Capricorn yellow chat

Species summary and future directions report

Queensland Government

Prepared by: Threatened Species Operations/Wildlife and Threatened Species Operations, Department of Environment and Science

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Abbreviations

ASL Above sea level

BLA Birdlife Australia

CBA Captive Breeding Agreement

CBP Captive Breeding Program

CQU Central Queensland University

CYC Capricorn Yellow Chat

DAF Department for Agriculture and Fisheries

DAWE Commonwealth Department of Agriculture, Water and Environment

DES Department of Environment and Science

DLGRMA Department of Local Government, Racing and Multicultural Affairs

DoD Department of Defence

DSDMIP Department of State Development, Manufacturing, Infrastructure and Planning

DTMR Department of Transport and Main Roads

FBA Fitzroy Basin Association

GA Greening Australia

HAT Highest Astronomical Tide

QPWS Queensland Parks and Wildlife

SSAA Sporting Shooters Association Australia

STC Scientific Technical Committee

TSO Threatened Species Operations

Summary

The Capricorn yellow chat *Epthianura crocea macgregori* is one of three sub-species of yellow chat *E. crocea*. The Capricorn yellow chat is a small yellow passerine weighing 10-11g that is restricted to the wetlands found on the marine plans north, south-east and east of Rockhampton. There are three distinct sub-populations found in the Broad Sound north of Rockhampton, Fitzroy River delta south-east of Rockhampton and Curtis Island ~40km east of the Fitzroy River delta. Currently the population is approximately 250 (+/- 31), but fluctuations occur depending on seasonal rainfall events.

A previous recovery plan was approved in 2009 and expired in 2014. This species summary and future directions report updates recovery actions based on contemporary knowledge in regard to threats and management actions. While some actions remain relevant to the recovery of the CYC, contemporary research has identified additional threats, while other threats are no longer relevant. The development of this report was developed in consultation with species experts, research agencies, land managers, natural resource management groups, state government agencies, local governments, industry representatives and Non-Government Organisations (NGO) involved in the management of the CYC to update management actions required for the effective management and recovery of the CYC.

The management and conservation of the CYC is complex as it faces multiple threats including sea level rise, climate change (i.e. increased drought, fire hazard, etc.), damage to foraging and breeding habitat from feral animals and high intensity pastoralism, altered hydrological regimes, weed incursions and native and introduced predators.

The recovery actions identified in this report fall into five management streams:

- monitoring of CYC sub-populations and habitat conditions;
- ecological research to further inform recovery and management actions;
- implementation of best practice management actions;
- coordination and
- statutory actions.

Key recovery actions for the CYC include the maintenance of conservative stocking rates by pastoralists, along with further research in this area and appropriate responses to the impacts of climate change, specifically sea level rise and heat waves.

These management actions need to be implemented by various stakeholders.

Introduction

The Capricorn yellow chat (CYC), *Epthianura crocea macgregori*, is one of three sub-species of yellow chat (Schodde & Mason 1999) and is restricted to the low-lying coastal plains in the Rockhampton region (Houston et al. 2013). The CYC is endemic to Queensland and geographically isolated from the Alligator River and central Australian races (Schodde & Mason 1999). The CYC is listed as Endangered under Queensland's *Nature Conservation Act 1992* and Critically Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

A recovery plan has previously been developed for the CYC (Houston & Melzer 2008; http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67090) and was commenced in 2009 but has since expired. Many of the actions in the recovery plan had either been implemented, were no longer relevant or did not reflect contemporary research/knowledge relevant to the conservation of the species. Further, there is no current Conservation Advice available for the species (refer to the Australian Governments Species Profile and Threats Database; http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67090.

Development of future directions report

Following consultation with stakeholders, Threatened Species Operations (TSO), Department of Environment and Science, developed a report to update recovery actions for the CYC. A project plan was developed that identified the objectives of the project and what the project would deliver, which included the:

- Review of the existing National Recovery Plan
- Formation of a CYC working group to inform the management actions and future direction report
- Investigate and recommend options for implementing a standard census of the CYC population

Rather than developing a fully-fledged recovery plan, the project plan identified the development of future directions for the recovery of the CYC by engaging key stakeholders in the management of the species. Key stakeholders involved in the recovery of the CYC were identified and included species experts, research organisations, natural resource management groups, non-Government organisations, Queensland Parks and Wildlife Service (QPWS) and industry representatives.

All stakeholders were invited to attend a one-day workshop in Rockhampton in February 2020. At this workshop the previous recovery plan (Houston & Melzer 2008) and recovery actions were reviewed, contemporary research knowledge and gaps were discussed and relevant research and management actions were identified. The key stakeholders involved in the workshop, the development of this report, along with their interests, are identified in Table 1.

Table 1 List of stakeholders and their interests involved in the CYC workshop

Stakeholder	Interests
Central Queensland University	Species research, species conservation
Fitzroy Basin Association	Species conservation, land manager support
Greening Australia	Species conservation, land manager support
Cheetham Salt	Industry development, species conservation
QPWS Marine Parks	Species conservation
Threatened Species Operations, DES	Species conservation
Birdlife Australia Capricornia	Species conservation, land manager support
Rockhampton Regional Council & Livingstone Shire	Policy management and industry development

The objectives from the existing recovery plan (Houston & Melzer 2008) were reviewed during the development of this document. The objectives for the future directions report were not discussed in detail at the workshop and were developed during the production of this report. Stakeholders were then asked to review these objectives to provide input.

During the workshop with all stakeholders, a detailed review of recovery actions from the existing recovery plan

(Houston & Melzer 2008) was undertaken. Some of these recovery actions in the existing recovery plan were removed because they are no longer relevant, amended as they were partially implemented or updated to reflect contemporary knowledge. Other actions have been added through discussions during the workshop, through further discussions with stakeholders and through the development of this document. This has resulted in detailed recovery actions for the CYC that need to be implemented as well as identifying key stakeholders to implement the actions.

The development of the future directions report included a literature review of the taxonomy, ecological requirements and research priorities for the CYC. This included a review of threats to the CYC and their description, including additional threats identified by contemporary research. Finally, a review of management actions from the existing recovery plan (Houston & Melzer 2008) and contemporary research was undertaken to update and develop management actions for the recovery of the CYC.

Management actions were allocated to one of five management streams, including population and habitat monitoring, research priorities, on-ground management actions, stakeholder engagement and governance. Additionally, key stakeholders to implement or be involved in the implementation of each management action were identified. The cost to deliver these management actions was not calculated.

Following this workshop, TSO developed this future directions report for the CYC, with several follow up discussions with specific stakeholders to clarify some issues.

Background

Historically, four subspecies of yellow chat *E. crocea* have been described (Keast 1958), but today only three are recognised (Schodde & Mason 1999). The CYC is a small passerine weighing 10-11g and has a wingspan of 56-60mm and a bill length of 10.7-11.6mm (Houston et al. 2015). Breeding male birds have a bright yellow crown, an olive back, yellow rump with a 4-6mm wide black bar across its chest (Schodde & Mason 1999). Non-breeding males are similar in colouration, with the black breast bar being reduced or absent (Menkhorst et al. 2017). Breeding females have a yellow crown, grading to an olive back and a golden yellow rump and vent (Schodde & Mason 1999), although there is some conjecture regarding breeding females as they usually don't have a yellow crown (W. Houston pers. comm. 2020). Non-breeding females are similar in appearance, with underparts being generally paler in colour and the throat and chin being white (Menkhorst et al. 2017).

The CYC was first collected in the Rockhampton district in 1859 (Mack 1930), and Torilla Plain in the Broad Sound area north of Rockhampton (Houston & Melzer 2008). "There were no further published sightings over the next 60 years (Blakers et al. 1984) and the species was considered to be either a rare vagrant (Longmore 1978)" (in Houston & Melzer 2008) or possibly extinct (Higgins et al. 2001).

A small sub-population of less than 50 birds was discovered in 1991 in the north-east part of Curtis Island, to the east of the Fitzroy River delta (Arnold et al. 1993). The CYC was subsequently located at three localities on the Torilla Plain (in the Broad Sound) in July 2003 (Jaensch et al. 2004) and at two sites in the Fitzroy River delta, Twelve Mile and Raglan Creeks, in February 2004 (Houston et al. 2004a). Since these discoveries, CYC have been located at additional sites in the Broad Sound and Fitzroy River delta areas, and along with Curtis Island, represent the only extant sub-populations of the CYC (Figure 1) (Houston et al. 2009; Houston et al. 2013; Houston et al. 2018a).

The Broad Sound and Fitzroy River delta sub-populations are separated by approximately 140km, with approximately 40km between the Fitzroy River delta and Curtis Island sub-populations (Houston et al. 2015). These sub-populations occupy and area of approximately 7,000ha (Houston et al. 2015). There is little or no connectivity between these sub-populations with unsuitable habitat consisting of unvegetated salt flats and mangroves with very little samphire or grass-sedge wetlands (Houston et al. 2015).

All subspecies of the yellow chat are predominantly invertivores (Keast 1958; Higgins et al. 2001) and feed within low vegetation in or near channels and basins (Houston & Melzer 2008). Foraging by adult birds is generally on the ground at the base of sedges on bare mud or dry substrates, depending on season, amongst low vegetation such as grass tussocks, samphire vegetation and occasionally shrubs fringing the sedge-beds (Jaensch et al. 2004; Houston et al. 2004b) and rarely in dense para grass *Urochloa mutica* swards (Houston & Melzer 2008). When nesting, adults have been observed foraging around pools and muddy substrates bordering sedge-beds (Houston et al. 2004a; Houston et al. 2020a).

The CYC population is approximately 250 (+/-31) in size across three disjunct sub-populations, with the majority of the population (≥75%) found in the Broad Sound region, while ~22% of the population is found in the Fitzroy River delta and ~3% on Curtis Island (Houston et al. 2018a). However, the number of CYC on Curtis Island has recently increased and may represent 10% of the population, depending on seasonal fluctuations (W. Houston & R. Black pers. comm. 2020). The small population size of these disjunct sub-populations makes them vulnerable to local extinction (Houston et al. 2018b). Furthermore, the movements and dispersal of the CYC are poorly understood

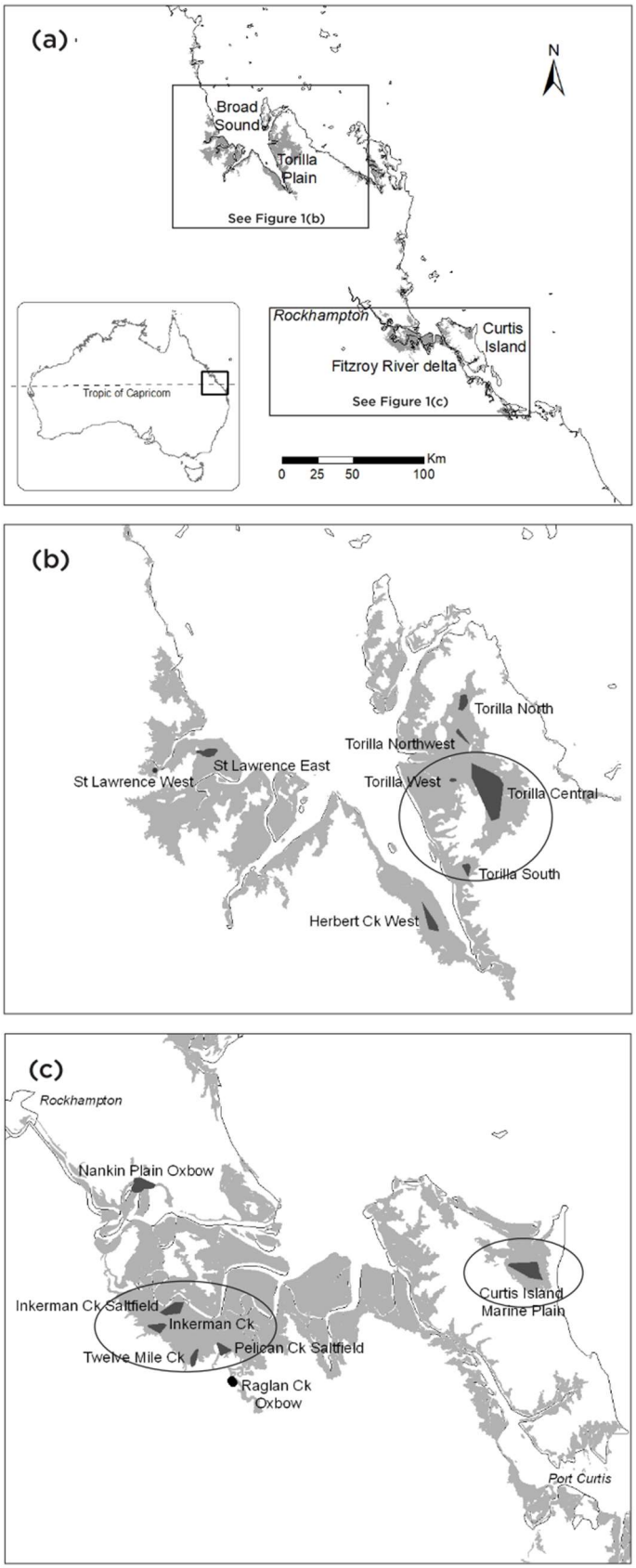

Figure 1(a) Range of the Capricorn Yellow Chat, with known sites shown by dark-grey polygons superimposed on marine plains indicated by pale-grey shading in (b) Broad Sound and (c) Fitzroy River Delta and Curtis Island. Maps sourced from Houston et al. *(2020a).*

and further detailed studies are required (Houston et al. 2018).

Habitat requirements

Habitat requirements of the CYC is dominated by seasonally inundated marine plains (defined as landzone 1 by RE description) inundated by fresh water during the wet season (Houston et al. 2013). CYC occupy marine plains with grass-sedge wetlands with patches of salt-tolerant samphire, creating a more open vegetation structure and are generally not found in adjacent unvegetated salt flats or mangrove dominated vegetation (Houston et al. 2013). CYC are also found in tall supratidal saltmarshes with occasional influence by king tides (Houston et al. 2013). These marine plains receive significant freshwater flows during the wet-season (December-February), before generally drying out (Houston et al. 2013).

The vegetation generally corresponds with RE 11.1.1, 11.1.2b, 11.1.3, 11.3.27 and 12.1.2, with dominant species including, but not limited to, *Cyperus alopecuroides*, *Schoenoplectus subulatus*, interspersed with other species, including *Paspalum distichum, Sporobolus virginicus, Tecticornia pergranulata, Eleocharis dulcis* and *Leptochloa fusca* (Jaensch et al. 2004; Houston et al. 2004a; Houston et al. 2004b; Houston et al. 2013). The marine plains are treeless, except for the bordering areas of mangroves (Houston et al. 2013).

The marine plains provide two important components for CYC habitat being, areas of tall sedge, samphire or grass vegetation (0.4 – 2m in height) for roosting and nesting habitat and sparse grasslands and samphire for foraging (Houston et al. 2004b; Jaensch et al. 2004; Houston et al. 2013). These marine plain wetlands occupied by the CYC are predominantly less than 5m above sea level and either below the estimated the Highest Astronomical Tide (HAT) or within 1.5m (Houston et al. 2013).

Research subsequent to the 2008 recovery plan has found that many sites supporting CYCs are associated with banks that prevent tidal ingress. Banks generally increase the wetland area, extend the hydroperiod and support salt-tolerant sedges such as *Schoenoplectus subulatus* that CYCs use for breeding (Houston et al. 2009; Houston, et al. 2013). Where banks are large such as sea walls or levee banks (Glenprarie and Fitzroy Vale Pastoral Stations), wetlands can be large and support permanent populations of CYCs. In many places, smaller check banks are used and these also create valuable habitat for CYCs (e.g. Torilla Plain supports the largest population of CYCs Houston et al. 2013).

Breeding

Australia's four species of chats (*E. albifrons, E. aurifrons, E. crocea* and *E. tricolor*) have been described as opportunistic breeders following abundant rainfall, with adaptations for nomadism that allow them to exploit Australia's unpredictable environment (Williams 1979). Of these, Williams (1979) regarded the yellow chat (*E. c. crocea*) as having the greatest ability to withstand dry periods, a trait also observed in the CYC (Houston et al. 2018a).

The CYC predominantly breed in spring and summer following rainfall and inundation of the marine plains (Houston 2013), but has been observed breeding in all months except July (Houston et al. 2020a). The CYC has the ability to breed more than once per year and has been found to return to the same sites to breed (Houston et al. 2020a). Rainfall, and subsequent freshwater inundation of the marine plains trigger food production and the subsequent cue for the CYC to breed, while the timing and level of inundation may vary between sites, which influences insect abundance (Houston 2013; Houston et al. 2020a). Presence of dependent young were found to coincide with peaks in abundance of invertebrates (Houston 2013). Breeding success has been shown to be influenced by wet-season rainfall in the preceding year, with the timing and volume of rainfall events also influencing breeding success (Houston et al. 2018a).

The CYC nests close to the ground in grasses, samphire or sedges between 35 – 120 cm off the ground, with high levels of vegetative cover within 1-metre of the nest (Houston et al. 2020a). Nests are generally spaced between 50 – 100 metres, but clusters of nests have been observed (Houston et al. 2020a). Nest failure has been observed due to inundation for extended periods of time from extreme tidal events (Houston et al. 2020a).

Critical breeding sites for the CYC are the marine plains, dominated by grass-sedge swamps and samphire (Houston et al. 2020a). In general, breeding habitat of CYCs is confined to wetlands associated with depressions or flats of marine plains dominated by sedges, semi-aquatic grasses or samphire, some of which are saltmarshes with occasional tidal influence (Houston et al. 2020a). The most important habitat types supporting breeding were sedgelands dominated by either *Schoenoplectus subulatus, Cyperus alopecuroides* or *Eleocharis dulcis;* tall tussock grasslands of marine couch, and samphire shrublands of *Tecticornia pergranulata.* Para grass and *Paspalum disctichum* bordering sedge-lined channels or pools also provide valuable breeding habitat.

The clutch size of CYC ranges from two to three eggs, but may be greater as adults have been observed feeding in groups of up to four fledged young (Jaensch et al. 2004; Houston et al. 2004a; Houston et al. 2004b).

The incubation period of other species of Australian chats (*E. albifrons, E. aurifrons* and *E. tricolor*) is between 13-14 days (Williams 1979). Nestlings remain in the nest for a further 14-15 days, where, after emerging, remain near it for a further two days before moving away with the parents to link up with other birds to form loose flocks (Williams 1979). Mixed flocks of adult, immature, intermediate CYCs have been observed 4-5 months post-breeding (Houston et al. 2020a). Adult chats continue to feed juveniles for an undetermined period of time and successful reproduction likely occupies adult birds for at least five weeks (Williams 1979). Breeding patterns of the CYC is thought to be similar to other species of Australian chats.

Foraging

When breeding, the CYC has been observed foraging on muddy substrates around the edges of channels and pools for semi-aquatic prey at the base of sedges and samphire (Houston et al. 2020a). Adult chats have been observed feeding on a variety of insects including flies, caterpillars of moths and butterflies, spiders, grasshoppers, damsel flies, winged ants, cockroaches and beetles (Houston et al. 2020a).

Habitat critical to the survival of the species

All habitat occupied by the CYC during breeding and non-breeding cycles are critical to the survival of the species.

Habitat critical to the survival of the CYC (the marine plains described above), are sedgelands (dominated by *Schoenoplectus subulatus, Cyperus alopecuroides, Eleocharis dulcis*), mid-tall dense tussock grasslands (marine couch), and samphire shrublands (*Tecticornia pergranulata*) that are greater than 40cm in height (Houston et al. 2020a) on seasonally inundated marine plains in the:

- Broad Sound (Torilla Plains – Torilla Central, North, North West, West, South; St. Lawrence East & West, Waverley Plain, Glenprarie Pastoral Station);
- Fitzroy River delta (Inkerman, Twelve Mile Creeks and Raglan Creek Oxbow, Inkerman Creek and Pelican Creek saltfields, Fitzroy Vale Pastoral Station and an Unspecified location); and
- Curtis Island Marine Plain (Houston et al. 2013, Houston et al. 2018a; Houston pers.com 2020).

These marine plains have shallow channels and depressions with a mosaic of dense sedge-beds, grasslands, tall samphire and areas of mud and/or shallow water (Houston et al. 2004b; Jaensch et al. 2004).

Currently, the Broad Sound provides the most critical habitat to the survival of the CYC as it supports ~ 75 percent of the known population, with ~22% of the population found in the Fitzroy River delta and ~3% found on Curtis Island (Houston et al. 2018a).

Critical areas of breeding habitat for the CYC include:

- Torilla Central in the Broad Sound
- Glenprarie in western Broad Sound
- Twelve Mile Creek, Nankin Creek Oxbow (Fitzroy Vale Pastoral Station) and Inkerman Creek on the Fitzroy River delta
- Curtis Island Marine Plain (Houston et al. 2018a).

Biology and ecology relevant to threats

An important attribute of CYC habitat is the high degree of complexity of habitat types on the marine plains. The CYC is dependent on marine plain wetlands subject to periods of inundation of saltwater during king tides and seasonal freshwater flows during the wet season (Houston et al. 2013). Thus, climatic factors that influence temporal or amounts of rainfall or tidal movements and actions that alter the hydrology of these marine plains, are likely to influence the breeding cues and success of the CYC, which in turn affect the long term survival of the CYC.

The decline in habitat condition and decline of tall plant cover due to sea level rise and tidal influence on marine plains, has resulted in a significant decrease in CYC sightings on the Curtis Island marine plain (Houston et al. 2020b). However, incremental increases in sea level may facilitate the successional replacement of tall plant cover (Houston et al. 2020b).

Adults tending both non-fledged active young and fledged young forage near tall sedges in close proximity to abundant food resources (muddy edges of these sedge-beds and/or sedge seed heads) (Houston et al. 2004b; Houston et al. 2020a). The combination of protective cover and abundant food resources appears to be an important component of optimal breeding habitat (Houston et al. 2004b).

Threats to Capricorn yellow chat

Sea level rise, along with damage to roosting and breeding habitat activities provide the greatest threat to the persistence and recovery of the CYC and are described in detail below.

Hydrological regimes of marine plains

The productivity of marine plain wetlands is highly dependent on periodical freshwater and tidal in flows. Interruption to the hydrological regimes will affect the vegetation structure and productivity of this habitat on which the CYC is dependent.

Upstream land-uses that reduce freshwater surface in-flows and/or sheet overland flows will influence the natural flooding processes of the marine plain. This will influence habitat quality and reduce productivity of insect diversity and abundance required by the CYC, which will in-turn reduce breeding and the long-term survival of the species.

Both dams and ponded pasture banks established for agricultural purposes may contribute to this problem by reducing the quantity of freshwater reaching breeding habitats on marine plains. Ponded pasture banks are used extensively in this region to establish wetlands for ponded pasture grasses in order to increase productivity of the land for pastoralism. The creation of large dams on important catchments associated with the Torilla Plain breeding habitat, such as Wardallah Creek, could have serious consequences for CYC persistence.

Any construction activities on marine plains supporting CYCs need careful consideration as these can impede freshwater flows and affect downstream wetlands. Examples of potential disturbance include embankments associated with roads or pipelines that act as barriers. Pipelines that cross creeks supporting CYCs could also interfere with hydrology and associated downstream flows.

Levee banks cause a discontinuity between the upper and lower marine plain and have the capacity to cause extensive pooling of freshwater, increasing the hydroperiod, as well as preventing tidal inflows. As these banks prevent the movement of fish between freshwater, estuarine and marine habitats, the *Ponded Pastures Policy 2001* was introduced to prevent the construction of new banks below the HAT. Existing levee banks should be maintained as they provide suitable habitat for the CYC, while the construction of new levee banks is not recommended. Conversely, small check banks in channels, located at the extent of tidal incursion, do not provide a significant barrier to freshwater flows (Houston et al. 2009; Houston et al. 2013). The strategic placement of banks causes an increased hydroperiod, which has the potential to enhance low quality habitat used by CYC for foraging, which have been found breeding in association with check banks (Houston et al. 2009; Houston et al. 2013).

Damage to roosting and breeding habitat

Feral Pigs

Where feral pig S*us scrofa* numbers are very high, they can cause extensive damage to CYC habitat by uprooting sedges and associated grasslands of the marine plain wetlands on which the CYC is dependent for shelter and foraging (Houston & Melzer 2008). Feral pigs are present at all three localities where the CYC occurs although their population size varies between locations.

Historically, feral pigs have been at high densities on Curtis Island (J. Hodgon pers. comm 2020) and have caused extensive damage to the marine plains on Curtis Island (Houston & Melzer 2008). A feral pig management program by QPWS and supported by the Sporting Shooters Association Australia (SSAA), has resulted in feral pig numbers significantly declining on Curtis Island (J. Hodgon pers. comm 2020). However, there are problems with re-invasion and on-going management is required (J. Hodgon pers. comm 2020). Impacts by feral pigs at other sites has been minimal to date (Houston & Melzer 2008) but does occur.

On the Torilla Plain, landowners regularly undertake feral pig management when conditions are permitting (W. Houston pers. comm. 2020). The Fitzroy Basin Association (FBA) has also funded and supported the coordination of feral pig management programs on the Torilla Plain and neighbouring land owned and managed by the Department of Defence (DoD) for several years. Funding to continue and expand this program (to the western Broad Sound), is currently being sought by the FBA through external sources (S. van Nunen pers. comm 2020).

Eradication of feral pigs is unlikely and coordinated feral pig management programs, undertaken by landowners, is required to reduce damage caused by feral pigs.

Pastoralism

Like feral pigs, pastoralism also causes damage to CYC habitat. However, unlike feral pigs, there is the ability to manipulate stocking rates and timing through rotation of grazing/resting paddocks, which provides benefits for

pastoralism and the conservation of the CYC. The grazing of the marine plains by domestic stock results in the trampling and grazing of sedges and grasses and damages CYC habitat. Where stocking rates are high, grazing coincides with breeding and paddocks are not rested, significant damage can be caused to CYC habitat by pastoralism.

On Curtis Island the exclusion of pastoralism from the marine plain in recent years has resulted in dramatic changes to the vegetation. The common reed (*Phragmites australis*) was not recorded before cattle were removed, but has established multiple patches, 20-50 metres in size, suggesting that new growth was suppressed by grazing (R. Black pers. comm 2020). These patches provide a series of refuge islands of tall cover for CYC moving between wetlands, when they are most vulnerable to attack by birds of prey (R. Black pers. comm. 2020). Similar observations have been made on the Torilla Plain in paddocks that have been rested for extended periods or that are not generally grazed (W. Houston pers. comm. 2020).

The exclusion of pastoralism on Curtis Island has also resulted in a slower increase in clump size of *Tecticornia pergranulata*, which previously only grew to clumps approximately 30x 30cm, but is now growing in clumps to 120 x 50 cm. This is likely due to the removal of grazing (R. Black pers. comm. 2020).

However, pastoralists that have been involved in the conservation of the CYC must be acknowledged for their use of conservative stocking rates that are compatible with maintaining CYC habitat (Houston et al. 2013; W. Houston et al. 2020a). This indicates that pastoralism, the primary land use in the Broad Sound area, is compatible with CYC conservation, under specific grazing regimes. Grazing regimes that involve conservative stocking rates and maintains vegetation above 40 cm (Houston et al. 2020a), is likely to result in favourable habitat for CYC (Houston & Melzer 2008) as well as provide benefits for pastoralists.

Introduced plant species

The establishment of pasture grasses on the marine plain wetlands will displace native sedges and grasses, which form the habitat of the CYC. Throughout the region, the marine plains have been substantially altered by introduced pasture grasses (particularly para grass), which are now a dominant component of the marine plain vegetation on the Torilla Plain (Houston & Melzer 2008). Para grass also occurs within the north-western arm of the marine plain on Curtis Island, but not in the area occupied by yellow chats within the conservation park (Houston & Melzer 2008). Based on comparisons with vegetation patterns elsewhere on the Torilla Plain and Curtis Island, para grass appears to have replaced the native water couch (Houston & Melzer 2008). However, it appears that para grass has not had a significant impact on the CYC, as the central Torilla Plain supports the greatest numbers of CYC (Houston & Melzer 2008). Further research is needed to fully assess the impact of pasture grasses to CYC habitat.

Several other exotic pasture species, regarded as environmental weeds, because of their capacity to become established in wetlands, occur at sites where the CYC is found. [1]Olive hymenachne *Hymenachne amplexicaulis* occurs in a single Melaleuca swamp on the marine plain at Curtis Island, and aleman grass *Echinochloa polystachya* occurs in basins on the Torilla Plains (Houston & Melzer 2008). However, olive hymenachne is unlikely to become a problem in CYC habitat due to its low salinity tolerance. Most sites where CYCs breed, whilst inundated by freshwater in the wet season, become brackish to hypersaline as they dry (Houston et al. 2013; Houston et al. 2018a). Aleman grass may pose a greater risk to CYC habitat and may have the capacity to displace *Cyperus alopecuroides*, the dominant sedge within freshwater-influenced secondary channels and edges of main channels (Houston & Melzer 2008).

The removal of cattle grazing from areas of CYC habitat may have detrimental effects where exotic pasture grasses have been established and is likely to result in the increased biomass of pasture grasses and displacement of native species with significant impacts to CYC habitat. Where exotic pasture grasses and CYC habitat occurs, pastoralism (at an appropriate intensity) is likely to be beneficial to the conservation of CYC habitat. Further research is required to determine appropriate grazing regimes and understand the relationship between cattle grazing and CYC habitat conservation, along with the development of extension material to improve the management of CYC habitat by pastoralists.

Harrisia cactus *Harrisia martinii* was found to invade CYC breeding habitat at specific locations, preventing access by land managers and reducing pastoral productivity (Houston & Elder 2019). Early attempts to control it using

[1] *Hymenachne acutigluma* or Hymenachne is a native species that occurs from Sarina (~180km north of Torilla Plains) and extends further northward. This species has not been recorded south of Sarina, but has the potential to be recorded. Hymenachne is not a weed species, but Olive hymenachne is.

chemicals resulted in death of the associated samphire vegetation (Houston pers. Comm 2020), *Tectocornia pergranulata*, used by CYCs for nesting (Houston et al. 2020a). The suppression of Harrisia cactus using a biocontrol, Harrisia mealybug *Hypogeococcus festerianus*, has been successful and should be applied where necessary (Houston & Elder 2019).

On Glenprarie Pastoral Station (DoD property) prickly acacia *Vachellia nilotica* has increased significantly since 2006 from a few scattered trees to being widespread across the marine plain and along the braided channels (R. Black pers. comm. 2020). Prickly acacia forms dense small trees from which birds of prey (i.e. brown goshawk, collared sparrow hawk and other species) are able to launch attacks. The treeless marine plains offer little protection to the CYC from these ambush predators and the control of any weedy tree growth (i.e. prickly acacia) is required to protect CYC populations.

Rubber vine *Cryptostegia grandiflora* may be a threat to CYC habitat, but further research is required to determine its impacts on CYC and its habitat.

Habitat Loss

Industrial expansion within the Fitzroy River delta associated with the development/expansion of industry (i.e. salt fields) and infrastructure (i.e. port development or pipeline construction) may occur. Such industrial expansion has the potential to result in the direct loss of CYC habitat through vegetation clearing to facilitate these developments.

At Twelve Mile Creek, lease holdings of an existing salt field contains some CYC breeding habitat (Houston & Melzer 2008). This area consists of saltmarsh and braided channels and lies at the upper extent of the leases, and outside of the current area of industrial operations (Houston & Melzer 2008). Any expansion of the operations at the salt fields into this area may have a substantial impact on this important breeding site.

There are no known industrial development or expansion plans on the Torilla Plain or Curtis Island, although economic deposits of shale oil have been found near the Torilla Plain.

Sea level rise / climate change

For a species to be vulnerable to climate change a species must have some level of exposure (i.e. the extent to which climate change will be experienced by a species) and be sensitive to the effects of climate change (i.e. severity impact from climate change) (Franklin & Garnett 2014). Sea-level rise due to anthropogenic climate change is a potential threat to birds that are dependent on coastal saltmarshes and mangroves (Franklin et al. 2014) and with part of the CYC life strategy dependent on saltmarshes, and to a lesser extent mangroves, (Houston et al. 2013) the species is vulnerable to climate change.

Modelling of Australian avifauna that are subject to sea-level rise from climate change was identified as inconsistent, with each species modelled subjectively based on the natural adaptation to geomorphology due to sea-level rise and interaction with human impacts that are likely to disrupt adaptation (Franklin et al. 2014). This process identified the CYC exposure to climate change was Low, while the sensitivity of the CYC to Climate Change was considered Very High (Garnett & Franklin 2014).

As the CYC occupies a very narrow niche on the marine plains of central Queensland, the species is highly susceptible to sea-level rise due to anthropogenic climate change with the majority of the CYC habitat less than 5m ASL (Houston et al. 2020b). The decline of CYC habitat quality on Curtis Island due to sea-level rise has been documented over a 16 year period, where Mean Sea-Level (MSL) was observed to have risen by ~80mm, with yearly increases in MSL corresponding with global increases (Houston et al. 2020b). This sea-level rise results in the loss of hydrophilic tall plant cover and reduced habitat quality for the CYC and by mid-century some marine plains in central Queensland are unlikely to be able to provide suitable habitat to sustain populations of the CYC (Houston et al. 2020b). The populations of CYC on Curtis Island and the Fitzroy River delta are considered to be most at risk to the impact of sea-level rise (Houston et al. 2020b).

Similarly, climate change scenarios predict an increased likelihood of extreme weather events, including heat waves, droughts, wild fires, cyclones, floods and storm surges (Franklin et al. 2014), all of which can impact on CYC habitat and survival (Houston et al. 2020b). During heatwaves, CYC have been observed perching in elevated positions (e.g. fences), gaping and lifting their wings to permit airflow to the flanks and back (Houston et al. 2020b). With predicted increases in duration of heatwaves, CYC tolerance may be exceeded (Houston et al. 2020b). Rainfall unpredictability and wet season failure are a feature of CYC habitat and with an increase in drought severity, the capacity of the system to support CYC habitat may be exceeded (Houston et al. 2020b).

Wildfires

Due to their location, the marine plains are generally naturally protected from wildfire, due to the associated flows

of freshwater and tidal flows (DNPRSR 2013). However, fuel loads can increase due the establishment of pasture grasses and areas of the marine plain that are not actively grazed may be susceptible to wildfires, particularly during catastrophic fire conditions. While the vegetation communities of the marine plains are resilient to fire (DNPRSR 2013), a fire in areas of CYC habitat could be catastrophic for a sub-population and the burning of CYC habitat is not recommended under any circumstances. Further, pasture grasses, particularly para grass, have the potential to increase fuel loads and fire risk to the marine plains, increasing the risk of wildfire to CYC habitat (Houston et al. 2013).

Areas of vegetation surrounding CYC habitat that are not actively grazed need to be monitored closely to determine if fuel reduction is required to protect CYC habitat. Fuel reduction may be undertaken in various ways, including prescribed burns, short-term high intensity grazing or mechanical reduction and will depend on site specific issues. The monitoring of fuel loads for the risk of wildfire is more relevant for CYC habitat on Curtis Island National Park, which is not grazed and may experience high fuel loads. However, wildfires in the Broad Sound region and Fitzroy River delta cannot be ruled out and fuel loads need to be monitored in surrounding CYC habitat.

Pastoralists on the Torilla Plain are concerned that wildfire would result in a loss of important forage species such as para grass on the marine plains and actively manage their properties to prevent wildfire. This has benefits for the CYC as it reduces the potential for wildfire to impact CYC habitat.

Other threats

Houston & Melzer (2008) identified several additional potential threats to CYC, but their impacts are poorly understood. These include:

1. increased groundwater salinisation from ground water extraction and salt mining activities which may cause consequential change in vegetation composition and structure;
2. siltation of existing channels as a result of current management regimes (grazing, clearing in catchment, changes in flow regime) or industrial expansion;
3. unmanaged public access/uncontrolled ecotourism and trampling of sedges and disturbance to birds;
4. prolonged floods, impacting on breeding success;
5. predation by feral animals including cats. Feral cats are present at both Torilla Plain and Curtis Island and represent a potential threat. The threat of other predators, wild dogs and foxes, has also been identified.

These threats are briefly discussed below.

Increased soil salinity

Ground water extraction from aquifers and industrial scale saltpans are likely to increase soil salinity levels on localised and regional scales. This has the potential to impact CYC habitat in the immediate vicinity, and other locations in the landscape. This is highly dependent on local geology and groundwater levels and movement. The timeframe of which this process is likely to operate is unknown and this impact has not been quantified.

Siltation of channels

The siltation of channels in waterways is a natural process which will change through time due to influences including rainfall and changes in sea level. This is exacerbated by anthropogenic actions associated with land clearing, industrial development and pastoralism. The identification of key channels that maintain water flows to and from the marine plain is required to determine if the flow of water is being impeded in the region and would be best undertaken as a regional monitoring program.

Uncontrolled access

There are plans to improve visitor access to Curtis Island National Park, which could increase public access to the marine plains and CYC habitat. Any increase in public access, particularly by bird watchers, has the potential to disturb CYC habitat. Access to other areas of CYC habitat is unlikely as the populations are on private property.

Prolonged floods

If levee banks are constructed on the marine plains and impede the flow of water or there are prolonged periods of rainfall (or a combination of), the marine plains will experience prolonged periods of inundation. Increased periods of inundation by freshwater, will affect CYC habitat as the vegetation requires wet and dry periods to survive.

Feral predators

Feral cats, foxes *Vulpes vulpes* and wild dogs/dingos *Canis lupus* are a potential threat to the CYC.

In north-eastern Australia feral cats have been shown to have a preference for birds that weigh between 10-50g (Kutt 2012), which suggests their impact may not be significant on the CYC as it weighs at the lower end of this spectrum. In central Australia, feral cats have been identified predating birds to a much greater extent than foxes or dingos, with temporal variation observed (Paltridge 2002). In regards to wild dogs/dingoes, they were found to predominantly consume medium sized Macropods in north eastern Australia (Brook & Kutt 2011).

Significant impacts from these species cannot be eliminated and requires further research. Additionally, there may be interactions between these species (i.e. meso-predator release), where the management of one predator may increase predation by another species. However, predation levels are likely to vary on regional scales and requires further research to determine the impact of these predators on CYC populations.

Other predators cannot be discounted and include native species of snakes, including pythons and elapids, as well as several species birds of prey. Major (1991) identified avian and reptilian predators as the most likely cause of predation of white-fronted chats nests. The impact of these native species on CYC populations is unknown and efforts to mitigate their impact should not be undertaken until such time that their impacts have been quantified. Australian Hobbies have been observed attacking CYCs on Curtis Island, which may explain why population growth appears limited, even after good breeding events (R. Black pers.comm. 2020). These attacks were launched from the tree line on the edge of the marine plain from distances of up to 750 metres, with the flight directly to the site where CYCs were perched on tall grasses, indicating a targeted attack. This demonstrates the need to control woody weeds on the edge of the marine plain.

Current threats to sub-populations

All sub-populations of the CYC are under threat from one or more of the threats identified above. The threat for each sub-population has been identified in Table 2.

Table 2 Current threats and their level of impact to CYC sub-populations

Threat	Broad Sound	Fitzroy River delta	Curtis Island
Hydrological regimes	Freshwater & levee banks, large dams	Freshwater & Tidal	Tidal
Damage to breeding & roosting habitat	Feral Pigs Pastoralism*	Feral Pigs Pastoralism*	Feral pigs and feral horses
Introduced plant species	Introduced pasture grasses and prickly acacia	Introduced pasture grasses, rubber vine, Harrisia cactus	Introduced pasture grasses
Habitat loss from industrial development	Potential	Potential	Unlikely
Sea level rise	Moderate (some sites are more vulnerable)	High	High
Climate change (drought, floods, heat waves, fire threat etc)	High	High	High
Wildfires	Low	Low	Medium
Increased soil salinity	Unlikely	Possibly	Unlikely occurring in core habitat
Uncontrolled access	Absent	Absent	Potential
Prolonged floods	Potential		
Feral predators	Present	Present	Present

*Currently the Broad Sound and Fitzroy River delta are under conservative stocking regimes

Only one population, Curtis Island, is formally protected in the state/national reserve system in Curtis Island National Park, while the sub-populations in the Broad Sound region and Fitzroy River delta are found on a mix of

free hold and lease hold land. Due to the compatibility between CYC conservation and appropriate grazing regimes, the protection of further CYC habitat in the reserve system is not required at this time. However, this may change in the future if landholder or land management practices were to change.

Despite being in a protected area, the Curtis Island population is threatened by sea level rise from climate change, feral animals (feral pigs and horses), weed invasion and wildfire from the surrounding landscape. Further industrial development of Curtis Island is unlikely and feral predators are present.

The sub-population of the Fitzroy River delta are threatened by altered hydrological regimes from industry, habitat loss due to industrial expansion, weed establishment (particularly pasture grasses and other species), feral pigs and inappropriate grazing regimes. However, pastoralists in this area are interested in actively managing CYC habitat but require further support to do so. Due to industrial development and pastoralism in the surrounding landscape, the threat of wildfire is reduced but cannot be eliminated during catastrophic weather conditions and feral predators are present.

The Broad Sound populations of CYC are threatened by changes to hydrological regimes primarily from upstream industrial and pastoral developments such as dams on the main catchments that supply freshwater to the marine plains supporting CYC habitats, the construction of levee banks (i.e. road access), establishment of pasture grasses and prickly acacia and feral pigs. While these locations are grazed, stocking rates are compatible with the conservation of CYC and also provides benefit through the reduction of biomass of para grass. Current stocking rates are strongly encouraged to be maintained as any changes could have significant impacts on CYC habitats and the overall population. Pastoralists require on-going support to manage CYC habitat in this region. The threat of wildfire is reduced due to pastoralism in the region but cannot be eliminated during catastrophic weather conditions. Sea level rise due to climate change is not believed to be a significant threat at this time but may increase in the future.

Recovery actions for the CYC

Recovery actions for the CYC have been split into five different management streams, with the objective of each management stream detailed in Table 3. These objectives will be achieved through the recovery actions identified in Table 3, with more specific details provided below. Actions have been prioritised using colour coding, with green being highest priority actions, followed by orange and red. These priorities are indicative only as there are not dedicated funds for CYC recovery. Actions will be implemented when funding is available or relevant stakeholders have the capacity to implement the action (i.e. QPWS prepare fire management guidelines).

The long-term benefit of these actions will see the sub-populations of the CYC maintained at their current levels in their known locations.

While the knowledge regarding the CYC habitat and ecological requirements are relatively well known (Houston et al. 2013; Houston et al. 2004b) requirements relating to dispersal triggers, habitat requirements when dispersing, drought and flood refuge habitat is limited. Consequently, recovery actions based on existing knowledge should take a precautionary approach and consider these unquantified factors and how these may influence the species recovery.

Table 3 Summary of recovery actions identifying where they need to occur and their priority

Recovery Action	Broad Sound	Fitzroy River delta	Curtis Island	Administration
Habitat and population monitoring and surveys **Objective:** Undertake population and habitat monitoring to identity trends in the CYC population and changes to habitat condition.				
1.1 Monitoring population and trends	✓	✓	✓	
1.2 Surveys for new populations	✓	✓		
1.3 Habitat mapping	✓	✓	✓	
1.4 Habitat condition monitoring	✓	✓	✓	
Ecological research **Objective**: Research the ecology of the CYC to better inform and guide management.				
2.1 Genetics, demographics and dispersal	✓	✓	✓	
2.2 Impact of mammalian predators	✓	✓	✓	
2.3 Relationship between para grass and CYC	✓	✓		
2.4 LiDAR Mapping	✓	✓		
2.5 Publish outcomes of research				✓
Management actions **Objective:** Secure existing sub-populations through implementation of management actions				
3.1 Maintain hydrological regimes	✓	✓	✓	
3.2 Feral pig management	✓	✓	✓	
3.3 Conservative grazing of CYC habitat	✓	✓		
3.4 Fire management	✓		✓	
3.5 Weed management	✓	✓	✓	
3.6 Sea level rise/Climate change	✓	✓	✓	
3.7 Investigate intervention & ex-situ management options for the CYC				✓
Coordination and stakeholder engagement **Objective:** Key stakeholders are aware of statutory requirements and engaged in CYC management and recovery				
4.1 Establish CYC working group				✓
4.2 Development of land management manual	✓	✓		
4.3 Department of Defence Consultation, (Glenprarie)	✓			✓
4.4 Inform development assessment agencies about updated conservation advice				✓
4.5 Consultation with DAF on aquaculture development				✓
4.6 Review of actions by stakeholders				✓

Statutory requirements **Objective:** Species nomination is submitted to the Species Technical Committee				
5.1 Develop species nomination and submit to the Species Technical Committee				✓

Priority ratings - Green – High, Orange – Medium and Red – Low

Note: priority ratings are indicative only and will be subject to funding availability for each action

Population monitoring and surveys

Monitor CYC sub-populations, trends and habitat condition

Action 1.1: Continue population monitoring and trend of CYC using established population survey methodology

Performance criterion: Each sub-population monitored annually or bi-annually

Background, justification and methods

Between 2004-2010, the average population size of the CYC was identified to be 251 +/- 31 with the majority of the population on the Torilla Plain (75%), and ~23% of the population on the Fitzroy River Delta and ~3% of the population on Curtis Island (Houston et al. 2018a). This data was collected during a period of wet and dry years and is considered a benchmark for the population size of the CYC (Houston et al. 2018a). This is of particular importance as population size can vary significantly between wet and dry years (Houston et al. 2018a). Small populations are vulnerable to the effects of inbreeding, which is further complicated by the fragmented and fluctuating nature of CYC populations (Houston et al. 2018b).

The on-going annual monitoring of CYC sub-populations is essential to determine the long-term trend of the population and if intervention is required should long-term population declines be observed. Survey methodology should follow that of Houston et al. (2018a). Additionally, acoustic monitoring devices should be deployed at areas where new populations may be detected, with follow up visual surveys if CYC are detected acoustically.

Further population surveys will inform the CYC population size and long-term trend. The collection of population data from all known sites either annually or bi-annually, will facilitate the calculation of long-term population numbers, trends and status. This will also inform if sub-populations require greater intervention to ensure the long-term conservation of each sub-population. Population surveys using existing methodologies (see Houston et al. 2018a) need to be followed.

Potential contributors: Researchers (CQU), TSO, Birds Australia and affiliations, FBA

Surveys for new populations

Action 1.2: Undertake surveys for new populations

Performance criterion: Acoustic recorders deployed at strategic locations and times to locate new populations or document important habitat for the movement of CYC in the landscape

Background, justification and methods

The location of the majority of CYC populations are known, but there could be small populations or important pockets of CYC habitat within the marine plain that are currently not documented. Additionally, some of these small pockets of habitat may be essential for the movement of the CYC in the landscape at specific times of the year. Rather than survey these areas physically for CYC, acoustic recorders should be deployed outside of the breeding season. Acoustic monitors have the advantage of being deployed in the field for extended periods with the data analysed using voice recognition software at a later time. This will assist with identifying new populations or seasonal use of habitat currently unknown to be utilised.

Acoustic recorders should be deployed outside of the breeding season to detect breeding activity at previously unknown locations and/or the movement of CYC from breeding sites to dry season refuges. Acoustic recorders should be deployed in areas of suitable habitat, particularly in the following Regional Ecosystems, 11.1.2b, 11.1.3, 11.1.1, 11.3.27 (targeting subcategories 11.3.27x1a, 11.3.27x1b and 11.3.27x1c as these have a saline influence). Surveys in 11.1.3 and 12.1.2 require surveys to be undertaken in areas of marine couch with a taller (~40cm tall) hummock structure. All areas of potential habitat are on private land and require consultation with the landowners/managers before undertaking surveys. If CYC are detected at any sites of potential habitat, follow up surveys will be required to confirm their presence.

Potential contributors: CQU, FBA, QPWS

Habitat mapping

Action 1.3 Undertake finer scale (1:25,000 or greater) RE mapping to define RE 11.1.2b (saltmarsh) and 11.2.1a (salt flat) and define narrow bands of 11.1.3

Performance criterion: Fine resolution mapping of the marine plains available

Background, justification and methods

The CYC shows a seasonal pattern of habitat use, using flooded saltmarsh and grass-sedge wetland breeding habitats during the wet season and dry season refuges of the upper marine plain during dry periods (Houston et al. 2018a). Despite extensive marine plains present in the area, only small fragments are suitable as CYC habitat. However, the majority of the breeding and non-breeding habitat utilised by the CYC has been identified (Houston et al. 2018a). Further, during the dry season, only five sites have been identified where the CYC persist (Houston et al. 2018a). Mapping of breeding and non-breeding habitat is essential to monitor habitat condition and any changes through time to determine if habitat changes are occurring and the likely cause of any changes in habitat condition.

Where the impact of development is being assessed, the monitoring of CYC habitat should be monitored a year (or more) before any development works are undertaken.

Within the current REs of the marine plains, further essential habitat of tall supratidal salt marsh maybe identified through fine scale RE mapping. Fine scale RE mapping of this habitat will greatly improve areas to target for CYC surveys and population monitoring, improve habitat monitoring of essential CYC habitat and improve management outcomes for the CYC.

Potential contributors: FBA, TSO, QPWS

Habitat condition monitoring

Action 1.4 Habitat condition monitoring

Performance criterion: Rapid assessment technique for assessing habitat condition developed and is used annually/bi-annually to monitor habitat condition

Background, justification and methods

The monitoring of CYC habitat is essential as it is highly vulnerable to variations in hydrology. The development of a methodology using LiDAR to monitor critical breeding and dry season refuge habitats of CYC will benefit the species by monitoring changes in condition and extent through time and will be used to inform future management of the marine plains. The location of critical breeding and dry season refuge habitats are known and a project to develop a habitat condition monitoring methodology using LiDAR, in conjunction with some ground-truthing of condition, will be beneficial in monitoring CYC habitat changes through time.

Potential contributors: FBA, QPWS, CQU, TSO

Ecological Research

Research genetics, demographics and dispersal of CYC

Action 2.1 CYC Ecological research including genetic structure, demographics and dispersal of the CYC

Performance criterion: Research of the genetic structure, demographics and dispersal of the CYC undertaken and incorporated into management actions.

Background, justification and methods

Increasing the knowledge of the ecology of threatened species is essential to their management and recovery of threatened species (Houston et al. 2020a). Understanding the relationship between the CYC sub-populations, their breeding success, survival rates and longevity is essential to the recovery of the CYC.

Previous genetic research of the CYC (Houston et al. 2018b) has found restricted gene flow between sub-populations from the Torilla Plain and southern Fitzroy River Delta. Genetic samples of CYC were only collected from one location each (Houston et al. 2018b) and this sampling effort, particularly from the Torilla Plain which supports ~73% of the CYC population (Houston et al. 2018a), requires further assessment. Additionally, CYC from Curtis Island also needs to be included in this assessment as they have not previously been assessed (Houston et al. 2018b).

This genetic research of CYC populations has been partially funded by Birds Australia, although additional funds

are required to sample all sub-populations.

The collection of genetic samples from the CYC provides the opportunity to band captured individuals to gain a better understanding of the demographics, breeding, survival rates and dispersal of the CYC. This demographic study is strongly linked to the productivity of critical habitats and resource abundance essential to the CYC survival.

The banding of CYC will also allow for a population index of CYC population abundance to be calibrated against mark-recapture data (Action 1.1).

Potential contributors: Universities (i.e. CQU), Birds Australia, QPWS, TSO

Research impact of mammalian predators on CYC

Action 2.2: Undertake research into the impact to CYC populations caused by predators specifically feral cats, foxes and wild dogs

Performance criteria: Research program undertaken to quantify the impact of feral cats, foxes and wild dogs to CYC populations

Background, justification and methods

The fox *Vulpes vulpes*, feral cat *Felis catus* and wild dog *Canis lupus* are well documented predators of Australian wildlife, including birds (Paltridge 2002; Woinarski et al. 2017, 2018; Doherty et al. 2015). The impact of these mammalian predators on CYC populations is largely unknown and the impact of one or more of these species could be significant. Increased knowledge of the impacts these predators will provide a better understanding of these predators on the population dynamics of the CYC and identify if additional management actions are required. The relationship between these predators also needs to be considered.

Birds Australia has undertaken some feral cat monitoring in the area.

Potential contributors: Universities (i.e. CQU), QPWS, BA

Research relationship between pastoralism and CYC

Action 2.3: Relationship between pastoralism, particularly pasture grasses and watering points, and the CYC

Performance criteria: The value of pastoralism, pasture grasses and watering points, to the conservation of the CYC, is determined

Background, justification and methods

The marine plains provide highly productive grazing opportunities for pastoral enterprises, with most of the sites that contain CYC habitat on the Torilla Plain and some sites of the Fitzroy River delta, subject to pastoralism. Pasture grasses of interest include para grass and aleman grass. Like all grazing habitats, the marine plains are susceptible to overgrazing if overstocking occurs.

The conservation and grazing of CYC habitat are not mutually exclusive. Significant areas of the CYC habitat have historically been subject to ponded pastures and the cessation of grazing is likely to result in increased density of pasture grasses, reducing areas of ground based foraging habitats and result in detrimental impacts on the conservation of the CYC (Houston et al. 2018a).

The conservation of CYC habitat is a delicate balance between maintaining suitable stocking rates such that CYC habitats are not over grazed and that grazing is not eliminated.

The threat to CYC habitat by pasture grasses, has been identified and has been recommended to be managed by appropriate grazing regimes to limit their spread (Jaensch et al. 2004). Pasture grasses can become established in areas of CYC habitat reducing the abundance and quality of habitat for the CYC. Para grass is viewed as a weed species from a conservation perspective, while pastoralists view it as a desirable pasture species. However, while the CYC appears to avoid areas of dense para grass, it has been observed foraging in areas adjacent to, and in, grazed para grass (Houston & Melzer 2008), which may provide tall cover for the CYC (Houston et al. 2013) and nesting habitat (Houston et al. 2020a). Due to the abundance of pasture grasses, the eradication of these species is not feasible. There is evidence that indicates co-benefits between pastoralism and CYC conservation, with the grazing of pasture grasses identified as an efficient method of CYC habitat management. This requires further research to determine if cattle grazing of pasture grasses, i.e. para grass and aleman grass, is an effective management tool in areas where the CYC co-exists with pastoralism.

On the Torilla Plain, which has the highest numbers of CYC (~73% of the population) para grass is common and subject to pastoralism (Houston et al. 2018a). Further, para grass may provide cover for the CYC and actually enhance habitat complexity (Houston et al. 2013). The presence of the largest CYC population in areas of para grass, suggests that if the density/biomass of para grass is managed appropriately through grazing that there could

be increased benefits for the CYC and pastoralists.

This research should also explore the economic benefits between pastoralism and CYC conservation to demonstrate the value of primary production to the conservation of threatened species.

Currently, stocking rates on the marine plains in areas of CYC habitat are conservative and strong relationships have been established between conservationists, researchers and pastoralists. For the conservation of the CYC and its habitat the maintenance of these relationships and conservative stocking rates are essential. The development of a research project that manipulates grazing pressure in areas of CYC habitat to manage density of pasture grasses to improve CYC habitat will be beneficial for the management of CYC habitat and pastoralists.

Additionally, watering points on pastoral properties may enhance habitat for the CYC (Houston et al. 2018a), despite it being believed that the CYC may be able to achieve its metabolic water requirements through its diet (Houston 2013). During heatwaves, which will become more prevalent due to climate change (Franklin et al. 2014), flocks of CYCs have been observed near semi-/permanent water sites (Houston et al. 2020a) and water points may be used by CYC to cool themselves. The relationship between stock watering points, CYC and heatwaves should be investigated as part of this project. However, this may be difficult as it is not possible to predict heatwaves, particularly in the context of a research project.

Potential contributors: Universities (i.e. CQU), TSO, pastoralists, Greening Australia, Capricorn Catchments, FBA

Undertake LiDAR mapping of CYC habitat

Action 2.4: Undertake LiDAR mapping of CYC habitat to identify areas at risk of sea level rise

Performance criteria: Research project undertaken to identify priority areas to install banks to protect and improve CYC habitat

Background, justification and methods

CYC habitat is vulnerable to the effects of sea level rise and the installation of banks will protect and improve CYC habitat by increasing the hydroperiod of these areas. Contour mapping of the marine plain using LiDAR has been undertaken on Curtis Island to identify CYC habitat that is vulnerable to the effects of sea level rise. This is being used by QPWS to identify suitable locations to install banks to maintain or improve CYC habitat. However, the remaining areas of CYC habitat has not been undertaken and is required to identify CYC habitat that is vulnerable to sea level rise and identify where the construction of new banks would be most effective.

Potential contributors: Universities (i.e. CQU), TSO, pastoralists, QPWS, Greening Australia, Capricorn Catchments, FBA

Publish outcomes of research and monitoring

Action 2.5: Publish results from research/monitoring programs in technical reports and papers

Performance criteria: Results from research is published in journals or technical reports to inform management

Background, justification and methods

There are several specific research/monitoring projects that have been identified in this future directions report that have been recommended to improve the knowledge, management and recovery of the CYC. To promote the results from this research/monitoring, the sharing of results from these projects is essential to demonstrate that this work is being undertaken and resulting in prescriptive management and recovery actions for the CYC. This will increase awareness of the recovery efforts for the CYC in not only in the scientific community, but also in the broader community and potentially attract further funds for the management and recovery of the CYC. All research/monitoring projects will be expected to publish results in journals for publications.

Potential contributors: Research agencies, QPWS, TSO, FBA, GA

Management actions

Maintenance of hydrological regimes

Action 3.1: Maintain freshwater inflows and tidal flows to the marine plain

Performance criteria: Development activities upstream of CYC habitat do not impact flows into the marine plains

Background, justification and methods

The maintenance of the current hydrological regime, including freshwater and, where appropriate, tidal inflows, of the marine plains is essential to the maintenance of the CYC habitat and population. The habitat requirements of

the marine plains required by the CYC are subject to periodic freshwater inundation from wet season rains and occasional salt-water inundation from Highest Astronomical Tides (HAT). This regime is essential to maintain the habitats critical to the survival of the CYC.

Any alteration to freshwater flows in catchments that support CYC habitat may affect the timing and extent of inundation required for the breeding of the CYC and their survival during the dry season. Any such alteration of flows may result in widespread pooling of water, a reduction in inflows, influence the timing of inflows and reduce the complex channel system, all of which affects CYC habitat. This will in turn affect the breeding and non-breeding habitats required by the CYC.

Such impacts may be caused by the construction of weirs, water harvesting, road infrastructure or the construction of levee banks for industrial expansion (i.e. salt fields, coal mines), dams for increased water security, pastoralism or recreational activities (i.e. access roads to boat ramps). Any impact assessment must not only consider the effect on the hydrological system (i.e. reduced/increased rate of flow, timing of flows), but the effect that this alteration may have on CYC habitats.

While pastoralism is identified as a potential impact to CYC habitat through ponded pasture development, this threat has been reduced through the *Ponded Pastures Policy 2001*, which prevents the building of levee banks below the HAT, in or adjacent to natural wetlands or located in areas away from areas of high conservation or fish habitat values. Further, the policy indicates that ponded pastures should only proceed in areas where proponents can demonstrate there will be minimal or acceptable environmental impacts. This policy does not affect existing structures that influence freshwater or saltwater inflows and as such, existing structures on the marine plains continue to be a threat to the CYC and the habitats they utilise.

As the CYC is listed as Endangered under the NCA and Critically Endangered under the EPBC Act, any proposed development that may affect the species, including hydrological regimes, is required to undertake an assessment of impacts against the CYC. Similarly, there are triggers under local planning schemes that require consideration to the impact of proposed developments to the CYC. The most effective way of protecting the hydrological regime that is critical to maintaining CYC habitat is through developing detailed Conservation Advice and impact assessment guidelines for the CYC as well as identifying essential habitat. Additionally, undertaking extension work with assessment agencies (i.e. local, state and Commonwealth governments) (discussed below) to increase their awareness of impacts to the CYC and its habitat will ensure any proposed developments will be assessed rigorously against the Conservation Advice and assessment guidelines. This will remove or minimise impacts to CYC habitat associated with development.

Tidal inflows of the marine plains are essential in some habitats (e.g. supratidal saltmarsh) to maintain the CYC habitat requirements for breeding, foraging and drought refuge. However, sea level rise due to the effects of climate change have severely affected some CYC habitat, particularly the southern sub-populations, with modelling suggesting most areas will be unsuitable for CYC by 2050 (Houston et al. 2020b). The construction of earthen banks to protect these areas of CYC habitat is required and needs to be informed by a research project to identify where banks would be most effective. Consultation with DAF is required to ensure that the construction of any banks is not in conflict with the *Ponded Pastures Policy 2001*.

Potential contributors: Research agencies (i.e. CQU), TFS, FBA, DAF, QPWS

Feral pig management

Action 3.2: Integrate feral pig management for each sub-population by landowners/managers (see specific Curtis island section)

Performance criteria: Feral pig numbers are maintained at low levels such that their impacts to CYC are minimal

Background, justification and methods

Feral pigs are a recognised threat to the CYC as they uproot and destroy critical breeding and non-breeding habitat (Houston & Melzer 2008). Feral pigs are present at all three sites where sub-populations of the CYC exists (Houston & Melzer 2008).

Historically feral pig numbers have been very high on Curtis Island. However, recent control efforts by QPWS have seen the population reduced significantly with population numbers maintained at low levels (Houston et al. 2020b). Feral pig control is ongoing on Curtis Island and QPWS aim to suppress this population.

The Torilla Plain and Fitzroy River delta are not immune from the impact of feral pigs, with a significant feral pig populations present. Coordinated feral pig control programs will not only benefit the CYC, but individual landowners are likely to benefit from reduced damage to pastures.

Torilla Plains

Feral pigs are common across the Torilla Plains. There are nine landowners across the Torilla Plains and the

coordination of feral pig control measures by these landowners will be required to effectively reduce feral pig numbers. The eradication of feral pigs from the Torilla Plains is not a viable option as continual re-invasion will occur from the surrounding landscape. An on-going control program will be required to reduce their long-term impacts on CYC habitats. The coordination of a feral pig control program in this region is required to be undertaken by a NRM group with close links to landowners and the broader community.

There is no existing data on the feral pig populations on the Torilla Plain and this will be difficult to quantify without significant investment. Before a coordinated feral pig control program is implemented, a vegetation monitoring program should be established to determine CYC habitat condition. Following the implementation of a feral pig control program, the numbers of feral pigs controlled, including gender and age (juvenile/adult) where possible, should be recorded. This will contribute to monitoring the success of the feral pig management program in the area through time and inform future management programs.

Fitzroy River delta

Populations of CYC on the Fitzroy River Delta include the areas around Inkerman and Twelve Mile Creek. Feral pig numbers in this area have not been quantified but are assumed to be present in reasonably large numbers given the suitability of habitat in the region. Quantifying the impact of feral pigs on CYC habitat in the Fitzroy River delta will be required before feral pig control programs are undertaken. Greening Australia, in conjunction with Capricornia Catchments, is working with landowners with CYC habitat in the Fitzroy River delta and are able to assist landowners with feral pig monitoring and any subsequent control program in the area.

Feral pig control programs will need to comply with the relevant Local Government Authorities Biosecurity Plan and will need to be coordinated between landowners. Before a coordinated feral pig control program is implemented, a vegetation monitoring program should be established to determine CYC habitat condition. Following the implementation of a feral pig control program, the numbers of feral pigs controlled, including gender and age (juvenile/adult) where possible, should be recorded. This will contribute to monitoring the success of the feral pig management program in the area through time and inform future management programs.

Curtis Island

Feral pigs have historically been in high numbers on Curtis Island, with populations of feral horses and feral cattle also present (J. Hodgon pers. com 2020). QPWS, with the assistance from the Sporting Shooters Association of Australia (SSAA), has invested heavily in the removal of feral pigs and their impacts on Curtis Island are now considered negligible. While feral pig numbers are low, QPWS and SSAA will continue to undertake a control program with the aim to maintain a low population on Curtis Island as continued reinvasion from the mainland is likely (J. Hodgon pers. com 2020). A small population of feral horses *Equus ferus* and feral cattle *Bos taurus* are also present and will be managed. QPWS has the responsibility to control feral animals on Curtis Island.

Potential contributors: FBA, Greening Australia, QPWS, Birds Australia

Conservative stocking rates in areas of CYC habitat

Action 3.3: Grazing of CYC habitat to improve its condition (see 2.3)

Performance criterion: Grazing practices that are favourable to maintain CYC habitat condition and pastoralism are identified and broadly implemented by landowners/managers where applicable

Background, justification and methods

Historically, the marine plains have been subject to the establishment of ponded pasture grasses to establish pastures for the pastoral industry. Since the development of the *Ponded Pastures Policy 2001*, this pastoral development activity has essentially ceased on the marine plains, although pastoralism still occurs in the region. These ponded pastures have left a legacy in that while they are beneficial for the pastoral industry, they are potentially detrimental to CYC habitat if they are not grazed appropriately. However, the extent to which these pasture grasses are detrimental is not clear as the Torilla Plains is actively grazed with extensive para grass pastures and has the largest population of CYC (~73% of the total population). This suggests that the CYC is able to co-exist with pasture grasses provided that pasture grass density is managed by appropriate grazing intensity.

The role of grazing/pastoralism in improving/degrading CYC habitat is poorly understood. However, the grazing of marine plains by pastoralists using conservative stocking rates that allow periodic resting of CYC habitat is likely to be mutually beneficial for pastoralists and the conservation of the CYC. Rotational stocking rates utilise high density stocking rates for short periods of time to target pasture grasses and reducing stocking rates when the biomass has been reduced. This provides native plant species the ability to grow with less competition from pasture grasses and also allows the pasture grasses to recover before being grazed again later in the season. By strategically grazing pastures to avoid breeding periods and drought periods, CYC habitat will be protected during critical periods of their life cycle, while also providing a valuable resource for pastoralists.

Guidelines for rotational grazing regimes have not been developed and need to be developed in close consultation

through research and with individual pastoralists. The development of rotational stocking regimes requires CYC habitat monitoring to be undertaken, while working closely with pastoralists to manipulate grazing periods and stocking rates to determine the optimal regime for CYC and pastoralists.

The fencing of CYC habitat on the Torilla Plain and Fitzroy River delta provides the opportunity to establish and maintain conservative stocking rates in these areas. A project on Twelve Mile Creek has been initiated (in 2020) to fence CYC habitat, and support conservative stocking rates, on pastoral properties. Additional funding is required to support these actions on Twelve Mile Creek, and other areas where CYC habitat can be found, into the future.

Potential contributors: Researchers, FBA, Pastoralists, Greening Australia, Capricornia Catchments

Fire Management

Action 3.4: Improve fire management strategies to protect the marine plain from catastrophic fires based on findings from Curtis Island program

Performance criterion: Fire management strategies to protect the marine plains from catastrophic fire developed for Curtis Island are applied to other areas of CYC habitat (where applicable)

Background, justification and methods

Due to the location of CYC habitat on the marine plains, this habitat is not naturally subject to a specific fire regime (DNPRSR 2013). Some plant species on the marine plains are tolerant of the impacts of fire, but do not require fire to regenerate (DNPRSR 2013). However, fire may carry into the marine plains from the surrounding vegetation (DNPRSR 2013), which may be exacerbated during extreme or catastrophic weather conditions, and impact CYC habitat. Additionally, introduced pasture grasses, such as para grass, increase fuel loads in or adjacent to areas of CYC habitat (Houston et al. 2013) and fire severity (DNPRSR 2013), potentially causing significant impacts to CYC habitat.

Fire should be excluded from the marine plains and areas of CYC habitat, as the loss of areas of CYC habitat due to fire could be catastrophic for the conservation of the species. CYC habitat should be protected from the impacts of fire by burning areas of adjacent vegetation under controlled conditions. This should be undertaken during periods when the marine plains are inundated (i.e. high tides, freshwater flooding) to prevent fire impacting CYC habitat.

On private and lease hold land, in areas where para grass and other pasture grasses dominate CYC habitat, there is likely to be some benefit from grazing these areas by cattle to reduce the biomass present and protect these areas from the impact of wildfire. The existing relationships between NRM staff, researchers and graziers must be maintained, with current stocking rates not altered to maintain the CYC habitat and current pastoral enterprises (Houston et al. 2013). The use of controlled burns on properties that are pastoral enterprises is not required as this action removes desirable pastures. However, the regular maintenance of firebreaks on these properties is required, along with limiting access to the marine plains during dangerous fire weather. The use of fire as a management action should only be used around areas established for conservation purposes to ensure other land uses are not impacted by this management action.

The land use on Glenprairie Station is transitioning from a grazing enterprise to a Defence Training Area and the de-stocking of Glenprairie Station will result in increased fuel loads. The likelihood of fire ignition on Glenprairie Station will be significantly higher due to Defence training activities and this transition from grazing to Defence training activities will see a significant increase in risk to CYC habitat from fire. Mitigation measures including the construction and maintenance of adequate fire breaks will be required to protect critical CYC habitat.

Burning regimes for vegetation communities adjacent to the marine plains, specifically on Curtis Island, need to be developed to protect CYC habitat from the impact of catastrophic fire. The aim is to reduce fuel loads on the vegetation surrounding the plains, while not affecting CYC habitat.

Potential contributors: QPWS

Weed management

Action 3.5: Undertake weed management at all sites to mitigate the impacts of weeds

Performance criteria: All land managers are undertaking weed management actions to minimise the impacts of weeds to CYC habitat

Background, justification and methods

The introduction of non-native species has the potential to impact on CYC habitat. The marine plains are generally hostile places for most plant species due to high levels of salinity and prolonged periods of inundation, making them less susceptible to weeds than other habitats. However, ponded pastures alter the hydrological regime to

create a suitable environment for pasture grasses to grow and weed control needs to focus on species that directly impact on CYC habitat or impact their survival. Currently, weed species of concern include pasture grasses outside of pastoral properties in the Broad Sound area (i.e. para grass and aleman grass), Harissia cactus (Fitzroy River delta) and prickly acacia (Glenprarie Pastoral Station). Rubber vine is also a concern, but its impact to CYC habitat is unclear.

The most efficient way of addressing this issue is the development of weed management plans for properties/sites that have CYC habitat. These weed management plans would identify target weed species, strategies for management of each species on the property, management techniques including the use of appropriate herbicides or biocontrol agents (if applicable) and funding available to support landowners with weed management. Any weed management programs need to consider the existing land use, as this action will not be consistent with working pastoral stations and will need to be tailored accordingly.

Potential contributors: Property owners/managers, CC, GA, FBA, QPWS

Mitigating the effects of sea level rise

Action 3.6: Construction of protective earthen banks around areas of CYC habitat

Performance criteria: Earthen banks of small stature are constructed on the marine plain at strategic locations to protect CYC habitat

Background, justification and methods

Climate change and the associated effects of sea level rise have been described by (Houston et al. 2020b). The effects of sea level rise are likely to be more significant for the sub-populations of CYC on Curtis Island and the Fitzroy River delta and are likely to result in the inundation of CYC habitat by saltwater by mid-century (Houston et al. 2020b). Sea level rise will cause increased tidal influence, inundating areas of vegetation or changing salinity levels and impacting CYC habitat (Houston et al. 2020b).

If sea level rise is gradual, successional changes in vegetation is likely to see the replacement of freshwater vegetation in suitable areas, providing suitable habitat for the CYC, with the natural rate of sedimentation of the marine plain facilitating the replacement of suitable CYC habitat. (Houston et al. 2020b). However, there is a large amount of uncertainty with sedimentation rates, which will influence the movement and establishment of vegetation and CYC habitat on the marine plains (Houston et al. 2020b).

The population of CYC on the Fitzroy River delta and Curtis Island are generally less than 2m above sea level (ASL) making ~25% of the population susceptible to the effects of sea level rise from climate change (Houston et al. 2020b). Due to the uncertainty of sedimentation and the presence of CYC these areas should be protected from sea level rise rather than waiting to see if natural processes result in suitable CYC habitat.

The most effective way to protect CYC habitat in the area is to prevent or reduce seawater encroachment into the upper marine plain, through the construction of small earthen banks that are up to 50m in length and less than 2m in height at strategic locations (Houston et al. 2020b). Banks of these nature prevent salt water inundation, promote sedimentation and prolong periods of freshwater inundation, without disrupting freshwater and tidal flows across the whole marine plain and will protect CYC habitat (Houston et al. 2020b).

The location of earthen banks needs to be informed by LiDAR mapping (Houston et al. 2020b), which has been undertaken for the Curtis Island population, and is required for Broad Sound and Fitzroy River delta sub-populations. This action will need to be linked to research outcomes to ensure any banks are placed in appropriate locations and do not impact on existing land uses. Consultation with DAF is likely to be required as the construction of earthen banks may be in conflict with the *Ponded Pastures Policy 2001*.

Potential contributors: All

Investigate in-situ and ex-situ population management options for the CYC

Action 3.7: Investigate in-situ and ex-situ population management options including establishment of new or supplementation of existing CYC sub-populations using captive bred animals or translocated animals and the creation of an insurance population

Performance criteria: Appropriate actions and triggers to intervene in the management of CYC populations are identified

Background, justification and methods

The three sub-populations of CYC are small, with the largest sub-population, Broad Sound, containing 74.5% of the total population (Houston et al. 2018a) . During periods of drought, significant population declines in the Broad Sound have been observed (Houston et al. 2018a). Such significant fluctuation in population sizes across the

species' distribution, with on-going active threats, indicate that management actions to manipulate sub-populations may be required. These actions include the establishment of new or supplementation of existing CYC sub-populations using captive bred animals or translocated animals and the creation of an insurance population using a captive bred population (CBP).

Such actions are a line of last resort to prevent the species/sub-populations extinction (IUCN/SSC 2014). However, a threatened species may not benefit from such actions for a variety of reasons (refer to Snyder et al. 1996) and careful consideration is required before individuals are taken from the wild for the purpose of translocations, population supplementation or establishment of a CBP (McCleery et al. 2014).

These actions were not discussed at the workshop. However, an investigation into these recovery actions, along with all other considerations, has been identified to determine if or what actions may be appropriate. This investigation should also identify thresholds to determine when planning for such interference begins and the trigger for the action to occur.

Potential contributors: All

Coordination

Establish a CYC working group

Action 4.1: Establish and maintain a CYC working group to coordinate recovery actions

Performance Criteria: CYC working group is established, has formal governance processes and meets regularly to coordinate recovery actions

Background, justification and methods

Since the CYC rediscovery, the recovery of the CYC has been largely lead by one dedicated individual, with the coordination of recovery actions identified as being reliant on a single champion (Holmes et al. 2017). A formal team needs to be established to better support the CYC champion and share the responsibility of coordinating recovery actions, share learnings, secure funding to deliver actions and disseminate information to improve outcomes for the conservation of the species. A workshop was convened by DES in February 2020 that brought together a variety of stakeholders to identify current threats impacting the CYC and actions required to mitigate them. However, this group has not been formally established.

Once a group is formally established, other issues relating to the governance of the group (i.e. representation, Terms of Reference etc) can be resolved at the initial meetings of the working group.

Potential contributors: TSO, QPWS, CQU, Greening Australia, Fitzroy Basin Association, Birds Australia, Industry representatives, Capricornia Catchments

Develop land management manual

Action 4.2: Develop a land management manual to support landowners/managers in the management of CYC habitat

Performance criteria: A land management booklet is developed to assist landowners with the management of CYC habitat on their properties

Background, justification, Methods

The majority of CYC habitat and sub-populations are found on private or lease hold land and the conservation of the CYC is not the primary action for these land managers. The development of land management manual will highlight the importance of CYC conservation and identify how through appropriate management, pastoralism and industry can work with conservation organisations to deliver mutually beneficial outcomes.

A land management booklet should include, but not be limited to the following:

- CYC background
- Threats to the CYC
- Management actions
- Examples of best practice management to landowners and CYC

The development of such material will assist with the development of relationships with landowners/managers and identify how through appropriate management, the CYC habitat and populations will benefit without affecting current land management strategies. This has been funded by Greening Australia, with Birdlife Australia

undertaking the work.

Potential contributors: Greening Australia, Birdlife Australia

Department of Defence consultation (Glenprarie Station)

Action 4.3: Develop relationships with relevant staff from the Department of Defence (DoD) responsible for the management of Glenprarie section of the Shoalwater Bay Training Area.

Performance criteria: Appropriate DoD personnel identified, and regular correspondence established to discuss CYC conservation and management

Background, justification, methods

The DoD has recently purchased a pastoral station, Glenprarie, in the Broad Sound region that is adjacent to the existing Shoalwater Bay Training Area. CYC habitat can be found on Glenprarie Pastoral Station, which will continue to be grazed until 2022. After this time, it is unclear how the DoD plan to use this property.

All activities on Commonwealth land are required to comply with Commonwealth legislation, meaning the DoD need to consider the requirements of the EPBC Act in their operations. While some activities on Commonwealth land are also subject to various State legislation. Measures to protect the CYC populations and habitat from Defence Activities need to be discussed with the DoD.

Consultation with DoD staff that are responsible for the day to day management of the Shoalwater Bay Training Area is required to be established and where possible, management actions that are relevant to the Broad Sound and Glenprarie Station should be implemented.

Further, as a stakeholder involved in land management for the CYC, an DoD representative could be invited to join the proposed CYC working group (discussed below), to ensure their management actions are complimentary to CYC conservation and the actions being undertaken by other stakeholders.

The involvement of the DoD in the management of the CYC is essential as the CYC population on Glenprarie will be an important in the future due to sea level rise associated with climate change (R. Black pers. comm. 2020).

Potential contributors: TSO

Inform development assessment agencies about updated Conservation Advice

Action 4.4: Consult with relevant Commonwealth, State and Local government agencies and other stakeholders to ensure the recovery and management actions are incorporated into Commonwealth, State and Local Government planning and assessment processes, NRM strategies and water allocation plans.

Performance criteria: Impacts to CYC from expansion or development of industrial activities is reduced

Background, justification and methods

Various industrial developments within the Capricorn Coast region in which the CYC is found, are subject to potential development. Within the Fitzroy River Delta, there are multiple leases associated with salt fields and their expansion has the potential to impact CYC habitat. Additionally, there is a proposed coal mine which may impact flows along the Styx River, while Curtis Island has recently been developed as part of a LNG development. Other potential developments include the construction of levee banks in tidally influenced areas to maintain existing or develop new infrastructure (i.e. roads).

Depending on the scale of the proposed development, it may require approval from all, or some, of the regulators (Commonwealth, State and Local Government), responsible for the assessment of Environmental Impact Statements or other similar documents.

Similarly, several regional strategies need to be consulted in this process to ensure that the CYC is considered in a regional planning context. This will include consultation with NRM bodies and water management agencies.

By identifying the location of CYC populations, associated habitat, impacts to the population and habitat and appropriate mitigation actions, through consultation with relevant statutory bodies and other stakeholders, the impacts associated with development to the CYC, may be eliminated or appropriately minimised.

The development of Conservation Advice that reflects the actions in this report for the CYC is essential to highlight the sensitivity of the CYC to developments that may impact the marine plains of the region.

Consultation with several government departments (DES, DNRME, DSDMIP, DLGRMA, DTMR, DAWE) will be required, along with relevant Local Government Authorities.

Potential contributors: FBA, TSO

Consultation with DAF on Aquaculture development

Action 4.5: Develop relationships with DAF staff involved in aquaculture development to raise awareness of CYC conservation for this emerging industry

Performance criteria: Relationships established and CYC conservation is considered in industry development

Background, justification and methods

The Department of Agriculture and Fisheries (DAF) has been investigating aquaculture opportunities in the Capricornia region. The development of aquaculture will potentially impact the marine plains and CYC habitat by various mechanisms, including changes to hydrological regimes and CYC habitat loss. There may also be opportunities to develop programs that are compatible between aquaculture and CYC conservation (i.e. construction of small earthen banks to limit the impact of sea level rise). Further consultation with DAF is required to ensure that CYC habitat is protected through the development of aquaculture and that any programs are compatible with CYC conservation.

Responsibility: TSO, FBA

Review of actions

Action 4.6: Regular review of research and recovery actions

Performance criteria: Working group reviews the status, progress and effectiveness of research projects, recovery actions and working group in achieving the objectives of the future directions report

Background, justification and methods

The effective operation of the working group is essential to the recovery of the CYC. Existing activities are likely to operate effectively as these aspects of the project have momentum. Other activities may require considerable support and input by stakeholders before they achieve their intended objectives. The establishment of a working group, that critically reviews the implementation and delivery of the actions identified in this report, as well as the regular review of these actions is essential to the delivery of research and recovery actions.

During the establishment phase of the working group, the group should meet every 3 – 4 months, moving to regular 6-month meetings. To reduce time commitment and travel expenses, virtual meetings should be conducted to maximise funding available for the delivery of research projects and management actions. This would include an annual report on the actions implemented and identification of changes to the recovery actions identified in this future directions report. Management actions identified in this report should be revaluated every five years although if required management actions can be added or altered as required.

Potential contributors: All members of the proposed working group (TSO lead)

Statutory requirements

Update threatened species nomination

Action 5.1: Develop nomination to update the NCA status of the CYC and submit to the DES Species Technical Committee

Performance criteria: Species nomination for the CYC is submitted to the STC for consideration

Background, justification and methods

The status of the CYC is listed differently under the NCA and EPBC Act. The consistent listing under the NCA and EPBC Act will accurately identify the species extinction risk, which will assist in determining conservation priorities for conservation agencies. This alignment will also benefit any funding applications by demonstrating alignment in the species status.

As the Queensland Government has signed the Memorandum of Understanding between the states and Commonwealth Government for the Common Assessment Method, the proposed nomination to align the status between the NCA and EPBC Act needs to be submitted to the DES Species Technical Committee for assessment. If approved, it would be recommended to be developed into Conservation Advice and registered on the DAWE SPRAT database.

Conservation advice or recovery plans are used not only by stakeholders to implement recovery actions, but also other stakeholders in development applications. As the recovery plan for the CYC is out of date and Conservation Advice under the EPBC Act has not been prepared (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67090), the updated species nomination will assist in the species

recovery and assessing impacts associated with development.

Potential contributors: TSO, CQU

Conclusion

The CYC has a highly restricted distribution which is likely to pre-date European settlement (Houston et al. 2018b). The southern sub-populations are at greatest risk of extinction due to their population size (i.e. less than 30 pairs). However, greater conservation benefit could be realised from investment in the northern sub-population (Houston et al. 2018b). Most of northern and southern sub-populations are found on privately owned and managed pastoral or industrial properties, with only the Curtis Island population conserved in the QPWS reserve system. Investment in the conservation of the CYC will require continued engagement with, and good-will from these private landowners, with management actions delivered across the species entire distribution to conserve all sub-populations.

Due to the historic and current restricted range of the CYC (Houston et al. 2018a), recovery of the species such that it be downgraded from Critically Endangered to Endangered or Vulnerable is unlikely, due to difficulties in converting areas currently unsuitable for the CYC to be suitable habitat. Further, maintaining the CYC as Critically Endangered alone, provides many challenges when considering the management actions identified (Table 3) and challenges in funding these actions.

The CYC faces many threats (Table 2 Current threats and their level of impact to CYC sub-populations) many of which are multi-faceted. Key management actions have been identified along with their priority for implementation (Table 3) all of which contribute to the aim of maintaining the species current population size, distribution and status. The costs of implementing these management actions has not been identified as part of this project. The funding of all of these actions is unlikely to be realised as a single or on-going investment of funds due to the significant investment required to implement all actions and the competition for conservation funds in Australia more generally. By identifying actions without associated costs, stakeholders are able to source funds through various funding options to fulfil all or part of management actions identified, without being weighed down by the overarching costs for the ongoing survival of the CYC. Since the species rediscovery in the region (Houston et al. 2004a; Houston et al. 2004b; Jaensch et al. 2004), significant research about the species ecology and requirements for conservation has been undertaken. Despite this, further research of the species ecology and implications for management is required and research priorities have been identified in this report (Table 3) and will be invaluable in ensuring the conservation of the CYC. The importance of improving the ecological understanding of a species is essential to the development of effective management of threatened species (Pullin et al. 2004).

Finally, while not identified as a recovery action, the importance of engaging Aboriginal communities in threatened species recovery programs is becoming increasingly realised (Ens et al. 2015; Cullen-Unsworth et al. 2012) and is integral to the recovery of some threatened species in Australia (Read & Ward 2011). Opportunities to engage with Traditional owners through local Aboriginal corporations should be further investigated to improve conservation, cultural and social outcomes.

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