Australian Government
Department of Agriculture, Water and the Environment

Conservation Advice for *Erythrotriorchis radiatus* (red goshawk)

This draft document is being released for consultation on the species listing eligibility and conservation actions

The purpose of this consultation document is to elicit additional information to better understand the eligibility of the species for listing and inform conservation actions, further planning and the potential need for a Recovery Plan.

The draft assessment below should therefore be considered **tentative** at this stage, as it may change as a result of responses to this consultation process.

Note: Specific consultation questions relating to the below draft assessment and preliminary determination have been included in the consultation cover paper for your consideration.

This document combines the approved conservation advice and listing assessment for the species. It provides a foundation for conservation actions and further planning.

Female Red Goshawk (*Erythrotriorchis radiatus*) © Copyright, feathercollector (from Shutterstock)

Conservation status

Erythrotriorchis radiatus (red goshawk) is proposed to be transferred from the Vulnerable category to the Endangered category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999.*

Erythrotriorchis radiatus was assessed by the Threatened Species Scientific Committee to be eligible for listing as Endangered under criterion 3. The Committee's assessment is at Attachment A. The Committee's assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: Ineligible
- Criterion 2: Ineligible
- Criterion 3: C2a(ii): Endangered
- Criterion 4: D1: Ineligible
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Endangered category are that the population is estimated to be low (1,340 mature individuals in the wild) with a declining trend (high reliability), and all individuals exist in one subpopulation spread over an extremely large area (MacColl et al. 2021). Red goshawks were previously thought to exist in two large subpopulations (Garnett et al. 2011), however satellite tracking studies have revealed that the species' mobility is far greater than previously realised meaning there are no dispersal barriers (i.e. Gulf Plains) and just one interconnected subpopulation (MacColl et al. 2021).

Despite the capacity for large-scale movement, there has been a major contraction of the breeding range since 1980 (MacColl et al. 2021). The species' extent of occurrence (EOO) is currently estimated at 3,800,000 km^2 (range 3,300,000–4,600,000 km^2) and area of occupancy (AOO) at 134,000 km^2 (90,000–140,000 km^2; MacColl et al. 2021). Records indicate that both the EOO and AOO are continuing to contract (high reliability; MacColl et al. 2021).

Species can also be listed as threatened under state and territory legislation. For information on the current listing status of this species under relevant state or territory legislation, see the Species Profile and Threats Database.

Species information

Taxonomy

Conventionally accepted as *Erythrotriorchis radiatus* (Latham 1801).

Description

The red goshawk is a large, swift and powerful hawk, rufous-brown in colour, and growing to a length of 45–60 cm, with a wingspan of 100–135 cm. It is one of the most sexually dimorphic raptors in the world (Baker-Gabb 1984), with females (1100 g) nearly twice as heavy as males (630 g). Adult males are boldly mottled and streaked, with rufous scalloping on the back and upperwings, rufous underparts, bold bars on the underwings, and with large yellowish legs and feet (Marchant & Higgins 1993). Adult females are more powerfully built, paler and more heavily streaked below, and showing some white on the underbody. Juveniles have redder upperparts,

and the head and underparts are rich rufous with fine dark streaks. The rufous head of the juvenile distinguishes it from adults (Marchant & Higgins 1993).

The red goshawk is a solitary and secretive bird that is generally silent. Even when nesting, red goshawks are inconspicuous; they do not usually reveal themselves by flying off in alarm when approached (Aumann & Baker-Gabb 1991). Despite the differences between red goshawks and other raptors being well documented (for example Debus & Czechura 1988a), the species are difficult to distinguish.

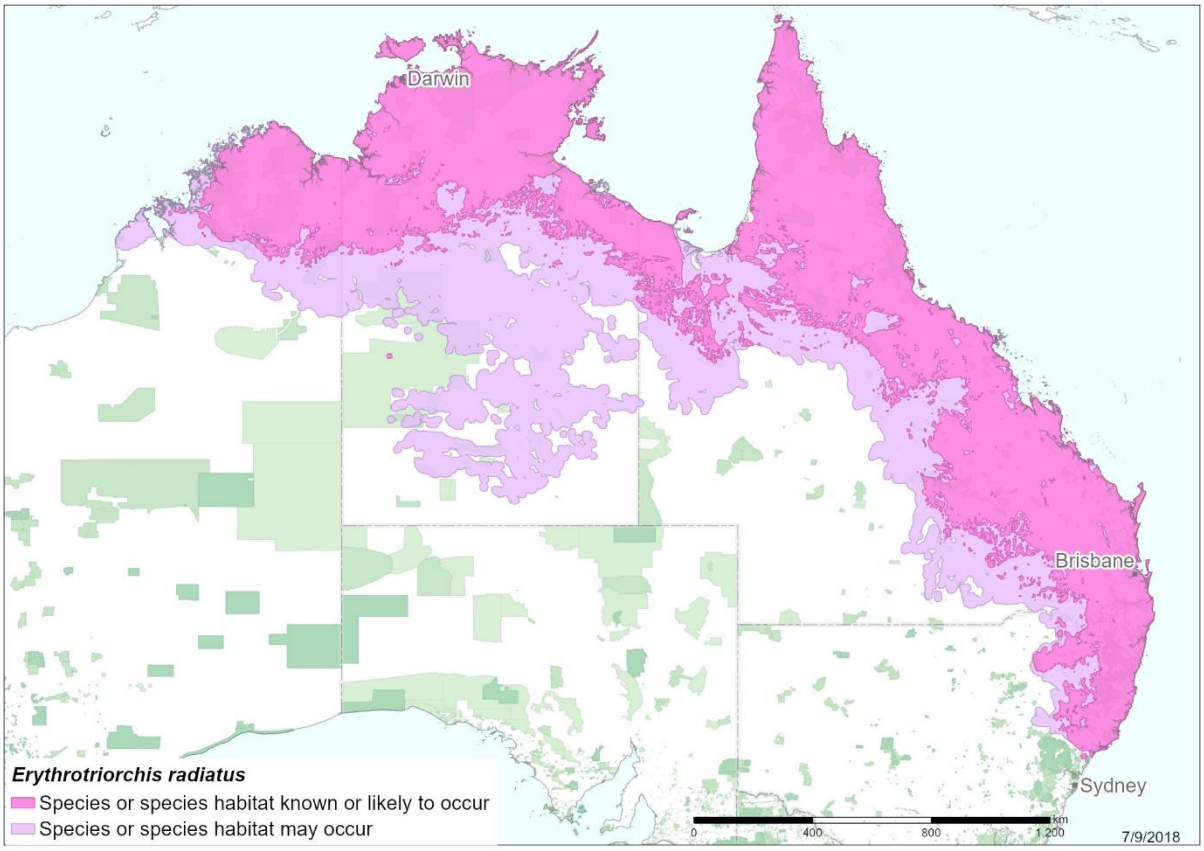
Distribution

Red goshawks are currently known to breed from the Kimberley east to Cape York Peninsula, and on the Tiwi Islands (MacColl et al. 2021). They may still breed at very low densities in the Wet Tropics and Einasleigh Uplands though record data are scarce (MacColl et al. 2021). Recorded birds from far outside the breeding range in central Australia (Aumann 2001) and the Pilbara (L Trotter pers. comm. cited in MacColl et al. 2021) likely include both dispersive juveniles (Aumann 2001) and seasonal migrants from further north. This is based on data from satellite-tagged adult females completing their non-breeding migration, which have covered distances of greater than 1000 km to more southerly non-breeding home ranges (MacColl et al. 2021).

The Gulf Plains bioregion, formerly viewed as a dispersal barrier, is now considered readily traversable (MacColl et al. 2021). The satellite tracked adults and juveniles from Queensland and the Northern Territory also soared to higher than 1000 m, suggesting the Tiwi Islands population is unlikely to be isolated by the narrow water barrier to the mainland (~27 km) (MacColl et al. 2021).

The breeding range of Red goshawks has significantly contracted since 1980. The species gradually declined to extinction in New South Wales over the 1980s and 1990s (Cooper et al. 2014) with populations in south-east Queensland largely disappearing before 2010 (Seaton 2014). Apart from the satellite tracked birds, records south of Cape York Peninsula over the last decade are increasingly scant, although some places where the species has been recorded historically (for example Shoalwater Bay) have not been surveyed recently (MacColl et al. 2021). Given the species wide ranging habits, inconspicuous nature, and difficulties with reliable field identification, its status in many regions outside northern Australia can be considered uncertain (C MacColl pers. comm. May 2022).

Map 1 Modelled distribution of red goshawk - *Please note this map is currently under revision following initial feedback from key stakeholders.*



Source: Base map Geoscience Australia; species distribution data Species of National Environmental Significance database.
Caveat: The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything contained herein.
Species distribution mapping: The species distribution mapping categories are indicative only and aim to capture (a) the habitat or geographic feature that represents to recent observed locations of the species (known to occur) or habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

Cultural and community significance

Red Goshawks occur on the lands of more than 50 Indigenous peoples (MacColl et al. 2021). The species is of cultural significance to Indigenous peoples on the Tiwi Islands, and the Lama Lama people on Cape York Peninsula (DERM 2012). Indigenous burning practices also help to maintain an open understorey below a canopy of large, widely-spaced trees (DERM 2012).

This statement of significance is not intended to be comprehensive, applicable to, or speak for, all Indigenous Australians and it is acknowledged that Indigenous groups and individuals are the custodians of this knowledge.

Relevant biology and ecology

Feeding ecology

The species inhabits coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers, and the edges of rainforests (Marchant & Higgins 1993).

Resident pairs of red goshawks prefer intact, extensive woodlands and forests with a mosaic of open vegetation types that are suitable for fast manoeuvring flight (Marchant & Higgins 1993). Favoured areas appear to contain permanent water, are relatively fertile and biologically rich, and support large populations of bird prey species. In partly cleared parts of eastern Queensland the species is associated with gorge and escarpment country (Czechura & Hobson 2000; Czechura et al. 2010). Wetlands also constitute important foraging habitat particularly during the winter months when birds begin to congregate as waterbodies begin to dry out.

Red goshawks hunt live prey with medium to large sized birds making up 95% of the species' diet; though birds also take mammals, reptiles and insects (Czechura & Hobson 2000). Males mostly capture birds the size of the rainbow lorikeet (*Trichoglossus haematodus*) and bar-shouldered dove (*Geopelia humeralis*), while females commonly kill birds the size of the red-tailed black-cockatoo (*Calyptorhynchus banksii*) and blue-winged kookaburra (*Dacelo leachii*) (Cupper & Cupper 1981; Aumann & Baker-Gabb 1991).. The species primarily captures its prey by short-stay perch hunting beneath the canopy but may also launch in a falcon-style stoop from high in the air.

Reproductive ecology

Red goshawks typically breed in trees >20 m tall (range 18.5–40.5 m) with an open limb and canopy structure (Aumann & Baker-Gabb 1991; Debus 2017; C MacColl pers. comm. May 2022), though there is anecdotal evidence of birds using trees 14 m in height (C MacColl pers. comm. May 2022). The height can be considered relative, within a given vegetation community red goshawks are known to select the tallest stands (Recovery Team pers. comms. 2022). These trees commonly occur in proximity to, or along, a watercourse or wetland (Debus 2017). The species rarely breeds in fragmented areas (Aumann & Baker-Gabb 1991; Czechura 2001), though on the Tiwi Islands, pairs have been observed nesting within roadside remnant forest and plantation buffers.

Research by Baker-Gabb (2013) demonstrated that breeding success declines when a threshold level of greater than 25% of forest is cleared within 4 km of nesting birds. Debus and Searle (2014) also suggest the removal of actual or potential nest trees is detrimental to their ongoing persistence in an area, particularly as they select for the tallest stands in a given area.

Red goshawks maintain the same territories (including nest sites) year after year by breeding pairs (Hollands 1984; Aumann & Baker-Gabb 1991). There can be multiple alternate nests used throughout the territory in successive breeding seasons, but they are typically within 200m of one another and sometimes >800m apart. Breeding generally occurs in spring in the south-east, with egg laying occurring from August to October (Debus & Czechura 1988b), and in the dry season May to October in the north (Aumann & Baker-Gabb 1991). Breeding activities are spread over many months; in north, courtship begins in April with the young not leaving their natal territory until the end of the year (Aumann and Baker-Gabb 1991).

A basket-shaped nest of sticks (approximately 0.5–1.2 m across) is constructed by the male, in which the female lays 1–2 eggs (Aumann & Baker-Gabb 1991). The female incubates the eggs for 39–43 days (Debus et al. 2015). During this period the red goshawk male does most of the food provisioning. The nestling period is 51–53+ days (Aumann & Baker-Gabb 1991). Fledged young are totally dependent on their parents for food for 25–30 days and at least partially dependent for another 40–50 days and may remain with their parents for 4–5 months (Aumann & Baker-

Gabb 1991). After breeding, some individuals move long distances and may occupy more inland open habitat areas (MacColl et al. 2021). The age at which red goshawks first breed is not well known, nor is the life expectancy. The generation length is estimated at 7.5 years (low reliability; Bird et al. 2020).

Movement patterns

Red goshawks are usually observed alone, but occasionally in pairs or family groups. Some pairs remain within the nesting territory year-round whilst some adult females are known to migrate from northern Australia to more southerly home ranges when not breeding (Aumann & Baker-Gabb 1991; Debus & Czechura 1988; MacColl et al. 2021). In the south-east of their range, some adults appeared to migrate down from the ranges to lowland winter territories (Czechura 1996, 1997). Juveniles may disperse widely and are probably responsible for the bulk of the sightings outside the core breeding areas (Debus & Czechura 1988b).

As is common among large bird-eating raptors (Newton 1979), red goshawks have large home ranges and occur at low densities. Tracking of two adult red goshawks fitted with radio-transmitters established that the female flew 5–7 km from the nest and the male 7–10 km during the critical phases of the breeding season (i.e. whilst provisioning young). The breeding home range was determined to be 120 km^2 and 200 km^2 respectively (Aumann & Baker-Gabb 1991). Czechura (1996) recorded red goshawks flying 6–10 km to hunting areas. Recent satellite tracking studies have also shown red goshawks travelling distances over 1500 km and soaring to heights of >1000 m (MacColl et al. 2021).

Habitat critical to the survival

Habitat critical to the survival or important areas of habitat of a species or ecological community refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long-term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Due to a small population size, all foraging and breeding habitat is considered critical to the survival of the species. Red goshawks naturally occur at low densities and require tracts of relatively intact and biodiverse land for hunting and nesting. Habitat critical to the survival of the red goshawks includes:

- *Foraging habitat:*
  - Coastal and subcoastal tall open forests and woodlands;
  - Tropical savannas traversed by wooded or forested creeks and rivers;
  - Freshwater wetlands and their margins; and
  - Edges of rainforest.
- *Breeding habitat:*

- Areas with large, tall trees (>14 m) within proximity to a watercourse (within 2.5 km), that occur within foraging habitat. Particularly important breeding habitat includes:
  - Riparian vegetation supporting tall stands of remnant paperbark trees (Melaleuca sp.) with horizontal limbs along watercourses.
  - Tall dry woodlands in proximity to watercourses with Darwin strinybark (*Eucalyptus tetrodonta*) dominated woodlands the primary breeding habitat across northern Australia.
- These breeding habitats are often found in areas of topographic ruggedness such as plateaus or gorges where breeding can occur on elevated country in dry woodlands or on lower creek systems.

Any breeding or foraging habitat in areas where the species is known or likely to occur (as defined by the distribution map provided in Map 1) and any newly discovered breeding or foraging locations should be considered habitat critical to the survival. Areas that are not currently occupied by the species, but which may become suitable in the future, should also be considered habitat critical to survival.

No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat.

Key considerations in environmental impact assessments

Habitat critical to the survival of the red goshawk occurs in a wide range of land tenure arrangements, including on private land, nature reserves, state forests and National Parks (including Kakadu National Park World Heritage Area). It is essential that the highest level of protection is provided to these areas, with targeted management of critical habitat.

When considering habitat loss, alteration or degradation of habitat in any part of the red goshawk's range, including in areas where the species 'may occur', surveys for occupancy and identifying suitable habitat remain an important tool in refining understanding of the area's relative importance for the red goshawk. Areas that are not currently occupied by the species, but which may become suitable in the future, should also be considered habitat critical to survival. Their pattern of habitat use means that both recent survey data and historical records need to be considered when assessing the relative importance of a local area or region for red goshawks.

Habitat critical to the survival of the species must not be destroyed or degraded. Actions that have indirect negative impacts on habitat critical to the survival must be minimised and adequately mitigated. Actions that compromise adult and juvenile survival must also be avoided, for example, the transmission and introduction of diseases. Actions must not be assessed in isolation and consideration must be given to existing and future activities that may impact the species to ensure conservation outcomes on a landscape scale are achieved.

Threats

The main threats causing the decline of the red goshawk are extensive habitat loss, degradation, and fragmentation. Land clearing for agriculture, forestry and mining are the major known threats to the species (DERM 2012). Since 2000, the red goshawk has lost approximately 3 million hectares of its known and potential habitat (Ward et al. 2019). Clearance of habitat for agricultural and urban development is associated with declines of the species in New South

Wales and southern Queensland (Czechura & Hobson 2000; Czechura et al. 2011). Draining of wetlands has also been linked to decreased red goshawk abundance (for example, the Macquarie Marshes, NSW, in the period 1951–1956; Len Harvey pers. comm. cited in MacColl et al. 2021). On Melville Island (the larger of the two main Tiwi Islands), breeding success was reduced when more than 25% of forest and woodland was cleared for forestry within 4 km of nest sites (DERM 2012). No native vegetation clearing has occurred since 2008 with many of the monitored nests having been built in native vegetation along roads or firebreaks adjacent to plantations (S Ryan unpublished cited in MacColl et al. 2021).

Altered fire regimes also affect the availability of prey because woodland thickening impedes hunting efficiency (Czechura & Hobson 2000; Czechura et al. 2011; DERM 2012). Other threats that may impact the species include: genetic bottlenecks, secondary poisoning, illegal egg collecting and Psittacine Beak and Feather Disease (PBFD) (DERM 2012).

Table 1 Threats to red goshawk

Threats in Table 1 are noted in approximate order of highest to lowest impact, based on available evidence.

Threat	Status [a]	Evidence
Habitat loss, disturbance and modifications impacts		
Land clearing and fragmentation	• Timing: historical, current & future • Confidence: observed • Likelihood: almost certain • Consequence: major • Trend: increasing • Extent: across part of its range	Habitat loss is the biggest threat to the species (ACF 2020; MacColl et al. 2021). Red goshawk foraging and breeding habitat have been impacted by the historic and ongoing clearing and fragmentation of native forests and woodlands for agriculture (Hollands 1984; Debus & Czechura 1988; Aumann & Baker-Gabb 1991; Debus 1993; Czechura 1996; Czechura & Hobson 2000; MacColl et al. 2021), forestry (Baker-Gabb 2009; Woinarski et al. 2003; Woinarski et al. 2007), mining and urbanisation (ACF 2020). This is especially evident on the east coast. Widespread deforestation, particularly of lowland and riverine forests has caused the species to decline in NSW and Queensland, and will impact the northern part of the range as clearing continues and previously intact habitat is fragmented by greenfields development (ACF 2020). Nests are particularly vulnerable to habitat clearing as red goshawks usually nest in the tallest trees, which are exposed to storm damage and other disturbance when surrounding vegetation is removed. Red goshawk declines have occurred due to forestry operations, particularly on Melville Island, Northern Territory (Woinarski et al. 2003; Woinarski et al. 2007). A study by Baker-Gabb (2009) found that forest clearing on the Tiwi Islands that removed more than 25% of hunting habitat within 4 km of nests had a significant impact on nesting success by reducing the output of fledged young, even

Threat	Status [a]	Evidence
		though it had little impact on the occupation of territories. Disturbance of habitat, particularly breeding habitat resulting in breeding failure, from forestry activities threatens the species. Nests are particularly vulnerable as they are usually found in the tallest trees, which are typically the most valuable for timber (DERM 2012). Additionally, nearly 15,000 ha of red goshawk habitat has been destroyed in urban areas between 2000 to 2017 (ACF 2020). Red goshawks are impacted from activities such as housing developments and the associated infrastructure; or increased human disturbance (for example noise from traffic). Ongoing clearing of coastal forests for urban development in eastern Australia will reduce numbers further unless critical habitat is protected and restored (ACF 2020). This is a threatening process also developing in areas of northern Australia which supports tall forests subject to broad-scale clearing for bauxite mining developments such as western Cape York Peninsula.
Habitat loss and degradation through the draining of wetlands	• Timing: historical, current & future • Confidence: estimated • Likelihood: possible • Consequence: moderate • Trend: unknown • Extent: across part of its range	Since European settlement, there has been extensive degradation and/or clearing of native ecosystems for agriculture and urbanisation (Findlayson & Rea 1999). This has ultimately led to the loss of natural wetlands across much of Australia. Given that the presence of permanent fresh water is an essential component of red goshawk habitat, the degradation of rivers and wetlands utilised by potential prey species of the red goshawk may reduce prey availability, impacting foraging and breeding success (Czechura 1996; Czechura & Hobson 2000).
Habitat degradation caused by domestic livestock grazing	• Timing: historical, current & future • Confidence: suspected • Likelihood: likely • Consequence: moderate • Trend: unknown • Extent: across part of its range	Native tree and shrub seedlings are highly susceptible to domestic livestock grazing. Unlike native herbivores, most domestic stock are hard-hoofed and cause significantly more damage to soil structure from compaction, and damage to native plants by trampling (Willson & Bignall 2009). This can lead to a reduction or removal of understorey habitat which can reduce the abundance of red goshawk prey. Impacts to riparian vegetation has been observed in the Kimberley region leading to the decline of the Purple-crowned Fairy-wren (*Malurus coronatus*). This is critical breeding habitat for the Red Goshawk in that region and other rangeland areas, therefore degradation of these systems poses a high risk to the species persistence there.
Fire		

Threat	**Status** [a]	**Evidence**
Fire regimes that cause biodiversity decline	• Timing: current & future • Confidence: suspected • Likelihood: likely • Consequence: major • Trend: increasing • Extent: across part of its range	Inappropriate fire regimes on mainland northern Australia may have changed habitat structure, impacting the availability of the red goshawk's prey species (MacColl et al. 2021). For example, reduced fire frequencies (for example, due to loss of cultural burning or inappropriate burning seasonality) has led to vegetation thickening across some parts of the savannahs of the species' range, which would likely impede the species' ability to forage as birds require a canopy of large widely-spaced trees and an open understorey to hunt (DERM 2012). Conversely, too intense fires can also destroy nesting trees and/or reduce breeding success as nests can be abandoned or nestlings killed in the nest by canopy fires (DERM 2012; Aumann & Baker-Gabb 1991).
Climate change		
Increased likelihood of extreme weather events (e.g., heatwave, and drought)	• Timing: current & future • Confidence: known • Likelihood: possible • Consequence: unknown • Trend: increasing • Extent: across part of its range	Since 1950, the number of record hot days (above 35°C) across Australia has more than doubled and the mean temperature has increased by about 1.4°C since 1910 (BOM & CSIRO 2020; IPCC 2021). Heatwaves are also lasting longer, reaching more extreme maximum temperatures, and occurring more frequently over many regions of Australia, including south-eastern Australia (Perkins-Kirkpatrick et al. 2016; Evans et al. 2017; Herold et al. 2018; BOM & CSIRO 2020). Heatwaves also exacerbate drought, which in turn can also increase bushfire risk (Climate Council 2014) and adversely impact resource availability (BOM & CSIRO 2020). Birds are also vulnerable to extreme heatwaves that overwhelm their physiological limits (McKechnie et al. 2012). It is not fully known how these weather events, or the cumulative effect of these weather events, affect red goshawk survival, reproduction and its habitat. However, storm activity is known to have collapsed nests in northern Australia causing breeding failures at the egg stage (C MacColl pers. comms. May 2022). The precautionary principle should be applied to ensure suitable quality and quantity of habitat is conserved across the species' known and suspected range.
Poisoning		
Secondary poisoning	• Timing: current & future • Confidence: inferred • Likelihood: likely • Consequence: moderate • Trend: unknown • Extent: across part of its range	Use of persistent pesticides (for example organophosphates, organochlorine or rodenticide products) may result in pesticide contamination of prey species and cause secondary poisoning of red goshawks (Debus 2012). For example, the red goshawk is likely susceptible to secondary poisoning from rodenticides if it

Threat	Status [a]	Evidence
		consumes the flesh of another animal that has ingested a poison (Debus 2012). Other chemicals such as DDT likely threatened the species in the past, impacting eggshell thickness and breeding success (as inferred by studies on grey falcon *Falco hypoleucos*; Olsen 1993). However DDT has now been banned in Australia. The impact of newer chemicals on red goshawks are not known.
Disease		
Psittacine Beak and Feather Disease (PBFD)	• Status: current • Confidence: known • Consequence: unknown • Trend: unknown • Extent: unknown	PBFD is a widespread, lethal disease, typically transferring between adults, nestlings and contaminated nest hollows (DEE 2016). Typically associated with parrots, raptors are susceptible to PBFD (Raidal & Peters 2018). A recent analysis of a dead red goshawk chick found under a nest in Cape York by C MacColl (pers. comm. 2022) tested positive for PBFD, however it is not known how PBFD impacts red goshawk survival at a population level. Further research on the impact of the disease on the species is warranted.

[a]Timing—identifies the temporal nature of the threat
Confidence—identifies the nature of the evidence about the impact of the threat on the species
Likelihood—identifies the likelihood of the threat impacting on the whole population or extent of the species
Consequence—identifies the severity of the threat
Trend—identifies the extent to which it will continue to operate on the species
Extent—identifies its spatial context in terms of the range of the species

Categories for likelihood are defined as follows:
Almost certain – expected to occur every year
Likely – expected to occur at least once every five years
Possible – might occur at some time
Unlikely – known to have occurred only a few times
Unknown – currently unknown how often the threat will occur
Categories for consequences are defined as follows:
Not significant – no long-term effect on individuals or populations
Minor – individuals are adversely affected but no effect at population level
Moderate – population recovery stable or declining
Major – population decline is ongoing
Catastrophic – population trajectory close to extinction

Each threat has been described in Table 1 in terms of the extent that it is operating on the species. The risk matrix provides a visual depiction of the level of risk being imposed by a threat and supports the prioritisation of subsequent management and conservation actions. In preparing a risk matrix, several factors have been taken into consideration, they are: the life stage they affect; the duration of the impact; the spatial extent, and the efficacy of current management regimes, assuming that management will continue to be applied appropriately. The risk matrix and ranking of threats has been developed using available literature.

Table 2 Risk Matrix for red goshawk

Likelihood	Consequences				
	Not significant	Minor	Moderate	Major	Catastrophic
Almost certain		Increased likelihood of extreme weather events (e.g. heatwave, and drought)			
Likely		Habitat loss through draining and degradation of wetlands Habitat loss caused by rural and residential development	Habitat degradation caused by domestic livestock grazing	Land clearing and fragmentation Fire regimes that cause biodiversity decline	
Possible		Secondary poisoning Psittacine Beak and Feather Disease (PBFD)			
Unlikely					
Unknown					

Risk Matrix legend/Risk rating:

Low Risk	Moderate Risk	High Risk	Very High Risk

Priority actions have then been developed to manage the threats, particularly where the risk was deemed to be 'very high' (red shading) or 'high' (orange shading). For those threats with an unknown or low risk (blue and green shading respectively) research and monitoring actions have been developed to understand and evaluate the impact of the threats, where appropriate.

Conservation and recovery actions

Primary conservation objectives

- By 2032, the population size of the red goshawk has increased across the species' range.
- By 2032, the area of occupancy of the red goshawk has increased.

Conservation and management priorities

Land clearing and fragmentation

- Rehabilitate known breeding habitat of red goshawks (e.g., restoring forests that could become habitat in several decades).
- Ensure forestry management plans in Queensland and the Northern Territory are updated to ensure that:
  - Known red goshawk habitat is protected from logging practices that negatively impact the species.
  - Disturbance is minimised in areas where the red goshawk is known to breed and

  - Nesting habitat is maintained in parts of production forest considered important for raptors including the retention of adequate tall trees suitable for breeding by the red goshawk.

Fire regimes that cause biodiversity decline

- Implement fire management regimes that maintain habitat structure in areas supporting breeding populations, particularly:
  - Protection burns along waterways and wetlands to safeguard riparian vegetation especially tall remnant stands of paperbarks (Melaleuca sp.).
  - Maintaining open and semi-open woodlands from woody vegetation encroachment through regular though periodic burning.
- Implement fire management regimes that reduce the risk of late season wildfires which may incinerate nesting trees and vulnerable young.

Habitat degradation caused by domestic livestock grazing

- Prevent intensive grazing in high value breeding habitats.
- Modify grazing management practices that will maintain or improve habitat values and still allow some grazing to occur at strategic times of the year.

Stakeholder engagement/community engagement

- Raise awareness among landholders through in areas known to have important habitat for the red goshawk, to engage them in proactive management and monitoring of any red goshawks on their land.
- Raise the profile of the species and its important areas of habitat with landholders and generate awareness of impacts of grazing regimes that trample native vegetation and reduce the prey available to the red goshawk.
- Promote and incentivise land management practices that produce, enhance and/or increase the extent of red goshawk habitat and implement appropriate fire regimes, such as mosaic burning, on public and private land.
- Build strong collaboration with Aboriginal communities to develop a broader understanding of the cultural significance of the red goshawk to inform recovery actions.
- Target the development of in-perpetuity covenants or stewardship agreements to landholders with high quality forest and woodland habitat near watercourses.

Survey and monitoring priorities

- Encourage the public to report any records of red goshawks (particularly of nesting birds) to relevant state government agencies.
- Locate, monitor and protect known nesting sites and birds. However, note that the location of all sites should remain confidential to ensure the sites are not then exposed to other threats, such as egg collecting.
- Analyse red goshawk occurrence records over time to determine population trends and geographic range shift at regional, state, and national scale

- Determine the species' spatial ecology including its habitat selections and environmental requirements (e.g. using satellite-telemetry with high spatial and temporal resolution).
- Quantify productivity/breeding rates at red goshawk nests across northern Australia over multiple seasons so that threats to population recruitment can be assessed now and in the future.
- Monitor nest success and productivity at nest sites within disturbance landscapes to determine tolerance thresholds and associated land-use planning design (e.g. protection buffer sizes, connected corridors, habitat availability, etc)
- Monitor the progress of species recovery, including the effectiveness of current management arrangements and the need to adapt them if necessary.

Information and research priorities

- Refine and update the species distribution map and its ecological context (e.g. breeding range, juvenile dispersion, migration pathways, etc)
- Characterise habitat critical to the survival of the red goshawk particularly breeding habitat requirements, including Critical Habitat as defined under section 207A of the EPBC Act and include the area defined in the Register of Critical Habitat.
- Identify important populations across the species range based on breeding densities (through in-fill surveys where needed) and availability of critical habitats
- Develop a better understanding of how habitat changes (e.g. through clearing, fire regimes, restoration) and degradation (e.g. through grazing pressure) effects the prey populations (species composition, diversity, and abundance) needed to support Red Goshawks
- Support Aboriginal communities to research, revive and document (where culturally appropriate) their connections, knowledge and land management practices and stories.
- Determine the impact of pesticides and poisons (for example, organophosphates, organochlorines and rodenticides) on the red goshawk.
- Determine the potential impact of PBFD on red goshawk breeding success and survival.

Links to relevant implementation documents

- Department of Environment and Resource Management (2012). National recovery plan for the red goshawk Erythrotriorchis radiatus. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra. Queensland Department of Environment and Resource Management, Brisbane.
- New South Wales Government Department of red goshawk species profile.
- Northern Territory Government Department of Environment, Parks and Water Security red goshawk species profile.

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Attachment A: Listing Assessment for *Erythrotriorchis radiatus*

Reason for assessment

This assessment follows prioritisation of a nomination from the TSSC.

Assessment of eligibility for listing

This assessment uses the criteria set out in the EPBC Regulations. The thresholds used correspond with those in the IUCN Red List criteria except where noted in criterion 4, sub-criterion D2. The IUCN criteria are used by Australian jurisdictions to achieve consistent listing assessments through the Common Assessment Method (CAM).

Key assessment parameters

Table 3 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria. The definition of each of the parameters follows the Guidelines for Using the IUCN Red List Categories and Criteria.

Table 3 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	1,340	900	1,400	Because of its rarity, it is difficult to estimate the size of the red goshawk population anywhere within the species' range. There were estimated to be 700 pairs of red goshawks in 2012 (including 100 pairs on the Tiwi Islands; DERM 2012). Of these, 10–30 pairs that once occurred in south eastern Queensland (DERM 2012) appear no longer to be present (Seaton 2014). The reliability of these estimates is low (S Garnett pers. comm. 2022)
Trend	Declining			High reliability (MacColl et al. 2021).
Generation time (years)	7.5	5.6	9.4	Low reliability (Bird et al. 2020).
Extent of occurrence	3,800,000 km^2	3,300,000 km^2	4,600,000 km^2	The EOO is based on all records since 1990 (MacColl et al. 2021).
Trend	Contracting			High reliability (MacColl et al. 2021).
Area of Occupancy	134,000 km^2	90,000 km^2	140,000 km^2	The minimum AOO is the number of 2 x 2 km squares that includes all records from 1990 (S Garnett pers. comm. 2022).
AOO is a standardised spatial measure of the risk of extinction, that represents the area of suitable habitat known, inferred or projected to be currently occupied by the taxon. It is estimated using a 2 x 2 km grid to enable comparison with the criteria thresholds. The resolution (grid size) that maximizes the correlation between AOO and extinction risk is determined more by the spatial scale of threats than by the spatial scale at which AOO is estimated or shape of the taxon's distribution. It is not a fine-scale estimate of the actual area occupied. In some cases, AOO is the smallest area essential at any stage to the survival of existing populations of a taxon (for example breeding sites for migratory species).				

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	Contracting			High reliability (MacColl et al. 2021).
Number of subpopulations	1	1	3	Species experts now agree that there is likely one single population comprising 100% of the mature individuals, as the Gulf Plains bioregion, formerly viewed as a dispersal barrier, is now considered surmountable by the species based on satellite tracking data (MacColl et al. 2021). Satellite tracking also revealed adults and juveniles from the Northern Territory and Queensland soared above 1000 m, suggesting the Tiwi Islands population is also unlikely to be isolated by the narrow water barrier to the mainland (~27 km) (MacColl et al. 2021).
Trend	Stable			High reliability (MacColl et al. 2021).
Basis of assessment of subpopulation number	It was previously thought that the Gulf of Carpentaria split mainland and Tiwi Island populations , but tracking studies suggest otherwise (MacColl et al. 2021).			
No. locations	>10			MacColl (et al. 2021).
Trend	Not calculated			
Basis of assessment of location number	The number of locations was calculated based on the most serious plausible threat – land clearing and fragmentation. The spatial nature of the land clearing is such that there are more than 10 geographically or ecologically distinct areas where a single threatening event would not affect all individuals of the species within one generation (MacColl et al. 2021).			
Fragmentation	Not severely fragmented (MacColl et al. 2021).			
Fluctuations	Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals (MacColl et al. 2021).			

Criterion 1 Population size reduction

Reduction in total numbers (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered **Very severe reduction**	**Endangered** **Severe reduction**	**Vulnerable** **Substantial reduction**
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%

A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.

A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [*(a) cannot be used for A3*]

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

Based on any of the following

(a) direct observation [except A3]

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Criterion 1 evidence

Not eligible

There are estimated to be 1,340 (range 900–1,400) mature red goshawks in the wild with a declining trend, and the EOO and AOO are continuing to contract (MacColl et al. 2021). Although there is evidence of a substantial range contraction over several decades, a population decline approaching 30% is not likely over three generations (22 years; Bird et al. 2020; MacColl et al. 2021).

The data presented above appear to demonstrate the species is **not eligible** for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 2 Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy

		Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1.	Extent of occurrence (EOO)	**< 100 km²**	**< 5,000 km²**	**< 20,000 km²**
B2.	Area of occupancy (AOO)	**< 10 km²**	**< 500 km²**	**< 2,000 km²**
AND at least 2 of the following 3 conditions:				
(a)	Severely fragmented OR Number of locations	**= 1**	**≤ 5**	**≤ 10**
(b)	Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c)	Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Criterion 2 evidence

Not eligible

MacColl et al. (2021) estimated the red goshawk EOO to be 3,800,000 km² (range 3,300,000–4,600,000 km²; high reliability) and the AOO to be 134,000 km² (range 90,000–140,000 km²; low reliability). Both the EOO and AOO have contracting trends (high reliability) (MacColl et al. 2021), but neither the EOO or AOO are close to the upper threshold for a Vulnerable listing.

The data presented above appear to demonstrate the species is **not eligible** for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 3 Population size and decline

		Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals		**< 250**	**< 2,500**	**< 10,000**
AND either (C1) or (C2) is true				
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)		**Very high rate 25% in 3 years or 1 generation (whichever is longer)**	**High rate 20% in 5 years or 2 generation (whichever is longer)**	**Substantial rate 10% in 10 years or 3 generations (whichever is longer)**
C2. An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:				
(a)	(i) Number of mature individuals in each subpopulation	**≤ 50**	**≤ 250**	**≤ 1,000**
	(ii) % of mature individuals in one subpopulation =	**90 – 100%**	**95 – 100%**	**100%**
(b) Extreme fluctuations in the number of mature individuals				

Criterion 3 evidence

Eligible under Criterion 3 C2a(ii) for listing as Endangered

There are currently estimated to be 1,340 (range 900–1,400) mature red goshawks in the wild with a declining trend (high reliability; MacColl et al. 2021). A continuing population decline is projected (MacColl et al. 2021) as the main threat of land clearing and fragmentation have not ceased. Other threats such as inappropriate fire regimes, draining of wetlands, rural and residential development, domestic livestock grazing, and climate change also continue to remove and degrade breeding habitat (DERM 2012; MacColl et al. 2022). Red goshawks occur as a single panmictic population based on satellite tracking studies (MacColl et al. 2022). The species is not subject to extreme fluctuations in the number of mature individuals (MacColl et al. 2022).

The data presented above appear to demonstrate the species is eligible for listing as **Endangered** under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 4 Number of mature individuals

	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
D. Number of mature individuals	< 50	< 250	< 1,000
D2.[1] *Only applies to the Vulnerable category* Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time			D2. Typically: area of occupancy < 20 km² or number of locations ≤ 5

[1] The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments may include information relevant to D2. This information will not be considered by the Committee in making its recommendation of the species' eligibility for listing under the EPBC Act, but may assist other jurisdictions to adopt the assessment outcome under the *common assessment method*.

Criterion 4 evidence

Not eligible

There are estimated to be 1,340 (range 900–1,400) mature red goshawks in the wild (MacColl et al. 2021) which is not considered extremely low, very low or low. Although this estimate has low reliability it is unlikely that the total population size is fewer than 1,000 individuals.

The data presented above appear to demonstrate the species is **not eligible** for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 5 Quantitative analysis

	Critically Endangered Immediate future	Endangered Near future	Vulnerable Medium-term future
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

Criterion 5 evidence

Insufficient data to determine eligibility

Population viability analysis appears not to have been undertaken for the entire population of red goshawks. Therefore, there are insufficient data to demonstrate if the species is eligible for

listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Adequacy of survey

The survey effort has been considered adequate and there is sufficient scientific evidence to support the assessment.

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Agriculture, Water and the Environment 2022, *Conservation Advice for Erythrotriorchis radiatus* (red goshawk), Canberra. 

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