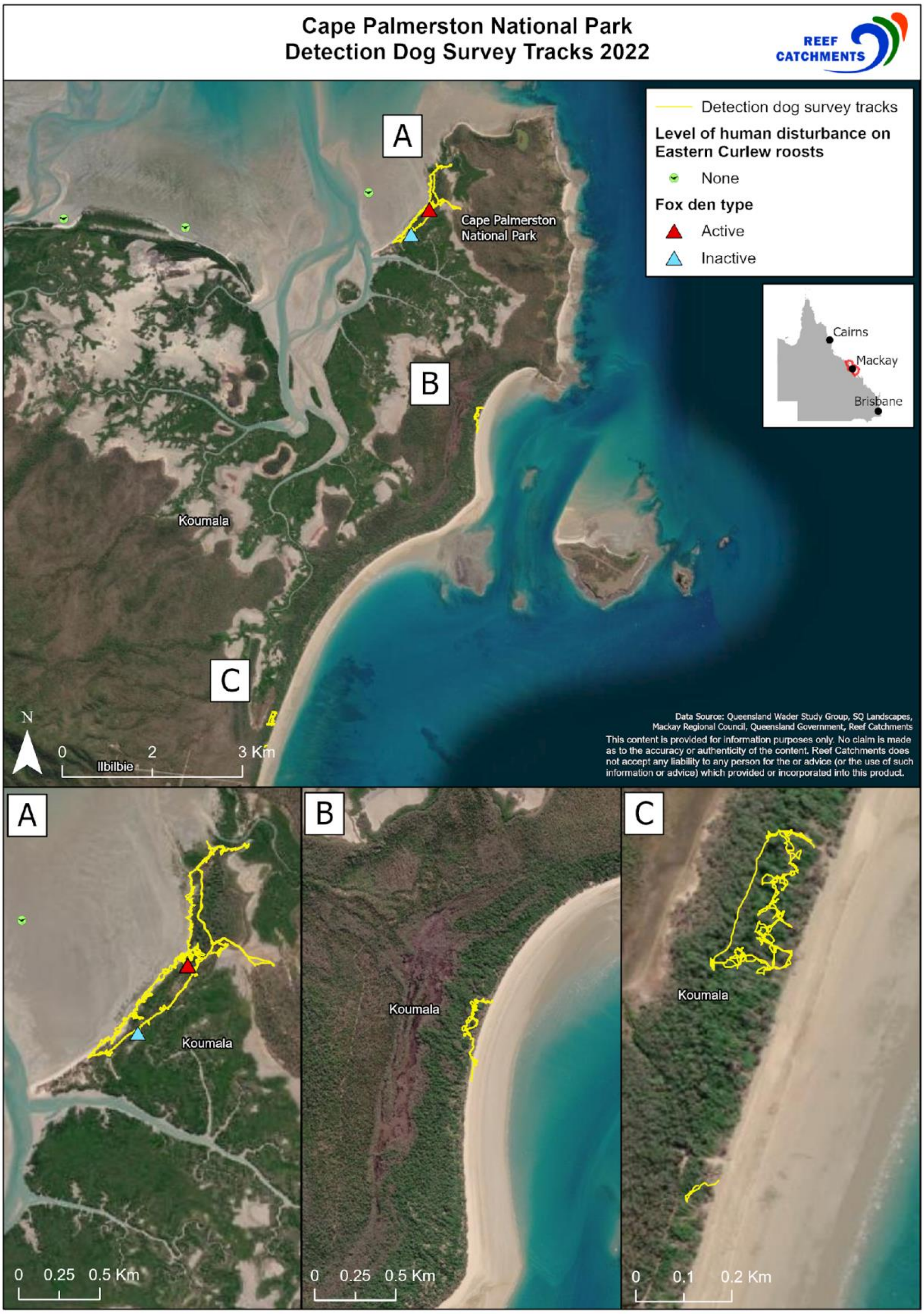

Figure 4: Conservation detection dog survey tracks at Cape Palmerston National Park showing Eastern Curlew roost sites and fox dens located.

Figure 5: Conservation detection dog survey tracks at East Point showing Eastern Curlew roost sites and fox dens located.

Figure 6: Conservation detection dog survey tracks at Hay Point showing fox dens located.

Figure 7: Conservation detection dog survey tracks at Hay Point showing Eastern Curlew roosting sites.

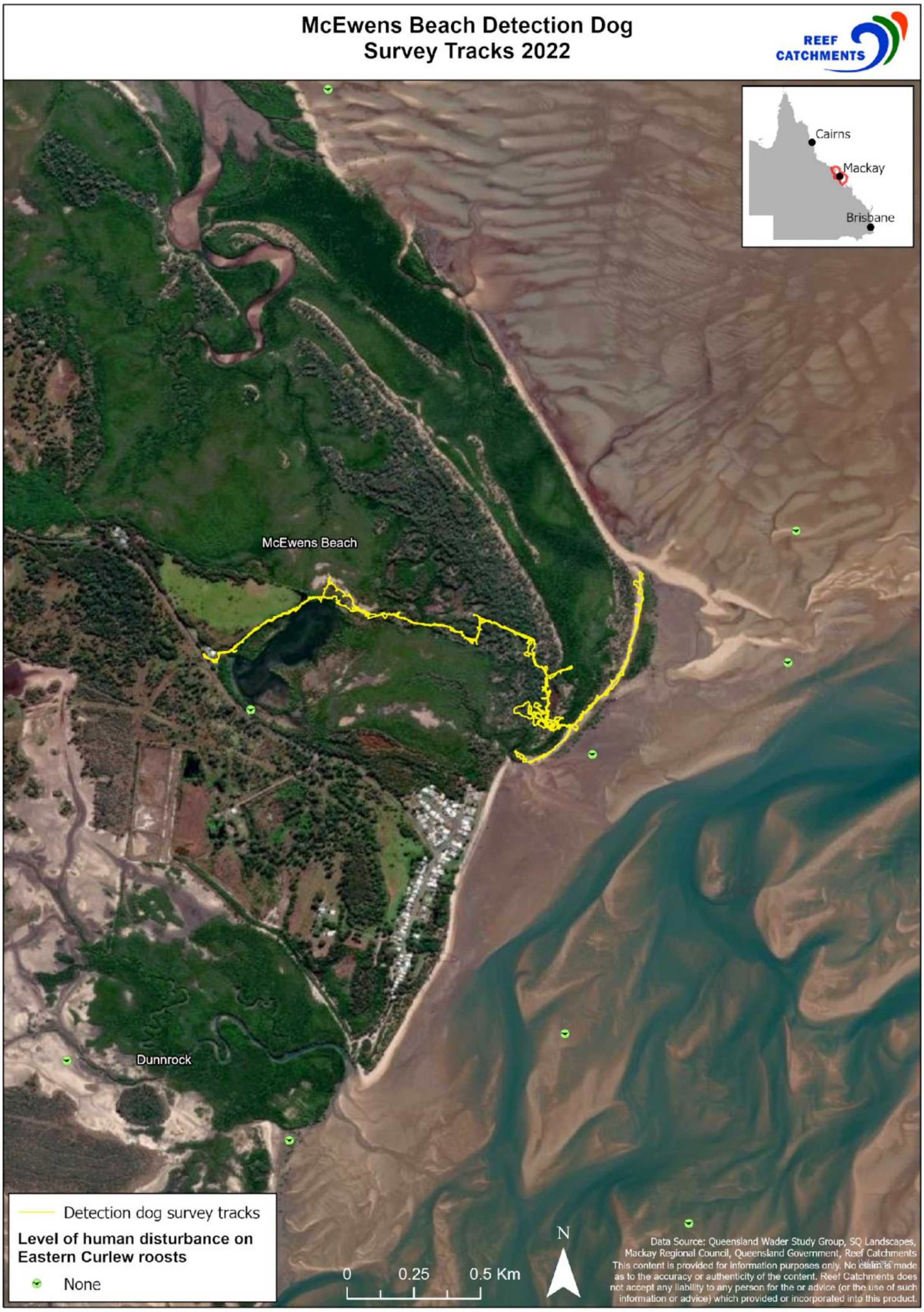

Figure 8: Conservation detection dog survey tracks at Hay Point showing Eastern Curlew roosting sites.

Figure 9: Conservation detection dog survey tracks at Hay Point showing Eastern Curlew roosting sites and fox den sites.

Figure 10: Conservation detection dog survey tracks at Hay Point showing Eastern Curlew roosting sites.

Figure 11: Conservation detection dog survey tracks at Hay Point showing Eastern Curlew roosting sites.